

COLOUR

Colour Documentation

Release 0.4.2

Colour Developers

Apr 08, 2023

CONTENTS

| | |
|---|-------------|
| 1 2 Sponsors | 3 |
| 2 3 Features | 5 |
| 2.1 3.1 Automatic Colour Conversion Graph - <code>colour.graph</code> | 5 |
| 2.2 3.2 Chromatic Adaptation - <code>colour.adaptation</code> | 7 |
| 2.3 3.3 Algebra - <code>colour.algebra</code> | 7 |
| 2.4 3.4 Colour Appearance Models - <code>colour.appearance</code> | 7 |
| 2.5 3.5 Colour Blindness - <code>colour.blindness</code> | 8 |
| 2.6 3.6 Colour Correction - <code>colour.characterisation</code> | 8 |
| 2.7 3.7 ACES Input Transform - <code>colour.characterisation</code> | 9 |
| 2.8 3.8 Colorimetry - <code>colour.colorimetry</code> | 9 |
| 2.9 3.9 Contrast Sensitivity Function - <code>colour.contrast</code> | 13 |
| 2.10 3.10 Colour Difference - <code>colour.difference</code> | 13 |
| 2.11 3.11 IO - <code>colour.io</code> | 14 |
| 2.12 3.12 Colour Models - <code>colour.models</code> | 14 |
| 2.13 3.13 Colour Notation Systems - <code>colour.notation</code> | 23 |
| 2.14 3.14 Optical Phenomena - <code>colour.phenomena</code> | 24 |
| 2.15 3.15 Light Quality - <code>colour.quality</code> | 24 |
| 2.16 3.16 Spectral Up-Sampling & Recovery - <code>colour.recovery</code> | 25 |
| 2.17 3.17 Correlated Colour Temperature Computation Methods - <code>colour.temperature</code> | 26 |
| 2.18 3.18 Colour Volume - <code>colour.volume</code> | 27 |
| 2.19 3.19 Geometry Primitives Generation - <code>colour.geometry</code> | 27 |
| 2.20 3.20 Plotting - <code>colour.plotting</code> | 27 |
| 3 4 User Guide | 41 |
| 3.1 User Guide | 41 |
| 4 5 API Reference | 81 |
| 4.1 API Reference | 81 |
| 5 6 See Also | 1223 |
| 5.1 6.1 Software | 1223 |
| 6 7 Code of Conduct | 1225 |
| 7 8 Contact & Social | 1227 |
| 8 9 About | 1229 |
| Bibliography | 1231 |
| Index | 1249 |



Colour is an open-source [Python](#) package providing a comprehensive number of algorithms and datasets for colour science.

It is freely available under the [New BSD License](#) terms.

Colour is an affiliated project of [NumFOCUS](#), a 501(c)(3) nonprofit in the United States.

The draft release notes from the [develop](#) branch are available at this [url](#).

2 SPONSORS

We are grateful for the support of our [sponsors](#). If you'd like to join them, please consider [becoming a sponsor on OpenCollective](#).

3 FEATURES

Most of the objects are available from the `colour` namespace:

```
>>> import colour
```

2.1 3.1 Automatic Colour Conversion Graph - `colour.graph`

Starting with version *0.3.14*, **Colour** implements an automatic colour conversion graph enabling easier colour conversions.

(continued from previous page)

```
...     "Spectral Distribution",
...     "sRGB",
...     sd_to_XYZ={"illuminant": illuminant},
... )
array([ 0.47924575,  0.31676968,  0.17362725])
```

2.2 3.2 Chromatic Adaptation - colour.adaptation

```
>>> XYZ = [0.20654008, 0.12197225, 0.05136952]
>>> D65 = colour.CCS_ILLUMINANTS["CIE 1931 2 Degree Standard Observer"]["D65"]
...
... ]
>>> A = colour.CCS_ILLUMINANTS["CIE 1931 2 Degree Standard Observer"]["A"]
>>> colour.chromatic_adaptation(
...     XYZ, colour.xy_to_XYZ(D65), colour.xy_to_XYZ(A)
... )
array([ 0.2533053 ,  0.13765138,  0.01543307])
>>> sorted(colour.CHROMATIC_ADAPTATION_METHODS)
['CIE 1994', 'CMCCAT2000', 'Fairchild 1990', 'Von Kries', 'Zhai 2018']
```

2.3 3.3 Algebra - colour.algebra

2.3.1 3.3.1 Kernel Interpolation

```
>>> y = [5.9200, 9.3700, 10.8135, 4.5100, 69.5900, 27.8007, 86.0500]
>>> x = range(len(y))
>>> colour.KernelInterpolator(x, y)([0.25, 0.75, 5.50])
array([ 6.18062083,  8.08238488, 57.85783403])
```

2.3.2 3.3.2 Sprague (1880) Interpolation

```
>>> y = [5.9200, 9.3700, 10.8135, 4.5100, 69.5900, 27.8007, 86.0500]
>>> x = range(len(y))
>>> colour.SpragueInterpolator(x, y)([0.25, 0.75, 5.50])
array([ 6.72951612,  7.81406251, 43.77379185])
```

2.4 3.4 Colour Appearance Models - colour.appearance

```
>>> XYZ = [0.20654008 * 100, 0.12197225 * 100, 0.05136952 * 100]
>>> XYZ_w = [95.05, 100.00, 108.88]
>>> L_A = 318.31
>>> Y_b = 20.0
>>> colour.XYZ_to_CIECAM02(XYZ, XYZ_w, L_A, Y_b)
CAM_Specification_CIECAM02(J=34.434525727858997, C=67.365010921125943, h=22.
↳ 279164147957065, s=62.81485585332716, Q=177.47124941102123, M=70.024939419291414, H=2.
↳ 6896085344238898, HC=None)
```

(continues on next page)

(continued from previous page)

```
>>> colour.XYZ_to_CIECAM16(XYZ, XYZ_w, L_A, Y_b)
CAM_Specification_CIECAM16(J=34.434525727858997, C=67.365010921125943, h=22.
↳ 279164147957065, s=62.81485585332716, Q=177.47124941102123, M=70.024939419291414, H=2.
↳ 6896085344238898, HC=None)
>>> colour.XYZ_to_CAM16(XYZ, XYZ_w, L_A, Y_b)
CAM_Specification_CAM16(J=33.880368498111686, C=69.444353357408033, h=19.510887327451748,
↳ s=64.03612114840314, Q=176.03752758512178, M=72.18638534116765, H=399.52975599115319,
↳ HC=None)
>>> colour.XYZ_to_Hellwig2022(XYZ, XYZ_w, L_A)
CAM_Specification_Hellwig2022(J=33.880368498111686, C=40.347043294550311, h=19.
↳ 510887327451748, s=117.38555017188679, Q=45.34489577734751, M=53.228355383108031, H=399.
↳ 52975599115319, HC=None)
>>> colour.XYZ_to_Kim2009(XYZ, XYZ_w, L_A)
CAM_Specification_Kim2009(J=19.879918542450902, C=55.839055250876946, h=22.
↳ 013388165090046, s=112.97979354939129, Q=36.309026130161449, M=46.346415858227864, H=2.
↳ 3543198369639931, HC=None)
>>> colour.XYZ_to_ZCAM(XYZ, XYZ_w, L_A, Y_b)
CAM_Specification_ZCAM(J=38.347186278956357, C=21.12138989208518, h=33.711578931095197,
↳ s=81.444585609489536, Q=76.986725284523772, M=42.403805833900506, H=0.45779200212219573,
↳ HC=None, V=43.623590687423544, K=43.20894953152817, W=34.829588380192149)
```

2.5 3.5 Colour Blindness - colour.blindness

```
>>> import numpy as np
>>> cmfs = colour.LMS_CMFS["Stockman & Sharpe 2 Degree Cone Fundamentals"]
>>> colour.msds_cmfs_anomalous_trichromacy_Machado2009(
...     cmfs, np.array([15, 0, 0])
... )[450]
array([ 0.08912884,  0.0870524 ,  0.955393  ])
>>> primaries = colour.MSDS_DISPLAY_PRIMARIES["Apple Studio Display"]
>>> d_LMS = (15, 0, 0)
>>> colour.matrix_anomalous_trichromacy_Machado2009(cmfs, primaries, d_LMS)
array([[ -0.27774652,  2.65150084, -1.37375432],
       [ 0.27189369,  0.20047862,  0.52762768],
       [ 0.00644047,  0.25921579,  0.73434374]])
```

2.6 3.6 Colour Correction - colour.characterisation

```
>>> import numpy as np
>>> RGB = [0.17224810, 0.09170660, 0.06416938]
>>> M_T = np.random.random((24, 3))
>>> M_R = M_T + (np.random.random((24, 3)) - 0.5) * 0.5
>>> colour.colour_correction(RGB, M_T, M_R)
array([ 0.1806237 ,  0.07234791,  0.07848845])
>>> sorted(colour.COLOUR_CORRECTION_METHODS)
['Cheung 2004', 'Finlayson 2015', 'Vandermonde']
```


2.7 3.7 ACES Input Transform - colour characterisation

```
>>> sensitivities = colour.MSDS_CAMERA_SENSITIVITIES["Nikon 5100 (NPL)"]
>>> illuminant = colour.SDS_ILLUMINANTS["D55"]
>>> colour.matrix_idt(sensitivities, illuminant)
(array([[ 0.46579986,  0.13409221,  0.01935163],
        [ 0.01786092,  0.77557268, -0.16775531],
        [ 0.03458647, -0.16152923,  0.74270363]]), array([ 1.58214188,  1.
↪28910346]))
```

2.8 3.8 Colorimetry - colour.colorimetry

2.8.1 3.8.1 Spectral Computations

```
>>> colour.sd_to_XYZ(colour.SDS_LIGHT_SOURCES["Neodimium Incandescent"])
array([ 36.94726204,  32.62076174,  13.0143849 ])
>>> sorted(colour.SPECTRAL_TO_XYZ_METHODS)
['ASTM E308', 'Integration', 'astm2015']
```

2.8.2 3.8.2 Multi-Spectral Computations

```
>>> msds = np.array(
...     [
...         [
...             0.01367208,
...             0.09127947,
...             0.01524376,
...             0.02810712,
...             0.19176012,
...             0.04299992,
...         ],
...         [
...             0.00959792,
...             0.25822842,
...             0.41388571,
...             0.22275120,
...             0.00407416,
...             0.37439537,
...         ],
...         [
...             0.01791409,
...             0.29707789,
...             0.56295109,
...             0.23752193,
...             0.00236515,
...             0.58190280,
...         ],
...     ],
...     [
...         [
...             0.01492332,
```

(continues on next page)

(continued from previous page)

```

...      0.10421912,
...      0.02240025,
...      0.03735409,
...      0.57663846,
...      0.32416266,
...      ],
...      [
...      0.04180972,
...      0.26402685,
...      0.03572137,
...      0.00413520,
...      0.41808194,
...      0.24696727,
...      ],
...      [
...      0.00628672,
...      0.11454948,
...      0.02198825,
...      0.39906919,
...      0.63640803,
...      0.01139849,
...      ],
...      ],
...      [
...      [
...      0.04325933,
...      0.26825359,
...      0.23732357,
...      0.05175860,
...      0.01181048,
...      0.08233768,
...      ],
...      [
...      0.02484169,
...      0.12027161,
...      0.00541695,
...      0.00654612,
...      0.18603799,
...      0.36247808,
...      ],
...      [
...      0.03102159,
...      0.16815442,
...      0.37186235,
...      0.08610666,
...      0.00413520,
...      0.78492409,
...      ],
...      ],
...      [
...      [
...      0.11682307,
...      0.78883040,
...      0.74468607,
...      0.83375293,
...      0.90571451,

```

(continues on next page)

(continued from previous page)

```

...         0.70054168,
...         ],
...         [
...             0.06321812,
...             0.41898224,
...             0.15190357,
...             0.24591440,
...             0.55301750,
...             0.00657664,
...         ],
...         [
...             0.00305180,
...             0.11288624,
...             0.11357290,
...             0.12924391,
...             0.00195315,
...             0.21771573,
...         ],
...     ],
... ]
... )
>>> colour.msds_to_XYZ(
...     msds,
...     method="Integration",
...     shape=colour.SpectralShape(400, 700, 60),
... )
array([[ 7.68544647,  4.09414317,  8.49324254],
       [17.12567298, 27.77681821, 25.52573685],
       [19.10280411, 34.45851476, 29.76319628]],
      [[18.03375827,  8.62340812,  9.71702574],
       [15.03110867,  6.54001068, 24.53208465],
       [37.68269495, 26.4411103 , 10.66361816]],
      [[ 8.09532373, 12.75333339, 25.79613956],
       [ 7.09620297,  2.79257389, 11.15039854],
       [ 8.933163   , 19.39985815, 17.14915636]],
      [[80.00969553, 80.39810464, 76.08184429],
       [33.27611427, 24.38947838, 39.34919287],
       [ 8.89425686, 11.05185138, 10.86767594]])
>>> sorted(colour.MSDS_TO_XYZ_METHODS)
['ASTM E308', 'Integration', 'astm2015']

```

2.8.3 3.8.3 Blackbody Spectral Radiance Computation

```

>>> colour.sd_blackbody(5000)
SpectralDistribution([[ 3.60000000e+02,  6.65427827e+12],
                    [ 3.61000000e+02,  6.70960528e+12],
                    [ 3.62000000e+02,  6.76482512e+12],
                    ...
                    [ 7.78000000e+02,  1.06068004e+13],
                    [ 7.79000000e+02,  1.05903327e+13],
                    [ 7.80000000e+02,  1.05738520e+13]],
                    interpolator=SpragueInterpolator,
                    interpolator_args={},
                    extrapolator=Extrapolator,

```

(continues on next page)

(continued from previous page)

```
extrapolator_args={'right': None, 'method': 'Constant', 'left': None}
↪)
```

2.8.4 3.8.4 Dominant, Complementary Wavelength & Colour Purity Computation

```
>>> xy = [0.54369557, 0.32107944]
>>> xy_n = [0.31270000, 0.32900000]
>>> colour.dominant_wavelength(xy, xy_n)
(array(616.0),
 array([ 0.68354746,  0.31628409]),
 array([ 0.68354746,  0.31628409]))
```

2.8.5 3.8.5 Lightness Computation

```
>>> colour.lightness(12.19722535)
41.527875844653451
>>> sorted(colour.LIGHTNESS_METHODS)
['Abebe 2017',
 'CIE 1976',
 'Fairchild 2010',
 'Fairchild 2011',
 'Glasser 1958',
 'Lstar1976',
 'Wyszecki 1963']
```

2.8.6 3.8.6 Luminance Computation

```
>>> colour.luminance(41.52787585)
12.197225353400775
>>> sorted(colour.LUMINANCE_METHODS)
['ASTM D1535',
 'CIE 1976',
 'Fairchild 2010',
 'Fairchild 2011',
 'Newhall 1943',
 'astm2008',
 'cie1976']
```

2.8.7 3.8.7 Whiteness Computation

```
>>> XYZ = [95.00000000, 100.00000000, 105.00000000]
>>> XYZ_0 = [94.80966767, 100.00000000, 107.30513595]
>>> colour.whiteness(XYZ, XYZ_0)
array([ 93.756, -1.33000001])
>>> sorted(colour.WHITENESS_METHODS)
['ASTM E313',
 'Berger 1959',
 'CIE 2004',
 'Ganz 1979',
```

(continues on next page)

(continued from previous page)

```
'Stensby 1968',
'Taube 1960',
'cie2004']
```

2.8.8 3.8.8 Yellowness Computation

```
>>> XYZ = [95.00000000, 100.00000000, 105.00000000]
>>> colour.yellowness(XYZ)
4.34000000000000034
>>> sorted(colour.YELLOWNESS_METHODS)
['ASTM D1925', 'ASTM E313', 'ASTM E313 Alternative']
```

2.8.9 3.8.9 Luminous Flux, Efficiency & Efficacy Computation

```
>>> sd = colour.SDS_LIGHT_SOURCES["Neodimium Incandescent"]
>>> colour.luminous_flux(sd)
23807.655527367202
>>> sd = colour.SDS_LIGHT_SOURCES["Neodimium Incandescent"]
>>> colour.luminous_efficiency(sd)
0.19943935624521045
>>> sd = colour.SDS_LIGHT_SOURCES["Neodimium Incandescent"]
>>> colour.luminous_efficacy(sd)
136.21708031547874
```

2.9 3.9 Contrast Sensitivity Function - colour.contrast

```
>>> colour.contrast_sensitivity_function(u=4, X_0=60, E=65)
358.51180789884984
>>> sorted(colour.CONTRAST_SENSITIVITY_METHODS)
['Barten 1999']
```

2.10 3.10 Colour Difference - colour.difference

```
>>> Lab_1 = [100.00000000, 21.57210357, 272.22819350]
>>> Lab_2 = [100.00000000, 426.67945353, 72.39590835]
>>> colour.delta_E(Lab_1, Lab_2)
94.035649026659485
>>> sorted(colour.DELTA_E_METHODS)
['CAM02-LCD',
 'CAM02-SCD',
 'CAM02-UCS',
 'CAM16-LCD',
 'CAM16-SCD',
 'CAM16-UCS',
 'CIE 1976',
 'CIE 1994',
 'CIE 2000',
 'CMC',
```

(continues on next page)

(continued from previous page)

```
'DIN99',  
'ITP',  
'cie1976',  
'cie1994',  
'cie2000']
```

2.11 3.11 IO - colour.io

2.11.1 3.11.1 Images

```
>>> RGB = colour.read_image("Ishihara_Colour_Blindness_Test_Plate_3.png")  
>>> RGB.shape  
(276, 281, 3)
```

2.11.2 3.11.2 Look Up Table (LUT) Data

```
>>> LUT = colour.read_LUT("ACES_Proxy_10_to_ACES.cube")  
>>> print(LUT)
```

```
LUT3x1D - ACES Proxy 10 to ACES  
-----  
Dimensions : 2  
Domain      : [[0 0 0]  
               [1 1 1]]  
Size        : (32, 3)
```

```
>>> RGB = [0.17224810, 0.09170660, 0.06416938]  
>>> LUT.apply(RGB)  
array([ 0.00575674,  0.00181493,  0.00121419])
```

2.12 3.12 Colour Models - colour.models

2.12.1 3.12.1 CIE xyY Colourspace

```
>>> colour.XYZ_to_xyY([0.20654008, 0.12197225, 0.05136952])  
array([ 0.54369557,  0.32107944,  0.12197225])
```

2.12.2 3.12.2 CIE L*a*b* Colourspace

```
>>> colour.XYZ_to_Lab([0.20654008, 0.12197225, 0.05136952])  
array([ 41.52787529,  52.63858304,  26.92317922])
```

2.12.3 3.12.3 CIE L*u*v* Colourspace

```
>>> colour.XYZ_to_Luv([0.20654008, 0.12197225, 0.05136952])
array([ 41.52787529, 96.83626054, 17.75210149])
```

2.12.4 3.12.4 CIE 1960 UCS Colourspace

```
>>> colour.XYZ_to_UCS([0.20654008, 0.12197225, 0.05136952])
array([ 0.13769339, 0.12197225, 0.1053731 ])
```

2.12.5 3.12.5 CIE 1964 U*V*W* Colourspace

```
>>> XYZ = [0.20654008 * 100, 0.12197225 * 100, 0.05136952 * 100]
>>> colour.XYZ_to_UVW(XYZ)
array([ 94.55035725, 11.55536523, 40.54757405])
```

2.12.6 3.12.6 Hunter L,a,b Colour Scale

```
>>> XYZ = [0.20654008 * 100, 0.12197225 * 100, 0.05136952 * 100]
>>> colour.XYZ_to_Hunter_Lab(XYZ)
array([ 34.92452577, 47.06189858, 14.38615107])
```

2.12.7 3.12.7 Hunter Rd,a,b Colour Scale

```
>>> XYZ = [0.20654008 * 100, 0.12197225 * 100, 0.05136952 * 100]
>>> colour.XYZ_to_Hunter_Rdab(XYZ)
array([ 12.197225 , 57.12537874, 17.46241341])
```

2.12.8 3.12.8 CAM02-LCD, CAM02-SCD, and CAM02-UCS Colourspaces - Luo, Cui and Li (2006)

```
>>> XYZ = [0.20654008 * 100, 0.12197225 * 100, 0.05136952 * 100]
>>> XYZ_w = [95.05, 100.00, 108.88]
>>> L_A = 318.31
>>> Y_b = 20.0
>>> surround = colour.VIEWING_CONDITIONS_CIECAM02["Average"]
>>> specification = colour.XYZ_to_CIECAM02(XYZ, XYZ_w, L_A, Y_b, surround)
>>> JMh = (specification.J, specification.M, specification.h)
>>> colour.JMh_CIECAM02_to_CAM02UCS(JMh)
array([ 47.16899898, 38.72623785, 15.8663383 ])
>>> XYZ = [0.20654008, 0.12197225, 0.05136952]
>>> XYZ_w = [95.05 / 100, 100.00 / 100, 108.88 / 100]
>>> colour.XYZ_to_CAM02UCS(XYZ, XYZ_w=XYZ_w, L_A=L_A, Y_b=Y_b)
array([ 47.16899898, 38.72623785, 15.8663383 ])
```

2.12.9 3.12.9 CAM16-LCD, CAM16-SCD, and CAM16-UCS Colourspaces - Li et al. (2017)

```
>>> XYZ = [0.20654008 * 100, 0.12197225 * 100, 0.05136952 * 100]
>>> XYZ_w = [95.05, 100.00, 108.88]
>>> L_A = 318.31
>>> Y_b = 20.0
>>> surround = colour.VIEWING_CONDITIONS_CAM16["Average"]
>>> specification = colour.XYZ_to_CAM16(XYZ, XYZ_w, L_A, Y_b, surround)
>>> JMh = (specification.J, specification.M, specification.h)
>>> colour.JMh_CAM16_to_CAM16UCS(JMh)
array([ 46.55542238,  40.22460974,  14.25288392])
>>> XYZ = [0.20654008, 0.12197225, 0.05136952]
>>> XYZ_w = [95.05 / 100, 100.00 / 100, 108.88 / 100]
>>> colour.XYZ_to_CAM16UCS(XYZ, XYZ_w=XYZ_w, L_A=L_A, Y_b=Y_b)
array([ 46.55542238,  40.22460974,  14.25288392])
```

2.12.10 3.12.10 ICaCb Colourspace

```
>>> XYZ_to_ICaCb(np.array([0.20654008, 0.12197225, 0.05136952]))
array([ 0.06875297,  0.05753352,  0.02081548])
```

2.12.11 3.12.11 IgPgTg Colourspace

```
>>> colour.XYZ_to_IgPgTg([0.20654008, 0.12197225, 0.05136952])
array([ 0.42421258,  0.18632491,  0.10689223])
```

2.12.12 3.12.12 IPT Colourspace

```
>>> colour.XYZ_to_IPT([0.20654008, 0.12197225, 0.05136952])
array([ 0.38426191,  0.38487306,  0.18886838])
```

2.12.13 3.12.13 Munish Ragoo and Farup (2021) Optimised IPT Colourspace

```
>>> colour.XYZ_to_IPT_Munish2021([0.20654008, 0.12197225, 0.05136952])
array([ 0.42248243,  0.2910514 ,  0.20410663])
```

2.12.14 3.12.14 DIN99 Colourspace

```
>>> Lab = [41.52787529, 52.63858304, 26.92317922]
>>> colour.Lab_to_DIN99(Lab)
array([ 53.22821988,  28.41634656,  3.89839552])
```


2.12.15 3.12.15 hdr-CIELAB Colourspace

```
>>> colour.XYZ_to_hdr_CIELab([0.20654008, 0.12197225, 0.05136952])
array([ 51.87002062,  60.4763385 ,  32.14551912])
```

2.12.16 3.12.16 hdr-IPT Colourspace

```
>>> colour.XYZ_to_hdr_IPT([0.20654008, 0.12197225, 0.05136952])
array([ 25.18261761, -22.62111297,   3.18511729])
```

2.12.17 3.12.17 Oklab Colourspace

```
>>> colour.XYZ_to_Oklab([0.20654008, 0.12197225, 0.05136952])
array([ 0.51634019,  0.154695  ,  0.06289579])
```

2.12.18 3.12.18 OSA UCS Colourspace

```
>>> XYZ = [0.20654008 * 100, 0.12197225 * 100, 0.05136952 * 100]
>>> colour.XYZ_to_OSA_UCS(XYZ)
array([-3.0049979 ,  2.99713697, -9.66784231])
```

2.12.19 3.12.19 ProLab Colourspace

```
>>> colour.XYZ_to_ProLab([0.51634019, 0.15469500, 0.06289579])
array([1.24610688, 2.39525236, 0.41902126])
```

2.12.20 3.12.20 Jzazbz Colourspace

```
>>> colour.XYZ_to_Jzazbz([0.20654008, 0.12197225, 0.05136952])
array([ 0.00535048,  0.00924302,  0.00526007])
```

2.12.21 3.12.21 Y'CbCr Colour Encoding

```
>>> colour.RGB_to_YCbCr([1.0, 1.0, 1.0])
array([ 0.92156863,  0.50196078,  0.50196078])
```

2.12.22 3.12.22 YCoCg Colour Encoding

```
>>> colour.RGB_to_YCoCg([0.75, 0.75, 0.0])
array([ 0.5625,  0.375 ,  0.1875])
```

2.12.23 3.12.23 ICtCp Colour Encoding

```
>>> colour.RGB_to_ICtCp([0.45620519, 0.03081071, 0.04091952])
array([ 0.07351364,  0.00475253,  0.09351596])
```

2.12.24 3.12.24 HSV Colourspace

```
>>> colour.RGB_to_HSV([0.45620519, 0.03081071, 0.04091952])
array([ 0.99603944,  0.93246304,  0.45620519])
```

2.12.25 3.12.25 IHLS Colourspace

```
>>> colour.RGB_to_IHLS([0.45620519, 0.03081071, 0.04091952])
array([ 6.26236117,  0.12197943,  0.42539448])
```

2.12.26 3.12.26 Prismatic Colourspace

```
>>> colour.RGB_to_Prismatic([0.25, 0.50, 0.75])
array([ 0.75      ,  0.16666667,  0.33333333,  0.5      ])
```

2.12.27 3.12.27 RGB Colourspace and Transformations

```
>>> XYZ = [0.21638819, 0.12570000, 0.03847493]
>>> illuminant_XYZ = [0.34570, 0.35850]
>>> illuminant_RGB = [0.31270, 0.32900]
>>> chromatic_adaptation_transform = "Bradford"
>>> matrix_XYZ_to_RGB = [
...     [3.24062548, -1.53720797, -0.49862860],
...     [-0.96893071, 1.87575606, 0.04151752],
...     [0.05571012, -0.20402105, 1.05699594],
... ]
>>> colour.XYZ_to_RGB(
...     XYZ,
...     illuminant_XYZ,
...     illuminant_RGB,
...     matrix_XYZ_to_RGB,
...     chromatic_adaptation_transform,
... )
array([ 0.45595571,  0.03039702,  0.04087245])
```

2.12.28 3.12.28 RGB Colourspace Derivation

```
>>> p = [0.73470, 0.26530, 0.00000, 1.00000, 0.00010, -0.07700]
>>> w = [0.32168, 0.33767]
>>> colour.normalised_primary_matrix(p, w)
array([[ 9.52552396e-01,  0.00000000e+00,  9.36786317e-05],
       [ 3.43966450e-01,  7.28166097e-01, -7.21325464e-02],
       [ 0.00000000e+00,  0.00000000e+00,  1.00882518e+00]])
```

2.12.29 3.12.29 RGB Colourspaces

```
>>> sorted(colour.RGB_COLOURSPACES)
['ACES2065-1',
 'ACEScc',
 'ACEScct',
 'ACEScg',
 'ACESproxy',
 'ARRI Wide Gamut 3',
 'ARRI Wide Gamut 4',
 'Adobe RGB (1998)',
 'Adobe Wide Gamut RGB',
 'Apple RGB',
 'Best RGB',
 'Beta RGB',
 'Blackmagic Wide Gamut',
 'CIE RGB',
 'Cinema Gamut',
 'ColorMatch RGB',
 'DCDM XYZ',
 'DCI-P3',
 'DCI-P3-P',
 'DJI D-Gamut',
 'DRAGONcolor',
 'DRAGONcolor2',
 'DaVinci Wide Gamut',
 'Display P3',
 'Don RGB 4',
 'EBU Tech. 3213-E',
 'ECI RGB v2',
 'ERIMM RGB',
 'Ekta Space PS 5',
 'F-Gamut',
 'FilmLight E-Gamut',
 'ITU-R BT.2020',
 'ITU-R BT.470 - 525',
 'ITU-R BT.470 - 625',
 'ITU-R BT.709',
 'ITU-T H.273 - 22 Unspecified',
 'ITU-T H.273 - Generic Film',
 'Max RGB',
 'N-Gamut',
 'NTSC (1953)',
 'NTSC (1987)',
 'P3-D65',
 'Pal/Secam',
```

(continues on next page)

(continued from previous page)

```
'ProPhoto RGB',
'Protune Native',
'REDWideGamutRGB',
'REDcolor',
'REDcolor2',
'REDcolor3',
'REDcolor4',
'RIMM RGB',
'ROMM RGB',
'Russell RGB',
'S-Gamut',
'S-Gamut3',
'S-Gamut3.Cine',
'SMPTE 240M',
'SMPTE C',
'Sharp RGB',
'V-Gamut',
'Venice S-Gamut3',
'Venice S-Gamut3.Cine',
'Xtreme RGB',
'aces',
'adobe1998',
'prophoto',
'sRGB']
```

2.12.30 3.12.30 OETFs

```
>>> sorted(colour.OETFs)
['ARIB STD-B67',
'Blackmagic Film Generation 5',
'DaVinci Intermediate',
'ITU-R BT.2020',
'ITU-R BT.2100 HLG',
'ITU-R BT.2100 PQ',
'ITU-R BT.601',
'ITU-R BT.709',
'ITU-T H.273 IEC 61966-2',
'ITU-T H.273 Log',
'ITU-T H.273 Log Sqrt',
'SMPTE 240M']
```

2.12.31 3.12.31 EOTFs

```
>>> sorted(colour.EOTFs)
['DCDM',
'DICOM GSDF',
'ITU-R BT.1886',
'ITU-R BT.2100 HLG',
'ITU-R BT.2100 PQ',
'ITU-T H.273 ST.428-1',
'SMPTE 240M',
'ST 2084',
'sRGB']
```

2.12.32 3.12.32 OOTFs

```
>>> sorted(colour.OOTFS)
['ITU-R BT.2100 HLG', 'ITU-R BT.2100 PQ']
```

2.12.33 3.12.33 Log Encoding / Decoding

```
>>> sorted(colour.LOG_ENCODINGS)
['ACEScc',
 'ACEScct',
 'ACESproxy',
 'ARRI LogC3',
 'ARRI LogC4',
 'Canon Log',
 'Canon Log 2',
 'Canon Log 3',
 'Cineon',
 'D-Log',
 'ERIMM RGB',
 'F-Log',
 'Filmic Pro 6',
 'L-Log',
 'Log2',
 'Log3G10',
 'Log3G12',
 'N-Log',
 'PLog',
 'Panalog',
 'Protune',
 'REDLog',
 'REDLogFilm',
 'S-Log',
 'S-Log2',
 'S-Log3',
 'T-Log',
 'V-Log',
 'ViperLog']
```

2.12.34 3.12.34 CCTFs Encoding / Decoding

```
>>> sorted(colour.CCTF_ENCODINGS)
['ACEScc',
 'ACEScct',
 'ACESproxy',
 'ARRI LogC3',
 'ARRI LogC4',
 'ARIB STD-B67',
 'Canon Log',
 'Canon Log 2',
 'Canon Log 3',
 'Cineon',
 'D-Log',
 'DCDM',
```

(continues on next page)

(continued from previous page)

```
'DICOM GSDF',
'ERIMM RGB',
'F-Log',
'Filmic Pro 6',
'Gamma 2.2',
'Gamma 2.4',
'Gamma 2.6',
'ITU-R BT.1886',
'ITU-R BT.2020',
'ITU-R BT.2100 HLG',
'ITU-R BT.2100 PQ',
'ITU-R BT.601',
'ITU-R BT.709',
'Log2',
'Log3G10',
'Log3G12',
'PLog',
'Panalog',
'ProPhoto RGB',
'Protune',
'REDLog',
'REDLogFilm',
'RIMM RGB',
'ROMM RGB',
'S-Log',
'S-Log2',
'S-Log3',
'SMPTE 240M',
'ST 2084',
'T-Log',
'V-Log',
'ViperLog',
'sRGB']
```

2.12.35 3.12.35 Recommendation ITU-T H.273 Code points for Video Signal Type Identification

```
>>> colour.COLOUR_PRIMARIES_ITUTH273.keys()
dict_keys([0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 22, 23])
>>> colour.COLOUR_PRIMARIES_ITUTH273.keys()
>>> description = colour.models.describe_video_signal_colour_primaries(1)
```

```
=====
*                                                                    *
*  Colour Primaries: 1                                              *
*  -----                                                         *
*                                                                    *
*  Primaries      : [[ 0.64  0.33]                                   *
*                   [ 0.3   0.6 ]                                   *
*                   [ 0.15  0.06]]                                  *
*  Whitepoint     : [ 0.3127 0.329 ]                                *
*  Whitepoint Name : D65                                           *
*  NPM            : [[ 0.4123908  0.35758434  0.18048079]         *
*                   [ 0.21263901  0.71516868  0.07219232]         *
*                   [ 0.01933082  0.11919478  0.95053215]]         *
*                                                                    *
```

(continues on next page)

(continued from previous page)

```

*   NPM -1           : [[ 3.24096994 -1.53738318 -0.49861076]
*                       [-0.96924364  1.8759675   0.04155506]
*                       [ 0.05563008 -0.20397696  1.05697151]]
*   FFmpeg Constants : ['AVCOL_PRI_BT709', 'BT709']
*
=====
>>> colour.TRANSFER_CHARACTERISTICS_ITUTH273.keys()
dict_keys([0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19])
>>> description = (
...     colour.models.describe_video_signal_transfer_characteristics(1)
... )
=====
*
*   Transfer Characteristics: 1
*   -----
*
*   Function           : <function oetf_BT709 at 0x165bb3550>
*   FFmpeg Constants   : ['AVCOL_TRC_BT709', 'BT709']
*
=====
>>> colour.MATRIX_COEFFICIENTS_ITUTH273.keys()
dict_keys([0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15])
>>> description = colour.models.describe_video_signal_matrix_coefficients(
...     1
... )
=====
*
*   Matrix Coefficients: 1
*   -----
*
*   Matrix Coefficients : [ 0.2126  0.0722]
*   FFmpeg Constants     : ['AVCOL_SPC_BT709', 'BT709']
*
=====

```

2.13 3.13 Colour Notation Systems - colour.notation

2.13.1 3.13.1 Munsell Value

```

>>> colour.munsell_value(12.23634268)
4.0824437076525664
>>> sorted(colour.MUNSELL_VALUE_METHODS)
['ASTM D1535',
 'Ladd 1955',
 'McCamy 1987',
 'Moon 1943',
 'Munsell 1933',
 'Priest 1920',
 'Saunderson 1944',
 'astm2008']

```

2.13.2 3.13.2 Munsell Colour

```
>>> colour.xyY_to_munsell_colour([0.38736945, 0.35751656, 0.59362000])
'4.2YR 8.1/5.3'
>>> colour.munsell_colour_to_xyY("4.2YR 8.1/5.3")
array([ 0.38736945,  0.35751656,  0.59362    ])
```

2.14 3.14 Optical Phenomena - colour.phenomena

```
>>> colour.rayleigh_scattering_sd()
SpectralDistribution([[ 3.60000000e+02,  5.99101337e-01],
                    [ 3.61000000e+02,  5.92170690e-01],
                    [ 3.62000000e+02,  5.85341006e-01],
                    ...
                    [ 7.78000000e+02,  2.55208377e-02],
                    [ 7.79000000e+02,  2.53887969e-02],
                    [ 7.80000000e+02,  2.52576106e-02]],
                    interpolator=SpragueInterpolator,
                    interpolator_args={},
                    extrapolator=Extrapolator,
                    extrapolator_args={'right': None, 'method': 'Constant', 'left': None})
↪)
```

2.15 3.15 Light Quality - colour.quality

2.15.1 3.15.1 Colour Fidelity Index

```
>>> colour.colour_fidelity_index(colour.SDS_ILLUMINANTS["FL2"])
70.120825477833037
>>> sorted(colour.COLOUR_FIDELITY_INDEX_METHODS)
['ANSI/IES TM-30-18', 'CIE 2017']
```

2.15.2 3.15.2 Colour Rendering Index

```
>>> colour.colour_quality_scale(colour.SDS_ILLUMINANTS["FL2"])
64.111703163816699
>>> sorted(colour.COLOUR_QUALITY_SCALE_METHODS)
['NIST CQS 7.4', 'NIST CQS 9.0']
```

2.15.3 3.15.3 Colour Quality Scale

```
>>> colour.colour_rendering_index(colour.SDS_ILLUMINANTS["FL2"])
64.233724121664807
```


2.15.4 3.15.4 Academy Spectral Similarity Index (SSI)

```
>>> colour.spectral_similarity_index(
...     colour.SDS_ILLUMINANTS["C"], colour.SDS_ILLUMINANTS["D65"]
... )
94.0
```

2.16 3.16 Spectral Up-Sampling & Recovery - colour.recovery

2.16.1 3.16.1 Reflectance Recovery

```
>>> colour.XYZ_to_sd([0.20654008, 0.12197225, 0.05136952])
SpectralDistribution([[ 3.60000000e+02,  8.40144095e-02],
                    [ 3.65000000e+02,  8.41264236e-02],
                    [ 3.70000000e+02,  8.40057597e-02],
                    ...
                    [ 7.70000000e+02,  4.46743012e-01],
                    [ 7.75000000e+02,  4.46817187e-01],
                    [ 7.80000000e+02,  4.46857696e-01]],
SpragueInterpolator,
{},
Extrapolator,
{'method': 'Constant', 'left': None, 'right': None})

>>> sorted(colour.REFLECTANCE_RECOVERY_METHODS)
['Jakob 2019', 'Mallett 2019', 'Meng 2015', 'Otsu 2018', 'Smits 1999']
```

2.16.2 3.16.2 Camera RGB Sensitivities Recovery

```
>>> illuminant = colour.colorimetry.SDS_ILLUMINANTS["D65"]
>>> sensitivities = colour.characterisation.MSDS_CAMERA_SENSITIVITIES[
...     "Nikon 5100 (NPL)"
... ]
>>> reflectances = [
...     sd.copy().align(
...         colour.recovery.SPECTRAL_SHAPE_BASIS_FUNCTIONS_DYER2017
...     )
...     for sd in colour.characterisation.SDS_COLOURCHECKERS[
...         "BabelColor Average"
...     ].values()
... ]
>>> reflectances = colour.colorimetry.sds_and_msds_to_msds(reflectances)
>>> RGB = colour.colorimetry.msds_to_XYZ(
...     reflectances,
...     method="Integration",
...     cmfs=sensitivities,
...     illuminant=illuminant,
...     k=0.01,
...     shape=colour.recovery.SPECTRAL_SHAPE_BASIS_FUNCTIONS_DYER2017,
... )
>>> colour.recovery.RGB_to_msds_camera_sensitivities_Jiang2013(
...     RGB,
```

(continues on next page)

(continued from previous page)

```

...     illuminant,
...     reflectances,
...     colour.recovery.BASIS_FUNCTIONS_DYER2017,
...     colour.recovery.SPECTRAL_SHAPE_BASIS_FUNCTIONS_DYER2017,
... )
RGB_CameraSensitivities([[ 4.00000000e+02,  7.22815777e-03,  9.22506480e-03,
                           -9.88368972e-03],
                        [ 4.10000000e+02, -8.50457609e-03,  1.12777480e-02,
                           3.86248655e-03],
                        [ 4.20000000e+02,  4.58191132e-02,  7.15520948e-02,
                           4.04068293e-01],
                        ...
                        [ 6.80000000e+02,  4.08276173e-02,  5.55290476e-03,
                           1.39907862e-03],
                        [ 6.90000000e+02, -3.71437574e-03,  2.50935640e-03,
                           3.97652622e-04],
                        [ 7.00000000e+02, -5.62256563e-03,  1.56433970e-03,
                           5.84726936e-04]],
                        ['red', 'green', 'blue'],
                        SpragueInterpolator,
                        {},
                        Extrapolator,
                        {'method': 'Constant', 'left': None, 'right': None})

```

2.17 3.17 Correlated Colour Temperature Computation Methods - colour.temperature

```

>>> colour.uv_to_CCT([0.1978, 0.3122])
array([ 6.50751282e+03,  3.22335875e-03])
>>> sorted(colour.UV_TO_CCT_METHODS)
['Krystek 1985', 'Ohno 2013', 'Planck 1900', 'Robertson 1968', 'ohno2013', 'robertson1968',
 →]
>>> sorted(colour.XY_TO_CCT_METHODS)
['CIE Illuminant D Series',
 'Hernandez 1999',
 'Kang 2002',
 'McCamy 1992',
 'daylight',
 'hernandez1999',
 'kang2002',
 'mccamy1992']

```

2.18 3.18 Colour Volume - colour.volume

```
>>> colour.RGB_colourspace_volume_MonteCarlo(
...     colour.RGB_COLOURSPACE_RGB["sRGB"]
... )
821958.300000000005
```

2.19 3.19 Geometry Primitives Generation - colour.geometry

```
>>> colour.primitive("Grid")
(array([ [-0.5,  0.5,  0. ], [ 0.,  1.], [ 0.,  0.,  1.], [ 0.,  1.,  0.,  1.]],
      ([ 0.5,  0.5,  0. ], [ 1.,  1.], [ 0.,  0.,  1.], [ 1.,  1.,  0.,  1.]),
      ([ -0.5, -0.5,  0. ], [ 0.,  0.], [ 0.,  0.,  1.], [ 0.,  0.,  0.,  1.]),
      ([ 0.5, -0.5,  0. ], [ 1.,  0.], [ 0.,  0.,  1.], [ 1.,  0.,  0.,  1.]]),
      dtype=[('position', '<f4', (3,)), ('uv', '<f4', (2,)), ('normal', '<f4', (3,)), (
→ 'colour', '<f4', (4,))]), array([[0, 2, 1],
      [2, 3, 1]], dtype=uint32), array([[0, 2],
      [2, 3],
      [3, 1],
      [1, 0]], dtype=uint32))
>>> sorted(colour.PRIMITIVE_METHODS)
['Cube', 'Grid']
>>> colour.primitive_vertices("Quad MPL")
array([[ 0.,  0.,  0.],
      [ 1.,  0.,  0.],
      [ 1.,  1.,  0.],
      [ 0.,  1.,  0.]])
>>> sorted(colour.PRIMITIVE_VERTICES_METHODS)
['Cube MPL', 'Grid MPL', 'Quad MPL', 'Sphere']
```

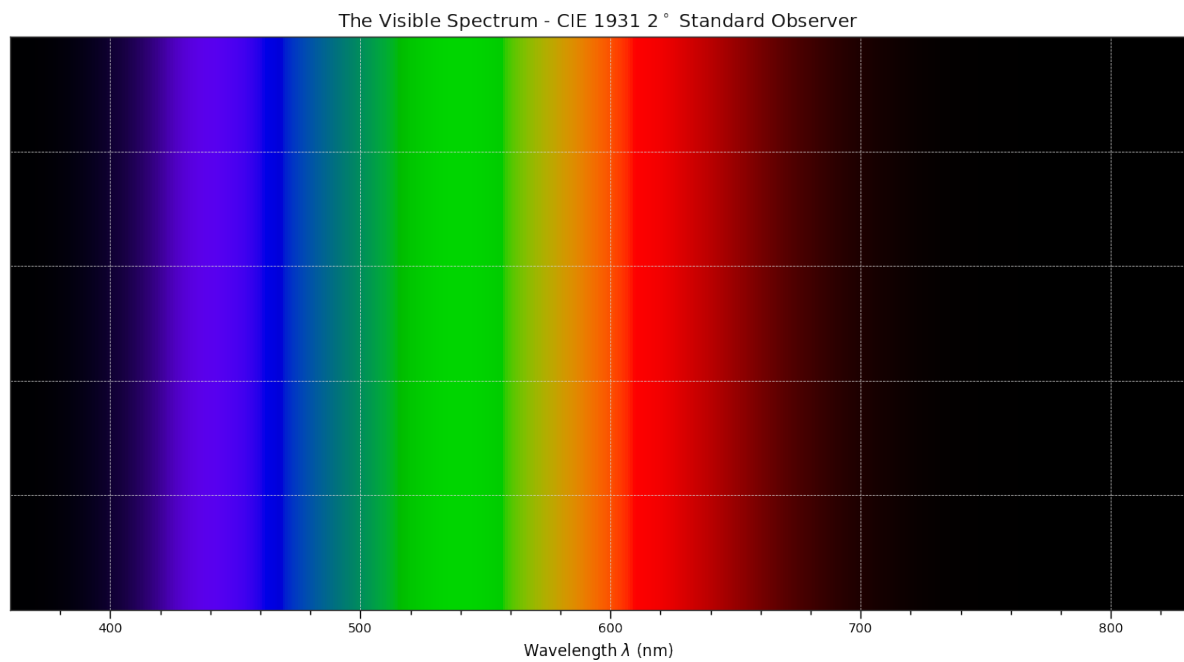
2.20 3.20 Plotting - colour.plotting

Most of the objects are available from the colour.plotting namespace:

```
>>> from colour.plotting import *
>>> colour_style()
```

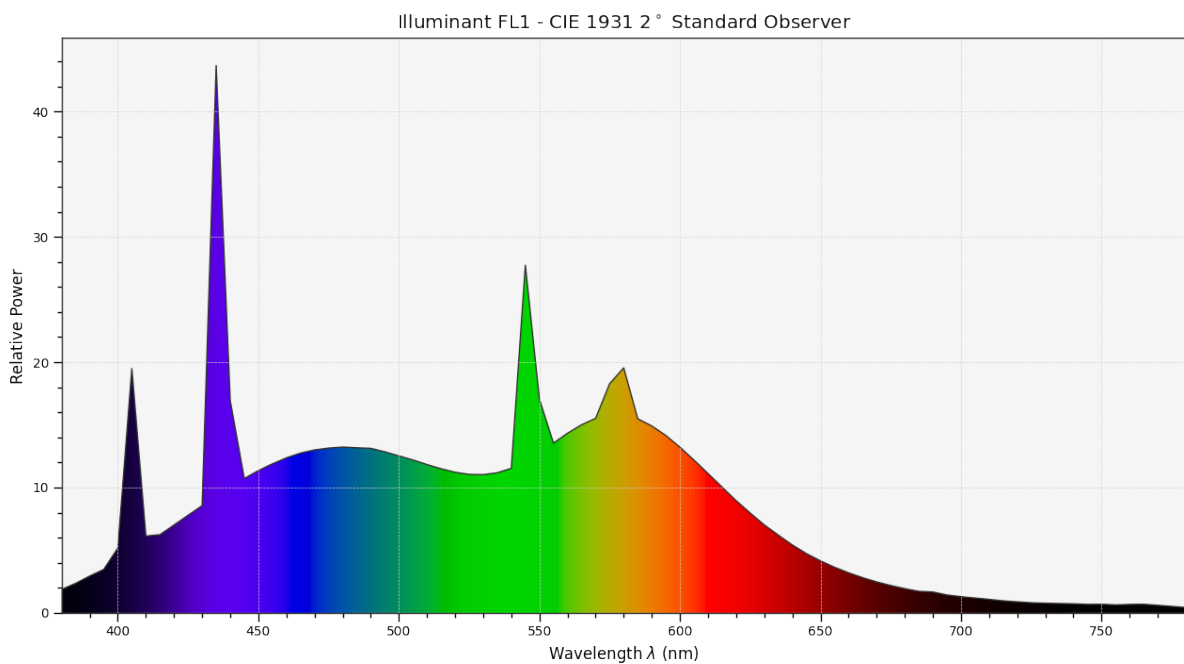
2.20.1 3.20.1 Visible Spectrum

```
>>> plot_visible_spectrum("CIE 1931 2 Degree Standard Observer")
```



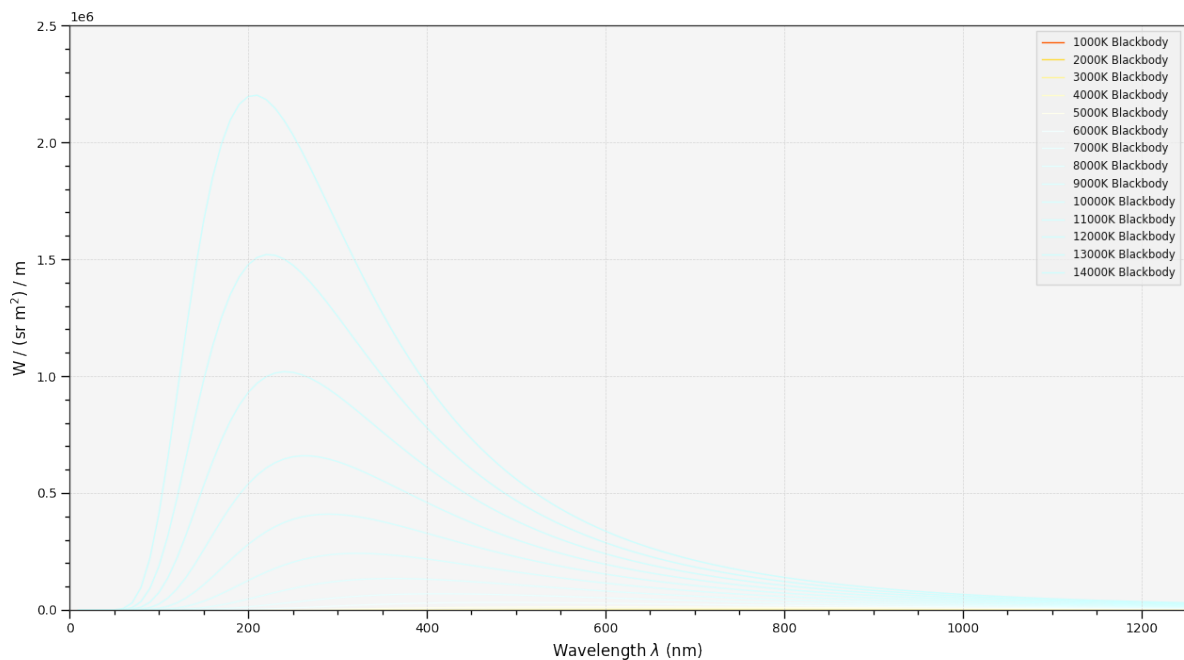
2.20.2 3.20.2 Spectral Distribution

```
>>> plot_single_illuminant_sd("FL1")
```



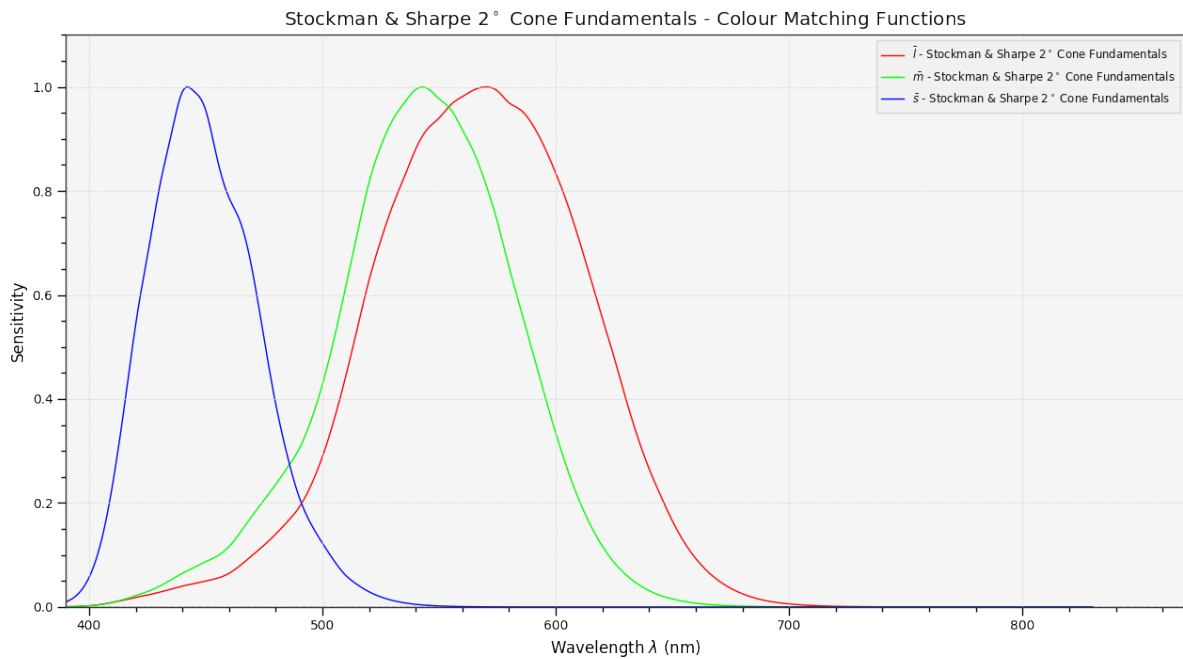
2.20.3 3.20.3 Blackbody

```
>>> blackbody_sds = [
...     colour.sd_blackbody(i, colour.SpectralShape(0, 10000, 10))
...     for i in range(1000, 15000, 1000)
... ]
>>> plot_multi_sds(
...     blackbody_sds,
...     y_label="W / (sr m$^2$) / m",
...     plot_kwargs={"use_sd_colours": True, "normalise_sd_colours": True},
...     legend_location="upper right",
...     bounding_box=(0, 1250, 0, 2.5e6),
... )
```



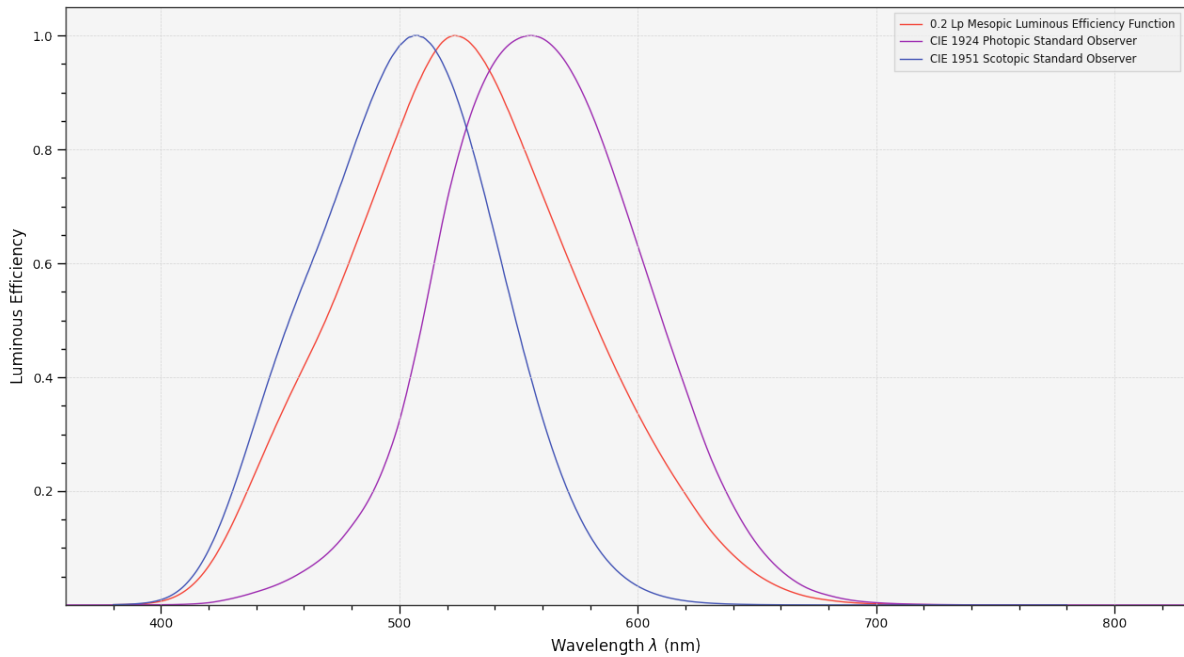
2.20.4 3.20.4 Colour Matching Functions

```
>>> plot_single_cmfs(
...     "Stockman & Sharpe 2 Degree Cone Fundamentals",
...     y_label="Sensitivity",
...     bounding_box=(390, 870, 0, 1.1),
... )
```



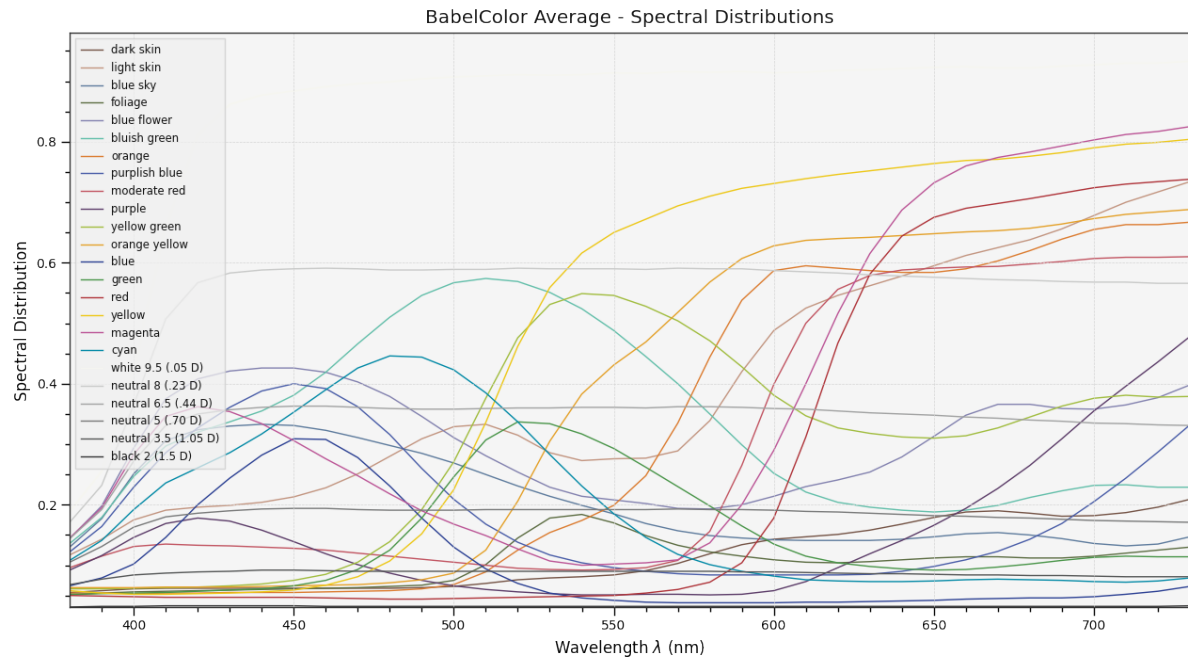
2.20.5 3.20.5 Luminous Efficiency

```
>>> sd_mesopic_luminous_efficiency_function = (
...     colour.sd_mesopic_luminous_efficiency_function(0.2)
... )
>>> plot_multi_sds(
...     (
...         sd_mesopic_luminous_efficiency_function,
...         colour.PHOTOPIC_LEFS["CIE 1924 Photopic Standard Observer"],
...         colour.SCOTOPIC_LEFS["CIE 1951 Scotopic Standard Observer"],
...     ),
...     y_label="Luminous Efficiency",
...     legend_location="upper right",
...     y_tighten=True,
...     margins=(0, 0, 0, 0.1),
... )
```

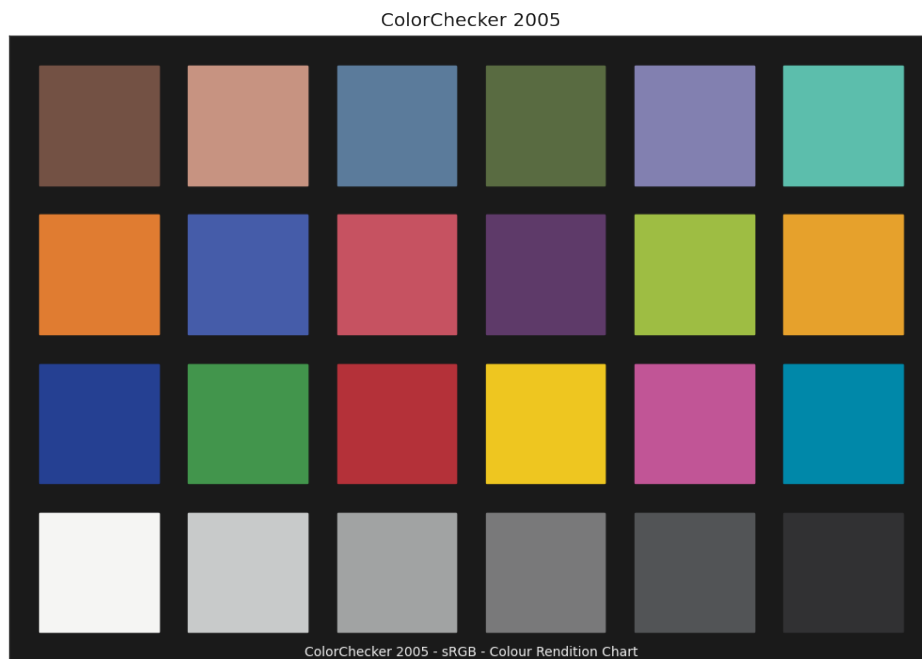


2.20.6 3.20.6 Colour Checker

```
>>> from colour.characterisation.dataset.colour_checkers.sds import (
...     COLOURCHECKER_INDEXES_TO_NAMES_MAPPING,
... )
>>> plot_multi_sds(
...     [
...         colour.SDS_COLOURCHECKERS["BabelColor Average"][value]
...         for key, value in sorted(
...             COLOURCHECKER_INDEXES_TO_NAMES_MAPPING.items()
...         )
...     ],
...     plot_kwargs={
...         "use_sd_colours": True,
...     },
...     title=("BabelColor Average - " "Spectral Distributions"),
... )
```

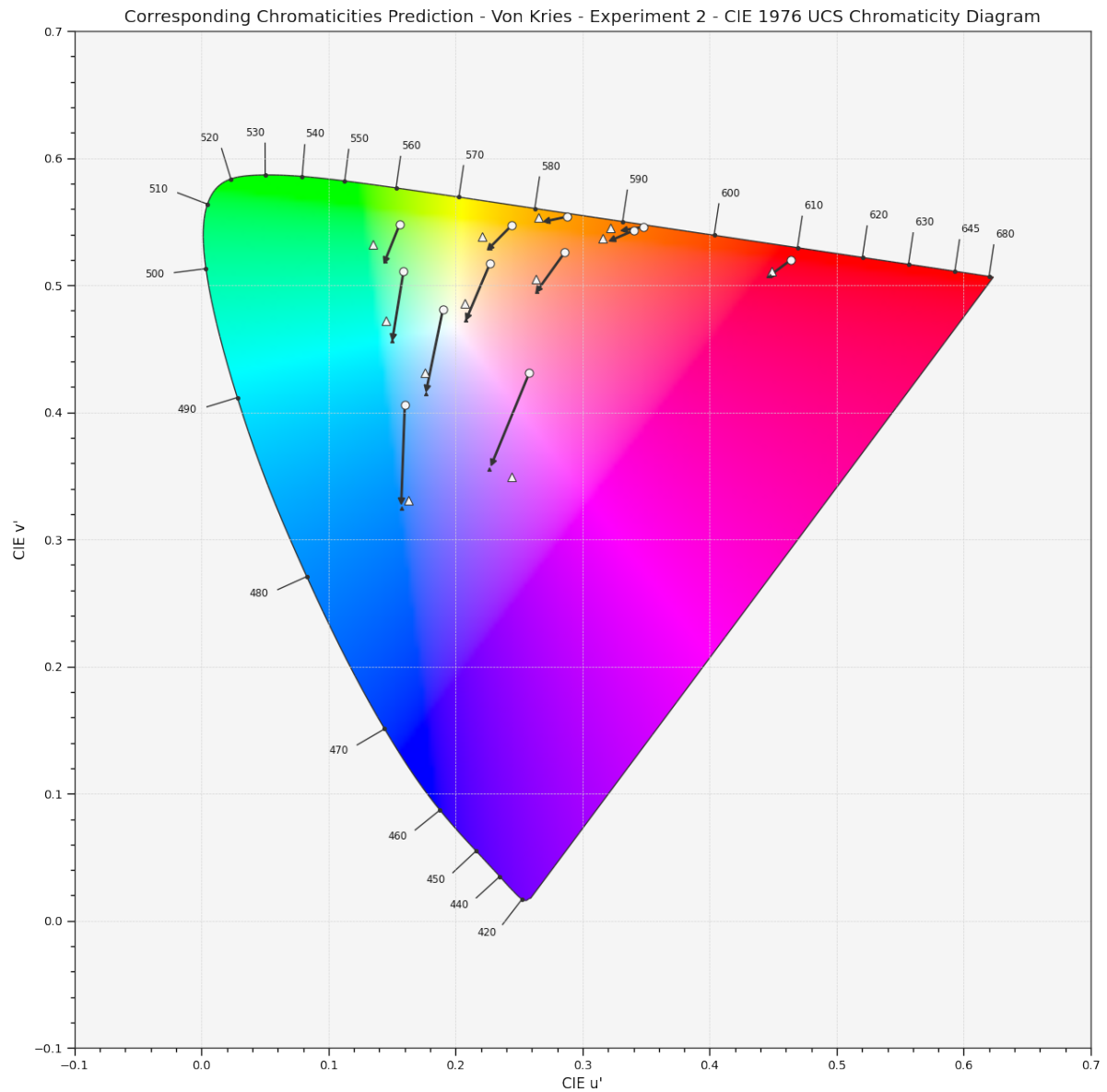


```
>>> plot_single_colour_checker(
...     "ColorChecker 2005", text_kwargs={"visible": False}
... )
```



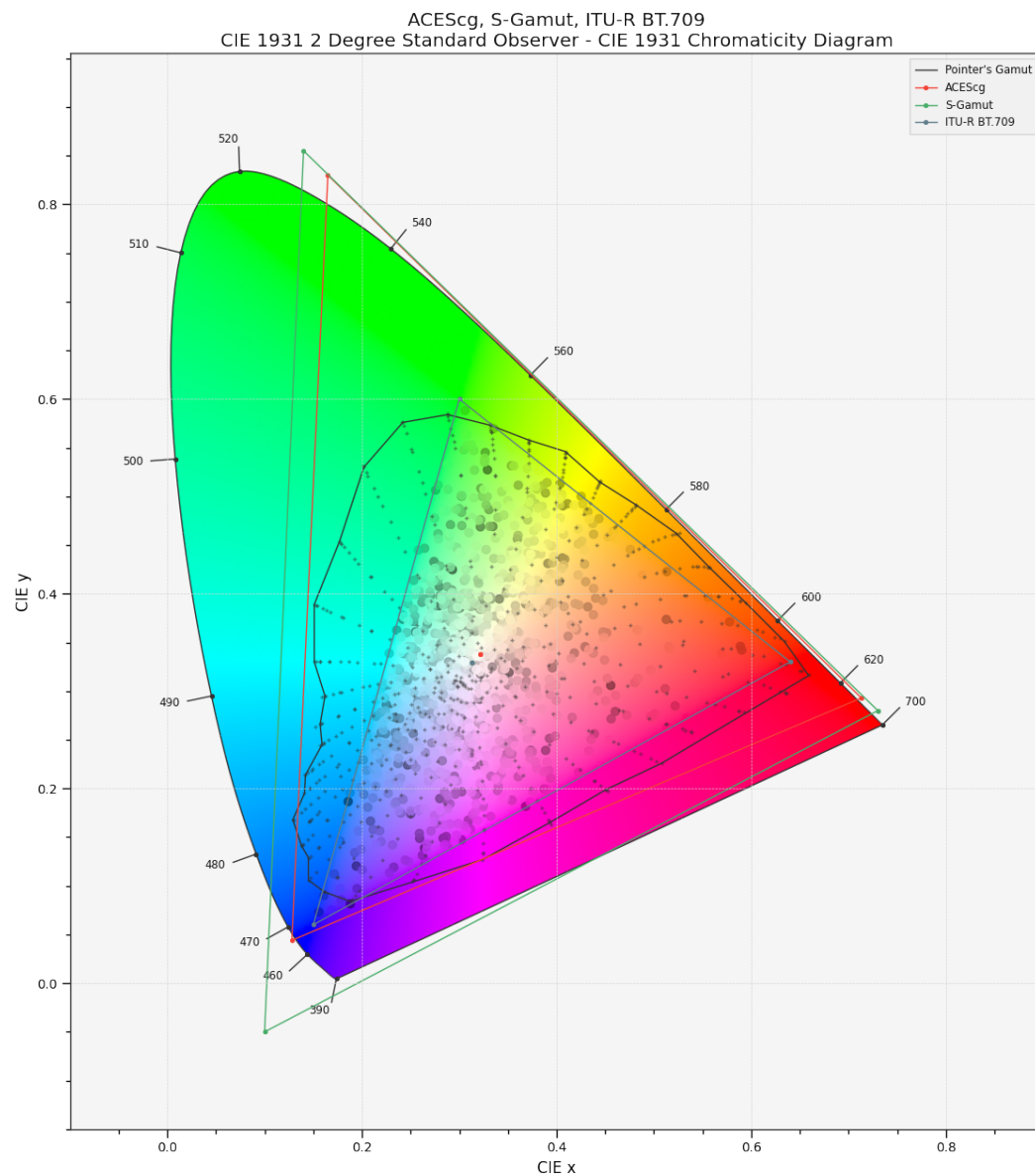
2.20.7 3.20.7 Chromaticities Prediction

```
>>> plot_corresponding_chromaticities_prediction(
...     2, "Von Kries", "Bianco 2010"
... )
```



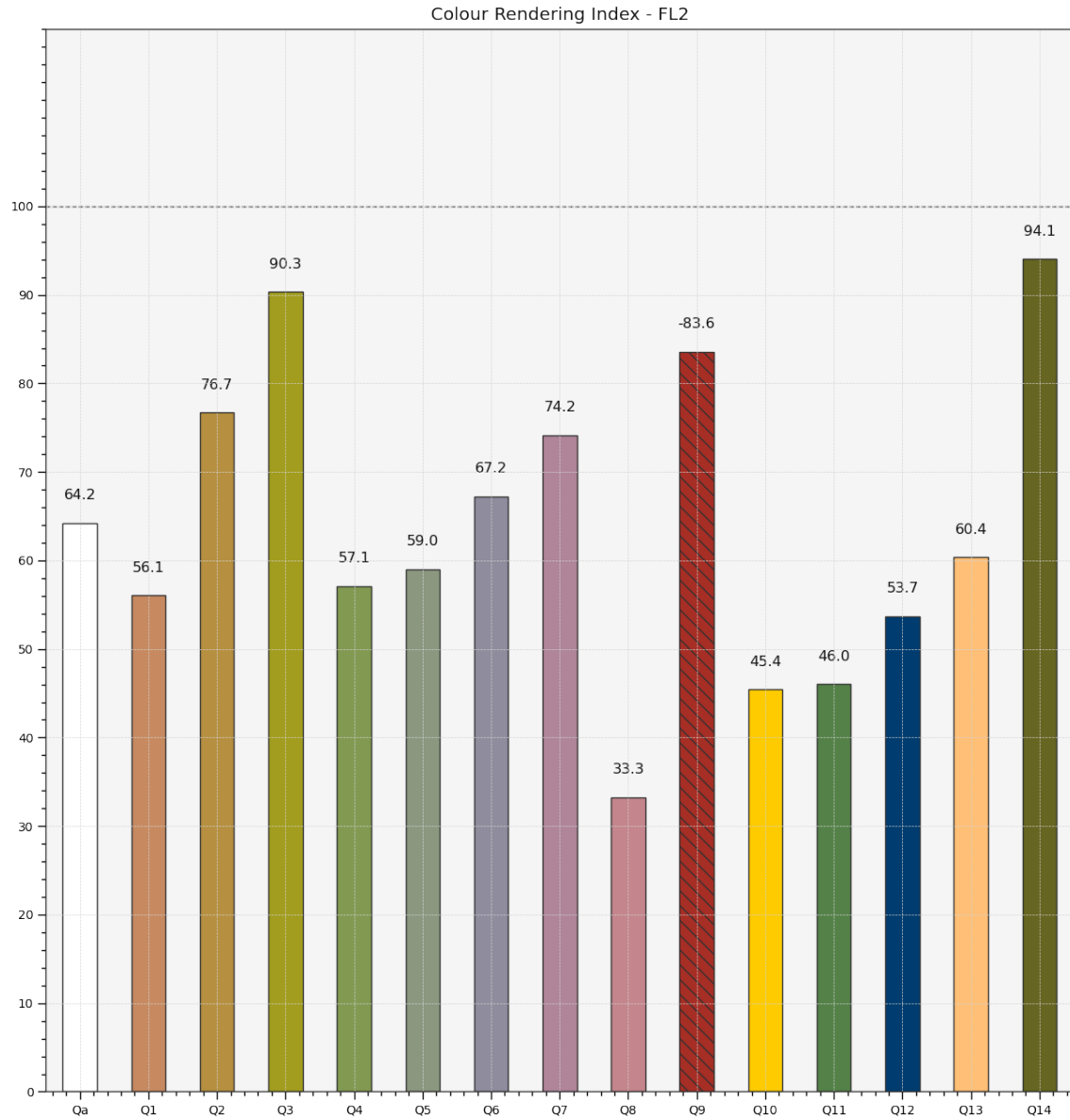
2.20.8 3.20.8 Chromaticities

```
>>> import numpy as np
>>> RGB = np.random.random((32, 32, 3))
>>> plot_RGB_chromaticities_in_chromaticity_diagram_CIE1931(
...     RGB,
...     "ITU-R BT.709",
...     colourspace=["ACESc", "S-Gamut"],
...     show_pointer_gamut=True,
... )
```



2.20.9 3.20.9 Colour Rendering Index

```
>>> plot_single_sd_colour_rendering_index_bars(
...     colour.SDS_ILLUMINANTS["FL2"]
... )
```



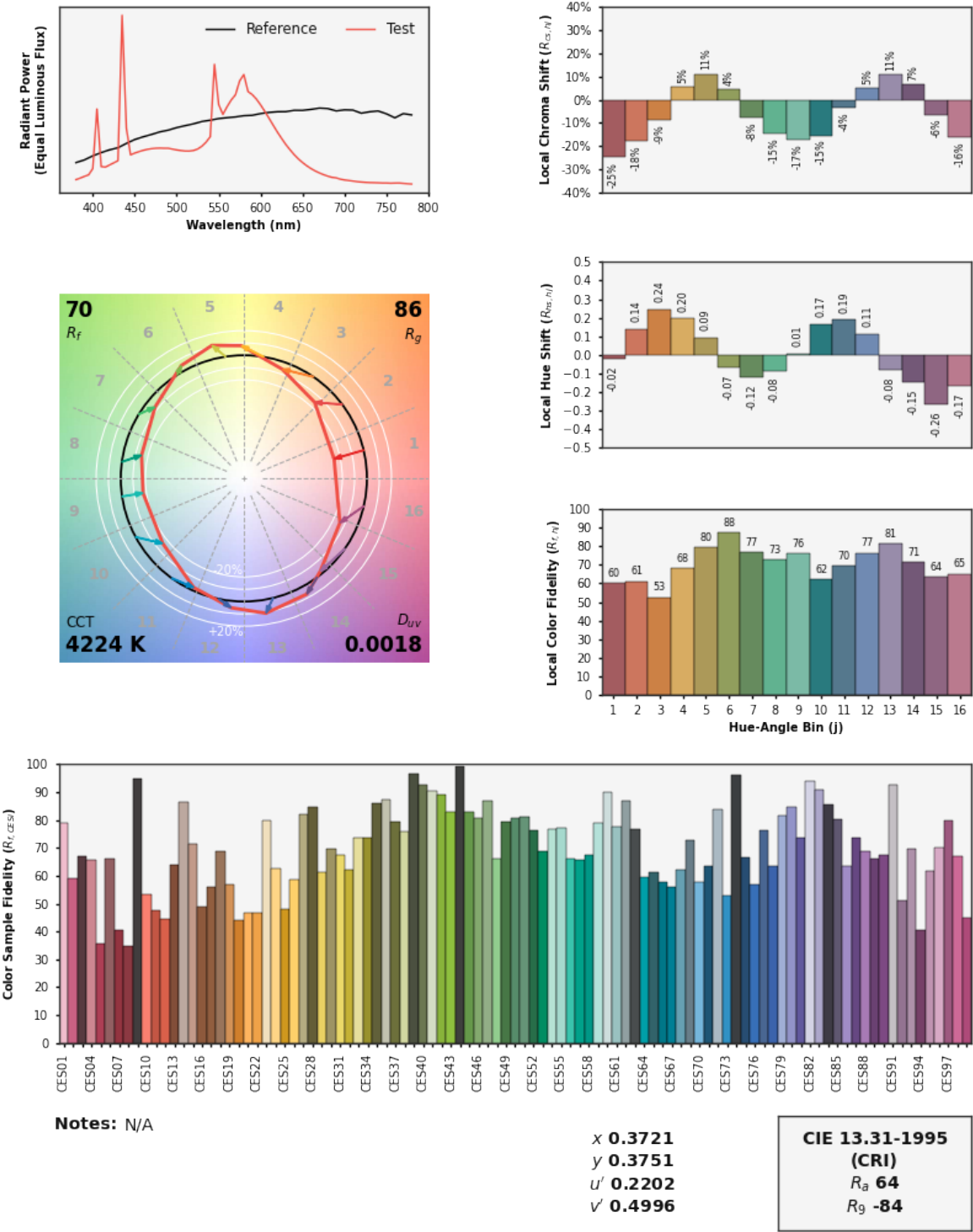
2.20.10 3.20.10 ANSI/IES TM-30-18 Colour Rendition Report

```
>>> plot_single_sd_colour_rendition_report(colour.SDS_ILLUMINANTS["FL2"])
```

IES TM-30-18 Colour Rendition Report

Source: FL2
Date: N/A

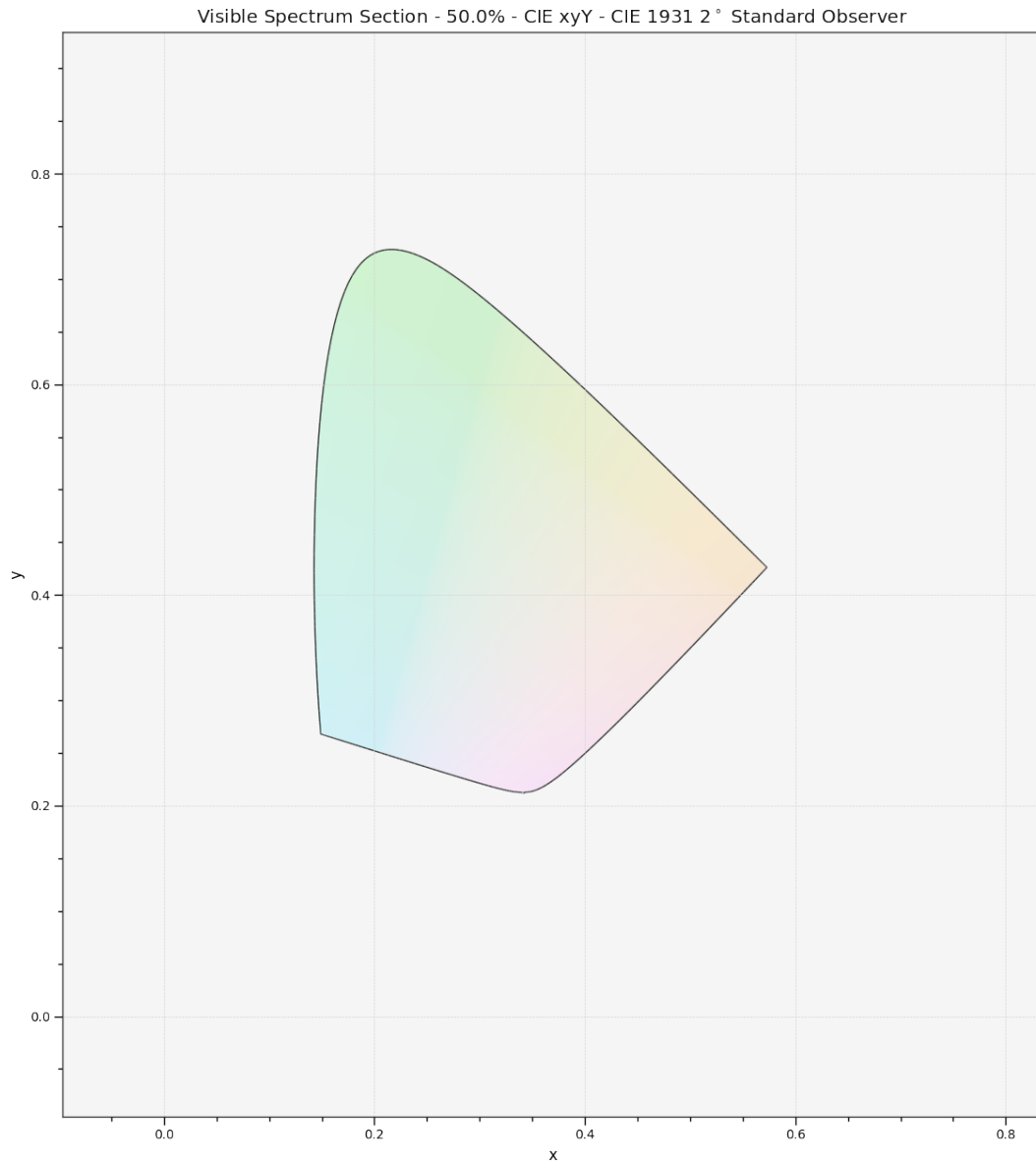
Manufacturer: N/A
Model: N/A



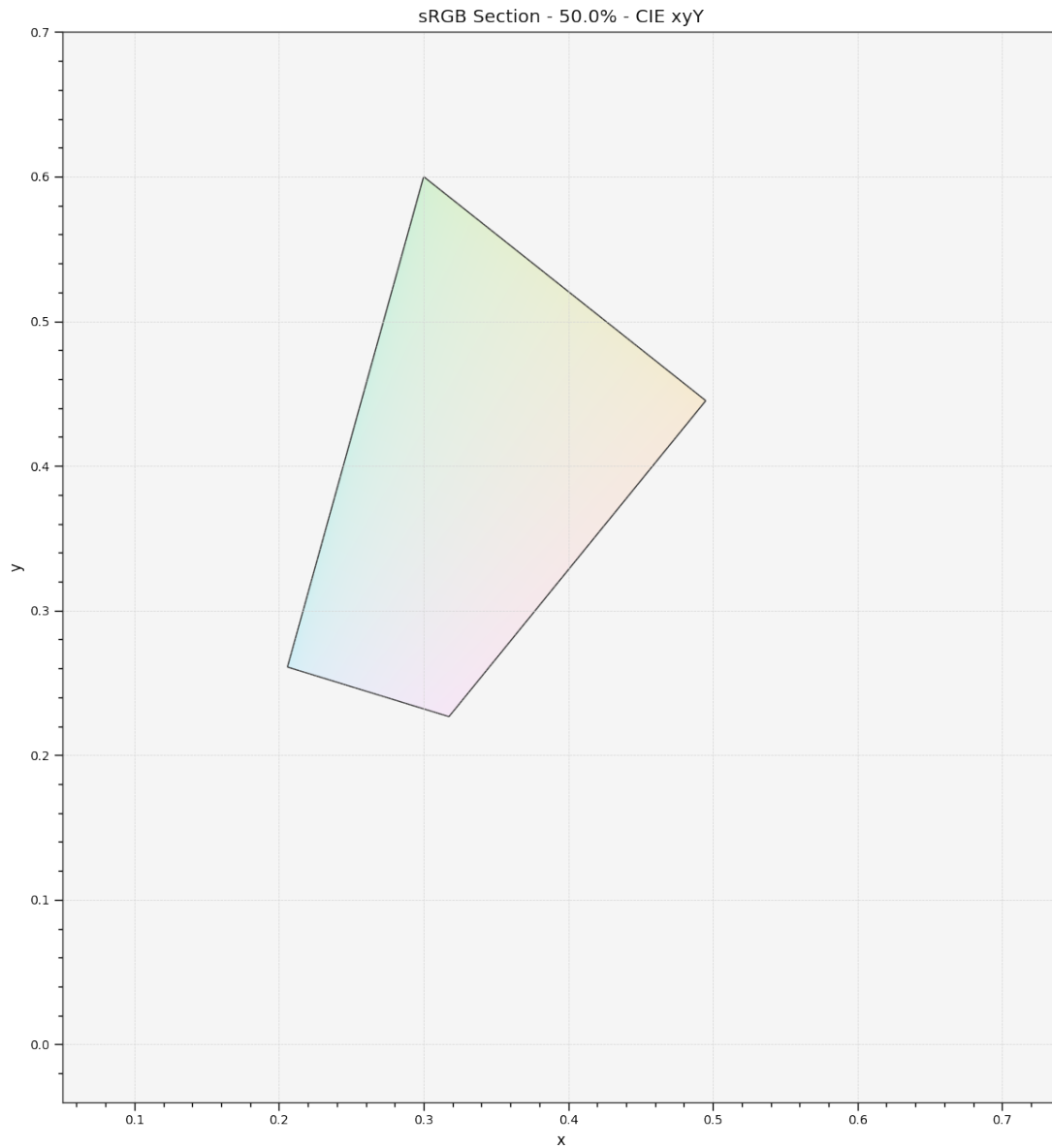
Colours are for visual orientation purposes only. Created with Colour v0.4.2-1-g2e84c889.

2.20.11 3.20.11 Gamut Section

```
>>> plot_visible_spectrum_section(  
...     section_colours="RGB", section_opacity=0.15  
... )
```

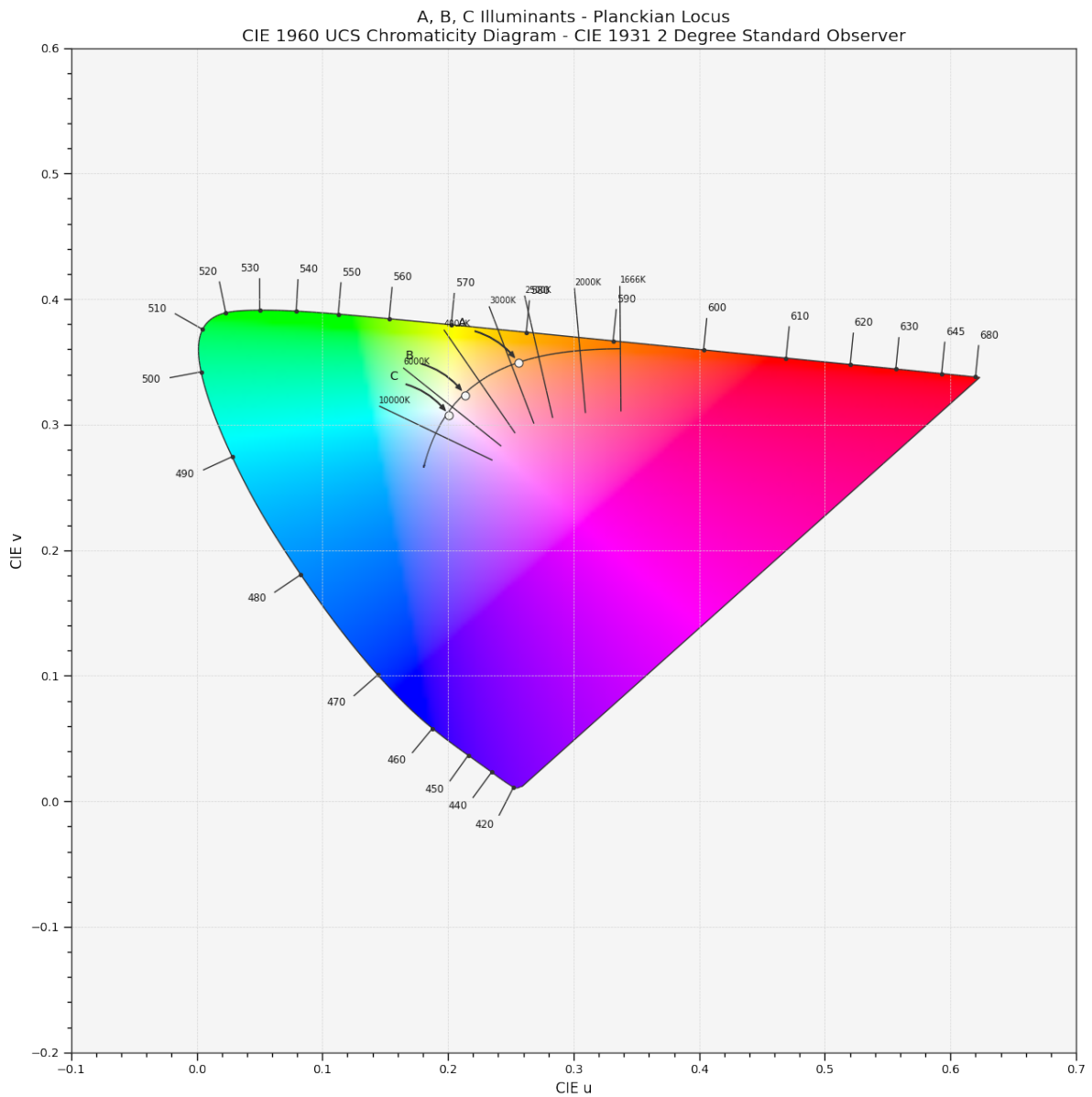


```
>>> plot_RGB_colourspace_section(  
...     "sRGB", section_colours="RGB", section_opacity=0.15  
... )
```



2.20.12 3.20.12 Colour Temperature

```
>>> plot_planckian_locus_in_chromaticity_diagram_CIE1960UCS(  
...     ["A", "B", "C"]  
... )
```



4 USER GUIDE

3.1 User Guide

The user guide provides an overview of **Colour** and explains important concepts and features, details can be found in the [API Reference](#).

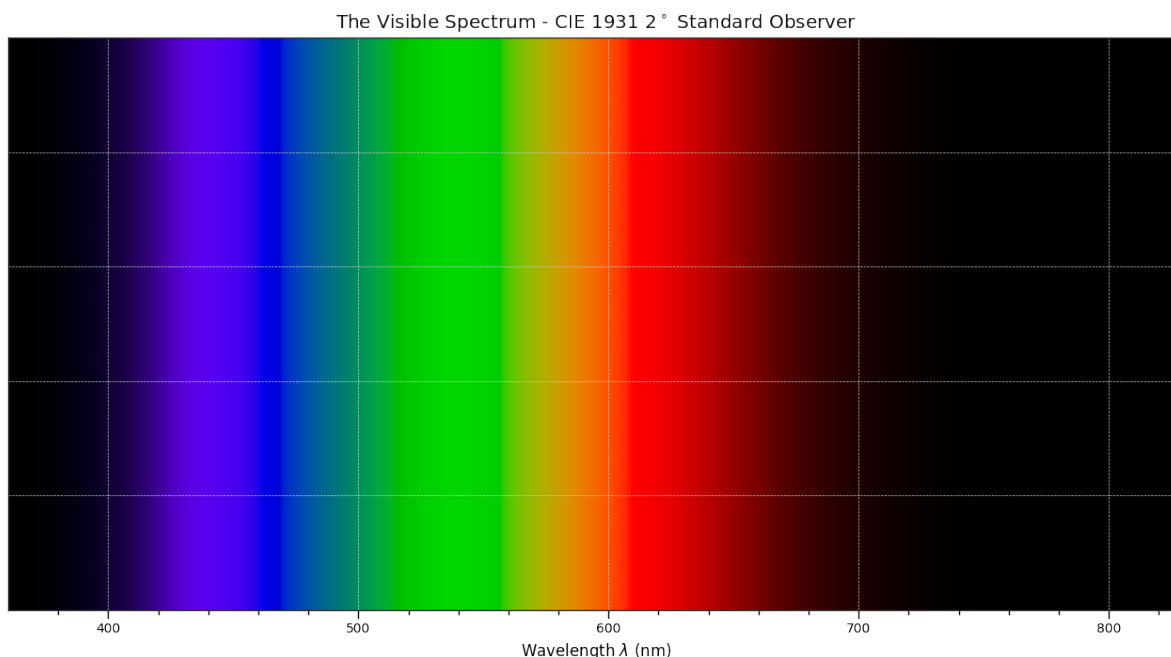
3.1.1 Tutorial

Note: An interactive version of the tutorial is available via [Google Colab](#).

Colour spreads over various domains of Colour Science, from colour models to optical phenomena, this tutorial does not give a complete overview of the API but is a good introduction to the main concepts.

Note: A directory with examples is available at this path in **Colour** installation: *colour/examples*. It can also be explored directly on [Github](#).

```
from colour.plotting import *  
  
colour_style()  
  
plot_visible_spectrum()
```



Overview

Colour is organised around various sub-packages:

- *adaptation*: Chromatic adaptation models and transformations.
- *algebra*: Algebra utilities.
- *appearance*: Colour appearance models.
- *biochemistry*: Biochemistry computations.
- *blindness*: Colour vision deficiency models.
- *characterisation*: Colour correction, camera and display characterisation.
- *colorimetry*: Core objects for colour computations.
- *constants*: *CIE* and *CODATA* constants.
- *continuous*: Base objects for continuous data representation.
- *contrast*: Objects for contrast sensitivity computation.
- *corresponding*: Corresponding colour chromaticities computations.
- *difference*: Colour difference computations.
- *geometry*: Geometry primitives generation.
- *graph*: Graph for automatic colour conversions.
- *hints*: Type hints for annotations.
- *io*: Input / output objects for reading and writing data.
- *models*: Colour models.
- *notation*: Colour notation systems.
- *phenomena*: Computation of various optical phenomena.
- *plotting*: Diagrams, figures, etc. . .
- *quality*: Colour quality computation.

- *recovery*: Reflectance recovery.
- *temperature*: Colour temperature and correlated colour temperature computation.
- *utilities*: Various utilities and data structures.
- *volume*: Colourspace volumes computation and optimal colour stimuli.

Most of the public API is available from the root colour namespace:

```
import colour

print(colour.__all__[:5] + ["..."])
```

```
['domain_range_scale', 'get_domain_range_scale', 'set_domain_range_scale', 'CHROMATIC_
↳ ADAPTATION_METHODS', 'CHROMATIC_ADAPTATION_TRANSFORMS', '...']
```

The various sub-packages also expose their public API:

```
from pprint import pprint

for sub_package in (
    "adaptation",
    "algebra",
    "appearance",
    "biochemistry",
    "blindness",
    "characterisation",
    "colorimetry",
    "constants",
    "continuous",
    "contrast",
    "corresponding",
    "difference",
    "geometry",
    "graph",
    "hints",
    "io",
    "models",
    "notation",
    "phenomena",
    "plotting",
    "quality",
    "recovery",
    "temperature",
    "utilities",
    "volume",
):
    print(sub_package.title())
    pprint(getattr(colour, sub_package).__all__[:5] + ["..."])
    print("\n")
```

```
Adaptation
['CHROMATIC_ADAPTATION_TRANSFORMS',
 'CAT_BIANCO2010',
 'CAT_BRADFORD',
 'CAT_CAT02',
 'CAT_CAT02_BRILL2008',
 '...']
```

(continues on next page)

(continued from previous page)

Algebra

```
['cartesian_to_spherical',  
 'spherical_to_cartesian',  
 'cartesian_to_polar',  
 'polar_to_cartesian',  
 'cartesian_to_cylindrical',  
 '...']
```

Appearance

```
['InductionFactors_Hunt',  
 'VIEWING_CONDITIONS_HUNT',  
 'CAM_Specification_Hunt',  
 'XYZ_to_Hunt',  
 'CAM_Specification_ATD95',  
 '...']
```

Biochemistry

```
['REACTION_RATE_MICHAELISMENTEN_METHODS',  
 'reaction_rate_MichaelisMenten',  
 'SUBSTRATE_CONCENTRATION_MICHAELISMENTEN_METHODS',  
 'substrate_concentration_MichaelisMenten',  
 'reaction_rate_MichaelisMenten_Michaelis1913',  
 '...']
```

Blindness

```
['CVD_MATRICES_MACHADO2010',  
 'msds_cmfs_anomalous_trichromacy_Machado2009',  
 'matrix_anomalous_trichromacy_Machado2009',  
 'matrix_cvd_Machado2009',  
 '...']
```

Characterisation

```
['RGB_CameraSensitivities',  
 'RGB_DisplayPrimaries',  
 'MSDS_ACES_RICD',  
 'MSDS_CAMERA_SENSITIVITIES',  
 'CCS_COLOURCHECKERS',  
 '...']
```

Colorimetry

```
['SpectralShape',  
 'SPECTRAL_SHAPE_DEFAULT',  
 'SpectralDistribution',  
 'MultiSpectralDistributions',  
 'reshape_sd',  
 '...']
```

Constants

(continues on next page)

(continued from previous page)

```
[ 'CONSTANT_K_M',
  'CONSTANT_KP_M',
  'CONSTANT_AVOGADRO',
  'CONSTANT_BOLTZMANN',
  'CONSTANT_LIGHT_SPEED',
  '...']
```

Continuous

```
['AbstractContinuousFunction', 'Signal', 'MultiSignals', '...']
```

Contrast

```
['optical_MTF_Barten1999',
 'pupil_diameter_Barten1999',
 'sigma_Barten1999',
 'retinal_illuminance_Barten1999',
 'maximum_angular_size_Barten1999',
 '...']
```

Corresponding

```
['BRENEMAN_EXPERIMENTS',
 'BRENEMAN_EXPERIMENT_PRIMARIES_CHROMATICITIES',
 'CorrespondingColourDataset',
 'CorrespondingChromaticitiesPrediction',
 'corresponding_chromaticities_prediction_CIE1994',
 '...']
```

Difference

```
['delta_E_CAM02LCD',
 'delta_E_CAM02SCD',
 'delta_E_CAM02UCS',
 'delta_E_CAM16LCD',
 'delta_E_CAM16SCD',
 '...']
```

Geometry

```
['PLANE_TO_AXIS_MAPPING',
 'primitive_grid',
 'primitive_cube',
 'hull_section',
 'PRIMITIVE_METHODS',
 '...']
```

Graph

```
['CONVERSION_GRAPH',
 'CONVERSION_GRAPH_NODE_LABELS',
 'describe_conversion_path',
 'convert',
 '...']
```

(continues on next page)

(continued from previous page)

Hints

```
['Any', 'Callable', 'Dict', 'Generator', 'Iterable', '...']
```

Io

```
['LUT1D',
 'LUT3x1D',
 'LUT3D',
 'LUT_to_LUT',
 'AbstractLUTSequenceOperator',
 '...']
```

Models

```
['Jab_to_JCh',
 'JCh_to_Jab',
 'COLOURSPACE_MODELS',
 'COLOURSPACE_MODELS_AXIS_LABELS',
 'COLOURSPACE_MODELS_DOMAIN_RANGE_SCALE_1_TO_REFERENCE',
 '...']
```

Notation

```
['MUNSELL_COLOURS_ALL',
 'MUNSELL_COLOURS_1929',
 'MUNSELL_COLOURS_REAL',
 'MUNSELL_COLOURS',
 'munsell_value',
 '...']
```

Phenomena

```
['scattering_cross_section',
 'rayleigh_optical_depth',
 'rayleigh_scattering',
 'sd_rayleigh_scattering',
 '...']
```

Plotting

```
['SD_ASTMG173_ETR',
 'SD_ASTMG173_GLOBAL_TILT',
 'SD_ASTMG173_DIRECT_CIRCUMSOLAR',
 'CONSTANTS_COLOUR_STYLE',
 'CONSTANTS_ARROW_STYLE',
 '...']
```

Quality

```
['SDS_TCS',
 'SDS_VS',
 'ColourRendering_Specification_CIE2017',
 'colour_fidelity_index_CIE2017',
 'ColourQuality_Specification_ANSIESTM3018',
 '...']
```

(continues on next page)

(continued from previous page)

Recovery

```
[ 'SPECTRAL_SHAPE_sRGB_MALLET2019',
  'MSDS_BASIS_FUNCTIONS_sRGB_MALLET2019',
  'SPECTRAL_SHAPE_OTSU2018',
  'BASIS_FUNCTIONS_OTSU2018',
  'CLUSTER_MEANS_OTSU2018',
  '...']
```

Temperature

```
['xy_to_CCT_CIE_D',
 'CCT_to_xy_CIE_D',
 'xy_to_CCT_Hernandez1999',
 'CCT_to_xy_Hernandez1999',
 'xy_to_CCT_Kang2002',
 '...']
```

Utilities

```
['Lookup',
 'Structure',
 'CanonicalMapping',
 'LazyCanonicalMapping',
 'Node',
 '...']
```

Volume

```
['OPTIMAL_COLOUR_STIMULI_ILLUMINANTS',
 'is_within_macadam_limits',
 'is_within_mesh_volume',
 'is_within_pointer_gamut',
 'generate_pulse_waves',
 '...']
```

The codebase is documented and most docstrings have usage examples:

```
print(colour.temperature.CCT_to_uv_Ohno2013.__doc__)
```

Return the *CIE UCS* colourspace *uv* chromaticity coordinates from given correlated colour temperature :math:T_{cp}, :math:\Delta_{uv} and colour matching functions using *Ohno (2013)* method.

Parameters

CCT_D_uv

Correlated colour temperature :math:T_{cp}, :math:\Delta_{uv}.

cmfs

Standard observer colour matching functions, default to the *CIE 1931 2 Degree Standard Observer*.

Returns

:class:`numpy.ndarray`

CIE UCS colourspace *uv* chromaticity coordinates.

(continues on next page)

(continued from previous page)

References

`:cite:`Ohno2014a``

Examples

```
>>> from pprint import pprint
>>> from colour import MSDS_CMFS, SPECTRAL_SHAPE_DEFAULT
>>> cmfs = (
...     MSDS_CMFS["CIE 1931 2 Degree Standard Observer"]
...     .copy()
...     .align(SPECTRAL_SHAPE_DEFAULT)
... )
>>> CCT_D_uv = np.array([6507.4342201047066, 0.003223690901513])
>>> CCT_to_uv_Ohno2013(CCT_D_uv, cmfs) # doctest: +ELLIPSIS
array([ 0.1977999...,  0.3122004...])
```

At the core of **Colour** is the `colour.colorimetry` sub-package, it defines the objects needed for spectral computations and many others:

```
pprint(colour.colorimetry.__all__)
```

```
['SpectralShape',
 'SPECTRAL_SHAPE_DEFAULT',
 'SpectralDistribution',
 'MultiSpectralDistributions',
 'reshape_sd',
 'reshape_msds',
 'sds_and_msds_to_sds',
 'sds_and_msds_to_msds',
 'sd_blackbody',
 'blackbody_spectral_radiance',
 'planck_law',
 'LMS_ConeFundamentals',
 'RGB_ColourMatchingFunctions',
 'XYZ_ColourMatchingFunctions',
 'CCS_ILLUMINANTS',
 'MSDS_CMFS',
 'MSDS_CMFS_LMS',
 'MSDS_CMFS_RGB',
 'MSDS_CMFS_STANDARD_OBSERVER',
 'SDS_BASIS_FUNCTIONS_CIE_ILLUMINANT_D_SERIES',
 'SDS_ILLUMINANTS',
 'SDS_LEFS',
 'SDS_LEFS_PHOTOPIC',
 'SDS_LEFS_SCOTOPIC',
 'TVS_ILLUMINANTS',
 'TVS_ILLUMINANTS_HUNTERLAB',
 'CCS_LIGHT_SOURCES',
 'SDS_LIGHT_SOURCES',
 'sd_constant',
 'sd_zeros',
 'sd_ones',
 'msds_constant',
 'msds_zeros',
```

(continues on next page)

(continued from previous page)

```

'msds_ones',
'SD_GAUSSIAN_METHODS',
'sd_gaussian',
'sd_gaussian_normal',
'sd_gaussian_fwhm',
'SD_SINGLE_LED_METHODS',
'sd_single_led',
'sd_single_led_Ohno2005',
'SD_MULTI_LEDS_METHODS',
'sd_multi_leds',
'sd_multi_leds_Ohno2005',
'SD_TO_XYZ_METHODS',
'MSDS_TO_XYZ_METHODS',
'sd_to_XYZ',
'msds_to_XYZ',
'SPECTRAL_SHAPE_ASTME308',
'handle_spectral_arguments',
'lagrange_coefficients_ASTME2022',
'tristimulus_weighting_factors_ASTME2022',
'adjust_tristimulus_weighting_factors_ASTME308',
'sd_to_XYZ_integration',
'sd_to_XYZ_tristimulus_weighting_factors_ASTME308',
'sd_to_XYZ_ASTME308',
'msds_to_XYZ_integration',
'msds_to_XYZ_ASTME308',
'wavelength_to_XYZ',
'spectral_uniformity',
'BANDPASS_CORRECTION_METHODS',
'bandpass_correction',
'bandpass_correction_Stearns1988',
'sd_CIE_standard_illuminant_A',
'sd_CIE_illuminant_D_series',
'daylight_locus_function',
'sd_mesopic_luminous_efficiency_function',
'mesopic_weighting_function',
'LIGHTNESS_METHODS',
'lightness',
'lightness_Glasser1958',
'lightness_Wyszecki1963',
'lightness_CIE1976',
'lightness_Fairchild2010',
'lightness_Fairchild2011',
'lightness_Abebe2017',
'intermediate_lightness_function_CIE1976',
'LUMINANCE_METHODS',
'luminance',
'luminance_Newhall1943',
'luminance_ASTMD1535',
'luminance_CIE1976',
'luminance_Fairchild2010',
'luminance_Fairchild2011',
'luminance_Abebe2017',
'intermediate_luminance_function_CIE1976',
'dominant_wavelength',
'complementary_wavelength',
'excitation_purity',

```

(continues on next page)

(continued from previous page)

```
'colorimetric_purity',
'luminous_flux',
'luminous_efficiency',
'luminous_efficacy',
'RGB_10_degree_cmfs_to_LMS_10_degree_cmfs',
'RGB_2_degree_cmfs_to_XYZ_2_degree_cmfs',
'RGB_10_degree_cmfs_to_XYZ_10_degree_cmfs',
'LMS_2_degree_cmfs_to_XYZ_2_degree_cmfs',
'LMS_10_degree_cmfs_to_XYZ_10_degree_cmfs',
'WHITENESS_METHODS',
'whiteness',
'whiteness_Berger1959',
'whiteness-Taube1960',
'whiteness_Stensby1968',
'whiteness_ASTME313',
'whiteness_Ganz1979',
'whiteness_CIE2004',
'YELLOWNESS_METHODS',
'yellowness',
'yellowness_ASTMD1925',
'yellowness_ASTME313_alternative',
'YELLOWNESS_COEFFICIENTS_ASTME313',
'yellowness_ASTME313']
```

Colour computations leverage a comprehensive quantity of datasets available in most sub-packages, for example the `colour.colorimetry.datasets` defines the following components:

```
pprint(colour.colorimetry.datasets.__all__)
```

```
['MSDS_CMFS',
'MSDS_CMFS_LMS',
'MSDS_CMFS_RGB',
'MSDS_CMFS_STANDARD_OBSERVER',
'CCS_ILLUMINANTS',
'SDS_BASIS_FUNCTIONS_CIE_ILLUMINANT_D_SERIES',
'TVS_ILLUMINANTS_HUNTERLAB',
'SDS_ILLUMINANTS',
'TVS_ILLUMINANTS',
'CCS_LIGHT_SOURCES',
'SDS_LIGHT_SOURCES',
'SDS_LEFS',
'SDS_LEFS_PHOTOPIC',
'SDS_LEFS_SCOTOPIC']
```

From Spectral Distribution

Whether it be a sample spectral distribution, colour matching functions or illuminants, spectral data is manipulated using an object built with the `colour.SpectralDistribution` class or based on it:

```
# Defining a sample spectral distribution data.
data_sample = {
    380: 0.048,
    385: 0.051,
    390: 0.055,
    395: 0.060,
```

(continues on next page)

(continued from previous page)

400: 0.065,
405: 0.068,
410: 0.068,
415: 0.067,
420: 0.064,
425: 0.062,
430: 0.059,
435: 0.057,
440: 0.055,
445: 0.054,
450: 0.053,
455: 0.053,
460: 0.052,
465: 0.052,
470: 0.052,
475: 0.053,
480: 0.054,
485: 0.055,
490: 0.057,
495: 0.059,
500: 0.061,
505: 0.062,
510: 0.065,
515: 0.067,
520: 0.070,
525: 0.072,
530: 0.074,
535: 0.075,
540: 0.076,
545: 0.078,
550: 0.079,
555: 0.082,
560: 0.087,
565: 0.092,
570: 0.100,
575: 0.107,
580: 0.115,
585: 0.122,
590: 0.129,
595: 0.134,
600: 0.138,
605: 0.142,
610: 0.146,
615: 0.150,
620: 0.154,
625: 0.158,
630: 0.163,
635: 0.167,
640: 0.173,
645: 0.180,
650: 0.188,
655: 0.196,
660: 0.204,
665: 0.213,
670: 0.222,
675: 0.231,

(continues on next page)

(continued from previous page)

```

680: 0.242,
685: 0.251,
690: 0.261,
695: 0.271,
700: 0.282,
705: 0.294,
710: 0.305,
715: 0.318,
720: 0.334,
725: 0.354,
730: 0.372,
735: 0.392,
740: 0.409,
745: 0.420,
750: 0.436,
755: 0.450,
760: 0.462,
765: 0.465,
770: 0.448,
775: 0.432,
780: 0.421,
}

sd = colour.SpectralDistribution(data_sample, name="Sample")
print(repr(sd))

```

```

SpectralDistribution([[ 3.80000000e+02,  4.80000000e-02],
 [ 3.85000000e+02,  5.10000000e-02],
 [ 3.90000000e+02,  5.50000000e-02],
 [ 3.95000000e+02,  6.00000000e-02],
 [ 4.00000000e+02,  6.50000000e-02],
 [ 4.05000000e+02,  6.80000000e-02],
 [ 4.10000000e+02,  6.80000000e-02],
 [ 4.15000000e+02,  6.70000000e-02],
 [ 4.20000000e+02,  6.40000000e-02],
 [ 4.25000000e+02,  6.20000000e-02],
 [ 4.30000000e+02,  5.90000000e-02],
 [ 4.35000000e+02,  5.70000000e-02],
 [ 4.40000000e+02,  5.50000000e-02],
 [ 4.45000000e+02,  5.40000000e-02],
 [ 4.50000000e+02,  5.30000000e-02],
 [ 4.55000000e+02,  5.30000000e-02],
 [ 4.60000000e+02,  5.20000000e-02],
 [ 4.65000000e+02,  5.20000000e-02],
 [ 4.70000000e+02,  5.20000000e-02],
 [ 4.75000000e+02,  5.30000000e-02],
 [ 4.80000000e+02,  5.40000000e-02],
 [ 4.85000000e+02,  5.50000000e-02],
 [ 4.90000000e+02,  5.70000000e-02],
 [ 4.95000000e+02,  5.90000000e-02],
 [ 5.00000000e+02,  6.10000000e-02],
 [ 5.05000000e+02,  6.20000000e-02],
 [ 5.10000000e+02,  6.50000000e-02],
 [ 5.15000000e+02,  6.70000000e-02],
 [ 5.20000000e+02,  7.00000000e-02],
 [ 5.25000000e+02,  7.20000000e-02],

```

(continues on next page)

(continued from previous page)

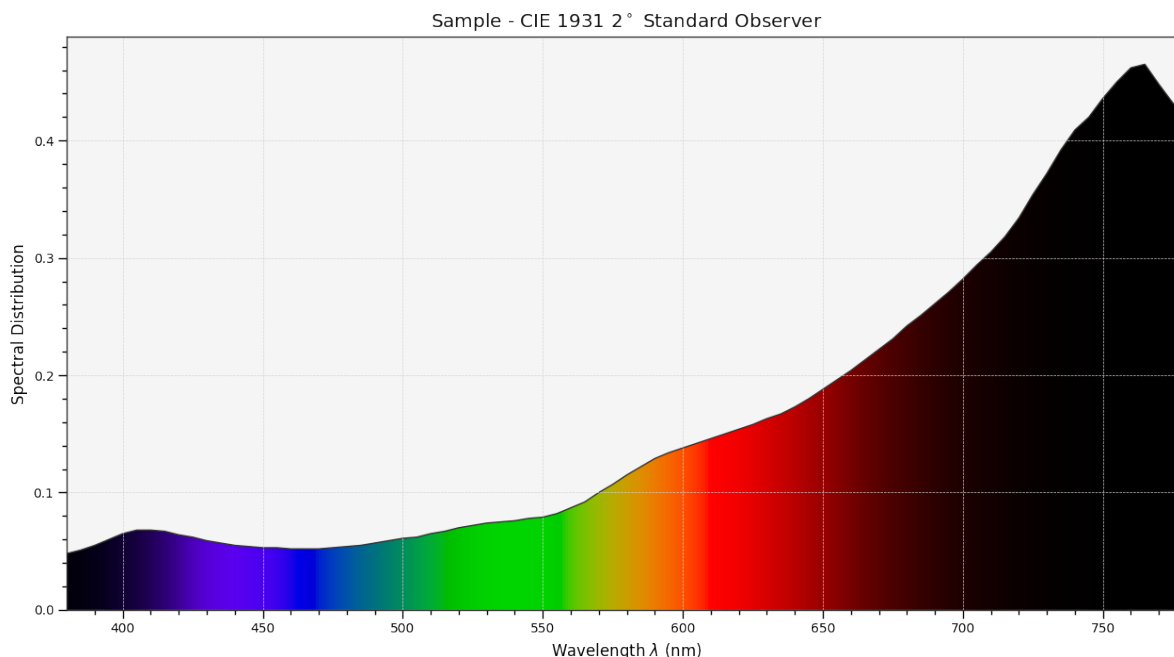
```

[ 5.30000000e+02, 7.40000000e-02],
[ 5.35000000e+02, 7.50000000e-02],
[ 5.40000000e+02, 7.60000000e-02],
[ 5.45000000e+02, 7.80000000e-02],
[ 5.50000000e+02, 7.90000000e-02],
[ 5.55000000e+02, 8.20000000e-02],
[ 5.60000000e+02, 8.70000000e-02],
[ 5.65000000e+02, 9.20000000e-02],
[ 5.70000000e+02, 1.00000000e-01],
[ 5.75000000e+02, 1.07000000e-01],
[ 5.80000000e+02, 1.15000000e-01],
[ 5.85000000e+02, 1.22000000e-01],
[ 5.90000000e+02, 1.29000000e-01],
[ 5.95000000e+02, 1.34000000e-01],
[ 6.00000000e+02, 1.38000000e-01],
[ 6.05000000e+02, 1.42000000e-01],
[ 6.10000000e+02, 1.46000000e-01],
[ 6.15000000e+02, 1.50000000e-01],
[ 6.20000000e+02, 1.54000000e-01],
[ 6.25000000e+02, 1.58000000e-01],
[ 6.30000000e+02, 1.63000000e-01],
[ 6.35000000e+02, 1.67000000e-01],
[ 6.40000000e+02, 1.73000000e-01],
[ 6.45000000e+02, 1.80000000e-01],
[ 6.50000000e+02, 1.88000000e-01],
[ 6.55000000e+02, 1.96000000e-01],
[ 6.60000000e+02, 2.04000000e-01],
[ 6.65000000e+02, 2.13000000e-01],
[ 6.70000000e+02, 2.22000000e-01],
[ 6.75000000e+02, 2.31000000e-01],
[ 6.80000000e+02, 2.42000000e-01],
[ 6.85000000e+02, 2.51000000e-01],
[ 6.90000000e+02, 2.61000000e-01],
[ 6.95000000e+02, 2.71000000e-01],
[ 7.00000000e+02, 2.82000000e-01],
[ 7.05000000e+02, 2.94000000e-01],
[ 7.10000000e+02, 3.05000000e-01],
[ 7.15000000e+02, 3.18000000e-01],
[ 7.20000000e+02, 3.34000000e-01],
[ 7.25000000e+02, 3.54000000e-01],
[ 7.30000000e+02, 3.72000000e-01],
[ 7.35000000e+02, 3.92000000e-01],
[ 7.40000000e+02, 4.09000000e-01],
[ 7.45000000e+02, 4.20000000e-01],
[ 7.50000000e+02, 4.36000000e-01],
[ 7.55000000e+02, 4.50000000e-01],
[ 7.60000000e+02, 4.62000000e-01],
[ 7.65000000e+02, 4.65000000e-01],
[ 7.70000000e+02, 4.48000000e-01],
[ 7.75000000e+02, 4.32000000e-01],
[ 7.80000000e+02, 4.21000000e-01]],
interpolator=SpragueInterpolator,
interpolator_args={},
extrapolator=Extrapolator,
extrapolator_args={u'right': None, u'method': u'Constant', u'left':
↪ None}}

```

The sample spectral distribution can be easily plotted against the visible spectrum:

```
# Plotting the sample spectral distribution.
plot_single_sd(sd)
```



With the sample spectral distribution defined, its shape is retrieved as follows:

```
# Displaying the sample spectral distribution shape.
print(sd.shape)
```

```
(380.0, 780.0, 5.0)
```

The returned shape is an instance of the `colour.SpectralShape` class:

```
repr(sd.shape)
```

```
'SpectralShape(380.0, 780.0, 5.0)'
```

The `colour.SpectralShape` class is used throughout **Colour** to define spectral dimensions and is instantiated as follows:

```
# Using *colour.SpectralShape* with iteration.
shape = colour.SpectralShape(start=0, end=10, interval=1)
for wavelength in shape:
    print(wavelength)

# *colour.SpectralShape.wavelengths* property is providing the complete
# range of wavelengths.
shape = colour.SpectralShape(0, 10, 0.5)
shape.wavelengths
```

```
0.0
1.0
2.0
3.0
```

(continues on next page)

(continued from previous page)

```
4.0
5.0
6.0
7.0
8.0
9.0
10.0
```

```
array([ 0. ,  0.5,  1. ,  1.5,  2. ,  2.5,  3. ,  3.5,  4. ,
        4.5,  5. ,  5.5,  6. ,  6.5,  7. ,  7.5,  8. ,  8.5,
        9. ,  9.5, 10. ])
```

Colour defines three convenient objects to create constant spectral distributions:

- `colour.sd_constant`
- `colour.sd_zeros`
- `colour.sd_ones`

```
# Defining a constant spectral distribution.
sd_constant = colour.sd_constant(100)
print('"Constant Spectral Distribution"')
print(sd_constant.shape)
print(sd_constant[400])

# Defining a zeros filled spectral distribution.
print('\n"Zeros Filled Spectral Distribution"')
sd_zeros = colour.sd_zeros()
print(sd_zeros.shape)
print(sd_zeros[400])

# Defining a ones filled spectral distribution.
print('\n"Ones Filled Spectral Distribution"')
sd_ones = colour.sd_ones()
print(sd_ones.shape)
print(sd_ones[400])
```

```
"Constant Spectral Distribution"
(360.0, 780.0, 1.0)
100.0

"Zeros Filled Spectral Distribution"
(360.0, 780.0, 1.0)
0.0

"Ones Filled Spectral Distribution"
(360.0, 780.0, 1.0)
1.0
```

By default the shape used by `colour.sd_constant`, `colour.sd_zeros` and `colour.sd_ones` is the one defined by the `colour.SPECTRAL_SHAPE_DEFAULT` attribute and based on *ASTM E308-15* practise shape.

```
print(repr(colour.SPECTRAL_SHAPE_DEFAULT))
```

```
SpectralShape(360, 780, 1)
```

A custom shape can be passed to construct a constant spectral distribution with user defined dimensions:

```
colour.sd_ones(colour.SpectralShape(400, 700, 5))[450]
```

```
1.0
```

The `colour.SpectralDistribution` class supports the following arithmetical operations:

- *addition*
- *subtraction*
- *multiplication*
- *division*
- *exponentiation*

```
sd1 = colour.sd_ones()
print('"Ones Filled Spectral Distribution"')
print(sd1[400])

print('\n"x2 Constant Multiplied"')
print((sd1 * 2)[400])

print('\n"+ Spectral Distribution"')
print((sd1 + colour.sd_ones())[400])
```

```
"Ones Filled Spectral Distribution"
1.0

"x2 Constant Multiplied"
2.0

"+ Spectral Distribution"
2.0
```

Often interpolation of the spectral distribution is required, this is achieved with the `colour.SpectralDistribution.interpolate` method. Depending on the wavelengths uniformity, the default interpolation method will differ. Following *CIE 167:2005* recommendation: The method developed by *Sprague (1880)* should be used for interpolating functions having a uniformly spaced independent variable and a *Cubic Spline* method for non-uniformly spaced independent variable [CIET13805a].

The uniformity of the sample spectral distribution is assessed as follows:

```
# Checking the sample spectral distribution uniformity.
print(sd.is_uniform())
```

```
True
```

In this case, since the sample spectral distribution is uniform the interpolation defaults to the `colour.SpragueInterpolator` interpolator.

Note: Interpolation happens in place and may alter the original data, use the `colour.SpectralDistribution.copy` method to generate a copy of the spectral distribution before interpolation.

```
# Copying the sample spectral distribution.
sd_copy = sd.copy()
```

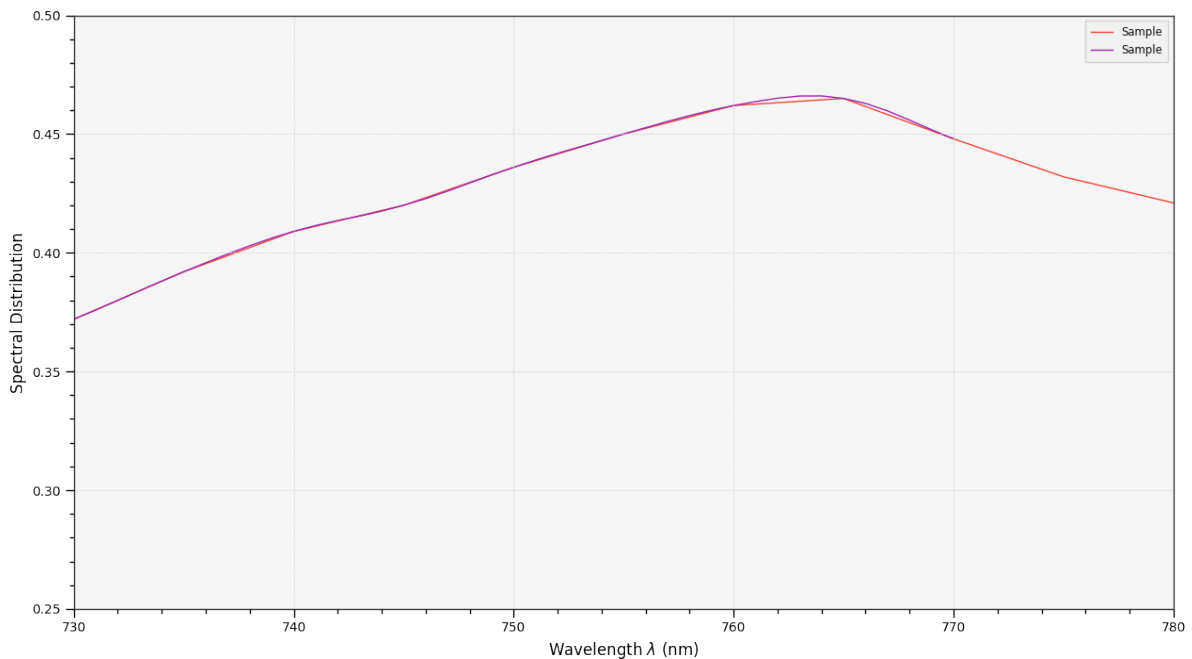
(continues on next page)

(continued from previous page)

```
# Interpolating the copied sample spectral distribution.
sd_copy.interpolate(colour.SpectralShape(400, 770, 1))
sd_copy[401]
```

```
0.065809599999999996
```

```
# Comparing the interpolated spectral distribution with the original one.
plot_multi_sds([sd, sd_copy], bounding_box=[730, 780, 0.25, 0.5])
```



Extrapolation although dangerous can be used to help aligning two spectral distributions together. *CIE publication CIE 15:2004 “Colorimetry”* recommends that unmeasured values may be set equal to the nearest measured value of the appropriate quantity in truncation [[CIET14804f](#)]:

```
# Extrapolating the copied sample spectral distribution.
sd_copy.extrapolate(colour.SpectralShape(340, 830, 1))
sd_copy[340], sd_copy[830]
```

```
(0.065000000000000002, 0.44800000000000018)
```

The underlying interpolator can be swapped for any of the **Colour** interpolators:

```
pprint(
    [
        export
        for export in colour.algebra.interpolation.__all__
        if "Interpolator" in export
    ]
)
```

```
[u'KernelInterpolator',
 u'LinearInterpolator',
 u'SpragueInterpolator',
 u'CubicSplineInterpolator',
```

(continues on next page)

(continued from previous page)

```
u'PchipInterpolator',
u'NullInterpolator']
```

```
# Changing interpolator while trimming the copied spectral distribution.
sd_copy.interpolate(
    colour.SpectralShape(400, 700, 10),
    interpolator=colour.LinearInterpolator,
)
```

```
SpectralDistribution([[ 4.00000000e+02,  6.50000000e-02],
                    [ 4.10000000e+02,  6.80000000e-02],
                    [ 4.20000000e+02,  6.40000000e-02],
                    [ 4.30000000e+02,  5.90000000e-02],
                    [ 4.40000000e+02,  5.50000000e-02],
                    [ 4.50000000e+02,  5.30000000e-02],
                    [ 4.60000000e+02,  5.20000000e-02],
                    [ 4.70000000e+02,  5.20000000e-02],
                    [ 4.80000000e+02,  5.40000000e-02],
                    [ 4.90000000e+02,  5.70000000e-02],
                    [ 5.00000000e+02,  6.10000000e-02],
                    [ 5.10000000e+02,  6.50000000e-02],
                    [ 5.20000000e+02,  7.00000000e-02],
                    [ 5.30000000e+02,  7.40000000e-02],
                    [ 5.40000000e+02,  7.60000000e-02],
                    [ 5.50000000e+02,  7.90000000e-02],
                    [ 5.60000000e+02,  8.70000000e-02],
                    [ 5.70000000e+02,  1.00000000e-01],
                    [ 5.80000000e+02,  1.15000000e-01],
                    [ 5.90000000e+02,  1.29000000e-01],
                    [ 6.00000000e+02,  1.38000000e-01],
                    [ 6.10000000e+02,  1.46000000e-01],
                    [ 6.20000000e+02,  1.54000000e-01],
                    [ 6.30000000e+02,  1.63000000e-01],
                    [ 6.40000000e+02,  1.73000000e-01],
                    [ 6.50000000e+02,  1.88000000e-01],
                    [ 6.60000000e+02,  2.04000000e-01],
                    [ 6.70000000e+02,  2.22000000e-01],
                    [ 6.80000000e+02,  2.42000000e-01],
                    [ 6.90000000e+02,  2.61000000e-01],
                    [ 7.00000000e+02,  2.82000000e-01]],
                    interpolator=SpragueInterpolator,
                    interpolator_args={},
                    extrapolator=Extrapolator,
                    extrapolator_args={u'right': None, u'method': u'Constant', u'left':
None}))
```

The extrapolation behaviour can be changed for Linear method instead of the Constant default method or even use arbitrary constant left and right values:

```
# Extrapolating the copied sample spectral distribution with *Linear* method.
sd_copy.extrapolate(
    colour.SpectralShape(340, 830, 1),
    extrapolator_kwargs={"method": "Linear", "right": 0},
)
sd_copy[340], sd_copy[830]
```

```
(0.0469999999999999348, 0.0)
```

Aligning a spectral distribution is a convenient way to first interpolate the current data within its original bounds, then, if required, extrapolate any missing values to match the requested shape:

```
# Aligning the cloned sample spectral distribution.
# The spectral distribution is first trimmed as above.
sd_copy.interpolate(colour.SpectralShape(400, 700, 1))
sd_copy.align(colour.SpectralShape(340, 830, 5))
sd_copy[340], sd_copy[830]
```

```
(0.0650000000000000002, 0.28199999999999975)
```

The `colour.SpectralDistribution` class also supports various arithmetic operations like *addition*, *subtraction*, *multiplication*, *division* or *exponentiation* with *numeric* and *array_like* variables or other `colour.SpectralDistribution` class instances:

```
sd = colour.SpectralDistribution(
    {
        410: 0.25,
        420: 0.50,
        430: 0.75,
        440: 1.0,
        450: 0.75,
        460: 0.50,
        480: 0.25,
    }
)

print((sd.copy() + 1).values)
print((sd.copy() * 2).values)
print((sd * [0.35, 1.55, 0.75, 2.55, 0.95, 0.65, 0.15]).values)
print(
    (
        sd
        * colour.sd_constant(2, sd.shape)
        * colour.sd_constant(3, sd.shape)
    ).values
)
```

```
[ 1.25  1.5   1.75  2.    1.75  1.5   1.25]
[ 0.5   1.    1.5   2.    1.5   1.    0.5]
[ 0.0875 0.775 0.5625 2.55   0.7125 0.325 0.0375]
[ 1.5   3.    4.5   6.    4.5   3.    nan  1.5]
```

The spectral distribution can be normalised with an arbitrary factor:

```
print(sd.normalise().values)
print(sd.normalise(100).values)
```

```
[ 0.25  0.5   0.75  1.    0.75  0.5   0.25]
[ 25.   50.   75.  100.   75.   50.   25.]
```

At the heart of the `colour.SpectralDistribution` class is the `colour.continuous.Signal` class which implements the `colour.continuous.Signal.function` method.

Evaluating the function for any independent domain $x \in \mathbb{R}$ variable returns a corresponding range $y \in \mathbb{R}$

variable.

It adopts an interpolating function encapsulated inside an extrapolating function. The resulting function independent domain, stored as discrete values in the `colour.continuous.Signal.domain` attribute corresponds with the function dependent and already known range stored in the `colour.continuous.Signal.range` attribute.

Describing the `colour.continuous.Signal` class is beyond the scope of this tutorial but the core capability can be described.

```
import numpy as np

range_ = np.linspace(10, 100, 10)
signal = colour.continuous.Signal(range_)
print(repr(signal))
```

```
Signal([[ 0.,  10.],
 [ 1.,  20.],
 [ 2.,  30.],
 [ 3.,  40.],
 [ 4.,  50.],
 [ 5.,  60.],
 [ 6.,  70.],
 [ 7.,  80.],
 [ 8.,  90.],
 [ 9., 100.]],
 interpolator=KernelInterpolator,
 interpolator_kwargs={},
 extrapolator=Extrapolator,
 extrapolator_kwargs={'right': nan, 'method': 'Constant', 'left': nan})
```

```
# Returning the corresponding range *x* variable for any arbitrary independent domain *x*_
↳ variable.
signal[np.random.uniform(0, 9, 10)]
```

```
array([ 55.91309735,  65.4172615 ,  65.54495059,  88.17819416,
        61.88860248,  10.53878826,  55.25130534,  46.14659783,
        86.41406136,  84.59897703])
```

Convert to Tristimulus Values

From a given spectral distribution, *CIE XYZ* tristimulus values can be calculated:

```
sd = colour.SpectralDistribution(data_sample)
cmfs = colour.MSDS_CMFS["CIE 1931 2 Degree Standard Observer"]
illuminant = colour.SDS_ILLUMINANTS["D65"]

# Calculating the sample spectral distribution *CIE XYZ* tristimulus values.
XYZ = colour.sd_to_XYZ(sd, cmfs, illuminant)
print(XYZ)
```

```
[ 10.97085572   9.70278591   6.05562778]
```

From CIE XYZ Colourspace

CIE XYZ is the central colourspace for Colour Science from which many computations are available, expanding to even more computations:

```
# Displaying objects interacting directly with the *CIE XYZ* colourspace.
pprint(colour.COLOURSPACE_MODELS)
```

```
('CAM02LCD',
 'CAM02SCD',
 'CAM02UCS',
 'CAM16LCD',
 'CAM16SCD',
 'CAM16UCS',
 'CIE XYZ',
 'CIE xyY',
 'CIE Lab',
 'CIE LCHab',
 'CIE Luv',
 'CIE Luv uv',
 'CIE LCHuv',
 'CIE UCS',
 'CIE UCS uv',
 'CIE UVW',
 'DIN99',
 'Hunter Lab',
 'Hunter Rdab',
 'ICtCp',
 'IPT',
 'IgPgTg',
 'Jzazbz',
 'OSA UCS',
 'Oklab',
 'hdr-CIELAB',
 'hdr-IPT')
```

Convert to Display Colours

CIE XYZ tristimulus values can be converted into *sRGB* colourspace *RGB* values in order to display them on screen:

```
# The output domain of *colour.sd_to_XYZ* is [0, 100] and the input
# domain of *colour.XYZ_to_sRGB* is [0, 1]. It needs to be accounted for,
# thus the input *CIE XYZ* tristimulus values are scaled.
RGB = colour.XYZ_to_sRGB(XYZ / 100)
print(RGB)
```

```
[ 0.45675795  0.30986982  0.24861924]
```

```
# Plotting the *sRGB* colourspace colour of the *Sample* spectral distribution.
plot_single_colour_swatch(
    ColourSwatch(RGB, "Sample"), text_kwargs={"size": "x-large"}
)
```



Generate Colour Rendition Charts

Likewise, colour values from a colour rendition chart sample can be computed.

Note: This is useful for render time checks in the VFX industry, where a synthetic colour chart can be inserted into a render to ensure the colour management is acting as expected.

The `colour.characterisation` sub-package contains the dataset for various colour rendition charts:

```
# Colour rendition charts chromaticity coordinates.
print(sorted(colour.characterisation.CCS_COLOURCHECKERS.keys()))

# Colour rendition charts spectral distributions.
print(sorted(colour.characterisation.SDS_COLOURCHECKERS.keys()))
```

```
['BabelColor Average', 'ColorChecker 1976', 'ColorChecker 2005', 'ColorChecker24 - After_
↪ November 2014', 'ColorChecker24 - Before November 2014', 'babel_average', 'cc2005',
↪ 'cca2014', 'ccb2014']
['BabelColor Average', 'ColorChecker N Ohta', 'babel_average', 'cc_ohta']
```

Note: The above `cc2005`, `babel_average` and `cc_ohta` keys are convenient aliases for respectively `ColorChecker 2005`, `BabelColor Average` and `ColorChecker N Ohta` keys.

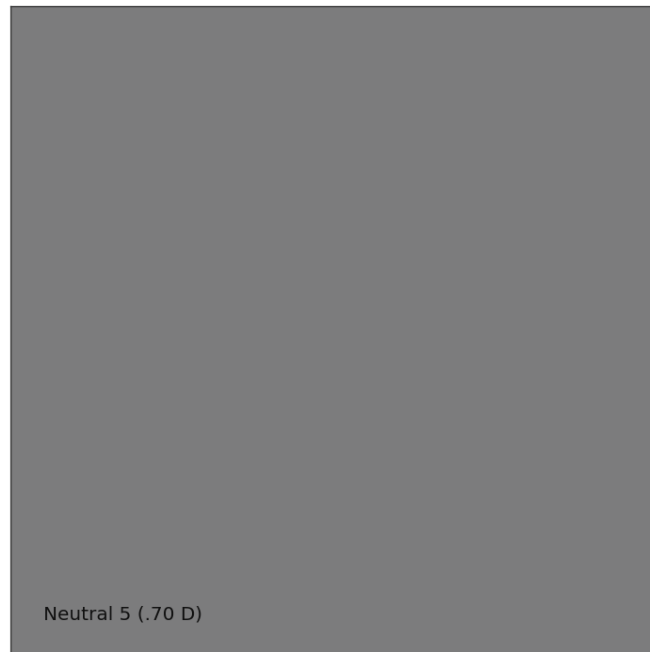
```
# Plotting the *sRGB* colourspace colour of *neutral 5 (.70 D)* patch.
patch_name = "neutral 5 (.70 D)"
patch_sd = colour.SDS_COLOURCHECKERS["ColorChecker N Ohta"][patch_name]
XYZ = colour.sd_to_XYZ(patch_sd, cmfs, illuminant)
RGB = colour.XYZ_to_sRGB(XYZ / 100)

plot_single_colour_swatch(
```

(continues on next page)

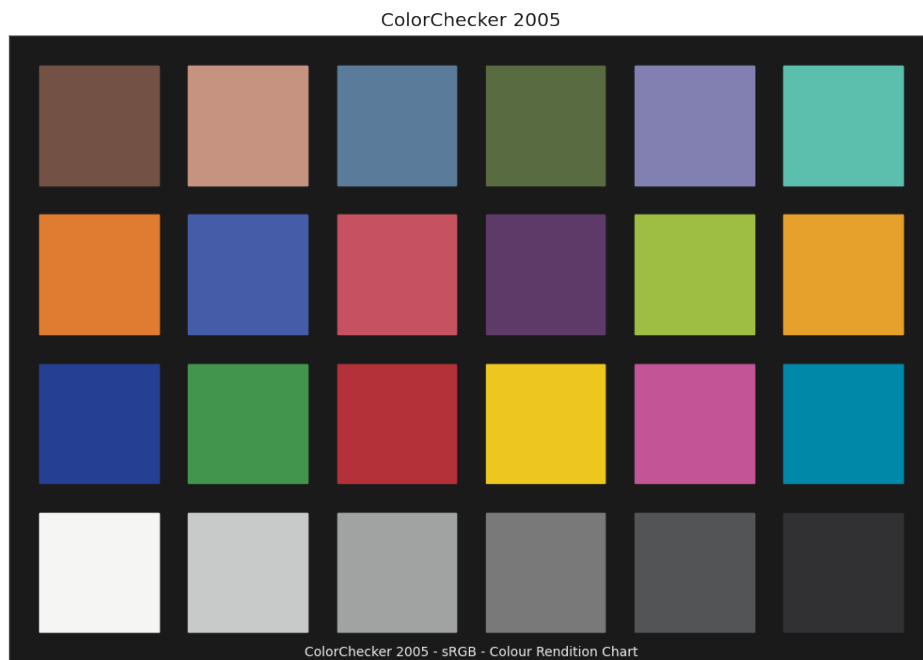
(continued from previous page)

```
ColourSwatch(RGB, patch_name.title()), text_kwargs={"size": "x-large"}
)
```



Colour defines a convenient plotting object to draw synthetic colour rendition charts figures:

```
plot_single_colour_checker(
    colour_checker="ColorChecker 2005", text_kwargs={"visible": False}
)
```



Convert to Chromaticity Coordinates

Given a spectral distribution, chromaticity coordinates *CIE xy* can be computed using the `colour.XYZ_to_xy` definition:

```
# Computing *CIE xy* chromaticity coordinates for the *neutral 5 (.70 D)* patch.
xy = colour.XYZ_to_xy(XYZ)
print(xy)
```

```
[ 0.31259787  0.32870029]
```

Chromaticity coordinates *CIE xy* can be plotted into the *CIE 1931 Chromaticity Diagram*:

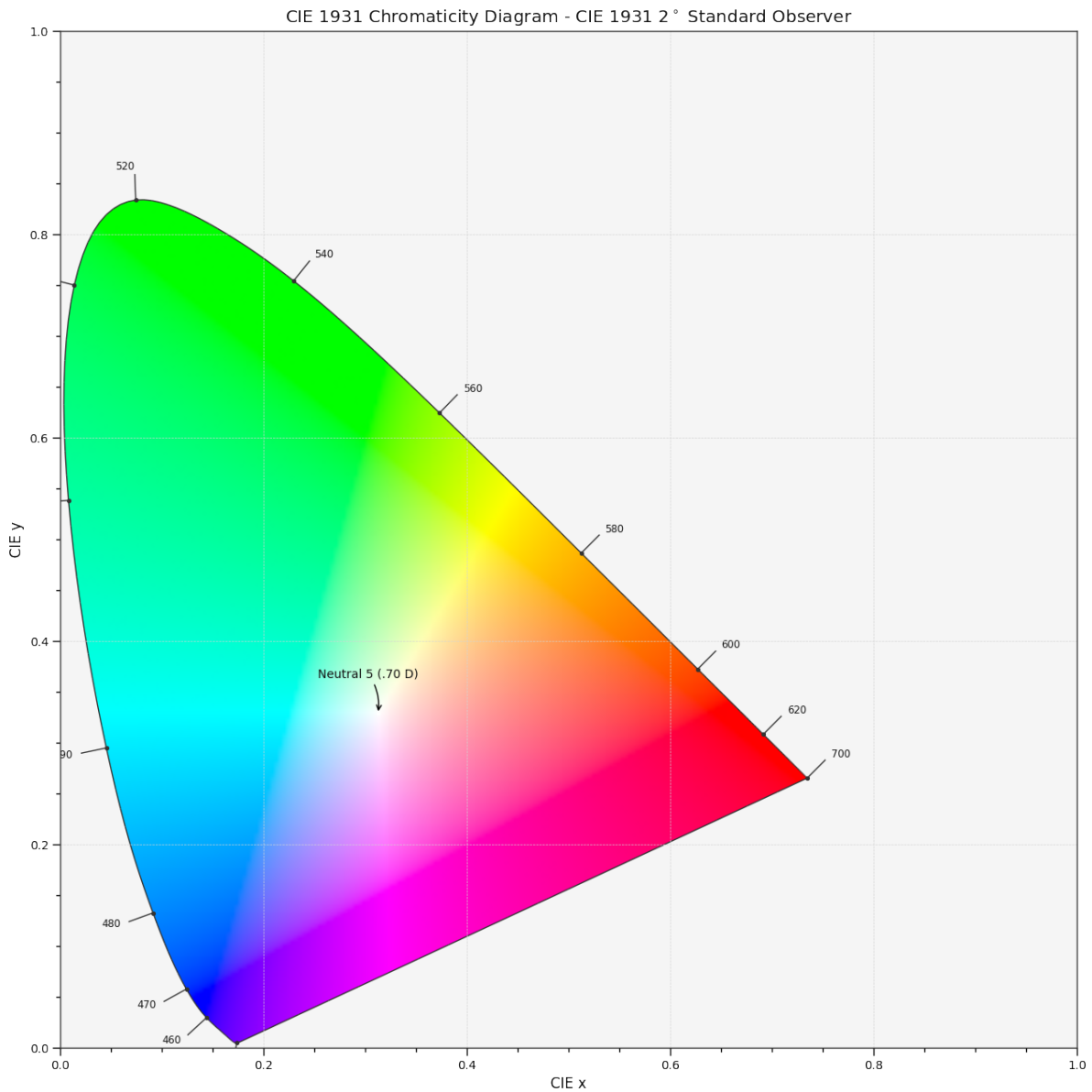
```
import matplotlib.pyplot as plt

# Plotting the *CIE 1931 Chromaticity Diagram*.
# The argument *standalone=False* is passed so that the plot doesn't get
# displayed and can be used as a basis for other plots.
plot_chromaticity_diagram_CIE1931(standalone=False)

# Plotting the *CIE xy* chromaticity coordinates.
x, y = xy
plt.plot(x, y, "o-", color="white")

# Annotating the plot.
plt.annotate(
    patch_sd.name.title(),
    xy=xy,
    xytext=(-50, 30),
    textcoords="offset points",
    arrowprops=dict(arrowstyle="->", connectionstyle="arc3, rad=-0.2"),
)

# Displaying the plot.
render(
    standalone=True,
    limits=(-0.1, 0.9, -0.1, 0.9),
    x_tighten=True,
    y_tighten=True,
)
```

See More

- The [Basic Concepts](#) page puts an emphasis on basic but important to understand concepts of **Colour**.
- The [Advanced Concepts](#) page describes some advanced usage scenarios of **Colour**.
- The [Google Colab How-To](#) guide for **Colour** shows various techniques to solve specific problems and highlights some interesting use cases.

3.1.2 How-To

The [Google Colab How-To](#) guide for **Colour** shows various techniques to solve specific problems and highlights some interesting use cases.

3.1.3 Basic Concepts

This page puts an emphasis on basic concepts of **Colour**, those are important to understand.

Object Name Categorisation

The API tries to bundle the objects by categories by naming them with common prefixes which makes introspection and auto-completion easier.

For example, in [IPython](#) or [Jupyter Notebook](#), most of the definitions pertaining to the spectral distribution handling can be found as follows:

```
In [1]: import colour

In [2]: colour.sd_
sd_blackbody()          sd_gaussian()          sd_
↪ rayleigh_scattering() sd_zeros
sd_CIE_illuminant_D_series() sd_mesopic_luminous_efficiency_function() sd_
↪ single_led()
sd_CIE_standard_illuminant_A() sd_multi_leds()          sd_
↪ to_aces_relative_exposure_values()
sd_constant()           sd_ones()          sd_
↪ to_XYZ
```

Likewise, for the spectral distribution handling related attributes:

```
In [2]: colour.SD
SD_GAUSSIAN_METHODS  SD_TO_XYZ_METHODS  SDS_ILLUMINANTS  SDS_
↪ LIGHT_SOURCES
SD_MULTI_LEDS_METHODS SDS_COLOURCHECKERS  SDS_LEFS
SD_SINGLE_LED_METHODS SDS_FILTERS          SDS_LENSSES
```

Similarly, all the RGB colourspaces can be individually accessed from the `colour.models` namespace:

```
In [2]: colour.models.RGB_COLOURSPACE
RGB_COLOURSPACE_ACES2065_1          RGB_COLOURSPACE_ACESPROXY ↪
↪ RGB_COLOURSPACE_APPLE_RGB          RGB_COLOURSPACE_BT470_525
RGB_COLOURSPACE_ACESCC              RGB_COLOURSPACE_ADOBE_
↪ RGB1998          RGB_COLOURSPACE_BEST_RGB          RGB_COLOURSPACE_BT470_625
RGB_COLOURSPACE_ACESCCCT              RGB_COLOURSPACE_ADOBE_WIDE_
↪ GAMUT_RGB          RGB_COLOURSPACE_BETA_RGB          RGB_COLOURSPACE_BT709          >
RGB_COLOURSPACE_ACESCG              RGB_COLOURSPACE_ARRI_WIDE_
↪ GAMUT_3          RGB_COLOURSPACE_BT2020          RGB_COLOURSPACE_CIE_RGB
```

Abbreviations

The following abbreviations are in use in **Colour**:

- **CAM** : Colour Appearance Model
- **CCS** : Chromaticity Coordinates
- **CCTF** : Colour Component Transfer Function
- **CCT** : Correlated Colour Temperature
- **CMY** : Cyan, Magenta, Yellow
- **CMYK** : Cyan, Magenta, Yellow, Black
- **CVD** : Colour Vision Deficiency
- **CV** : Code Value
- **EOTF** : Electro-Optical Transfer Function
- **IDT** : Input Device Transform
- **MSDS** : Multi-Spectral Distributions
- **OETF** : Optical-Electrical Transfer Function
- **OOTF** : Optical-Optical Transfer Function
- **SD** : Spectral Distribution
- **TVS** : Tristimulus Values

N-Dimensional Array Support

Most of **Colour** definitions are fully vectorised and support n-dimensional array by leveraging **Numpy**.

While it is recommended to use **ndarray** as input for the API objects, it is possible to use tuples or lists:

```
import colour
```

```
xyY = (0.4316, 0.3777, 0.1008)
colour.xyY_to_XYZ(xyY)
```

```
array([ 0.11518475,  0.1008      ,  0.05089373])
```

```
xyY = [0.4316, 0.3777, 0.1008]
colour.xyY_to_XYZ(xyY)
```

```
array([ 0.11518475,  0.1008      ,  0.05089373])
```

```
xyY = [
    (0.4316, 0.3777, 0.1008),
    (0.4316, 0.3777, 0.1008),
    (0.4316, 0.3777, 0.1008),
]
colour.xyY_to_XYZ(xyY)
```

```
array([[ 0.11518475,  0.1008      ,  0.05089373],
       [ 0.11518475,  0.1008      ,  0.05089373],
       [ 0.11518475,  0.1008      ,  0.05089373]])
```

As shown in the above example, there is widespread support for n-dimensional arrays:

```
import numpy as np
```

```
xyY = np.array([0.4316, 0.3777, 0.1008])
xyY = np.tile(xyY, (6, 1))
colour.xyY_to_XYZ(xyY)
```

```
array([[ 0.11518475,  0.1008      ,  0.05089373],
       [ 0.11518475,  0.1008      ,  0.05089373],
       [ 0.11518475,  0.1008      ,  0.05089373],
       [ 0.11518475,  0.1008      ,  0.05089373],
       [ 0.11518475,  0.1008      ,  0.05089373],
       [ 0.11518475,  0.1008      ,  0.05089373]])
```

```
colour.xyY_to_XYZ(xyY.reshape([2, 3, 3]))
```

```
array([[[ 0.11518475,  0.1008      ,  0.05089373],
        [ 0.11518475,  0.1008      ,  0.05089373],
        [ 0.11518475,  0.1008      ,  0.05089373]],

       [[ 0.11518475,  0.1008      ,  0.05089373],
        [ 0.11518475,  0.1008      ,  0.05089373],
        [ 0.11518475,  0.1008      ,  0.05089373]]])
```

Which enables image processing:

```
RGB = colour.read_image("_static/Logo_Small_001.png")
RGB = RGB[..., 0:3] # Discarding alpha channel.
XYZ = colour.sRGB_to_XYZ(RGB)
colour.plotting.plot_image(XYZ, text_kwargs={"text": "sRGB to XYZ"})
```



Spectral Representation and Continuous Signal

Floating Point Wavelengths

Colour [current representation](#) of spectral data is atypical and has been influenced by the failures and shortcomings of the previous implementation that required [less than ideal code](#) to support floating point wavelengths. Wavelengths should not have to be defined as integer values and it is effectively common to get data from instruments whose domain is returned as floating point values.

For example, the data from an [Ocean Insight \(Optics\) STS-VIS](#) spectrometer is typically saved with 3 digits decimal precision:

```
Data from Subt2_14-36-15-210.txt Node

Date: Sat Nov 17 14:36:15 NZDT 2018
User: kelsolaar
Spectrometer: S12286
Trigger mode: 0
Resolution mode: 1024 pixels
Integration Time (sec): 5.000000E0
Scans to average: 3
Nonlinearity correction enabled: true
Boxcar width: 3
Baseline correction enabled: true
XAxis mode: Wavelengths
Number of Pixels in Spectrum: 1024
# >>>>Begin Spectral Data<<<<
338.028      279.71
338.482      285.43
338.936      291.33
...
821.513      3112.65
822.008      3133.74
822.503      3107.11
```

A solution to the problem is to quantize the data at integer values but it is often non-desirable. The spectra representation implementation prior to **Colour 0.3.11** was relying on a [custom mutable mapping](#) which was allowing to retrieve decimal keys within a given precision:

```
data_1 = {0.1999999998: "Nemo", 0.2000000000: "John"}
apm_1 = ArbitraryPrecisionMapping(data_1, key_decimals=10)
tuple(apm_1.keys())
```

```
(0.1999999998, 0.2)
```

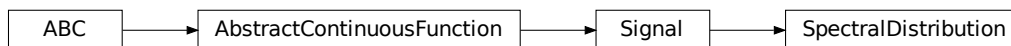
```
apm_2 = ArbitraryPrecisionMapping(data_1, key_decimals=7)
tuple(apm_2.keys())
```

```
(0.2,)
```

While functional, the approach was brittle and not elegant which triggered a [significant amount of rework](#).

Continuous Signal

All the spectral distributions in **Colour** are instances of the `colour.SpectralDistribution` class (or its sub-classes), a sub-class of the `colour.continuous.Signal` class which is itself an implementation of the `colour.continuous.AbstractContinuousFunction` ABCMeta class:



Likewise, the multi-spectral distributions are instances `colour.MultiSpectralDistributions` class (or its sub-classes), a sub-class of the `colour.continuous.MultiSignals` class which is a container for multiple `colour.continuous.Signal` sub-class instances and also implements the `colour.continuous.AbstractContinuousFunction` ABCMeta class.



The `colour.continuous.Signal` class implements the `Signal.function()` method so that evaluating the function for any independent domain $x \in \mathbb{R}$ variable returns a corresponding range $y \in \mathbb{R}$ variable.

It adopts an interpolating function encapsulated inside an extrapolating function. The resulting function independent domain, stored as discrete values in the `colour.continuous.Signal.domain` attribute corresponds with the function dependent and already known range stored in the `colour.continuous.Signal.range` attribute.

Consequently, it is possible to get the value of a spectral distribution at any given wavelength:

```
data = {
    500: 0.0651,
    520: 0.0705,
    540: 0.0772,
    560: 0.0870,
    580: 0.1128,
    600: 0.1360,
}
sd = colour.SpectralDistribution(data)
sd[555.5]
```

```
0.083453673782958995
```

Getting, Setting, Indexing and Slicing

Attention: Indexing a spectral distribution (or multi-spectral distribution) with a numeric (or a numeric sequence) returns the corresponding value(s). Indexing a spectral distribution (or multi-spectral distribution) with a slice returns the values for the corresponding wavelength *indexes*.

While it is tempting to think that the `colour.SpectralDistribution` and `colour.MultiSpectralDistributions` classes behave like Numpy's `ndarray`, they do not entirely and some peculiarities exist that make them different.

An important difference lies in the behaviour with respect to getting and setting the values of the data.

Getting the value(s) for a single (or multiple wavelengths) is done by indexing the `colour.SpectralDistribution` (or `colour.MultiSpectralDistributions`) class with the a single numeric or array of numeric wavelengths, e.g. `sd[555.5]` or `sd[555.25, 555.25, 555.75]`.

However, if getting the values using a `slice` class instance, e.g. `sd[0:3]`, the underlying discrete values for the indexes represented by the `slice` class instance are returned instead.

As shown in the previous section, getting the value of a wavelength is done as follows:

```
data = {
    500: 0.0651,
    520: 0.0705,
    540: 0.0772,
    560: 0.0870,
    580: 0.1128,
    600: 0.1360,
}
sd = colour.SpectralDistribution(data)
sd[555]
```

```
0.083135180664062502,
```

Multiple wavelength values can be retrieved as follows:

```
sd[(555.0, 556.25, 557.5, 558.75, 560.0)]
```

```
array([ 0.08313518,  0.08395997,  0.08488108,  0.085897   ,  0.087   ])
```

However, slices will return the values for the corresponding wavelength *indexes*:

```
sd[0:3]
```

```
array([ 0.0651,  0.0705,  0.0772])
```

```
sd[:]
```

```
array([ 0.0651,  0.0705,  0.0772,  0.087   ,  0.1128,  0.136   ])
```

Note: Indexing a multi-spectral distribution is achieved similarly, it can however be sliced along multiple axes because the data is 2-dimensional, e.g. `msds[0:3, 0:2]`.

A copy of the underlying `colour.SpectralDistribution` and `colour.MultiSpectralDistributions`

classes discretized data can be accessed via the `wavelengths` and `values` properties. However, it cannot be changed directly via the properties or slicing:

Attention: The data returned by the `wavelengths` and `values` properties is a *copy* of the underlying `colour.SpectralDistribution` and `colour.MultiSpectralDistributions` classes discretized data: It can only be changed indirectly.

```
data = {
    500: 0.0651,
    520: 0.0705,
    540: 0.0772,
    560: 0.0870,
    580: 0.1128,
    600: 0.1360,
}
sd = colour.SpectralDistribution(data)
# Note: The wavelength 500nm is at index 0.
sd.values[0] = 0
sd[500]
```

```
0.065100000000000019
```

Instead, the values can be set indirectly:

```
values = sd.values
values[0] = 0
sd.values = values
sd.values
```

```
array([ 0.    ,  0.0705,  0.0772,  0.087 ,  0.1128,  0.136 ])
```

Domain-Range Scales

Note: This section contains important information.

Colour adopts 4 main input domains and output ranges:

- *Scalars* usually in domain-range $[0, 1]$ (or $[0, 10]$ for *Munsell Value*).
- *Percentages* usually in domain-range $[0, 100]$.
- *Degrees* usually in domain-range $[0, 360]$.
- *Integers* usually in domain-range $[0, 2^{*n} - 1]$ where n is the bit depth.

It is error prone but it is also a direct consequence of the inconsistency of the colour science field itself. We have discussed at length about this and we were leaning toward normalisation of the whole API to domain-range $[0, 1]$, we never committed for reasons highlighted by the following points:

- Colour Scientist performing computations related to Munsell Renotation System would be very surprised if the output *Munsell Value* was in range $[0, 1]$ or $[0, 100]$.
- A Visual Effect Industry artist would be astonished to find out that conversion from *CIE XYZ* to *sRGB* was yielding values in range $[0, 100]$.

However benefits of having a consistent and predictable domain-range scale are numerous thus with [Colour 0.3.12](#) we have introduced a mechanism to allow users to work within one of the two available domain-range scales.

Scale - Reference

‘Reference’ is the default domain-range scale of **Colour**, objects adopt the implemented reference, i.e. paper, publication, etc., domain-range scale.

The **‘Reference’** domain-range scale is inconsistent, e.g. colour appearance models, spectral conversions are typically in domain-range $[0, 100]$ while RGB models will operate in domain-range $[0, 1]$. Some objects, e.g. `colour.colorimetry.lightness_Fairchild2011()` definition have mismatched domain-range: input domain $[0, 1]$ and output range $[0, 100]$.

Scale - 1

‘1’ is a domain-range scale converting all the relevant objects from **Colour** public API to domain-range $[0, 1]$:

- *Scalars* in domain-range $[0, 10]$, e.g. *Munsell Value* are scaled by 10.
- *Percentages* in domain-range $[0, 100]$ are scaled by 100.
- *Degrees* in domain-range $[0, 360]$ are scaled by 360.
- *Integers* in domain-range $[0, 2^{**n} - 1]$ where n is the bit depth are scaled by $2^{**n} - 1$.
- *Dimensionless* values are unaffected and are indicated with *DN*.
- *Unaffected* values are unaffected and are indicated with *UN*.

Warning: The conversion to **‘1’** domain-range scale is a *soft* normalisation and similarly to the **‘Reference’** domain-range scale it is normal to encounter values exceeding 1, e.g. High Dynamic Range Imagery (HDRI) or negative values, e.g. out-of-gamut RGB colourspace values. Some definitions such as `colour.models.eotf_ST2084()` which decodes absolute luminance values are not affected by any domain-range scales and are indicated with *UN*.

Understanding the Domain-Range Scale of an Object

Using `colour.adaptation.chromatic_adaptation_CIE1994()` definition docstring as an example, the *Notes* section features two tables.

The first table is for the domain, and lists the input arguments affected by the two domain-range scales and which normalisation they should adopt depending the domain-range scale in use:

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ_1 | $[0, 100]$ | $[0, 1]$ |
| Y_o | $[0, 100]$ | $[0, 1]$ |

The second table is for the range and lists the return value of the definition:

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ_2 | $[0, 100]$ | $[0, 1]$ |

Working with the Domain-Range Scales

The current domain-range scale is returned with the `colour.get_domain_range_scale()` definition:

```
import colour

colour.get_domain_range_scale()
```

```
u'reference'
```

Changing from the **‘Reference’** default domain-range scale to **‘1’** is done with the `colour.set_domain_range_scale()` definition:

```
XYZ_1 = [28.00, 21.26, 5.27]
xy_o1 = [0.4476, 0.4074]
xy_o2 = [0.3127, 0.3290]
Y_o = 20
E_o1 = 1000
E_o2 = 1000
colour.adaptation.chromatic_adaptation_CIE1994(
    XYZ_1, xy_o1, xy_o2, Y_o, E_o1, E_o2
)
```

```
array([ 24.03379521,  21.15621214,  17.64301199])
```

```
colour.set_domain_range_scale("1")

XYZ_1 = [0.2800, 0.2126, 0.0527]
Y_o = 0.2
colour.adaptation.chromatic_adaptation_CIE1994(
    XYZ_1, xy_o1, xy_o2, Y_o, E_o1, E_o2
)
```

```
array([ 0.24033795,  0.21156212,  0.17643012])
```

The output tristimulus values with the **‘1’** domain-range scale are equal to those from **‘Reference’** default domain-range scale divided by 100.

Passing incorrectly scaled values to the `colour.adaptation.chromatic_adaptation_CIE1994()` definition would result in unexpected values and a warning in that case:

```
colour.set_domain_range_scale("Reference")

colour.adaptation.chromatic_adaptation_CIE1994(
    XYZ_1, xy_o1, xy_o2, Y_o, E_o1, E_o2
)
```

```
File "<ipython-input-...>", line 4, in <module>
    E_o2)
File "/colour-science/colour/colour/adaptation/cie1994.py", line 134, in chromatic_
↪adaptation_CIE1994
    warning(('Y_o" luminance factor must be in [18, 100] domain, '
/colour-science/colour/colour/utilities/verbose.py:207: ColourWarning: "Y_o" luminance_
↪factor must be in [18, 100] domain, unpredictable results may occur!
    warn(*args, **kwargs)
array([ 0.17171825,  0.13731098,  0.09972054])
```

Setting the '1' domain-range scale has the following effect on the `colour.adaptation.chromatic_adaptation_CIE1994()` definition:

As it expects values in domain $[0, 100]$, scaling occurs and the relevant input values, i.e. the values listed in the domain table, XYZ₁ and Y_o are converted from domain $[0, 1]$ to domain $[0, 100]$ by `colour.utilities.to_domain_100()` definition and conversely return value XYZ₂ is converted from range $[0, 100]$ to range $[0, 1]$ by `colour.utilities.from_range_100()` definition.

A convenient alternative to the `colour.set_domain_range_scale()` definition is the `colour.domain_range_scale` context manager and decorator. It temporarily overrides **Colour** domain-range scale with given scale value:

```
with colour.domain_range_scale("1"):
    colour.adaptation.chromatic_adaptation_CIE1994(
        XYZ_1, xy_o1, xy_o2, Y_o, E_o1, E_o2
    )
```

```
[ 0.24033795  0.21156212  0.17643012]
```

Multiprocessing on Windows with Domain-Range Scales

Windows does not have a `fork` system call, a consequence is that child processes do not necessarily inherit from changes made to global variables.

It has crucial consequences as **Colour** stores the current domain-range scale into a global variable.

The solution is to define an initialisation definition that defines the scale upon child processes spawning.

The `colour.utilities.multiprocessing_pool` context manager conveniently performs the required initialisation so that the domain-range scale is propagated appropriately to child processes.

Safe Power and Division

Colour default handling of fractional power and zero-division occurring during practical applications is managed via various definitions and context managers.

Safe Power

NaNs generation occurs when a negative number a is raised to the fractional power p . This can be avoided using the `colour.algebra.spow()` definition that raises to the power as follows: $\text{sign}(a) * |a|^p$.

To the extent possible, the `colour.algebra.spow()` definition has been used throughout the codebase. The default behaviour is controlled with the following definitions:

- `colour.algebra.is_spow_enabled()`
- `colour.algebra.set_spow_enabled()`
- `colour.algebra.spow_enable()` (Context Manager & Decorator)

Safe Division

NaNs and +/- infs generation occurs when a number a is divided 0. This can be avoided using the `colour.algebra.sdiv()` definition. It has been used wherever deemed relevant in the codebase. The default behaviour is controlled with the following definitions:

- `colour.algebra.get_sdiv_mode()`
- `colour.algebra.set_sdiv_mode()`
- `colour.algebra.sdiv_mode()` (Context Manager & Decorator)

The following modes are available:

- Numpy: The current *Numpy* zero-division handling occurs.
- Ignore: Zero-division occurs silently.
- Warning: Zero-division occurs with a warning.
- Ignore Zero Conversion: Zero-division occurs silently and NaNs or +/- infs values are converted to zeros. See `numpy.nan_to_num()` definition for more details.
- Warning Zero Conversion: Zero-division occurs with a warning and NaNs or +/- infs values are converted to zeros. See `numpy.nan_to_num()` definition for more details.
- Ignore Limit Conversion: Zero-division occurs silently and NaNs or +/- infs values are converted to zeros or the largest +/- finite floating point values representable by the division result `numpy.dtype`. See `numpy.nan_to_num()` definition for more details.
- Warning Limit Conversion: Zero-division occurs with a warning and NaNs or +/- infs values are converted to zeros or the largest +/- finite floating point values representable by the division result `numpy.dtype`.

```
colour.algebra.get_sdiv_mode()
```

```
'Ignore Zero Conversion'
```

```
colour.algebra.set_sdiv_mode("Numpy")
colour.UCS_to_uv([0, 0, 0])
```

```
/Users/kelsolaar/Documents/Development/colour-science/colour/colour/algebra/common.
↳py:317: RuntimeWarning: invalid value encountered in true_divide
  c = a / b
array([ nan,  nan])
```

```
colour.algebra.set_sdiv_mode("Ignore Zero Conversion")
colour.UCS_to_uv([0, 0, 0])
```

```
array([ 0.,  0.]
```

3.1.4 Advanced Concepts

This page describes some advanced usage scenarios of **Colour**.

Environment

Various environment variables can be used to modify **Colour** behaviour at runtime:

- `COLOUR_SCIENCE_DEFAULT_INT_DTYPE`: Set the default integer dtype for most of **Colour** computations. Possible values are `int32` and `int64` (default). Changing the integer dtype *will almost certainly break Colour! With great power comes great responsibility.*
- `COLOUR_SCIENCE_DEFAULT_FLOAT_DTYPE`: Set the float dtype for most of **Colour** computations. Possible values are `float16`, `float32` and `float64` (default). Changing the float dtype might result in various **Colour** *functionality breaking entirely. With great power comes great responsibility.*
- `COLOUR_SCIENCE_COLOUR_SHOW_WARNINGS_WITH_TRACEBACK`: Result in the `warnings.showwarning()` definition to be replaced with the `colour.utilities.show_warning()` definition and thus providing complete traceback from the point where the warning occurred.

Caching

Colour uses various internal caches to improve speed and prevent redundant processes, notably for spectral related computations.

The internal caches are managed with the `colour.utilities.CACHE_REGISTRY` cache registry object:

```
import colour

print(colour.utilities.CACHE_REGISTRY)
```

```
{'colour.colorimetry.spectrum._CACHE_RESAPED_SDS_AND_MSDS': '0 item(s)',
 'colour.colorimetry.tristimulus_values._CACHE_LAGRANGE_INTERPOLATING_COEFFICIENTS': '0 '
 → 'item(s)',
 'colour.colorimetry.tristimulus_values._CACHE_SD_TO_XYZ': '0 item(s)',
 'colour.colorimetry.tristimulus_values._CACHE_TRISTIMULUS_WEIGHTING_FACTORS': '0 '
                                         'item(s)',
 'colour.quality.cf12017._CACHE_TCS_CIE2017': '0 item(s)',
 'colour.volume.macadam_limits._CACHE_OPTIMAL_COLOUR_STIMULI_XYZ': '0 item(s)',
 'colour.volume.macadam_limits._CACHE_OPTIMAL_COLOUR_STIMULI_XYZ_TRIANGULATIONS': '0 '
                                         'item(s)'
 → ',
 'colour.volume.spectrum._CACHE_OUTER_SURFACE_XYZ': '0 item(s)',
 'colour.volume.spectrum._CACHE_OUTER_SURFACE_XYZ_POINTS': '0 item(s)'}

```

See `colour.utilities.CacheRegistry` class documentation for more information on how to manage the cache registry.

Using Colour without SciPy

With the release of [Colour 0.3.8](#), [SciPy](#) became a requirement.

SciPy is notoriously hard to compile, especially [on Windows](#). Some Digital Content Creation (DCC) applications are shipping Python interpreters compiled with versions of [Visual Studio](#) such as 2011 or 2015. Those are incompatible with the Python Wheels commonly built with [Visual Studio 2008 \(Python 2.7\)](#) or [Visual Studio 2017 \(Python 3.6\)](#).

It is however possible to use **Colour** in a partially broken state and mock **SciPy** by using the `mock_for_colour.py` module.

Assuming it is available for import, a typical usage would be as follows:

```
import sys
from mock_for_colour import MockModule

for module in (
    "scipy",
    "scipy.interpolate",
    "scipy.linalg",
    "scipy.ndimage",
    "scipy.ndimage.filters",
    "scipy.spatial",
    "scipy.spatial.distance",
    "scipy.optimize",
):
    sys.modules[str(module)] = MockModule(str(module))

import colour

xyY = (0.4316, 0.3777, 0.1008)
colour.xyY_to_XYZ(xyY)
```

```
array([ 0.11518475,  0.1008      ,  0.05089373])
```

Or directly using the `mock_scipy_for_colour` definition:

```
from mock_for_colour import mock_scipy_for_colour

mock_scipy_for_colour()

import colour

xyY = (0.4316, 0.3777, 0.1008)
colour.xyY_to_XYZ(xyY)
```

```
array([ 0.11518475,  0.1008      ,  0.05089373])
```

Anything relying on the spectral code will be unusable, but a great amount of useful functionality will still be available.

3.1.5 Bibliography

Indirect References

Some extra references used in the codebase but not directly part of the public api:

- [\[Cen14e\]](#)
- [\[Cen14k\]](#)
- [\[Cen14h\]](#)
- [\[Cen14c\]](#)
- [\[Cen14j\]](#)
- [\[Cen14i\]](#)
- [\[Cen14g\]](#)
- [\[Cen14d\]](#)
- [\[Cen14f\]](#)
- [\[Cen14b\]](#)
- [\[Cen14a\]](#)
- [\[CIET13805c\]](#)
- [\[Dji17\]](#)
- [\[FiLMiCInc17\]](#)
- [\[Han03\]](#)
- [\[Hou15\]](#)
- [\[Laurent12\]](#)
- [\[Mac35\]](#)
- [\[Mac42\]](#)
- [\[MorovivcL00\]](#)
- [\[MunsellCSscienceb\]](#)
- [\[Poi80\]](#)
- [\[RenewableRDCenter03\]](#)
- [\[SWD05\]](#)
- [\[Sir18\]](#)
- [\[SHF00\]](#)
- [\[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee20\]](#)
- [\[WEydelbergVileshin02\]](#)
- [\[War16\]](#)
- [\[WS00b\]](#)
- [\[WS00h\]](#)
- [\[WS00g\]](#)
- [\[WS00e\]](#)

5 API REFERENCE

4.1 API Reference

4.1.1 Colour

Chromatic Adaptation

Chromatic Adaptation

colour

| | |
|--|--|
| <code>chromatic_adaptation(XYZ, XYZ_w, XYZ_wr[, ...])</code> | Adapt given stimulus from test viewing conditions to reference viewing conditions. |
| <code>CHROMATIC_ADAPTATION_METHODS</code> | Supported chromatic adaptation methods. |
| <code>VIEWING_CONDITIONS_CMCCAT2000</code> | Reference <i>CMCCAT2000</i> chromatic adaptation model viewing conditions. |

colour.chromatic_adaptation

`colour.chromatic_adaptation(XYZ: ArrayLike, XYZ_w: ArrayLike, XYZ_wr: ArrayLike, method: Literal['CIE 1994', 'CMCCAT2000', 'Fairchild 1990', 'Zhai 2018', 'Von Kries'] | str = 'Von Kries', **kwargs: Any) → ndarray`

Adapt given stimulus from test viewing conditions to reference viewing conditions.

Parameters

- **XYZ** (ArrayLike) – *CIE XYZ* tristimulus values of stimulus to adapt.
- **XYZ_w** (ArrayLike) – Test viewing condition *CIE XYZ* tristimulus values of the whitepoint.
- **XYZ_wr** (ArrayLike) – Reference viewing condition *CIE XYZ* tristimulus values of the whitepoint.
- **method** (*Literal*['CIE 1994', 'CMCCAT2000', 'Fairchild 1990', 'Zhai 2018', 'Von Kries'] | str) – Computation method.
- **E_o1** – {`colour.adaptation.chromatic_adaptation_CIE1994()`}, Test illuminance E_{o1} in cd/m^2 .
- **E_o2** – {`colour.adaptation.chromatic_adaptation_CIE1994()`}, Reference illuminance E_{o2} in cd/m^2 .
- **n** – {`colour.adaptation.chromatic_adaptation_CIE1994()`}, Noise component in fundamental primary system.

- **Y_o** – {`colour.adaptation.chromatic_adaptation_CIE1994()`}, Luminance factor Y_o of achromatic background normalised to domain $[0.18, 1]$ in ‘Reference’ domain-range scale.
- **direction** – {`colour.adaptation.chromatic_adaptation_CMCCAT2000()`}, Chromatic adaptation direction.
- **L_A1** – {`colour.adaptation.chromatic_adaptation_CMCCAT2000()`}, Luminance of test adapting field L_{A1} in cd/m^2 .
- **L_A2** – {`colour.adaptation.chromatic_adaptation_CMCCAT2000()`}, Luminance of reference adapting field L_{A2} in cd/m^2 .
- **surround** – {`colour.adaptation.chromatic_adaptation_CMCCAT2000()`}, Surround viewing conditions induction factors.
- **discount_illuminant** – {`colour.adaptation.chromatic_adaptation_Fairchild1990()`}, Truth value indicating if the illuminant should be discounted.
- **Y_n** – {`colour.adaptation.chromatic_adaptation_Fairchild1990()`}, Luminance Y_n of test adapting stimulus in cd/m^2 .
- **D_b** – {`colour.adaptation.chromatic_adaptation_Zhai2018()`}, Degree of adaptation D_β of input illuminant β .
- **D_d** – {`colour.adaptation.chromatic_adaptation_Zhai2018()`}, Degree of adaptation D_Δ of output illuminant Δ .
- **transform** – {`colour.adaptation.chromatic_adaptation_VonKries()`, `colour.adaptation.chromatic_adaptation_Zhai2018()`}, Chromatic adaptation transform.
- **XYZ_wo** – {`colour.adaptation.chromatic_adaptation_Zhai2018()`}, Baseline illuminant (BI) o .
- **kwargs** (Any) –

Returns

CIE XYZ_c tristimulus values of the stimulus corresponding colour.

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |
| XYZ_w | [0, 1] | [0, 1] |
| XYZ_wr | [0, 1] | [0, 1] |
| XYZ_wo | [0, 1] | [0, 1] |
| Y_o | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ_c | [0, 1] | [0, 1] |

References

[CIET13294], [Fai91], [Fai13f], [Fai13a], [LLRH02], [WRC12d]

Examples

Von Kries chromatic adaptation:

```
>>> import numpy as np
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> XYZ_w = np.array([0.95045593, 1.00000000, 1.08905775])
>>> XYZ_wr = np.array([0.96429568, 1.00000000, 0.82510460])
>>> chromatic_adaptation(XYZ, XYZ_w, XYZ_wr)
...
array([ 0.2163881...,  0.1257      ,  0.0384749...])
```

CIE 1994 chromatic adaptation, requires extra *kwargs*:

```
>>> XYZ = np.array([0.2800, 0.2126, 0.0527])
>>> XYZ_w = np.array([1.09867452, 1.00000000, 0.35591556])
>>> XYZ_wr = np.array([0.95045593, 1.00000000, 1.08905775])
>>> Y_o = 0.20
>>> E_o = 1000
>>> chromatic_adaptation(
...     XYZ, XYZ_w, XYZ_wr, method="CIE 1994", Y_o=Y_o, E_o1=E_o, E_o2=E_o
... )
...
array([ 0.2403379...,  0.2115621...,  0.1764301...])
```

CMCCAT2000 chromatic adaptation, requires extra *kwargs*:

```
>>> XYZ = np.array([0.2248, 0.2274, 0.0854])
>>> XYZ_w = np.array([1.1115, 1.0000, 0.3520])
>>> XYZ_wr = np.array([0.9481, 1.0000, 1.0730])
>>> L_A = 200
>>> chromatic_adaptation(
...     XYZ, XYZ_w, XYZ_wr, method="CMCCAT2000", L_A1=L_A, L_A2=L_A
... )
...
array([ 0.1952698...,  0.2306834...,  0.2497175...])
```

Fairchild (1990) chromatic adaptation, requires extra *kwargs*:

```
>>> XYZ = np.array([0.1953, 0.2307, 0.2497])
>>> Y_n = 200
>>> chromatic_adaptation(
...     XYZ, XYZ_w, XYZ_wr, method="Fairchild 1990", Y_n=Y_n
... )
...
array([ 0.2332526...,  0.2332455...,  0.7611593...])
```

Zhai and Luo (2018) chromatic adaptation:

```
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> XYZ_w = np.array([0.95045593, 1.00000000, 1.08905775])
>>> XYZ_wr = np.array([0.96429568, 1.00000000, 0.82510460])
>>> chromatic_adaptation(XYZ, XYZ_w, XYZ_wr, method="Zhai 2018")
```

(continues on next page)

(continued from previous page)

```
...
array([ 0.2163881...,  0.1257      ,  0.0384749...])
>>> chromatic_adaptation(
...     XYZ,
...     XYZ_w,
...     XYZ_wr,
...     method="Zhai 2018",
...     D_b=0.9,
...     XYZ_wo=np.array([100, 100, 100]),
... )
...
array([ 0.2152436...,  0.1253522...,  0.0388406...])
```

colour.CHROMATIC_ADAPTATION_METHODS

```
colour.CHROMATIC_ADAPTATION_METHODS = CanonicalMapping({'CIE 1994': ..., 'CMCCAT2000':
..., 'Fairchild 1990': ..., 'Von Kries': ..., 'Zhai 2018': ...})
```

Supported chromatic adaptation methods.

References

[CIET13294], [Fai91], [Fai13f], [Fai13a], [LLRH02], [WRC12d], [ZL18]

colour.VIEWING_CONDITIONS_CMCCAT2000

```
colour.VIEWING_CONDITIONS_CMCCAT2000 = CanonicalMapping({'Average': ..., 'Dim': ...,
'Dark': ...})
```

Reference *CMCCAT2000* chromatic adaptation model viewing conditions.

References

[LLRH02], [WRC12d]

Dataset

colour

| CHROMATIC_ADAPTATION_TRANSFORMS | Chromatic adaptation transforms. |
|---------------------------------|----------------------------------|
|---------------------------------|----------------------------------|

colour.CHROMATIC_ADAPTATION_TRANSFORMS

```
colour.CHROMATIC_ADAPTATION_TRANSFORMS = CanonicalMapping({'XYZ Scaling': ..., 'Von
Kries': ..., 'Bradford': ..., 'Sharp': ..., 'Fairchild': ..., 'CMCCAT97': ...,
'CMCCAT2000': ..., 'CAT02': ..., 'CAT02 Brill 2008': ..., 'CAT16': ..., 'Bianco 2010': ...,
'Bianco PC 2010': ...})
```

Chromatic adaptation transforms.

References

[BS10], [BS08], [Fai], [LPLMartinezverdu07], [LLW+17], [Lin09a], [WRC12e], [WRC12d], [Wikipedia07c]

Fairchild (1990)

`colour.adaptation`

| | |
|---|---|
| <code>chromatic_adaptation_Fairchild1990(XYZ_1, ...)</code> | Adapt given stimulus <i>CIE XYZ_1</i> tristimulus values from test viewing conditions to reference viewing conditions using <i>Fairchild (1990)</i> chromatic adaptation model. |
|---|---|

`colour.adaptation.chromatic_adaptation_Fairchild1990`

`colour.adaptation.chromatic_adaptation_Fairchild1990(XYZ_1: ArrayLike, XYZ_n: ArrayLike, XYZ_r: ArrayLike, Y_n: FloatingOrArrayLike, discount_illuminant: bool = False) → ndarray`

Adapt given stimulus *CIE XYZ_1* tristimulus values from test viewing conditions to reference viewing conditions using *Fairchild (1990)* chromatic adaptation model.

Parameters

- **XYZ_1** (ArrayLike) – *CIE XYZ_1* tristimulus values of test sample / stimulus.
- **XYZ_n** (ArrayLike) – Test viewing condition *CIE XYZ_n* tristimulus values of whitepoint.
- **XYZ_r** (ArrayLike) – Reference viewing condition *CIE XYZ_r* tristimulus values of whitepoint.
- **Y_n** (FloatingOrArrayLike) – Luminance Y_n of test adapting stimulus in cd/m^2 .
- **discount_illuminant** (bool) – Truth value indicating if the illuminant should be discounted.

Returns

Adapted *CIE XYZ_2* tristimulus values of stimulus.

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ_1 | [0, 100] | [0, 1] |
| XYZ_n | [0, 100] | [0, 1] |
| XYZ_r | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ_2 | [0, 100] | [0, 1] |

References

[Fai91], [Fai13f]

Examples

```
>>> XYZ_1 = np.array([19.53, 23.07, 24.97])
>>> XYZ_n = np.array([111.15, 100.00, 35.20])
>>> XYZ_r = np.array([94.81, 100.00, 107.30])
>>> Y_n = 200
>>> chromatic_adaptation_Fairchild1990(XYZ_1, XYZ_n, XYZ_r, Y_n)
...
array([ 23.3252634...,  23.3245581...,  76.1159375...])
```

CIE 1994

colour.adaptation

| | |
|--|---|
| <code>chromatic_adaptation_CIE1994(XYZ_1, xy_o1, ...)</code> | Adapt given stimulus <i>CIE XYZ_1</i> tristimulus values from test viewing conditions to reference viewing conditions using <i>CIE 1994</i> chromatic adaptation model. |
|--|---|

colour.adaptation.chromatic_adaptation_CIE1994

colour.adaptation.chromatic_adaptation_CIE1994(*XYZ_1*: ArrayLike, *xy_o1*: ArrayLike, *xy_o2*: ArrayLike, *Y_o*: FloatingOrArrayLike, *E_o1*: FloatingOrArrayLike, *E_o2*: FloatingOrArrayLike, *n*: FloatingOrArrayLike = 1) → ndarray

Adapt given stimulus *CIE XYZ_1* tristimulus values from test viewing conditions to reference viewing conditions using *CIE 1994* chromatic adaptation model.

Parameters

- **XYZ_1** (ArrayLike) – *CIE XYZ* tristimulus values of test sample / stimulus.
- **xy_o1** (ArrayLike) – Chromaticity coordinates x_{o1} and y_{o1} of test illuminant and background.
- **xy_o2** (ArrayLike) – Chromaticity coordinates x_{o2} and y_{o2} of reference illuminant and background.
- **Y_o** (FloatingOrArrayLike) – Luminance factor Y_o of achromatic background as percentage normalised to domain [18, 100] in ‘Reference’ domain-range scale.
- **E_o1** (FloatingOrArrayLike) – Test illuminance E_{o1} in cd/m^2 .
- **E_o2** (FloatingOrArrayLike) – Reference illuminance E_{o2} in cd/m^2 .
- **n** (FloatingOrArrayLike) – Noise component in fundamental primary system.

Returns

Adapted *CIE XYZ_2* tristimulus values of test stimulus.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ_1 | [0, 100] | [0, 1] |
| Y_o | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ_2 | [0, 100] | [0, 1] |

References

[CIET13294]

Examples

```
>>> XYZ_1 = np.array([28.00, 21.26, 5.27])
>>> xy_o1 = np.array([0.4476, 0.4074])
>>> xy_o2 = np.array([0.3127, 0.3290])
>>> Y_o = 20
>>> E_o1 = 1000
>>> E_o2 = 1000
>>> chromatic_adaptation_CIE1994(XYZ_1, xy_o1, xy_o2, Y_o, E_o1, E_o2)
...
array([ 24.0337952..., 21.1562121..., 17.6430119...])
```

CMCCAT2000

colour.adaptation

| | |
|---|--|
| <code>chromatic_adaptation_CMCCAT2000(XYZ, XYZ_w, ...)</code> | Adapt given stimulus <i>CIE XYZ</i> tristimulus values using given viewing conditions. |
| <code>VIEWING_CONDITIONS_CMCCAT2000</code> | Reference <i>CMCCAT2000</i> chromatic adaptation model viewing conditions. |

colour.adaptation.chromatic_adaptation_CMCCAT2000

`colour.adaptation.chromatic_adaptation_CMCCAT2000(XYZ: ArrayLike, XYZ_w: ArrayLike, XYZ_wr: ArrayLike, L_A1: FloatingOrArrayLike, L_A2: FloatingOrArrayLike, surround: InductionFactors_CMCCAT2000 = VIEWING_CONDITIONS_CMCCAT2000['Average'], direction: Literal['Forward', 'Inverse'] | str = 'Forward') → ndarray`

Adapt given stimulus *CIE XYZ* tristimulus values using given viewing conditions.

This definition is a convenient wrapper around `colour.adaptation.chromatic_adaptation_forward_CMCCAT2000()` and `colour.adaptation.chromatic_adaptation_inverse_CMCCAT2000()`.

Parameters

- **XYZ** (ArrayLike) – *CIE XYZ* tristimulus values of the stimulus to adapt.
- **XYZ_w** (ArrayLike) – Source viewing condition *CIE XYZ* tristimulus values of the whitepoint.
- **XYZ_wr** (ArrayLike) – Target viewing condition *CIE XYZ* tristimulus values of the whitepoint.
- **L_A1** (FloatingOrArrayLike) – Luminance of test adapting field L_{A1} in cd/m^2 .
- **L_A2** (FloatingOrArrayLike) – Luminance of reference adapting field L_{A2} in cd/m^2 .
- **surround** (`InductionFactors_CMCCAT2000`) – Surround viewing conditions induction factors.
- **direction** (`Literal['Forward', 'Inverse'] | str`) – Chromatic adaptation direction.

Returns

Adapted stimulus *CIE XYZ* tristimulus values.

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |
| XYZ_w | [0, 100] | [0, 1] |
| XYZ_wr | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |

References

[LLRH02], [WRC12d]

Examples

```
>>> XYZ = np.array([22.48, 22.74, 8.54])
>>> XYZ_w = np.array([111.15, 100.00, 35.20])
>>> XYZ_wr = np.array([94.81, 100.00, 107.30])
>>> L_A1 = 200
>>> L_A2 = 200
>>> chromatic_adaptation_CMCCAT2000(
...     XYZ, XYZ_w, XYZ_wr, L_A1, L_A2, direction="Forward"
... )
...
array([ 19.5269832...,  23.0683396...,  24.9717522...])
```

Using the *CMCCAT2000* inverse model:


```
>>> XYZ = np.array([19.52698326, 23.06833960, 24.97175229])
>>> XYZ_w = np.array([111.15, 100.00, 35.20])
>>> XYZ_wr = np.array([94.81, 100.00, 107.30])
>>> L_A1 = 200
>>> L_A2 = 200
>>> chromatic_adaptation_CMCCAT2000(
...     XYZ, XYZ_w, XYZ_wr, L_A1, L_A2, direction="Inverse"
... )
...
array([ 22.48,  22.74,   8.54])
```

colour.adaptation.VIEWING_CONDITIONS_CMCCAT2000

colour.adaptation.VIEWING_CONDITIONS_CMCCAT2000 = CanonicalMapping({'Average': ..., 'Dim': ..., 'Dark': ...})

Reference *CMCCAT2000* chromatic adaptation model viewing conditions.

References

[LLRH02], [WRC12d]

Ancillary Objects

colour.adaptation

| | |
|---|--|
| chromatic_adaptation_forward_CMCCAT2000(XYZ, ...) | Adapt given stimulus <i>CIE XYZ</i> tristimulus values from test viewing conditions to reference viewing conditions using <i>CMCCAT2000</i> forward chromatic adaptation model. |
| chromatic_adaptation_inverse_CMCCAT2000(...) | Adapt given stimulus corresponding colour <i>CIE XYZ</i> tristimulus values from reference viewing conditions to test viewing conditions using <i>CMCCAT2000</i> inverse chromatic adaptation model. |
| InductionFactors_CMCCAT2000(F) | <i>CMCCAT2000</i> chromatic adaptation model induction factors. |

colour.adaptation.chromatic_adaptation_forward_CMCCAT2000

colour.adaptation.chromatic_adaptation_forward_CMCCAT2000(XYZ: ArrayLike, XYZ_w: ArrayLike, XYZ_wr: ArrayLike, L_A1: FloatingOrArrayLike, L_A2: FloatingOrArrayLike, surround: InductionFactors_CMCCAT2000 = VIEWING_CONDITIONS_CMCCAT2000['Average']) → ndarray

Adapt given stimulus *CIE XYZ* tristimulus values from test viewing conditions to reference viewing conditions using *CMCCAT2000* forward chromatic adaptation model.

Parameters

- **XYZ** (ArrayLike) – *CIE XYZ* tristimulus values of the stimulus to adapt.
- **XYZ_w** (ArrayLike) – Test viewing condition *CIE XYZ* tristimulus values of the whitepoint.

- **XYZ_wr** (ArrayLike) – Reference viewing condition *CIE XYZ* tristimulus values of the whitepoint.
- **L_A1** (FloatingOrArrayLike) – Luminance of test adapting field L_{A1} in cd/m^2 .
- **L_A2** (FloatingOrArrayLike) – Luminance of reference adapting field L_{A2} in cd/m^2 .
- **surround** ([InductionFactors_CMCCAT2000](#)) – Surround viewing conditions induction factors.

Returns

CIE XYZ_c tristimulus values of the stimulus corresponding colour.

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |
| XYZ_w | [0, 100] | [0, 1] |
| XYZ_wr | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ_c | [0, 100] | [0, 1] |

References

[LLRH02], [WRC12d]

Examples

```
>>> XYZ = np.array([22.48, 22.74, 8.54])
>>> XYZ_w = np.array([111.15, 100.00, 35.20])
>>> XYZ_wr = np.array([94.81, 100.00, 107.30])
>>> L_A1 = 200
>>> L_A2 = 200
>>> chromatic_adaptation_forward_CMCCAT2000(XYZ, XYZ_w, XYZ_wr, L_A1, L_A2)
...
array([ 19.5269832...,  23.0683396...,  24.9717522...])
```

colour.adaptation.chromatic_adaptation_inverse_CMCCAT2000

`colour.adaptation.chromatic_adaptation_inverse_CMCCAT2000(XYZ_c: ArrayLike, XYZ_w: ArrayLike, XYZ_wr: ArrayLike, L_A1: FloatingOrArrayLike, L_A2: FloatingOrArrayLike, surround: InductionFactors_CMCCAT2000 = VIEW-ING_CONDITIONS_CMCCAT2000['Average'])`
→ `ndarray`

Adapt given stimulus corresponding colour *CIE XYZ* tristimulus values from reference viewing conditions to test viewing conditions using *CMCCAT2000* inverse chromatic adaptation model.

Parameters

- **XYZ_c** (ArrayLike) – *CIE XYZ* tristimulus values of the stimulus to adapt.
- **XYZ_w** (ArrayLike) – Test viewing condition *CIE XYZ* tristimulus values of the whitepoint.
- **XYZ_wr** (ArrayLike) – Reference viewing condition *CIE XYZ* tristimulus values of the whitepoint.
- **L_A1** (FloatingOrArrayLike) – Luminance of test adapting field L_{A1} in cd/m^2 .
- **L_A2** (FloatingOrArrayLike) – Luminance of reference adapting field L_{A2} in cd/m^2 .
- **surround** ([InductionFactors_CMCCAT2000](#)) – Surround viewing conditions induction factors.

Returns

CIE XYZ_c tristimulus values of the adapted stimulus.

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ_c | [0, 100] | [0, 1] |
| XYZ_w | [0, 100] | [0, 1] |
| XYZ_wr | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |

References

[[LLRH02](#)], [[WRC12d](#)]

Examples

```
>>> XYZ_c = np.array([19.53, 23.07, 24.97])
>>> XYZ_w = np.array([111.15, 100.00, 35.20])
>>> XYZ_wr = np.array([94.81, 100.00, 107.30])
>>> L_A1 = 200
>>> L_A2 = 200
>>> chromatic_adaptation_inverse_CMCCAT2000(
...     XYZ_c, XYZ_w, XYZ_wr, L_A1, L_A2
... )
...
array([ 22.4839876...,  22.7419485...,  8.5393392...])
```

colour.adaptation.InductionFactors_CMCCAT2000

class colour.adaptation.InductionFactors_CMCCAT2000(*F*: *float*)

CMCCAT2000 chromatic adaptation model induction factors.

Parameters

F (*float*) – *F* surround condition.

References

[LLRH02], [WRC12d]

Create new instance of InductionFactors_CMCCAT2000(*F*,)

`__init__()`

Methods

| | |
|--|--|
| <code>__init__()</code> | |
| <code>count(value, /)</code> | Return number of occurrences of value. |
| <code>index(value[, start, stop])</code> | Return first index of value. |

Attributes

| | |
|----------|--------------------------|
| <i>F</i> | Alias for field number 0 |
|----------|--------------------------|

Von Kries

colour.adaptation

| | |
|--|--|
| <code>chromatic_adaptation_VonKries(XYZ, XYZ_w, XYZ_wr)</code> | Adapt given stimulus from test viewing conditions to reference viewing conditions. |
| <code>CHROMATIC_ADAPTATION_TRANSFORMS</code> | Chromatic adaptation transforms. |

colour.adaptation.chromatic_adaptation_VonKries

colour.adaptation.chromatic_adaptation_VonKries(*XYZ*: *ArrayLike*, *XYZ_w*: *ArrayLike*, *XYZ_wr*: *ArrayLike*, *transform*: *Literal*['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling'] | *str* = 'CAT02') → *ndarray*

Adapt given stimulus from test viewing conditions to reference viewing conditions.

Parameters

- **XYZ** (*ArrayLike*) – CIE XYZ tristimulus values of stimulus to adapt.
- **XYZ_w** (*ArrayLike*) – Test viewing conditions CIE XYZ tristimulus values of white-point.

- **XYZ_wr** (ArrayLike) – Reference viewing conditions *CIE XYZ* tristimulus values of whitepoint.
- **transform** (Literal['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling'] | str) – Chromatic adaptation transform.

Returns

CIE XYZ_c tristimulus values of the stimulus corresponding colour.

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |
| XYZ_n | [0, 1] | [0, 1] |
| XYZ_r | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ_c | [0, 1] | [0, 1] |

References

[Fai13a]

Examples

```
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> XYZ_w = np.array([0.95045593, 1.00000000, 1.08905775])
>>> XYZ_wr = np.array([0.96429568, 1.00000000, 0.82510460])
>>> chromatic_adaptation_VonKries(XYZ, XYZ_w, XYZ_wr)
array([ 0.2163881...,  0.1257      ,  0.0384749...])
```

Using Bradford method:

```
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> XYZ_w = np.array([0.95045593, 1.00000000, 1.08905775])
>>> XYZ_wr = np.array([0.96429568, 1.00000000, 0.82510460])
>>> transform = "Bradford"
>>> chromatic_adaptation_VonKries(XYZ, XYZ_w, XYZ_wr, transform)
...
array([ 0.2166600...,  0.1260477...,  0.0385506...])
```

colour.adaptation.CHROMATIC_ADAPTATION_TRANSFORMS

```
colour.adaptation.CHROMATIC_ADAPTATION_TRANSFORMS = CanonicalMapping({'XYZ Scaling': ...,
'Von Kries': ..., 'Bradford': ..., 'Sharp': ..., 'Fairchild': ..., 'CMCCAT97': ...,
'CMCCAT2000': ..., 'CAT02': ..., 'CAT02 Brill 2008': ..., 'CAT16': ..., 'Bianco 2010': ...,
'Bianco PC 2010': ...})
```

Chromatic adaptation transforms.

References

[BS10], [BS08], [Fai], [LPLMartinezverdu07], [LLW+17], [Lin09a], [WRC12e], [WRC12d], [Wikipedia07c]

Dataset

colour.adaptation

| | |
|---------------------|--|
| CAT_BRADFORD | ndarray(shape, dtype=float, buffer=None, offset=0, |
| CAT_BIANCO2010 | ndarray(shape, dtype=float, buffer=None, offset=0, |
| CAT_PC_BIANCO2010 | ndarray(shape, dtype=float, buffer=None, offset=0, |
| CAT_CAT02_BRILL2008 | ndarray(shape, dtype=float, buffer=None, offset=0, |
| CAT_CAT02 | ndarray(shape, dtype=float, buffer=None, offset=0, |
| CAT_CAT16 | ndarray(shape, dtype=float, buffer=None, offset=0, |
| CAT_CMCCAT2000 | ndarray(shape, dtype=float, buffer=None, offset=0, |
| CAT_CMCCAT97 | ndarray(shape, dtype=float, buffer=None, offset=0, |
| CAT_FAIRCHILD | ndarray(shape, dtype=float, buffer=None, offset=0, |
| CAT_SHARP | ndarray(shape, dtype=float, buffer=None, offset=0, |
| CAT_VON_KRIES | ndarray(shape, dtype=float, buffer=None, offset=0, |
| CAT_XYZ_SCALING | ndarray(shape, dtype=float, buffer=None, offset=0, |

colour.adaptation.CAT_BRADFORD

```
colour.adaptation.CAT_BRADFORD = array([[ 0.8951, 0.2664, -0.1614], [-0.7502, 1.7135,
0.0367], [ 0.0389, -0.0685, 1.0296]])
```

```
ndarray(shape, dtype=float, buffer=None, offset=0,
strides=None, order=None)
```

An array object represents a multidimensional, homogeneous array of fixed-size items. An associated data-type object describes the format of each element in the array (its byte-order, how many bytes it occupies in memory, whether it is an integer, a floating point number, or something else, etc.)

Arrays should be constructed using *array*, *zeros* or *empty* (refer to the See Also section below). The parameters given here refer to a low-level method (*ndarray(...)*) for instantiating an array.

For more information, refer to the *numpy* module and examine the methods and attributes of an array.

Parameters

- **below** ((for the `__new__` method; see Notes) –
- **shape** (tuple of ints) – Shape of created array.
- **dtype** (data-type, optional) – Any object that can be interpreted as a numpy data type.
- **buffer** (object exposing buffer interface, optional) – Used to fill the array with data.
- **offset** (int, optional) – Offset of array data in buffer.
- **strides** (tuple of ints, optional) – Strides of data in memory.
- **order** ({'C', 'F'}, optional) – Row-major (C-style) or column-major (Fortran-style) order.

Attributes

T

[ndarray] Transpose of the array.

data

[buffer] The array's elements, in memory.

dtype

[dtype object] Describes the format of the elements in the array.

flags

[dict] Dictionary containing information related to memory use, e.g., 'C_CONTIGUOUS', 'OWNDATA', 'WRITEABLE', etc.

flat

[numpy.flatiter object] Flattened version of the array as an iterator. The iterator allows assignments, e.g., `x.flat = 3` (See *ndarray.flat* for assignment examples; TODO).

imag

[ndarray] Imaginary part of the array.

real

[ndarray] Real part of the array.

size

[int] Number of elements in the array.

itemsize

[int] The memory use of each array element in bytes.

nbytes

[int] The total number of bytes required to store the array data, i.e., `itemsize * size`.

ndim

[int] The array's number of dimensions.

shape

[tuple of ints] Shape of the array.

strides

[tuple of ints] The step-size required to move from one element to the next in memory. For example, a contiguous (3, 4) array of type `int16` in C-order has strides (8, 2). This implies that to move from element to element in memory requires jumps of 2 bytes. To move from row-to-row, one needs to jump 8 bytes at a time (2 * 4).

ctypes

[ctypes object] Class containing properties of the array needed for interaction with ctypes.

base

[ndarray] If the array is a view into another array, that array is its *base* (unless that array is also a view). The *base* array is where the array data is actually stored.

See also:**array**

Construct an array.

zeros

Create an array, each element of which is zero.

empty

Create an array, but leave its allocated memory unchanged (i.e., it contains “garbage”).

dtype

Create a data-type.

numpy.typing.NDArray

An ndarray alias *generic* w.r.t. its *dtype.type* `<numpy.dtype.type>`.

Notes

There are two modes of creating an array using `__new__`:

1. If *buffer* is None, then only *shape*, *dtype*, and *order* are used.
2. If *buffer* is an object exposing the buffer interface, then all keywords are interpreted.

No `__init__` method is needed because the array is fully initialized after the `__new__` method.

Examples

These examples illustrate the low-level *ndarray* constructor. Refer to the *See Also* section above for easier ways of constructing an ndarray.

First mode, *buffer* is None:

```
>>> np.ndarray(shape=(2,2), dtype=float, order='F')
array([[0.0e+000, 0.0e+000], # random
       [      nan, 2.5e-323]])
```

Second mode:

```
>>> np.ndarray((2,), buffer=np.array([1,2,3]),
...           offset=np.int_().itemsize,
...           dtype=int) # offset = 1*itemsize, i.e. skip first element
array([2, 3])
```


colour.adaptation.CAT_BIANCO2010

```
colour.adaptation.CAT_BIANCO2010 = array([[ 0.8752, 0.2787, -0.1539], [-0.8904, 1.8709,
0.0195], [-0.0061, 0.0162, 0.9899]])
```

```
ndarray(shape, dtype=float, buffer=None, offset=0,
        strides=None, order=None)
```

An array object represents a multidimensional, homogeneous array of fixed-size items. An associated data-type object describes the format of each element in the array (its byte-order, how many bytes it occupies in memory, whether it is an integer, a floating point number, or something else, etc.)

Arrays should be constructed using *array*, *zeros* or *empty* (refer to the See Also section below). The parameters given here refer to a low-level method (*ndarray(...)*) for instantiating an array.

For more information, refer to the *numpy* module and examine the methods and attributes of an array.

Parameters

- **below** ((for the `__new__` method; see Notes) –
- **shape** (tuple of ints) – Shape of created array.
- **dtype** (data-type, optional) – Any object that can be interpreted as a numpy data type.
- **buffer** (object exposing buffer interface, optional) – Used to fill the array with data.
- **offset** (int, optional) – Offset of array data in buffer.
- **strides** (tuple of ints, optional) – Strides of data in memory.
- **order** ({'C', 'F'}, optional) – Row-major (C-style) or column-major (Fortran-style) order.

Attributes**T**

[ndarray] Transpose of the array.

data

[buffer] The array's elements, in memory.

dtype

[dtype object] Describes the format of the elements in the array.

flags

[dict] Dictionary containing information related to memory use, e.g., 'C_CONTIGUOUS', 'OWNDATA', 'WRITEABLE', etc.

flat

[numpy.flatiter object] Flattened version of the array as an iterator. The iterator allows assignments, e.g., `x.flat = 3` (See *ndarray.flat* for assignment examples; TODO).

imag

[ndarray] Imaginary part of the array.

real

[ndarray] Real part of the array.

size

[int] Number of elements in the array.

itemsize

[int] The memory use of each array element in bytes.

nbytes

[int] The total number of bytes required to store the array data, i.e., `itemsize * size`.

ndim

[int] The array's number of dimensions.

shape

[tuple of ints] Shape of the array.

strides

[tuple of ints] The step-size required to move from one element to the next in memory. For example, a contiguous (3, 4) array of type `int16` in C-order has strides (8, 2). This implies that to move from element to element in memory requires jumps of 2 bytes. To move from row-to-row, one needs to jump 8 bytes at a time ($2 * 4$).

ctypes

[ctypes object] Class containing properties of the array needed for interaction with ctypes.

base

[ndarray] If the array is a view into another array, that array is its *base* (unless that array is also a view). The *base* array is where the array data is actually stored.

See also:**array**

Construct an array.

zeros

Create an array, each element of which is zero.

empty

Create an array, but leave its allocated memory unchanged (i.e., it contains “garbage”).

dtype

Create a data-type.

numpy.typing.NDArray

An ndarray alias `generic` w.r.t. its `dtype.type` `<numpy.dtype.type>`.

Notes

There are two modes of creating an array using `__new__`:

1. If *buffer* is `None`, then only *shape*, *dtype*, and *order* are used.
2. If *buffer* is an object exposing the buffer interface, then all keywords are interpreted.

No `__init__` method is needed because the array is fully initialized after the `__new__` method.

Examples

These examples illustrate the low-level *ndarray* constructor. Refer to the *See Also* section above for easier ways of constructing an ndarray.

First mode, *buffer* is `None`:

```
>>> np.ndarray(shape=(2,2), dtype=float, order='F')
array([[0.0e+000, 0.0e+000], # random
       [      nan, 2.5e-323]])
```

Second mode:

```
>>> np.ndarray((2,), buffer=np.array([1,2,3]),
...           offset=np.int_().itemsize,
...           dtype=int) # offset = 1*itemsize, i.e. skip first element
array([2, 3])
```

colour.adaptation.CAT_PC_BIANCO2010

```
colour.adaptation.CAT_PC_BIANCO2010 = array([[ 0.6489,  0.3915, -0.0404], [-0.3775,  1.3055,
 0.072 ], [-0.0271,  0.0888,  0.9383]])
```

ndarray(shape, dtype=float, buffer=None, offset=0, strides=None, order=None)

An array object represents a multidimensional, homogeneous array of fixed-size items. An associated data-type object describes the format of each element in the array (its byte-order, how many bytes it occupies in memory, whether it is an integer, a floating point number, or something else, etc.)

Arrays should be constructed using *array*, *zeros* or *empty* (refer to the See Also section below). The parameters given here refer to a low-level method (*ndarray(...)*) for instantiating an array.

For more information, refer to the *numpy* module and examine the methods and attributes of an array.

Parameters

- **below** ((for the `__new__` method; see Notes) –
- **shape** (tuple of ints) – Shape of created array.
- **dtype** (data-type, optional) – Any object that can be interpreted as a numpy data type.
- **buffer** (object exposing buffer interface, optional) – Used to fill the array with data.
- **offset** (int, optional) – Offset of array data in buffer.
- **strides** (tuple of ints, optional) – Strides of data in memory.
- **order** ({'C', 'F'}, optional) – Row-major (C-style) or column-major (Fortran-style) order.

Attributes

T

[ndarray] Transpose of the array.

data

[buffer] The array's elements, in memory.

dtype

[dtype object] Describes the format of the elements in the array.

flags

[dict] Dictionary containing information related to memory use, e.g., 'C_CONTIGUOUS', 'OWNDATA', 'WRITEABLE', etc.

flat

[numpy.flatiter object] Flattened version of the array as an iterator. The iterator allows assignments, e.g., `x.flat = 3` (See *ndarray.flat* for assignment examples; TODO).

imag

[ndarray] Imaginary part of the array.

real

[ndarray] Real part of the array.

size

[int] Number of elements in the array.

itemsize

[int] The memory use of each array element in bytes.

nbytes

[int] The total number of bytes required to store the array data, i.e., `itemsize * size`.

ndim

[int] The array's number of dimensions.

shape

[tuple of ints] Shape of the array.

strides

[tuple of ints] The step-size required to move from one element to the next in memory. For example, a contiguous (3, 4) array of type `int16` in C-order has strides (8, 2). This implies that to move from element to element in memory requires jumps of 2 bytes. To move from row-to-row, one needs to jump 8 bytes at a time ($2 * 4$).

ctypes

[ctypes object] Class containing properties of the array needed for interaction with ctypes.

base

[ndarray] If the array is a view into another array, that array is its *base* (unless that array is also a view). The *base* array is where the array data is actually stored.

See also:

array

Construct an array.

zeros

Create an array, each element of which is zero.

empty

Create an array, but leave its allocated memory unchanged (i.e., it contains “garbage”).

dtype

Create a data-type.

numpy.typing.NDArray

An ndarray alias *generic* w.r.t. its `dtype.type` `<numpy.dtype.type>`.

Notes

There are two modes of creating an array using `__new__`:

1. If *buffer* is `None`, then only *shape*, *dtype*, and *order* are used.
2. If *buffer* is an object exposing the buffer interface, then all keywords are interpreted.

No `__init__` method is needed because the array is fully initialized after the `__new__` method.

Examples

These examples illustrate the low-level *ndarray* constructor. Refer to the *See Also* section above for easier ways of constructing an ndarray.

First mode, *buffer* is None:

```
>>> np.ndarray(shape=(2,2), dtype=float, order='F')
array([[0.0e+000, 0.0e+000], # random
       [      nan, 2.5e-323]])
```

Second mode:

```
>>> np.ndarray((2,), buffer=np.array([1,2,3]),
...           offset=np.int_().itemsize,
...           dtype=int) # offset = 1*itemsize, i.e. skip first element
array([2, 3])
```

colour.adaptation.CAT_CAT02_BRILL2008

```
colour.adaptation.CAT_CAT02_BRILL2008 = array([[ 0.7328, 0.4296, -0.1624], [-0.7036,
1.6975, 0.0061], [ 0. , 0. , 1. ]])
```

```
ndarray(shape, dtype=float, buffer=None, offset=0,
        strides=None, order=None)
```

An array object represents a multidimensional, homogeneous array of fixed-size items. An associated data-type object describes the format of each element in the array (its byte-order, how many bytes it occupies in memory, whether it is an integer, a floating point number, or something else, etc.)

Arrays should be constructed using *array*, *zeros* or *empty* (refer to the *See Also* section below). The parameters given here refer to a low-level method (*ndarray(...)*) for instantiating an array.

For more information, refer to the *numpy* module and examine the methods and attributes of an array.

Parameters

- **below** ((for the `__new__` method; see Notes) –
- **shape** (tuple of ints) – Shape of created array.
- **dtype** (data-type, optional) – Any object that can be interpreted as a numpy data type.
- **buffer** (object exposing buffer interface, optional) – Used to fill the array with data.
- **offset** (int, optional) – Offset of array data in buffer.
- **strides** (tuple of ints, optional) – Strides of data in memory.
- **order** ({'C', 'F'}, optional) – Row-major (C-style) or column-major (Fortran-style) order.

Attributes

T

[ndarray] Transpose of the array.

data

[buffer] The array's elements, in memory.

dtype

[dtype object] Describes the format of the elements in the array.

flags

[dict] Dictionary containing information related to memory use, e.g., 'C_CONTIGUOUS', 'OWNDATA', 'WRITEABLE', etc.

flat

[numpy.flatiter object] Flattened version of the array as an iterator. The iterator allows assignments, e.g., `x.flat = 3` (See `ndarray.flat` for assignment examples; TODO).

imag

[ndarray] Imaginary part of the array.

real

[ndarray] Real part of the array.

size

[int] Number of elements in the array.

itemsize

[int] The memory use of each array element in bytes.

nbytes

[int] The total number of bytes required to store the array data, i.e., `itemsize * size`.

ndim

[int] The array's number of dimensions.

shape

[tuple of ints] Shape of the array.

strides

[tuple of ints] The step-size required to move from one element to the next in memory. For example, a contiguous (3, 4) array of type `int16` in C-order has strides (8, 2). This implies that to move from element to element in memory requires jumps of 2 bytes. To move from row-to-row, one needs to jump 8 bytes at a time ($2 * 4$).

ctypes

[ctypes object] Class containing properties of the array needed for interaction with ctypes.

base

[ndarray] If the array is a view into another array, that array is its *base* (unless that array is also a view). The *base* array is where the array data is actually stored.

See also:

array

Construct an array.

zeros

Create an array, each element of which is zero.

empty

Create an array, but leave its allocated memory unchanged (i.e., it contains "garbage").

dtype

Create a data-type.

numpy.typing.NDArray

An ndarray alias `generic` w.r.t. its `dtype.type <numpy.dtype.type>`.

Notes

There are two modes of creating an array using `__new__`:

1. If `buffer` is `None`, then only `shape`, `dtype`, and `order` are used.
2. If `buffer` is an object exposing the buffer interface, then all keywords are interpreted.

No `__init__` method is needed because the array is fully initialized after the `__new__` method.

Examples

These examples illustrate the low-level `ndarray` constructor. Refer to the *See Also* section above for easier ways of constructing an ndarray.

First mode, `buffer` is `None`:

```
>>> np.ndarray(shape=(2,2), dtype=float, order='F')
array([[0.0e+000, 0.0e+000], # random
       [      nan, 2.5e-323]])
```

Second mode:

```
>>> np.ndarray((2,), buffer=np.array([1,2,3]),
...            offset=np.int_().itemsize,
...            dtype=int) # offset = 1*itemsize, i.e. skip first element
array([2, 3])
```

colour.adaptation.CAT_CAT02

```
colour.adaptation.CAT_CAT02 = array([[ 0.7328, 0.4296, -0.1624], [-0.7036, 1.6975, 0.0061],
[ 0.003 , 0.0136, 0.9834]])
```

ndarray(shape, dtype=float, buffer=None, offset=0, strides=None, order=None)

An array object represents a multidimensional, homogeneous array of fixed-size items. An associated data-type object describes the format of each element in the array (its byte-order, how many bytes it occupies in memory, whether it is an integer, a floating point number, or something else, etc.)

Arrays should be constructed using `array`, `zeros` or `empty` (refer to the *See Also* section below). The parameters given here refer to a low-level method (`ndarray(...)`) for instantiating an array.

For more information, refer to the `numpy` module and examine the methods and attributes of an array.

Parameters

- **below** ((for the `__new__` method; see Notes) –
- **shape** (`tuple` of `ints`) – Shape of created array.
- **dtype** (data-type, optional) – Any object that can be interpreted as a numpy data type.
- **buffer** (object exposing buffer interface, optional) – Used to fill the array with data.

- **offset** (`int`, optional) – Offset of array data in buffer.
- **strides** (`tuple` of `ints`, optional) – Strides of data in memory.
- **order** (`{'C', 'F'}`, optional) – Row-major (C-style) or column-major (Fortran-style) order.

Attributes

T

[`ndarray`] Transpose of the array.

data

[`buffer`] The array's elements, in memory.

dtype

[`dtype` object] Describes the format of the elements in the array.

flags

[`dict`] Dictionary containing information related to memory use, e.g., `'C_CONTIGUOUS'`, `'OWNDATA'`, `'WRITEABLE'`, etc.

flat

[`numpy.flatiter` object] Flattened version of the array as an iterator. The iterator allows assignments, e.g., `x.flat = 3` (See `ndarray.flat` for assignment examples; TODO).

imag

[`ndarray`] Imaginary part of the array.

real

[`ndarray`] Real part of the array.

size

[`int`] Number of elements in the array.

itemsize

[`int`] The memory use of each array element in bytes.

nbytes

[`int`] The total number of bytes required to store the array data, i.e., `itemsize * size`.

ndim

[`int`] The array's number of dimensions.

shape

[`tuple` of `ints`] Shape of the array.

strides

[`tuple` of `ints`] The step-size required to move from one element to the next in memory. For example, a contiguous (3, 4) array of type `int16` in C-order has strides (8, 2). This implies that to move from element to element in memory requires jumps of 2 bytes. To move from row-to-row, one needs to jump 8 bytes at a time (2 * 4).

ctypes

[`ctypes` object] Class containing properties of the array needed for interaction with ctypes.

base

[`ndarray`] If the array is a view into another array, that array is its *base* (unless that array is also a view). The *base* array is where the array data is actually stored.

See also:

array

Construct an array.

zeros

Create an array, each element of which is zero.

empty

Create an array, but leave its allocated memory unchanged (i.e., it contains “garbage”).

dtype

Create a data-type.

numpy.typing.NDArray

An ndarray alias *generic* w.r.t. its *dtype.type* `<numpy.dtype.type>`.

Notes

There are two modes of creating an array using `__new__`:

1. If *buffer* is `None`, then only *shape*, *dtype*, and *order* are used.
2. If *buffer* is an object exposing the buffer interface, then all keywords are interpreted.

No `__init__` method is needed because the array is fully initialized after the `__new__` method.

Examples

These examples illustrate the low-level *ndarray* constructor. Refer to the *See Also* section above for easier ways of constructing an ndarray.

First mode, *buffer* is `None`:

```
>>> np.ndarray(shape=(2,2), dtype=float, order='F')
array([[0.0e+000, 0.0e+000], # random
       [      nan, 2.5e-323]])
```

Second mode:

```
>>> np.ndarray((2,), buffer=np.array([1,2,3]),
...           offset=np.int_().itemsize,
...           dtype=int) # offset = 1*itemsize, i.e. skip first element
array([2, 3])
```

colour.adaptation.CAT_CAT16

```
colour.adaptation.CAT_CAT16 = array([[ 0.401288, 0.650173, -0.051461], [-0.250268,
1.204414, 0.045854], [-0.002079, 0.048952, 0.953127]])
```

```
ndarray(shape, dtype=float, buffer=None, offset=0,
        strides=None, order=None)
```

An array object represents a multidimensional, homogeneous array of fixed-size items. An associated data-type object describes the format of each element in the array (its byte-order, how many bytes it occupies in memory, whether it is an integer, a floating point number, or something else, etc.)

Arrays should be constructed using *array*, *zeros* or *empty* (refer to the *See Also* section below). The parameters given here refer to a low-level method (*ndarray(...)*) for instantiating an array.

For more information, refer to the *numpy* module and examine the methods and attributes of an array.

Parameters

- **below** ((for the `__new__` method; see Notes) –

- **shape** (tuple of ints) – Shape of created array.
- **dtype** (data-type, optional) – Any object that can be interpreted as a numpy data type.
- **buffer** (object exposing buffer interface, optional) – Used to fill the array with data.
- **offset** (int, optional) – Offset of array data in buffer.
- **strides** (tuple of ints, optional) – Strides of data in memory.
- **order** ({'C', 'F'}, optional) – Row-major (C-style) or column-major (Fortran-style) order.

Attributes

T

[ndarray] Transpose of the array.

data

[buffer] The array's elements, in memory.

dtype

[dtype object] Describes the format of the elements in the array.

flags

[dict] Dictionary containing information related to memory use, e.g., 'C_CONTIGUOUS', 'OWNDATA', 'WRITEABLE', etc.

flat

[numpy.flatiter object] Flattened version of the array as an iterator. The iterator allows assignments, e.g., `x.flat = 3` (See *ndarray.flat* for assignment examples; TODO).

imag

[ndarray] Imaginary part of the array.

real

[ndarray] Real part of the array.

size

[int] Number of elements in the array.

itemsize

[int] The memory use of each array element in bytes.

nbytes

[int] The total number of bytes required to store the array data, i.e., `itemsize * size`.

ndim

[int] The array's number of dimensions.

shape

[tuple of ints] Shape of the array.

strides

[tuple of ints] The step-size required to move from one element to the next in memory. For example, a contiguous (3, 4) array of type `int16` in C-order has strides (8, 2). This implies that to move from element to element in memory requires jumps of 2 bytes. To move from row-to-row, one needs to jump 8 bytes at a time ($2 * 4$).

ctypes

[ctypes object] Class containing properties of the array needed for interaction with ctypes.

base

[ndarray] If the array is a view into another array, that array is its *base* (unless that array is also a view). The *base* array is where the array data is actually stored.

See also:

array

Construct an array.

zeros

Create an array, each element of which is zero.

empty

Create an array, but leave its allocated memory unchanged (i.e., it contains “garbage”).

dtype

Create a data-type.

numpy.typing.NDArray

An ndarray alias **generic** w.r.t. its `dtype.type` `<numpy.dtype.type>`.

Notes

There are two modes of creating an array using `__new__`:

1. If `buffer` is `None`, then only `shape`, `dtype`, and `order` are used.
2. If `buffer` is an object exposing the buffer interface, then all keywords are interpreted.

No `__init__` method is needed because the array is fully initialized after the `__new__` method.

Examples

These examples illustrate the low-level `ndarray` constructor. Refer to the *See Also* section above for easier ways of constructing an ndarray.

First mode, `buffer` is `None`:

```
>>> np.ndarray(shape=(2,2), dtype=float, order='F')
array([[0.0e+000, 0.0e+000], # random
       [      nan, 2.5e-323]])
```

Second mode:

```
>>> np.ndarray((2,), buffer=np.array([1,2,3]),
...           offset=np.int_().itemsize,
...           dtype=int) # offset = 1*itemsize, i.e. skip first element
array([2, 3])
```

colour.adaptation.CAT_CMCCAT2000

```
colour.adaptation.CAT_CMCCAT2000 = array([[ 7.98200000e-01,  3.38900000e-01,
-1.37100000e-01], [ -5.91800000e-01,  1.55120000e+00,  4.06000000e-02], [ 8.00000000e-04,
 2.39000000e-02,  9.75300000e-01]])
```

```
ndarray(shape, dtype=float, buffer=None, offset=0,
        strides=None, order=None)
```

An array object represents a multidimensional, homogeneous array of fixed-size items. An associated data-type object describes the format of each element in the array (its byte-order, how many bytes it occupies in memory, whether it is an integer, a floating point number, or something else, etc.)

Arrays should be constructed using `array`, `zeros` or `empty` (refer to the See Also section below). The parameters given here refer to a low-level method (`ndarray(...)`) for instantiating an array.

For more information, refer to the *numpy* module and examine the methods and attributes of an array.

Parameters

- **below** ((for the `__new__` method; see Notes) –
- **shape** (tuple of ints) – Shape of created array.
- **dtype** (data-type, optional) – Any object that can be interpreted as a numpy data type.
- **buffer** (object exposing buffer interface, optional) – Used to fill the array with data.
- **offset** (int, optional) – Offset of array data in buffer.
- **strides** (tuple of ints, optional) – Strides of data in memory.
- **order** ({'C', 'F'}, optional) – Row-major (C-style) or column-major (Fortran-style) order.

Attributes

T

[ndarray] Transpose of the array.

data

[buffer] The array's elements, in memory.

dtype

[dtype object] Describes the format of the elements in the array.

flags

[dict] Dictionary containing information related to memory use, e.g., 'C_CONTIGUOUS', 'OWNDATA', 'WRITEABLE', etc.

flat

[numpy.flatiter object] Flattened version of the array as an iterator. The iterator allows assignments, e.g., `x.flat = 3` (See *ndarray.flat* for assignment examples; TODO).

imag

[ndarray] Imaginary part of the array.

real

[ndarray] Real part of the array.

size

[int] Number of elements in the array.

itemsize

[int] The memory use of each array element in bytes.

nbytes

[int] The total number of bytes required to store the array data, i.e., `itemsize * size`.

ndim

[int] The array's number of dimensions.

shape

[tuple of ints] Shape of the array.

strides

[tuple of ints] The step-size required to move from one element to the next in memory. For example, a contiguous (3, 4) array of type `int16` in C-order has strides (8, 2). This implies that to move from element to element in memory requires jumps of 2 bytes. To move from row-to-row, one needs to jump 8 bytes at a time (2 * 4).

ctypes

[ctypes object] Class containing properties of the array needed for interaction with ctypes.

base

[ndarray] If the array is a view into another array, that array is its *base* (unless that array is also a view). The *base* array is where the array data is actually stored.

See also:**array**

Construct an array.

zeros

Create an array, each element of which is zero.

empty

Create an array, but leave its allocated memory unchanged (i.e., it contains “garbage”).

dtype

Create a data-type.

numpy.typing.NDArray

An ndarray alias *generic* w.r.t. its *dtype.type* `<numpy.dtype.type>`.

Notes

There are two modes of creating an array using `__new__`:

1. If *buffer* is None, then only *shape*, *dtype*, and *order* are used.
2. If *buffer* is an object exposing the buffer interface, then all keywords are interpreted.

No `__init__` method is needed because the array is fully initialized after the `__new__` method.

Examples

These examples illustrate the low-level *ndarray* constructor. Refer to the *See Also* section above for easier ways of constructing an ndarray.

First mode, *buffer* is None:

```
>>> np.ndarray(shape=(2,2), dtype=float, order='F')
array([[0.0e+000, 0.0e+000], # random
       [      nan, 2.5e-323]])
```

Second mode:

```
>>> np.ndarray((2,), buffer=np.array([1,2,3]),
...           offset=np.int_().itemsize,
...           dtype=int) # offset = 1*itemsize, i.e. skip first element
array([2, 3])
```

colour.adaptation.CAT_CMCCAT97

```
colour.adaptation.CAT_CMCCAT97 = array([[ 0.8951, -0.7502, 0.0389], [ 0.2664, 1.7135, 0.0685], [-0.1614, 0.0367, 1.0296]])
```

ndarray(shape, dtype=float, buffer=None, offset=0, strides=None, order=None)

An array object represents a multidimensional, homogeneous array of fixed-size items. An associated data-type object describes the format of each element in the array (its byte-order, how many bytes it occupies in memory, whether it is an integer, a floating point number, or something else, etc.)

Arrays should be constructed using *array*, *zeros* or *empty* (refer to the See Also section below). The parameters given here refer to a low-level method (*ndarray(...)*) for instantiating an array.

For more information, refer to the *numpy* module and examine the methods and attributes of an array.

Parameters

- **below** ((for the `__new__` method; see Notes) –
- **shape** (tuple of ints) – Shape of created array.
- **dtype** (data-type, optional) – Any object that can be interpreted as a numpy data type.
- **buffer** (object exposing buffer interface, optional) – Used to fill the array with data.
- **offset** (int, optional) – Offset of array data in buffer.
- **strides** (tuple of ints, optional) – Strides of data in memory.
- **order** ({'C', 'F'}, optional) – Row-major (C-style) or column-major (Fortran-style) order.

Attributes

T

[ndarray] Transpose of the array.

data

[buffer] The array's elements, in memory.

dtype

[dtype object] Describes the format of the elements in the array.

flags

[dict] Dictionary containing information related to memory use, e.g., 'C_CONTIGUOUS', 'OWNDATA', 'WRITEABLE', etc.

flat

[numpy.flatiter object] Flattened version of the array as an iterator. The iterator allows assignments, e.g., `x.flat = 3` (See *ndarray.flat* for assignment examples; TODO).

imag

[ndarray] Imaginary part of the array.

real

[ndarray] Real part of the array.

size

[int] Number of elements in the array.

itemsize

[int] The memory use of each array element in bytes.

nbytes

[int] The total number of bytes required to store the array data, i.e., `itemsize * size`.

ndim

[int] The array's number of dimensions.

shape

[tuple of ints] Shape of the array.

strides

[tuple of ints] The step-size required to move from one element to the next in memory. For example, a contiguous (3, 4) array of type `int16` in C-order has strides (8, 2). This implies that to move from element to element in memory requires jumps of 2 bytes. To move from row-to-row, one needs to jump 8 bytes at a time ($2 * 4$).

ctypes

[ctypes object] Class containing properties of the array needed for interaction with ctypes.

base

[ndarray] If the array is a view into another array, that array is its *base* (unless that array is also a view). The *base* array is where the array data is actually stored.

See also:**array**

Construct an array.

zeros

Create an array, each element of which is zero.

empty

Create an array, but leave its allocated memory unchanged (i.e., it contains “garbage”).

dtype

Create a data-type.

numpy.typing.NDArray

An ndarray alias `generic` w.r.t. its `dtype.type` `<numpy.dtype.type>`.

Notes

There are two modes of creating an array using `__new__`:

1. If *buffer* is `None`, then only *shape*, *dtype*, and *order* are used.
2. If *buffer* is an object exposing the buffer interface, then all keywords are interpreted.

No `__init__` method is needed because the array is fully initialized after the `__new__` method.

Examples

These examples illustrate the low-level *ndarray* constructor. Refer to the *See Also* section above for easier ways of constructing an ndarray.

First mode, *buffer* is `None`:

```
>>> np.ndarray(shape=(2,2), dtype=float, order='F')
array([[0.0e+000, 0.0e+000], # random
       [ nan, 2.5e-323]])
```

Second mode:

```
>>> np.ndarray((2,), buffer=np.array([1,2,3]),
...           offset=np.int_().itemsize,
...           dtype=int) # offset = 1*itemsize, i.e. skip first element
array([2, 3])
```

colour.adaptation.CAT_FAIRCHILD

```
colour.adaptation.CAT_FAIRCHILD = array([[ 0.8562,  0.3372, -0.1934], [-0.836 ,  1.8327,
 0.0033], [ 0.0357, -0.0469,  1.0112]])
```

ndarray(shape, dtype=float, buffer=None, offset=0, strides=None, order=None)

An array object represents a multidimensional, homogeneous array of fixed-size items. An associated data-type object describes the format of each element in the array (its byte-order, how many bytes it occupies in memory, whether it is an integer, a floating point number, or something else, etc.)

Arrays should be constructed using *array*, *zeros* or *empty* (refer to the See Also section below). The parameters given here refer to a low-level method (*ndarray(...)*) for instantiating an array.

For more information, refer to the *numpy* module and examine the methods and attributes of an array.

Parameters

- **below** ((for the `__new__` method; see Notes) –
- **shape** (*tuple* of ints) – Shape of created array.
- **dtype** (data-type, optional) – Any object that can be interpreted as a numpy data type.
- **buffer** (object exposing buffer interface, optional) – Used to fill the array with data.
- **offset** (*int*, optional) – Offset of array data in buffer.
- **strides** (*tuple* of ints, optional) – Strides of data in memory.
- **order** ({'C', 'F'}, optional) – Row-major (C-style) or column-major (Fortran-style) order.

Attributes

T

[ndarray] Transpose of the array.

data

[buffer] The array's elements, in memory.

dtype

[dtype object] Describes the format of the elements in the array.

flags

[dict] Dictionary containing information related to memory use, e.g., 'C_CONTIGUOUS', 'OWNDATA', 'WRITEABLE', etc.

flat

[numpy.flatiter object] Flattened version of the array as an iterator. The iterator allows assignments, e.g., `x.flat = 3` (See *ndarray.flat* for assignment examples; TODO).

imag

[ndarray] Imaginary part of the array.

real

[ndarray] Real part of the array.

size

[int] Number of elements in the array.

itemsize

[int] The memory use of each array element in bytes.

nbytes

[int] The total number of bytes required to store the array data, i.e., `itemsize * size`.

ndim

[int] The array's number of dimensions.

shape

[tuple of ints] Shape of the array.

strides

[tuple of ints] The step-size required to move from one element to the next in memory. For example, a contiguous (3, 4) array of type `int16` in C-order has strides (8, 2). This implies that to move from element to element in memory requires jumps of 2 bytes. To move from row-to-row, one needs to jump 8 bytes at a time ($2 * 4$).

ctypes

[ctypes object] Class containing properties of the array needed for interaction with ctypes.

base

[ndarray] If the array is a view into another array, that array is its *base* (unless that array is also a view). The *base* array is where the array data is actually stored.

See also:**array**

Construct an array.

zeros

Create an array, each element of which is zero.

empty

Create an array, but leave its allocated memory unchanged (i.e., it contains “garbage”).

dtype

Create a data-type.

numpy.typing.NDArray

An ndarray alias *generic* w.r.t. its `dtype.type` `<numpy.dtype.type>`.

Notes

There are two modes of creating an array using `__new__`:

1. If *buffer* is `None`, then only *shape*, *dtype*, and *order* are used.
2. If *buffer* is an object exposing the buffer interface, then all keywords are interpreted.

No `__init__` method is needed because the array is fully initialized after the `__new__` method.

Examples

These examples illustrate the low-level *ndarray* constructor. Refer to the *See Also* section above for easier ways of constructing an *ndarray*.

First mode, *buffer* is *None*:

```
>>> np.ndarray(shape=(2,2), dtype=float, order='F')
array([[0.0e+000, 0.0e+000], # random
       [      nan, 2.5e-323]])
```

Second mode:

```
>>> np.ndarray((2,), buffer=np.array([1,2,3]),
...           offset=np.int_().itemsize,
...           dtype=int) # offset = 1*itemsize, i.e. skip first element
array([2, 3])
```

colour.adaptation.CAT_SHARP

```
colour.adaptation.CAT_SHARP = array([[ 1.2694, -0.0988, -0.1706], [-0.8364, 1.8006,
0.0357], [ 0.0297, -0.0315, 1.0018]])
```

```
ndarray(shape, dtype=float, buffer=None, offset=0,
        strides=None, order=None)
```

An array object represents a multidimensional, homogeneous array of fixed-size items. An associated data-type object describes the format of each element in the array (its byte-order, how many bytes it occupies in memory, whether it is an integer, a floating point number, or something else, etc.)

Arrays should be constructed using *array*, *zeros* or *empty* (refer to the *See Also* section below). The parameters given here refer to a low-level method (*ndarray(...)*) for instantiating an array.

For more information, refer to the *numpy* module and examine the methods and attributes of an array.

Parameters

- **below** ((for the `__new__` method; see Notes) –
- **shape** (*tuple* of ints) – Shape of created array.
- **dtype** (data-type, optional) – Any object that can be interpreted as a numpy data type.
- **buffer** (object exposing buffer interface, optional) – Used to fill the array with data.
- **offset** (*int*, optional) – Offset of array data in buffer.
- **strides** (*tuple* of ints, optional) – Strides of data in memory.
- **order** ({'C', 'F'}, optional) – Row-major (C-style) or column-major (Fortran-style) order.

Attributes

T

[ndarray] Transpose of the array.

data

[buffer] The array's elements, in memory.

dtype

[dtype object] Describes the format of the elements in the array.

flags

[dict] Dictionary containing information related to memory use, e.g., 'C_CONTIGUOUS', 'OWNDATA', 'WRITEABLE', etc.

flat

[numpy.flatiter object] Flattened version of the array as an iterator. The iterator allows assignments, e.g., `x.flat = 3` (See `ndarray.flat` for assignment examples; TODO).

imag

[ndarray] Imaginary part of the array.

real

[ndarray] Real part of the array.

size

[int] Number of elements in the array.

itemsize

[int] The memory use of each array element in bytes.

nbytes

[int] The total number of bytes required to store the array data, i.e., `itemsize * size`.

ndim

[int] The array's number of dimensions.

shape

[tuple of ints] Shape of the array.

strides

[tuple of ints] The step-size required to move from one element to the next in memory. For example, a contiguous (3, 4) array of type `int16` in C-order has strides (8, 2). This implies that to move from element to element in memory requires jumps of 2 bytes. To move from row-to-row, one needs to jump 8 bytes at a time ($2 * 4$).

ctypes

[ctypes object] Class containing properties of the array needed for interaction with ctypes.

base

[ndarray] If the array is a view into another array, that array is its *base* (unless that array is also a view). The *base* array is where the array data is actually stored.

See also:

array

Construct an array.

zeros

Create an array, each element of which is zero.

empty

Create an array, but leave its allocated memory unchanged (i.e., it contains "garbage").

dtype

Create a data-type.

numpy.typing.NDArray

An ndarray alias `generic` w.r.t. its `dtype.type <numpy.dtype.type>`.

Notes

There are two modes of creating an array using `__new__`:

1. If `buffer` is `None`, then only `shape`, `dtype`, and `order` are used.
2. If `buffer` is an object exposing the buffer interface, then all keywords are interpreted.

No `__init__` method is needed because the array is fully initialized after the `__new__` method.

Examples

These examples illustrate the low-level `ndarray` constructor. Refer to the *See Also* section above for easier ways of constructing an ndarray.

First mode, `buffer` is `None`:

```
>>> np.ndarray(shape=(2,2), dtype=float, order='F')
array([[0.0e+000, 0.0e+000], # random
       [      nan, 2.5e-323]])
```

Second mode:

```
>>> np.ndarray((2,), buffer=np.array([1,2,3]),
...           offset=np.int_().itemsize,
...           dtype=int) # offset = 1*itemsize, i.e. skip first element
array([2, 3])
```

colour.adaptation.CAT_VON_KRIES

```
colour.adaptation.CAT_VON_KRIES = array([[ 0.40024, 0.7076 , -0.08081], [-0.2263 , 1.16532,
0.0457 ], [ 0. , 0. , 0.91822]])
```

```
ndarray(shape, dtype=float, buffer=None, offset=0,
        strides=None, order=None)
```

An array object represents a multidimensional, homogeneous array of fixed-size items. An associated data-type object describes the format of each element in the array (its byte-order, how many bytes it occupies in memory, whether it is an integer, a floating point number, or something else, etc.)

Arrays should be constructed using `array`, `zeros` or `empty` (refer to the *See Also* section below). The parameters given here refer to a low-level method (`ndarray(...)`) for instantiating an array.

For more information, refer to the `numpy` module and examine the methods and attributes of an array.

Parameters

- **below** ((for the `__new__` method; see Notes) –
- **shape** (`tuple` of `ints`) – Shape of created array.
- **dtype** (data-type, optional) – Any object that can be interpreted as a numpy data type.
- **buffer** (object exposing buffer interface, optional) – Used to fill the array with data.

- **offset** (`int`, optional) – Offset of array data in buffer.
- **strides** (`tuple` of `ints`, optional) – Strides of data in memory.
- **order** (`{'C', 'F'}`, optional) – Row-major (C-style) or column-major (Fortran-style) order.

Attributes

T

[`ndarray`] Transpose of the array.

data

[`buffer`] The array's elements, in memory.

dtype

[`dtype` object] Describes the format of the elements in the array.

flags

[`dict`] Dictionary containing information related to memory use, e.g., 'C_CONTIGUOUS', 'OWNDATA', 'WRITEABLE', etc.

flat

[`numpy.flatiter` object] Flattened version of the array as an iterator. The iterator allows assignments, e.g., `x.flat = 3` (See `ndarray.flat` for assignment examples; TODO).

imag

[`ndarray`] Imaginary part of the array.

real

[`ndarray`] Real part of the array.

size

[`int`] Number of elements in the array.

itemsize

[`int`] The memory use of each array element in bytes.

nbytes

[`int`] The total number of bytes required to store the array data, i.e., `itemsize * size`.

ndim

[`int`] The array's number of dimensions.

shape

[`tuple` of `ints`] Shape of the array.

strides

[`tuple` of `ints`] The step-size required to move from one element to the next in memory. For example, a contiguous (3, 4) array of type `int16` in C-order has strides (8, 2). This implies that to move from element to element in memory requires jumps of 2 bytes. To move from row-to-row, one needs to jump 8 bytes at a time (2 * 4).

ctypes

[`ctypes` object] Class containing properties of the array needed for interaction with ctypes.

base

[`ndarray`] If the array is a view into another array, that array is its *base* (unless that array is also a view). The *base* array is where the array data is actually stored.

See also:

array

Construct an array.

zeros

Create an array, each element of which is zero.

empty

Create an array, but leave its allocated memory unchanged (i.e., it contains “garbage”).

dtype

Create a data-type.

numpy.typing.NDArray

An ndarray alias *generic* w.r.t. its *dtype.type* *<numpy.dtype.type>*.

Notes

There are two modes of creating an array using `__new__`:

1. If *buffer* is `None`, then only *shape*, *dtype*, and *order* are used.
2. If *buffer* is an object exposing the buffer interface, then all keywords are interpreted.

No `__init__` method is needed because the array is fully initialized after the `__new__` method.

Examples

These examples illustrate the low-level *ndarray* constructor. Refer to the *See Also* section above for easier ways of constructing an ndarray.

First mode, *buffer* is `None`:

```
>>> np.ndarray(shape=(2,2), dtype=float, order='F')
array([[0.0e+000, 0.0e+000], # random
       [      nan, 2.5e-323]])
```

Second mode:

```
>>> np.ndarray((2,), buffer=np.array([1,2,3]),
...           offset=np.int_().itemsize,
...           dtype=int) # offset = 1*itemsize, i.e. skip first element
array([2, 3])
```

colour.adaptation.CAT_XYZ_SCALING

```
colour.adaptation.CAT_XYZ_SCALING = array([[ 1.,  0.,  0.], [ 0.,  1.,  0.], [ 0.,  0.,  1.]])
```

```
ndarray(shape, dtype=float, buffer=None, offset=0,
        strides=None, order=None)
```

An array object represents a multidimensional, homogeneous array of fixed-size items. An associated data-type object describes the format of each element in the array (its byte-order, how many bytes it occupies in memory, whether it is an integer, a floating point number, or something else, etc.)

Arrays should be constructed using *array*, *zeros* or *empty* (refer to the *See Also* section below). The parameters given here refer to a low-level method (*ndarray(...)*) for instantiating an array.

For more information, refer to the *numpy* module and examine the methods and attributes of an array.

Parameters

- **below** ((for the `__new__` method; see Notes) –

- **shape** (tuple of ints) – Shape of created array.
- **dtype** (data-type, optional) – Any object that can be interpreted as a numpy data type.
- **buffer** (object exposing buffer interface, optional) – Used to fill the array with data.
- **offset** (int, optional) – Offset of array data in buffer.
- **strides** (tuple of ints, optional) – Strides of data in memory.
- **order** ({'C', 'F'}, optional) – Row-major (C-style) or column-major (Fortran-style) order.

Attributes

T

[ndarray] Transpose of the array.

data

[buffer] The array's elements, in memory.

dtype

[dtype object] Describes the format of the elements in the array.

flags

[dict] Dictionary containing information related to memory use, e.g., 'C_CONTIGUOUS', 'OWNDATA', 'WRITEABLE', etc.

flat

[numpy.flatiter object] Flattened version of the array as an iterator. The iterator allows assignments, e.g., `x.flat = 3` (See `ndarray.flat` for assignment examples; TODO).

imag

[ndarray] Imaginary part of the array.

real

[ndarray] Real part of the array.

size

[int] Number of elements in the array.

itemsize

[int] The memory use of each array element in bytes.

nbytes

[int] The total number of bytes required to store the array data, i.e., `itemsize * size`.

ndim

[int] The array's number of dimensions.

shape

[tuple of ints] Shape of the array.

strides

[tuple of ints] The step-size required to move from one element to the next in memory. For example, a contiguous (3, 4) array of type `int16` in C-order has strides (8, 2). This implies that to move from element to element in memory requires jumps of 2 bytes. To move from row-to-row, one needs to jump 8 bytes at a time ($2 * 4$).

ctypes

[ctypes object] Class containing properties of the array needed for interaction with ctypes.

base

[ndarray] If the array is a view into another array, that array is its *base* (unless that array is also a view). The *base* array is where the array data is actually stored.

See also:**array**

Construct an array.

zeros

Create an array, each element of which is zero.

empty

Create an array, but leave its allocated memory unchanged (i.e., it contains “garbage”).

dtype

Create a data-type.

numpy.typing.NDArray

An ndarray alias *generic* w.r.t. its *dtype.type* `<numpy.dtype.type>`.

Notes

There are two modes of creating an array using `__new__`:

1. If *buffer* is `None`, then only *shape*, *dtype*, and *order* are used.
2. If *buffer* is an object exposing the buffer interface, then all keywords are interpreted.

No `__init__` method is needed because the array is fully initialized after the `__new__` method.

Examples

These examples illustrate the low-level *ndarray* constructor. Refer to the *See Also* section above for easier ways of constructing an ndarray.

First mode, *buffer* is `None`:

```
>>> np.ndarray(shape=(2,2), dtype=float, order='F')
array([[0.0e+000, 0.0e+000], # random
       [      nan, 2.5e-323]])
```

Second mode:

```
>>> np.ndarray((2,), buffer=np.array([1,2,3]),
...           offset=np.int_().itemsize,
...           dtype=int) # offset = 1*itemsize, i.e. skip first element
array([2, 3])
```

Ancillary Objects

`colour.adaptation`

| | |
|---|--|
| <code>matrix_chromatic_adaptation_VonKries(XYZ_w, ...)</code> | Compute the <i>chromatic adaptation</i> matrix from test viewing conditions to reference viewing conditions. |
|---|--|

colour.adaptation.matrix_chromatic_adaptation_VonKries

`colour.adaptation.matrix_chromatic_adaptation_VonKries`(*XYZ_w*: ArrayLike, *XYZ_wr*: ArrayLike, *transform*: [Literal](#)['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling'] | *str* = 'CAT02') → [ndarray](#)

Compute the *chromatic adaptation* matrix from test viewing conditions to reference viewing conditions.

Parameters

- **XYZ_w** (ArrayLike) – Test viewing conditions *CIE XYZ* tristimulus values of white-point.
- **XYZ_wr** (ArrayLike) – Reference viewing conditions *CIE XYZ* tristimulus values of whitepoint.
- **transform** ([Literal](#)['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling'] | *str*) – Chromatic adaptation transform.

Returns

Chromatic adaptation matrix M_{cat} .

Return type

[numpy.ndarray](#)

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ_w | [0, 1] | [0, 1] |
| XYZ_wr | [0, 1] | [0, 1] |

References

[Fai13a]

Examples

```
>>> XYZ_w = np.array([0.95045593, 1.00000000, 1.08905775])
>>> XYZ_wr = np.array([0.96429568, 1.00000000, 0.82510460])
>>> matrix_chromatic_adaptation_VonKries(XYZ_w, XYZ_wr)
...
array([[ 1.0425738...,  0.0308910..., -0.0528125...],
       [ 0.0221934...,  1.0018566..., -0.0210737...],
       [-0.0011648..., -0.0034205...,  0.7617890...]])
```

Using Bradford method:

```
>>> XYZ_w = np.array([0.95045593, 1.00000000, 1.08905775])
>>> XYZ_wr = np.array([0.96429568, 1.00000000, 0.82510460])
>>> method = "Bradford"
>>> matrix_chromatic_adaptation_VonKries(XYZ_w, XYZ_wr, method)
...
array([[ 1.0479297...,  0.0229468..., -0.0501922...],
       [ 0.0296278...,  0.9904344..., -0.0170738...],
       [-0.0092430...,  0.0150551...,  0.7518742...]])
```

Zhai and Luo (2018)

colour.adaptation

`chromatic_adaptation_Zhai2018(XYZ_b,
XYZ_wb, ...)`

Adapt given sample colour XYZ_β tristimulus values from input viewing conditions under β illuminant to output viewing conditions under δ illuminant using *Zhai and Luo (2018)* chromatic adaptation model.

colour.adaptation.chromatic_adaptation_Zhai2018

`colour.adaptation.chromatic_adaptation_Zhai2018(XYZ_b: SupportsArray[dtype[Any]] |
_NestedSequence[_SupportsArray[dtype[Any]]] |
bool | int | float | complex | str | bytes |
_NestedSequence[bool | int | float | complex | str
| bytes], XYZ_wb: SupportsArray[dtype[Any]] |
_NestedSequence[_SupportsArray[dtype[Any]]] |
bool | int | float | complex | str | bytes |
_NestedSequence[bool | int | float | complex | str
| bytes], XYZ_wd: SupportsArray[dtype[Any]] |
_NestedSequence[_SupportsArray[dtype[Any]]] |
bool | int | float | complex | str | bytes |
_NestedSequence[bool | int | float | complex | str
| bytes], D_b: float |
_SupportsArray[dtype[Any]] |
_NestedSequence[_SupportsArray[dtype[Any]]] |
bool | int | complex | str | bytes |
_NestedSequence[bool | int | float | complex | str
| bytes] = 1, D_d: float |
_SupportsArray[dtype[Any]] |
_NestedSequence[_SupportsArray[dtype[Any]]] |
bool | int | complex | str | bytes |
_NestedSequence[bool | int | float | complex | str
| bytes] = 1, XYZ_wo:
_SupportsArray[dtype[Any]] |
_NestedSequence[_SupportsArray[dtype[Any]]] |
bool | int | float | complex | str | bytes |
_NestedSequence[bool | int | float | complex | str
| bytes] = np.array([1, 1, 1]), transform:
Literal['CAT02', 'CAT16'] | str = 'CAT02') →
ndarray`

Adapt given sample colour XYZ_β tristimulus values from input viewing conditions under β illuminant to output viewing conditions under δ illuminant using *Zhai and Luo (2018)* chromatic adaptation model.

According to the definition of D , a one-step CAT such as CAT02 can only be used to transform colors from an incomplete adapted field into a complete adapted field. When CAT02 are used to transform an incomplete to incomplete case, D has no baseline level to refer to. *Smet et al. (2017)* proposed a new concept of two-step CAT to replace the present CATs such as CAT02 with only one-step transform in order to define D more clearly. A two-step CAT involves an illuminant representing the baseline states between the test and reference illuminants for the calculation. In the first step the test color is transformed from test illuminant to the baseline illuminant (BI), and it is then transformed to the reference illuminant. Degrees of adaptation under the other illuminants should be calculated relative to the adaptation under the BI . When D becomes lower towards zero, the adaptation point of the observer moves towards the BI . Therefore, the chromaticity of the BI should be an intrinsic property of the human vision system.

Parameters

- **XYZ_b** (`_SupportsArray[dtype[Any]] | _NestedSequence[_SupportsArray[dtype[Any]]]` | `bool | int | float | complex | str | bytes` | `_NestedSequence[bool | int | float | complex | str | bytes]`) – Sample colour XYZ_β under input illuminant β .
- **XYZ_wb** (`_SupportsArray[dtype[Any]] | _NestedSequence[_SupportsArray[dtype[Any]]]` | `bool | int | float | complex | str | bytes` | `_NestedSequence[bool | int | float | complex | str | bytes]`) – Input illuminant β .
- **XYZ_wd** (`_SupportsArray[dtype[Any]] | _NestedSequence[_SupportsArray[dtype[Any]]]` | `bool | int | float | complex | str | bytes` | `_NestedSequence[bool | int | float | complex | str | bytes]`) – Output illuminant δ .
- **D_b** (`float` | `_SupportsArray[dtype[Any]]` | `_NestedSequence[_SupportsArray[dtype[Any]]]` | `bool | int | complex | str | bytes` | `_NestedSequence[bool | int | float | complex | str | bytes]`) – Degree of adaptation D_β of input illuminant β .
- **D_d** (`float` | `_SupportsArray[dtype[Any]]` | `_NestedSequence[_SupportsArray[dtype[Any]]]` | `bool | int | complex | str | bytes` | `_NestedSequence[bool | int | float | complex | str | bytes]`) – Degree of adaptation D_δ of output illuminant δ .
- **XYZ_wo** (`_SupportsArray[dtype[Any]] | _NestedSequence[_SupportsArray[dtype[Any]]]` | `bool | int | float | complex | str | bytes` | `_NestedSequence[bool | int | float | complex | str | bytes]`) – Baseline illuminant (BI) o .
- **transform** (`Literal['CAT02', 'CAT16'] | str`) – Chromatic adaptation transform.

Returns

Sample corresponding colour XYZ_δ tristimulus values under output illuminant D_δ .

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ_b | [0, 1] | [0, 1] |
| XYZ_wb | [0, 1] | [0, 1] |
| XYZ_wd | [0, 1] | [0, 1] |
| XYZ_wo | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ_d | [0, 1] | [0, 1] |

References

[ZL18]

Examples

```
>>> XYZ_b = np.array([48.900, 43.620, 6.250])
>>> XYZ_wb = np.array([109.850, 100, 35.585])
>>> XYZ_wd = np.array([95.047, 100, 108.883])
>>> D_b = 0.9407
>>> D_d = 0.9800
>>> XYZ_wo = np.array([100, 100, 100])
>>> chromatic_adaptation_Zhai2018(
...     XYZ_b, XYZ_wb, XYZ_wd, D_b, D_d, XYZ_wo
... )
array([ 39.1856164...,  42.1546179...,  19.2367203...])
>>> XYZ_d = np.array([39.18561644, 42.15461798, 19.23672036])
>>> chromatic_adaptation_Zhai2018(
...     XYZ_d, XYZ_wd, XYZ_wb, D_d, D_b, XYZ_wo
... )
array([ 48.9 ,  43.62,   6.25])
```

Algebra

Extrapolation

colour

| | |
|---|---|
| <code>Extrapolator</code> ([interpolator, method, left, ...]) | Extrapolate the 1-D function of given interpolator. |
|---|---|

colour.Extrapolator

class colour.Extrapolator(interpolator: [TypeInterpolator](#) | *None* = *None*, method: *Literal*['Linear', 'Constant'] | *str* = 'Linear', left: *Number* | *None* = *None*, right: *Number* | *None* = *None*, dtype: *Type*[*DTypeNumber*] | *None* = *None*)

Bases: [object](#)

Extrapolate the 1-D function of given interpolator.

The `colour.Extrapolator` class acts as a wrapper around a given *Colour* or *scipy* interpolator class instance with compatible signature. Two extrapolation methods are available:

- *Linear*: Linearly extrapolates given points using the slope defined by the interpolator boundaries (xi[0], xi[1]) if x < xi[0] and (xi[-1], xi[-2]) if x > xi[-1].
- *Constant*: Extrapolates given points by assigning the interpolator boundaries values xi[0] if x < xi[0] and xi[-1] if x > xi[-1].

Specifying the *left* and *right* arguments takes precedence on the chosen extrapolation method and will assign the respective *left* and *right* values to the given points.

Parameters

- **interpolator** (Optional[[TypeInterpolator](#)]) – Interpolator object.
- **method** (Union[Literal['Linear', 'Constant'], str]) – Extrapolation method.
- **left** (Optional[Number]) – Value to return for $x < x_i[0]$.
- **right** (Optional[Number]) – Value to return for $x > x_i[-1]$.
- **dtype** (Optional[Type[DTypeNumber]]) – Data type used for internal conversions.

Methods

- `__init__()`
- `__class__()`

Notes

- The interpolator must define `x` and `y` properties.

References

[[sastanin](#)], [[WRC12b](#)]

Examples

Extrapolating a single numeric variable:

```
>>> from colour.algebra import LinearInterpolator
>>> x = np.array([3, 4, 5])
>>> y = np.array([1, 2, 3])
>>> interpolator = LinearInterpolator(x, y)
>>> extrapolator = Extrapolator(interpolator)
>>> extrapolator(1)
-1.0
```

Extrapolating an *ArrayLike* variable:

```
>>> extrapolator(np.array([6, 7, 8]))
array([ 4.,  5.,  6.])
```

Using the *Constant* extrapolation method:

```
>>> x = np.array([3, 4, 5])
>>> y = np.array([1, 2, 3])
>>> interpolator = LinearInterpolator(x, y)
>>> extrapolator = Extrapolator(interpolator, method="Constant")
>>> extrapolator(np.array([0.1, 0.2, 8, 9]))
array([ 1.,  1.,  3.,  3.])
```

Using defined *left* boundary and *Constant* extrapolation method:

```
>>> x = np.array([3, 4, 5])
>>> y = np.array([1, 2, 3])
>>> interpolator = LinearInterpolator(x, y)
>>> extrapolator = Extrapolator(interpolator, method="Constant", left=0)
>>> extrapolator(np.array([0.1, 0.2, 8, 9]))
array([ 0.,  0.,  3.,  3.]
```

__init__(*interpolator*: [TypeInterpolator](#) | *None* = *None*, *method*: [Literal](#)['Linear', 'Constant'] | *str* = 'Linear', *left*: *Number* | *None* = *None*, *right*: *Number* | *None* = *None*, *dtype*: [Type](#)[*DTypeNumber*] | *None* = *None*) → *None*

Parameters

- **interpolator** ([TypeInterpolator](#) | *None*) –
- **method** ([Literal](#)['Linear', 'Constant'] | *str*) –
- **left** (*Number* | *None*) –
- **right** (*Number* | *None*) –
- **dtype** ([Type](#)[*DTypeNumber*] | *None*) –

Return type

None

property interpolator: [TypeInterpolator](#)

Getter and setter property for the *Colour* or *scipy* interpolator class instance.

Parameters

value – Value to set the *Colour* or *scipy* interpolator class instance with.

Returns

Colour or *scipy* interpolator class instance.

Return type

[TypeInterpolator](#)

__weakref__

list of weak references to the object (if defined)

property method: [Literal](#)['Linear', 'Constant'] | *str*

Getter and setter property for the extrapolation method.

Parameters

value – Value to set the extrapolation method. with.

Returns

Extrapolation method.

Return type

str

property left: *Number* | *None*

Getter and setter property for left value to return for $x < xi[0]$.

Parameters

value – Left value to return for $x < xi[0]$.

Returns

Left value to return for $x < xi[0]$.

Return type

None or *Number*

property right: `Number` | `None`

Getter and setter property for right value to return for $x > xi[-1]$.

Parameters

value – Right value to return for $x > xi[-1]$.

Returns

Right value to return for $x > xi[-1]$.

Return type

`None` or `Number`

__call__(*x*: *FloatingOrArrayLike*) → *FloatingOrNDArray*

Evaluate the Extrapolator at given point(s).

Parameters

x (*FloatingOrArrayLike*) – Point(s) to evaluate the Extrapolator at.

Returns

Extrapolated points value(s).

Return type

`numpy.floating` or `numpy.ndarray`

Interpolation

colour

| | |
|--|---|
| <code>KernelInterpolator(x, y[, window, kernel, ...])</code> | Kernel based interpolation of a 1-D function. |
| <code>NearestNeighbourInterpolator(*args, **kwargs)</code> | A nearest-neighbour interpolator. |
| <code>LinearInterpolator(x, y[, dtype])</code> | Interpolate linearly a 1-D function. |
| <code>NullInterpolator(x, y[, absolute_tolerance, ...])</code> | Perform 1-D function null interpolation, i.e. a call within given tolerances will return existing <i>y</i> variable values and default if outside tolerances. |
| <code>PchipInterpolator(x, y, *args, **kwargs)</code> | Interpolate a 1-D function using Piecewise Cubic Hermite Interpolating Polynomial interpolation. |
| <code>SpragueInterpolator(x, y[, dtype])</code> | Construct a fifth-order polynomial that passes through <i>y</i> dependent variable. |

colour.KernelInterpolator

class `colour.KernelInterpolator`(*x*: *ArrayLike*, *y*: *ArrayLike*, *window*: *float* = 3, *kernel*: *Callable* = *kernel_lanczos*, *kernel_kwargs*: *Dict* | *None* = *None*, *padding_kwargs*: *Dict* | *None* = *None*, *dtype*: *Type*[*DTypeNumber*] | *None* = *None*)

Bases: `object`

Kernel based interpolation of a 1-D function.

The reconstruction of a continuous signal can be described as a linear convolution operation. Interpolation can be expressed as a convolution of the given discrete function $g(x)$ with some continuous interpolation kernel $k(w)$:

$$\hat{g}(w_0) = [k * g](w_0) = \sum_{x=-\infty}^{\infty} k(w_0 - x) \cdot g(x)$$

Parameters

- x** (*ArrayLike*) – Independent *x* variable values corresponding with *y* variable.

- **y** (ArrayLike) – Dependent and already known *y* variable values to interpolate.
- **window** (Floating) – Width of the window in samples on each side.
- **kernel** (Callable) – Kernel to use for interpolation.
- **kernel_kwargs** (Optional[Dict]) – Arguments to use when calling the kernel.
- **padding_kwargs** (Optional[Dict]) – Arguments to use when padding *y* variable values with the `np.pad()` definition.
- **dtype** (Optional[Type[DTypeNumber]]) – Data type used for internal conversions.

Attributes

- `x`
- `y`
- `window`
- `kernel`
- `kernel_kwargs`
- `padding_kwargs`

Methods

- `__init__()`
- `__call__()`

References

[BB09], [Wikipedia05a]

Examples

Interpolating a single numeric variable:

```
>>> y = np.array(
...     [5.9200, 9.3700, 10.8135, 4.5100, 69.5900, 27.8007, 86.0500]
... )
>>> x = np.arange(len(y))
>>> f = KernelInterpolator(x, y)
>>> f(0.5)
6.9411400...
```

Interpolating an *ArrayLike* variable:

```
>>> f([0.25, 0.75])
array([ 6.1806208...,  8.0823848...])
```

Using a different *lanczos* kernel:

```
>>> f = KernelInterpolator(x, y, kernel=kernel_sinc)
>>> f([0.25, 0.75])
array([ 6.5147317...,  8.3965466...])
```


Using a different window size:

```
>>> f = KernelInterpolator(
...     x, y, window=16, kernel=kernel_lanczos, kernel_kwargs={"a": 16}
... )
>>> f([0.25, 0.75])
array([ 5.3961792...,  5.6521093...])
```

```
__init__(x: ArrayLike, y: ArrayLike, window: float = 3, kernel: Callable = kernel_lanczos,
         kernel_kwargs: Dict | None = None, padding_kwargs: Dict | None = None, dtype:
         Type[DTypeNumber] | None = None) → None
```

Parameters

- **x** (ArrayLike) –
- **y** (ArrayLike) –
- **window** (float) –
- **kernel** (Callable) –
- **kernel_kwargs** (Dict | None) –
- **padding_kwargs** (Dict | None) –
- **dtype** (Type[DTypeNumber] | None) –

Return type

None

property **x**: **ndarray**

Getter and setter property for the independent x variable.

Parameters

value – Value to set the independent x variable with.

Returns

Independent x variable.

Return type

`numpy.ndarray`

property **y**: **ndarray**

Getter and setter property for the dependent and already known y variable.

Parameters

value – Value to set the dependent and already known y variable with.

Returns

Dependent and already known y variable.

Return type

`numpy.ndarray`

property **window**: **float**

Getter and setter property for the window.

Parameters

value – Value to set the window with.

Returns

Window.

Return type

`numpy.float64`

property kernel: `Callable`

Getter and setter property for the kernel callable.

Parameters

value – Value to set the kernel callable.

Returns

Kernel callable.

Return type

`Callable`

property kernel_kwargs: `Dict`

Getter and setter property for the kernel call time arguments.

Parameters

value – Value to call the interpolation kernel with.

Returns

Kernel call time arguments.

Return type

`dict`

property padding_kwargs: `Dict`

Getter and setter property for the kernel call time arguments.

Parameters

value – Value to call the interpolation kernel with.

Returns

Kernel call time arguments.

Return type

`dict`

__call__(*x*: *FloatingOrArrayLike*) → *FloatingOrNDArray*

Evaluate the interpolator at given point(s).

Parameters

x (*FloatingOrArrayLike*) – Point(s) to evaluate the interpolant at.

Returns

Interpolated value(s).

Return type

`numpy.floating` or `numpy.ndarray`

__weakref__

list of weak references to the object (if defined)

`colour.NearestNeighbourInterpolator`

class `colour.NearestNeighbourInterpolator`(*args: `Any`, **kwargs: `Any`)

Bases: `KernelInterpolator`

A nearest-neighbour interpolator.

Parameters

- **dtype** – Data type used for internal conversions.
- **padding_kwargs** – Arguments to use when padding *y* variable values with the `np.pad()` definition.
- **window** – Width of the window in samples on each side.

- **x** – Independent x variable values corresponding with y variable.
- **y** – Dependent and already known y variable values to interpolate.
- **args** (*Any*) –
- **kwargs** (*Any*) –

Methods

- `__init__()`

`__init__(*args: Any, **kwargs: Any) → None`

Parameters

- **args** (*Any*) –
- **kwargs** (*Any*) –

Return type

None

`colour.LinearInterpolator`

class `colour.LinearInterpolator(x: ArrayLike, y: ArrayLike, dtype: Type[DTypeNumber] | None = None)`

Bases: `object`

Interpolate linearly a 1-D function.

Parameters

- **x** (*ArrayLike*) – Independent x variable values corresponding with y variable.
- **y** (*ArrayLike*) – Dependent and already known y variable values to interpolate.
- **dtype** (*Optional*[*Type*[DTypeNumber]]) – Data type used for internal conversions.

Attributes

- **x**
- **y**

Methods

- `__init__()`
- `__call__()`

Notes

- This class is a wrapper around *numpy.interp* definition.

Examples

Interpolating a single numeric variable:

```
>>> y = np.array(
...     [5.9200, 9.3700, 10.8135, 4.5100, 69.5900, 27.8007, 86.0500]
... )
>>> x = np.arange(len(y))
>>> f = LinearInterpolator(x, y)
>>> f(0.5)
7.64...
```

Interpolating an *ArrayLike* variable:

```
>>> f([0.25, 0.75])
array([ 6.7825,  8.5075])
```

__init__(*x*: *ArrayLike*, *y*: *ArrayLike*, *dtype*: *Type*[*DTypeNumber*] | *None* = *None*) → *None*

Parameters

- **x** (*ArrayLike*) –
- **y** (*ArrayLike*) –
- **dtype** (*Type*[*DTypeNumber*] | *None*) –

Return type

None

property x: *ndarray*

Getter and setter property for the independent *x* variable.

Parameters

value – Value to set the independent *x* variable with.

Returns

Independent *x* variable.

Return type

numpy.ndarray

property y: *ndarray*

Getter and setter property for the dependent and already known *y* variable.

Parameters

value – Value to set the dependent and already known *y* variable with.

Returns

Dependent and already known *y* variable.

Return type

numpy.ndarray

__call__(*x*: *FloatingOrArrayLike*) → *FloatingOrNDArray*

Evaluate the interpolating polynomial at given point(s).

Parameters

x (*FloatingOrArrayLike*) – Point(s) to evaluate the interpolant at.

Returns

Interpolated value(s).

Return type

`numpy.float64` or `numpy.ndarray`

__weakref__

list of weak references to the object (if defined)

colour.NullInterpolator

class `colour.NullInterpolator`(*x*: *ArrayLike*, *y*: *ArrayLike*, *absolute_tolerance*: *float* = 10e-7, *relative_tolerance*: *float* = 10e-7, *default*: *float* = np.nan, *dtype*: *Type[DTypeNumber]* | *None* = None)

Bases: `object`

Perform 1-D function null interpolation, i.e. a call within given tolerances will return existing *y* variable values and default if outside tolerances.

Parameters

- **x** (*ArrayLike*) – Independent *x* variable values corresponding with *y* variable.
- **y** (*ArrayLike*) – Dependent and already known *y* variable values to interpolate.
- **absolute_tolerance** (*Floating*) – Absolute tolerance.
- **relative_tolerance** (*Floating*) – Relative tolerance.
- **default** (*Floating*) – Default value for interpolation outside tolerances.
- **dtype** (*Optional[Type[DTypeNumber]]*) – Data type used for internal conversions.

Attributes

- *x*
- *y*
- *relative_tolerance*
- *absolute_tolerance*
- *default*

Methods

- `__init__()`
- `__call__()`

Examples

```
>>> y = np.array(
...     [5.9200, 9.3700, 10.8135, 4.5100, 69.5900, 27.8007, 86.0500]
... )
>>> x = np.arange(len(y))
>>> f = NullInterpolator(x, y)
>>> f(0.5)
nan
>>> f(1.0)
9.3699999...
>>> f = NullInterpolator(x, y, absolute_tolerance=0.01)
>>> f(1.01)
9.3699999...
```

__init__(*x*: ArrayLike, *y*: ArrayLike, *absolute_tolerance*: float = 10e-7, *relative_tolerance*: float = 10e-7, *default*: float = np.nan, *dtype*: Type[DTypeNumber] | None = None) → None

Parameters

- **x** (ArrayLike) –
- **y** (ArrayLike) –
- **absolute_tolerance** (float) –
- **relative_tolerance** (float) –
- **default** (float) –
- **dtype** (Type[DTypeNumber] | None) –

Return type

None

__weakref__

list of weak references to the object (if defined)

property **x**: ndarray

Getter and setter property for the independent *x* variable.

Parameters

value – Value to set the independent *x* variable with.

Returns

Independent *x* variable.

Return type

numpy.ndarray

property **y**: ndarray

Getter and setter property for the dependent and already known *y* variable.

Parameters

value – Value to set the dependent and already known *y* variable with.

Returns

Dependent and already known *y* variable.

Return type

numpy.ndarray

property **relative_tolerance**: float

Getter and setter property for the relative tolerance.

Parameters

value – Value to set the relative tolerance with.

Returns

Relative tolerance.

Return type

`numpy.float64`

property **absolute_tolerance**: `float`

Getter and setter property for the absolute tolerance.

Parameters

value – Value to set the absolute tolerance with.

Returns

Absolute tolerance.

Return type

`numpy.float64`

property **default**: `float`

Getter and setter property for the default value for call outside tolerances.

Parameters

value – Value to set the default value with.

Returns

Default value.

Return type

`numpy.float64`

__call__(*x*: *FloatingOrArrayLike*) → *FloatingOrNDArray*

Evaluate the interpolator at given point(s).

Parameters

x (*FloatingOrArrayLike*) – Point(s) to evaluate the interpolant at.

Returns

Interpolated value(s).

Return type

`numpy.float64` or `numpy.ndarray`

colour.PchipInterpolator

class `colour.PchipInterpolator`(*x*: *ArrayLike*, *y*: *ArrayLike*, **args*: *Any*, ***kwargs*: *Any*)

Bases: `PchipInterpolator`

Interpolate a 1-D function using Piecewise Cubic Hermite Interpolating Polynomial interpolation.

Attributes

- *y*

Methods

- `__init__()`

Notes

- This class is a wrapper around `scipy.interpolate.PchipInterpolator` class.

Parameters

- `x` (ArrayLike) –
- `y` (ArrayLike) –
- `args` (Any) –
- `kwargs` (Any) –

`__init__(x: ArrayLike, y: ArrayLike, *args: Any, **kwargs: Any) → None`

Parameters

- `x` (ArrayLike) –
- `y` (ArrayLike) –
- `args` (Any) –
- `kwargs` (Any) –

Return type

None

property `y`: `ndarray`

Getter property for the dependent and already known *y* variable.

Returns

Dependent and already known *y* variable.

Return type

`numpy.ndarray`

`colour.SpragueInterpolator`

class `colour.SpragueInterpolator(x: ArrayLike, y: ArrayLike, dtype: Type[DTypeNumber] | None = None)`

Bases: `object`

Construct a fifth-order polynomial that passes through *y* dependent variable.

Sprague (1880) method is recommended by the *CIE* for interpolating functions having a uniformly spaced independent variable.

Parameters

- `x` (ArrayLike) – Independent *x* variable values corresponding with *y* variable.
- `y` (ArrayLike) – Dependent and already known *y* variable values to interpolate.
- `dtype` (Optional[`Type[DTypeNumber]`]) – Data type used for internal conversions.

Attributes

- `x`
- `y`

Methods

- `__init__()`
- `__call__()`

Notes

- The minimum number k of data points required along the interpolation axis is $k = 6$.

References

[CIET13805b], [WRC12c]

Examples

Interpolating a single numeric variable:

```
>>> y = np.array(
...     [5.9200, 9.3700, 10.8135, 4.5100, 69.5900, 27.8007, 86.0500]
... )
>>> x = np.arange(len(y))
>>> f = SpragueInterpolator(x, y)
>>> f(0.5)
7.2185025...
```

Interpolating an *ArrayLike* variable:

```
>>> f([0.25, 0.75])
array([ 6.7295161...,  7.8140625...])
```

```
SPRAGUE_C_COEFFICIENTS = array([[ 884, -1960, 3033, -2648, 1080, -180], [ 508, -540,
488, -367, 144, -24], [ -24, 144, -367, 488, -540, 508], [ -180, 1080, -2648, 3033,
-1960, 884]])
```

Defines the coefficients used to generate extra points for boundaries interpolation.

SPRAGUE_C_COEFFICIENTS, (4, 6)

References

[CIET13805c]

`__init__(x: ArrayLike, y: ArrayLike, dtype: Type[DTypeNumber] | None = None) → None`

Parameters

- `x` (*ArrayLike*) –
- `y` (*ArrayLike*) –
- `dtype` (*Type*[DTypeNumber] | *None*) –

Return type

None

property x: `ndarray`

Getter and setter property for the independent x variable.

Parameters

value – Value to set the independent x variable with.

Returns

Independent x variable.

Return type

`numpy.ndarray`

property y: `ndarray`

Getter and setter property for the dependent and already known y variable.

Parameters

value – Value to set the dependent and already known y variable with.

Returns

Dependent and already known y variable.

Return type

`numpy.ndarray`

__call__(x : *FloatingOrArrayLike*) \rightarrow *FloatingOrNDArray*

Evaluate the interpolating polynomial at given point(s).

Parameters

x (*FloatingOrArrayLike*) – Point(s) to evaluate the interpolant at.

Returns

Interpolated value(s).

Return type

`numpy.floating` or `numpy.ndarray`

__weakref__

list of weak references to the object (if defined)

| | |
|--|--|
| <code>lagrange_coefficients(r[, n])</code> | Compute the <i>Lagrange Coefficients</i> at given point r for degree n . |
| <code>TABLE_INTERPOLATION_METHODS</code> | Supported table interpolation methods. |
| <code>table_interpolation(V_xyz, table[, method])</code> | Perform interpolation of given V_{xyz} values using given interpolation table. |

colour.lagrange_coefficients

`colour.lagrange_coefficients(r: float, n: int = 4) \rightarrow ndarray`

Compute the *Lagrange Coefficients* at given point r for degree n .

Parameters

- **r** (`float`) – Point to get the *Lagrange Coefficients* at.
- **n** (`int`) – Degree of the *Lagrange Coefficients* being calculated.

Return type

`numpy.ndarray`

References

[Fai85], [Wikipedia03a]

Examples

```
>>> lagrange_coefficients(0.1)
array([ 0.8265,  0.2755, -0.1305,  0.0285])
```

colour.TABLE_INTERPOLATION_METHODS

```
colour.TABLE_INTERPOLATION_METHODS = CanonicalMapping({'Trilinear': ..., 'Tetrahedral':
...})
```

Supported table interpolation methods.

References

[Boub], [Kir06]

colour.table_interpolation

```
colour.table_interpolation(V_xyz: ArrayLike, table: ArrayLike, method: Literal['Trilinear',
'Tetrahedral'] | str = 'Trilinear') → ndarray
```

Perform interpolation of given V_{xyz} values using given interpolation table.

Parameters

- **V_xyz** (ArrayLike) – V_{xyz} values to interpolate.
- **table** (ArrayLike) – 4-Dimensional (NxNxNx3) interpolation table.
- **method** (Literal['Trilinear', 'Tetrahedral'] | str) – Interpolation method.

Returns

Interpolated V_{xyz} values.

Return type

numpy.ndarray

References

[Boub], [Kir06]

Examples

```
>>> import os
>>> import colour
>>> path = os.path.join(
...     os.path.dirname(__file__),
...     "..",
...     "io",
...     "luts",
...     "tests",
...     "resources",
```

(continues on next page)

(continued from previous page)

```
...     "iridas_cube",
...     "Colour_Correct.cube",
... )
>>> LUT = colour.read_LUT(path)
>>> table = LUT.table
>>> prng = np.random.RandomState(4)
>>> V_xyz = colour.algebra.random_triplet_generator(3, random_state=prng)
>>> print(V_xyz)
[[ 0.9670298...  0.7148159...  0.9762744...]
 [ 0.5472322...  0.6977288...  0.0062302...]
 [ 0.9726843...  0.2160895...  0.2529823...]]
>>> table_interpolation(V_xyz, table)
array([[ 1.0120664...,  0.7539146...,  1.0228540...],
       [ 0.5075794...,  0.6479459...,  0.1066404...],
       [ 1.0976519...,  0.1785998...,  0.2299897...]])
>>> table_interpolation(V_xyz, table, method="Tetrahedral")
...
array([[ 1.0196197...,  0.7674062...,  1.0311751...],
       [ 0.5105603...,  0.6466722...,  0.1077296...],
       [ 1.1178206...,  0.1762039...,  0.2209534...]])
```

Interpolation Kernels

colour

| | |
|--|--|
| <code>kernel_nearest_neighbour(x)</code> | Return the <i>nearest-neighbour</i> kernel evaluated at given samples. |
| <code>kernel_linear(x)</code> | Return the <i>linear</i> kernel evaluated at given samples. |
| <code>kernel_sinc(x[, a])</code> | Return the <i>sinc</i> kernel evaluated at given samples. |
| <code>kernel_lanczos(x[, a])</code> | Return the <i>lanczos</i> kernel evaluated at given samples. |
| <code>kernel_cardinal_spline(x[, a, b])</code> | Return the <i>cardinal spline</i> kernel evaluated at given samples. |

colour.kernel_nearest_neighbour

colour.**kernel_nearest_neighbour**(x: *ArrayLike*) → ndarray

Return the *nearest-neighbour* kernel evaluated at given samples.

Parameters

x (ArrayLike) – Samples at which to evaluate the *nearest-neighbour* kernel.

Returns

The *nearest-neighbour* kernel evaluated at given samples.

Return type

numpy.ndarray

References

[BB09]

Examples

```
>>> kernel_nearest_neighbour(np.linspace(0, 1, 10))
array([1, 1, 1, 1, 1, 0, 0, 0, 0, 0])
```

colour.kernel_linear

colour.**kernel_linear**(x: *ArrayLike*) → ndarray

Return the *linear* kernel evaluated at given samples.

Parameters

x (*ArrayLike*) – Samples at which to evaluate the *linear* kernel.

Returns

The *linear* kernel evaluated at given samples.

Return type

numpy.ndarray

References

[BB09]

Examples

```
>>> kernel_linear(np.linspace(0, 1, 10))
array([ 1.          ,  0.888888... ,  0.777777... ,  0.666666... ,  0.555555... ,
        0.444444... ,  0.333333... ,  0.222222... ,  0.111111... ,  0.          ])
```

colour.kernel_sinc

colour.**kernel_sinc**(x: *ArrayLike*, a: *float* = 3) → ndarray

Return the *sinc* kernel evaluated at given samples.

Parameters

- **x** (*ArrayLike*) – Samples at which to evaluate the *sinc* kernel.
- **a** (*float*) – Size of the *sinc* kernel.

Returns

The *sinc* kernel evaluated at given samples.

Return type

numpy.ndarray

References

[BB09]

Examples

```
>>> kernel_sinc(np.linspace(0, 1, 10))
array([ 1.0000000...e+00,  9.7981553...e-01,  9.2072542...e-01,
        8.2699334...e-01,  7.0531659...e-01,  5.6425327...e-01,
        4.1349667...e-01,  2.6306440...e-01,  1.2247694...e-01,
        3.8981718...e-17])
```

colour.kernel_lanczos

colour.**kernel_lanczos**(*x*: ArrayLike, *a*: float = 3) → ndarray

Return the *lanczos* kernel evaluated at given samples.

Parameters

- *x* (ArrayLike) – Samples at which to evaluate the *lanczos* kernel.
- *a* (float) – Size of the *lanczos* kernel.

Returns

The *lanczos* kernel evaluated at given samples.

Return type

numpy.ndarray

References

[Wikipedia05a]

Examples

```
>>> kernel_lanczos(np.linspace(0, 1, 10))
array([ 1.0000000...e+00,  9.7760615...e-01,  9.1243770...e-01,
        8.1030092...e-01,  6.8012706...e-01,  5.3295773...e-01,
        3.8071690...e-01,  2.3492839...e-01,  1.0554054...e-01,
        3.2237621...e-17])
```

colour.kernel_cardinal_spline

colour.**kernel_cardinal_spline**(*x*: ArrayLike, *a*: float = 0.5, *b*: float = 0.0) → ndarray

Return the *cardinal spline* kernel evaluated at given samples.

Notable *cardinal spline* *a* and *b* parameterizations:

- *Catmull-Rom*: ($a = 0.5, b = 0$)
- *Cubic B-Spline*: ($a = 0, b = 1$)
- *Mitchell-Netravalli*: ($a = \frac{1}{3}, b = \frac{1}{3}$)

Parameters

- **x** (ArrayLike) – Samples at which to evaluate the *cardinal spline* kernel.
- **a** (float) – *a* control parameter.
- **b** (float) – *b* control parameter.

Returns

The *cardinal spline* kernel evaluated at given samples.

Return type

`numpy.ndarray`

References

[BB09]

Examples

```
>>> kernel_cardinal_spline(np.linspace(0, 1, 10))
array([ 1.          ,  0.9711934...,  0.8930041...,  0.7777777...,  0.6378600...,
        0.4855967...,  0.3333333...,  0.1934156...,  0.0781893...,  0.          ])
```

Ancillary Objects

`colour.algebra`

| | |
|--|--|
| <code>table_interpolation_trilinear(V_xyz, table)</code> | Perform the trilinear interpolation of given V_{xyz} values using given interpolation table. |
| <code>table_interpolation_tetrahedral(V_xyz, table)</code> | Perform the tetrahedral interpolation of given V_{xyz} values using given interpolation table. |

`colour.algebra.table_interpolation_trilinear`

`colour.algebra.table_interpolation_trilinear(V_xyz: ArrayLike, table: ArrayLike) → ndarray`

Perform the trilinear interpolation of given V_{xyz} values using given interpolation table.

Parameters

- **V_xyz** (ArrayLike) – V_{xyz} values to interpolate.
- **table** (ArrayLike) – 4-Dimensional ($N \times N \times N \times 3$) interpolation table.

Returns

Interpolated V_{xyz} values.

Return type

`numpy.ndarray`

References

[Boub]

Examples

```
>>> import os
>>> import colour
>>> path = os.path.join(
...     os.path.dirname(__file__),
...     "..",
...     "io",
...     "luts",
...     "tests",
...     "resources",
...     "iridas_cube",
...     "Colour_Correct.cube",
... )
>>> LUT = colour.read_LUT(path)
>>> table = LUT.table
>>> prng = np.random.RandomState(4)
>>> V_xyz = colour.algebra.random_triplet_generator(3, random_state=prng)
>>> print(V_xyz)
[[ 0.9670298...  0.7148159...  0.9762744...]
 [ 0.5472322...  0.6977288...  0.0062302...]
 [ 0.9726843...  0.2160895...  0.2529823...]]
>>> table_interpolation_trilinear(V_xyz, table)
array([[ 1.0120664...,  0.7539146...,  1.0228540...],
       [ 0.5075794...,  0.6479459...,  0.1066404...],
       [ 1.0976519...,  0.1785998...,  0.2299897...]])
```

colour.algebra.table_interpolation_tetrahedral

colour.algebra.**table_interpolation_tetrahedral**(*V_xyz*: *ArrayLike*, *table*: *ArrayLike*) → *ndarray*

Perform the tetrahedral interpolation of given V_{xyz} values using given interpolation table.

Parameters

- **V_xyz** (*ArrayLike*) – V_{xyz} values to interpolate.
- **table** (*ArrayLike*) – 4-Dimensional ($N \times N \times N \times 3$) interpolation table.

Returns

Interpolated V_{xyz} values.

Return type

numpy.ndarray

References

[Kir06]

Examples

```
>>> import os
>>> import colour
>>> path = os.path.join(
...     os.path.dirname(__file__),
...     "..",
...     "io",
...     "luts",
...     "tests",
...     "resources",
...     "iridas_cube",
...     "Colour_Correct.cube",
... )
>>> LUT = colour.read_LUT(path)
>>> table = LUT.table
>>> prng = np.random.RandomState(4)
>>> V_xyz = colour.algebra.random_triplet_generator(3, random_state=prng)
>>> print(V_xyz)
[[ 0.9670298...  0.7148159...  0.9762744...]
 [ 0.5472322...  0.6977288...  0.0062302...]
 [ 0.9726843...  0.2160895...  0.2529823...]]
>>> table_interpolation_tetrahedral(V_xyz, table)
array([[ 1.0196197...,  0.7674062...,  1.0311751...],
       [ 0.5105603...,  0.6466722...,  0.1077296...],
       [ 1.1178206...,  0.1762039...,  0.2209534...]])
```

Coordinates

colour.algebra

| | |
|--|---|
| <code>cartesian_to_spherical(a)</code> | Transform given cartesian coordinates array xyz to spherical coordinates array $\rho\theta\phi$ (radial distance, inclination or elevation and azimuth). |
| <code>spherical_to_cartesian(a)</code> | Transform given spherical coordinates array $\rho\theta\phi$ (radial distance, inclination or elevation and azimuth) to cartesian coordinates array xyz . |
| <code>cartesian_to_polar(a)</code> | Transform given cartesian coordinates array xy to polar coordinates array $\rho\phi$ (radial coordinate, angular coordinate). |
| <code>polar_to_cartesian(a)</code> | Transform given polar coordinates array $\rho\phi$ (radial coordinate, angular coordinate) to cartesian coordinates array xy . |
| <code>cartesian_to_cylindrical(a)</code> | Transform given cartesian coordinates array xyz to cylindrical coordinates array $\rho\phi z$ (radial distance, azimuth and height). |
| <code>cylindrical_to_cartesian(a)</code> | Transform given cylindrical coordinates array $\rho\phi z$ (radial distance, azimuth and height) to cartesian coordinates array xyz . |

colour.algebra.cartesian_to_spherical

colour.algebra.**cartesian_to_spherical**(*a*: ArrayLike) → ndarray

Transform given cartesian coordinates array *xyz* to spherical coordinates array $\rho\theta\phi$ (radial distance, inclination or elevation and azimuth).

Parameters

a (ArrayLike) – Cartesian coordinates array *xyz* to transform.

Returns

Spherical coordinates array $\rho\theta\phi$, ρ is in range $[0, +\infty]$, θ is in range $[0, \pi]$ radians, i.e. $[0, 180]$ degrees, and ϕ is in range $[-\pi, \pi]$ radians, i.e. $[-180, 180]$ degrees.

Return type

numpy.ndarray

References

[Wikipedia06a], [Wikipedia05e]

Examples

```
>>> a = np.array([3, 1, 6])
>>> cartesian_to_spherical(a)
array([ 6.7823299...,  0.4850497...,  0.3217505...])
```

colour.algebra.spherical_to_cartesian

colour.algebra.**spherical_to_cartesian**(*a*: ArrayLike) → ndarray

Transform given spherical coordinates array $\rho\theta\phi$ (radial distance, inclination or elevation and azimuth) to cartesian coordinates array *xyz*.

Parameters

a (ArrayLike) – Spherical coordinates array $\rho\theta\phi$ to transform, ρ is in range $[0, +\infty]$, θ is in range $[0, \pi]$ radians, i.e. $[0, 180]$ degrees, and ϕ is in range $[-\pi, \pi]$ radians, i.e. $[-180, 180]$ degrees.

Returns

Cartesian coordinates array *xyz*.

Return type

numpy.ndarray

References

[Wikipedia06a], [Wikipedia05e]

Examples

```
>>> a = np.array([6.78232998, 0.48504979, 0.32175055])
>>> spherical_to_cartesian(a)
array([ 3.0000000...,  0.9999999...,  5.9999999...])
```

colour.algebra.cartesian_to_polar

colour.algebra.cartesian_to_polar(*a*: ArrayLike) → ndarray

Transform given cartesian coordinates array xy to polar coordinates array $\rho\phi$ (radial coordinate, angular coordinate).

Parameters

a (ArrayLike) – Cartesian coordinates array xy to transform.

Returns

Polar coordinates array $\rho\phi$, ρ is in range $[0, +\infty]$, ϕ is in range $[-\pi, \pi]$ radians, i.e. $[-180, 180]$ degrees.

Return type

numpy.ndarray

References

[Wikipedia06a], [Wikipedia05e]

Examples

```
>>> a = np.array([3, 1])
>>> cartesian_to_polar(a)
array([ 3.1622776...,  0.3217505...])
```

colour.algebra.polar_to_cartesian

colour.algebra.polar_to_cartesian(*a*: ArrayLike) → ndarray

Transform given polar coordinates array $\rho\phi$ (radial coordinate, angular coordinate) to cartesian coordinates array xy .

Parameters

a (ArrayLike) – Polar coordinates array $\rho\phi$ to transform, ρ is in range $[0, +\infty]$, ϕ is in range $[-\pi, \pi]$ radians i.e. $[-180, 180]$ degrees.

Returns

Cartesian coordinates array xy .

Return type

numpy.ndarray

References

[[Wikipedia06a](#)], [[Wikipedia05e](#)]

Examples

```
>>> a = np.array([3.16227766, 0.32175055])
>>> polar_to_cartesian(a)
array([ 3.          ,  0.9999999...])
```

colour.algebra.cartesian_to_cylindrical

colour.algebra.**cartesian_to_cylindrical**(*a*: ArrayLike) → ndarray

Transform given cartesian coordinates array *xyz* to cylindrical coordinates array $\rho\phi z$ (radial distance, azimuth and height).

Parameters

a (ArrayLike) – Cartesian coordinates array *xyz* to transform.

Returns

Cylindrical coordinates array $\rho\phi z$, ρ is in range $[0, +\infty]$, ϕ is in range $[-\pi, \pi]$ radians i.e. $[-180, 180]$ degrees, z is in range $[0, +\infty]$.

Return type

numpy.ndarray

References

[[Wikipedia06a](#)], [[Wikipedia05e](#)]

Examples

```
>>> a = np.array([3, 1, 6])
>>> cartesian_to_cylindrical(a)
array([ 3.1622776...,  0.3217505...,  6.          ])
```

colour.algebra.cylindrical_to_cartesian

colour.algebra.**cylindrical_to_cartesian**(*a*: ArrayLike) → ndarray

Transform given cylindrical coordinates array $\rho\phi z$ (radial distance, azimuth and height) to cartesian coordinates array *xyz*.

Parameters

a (ArrayLike) – Cylindrical coordinates array $\rho\phi z$ to transform, ρ is in range $[0, +\infty]$, ϕ is in range $[-\pi, \pi]$ radians i.e. $[-180, 180]$ degrees, z is in range $[0, +\infty]$.

Returns

Cartesian coordinates array *xyz*.

Return type

numpy.ndarray

References

[Wikipedia06a], [Wikipedia05e]

Examples

```
>>> a = np.array([3.16227766, 0.32175055, 6.00000000])
>>> cylindrical_to_cartesian(a)
array([ 3.          ,  0.9999999...,  6.          ])
```

Random

colour.algebra

| | |
|--|--|
| <code>random_triplet_generator(size[, limits, ...])</code> | Return a generator yielding random triplets. |
|--|--|

colour.algebra.random_triplet_generator

colour.algebra.random_triplet_generator(size: *int*, limits: *ArrayLike* = np.array([[0, 1], [0, 1], [0, 1]]), random_state: *RandomState* = *RANDOM_STATE*) → *ndarray*

Return a generator yielding random triplets.

Parameters

- **size** (*int*) – Generator size.
- **limits** (*ArrayLike*) – Random values limits on each triplet axis.
- **random_state** (*RandomState*) – Mersenne Twister pseudo-random number generator.

Returns

Random triplet generator.

Return type

numpy.ndarray

Notes

- The test is assuming that `np.random.RandomState()` definition will return the same sequence no matter which *OS* or *Python* version is used. There is however no formal promise about the *prng* sequence reproducibility of either *Python* or *Numpy* implementations, see [Laurent12].

Examples

```
>>> from pprint import pprint
>>> prng = np.random.RandomState(4)
>>> random_triplet_generator(10, random_state=prng)
...
array([[ 0.9670298...,  0.7793829...,  0.4361466...],
       [ 0.5472322...,  0.1976850...,  0.9489773...],
       [ 0.9726843...,  0.8629932...,  0.7863059...],
       [ 0.7148159...,  0.9834006...,  0.8662893...],
```

(continues on next page)

(continued from previous page)

```
[ 0.6977288..., 0.1638422..., 0.1731654...],
[ 0.2160895..., 0.5973339..., 0.0749485...],
[ 0.9762744..., 0.0089861..., 0.6007427...],
[ 0.0062302..., 0.3865712..., 0.1679721...],
[ 0.2529823..., 0.0441600..., 0.7333801...],
[ 0.4347915..., 0.9566529..., 0.4084438...]]])
```

Regression

`colour.algebra`

| | |
|--|--|
| <code>least_square_mapping_MoorePenrose(y, x)</code> | Compute the <i>least-squares</i> mapping from dependent variable y to independent variable x using <i>Moore-Penrose</i> inverse. |
|--|--|

`colour.algebra.least_square_mapping_MoorePenrose`

`colour.algebra.least_square_mapping_MoorePenrose(y: ArrayLike, x: ArrayLike) → ndarray`

Compute the *least-squares* mapping from dependent variable y to independent variable x using *Moore-Penrose* inverse.

Parameters

- **y** (ArrayLike) – Dependent and already known y variable.
- **x** (ArrayLike) – Independent x variable(s) values corresponding with y variable.

Returns

Least-squares mapping.

Return type

`numpy.ndarray`

References

[FMH15]

Examples

```
>>> prng = np.random.RandomState(2)
>>> y = prng.random_sample((24, 3))
>>> x = y + (prng.random_sample((24, 3)) - 0.5) * 0.5
>>> least_square_mapping_MoorePenrose(y, x)
array([[ 1.0526376...,  0.1378078..., -0.2276339...],
       [ 0.0739584...,  1.0293994..., -0.1060115...],
       [ 0.0572550..., -0.2052633...,  1.1015194...]])
```

Common

colour.algebra

| | |
|---|---|
| <code>get_sdiv_mode()</code> | Return <i>Colour</i> safe division mode. |
| <code>set_sdiv_mode(mode)</code> | Set <i>Colour</i> safe division function mode. |
| <code>sdiv_mode([mode])</code> | Define a context manager and decorator temporarily setting <i>Colour</i> safe division function mode. |
| <code>sdiv(a, b)</code> | Divide given array <i>a</i> with array <i>b</i> while handling zero-division. |
| <code>is_spow_enabled()</code> | Return whether <i>Colour</i> safe / symmetrical power function is enabled. |
| <code>set_spow_enable(enable)</code> | Set <i>Colour</i> safe / symmetrical power function enabled state. |
| <code>spow_enable(enable)</code> | Define a context manager and decorator temporarily setting <i>Colour</i> safe / symmetrical power function enabled state. |
| <code>spow(a, p)</code> | Raise given array <i>a</i> to the power <i>p</i> as follows: $\text{sign}(a) * a ^p$. |
| <code>normalise_vector(a)</code> | Normalise given vector <i>a</i> . |
| <code>normalise_maximum(a[, axis, factor, clip])</code> | Normalise given array <i>a</i> values by <i>a</i> maximum value and optionally clip them between. |
| <code>vector_dot(m, v)</code> | Perform the dot product of the matrix array <i>m</i> with the vector array <i>v</i> . |
| <code>matrix_dot(a, b)</code> | Perform the dot product of the matrix array <i>a</i> with the matrix array <i>b</i> . |
| <code>euclidean_distance(a, b)</code> | Return the <i>Euclidean</i> distance between point array <i>a</i> and point array <i>b</i> . |
| <code>manhattan_distance(a, b)</code> | Return the <i>Manhattan</i> (or <i>City-Block</i>) distance between point array <i>a</i> and point array <i>b</i> . |
| <code>linear_conversion(a, old_range, new_range)</code> | Perform a simple linear conversion of given array <i>a</i> between the old and new ranges. |
| <code>linstep_function(x[, a, b, clip])</code> | Perform a simple linear interpolation between given array <i>a</i> and array <i>b</i> using <i>x</i> array. |
| <code>lerp(x[, a, b, clip])</code> | Perform a simple linear interpolation between given array <i>a</i> and array <i>b</i> using <i>x</i> array. |
| <code>smoothstep_function(x[, a, b, clip])</code> | Evaluate the <i>smoothstep</i> sigmoid-like function on array <i>x</i> . |
| <code>smooth(x[, a, b, clip])</code> | Evaluate the <i>smoothstep</i> sigmoid-like function on array <i>x</i> . |
| <code>is_identity(a)</code> | Return whether <i>a</i> array is an identity matrix. |
| <code>eigen_decomposition(a[, eigen_w_v_count, ...])</code> | Return the eigen-values <i>w</i> and eigen-vectors <i>v</i> of given array <i>a</i> in given order. |

colour.algebra.get_sdiv_mode

colour.algebra.get_sdiv_mode() → Literal['Numpy', 'Ignore', 'Warning', 'Raise', 'Ignore Zero Conversion', 'Warning Zero Conversion', 'Ignore Limit Conversion', 'Warning Limit Conversion']

Return *Colour* safe division mode.

Returns

Colour safe division mode, see colour.algebra.sdiv() definition for an explanation about the possible modes.

Return type

`str`

Examples

```
>>> with sdiv_mode("Numpy"):
...     get_sdiv_mode()
...
'numpy'
>>> with sdiv_mode("Ignore Zero Conversion"):
...     get_sdiv_mode()
...
'ignore zero conversion'
```

colour.algebra.set_sdiv_mode

`colour.algebra.set_sdiv_mode(mode: Literal['Numpy', 'Ignore', 'Warning', 'Raise', 'Ignore Zero Conversion', 'Warning Zero Conversion', 'Ignore Limit Conversion', 'Warning Limit Conversion'] | str)`

Set *Colour* safe division function mode.

Parameters

mode (*Literal*['Numpy', 'Ignore', 'Warning', 'Raise', 'Ignore Zero Conversion', 'Warning Zero Conversion', 'Ignore Limit Conversion', 'Warning Limit Conversion'] | *str*) – *Colour* safe division mode, see `colour.algebra.sdiv()` definition for an explanation about the possible modes.

Examples

```
>>> with sdiv_mode(get_sdiv_mode()):
...     print(get_sdiv_mode())
...     set_sdiv_mode("Raise")
...     print(get_sdiv_mode())
...
ignore zero conversion
raise
```

colour.algebra.sdiv_mode

class `colour.algebra.sdiv_mode(mode: Literal['Numpy', 'Ignore', 'Warning', 'Raise', 'Ignore Zero Conversion', 'Warning Zero Conversion', 'Ignore Limit Conversion', 'Warning Limit Conversion'] | None = None)`

Define a context manager and decorator temporarily setting *Colour* safe division function mode.

Parameters

mode (*Optional*[*Literal*['Numpy', 'Ignore', 'Warning', 'Raise', 'Ignore Zero Conversion', 'Warning Zero Conversion', 'Ignore Limit Conversion', 'Warning Limit Conversion']] – *Colour* safe division function mode, see `colour.algebra.sdiv()` definition for an explanation about the possible modes.

__init__ (*mode: Literal*['Numpy', 'Ignore', 'Warning', 'Raise', 'Ignore Zero Conversion', 'Warning Zero Conversion', 'Ignore Limit Conversion', 'Warning Limit Conversion'] | *None* = *None*) → *None*

Parameters

mode (`Literal['Numpy', 'Ignore', 'Warning', 'Raise', 'Ignore Zero Conversion', 'Warning Zero Conversion', 'Ignore Limit Conversion', 'Warning Limit Conversion'] | None`) –

Return type

None

Methods

```
__init__([mode])
```

colour.algebra.sdiv

`colour.algebra.sdiv(a: FloatingOrArrayLike, b: FloatingOrArrayLike) → FloatingOrNDArray`

Divide given array *b* with array *b* while handling zero-division.

This definition avoids NaNs and +/- infs generation when array *b* is equal to zero. This behaviour can be controlled with the `colour.algebra.set_sdiv_mode()` definition or with the `sdiv_mode()` context manager. The following modes are available:

- **Numpy:** The current *Numpy* zero-division handling occurs.
- **Ignore:** Zero-division occurs silently.
- **Warning:** Zero-division occurs with a warning.
- **Ignore Zero Conversion:** Zero-division occurs silently and NaNs or +/- infs values are converted to zeros. See `numpy.nan_to_num()` definition for more details.
- **Warning Zero Conversion:** Zero-division occurs with a warning and NaNs or +/- infs values are converted to zeros. See `numpy.nan_to_num()` definition for more details.
- **Ignore Limit Conversion:** Zero-division occurs silently and NaNs or +/- infs values are converted to zeros or the largest +/- finite floating point values representable by the division result `numpy.dtype`. See `numpy.nan_to_num()` definition for more details.
- **Warning Limit Conversion:** Zero-division occurs with a warning and NaNs or +/- infs values are converted to zeros or the largest +/- finite floating point values representable by the division result `numpy.dtype`.

Parameters

- **a** (`FloatingOrArrayLike`) – Numerator array *a*.
- **b** (`FloatingOrArrayLike`) – Denominator array *b*.

Returns

Array *b* safely divided by *a*.

Return type

`np.floating` or `numpy.ndarray`

Examples

```
>>> a = np.array([0, 1, 2])
>>> b = np.array([2, 1, 0])
>>> sdiv(a, b)
array([ 0.,  1.,  0.])
>>> try:
...     with sdiv_mode("Raise"):
...         sdiv(a, b)
... except Exception as error:
...     error
...
FloatingPointError('divide by zero encountered in...divide')
>>> with sdiv_mode("Ignore Zero Conversion"):
...     sdiv(a, b)
...
array([ 0.,  1.,  0.])
>>> with sdiv_mode("Warning Zero Conversion"):
...     sdiv(a, b)
...
array([ 0.,  1.,  0.])
>>> with sdiv_mode("Ignore Limit Conversion"):
...     sdiv(a, b)
...
array([ 0.00000000e+000,  1.00000000e+000,  1.79769313e+308])
>>> with sdiv_mode("Warning Limit Conversion"):
...     sdiv(a, b)
...
array([ 0.00000000e+000,  1.00000000e+000,  1.79769313e+308])
```

colour.algebra.is_spow_enabled

colour.algebra.is_spow_enabled() → bool

Return whether *Colour* safe / symmetrical power function is enabled.

Returns

Whether *Colour* safe / symmetrical power function is enabled.

Return type

bool

Examples

```
>>> with spow_enable(False):
...     is_spow_enabled()
...
False
>>> with spow_enable(True):
...     is_spow_enabled()
...
True
```

colour.algebra.set_spow_enable

colour.algebra.set_spow_enable(enable: bool)

Set Colour safe / symmetrical power function enabled state.

Parameters

enable (bool) – Whether to enable Colour safe / symmetrical power function.

Examples

```
>>> with spow_enable(is_spow_enabled()):
...     print(is_spow_enabled())
...     set_spow_enable(False)
...     print(is_spow_enabled())
...
True
False
```

colour.algebra.spow_enable

class colour.algebra.spow_enable(enable: bool)

Define a context manager and decorator temporarily setting Colour safe / symmetrical power function enabled state.

Parameters

enable (Boolean) – Whether to enable or disable Colour safe / symmetrical power function.

__init__(enable: bool) → None

Parameters

enable (bool) –

Return type

None

Methods

```
__init__(enable)
```

colour.algebra.spow

colour.algebra.spow(a: FloatingOrArrayLike, p: FloatingOrArrayLike) → FloatingOrNDArray

Raise given array a to the power p as follows: $\text{sign}(a) * |a|^p$.

This definition avoids NaNs generation when array a is negative and the power p is fractional. This behaviour can be enabled or disabled with the `colour.algebra.set_spow_enable()` definition or with the `spow_enable()` context manager.

Parameters

- **a** (FloatingOrArrayLike) – Array a .
- **p** (FloatingOrArrayLike) – Power p .

Returns

Array *a* safely raised to the power *p*.

Return type

np.floating or `numpy.ndarray`

Examples

```
>>> np.power(-2, 0.15)
nan
>>> spow(-2, 0.15)
-1.1095694...
>>> spow(0, 0)
0.0
```

colour.algebra.normalise_vector

`colour.algebra.normalise_vector(a: FloatingOrArrayLike) → FloatingOrNDArray`

Normalise given vector *a*.

Parameters

a (`FloatingOrArrayLike`) – Vector *a* to normalise.

Returns

Normalised vector *a*.

Return type

`numpy.ndarray`

Examples

```
>>> a = np.array([0.20654008, 0.12197225, 0.05136952])
>>> normalise_vector(a)
array([ 0.8419703...,  0.4972256...,  0.2094102...])
```

colour.algebra.normalise_maximum

`colour.algebra.normalise_maximum(a: ArrayLike, axis: int | None = None, factor: float = 1, clip: bool = True) → ndarray`

Normalise given array *a* values by *a* maximum value and optionally clip them between.

Parameters

- **a** (`ArrayLike`) – Array *a* to normalise.
- **axis** (`int` | `None`) – Normalization axis.
- **factor** (`float`) – Normalization factor.
- **clip** (`bool`) – Clip values to domain [0, 'factor'].

Returns

Maximum normalised array *a*.

Return type

`numpy.ndarray`

Examples

```
>>> a = np.array([0.48222001, 0.31654775, 0.22070353])
>>> normalise_maximum(a)
array([ 1.          ,  0.6564384...,  0.4576822...])
```

colour.algebra.vector_dot

colour.algebra.**vector_dot**(*m*: ArrayLike, *v*: ArrayLike) → ndarray

Perform the dot product of the matrix array *m* with the vector array *v*.

This definition is a convenient wrapper around `np.einsum()` with the following subscripts: `'...ij,...j->...i'`.

Parameters

- **m** (ArrayLike) – Matrix array *m*.
- **v** (ArrayLike) – Vector array *v*.

Returns

Transformed vector array *v*.

Return type

numpy.ndarray

Examples

```
>>> m = np.array(
...     [
...         [0.7328, 0.4296, -0.1624],
...         [-0.7036, 1.6975, 0.0061],
...         [0.0030, 0.0136, 0.9834],
...     ]
... )
>>> m = np.reshape(np.tile(m, (6, 1)), (6, 3, 3))
>>> v = np.array([0.20654008, 0.12197225, 0.05136952])
>>> v = np.tile(v, (6, 1))
>>> vector_dot(m, v)
array([[ 0.1954094...,  0.0620396...,  0.0527952...],
       [ 0.1954094...,  0.0620396...,  0.0527952...],
       [ 0.1954094...,  0.0620396...,  0.0527952...],
       [ 0.1954094...,  0.0620396...,  0.0527952...],
       [ 0.1954094...,  0.0620396...,  0.0527952...],
       [ 0.1954094...,  0.0620396...,  0.0527952...]])
```

colour.algebra.matrix_dot

colour.algebra.**matrix_dot**(*a*: ArrayLike, *b*: ArrayLike) → ndarray

Perform the dot product of the matrix array *a* with the matrix array *b*.

This definition is a convenient wrapper around `np.einsum()` with the following subscripts: `'...ij,...jk->...ik'`.

Parameters

- **a** (ArrayLike) – Matrix array *a*.

- **b** (ArrayLike) – Matrix array *b*.

Return type

`numpy.ndarray`

Examples

```
>>> a = np.array(
...     [
...         [0.7328, 0.4296, -0.1624],
...         [-0.7036, 1.6975, 0.0061],
...         [0.0030, 0.0136, 0.9834],
...     ]
... )
>>> a = np.reshape(np.tile(a, (6, 1)), (6, 3, 3))
>>> b = a
>>> matrix_dot(a, b)
array([[[ 0.2342420...,  1.0418482..., -0.2760903...],
        [-1.7099407...,  2.5793226...,  0.1306181...],
        [-0.0044203...,  0.0377490...,  0.9666713...]],
       [[ 0.2342420...,  1.0418482..., -0.2760903...],
        [-1.7099407...,  2.5793226...,  0.1306181...],
        [-0.0044203...,  0.0377490...,  0.9666713...]],
       [[ 0.2342420...,  1.0418482..., -0.2760903...],
        [-1.7099407...,  2.5793226...,  0.1306181...],
        [-0.0044203...,  0.0377490...,  0.9666713...]],
       [[ 0.2342420...,  1.0418482..., -0.2760903...],
        [-1.7099407...,  2.5793226...,  0.1306181...],
        [-0.0044203...,  0.0377490...,  0.9666713...]],
       [[ 0.2342420...,  1.0418482..., -0.2760903...],
        [-1.7099407...,  2.5793226...,  0.1306181...],
        [-0.0044203...,  0.0377490...,  0.9666713...]],
       [[ 0.2342420...,  1.0418482..., -0.2760903...],
        [-1.7099407...,  2.5793226...,  0.1306181...],
        [-0.0044203...,  0.0377490...,  0.9666713...]]])
```

colour.algebra.euclidean_distance

`colour.algebra.euclidean_distance(a: ArrayLike, b: ArrayLike) → FloatingOrNDArray`

Return the *Euclidean* distance between point array *a* and point array *b*.

For a two-dimensional space, the metric is as follows:

$$E_D = [(x_a - x_b)^2 + (y_a - y_b)^2]^{1/2}$$

Parameters

- **a** (ArrayLike) – Point array *a*.
- **b** (ArrayLike) – Point array *b*.

Returns

Euclidean distance.

Return typenp.floating or `numpy.ndarray`**Examples**

```
>>> a = np.array([100.00000000, 21.57210357, 272.22819350])
>>> b = np.array([100.00000000, 426.67945353, 72.39590835])
>>> euclidean_distance(a, b)
451.7133019...
```

colour.algebra.manhattan_distancecolour.algebra.manhattan_distance(*a*: ArrayLike, *b*: ArrayLike) → FloatingOrNDArrayReturn the *Manhattan* (or *City-Block*) distance between point array *a* and point array *b*.

For a two-dimensional space, the metric is as follows:

$$M_D = |x_a - x_b| + |y_a - y_b|$$

Parameters

- **a** (ArrayLike) – Point array *a*.
- **b** (ArrayLike) – Point array *b*.

Returns*Manhattan* distance.**Return type**np.floating or `numpy.ndarray`**Examples**

```
>>> a = np.array([100.00000000, 21.57210357, 272.22819350])
>>> b = np.array([100.00000000, 426.67945353, 72.39590835])
>>> manhattan_distance(a, b)
604.9396351...
```

colour.algebra.linear_conversioncolour.algebra.linear_conversion(*a*: ArrayLike, *old_range*: ArrayLike, *new_range*: ArrayLike) → `ndarray`Perform a simple linear conversion of given array *a* between the old and new ranges.**Parameters**

- **a** (ArrayLike) – Array *a* to perform the linear conversion onto.
- **old_range** (ArrayLike) – Old range.
- **new_range** (ArrayLike) – New range.

Returns

Linear conversion result.

Return type`numpy.ndarray`

Examples

```
>>> a = np.linspace(0, 1, 10)
>>> linear_conversion(a, np.array([0, 1]), np.array([1, 10]))
array([ 1.,  2.,  3.,  4.,  5.,  6.,  7.,  8.,  9., 10.]
```

colour.algebra.linstep_function

`colour.algebra.linstep_function`(*x: FloatingOrArrayLike*, *a: FloatingOrArrayLike = 0*, *b: FloatingOrArrayLike = 1*, *clip: bool = False*) → `ndarray`

Perform a simple linear interpolation between given array *a* and array *b* using *x* array.

Parameters

- **x** (`FloatingOrArrayLike`) – Array *x* value to use to interpolate between array *a* and array *b*.
- **a** (`FloatingOrArrayLike`) – Array *a*, the start of the range in which to interpolate.
- **b** (`FloatingOrArrayLike`) – Array *b*, the end of the range in which to interpolate.
- **clip** (`bool`) – Whether to clip the output values to range [*a*, *b*].

Returns

Linear interpolation result.

Return type

`numpy.ndarray`

Examples

```
>>> a = 0
>>> b = 2
>>> linstep_function(0.5, a, b)
1.0
```

colour.algebra.lerp

`colour.algebra.lerp`(*x: FloatingOrArrayLike*, *a: FloatingOrArrayLike = 0*, *b: FloatingOrArrayLike = 1*, *clip: bool = False*) → `ndarray`

Perform a simple linear interpolation between given array *a* and array *b* using *x* array.

Parameters

- **x** (`FloatingOrArrayLike`) – Array *x* value to use to interpolate between array *a* and array *b*.
- **a** (`FloatingOrArrayLike`) – Array *a*, the start of the range in which to interpolate.
- **b** (`FloatingOrArrayLike`) – Array *b*, the end of the range in which to interpolate.
- **clip** (`bool`) – Whether to clip the output values to range [*a*, *b*].

Returns

Linear interpolation result.

Return type

`numpy.ndarray`

Examples

```
>>> a = 0
>>> b = 2
>>> linstep_function(0.5, a, b)
1.0
```

colour.algebra.smoothstep_function

`colour.algebra.smoothstep_function`(*x*: *FloatingOrArrayLike*, *a*: *FloatingOrArrayLike* = 0, *b*: *FloatingOrArrayLike* = 1, *clip*: *bool* = False) → *ndarray*

Evaluate the *smoothstep* sigmoid-like function on array *x*.

Parameters

- **x** (*FloatingOrArrayLike*) – Array *x*.
- **a** (*FloatingOrArrayLike*) – Low input domain limit, i.e. the left edge.
- **b** (*FloatingOrArrayLike*) – High input domain limit, i.e. the right edge.
- **clip** (*bool*) – Whether to scale, bias and clip input values to domain [a, b].

Returns

Array *x* after *smoothstep* sigmoid-like function evaluation.

Return type

numpy.ndarray

Examples

```
>>> x = np.linspace(-2, 2, 5)
>>> smoothstep_function(x, -2, 2, clip=True)
array([ 0.      ,  0.15625,  0.5      ,  0.84375,  1.      ])
```

colour.algebra.smooth

`colour.algebra.smooth`(*x*: *FloatingOrArrayLike*, *a*: *FloatingOrArrayLike* = 0, *b*: *FloatingOrArrayLike* = 1, *clip*: *bool* = False) → *ndarray*

Evaluate the *smoothstep* sigmoid-like function on array *x*.

Parameters

- **x** (*FloatingOrArrayLike*) – Array *x*.
- **a** (*FloatingOrArrayLike*) – Low input domain limit, i.e. the left edge.
- **b** (*FloatingOrArrayLike*) – High input domain limit, i.e. the right edge.
- **clip** (*bool*) – Whether to scale, bias and clip input values to domain [a, b].

Returns

Array *x* after *smoothstep* sigmoid-like function evaluation.

Return type

numpy.ndarray

Examples

```
>>> x = np.linspace(-2, 2, 5)
>>> smoothstep_function(x, -2, 2, clip=True)
array([ 0.        ,  0.15625,  0.5        ,  0.84375,  1.        ])
```

colour.algebra.is_identity

`colour.algebra.is_identity(a: ArrayLike) → bool`

Return whether *a* array is an identity matrix.

Parameters

a (ArrayLike) – Array *a* to test.

Returns

Whether *a* array is an identity matrix.

Return type

bool

Examples

```
>>> is_identity(np.array([1, 0, 0, 0, 1, 0, 0, 0, 1]).reshape(3, 3))
True
>>> is_identity(np.array([1, 2, 0, 0, 1, 0, 0, 0, 1]).reshape(3, 3))
False
```

colour.algebra.eigen_decomposition

`colour.algebra.eigen_decomposition(a: ArrayLike, eigen_w_v_count: int | None = None, descending_order: bool = True, covariance_matrix: bool = False) → Tuple[ndarray, ndarray]`

Return the eigen-values *w* and eigen-vectors *v* of given array *a* in given order.

Parameters

- **a** (ArrayLike) – Array to return the eigen-values *w* and eigen-vectors *v* for
- **eigen_w_v_count** (int | None) – Eigen-values *w* and eigen-vectors *v* count.
- **descending_order** (bool) – Whether to return the eigen-values *w* and eigen-vectors *v* in descending order.
- **covariance_matrix** (bool) – Whether to compute the eigen-values *w* and eigen-vectors *v* of the array *a* covariance matrix $A = a^T \cdot a$.

Returns

Tuple of eigen-values *w* and eigen-vectors *v*. The eigenv-values are in given order, each repeated according to its multiplicity. The column $v[:, i]$ is the normalized eigen-vector corresponding to the eigen-value $w[i]$.

Return type

tuple

Examples

```
>>> a = np.diag([1, 2, 3])
>>> w, v = eigen_decomposition(a)
>>> w
array([ 3.,  2.,  1.])
>>> v
array([[ 0.,  0.,  1.],
       [ 0.,  1.,  0.],
       [ 1.,  0.,  0.]])
>>> w, v = eigen_decomposition(a, 1)
>>> w
array([ 3.])
>>> v
array([[ 0.],
       [ 0.],
       [ 1.]])
>>> w, v = eigen_decomposition(a, descending_order=False)
>>> w
array([ 1.,  2.,  3.])
>>> v
array([[ 1.,  0.,  0.],
       [ 0.,  1.,  0.],
       [ 0.,  0.,  1.]])
>>> w, v = eigen_decomposition(a, covariance_matrix=True)
>>> w
array([ 9.,  4.,  1.])
>>> v
array([[ 0.,  0.,  1.],
       [ 0.,  1.,  0.],
       [ 1.,  0.,  0.]])
```

Colour Appearance Models

ATD (1995)

colour

| | |
|---|---|
| <code>XYZ_to_ATD95(XYZ, XYZ_0, Y_0, k_1, k_2[, sigma])</code> | Compute the <i>ATD (1995)</i> colour vision model correlates. |
| <code>CAM_Specification_ATD95(h, C, Q, A_1, T_1, ...)</code> | Define the <i>ATD (1995)</i> colour vision model specification. |

colour.XYZ_to_ATD95

`colour.XYZ_to_ATD95(XYZ: ArrayLike, XYZ_0: ArrayLike, Y_0: FloatingOrArrayLike, k_1: FloatingOrArrayLike, k_2: FloatingOrArrayLike, sigma: FloatingOrArrayLike = 300) → CAM_Specification_ATD95`

Compute the *ATD (1995)* colour vision model correlates.

Parameters

- **XYZ** (ArrayLike) – CIE XYZ tristimulus values of test sample / stimulus.
- **XYZ_0** (ArrayLike) – CIE XYZ tristimulus values of reference white.

- **Y_0** (FloatingOrArrayLike) – Absolute adapting field luminance in cd/m^2 .
- **k_1** (FloatingOrArrayLike) – Application specific weight k_1 .
- **k_2** (FloatingOrArrayLike) – Application specific weight k_2 .
- **sigma** (FloatingOrArrayLike) – Constant σ varied to predict different types of data.

Returns

ATD (1995) colour vision model specification.

Return type

`colour.CAM_Specification_ATD95`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |
| XYZ_0 | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|---------------------------|-------------------|-----------|
| CAM_Specification_ATD95.h | [0, 360] | [0, 1] |

- For unrelated colors, there is only self-adaptation and k_1 is set to 1.0 while k_2 is set to 0.0. For related colors such as typical colorimetric applications, k_1 is set to 0.0 and k_2 is set to a value between 15 and 50 (*Guth, 1995*).

References

[Fai13e], [Gut95]

Examples

```
>>> XYZ = np.array([19.01, 20.00, 21.78])
>>> XYZ_0 = np.array([95.05, 100.00, 108.88])
>>> Y_0 = 318.31
>>> k_1 = 0.0
>>> k_2 = 50.0
>>> XYZ_to_ATD95(XYZ, XYZ_0, Y_0, k_1, k_2)
CAM_Specification_ATD95(h=1.9089869..., C=1.2064060..., Q=0.1814003..., A_1=0.
↪1787931... T_1=0.0286942..., D_1=0.0107584..., A_2=0.0192182..., T_2=0.0205377..., ↪
↪D_2=0.0107584...)
```

colour.CAM_Specification_ATD95

```
class colour.CAM_Specification_ATD95(h: FloatingOrNDArray | None = <factory>, C:
    FloatingOrNDArray | None = <factory>, Q:
    FloatingOrNDArray | None = <factory>, A_1:
    FloatingOrNDArray | None = <factory>, T_1:
    FloatingOrNDArray | None = <factory>, D_1:
    FloatingOrNDArray | None = <factory>, A_2:
    FloatingOrNDArray | None = <factory>, T_2:
    FloatingOrNDArray | None = <factory>, D_2:
    FloatingOrNDArray | None = <factory>)
```

Define the *ATD* (1995) colour vision model specification.

This specification has field names consistent with the remaining colour appearance models in `colour.appearance` but diverge from *Fairchild (2013)* reference.

Parameters

- **h** (FloatingOrNDArray | None) – Hue angle H in degrees.
- **C** (FloatingOrNDArray | None) – Correlate of *saturation* C . *Guth (1995)* incorrectly uses the terms *saturation* and *chroma* interchangeably. However, C is here a measure of *saturation* rather than *chroma* since it is measured relative to the achromatic response for the stimulus rather than that of a similarly illuminated white.
- **Q** (FloatingOrNDArray | None) – Correlate of *brightness* Br .
- **A_1** (FloatingOrNDArray | None) – First stage A_1 response.
- **T_1** (FloatingOrNDArray | None) – First stage T_1 response.
- **D_1** (FloatingOrNDArray | None) – First stage D_1 response.
- **A_2** (FloatingOrNDArray | None) – Second stage A_2 response.
- **T_2** (FloatingOrNDArray | None) – Second stage A_2 response.
- **D_2** (FloatingOrNDArray | None) – Second stage D_2 response.

Notes

- This specification is the one used in the current model implementation.

References

[Fai13e], [Gut95]

```
__init__(h: FloatingOrNDArray | None = <factory>, C: FloatingOrNDArray | None = <factory>,
    Q: FloatingOrNDArray | None = <factory>, A_1: FloatingOrNDArray | None =
    <factory>, T_1: FloatingOrNDArray | None = <factory>, D_1: FloatingOrNDArray |
    None = <factory>, A_2: FloatingOrNDArray | None = <factory>, T_2:
    FloatingOrNDArray | None = <factory>, D_2: FloatingOrNDArray | None =
    <factory>) → None
```

Parameters

- **h** (FloatingOrNDArray | None) –
- **C** (FloatingOrNDArray | None) –
- **Q** (FloatingOrNDArray | None) –
- **A_1** (FloatingOrNDArray | None) –

- `T_1` (FloatingOrNDArray | None) –
- `D_1` (FloatingOrNDArray | None) –
- `A_2` (FloatingOrNDArray | None) –
- `T_2` (FloatingOrNDArray | None) –
- `D_2` (FloatingOrNDArray | None) –

Return type
None

Methods

| | | |
|---|---------------------------|---|
| <code>__init__</code> ([<code>h</code> , <code>C</code> , <code>Q</code> , <code>A_1</code> , <code>T_1</code> , <code>D_1</code> , <code>A_2</code> , <code>T_2</code> , <code>D_2</code>]) | | |
| <code>arithmetical_operation</code> (<code>a</code> , | <code>operation</code> [, | Perform given arithmetical operation with <i>a</i> operand on the dataclass-like class. |
| <code>in_place</code>]) | | |

Attributes

| | |
|---------------------|--|
| <code>fields</code> | Getter property for the fields of the dataclass-like class. |
| <code>items</code> | Getter property for the dataclass-like class items, i.e. the field names and values. |
| <code>keys</code> | Getter property for the dataclass-like class keys, i.e. the field names. |
| <code>values</code> | Getter property for the dataclass-like class values, i.e. the field values. |
| <code>h</code> | |
| <code>C</code> | |
| <code>Q</code> | |
| <code>A_1</code> | |
| <code>T_1</code> | |
| <code>D_1</code> | |
| <code>A_2</code> | |
| <code>T_2</code> | |
| <code>D_2</code> | |

CIECAM02

colour

| | |
|--|--|
| <code>XYZ_to_CIECAM02(XYZ, XYZ_w, L_A, Y_b[, ...])</code> | Compute the <i>CIECAM02</i> colour appearance model correlates from given <i>CIE XYZ</i> tristimulus values. |
| <code>CIECAM02_to_XYZ(specification, XYZ_w, L_A, Y_b)</code> | Convert from <i>CIECAM02</i> specification to <i>CIE XYZ</i> tristimulus values. |
| <code>CAM_Specification_CIECAM02(J, C, h, s, Q, M, ...)</code> | Define the <i>CIECAM02</i> colour appearance model specification. |
| <code>VIEWING_CONDITIONS_CIECAM02</code> | Reference <i>CIECAM02</i> colour appearance model viewing conditions. |

colour.XYZ_to_CIECAM02

`colour.XYZ_to_CIECAM02(XYZ: ArrayLike, XYZ_w: ArrayLike, L_A: FloatingOrArrayLike, Y_b: FloatingOrArrayLike, surround: InductionFactors_CIECAM02 = VIEWING_CONDITIONS_CIECAM02['Average'], discount_illuminant: bool = False) → CAM_Specification_CIECAM02`

Compute the *CIECAM02* colour appearance model correlates from given *CIE XYZ* tristimulus values.

Parameters

- **XYZ** (ArrayLike) – *CIE XYZ* tristimulus values of test sample / stimulus.
- **XYZ_w** (ArrayLike) – *CIE XYZ* tristimulus values of reference white.
- **L_A** (FloatingOrArrayLike) – Adapting field luminance L_A in cd/m^2 , (often taken to be 20% of the luminance of a white object in the scene).
- **Y_b** (FloatingOrArrayLike) – Luminous factor of background Y_b such as $Y_b = 100 \times L_b / L_w$ where L_w is the luminance of the light source and L_b is the luminance of the background. For viewing images, Y_b can be the average Y value for the pixels in the entire image, or frequently, a Y value of 20, approximate an L^* of 50 is used.
- **surround** (*InductionFactors_CIECAM02*) – Surround viewing conditions induction factors.
- **discount_illuminant** (bool) – Truth value indicating if the illuminant should be discounted.

Returns

CIECAM02 colour appearance model specification.

Return type

`colour.CAM_Specification_CIECAM02`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |
| XYZ_w | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|------------------------------|-------------------|-----------|
| CAM_Specification_CIECAM02.J | [0, 100] | [0, 1] |
| CAM_Specification_CIECAM02.C | [0, 100] | [0, 1] |
| CAM_Specification_CIECAM02.h | [0, 360] | [0, 1] |
| CAM_Specification_CIECAM02.s | [0, 100] | [0, 1] |
| CAM_Specification_CIECAM02.Q | [0, 100] | [0, 1] |
| CAM_Specification_CIECAM02.M | [0, 100] | [0, 1] |
| CAM_Specification_CIECAM02.H | [0, 400] | [0, 1] |

References

[Fai04], [LL13], [MFH+02], [Wikipedia07d]

Examples

```
>>> XYZ = np.array([19.01, 20.00, 21.78])
>>> XYZ_w = np.array([95.05, 100.00, 108.88])
>>> L_A = 318.31
>>> Y_b = 20.0
>>> surround = VIEWING_CONDITIONS_CIECAM02["Average"]
>>> XYZ_to_CIECAM02(XYZ, XYZ_w, L_A, Y_b, surround)
CAM_Specification_CIECAM02(J=41.7310911..., C=0.1047077..., h=219.0484326..., s=2.
↪ 3603053..., Q=195.3713259..., M=0.1088421..., H=278.0607358..., HC=None)
```

`colour.CIECAM02_to_XYZ`

`colour.CIECAM02_to_XYZ`(specification: `CAM_Specification_CIECAM02`, XYZ_w: `ArrayLike`, L_A: `FloatingOrArrayLike`, Y_b: `FloatingOrArrayLike`, surround: `InductionFactors_CIECAM02` = `VIEWING_CONDITIONS_CIECAM02['Average']`, discount_illuminant: `bool` = `False`) → `ndarray`

Convert from *CIECAM02* specification to *CIE XYZ* tristimulus values.

Parameters

- **specification** (`CAM_Specification_CIECAM02`) – *CIECAM02* colour appearance model specification. Correlate of *Lightness J*, correlate of *chroma C* or correlate of *colourfulness M* and *hue angle h* in degrees must be specified, e.g. *JCh* or *JMh*.
- **XYZ_w** (`ArrayLike`) – *CIE XYZ* tristimulus values of reference white.
- **L_A** (`FloatingOrArrayLike`) – Adapting field *luminance L_A* in *cd/m²*, (often taken to be 20% of the luminance of a white object in the scene).

- **Y_b** (`FloatingOrArrayLike`) – Luminous factor of background Y_b such as $Y_b = 100xL_b/L_w$ where L_w is the luminance of the light source and L_b is the luminance of the background. For viewing images, Y_b can be the average Y value for the pixels in the entire image, or frequently, a Y value of 20, approximate an L^* of 50 is used.
- **surround** (`InductionFactors_CIECAM02`) – Surround viewing conditions.
- **discount_illuminant** (`bool`) – Discount the illuminant.

Returns

CIE XYZ tristimulus values.

Return type

`numpy.ndarray`

Raises

ValueError – If neither C or M correlates have been defined in the specification argument.

Notes

| Domain | Scale - Reference | Scale - 1 |
|---|-------------------|-----------|
| <code>CAM_Specification_CIECAM02.J</code> | [0, 100] | [0, 1] |
| <code>CAM_Specification_CIECAM02.C</code> | [0, 100] | [0, 1] |
| <code>CAM_Specification_CIECAM02.h</code> | [0, 360] | [0, 1] |
| <code>CAM_Specification_CIECAM02.s</code> | [0, 100] | [0, 1] |
| <code>CAM_Specification_CIECAM02.Q</code> | [0, 100] | [0, 1] |
| <code>CAM_Specification_CIECAM02.M</code> | [0, 100] | [0, 1] |
| <code>CAM_Specification_CIECAM02.H</code> | [0, 360] | [0, 1] |
| <code>XYZ_w</code> | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |

References

[Fai04], [LL13], [MFH+02], [Wikipedia07d]

Examples

```
>>> specification = CAM_Specification_CIECAM02(
...     J=41.731091132513917, C=0.104707757171031, h=219.048432658311780
... )
>>> XYZ_w = np.array([95.05, 100.00, 108.88])
>>> L_A = 318.31
>>> Y_b = 20.0
>>> CIECAM02_to_XYZ(specification, XYZ_w, L_A, Y_b)
array([ 19.01..., 20..., 21.78...])
```

colour.CAM_Specification_CIECAM02

```
class colour.CAM_Specification_CIECAM02(J: FloatingOrNDArray | None = <factory>, C:
    FloatingOrNDArray | None = <factory>, h:
    FloatingOrNDArray | None = <factory>, s:
    FloatingOrNDArray | None = <factory>, Q:
    FloatingOrNDArray | None = <factory>, M:
    FloatingOrNDArray | None = <factory>, H:
    FloatingOrNDArray | None = <factory>, HC:
    FloatingOrNDArray | None = <factory>)
```

Define the *CIECAM02* colour appearance model specification.

Parameters

- **J** (FloatingOrNDArray | None) – Correlate of *Lightness J*.
- **C** (FloatingOrNDArray | None) – Correlate of *chroma C*.
- **h** (FloatingOrNDArray | None) – *Hue* angle *h* in degrees.
- **s** (FloatingOrNDArray | None) – Correlate of *saturation s*.
- **Q** (FloatingOrNDArray | None) – Correlate of *brightness Q*.
- **M** (FloatingOrNDArray | None) – Correlate of *colourfulness M*.
- **H** (FloatingOrNDArray | None) – *Hue h* quadrature *H*.
- **HC** (FloatingOrNDArray | None) – *Hue h* composition H^C .

References

[Fai04], [LL13], [MFH+02], [Wikipedia07d]

```
__init__(J: FloatingOrNDArray | None = <factory>, C: FloatingOrNDArray | None = <factory>,
    h: FloatingOrNDArray | None = <factory>, s: FloatingOrNDArray | None = <factory>,
    Q: FloatingOrNDArray | None = <factory>, M: FloatingOrNDArray | None =
    <factory>, H: FloatingOrNDArray | None = <factory>, HC: FloatingOrNDArray | None
    = <factory>) → None
```

Parameters

- **J** (FloatingOrNDArray | None) –
- **C** (FloatingOrNDArray | None) –
- **h** (FloatingOrNDArray | None) –
- **s** (FloatingOrNDArray | None) –
- **Q** (FloatingOrNDArray | None) –
- **M** (FloatingOrNDArray | None) –
- **H** (FloatingOrNDArray | None) –
- **HC** (FloatingOrNDArray | None) –

Return type

None

Methods

`__init__([J, C, h, s, Q, M, H, HC])`

| | | |
|--|--------------------------|---|
| <code>arithmetical_operation(a, in_place)</code> | <code>operation[,</code> | Perform given arithmetical operation with <i>a</i> operand on the dataclass-like class. |
|--|--------------------------|---|

Attributes

| | |
|---------------------|--|
| <code>fields</code> | Getter property for the fields of the dataclass-like class. |
| <code>items</code> | Getter property for the dataclass-like class items, i.e. the field names and values. |
| <code>keys</code> | Getter property for the dataclass-like class keys, i.e. the field names. |
| <code>values</code> | Getter property for the dataclass-like class values, i.e. the field values. |
| <code>J</code> | |
| <code>C</code> | |
| <code>h</code> | |
| <code>s</code> | |
| <code>Q</code> | |
| <code>M</code> | |
| <code>H</code> | |
| <code>HC</code> | |

`colour.VIEWING_CONDITIONS_CIECAM02`

`colour.VIEWING_CONDITIONS_CIECAM02 = CanonicalMapping({'Average': ..., 'Dim': ..., 'Dark': ...})`

Reference *CIECAM02* colour appearance model viewing conditions.

References

[Fai04], [LL13], [MFH+02], [Wikipedia07d]

Ancillary Objects

`colour.appearance`

`CAM_KWARGS_CIECAM02_sRGB`

Default parameter values for the *CIECAM02* colour appearance model usage in the context of *sRGB*.

`InductionFactors_CIECAM02(F, c, N_c)`

CIECAM02 colour appearance model induction factors.

colour.appearance.CAM_KWARGS_CIECAM02_sRGB

```
colour.appearance.CAM_KWARGS_CIECAM02_sRGB = {'L_A': 4.074366543152521, 'XYZ_w': array([
95.04559271, 100. , 108.90577508]), 'Y_b': 20, 'surround': InductionFactors_CIECAM02(F=1,
c=0.69, N_c=1)}
```

Default parameter values for the *CIECAM02* colour appearance model usage in the context of *sRGB*.

References

[Fai04], [InternationalECommission99], [LL13], [MFH+02], [Wikipedia07d]

colour.appearance.InductionFactors_CIECAM02

class colour.appearance.InductionFactors_CIECAM02(*F*, *c*, *N_c*)
CIECAM02 colour appearance model induction factors.

Parameters

- **F** – Maximum degree of adaptation F .
- **c** – Exponential non-linearity c .
- **N_c** – Chromatic induction factor N_c .

References

[Fai04], [LL13], [MFH+02], [Wikipedia07d]

Create new instance of InductionFactors_CIECAM02(*F*, *c*, *N_c*)

`__init__()`

Methods

| | |
|--|--|
| <code>__init__()</code> | |
| <code>count(value, /)</code> | Return number of occurrences of value. |
| <code>index(value[, start, stop])</code> | Return first index of value. |

Attributes

| | |
|------------------|--------------------------|
| <code>F</code> | Alias for field number 0 |
| <code>N_c</code> | Alias for field number 2 |
| <code>c</code> | Alias for field number 1 |

CIECAM16

colour

| | |
|--|--|
| <code>XYZ_to_CIECAM16(XYZ, XYZ_w, L_A, Y_b[, ...])</code> | Compute the <i>CIECAM16</i> colour appearance model correlates from given <i>CIE XYZ</i> tristimulus values. |
| <code>CIECAM16_to_XYZ(specification, XYZ_w, L_A, Y_b)</code> | Convert from <i>CIECAM16</i> specification to <i>CIE XYZ</i> tristimulus values. |
| <code>CAM_Specification_CIECAM16(J, C, h, s, Q, M, ...)</code> | Define the <i>CIECAM16</i> colour appearance model specification. |
| <code>VIEWING_CONDITIONS_CIECAM16</code> | Reference <i>CIECAM16</i> colour appearance model viewing conditions. |

colour.XYZ_to_CIECAM16

`colour.XYZ_to_CIECAM16(XYZ: ArrayLike, XYZ_w: ArrayLike, L_A: FloatingOrArrayLike, Y_b: FloatingOrArrayLike, surround: InductionFactors_CIECAM02 | InductionFactors_CIECAM16 = VIEWING_CONDITIONS_CIECAM16['Average'], discount_illuminant: bool = False) → CAM_Specification_CIECAM16`

Compute the *CIECAM16* colour appearance model correlates from given *CIE XYZ* tristimulus values.

Parameters

- **XYZ** (ArrayLike) – *CIE XYZ* tristimulus values of test sample / stimulus.
- **XYZ_w** (ArrayLike) – *CIE XYZ* tristimulus values of reference white.
- **L_A** (FloatingOrArrayLike) – Adapting field luminance L_A in cd/m^2 , (often taken to be 20% of the luminance of a white object in the scene).
- **Y_b** (FloatingOrArrayLike) – Luminous factor of background Y_b such as $Y_b = 100xL_b/L_w$ where L_w is the luminance of the light source and L_b is the luminance of the background. For viewing images, Y_b can be the average Y value for the pixels in the entire image, or frequently, a Y value of 20, approximate an L^* of 50 is used.
- **surround** (`InductionFactors_CIECAM02` | `InductionFactors_CIECAM16`) – Surround viewing conditions induction factors.
- **discount_illuminant** (bool) – Truth value indicating if the illuminant should be discounted.

Returns

CIECAM16 colour appearance model specification.

Return type

`colour.CAM_Specification_CIECAM16`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |
| XYZ_w | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|------------------------------|-------------------|-----------|
| CAM_Specification_CIECAM16.J | [0, 100] | [0, 1] |
| CAM_Specification_CIECAM16.C | [0, 100] | [0, 1] |
| CAM_Specification_CIECAM16.h | [0, 360] | [0, 1] |
| CAM_Specification_CIECAM16.s | [0, 100] | [0, 1] |
| CAM_Specification_CIECAM16.Q | [0, 100] | [0, 1] |
| CAM_Specification_CIECAM16.M | [0, 100] | [0, 1] |
| CAM_Specification_CIECAM16.H | [0, 400] | [0, 1] |

References

[CIED1CIED822]

Examples

```
>>> XYZ = np.array([19.01, 20.00, 21.78])
>>> XYZ_w = np.array([95.05, 100.00, 108.88])
>>> L_A = 318.31
>>> Y_b = 20.0
>>> surround = VIEWING_CONDITIONS_CIECAM16["Average"]
>>> XYZ_to_CIECAM16(XYZ, XYZ_w, L_A, Y_b, surround)
CAM_Specification_CIECAM16(J=41.7312079..., C=0.1033557..., h=217.0679597..., s=2.
↪ 3450150..., Q=195.3717089..., M=0.1074367..., H=275.5949861..., HC=None)
```

`colour.CIECAM16_to_XYZ`

`colour.CIECAM16_to_XYZ`(specification: `CAM_Specification_CIECAM16`, XYZ_w: *ArrayLike*, L_A: *FloatingOrArrayLike*, Y_b: *FloatingOrArrayLike*, surround: `InductionFactors_CIECAM02 | InductionFactors_CIECAM16 = VIEWING_CONDITIONS_CIECAM16['Average']`, discount_illuminant: *bool* = `False`) → *ndarray*

Convert from *CIECAM16* specification to *CIE XYZ* tristimulus values.

Parameters

- **specification** (`CAM_Specification_CIECAM16`) – *CIECAM16* colour appearance model specification. Correlate of *Lightness J*, correlate of *chroma C* or correlate of *colourfulness M* and *hue angle h* in degrees must be specified, e.g. *JCh* or *JMh*.
- **XYZ_w** (*ArrayLike*) – *CIE XYZ* tristimulus values of reference white.
- **L_A** (*FloatingOrArrayLike*) – Adapting field *luminance L_A* in *cd/m²*, (often taken to be 20% of the luminance of a white object in the scene).

- **Y_b** (`FloatingOrArrayLike`) – Luminous factor of background Y_b such as $Y_b = 100xL_b/L_w$ where L_w is the luminance of the light source and L_b is the luminance of the background. For viewing images, Y_b can be the average Y value for the pixels in the entire image, or frequently, a Y value of 20, approximate an L^* of 50 is used.
- **surround** (`InductionFactors_CIECAM02` | `InductionFactors_CIECAM16`) – Surround viewing conditions.
- **discount_illuminant** (`bool`) – Discount the illuminant.

Returns

CIE XYZ tristimulus values.

Return type

`numpy.ndarray`

Raises

ValueError – If neither C or M correlates have been defined in the specification argument.

Notes

| Domain | Scale - Reference | Scale - 1 |
|---|-------------------|-----------|
| <code>CAM_Specification_CIECAM16.J</code> | [0, 100] | [0, 1] |
| <code>CAM_Specification_CIECAM16.C</code> | [0, 100] | [0, 1] |
| <code>CAM_Specification_CIECAM16.h</code> | [0, 360] | [0, 1] |
| <code>CAM_Specification_CIECAM16.s</code> | [0, 100] | [0, 1] |
| <code>CAM_Specification_CIECAM16.Q</code> | [0, 100] | [0, 1] |
| <code>CAM_Specification_CIECAM16.M</code> | [0, 100] | [0, 1] |
| <code>CAM_Specification_CIECAM16.H</code> | [0, 360] | [0, 1] |
| <code>XYZ_w</code> | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|------------------|-------------------|-----------|
| <code>XYZ</code> | [0, 100] | [0, 1] |

References

[CIED1CIED822]

Examples

```
>>> specification = CAM_Specification_CIECAM16(
...     J=41.731207905126638, C=0.103355738709070, h=217.067959767393010
... )
>>> XYZ_w = np.array([95.05, 100.00, 108.88])
>>> L_A = 318.31
>>> Y_b = 20.0
>>> CIECAM16_to_XYZ(specification, XYZ_w, L_A, Y_b)
array([ 19.01..., 20..., 21.78...])
```

colour.CAM_Specification_CIECAM16

```
class colour.CAM_Specification_CIECAM16(J: FloatingOrNDArray | None = <factory>, C:
    FloatingOrNDArray | None = <factory>, h:
    FloatingOrNDArray | None = <factory>, s:
    FloatingOrNDArray | None = <factory>, Q:
    FloatingOrNDArray | None = <factory>, M:
    FloatingOrNDArray | None = <factory>, H:
    FloatingOrNDArray | None = <factory>, HC:
    FloatingOrNDArray | None = <factory>)
```

Define the *CIECAM16* colour appearance model specification.

Parameters

- **J** (FloatingOrNDArray | None) – Correlate of *Lightness J*.
- **C** (FloatingOrNDArray | None) – Correlate of *chroma C*.
- **h** (FloatingOrNDArray | None) – *Hue* angle *h* in degrees.
- **s** (FloatingOrNDArray | None) – Correlate of *saturation s*.
- **Q** (FloatingOrNDArray | None) – Correlate of *brightness Q*.
- **M** (FloatingOrNDArray | None) – Correlate of *colourfulness M*.
- **H** (FloatingOrNDArray | None) – *Hue h* quadrature *H*.
- **HC** (FloatingOrNDArray | None) – *Hue h* composition H^C .

References

[[CIED1CIED822](#)]

```
__init__(J: FloatingOrNDArray | None = <factory>, C: FloatingOrNDArray | None = <factory>,
    h: FloatingOrNDArray | None = <factory>, s: FloatingOrNDArray | None = <factory>,
    Q: FloatingOrNDArray | None = <factory>, M: FloatingOrNDArray | None =
    <factory>, H: FloatingOrNDArray | None = <factory>, HC: FloatingOrNDArray | None
    = <factory>) → None
```

Parameters

- **J** (FloatingOrNDArray | None) –
- **C** (FloatingOrNDArray | None) –
- **h** (FloatingOrNDArray | None) –
- **s** (FloatingOrNDArray | None) –
- **Q** (FloatingOrNDArray | None) –
- **M** (FloatingOrNDArray | None) –
- **H** (FloatingOrNDArray | None) –
- **HC** (FloatingOrNDArray | None) –

Return type

None

Methods

`__init__([J, C, h, s, Q, M, H, HC])`

| | | |
|--|--------------------------|---|
| <code>arithmetical_operation(a, in_place)</code> | <code>operation[,</code> | Perform given arithmetical operation with <i>a</i> operand on the dataclass-like class. |
|--|--------------------------|---|

Attributes

| | |
|---------------------|---|
| <code>fields</code> | Getter property for the fields of the dataclass-like class. |
|---------------------|---|

| | |
|--------------------|--|
| <code>items</code> | Getter property for the dataclass-like class items, i.e. the field names and values. |
|--------------------|--|

| | |
|-------------------|--|
| <code>keys</code> | Getter property for the dataclass-like class keys, i.e. the field names. |
|-------------------|--|

| | |
|---------------------|---|
| <code>values</code> | Getter property for the dataclass-like class values, i.e. the field values. |
|---------------------|---|

`J`

`C`

`h`

`s`

`Q`

`M`

`H`

`HC`

`colour.VIEWING_CONDITIONS_CIECAM16`

`colour.VIEWING_CONDITIONS_CIECAM16 = CanonicalMapping({'Average': ..., 'Dim': ..., 'Dark': ...})`

Reference *CIECAM16* colour appearance model viewing conditions.

References

[[CIED1CIED822](#)]

Ancillary Objects

`colour.appearance`

`InductionFactors_CIECAM16(F, c, N_c)`

CIECAM16 colour appearance model induction factors.

colour.appearance.InductionFactors_CIECAM16

class colour.appearance.InductionFactors_CIECAM16(*F*, *c*, *N_c*)
CIECAM16 colour appearance model induction factors.

Parameters

- **F** – Maximum degree of adaptation *F*.
- **c** – Exponential non-linearity *c*.
- **N_c** – Chromatic induction factor *N_c*.

Notes

- The *CIECAM16* colour appearance model induction factors are the same as *CIECAM02* colour appearance model.

References

[CIED1CIED822]

Create new instance of InductionFactors_CIECAM16(*F*, *c*, *N_c*)

`__init__()`

Methods

| | |
|--|--|
| <code>__init__()</code> | |
| <code>count(value, /)</code> | Return number of occurrences of value. |
| <code>index(value[, start, stop])</code> | Return first index of value. |

Attributes

| | |
|------------------|--------------------------|
| <code>F</code> | Alias for field number 0 |
| <code>N_c</code> | Alias for field number 2 |
| <code>c</code> | Alias for field number 1 |

CAM16

colour

| | |
|---|---|
| <code>XYZ_to_CAM16(XYZ, XYZ_w, L_A, Y_b[, ...])</code> | Compute the <i>CAM16</i> colour appearance model correlates from given <i>CIE XYZ</i> tristimulus values. |
| <code>CAM16_to_XYZ(specification, XYZ_w, L_A, Y_b)</code> | Convert from <i>CAM16</i> specification to <i>CIE XYZ</i> tristimulus values. |
| <code>CAM_Specification_CAM16(J, C, h, s, Q, M, H, HC)</code> | Define the <i>CAM16</i> colour appearance model specification. |
| <code>VIEWING_CONDITIONS_CAM16</code> | Reference <i>CAM16</i> colour appearance model viewing conditions. |

colour.XYZ_to_CAM16

`colour.XYZ_to_CAM16(XYZ: ArrayLike, XYZ_w: ArrayLike, L_A: FloatingOrArrayLike, Y_b: FloatingOrArrayLike, surround: InductionFactors_CIECAM02 | InductionFactors_CAM16 = VIEWING_CONDITIONS_CAM16['Average'], discount_illuminant: bool = False) → CAM_Specification_CAM16`

Compute the CAM16 colour appearance model correlates from given CIE XYZ tristimulus values.

Parameters

- **XYZ** (ArrayLike) – CIE XYZ tristimulus values of test sample / stimulus.
- **XYZ_w** (ArrayLike) – CIE XYZ tristimulus values of reference white.
- **L_A** (FloatingOrArrayLike) – Adapting field luminance L_A in cd/m^2 , (often taken to be 20% of the luminance of a white object in the scene).
- **Y_b** (FloatingOrArrayLike) – Luminous factor of background Y_b such as $Y_b = 100 \times L_b / L_w$ where L_w is the luminance of the light source and L_b is the luminance of the background. For viewing images, Y_b can be the average Y value for the pixels in the entire image, or frequently, a Y value of 20, approximate an L^* of 50 is used.
- **surround** (InductionFactors_CIECAM02 | InductionFactors_CAM16) – Surround viewing conditions induction factors.
- **discount_illuminant** (bool) – Truth value indicating if the illuminant should be discounted.

Returns

CAM16 colour appearance model specification.

Return type

`colour.CAM_Specification_CAM16`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |
| XYZ_w | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|---------------------------|-------------------|-----------|
| CAM_Specification_CAM16.J | [0, 100] | [0, 1] |
| CAM_Specification_CAM16.C | [0, 100] | [0, 1] |
| CAM_Specification_CAM16.h | [0, 360] | [0, 1] |
| CAM_Specification_CAM16.s | [0, 100] | [0, 1] |
| CAM_Specification_CAM16.Q | [0, 100] | [0, 1] |
| CAM_Specification_CAM16.M | [0, 100] | [0, 1] |
| CAM_Specification_CAM16.H | [0, 400] | [0, 1] |

References

[LLW+17]

Examples

```
>>> XYZ = np.array([19.01, 20.00, 21.78])
>>> XYZ_w = np.array([95.05, 100.00, 108.88])
>>> L_A = 318.31
>>> Y_b = 20.0
>>> surround = VIEWING_CONDITIONS_CAM16["Average"]
>>> XYZ_to_CAM16(XYZ, XYZ_w, L_A, Y_b, surround)
CAM_Specification_CAM16(J=41.7312079..., C=0.1033557..., h=217.0679597..., s=2.
↪ 3450150..., Q=195.3717089..., M=0.1074367..., H=275.5949861..., HC=None)
```

colour.CAM16_to_XYZ

`colour.CAM16_to_XYZ(specification: CAM_Specification_CAM16, XYZ_w: ArrayLike, L_A: FloatingOrArrayLike, Y_b: FloatingOrArrayLike, surround: InductionFactors_CIECAM02 | InductionFactors_CAM16 = VIEWING_CONDITIONS_CAM16['Average'], discount_illuminant: bool = False) → ndarray`

Convert from CAM16 specification to CIE XYZ tristimulus values.

Parameters

- **specification** (`CAM_Specification_CAM16`) – CAM16 colour appearance model specification. Correlate of *Lightness* J , correlate of *chroma* C or correlate of *colourfulness* M and *hue* angle h in degrees must be specified, e.g. JCh or JMh .
- **XYZ_w** (`ArrayLike`) – CIE XYZ tristimulus values of reference white.
- **L_A** (`FloatingOrArrayLike`) – Adapting field *luminance* L_A in cd/m^2 , (often taken to be 20% of the luminance of a white object in the scene).
- **Y_b** (`FloatingOrArrayLike`) – Luminous factor of background Y_b such as $Y_b = 100 \times L_b / L_w$ where L_w is the luminance of the light source and L_b is the luminance of the background. For viewing images, Y_b can be the average Y value for the pixels in the entire image, or frequently, a Y value of 20, approximate an L^* of 50 is used.
- **surround** (`InductionFactors_CIECAM02` | `InductionFactors_CAM16`) – Surround viewing conditions.
- **discount_illuminant** (`bool`) – Discount the illuminant.

Returns

CIE XYZ tristimulus values.

Return type

`numpy.ndarray`

Raises

ValueError – If neither C or M correlates have been defined in the specification argument.

Notes

| Domain | Scale - Reference | Scale - 1 |
|---------------------------|-------------------|-----------|
| CAM_Specification_CAM16.J | [0, 100] | [0, 1] |
| CAM_Specification_CAM16.C | [0, 100] | [0, 1] |
| CAM_Specification_CAM16.h | [0, 360] | [0, 1] |
| CAM_Specification_CAM16.s | [0, 100] | [0, 1] |
| CAM_Specification_CAM16.Q | [0, 100] | [0, 1] |
| CAM_Specification_CAM16.M | [0, 100] | [0, 1] |
| CAM_Specification_CAM16.H | [0, 360] | [0, 1] |
| XYZ_w | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |

References

[LLW+17]

Examples

```
>>> specification = CAM_Specification_CAM16(
...     J=41.731207905126638, C=0.103355738709070, h=217.067959767393010
... )
>>> XYZ_w = np.array([95.05, 100.00, 108.88])
>>> L_A = 318.31
>>> Y_b = 20.0
>>> CAM16_to_XYZ(specification, XYZ_w, L_A, Y_b)
array([ 19.01..., 20..., 21.78...])
```

colour.CAM_Specification_CAM16

```
class colour.CAM_Specification_CAM16(J: FloatingOrNDArray | None = <factory>, C:
    FloatingOrNDArray | None = <factory>, h:
    FloatingOrNDArray | None = <factory>, s:
    FloatingOrNDArray | None = <factory>, Q:
    FloatingOrNDArray | None = <factory>, M:
    FloatingOrNDArray | None = <factory>, H:
    FloatingOrNDArray | None = <factory>, HC:
    FloatingOrNDArray | None = <factory>)
```

Define the CAM16 colour appearance model specification.

Parameters

- **J** (*FloatingOrNDArray | None*) – Correlate of *Lightness J*.
- **C** (*FloatingOrNDArray | None*) – Correlate of *chroma C*.
- **h** (*FloatingOrNDArray | None*) – *Hue* angle *h* in degrees.
- **s** (*FloatingOrNDArray | None*) – Correlate of *saturation s*.
- **Q** (*FloatingOrNDArray | None*) – Correlate of *brightness Q*.

- **M** (FloatingOrNDArray | None) – Correlate of *colourfulness* M .
- **H** (FloatingOrNDArray | None) – *Hue* h quadrature H .
- **HC** (FloatingOrNDArray | None) – *Hue* h composition H^C .

References

[LLW+17]

__init__(J : FloatingOrNDArray | None = <factory>, C : FloatingOrNDArray | None = <factory>, h : FloatingOrNDArray | None = <factory>, s : FloatingOrNDArray | None = <factory>, Q : FloatingOrNDArray | None = <factory>, M : FloatingOrNDArray | None = <factory>, H : FloatingOrNDArray | None = <factory>, HC : FloatingOrNDArray | None = <factory>) → None

Parameters

- **J** (FloatingOrNDArray | None) –
- **C** (FloatingOrNDArray | None) –
- **h** (FloatingOrNDArray | None) –
- **s** (FloatingOrNDArray | None) –
- **Q** (FloatingOrNDArray | None) –
- **M** (FloatingOrNDArray | None) –
- **H** (FloatingOrNDArray | None) –
- **HC** (FloatingOrNDArray | None) –

Return type

None

Methods

__init__($[J, C, h, s, Q, M, H, HC]$)

| | | |
|---|-------------|--|
| arithmetical_operation(a , in_place)] | operation[, | Perform given arithmetical operation with a operand on the dataclass-like class. |
|---|-------------|--|

Attributes

| | |
|---------------------|--|
| <code>fields</code> | Getter property for the fields of the dataclass-like class. |
| <code>items</code> | Getter property for the dataclass-like class items, i.e. the field names and values. |
| <code>keys</code> | Getter property for the dataclass-like class keys, i.e. the field names. |
| <code>values</code> | Getter property for the dataclass-like class values, i.e. the field values. |
| <code>J</code> | |
| <code>C</code> | |
| <code>h</code> | |
| <code>s</code> | |
| <code>Q</code> | |
| <code>M</code> | |
| <code>H</code> | |
| <code>HC</code> | |

`colour.VIEWING_CONDITIONS_CAM16`

```
colour.VIEWING_CONDITIONS_CAM16 = CanonicalMapping({'Average': ..., 'Dim': ..., 'Dark': ...})
```

Reference *CAM16* colour appearance model viewing conditions.

References

[[LLW+17](#)]

Ancillary Objects

`colour.appearance`

| | |
|--|---|
| <code>InductionFactors_CAM16(F, c, N_c)</code> | <i>CAM16</i> colour appearance model induction factors. |
|--|---|

colour.appearance.InductionFactors_CAM16

class colour.appearance.InductionFactors_CAM16(*F*, *c*, *N_c*)
CAM16 colour appearance model induction factors.

Parameters

- **F** – Maximum degree of adaptation F .
- **c** – Exponential non-linearity c .
- **N_c** – Chromatic induction factor N_c .

Notes

- The CAM16 colour appearance model induction factors are the same as CIECAM02 colour appearance model.

References

[LLW+17]

Create new instance of InductionFactors_CAM16(*F*, *c*, *N_c*)

`__init__()`

Methods

| | |
|--|--|
| <code>__init__()</code> | |
| <code>count(value, /)</code> | Return number of occurrences of value. |
| <code>index(value[, start, stop])</code> | Return first index of value. |

Attributes

| | |
|------------------|--------------------------|
| <code>F</code> | Alias for field number 0 |
| <code>N_c</code> | Alias for field number 2 |
| <code>c</code> | Alias for field number 1 |

Hellwig and Fairchild (2022) Colour Appearance Model

colour

| | |
|--|---|
| <code>XYZ_to_Hellwig2022(XYZ, XYZ_w, L_A, Y_b[, ...])</code> | Compute the <i>Hellwig and Fairchild (2022)</i> colour appearance model correlates from given CIE XYZ tristimulus values. |
| <code>Hellwig2022_to_XYZ(specification, XYZ_w, ...)</code> | Convert from <i>Hellwig and Fairchild (2022)</i> specification to CIE XYZ tristimulus values. |
| <code>CAM_Specification_Hellwig2022(J, C, h, s, Q, ...)</code> | Define the <i>Hellwig and Fairchild (2022)</i> colour appearance model specification. |
| <code>VIEWING_CONDITIONS_HELLWIG2022</code> | Reference <i>Hellwig and Fairchild (2022)</i> colour appearance model viewing conditions. |

colour.XYZ_to_Hellwig2022

```
colour.XYZ_to_Hellwig2022(XYZ: ArrayLike, XYZ_w: ArrayLike, L_A: FloatingOrArrayLike, Y_b:
    FloatingOrArrayLike, surround: InductionFactors_CIECAM02 |
    InductionFactors_Hellwig2022 =
    VIEWING_CONDITIONS_HELLWIG2022['Average'], discount_illuminant:
    bool = False) → CAM_Specification_Hellwig2022
```

Compute the *Hellwig and Fairchild (2022)* colour appearance model correlates from given *CIE XYZ* tristimulus values.

This implementation supports the *Helmholtz-Kohlrausch* effect extension from [HSF22].

Parameters

- **XYZ** (ArrayLike) – *CIE XYZ* tristimulus values of test sample / stimulus.
- **XYZ_w** (ArrayLike) – *CIE XYZ* tristimulus values of reference white.
- **L_A** (FloatingOrArrayLike) – Adapting field luminance L_A in cd/m^2 , (often taken to be 20% of the luminance of a white object in the scene).
- **Y_b** (FloatingOrArrayLike) – Luminous factor of background Y_b such as $Y_b = 100xL_b/L_w$ where L_w is the luminance of the light source and L_b is the luminance of the background. For viewing images, Y_b can be the average Y value for the pixels in the entire image, or frequently, a Y value of 20, approximate an L^* of 50 is used.
- **surround** (InductionFactors_CIECAM02 | InductionFactors_Hellwig2022) – Surround viewing conditions induction factors.
- **discount_illuminant** (bool) – Truth value indicating if the illuminant should be discounted.

Returns

Hellwig and Fairchild (2022) colour appearance model specification.

Return type

colour.CAM_Specification_Hellwig2022

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |
| XYZ_w | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|------------------------------------|-------------------|-----------|
| CAM_Specification_Hellwig2022.J | [0, 100] | [0, 1] |
| CAM_Specification_Hellwig2022.C | [0, 100] | [0, 1] |
| CAM_Specification_Hellwig2022.h | [0, 360] | [0, 1] |
| CAM_Specification_Hellwig2022.s | [0, 100] | [0, 1] |
| CAM_Specification_Hellwig2022.Q | [0, 100] | [0, 1] |
| CAM_Specification_Hellwig2022.M | [0, 100] | [0, 1] |
| CAM_Specification_Hellwig2022.H | [0, 400] | [0, 1] |
| CAM_Specification_Hellwig2022.J_HK | [0, 100] | [0, 1] |
| CAM_Specification_Hellwig2022.Q_HK | [0, 100] | [0, 1] |

References

[FH22], [HF22], [HSF22]

Examples

```
>>> XYZ = np.array([19.01, 20.00, 21.78])
>>> XYZ_w = np.array([95.05, 100.00, 108.88])
>>> L_A = 318.31
>>> Y_b = 20.0
>>> surround = VIEWING_CONDITIONS_HELLWIG2022["Average"]
>>> XYZ_to_Hellwig2022(XYZ, XYZ_w, L_A, Y_b, surround)
...
CAM_Specification_Hellwig2022(J=41.7312079..., C=0.0257636..., h=217.0679597..., s=0.
→0608550..., Q=55.8523226..., M=0.0339889..., H=275.5949861..., HC=None, J_HK=41.
→8802782..., Q_HK=56.0518358...)
```

colour.Hellwig2022_to_XYZ

`colour.Hellwig2022_to_XYZ(specification: CAM_Specification_Hellwig2022, XYZ_w: ArrayLike, L_A: FloatingOrArrayLike, Y_b: FloatingOrArrayLike, surround: InductionFactors_CIECAM02 | InductionFactors_Hellwig2022 = VIEWING_CONDITIONS_HELLWIG2022['Average'], discount_illuminant: bool = False) → ndarray`

Convert from *Hellwig and Fairchild (2022)* specification to *CIE XYZ* tristimulus values.

This implementation supports the *Helmholtz-Kohlrausch* effect extension from [HSF22].

Parameters

- **specification** (`CAM_Specification_Hellwig2022`) – *Hellwig and Fairchild (2022)* colour appearance model specification. Correlate of *Lightness J*, correlate of *chroma C* or correlate of *colourfulness M* and *hue angle h* in degrees must be specified, e.g. *JCh* or *JMh*.
- **XYZ_w** (`ArrayLike`) – *CIE XYZ* tristimulus values of reference white.
- **L_A** (`FloatingOrArrayLike`) – Adapting field *luminance L_A* in *cd/m²*, (often taken to be 20% of the luminance of a white object in the scene).
- **Y_b** (`FloatingOrArrayLike`) – Luminous factor of background *Y_b* such as $Y_b = 100xL_b/L_w$ where L_w is the luminance of the light source and L_b is the luminance of the background. For viewing images, *Y_b* can be the average *Y* value for the pixels in the entire image, or frequently, a *Y* value of 20, approximate an *L** of 50 is used.
- **surround** (`InductionFactors_CIECAM02` | `InductionFactors_Hellwig2022`) – Surround viewing conditions.
- **discount_illuminant** (`bool`) – Discount the illuminant.

Returns

CIE XYZ tristimulus values.

Return type

`numpy.ndarray`

Raises

ValueError – If neither *C* or *M* correlates have been defined in the specification argument.

Notes

| Domain | Scale - Reference | Scale - 1 |
|------------------------------------|-------------------|-----------|
| CAM_Specification_Hellwig2022.J | [0, 100] | [0, 1] |
| CAM_Specification_Hellwig2022.C | [0, 100] | [0, 1] |
| CAM_Specification_Hellwig2022.h | [0, 360] | [0, 1] |
| CAM_Specification_Hellwig2022.s | [0, 100] | [0, 1] |
| CAM_Specification_Hellwig2022.Q | [0, 100] | [0, 1] |
| CAM_Specification_Hellwig2022.M | [0, 100] | [0, 1] |
| CAM_Specification_Hellwig2022.H | [0, 400] | [0, 1] |
| CAM_Specification_Hellwig2022.J_HK | [0, 100] | [0, 1] |
| CAM_Specification_Hellwig2022.Q_HK | [0, 100] | [0, 1] |
| XYZ_w | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |

References

[FH22], [HF22], [HSF22]

Examples

```
>>> specification = CAM_Specification_Hellwig2022(
...     J=41.731207905126638, C=0.025763615829912909, h=217.06795976739301
... )
>>> XYZ_w = np.array([95.05, 100.00, 108.88])
>>> L_A = 318.31
>>> Y_b = 20.0
>>> Hellwig2022_to_XYZ(specification, XYZ_w, L_A, Y_b)
...
array([ 19.01...,  20...,  21.78...])
>>> specification = CAM_Specification_Hellwig2022(
...     J_HK=41.880278283880095,
...     C=0.025763615829912909,
...     h=217.06795976739301,
... )
>>> Hellwig2022_to_XYZ(specification, XYZ_w, L_A, Y_b)
...
array([ 19.01...,  20...,  21.78...])
```

colour.CAM_Specification_Hellwig2022

```
class colour.CAM_Specification_Hellwig2022(J: FloatingOrNDArray | None = <factory>, C:
    FloatingOrNDArray | None = <factory>, h:
    FloatingOrNDArray | None = <factory>, s:
    FloatingOrNDArray | None = <factory>, Q:
    FloatingOrNDArray | None = <factory>, M:
    FloatingOrNDArray | None = <factory>, H:
    FloatingOrNDArray | None = <factory>, HC:
    FloatingOrNDArray | None = <factory>, J_HK:
    FloatingOrNDArray | None = <factory>, Q_HK:
    FloatingOrNDArray | None = <factory>)
```

Define the *Hellwig and Fairchild (2022)* colour appearance model specification.

This specification supports the *Helmholtz-Kohlrausch* effect extension from [HSF22].

Parameters

- **J** (FloatingOrNDArray | None) – Correlate of *Lightness* J .
- **C** (FloatingOrNDArray | None) – Correlate of *chroma* C .
- **h** (FloatingOrNDArray | None) – *Hue* angle h in degrees.
- **s** (FloatingOrNDArray | None) – Correlate of *saturation* s .
- **Q** (FloatingOrNDArray | None) – Correlate of *brightness* Q .
- **M** (FloatingOrNDArray | None) – Correlate of *colourfulness* M .
- **H** (FloatingOrNDArray | None) – *Hue* h quadrature H .
- **HC** (FloatingOrNDArray | None) – *Hue* h composition H^C .
- **J_HK** (FloatingOrNDArray | None) – Correlate of *Lightness* J_{HK} accounting for *Helmholtz-Kohlrausch* effect.
- **Q_HK** (FloatingOrNDArray | None) – Correlate of *brightness* Q_{HK} accounting for *Helmholtz-Kohlrausch* effect.

References

[FH22], [HF22], [HSF22]

```
__init__(J: FloatingOrNDArray | None = <factory>, C: FloatingOrNDArray | None = <factory>,
    h: FloatingOrNDArray | None = <factory>, s: FloatingOrNDArray | None = <factory>,
    Q: FloatingOrNDArray | None = <factory>, M: FloatingOrNDArray | None =
    <factory>, H: FloatingOrNDArray | None = <factory>, HC: FloatingOrNDArray | None
    = <factory>, J_HK: FloatingOrNDArray | None = <factory>, Q_HK:
    FloatingOrNDArray | None = <factory>) → None
```

Parameters

- **J** (FloatingOrNDArray | None) –
- **C** (FloatingOrNDArray | None) –
- **h** (FloatingOrNDArray | None) –
- **s** (FloatingOrNDArray | None) –
- **Q** (FloatingOrNDArray | None) –
- **M** (FloatingOrNDArray | None) –
- **H** (FloatingOrNDArray | None) –

- **HC** (FloatingOrNDArray | None) –
- **J_HK** (FloatingOrNDArray | None) –
- **Q_HK** (FloatingOrNDArray | None) –

Return type

None

Methods

| | |
|---|---|
| <code>__init__([J, C, h, s, Q, M, H, HC, J_HK, Q_HK])</code> | |
| <code>arithmetical_operation(a, operation[, in_place])</code> | Perform given arithmetical operation with <i>a</i> operand on the dataclass-like class. |

Attributes

| | |
|--------|--|
| fields | Getter property for the fields of the dataclass-like class. |
| items | Getter property for the dataclass-like class items, i.e. the field names and values. |
| keys | Getter property for the dataclass-like class keys, i.e. the field names. |
| values | Getter property for the dataclass-like class values, i.e. the field values. |
| J | |
| C | |
| h | |
| s | |
| Q | |
| M | |
| H | |
| HC | |
| J_HK | |
| Q_HK | |

colour.VIEWING_CONDITIONS_HELLWIG2022

`colour.VIEWING_CONDITIONS_HELLWIG2022 = CanonicalMapping({'Average': ..., 'Dim': ..., 'Dark': ...})`

Reference *Hellwig and Fairchild (2022)* colour appearance model viewing conditions.

References

[HF22]

Ancillary Objects

`colour.appearance`

| | |
|--|--|
| <code>InductionFactors_Hellwig2022(F, c, N_c)</code> | <i>Hellwig and Fairchild (2022)</i> colour appearance model induction factors. |
|--|--|

colour.appearance.InductionFactors_Hellwig2022

class `colour.appearance.InductionFactors_Hellwig2022(F, c, N_c)`
Hellwig and Fairchild (2022) colour appearance model induction factors.

Parameters

- **F** – Maximum degree of adaptation F .
- **c** – Exponential non-linearity c .
- **N_c** – Chromatic induction factor N_c .

Notes

- The *Hellwig and Fairchild (2022)* colour appearance model induction factors are the same as *CIECAM02* and *CAM16* colour appearance model.

References

[FH22], [HF22]

Create new instance of `InductionFactors_Hellwig2022(F, c, N_c)`

`__init__()`

Methods

| | |
|--|--|
| <code>__init__()</code> | |
| <code>count(value, /)</code> | Return number of occurrences of value. |
| <code>index(value[, start, stop])</code> | Return first index of value. |

Attributes

| | |
|-----|--------------------------|
| F | Alias for field number 0 |
| N_c | Alias for field number 2 |
| c | Alias for field number 1 |

Hunt

colour

| | |
|--|---|
| <code>XYZ_to_Hunt(XYZ, XYZ_w, XYZ_b, L_A[, ...])</code> | Compute the <i>Hunt</i> colour appearance model correlates. |
| <code>CAM_Specification_Hunt(J, C, h, s, Q, M, H, HC)</code> | Define the <i>Hunt</i> colour appearance model specification. |
| <code>VIEWING_CONDITIONS_HUNT</code> | Reference <i>Hunt</i> colour appearance model viewing conditions. |

colour.XYZ_to_Hunt

`colour.XYZ_to_Hunt(XYZ: ArrayLike, XYZ_w: ArrayLike, XYZ_b: ArrayLike, L_A: FloatingOrArrayLike, surround: InductionFactors_Hunt = VIEWING_CONDITIONS_HUNT['Normal Scenes'], L_AS: FloatingOrArrayLike | None = None, CCT_w: FloatingOrArrayLike | None = None, XYZ_p: ArrayLike | None = None, p: FloatingOrArrayLike | None = None, S: FloatingOrArrayLike | None = None, S_w: FloatingOrArrayLike | None = None, helson_judd_effect: bool = False, discount_illuminant: bool = True) → CAM_Specification_Hunt`

Compute the *Hunt* colour appearance model correlates.

Parameters

- **XYZ** (ArrayLike) – CIE XYZ tristimulus values of test sample / stimulus.
- **XYZ_w** (ArrayLike) – CIE XYZ tristimulus values of reference white.
- **XYZ_b** (ArrayLike) – CIE XYZ tristimulus values of background.
- **L_A** (FloatingOrArrayLike) – Adapting field luminance L_A in cd/m^2 .
- **surround** (InductionFactors_Hunt) – Surround viewing conditions induction factors.
- **L_AS** (FloatingOrArrayLike | None) – Scotopic luminance L_{AS} of the illuminant, approximated if not specified.
- **CCT_w** (FloatingOrArrayLike | None) – Correlated color temperature T_{cp} of the illuminant, needed to approximate L_{AS} .
- **XYZ_p** (ArrayLike | None) – CIE XYZ tristimulus values of proximal field, assumed to be equal to background if not specified.
- **p** (FloatingOrArrayLike | None) – Simultaneous contrast / assimilation factor p with value normalised to domain $[-1, 0]$ when simultaneous contrast occurs and normalised to domain $[0, 1]$ when assimilation occurs.
- **S** (FloatingOrArrayLike | None) – Scotopic response S to the stimulus, approximated using tristimulus values Y of the stimulus if not specified.

- **S_w** (`FloatingOrArrayLike` | `None`) – Scotopic response S_w for the reference white, approximated using the tristimulus values Y_w of the reference white if not specified.
- **helson_judd_effect** (`bool`) – Truth value indicating whether the *Helson-Judd* effect should be accounted for.
- **discount_illuminant** (`bool`) – Truth value indicating if the illuminant should be discounted.

Returns

Hunt colour appearance model specification.

Return type

`colour.CAM_Specification_Hunt`

Raises

ValueError – If an illegal argument combination is specified.

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |
| XYZ_w | [0, 100] | [0, 1] |
| XYZ_b | [0, 100] | [0, 1] |
| XYZ_p | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|---------------------------------------|-------------------|-----------|
| <code>CAM_Specification_Hunt.h</code> | [0, 360] | [0, 1] |

References

[Fai13b], [Hun04]

Examples

```
>>> XYZ = np.array([19.01, 20.00, 21.78])
>>> XYZ_w = np.array([95.05, 100.00, 108.88])
>>> XYZ_b = np.array([95.05, 100.00, 108.88])
>>> L_A = 318.31
>>> surround = VIEWING_CONDITIONS_HUNT["Normal Scenes"]
>>> CCT_w = 6504
>>> XYZ_to_Hunt(XYZ, XYZ_w, XYZ_b, L_A, surround, CCT_w=CCT_w)
...
CAM_Specification_Hunt(J=30.0462678..., C=0.1210508..., h=269.2737594..., s=0.
↪ 0199093..., Q=22.2097654..., M=0.1238964..., H=None, HC=None)
```


colour.CAM_Specification_Hunt

```
class colour.CAM_Specification_Hunt(J: FloatingOrNDArray | None = <factory>, C:
    FloatingOrNDArray | None = <factory>, h:
    FloatingOrNDArray | None = <factory>, s: FloatingOrNDArray
    | None = <factory>, Q: FloatingOrNDArray | None =
    <factory>, M: FloatingOrNDArray | None = <factory>, H:
    FloatingOrNDArray | None = <factory>, HC:
    FloatingOrNDArray | None = <factory>)
```

Define the *Hunt* colour appearance model specification.

This specification has field names consistent with the remaining colour appearance models in `colour.appearance` but diverge from *Fairchild (2013)* reference.

Parameters

- **J** (FloatingOrNDArray | None) – Correlate of *Lightness* J .
- **C** (FloatingOrNDArray | None) – Correlate of *chroma* C_{94} .
- **h** (FloatingOrNDArray | None) – *Hue* angle h_S in degrees.
- **s** (FloatingOrNDArray | None) – Correlate of *saturation* s .
- **Q** (FloatingOrNDArray | None) – Correlate of *brightness* Q .
- **M** (FloatingOrNDArray | None) – Correlate of *colourfulness* M_{94} .
- **H** (FloatingOrNDArray | None) – *Hue* h quadrature H .
- **HC** (FloatingOrNDArray | None) – *Hue* h composition H_C .

Notes

- This specification is the one used in the current model implementation.

References

[Fai13b], [Hun04]

```
__init__(J: FloatingOrNDArray | None = <factory>, C: FloatingOrNDArray | None = <factory>,
    h: FloatingOrNDArray | None = <factory>, s: FloatingOrNDArray | None = <factory>,
    Q: FloatingOrNDArray | None = <factory>, M: FloatingOrNDArray | None =
    <factory>, H: FloatingOrNDArray | None = <factory>, HC: FloatingOrNDArray | None
    = <factory>) → None
```

Parameters

- **J** (FloatingOrNDArray | None) –
- **C** (FloatingOrNDArray | None) –
- **h** (FloatingOrNDArray | None) –
- **s** (FloatingOrNDArray | None) –
- **Q** (FloatingOrNDArray | None) –
- **M** (FloatingOrNDArray | None) –
- **H** (FloatingOrNDArray | None) –
- **HC** (FloatingOrNDArray | None) –

Return type

None

Methods

| | | |
|--|--------------------------|---|
| <code>__init__([J, C, h, s, Q, M, H, HC])</code> | | |
| <code>arithmetical_operation(a, in_place)</code> | <code>operation[,</code> | Perform given arithmetical operation with <i>a</i> operand on the dataclass-like class. |

Attributes

| | |
|---------------------|--|
| <code>fields</code> | Getter property for the fields of the dataclass-like class. |
| <code>items</code> | Getter property for the dataclass-like class items, i.e. the field names and values. |
| <code>keys</code> | Getter property for the dataclass-like class keys, i.e. the field names. |
| <code>values</code> | Getter property for the dataclass-like class values, i.e. the field values. |
| <code>J</code> | |
| <code>C</code> | |
| <code>h</code> | |
| <code>s</code> | |
| <code>Q</code> | |
| <code>M</code> | |
| <code>H</code> | |
| <code>HC</code> | |

`colour.VIEWING_CONDITIONS_HUNT`

`colour.VIEWING_CONDITIONS_HUNT = CanonicalMapping({'Small Areas, Uniform Background & Surrounds': ..., 'Normal Scenes': ..., 'Television & CRT, Dim Surrounds': ..., 'Large Transparencies On Light Boxes': ..., 'Projected Transparencies, Dark Surrounds': ..., 'small_uniform': ..., 'normal': ..., 'tv_dim': ..., 'light_boxes': ..., 'projected_dark': ...})`

Reference *Hunt* colour appearance model viewing conditions.

References

[Fai13b], [Hun04]

Aliases:

- ‘small_uniform’: ‘Small Areas, Uniform Background & Surrounds’
- ‘normal’: ‘Normal Scenes’
- ‘tv_dim’: ‘Television & CRT, Dim Surrounds’
- ‘light_boxes’: ‘Large Transparencies On Light Boxes’
- ‘projected_dark’: ‘Projected Transparencies, Dark Surrounds’

Kim, Weyrich and Kautz (2009)

colour

| | |
|---|---|
| <code>XYZ_to_Kim2009(XYZ, XYZ_w, L_A[, media, ...])</code> | Compute the <i>Kim, Weyrich and Kautz (2009)</i> colour appearance model correlates from given <i>CIE XYZ</i> tristimulus values. |
| <code>Kim2009_to_XYZ(specification, XYZ_w, L_A[, ...])</code> | Convert from <i>Kim, Weyrich and Kautz (2009)</i> specification to <i>CIE XYZ</i> tristimulus values. |
| <code>CAM_Specification_Kim2009(J, C, h, s, Q, M, ...)</code> | Define the <i>Kim, Weyrich and Kautz (2009)</i> colour appearance model specification. |
| <code>MEDIA_PARAMETERS_KIM2009</code> | Reference <i>Kim, Weyrich and Kautz (2009)</i> colour appearance model media parameters. |
| <code>VIEWING_CONDITIONS_KIM2009</code> | Reference <i>Kim, Weyrich and Kautz (2009)</i> colour appearance model viewing conditions. |

colour.XYZ_to_Kim2009

`colour.XYZ_to_Kim2009(XYZ: ArrayLike, XYZ_w: ArrayLike, L_A: FloatingOrArrayLike, media: MediaParameters_Kim2009 = MEDIA_PARAMETERS_KIM2009['CRT Displays'], surround: InductionFactors_Kim2009 = VIEWING_CONDITIONS_KIM2009['Average'], discount_illuminant: bool = False, n_c: float = 0.57) → CAM_Specification_Kim2009`

Compute the *Kim, Weyrich and Kautz (2009)* colour appearance model correlates from given *CIE XYZ* tristimulus values.

Parameters

- **XYZ** (ArrayLike) – *CIE XYZ* tristimulus values of test sample / stimulus.
- **XYZ_w** (ArrayLike) – *CIE XYZ* tristimulus values of reference white.
- **L_A** (FloatingOrArrayLike) – Adapting field *luminance* L_A in cd/m^2 , (often taken to be 20% of the luminance of a white object in the scene).
- **media** (`MediaParameters_Kim2009`) – Media parameters.
- **surround** (`InductionFactors_Kim2009`) – Surround viewing conditions induction factors.
- **discount_illuminant** (bool) – Truth value indicating if the illuminant should be discounted.
- **n_c** (float) – Cone response sigmoidal curve modulating factor n_c .

Returns

Kim, Weyrich and Kautz (2009) colour appearance model specification.

Return type

`colour.CAM_Specification_Kim2009`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |
| XYZ_w | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-----------------------------|-------------------|-----------|
| CAM_Specification_Kim2009.J | [0, 100] | [0, 1] |
| CAM_Specification_Kim2009.C | [0, 100] | [0, 1] |
| CAM_Specification_Kim2009.h | [0, 360] | [0, 1] |
| CAM_Specification_Kim2009.s | [0, 100] | [0, 1] |
| CAM_Specification_Kim2009.Q | [0, 100] | [0, 1] |
| CAM_Specification_Kim2009.M | [0, 100] | [0, 1] |
| CAM_Specification_Kim2009.H | [0, 400] | [0, 1] |

References

[KWK09]

Examples

```
>>> XYZ = np.array([19.01, 20.00, 21.78])
>>> XYZ_w = np.array([95.05, 100.00, 108.88])
>>> L_A = 318.31
>>> media = MEDIA_PARAMETERS_KIM2009["CRT Displays"]
>>> surround = VIEWING_CONDITIONS_KIM2009["Average"]
>>> XYZ_to_Kim2009(XYZ, XYZ_w, L_A, media, surround)
...
CAM_Specification_Kim2009(J=28.8619089..., C=0.5592455..., h=219.0480667..., s=9.
↪ 3837797..., Q=52.7138883..., M=0.4641738..., H=278.0602824..., HC=None)
```

colour.Kim2009_to_XYZ

`colour.Kim2009_to_XYZ(specification: CAM_Specification_Kim2009, XYZ_w: ArrayLike, L_A: FloatingOrArrayLike, media: MediaParameters_Kim2009 = MEDIA_PARAMETERS_KIM2009['CRT Displays'], surround: InductionFactors_Kim2009 = VIEWING_CONDITIONS_KIM2009['Average'], discount_illuminant: bool = False, n_c: float = 0.57) → ndarray`

Convert from *Kim, Weyrich and Kautz (2009)* specification to CIE XYZ tristimulus values.

Parameters

- **specification** (`CAM_Specification_Kim2009`) – *Kim, Weyrich and Kautz (2009)* colour appearance model specification. Correlate of *Lightness J*, correlate of *chroma C* or correlate of *colourfulness M* and *hue angle h* in degrees must be specified, e.g. *JCh* or *JMh*.

- **XYZ_w** (ArrayLike) – CIE XYZ tristimulus values of reference white.
- **L_A** (FloatingOrArrayLike) – Adapting field *luminance* L_A in cd/m^2 , (often taken to be 20% of the luminance of a white object in the scene).
- **media** (MediaParameters_Kim2009) – Media parameters.
- **surround1** – Surround viewing conditions induction factors.
- **discount_illuminant** (bool) – Discount the illuminant.
- **n_c** (float) – Cone response sigmoidal curve modulating factor n_c .
- **surround** (InductionFactors_Kim2009) –

Returns

CIE XYZ tristimulus values.

Return type

`numpy.ndarray`

Raises

ValueError – If neither *C* or *M* correlates have been defined in the specification argument.

Notes

| Domain | Scale - Reference | Scale - 1 |
|-----------------------------|-------------------|-----------|
| CAM_Specification_Kim2009.J | [0, 100] | [0, 1] |
| CAM_Specification_Kim2009.C | [0, 100] | [0, 1] |
| CAM_Specification_Kim2009.h | [0, 360] | [0, 1] |
| CAM_Specification_Kim2009.s | [0, 100] | [0, 1] |
| CAM_Specification_Kim2009.Q | [0, 100] | [0, 1] |
| CAM_Specification_Kim2009.M | [0, 100] | [0, 1] |
| CAM_Specification_Kim2009.H | [0, 360] | [0, 1] |
| XYZ_w | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |

References

[KWK09]

Examples

```
>>> specification = CAM_Specification_Kim2009(
...     J=28.861908975839647, C=0.5592455924373706, h=219.04806677662953
... )
>>> XYZ_w = np.array([95.05, 100.00, 108.88])
>>> L_A = 318.31
>>> media = MEDIA_PARAMETERS_KIM2009["CRT Displays"]
>>> surround = VIEWING_CONDITIONS_KIM2009["Average"]
>>> Kim2009_to_XYZ(specification, XYZ_w, L_A, media, surround)
...
array([ 19.0099995...,  19.9999999...,  21.7800000...])
```

colour.CAM_Specification_Kim2009

```
class colour.CAM_Specification_Kim2009(J: FloatingOrNDArray | None = <factory>, C:
    FloatingOrNDArray | None = <factory>, h:
    FloatingOrNDArray | None = <factory>, s:
    FloatingOrNDArray | None = <factory>, Q:
    FloatingOrNDArray | None = <factory>, M:
    FloatingOrNDArray | None = <factory>, H:
    FloatingOrNDArray | None = <factory>, HC:
    FloatingOrNDArray | None = <factory>)
```

Define the *Kim, Weyrich and Kautz (2009)* colour appearance model specification.

Parameters

- **J** (FloatingOrNDArray | None) – Correlate of *Lightness J*.
- **C** (FloatingOrNDArray | None) – Correlate of *chroma C*.
- **h** (FloatingOrNDArray | None) – *Hue angle h* in degrees.
- **s** (FloatingOrNDArray | None) – Correlate of *saturation s*.
- **Q** (FloatingOrNDArray | None) – Correlate of *brightness Q*.
- **M** (FloatingOrNDArray | None) – Correlate of *colourfulness M*.
- **H** (FloatingOrNDArray | None) – *Hue h* quadrature *H*.
- **HC** (FloatingOrNDArray | None) – *Hue h* composition H^C .

References

[KWK09]

```
__init__(J: FloatingOrNDArray | None = <factory>, C: FloatingOrNDArray | None = <factory>,
    h: FloatingOrNDArray | None = <factory>, s: FloatingOrNDArray | None = <factory>,
    Q: FloatingOrNDArray | None = <factory>, M: FloatingOrNDArray | None =
    <factory>, H: FloatingOrNDArray | None = <factory>, HC: FloatingOrNDArray | None
    = <factory>) → None
```

Parameters

- **J** (FloatingOrNDArray | None) –
- **C** (FloatingOrNDArray | None) –
- **h** (FloatingOrNDArray | None) –
- **s** (FloatingOrNDArray | None) –
- **Q** (FloatingOrNDArray | None) –
- **M** (FloatingOrNDArray | None) –
- **H** (FloatingOrNDArray | None) –
- **HC** (FloatingOrNDArray | None) –

Return type

None

Methods

`__init__([J, C, h, s, Q, M, H, HC])`

| | | |
|--|--------------------------|---|
| <code>arithmetical_operation(a, in_place)</code> | <code>operation[,</code> | Perform given arithmetical operation with <i>a</i> operand on the dataclass-like class. |
|--|--------------------------|---|

Attributes

| | |
|---------------------|--|
| <code>fields</code> | Getter property for the fields of the dataclass-like class. |
| <code>items</code> | Getter property for the dataclass-like class items, i.e. the field names and values. |
| <code>keys</code> | Getter property for the dataclass-like class keys, i.e. the field names. |
| <code>values</code> | Getter property for the dataclass-like class values, i.e. the field values. |
| <code>J</code> | |
| <code>C</code> | |
| <code>h</code> | |
| <code>s</code> | |
| <code>Q</code> | |
| <code>M</code> | |
| <code>H</code> | |
| <code>HC</code> | |

`colour.MEDIA_PARAMETERS_KIM2009`

```
colour.MEDIA_PARAMETERS_KIM2009 = CanonicalMapping({'High-luminance LCD Display': ...,
'Transparent Advertising Media': ..., 'CRT Displays': ..., 'Reflective Paper': ...,
'bright_lcd_display': ..., 'advertising_transparencies': ..., 'crt': ..., 'paper': ...})
```

Reference Kim, Weyrich and Kautz (2009) colour appearance model media parameters.

References

[KWK09]

Aliases:

- `'bright_lcd_display'`: `'High-luminance LCD Display'`
- `'advertising_transparencies'`: `'Transparent Advertising Media'`
- `'crt'`: `'CRT Displays'`
- `'paper'`: `'Reflective Paper'`

colour.VIEWING_CONDITIONS_KIM2009

```
colour.VIEWING_CONDITIONS_KIM2009 = CanonicalMapping({'Average': ..., 'Dim': ..., 'Dark': ...})
```

Reference *Kim, Weyrich and Kautz (2009)* colour appearance model viewing conditions.

References

[KWK09]

Ancillary Objects

colour.appearance

| | |
|--|---|
| <code>InductionFactors_Kim2009(F, c, N_c)</code> | <i>Kim, Weyrich and Kautz (2009)</i> colour appearance model induction factors. |
| <code>MediaParameters_Kim2009(E)</code> | <i>Kim, Weyrich and Kautz (2009)</i> colour appearance model media parameters. |

colour.appearance.InductionFactors_Kim2009

```
class colour.appearance.InductionFactors_Kim2009(F, c, N_c)
```

Kim, Weyrich and Kautz (2009) colour appearance model induction factors.

Parameters

- **F** – Maximum degree of adaptation F .
- **c** – Exponential non-linearity c .
- **N_c** – Chromatic induction factor N_c .

Notes

- The *Kim, Weyrich and Kautz (2009)* colour appearance model induction factors are the same as *CIECAM02* colour appearance model.
- The *Kim, Weyrich and Kautz (2009)* colour appearance model separates the surround modelled by the `colour.appearance.InductionFactors_Kim2009` class instance from the media, modeled with the `colour.appearance.MediaParameters_Kim2009` class instance.

References

[KWK09]

Create new instance of `InductionFactors_Kim2009(F, c, N_c)`

`__init__()`

Methods

| | |
|--|--|
| <code>__init__()</code> | |
| <code>count(value, /)</code> | Return number of occurrences of value. |
| <code>index(value[, start, stop])</code> | Return first index of value. |

Attributes

| | |
|------------------|--------------------------|
| <code>F</code> | Alias for field number 0 |
| <code>N_c</code> | Alias for field number 2 |
| <code>c</code> | Alias for field number 1 |

`colour.appearance.MediaParameters_Kim2009`

class `colour.appearance.MediaParameters_Kim2009(E)`

Kim, Weyrich and Kautz (2009) colour appearance model media parameters.

Parameters

E – Lightness prediction modulating parameter *E*.

References

[KWK09]

Return a new instance of the `colour.appearance.MediaParameters_Kim2009` class.

`__init__()`

Methods

| | |
|--|--|
| <code>__init__()</code> | |
| <code>count(value, /)</code> | Return number of occurrences of value. |
| <code>index(value[, start, stop])</code> | Return first index of value. |

Attributes

| | |
|----------------|--------------------------|
| <code>E</code> | Alias for field number 0 |
|----------------|--------------------------|

$LLAB(l : c)$

colour

| | |
|--|--|
| <code>XYZ_to_LLAB(XYZ, XYZ_0, Y_b, L, surround)</code> | Compute the $:math: 'LLAB(l:c)'$ colour appearance model correlates. |
| <code>CAM_Specification_LLAB(J, C, h, s, M, HC, a, b)</code> | Define the $:math: 'LLAB(l:c)'$ colour appearance model specification. |
| <code>VIEWING_CONDITIONS_LLAB</code> | Reference $LLAB(l : c)$ colour appearance model viewing conditions. |

colour.XYZ_to_LLAB

`colour.XYZ_to_LLAB(XYZ: _SupportsArray[dtype[Any]] | _NestedSequence[_SupportsArray[dtype[Any]] | bool | int | float | complex | str | bytes | _NestedSequence[bool | int | float | complex | str | bytes], XYZ_0: _SupportsArray[dtype[Any]] | _NestedSequence[_SupportsArray[dtype[Any]] | bool | int | float | complex | str | bytes | _NestedSequence[bool | int | float | complex | str | bytes], Y_b: float | _SupportsArray[dtype[Any]] | _NestedSequence[_SupportsArray[dtype[Any]] | bool | int | complex | str | bytes | _NestedSequence[bool | int | float | complex | str | bytes], L: float | _SupportsArray[dtype[Any]] | _NestedSequence[_SupportsArray[dtype[Any]] | bool | int | complex | str | bytes | _NestedSequence[bool | int | float | complex | str | bytes], surround: InductionFactors_LLAB = VIEWING_CONDITIONS_LLAB['Reference Samples & Images, Average Surround, Subtending < 4']) → CAM_Specification_LLAB`

Compute the $:math: 'LLAB(l:c)'$ colour appearance model correlates.

Parameters

- **XYZ** (`_SupportsArray[dtype[Any]] | _NestedSequence[_SupportsArray[dtype[Any]] | bool | int | float | complex | str | bytes | _NestedSequence[bool | int | float | complex | str | bytes]`) – CIE XYZ tristimulus values of test sample / stimulus.
- **XYZ_0** (`_SupportsArray[dtype[Any]] | _NestedSequence[_SupportsArray[dtype[Any]] | bool | int | float | complex | str | bytes | _NestedSequence[bool | int | float | complex | str | bytes]`) – CIE XYZ tristimulus values of reference white.
- **Y_b** (`(float | _SupportsArray[dtype[Any]] | _NestedSequence[_SupportsArray[dtype[Any]] | bool | int | complex | str | bytes | _NestedSequence[bool | int | float | complex | str | bytes])`) – Luminance factor of the background in cd/m^2 .
- **L** (`(float | _SupportsArray[dtype[Any]] | _NestedSequence[_SupportsArray[dtype[Any]] | bool | int | complex | str | bytes | _NestedSequence[bool | int | float | complex | str | bytes])`) – Absolute luminance L of reference white in cd/m^2 .
- **surround** (`InductionFactors_LLAB`) – Surround viewing conditions induction factors.

Returns

$:math: 'LLAB(l:c)'$ colour appearance model specification.

Return type

`colour.CAM_Specification_LLAB`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |
| XYZ_0 | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|--------------------------|-------------------|-----------|
| CAM_Specification_LLAB.h | [0, 360] | [0, 1] |

References

[Fai13h], [LLK96], [LM96]

Examples

```
>>> XYZ = np.array([19.01, 20.00, 21.78])
>>> XYZ_0 = np.array([95.05, 100.00, 108.88])
>>> Y_b = 20.0
>>> L = 318.31
>>> surround = VIEWING_CONDITIONS_LLAB["ref_average_4_minus"]
>>> XYZ_to_LLAB(XYZ, XYZ_0, Y_b, L, surround)
CAM_Specification_LLAB(J=37.3668650..., C=0.0089496..., h=270..., s=0.0002395..., L
↪ M=0.0190185..., HC=None, a=..., b=-0.0190185...)
```

colour.CAM_Specification_LLAB

```
class colour.CAM_Specification_LLAB(J: float | ~numpy.ndarray | None = <factory>, C: float |
    ~numpy.ndarray | None = <factory>, h: float |
    ~numpy.ndarray | None = <factory>, s: float |
    ~numpy.ndarray | None = <factory>, M: float |
    ~numpy.ndarray | None = <factory>, HC: float |
    ~numpy.ndarray | None = <factory>, a: float |
    ~numpy.ndarray | None = <factory>, b: float |
    ~numpy.ndarray | None = <factory>)
```

Define the *:math: `LLAB(l:c)`* colour appearance model specification.

This specification has field names consistent with the remaining colour appearance models in `colour.appearance` but diverge from *Fairchild (2013)* reference.

Parameters

- **J** (float | numpy.ndarray | None) – Correlate of *Lightness* L_L .
- **C** (float | numpy.ndarray | None) – Correlate of *chroma* Ch_L .
- **h** (float | numpy.ndarray | None) – *Hue* angle h_L in degrees.
- **s** (float | numpy.ndarray | None) – Correlate of *saturation* s_L .
- **M** (float | numpy.ndarray | None) – Correlate of *colourfulness* C_L .
- **HC** (float | numpy.ndarray | None) – *Hue* h composition H^C .
- **a** (float | numpy.ndarray | None) – Opponent signal A_L .
- **b** (float | numpy.ndarray | None) – Opponent signal B_L .

Notes

- This specification is the one used in the current model implementation.

References

[Fai13h], [LLK96], [LM96]

```
__init__(J: float | ~numpy.ndarray | None = <factory>, C: float | ~numpy.ndarray | None =
    <factory>, h: float | ~numpy.ndarray | None = <factory>, s: float | ~numpy.ndarray
    | None = <factory>, M: float | ~numpy.ndarray | None = <factory>, HC: float |
    ~numpy.ndarray | None = <factory>, a: float | ~numpy.ndarray | None = <factory>,
    b: float | ~numpy.ndarray | None = <factory>) → None
```

Parameters

- **J** (float | ndarray | None) –
- **C** (float | ndarray | None) –
- **h** (float | ndarray | None) –
- **s** (float | ndarray | None) –
- **M** (float | ndarray | None) –
- **HC** (float | ndarray | None) –
- **a** (float | ndarray | None) –
- **b** (float | ndarray | None) –

Return type

None

Methods

```
__init__([J, C, h, s, M, HC, a, b])
```

| | | |
|---|-------------|--|
| arithmetical_operation(a, in_place)] | operation[, | Perform given arithmetical operation with <i>a</i> operand on the dataclass-like class. |
|---|-------------|--|

Attributes

| | |
|--------|--|
| fields | Getter property for the fields of the dataclass-like class. |
| items | Getter property for the dataclass-like class items, i.e. the field names and values. |
| keys | Getter property for the dataclass-like class keys, i.e. the field names. |
| values | Getter property for the dataclass-like class values, i.e. the field values. |
| J | |
| C | |
| h | |
| s | |
| M | |
| HC | |
| a | |
| b | |

colour.VIEWING_CONDITIONS_LLAB

```
colour.VIEWING_CONDITIONS_LLAB = CanonicalMapping({'Reference Samples & Images, Average Surround, Subtending > 4': ..., 'Reference Samples & Images, Average Surround, Subtending < 4': ..., 'Television & VDU Displays, Dim Surround': ..., 'Cut Sheet Transparency, Dim Surround': ..., '35mm Projection Transparency, Dark Surround': ..., 'ref_average_4_plus': ..., 'ref_average_4_minus': ..., 'tv_dim': ..., 'sheet_dim': ..., 'projected_dark': ...})
```

Reference *LLAB*(*l* : *c*) colour appearance model viewing conditions.

References

[Fai13h], [LLK96], [LM96]

Aliases:

- 'ref_average_4_plus': 'Reference Samples & Images, Average Surround, Subtending > 4'
- 'ref_average_4_minus': 'Reference Samples & Images, Average Surround, Subtending < 4'
- 'tv_dim': 'Television & VDU Displays, Dim Surround'
- 'sheet_dim': 'Cut Sheet Transparency, Dim Surround'
- 'projected_dark': '35mm Projection Transparency, Dark Surround'

Ancillary Objects

colour.appearance

| | |
|---|--|
| InductionFactors_LLAB(D, F_S, F_L, F_C) | :math:`LLAB(l:c)` colour appearance model induction factors. |
|---|--|

colour.appearance.InductionFactors_LLAB

class colour.appearance.InductionFactors_LLAB(*D*, *F_S*, *F_L*, *F_C*)
:math: `LLAB(l:c)` colour appearance model induction factors.

Parameters

- **D** – *Discounting-the-Illuminant* factor D .
- **F_S** – *Surround* induction factor F_S .
- **F_L** – *Lightness* induction factor F_L .
- **F_C** – *Chroma* induction factor F_C .

References

[Fai13h], [LLK96], [LM96]

Create new instance of InductionFactors_LLAB(*D*, *F_S*, *F_L*, *F_C*)

`__init__()`

Methods

| | |
|--|--|
| <code>__init__()</code> | |
| <code>count(value, /)</code> | Return number of occurrences of value. |
| <code>index(value[, start, stop])</code> | Return first index of value. |

Attributes

| | |
|------------------|--------------------------|
| <code>D</code> | Alias for field number 0 |
| <code>F_C</code> | Alias for field number 3 |
| <code>F_L</code> | Alias for field number 2 |
| <code>F_S</code> | Alias for field number 1 |

Nayatani (1995)

colour

| | |
|--|--|
| <code>XYZ_to_Nayatani95(XYZ, XYZ_n, Y_o, E_o, E_or)</code> | Compute the <i>Nayatani (1995)</i> colour appearance model correlates. |
| <code>CAM_Specification_Nayatani95(L_star_P, C, h, ...)</code> | Define the <i>Nayatani (1995)</i> colour appearance model specification. |

colour.XYZ_to_Nayatani95

`colour.XYZ_to_Nayatani95`(XYZ: ArrayLike, XYZ_n: ArrayLike, Y_o: FloatingOrArrayLike, E_o: FloatingOrArrayLike, E_or: FloatingOrArrayLike, n: FloatingOrArrayLike = 1) → [CAM_Specification_Nayatani95](#)

Compute the *Nayatani (1995)* colour appearance model correlates.

Parameters

- **XYZ** (ArrayLike) – CIE XYZ tristimulus values of test sample / stimulus.
- **XYZ_n** (ArrayLike) – CIE XYZ tristimulus values of reference white.
- **Y_o** (FloatingOrArrayLike) – Luminance factor Y_o of achromatic background as percentage normalised to domain [0.18, 1.0] in ‘Reference’ domain-range scale.
- **E_o** (FloatingOrArrayLike) – Illuminance E_o of the viewing field in lux.
- **E_or** (FloatingOrArrayLike) – Normalising illuminance E_{or} in lux usually normalised to domain [1000, 3000].
- **n** (FloatingOrArrayLike) – Noise term used in the non-linear chromatic adaptation model.

Returns

Nayatani (1995) colour appearance model specification.

Return type

[colour.CAM_Specification_Nayatani95](#)

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |
| XYZ_n | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|--------------------------------|-------------------|-----------|
| CAM_Specification_Nayatani95.h | [0, 360] | [0, 1] |

References

[Fai13c], [NSY95]

Examples

```
>>> XYZ = np.array([19.01, 20.00, 21.78])
>>> XYZ_n = np.array([95.05, 100.00, 108.88])
>>> Y_o = 20.0
>>> E_o = 5000.0
>>> E_or = 1000.0
>>> XYZ_to_Nayatani95(XYZ, XYZ_n, Y_o, E_o, E_or)
CAM_Specification_Nayatani95(L_star_P=49.9998829..., C=0.0133550..., h=257.5232268...
↪, s=0.0133550..., Q=62.6266734..., M=0.0167262..., H=None, HC=None, L_star_N=50.
↪0039154...)
```

`colour.CAM_Specification_Nayatani95`

```
class colour.CAM_Specification_Nayatani95(L_star_P: FloatingOrNDArray | None = <factory>, C:
    FloatingOrNDArray | None = <factory>, h:
    FloatingOrNDArray | None = <factory>, s:
    FloatingOrNDArray | None = <factory>, Q:
    FloatingOrNDArray | None = <factory>, M:
    FloatingOrNDArray | None = <factory>, H:
    FloatingOrNDArray | None = <factory>, HC:
    FloatingOrNDArray | None = <factory>, L_star_N:
    FloatingOrNDArray | None = <factory>)
```

Define the *Nayatani (1995)* colour appearance model specification.

This specification has field names consistent with the remaining colour appearance models in `colour.appearance` but diverge from *Fairchild (2013)* reference.

Parameters

- **L_star_P** (FloatingOrNDArray | None) – Correlate of *achromatic Lightness* L_p^* .
- **C** (FloatingOrNDArray | None) – Correlate of *chroma* C .
- **h** (FloatingOrNDArray | None) – *Hue* angle θ in degrees.
- **s** (FloatingOrNDArray | None) – Correlate of *saturation* S .
- **Q** (FloatingOrNDArray | None) – Correlate of *brightness* B_r .
- **M** (FloatingOrNDArray | None) – Correlate of *colourfulness* M .
- **H** (FloatingOrNDArray | None) – *Hue* h quadrature H .
- **HC** (FloatingOrNDArray | None) – *Hue* h composition H_C .
- **L_star_N** (FloatingOrNDArray | None) – Correlate of *normalised achromatic Lightness* L_n^* .

Notes

- This specification is the one used in the current model implementation.

References

[Fai13c], [NSY95]

```
__init__(L_star_P: FloatingOrNDArray | None = <factory>, C: FloatingOrNDArray | None =
    <factory>, h: FloatingOrNDArray | None = <factory>, s: FloatingOrNDArray | None =
    <factory>, Q: FloatingOrNDArray | None = <factory>, M: FloatingOrNDArray | None
    = <factory>, H: FloatingOrNDArray | None = <factory>, HC: FloatingOrNDArray |
    None = <factory>, L_star_N: FloatingOrNDArray | None = <factory>) → None
```

Parameters

- **L_star_P** (FloatingOrNDArray | None) –
- **C** (FloatingOrNDArray | None) –
- **h** (FloatingOrNDArray | None) –
- **s** (FloatingOrNDArray | None) –
- **Q** (FloatingOrNDArray | None) –
- **M** (FloatingOrNDArray | None) –
- **H** (FloatingOrNDArray | None) –

- **HC** (FloatingOrNDArray | None) –
- **L_star_N** (FloatingOrNDArray | None) –

Return type

None

Methods

| | |
|---|---|
| <code>__init__([L_star_P, C, h, s, Q, M, H, HC, ...])</code> | |
| <code>arithmetical_operation(a, operation[, in_place])</code> | Perform given arithmetical operation with <i>a</i> operand on the dataclass-like class. |

Attributes

| | |
|-----------------------|--|
| <code>fields</code> | Getter property for the fields of the dataclass-like class. |
| <code>items</code> | Getter property for the dataclass-like class items, i.e. the field names and values. |
| <code>keys</code> | Getter property for the dataclass-like class keys, i.e. the field names. |
| <code>values</code> | Getter property for the dataclass-like class values, i.e. the field values. |
| <code>L_star_P</code> | |
| <code>C</code> | |
| <code>h</code> | |
| <code>s</code> | |
| <code>Q</code> | |
| <code>M</code> | |
| <code>H</code> | |
| <code>HC</code> | |
| <code>L_star_N</code> | |

RLAB

colour

| | |
|---|---|
| <code>XYZ_to_RLAB(XYZ, XYZ_n, Y_n[, sigma, D])</code> | Compute the <i>RLAB</i> model color appearance correlates. |
| <code>CAM_Specification_RLAB(J, C, h, s, HC, a, b)</code> | Define the <i>RLAB</i> colour appearance model specification. |
| <code>VIEWING_CONDITIONS_RLAB</code> | Reference <i>RLAB</i> colour appearance model viewing conditions. |

colour.XYZ_to_RLAB

`colour.XYZ_to_RLAB(XYZ: ArrayLike, XYZ_n: ArrayLike, Y_n: FloatingOrArrayLike, sigma: FloatingOrArrayLike = VIEWING_CONDITIONS_RLAB['Average'], D: FloatingOrArrayLike = D_FACTOR_RLAB['Hard Copy Images']) → CAM_Specification_RLAB`

Compute the *RLAB* model color appearance correlates.

Parameters

- **XYZ** (ArrayLike) – CIE XYZ tristimulus values of test sample / stimulus.
- **XYZ_n** (ArrayLike) – CIE XYZ tristimulus values of reference white.
- **Y_n** (FloatingOrArrayLike) – Absolute adapting luminance in cd/m^2 .
- **sigma** (FloatingOrArrayLike) – Relative luminance of the surround, see `colour.VIEWING_CONDITIONS_RLAB` for reference.
- **D** (FloatingOrArrayLike) – *Discounting-the-Illuminant* factor normalised to domain [0, 1].

Returns

RLAB colour appearance model specification.

Return type

CAM_Specification_RLAB

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |
| XYZ_n | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|--------------------------|-------------------|-----------|
| CAM_Specification_RLAB.h | [0, 360] | [0, 1] |

References

[Fai96], [Fai13d]

Examples

```
>>> XYZ = np.array([19.01, 20.00, 21.78])
>>> XYZ_n = np.array([109.85, 100, 35.58])
>>> Y_n = 31.83
>>> sigma = VIEWING_CONDITIONS_RLAB["Average"]
>>> D = D_FACTOR_RLAB["Hard Copy Images"]
>>> XYZ_to_RLAB(XYZ, XYZ_n, Y_n, sigma, D)
CAM_Specification_RLAB(J=49.8347069..., C=54.8700585..., h=286.4860208..., s=1.
↪1010410..., HC=None, a=15.5711021..., b=-52.6142956...)
```

colour.CAM_Specification_RLAB

```
class colour.CAM_Specification_RLAB(J: FloatingOrNDArray | None = <factory>, C:
    FloatingOrNDArray | None = <factory>, h:
    FloatingOrNDArray | None = <factory>, s: FloatingOrNDArray
    | None = <factory>, HC: FloatingOrNDArray | None =
    <factory>, a: FloatingOrNDArray | None = <factory>, b:
    FloatingOrNDArray | None = <factory>)
```

Define the *RLAB* colour appearance model specification.

This specification has field names consistent with the remaining colour appearance models in `colour.appearance` but diverge from *Fairchild (2013)* reference.

Parameters

- **J** (FloatingOrNDArray | None) – Correlate of *Lightness* L^R .
- **C** (FloatingOrNDArray | None) – Correlate of *achromatic chroma* C^R .
- **h** (FloatingOrNDArray | None) – *Hue* angle h^R in degrees.
- **s** (FloatingOrNDArray | None) – Correlate of *saturation* s^R .
- **HC** (FloatingOrNDArray | None) – *Hue* h composition H^C .
- **a** (FloatingOrNDArray | None) – Red-green chromatic response a^R .
- **b** (FloatingOrNDArray | None) – Yellow-blue chromatic response b^R .

Notes

- This specification is the one used in the current model implementation.

References

[Fai96], [Fai13d]

```
--init__(J: FloatingOrNDArray | None = <factory>, C: FloatingOrNDArray | None = <factory>,
    h: FloatingOrNDArray | None = <factory>, s: FloatingOrNDArray | None = <factory>,
    HC: FloatingOrNDArray | None = <factory>, a: FloatingOrNDArray | None =
    <factory>, b: FloatingOrNDArray | None = <factory>) → None
```

Parameters

- **J** (FloatingOrNDArray | None) –
- **C** (FloatingOrNDArray | None) –
- **h** (FloatingOrNDArray | None) –
- **s** (FloatingOrNDArray | None) –
- **HC** (FloatingOrNDArray | None) –
- **a** (FloatingOrNDArray | None) –
- **b** (FloatingOrNDArray | None) –

Return type

None

Methods

| |
|---|
| <code>__init__([J, C, h, s, HC, a, b])</code> |
|---|

Attributes

| | |
|---------------------|--|
| <code>fields</code> | Getter property for the fields of the dataclass-like class. |
| <code>items</code> | Getter property for the dataclass-like class items, i.e. the field names and values. |
| <code>keys</code> | Getter property for the dataclass-like class keys, i.e. the field names. |
| <code>values</code> | Getter property for the dataclass-like class values, i.e. the field values. |
| <code>J</code> | |
| <code>C</code> | |
| <code>h</code> | |
| <code>s</code> | |
| <code>HC</code> | |
| <code>a</code> | |
| <code>b</code> | |

`colour.VIEWING_CONDITIONS_RLAB`

`colour.VIEWING_CONDITIONS_RLAB = CanonicalMapping({'Average': ..., 'Dim': ..., 'Dark': ...})`
Reference *RLAB* colour appearance model viewing conditions.

References

[Fai96], [Fai13d]

Ancillary Objects

`colour.appearance`

| | |
|----------------------------|--|
| <code>D_FACTOR_RLAB</code> | <i>RLAB</i> colour appearance model <i>Discounting-the-Illuminant</i> factor values. |
|----------------------------|--|

colour.appearance.D_FACTOR_RLAB

```
colour.appearance.D_FACTOR_RLAB = CanonicalMapping({'Hard Copy Images': ..., 'Soft Copy Images': ..., 'Projected Transparencies, Dark Room': ..., 'hard_cp_img': ..., 'soft_cp_img': ..., 'projected_dark': ...})
```

RLAB colour appearance model *Discounting-the-Illuminant* factor values.

References

[Fai96], [Fai13d]

Aliases:

- 'hard_cp_img': 'Hard Copy Images'
- 'soft_cp_img': 'Soft Copy Images'
- 'projected_dark': 'Projected Transparencies, Dark Room'

ZCAM

colour

| | |
|---|--|
| <code>XYZ_to_ZCAM(XYZ, XYZ_w, L_A, Y_b[, ...])</code> | Compute the <i>ZCAM</i> colour appearance model correlates from given <i>CIE XYZ</i> tristimulus values. |
| <code>ZCAM_to_XYZ(specification, XYZ_w, L_A, Y_b)</code> | Convert from <i>ZCAM</i> specification to <i>CIE XYZ</i> tristimulus values. |
| <code>CAM_Specification_ZCAM(J, C, h, s, Q, M, H, ...)</code> | Define the <i>ZCAM</i> colour appearance model specification. |
| <code>VIEWING_CONDITIONS_ZCAM</code> | Reference <i>ZCAM</i> colour appearance model viewing conditions. |

colour.XYZ_to_ZCAM

```
colour.XYZ_to_ZCAM(XYZ: ArrayLike, XYZ_w: ArrayLike, L_A: FloatingOrArrayLike, Y_b: FloatingOrArrayLike, surround: InductionFactors_ZCAM = VIEWING_CONDITIONS_ZCAM['Average'], discount_illuminant: bool = False) → CAM_Specification_ZCAM
```

Compute the *ZCAM* colour appearance model correlates from given *CIE XYZ* tristimulus values.

Parameters

- **XYZ** (ArrayLike) – Absolute *CIE XYZ* tristimulus values of test sample / stimulus.
- **XYZ_w** (ArrayLike) – Absolute *CIE XYZ* tristimulus values of the white under reference illuminant.
- **L_A** (FloatingOrArrayLike) – Test adapting field *luminance* L_A in cd/m^2 such as $L_A = L_w * Y_b/100$ (where L_w is luminance of the reference white and Y_b is the background luminance factor).
- **Y_b** (FloatingOrArrayLike) – Luminous factor of background Y_b such as $Y_b = 100 * L_b/L_w$ where L_w is the luminance of the light source and L_b is the luminance of the background. For viewing images, Y_b can be the average Y value for the pixels in the entire image, or frequently, a Y value of 20, approximate an L^* of 50 is used.
- **surround** (InductionFactors_ZCAM) – Surround viewing conditions induction factors.

- **discount_illuminant** (`bool`) – Truth value indicating if the illuminant should be discounted.

Returns

ZCAM colour appearance model specification.

Return type

`colour.CAM_Specification_ZCAM`

Warning: The underlying *SMPTE ST 2084:2014* transfer function is an absolute transfer function.

Notes

- *Safdar, Hardeberg and Luo (2021)* does not specify how the chromatic adaptation to *CIE Standard Illuminant D65* in *Step 0* should be performed. A one-step *Von Kries* chromatic adaptation transform is not symmetrical or transitive when a degree of adaptation is involved. *Safdar, Hardeberg and Luo (2018)* uses *Zhai and Luo (2018)* two-steps chromatic adaptation transform, thus it seems sensible to adopt this transform for the ZCAM colour appearance model until more information is available. It is worth noting that a one-step *Von Kries* chromatic adaptation transform with support for degree of adaptation produces values closer to the supplemental document compared to the *Zhai and Luo (2018)* two-steps chromatic adaptation transform but then the ZCAM colour appearance model does not round-trip properly.
- The underlying *SMPTE ST 2084:2014* transfer function is an absolute transfer function, thus the domain and range values for the *Reference* and *1* scales are only indicative that the data is not affected by scale transformations.

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [UN] | [UN] |
| XYZ_tw | [UN] | [UN] |
| XYZ_rw | [UN] | [UN] |

| Range | Scale - Reference | Scale - 1 |
|---------------------------|-------------------|-----------|
| CAM_Specification_ZCAM.J | [UN] | [0, 1] |
| CAM_Specification_ZCAM.C | [UN] | [0, 1] |
| CAM_Specification_ZCAM.h | [0, 360] | [0, 1] |
| CAM_Specification_ZCAM.s | [UN] | [0, 1] |
| CAM_Specification_ZCAM.Q | [UN] | [0, 1] |
| CAM_Specification_ZCAM.M | [UN] | [0, 1] |
| CAM_Specification_ZCAM.H | [0, 400] | [0, 1] |
| CAM_Specification_ZCAM.HC | [UN] | [0, 1] |
| CAM_Specification_ZCAM.V | [UN] | [0, 1] |
| CAM_Specification_ZCAM.K | [UN] | [0, 1] |
| CAM_Specification_ZCAM.H | [UN] | [0, 1] |

References

[SHKL18], [SHRL21], [ZL18]

Examples

```
>>> XYZ = np.array([185, 206, 163])
>>> XYZ_w = np.array([256, 264, 202])
>>> L_A = 264
>>> Y_b = 100
>>> surround = VIEWING_CONDITIONS_ZCAM["Average"]
>>> XYZ_to_ZCAM(XYZ, XYZ_w, L_A, Y_b, surround)
...
CAM_Specification_ZCAM(J=92.2504437..., C=3.0216926..., h=196.3245737..., s=19.
→ 1319556..., Q=321.3408463..., M=10.5256217..., H=237.6114442..., HC=None, V=34.
→ 7006776..., K=25.8835968..., W=91.6821728...)
```

colour.ZCAM_to_XYZ

`colour.ZCAM_to_XYZ(specification: CAM_Specification_ZCAM, XYZ_w: ArrayLike, L_A: FloatingOrArrayLike, Y_b: FloatingOrArrayLike, surround: InductionFactors_ZCAM = VIEWING_CONDITIONS_ZCAM['Average'], discount_illuminant: bool = False) → ndarray`

Convert from ZCAM specification to CIE XYZ tristimulus values.

Parameters

- **specification** (`CAM_Specification_ZCAM`) – ZCAM colour appearance model specification. Correlate of *Lightness* J , correlate of *chroma* C or correlate of *colourfulness* M and *hue* angle h in degrees must be specified, e.g. JCh or JMh .
- **XYZ_w** (`ArrayLike`) – Absolute CIE XYZ tristimulus values of the white under reference illuminant.
- **L_A** (`FloatingOrArrayLike`) – Test adapting field *luminance* L_A in cd/m^2 such as $L_A = L_w * Y_b/100$ (where L_w is luminance of the reference white and Y_b is the background luminance factor).
- **Y_b** (`FloatingOrArrayLike`) – Luminous factor of background Y_b such as $Y_b = 100xL_b/L_w$ where L_w is the luminance of the light source and L_b is the luminance of the background. For viewing images, Y_b can be the average Y value for the pixels in the entire image, or frequently, a Y value of 20, approximate an L^* of 50 is used.
- **surround** (`InductionFactors_ZCAM`) – Surround viewing conditions induction factors.
- **discount_illuminant** (`bool`) – Truth value indicating if the illuminant should be discounted.

Returns

CIE XYZ tristimulus values.

Return type

`numpy.ndarray`

Raises

ValueError – If neither C or M correlates have been defined in the specification argument.

Warning: The underlying *SMPTE ST 2084:2014* transfer function is an absolute transfer function.

Notes

- *Safdar, Hardeberg and Luo (2021)* does not specify how the chromatic adaptation to *CIE Standard Illuminant D65* in *Step 0* should be performed. A one-step *Von Kries* chromatic adaptation transform is not symmetrical or transitive when a degree of adaptation is involved. *Safdar, Hardeberg and Luo (2018)* uses *Zhai and Luo (2018)* two-steps chromatic adaptation transform, thus it seems sensible to adopt this transform for the ZCAM colour appearance model until more information is available. It is worth noting that a one-step *Von Kries* chromatic adaptation transform with support for degree of adaptation produces values closer to the supplemental document compared to the *Zhai and Luo (2018)* two-steps chromatic adaptation transform but then the ZCAM colour appearance model does not round-trip properly.
- *Step 4* of the inverse model uses a rounded exponent of 1.3514 preventing the model to round-trip properly. Given that this implementation takes some liberties with respect to the chromatic adaptation transform to use, it was deemed appropriate to use an exponent value that enables the ZCAM colour appearance model to round-trip.
- The underlying *SMPTE ST 2084:2014* transfer function is an absolute transfer function, thus the domain and range values for the *Reference* and *1* scales are only indicative that the data is not affected by scale transformations.

| Domain | Scale - Reference | Scale - 1 |
|---------------------------|-------------------|-----------|
| CAM_Specification_ZCAM.J | [UN] | [0, 1] |
| CAM_Specification_ZCAM.C | [UN] | [0, 1] |
| CAM_Specification_ZCAM.h | [0, 360] | [0, 1] |
| CAM_Specification_ZCAM.s | [UN] | [0, 1] |
| CAM_Specification_ZCAM.Q | [UN] | [0, 1] |
| CAM_Specification_ZCAM.M | [UN] | [0, 1] |
| CAM_Specification_ZCAM.H | [0, 400] | [0, 1] |
| CAM_Specification_ZCAM.HC | [UN] | [0, 1] |
| CAM_Specification_ZCAM.V | [UN] | [0, 1] |
| CAM_Specification_ZCAM.K | [UN] | [0, 1] |
| CAM_Specification_ZCAM.H | [UN] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [UN] | [UN] |

References

[SHKL18], [SHRL21], [ZL18]

Examples

```
>>> specification = CAM_Specification_ZCAM(
...     J=92.250443780723629, C=3.0216926733329013, h=196.32457375575581
... )
>>> XYZ_w = np.array([256, 264, 202])
>>> L_A = 264
>>> Y_b = 100
>>> surround = VIEWING_CONDITIONS_ZCAM["Average"]
>>> ZCAM_to_XYZ(specification, XYZ_w, L_A, Y_b, surround)
...
array([ 185.,  206.,  163.])
```

colour.CAM_Specification_ZCAM

```
class colour.CAM_Specification_ZCAM(J: FloatingOrNDArray | None = <factory>, C:
    FloatingOrNDArray | None = <factory>, h:
    FloatingOrNDArray | None = <factory>, s: FloatingOrNDArray
    | None = <factory>, Q: FloatingOrNDArray | None =
    <factory>, M: FloatingOrNDArray | None = <factory>, H:
    FloatingOrNDArray | None = <factory>, HC:
    FloatingOrNDArray | None = <factory>, V:
    FloatingOrNDArray | None = <factory>, K:
    FloatingOrNDArray | None = <factory>, W:
    FloatingOrNDArray | None = <factory>)
```

Define the ZCAM colour appearance model specification.

Parameters

- **J** (FloatingOrNDArray | None) – *Lightness J* is the “brightness of an area (Q) judged relative to the brightness of a similarly illuminated area that appears to be white or highly transmitting (Q_w)”, i.e., $J = (Q/Q_w)$. It is a visual scale with two well defined levels i.e., zero and 100 for a pure black and a reference white, respectively. Note that in HDR visual field, samples could have a higher luminance than that of the reference white, so the lightness could be over 100. Subscripts s and w are used to annotate the sample and the reference white, respectively.
- **C** (FloatingOrNDArray | None) – *Chroma C* is “colourfulness of an area (M) judged as a proportion of the brightness of a similarly illuminated area that appears white or highly transmitting (Q_w)”, i.e., $C = (M/Q_w)$. It is an open-end scale with origin as a colour in the neutral axis. It can be estimated as the magnitude of the chromatic difference between the test colour and a neutral colour having the lightness same as the test colour.
- **h** (FloatingOrNDArray | None) – *Hue angle h* is a scale ranged from 0° to 360° with the hues following rainbow sequence. The same distance between pairs of hues in a constant lightness and chroma shows the same perceived colour difference.
- **s** (FloatingOrNDArray | None) – *Saturation s* is the “colourfulness (M) of an area judged in proportion to its brightness (Q)”, i.e., $s = (M/Q)$. It can also be defined as the chroma of an area judged in proportion to its lightness, i.e., $s = (C/J)$. It is an open-end scale with all neutral colours to have saturation of zero. For example, the red bricks in a building would exhibit different colours when illuminated by daylight. Those (directly) under daylight will appear to be bright and colourful, and those under shadow will appear darker and less colourful. However, the two areas have the same saturation.

- **Q** (FloatingOrNDArray | None) – *Brightness* Q is an “attribute of a visual perception according to which an area appears to emit, or reflect, more or less light”. It is an open-end scale with origin as pure black or complete darkness. It is an absolute scale according to the illumination condition i.e., an increase of brightness of an object when the illuminance of light is increased. This is a visual phenomenon known as Stevens effect.
- **M** (FloatingOrNDArray | None) – *Colourfulness* M is an “attribute of a visual perception according to which the perceived colour of an area appears to be more or less chromatic”. It is an open-end scale with origin as a neutral colour i.e., appearance of no hue. It is an absolute scale according to the illumination condition i.e., an increase of colourfulness of an object when the illuminance of light is increased. This is a visual phenomenon known as Hunt effect.
- **H** (FloatingOrNDArray | None) – *Hue* h quadrature H_C is an “attribute of a visual perception according to which an area appears to be similar to one of the colours: red, yellow, green, and blue, or to a combination of adjacent pairs of these colours considered in a closed ring”. It has a 0-400 scale, i.e., hue quadrature of 0, 100, 200, 300, and 400 range from unitary red to, yellow, green, blue, and back to red, respectively. For example, a cyan colour consists of 50% green and 50% blue, corresponding to a hue quadrature of 250.
- **HC** (FloatingOrNDArray | None) – *Hue* h composition H^C used to define the hue appearance of a sample. Note that hue circles formed by the equal hue angle and equal hue composition appear to be quite different.
- **V** (FloatingOrNDArray | None) – *Vividness* V is an “attribute of colour used to indicate the degree of departure of the colour (of stimulus) from a neutral black colour”, i.e., $V = \sqrt{J^2 + C^2}$. It is an open-end scale with origin at pure black. This reflects the visual phenomena of an object illuminated by a light to increase both the lightness and the chroma.
- **K** (FloatingOrNDArray | None) – *Blackness* K is a visual attribute according to which an area appears to contain more or less black content. It is a scale in the Natural Colour System (NCS) and can also be defined in resemblance to a pure black. It is an open-end scale with 100 as pure black (luminance of 0 cd/m^2), i.e., $K = (100 - \sqrt{J^2 + C^2}) = (100 - V)$. The visual effect can be illustrated by mixing a black to a colour pigment. The more black pigment is added, the higher blackness will be. A blacker colour will have less lightness and/or chroma than a less black colour.
- **W** (FloatingOrNDArray | None) – *Whiteness* W is a visual attribute according to which an area appears to contain more or less white content. It is a scale of the NCS and can also be defined in resemblance to a pure white. It is an open-end scale with 100 as reference white, i.e., $W = (100 - \sqrt{(100 - J)^2 + C^2}) = (100 - D)$. The visual effect can be illustrated by mixing a white to a colour pigment. The more white pigment is added, the higher whiteness will be. A whiter colour will have a lower chroma and higher lightness than the less white colour.

References

[SHRL21]

```
__init__(J: FloatingOrNDArray | None = <factory>, C: FloatingOrNDArray | None = <factory>,
          h: FloatingOrNDArray | None = <factory>, s: FloatingOrNDArray | None = <factory>,
          Q: FloatingOrNDArray | None = <factory>, M: FloatingOrNDArray | None =
          <factory>, H: FloatingOrNDArray | None = <factory>, HC: FloatingOrNDArray | None
          = <factory>, V: FloatingOrNDArray | None = <factory>, K: FloatingOrNDArray | None
          = <factory>, W: FloatingOrNDArray | None = <factory>) → None
```

Parameters

- **J** (FloatingOrNDArray | None) –
- **C** (FloatingOrNDArray | None) –
- **h** (FloatingOrNDArray | None) –
- **s** (FloatingOrNDArray | None) –
- **Q** (FloatingOrNDArray | None) –
- **M** (FloatingOrNDArray | None) –
- **H** (FloatingOrNDArray | None) –
- **HC** (FloatingOrNDArray | None) –
- **V** (FloatingOrNDArray | None) –
- **K** (FloatingOrNDArray | None) –
- **W** (FloatingOrNDArray | None) –

Return type

None

Methods

```
__init__([J, C, h, s, Q, M, H, HC, V, K, W])
```

| | | |
|--|--------------------------|---|
| <code>arithmetical_operation(a, in_place)</code> | <code>operation[,</code> | Perform given arithmetical operation with <i>a</i> operand on the dataclass-like class. |
|--|--------------------------|---|

Attributes

| | |
|--------|--|
| fields | Getter property for the fields of the dataclass-like class. |
| items | Getter property for the dataclass-like class items, i.e. the field names and values. |
| keys | Getter property for the dataclass-like class keys, i.e. the field names. |
| values | Getter property for the dataclass-like class values, i.e. the field values. |
| J | |
| C | |
| h | |
| s | |
| Q | |
| M | |
| H | |
| HC | |
| V | |
| K | |
| W | |

colour.VIEWING_CONDITIONS_ZCAM

colour.VIEWING_CONDITIONS_ZCAM = CanonicalMapping({'Average': ..., 'Dim': ..., 'Dark': ...})

Reference ZCAM colour appearance model viewing conditions.

References

[SHRL21]

Ancillary Objects

colour.appearance

| | |
|---------------------------------------|---|
| InductionFactors_ZCAM(F_s, F, c, N_c) | ZCAM colour appearance model induction factors. |
|---------------------------------------|---|

colour.appearance.InductionFactors_ZCAM

class colour.appearance.InductionFactors_ZCAM(F_s , F , c , N_c)

ZCAM colour appearance model induction factors.

Parameters

- **F_s** – Surround impact F_s .
- **F** – Maximum degree of adaptation F .
- **c** – Exponential non-linearity c .
- **N_c** – Chromatic induction factor N_c .

Notes

- The ZCAM colour appearance model induction factors are inherited from the *CIECAM02* colour appearance model.

References

[SHRL21]

Create new instance of InductionFactors_ZCAM(F_s , F , c , N_c)

`__init__()`

Methods

| | |
|--|--|
| <code>__init__()</code> | |
| <code>count(value, /)</code> | Return number of occurrences of value. |
| <code>index(value[, start, stop])</code> | Return first index of value. |

Attributes

| | |
|------------------|--------------------------|
| <code>F</code> | Alias for field number 1 |
| <code>F_s</code> | Alias for field number 0 |
| <code>N_c</code> | Alias for field number 3 |
| <code>c</code> | Alias for field number 2 |

Helmholtz-Kohlrausch Effect Estimation

colour

| | |
|--|---|
| <code>HKE_NAYATANI1997_METHODS</code> | <i>Nayatani (1997)</i> HKE computation methods, choice between variable achromatic colour ('VAC') and variable chromatic colour ('VCC') |
| <code>HelmholtzKohlrausch_effect_object_Nayatani19...</code> | Return the <i>HKE</i> value for object colours using <i>Nayatani (1997)</i> method. |
| <code>HelmholtzKohlrausch_effect_luminous_Nayatani...</code> | Return the <i>HKE</i> factor for luminous colours using <i>Nayatani (1997)</i> method. |

colour.HKE_NAYATANI1997_METHODS

`colour.HKE_NAYATANI1997_METHODS = CanonicalMapping({'VAC': ..., 'VCC': ...})`

Nayatani (1997) HKE computation methods, choice between variable achromatic colour ('VAC') and variable chromatic colour ('VCC')

References

[Nay97]

colour.HelmholtzKohlrausch_effect_object_Nayatani1997

`colour.HelmholtzKohlrausch_effect_object_Nayatani1997`(*uv: ArrayLike, uv_c: ArrayLike, L_a: FloatingOrArrayLike, method: Literal['VAC', 'VCC'] | str = 'VCC') → FloatingOrNDArray*

Return the *HKE* value for object colours using *Nayatani (1997)* method.

Parameters

- **uv** (ArrayLike) – CIE *uv* chromaticity coordinates of samples.
- **uv_c** (ArrayLike) – CIE *uv* chromaticity coordinates of reference white.
- **L_a** (FloatingOrArrayLike) – Adapting luminance in cd/m^2 .
- **method** (Literal['VAC', 'VCC'] | str) – Which estimation method to use, VCC or VAC.

Returns

Luminance factor (Γ) value(s) computed with *Nayatani* object colour estimation method.

Return type

`numpy.floating` or `numpy.ndarray`

References

[Nay97]

Examples

```
>>> import colour
>>> white = colour.xy_to_Luv_uv(colour.temperature.CCT_to_xy_CIE_D(6504))
>>> colours = colour.XYZ_to_xy(
...     [colour.wavelength_to_XYZ(430 + i * 50) for i in range(5)]
... )
>>> L_adapting = 65
>>> HelmholtzKohlrausch_effect_object_Nayatani1997(
...     colour.xy_to_Luv_uv(colours), white, L_adapting
... )
array([ 2.2468383...,  1.4619799...,  1.1801658...,  0.9031318...,  1.7999376...])
```

colour.HelmholtzKohlrausch_effect_luminous_Nayatani1997

`colour.HelmholtzKohlrausch_effect_luminous_Nayatani1997`(*uv*: ArrayLike, *uv_c*: ArrayLike, *L_a*: FloatingOrArrayLike, *method*: Literal['VAC', 'VCC'] | *str* = 'VCC') → FloatingOrNDArray

Return the *HKE* factor for luminous colours using *Nayatani (1997)* method.

Parameters

- **uv** (ArrayLike) – CIE *uv* chromaticity coordinates of samples.
- **uv_c** (ArrayLike) – CIE *uv* chromaticity coordinates of reference white.
- **L_a** (FloatingOrArrayLike) – Adapting luminance in cd/m^2 .
- **method** (Literal['VAC', 'VCC'] | *str*) – Which estimation method to use, VCC or VAC.

Returns

Luminance factor (Γ) value(s) computed with *Nayatani luminous colour estimation method*.

Return type

`numpy.floating` or `numpy.ndarray`

References

[Nay97]

Examples

```
>>> import colour
>>> white = colour.xy_to_Luv_uv(colour.temperature.CCT_to_xy_CIE_D(6504))
>>> colours = colour.XYZ_to_xy(
...     [colour.wavelength_to_XYZ(430 + i * 50) for i in range(5)]
... )
>>> L_adapting = 65
>>> HelmholtzKohlrausch_effect_luminous_Nayatani1997(
...     colour.xy_to_Luv_uv(colours), white, L_adapting
... )
array([ 7.4460471...,  2.4767159...,  1.4723422...,  0.7938695...,  4.1828629...])
```

Ancillary Objects

`colour.appearance`

| | |
|---|--|
| <code>coefficient_q_Nayatani1997(theta)</code> | Return the $q(\theta)$ coefficient for <i>Nayatani (1997)</i> <i>HKE</i> computations. |
| <code>coefficient_K_Br_Nayatani1997(L_a)</code> | Return the K_{Br} coefficient for <i>Nayatani (1997)</i> <i>HKE</i> computations. |

colour.appearance.coefficient_q_Nayatani1997

`colour.appearance.coefficient_q_Nayatani1997(theta: FloatingOrArrayLike) → FloatingOrNDArray`

Return the $q(\theta)$ coefficient for *Nayatani (1997) HKE* computations.

The hue angle θ can be computed as follows:

$$\tan^{-1} \frac{v' - v'_c}{u' - u'_c}$$

where u' and v' are the CIE 1976 chromaticity coordinates of the test chromatic light and u'_c and v'_c are the CIE 1976 chromaticity coordinates of the reference white light.

Parameters

theta (FloatingOrArrayLike) – Hue angle (θ) in radians.

Returns

q coefficient for *Nayatani (1997) HKE* methods.

Return type

`numpy.floating` or `numpy.ndarray`

References

[Nay97]

Examples

This recreates *FIG. A-1*.

```
>>> import matplotlib.pyplot as plt
>>> angles = [(np.pi * 2 / 100 * i) for i in range(100)]
>>> q_values = coefficient_q_Nayatani1997(angles)
>>> plt.plot(np.array(angles), q_values / (np.pi * 2) * 180)
...
[<matplotlib.lines.Line2D object at 0x...>]
>>> plt.show()
```

colour.appearance.coefficient_K_Br_Nayatani1997

`colour.appearance.coefficient_K_Br_Nayatani1997(L_a: FloatingOrArrayLike) → FloatingOrNDArray`

Return the K_{Br} coefficient for *Nayatani (1997) HKE* computations.

Parameters

L_a (FloatingOrArrayLike) – Adapting luminance in cd/m^2 .

Returns

K_{Br} coefficient for *Nayatani (1997) HKE* methods.

Return type

`numpy.floating` or `numpy.ndarray`

Notes

- The K_{Br} coefficient is normalised to unity around $63.66cd/m^2$.

References

[Nay97]

Examples

```
>>> L_a_values = [10 + i * 20 for i in range(5)]
>>> coefficient_K_Br_Nayatani1997(L_a_values)
array([ 0.7134481...,  0.8781172...,  0.9606248...,  1.0156689...,  1.0567008...])
>>> coefficient_K_Br_Nayatani1997(63.66)
1.0001284...
```

Biochemistry

Michaelis–Menten Kinetics

colour.biochemistry

| | |
|---|---|
| REACTION_RATE_MICHAELISMEN_TEN_METHODS | Supported <i>Michaelis-Menten</i> kinetics reaction rate equation computation methods. |
| reaction_rate_MichaelisMenten(S, V_max, K_m) | Describe the rate of enzymatic reactions, by relating reaction rate v to concentration of a substrate S according to given method. |
| SUBSTRATE_CONCENTRATION_MICHAELISMEN_TEN_METH | Supported <i>Michaelis-Menten</i> kinetics substrate concentration equation computation methods. |
| substrate_concentration_MichaelisMenten(v, ...) | Describe the rate of enzymatic reactions, by relating concentration of a substrate S to reaction rate v according to given method. |
| reaction_rate_MichaelisMenten_Michaelis1913(...) | Describe the rate of enzymatic reactions, by relating reaction rate v to concentration of a substrate S . |
| substrate_concentration_MichaelisMenten_Mich(...) | Describe the rate of enzymatic reactions, by relating concentration of a substrate S to reaction rate v . |
| reaction_rate_MichaelisMenten_Abebe2017(S, ...) | Describe the rate of enzymatic reactions, by relating reaction rate v to concentration of a substrate S according to the modified <i>Michaelis-Menten</i> kinetics equation as given by Abebe, Pouli, Larabi and Reinhard (2017). |
| substrate_concentration_MichaelisMenten_Abeb(...) | Describe the rate of enzymatic reactions, by relating concentration of a substrate S to reaction rate v according to the modified <i>Michaelis-Menten</i> kinetics equation as given by Abebe, Pouli, Larabi and Reinhard (2017). |

colour.biochemistry.REACTION_RATE_MICHAELISMENTEN_METHODS

```
colour.biochemistry.REACTION_RATE_MICHAELISMENTEN_METHODS = CanonicalMapping({'Michaelis 1913': ..., 'Abebe 2017': ...})
```

Supported *Michaelis-Menten* kinetics reaction rate equation computation methods.

References

[Wikipedia03d], [APLR17]

colour.biochemistry.reaction_rate_MichaelisMenten

```
colour.biochemistry.reaction_rate_MichaelisMenten(S: FloatingOrArrayLike, V_max:
FloatingOrArrayLike, K_m:
FloatingOrArrayLike, method:
Literal['Michaelis 1913', 'Abebe 2017'] | str =
'Michaelis 1913', **kwargs: Any) →
FloatingOrNDArray
```

Describe the rate of enzymatic reactions, by relating reaction rate v to concentration of a substrate S according to given method.

Parameters

- **S** (FloatingOrArrayLike) – Concentration of a substrate S .
- **V_max** (FloatingOrArrayLike) – Maximum rate V_{max} achieved by the system, at saturating substrate concentration.
- **K_m** (FloatingOrArrayLike) – Substrate concentration K_m at which the reaction rate is half of V_{max} .
- **method** (Literal['Michaelis 1913', 'Abebe 2017'] | str) – Computation method.
- **b_m** – {colour.biochemistry.reaction_rate_MichaelisMenten_Abebe2017()}, Bias factor b_m .
- **kwargs** (Any) –

Returns

Reaction rate v .

Return type

numpy.floating or numpy.ndarray

References

[Wikipedia03d], [APLR17]

Examples

```
>>> reaction_rate_MichaelisMenten(0.5, 2.5, 0.8)
0.9615384...
>>> reaction_rate_MichaelisMenten(
...     0.5, 2.5, 0.8, method="Abebe 2017", b_m=0.813
... )
1.0360547...
```

colour.biochemistry.SUBSTRATE_CONCENTRATION_MICHAELISMENTEN_METHODS

colour.biochemistry.SUBSTRATE_CONCENTRATION_MICHAELISMENTEN_METHODS =
CanonicalMapping({'Michaelis 1913': ..., 'Abebe 2017': ...})

Supported *Michaelis-Menten* kinetics substrate concentration equation computation methods.

References

[Wikipedia03d], [APLR17]

colour.biochemistry.substrate_concentration_MichaelisMenten

colour.biochemistry.substrate_concentration_MichaelisMenten(*v*: FloatingOrArrayLike, *V_max*: FloatingOrArrayLike, *K_m*: FloatingOrArrayLike, *method*: Literal['Michaelis 1913', 'Abebe 2017'] | *str* = 'Michaelis 1913', ***kwargs*: Any) → FloatingOrNDArray

Describe the rate of enzymatic reactions, by relating concentration of a substrate *S* to reaction rate *v* according to given method.

Parameters

- **v** (FloatingOrArrayLike) – Reaction rate *v*.
- **V_max** (FloatingOrArrayLike) – Maximum rate V_{max} achieved by the system, at saturating substrate concentration.
- **K_m** (FloatingOrArrayLike) – Substrate concentration K_m at which the reaction rate is half of V_{max} .
- **method** (Literal['Michaelis 1913', 'Abebe 2017'] | *str*) – Computation method.
- **b_m** – {colour.biochemistry.substrate_concentration_MichaelisMenten_Abebe2017()}, Bias factor b_m .
- **kwargs** (Any) –

Returns

Concentration of a substrate *S*.

Return type

numpy.floating or numpy.ndarray

References

[Wikipedia03d], [APLR17]

Examples

```
>>> substrate_concentration_MichaelisMenten(0.961538461538461, 2.5, 0.8)
...
0.4999999...
>>> substrate_concentration_MichaelisMenten(
...     1.036054703688355, 2.5, 0.8, method="Abebe 2017", b_m=0.813
... )
...
0.5000000...
```

colour.biochemistry.reaction_rate_MichaelisMenten_Michaelis1913

colour.biochemistry.reaction_rate_MichaelisMenten_Michaelis1913(*S*: *FloatingOrArrayLike*,
 V_max: *FloatingOrArrayLike*,
 K_m: *FloatingOrArrayLike*) →
 FloatingOrNDArray

Describe the rate of enzymatic reactions, by relating reaction rate v to concentration of a substrate S .

Parameters

- **S** (*FloatingOrArrayLike*) – Concentration of a substrate S .
- **V_max** (*FloatingOrArrayLike*) – Maximum rate V_{max} achieved by the system, at saturating substrate concentration.
- **K_m** (*FloatingOrArrayLike*) – Substrate concentration K_m at which the reaction rate is half of V_{max} .

Returns

Reaction rate v .

Return type

`numpy.floating` or `numpy.ndarray`

References

[Wikipedia03d]

Examples

```
>>> reaction_rate_MichaelisMenten(0.5, 2.5, 0.8)
0.9615384...
```

colour.biochemistry.substrate_concentration_MichaelisMenten_Michaelis1913

`colour.biochemistry.substrate_concentration_MichaelisMenten_Michaelis1913`(*v*: *FloatingOrArrayLike*, *V_max*: *FloatingOrArrayLike*, *K_m*: *FloatingOrArrayLike*) → *FloatingOrNDArray*

Describe the rate of enzymatic reactions, by relating concentration of a substrate S to reaction rate v .

Parameters

- **v** (*FloatingOrArrayLike*) – Reaction rate v .
- **V_max** (*FloatingOrArrayLike*) – Maximum rate V_{max} achieved by the system, at saturating substrate concentration.
- **K_m** (*FloatingOrArrayLike*) – Substrate concentration K_m at which the reaction rate is half of V_{max} .

Returns

Concentration of a substrate S .

Return type

`numpy.floating` or `numpy.ndarray`

References

[Wikipedia03d]

Examples

```
>>> substrate_concentration_MichaelisMenten(0.961538461538461, 2.5, 0.8)
...
0.4999999...
```

colour.biochemistry.reaction_rate_MichaelisMenten_Abebe2017

`colour.biochemistry.reaction_rate_MichaelisMenten_Abebe2017`(*S*: *FloatingOrArrayLike*, *V_max*: *FloatingOrArrayLike*, *K_m*: *FloatingOrArrayLike*, *b_m*: *FloatingOrArrayLike*) → *FloatingOrNDArray*

Describe the rate of enzymatic reactions, by relating reaction rate v to concentration of a substrate S according to the modified *Michaelis-Menten* kinetics equation as given by Abebe, Pouli, Larabi and Reinhard (2017).

Parameters

- **S** (*FloatingOrArrayLike*) – Concentration of a substrate S (or $(\frac{Y}{Y_n})^\epsilon$).
- **V_max** (*FloatingOrArrayLike*) – Maximum rate V_{max} (or a_m) achieved by the system, at saturating substrate concentration.
- **K_m** (*FloatingOrArrayLike*) – Substrate concentration K_m (or c_m) at which the reaction rate is half of V_{max} .

- **b_m** (FloatingOrArrayLike) – Bias factor b_m .

Returns

Reaction rate v .

Return type

`numpy.float64` or `numpy.ndarray`

References

[APLR17]

Examples

```
>>> reaction_rate_MichaelisMenten_Abebe2017(0.5, 1.448, 0.635, 0.813)
...
0.6951512...
```

colour.biochemistry.substrate_concentration_MichaelisMenten_Abebe2017

`colour.biochemistry.substrate_concentration_MichaelisMenten_Abebe2017`(v : *FloatingOrArrayLike*,
 V_{max} : *FloatingOrArrayLike*,
 K_m : *FloatingOrArrayLike*,
 b_m : *FloatingOrArrayLike*)
→ *FloatingOrNDArray*

Describe the rate of enzymatic reactions, by relating concentration of a substrate S to reaction rate v according to the modified *Michaelis-Menten* kinetics equation as given by Abebe, Pouli, Larabi and Reinhard (2017).

Parameters

- **v** (FloatingOrArrayLike) – Reaction rate v .
- **V_max** (FloatingOrArrayLike) – Maximum rate V_{max} (or a_m) achieved by the system, at saturating substrate concentration.
- **K_m** (FloatingOrArrayLike) – Substrate concentration K_m (or c_m) at which the reaction rate is half of V_{max} .
- **b_m** (FloatingOrArrayLike) – Bias factor b_m .

Returns

Concentration of a substrate S .

Return type

`numpy.float64` or `numpy.ndarray`

References

[APLR17]

Examples

```
>>> substrate_concentration_MichaelisMenten_Abebe2017(
...     0.695151224195871, 1.448, 0.635, 0.813
... )
0.4999999...
```

Colour Vision Deficiency

Machado, Oliveira and Fernandes (2009)

colour

| | |
|--|---|
| <code>msds_cmfs_anomalous_trichromacy_Machado2009(</code> | Shift given <i>LMS</i> cone fundamentals colour matching functions with given Δ_{LMS} shift amount in nanometers to simulate anomalous trichromacy using <i>Machado et al. (2009)</i> method. |
| <code>matrix_anomalous_trichromacy_Machado2009(...)</code> | Compute the <i>Machado et al. (2009)</i> CVD matrix for given <i>LMS</i> cone fundamentals colour matching functions and display primaries tri-spectral distributions with given Δ_{LMS} shift amount in nanometers to simulate anomalous trichromacy. |
| <code>matrix_cvd_Machado2009(deficiency, severity)</code> | Compute <i>Machado et al. (2009)</i> CVD matrix for given deficiency and severity using the pre-computed matrices dataset. |

colour.msds_cmfs_anomalous_trichromacy_Machado2009

`colour.msds_cmfs_anomalous_trichromacy_Machado2009(cmfs: LMS_ConeFundamentals, d_LMS: ArrayLike) → LMS_ConeFundamentals`

Shift given *LMS* cone fundamentals colour matching functions with given Δ_{LMS} shift amount in nanometers to simulate anomalous trichromacy using *Machado et al. (2009)* method.

Parameters

- `cmfs` ([LMS_ConeFundamentals](#)) – *LMS* cone fundamentals colour matching functions.
- `d_LMS` ([ArrayLike](#)) – Δ_{LMS} shift amount in nanometers.

Return type

[LMS_ConeFundamentals](#)

Notes

- Input *LMS* cone fundamentals colour matching functions interval is expected to be 1 nanometer, incompatible input will be interpolated at 1 nanometer interval.
- Input Δ_{LMS} shift amount is in domain [0, 20].

Returns

Anomalous trichromacy *LMS* cone fundamentals colour matching functions.

Return type

`colour.LMS_ConeFundamentals`

Parameters

- **cmfs** (`LMS_ConeFundamentals`) –
- **d_LMS** (`ArrayLike`) –

Warning: *Machado et al. (2009)* simulation of tritanomaly is based on the shift paradigm as an approximation to the actual phenomenon and restrain the model from trying to model tritanopia. The pre-generated matrices are using a shift value in domain [5, 59] contrary to the domain [0, 20] used for protanomaly and deuteranomaly simulation.

References

[Colblindorb], [Colblindora], [Colblindorc], [MOF09]

Examples

```
>>> from colour.colorimetry import MSDS_CMFS_LMS
>>> cmfs = MSDS_CMFS_LMS["Stockman & Sharpe 2 Degree Cone Fundamentals"]
>>> cmfs[450]
array([ 0.0498639,  0.0870524,  0.955393 ])
>>> msds_cmfs_anomalous_trichromacy_Machado2009(
...     cmfs, np.array([15, 0, 0])
... )
...     450
... ]
array([ 0.0891288...,  0.0870524 ,  0.955393  ])
```

`colour.matrix_anomalous_trichromacy_Machado2009`

`colour.matrix_anomalous_trichromacy_Machado2009`(*cmfs*: `LMS_ConeFundamentals`, *primaries*: `RGB_DisplayPrimaries`, *d_LMS*: `ArrayLike`) → `ndarray`

Compute the *Machado et al. (2009)* CVD matrix for given *LMS* cone fundamentals colour matching functions and display primaries tri-spectral distributions with given Δ_{LMS} shift amount in nanometers to simulate anomalous trichromacy.

Parameters

- **cmfs** (`LMS_ConeFundamentals`) – *LMS* cone fundamentals colour matching functions.
- **primaries** (`RGB_DisplayPrimaries`) – *RGB* display primaries tri-spectral distributions.

- **d_LMS** (ArrayLike) – Δ_{LMS} shift amount in nanometers.

Return type*ndarray***Notes**

- Input *LMS* cone fundamentals colour matching functions interval is expected to be 1 nanometer, incompatible input will be interpolated at 1 nanometer interval.
- Input Δ_{LMS} shift amount is in domain [0, 20].

Returns

Anomalous trichromacy matrix.

Return type*numpy.ndarray***Parameters**

- **cmfs** (*LMS_ConeFundamentals*) –
- **primaries** (*RGB_DisplayPrimaries*) –
- **d_LMS** (ArrayLike) –

References

[Colblindorb], [Colblindora], [Colblindorc], [MOF09]

Examples

```
>>> from colour.characterisation import MSDS_DISPLAY_PRIMARIES
>>> from colour.colorimetry import MSDS_CMFS_LMS
>>> cmfs = MSDS_CMFS_LMS["Stockman & Sharpe 2 Degree Cone Fundamentals"]
>>> d_LMS = np.array([15, 0, 0])
>>> primaries = MSDS_DISPLAY_PRIMARIES["Apple Studio Display"]
>>> matrix_anomalous_trichromacy_Machado2009(cmfs, primaries, d_LMS)
...
array([[ -0.2777465...,  2.6515008..., -1.3737543...],
       [ 0.2718936...,  0.2004786...,  0.5276276...],
       [ 0.0064404...,  0.2592157...,  0.7343437...]])
```

colour.matrix_cvd_Machado2009

`colour.matrix_cvd_Machado2009(deficiency: Literal['Deuteranomaly', 'Protanomaly', 'Tritanomaly'] | str, severity: float) → ndarray`

Compute *Machado et al. (2009)* CVD matrix for given deficiency and severity using the pre-computed matrices dataset.

Parameters

- **deficiency** (*Literal*['Deuteranomaly', 'Protanomaly', 'Tritanomaly'] | str) – Colour blindness / vision deficiency types : - *Protanomaly* : defective long-wavelength cones (L-cones). The complete absence of L-cones is known as *Protanopia* or *red-dichromacy*. - *Deuteranomaly* : defective medium-wavelength cones (M-cones) with peak of sensitivity moved towards the red sensitive cones. The complete absence of M-cones is known as *Deuteranopia*. - *Tritanomaly* :

defective short-wavelength cones (S-cones), an alleviated form of blue-yellow color blindness. The complete absence of S-cones is known as *Tritanopia*.

- **severity** (`float`) – Severity of the colour vision deficiency in domain [0, 1].

Returns

CVD matrix.

Return type

`numpy.ndarray`

References

[Colblindorb], [Colblindora], [Colblindorc], [MOF09]

Examples

```
>>> matrix_cvd_Machado2009("Protanomaly", 0.15)
array([[ 0.7869875...,  0.2694875..., -0.0564735...],
       [ 0.0431695...,  0.933774 ...,  0.023058 ...],
       [-0.004238 ..., -0.0024515...,  1.0066895...]])
```

Dataset

colour

| | |
|--------------------------|---|
| CVD_MATRICES_MACHADO2010 | Machado (2010) Simulation matrices Φ_{CVD} . |
|--------------------------|---|

colour.CVD_MATRICES_MACHADO2010

`colour.CVD_MATRICES_MACHADO2010 = CanonicalMapping({'Protanomaly': ..., 'Deuteranomaly': ..., 'Tritanomaly': ...})`
Machado (2010) Simulation matrices Φ_{CVD} .

Colour Characterisation

ACES Spectral Conversion

colour

| | |
|---|--|
| <code>sd_to_aces_relative_exposure_values(sd[, ...])</code> | Convert given spectral distribution to <i>ACES2065-1</i> colourspace relative exposure values. |
| <code>sd_to_ACES2065_1(sd[, illuminant, ...])</code> | Convert given spectral distribution to <i>ACES2065-1</i> colourspace relative exposure values. |

colour.sd_to_aces_relative_exposure_values

`colour.sd_to_aces_relative_exposure_values(sd: SpectralDistribution, illuminant: SpectralDistribution | None = None, chromatic_adaptation_transform: Literal['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling'] | str | None = 'CAT02', **kwargs) → ndarray`

Convert given spectral distribution to *ACES2065-1* colourspace relative exposure values.

Parameters

- **sd** ([SpectralDistribution](#)) – Spectral distribution.
- **illuminant** ([SpectralDistribution](#) | *None*) – Illuminant spectral distribution, default to *CIE Standard Illuminant D65*.
- **chromatic_adaptation_transform** ([Literal](#)['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling'] | *str* | *None*) – Chromatic adaptation transform.

Returns

ACES2065-1 colourspace relative exposure values array.

Return type

[numpy.ndarray](#)

Notes

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |

- The chromatic adaptation method implemented here is a bit unusual as it involves building a new colourspace based on *ACES2065-1* colourspace primaries but using the whitepoint of the illuminant that the spectral distribution was measured under.

References

[For18], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14b], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14c], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommitteea]

Examples

```
>>> from colour import SDS_COLOURCHECKERS
>>> sd = SDS_COLOURCHECKERS["ColorChecker N 0hta"]["dark skin"]
>>> sd_to_aces_relative_exposure_values(
...     sd, chromatic_adaptation_transform=None
... )
array([ 0.1171814...,  0.0866360...,  0.0589726...])
>>> sd_to_aces_relative_exposure_values(
...     sd, apply_chromatic_adaptation=True
... )
```

(continues on next page)

(continued from previous page)

```
...
array([ 0.1180779...,  0.0869031...,  0.0589125...])
```

colour.sd_to_ACES2065_1

`colour.sd_to_ACES2065_1(sd: SpectralDistribution, illuminant: SpectralDistribution | None = None, chromatic_adaptation_transform: Literal['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling'] | str | None = 'CAT02', **kwargs) → ndarray`

Convert given spectral distribution to *ACES2065-1* colourspace relative exposure values.

Parameters

- **sd** ([SpectralDistribution](#)) – Spectral distribution.
- **illuminant** ([SpectralDistribution](#) | *None*) – *Illuminant* spectral distribution, default to *CIE Standard Illuminant D65*.
- **chromatic_adaptation_transform** ([Literal](#)['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling'] | *str* | *None*) – *Chromatic adaptation* transform.

Returns

ACES2065-1 colourspace relative exposure values array.

Return type

[numpy.ndarray](#)

Notes

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |

- The chromatic adaptation method implemented here is a bit unusual as it involves building a new colourspace based on *ACES2065-1* colourspace primaries but using the whitepoint of the illuminant that the spectral distribution was measured under.

References

[For18], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14b], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14c], [TheAoMPAa-SciencesScienceaTCouncilAcademyCESACESPSubcommittea]

Examples

```
>>> from colour import SDS_COLOURCHECKERS
>>> sd = SDS_COLOURCHECKERS["ColorChecker N 0hta"]["dark skin"]
>>> sd_to_aces_relative_exposure_values(
...     sd, chromatic_adaptation_transform=None
... )
array([ 0.1171814...,  0.0866360...,  0.0589726...])
>>> sd_to_aces_relative_exposure_values(
...     sd, apply_chromatic_adaptation=True
... )
...
array([ 0.1180779...,  0.0869031...,  0.0589125...])
```

Ancillary Objects

colour.characterisation

MSDS_ACES_RICD

Implement support for a camera *RGB* sensitivities.

colour.characterisation.MSDS_ACES_RICD

colour.characterisation.MSDS_ACES_RICD = RGB_CameraSensitivities(name='ACES RICD', ...)

Implement support for a camera *RGB* sensitivities.

Parameters

- **data** – Data to be stored in the multi-spectral distributions.
- **domain** – Values to initialise the multiple `colour.SpectralDistribution` class instances `colour.continuous.Signal.wavelengths` attribute with. If both data and domain arguments are defined, the latter will be used to initialise the `colour.continuous.Signal.wavelengths` property.
- **labels** – Names to use for the `colour.SpectralDistribution` class instances.
- **extrapolator** – Extrapolator class type to use as extrapolating function for the `colour.SpectralDistribution` class instances.
- **extrapolator_kwargs** – Arguments to use when instantiating the extrapolating function of the `colour.SpectralDistribution` class instances.
- **interpolator** – Interpolator class type to use as interpolating function for the `colour.SpectralDistribution` class instances.
- **interpolator_kwargs** – Arguments to use when instantiating the interpolating function of the `colour.SpectralDistribution` class instances.
- **name** – Multi-spectral distributions name.
- **display_labels** – Multi-spectral distributions labels for figures, default to `colour.colorimetry.RGB_CameraSensitivities.labels` property value.

ACES Input Transform Computation

colour

| | |
|---|---|
| <code>matrix_idt(sensitivities, illuminant[, ...])</code> | Compute an <i>Input Device Transform</i> (IDT) matrix for given camera <i>RGB</i> spectral sensitivities, illuminant, training data, standard observer colour matching functions and optimization settings according to <i>RAW to ACES v1</i> and <i>P-2013-001</i> procedures. |
| <code>camera_RGB_to_ACES2065_1(RGB, B, b[, k, clip])</code> | Convert given camera <i>RGB</i> colourspace array to <i>ACES2065-1</i> colourspace using the <i>Input Device Transform</i> (IDT) matrix <i>B</i> , the white balance multipliers <i>b</i> and the exposure factor <i>k</i> according to <i>P-2013-001</i> procedure. |

colour.matrix_idt

`colour.matrix_idt(sensitivities: RGB_CameraSensitivities, illuminant: SpectralDistribution, training_data: MultiSpectralDistributions | None = None, cmfs: MultiSpectralDistributions | None = None, optimisation_factory: Callable = optimisation_factory_rawtoaces_v1, optimisation_kwargs: Dict | None = None, chromatic_adaptation_transform: Literal['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling'] | str | None = 'CAT02', additional_data: bool = False) → Tuple[ndarray, ndarray, ndarray, ndarray] | Tuple[ndarray, ndarray]`

Compute an *Input Device Transform* (IDT) matrix for given camera *RGB* spectral sensitivities, illuminant, training data, standard observer colour matching functions and optimization settings according to *RAW to ACES v1* and *P-2013-001* procedures.

Parameters

- **sensitivities** (*RGB_CameraSensitivities*) – Camera *RGB* spectral sensitivities.
- **illuminant** (*SpectralDistribution*) – Illuminant spectral distribution.
- **training_data** (*MultiSpectralDistributions* | *None*) – Training data multi-spectral distributions, defaults to using the *RAW to ACES v1* 190 patches.
- **cmfs** (*MultiSpectralDistributions* | *None*) – Standard observer colour matching functions, default to the *CIE 1931 2 Degree Standard Observer*.
- **optimisation_factory** (*Callable*) – Callable producing the objective function and the *CIE XYZ* to optimisation colour model function.
- **optimisation_kwargs** (*Dict* | *None*) – Parameters for `scipy.optimize.minimize()` definition.
- **chromatic_adaptation_transform** (*Literal*['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling'] | *str* | *None*) – *Chromatic adaptation* transform, if *None* no chromatic adaptation is performed.
- **additional_data** (*bool*) – If *True*, the *XYZ* and *RGB* tristimulus values are also returned.

Returns

Tuple of *Input Device Transform* (IDT) matrix and white balance multipliers or tuple of *Input Device Transform* (IDT) matrix, white balance multipliers, *XYZ* and *RGB* tristimulus values.

Return type

tuple

References

[DFI+17], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee15]

Examples

Computing the *Input Device Transform* (IDT) matrix for a *CANON EOS 5DMark II* and *CIE Illuminant D Series D55* using the method given in *RAW to ACES v1*:

```
>>> path = os.path.join(
...     ROOT_RESOURCES_RAWTOACES,
...     "CANON_EOS_5DMark_II_RGB_Sensitivities.csv",
... )
>>> sensitivities = sds_and_msds_to_msds(
...     read_sds_from_csv_file(path).values()
... )
>>> illuminant = SDS_ILLUMINANTS["D55"]
>>> M, RGB_w = matrix_idt(sensitivities, illuminant)
>>> np.around(M, 3)
array([[ 0.85 , -0.016,  0.151],
       [ 0.051,  1.126, -0.185],
       [ 0.02 , -0.194,  1.162]])
>>> RGB_w
array([ 2.3414154...,  1.          ,  1.5163375...])
```

The *RAW to ACES v1* matrix for the same camera and optimized by [Ceres Solver](#) is as follows:

```
0.864994 -0.026302 0.161308
0.056527 1.122997 -0.179524
0.023683 -0.202547 1.178864
```

```
>>> M, RGB_w = matrix_idt(
...     sensitivities,
...     illuminant,
...     optimisation_factory=optimisation_factory_Jzazbz,
... )
>>> np.around(M, 3)
array([[ 0.848, -0.016,  0.158],
       [ 0.053,  1.114, -0.175],
       [ 0.023, -0.225,  1.196]])
>>> RGB_w
array([ 2.3414154...,  1.          ,  1.5163375...])
```

colour.camera_RGB_to_ACES2065_1

`colour.camera_RGB_to_ACES2065_1(`*RGB*`:` ArrayLike`,` *B*`:` ArrayLike`,` *b*`:` ArrayLike`,` *k*`:` ArrayLike `=` `np.ones(3), clip:` bool `= False)` \rightarrow ndarray

Convert given camera *RGB* colourspace array to *ACES2065-1* colourspace using the *Input Device Transform* (IDT) matrix *B*, the white balance multipliers *b* and the exposure factor *k* according to *P-2013-001* procedure.

Parameters

- **RGB** (ArrayLike) – Camera *RGB* colourspace array.
- **B** (ArrayLike) – *Input Device Transform* (IDT) matrix *B*.
- **b** (ArrayLike) – White balance multipliers *b*.
- **k** (ArrayLike) – Exposure factor *k* that results in a nominally “18% gray” object in the scene producing ACES values [0.18, 0.18, 0.18].
- **clip** (bool) – Whether to clip the white balanced camera *RGB* colourspace array between $-\infty$ and 1. The intent is to keep sensor saturated values achromatic after white balancing.

Returns

ACES2065-1 colourspace relative exposure values array.

Return type

numpy.ndarray

References

[[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee15](#)]

Examples

```
>>> path = os.path.join(
...     ROOT_RESOURCES_RAWTOACES,
...     "CANON_EOS_5DMark_II_RGB_Sensitivities.csv",
... )
>>> sensitivities = sds_and_msds_to_msds(
...     read_sds_from_csv_file(path).values()
... )
>>> illuminant = SDS_ILLUMINANTS["D55"]
>>> B, b = matrix_idt(sensitivities, illuminant)
>>> camera_RGB_to_ACES2065_1(np.array([0.1, 0.2, 0.3]), B, b)
...
array([ 0.2646811...,  0.1528898...,  0.4944335...])
```

Ancillary Objects

colour.characterisation

| | |
|--|--|
| <code>read_training_data_rawtoaces_v1()</code> | Read the <i>RAW to ACES</i> v1 190 patches. |
| <code>generate_illuminants_rawtoaces_v1()</code> | Generate a series of illuminants according to <i>RAW to ACES</i> v1: |
| <code>white_balance_multipliers(sensitivities, ...)</code> | Compute the <i>RGB</i> white balance multipliers for given camera <i>RGB</i> spectral sensitivities and illuminant. |
| <code>normalise_illuminant(illuminant, sensitivities)</code> | Normalise given illuminant with given camera <i>RGB</i> spectral sensitivities. |
| <code>training_data_sds_to_RGB(training_data, ...)</code> | Convert given training data to <i>RGB</i> tristimulus values using given illuminant and given camera <i>RGB</i> spectral sensitivities. |
| <code>training_data_sds_to_XYZ(training_data, ...)</code> | Convert given training data to <i>CIE XYZ</i> tristimulus values using given illuminant and given standard observer colour matching functions. |
| <code>best_illuminant(RGB_w, sensitivities, ...)</code> | Select the best illuminant for given <i>RGB</i> white balance multipliers, and sensitivities in given series of illuminants. |
| <code>optimisation_factory_rawtoaces_v1()</code> | Produce the objective function and <i>CIE XYZ</i> colour space to optimisation colour space/colour model function according to <i>RAW to ACES</i> v1. |
| <code>optimisation_factory_Jzazbz()</code> | Produce the objective function and <i>CIE XYZ</i> colour space to optimisation colour space/colour model function based on the $J_z a_z b_z$ colour space. |

colour.characterisation.read_training_data_rawtoaces_v1

`colour.characterisation.read_training_data_rawtoaces_v1()` → *MultiSpectralDistributions*

Read the *RAW to ACES* v1 190 patches.

Returns

RAW to ACES v1 190 patches.

Return type

`colour.MultiSpectralDistributions`

References

[DFI+17]

Examples

```
>>> len(read_training_data_rawtoaces_v1().labels)
190
```

colour.characterisation.generate_illuminants_rawtoaces_v1

colour.characterisation.generate_illuminants_rawtoaces_v1() → *CanonicalMapping*

Generate a series of illuminants according to *RAW to ACES v1*:

- *CIE Illuminant D Series* in range [4000, 25000] kelvin degrees.
- *Blackbodies* in range [1000, 3500] kelvin degrees.
- A.M.P.A.S. variant of *ISO 7589 Studio Tungsten*.

Returns

Series of illuminants.

Return type

colour.utilities.CanonicalMapping

Notes

- This definition introduces a few differences compared to *RAW to ACES v1*: *CIE Illuminant D Series* are computed in range [4002.15, 7003.77] kelvin degrees and the C_2 change is not used in *RAW to ACES v1*.

References

[DFI+17]

Examples

```
>>> list(sorted(generate_illuminants_rawtoaces_v1().keys()))
['1000K Blackbody', '1500K Blackbody', '2000K Blackbody', '2500K Blackbody', '3000K_
→Blackbody', '3500K Blackbody', 'D100', 'D105', 'D110', 'D115', 'D120', 'D125',
→'D130', 'D135', 'D140', 'D145', 'D150', 'D155', 'D160', 'D165', 'D170', 'D175',
→'D180', 'D185', 'D190', 'D195', 'D200', 'D205', 'D210', 'D215', 'D220', 'D225',
→'D230', 'D235', 'D240', 'D245', 'D250', 'D40', 'D45', 'D50', 'D55', 'D60', 'D65',
→'D70', 'D75', 'D80', 'D85', 'D90', 'D95', 'iso7589']
```

colour.characterisation.white_balance_multipliers

colour.characterisation.white_balance_multipliers(sensitivities: *RGB_CameraSensitivities*,
illuminant: *SpectralDistribution*) → ndarray

Compute the *RGB* white balance multipliers for given camera *RGB* spectral sensitivities and illuminant.

Parameters

- **sensitivities** (*RGB_CameraSensitivities*) – Camera *RGB* spectral sensitivities.
- **illuminant** (*SpectralDistribution*) – Illuminant spectral distribution.

Returns*RGB* white balance multipliers.**Return type**`numpy.ndarray`**References**[\[DFI+17\]](#)**Examples**

```
>>> path = os.path.join(
...     ROOT_RESOURCES_RAWTOACES,
...     "CANON_EOS_5DMark_II_RGB_Sensitivities.csv",
... )
>>> sensitivities = sds_and_msds_to_msds(
...     read_sds_from_csv_file(path).values()
... )
>>> illuminant = SDS_ILLUMINANTS["D55"]
>>> white_balance_multipliers(sensitivities, illuminant)
...
array([ 2.3414154...,  1.          ,  1.5163375...])
```

colour.characterisation.normalise_illuminant

`colour.characterisation.normalise_illuminant`(*illuminant*: [SpectralDistribution](#), *sensitivities*: [RGB_CameraSensitivities](#)) → [SpectralDistribution](#)

Normalise given illuminant with given camera *RGB* spectral sensitivities.

The multiplicative inverse scaling factor k is computed by multiplying the illuminant by the sensitivities channel with the maximum value.

Parameters

- **illuminant** ([SpectralDistribution](#)) – Illuminant spectral distribution.
- **sensitivities** ([RGB_CameraSensitivities](#)) – Camera *RGB* spectral sensitivities.

Returns

Normalised illuminant.

Return type[colour.SpectralDistribution](#)**Examples**

```
>>> path = os.path.join(
...     ROOT_RESOURCES_RAWTOACES,
...     "CANON_EOS_5DMark_II_RGB_Sensitivities.csv",
... )
>>> sensitivities = sds_and_msds_to_msds(
...     read_sds_from_csv_file(path).values()
... )
>>> illuminant = SDS_ILLUMINANTS["D55"]
>>> np.sum(illuminant.values)
```

(continues on next page)

(continued from previous page)

```

7276.1490000...
>>> np.sum(normalise_illuminant(illuminant, sensitivities).values)
...
3.4390373...

```

colour.characterisation.training_data_sds_to_RGB

colour.characterisation.**training_data_sds_to_RGB**(*training_data*: [MultiSpectralDistributions](#),
sensitivities: [RGB_CameraSensitivities](#),
illuminant: [SpectralDistribution](#)) →
 Tuple[ndarray, ndarray]

Convert given training data to *RGB* tristimulus values using given illuminant and given camera *RGB* spectral sensitivities.

Parameters

- **training_data** ([MultiSpectralDistributions](#)) – Training data multi-spectral distributions.
- **sensitivities** ([RGB_CameraSensitivities](#)) – Camera *RGB* spectral sensitivities.
- **illuminant** ([SpectralDistribution](#)) – Illuminant spectral distribution.

Returns

Tuple of training data *RGB* tristimulus values and white balance multipliers.

Return type

tuple

Examples

```

>>> path = os.path.join(
...     ROOT_RESOURCES_RAWTOACES,
...     "CANON_EOS_5DMark_II_RGB_Sensitivities.csv",
... )
>>> sensitivities = sds_and_msds_to_msds(
...     read_sds_from_csv_file(path).values()
... )
>>> illuminant = normalise_illuminant(
...     SDS_ILLUMINANTS["D55"], sensitivities
... )
>>> training_data = read_training_data_rawtoaces_v1()
>>> RGB, RGB_w = training_data_sds_to_RGB(
...     training_data, sensitivities, illuminant
... )
>>> RGB[:5]
array([[ 0.0207582...,  0.0196857...,  0.0213935...],
       [ 0.0895775...,  0.0891922...,  0.0891091...],
       [ 0.7810230...,  0.7801938...,  0.7764302...],
       [ 0.1995 ...,  0.1995 ...,  0.1995 ...],
       [ 0.5898478...,  0.5904015...,  0.5851076...]])
>>> RGB_w
array([ 2.3414154...,  1.          ,  1.5163375...])

```

colour.characterisation.training_data_sds_to_XYZ

`colour.characterisation.training_data_sds_to_XYZ(training_data: MultiSpectralDistributions, cmfs: MultiSpectralDistributions, illuminant: SpectralDistribution, chromatic_adaptation_transform: Literal['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling'] | str | None = 'CAT02') → ndarray`

Convert given training data to *CIE XYZ* tristimulus values using given illuminant and given standard observer colour matching functions.

Parameters

- **training_data** (`MultiSpectralDistributions`) – Training data multi-spectral distributions.
- **cmfs** (`MultiSpectralDistributions`) – Standard observer colour matching functions.
- **illuminant** (`SpectralDistribution`) – Illuminant spectral distribution.
- **chromatic_adaptation_transform** (`Literal['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling'] | str | None`) – *Chromatic adaptation* transform, if *None* no chromatic adaptation is performed.

Returns

Training data *CIE XYZ* tristimulus values.

Return type

`numpy.ndarray`

Examples

```
>>> from colour import MSDS_CMFS
>>> path = os.path.join(
...     ROOT_RESOURCES_RAWTOACES,
...     "CANON_EOS_5DMark_II_RGB_Sensitivities.csv",
... )
>>> cmfs = MSDS_CMFS["CIE 1931 2 Degree Standard Observer"]
>>> sensitivities = sds_and_msds_to_msds(
...     read_sds_from_csv_file(path).values()
... )
>>> illuminant = normalise_illuminant(
...     SDS_ILLUMINANTS["D55"], sensitivities
... )
>>> training_data = read_training_data_rawtoaces_v1()
>>> training_data_sds_to_XYZ(training_data, cmfs, illuminant)[:5]
...
array([[ 0.0174353...,  0.0179504...,  0.0196109...],
       [ 0.0855607...,  0.0895735...,  0.0901703...],
       [ 0.7455880...,  0.7817549...,  0.7834356...],
       [ 0.1900528...,  0.1995    ...,  0.2012606...],
       [ 0.5626319...,  0.5914544...,  0.5894500...]])
```

colour.characterisation.best_illuminant

colour.characterisation.**best_illuminant**(*RGB_w*: ArrayLike, *sensitivities*: RGB_CameraSensitivities, *illuminants*: Mapping) → SpectralDistribution

Select the best illuminant for given *RGB* white balance multipliers, and sensitivities in given series of illuminants.

Parameters

- **RGB_w** (ArrayLike) – *RGB* white balance multipliers.
- **sensitivities** (RGB_CameraSensitivities) – Camera *RGB* spectral sensitivities.
- **illuminants** (Mapping) – Illuminant spectral distributions to choose the best illuminant from.

Returns

Best illuminant.

Return type

colour.SpectralDistribution

Examples

```
>>> path = os.path.join(
...     ROOT_RESOURCES_RAWTOACES,
...     "CANON_EOS_5DMark_II_RGB_Sensitivities.csv",
... )
>>> sensitivities = sds_and_msds_to_msds(
...     read_sds_from_csv_file(path).values()
... )
>>> illuminants = generate_illuminants_rawtoaces_v1()
>>> RGB_w = white_balance_multipliers(
...     sensitivities, SDS_ILLUMINANTS["FL2"]
... )
>>> best_illuminant(RGB_w, sensitivities, illuminants).name
'D40'
```

colour.characterisation.optimisation_factory_rawtoaces_v1

colour.characterisation.**optimisation_factory_rawtoaces_v1**() → Tuple[Callable, Callable]

Produce the objective function and *CIE XYZ* colourspace to optimisation colourspace/colour model function according to *RAW to ACES v1*.

The objective function returns the euclidean distance between the training data *RGB* tristimulus values and the training data *CIE XYZ* tristimulus values** in *CIE L*a*b** colourspace.

Returns

Objective function and *CIE XYZ* colourspace to *CIE L*a*b** colourspace function.

Return type

tuple

Examples

```
>>> optimisation_factory_rawtoaces_v1()
(<function optimisation_factory_rawtoaces_v1.<locals>.objective_function at 0x...>,
↪<function optimisation_factory_rawtoaces_v1.<locals>.XYZ_to_optimization_colour_
↪model at 0x...>)
```

colour.characterisation.optimisation_factory_Jzazbz

colour.characterisation.**optimisation_factory_Jzazbz**() → [Tuple](#)[[Callable](#), [Callable](#)]

Produce the objective function and *CIE XYZ* colourspace to optimisation colourspace/colour model function based on the $J_z a_z b_z$ colourspace.

The objective function returns the euclidean distance between the training data *RGB* tristimulus values and the training data *CIE XYZ* tristimulus values** in the $J_z a_z b_z$ colourspace.

Returns

Objective function and *CIE XYZ* colourspace to $J_z a_z b_z$ colourspace function.

Return type

[tuple](#)

Examples

```
>>> optimisation_factory_Jzazbz()
(<function optimisation_factory_Jzazbz.<locals>.objective_function at 0x...>,
↪<function optimisation_factory_Jzazbz.<locals>.XYZ_to_optimization_colour_model at_
↪0x...>)
```

Colour Fitting

colour

| | |
|--|---|
| POLYNOMIAL_EXPANSION_METHODS | Supported polynomial expansion methods. |
| polynomial_expansion(a[, method]) | Perform polynomial expansion of given a array. |
| MATRIX_COLOUR_CORRECTION_METHODS | Supported colour correction matrix methods. |
| matrix_colour_correction(M_T, M_R[, method]) | Compute a colour correction matrix from given M_T colour array to M_R colour array. |
| COLOUR_CORRECTION_METHODS | Supported colour correction methods. |
| colour_correction(RGB, M_T, M_R[, method]) | Perform colour correction of given <i>RGB</i> colourspace array using the colour correction matrix from given M_T colour array to M_R colour array. |

colour.POLYNOMIAL_EXPANSION_METHODS

```
colour.POLYNOMIAL_EXPANSION_METHODS = CanonicalMapping({'Cheung 2004': ..., 'Finlayson 2015': ..., 'Vandermonde': ...})
```

Supported polynomial expansion methods.

References

[CWCRO4], [FMH15], [WR04], [Wikipedia03f]

colour.polynomial_expansion

```
colour.polynomial_expansion(a: ArrayLike, method: Literal['Cheung 2004', 'Finlayson 2015', 'Vandermonde'] | str = 'Cheung 2004', **kwargs: Any) → ndarray
```

Perform polynomial expansion of given *a* array.

Parameters

- **a** (ArrayLike) – *a* array to expand.
- **method** (Literal['Cheung 2004', 'Finlayson 2015', 'Vandermonde'] | str) – Computation method.
- **degree** – {colour.characterisation.polynomial_expansion_Finlayson2015(), colour.characterisation.polynomial_expansion_Vandermonde()}, Expanded polynomial degree, must be one of [1, 2, 3, 4] for colour.characterisation.polynomial_expansion_Finlayson2015() definition.
- **root_polynomial_expansion** – {colour.characterisation.polynomial_expansion_Finlayson2015()}, Whether to use the root-polynomials set for the expansion.
- **terms** – {colour.characterisation.matrix_augmented_Cheung2004()}, Number of terms of the expanded polynomial.
- **kwargs** (Any) –

Returns

Expanded *a* array.

Return type

numpy.ndarray

References

[CWCRO4], [FMH15], [WR04], [Wikipedia03f]

Examples

```
>>> RGB = np.array([0.17224810, 0.09170660, 0.06416938])
>>> polynomial_expansion(RGB)
array([ 0.1722481...,  0.0917066...,  0.0641693...])
>>> polynomial_expansion(RGB, "Cheung 2004", terms=5)
array([ 0.1722481...,  0.0917066...,  0.0641693...,  0.0010136...,  1...])
```


colour.MATRIX_COLOUR_CORRECTION_METHODS

```
colour.MATRIX_COLOUR_CORRECTION_METHODS = CanonicalMapping({'Cheung 2004': ..., 'Finlayson 2015': ..., 'Vandermonde': ...})
```

Supported colour correction matrix methods.

References

[CWCRO4], [FMH15], [WR04], [Wikipedia03f]

colour.matrix_colour_correction

```
colour.matrix_colour_correction(M_T: ArrayLike, M_R: ArrayLike, method: Literal['Cheung 2004', 'Finlayson 2015', 'Vandermonde'] | str = 'Cheung 2004', **kwargs: Any) → ndarray
```

Compute a colour correction matrix from given M_T colour array to M_R colour array.

The resulting colour correction matrix is computed using multiple linear or polynomial regression using given method. The purpose of that object is for example the matching of two *ColorChecker* colour rendition charts together.

Parameters

- **M_T** (ArrayLike) – Test array M_T to fit onto array M_R .
- **M_R** (ArrayLike) – Reference array the array M_T will be colour fitted against.
- **method** (Literal['Cheung 2004', 'Finlayson 2015', 'Vandermonde'] | str) – Computation method.
- **degree** – {colour.characterisation.polynomial_expansion_Finlayson2015(), colour.characterisation.polynomial_expansion_Vandermonde()}, Expanded polynomial degree, must be one of [1, 2, 3, 4] for colour.characterisation.polynomial_expansion_Finlayson2015() definition.
- **root_polynomial_expansion** – {colour.characterisation.polynomial_expansion_Finlayson2015()}, Whether to use the root-polynomials set for the expansion.
- **terms** – {colour.characterisation.matrix_augmented_Cheung2004()}, Number of terms of the expanded polynomial.
- **kwargs** (Any) –

Returns

Colour correction matrix.

Return type

numpy.ndarray

References

[CWCRO4], [FMH15], [WR04], [Wikipedia03f]

Examples

```
>>> M_T = np.array(
...     [
...         [0.17224810, 0.09170660, 0.06416938],
...         [0.49189645, 0.27802050, 0.21923399],
...         [0.10999751, 0.18658946, 0.29938611],
...         [0.11666120, 0.14327905, 0.05713804],
...         [0.18988879, 0.18227649, 0.36056247],
...         [0.12501329, 0.42223442, 0.37027445],
...         [0.64785606, 0.22396782, 0.03365194],
...         [0.06761093, 0.11076896, 0.39779139],
...         [0.49101797, 0.09448929, 0.11623839],
...         [0.11622386, 0.04425753, 0.14469986],
...         [0.36867946, 0.44545230, 0.06028681],
...         [0.61632937, 0.32323906, 0.02437089],
...         [0.03016472, 0.06153243, 0.29014596],
...         [0.11103655, 0.30553067, 0.08149137],
...         [0.41162190, 0.05816656, 0.04845934],
...         [0.73339206, 0.53075188, 0.02475212],
...         [0.47347718, 0.08834792, 0.30310315],
...         [0.00000000, 0.25187016, 0.35062450],
...         [0.76809639, 0.78486240, 0.77808297],
...         [0.53822392, 0.54307997, 0.54710883],
...         [0.35458526, 0.35318419, 0.35524431],
...         [0.17976704, 0.18000531, 0.17991488],
...         [0.09351417, 0.09510603, 0.09675027],
...         [0.03405071, 0.03295077, 0.03702047],
...     ]
... )
>>> M_R = np.array(
...     [
...         [0.15579559, 0.09715755, 0.07514556],
...         [0.39113140, 0.25943419, 0.21266708],
...         [0.12824821, 0.18463570, 0.31508023],
...         [0.12028974, 0.13455659, 0.07408400],
...         [0.19368988, 0.21158946, 0.37955964],
...         [0.19957425, 0.36085439, 0.40678123],
...         [0.48896605, 0.20691688, 0.05816533],
...         [0.09775522, 0.16710693, 0.47147724],
...         [0.39358649, 0.12233400, 0.10526425],
...         [0.10780332, 0.07258529, 0.16151473],
...         [0.27502671, 0.34705454, 0.09728099],
...         [0.43980441, 0.26880559, 0.05430533],
...         [0.05887212, 0.11126272, 0.38552469],
...         [0.12705825, 0.25787860, 0.13566464],
...         [0.35612929, 0.07933258, 0.05118732],
...         [0.48131976, 0.42082843, 0.07120612],
...         [0.34665585, 0.15170714, 0.24969804],
...         [0.08261116, 0.24588716, 0.48707733],
...         [0.66054904, 0.65941137, 0.66376412],
...         [0.48051509, 0.47870296, 0.48230082],
...     ]
... )
```

(continues on next page)

(continued from previous page)

```

...     [0.33045354, 0.32904184, 0.33228886],
...     [0.18001305, 0.17978567, 0.18004416],
...     [0.10283975, 0.10424680, 0.10384975],
...     [0.04742204, 0.04772203, 0.04914226],
... ]
... )
>>> matrix_colour_correction(M_T, M_R)
array([[ 0.6982266...,  0.0307162...,  0.1621042...],
       [ 0.0689349...,  0.6757961...,  0.1643038...],
       [-0.0631495...,  0.0921247...,  0.9713415...]])

```

colour.COLOUR_CORRECTION_METHODS

```
colour.COLOUR_CORRECTION_METHODS = CanonicalMapping({'Cheung 2004': ..., 'Finlayson 2015': ..., 'Vandermonde': ...})
```

Supported colour correction methods.

References

[CWCRO4], [FMH15], [WR04], [Wikipedia03f]

colour.colour_correction

```
colour.colour_correction(
    RGB: ArrayLike, M_T: ArrayLike, M_R: ArrayLike,
    method: Literal['Cheung 2004', 'Finlayson 2015', 'Vandermonde'] | str = 'Cheung 2004',
    **kwargs: Any) → ndarray
```

Perform colour correction of given *RGB* colourspace array using the colour correction matrix from given M_T colour array to M_R colour array.

Parameters

- **RGB** (ArrayLike) – *RGB* colourspace array to colour correct.
- **M_T** (ArrayLike) – Test array M_T to fit onto array M_R .
- **M_R** (ArrayLike) – Reference array the array M_T will be colour fitted against.
- **method** (Literal['Cheung 2004', 'Finlayson 2015', 'Vandermonde'] | str) – Computation method.
- **degree** – {colour.characterisation.polynomial_expansion_Finlayson2015(), colour.characterisation.polynomial_expansion_Vandermonde()}, Expanded polynomial degree, must be one of [1, 2, 3, 4] for colour.characterisation.polynomial_expansion_Finlayson2015() definition.
- **root_polynomial_expansion** – {colour.characterisation.polynomial_expansion_Finlayson2015()}, Whether to use the root-polynomials set for the expansion.
- **terms** – {colour.characterisation.matrix_augmented_Cheung2004()}, Number of terms of the expanded polynomial.
- **kwargs** (Any) –

Returns

Colour corrected *RGB* colourspace array.

Return type

numpy.ndarray

References

[CWC04], [FMH15], [WR04], [Wikipedia03f]

Examples

```
>>> RGB = np.array([0.17224810, 0.09170660, 0.06416938])
>>> M_T = np.array(
...     [
...         [0.17224810, 0.09170660, 0.06416938],
...         [0.49189645, 0.27802050, 0.21923399],
...         [0.10999751, 0.18658946, 0.29938611],
...         [0.11666120, 0.14327905, 0.05713804],
...         [0.18988879, 0.18227649, 0.36056247],
...         [0.12501329, 0.42223442, 0.37027445],
...         [0.64785606, 0.22396782, 0.03365194],
...         [0.06761093, 0.11076896, 0.39779139],
...         [0.49101797, 0.09448929, 0.11623839],
...         [0.11622386, 0.04425753, 0.14469986],
...         [0.36867946, 0.44545230, 0.06028681],
...         [0.61632937, 0.32323906, 0.02437089],
...         [0.03016472, 0.06153243, 0.29014596],
...         [0.11103655, 0.30553067, 0.08149137],
...         [0.41162190, 0.05816656, 0.04845934],
...         [0.73339206, 0.53075188, 0.02475212],
...         [0.47347718, 0.08834792, 0.30310315],
...         [0.00000000, 0.25187016, 0.35062450],
...         [0.76809639, 0.78486240, 0.77808297],
...         [0.53822392, 0.54307997, 0.54710883],
...         [0.35458526, 0.35318419, 0.35524431],
...         [0.17976704, 0.18000531, 0.17991488],
...         [0.09351417, 0.09510603, 0.09675027],
...         [0.03405071, 0.03295077, 0.03702047],
...     ]
... )
>>> M_R = np.array(
...     [
...         [0.15579559, 0.09715755, 0.07514556],
...         [0.39113140, 0.25943419, 0.21266708],
...         [0.12824821, 0.18463570, 0.31508023],
...         [0.12028974, 0.13455659, 0.07408400],
...         [0.19368988, 0.21158946, 0.37955964],
...         [0.19957425, 0.36085439, 0.40678123],
...         [0.48896605, 0.20691688, 0.05816533],
...         [0.09775522, 0.16710693, 0.47147724],
...         [0.39358649, 0.12233400, 0.10526425],
...         [0.10780332, 0.07258529, 0.16151473],
...         [0.27502671, 0.34705454, 0.09728099],
...         [0.43980441, 0.26880559, 0.05430533],
...         [0.05887212, 0.11126272, 0.38552469],
...         [0.12705825, 0.25787860, 0.13566464],
...         [0.35612929, 0.07933258, 0.05118732],
...         [0.48131976, 0.42082843, 0.07120612],
...         [0.34665585, 0.15170714, 0.24969804],
...         [0.08261116, 0.24588716, 0.48707733],
...         [0.66054904, 0.65941137, 0.66376412],
```

(continues on next page)

(continued from previous page)

```

...      [0.48051509, 0.47870296, 0.48230082],
...      [0.33045354, 0.32904184, 0.33228886],
...      [0.18001305, 0.17978567, 0.18004416],
...      [0.10283975, 0.10424680, 0.10384975],
...      [0.04742204, 0.04772203, 0.04914226],
...      ]
...  )
>>> colour_correction(RGB, M_T, M_R)
array([ 0.1334872...,  0.0843921...,  0.0599014...])

```

Ancillary Objects

colour.characterisation

| | |
|---|---|
| <code>matrix_augmented_Cheung2004(RGB[, terms])</code> | Perform polynomial expansion of given <i>RGB</i> colourspace array using <i>Cheung et al. (2004)</i> method. |
| <code>polynomial_expansion_Finlayson2015(RGB[, ...])</code> | Perform polynomial expansion of given <i>RGB</i> colourspace array using <i>Finlayson et al. (2015)</i> method. |
| <code>polynomial_expansion_Vandermonde(a[, degree])</code> | Perform polynomial expansion of given <i>a</i> array using <i>Vandermonde</i> method. |
| <code>matrix_colour_correction_Cheung2004(M_T, M_R)</code> | Compute a colour correction matrix from given M_T colour array to M_R colour array using <i>Cheung et al. (2004)</i> method. |
| <code>matrix_colour_correction_Finlayson2015(M_T, M_R)</code> | Compute a colour correction matrix from given M_T colour array to M_R colour array using <i>Finlayson et al. (2015)</i> method. |
| <code>matrix_colour_correction_Vandermonde(M_T, M_R)</code> | Compute a colour correction matrix from given M_T colour array to M_R colour array using <i>Vandermonde</i> method. |
| <code>colour_correction_Cheung2004(RGB, M_T, M_R)</code> | Perform colour correction of given <i>RGB</i> colourspace array using the colour correction matrix from given M_T colour array to M_R colour array using <i>Cheung et al. (2004)</i> method. |
| <code>colour_correction_Finlayson2015(RGB, M_T, M_R)</code> | Perform colour correction of given <i>RGB</i> colourspace array using the colour correction matrix from given M_T colour array to M_R colour array using <i>Finlayson et al. (2015)</i> method. |
| <code>colour_correction_Vandermonde(RGB, M_T, M_R)</code> | Perform colour correction of given <i>RGB</i> colourspace array using the colour correction matrix from given M_T colour array to M_R colour array using <i>Vandermonde</i> method. |

colour.characterisation.matrix_augmented_Cheung2004

colour.characterisation.**matrix_augmented_Cheung2004**(*RGB*: ArrayLike, *terms*: [Literal](#)[3, 5, 7, 8, 10, 11, 14, 16, 17, 19, 20, 22] = 3) → [ndarray](#)

Perform polynomial expansion of given *RGB* colourspace array using *Cheung et al. (2004)* method.

Parameters

- **RGB** (ArrayLike) – *RGB* colourspace array to expand.
- **terms** ([Literal](#)[3, 5, 7, 8, 10, 11, 14, 16, 17, 19, 20, 22]) – Number of terms of the expanded polynomial.

Returns

Expanded *RGB* colourspace array.

Return type

[numpy.ndarray](#)

Notes

- This definition combines the augmented matrices given in [\[CWCR04\]](#) and [\[WR04\]](#).

References

[\[CWCR04\]](#), [\[WR04\]](#)

Examples

```
>>> RGB = np.array([0.17224810, 0.09170660, 0.06416938])
>>> matrix_augmented_Cheung2004(RGB, terms=5)
array([ 0.1722481...,  0.0917066...,  0.0641693...,  0.0010136...,  1...])
```

colour.characterisation.polynomial_expansion_Finlayson2015

colour.characterisation.**polynomial_expansion_Finlayson2015**(*RGB*: ArrayLike, *degree*: [Literal](#)[1, 2, 3, 4] = 1, *root_polynomial_expansion*: *bool* = *True*) → [ndarray](#)

Perform polynomial expansion of given *RGB* colourspace array using *Finlayson et al. (2015)* method.

Parameters

- **RGB** (ArrayLike) – *RGB* colourspace array to expand.
- **degree** ([Literal](#)[1, 2, 3, 4]) – Expanded polynomial degree.
- **root_polynomial_expansion** (*bool*) – Whether to use the root-polynomials set for the expansion.

Returns

Expanded *RGB* colourspace array.

Return type

[numpy.ndarray](#)

References

[FMH15]

Examples

```
>>> RGB = np.array([0.17224810, 0.09170660, 0.06416938])
>>> polynomial_expansion_Finlayson2015(RGB, degree=2)
array([ 0.1722481...,  0.0917066...,  0.0641693...,  0.1256832...,  0.0767121...,
        0.1051335...])
```

colour.characterisation.polynomial_expansion_Vandermonde

colour.characterisation.polynomial_expansion_Vandermonde(*a*: ArrayLike, *degree*: int = 1) → ndarray

Perform polynomial expansion of given *a* array using *Vandermonde* method.

Parameters

- **a** (ArrayLike) – *a* array to expand.
- **degree** (int) – Expanded polynomial degree.

Returns

Expanded *a* array.

Return type

numpy.ndarray

References

[Wikipedia03f]

Examples

```
>>> RGB = np.array([0.17224810, 0.09170660, 0.06416938])
>>> polynomial_expansion_Vandermonde(RGB)
array([ 0.1722481 ,  0.0917066 ,  0.06416938,  1.          ])
```

colour.characterisation.matrix_colour_correction_Cheung2004

colour.characterisation.matrix_colour_correction_Cheung2004(*M_T*: ArrayLike, *M_R*: ArrayLike, *terms*: Literal[3, 5, 7, 8, 10, 11, 14, 16, 17, 19, 20, 22] = 3) → ndarray

Compute a colour correction matrix from given M_T colour array to M_R colour array using *Cheung et al. (2004)* method.

Parameters

- **M_T** (ArrayLike) – Test array M_T to fit onto array M_R .
- **M_R** (ArrayLike) – Reference array the array M_T will be colour fitted against.
- **terms** (Literal[3, 5, 7, 8, 10, 11, 14, 16, 17, 19, 20, 22]) – Number of terms of the expanded polynomial.

Returns

Colour correction matrix.

Return type

`numpy.ndarray`

References

[CWCR04], [WR04]

Examples

```
>>> prng = np.random.RandomState(2)
>>> M_T = prng.random_sample((24, 3))
>>> M_R = M_T + (prng.random_sample((24, 3)) - 0.5) * 0.5
>>> matrix_colour_correction_Cheung2004(M_T, M_R)
array([[ 1.0526376...,  0.1378078..., -0.2276339...],
       [ 0.0739584...,  1.0293994..., -0.1060115...],
       [ 0.0572550..., -0.2052633...,  1.1015194...]])
```

colour.characterisation.matrix_colour_correction_Finlayson2015

`colour.characterisation.matrix_colour_correction_Finlayson2015`(*M_T*: *ArrayLike*, *M_R*: *ArrayLike*, *degree*: *Literal*[1, 2, 3, 4] = 1, *root_polynomial_expansion*: *bool* = *True*) → *ndarray*

Compute a colour correction matrix from given M_T colour array to M_R colour array using *Finlayson et al. (2015)* method.

Parameters

- ***M_T*** (*ArrayLike*) – Test array M_T to fit onto array M_R .
- ***M_R*** (*ArrayLike*) – Reference array the array M_T will be colour fitted against.
- ***degree*** (*Literal*[1, 2, 3, 4]) – Expanded polynomial degree.
- ***root_polynomial_expansion*** (*bool*) – Whether to use the root-polynomials set for the expansion.

Returns

Colour correction matrix.

Return type

`numpy.ndarray`

References

[FMH15]

Examples

```
>>> prng = np.random.RandomState(2)
>>> M_T = prng.random_sample((24, 3))
>>> M_R = M_T + (prng.random_sample((24, 3)) - 0.5) * 0.5
>>> matrix_colour_correction_Finlayson2015(M_T, M_R)
array([[ 1.0526376...,  0.1378078..., -0.2276339...],
       [ 0.0739584...,  1.0293994..., -0.1060115...],
       [ 0.0572550..., -0.2052633...,  1.1015194...]])
```

colour.characterisation.matrix_colour_correction_Vandermonde

colour.characterisation.**matrix_colour_correction_Vandermonde**(*M_T*: ArrayLike, *M_R*: ArrayLike, *degree*: int = 1) → ndarray

Compute a colour correction matrix from given M_T colour array to M_R colour array using *Vandermonde* method.

Parameters

- **M_T** (ArrayLike) – Test array M_T to fit onto array M_R .
- **M_R** (ArrayLike) – Reference array the array M_T will be colour fitted against.
- **degree** (int) – Expanded polynomial degree.

Returns

Colour correction matrix.

Return type

numpy.ndarray

References

[Wikipedia03f]

Examples

```
>>> prng = np.random.RandomState(2)
>>> M_T = prng.random_sample((24, 3))
>>> M_R = M_T + (prng.random_sample((24, 3)) - 0.5) * 0.5
>>> matrix_colour_correction_Vandermonde(M_T, M_R)
array([[ 1.0300256...,  0.1141770..., -0.2621816...,  0.0418022...],
       [ 0.0670209...,  1.0221494..., -0.1166108...,  0.0128250...],
       [ 0.0744612..., -0.1872819...,  1.1278078..., -0.0318085...]])
```

colour.characterisation.colour_correction_Cheung2004

colour.characterisation.**colour_correction_Cheung2004**(*RGB*: ArrayLike, *M_T*: ArrayLike, *M_R*: ArrayLike, *terms*: Literal[3, 5, 7, 8, 10, 11, 14, 16, 17, 19, 20, 22] = 3) → ndarray

Perform colour correction of given *RGB* colourspace array using the colour correction matrix from given M_T colour array to M_R colour array using *Cheung et al. (2004)* method.

Parameters

- **RGB** (ArrayLike) – *RGB* colourspace array to colour correct.

- **M_T** (ArrayLike) – Test array M_T to fit onto array M_R .
- **M_R** (ArrayLike) – Reference array the array M_T will be colour fitted against.
- **terms** (Literal[3, 5, 7, 8, 10, 11, 14, 16, 17, 19, 20, 22]) – Number of terms of the expanded polynomial.

Returns

Colour corrected *RGB* colourspace array.

Return type

`numpy.ndarray`

References

[CWCRO4], [WR04]

Examples

```
>>> RGB = np.array([0.17224810, 0.09170660, 0.06416938])
>>> prng = np.random.RandomState(2)
>>> M_T = prng.random_sample((24, 3))
>>> M_R = M_T + (prng.random_sample((24, 3)) - 0.5) * 0.5
>>> colour_correction_Cheung2004(RGB, M_T, M_R)
array([ 0.1793456...,  0.1003392...,  0.0617218...])
```

colour.characterisation.colour_correction_Finlayson2015

`colour.characterisation.colour_correction_Finlayson2015`(*RGB*: ArrayLike, *M_T*: ArrayLike, *M_R*: ArrayLike, *degree*: Literal[1, 2, 3, 4] = 1, *root_polynomial_expansion*: bool = True) → ndarray

Perform colour correction of given *RGB* colourspace array using the colour correction matrix from given M_T colour array to M_R colour array using *Finlayson et al. (2015)* method.

Parameters

- **RGB** (ArrayLike) – *RGB* colourspace array to colour correct.
- **M_T** (ArrayLike) – Test array M_T to fit onto array M_R .
- **M_R** (ArrayLike) – Reference array the array M_T will be colour fitted against.
- **degree** (Literal[1, 2, 3, 4]) – Expanded polynomial degree.
- **root_polynomial_expansion** (bool) – Whether to use the root-polynomials set for the expansion.

Returns

Colour corrected *RGB* colourspace array.

Return type

`numpy.ndarray`

References

[FMH15]

Examples

```
>>> RGB = np.array([0.17224810, 0.09170660, 0.06416938])
>>> prng = np.random.RandomState(2)
>>> M_T = prng.random_sample((24, 3))
>>> M_R = M_T + (prng.random_sample((24, 3)) - 0.5) * 0.5
>>> colour_correction_Finlayson2015(RGB, M_T, M_R)
array([ 0.1793456...,  0.1003392...,  0.0617218...])
```

colour.characterisation.colour_correction_Vandermonde

colour.characterisation.colour_correction_Vandermonde(*RGB*: ArrayLike, *M_T*: ArrayLike, *M_R*: ArrayLike, *degree*: int = 1) → ndarray

Perform colour correction of given *RGB* colourspace array using the colour correction matrix from given *M_T* colour array to *M_R* colour array using *Vandermonde* method.

Parameters

- **RGB** (ArrayLike) – *RGB* colourspace array to colour correct.
- **M_T** (ArrayLike) – Test array *M_T* to fit onto array *M_R*.
- **M_R** (ArrayLike) – Reference array the array *M_T* will be colour fitted against.
- **degree** (int) – Expanded polynomial degree.

Returns

Colour corrected *RGB* colourspace array.

Return type

numpy.ndarray

References

[Wikipedia03f]

Examples

```
>>> RGB = np.array([0.17224810, 0.09170660, 0.06416938])
>>> prng = np.random.RandomState(2)
>>> M_T = prng.random_sample((24, 3))
>>> M_R = M_T + (prng.random_sample((24, 3)) - 0.5) * 0.5
>>> colour_correction_Vandermonde(RGB, M_T, M_R)
array([ 0.2128689...,  0.1106242...,  0.036213 ...])
```

Colour Rendition Charts

Dataset

colour

| | |
|---------------------------------|--|
| <code>CCS_COLOURCHECKERS</code> | Chromaticity coordinates of the colour checkers. |
| <code>SDS_COLOURCHECKERS</code> | Spectral distributions of the colour checkers. |

colour.CCS_COLOURCHECKERS

```
colour.CCS_COLOURCHECKERS = CanonicalMapping({'ColorChecker 1976': ..., 'ColorChecker 2005': ..., 'BabelColor Average': ..., 'ColorChecker24 - Before November 2014': ..., 'ColorChecker24 - After November 2014': ..., 'babel_average': ..., 'cc2005': ..., 'ccb2014': ..., 'cca2014': ...})
```

Chromaticity coordinates of the colour checkers.

References

[[BabelColor12a](#)], [[BabelColor12b](#)], [[XRite16](#)]

Aliases:

- 'babel_average': 'BabelColor Average'
- 'cc2005': 'ColorChecker 2005'
- 'ccb2014': 'ColorChecker24 - Before November 2014'
- 'cca2014': 'ColorChecker24 - After November 2014'

colour.SDS_COLOURCHECKERS

```
colour.SDS_COLOURCHECKERS = CanonicalMapping({'BabelColor Average': ..., 'ColorChecker N Ohta': ..., 'babel_average': ..., 'cc_ohta': ..., 'ISO 17321-1': ...})
```

Spectral distributions of the colour checkers.

References

[[Oht97](#)], [[BabelColor12a](#)], [[BabelColor12b](#)], [[MunsellCSciencea](#)], [[InternationalOfStandardization12](#)]

Notes

- Data from [[InternationalOfStandardization12](#)] and [[Oht97](#)] has been verified to be the same.

Aliases:

- 'babel_average': 'BabelColor Average'
- 'cc_ohta': 'ColorChecker N Ohta'
- 'ISO 17321-1': 'ColorChecker N Ohta'

Ancillary Objects

colour.characterisation

| | |
|--|-----------------------------|
| <code>ColourChecker(name, data, illuminant)</code> | <i>Colour Checker data.</i> |
|--|-----------------------------|

colour.characterisation.ColourChecker

class colour.characterisation.**ColourChecker**(name, data, illuminant)

Colour Checker data.

Parameters

- **name** – *Colour Checker* name.
- **data** – Chromaticity coordinates in *CIE xyY* colourspace.
- **illuminant** – *Colour Checker* illuminant chromaticity coordinates.

Create new instance of `ColourChecker(name, data, illuminant)`

`__init__()`

Methods

| | |
|--|--|
| <code>__init__()</code> | |
| <code>count(value, /)</code> | Return number of occurrences of value. |
| <code>index(value[, start, stop])</code> | Return first index of value. |

Attributes

| | |
|-------------------------|--------------------------|
| <code>data</code> | Alias for field number 1 |
| <code>illuminant</code> | Alias for field number 2 |
| <code>name</code> | Alias for field number 0 |

Cameras

colour.characterisation

| | |
|---|--|
| <code>RGB_CameraSensitivities(data, domain, ...)</code> | Implement support for a camera <i>RGB</i> sensitivities. |
|---|--|

colour.characterisation.RGB_CameraSensitivities

```
class colour.characterisation.RGB_CameraSensitivities(data: ArrayLike | <MagicMock
                                                    id='139666499392336'> | dict |
                                                    ~colour.continuous.multi_signals.MultiSignals
                                                    |
                                                    ~colour.colorimetry.spectrum.MultiSpectralDistributions
                                                    | ~typing.Sequence | <MagicMock
                                                    id='139666499392528'> |
                                                    ~colour.continuous.signal.Signal |
                                                    ~colour.colorimetry.spectrum.SpectralDistribution
                                                    | None = None, domain: ArrayLike |
                                                    ~colour.colorimetry.spectrum.SpectralShape
                                                    | None = None, labels: ~typing.Sequence
                                                    | None = None, **kwargs: ~typing.Any)
```

Bases: `MultiSpectralDistributions`

Implement support for a camera *RGB* sensitivities.

Parameters

- **data** (Optional[Union[ArrayLike, DataFrame, dict, MultiSignals, MultiSpectralDistributions, Sequence, Series, Signal, SpectralDistribution]]) – Data to be stored in the multi-spectral distributions.
- **domain** (Optional[Union[ArrayLike, SpectralShape]]) – Values to initialise the multiple `colour.SpectralDistribution` class instances `colour.continuous.Signal.wavelengths` attribute with. If both data and domain arguments are defined, the latter will be used to initialise the `colour.continuous.Signal.wavelengths` property.
- **labels** (Optional[Sequence]) – Names to use for the `colour.SpectralDistribution` class instances.
- **extrapolator** – Extrapolator class type to use as extrapolating function for the `colour.SpectralDistribution` class instances.
- **extrapolator_kwargs** – Arguments to use when instantiating the extrapolating function of the `colour.SpectralDistribution` class instances.
- **interpolator** – Interpolator class type to use as interpolating function for the `colour.SpectralDistribution` class instances.
- **interpolator_kwargs** – Arguments to use when instantiating the interpolating function of the `colour.SpectralDistribution` class instances.
- **name** – Multi-spectral distributions name.
- **display_labels** – Multi-spectral distributions labels for figures, default to `colour.colorimetry.RGB_CameraSensitivities.labels` property value.
- **kwargs** (Any) –

```
__init__(data: ArrayLike | <MagicMock id='139666499392336'> | dict |
          ~colour.continuous.multi_signals.MultiSignals |
          ~colour.colorimetry.spectrum.MultiSpectralDistributions | ~typing.Sequence |
          <MagicMock id='139666499392528'> | ~colour.continuous.signal.Signal |
          ~colour.colorimetry.spectrum.SpectralDistribution | None = None, domain: ArrayLike |
          ~colour.colorimetry.spectrum.SpectralShape | None = None, labels: ~typing.Sequence |
          None = None, **kwargs: ~typing.Any) → None
```

Parameters

- **data** (ArrayLike | <MagicMock id='139666499392336'> | dict | MultiSignals | MultiSpectralDistributions | Sequence | <MagicMock id='139666499392528'> | Signal | SpectralDistribution | None) –
- **domain** (ArrayLike | SpectralShape | None) –
- **labels** (Sequence | None) –
- **kwargs** (Any) –

Return type

None

Dataset

colour

`MSDS_CAMERA_SENSITIVITIES`

Multi-spectral distributions of camera sensitivities.

colour.MSDS_CAMERA_SENSITIVITIES

```
colour.MSDS_CAMERA_SENSITIVITIES = LazyCanonicalMapping({'Nikon 5100 (NPL)': ..., 'Sigma SDMerill (NPL)': ...})
```

Multi-spectral distributions of camera sensitivities.

References

[DFGM15]

Displays

colour.characterisation

`RGB_DisplayPrimaries(data, domain, labels, ...)`Implement support for a *RGB* display (such as a *CRT* or *LCD*) primaries multi-spectral distributions.**colour.characterisation.RGB_DisplayPrimaries**

```
class colour.characterisation.RGB_DisplayPrimaries(data: ArrayLike | <MagicMock
                                                    id='139666499473808'> | dict |
                                                    ~colour.continuous.multi_signals.MultiSignals
                                                    |
                                                    ~colour.colorimetry.spectrum.MultiSpectralDistributions
                                                    | ~typing.Sequence | <MagicMock
                                                    id='139666499478992'> |
                                                    ~colour.continuous.signal.Signal |
                                                    ~colour.colorimetry.spectrum.SpectralDistribution
                                                    | None = None, domain: ArrayLike |
                                                    ~colour.colorimetry.spectrum.SpectralShape |
                                                    None = None, labels: ~typing.Sequence |
                                                    None = None, **kwargs: ~typing.Any)
```

Bases: `MultiSpectralDistributions`

Implement support for a *RGB* display (such as a *CRT* or *LCD*) primaries multi-spectral distributions.

Parameters

- **data** (Optional[Union[ArrayLike, DataFrame, dict, MultiSignals, MultiSpectralDistributions, Sequence, Series, Signal, SpectralDistribution]]) – Data to be stored in the multi-spectral distributions.
- **domain** (Optional[Union[ArrayLike, SpectralShape]]) – Values to initialise the multiple `colour.SpectralDistribution` class instances `colour.continuous.Signal.wavelengths` attribute with. If both data and domain arguments are defined, the latter will be used to initialise the `colour.continuous.Signal.wavelengths` property.
- **labels** (Optional[Sequence]) – Names to use for the `colour.SpectralDistribution` class instances.
- **extrapolator** – Extrapolator class type to use as extrapolating function for the `colour.SpectralDistribution` class instances.
- **extrapolator_kwargs** – Arguments to use when instantiating the extrapolating function of the `colour.SpectralDistribution` class instances.
- **interpolator** – Interpolator class type to use as interpolating function for the `colour.SpectralDistribution` class instances.
- **interpolator_kwargs** – Arguments to use when instantiating the interpolating function of the `colour.SpectralDistribution` class instances.
- **name** – Multi-spectral distributions name.
- **display_labels** – Multi-spectral distributions labels for figures, default to `colour.colorimetry.RGB_DisplayPrimaries.labels` property value.
- **kwargs** (Any) –

```
__init__(data: ArrayLike | <MagicMock id='139666499473808'> | dict |
~colour.continuous.multi_signals.MultiSignals |
~colour.colorimetry.spectrum.MultiSpectralDistributions | ~typing.Sequence |
<MagicMock id='139666499478992'> | ~colour.continuous.signal.Signal |
~colour.colorimetry.spectrum.SpectralDistribution | None = None, domain: ArrayLike |
~colour.colorimetry.spectrum.SpectralShape | None = None, labels: ~typing.Sequence |
None = None, **kwargs: ~typing.Any) → None
```

Parameters

- **data** (ArrayLike | <MagicMock id='139666499473808'> | dict | MultiSignals | MultiSpectralDistributions | Sequence | <MagicMock id='139666499478992'> | Signal | SpectralDistribution | None) –
- **domain** (ArrayLike | SpectralShape | None) –
- **labels** (Sequence | None) –
- **kwargs** (Any) –

Return type

None

Dataset

colour

MSDS_DISPLAY_PRIMARIES

Primaries multi-spectral distributions of displays.

colour.MSDS_DISPLAY_PRIMARIES

```
colour.MSDS_DISPLAY_PRIMARIES = LazyCanonicalMapping({'Typical CRT Brainard 1997': ...,
'Apple Studio Display': ...})
```

Primaries multi-spectral distributions of displays.

References

[FW98], [Mac10]

Filters

Dataset

colour

| | |
|-------------|------------------------------------|
| SDS_FILTERS | Spectral distributions of filters. |
|-------------|------------------------------------|

colour.SDS_FILTERS

```
colour.SDS_FILTERS = LazyCanonicalMapping({'ISO 7589 Diffuser': ...})
```

Spectral distributions of filters.

References

[InternationalOfStandardization02]

Lenses

Dataset

colour

| | |
|------------|-----------------------------------|
| SDS_LENSES | Spectral distributions of lenses. |
|------------|-----------------------------------|

colour.SDS_LENSES

```
colour.SDS_LENSES = LazyCanonicalMapping({'ISO Standard Lens': ...})
```

Spectral distributions of lenses.

References

[InternationalOfStandardization02]

Colorimetry

Spectral Data Structure

colour

| | |
|--|---|
| <code>SpectralShape(start, end, interval)</code> | Define the base object for spectral distribution shape. |
| <code>SpectralDistribution(data, domain, **kwargs)</code> | Define the spectral distribution: the base object for spectral computations. |
| <code>MultiSpectralDistributions(data, domain, ...)</code> | Define the multi-spectral distributions: the base object for multi spectral computations. |

colour.SpectralShape

class colour.**SpectralShape**(start: Number, end: Number, interval: Number)

Bases: `object`

Define the base object for spectral distribution shape.

Parameters

- **start** (Number) – Wavelength λ_i range start in nm.
- **end** (Number) – Wavelength λ_i range end in nm.
- **interval** (Number) – Wavelength λ_i range interval.

Attributes

- `start`
- `end`
- `interval`
- `boundaries`
- `wavelengths`

Methods

- `__init__()`
- `__str__()`
- `__repr__()`
- `__hash__()`
- `__iter__()`
- `__contains__()`
- `__len__()`
- `__eq__()`

- `__ne__()`
- `range()`

Examples

```
>>> SpectralShape(360, 830, 1)
SpectralShape(360, 830, 1)
```

`__init__(start: Number, end: Number, interval: Number) → None`

Parameters

- **start** (Number) –
- **end** (Number) –
- **interval** (Number) –

Return type

None

property start: Number

Getter and setter property for the spectral shape start.

Parameters

value – Value to set the spectral shape start with.

Returns

Spectral shape start.

Return type

Number

property end: Number

Getter and setter property for the spectral shape end.

Parameters

value – Value to set the spectral shape end with.

Returns

Spectral shape end.

Return type

Number

property interval: Number

Getter and setter property for the spectral shape interval.

Parameters

value – Value to set the spectral shape interval with.

Returns

Spectral shape interval.

Return type

Number

property boundaries: Tuple

Getter and setter property for the spectral shape boundaries.

Parameters

value – Value to set the spectral shape boundaries with.

Returns

Spectral shape boundaries.

Return type`tuple`**property wavelengths:** `ndarray`

Getter property for the spectral shape wavelengths.

Returns

Spectral shape wavelengths.

Return type`numpy.ndarray`**`__str__()`** → `str`

Return a formatted string representation of the spectral shape.

Returns

Formatted string representation.

Return type`str`**`__repr__()`** → `str`

Return an evaluable string representation of the spectral shape.

Returns

Evaluable string representation.

Return type`str`**`__hash__()`** → `int`

Return the spectral shape hash.

Returns

Object hash.

Return type`numpy.integer`**`__iter__()`** → `Generator`

Return a generator for the spectral shape data.

Yields*Generator* – Spectral shape data generator.**Return type***Generator***Examples**

```
>>> shape = SpectralShape(0, 10, 1)
>>> for wavelength in shape:
...     print(wavelength)
...
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
```

(continues on next page)

(continued from previous page)

```
8.0
9.0
10.0
```

__contains__(*wavelength: FloatingOrArrayLike*) → `bool`

Return if the spectral shape contains given wavelength λ .

Parameters

wavelength (*FloatingOrArrayLike*) – Wavelength λ .

Returns

Whether wavelength λ is contained in the spectral shape.

Return type

`bool`

Examples

```
>>> 0.5 in SpectralShape(0, 10, 0.1)
True
>>> 0.6 in SpectralShape(0, 10, 0.1)
True
>>> 0.51 in SpectralShape(0, 10, 0.1)
False
>>> np.array([0.5, 0.6]) in SpectralShape(0, 10, 0.1)
True
>>> np.array([0.51, 0.6]) in SpectralShape(0, 10, 0.1)
False
```

__len__() → `int`

Return the spectral shape wavelength λ_n count.

Returns

Spectral shape wavelength λ_n count.

Return type

`numpy.integer`

Examples

```
>>> len(SpectralShape(0, 10, 0.1))
101
```

__eq__(*other: Any*) → `bool`

Return whether the spectral shape is equal to given other object.

Parameters

other (*Any*) – Object to test whether it is equal to the spectral shape.

Returns

Whether given object is equal to the spectral shape.

Return type

`bool`

Examples

```
>>> SpectralShape(0, 10, 0.1) == SpectralShape(0, 10, 0.1)
True
>>> SpectralShape(0, 10, 0.1) == SpectralShape(0, 10, 1)
False
```

`__ne__`(*other*: Any) → bool

Return whether the spectral shape is not equal to given other object.

Parameters

other (Any) – Object to test whether it is not equal to the spectral shape.

Returns

Whether given object is not equal to the spectral shape.

Return type

bool

Examples

```
>>> SpectralShape(0, 10, 0.1) != SpectralShape(0, 10, 0.1)
False
>>> SpectralShape(0, 10, 0.1) != SpectralShape(0, 10, 1)
True
```

`range`(*dtype*: Type[DTypeFloating] | None = None) → ndarray

Return an iterable range for the spectral shape.

Parameters

dtype (Type[DTypeFloating] | None) – Data type used to generate the range.

Returns

Iterable range for the spectral distribution shape

Return type

numpy.ndarray

Examples

```
>>> SpectralShape(0, 10, 0.1).wavelengths
array([ 0. ,  0.1,  0.2,  0.3,  0.4,  0.5,  0.6,  0.7,  0.8,
        0.9,  1. ,  1.1,  1.2,  1.3,  1.4,  1.5,  1.6,  1.7,
        1.8,  1.9,  2. ,  2.1,  2.2,  2.3,  2.4,  2.5,  2.6,
        2.7,  2.8,  2.9,  3. ,  3.1,  3.2,  3.3,  3.4,  3.5,
        3.6,  3.7,  3.8,  3.9,  4. ,  4.1,  4.2,  4.3,  4.4,
        4.5,  4.6,  4.7,  4.8,  4.9,  5. ,  5.1,  5.2,  5.3,
        5.4,  5.5,  5.6,  5.7,  5.8,  5.9,  6. ,  6.1,  6.2,
        6.3,  6.4,  6.5,  6.6,  6.7,  6.8,  6.9,  7. ,  7.1,
        7.2,  7.3,  7.4,  7.5,  7.6,  7.7,  7.8,  7.9,  8. ,
        8.1,  8.2,  8.3,  8.4,  8.5,  8.6,  8.7,  8.8,  8.9,
        9. ,  9.1,  9.2,  9.3,  9.4,  9.5,  9.6,  9.7,  9.8,
        9.9, 10. ])
```

`__weakref__`

list of weak references to the object (if defined)

colour.SpectralDistribution

```
class colour.SpectralDistribution(data: ArrayLike | dict | <MagicMock id='139666505445456'> |
                                ~colour.continuous.signal.Signal |
                                ~colour.colorimetry.spectrum.SpectralDistribution | None = None,
                                domain: ArrayLike | ~colour.colorimetry.spectrum.SpectralShape
                                | None = None, **kwargs: ~typing.Any)
```

Bases: [Signal](#)

Define the spectral distribution: the base object for spectral computations.

The spectral distribution will be initialised according to *CIE 15:2004* recommendation: the method developed by *Sprague (1880)* will be used for interpolating functions having a uniformly spaced independent variable and the *Cubic Spline* method for non-uniformly spaced independent variable. Extrapolation is performed according to *CIE 167:2005* recommendation.

Important: Specific documentation about getting, setting, indexing and slicing the spectral power distribution values is available in the [Spectral Representation and Continuous Signal](#) section.

Parameters

- **data** (Optional[Union[ArrayLike, [dict](#), Series, [Signal](#), [SpectralDistribution](#)]]) – Data to be stored in the spectral distribution.
- **domain** (Optional[Union[ArrayLike, [SpectralShape](#)]]) – Values to initialise the `colour.SpectralDistribution.wavelength` property with. If both data and domain arguments are defined, the latter will be used to initialise the `colour.SpectralDistribution.wavelength` property.
- **extrapolator** – Extrapolator class type to use as extrapolating function.
- **extrapolator_kwargs** – Arguments to use when instantiating the extrapolating function.
- **interpolator** – Interpolator class type to use as interpolating function.
- **interpolator_kwargs** – Arguments to use when instantiating the interpolating function.
- **name** – Spectral distribution name.
- **display_name** – Spectral distribution name for figures, default to `colour.SpectralDistribution.name` property value.
- **kwargs** ([Any](#)) –

Warning: The *Cubic Spline* method might produce unexpected results with exceptionally noisy or non-uniformly spaced data.

Attributes

- `display_name`
- `wavelengths`
- `values`
- `shape`

Methods

- `__init__()`
- `interpolate()`
- `extrapolate()`
- `align()`
- `trim()`
- `normalise()`

References

[CIET13805a], [CIET13805d], [CIET14804c]

Examples

Instantiating a spectral distribution with a uniformly spaced independent variable:

```
>>> from colour.utilities import numpy_print_options
>>> data = {
...     500: 0.0651,
...     520: 0.0705,
...     540: 0.0772,
...     560: 0.0870,
...     580: 0.1128,
...     600: 0.1360,
... }
>>> with numpy_print_options(suppress=True):
...     SpectralDistribution(data)
...
SpectralDistribution([[ 500.    ,    0.0651],
                    [ 520.    ,    0.0705],
                    [ 540.    ,    0.0772],
                    [ 560.    ,    0.087 ],
                    [ 580.    ,    0.1128],
                    [ 600.    ,    0.136 ]],
                    SpragueInterpolator,
                    {},
                    Extrapolator,
                    {'method': 'Constant', 'left': None, 'right': None})
```

Instantiating a spectral distribution with a non-uniformly spaced independent variable:


```
>>> data[510] = 0.31416
>>> with numpy_print_options(suppress=True):
...     SpectralDistribution(data)
...
SpectralDistribution([[ 500.    ,    0.0651 ],
                     [ 510.    ,    0.31416],
                     [ 520.    ,    0.0705 ],
                     [ 540.    ,    0.0772 ],
                     [ 560.    ,    0.087  ],
                     [ 580.    ,    0.1128 ],
                     [ 600.    ,    0.136  ]],
                    CubicSplineInterpolator,
                    {},
                    Extrapolator,
                    {'method': 'Constant', 'left': None, 'right': None})
```

Instantiation with a *Pandas* `pandas.Series`:

```
>>> from colour.utilities import is_pandas_installed
>>> if is_pandas_installed():
...     from pandas import Series
...
...     print(SpectralDistribution(Series(data)))
...
[[ 5.0000000...e+02  6.5100000...e-02]
 [ 5.2000000...e+02  7.0500000...e-02]
 [ 5.4000000...e+02  7.7200000...e-02]
 [ 5.6000000...e+02  8.7000000...e-02]
 [ 5.8000000...e+02  1.1280000...e-01]
 [ 6.0000000...e+02  1.3600000...e-01]
 [ 5.1000000...e+02  3.1416000...e-01]]
```

```
__init__(data: ArrayLike | dict | <MagicMock id='139666505445456'> |
          ~colour.continuous.signal.Signal | ~colour.colorimetry.spectrum.SpectralDistribution |
          None = None, domain: ArrayLike | ~colour.colorimetry.spectrum.SpectralShape | None =
          None, **kwargs: ~typing.Any) → None
```

Parameters

- **data** (ArrayLike | dict | <MagicMock id='139666505445456'> | Signal | SpectralDistribution | None) –
- **domain** (ArrayLike | SpectralShape | None) –
- **kwargs** (Any) –

Return type

None

property display_name: str

Getter and setter property for the spectral distribution display name.

Parameters

value – Value to set the spectral distribution display name with.

Returns

Spectral distribution display name.

Return type

str

property wavelengths: `ndarray`

Getter and setter property for the spectral distribution wavelengths λ_n .

Parameters

value – Value to set the spectral distribution wavelengths λ_n with.

Returns

Spectral distribution wavelengths λ_n .

Return type

`numpy.ndarray`

property values: `ndarray`

Getter and setter property for the spectral distribution values.

Parameters

value – Value to set the spectral distribution wavelengths values with.

Returns

Spectral distribution values.

Return type

`numpy.ndarray`

property shape: `SpectralShape`

Getter property for the spectral distribution shape.

Returns

Spectral distribution shape.

Return type

`colour.SpectralShape`

Notes

- A spectral distribution with a non-uniformly spaced independent variable have multiple intervals, in that case `colour.SpectralDistribution.shape` property returns the *minimum* interval size.

Examples

Shape of a spectral distribution with a uniformly spaced independent variable:

```
>>> data = {  
...     500: 0.0651,  
...     520: 0.0705,  
...     540: 0.0772,  
...     560: 0.0870,  
...     580: 0.1128,  
...     600: 0.1360,  
... }  
>>> SpectralDistribution(data).shape  
SpectralShape(500.0, 600.0, 20.0)
```

Shape of a spectral distribution with a non-uniformly spaced independent variable:

```
>>> data[510] = 0.31416  
>>> SpectralDistribution(data).shape  
SpectralShape(500.0, 600.0, 10.0)
```

interpolate(*shape*: [SpectralShape](#), *interpolator*: [Type\[TypeInterpolator\]](#) | *None* = *None*,
interpolator_kwargs: [Dict](#) | *None* = *None*) → [SpectralDistribution](#)

Interpolate the spectral distribution in-place according to *CIE 167:2005* recommendation (if the interpolator has not been changed at instantiation time) or given interpolation arguments.

The logic for choosing the interpolator class when *interpolator* is not given is as follows:

```
if self.interpolator not in (
    SpragueInterpolator,
    CubicSplineInterpolator,
):
    interpolator = self.interpolator
elif self.is_uniform():
    interpolator = SpragueInterpolator
else:
    interpolator = CubicSplineInterpolator
```

The logic for choosing the interpolator keyword arguments when *interpolator_kwargs* is not given is as follows:

```
if self.interpolator not in (
    SpragueInterpolator,
    CubicSplineInterpolator,
):
    interpolator_kwargs = self.interpolator_kwargs
else:
    interpolator_kwargs = {}
```

Parameters

- **shape** ([SpectralShape](#)) – Spectral shape used for interpolation.
- **interpolator** ([Type\[TypeInterpolator\]](#) | *None*) – Interpolator class type to use as interpolating function.
- **interpolator_kwargs** ([Dict](#) | *None*) – Arguments to use when instantiating the interpolating function.

Returns

Interpolated spectral distribution.

Return type

[colour.SpectralDistribution](#)

Notes

- Interpolation will be performed over boundaries range, if you need to extend the range of the spectral distribution use the [colour.SpectralDistribution.extrapolate\(\)](#) or [colour.SpectralDistribution.align\(\)](#) methods.

Warning:

- *Cubic Spline* interpolator requires at least 3 wavelengths λ_n for interpolation.
- *Sprague (1880)* interpolator requires at least 6 wavelengths λ_n for interpolation.

References

[CIET13805a]

Examples

Spectral distribution with a uniformly spaced independent variable uses *Sprague (1880)* interpolation:

```
>>> from colour.utilities import numpy_print_options
>>> data = {
...     500: 0.0651,
...     520: 0.0705,
...     540: 0.0772,
...     560: 0.0870,
...     580: 0.1128,
...     600: 0.1360,
... }
>>> sd = SpectralDistribution(data)
>>> with numpy_print_options(suppress=True):
...     print(sd.interpolate(SpectralShape(500, 600, 1)))
...
...
[[ 500.          0.0651    ...]
 [ 501.          0.0653522...]
 [ 502.          0.0656105...]
 [ 503.          0.0658715...]
 [ 504.          0.0661328...]
 [ 505.          0.0663929...]
 [ 506.          0.0666509...]
 [ 507.          0.0669069...]
 [ 508.          0.0671613...]
 [ 509.          0.0674150...]
 [ 510.          0.0676692...]
 [ 511.          0.0679253...]
 [ 512.          0.0681848...]
 [ 513.          0.0684491...]
 [ 514.          0.0687197...]
 [ 515.          0.0689975...]
 [ 516.          0.0692832...]
 [ 517.          0.0695771...]
 [ 518.          0.0698787...]
 [ 519.          0.0701870...]
 [ 520.          0.0705    ...]
 [ 521.          0.0708155...]
 [ 522.          0.0711336...]
 [ 523.          0.0714547...]
 [ 524.          0.0717789...]
 [ 525.          0.0721063...]
 [ 526.          0.0724367...]
 [ 527.          0.0727698...]
 [ 528.          0.0731051...]
 [ 529.          0.0734423...]
 [ 530.          0.0737808...]
 [ 531.          0.0741203...]
 [ 532.          0.0744603...]
 [ 533.          0.0748006...]
```

(continues on next page)

(continued from previous page)

| | |
|--------|---------------|
| [534. | 0.0751409...] |
| [535. | 0.0754813...] |
| [536. | 0.0758220...] |
| [537. | 0.0761633...] |
| [538. | 0.0765060...] |
| [539. | 0.0768511...] |
| [540. | 0.0772 ...] |
| [541. | 0.0775527...] |
| [542. | 0.0779042...] |
| [543. | 0.0782507...] |
| [544. | 0.0785908...] |
| [545. | 0.0789255...] |
| [546. | 0.0792576...] |
| [547. | 0.0795917...] |
| [548. | 0.0799334...] |
| [549. | 0.0802895...] |
| [550. | 0.0806671...] |
| [551. | 0.0810740...] |
| [552. | 0.0815176...] |
| [553. | 0.0820049...] |
| [554. | 0.0825423...] |
| [555. | 0.0831351...] |
| [556. | 0.0837873...] |
| [557. | 0.0845010...] |
| [558. | 0.0852763...] |
| [559. | 0.0861110...] |
| [560. | 0.087 ...] |
| [561. | 0.0879383...] |
| [562. | 0.0889300...] |
| [563. | 0.0899793...] |
| [564. | 0.0910876...] |
| [565. | 0.0922541...] |
| [566. | 0.0934760...] |
| [567. | 0.0947487...] |
| [568. | 0.0960663...] |
| [569. | 0.0974220...] |
| [570. | 0.0988081...] |
| [571. | 0.1002166...] |
| [572. | 0.1016394...] |
| [573. | 0.1030687...] |
| [574. | 0.1044972...] |
| [575. | 0.1059186...] |
| [576. | 0.1073277...] |
| [577. | 0.1087210...] |
| [578. | 0.1100968...] |
| [579. | 0.1114554...] |
| [580. | 0.1128 ...] |
| [581. | 0.1141333...] |
| [582. | 0.1154495...] |
| [583. | 0.1167424...] |
| [584. | 0.1180082...] |
| [585. | 0.1192452...] |
| [586. | 0.1204536...] |
| [587. | 0.1216348...] |
| [588. | 0.1227915...] |
| [589. | 0.1239274...] |

(continues on next page)

(continued from previous page)

```
[ 590.          0.1250465...]
```

| | |
|---------|-----------------|
| [591.] | 0.1261531... |
| [592.] | 0.1272517... |
| [593.] | 0.1283460... |
| [594.] | 0.1294393... |
| [595.] | 0.1305340... |
| [596.] | 0.1316310... |
| [597.] | 0.1327297... |
| [598.] | 0.1338277... |
| [599.] | 0.1349201... |
| [600.] | 0.136 ...] |

Spectral distribution with a non-uniformly spaced independent variable uses *Cubic Spline* interpolation:

```
>>> sd = SpectralDistribution(data)
>>> sd[510] = np.pi / 10
>>> with numpy_print_options(suppress=True):
...     print(sd.interpolate(SpectralShape(500, 600, 1)))
...
...
[[ 500.          0.0651   ...]
 [ 501.          0.1365202...]
```

| | |
|---------|-----------------|
| [502.] | 0.1953263... |
| [503.] | 0.2423724... |
| [504.] | 0.2785126... |
| [505.] | 0.3046010... |
| [506.] | 0.3214916... |
| [507.] | 0.3300387... |
| [508.] | 0.3310962... |
| [509.] | 0.3255184... |
| [510.] | 0.3141592... |
| [511.] | 0.2978729... |
| [512.] | 0.2775135... |
| [513.] | 0.2539351... |
| [514.] | 0.2279918... |
| [515.] | 0.2005378... |
| [516.] | 0.1724271... |
| [517.] | 0.1445139... |
| [518.] | 0.1176522... |
| [519.] | 0.0926962... |
| [520.] | 0.0705 ...] |
| [521.] | 0.0517370... |
| [522.] | 0.0363589... |
| [523.] | 0.0241365... |
| [524.] | 0.0148407... |
| [525.] | 0.0082424... |
| [526.] | 0.0041126... |
| [527.] | 0.0022222... |
| [528.] | 0.0023421... |
| [529.] | 0.0042433... |
| [530.] | 0.0076966... |
| [531.] | 0.0124729... |
| [532.] | 0.0183432... |
| [533.] | 0.0250785... |
| [534.] | 0.0324496... |

(continues on next page)

(continued from previous page)

| | |
|--------|---------------|
| [535. | 0.0402274...] |
| [536. | 0.0481829...] |
| [537. | 0.0560870...] |
| [538. | 0.0637106...] |
| [539. | 0.0708246...] |
| [540. | 0.0772 ...] |
| [541. | 0.0826564...] |
| [542. | 0.0872086...] |
| [543. | 0.0909203...] |
| [544. | 0.0938549...] |
| [545. | 0.0960760...] |
| [546. | 0.0976472...] |
| [547. | 0.0986321...] |
| [548. | 0.0990942...] |
| [549. | 0.0990971...] |
| [550. | 0.0987043...] |
| [551. | 0.0979794...] |
| [552. | 0.0969861...] |
| [553. | 0.0957877...] |
| [554. | 0.0944480...] |
| [555. | 0.0930304...] |
| [556. | 0.0915986...] |
| [557. | 0.0902161...] |
| [558. | 0.0889464...] |
| [559. | 0.0878532...] |
| [560. | 0.087 ...] |
| [561. | 0.0864371...] |
| [562. | 0.0861623...] |
| [563. | 0.0861600...] |
| [564. | 0.0864148...] |
| [565. | 0.0869112...] |
| [566. | 0.0876336...] |
| [567. | 0.0885665...] |
| [568. | 0.0896945...] |
| [569. | 0.0910020...] |
| [570. | 0.0924735...] |
| [571. | 0.0940936...] |
| [572. | 0.0958467...] |
| [573. | 0.0977173...] |
| [574. | 0.0996899...] |
| [575. | 0.1017491...] |
| [576. | 0.1038792...] |
| [577. | 0.1060649...] |
| [578. | 0.1082906...] |
| [579. | 0.1105408...] |
| [580. | 0.1128 ...] |
| [581. | 0.1150526...] |
| [582. | 0.1172833...] |
| [583. | 0.1194765...] |
| [584. | 0.1216167...] |
| [585. | 0.1236884...] |
| [586. | 0.1256760...] |
| [587. | 0.1275641...] |
| [588. | 0.1293373...] |
| [589. | 0.1309798...] |
| [590. | 0.1324764...] |

(continues on next page)

(continued from previous page)

```
[ 591.          0.1338114...]
```

```
[ 592.          0.1349694...]
```

```
[ 593.          0.1359349...]
```

```
[ 594.          0.1366923...]
```

```
[ 595.          0.1372262...]
```

```
[ 596.          0.1375211...]
```

```
[ 597.          0.1375614...]
```

```
[ 598.          0.1373316...]
```

```
[ 599.          0.1368163...]
```

```
[ 600.          0.136      ...]]
```

extrapolate(*shape*: [SpectralShape](#), *extrapolator*: [Type\[TypeExtrapolator\]](#) | *None* = *None*,
extrapolator_kwargs: [Dict](#) | *None* = *None*) → [SpectralDistribution](#)

Extrapolate the spectral distribution in-place according to *CIE 15:2004* and *CIE 167:2005* recommendations or given extrapolation arguments.

Parameters

- **shape** ([SpectralShape](#)) – Spectral shape used for extrapolation.
- **extrapolator** ([Type\[TypeExtrapolator\]](#) | *None*) – Extrapolator class type to use as extrapolating function.
- **extrapolator_kwargs** ([Dict](#) | *None*) – Arguments to use when instantiating the extrapolating function.

Returns

Extrapolated spectral distribution.

Return type

[colour.SpectralDistribution](#)

References

[CIET13805d], [CIET14804c]

Examples

```
>>> from colour.utilities import numpy_print_options
>>> data = {
...     500: 0.0651,
...     520: 0.0705,
...     540: 0.0772,
...     560: 0.0870,
...     580: 0.1128,
...     600: 0.1360,
... }
>>> sd = SpectralDistribution(data)
>>> sd.extrapolate(SpectralShape(400, 700, 20)).shape
SpectralShape(400.0, 700.0, 20.0)
>>> with numpy_print_options(suppress=True):
...     print(sd)
...
[[ 400.          0.0651]
 [ 420.          0.0651]
 [ 440.          0.0651]
 [ 460.          0.0651]
```

(continues on next page)

(continued from previous page)

```
[ 480.      0.0651]
[ 500.      0.0651]
[ 520.      0.0705]
[ 540.      0.0772]
[ 560.      0.087 ]
[ 580.      0.1128]
[ 600.      0.136 ]
[ 620.      0.136 ]
[ 640.      0.136 ]
[ 660.      0.136 ]
[ 680.      0.136 ]
[ 700.      0.136 ]]
```

align(shape: [SpectralShape](#), interpolator: [Type\[TypeInterpolator\]](#) | *None* = *None*, interpolator_kwargs: [Dict](#) | *None* = *None*, extrapolator: [Type\[TypeExtrapolator\]](#) | *None* = *None*, extrapolator_kwargs: [Dict](#) | *None* = *None*) → [SpectralDistribution](#)

Align the spectral distribution in-place to given spectral shape: Interpolates first then extrapolates to fit the given range.

Interpolation is performed according to *CIE 167:2005* recommendation (if the interpolator has not been changed at instantiation time) or given interpolation arguments.

The logic for choosing the interpolator class when interpolator is not given is as follows:

```
if self.interpolator not in (
    SpragueInterpolator,
    CubicSplineInterpolator,
):
    interpolator = self.interpolator
elif self.is_uniform():
    interpolator = SpragueInterpolator
else:
    interpolator = CubicSplineInterpolator
```

The logic for choosing the interpolator keyword arguments when interpolator_kwargs is not given is as follows:

```
if self.interpolator not in (
    SpragueInterpolator,
    CubicSplineInterpolator,
):
    interpolator_kwargs = self.interpolator_kwargs
else:
    interpolator_kwargs = {}
```

Parameters

- **shape** ([SpectralShape](#)) – Spectral shape used for alignment.
- **interpolator** ([Type\[TypeInterpolator\]](#) | *None*) – Interpolator class type to use as interpolating function.
- **interpolator_kwargs** ([Dict](#) | *None*) – Arguments to use when instantiating the interpolating function.
- **extrapolator** ([Type\[TypeExtrapolator\]](#) | *None*) – Extrapolator class type to use as extrapolating function.
- **extrapolator_kwargs** ([Dict](#) | *None*) – Arguments to use when instantiating the extrapolating function.

Returns

Aligned spectral distribution.

Return type

`colour.SpectralDistribution`

Examples

```
>>> from colour.utilities import numpy_print_options
>>> data = {
...     500: 0.0651,
...     520: 0.0705,
...     540: 0.0772,
...     560: 0.0870,
...     580: 0.1128,
...     600: 0.1360,
... }
>>> sd = SpectralDistribution(data)
>>> with numpy_print_options(suppress=True):
...     print(sd.align(SpectralShape(505, 565, 1)))
...
...
[[ 505.          0.0663929...]
 [ 506.          0.0666509...]
 [ 507.          0.0669069...]
 [ 508.          0.0671613...]
 [ 509.          0.0674150...]
 [ 510.          0.0676692...]
 [ 511.          0.0679253...]
 [ 512.          0.0681848...]
 [ 513.          0.0684491...]
 [ 514.          0.0687197...]
 [ 515.          0.0689975...]
 [ 516.          0.0692832...]
 [ 517.          0.0695771...]
 [ 518.          0.0698787...]
 [ 519.          0.0701870...]
 [ 520.          0.0705    ...]
 [ 521.          0.0708155...]
 [ 522.          0.0711336...]
 [ 523.          0.0714547...]
 [ 524.          0.0717789...]
 [ 525.          0.0721063...]
 [ 526.          0.0724367...]
 [ 527.          0.0727698...]
 [ 528.          0.0731051...]
 [ 529.          0.0734423...]
 [ 530.          0.0737808...]
 [ 531.          0.0741203...]
 [ 532.          0.0744603...]
 [ 533.          0.0748006...]
 [ 534.          0.0751409...]
 [ 535.          0.0754813...]
 [ 536.          0.0758220...]
 [ 537.          0.0761633...]
 [ 538.          0.0765060...]
 [ 539.          0.0768511...]
```

(continues on next page)

| | |
|--------|----------------|
| [540. | 0.0772 ...] |
| [541. | 0.0775527...] |
| [542. | 0.0779042...] |
| [543. | 0.0782507...] |
| [544. | 0.0785908...] |
| [545. | 0.0789255...] |
| [546. | 0.0792576...] |
| [547. | 0.0795917...] |
| [548. | 0.0799334...] |
| [549. | 0.0802895...] |
| [550. | 0.0806671...] |
| [551. | 0.0810740...] |
| [552. | 0.0815176...] |
| [553. | 0.0820049...] |
| [554. | 0.0825423...] |
| [555. | 0.0831351...] |
| [556. | 0.0837873...] |
| [557. | 0.0845010...] |
| [558. | 0.0852763...] |
| [559. | 0.0861110...] |
| [560. | 0.087 ...] |
| [561. | 0.0879383...] |
| [562. | 0.0889300...] |
| [563. | 0.0899793...] |
| [564. | 0.0910876...] |
| [565. | 0.0922541...]] |

Trim the spectral distribution wavelengths to given spectral shape.

shape (`SpectralShape`) – Spectral shape used for trimming.

Trimmed spectral distribution.

colour.SpectralDistribution

```
>>> from colour.utilities import numpy_print_options
>>> data = {
...     500: 0.0651,
...     520: 0.0705,
...     540: 0.0772,
...     560: 0.0870,
...     580: 0.1128,
...     600: 0.1360,
... }
>>> sd = SpectralDistribution(data)
>>> sd = sd.interpolate(SpectralShape(500, 600, 1))
>>> with numpy_print_options(suppress=True):
...     print(sd.trim(SpectralShape(520, 580, 5)))
...
...
```

4.1. API Reference

(continued from previous page)

| | |
|--------|---------------|
| [520. | 0.0705 ...] |
| [521. | 0.0708155...] |
| [522. | 0.0711336...] |
| [523. | 0.0714547...] |
| [524. | 0.0717789...] |
| [525. | 0.0721063...] |
| [526. | 0.0724367...] |
| [527. | 0.0727698...] |
| [528. | 0.0731051...] |
| [529. | 0.0734423...] |
| [530. | 0.0737808...] |
| [531. | 0.0741203...] |
| [532. | 0.0744603...] |
| [533. | 0.0748006...] |
| [534. | 0.0751409...] |
| [535. | 0.0754813...] |
| [536. | 0.0758220...] |
| [537. | 0.0761633...] |
| [538. | 0.0765060...] |
| [539. | 0.0768511...] |
| [540. | 0.0772 ...] |
| [541. | 0.0775527...] |
| [542. | 0.0779042...] |
| [543. | 0.0782507...] |
| [544. | 0.0785908...] |
| [545. | 0.0789255...] |
| [546. | 0.0792576...] |
| [547. | 0.0795917...] |
| [548. | 0.0799334...] |
| [549. | 0.0802895...] |
| [550. | 0.0806671...] |
| [551. | 0.0810740...] |
| [552. | 0.0815176...] |
| [553. | 0.0820049...] |
| [554. | 0.0825423...] |
| [555. | 0.0831351...] |
| [556. | 0.0837873...] |
| [557. | 0.0845010...] |
| [558. | 0.0852763...] |
| [559. | 0.0861110...] |
| [560. | 0.087 ...] |
| [561. | 0.0879383...] |
| [562. | 0.0889300...] |
| [563. | 0.0899793...] |
| [564. | 0.0910876...] |
| [565. | 0.0922541...] |
| [566. | 0.0934760...] |
| [567. | 0.0947487...] |
| [568. | 0.0960663...] |
| [569. | 0.0974220...] |
| [570. | 0.0988081...] |
| [571. | 0.1002166...] |
| [572. | 0.1016394...] |
| [573. | 0.1030687...] |
| [574. | 0.1044972...] |
| [575. | 0.1059186...] |

(continues on next page)

(continued from previous page)

```
[ 576.          0.1073277...]
[ 577.          0.1087210...]
[ 578.          0.1100968...]
[ 579.          0.1114554...]
[ 580.          0.1128    ...]]
```

normalise(factor: Number = 1) → *SpectralDistribution*

Normalise the spectral distribution using given normalization factor.

Parameters

factor (Number) – Normalization factor.

Returns

Normalised spectral distribution.

Return type

colour.SpectralDistribution

Examples

```
>>> from colour.utilities import numpy_print_options
>>> data = {
...     500: 0.0651,
...     520: 0.0705,
...     540: 0.0772,
...     560: 0.0870,
...     580: 0.1128,
...     600: 0.1360,
... }
>>> sd = SpectralDistribution(data)
>>> with numpy_print_options(suppress=True):
...     print(sd.normalise())
...
[[ 500.          0.4786764...]
 [ 520.          0.5183823...]
 [ 540.          0.5676470...]
 [ 560.          0.6397058...]
 [ 580.          0.8294117...]
 [ 600.           1.         ...]]
```

colour.MultiSpectralDistributions

```
class colour.MultiSpectralDistributions(data: ArrayLike | <MagicMock id='139666540997328'>
    | dict | ~colour.continuous.multi_signals.MultiSignals |
    ~colour.colorimetry.spectrum.MultiSpectralDistributions |
    ~typing.Sequence | <MagicMock
    id='139666505445456'> |
    ~colour.continuous.signal.Signal |
    ~colour.colorimetry.spectrum.SpectralDistribution | None
    = None, domain: ArrayLike |
    ~colour.colorimetry.spectrum.SpectralShape | None =
    None, labels: ~typing.Sequence | None = None, **kwargs:
    ~typing.Any)
```

Bases: *MultiSignals*

Define the multi-spectral distributions: the base object for multi spectral computations. It is used to model colour matching functions, display primaries, camera sensitivities, etc...

The multi-spectral distributions will be initialised according to *CIE 15:2004* recommendation: the method developed by *Sprague (1880)* will be used for interpolating functions having a uniformly spaced independent variable and the *Cubic Spline* method for non-uniformly spaced independent variable. Extrapolation is performed according to *CIE 167:2005* recommendation.

Important: Specific documentation about getting, setting, indexing and slicing the multi-spectral power distributions values is available in the [Spectral Representation and Continuous Signal](#) section.

Parameters

- **data** (Optional[Union[ArrayLike, DataFrame, dict, MultiSignals, MultiSpectralDistributions, Sequence, Series, Signal, SpectralDistribution]]) – Data to be stored in the multi-spectral distributions.
- **domain** (Optional[Union[ArrayLike, SpectralShape]]) – Values to initialise the multiple `colour.SpectralDistribution` class instances `colour.continuous.Signal.wavelengths` attribute with. If both data and domain arguments are defined, the latter will be used to initialise the `colour.continuous.Signal.wavelengths` property.
- **labels** (Optional[Sequence]) – Names to use for the `colour.SpectralDistribution` class instances.
- **extrapolator** – Extrapolator class type to use as extrapolating function for the `colour.SpectralDistribution` class instances.
- **extrapolator_kwargs** – Arguments to use when instantiating the extrapolating function of the `colour.SpectralDistribution` class instances.
- **interpolator** – Interpolator class type to use as interpolating function for the `colour.SpectralDistribution` class instances.
- **interpolator_kwargs** – Arguments to use when instantiating the interpolating function of the `colour.SpectralDistribution` class instances.
- **name** – Multi-spectral distributions name.
- **display_labels** – Multi-spectral distributions labels for figures, default to `colour.MultiSpectralDistributions.labels` property value.
- **kwargs** (Any) –

Warning: The *Cubic Spline* method might produce unexpected results with exceptionally noisy or non-uniformly spaced data.

Attributes

- `display_name`
- `display_labels`
- `wavelengths`
- `values`
- `shape`

Methods

- `__init__()`
- `interpolate()`
- `extrapolate()`
- `align()`
- `trim()`
- `normalise()`
- `to_sds()`

References

[CIET13805a], [CIET13805d], [CIET14804c]

Examples

Instantiating the multi-spectral distributions with a uniformly spaced independent variable:

```
>>> from colour.utilities import numpy_print_options
>>> data = {
...     500: (0.004900, 0.323000, 0.272000),
...     510: (0.009300, 0.503000, 0.158200),
...     520: (0.063270, 0.710000, 0.078250),
...     530: (0.165500, 0.862000, 0.042160),
...     540: (0.290400, 0.954000, 0.020300),
...     550: (0.433450, 0.994950, 0.008750),
...     560: (0.594500, 0.995000, 0.003900),
... }
>>> labels = ("x_bar", "y_bar", "z_bar")
>>> with numpy_print_options(suppress=True):
...     MultiSpectralDistributions(data, labels=labels)
...
...
MultiSpectral...([[ 500.      ,    0.0049 ,    0.323  ,    0.272  ],
... [ 510.      ,    0.0093 ,    0.503  ,    0.1582 ],
... [ 520.      ,    0.06327,    0.71   ,    0.07825],
... [ 530.      ,    0.1655 ,    0.862  ,    0.04216],
... [ 540.      ,    0.2904 ,    0.954  ,    0.0203 ],
... [ 550.      ,    0.43345,    0.99495,    0.00875],
... [ 560.      ,    0.5945 ,    0.995  ,    0.0039 ]],
... [...'x_bar', ...'y_bar', ...'z_bar'],
... SpragueInterpolator,
```

(continues on next page)

(continued from previous page)

```
... {},
... Extrapolator,
... {'method': 'Constant', 'left': None, 'right': None})
```

Instantiating a spectral distribution with a non-uniformly spaced independent variable:

```
>>> data[511] = (0.00314, 0.31416, 0.03142)
>>> with numpy_print_options(suppress=True):
...     MultiSpectralDistributions(data, labels=labels)
...
...
MultiSpectral...([[ 500.      ,    0.0049 ,    0.323  ,    0.272  ],
... [ 510.      ,    0.0093 ,    0.503  ,    0.1582 ],
... [ 511.      ,    0.00314,    0.31416,    0.03142],
... [ 520.      ,    0.06327,    0.71   ,    0.07825],
... [ 530.      ,    0.1655 ,    0.862  ,    0.04216],
... [ 540.      ,    0.2904 ,    0.954  ,    0.0203  ],
... [ 550.      ,    0.43345,    0.99495,    0.00875],
... [ 560.      ,    0.5945 ,    0.995  ,    0.0039  ]],
... [...'x_bar', ...'y_bar', ...'z_bar'],
... CubicSplineInterpolator,
... {},
... Extrapolator,
... {'method': 'Constant', 'left': None, 'right': None})
```

Instantiation with a *Pandas DataFrame*:

```
>>> from colour.utilities import is_pandas_installed
>>> if is_pandas_installed():
...     from pandas import DataFrame
...
...     x_bar = [data[key][0] for key in sorted(data.keys())]
...     y_bar = [data[key][1] for key in sorted(data.keys())]
...     z_bar = [data[key][2] for key in sorted(data.keys())]
...     print(
...         MultiSignals(
...             DataFrame(
...                 dict(zip(labels, [x_bar, y_bar, z_bar])), data.keys()
...             )
...         )
...     )
...
[[ 5.0000000...e+02  4.9000000...e-03  3.2300000...e-01  2.7200000...e-01]
 [ 5.1000000...e+02  9.3000000...e-03  5.0300000...e-01  1.5820000...e-01]
 [ 5.2000000...e+02  3.1400000...e-03  3.1416000...e-01  3.1420000...e-02]
 [ 5.3000000...e+02  6.3270000...e-02  7.1000000...e-01  7.8250000...e-02]
 [ 5.4000000...e+02  1.6550000...e-01  8.6200000...e-01  4.2160000...e-02]
 [ 5.5000000...e+02  2.9040000...e-01  9.5400000...e-01  2.0300000...e-02]
 [ 5.6000000...e+02  4.3345000...e-01  9.9495000...e-01  8.7500000...e-03]
 [ 5.1100000...e+02  5.9450000...e-01  9.9500000...e-01  3.9000000...e-03]]
```

```
__init__(data: ArrayLike | <MagicMock id='139666540997328'> | dict |
~colour.continuous.multi_signals.MultiSignals |
~colour.colorimetry.spectrum.MultiSpectralDistributions | ~typing.Sequence |
<MagicMock id='139666505445456'> | ~colour.continuous.signal.Signal |
~colour.colorimetry.spectrum.SpectralDistribution | None = None, domain: ArrayLike |
~colour.colorimetry.spectrum.SpectralShape | None = None, labels: ~typing.Sequence |
None = None, **kwargs: ~typing.Any) → None
```


Parameters

- **data** (ArrayLike | <MagicMock id='139666540997328'> | dict | MultiSignals | MultiSpectralDistributions | Sequence | <MagicMock id='139666505445456'> | Signal | SpectralDistribution | None) –
- **domain** (ArrayLike | SpectralShape | None) –
- **labels** (Sequence | None) –
- **kwargs** (Any) –

Return type

None

property display_name: str

Getter and setter property for the multi-spectral distributions display name.

Parameters**value** – Value to set the multi-spectral distributions display name with.**Returns**

Multi-spectral distributions display name.

Return type

str

property display_labels: List[str]

Getter and setter property for the multi-spectral distributions display labels.

Parameters**value** – Value to set the multi-spectral distributions display labels with.**Returns**

Multi-spectral distributions display labels.

Return type

list

property wavelengths: ndarrayGetter and setter property for the multi-spectral distributions wavelengths λ_n .**Parameters****value** – Value to set the multi-spectral distributions wavelengths λ_n with.**Returns**Multi-spectral distributions wavelengths λ_n .**Return type**

numpy.ndarray

property values: ndarray

Getter and setter property for the multi-spectral distributions values.

Parameters**value** – Value to set the multi-spectral distributions wavelengths values with.**Returns**

Multi-spectral distributions values.

Return type

numpy.ndarray

property shape: SpectralShape

Getter property for the multi-spectral distributions shape.

Returns

Multi-spectral distributions shape.

Return type

`colour.SpectralShape`

Notes

- Multi-spectral distributions with a non-uniformly spaced independent variable have multiple intervals, in that case `colour.MultiSpectralDistributions.shape` property returns the *minimum* interval size.

Examples

Shape of the multi-spectral distributions with a uniformly spaced independent variable:

```
>>> from colour.utilities import numpy_print_options
>>> data = {
...     500: (0.004900, 0.323000, 0.272000),
...     510: (0.009300, 0.503000, 0.158200),
...     520: (0.063270, 0.710000, 0.078250),
...     530: (0.165500, 0.862000, 0.042160),
...     540: (0.290400, 0.954000, 0.020300),
...     550: (0.433450, 0.994950, 0.008750),
...     560: (0.594500, 0.995000, 0.003900),
... }
>>> MultiSpectralDistributions(data).shape
SpectralShape(500.0, 560.0, 10.0)
```

Shape of the multi-spectral distributions with a non-uniformly spaced independent variable:

```
>>> data[511] = (0.00314, 0.31416, 0.03142)
>>> MultiSpectralDistributions(data).shape
SpectralShape(500.0, 560.0, 1.0)
```

interpolate(*shape*: `SpectralShape`, *interpolator*: `Type[TypeInterpolator]` | `None` = `None`,
interpolator_kwargs: `Dict` | `None` = `None`) → `MultiSpectralDistributions`

Interpolate the multi-spectral distributions in-place according to *CIE 167:2005* recommendation (if the interpolator has not been changed at instantiation time) or given interpolation arguments.

The logic for choosing the interpolator class when *interpolator* is not given is as follows:

```
if self.interpolator not in (
    SpragueInterpolator,
    CubicSplineInterpolator,
):
    interpolator = self.interpolator
elif self.is_uniform():
    interpolator = SpragueInterpolator
else:
    interpolator = CubicSplineInterpolator
```

The logic for choosing the interpolator keyword arguments when *interpolator_kwargs* is not given is as follows:

```

if self.interpolator not in (
    SpragueInterpolator,
    CubicSplineInterpolator,
):
    interpolator_kwargs = self.interpolator_kwargs
else:
    interpolator_kwargs = {}

```

Parameters

- **shape** ([SpectralShape](#)) – Spectral shape used for interpolation.
- **interpolator** ([Type\[TypeInterpolator\]](#) | None) – Interpolator class type to use as interpolating function.
- **interpolator_kwargs** ([Dict](#) | None) – Arguments to use when instantiating the interpolating function.

Returns

Interpolated multi-spectral distributions.

Return type

[colour.MultiSpectralDistributions](#)

Notes

- See [colour.SpectralDistribution.interpolate\(\)](#) method notes section.

Warning: See [colour.SpectralDistribution.interpolate\(\)](#) method warning section.

References

[CIET13805a]

Examples

Multi-spectral distributions with a uniformly spaced independent variable uses *Sprague (1880)* interpolation:

```

>>> from colour.utilities import numpy_print_options
>>> data = {
...     500: (0.004900, 0.323000, 0.272000),
...     510: (0.009300, 0.503000, 0.158200),
...     520: (0.063270, 0.710000, 0.078250),
...     530: (0.165500, 0.862000, 0.042160),
...     540: (0.290400, 0.954000, 0.020300),
...     550: (0.433450, 0.994950, 0.008750),
...     560: (0.594500, 0.995000, 0.003900),
... }
>>> msds = MultiSpectralDistributions(data)
>>> with numpy_print_options(suppress=True):
...     print(msds.interpolate(SpectralShape(500, 560, 1)))
...
...
[[ 500.          0.0049    ...    0.323    ...    0.272    ...]

```

(continues on next page)

(continued from previous page)

| | | | |
|--------|--------------|--------------|---------------|
| [501. | 0.0043252... | 0.3400642... | 0.2599848...] |
| [502. | 0.0037950... | 0.3572165... | 0.2479849...] |
| [503. | 0.0033761... | 0.3744030... | 0.2360688...] |
| [504. | 0.0031397... | 0.3916650... | 0.2242878...] |
| [505. | 0.0031582... | 0.4091067... | 0.2126801...] |
| [506. | 0.0035019... | 0.4268629... | 0.2012748...] |
| [507. | 0.0042365... | 0.4450668... | 0.1900968...] |
| [508. | 0.0054192... | 0.4638181... | 0.1791709...] |
| [509. | 0.0070965... | 0.4831505... | 0.1685260...] |
| [510. | 0.0093 ... | 0.503 ... | 0.1582 ...] |
| [511. | 0.0120562... | 0.5232543... | 0.1482365...] |
| [512. | 0.0154137... | 0.5439717... | 0.1386625...] |
| [513. | 0.0193991... | 0.565139 ... | 0.1294993...] |
| [514. | 0.0240112... | 0.5866255... | 0.1207676...] |
| [515. | 0.0292289... | 0.6082226... | 0.1124864...] |
| [516. | 0.0350192... | 0.6296821... | 0.1046717...] |
| [517. | 0.0413448... | 0.6507558... | 0.0973361...] |
| [518. | 0.0481727... | 0.6712346... | 0.0904871...] |
| [519. | 0.0554816... | 0.6909873... | 0.0841267...] |
| [520. | 0.06327 ... | 0.71 ... | 0.07825 ...] |
| [521. | 0.0715642... | 0.7283456... | 0.0728614...] |
| [522. | 0.0803970... | 0.7459679... | 0.0680051...] |
| [523. | 0.0897629... | 0.7628184... | 0.0636823...] |
| [524. | 0.0996227... | 0.7789004... | 0.0598449...] |
| [525. | 0.1099142... | 0.7942533... | 0.0564111...] |
| [526. | 0.1205637... | 0.8089368... | 0.0532822...] |
| [527. | 0.1314973... | 0.8230153... | 0.0503588...] |
| [528. | 0.1426523... | 0.8365417... | 0.0475571...] |
| [529. | 0.1539887... | 0.8495422... | 0.0448253...] |
| [530. | 0.1655 ... | 0.862 ... | 0.04216 ...] |
| [531. | 0.1772055... | 0.8738585... | 0.0395936...] |
| [532. | 0.1890877... | 0.8850940... | 0.0371046...] |
| [533. | 0.2011304... | 0.8957073... | 0.0346733...] |
| [534. | 0.2133310... | 0.9057092... | 0.0323006...] |
| [535. | 0.2256968... | 0.9151181... | 0.0300011...] |
| [536. | 0.2382403... | 0.9239560... | 0.0277974...] |
| [537. | 0.2509754... | 0.9322459... | 0.0257131...] |
| [538. | 0.2639130... | 0.9400080... | 0.0237668...] |
| [539. | 0.2770569... | 0.9472574... | 0.0219659...] |
| [540. | 0.2904 ... | 0.954 ... | 0.0203 ...] |
| [541. | 0.3039194... | 0.9602409... | 0.0187414...] |
| [542. | 0.3175893... | 0.9660106... | 0.0172748...] |
| [543. | 0.3314022... | 0.9713260... | 0.0158947...] |
| [544. | 0.3453666... | 0.9761850... | 0.0146001...] |
| [545. | 0.3595019... | 0.9805731... | 0.0133933...] |
| [546. | 0.3738324... | 0.9844703... | 0.0122777...] |
| [547. | 0.3883818... | 0.9878583... | 0.0112562...] |
| [548. | 0.4031674... | 0.9907270... | 0.0103302...] |
| [549. | 0.4181943... | 0.9930817... | 0.0094972...] |
| [550. | 0.43345 ... | 0.99495 ... | 0.00875 ...] |
| [551. | 0.4489082... | 0.9963738... | 0.0080748...] |
| [552. | 0.4645599... | 0.9973682... | 0.0074580...] |
| [553. | 0.4803950... | 0.9979568... | 0.0068902...] |
| [554. | 0.4963962... | 0.9981802... | 0.0063660...] |
| [555. | 0.5125410... | 0.9980910... | 0.0058818...] |
| [556. | 0.5288034... | 0.9977488... | 0.0054349...] |

(continues on next page)

(continued from previous page)

```
[ 557.          0.5451560...    0.9972150...    0.0050216...]
[ 558.          0.5615719...    0.9965479...    0.0046357...]
[ 559.          0.5780267...    0.9957974...    0.0042671...]
[ 560.          0.5945      ...    0.995      ...    0.0039      ...]]
```

Multi-spectral distributions with a non-uniformly spaced independent variable uses *Cubic Spline* interpolation:

```
>>> data[511] = (0.00314, 0.31416, 0.03142)
>>> msds = MultiSpectralDistributions(data)
>>> with numpy_print_options(suppress=True):
...     print(msds.interpolate(SpectralShape(500, 560, 1)))
...
...
[[ 500.          0.0049      ...    0.323      ...    0.272      ...]
 [ 501.          0.0300110...    0.9455153...    0.5985102...]
 [ 502.          0.0462136...    1.3563103...    0.8066498...]
 [ 503.          0.0547925...    1.5844039...    0.9126502...]
 [ 504.          0.0570325...    1.6588148...    0.9327429...]
 [ 505.          0.0542183...    1.6085619...    0.8831594...]
 [ 506.          0.0476346...    1.4626640...    0.7801312...]
 [ 507.          0.0385662...    1.2501401...    0.6398896...]
 [ 508.          0.0282978...    1.0000089...    0.4786663...]
 [ 509.          0.0181142...    0.7412892...    0.3126925...]
 [ 510.          0.0093      ...    0.503      ...    0.1582      ...]
 [ 511.          0.00314      ...    0.31416      ...    0.03142      ...]
 [ 512.          0.0006228...    0.1970419...   -0.0551709...]
 [ 513.          0.0015528...    0.1469341...   -0.1041165...]
 [ 514.          0.0054381...    0.1523785...   -0.1217152...]
 [ 515.          0.0117869...    0.2019173...   -0.1142659...]
 [ 516.          0.0201073...    0.2840925...   -0.0880670...]
 [ 517.          0.0299077...    0.3874463...   -0.0494174...]
 [ 518.          0.0406961...    0.5005208...   -0.0046156...]
 [ 519.          0.0519808...    0.6118579...    0.0400397...]
 [ 520.          0.06327      ...    0.71      ...    0.07825      ...]
 [ 521.          0.0741690...    0.7859059...    0.1050384...]
 [ 522.          0.0846726...    0.8402033...    0.1207164...]
 [ 523.          0.0948728...    0.8759363...    0.1269173...]
 [ 524.          0.1048614...    0.8961496...    0.1252743...]
 [ 525.          0.1147305...    0.9038874...    0.1174207...]
 [ 526.          0.1245719...    0.9021942...    0.1049899...]
 [ 527.          0.1344776...    0.8941145...    0.0896151...]
 [ 528.          0.1445395...    0.8826926...    0.0729296...]
 [ 529.          0.1548497...    0.8709729...    0.0565668...]
 [ 530.          0.1655      ...    0.862      ...    0.04216      ...]
 [ 531.          0.1765618...    0.858179      ...    0.0309976...]
 [ 532.          0.1880244...    0.8593588...    0.0229897...]
 [ 533.          0.1998566...    0.8647493...    0.0177013...]
 [ 534.          0.2120269...    0.8735601...    0.0146975...]
 [ 535.          0.2245042...    0.8850011...    0.0135435...]
 [ 536.          0.2372572...    0.8982820...    0.0138044...]
 [ 537.          0.2502546...    0.9126126...    0.0150454...]
 [ 538.          0.2634650...    0.9272026...    0.0168315...]
 [ 539.          0.2768572...    0.9412618...    0.0187280...]
 [ 540.          0.2904      ...    0.954      ...    0.0203      ...]
 [ 541.          0.3040682...    0.9647869...    0.0211987...]]
```

(continues on next page)

(continued from previous page)

```
[ 542.      0.3178617...  0.9736329...  0.0214207...]
[ 543.      0.3317865...  0.9807080...  0.0210486...]
[ 544.      0.3458489...  0.9861825...  0.0201650...]
[ 545.      0.3600548...  0.9902267...  0.0188525...]
[ 546.      0.3744103...  0.9930107...  0.0171939...]
[ 547.      0.3889215...  0.9947048...  0.0152716...]
[ 548.      0.4035944...  0.9954792...  0.0131685...]
[ 549.      0.4184352...  0.9955042...  0.0109670...]
[ 550.      0.43345   ...  0.99495   ...  0.00875   ...]
[ 551.      0.4486447...  0.9939867...  0.0065999...]
[ 552.      0.4640255...  0.9927847...  0.0045994...]
[ 553.      0.4795984...  0.9915141...  0.0028313...]
[ 554.      0.4953696...  0.9903452...  0.0013781...]
[ 555.      0.5113451...  0.9894483...  0.0003224...]
[ 556.      0.5275310...  0.9889934... -0.0002530...]
[ 557.      0.5439334...  0.9891509... -0.0002656...]
[ 558.      0.5605583...  0.9900910...  0.0003672...]
[ 559.      0.5774118...  0.9919840...  0.0017282...]
[ 560.      0.5945   ...  0.995   ...  0.0039   ...]]
```

extrapolate(*shape*: [SpectralShape](#), *extrapolator*: [Type\[TypeExtrapolator\]](#) | *None* = *None*,
extrapolator_kwargs: [Dict](#) | *None* = *None*) → [MultiSpectralDistributions](#)

Extrapolate the multi-spectral distributions in-place according to *CIE 15:2004* and *CIE 167:2005* recommendations or given extrapolation arguments.

Parameters

- **shape** ([SpectralShape](#)) – Spectral shape used for extrapolation.
- **extrapolator** ([Type\[TypeExtrapolator\]](#) | *None*) – Extrapolator class type to use as extrapolating function.
- **extrapolator_kwargs** ([Dict](#) | *None*) – Arguments to use when instantiating the extrapolating function.

Returns

Extrapolated multi-spectral distributions.

Return type

[colour.MultiSpectralDistributions](#)

References

[CIET13805d], [CIET14804c]

Examples

```
>>> from colour.utilities import numpy_print_options
>>> data = {
...     500: (0.004900, 0.323000, 0.272000),
...     510: (0.009300, 0.503000, 0.158200),
...     520: (0.063270, 0.710000, 0.078250),
...     530: (0.165500, 0.862000, 0.042160),
...     540: (0.290400, 0.954000, 0.020300),
...     550: (0.433450, 0.994950, 0.008750),
...     560: (0.594500, 0.995000, 0.003900),
... }
```

(continues on next page)

(continued from previous page)

```

>>> msds = MultiSpectralDistributions(data)
>>> msds.extrapolate(SpectralShape(400, 700, 10)).shape
SpectralShape(400.0, 700.0, 10.0)
>>> with numpy_print_options(suppress=True):
...     print(msds)
...
[[ 400.         0.0049      0.323      0.272 ]
 [ 410.         0.0049      0.323      0.272 ]
 [ 420.         0.0049      0.323      0.272 ]
 [ 430.         0.0049      0.323      0.272 ]
 [ 440.         0.0049      0.323      0.272 ]
 [ 450.         0.0049      0.323      0.272 ]
 [ 460.         0.0049      0.323      0.272 ]
 [ 470.         0.0049      0.323      0.272 ]
 [ 480.         0.0049      0.323      0.272 ]
 [ 490.         0.0049      0.323      0.272 ]
 [ 500.         0.0049      0.323      0.272 ]
 [ 510.         0.0093      0.503      0.1582 ]
 [ 520.         0.06327     0.71       0.07825]
 [ 530.         0.1655      0.862      0.04216]
 [ 540.         0.2904      0.954      0.0203 ]
 [ 550.         0.43345     0.99495     0.00875]
 [ 560.         0.5945      0.995      0.0039 ]
 [ 570.         0.5945      0.995      0.0039 ]
 [ 580.         0.5945      0.995      0.0039 ]
 [ 590.         0.5945      0.995      0.0039 ]
 [ 600.         0.5945      0.995      0.0039 ]
 [ 610.         0.5945      0.995      0.0039 ]
 [ 620.         0.5945      0.995      0.0039 ]
 [ 630.         0.5945      0.995      0.0039 ]
 [ 640.         0.5945      0.995      0.0039 ]
 [ 650.         0.5945      0.995      0.0039 ]
 [ 660.         0.5945      0.995      0.0039 ]
 [ 670.         0.5945      0.995      0.0039 ]
 [ 680.         0.5945      0.995      0.0039 ]
 [ 690.         0.5945      0.995      0.0039 ]
 [ 700.         0.5945      0.995      0.0039 ]]

```

align(shape: [SpectralShape](#), interpolator: [Type\[TypeInterpolator\]](#) | *None* = *None*, interpolator_kwargs: [Dict](#) | *None* = *None*, extrapolator: [Type\[TypeExtrapolator\]](#) | *None* = *None*, extrapolator_kwargs: [Dict](#) | *None* = *None*) → [MultiSpectralDistributions](#)

Align the multi-spectral distributions in-place to given spectral shape: Interpolates first then extrapolates to fit the given range.

Interpolation is performed according to *CIE 167:2005* recommendation (if the interpolator has not been changed at instantiation time) or given interpolation arguments.

The logic for choosing the interpolator class when interpolator is not given is as follows:

```

if self.interpolator not in (
    SpragueInterpolator,
    CubicSplineInterpolator,
):
    interpolator = self.interpolator
elif self.is_uniform():
    interpolator = SpragueInterpolator
else:

```

(continues on next page)

(continued from previous page)

```
interpolator = CubicSplineInterpolator
```

The logic for choosing the interpolator keyword arguments when `interpolator_kwargs` is not given is as follows:

```
if self.interpolator not in (
    SpragueInterpolator,
    CubicSplineInterpolator,
):
    interpolator_kwargs = self.interpolator_kwargs
else:
    interpolator_kwargs = {}
```

Parameters

- **shape** (`SpectralShape`) – Spectral shape used for alignment.
- **interpolator** (`Type[TypeInterpolator]` | `None`) – Interpolator class type to use as interpolating function.
- **interpolator_kwargs** (`Dict` | `None`) – Arguments to use when instantiating the interpolating function.
- **extrapolator** (`Type[TypeExtrapolator]` | `None`) – Extrapolator class type to use as extrapolating function.
- **extrapolator_kwargs** (`Dict` | `None`) – Arguments to use when instantiating the extrapolating function.

Returns

Aligned multi-spectral distributions.

Return type

`colour.MultiSpectralDistributions`

Examples

```
>>> from colour.utilities import numpy_print_options
>>> data = {
...     500: (0.004900, 0.323000, 0.272000),
...     510: (0.009300, 0.503000, 0.158200),
...     520: (0.063270, 0.710000, 0.078250),
...     530: (0.165500, 0.862000, 0.042160),
...     540: (0.290400, 0.954000, 0.020300),
...     550: (0.433450, 0.994950, 0.008750),
...     560: (0.594500, 0.995000, 0.003900),
... }
>>> msds = MultiSpectralDistributions(data)
>>> with numpy_print_options(suppress=True):
...     print(msds.align(SpectralShape(505, 565, 1)))
...
...
[[ 505.          0.0031582...  0.4091067...  0.2126801...]
 [ 506.          0.0035019...  0.4268629...  0.2012748...]
 [ 507.          0.0042365...  0.4450668...  0.1900968...]
 [ 508.          0.0054192...  0.4638181...  0.1791709...]
 [ 509.          0.0070965...  0.4831505...  0.1685260...]
 [ 510.          0.0093    ...  0.503    ...  0.1582    ...]
```

(continues on next page)

(continued from previous page)

```

[ 511.      0.0120562...  0.5232543...  0.1482365...]
[ 512.      0.0154137...  0.5439717...  0.1386625...]
[ 513.      0.0193991...  0.565139 ...  0.1294993...]
[ 514.      0.0240112...  0.5866255...  0.1207676...]
[ 515.      0.0292289...  0.6082226...  0.1124864...]
[ 516.      0.0350192...  0.6296821...  0.1046717...]
[ 517.      0.0413448...  0.6507558...  0.0973361...]
[ 518.      0.0481727...  0.6712346...  0.0904871...]
[ 519.      0.0554816...  0.6909873...  0.0841267...]
[ 520.      0.06327 ...  0.71 ...  0.07825 ...]
[ 521.      0.0715642...  0.7283456...  0.0728614...]
[ 522.      0.0803970...  0.7459679...  0.0680051...]
[ 523.      0.0897629...  0.7628184...  0.0636823...]
[ 524.      0.0996227...  0.7789004...  0.0598449...]
[ 525.      0.1099142...  0.7942533...  0.0564111...]
[ 526.      0.1205637...  0.8089368...  0.0532822...]
[ 527.      0.1314973...  0.8230153...  0.0503588...]
[ 528.      0.1426523...  0.8365417...  0.0475571...]
[ 529.      0.1539887...  0.8495422...  0.0448253...]
[ 530.      0.1655 ...  0.862 ...  0.04216 ...]
[ 531.      0.1772055...  0.8738585...  0.0395936...]
[ 532.      0.1890877...  0.8850940...  0.0371046...]
[ 533.      0.2011304...  0.8957073...  0.0346733...]
[ 534.      0.2133310...  0.9057092...  0.0323006...]
[ 535.      0.2256968...  0.9151181...  0.0300011...]
[ 536.      0.2382403...  0.9239560...  0.0277974...]
[ 537.      0.2509754...  0.9322459...  0.0257131...]
[ 538.      0.2639130...  0.9400080...  0.0237668...]
[ 539.      0.2770569...  0.9472574...  0.0219659...]
[ 540.      0.2904 ...  0.954 ...  0.0203 ...]
[ 541.      0.3039194...  0.9602409...  0.0187414...]
[ 542.      0.3175893...  0.9660106...  0.0172748...]
[ 543.      0.3314022...  0.9713260...  0.0158947...]
[ 544.      0.3453666...  0.9761850...  0.0146001...]
[ 545.      0.3595019...  0.9805731...  0.0133933...]
[ 546.      0.3738324...  0.9844703...  0.0122777...]
[ 547.      0.3883818...  0.9878583...  0.0112562...]
[ 548.      0.4031674...  0.9907270...  0.0103302...]
[ 549.      0.4181943...  0.9930817...  0.0094972...]
[ 550.      0.43345 ...  0.99495 ...  0.00875 ...]
[ 551.      0.4489082...  0.9963738...  0.0080748...]
[ 552.      0.4645599...  0.9973682...  0.0074580...]
[ 553.      0.4803950...  0.9979568...  0.0068902...]
[ 554.      0.4963962...  0.9981802...  0.0063660...]
[ 555.      0.5125410...  0.9980910...  0.0058818...]
[ 556.      0.5288034...  0.9977488...  0.0054349...]
[ 557.      0.5451560...  0.9972150...  0.0050216...]
[ 558.      0.5615719...  0.9965479...  0.0046357...]
[ 559.      0.5780267...  0.9957974...  0.0042671...]
[ 560.      0.5945 ...  0.995 ...  0.0039 ...]
[ 561.      0.5945 ...  0.995 ...  0.0039 ...]
[ 562.      0.5945 ...  0.995 ...  0.0039 ...]
[ 563.      0.5945 ...  0.995 ...  0.0039 ...]
[ 564.      0.5945 ...  0.995 ...  0.0039 ...]
[ 565.      0.5945 ...  0.995 ...  0.0039 ...]]

```

`trim(shape: SpectralShape) → MultiSpectralDistributions`

Trim the multi-spectral distributions wavelengths to given shape.

Parameters

shape (`SpectralShape`) – Spectral shape used for trimming.

Returns

Trimmed multi-spectral distributions.

Return type

`colour.MultiSpectralDistributions`

Examples

```
>>> from colour.utilities import numpy_print_options
>>> data = {
...     500: (0.004900, 0.323000, 0.272000),
...     510: (0.009300, 0.503000, 0.158200),
...     520: (0.063270, 0.710000, 0.078250),
...     530: (0.165500, 0.862000, 0.042160),
...     540: (0.290400, 0.954000, 0.020300),
...     550: (0.433450, 0.994950, 0.008750),
...     560: (0.594500, 0.995000, 0.003900),
... }
>>> msds = MultiSpectralDistributions(data)
>>> msds = msds.interpolate(SpectralShape(500, 560, 1))
>>> with numpy_print_options(suppress=True):
...     print(msds.trim(SpectralShape(520, 580, 5)))
...
...
[[ 520.          0.06327 ...    0.71          ...    0.07825 ...]
 [ 521.          0.0715642...    0.7283456...    0.0728614...]
 [ 522.          0.0803970...    0.7459679...    0.0680051...]
 [ 523.          0.0897629...    0.7628184...    0.0636823...]
 [ 524.          0.0996227...    0.7789004...    0.0598449...]
 [ 525.          0.1099142...    0.7942533...    0.0564111...]
 [ 526.          0.1205637...    0.8089368...    0.0532822...]
 [ 527.          0.1314973...    0.8230153...    0.0503588...]
 [ 528.          0.1426523...    0.8365417...    0.0475571...]
 [ 529.          0.1539887...    0.8495422...    0.0448253...]
 [ 530.          0.1655 ...    0.862 ...    0.04216 ...]
 [ 531.          0.1772055...    0.8738585...    0.0395936...]
 [ 532.          0.1890877...    0.8850940...    0.0371046...]
 [ 533.          0.2011304...    0.8957073...    0.0346733...]
 [ 534.          0.2133310...    0.9057092...    0.0323006...]
 [ 535.          0.2256968...    0.9151181...    0.0300011...]
 [ 536.          0.2382403...    0.9239560...    0.0277974...]
 [ 537.          0.2509754...    0.9322459...    0.0257131...]
 [ 538.          0.2639130...    0.9400080...    0.0237668...]
 [ 539.          0.2770569...    0.9472574...    0.0219659...]
 [ 540.          0.2904 ...    0.954 ...    0.0203 ...]
 [ 541.          0.3039194...    0.9602409...    0.0187414...]
 [ 542.          0.3175893...    0.9660106...    0.0172748...]
 [ 543.          0.3314022...    0.9713260...    0.0158947...]
 [ 544.          0.3453666...    0.9761850...    0.0146001...]
 [ 545.          0.3595019...    0.9805731...    0.0133933...]
 [ 546.          0.3738324...    0.9844703...    0.0122777...]
 [ 547.          0.3883818...    0.9878583...    0.0112562...]
 [ 548.          0.4031674...    0.9907270...    0.0103302...]
```

(continues on next page)

(continued from previous page)

```
[ 549.          0.4181943...  0.9930817...  0.0094972...]
[ 550.          0.43345   ...  0.99495   ...  0.00875   ...]
[ 551.          0.4489082...  0.9963738...  0.0080748...]
[ 552.          0.4645599...  0.9973682...  0.0074580...]
[ 553.          0.4803950...  0.9979568...  0.0068902...]
[ 554.          0.4963962...  0.9981802...  0.0063660...]
[ 555.          0.5125410...  0.9980910...  0.0058818...]
[ 556.          0.5288034...  0.9977488...  0.0054349...]
[ 557.          0.5451560...  0.9972150...  0.0050216...]
[ 558.          0.5615719...  0.9965479...  0.0046357...]
[ 559.          0.5780267...  0.9957974...  0.0042671...]
[ 560.          0.5945   ...  0.995   ...  0.0039   ...]]
```

normalise(factor: Number = 1) → *MultiSpectralDistributions*

Normalise the multi-spectral distributions with given normalization factor.

Parameters**factor** (Number) – Normalization factor.**Returns**

Normalised multi- spectral distribution.

Return type*colour.MultiSpectralDistributions***Notes**

- The implementation uses the maximum value for each *colour.SpectralDistribution* class instances.

Examples

```
>>> from colour.utilities import numpy_print_options
>>> data = {
...     500: (0.004900, 0.323000, 0.272000),
...     510: (0.009300, 0.503000, 0.158200),
...     520: (0.063270, 0.710000, 0.078250),
...     530: (0.165500, 0.862000, 0.042160),
...     540: (0.290400, 0.954000, 0.020300),
...     550: (0.433450, 0.994950, 0.008750),
...     560: (0.594500, 0.995000, 0.003900),
... }
>>> msds = MultiSpectralDistributions(data)
>>> with numpy_print_options(suppress=True):
...     print(msds.normalise())
...
[[ 500.          0.0082422...  0.3246231...  1.          ...]
 [ 510.          0.0156434...  0.5055276...  0.5816176...]
 [ 520.          0.1064255...  0.7135678...  0.2876838...]
 [ 530.          0.2783852...  0.8663316...  0.155   ...]
 [ 540.          0.4884777...  0.9587939...  0.0746323...]
 [ 550.          0.7291000...  0.9999497...  0.0321691...]
 [ 560.           1.          ...  1.          ...  0.0143382...]]
```

to_sds() → *List[SpectralDistribution]*

Convert the multi-spectral distributions to a list of spectral distributions.

Returns
List of spectral distributions.

Return type
`list`

Examples

```
>>> from colour.utilities import numpy_print_options
>>> data = {
...     500: (0.004900, 0.323000, 0.272000),
...     510: (0.009300, 0.503000, 0.158200),
...     520: (0.063270, 0.710000, 0.078250),
...     530: (0.165500, 0.862000, 0.042160),
...     540: (0.290400, 0.954000, 0.020300),
...     550: (0.433450, 0.994950, 0.008750),
...     560: (0.594500, 0.995000, 0.003900),
... }
>>> msds = MultiSpectralDistributions(data)
>>> with numpy_print_options(suppress=True):
...     for sd in msds.to_sds():
...         print(sd)
...
[[ 500.      0.0049 ...]
 [ 510.      0.0093 ...]
 [ 520.      0.06327...]
 [ 530.      0.1655 ...]
 [ 540.      0.2904 ...]
 [ 550.      0.43345...]
 [ 560.      0.5945 ...]]
[[ 500.      0.323 ...]
 [ 510.      0.503 ...]
 [ 520.      0.71 ...]
 [ 530.      0.862 ...]
 [ 540.      0.954 ...]
 [ 550.      0.99495...]
 [ 560.      0.995 ...]]
[[ 500.      0.272 ...]
 [ 510.      0.1582 ...]
 [ 520.      0.07825...]
 [ 530.      0.04216...]
 [ 540.      0.0203 ...]
 [ 550.      0.00875...]
 [ 560.      0.0039 ...]]
```

| | |
|-------------------------|----------------|
| SPECTRAL_SHAPE_ASTME308 | (360, 780, 1). |
| SPECTRAL_SHAPE_DEFAULT | (360, 780, 1). |

colour.SPECTRAL_SHAPE_ASTME308

```
colour.SPECTRAL_SHAPE_ASTME308 = SpectralShape(360, 780, 1)
(360, 780, 1).
```

References

[ASTMInternational15a]

Type

Shape for *ASTM E308-15* practise

colour.SPECTRAL_SHAPE_DEFAULT

```
colour.SPECTRAL_SHAPE_DEFAULT = SpectralShape(360, 780, 1)
(360, 780, 1).
```

References

[ASTMInternational15a]

Type

Shape for *ASTM E308-15* practise

Ancillary Objects

```
colour.colorimetry
```

| | |
|--|--|
| <code>reshape_sd(sd[, shape, method])</code> | Reshape given spectral distribution with given spectral shape. |
| <code>reshape_msds(msds[, shape, method])</code> | Reshape given multi-spectral distributions with given spectral shape. |
| <code>sds_and_msds_to_sds(sds)</code> | Convert given spectral and multi-spectral distributions to a list of spectral distributions. |
| <code>sds_and_msds_to_msds(sds)</code> | Convert given spectral and multi-spectral distributions to multi-spectral distributions. |

colour.colorimetry.reshape_sd

```
colour.colorimetry.reshape_sd(sd: SpectralDistribution, shape: SpectralShape =
    SPECTRAL_SHAPE_DEFAULT, method: Literal['Align', 'Extrapolate',
    'Interpolate', 'Trim'] | str = 'Align', **kwargs: Any) →
    SpectralDistribution
```

Reshape given spectral distribution with given spectral shape.

The reshaped object is cached, thus another call to the definition with the same arguments will yield the cached object immediately.

Parameters

- **sd** (`SpectralDistribution`) – Spectral distribution to reshape.
- **shape** (`SpectralShape`) – Spectral shape to reshape the spectral distribution with.
- **method** (`Literal['Align', 'Extrapolate', 'Interpolate', 'Trim'] | str`) – Reshape method.

- **kwargs** (Any) – {colour.SpectralDistribution.align(), colour.SpectralDistribution.extrapolate(), colour.SpectralDistribution.interpolate(), colour.SpectralDistribution.trim()}, See the documentation of the previously listed methods.

Return type

colour.SpectralDistribution

Warning: Contrary to *Numpy*, reshaping a spectral distribution alters its data!

colour.colorimetry.reshape_msds

colour.colorimetry.reshape_msds(msds: MultiSpectralDistributions, shape: SpectralShape = SPECTRAL_SHAPE_DEFAULT, method: Literal['Align', 'Extrapolate', 'Interpolate', 'Trim'] | str = 'Align', **kwargs: Any) → MultiSpectralDistributions

Reshape given multi-spectral distributions with given spectral shape.

The reshaped object is cached, thus another call to the definition with the same arguments will yield the cached object immediately.

Parameters

- **msds** (MultiSpectralDistributions) – Spectral distribution to reshape.
- **shape** (SpectralShape) – Spectral shape to reshape the multi-spectral distributions with.
- **method** (Literal['Align', 'Extrapolate', 'Interpolate', 'Trim'] | str) – Reshape method.
- **kwargs** (Any) – {colour.MultiSpectralDistributions.align(), colour.MultiSpectralDistributions.extrapolate(), colour.MultiSpectralDistributions.interpolate(), colour.MultiSpectralDistributions.trim()}, See the documentation of the previously listed methods.

Return type

colour.MultiSpectralDistributions

Warning: Contrary to *Numpy*, reshaping a multi-spectral distributions alters its data!

colour.colorimetry.sds_and_msds_to_sds

colour.colorimetry.sds_and_msds_to_sds(sds: Sequence[SpectralDistribution | MultiSpectralDistributions] | MultiSpectralDistributions) → List[SpectralDistribution]

Convert given spectral and multi-spectral distributions to a list of spectral distributions.

Parameters

sds (Sequence[SpectralDistribution | MultiSpectralDistributions] | MultiSpectralDistributions) – Spectral and multi-spectral distributions to convert to a list of spectral distributions.

Returns

List of spectral distributions.

Return type`list`**Examples**

```

>>> data = {
...     500: 0.0651,
...     520: 0.0705,
...     540: 0.0772,
...     560: 0.0870,
...     580: 0.1128,
...     600: 0.1360,
... }
>>> sd_1 = SpectralDistribution(data)
>>> sd_2 = SpectralDistribution(data)
>>> data = {
...     500: (0.004900, 0.323000, 0.272000),
...     510: (0.009300, 0.503000, 0.158200),
...     520: (0.063270, 0.710000, 0.078250),
...     530: (0.165500, 0.862000, 0.042160),
...     540: (0.290400, 0.954000, 0.020300),
...     550: (0.433450, 0.994950, 0.008750),
...     560: (0.594500, 0.995000, 0.003900),
... }
>>> multi_sds_1 = MultiSpectralDistributions(data)
>>> multi_sds_2 = MultiSpectralDistributions(data)
>>> len(sds_and_msds_to_sds([sd_1, sd_2, multi_sds_1, multi_sds_2]))
8

```

colour.colorimetry.sds_and_msds_to_msds

colour.colorimetry.**sds_and_msds_to_msds**(sds: *Sequence*[*SpectralDistribution* | *MultiSpectralDistributions*] | *MultiSpectralDistributions*)
→ *MultiSpectralDistributions*

Convert given spectral and multi-spectral distributions to multi-spectral distributions.

The spectral and multi-spectral distributions will be aligned to the intersection of their spectral shapes.

Parameters

sds (*Sequence*[*SpectralDistribution* | *MultiSpectralDistributions*] | *MultiSpectralDistributions*) – Spectral and multi-spectral distributions to convert to multi-spectral distributions.

Returns

Multi-spectral distributions.

Return type

`colour.MultiSpectralDistributions`

Examples

```
>>> data = {
...     500: 0.0651,
...     520: 0.0705,
...     540: 0.0772,
...     560: 0.0870,
...     580: 0.1128,
...     600: 0.1360,
... }
>>> sd_1 = SpectralDistribution(data)
>>> sd_2 = SpectralDistribution(data)
>>> data = {
...     500: (0.004900, 0.323000, 0.272000),
...     510: (0.009300, 0.503000, 0.158200),
...     520: (0.063270, 0.710000, 0.078250),
...     530: (0.165500, 0.862000, 0.042160),
...     540: (0.290400, 0.954000, 0.020300),
...     550: (0.433450, 0.994950, 0.008750),
...     560: (0.594500, 0.995000, 0.003900),
... }
>>> multi_sds_1 = MultiSpectralDistributions(data)
>>> multi_sds_2 = MultiSpectralDistributions(data)
>>> from colour.utilities import numpy_print_options
>>> with numpy_print_options(suppress=True, linewidth=160):
...     sds_and_msds_to_msds(
...         [sd_1, sd_2, multi_sds_1, multi_sds_2]
...     )
...
MultiSpectralDistributions([[ 500.          ,  0.0651    ..., 0.0651    ...,  0.0049
↪ ...,  0.323    ...,  0.272    ..., 0.0049    ...,  0.323    ...,  0.272    .
↪...],
...
...          [ 510.          ,  0.0676692..., 0.0676692...,  0.0093
↪ ...,  0.503    ...,  0.1582    ..., 0.0093    ...,  0.503    ...,  0.1582    .
↪...],
...
...          [ 520.          ,  0.0705    ..., 0.0705    ...,  0.06327
↪ ...,  0.71     ...,  0.07825   ..., 0.06327   ...,  0.71     ...,  0.07825   .
↪...],
...
...          [ 530.          ,  0.0737808..., 0.0737808...,  0.1655
↪ ...,  0.862    ...,  0.04216   ..., 0.1655    ...,  0.862    ...,  0.04216   .
↪...],
...
...          [ 540.          ,  0.0772    ..., 0.0772    ...,  0.2904
↪ ...,  0.954    ...,  0.0203    ..., 0.2904    ...,  0.954    ...,  0.0203    .
↪...],
...
...          [ 550.          ,  0.0806671..., 0.0806671...,  0.43345
↪ ...,  0.99495   ...,  0.00875   ..., 0.43345   ...,  0.99495   ...,  0.00875   .
↪...],
...
...          [ 560.          ,  0.087     ..., 0.087     ...,  0.5945
↪ ...,  0.995    ...,  0.0039    ..., 0.5945    ...,  0.995    ...,  0.0039    .
↪...]],
...
...         labels=['SpectralDistribution (...)',
↪ 'SpectralDistribution (...)', '0 - SpectralDistribution (...)', '1 -
↪ SpectralDistribution (...)', '2 - SpectralDistribution (...)', '0 -
↪ SpectralDistribution (...)', '1 - SpectralDistribution (...)', '2 -
↪ SpectralDistribution (...)'],
...         interpolator=SpragueInterpolator,
...         interpolator_kwargs={},
```

(continues on next page)

(continued from previous page)

```
extrapolator=Extrapolator,
extrapolator_kwargs={...})
```

Spectral Data Generation

colour

| | |
|---|--|
| <code>sd_CIE_standard_illuminant_A([shape])</code> | <i>CIE Standard Illuminant A</i> is intended to represent typical, domestic, tungsten-filament lighting. |
| <code>sd_CIE_illuminant_D_series(xy[, M1_M2_rounding])</code> | Return the spectral distribution of given <i>CIE Illuminant D Series</i> using given <i>CIE xy</i> chromaticity coordinates. |
| <code>sd_blackbody(temperature[, shape, c1, c2, n])</code> | Return the spectral distribution of the planckian radiator for given temperature $T[K]$ with values in <i>watts per steradian per square metre per nanometer</i> ($W/sr/m^2/nm$). |
| <code>sd_rayleigh_jeans(temperature[, shape])</code> | Return the spectral distribution of the planckian radiator for given temperature $T[K]$ with values in <i>watts per steradian per square metre per nanometer</i> ($W/sr/m^2/nm$) according to <i>Rayleigh-Jeans</i> law. |
| <code>sd_constant(k[, shape])</code> | Return a spectral distribution of given spectral shape filled with constant k values. |
| <code>sd_ones([shape])</code> | Return a spectral distribution of given spectral shape filled with ones. |
| <code>sd_zeros([shape])</code> | Return a spectral distribution of given spectral shape filled with zeros. |
| <code>msds_constant(k, labels[, shape])</code> | Return the multi-spectral distributions with given labels and given spectral shape filled with constant k values. |
| <code>msds_ones(labels[, shape])</code> | Return the multi-spectral distributions with given labels and given spectral shape filled with ones. |
| <code>msds_zeros(labels[, shape])</code> | Return the multi-spectral distributions with given labels and given spectral shape filled with zeros. |
| <code>SD_GAUSSIAN_METHODS</code> | Supported gaussian spectral distribution computation methods. |
| <code>sd_gaussian(mu_peak_wavelength, sigma_fwhm)</code> | Return a gaussian spectral distribution of given spectral shape using given method. |
| <code>SD_SINGLE_LED_METHODS</code> | Supported single <i>LED</i> spectral distribution computation methods. |
| <code>sd_single_led(peak_wavelength, fwhm[, ...])</code> | Return a single <i>LED</i> spectral distribution of given spectral shape at given peak wavelength and full width at half maximum according to given method. |
| <code>SD_MULTI_LEDS_METHODS</code> | Supported multi <i>LED</i> spectral distribution computation methods. |
| <code>sd_multi_leds(peak_wavelengths, fwhm[, ...])</code> | Return a multi <i>LED</i> spectral distribution of given spectral shape at given peak wavelengths and full widths at half maximum according to given method. |

colour.sd_CIE_standard_illuminant_A

`colour.sd_CIE_standard_illuminant_A(shape: SpectralShape = SPECTRAL_SHAPE_DEFAULT) → SpectralDistribution`

CIE Standard Illuminant A is intended to represent typical, domestic, tungsten-filament lighting.

Its spectral distribution is that of a Planckian radiator at a temperature of approximately 2856 K. *CIE Standard Illuminant A* should be used in all applications of colorimetry involving the use of incandescent lighting, unless there are specific reasons for using a different illuminant.

Parameters

shape (`SpectralShape`) – Spectral shape used to create the spectral distribution of the *CIE Standard Illuminant A*.

Returns

CIE Standard Illuminant A. spectral distribution.

Return type

`colour.SpectralDistribution`

References

[CIET14804a]

Examples

```
>>> from colour import SpectralShape
>>> sd_CIE_standard_illuminant_A(SpectralShape(400, 700, 10))
...
SpectralDistribution([[ 400.      , 14.7080384...],
                    [ 410.      , 17.6752521...],
                    [ 420.      , 20.9949572...],
                    [ 430.      , 24.6709226...],
                    [ 440.      , 28.7027304...],
                    [ 450.      , 33.0858929...],
                    [ 460.      , 37.8120566...],
                    [ 470.      , 42.8692762...],
                    [ 480.      , 48.2423431...],
                    [ 490.      , 53.9131532...],
                    [ 500.      , 59.8610989...],
                    [ 510.      , 66.0634727...],
                    [ 520.      , 72.4958719...],
                    [ 530.      , 79.1325945...],
                    [ 540.      , 85.9470183...],
                    [ 550.      , 92.9119589...],
                    [ 560.      , 100.      ...],
                    [ 570.      , 107.1837952...],
                    [ 580.      , 114.4363383...],
                    [ 590.      , 121.7312009...],
                    [ 600.      , 129.0427389...],
                    [ 610.      , 136.3462674...],
                    [ 620.      , 143.6182057...],
                    [ 630.      , 150.8361944...],
                    [ 640.      , 157.9791857...],
                    [ 650.      , 165.0275098...],
                    [ 660.      , 171.9629200...],
                    [ 670.      , 178.7686175...],
```

(continues on next page)

(continued from previous page)

```
[ 680.      , 185.4292591...],
[ 690.      , 191.9309499...],
[ 700.      , 198.2612232...]],
SpragueInterpolator,
{},
Extrapolator,
{'method': 'Constant', 'left': None, 'right': None})
```

colour.sd_CIE_illuminant_D_series

`colour.sd_CIE_illuminant_D_series(xy: ArrayLike, M1_M2_rounding: bool = True) → SpectralDistribution`

Return the spectral distribution of given *CIE Illuminant D Series* using given *CIE xy* chromaticity coordinates.

Parameters

- **xy** (ArrayLike) – *CIE xy* chromaticity coordinates.
- **M1_M2_rounding** (bool) – Whether to round *M1* and *M2* variables to 3 decimal places in order to yield the internationally agreed values.

Returns

CIE Illuminant D Series spectral distribution.

Return type

`colour.SpectralDistribution`

Notes

- The nominal *CIE xy* chromaticity coordinates which have been computed with `colour.temperature.CCT_to_xy_CIE_D()` must be given according to *CIE 015:2004* recommendation and thus multiplied by 1.4388 / 1.4380.
- ***M1* and *M2* variables are rounded to 3 decimal places** according to *CIE 015:2004* recommendation.

References

[CIET14804i], [WS00k]

Examples

```
>>> from colour.utilities import numpy_print_options
>>> from colour.temperature import CCT_to_xy_CIE_D
>>> CCT_D65 = 6500 * 1.4388 / 1.4380
>>> xy = CCT_to_xy_CIE_D(CCT_D65)
>>> with numpy_print_options(suppress=True):
...     sd_CIE_illuminant_D_series(xy)
...
SpectralDistribution([[ 300.      ,  0.0341...],
                    [ 305.      ,  1.6643...],
                    [ 310.      ,  3.2945...],
                    [ 315.      , 11.7652...],
                    [ 320.      , 20.236 ...],
```

(continues on next page)

(continued from previous page)

```

[ 325.    , 28.6447...],
[ 330.    , 37.0535...],
[ 335.    , 38.5011...],
[ 340.    , 39.9488...],
[ 345.    , 42.4302...],
[ 350.    , 44.9117...],
[ 355.    , 45.775 ...],
[ 360.    , 46.6383...],
[ 365.    , 49.3637...],
[ 370.    , 52.0891...],
[ 375.    , 51.0323...],
[ 380.    , 49.9755...],
[ 385.    , 52.3118...],
[ 390.    , 54.6482...],
[ 395.    , 68.7015...],
[ 400.    , 82.7549...],
[ 405.    , 87.1204...],
[ 410.    , 91.486 ...],
[ 415.    , 92.4589...],
[ 420.    , 93.4318...],
[ 425.    , 90.0570...],
[ 430.    , 86.6823...],
[ 435.    , 95.7736...],
[ 440.    , 104.8649...],
[ 445.    , 110.9362...],
[ 450.    , 117.0076...],
[ 455.    , 117.4099...],
[ 460.    , 117.8122...],
[ 465.    , 116.3365...],
[ 470.    , 114.8609...],
[ 475.    , 115.3919...],
[ 480.    , 115.9229...],
[ 485.    , 112.3668...],
[ 490.    , 108.8107...],
[ 495.    , 109.0826...],
[ 500.    , 109.3545...],
[ 505.    , 108.5781...],
[ 510.    , 107.8017...],
[ 515.    , 106.2957...],
[ 520.    , 104.7898...],
[ 525.    , 106.2396...],
[ 530.    , 107.6895...],
[ 535.    , 106.0475...],
[ 540.    , 104.4055...],
[ 545.    , 104.2258...],
[ 550.    , 104.0462...],
[ 555.    , 102.0231...],
[ 560.    , 100.    ...],
[ 565.    , 98.1671...],
[ 570.    , 96.3342...],
[ 575.    , 96.0611...],
[ 580.    , 95.788 ...],
[ 585.    , 92.2368...],
[ 590.    , 88.6856...],
[ 595.    , 89.3459...],
[ 600.    , 90.0062...],

```

(continues on next page)

(continued from previous page)

```

[ 605.    , 89.8026...],
[ 610.    , 89.5991...],
[ 615.    , 88.6489...],
[ 620.    , 87.6987...],
[ 625.    , 85.4936...],
[ 630.    , 83.2886...],
[ 635.    , 83.4939...],
[ 640.    , 83.6992...],
[ 645.    , 81.863 ...],
[ 650.    , 80.0268...],
[ 655.    , 80.1207...],
[ 660.    , 80.2146...],
[ 665.    , 81.2462...],
[ 670.    , 82.2778...],
[ 675.    , 80.281 ...],
[ 680.    , 78.2842...],
[ 685.    , 74.0027...],
[ 690.    , 69.7213...],
[ 695.    , 70.6652...],
[ 700.    , 71.6091...],
[ 705.    , 72.9790...],
[ 710.    , 74.349 ...],
[ 715.    , 67.9765...],
[ 720.    , 61.604 ...],
[ 725.    , 65.7448...],
[ 730.    , 69.8856...],
[ 735.    , 72.4863...],
[ 740.    , 75.087 ...],
[ 745.    , 69.3398...],
[ 750.    , 63.5927...],
[ 755.    , 55.0054...],
[ 760.    , 46.4182...],
[ 765.    , 56.6118...],
[ 770.    , 66.8054...],
[ 775.    , 65.0941...],
[ 780.    , 63.3828...],
[ 785.    , 63.8434...],
[ 790.    , 64.304 ...],
[ 795.    , 61.8779...],
[ 800.    , 59.4519...],
[ 805.    , 55.7054...],
[ 810.    , 51.959 ...],
[ 815.    , 54.6998...],
[ 820.    , 57.4406...],
[ 825.    , 58.8765...],
[ 830.    , 60.3125...],
LinearInterpolator,
{}),
Extrapolator,
{'method': 'Constant', 'left': None, 'right': None})

```

`colour.sd_blackbody`

`colour.sd_blackbody(temperature: float, shape: SpectralShape = SPECTRAL_SHAPE_DEFAULT, c1: float = CONSTANT_C1, c2: float = CONSTANT_C2, n: float = CONSTANT_N) → SpectralDistribution`

Return the spectral distribution of the planckian radiator for given temperature $T[K]$ with values in *watts per steradian per square metre per nanometer* ($W/sr/m^2/nm$).

Parameters

- **temperature** (`float`) – Temperature $T[K]$ in kelvin degrees.
- **shape** (`SpectralShape`) – Spectral shape used to create the spectral distribution of the planckian radiator.
- **c1** (`float`) – The official value of c_1 is provided by the Committee on Data for Science and Technology (CODATA) and is $c_1 = 3,741771 \times 10^{16} \text{ W/m}_2$ (Mohr and Taylor, 2000).
- **c2** (`float`) – Since T is measured on the International Temperature Scale, the value of c_2 used in colorimetry should follow that adopted in the current International Temperature Scale (ITS-90) (Preston-Thomas, 1990; Mielenz et al., 1991), namely $c_2 = 1,4388 \times 10^{-2} \text{ m/K}$.
- **n** (`float`) – Medium index of refraction. For dry air at 15C and 101 325 Pa, containing 0,03 percent by volume of carbon dioxide, it is approximately 1,00028 throughout the visible region although CIE 15:2004 recommends using $n = 1$.

Returns

Blackbody spectral distribution with values in *watts per steradian per square metre per nanometer* ($W/sr/m^2/nm$).

Return type

`colour.SpectralDistribution`

Examples

```
>>> from colour.utilities import numpy_print_options
>>> with numpy_print_options(suppress=True):
...     sd_blackbody(5000, shape=SpectralShape(400, 700, 20))
...
...
SpectralDistribution([[ 400.      ,  8742.5713329...],
 [ 420.      ,  9651.6810212...],
 [ 440.      , 10447.3423137...],
 [ 460.      , 11121.8597759...],
 [ 480.      , 11673.7121534...],
 [ 500.      , 12106.0645344...],
 [ 520.      , 12425.4166118...],
 [ 540.      , 12640.4550541...],
 [ 560.      , 12761.1284859...],
 [ 580.      , 12797.9345572...],
 [ 600.      , 12761.3938171...],
 [ 620.      , 12661.6795247...],
 [ 640.      , 12508.3723863...],
 [ 660.      , 12310.3119640...],
 [ 680.      , 12075.5205176...],
 [ 700.      , 11811.1793602...]],
 SpragueInterpolator,
 {}),
```

(continues on next page)

(continued from previous page)

```
Extrapolator,
{'method': 'Constant', 'left': None, 'right': None})
```

colour.sd_rayleigh_jeans

`colour.sd_rayleigh_jeans(temperature: float, shape: SpectralShape = SPECTRAL_SHAPE_DEFAULT)`
→ *SpectralDistribution*

Return the spectral distribution of the planckian radiator for given temperature $T[K]$ with values in *watts per steradian per square metre per nanometer* ($W/sr/m^2/nm$) according to *Rayleigh-Jeans* law.

Parameters

- **temperature** (float) – Temperature $T[K]$ in kelvin degrees.
- **shape** (SpectralShape) – Spectral shape used to create the spectral distribution of the planckian radiator.

Returns

Blackbody spectral distribution with values in *watts per steradian per square metre per nanometer* ($W/sr/m^2/nm$).

Return type

colour.SpectralDistribution

Notes

- The *Rayleigh-Jeans* law agrees with experimental results at large wavelengths (low frequencies) but strongly disagrees at short wavelengths (high frequencies). This inconsistency between observations and the predictions of classical physics is commonly known as the *ultraviolet catastrophe*.

Examples

```
>>> from colour.utilities import numpy_print_options
>>> with numpy_print_options(suppress=True):
...     sd_rayleigh_jeans(5000, shape=SpectralShape(400, 700, 20))
...
...
SpectralDistribution([[ 400.      , 1616829.9106941...],
                     [ 420.      , 1330169.9688456...],
                     [ 440.      , 1104316.5840408...],
                     [ 460.      , 924427.7490112...],
                     [ 480.      , 779721.2146480...],
                     [ 500.      , 662253.5314203...],
                     [ 520.      , 566097.0941823...],
                     [ 540.      , 486776.1157138...],
                     [ 560.      , 420874.0917050...],
                     [ 580.      , 365756.7299433...],
                     [ 600.      , 319373.8095198...],
                     [ 620.      , 280115.7588306...],
                     [ 640.      , 246708.6655722...],
                     [ 660.      , 218136.6091932...],
                     [ 680.      , 193583.6389284...],
                     [ 700.      , 172390.0279623...]])
```

(continues on next page)

(continued from previous page)

```
SpragueInterpolator,  
{},  
Extrapolator,  
{'method': 'Constant', 'left': None, 'right': None})
```

colour.sd_constant

`colour.sd_constant(k: float, shape: SpectralShape = SPECTRAL_SHAPE_DEFAULT, **kwargs: Any) → SpectralDistribution`

Return a spectral distribution of given spectral shape filled with constant k values.

Parameters

- **k** (`float`) – Constant k to fill the spectral distribution with.
- **shape** (`SpectralShape`) – Spectral shape used to create the spectral distribution.
- **kwargs** (`Any`) – {`colour.SpectralDistribution`}, See the documentation of the previously listed class.

Returns

Constant k filled spectral distribution.

Return type

`colour.SpectralDistribution`

Notes

- By default, the spectral distribution will use the shape given by `colour.SPECTRAL_SHAPE_DEFAULT` attribute.

Examples

```
>>> sd = sd_constant(100)  
>>> sd.shape  
SpectralShape(360.0, 780.0, 1.0)  
>>> sd[400]  
100.0
```

colour.sd_ones

`colour.sd_ones(shape: SpectralShape = SPECTRAL_SHAPE_DEFAULT, **kwargs: Any) → SpectralDistribution`

Return a spectral distribution of given spectral shape filled with ones.

Parameters

- **shape** (`SpectralShape`) – Spectral shape used to create the spectral distribution.
- **kwargs** (`Any`) – {`colour.sd_constant()`}, See the documentation of the previously listed definition.

Returns

Ones filled spectral distribution.

Return type

`colour.SpectralDistribution`

Notes

- By default, the spectral distribution will use the shape given by `colour.SPECTRAL_SHAPE_DEFAULT` attribute.

Examples

```
>>> sd = sd_ones()
>>> sd.shape
SpectralShape(360.0, 780.0, 1.0)
>>> sd[400]
1.0
```

`colour.sd_zeros`

`colour.sd_zeros(shape: SpectralShape = SPECTRAL_SHAPE_DEFAULT, **kwargs: Any) → SpectralDistribution`

Return a spectral distribution of given spectral shape filled with zeros.

Parameters

- **shape** ([SpectralShape](#)) – Spectral shape used to create the spectral distribution.
- **kwargs** ([Any](#)) – {`colour.sd_constant()`}, See the documentation of the previously listed definition.

Returns

Zeros filled spectral distribution.

Return type

`colour.SpectralDistribution`

Notes

- By default, the spectral distribution will use the shape given by `colour.SPECTRAL_SHAPE_DEFAULT` attribute.

Examples

```
>>> sd = sd_zeros()
>>> sd.shape
SpectralShape(360.0, 780.0, 1.0)
>>> sd[400]
0.0
```

colour.msds_constant

`colour.msds_constant(k: float, labels: Sequence, shape: SpectralShape = SPECTRAL_SHAPE_DEFAULT, **kwargs: Any) → MultiSpectralDistributions`

Return the multi-spectral distributions with given labels and given spectral shape filled with constant k values.

Parameters

- **k** (float) – Constant k to fill the multi-spectral distributions with.
- **labels** (Sequence) – Names to use for the `colour.SpectralDistribution` class instances.
- **shape** (SpectralShape) – Spectral shape used to create the multi-spectral distributions.
- **kwargs** (Any) – {`colour.MultiSpectralDistributions`}, See the documentation of the previously listed class.

Returns

Constant k filled multi-spectral distributions.

Return type

`colour.MultiSpectralDistributions`

Notes

- By default, the multi-spectral distributions will use the shape given by `colour.SPECTRAL_SHAPE_DEFAULT` attribute.

Examples

```
>>> msds = msds_constant(100, labels=["a", "b", "c"])
>>> msds.shape
SpectralShape(360.0, 780.0, 1.0)
>>> msds[400]
array([ 100.,  100.,  100.])
>>> msds.labels
['a', 'b', 'c']
```

colour.msds_ones

`colour.msds_ones(labels: Sequence, shape: SpectralShape = SPECTRAL_SHAPE_DEFAULT, **kwargs: Any) → MultiSpectralDistributions`

Return the multi-spectral distributions with given labels and given spectral shape filled with ones.

Parameters

- **labels** (Sequence) – Names to use for the `colour.SpectralDistribution` class instances.
- **shape** (SpectralShape) – Spectral shape used to create the multi-spectral distributions.
- **kwargs** (Any) – {`colour.msds_constant()`}, See the documentation of the previously listed definition.

Returns

Ones filled multi-spectral distributions.

Return type`colour.MultiSpectralDistributions`**Notes**

- By default, the multi-spectral distributions will use the shape given by `colour.SPECTRAL_SHAPE_DEFAULT` attribute.

Examples

```
>>> msds = msds_ones(labels=["a", "b", "c"])
>>> msds.shape
SpectralShape(360.0, 780.0, 1.0)
>>> msds[400]
array([ 1.,  1.,  1.])
>>> msds.labels
['a', 'b', 'c']
```

colour.msds_zeros

`colour.msds_zeros(labels: Sequence, shape: SpectralShape = SPECTRAL_SHAPE_DEFAULT, **kwargs: Any) → MultiSpectralDistributions`

Return the multi-spectral distributions with given labels and given spectral shape filled with zeros.

Parameters

- **labels** (*Sequence*) – Names to use for the `colour.SpectralDistribution` class instances.
- **shape** (*SpectralShape*) – Spectral shape used to create the multi-spectral distributions.
- **kwargs** (*Any*) – {`colour.msds_constant()`}, See the documentation of the previously listed definition.

Returns

Zeros filled multi-spectral distributions.

Return type`colour.MultiSpectralDistributions`**Notes**

- By default, the multi-spectral distributions will use the shape given by `colour.SPECTRAL_SHAPE_DEFAULT` attribute.

Examples

```
>>> msds = msds_zeros(labels=["a", "b", "c"])
>>> msds.shape
SpectralShape(360.0, 780.0, 1.0)
>>> msds[400]
array([ 0.,  0.,  0.])
>>> msds.labels
['a', 'b', 'c']
```

colour.SD_GAUSSIAN_METHODS

`colour.SD_GAUSSIAN_METHODS = CanonicalMapping({'Normal': ..., 'FWHM': ...})`

Supported gaussian spectral distribution computation methods.

colour.sd_gaussian

`colour.sd_gaussian(mu_peak_wavelength: float, sigma_fwhm: float, shape: SpectralShape = SPECTRAL_SHAPE_DEFAULT, method: Literal['Normal', 'FWHM'] | str = 'Normal', **kwargs: Any) → SpectralDistribution`

Return a gaussian spectral distribution of given spectral shape using given method.

Parameters

- **mu_peak_wavelength** (`float`) – Mean wavelength μ the gaussian spectral distribution will peak at.
- **sigma_fwhm** (`float`) – Standard deviation *sigma* of the gaussian spectral distribution or Full width at half maximum, i.e. width of the gaussian spectral distribution measured between those points on the y axis which are half the maximum amplitude.
- **shape** (`SpectralShape`) – Spectral shape used to create the spectral distribution.
- **method** (`Literal['Normal', 'FWHM'] | str`) – Computation method.
- **kwargs** (`Any`) – {`colour.colorimetry.sd_gaussian_normal()`, `colour.colorimetry.sd_gaussian_fwhm()`}, See the documentation of the previously listed definitions.

Returns

Gaussian spectral distribution.

Return type

`colour.SpectralDistribution`

Notes

- By default, the spectral distribution will use the shape given by `colour.SPECTRAL_SHAPE_DEFAULT` attribute.

Examples

```
>>> sd = sd_gaussian(555, 25)
>>> sd.shape
SpectralShape(360.0, 780.0, 1.0)
>>> sd[555]
1...
>>> sd[530]
0.6065306...
>>> sd = sd_gaussian(555, 25, method="FWHM")
>>> sd.shape
SpectralShape(360.0, 780.0, 1.0)
>>> sd[555]
1...
>>> sd[530]
0.3678794...
```

colour.SD_SINGLE_LED_METHODS

`colour.SD_SINGLE_LED_METHODS = CanonicalMapping({'Ohno 2005': ...})`

Supported single *LED* spectral distribution computation methods.

colour.sd_single_led

`colour.sd_single_led(peak_wavelength: float, fwhm: float, shape: SpectralShape = SPECTRAL_SHAPE_DEFAULT, method: Literal['Ohno 2005'] | str = 'Ohno 2005', **kwargs: Any) → SpectralDistribution`

Return a single *LED* spectral distribution of given spectral shape at given peak wavelength and full width at half maximum according to given method.

Parameters

- **peak_wavelength** (`float`) – Wavelength the single *LED* spectral distribution will peak at.
- **fwhm** (`float`) – Full width at half maximum, i.e. width of the underlying gaussian spectral distribution measured between those points on the y axis which are half the maximum amplitude.
- **shape** (`SpectralShape`) – Spectral shape used to create the spectral distribution.
- **method** (`Literal['Ohno 2005'] | str`) – Computation method.
- **kwargs** (`Any`) – {`colour.colorimetry.sd_single_led_ohno2005()`}, See the documentation of the previously listed definition.

Returns

Single *LED* spectral distribution.

Return type

`colour.SpectralDistribution`

Notes

- By default, the spectral distribution will use the shape given by `colour.SPECTRAL_SHAPE_DEFAULT` attribute.

References

[Ohn05], [OD08]

Examples

```
>>> sd = sd_single_led(555, 25)
>>> sd.shape
SpectralShape(360.0, 780.0, 1.0)
>>> sd[555]
1...
```

colour.SD_MULTI_LEDS_METHODS

`colour.SD_MULTI_LEDS_METHODS = CanonicalMapping({'Ohno 2005': ...})`

Supported multi *LED* spectral distribution computation methods.

colour.sd_multi_leds

`colour.sd_multi_leds(peak_wavelengths: ArrayLike, fwhm: ArrayLike, peak_power_ratios: ArrayLike | None = None, shape: SpectralShape = SPECTRAL_SHAPE_DEFAULT, method: Literal['Ohno 2005'] | str = 'Ohno 2005', **kwargs: Any) → SpectralDistribution`

Return a multi *LED* spectral distribution of given spectral shape at given peak wavelengths and full widths at half maximum according to given method.

Parameters

- **peak_wavelengths** (ArrayLike) – Wavelengths the multi *LED* spectral distribution will peak at, i.e. the peaks for each generated single *LED* spectral distributions.
- **fwhm** (ArrayLike) – Full widths at half maximum, i.e. widths of the underlying gaussian spectral distributions measured between those points on the y axis which are half the maximum amplitude.
- **peak_power_ratios** (ArrayLike | None) – Peak power ratios for each generated single *LED* spectral distributions.
- **shape** (SpectralShape) – Spectral shape used to create the spectral distribution.
- **method** (Literal['Ohno 2005'] | str) – Computation method.
- **kwargs** (Any) – {`colour.colorimetry.sd_multi_leds_Ohno2005()`}, See the documentation of the previously listed definition.

Returns

Multi *LED* spectral distribution.

Return type

`colour.SpectralDistribution`

Notes

- By default, the spectral distribution will use the shape given by `colour.SPECTRAL_SHAPE_DEFAULT` attribute.

References

[Ohn05], [OD08]

Examples

```
>>> sd = sd_multi_leds(
...     np.array([457, 530, 615]),
...     np.array([20, 30, 20]),
...     np.array([0.731, 1.000, 1.660]),
... )
>>> sd.shape
SpectralShape(360.0, 780.0, 1.0)
>>> sd[500]
0.1295132...
```

`colour.colorimetry`

| | |
|---|---|
| <code>blackbody_spectral_radiance(wavelength, ...)</code> | Return the spectral radiance of a blackbody as a function of wavelength at thermodynamic temperature $T[K]$ in a medium having index of refraction n . |
| <code>planck_law(wavelength, temperature[, c1, c2, n])</code> | Return the spectral radiance of a blackbody as a function of wavelength at thermodynamic temperature $T[K]$ in a medium having index of refraction n . |
| <code>rayleigh_jeans_law(wavelength, temperature)</code> | Return the approximation of the spectral radiance of a blackbody as a function of wavelength at thermodynamic temperature $T[K]$ according to <i>Rayleigh-Jeans</i> law. |
| <code>daylight_locus_function(x_D)</code> | Return the daylight locus as <i>CIE xy</i> chromaticity coordinates. |
| <code>sd_gaussian_normal(mu, sigma[, shape])</code> | Return a gaussian spectral distribution of given spectral shape at given mean wavelength μ and standard deviation σ . |
| <code>sd_gaussian_fwhm(peak_wavelength, fwhm[, shape])</code> | Return a gaussian spectral distribution of given spectral shape at given peak wavelength and full width at half maximum. |
| <code>sd_single_led_Ohno2005(peak_wavelength, fwhm)</code> | Return a single <i>LED</i> spectral distribution of given spectral shape at given peak wavelength and full width at half maximum according to <i>Ohno (2005)</i> method. |
| <code>sd_multi_leds_Ohno2005(peak_wavelengths, fwhm)</code> | Return a multi <i>LED</i> spectral distribution of given spectral shape at given peak wavelengths and full widths at half maximum according to <i>Ohno (2005)</i> method. |

colour.colorimetry.blackbody_spectral_radiance

`colour.colorimetry.blackbody_spectral_radiance`(*wavelength*: *FloatingOrArrayLike*, *temperature*: *FloatingOrArrayLike*, *c1*: *float* = *CONSTANT_C1*, *c2*: *float* = *CONSTANT_C2*, *n*: *float* = *CONSTANT_N*) → *FloatingOrNDArray*

Return the spectral radiance of a blackbody as a function of wavelength at thermodynamic temperature $T[K]$ in a medium having index of refraction n .

Parameters

- **wavelength** (*FloatingOrArrayLike*) – Wavelength in meters.
- **temperature** (*FloatingOrArrayLike*) – Temperature $T[K]$ in kelvin degrees.
- **c1** (*float*) – The official value of c_1 is provided by the Committee on Data for Science and Technology (CODATA) and is $c_1 = 3,741771 \times 10^{16} \text{ W/m}^2$ (*Mohr and Taylor, 2000*).
- **c2** (*float*) – Since T is measured on the International Temperature Scale, the value of c_2 used in colorimetry should follow that adopted in the current International Temperature Scale (ITS-90) (*Preston-Thomas, 1990; Mielenz et al., 1991*), namely $c_2 = 1,4388 \times 10^{-2} \text{ m/K}$.
- **n** (*float*) – Medium index of refraction. For dry air at 15C and 101 325 Pa, containing 0,03 percent by volume of carbon dioxide, it is approximately 1,00028 throughout the visible region although *CIE 15:2004* recommends using $n = 1$.

Returns

Radiance in *watts per steradian per square metre* (W/sr/m^2).

Return type

`numpy.floating` or `numpy.ndarray`

Warning: The `colour.colorimetry.planck Law()` definition behaviour with n-dimensional arrays is unusual: The wavelength and temperature parameters are first raveled using `numpy.ravel()`. Then, they are *broadcasted* together by transposing the temperature parameter. Finally, and for convenience, the return value is squeezed using `numpy.squeeze()`.

Notes

- The following implementation is expressed in terms of wavelength.
- The SI unit of radiance is *watts per steradian per square metre* (W/sr/m^2).

References

[CIET14804e]

Examples

```
>>> planck_law(500 * 1e-9, 5500)
20472701909806.5...
>>> planck_law(500 * 1e-9, [5000, 5500, 6000])
array([ 1.2106064...e+13,  2.0472701...e+13,  3.1754431...e+13])
```

colour.colorimetry.planck_law

colour.colorimetry.**planck_law**(wavelength: *FloatingOrArrayLike*, temperature: *FloatingOrArrayLike*, c1: *float* = *CONSTANT_C1*, c2: *float* = *CONSTANT_C2*, n: *float* = *CONSTANT_N*) → *FloatingOrNDArray*

Return the spectral radiance of a blackbody as a function of wavelength at thermodynamic temperature $T[K]$ in a medium having index of refraction n .

Parameters

- **wavelength** (*FloatingOrArrayLike*) – Wavelength in meters.
- **temperature** (*FloatingOrArrayLike*) – Temperature $T[K]$ in kelvin degrees.
- **c1** (*float*) – The official value of c_1 is provided by the Committee on Data for Science and Technology (CODATA) and is $c_1 = 3,741771 \times 10^{16} \text{ W/m}^2$ (Mohr and Taylor, 2000).
- **c2** (*float*) – Since T is measured on the International Temperature Scale, the value of c_2 used in colorimetry should follow that adopted in the current International Temperature Scale (ITS-90) (Preston-Thomas, 1990; Mielenz et al., 1991), namely $c_2 = 1,4388 \times 10^{-2} \text{ m/K}$.
- **n** (*float*) – Medium index of refraction. For dry air at 15C and 101 325 Pa, containing 0,03 percent by volume of carbon dioxide, it is approximately 1,00028 throughout the visible region although CIE 15:2004 recommends using $n = 1$.

Returns

Radiance in *watts per steradian per square metre* (W/sr/m^2).

Return type

`numpy.floating` or `numpy.ndarray`

Warning: The `colour.colorimetry.planck_law()` definition behaviour with n-dimensional arrays is unusual: The wavelength and temperature parameters are first raveled using `numpy.ravel()`. Then, they are *broadcasted* together by transposing the temperature parameter. Finally, and for convenience, the return value is squeezed using `numpy.squeeze()`.

Notes

- The following implementation is expressed in terms of wavelength.
- The SI unit of radiance is *watts per steradian per square metre* (W/sr/m^2).

References

[CIET14804e]

Examples

```
>>> planck_law(500 * 1e-9, 5500)
20472701909806.5...
>>> planck_law(500 * 1e-9, [5000, 5500, 6000])
array([ 1.2106064...e+13,  2.0472701...e+13,  3.1754431...e+13])
```

colour.colorimetry.rayleigh_jeans_law

colour.colorimetry.rayleigh_jeans_law(*wavelength*: FloatingOrArrayLike, *temperature*: FloatingOrArrayLike) → FloatingOrNDArray

Return the approximation of the spectral radiance of a blackbody as a function of wavelength at thermodynamic temperature $T[K]$ according to *Rayleigh-Jeans* law.

Parameters

- **wavelength** (FloatingOrArrayLike) – Wavelength in meters.
- **temperature** (FloatingOrArrayLike) – Temperature $T[K]$ in kelvin degrees.

Returns

Radiance in *watts per steradian per square metre* ($W/sr/m^2$).

Return type

numpy.float64 or numpy.ndarray

Warning: The `colour.colorimetry.rayleigh_jeans_law()` definition behaviour with n -dimensional arrays is unusual: The wavelength and temperature parameters are first raveled using `numpy.ravel()`. Then, they are *broadcasted* together by transposing the temperature parameter. Finally, and for convenience, the return value is squeezed using `numpy.squeeze()`.

Notes

- The *Rayleigh-Jeans* law agrees with experimental results at large wavelengths (low frequencies) but strongly disagrees at short wavelengths (high frequencies). This inconsistency between observations and the predictions of classical physics is commonly known as the *ultraviolet catastrophe*.
- The following implementation is expressed in terms of wavelength.
- The SI unit of radiance is *watts per steradian per square metre* ($W/sr/m^2$).

References

[Wikipedia03e]

Examples

```
>>> rayleigh_jeans_law(500 * 1e-9, 5500)
728478884562351.5...
>>> rayleigh_jeans_law(500 * 1e-9, [5000, 5500, 6000])
...
array([ 6.6225353...e+14,  7.2847888...e+14,  7.9470423...e+14])
```

colour.colorimetry.daylight_locus_function

colour.colorimetry.daylight_locus_function(*x_D*: *FloatingOrArrayLike*) → *FloatingOrNDArray*

Return the daylight locus as *CIE xy* chromaticity coordinates.

Parameters

x_D (*FloatingOrArrayLike*) – Chromaticity coordinate x_D .

Returns

Daylight locus as *CIE xy* chromaticity coordinates.

Return type

numpy.floating or *numpy.ndarray*

References

[WS00a]

Examples

```
>>> daylight_locus_function(0.31270)
0.3291051...
```

colour.colorimetry.sd_gaussian_normal

colour.colorimetry.sd_gaussian_normal(*mu*: *float*, *sigma*: *float*, *shape*: *SpectralShape* = *SPECTRAL_SHAPE_DEFAULT*, ***kwargs*: *Any*) → *SpectralDistribution*

Return a gaussian spectral distribution of given spectral shape at given mean wavelength μ and standard deviation *sigma*.

Parameters

- **mu** (*float*) – Mean wavelength μ the gaussian spectral distribution will peak at.
- **sigma** (*float*) – Standard deviation *sigma* of the gaussian spectral distribution.
- **shape** (*SpectralShape*) – Spectral shape used to create the spectral distribution.
- **kwargs** (*Any*) – {*colour.SpectralDistribution*}, See the documentation of the previously listed class.

Returns

Gaussian spectral distribution.

Return type`colour.SpectralDistribution`**Notes**

- By default, the spectral distribution will use the shape given by `colour.SPECTRAL_SHAPE_DEFAULT` attribute.

Examples

```
>>> sd = sd_gaussian_normal(555, 25)
>>> sd.shape
SpectralShape(360.0, 780.0, 1.0)
>>> sd[555]
1...
>>> sd[530]
0.6065306...
```

colour.colorimetry.sd_gaussian_fwhm

`colour.colorimetry.sd_gaussian_fwhm(peak_wavelength: float, fwhm: float, shape: SpectralShape = SPECTRAL_SHAPE_DEFAULT, **kwargs: Any) → SpectralDistribution`

Return a gaussian spectral distribution of given spectral shape at given peak wavelength and full width at half maximum.

Parameters

- **peak_wavelength** (`float`) – Wavelength the gaussian spectral distribution will peak at.
- **fwhm** (`float`) – Full width at half maximum, i.e. width of the gaussian spectral distribution measured between those points on the *y* axis which are half the maximum amplitude.
- **shape** (`SpectralShape`) – Spectral shape used to create the spectral distribution.
- **kwargs** (`Any`) – {`colour.SpectralDistribution`}, See the documentation of the previously listed class.

Returns

Gaussian spectral distribution.

Return type`colour.SpectralDistribution`**Notes**

- By default, the spectral distribution will use the shape given by `colour.SPECTRAL_SHAPE_DEFAULT` attribute.

Examples

```
>>> sd = sd_gaussian_fwhm(555, 25)
>>> sd.shape
SpectralShape(360.0, 780.0, 1.0)
>>> sd[555]
1...
>>> sd[530]
0.3678794...
```

colour.colorimetry.sd_single_led_Ohno2005

colour.colorimetry.**sd_single_led_Ohno2005**(*peak_wavelength*: *float*, *fwhm*: *float*, *shape*: *SpectralShape* = *SPECTRAL_SHAPE_DEFAULT*, ***kwargs*: *Any*) → *SpectralDistribution*

Return a single *LED* spectral distribution of given spectral shape at given peak wavelength and full width at half maximum according to *Ohno (2005)* method.

Parameters

- **peak_wavelength** (*float*) – Wavelength the single *LED* spectral distribution will peak at.
- **fwhm** (*float*) – Full width at half maximum, i.e. width of the underlying gaussian spectral distribution measured between those points on the *y* axis which are half the maximum amplitude.
- **shape** (*SpectralShape*) – Spectral shape used to create the spectral distribution.
- **kwargs** (*Any*) – {colour.colorimetry.sd_gaussian_fwhm()}, See the documentation of the previously listed definition.

Returns

Single *LED* spectral distribution.

Return type

colour.SpectralDistribution

Notes

- By default, the spectral distribution will use the shape given by colour.SPECTRAL_SHAPE_DEFAULT attribute.

References

[Ohn05], [OD08]

Examples

```
>>> sd = sd_single_led_Ohno2005(555, 25)
>>> sd.shape
SpectralShape(360.0, 780.0, 1.0)
>>> sd[555]
1...
```

colour.colorimetry.sd_multi_leds_Ohno2005

colour.colorimetry.**sd_multi_leds_Ohno2005**(*peak_wavelengths*: ArrayLike, *fwhm*: ArrayLike, *peak_power_ratios*: ArrayLike | *None* = *None*, *shape*: SpectralShape = SPECTRAL_SHAPE_DEFAULT, ***kwargs*: Any) → SpectralDistribution

Return a multi *LED* spectral distribution of given spectral shape at given peak wavelengths and full widths at half maximum according to *Ohno (2005)* method.

The multi *LED* spectral distribution is generated using many single *LED* spectral distributions generated with colour.sd_single_led_Ohno2005() definition.

Parameters

- **peak_wavelengths** (ArrayLike) – Wavelengths the multi *LED* spectral distribution will peak at, i.e. the peaks for each generated single *LED* spectral distributions.
- **fwhm** (ArrayLike) – Full widths at half maximum, i.e. widths of the underlying gaussian spectral distributions measured between those points on the *y* axis which are half the maximum amplitude.
- **peak_power_ratios** (ArrayLike | *None*) – Peak power ratios for each generated single *LED* spectral distributions.
- **shape** (SpectralShape) – Spectral shape used to create the spectral distribution.
- **kwargs** (Any) – {colour.colorimetry.sd_single_led_Ohno2005()}, See the documentation of the previously listed definition.

Returns

Multi *LED* spectral distribution.

Return type

colour.SpectralDistribution

Notes

- By default, the spectral distribution will use the shape given by colour.SPECTRAL_SHAPE_DEFAULT attribute.

References

[Ohn05], [OD08]

Examples

```
>>> sd = sd_multi_leds_Ohno2005(
...     np.array([457, 530, 615]),
...     np.array([20, 30, 20]),
...     np.array([0.731, 1.000, 1.660]),
... )
>>> sd.shape
SpectralShape(360.0, 780.0, 1.0)
>>> sd[500]
0.1295132...
```

Aliases

colour.colorimetry

| | |
|---|--|
| <code>planck_law(wavelength, temperature[, c1, c2, n])</code> | Return the spectral radiance of a blackbody as a function of wavelength at thermodynamic temperature $T[K]$ in a medium having index of refraction n . |
|---|--|

Conversion to Tristimulus Values

colour

| | |
|---|--|
| <code>sd_to_XYZ(sd[, cmfs, illuminant, k, method])</code> | Convert given spectral distribution to <i>CIE XYZ</i> tristimulus values using given colour matching functions, illuminant and method. |
| <code>SD_TO_XYZ_METHODS</code> | Supported spectral distribution to <i>CIE XYZ</i> tristimulus values conversion methods. |
| <code>msds_to_XYZ(msds[, cmfs, illuminant, k, method])</code> | Convert given multi-spectral distributions to <i>CIE XYZ</i> tristimulus values using given colour matching functions and illuminant. |
| <code>MSDS_TO_XYZ_METHODS</code> | Supported multi-spectral array to <i>CIE XYZ</i> tristimulus values conversion methods. |
| <code>wavelength_to_XYZ(wavelength[, cmfs])</code> | Convert given wavelength λ to <i>CIE XYZ</i> tristimulus values using given colour matching functions. |

colour.sd_to_XYZ

colour.**sd_to_XYZ**(*sd*: *ArrayLike* | [SpectralDistribution](#) | [MultiSpectralDistributions](#), *cmfs*: [MultiSpectralDistributions](#) | *None* = *None*, *illuminant*: [SpectralDistribution](#) | *None* = *None*, *k*: *Number* | *None* = *None*, *method*: *Literal*['ASTM E308', 'Integration'] | *str* = 'ASTM E308', ***kwargs*: *Any*) → *ndarray*

Convert given spectral distribution to *CIE XYZ* tristimulus values using given colour matching functions, illuminant and method.

If method is *Integration*, the spectral distribution can be either a `colour.SpectralDistribution` class instance or an *ArrayLike* in which case the shape must be passed.

Parameters

- **sd** (`ArrayLike` | `SpectralDistribution` | `MultiSpectralDistributions`) – Spectral distribution, if an `ArrayLike` and method is `Integration` the wavelengths are expected to be in the last axis, e.g. for a spectral array with 77 bins, sd shape could be (77,) or (1, 77).
- **cmfs** (`MultiSpectralDistributions` | `None`) – Standard observer colour matching functions, default to the *CIE 1931 2 Degree Standard Observer*.
- **illuminant** (`SpectralDistribution` | `None`) – Illuminant spectral distribution, default to *CIE Illuminant E*.
- **k** (`Number` | `None`) – Normalisation constant k . For reflecting or transmitting object colours, k is chosen so that $Y = 100$ for objects for which the spectral reflectance factor $R(\lambda)$ of the object colour or the spectral transmittance factor $\tau(\lambda)$ of the object is equal to unity for all wavelengths. For self-luminous objects and illuminants, the constants k is usually chosen on the grounds of convenience. If, however, in the CIE 1931 standard colorimetric system, the Y value is required to be numerically equal to the absolute value of a photometric quantity, the constant, k , must be put equal to the numerical value of K_m , the maximum spectral luminous efficacy (which is equal to $683 \text{ lm} \cdot \text{W}^{-1}$) and $\Phi_\lambda(\lambda)$ must be the spectral concentration of the radiometric quantity corresponding to the photometric quantity required.
- **method** (`Literal`['ASTM E308', 'Integration'] | `str`) – Computation method.
- **mi_5nm_omission_method** – `{colour.colorimetry.sd_to_XYZ_ASTME308()}`, 5 nm measurement intervals spectral distribution conversion to tristimulus values will use a 5 nm version of the colour matching functions instead of a table of tristimulus weighting factors.
- **mi_20nm_interpolation_method** – `{colour.colorimetry.sd_to_XYZ_ASTME308()}`, 20 nm measurement intervals spectral distribution conversion to tristimulus values will use a dedicated interpolation method instead of a table of tristimulus weighting factors.
- **shape** – Spectral shape of the spectral distribution, cmfs and illuminant will be aligned to it if sd is an `ArrayLike`.
- **use_practice_range** – `{colour.colorimetry.sd_to_XYZ_ASTME308()}`, Practise *ASTM E308-15* working wavelengths range is [360, 780], if `True` this argument will trim the colour matching functions appropriately.
- **kwargs** (`Any`) –

Returns

CIE XYZ tristimulus values.

Return type

`numpy.ndarray`

Notes

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |

- When k is set to a value other than `None`, the computed *CIE XYZ* tristimulus values are assumed to be absolute and are thus converted from percentages by a final division by 100.
- The code path using the `ArrayLike` spectral distribution produces results different to the code path using a `colour.SpectralDistribution` class instance: the former favours execution

speed by aligning the colour matching functions and illuminant to the given spectral shape while the latter favours precision by aligning the spectral distribution to the colour matching functions.

References

[ASTMInternational11], [ASTMInternational15a], [WS00c]

Examples

```
>>> import numpy as np
>>> from colour import (
...     MSDS_CMFS,
...     SDS_ILLUMINANTS,
...     SpectralDistribution,
...     SpectralShape,
... )
>>> cmfs = MSDS_CMFS["CIE 1931 2 Degree Standard Observer"]
>>> illuminant = SDS_ILLUMINANTS["D65"]
>>> shape = SpectralShape(400, 700, 20)
>>> data = np.array(
...     [
...         0.0641,
...         0.0645,
...         0.0562,
...         0.0537,
...         0.0559,
...         0.0651,
...         0.0705,
...         0.0772,
...         0.0870,
...         0.1128,
...         0.1360,
...         0.1511,
...         0.1688,
...         0.1996,
...         0.2397,
...         0.2852,
...     ]
... )
>>> sd = SpectralDistribution(data, shape)
>>> sd_to_XYZ(sd, cmfs, illuminant)
...
array([ 10.8401953...,   9.6841740...,   6.2158913...])
>>> sd_to_XYZ(sd, cmfs, illuminant, use_practice_range=False)
...
array([ 10.8402774...,   9.6841967...,   6.2158838...])
>>> sd_to_XYZ(sd, cmfs, illuminant, method="Integration")
...
array([ 10.8404805...,   9.6838697...,   6.2115722...])
>>> sd_to_XYZ(data, cmfs, illuminant, method="Integration", shape=shape)
...
array([ 10.8993917...,   9.6986145...,   6.2540301...])
```

The default CMFS are the *CIE 1931 2 Degree Standard Observer*, and the default illuminant is *CIE Illuminant E*:

```
>>> sd_to_XYZ(sd)
...
array([ 11.7781589...,  9.9585580...,  5.7408602...])
```

colour.SD_TO_XYZ_METHODS

`colour.SD_TO_XYZ_METHODS = CanonicalMapping({'ASTM E308': ..., 'Integration': ..., 'astm2015': ...})`

Supported spectral distribution to CIE XYZ tristimulus values conversion methods.

References

[ASTMInternational11], [ASTMInternational15a], [WS00c]

Aliases:

- 'astm2015': 'ASTM E308'

colour.msds_to_XYZ

`colour.msds_to_XYZ(msds: ArrayLike | SpectralDistribution | MultiSpectralDistributions, cmfs: MultiSpectralDistributions | None = None, illuminant: SpectralDistribution | None = None, k: Number | None = None, method: Literal['ASTM E308', 'Integration'] | str = 'ASTM E308', **kwargs: Any) → ndarray`

Convert given multi-spectral distributions to CIE XYZ tristimulus values using given colour matching functions and illuminant. For the *Integration* method, the multi-spectral distributions can be either a `colour.MultiSpectralDistributions` class instance or an `ArrayLike` in which case the shape must be passed.

Parameters

- **msds** (`ArrayLike` | `SpectralDistribution` | `MultiSpectralDistributions`) – Multi-spectral distributions, if an `ArrayLike` the wavelengths are expected to be in the last axis, e.g. for a 512x384 multi-spectral image with 77 bins, `msds` shape should be (384, 512, 77).
- **cmfs** (`MultiSpectralDistributions` | `None`) – Standard observer colour matching functions, default to the *CIE 1931 2 Degree Standard Observer*.
- **illuminant** (`SpectralDistribution` | `None`) – Illuminant spectral distribution, default to *CIE Illuminant E*.
- **k** (`Number` | `None`) – Normalisation constant k . For reflecting or transmitting object colours, k is chosen so that $Y = 100$ for objects for which the spectral reflectance factor $R(\lambda)$ of the object colour or the spectral transmittance factor $\tau(\lambda)$ of the object is equal to unity for all wavelengths. For self-luminous objects and illuminants, the constants k is usually chosen on the grounds of convenience. If, however, in the CIE 1931 standard colorimetric system, the Y value is required to be numerically equal to the absolute value of a photometric quantity, the constant, k , must be put equal to the numerical value of K_m , the maximum spectral luminous efficacy (which is equal to $683 \text{ lm} \cdot \text{W}^{-1}$) and $\Phi_\lambda(\lambda)$ must be the spectral concentration of the radiometric quantity corresponding to the photometric quantity required.
- **method** (`Literal`['ASTM E308', 'Integration'] | `str`) – Computation method.
- **mi_5nm_omission_method** – {`colour.colorimetry.msds_to_XYZ_ASTME308()`}, 5 nm measurement intervals multi-spectral distributions conversion to tristimulus

values will use a 5 nm version of the colour matching functions instead of a table of tristimulus weighting factors.

- **mi_20nm_interpolation_method** – `{colour.colorimetry.msds_to_XYZ_ASTME308()}`, 20 nm measurement intervals multi-spectral distributions conversion to tristimulus values will use a dedicated interpolation method instead of a table of tristimulus weighting factors.
- **shape** – `{colour.colorimetry.msds_to_XYZ_integration()}`, Spectral shape of the multi-spectral distributions array *msds*, *cmfs* and *illuminant* will be aligned to it.
- **use_practice_range** – `{colour.colorimetry.msds_to_XYZ_ASTME308()}`, Practise *ASTM E308-15* working wavelengths range is [360, 780], if *True* this argument will trim the colour matching functions appropriately.
- **kwargs** (*Any*) –

Returns

CIE XYZ tristimulus values, for a 512x384 multi-spectral image with 77 wavelengths, the output shape will be (384, 512, 3).

Return type

`numpy.ndarray`

Notes

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |

- When *k* is set to a value other than *None*, the computed *CIE XYZ* tristimulus values are assumed to be absolute and are thus converted from percentages by a final division by 100.
- The code path using the *ArrayLike* multi-spectral distributions produces results different to the code path using a `colour.MultiSpectralDistributions` class instance: the former favours execution speed by aligning the colour matching functions and illuminant to the given spectral shape while the latter favours precision by aligning the multi-spectral distributions to the colour matching functions.
- If precision is required, it is possible to interpolate the multi-spectral distributions with `scipy.interpolate.interp1d` class on the last / tail axis as follows:

```
interpolator = scipy.interpolate.interp1d(
    wavelengths,
    values,
    axis=-1,
    kind="linear",
    fill_value="extrapolate",
)
values_i = interpolator(wavelengths_i)
```

References

[ASTMInternational11], [ASTMInternational15a], [WS00c]

Examples

```
>>> from colour import MSDS_CMFS, SDS_ILLUMINANTS, SpectralDistribution
>>> cmfs = MSDS_CMFS["CIE 1931 2 Degree Standard Observer"]
>>> illuminant = SDS_ILLUMINANTS["D65"]
>>> shape = SpectralShape(400, 700, 60)
>>> data = np.array(
...     [
...         [
...             0.0137,
...             0.0159,
...             0.0096,
...             0.0111,
...             0.0179,
...             0.1057,
...             0.0433,
...             0.0258,
...             0.0248,
...             0.0186,
...             0.0310,
...             0.0473,
...         ],
...         [
...             0.0913,
...             0.3145,
...             0.2582,
...             0.0709,
...             0.2971,
...             0.4620,
...             0.2683,
...             0.0831,
...             0.1203,
...             0.1292,
...             0.1682,
...             0.3221,
...         ],
...         [
...             0.0152,
...             0.0842,
...             0.4139,
...             0.0220,
...             0.5630,
...             0.1918,
...             0.2373,
...             0.0430,
...             0.0054,
...             0.0079,
...             0.3719,
...             0.2268,
...         ],
...         [
...             0.0281,
```

(continues on next page)

(continued from previous page)

```

...         0.0907,
...         0.2228,
...         0.1249,
...         0.2375,
...         0.5625,
...         0.0518,
...         0.3230,
...         0.0065,
...         0.4006,
...         0.0861,
...         0.3161,
...     ],
...     [
...         0.1918,
...         0.7103,
...         0.0041,
...         0.1817,
...         0.0024,
...         0.4209,
...         0.0118,
...         0.2302,
...         0.1860,
...         0.9404,
...         0.0041,
...         0.1124,
...     ],
...     [
...         0.0430,
...         0.0437,
...         0.3744,
...         0.0020,
...         0.5819,
...         0.0027,
...         0.0823,
...         0.0081,
...         0.3625,
...         0.3213,
...         0.7849,
...         0.0024,
...     ],
... ]
... )
>>> msds = MultiSpectralDistributions(data, shape)
>>> msds_to_XYZ(msds, cmfs, illuminant, method="Integration")
...
array([[ 7.5029704...,  3.9487844...,  8.4034669...],
       [26.9259681..., 15.0724609..., 28.7057807...],
       [16.7032188..., 28.2172346..., 25.6455984...],
       [11.5767013...,  8.6400993...,  6.5768406...],
       [18.7314793..., 35.0750364..., 30.1457266...],
       [45.1656756..., 39.6136917..., 43.6783499...],
       [ 8.1755696..., 13.0934177..., 25.9420944...],
       [22.4676286..., 19.3099080...,  7.9637549...],
       [ 6.5781241...,  2.5255349..., 11.0930768...],
       [43.9147364..., 27.9803924..., 11.7292655...],
       [ 8.5365923..., 19.7030166..., 17.7050933...],

```

(continues on next page)

(continued from previous page)

```

    [ 23.9088250..., 26.2129529..., 30.6763148...]])
>>> data = np.reshape(data, (2, 6, 6))
>>> msds_to_XYZ(data, cmfs, illuminant, method="Integration", shape=shape)
...
array([[ [ 1.3104332..., 1.1377026..., 1.8267926...],
        [ 2.1875548..., 2.2510619..., 3.0721540...],
        [ 16.8714661..., 17.7063715..., 35.8709902...],
        [ 12.1648722..., 12.7222194..., 10.4880888...],
        [ 16.0419431..., 23.0985768..., 11.1479902...],
        [ 9.2391014..., 3.8301575..., 5.4703803...]],

       [ [ 13.8734231..., 17.3942194..., 11.0364103...],
        [ 27.7096381..., 20.8626722..., 35.5581690...],
        [ 22.7886687..., 11.4769218..., 78.3300659...],
        [ 51.1284864..., 52.2463568..., 26.1483754...],
        [ 14.4749229..., 20.5011495..., 6.6228107...],
        [ 33.6001365..., 36.3242617..., 2.8254217...]]]])

```

The default CMFS are the *CIE 1931 2 Degree Standard Observer*, and the default illuminant is *CIE Illuminant E*:

```

>>> msds_to_XYZ(msds, method="Integration")
...
array([[ 8.2415862..., 4.2543993..., 7.6100842...],
       [29.6144619..., 16.1158465..., 25.9015472...],
       [16.6799560..., 27.2350547..., 22.9413337...],
       [12.5597688..., 9.0667136..., 5.9670327...],
       [18.5804689..., 33.6618109..., 26.9249733...],
       [47.7113308..., 40.4573249..., 39.6439145...],
       [ 7.830207 ..., 12.3689624..., 23.3742655...],
       [24.1695370..., 20.0629815..., 7.2718670...],
       [ 7.2333751..., 2.7982097..., 10.0688374...],
       [48.7358074..., 30.2417164..., 10.6753233...],
       [ 8.3231013..., 18.6791507..., 15.8228184...],
       [24.6452277..., 26.0809382..., 27.7106399...]])

```

colour.MSDS_TO_XYZ_METHODS

`colour.MSDS_TO_XYZ_METHODS = CanonicalMapping({'ASTM E308': ..., 'Integration': ..., 'astm2015': ...})`

Supported multi-spectral array to *CIE XYZ* tristimulus values conversion methods.

References

[ASTMInternational11], [ASTMInternational15a], [WS00c]

Aliases:

- 'astm2015': 'ASTM E308'

colour.wavelength_to_XYZ

`colour.wavelength_to_XYZ(wavelength: FloatingOrNDArray, cmfs: MultiSpectralDistributions | None = None) → ndarray`

Convert given wavelength λ to CIE XYZ tristimulus values using given colour matching functions.

If the wavelength λ is not available in the colour matching function, its value will be calculated according to CIE 15:2004 recommendation: the method developed by *Sprague (1880)* will be used for interpolating functions having a uniformly spaced independent variable and the *Cubic Spline* method for non-uniformly spaced independent variable.

Parameters

- **wavelength** (FloatingOrNDArray) – Wavelength λ in nm.
- **cmfs** (MultiSpectralDistributions | None) – Standard observer colour matching functions, default to the CIE 1931 2 Degree Standard Observer.

Returns

CIE XYZ tristimulus values.

Return type

`numpy.ndarray`

Raises

ValueError – If wavelength λ is not contained in the colour matching functions domain.

Notes

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

Examples

```
>>> from colour import MSDS_CMFS
>>> cmfs = MSDS_CMFS["CIE 1931 2 Degree Standard Observer"]
>>> wavelength_to_XYZ(480, cmfs)
array([ 0.09564 , 0.13902 , 0.8129501...])
>>> wavelength_to_XYZ(480.5, cmfs)
array([ 0.0914287..., 0.1418350..., 0.7915726...])
```

Ancillary Objects

`colour.colorimetry`

`handle_spectral_arguments([cmfs, ...])`

Handle the spectral arguments of various *Colour* definitions performing spectral computations.

`colour.colorimetry.handle_spectral_arguments`

```
colour.colorimetry.handle_spectral_arguments(cmfs: MultiSpectralDistributions | None = None,
                                             illuminant: SpectralDistribution | None = None,
                                             cmfs_default: str = 'CIE 1931 2 Degree Standard Observer',
                                             illuminant_default: str = 'D65',
                                             shape_default: SpectralShape = SPECTRAL_SHAPE_DEFAULT,
                                             issue_runtime_warnings: bool = True) →
                                             Tuple[MultiSpectralDistributions, SpectralDistribution]
```

Handle the spectral arguments of various *Colour* definitions performing spectral computations.

- If `cmfs` is not given, one is chosen according to `cmfs_default`. The returned colour matching functions adopt the spectral shape given by `shape_default`.
- If `illuminant` is not given, one is chosen according to `illuminant_default`. The returned illuminant adopts the spectral shape of the returned colour matching functions.
- If `illuminant` is given, the returned illuminant spectral shape is aligned to that of the returned colour matching functions.

Parameters

- **`cmfs`** (`MultiSpectralDistributions` | `None`) – Standard observer colour matching functions, default to the *CIE 1931 2 Degree Standard Observer*.
- **`illuminant`** (`SpectralDistribution` | `None`) – Illuminant spectral distribution, default to *CIE Standard Illuminant D65*.
- **`cmfs_default`** (`str`) – The default colour matching functions to use if `cmfs` is not given.
- **`illuminant_default`** (`str`) – The default illuminant to use if `illuminant` is not given.
- **`shape_default`** (`SpectralShape`) – The default spectral shape to align the final colour matching functions and illuminant.
- **`issue_runtime_warnings`** (`bool`) – Whether to issue the runtime warnings.

Returns

Colour matching functions and illuminant.

Return type

`tuple`

Examples

```
>>> cmfs, illuminant = handle_spectral_arguments()
>>> cmfs.name, cmfs.shape, illuminant.name, illuminant.shape
('CIE 1931 2 Degree Standard Observer', SpectralShape(360.0, 780.0, 1.0), 'D65',
↪ SpectralShape(360.0, 780.0, 1.0))
>>> cmfs, illuminant = handle_spectral_arguments(
...     shape_default=SpectralShape(400, 700, 20)
... )
>>> cmfs.name, cmfs.shape, illuminant.name, illuminant.shape
('CIE 1931 2 Degree Standard Observer', SpectralShape(400.0, 700.0, 20.0), 'D65',
↪ SpectralShape(400.0, 700.0, 20.0))
```


ASTM E308-15

colour.colorimetry

| | |
|--|--|
| <code>sd_to_XYZ_ASTME308(sd[, cmfs, illuminant, ...])</code> | Convert given spectral distribution to <i>CIE XYZ</i> tristimulus values using given colour matching functions and illuminant according to practise <i>ASTM E308-15</i> method. |
| <code>msds_to_XYZ_ASTME308(msds[, cmfs, ...])</code> | Convert given multi-spectral distributions to <i>CIE XYZ</i> tristimulus values using given colour matching functions and illuminant according to practise <i>ASTM E308-15</i> method. |

colour.colorimetry.sd_to_XYZ_ASTME308

colour.colorimetry.sd_to_XYZ_ASTME308(sd: *SpectralDistribution*, cmfs: *MultiSpectralDistributions* | *None* = *None*, illuminant: *SpectralDistribution* | *None* = *None*, use_practice_range: *bool* = *True*, mi_5nm_omission_method: *bool* = *True*, mi_20nm_interpolation_method: *bool* = *True*, k: *Number* | *None* = *None*) → *ndarray*

Convert given spectral distribution to *CIE XYZ* tristimulus values using given colour matching functions and illuminant according to practise *ASTM E308-15* method.

Parameters

- **sd** (*SpectralDistribution*) – Spectral distribution.
- **cmfs** (*MultiSpectralDistributions* | *None*) – Standard observer colour matching functions, default to the *CIE 1931 2 Degree Standard Observer*.
- **illuminant** (*SpectralDistribution* | *None*) – Illuminant spectral distribution, default to *CIE Illuminant E*.
- **use_practice_range** (*bool*) – Practise *ASTM E308-15* working wavelengths range is [360, 780], if *True* this argument will trim the colour matching functions appropriately.
- **mi_5nm_omission_method** (*bool*) – 5 nm measurement intervals spectral distribution conversion to tristimulus values will use a 5 nm version of the colour matching functions instead of a table of tristimulus weighting factors.
- **mi_20nm_interpolation_method** (*bool*) – 20 nm measurement intervals spectral distribution conversion to tristimulus values will use a dedicated interpolation method instead of a table of tristimulus weighting factors.
- **k** (*Number* | *None*) – Normalisation constant k . For reflecting or transmitting object colours, k is chosen so that $Y = 100$ for objects for which the spectral reflectance factor $R(\lambda)$ of the object colour or the spectral transmittance factor $\tau(\lambda)$ of the object is equal to unity for all wavelengths. For self-luminous objects and illuminants, the constants k is usually chosen on the grounds of convenience. If, however, in the *CIE 1931* standard colorimetric system, the Y value is required to be numerically equal to the absolute value of a photometric quantity, the constant, k , must be put equal to the numerical value of K_m , the maximum spectral luminous efficacy (which is equal to $683 \text{ lm} \cdot \text{W}^{-1}$) and $\Phi_\lambda(\lambda)$ must be the spectral concentration of the radiometric quantity corresponding to the photometric quantity required.

Returns

CIE XYZ tristimulus values.

Return type`numpy.ndarray`**Notes**

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |

- When k is set to a value other than *None*, the computed *CIE XYZ* tristimulus values are assumed to be absolute and are thus converted from percentages by a final division by 100.

References[\[ASTMInternational15a\]](#)**Examples**

```
>>> from colour import MSDS_CMFS, SDS_ILLUMINANTS, SpectralDistribution
>>> cmfs = MSDS_CMFS["CIE 1931 2 Degree Standard Observer"]
>>> illuminant = SDS_ILLUMINANTS["D65"]
>>> shape = SpectralShape(400, 700, 20)
>>> data = np.array(
...     [
...         0.0641,
...         0.0645,
...         0.0562,
...         0.0537,
...         0.0559,
...         0.0651,
...         0.0705,
...         0.0772,
...         0.0870,
...         0.1128,
...         0.1360,
...         0.1511,
...         0.1688,
...         0.1996,
...         0.2397,
...         0.2852,
...     ]
... )
>>> sd = SpectralDistribution(data, shape)
>>> sd_to_XYZ_ASTME308(sd, cmfs, illuminant)
...
array([ 10.8401953...,   9.6841740...,   6.2158913...])
```

The default CMFS are the *CIE 1931 2 Degree Standard Observer*, and the default illuminant is *CIE Illuminant E*:

```
>>> sd_to_XYZ_ASTME308(sd)
...
array([ 11.7781589...,   9.9585580...,   5.7408602...])
```

`colour.colorimetry.msds_to_XYZ_ASTME308`

`colour.colorimetry.msds_to_XYZ_ASTME308`(*msds*: `MultiSpectralDistributions`, *cmfs*: `MultiSpectralDistributions` | `None` = `None`, *illuminant*: `SpectralDistribution` | `None` = `None`, *k*: `Number` | `None` = `None`, *use_practice_range*: `bool` = `True`, *mi_5nm_omission_method*: `bool` = `True`, *mi_20nm_interpolation_method*: `bool` = `True`) → `ndarray`

Convert given multi-spectral distributions to CIE XYZ tristimulus values using given colour matching functions and illuminant according to practise ASTM E308-15 method.

Parameters

- **msds** (`MultiSpectralDistributions`) – Multi-spectral distributions.
- **cmfs** (`MultiSpectralDistributions` | `None`) – Standard observer colour matching functions, default to the CIE 1931 2 Degree Standard Observer.
- **illuminant** (`SpectralDistribution` | `None`) – Illuminant spectral distribution, default to CIE Illuminant E.
- **k** (`Number` | `None`) – Normalisation constant k . For reflecting or transmitting object colours, k is chosen so that $Y = 100$ for objects for which the spectral reflectance factor $R(\lambda)$ of the object colour or the spectral transmittance factor $\tau(\lambda)$ of the object is equal to unity for all wavelengths. For self-luminous objects and illuminants, the constants k is usually chosen on the grounds of convenience. If, however, in the CIE 1931 standard colorimetric system, the Y value is required to be numerically equal to the absolute value of a photometric quantity, the constant, k , must be put equal to the numerical value of K_m , the maximum spectral luminous efficacy (which is equal to $683 \text{ lm} \cdot \text{W}^{-1}$) and $\Phi_\lambda(\lambda)$ must be the spectral concentration of the radiometric quantity corresponding to the photometric quantity required.
- **use_practice_range** (`bool`) – Practise ASTM E308-15 working wavelengths range is [360, 780], if `True` this argument will trim the colour matching functions appropriately.
- **mi_5nm_omission_method** (`bool`) – 5 nm measurement intervals multi-spectral distributions conversion to tristimulus values will use a 5 nm version of the colour matching functions instead of a table of tristimulus weighting factors.
- **mi_20nm_interpolation_method** (`bool`) – 20 nm measurement intervals multi-spectral distributions conversion to tristimulus values will use a dedicated interpolation method instead of a table of tristimulus weighting factors.

Returns

CIE XYZ tristimulus values.

Return type

`numpy.ndarray`

Notes

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |

- When k is set to a value other than `None`, the computed CIE XYZ tristimulus values are assumed to be absolute and are thus converted from percentages by a final division by 100.

References

[WS00c]

Examples

```
>>> from colour import MSDS_CMFS, SDS_ILLUMINANTS
>>> cmfs = MSDS_CMFS["CIE 1931 2 Degree Standard Observer"]
>>> illuminant = SDS_ILLUMINANTS["D65"]
>>> shape = SpectralShape(400, 700, 60)
>>> data = np.array(
...     [
...         [
...             0.0137,
...             0.0159,
...             0.0096,
...             0.0111,
...             0.0179,
...             0.1057,
...             0.0433,
...             0.0258,
...             0.0248,
...             0.0186,
...             0.0310,
...             0.0473,
...         ],
...         [
...             0.0913,
...             0.3145,
...             0.2582,
...             0.0709,
...             0.2971,
...             0.4620,
...             0.2683,
...             0.0831,
...             0.1203,
...             0.1292,
...             0.1682,
...             0.3221,
...         ],
...         [
...             0.0152,
...             0.0842,
...             0.4139,
...             0.0220,
...             0.5630,
...             0.1918,
...             0.2373,
...             0.0430,
...             0.0054,
...             0.0079,
...             0.3719,
...             0.2268,
...         ],
...         [
...             0.0281,
```

(continues on next page)

(continued from previous page)

```

...         0.0907,
...         0.2228,
...         0.1249,
...         0.2375,
...         0.5625,
...         0.0518,
...         0.3230,
...         0.0065,
...         0.4006,
...         0.0861,
...         0.3161,
...     ],
...     [
...         0.1918,
...         0.7103,
...         0.0041,
...         0.1817,
...         0.0024,
...         0.4209,
...         0.0118,
...         0.2302,
...         0.1860,
...         0.9404,
...         0.0041,
...         0.1124,
...     ],
...     [
...         0.0430,
...         0.0437,
...         0.3744,
...         0.0020,
...         0.5819,
...         0.0027,
...         0.0823,
...         0.0081,
...         0.3625,
...         0.3213,
...         0.7849,
...         0.0024,
...     ],
... ]
... )
>>> msds = MultiSpectralDistributions(data, shape)
>>> msds = msds.align(SpectralShape(400, 700, 20))
>>> msds_to_XYZ_ASTME308(msds, cmfs, illuminant)
...
array([[ 7.5052758...,  3.9557516...,  8.38929 ...],
       [26.9408494..., 15.0987746..., 28.6631260...],
       [16.7047370..., 28.2089815..., 25.6556751...],
       [11.5711808...,  8.6445071...,  6.5587827...],
       [18.7428858..., 35.0626352..., 30.1778517...],
       [45.1224886..., 39.6238997..., 43.5813345...],
       [ 8.1786985..., 13.0950215..., 25.9326459...],
       [22.4462888..., 19.3115133...,  7.9304333...],
       [ 6.5764361...,  2.5305945..., 11.07253 ...],
       [43.9113380..., 28.0003541..., 11.6852531...],

```

(continues on next page)

(continued from previous page)

```
[ 8.5496209..., 19.6913570..., 17.7400079...],
[ 23.8866733..., 26.2147704..., 30.6297684...]])
```

The default CMFS are the *CIE 1931 2 Degree Standard Observer*, and the default illuminant is *CIE Illuminant E*:

```
>>> msds_to_XYZ_ASTME308(msds)
...
array([[ 8.2439318...,  4.2617641...,  7.5977409...],
       [ 29.6290771..., 16.1443076..., 25.8640484...],
       [ 16.6819067..., 27.2271403..., 22.9490590...],
       [ 12.5543694...,  9.0705685...,  5.9516323...],
       [ 18.5921357..., 33.6508573..., 26.9511144...],
       [ 47.6698072..., 40.4630866..., 39.5612904...],
       [  7.8336896..., 12.3711768..., 23.3654245...],
       [ 24.1486630..., 20.0621956...,  7.2438655...],
       [  7.2323703...,  2.8033217..., 10.0510790...],
       [ 48.7322793..., 30.2614779..., 10.6377135...],
       [  8.3365770..., 18.6690888..., 15.8517212...],
       [ 24.6240657..., 26.0805317..., 27.6706915...]])
```

Ancillary Objects

colour.colorimetry

| | |
|---|--|
| <code>sd_to_XYZ_tristimulus_weighting_factors_ASTME308</code> | Convert given spectral distribution to <i>CIE XYZ</i> tristimulus values using given colour matching functions and illuminant using a table of tristimulus weighting factors according to practise <i>ASTM E308-15</i> method. |
| <code>adjust_tristimulus_weighting_factors_ASTME308(...)</code> | Adjust given table of tristimulus weighting factors to account for a shorter wavelengths range of the test spectral shape compared to the reference spectral shape using practise <i>ASTM E308-15</i> method: Weights at the wavelengths for which data are not available are added to the weights at the shortest and longest wavelength for which spectral data are available. |
| <code>lagrange_coefficients_ASTME2022([interval, ...])</code> | Compute the <i>Lagrange Coefficients</i> for given interval size using practise <i>ASTM E2022-11</i> method. |
| <code>tristimulus_weighting_factors_ASTME2022(...)</code> | Return a table of tristimulus weighting factors for given colour matching functions and illuminant using practise <i>ASTM E2022-11</i> method. |

colour.colorimetry.sd_to_XYZ_tristimulus_weighting_factors_ASTME308

colour.colorimetry.sd_to_XYZ_tristimulus_weighting_factors_ASTME308(*sd*: [SpectralDistribution](#), *cmfs*: [MultiSpectralDistributions](#) | *None* = *None*, *illuminant*: [SpectralDistribution](#) | *None* = *None*, *k*: *Number* | *None* = *None*) → [ndarray](#)

Convert given spectral distribution to *CIE XYZ* tristimulus values using given colour matching func-

tions and illuminant using a table of tristimulus weighting factors according to practise *ASTM E308-15* method.

Parameters

- **sd** ([SpectralDistribution](#)) – Spectral distribution.
- **cmfs** ([MultiSpectralDistributions](#) | None) – Standard observer colour matching functions, default to the *CIE 1931 2 Degree Standard Observer*.
- **illuminant** ([SpectralDistribution](#) | None) – Illuminant spectral distribution, default to *CIE Illuminant E*.
- **k** (Number | None) – Normalisation constant k . For reflecting or transmitting object colours, k is chosen so that $Y = 100$ for objects for which the spectral reflectance factor $R(\lambda)$ of the object colour or the spectral transmittance factor $\tau(\lambda)$ of the object is equal to unity for all wavelengths. For self-luminous objects and illuminants, the constants k is usually chosen on the grounds of convenience. If, however, in the CIE 1931 standard colorimetric system, the Y value is required to be numerically equal to the absolute value of a photometric quantity, the constant, k , must be put equal to the numerical value of K_m , the maximum spectral luminous efficacy (which is equal to $683 \text{ lm} \cdot \text{W}^{-1}$) and $\Phi_\lambda(\lambda)$ must be the spectral concentration of the radiometric quantity corresponding to the photometric quantity required.

Returns

CIE XYZ tristimulus values.

Return type

`numpy.ndarray`

Notes

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |

References

[[ASTMInternational15a](#)]

Examples

```
>>> from colour import MSDS_CMFS, SDS_ILLUMINANTS, SpectralDistribution
>>> cmfs = MSDS_CMFS["CIE 1931 2 Degree Standard Observer"]
>>> illuminant = SDS_ILLUMINANTS["D65"]
>>> shape = SpectralShape(400, 700, 20)
>>> data = np.array(
...     [
...         0.0641,
...         0.0645,
...         0.0562,
...         0.0537,
...         0.0559,
...         0.0651,
...         0.0705,
...         0.0772,
```

(continues on next page)

(continued from previous page)

```

...     0.0870,
...     0.1128,
...     0.1360,
...     0.1511,
...     0.1688,
...     0.1996,
...     0.2397,
...     0.2852,
... ]
... )
>>> sd = SpectralDistribution(data, shape)
>>> sd_to_XYZ_tristimulus_weighting_factors_ASTME308(
...     sd, cmfs, illuminant
... )
array([ 10.8405832...,  9.6844909...,  6.2155622...])

```

The default CMFS are the *CIE 1931 2 Degree Standard Observer*, and the default illuminant is *CIE Illuminant E*:

```

>>> sd_to_XYZ_tristimulus_weighting_factors_ASTME308(sd)
...
array([ 11.7786111...,  9.9589055...,  5.7403205...])

```

colour.colorimetry.adjust_tristimulus_weighting_factors_ASTME308

colour.colorimetry.adjust_tristimulus_weighting_factors_ASTME308(*W*: ArrayLike, *shape_r*: SpectralShape, *shape_t*: SpectralShape) → ndarray

Adjust given table of tristimulus weighting factors to account for a shorter wavelengths range of the test spectral shape compared to the reference spectral shape using practise *ASTM E308-15* method: Weights at the wavelengths for which data are not available are added to the weights at the shortest and longest wavelength for which spectral data are available.

Parameters

- **W** (ArrayLike) – Tristimulus weighting factors table.
- **shape_r** (SpectralShape) – Reference spectral shape.
- **shape_t** (SpectralShape) – Test spectral shape.

Returns

Adjusted tristimulus weighting factors.

Return type

numpy.ndarray

References

[ASTMInternational15a]

Examples

```
>>> from colour import (
...     MSDS_CMFS,
...     SpectralDistribution,
...     SpectralShape,
...     sd_CIE_standard_illuminant_A,
... )
>>> from colour.utilities import numpy_print_options
>>> cmfs = MSDS_CMFS["CIE 1964 10 Degree Standard Observer"]
>>> A = sd_CIE_standard_illuminant_A(cmfs.shape)
>>> W = tristimulus_weighting_factors_ASTME2022(
...     cmfs, A, SpectralShape(360, 830, 20)
... )
>>> with numpy_print_options(suppress=True):
...     adjust_tristimulus_weighting_factors_ASTME308(
...         W, SpectralShape(360, 830, 20), SpectralShape(400, 700, 20)
...     )
...
...
array([[ 0.0509543...,  0.0040971...,  0.2144280...],
       [ 0.7734225...,  0.0779839...,  3.6965732...],
       [ 1.9000905...,  0.3037005...,  9.7554195...],
       [ 1.9707727...,  0.8552809..., 11.4867325...],
       [ 0.7183623...,  2.1457000...,  6.7845806...],
       [ 0.0426667...,  4.8985328...,  2.3208000...],
       [ 1.5223302...,  9.6471138...,  0.7430671...],
       [ 5.6770329..., 14.4609708...,  0.1958194...],
       [12.4451744..., 17.4742541...,  0.0051827...],
       [20.5535772..., 17.5838219..., -0.0026512...],
       [25.3315384..., 14.8957035...,  0.         ],
       [21.5711570..., 10.0796619...,  0.         ],
       [12.1785817...,  5.0680655...,  0.         ],
       [ 4.6675746...,  1.8303239...,  0.         ],
       [ 1.3236117...,  0.5129694...,  0.         ],
       [ 0.4171109...,  0.1618194...,  0.         ]])
```

colour.colorimetry.lagrange_coefficients_ASTME2022

colour.colorimetry.lagrange_coefficients_ASTME2022(interval: *int* = 10, interval_type: *Literal*['Boundary', 'Inner'] | *str* = 'Inner') → *ndarray*

Compute the *Lagrange Coefficients* for given interval size using practise *ASTM E2022-11* method.

Parameters

- **interval** (*int*) – Interval size in nm.
- **interval_type** (*Literal*['Boundary', 'Inner'] | *str*) – If the interval is an *inner* interval *Lagrange Coefficients* are computed for degree 4. Degree 3 is used for a *boundary* interval.

Returns*Lagrange Coefficients.***Return type**`numpy.ndarray`**References**[\[ASTMInternational11\]](#)**Examples**

```
>>> lagrange_coefficients_ASTME2022(10, "inner")
...
array([[ -0.028...,  0.940...,  0.104..., -0.016...],
       [ -0.048...,  0.864...,  0.216..., -0.032...],
       [ -0.059...,  0.773...,  0.331..., -0.045...],
       [ -0.064...,  0.672...,  0.448..., -0.056...],
       [ -0.062...,  0.562...,  0.562..., -0.062...],
       [ -0.056...,  0.448...,  0.672..., -0.064...],
       [ -0.045...,  0.331...,  0.773..., -0.059...],
       [ -0.032...,  0.216...,  0.864..., -0.048...],
       [ -0.016...,  0.104...,  0.940..., -0.028...]])
>>> lagrange_coefficients_ASTME2022(10, "boundary")
...
array([[ 0.85...,  0.19..., -0.04...],
       [ 0.72...,  0.36..., -0.08...],
       [ 0.59...,  0.51..., -0.10...],
       [ 0.48...,  0.64..., -0.12...],
       [ 0.37...,  0.75..., -0.12...],
       [ 0.28...,  0.84..., -0.12...],
       [ 0.19...,  0.91..., -0.10...],
       [ 0.12...,  0.96..., -0.08...],
       [ 0.05...,  0.99..., -0.04...]])
```

colour.colorimetry.tristimulus_weighting_factors_ASTME2022

`colour.colorimetry.tristimulus_weighting_factors_ASTME2022`(*cmfs*: [MultiSpectralDistributions](#),
illuminant: [SpectralDistribution](#),
shape: [SpectralShape](#), *k*: *Number* |
None = *None*) → `ndarray`

Return a table of tristimulus weighting factors for given colour matching functions and illuminant using practise *ASTM E2022-11* method.

The computed table of tristimulus weighting factors should be used with spectral data that has been corrected for spectral bandpass dependence.

Parameters

- **cmfs** ([MultiSpectralDistributions](#)) – Standard observer colour matching functions.
- **illuminant** ([SpectralDistribution](#)) – Illuminant spectral distribution.
- **shape** ([SpectralShape](#)) – Shape used to build the table, only the interval is needed.

- **k** (Number | None) – Normalisation constant k . For reflecting or transmitting object colours, k is chosen so that $Y = 100$ for objects for which the spectral reflectance factor $R(\lambda)$ of the object colour or the spectral transmittance factor $\tau(\lambda)$ of the object is equal to unity for all wavelengths. For self-luminous objects and illuminants, the constants k is usually chosen on the grounds of convenience. If, however, in the CIE 1931 standard colorimetric system, the Y value is required to be numerically equal to the absolute value of a photometric quantity, the constant, k , must be put equal to the numerical value of K_m , the maximum spectral luminous efficacy (which is equal to $683 \text{ lm} \cdot \text{W}^{-1}$) and $\Phi_\lambda(\lambda)$ must be the spectral concentration of the radiometric quantity corresponding to the photometric quantity required.

Returns

Tristimulus weighting factors table.

Return type

`numpy.ndarray`

Raises

ValueError – If the colour matching functions or illuminant intervals are not equal to 1 nm.

Notes

- Input colour matching functions and illuminant intervals are expected to be equal to 1 nm. If the illuminant data is not available at 1 nm interval, it needs to be interpolated using *CIE* recommendations: The method developed by *Sprague (1880)* should be used for interpolating functions having a uniformly spaced independent variable and a *Cubic Spline* method for non-uniformly spaced independent variable.

References

[ASTMInternational11]

Examples

```
>>> from colour import (
...     MSDS_CMFS,
...     SpectralDistribution,
...     SpectralShape,
...     sd_CIE_standard_illuminant_A,
... )
>>> from colour.utilities import numpy_print_options
>>> cmfs = MSDS_CMFS["CIE 1964 10 Degree Standard Observer"]
>>> A = sd_CIE_standard_illuminant_A(cmfs.shape)
>>> with numpy_print_options(suppress=True):
...     tristimulus_weighting_factors_ASTME2022(
...         cmfs, A, SpectralShape(360, 830, 20)
...     )
...
...
array([[ -0.0002981...,  -0.0000317...,  -0.0013301...],
       [ -0.0087155...,  -0.0008915...,  -0.0407436...],
       [  0.0599679...,   0.0050203...,   0.2565018...],
       [  0.7734225...,   0.0779839...,   3.6965732...],
       [  1.9000905...,   0.3037005...,   9.7554195...],
```

(continues on next page)

(continued from previous page)

```
[ 1.9707727..., 0.8552809..., 11.4867325...],
[ 0.7183623..., 2.1457000..., 6.7845806...],
[ 0.0426667..., 4.8985328..., 2.3208000...],
[ 1.5223302..., 9.6471138..., 0.7430671...],
[ 5.6770329..., 14.4609708..., 0.1958194...],
[ 12.4451744..., 17.4742541..., 0.0051827...],
[ 20.5535772..., 17.5838219..., -0.0026512...],
[ 25.3315384..., 14.8957035..., 0.    ...],
[ 21.5711570..., 10.0796619..., 0.    ...],
[ 12.1785817..., 5.0680655..., 0.    ...],
[ 4.6675746..., 1.8303239..., 0.    ...],
[ 1.3236117..., 0.5129694..., 0.    ...],
[ 0.3175325..., 0.1230084..., 0.    ...],
[ 0.0746341..., 0.0290243..., 0.    ...],
[ 0.0182990..., 0.0071606..., 0.    ...],
[ 0.0047942..., 0.0018888..., 0.    ...],
[ 0.0013293..., 0.0005277..., 0.    ...],
[ 0.0004254..., 0.0001704..., 0.    ...],
[ 0.0000962..., 0.0000389..., 0.    ...]])
```

Integration

colour.colorimetry

| | |
|---|--|
| <code>sd_to_XYZ_integration(sd[, cmfs, ...])</code> | Convert given spectral distribution to <i>CIE XYZ</i> tristimulus values using given colour matching functions and illuminant according to classical integration method. |
| <code>msds_to_XYZ_integration(msds[, cmfs, ...])</code> | Convert given multi-spectral distributions to <i>CIE XYZ</i> tristimulus values using given colour matching functions and illuminant. |

colour.colorimetry.sd_to_XYZ_integration

colour.colorimetry.sd_to_XYZ_integration(sd: *ArrayLike* | *SpectralDistribution* | *MultiSpectralDistributions*, cmfs: *MultiSpectralDistributions* | *None* = *None*, illuminant: *SpectralDistribution* | *None* = *None*, k: *Number* | *None* = *None*, shape: *SpectralShape* | *None* = *None*) → *ndarray*

Convert given spectral distribution to *CIE XYZ* tristimulus values using given colour matching functions and illuminant according to classical integration method.

The spectral distribution can be either a `colour.SpectralDistribution` class instance or an *Array-Like* in which case the shape must be passed.

Parameters

- sd** (*ArrayLike* | *SpectralDistribution* | *MultiSpectralDistributions*) – Spectral distribution, if an *ArrayLike* the wavelengths are expected to be in the last axis, e.g. for a spectral array with 77 bins, sd shape could be (77,) or (1, 77).
- cmfs** (*MultiSpectralDistributions* | *None*) – Standard observer colour matching functions, default to the *CIE 1931 2 Degree Standard Observer*.

- **illuminant** ([SpectralDistribution](#) | None) – Illuminant spectral distribution, default to *CIE Illuminant E*.
- **k** (Number | None) – Normalisation constant k . For reflecting or transmitting object colours, k is chosen so that $Y = 100$ for objects for which the spectral reflectance factor $R(\lambda)$ of the object colour or the spectral transmittance factor $\tau(\lambda)$ of the object is equal to unity for all wavelengths. For self-luminous objects and illuminants, the constants k is usually chosen on the grounds of convenience. If, however, in the CIE 1931 standard colorimetric system, the Y value is required to be numerically equal to the absolute value of a photometric quantity, the constant, k , must be put equal to the numerical value of K_m , the maximum spectral luminous efficacy (which is equal to $683 \text{ lm} \cdot \text{W}^{-1}$) and $\Phi_\lambda(\lambda)$ must be the spectral concentration of the radiometric quantity corresponding to the photometric quantity required.
- **shape** ([SpectralShape](#) | None) – Spectral shape of the spectral distribution, cmfs and illuminant will be aligned to it if sd is an *ArrayLike*.

Returns

CIE XYZ tristimulus values.

Return type

`numpy.ndarray`

Notes

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |

- When k is set to a value other than *None*, the computed *CIE XYZ* tristimulus values are assumed to be absolute and are thus converted from percentages by a final division by 100.
- The code path using the *ArrayLike* spectral distribution produces results different to the code path using a `colour.SpectralDistribution` class instance: the former favours execution speed by aligning the colour matching functions and illuminant to the given spectral shape while the latter favours precision by aligning the spectral distribution to the colour matching functions.

References

[WS00c]

Examples

```
>>> from colour import MSDS_CMFS, SDS_ILLUMINANTS, SpectralDistribution
>>> cmfs = MSDS_CMFS["CIE 1931 2 Degree Standard Observer"]
>>> illuminant = SDS_ILLUMINANTS["D65"]
>>> shape = SpectralShape(400, 700, 20)
>>> data = np.array(
...     [
...         0.0641,
...         0.0645,
...         0.0562,
...         0.0537,
...         0.0559,
```

(continues on next page)

(continued from previous page)

```

...     0.0651,
...     0.0705,
...     0.0772,
...     0.0870,
...     0.1128,
...     0.1360,
...     0.1511,
...     0.1688,
...     0.1996,
...     0.2397,
...     0.2852,
... ]
... )
>>> sd = SpectralDistribution(data, shape)
>>> sd_to_XYZ_integration(sd, cmfs, illuminant)
...
array([ 10.8404805...,   9.6838697...,   6.2115722...])
>>> sd_to_XYZ_integration(data, cmfs, illuminant, shape=shape)
...
array([ 10.8993917...,   9.6986145...,   6.2540301...])

```

The default CMFS are the *CIE 1931 2 Degree Standard Observer*, and the default illuminant is *CIE Illuminant E*:

```

>>> sd_to_XYZ_integration(sd)
...
array([ 11.7786939...,   9.9583972...,   5.7371816...])

```

colour.colorimetry.msds_to_XYZ_integration

`colour.colorimetry.msds_to_XYZ_integration(msds: ArrayLike | SpectralDistribution | MultiSpectralDistributions, cmfs: MultiSpectralDistributions | None = None, illuminant: SpectralDistribution | None = None, k: Number | None = None, shape: SpectralShape | None = None) → ndarray`

Convert given multi-spectral distributions to *CIE XYZ* tristimulus values using given colour matching functions and illuminant.

The multi-spectral distributions can be either a `colour.MultiSpectralDistributions` class instance or an `ArrayLike` in which case the shape must be passed.

Parameters

- **msds** (`ArrayLike` | `SpectralDistribution` | `MultiSpectralDistributions`) – Multi-spectral distributions, if an `ArrayLike` the wavelengths are expected to be in the last axis, e.g. for a 512x384 multi-spectral image with 77 bins, `msds` shape should be (384, 512, 77).
- **cmfs** (`MultiSpectralDistributions` | `None`) – Standard observer colour matching functions, default to the *CIE 1931 2 Degree Standard Observer*.
- **illuminant** (`SpectralDistribution` | `None`) – Illuminant spectral distribution, default to *CIE Illuminant E*.
- **k** (`Number` | `None`) – Normalisation constant k . For reflecting or transmitting object colours, k is chosen so that $Y = 100$ for objects for which the spectral reflectance factor $R(\lambda)$ of the object colour or the spectral transmittance factor

$\tau(\lambda)$ of the object is equal to unity for all wavelengths. For self-luminous objects and illuminants, the constants k is usually chosen on the grounds of convenience. If, however, in the CIE 1931 standard colorimetric system, the Y value is required to be numerically equal to the absolute value of a photometric quantity, the constant, k , must be put equal to the numerical value of K_m , the maximum spectral luminous efficacy (which is equal to $683 \text{ lm} \cdot \text{W}^{-1}$) and $\Phi_\lambda(\lambda)$ must be the spectral concentration of the radiometric quantity corresponding to the photometric quantity required.

- **shape** ([SpectralShape](#) | None) – Spectral shape of the multi-spectral distributions, cmfs and illuminant will be aligned to it if msds is an *ArrayLike*.

Returns

CIE XYZ tristimulus values, for a 512x384 multi-spectral image with 77 bins, the output shape will be (384, 512, 3).

Return type

`numpy.ndarray`

Notes

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |

- When k is set to a value other than *None*, the computed CIE XYZ tristimulus values are assumed to be absolute and are thus converted from percentages by a final division by 100.
- The code path using the *ArrayLike* multi-spectral distributions produces results different to the code path using a [colour.MultiSpectralDistributions](#) class instance: the former favours execution speed by aligning the colour matching functions and illuminant to the given spectral shape while the latter favours precision by aligning the multi-spectral distributions to the colour matching functions.
- If precision is required, it is possible to interpolate the multi-spectral distributions with [scipy.interpolate.interp1d](#) class on the last / tail axis as follows:

```
interpolator = scipy.interpolate.interp1d(
    wavelengths,
    values,
    axis=-1,
    kind="linear",
    fill_value="extrapolate",
)
values_i = interpolator(wavelengths_i)
```

References

[WS00c]

Examples

```
>>> from colour import MSDS_CMFS, SDS_ILLUMINANTS
>>> cmfs = MSDS_CMFS["CIE 1931 2 Degree Standard Observer"]
>>> illuminant = SDS_ILLUMINANTS["D65"]
>>> shape = SpectralShape(400, 700, 60)
>>> data = np.array(
...     [
...         [
...             0.0137,
...             0.0159,
...             0.0096,
...             0.0111,
...             0.0179,
...             0.1057,
...             0.0433,
...             0.0258,
...             0.0248,
...             0.0186,
...             0.0310,
...             0.0473,
...         ],
...         [
...             0.0913,
...             0.3145,
...             0.2582,
...             0.0709,
...             0.2971,
...             0.4620,
...             0.2683,
...             0.0831,
...             0.1203,
...             0.1292,
...             0.1682,
...             0.3221,
...         ],
...         [
...             0.0152,
...             0.0842,
...             0.4139,
...             0.0220,
...             0.5630,
...             0.1918,
...             0.2373,
...             0.0430,
...             0.0054,
...             0.0079,
...             0.3719,
...             0.2268,
...         ],
...         [
...             0.0281,
...             0.0907,
...             0.2228,
...             0.1249,
...             0.2375,
...             0.5625,
```

(continues on next page)

(continued from previous page)

```

...         0.0518,
...         0.3230,
...         0.0065,
...         0.4006,
...         0.0861,
...         0.3161,
...     ],
...     [
...         0.1918,
...         0.7103,
...         0.0041,
...         0.1817,
...         0.0024,
...         0.4209,
...         0.0118,
...         0.2302,
...         0.1860,
...         0.9404,
...         0.0041,
...         0.1124,
...     ],
...     [
...         0.0430,
...         0.0437,
...         0.3744,
...         0.0020,
...         0.5819,
...         0.0027,
...         0.0823,
...         0.0081,
...         0.3625,
...         0.3213,
...         0.7849,
...         0.0024,
...     ],
... ]
... )
>>> msds = MultiSpectralDistributions(data, shape)
>>> msds_to_XYZ_integration(msds, cmfs, illuminant)
...
array([[ 7.5029704...,  3.9487844...,  8.4034669...],
       [26.9259681..., 15.0724609..., 28.7057807...],
       [16.7032188..., 28.2172346..., 25.6455984...],
       [11.5767013...,  8.6400993...,  6.5768406...],
       [18.7314793..., 35.0750364..., 30.1457266...],
       [45.1656756..., 39.6136917..., 43.6783499...],
       [ 8.1755696..., 13.0934177..., 25.9420944...],
       [22.4676286..., 19.3099080...,  7.9637549...],
       [ 6.5781241...,  2.5255349..., 11.0930768...],
       [43.9147364..., 27.9803924..., 11.7292655...],
       [ 8.5365923..., 19.7030166..., 17.7050933...],
       [23.9088250..., 26.2129529..., 30.6763148...]])
>>> data = np.reshape(data, (2, 6, 6))
>>> msds_to_XYZ_integration(data, cmfs, illuminant, shape=shape)
...
array([[[ 1.3104332...,  1.1377026...,  1.8267926...],

```

(continues on next page)

(continued from previous page)

```
[ 2.1875548..., 2.2510619..., 3.0721540...],
[ 16.8714661..., 17.7063715..., 35.8709902...],
[ 12.1648722..., 12.7222194..., 10.4880888...],
[ 16.0419431..., 23.0985768..., 11.1479902...],
[ 9.2391014..., 3.8301575..., 5.4703803...]],

[[ 13.8734231..., 17.3942194..., 11.0364103...],
[ 27.7096381..., 20.8626722..., 35.5581690...],
[ 22.7886687..., 11.4769218..., 78.3300659...],
[ 51.1284864..., 52.2463568..., 26.1483754...],
[ 14.4749229..., 20.5011495..., 6.6228107...],
[ 33.6001365..., 36.3242617..., 2.8254217...]]])
```

The default CMFS are the *CIE 1931 2 Degree Standard Observer*, and the default illuminant is *CIE Illuminant E*:

```
>>> msds_to_XYZ_integration(msds)
...
array([[ 8.2415862..., 4.2543993..., 7.6100842...],
[ 29.6144619..., 16.1158465..., 25.9015472...],
[ 16.6799560..., 27.2350547..., 22.9413337...],
[ 12.5597688..., 9.0667136..., 5.9670327...],
[ 18.5804689..., 33.6618109..., 26.9249733...],
[ 47.7113308..., 40.4573249..., 39.6439145...],
[ 7.830207 ..., 12.3689624..., 23.3742655...],
[ 24.1695370..., 20.0629815..., 7.2718670...],
[ 7.2333751..., 2.7982097..., 10.0688374...],
[ 48.7358074..., 30.2417164..., 10.6753233...],
[ 8.3231013..., 18.6791507..., 15.8228184...],
[ 24.6452277..., 26.0809382..., 27.7106399...]])
```

Spectral Bandpass Dependence Correction

colour

| | |
|--|--|
| <code>bandpass_correction(sd[, method])</code> | Implement spectral bandpass dependence correction on given spectral distribution using given method. |
| <code>BANDPASS_CORRECTION_METHODS</code> | Supported spectral bandpass dependence correction methods. |

colour.bandpass_correction

`colour.bandpass_correction(sd: SpectralDistribution, method: Literal['Stearns 1988'] | str = 'Stearns 1988') → SpectralDistribution`

Implement spectral bandpass dependence correction on given spectral distribution using given method.

Parameters

- `sd` ([SpectralDistribution](#)) – Spectral distribution.
- `method` ([Literal](#)['Stearns 1988'] | `str`) – Correction method.

Returns

Spectral bandpass dependence corrected spectral distribution.

Return type

`colour.SpectralDistribution`

References

[SS88], [WRC12a]

Examples

```
>>> from colour import SpectralDistribution
>>> from colour.utilities import numpy_print_options
>>> data = {
...     500: 0.0651,
...     520: 0.0705,
...     540: 0.0772,
...     560: 0.0870,
...     580: 0.1128,
...     600: 0.1360,
... }
>>> with numpy_print_options(suppress=True):
...     bandpass_correction(SpectralDistribution(data))
...
...
SpectralDistribution([[ 500.      ,  0.0646518...],
                    [ 520.      ,  0.0704293...],
                    [ 540.      ,  0.0769485...],
                    [ 560.      ,  0.0856928...],
                    [ 580.      ,  0.1129644...],
                    [ 600.      ,  0.1379256...]],
                    SpragueInterpolator,
                    {},
                    Extrapolator,
                    {'method': 'Constant', 'left': None, 'right': None})
```

colour.BANDPASS_CORRECTION_METHODS

`colour.BANDPASS_CORRECTION_METHODS = CanonicalMapping({'Stearns 1988': ...})`

Supported spectral bandpass dependence correction methods.

Stearns and Stearns (1988)

`colour.colorimetry`

`bandpass_correction_Stearns1988(sd)`

Implement spectral bandpass dependence correction on given spectral distribution using *Stearns and Stearns (1988)* method.

colour.colorimetry.bandpass_correction_Stearns1988

`colour.colorimetry.bandpass_correction_Stearns1988(sd: SpectralDistribution) → SpectralDistribution`

Implement spectral bandpass dependence correction on given spectral distribution using *Stearns and Stearns (1988)* method.

Parameters

sd ([SpectralDistribution](#)) – Spectral distribution.

Returns

Spectral bandpass dependence corrected spectral distribution.

Return type

[colour.SpectralDistribution](#)

References

[SS88], [WRC12a]

Examples

```
>>> from colour import SpectralDistribution
>>> from colour.utilities import numpy_print_options
>>> data = {
...     500: 0.0651,
...     520: 0.0705,
...     540: 0.0772,
...     560: 0.0870,
...     580: 0.1128,
...     600: 0.1360,
... }
>>> with numpy_print_options(suppress=True):
...     bandpass_correction_Stearns1988(SpectralDistribution(data))
...
...
SpectralDistribution([[ 500.          ,  0.0646518...],
                    [ 520.          ,  0.0704293...],
                    [ 540.          ,  0.0769485...],
                    [ 560.          ,  0.0856928...],
                    [ 580.          ,  0.1129644...],
                    [ 600.          ,  0.1379256...]],
                    SpragueInterpolator,
                    {},
                    Extrapolator,
                    {'method': 'Constant', 'left': None, 'right': None})
```

Colour Matching Functions

colour.colorimetry

| | |
|--|---|
| <code>LMS_ConeFundamentals(data, domain, labels, ...)</code> | Implement support for the Stockman and Sharpe <i>LMS</i> cone fundamentals colour matching functions. |
| <code>RGB_ColourMatchingFunctions(data, domain, ...)</code> | Implement support for the <i>CIE RGB</i> colour matching functions. |
| <code>XYZ_ColourMatchingFunctions(data, domain, ...)</code> | Implement support for the <i>CIE</i> Standard Observers <i>XYZ</i> colour matching functions. |

colour.colorimetry.LMS_ConeFundamentals

```
class colour.colorimetry.LMS_ConeFundamentals(data: ArrayLike | <MagicMock
                                              id='139666505454096'> | dict |
                                              ~colour.continuous.multi_signals.MultiSignals |
                                              ~colour.colorimetry.spectrum.MultiSpectralDistributions
                                              | ~typing.Sequence | <MagicMock
                                              id='139666505459408'> |
                                              ~colour.continuous.signal.Signal |
                                              ~colour.colorimetry.spectrum.SpectralDistribution |
                                              None = None, domain: ArrayLike |
                                              ~colour.colorimetry.spectrum.SpectralShape | None
                                              = None, labels: ~typing.Sequence | None = None,
                                              **kwargs: ~typing.Any)
```

Bases: `MultiSpectralDistributions`

Implement support for the Stockman and Sharpe *LMS* cone fundamentals colour matching functions.

Parameters

- **data** (Optional[Union[ArrayLike, DataFrame, dict, MultiSignals, MultiSpectralDistributions, Sequence, Series, Signal, SpectralDistribution]]) – Data to be stored in the multi-spectral distributions.
- **domain** (Optional[Union[ArrayLike, SpectralShape]]) – Values to initialise the multiple `colour.SpectralDistribution` class instances `colour.continuous.Signal.wavelengths` attribute with. If both data and domain arguments are defined, the latter will be used to initialise the `colour.continuous.Signal.wavelengths` property.
- **labels** (Optional[Sequence]) – Names to use for the `colour.SpectralDistribution` class instances.
- **extrapolator** – Extrapolator class type to use as extrapolating function for the `colour.SpectralDistribution` class instances.
- **extrapolator_kwargs** – Arguments to use when instantiating the extrapolating function of the `colour.SpectralDistribution` class instances.
- **interpolator** – Interpolator class type to use as interpolating function for the `colour.SpectralDistribution` class instances.
- **interpolator_kwargs** – Arguments to use when instantiating the interpolating function of the `colour.SpectralDistribution` class instances.
- **name** – Multi-spectral distributions name.

- **display_labels** – Multi-spectral distributions labels for figures, default to `colour.colorimetry.LMS_ConeFundamentals.labels` property value.
- **kwargs** (*Any*) –

```
__init__(data: ArrayLike | <MagicMock id='139666505454096'> | dict |
~colour.continuous.multi_signals.MultiSignals |
~colour.colorimetry.spectrum.MultiSpectralDistributions | ~typing.Sequence |
<MagicMock id='139666505459408'> | ~colour.continuous.signal.Signal |
~colour.colorimetry.spectrum.SpectralDistribution | None = None, domain: ArrayLike |
~colour.colorimetry.spectrum.SpectralShape | None = None, labels: ~typing.Sequence |
None = None, **kwargs: ~typing.Any) → None
```

Parameters

- **data** (*ArrayLike* | *<MagicMock id='139666505454096'>* | *dict* | *MultiSignals* | *MultiSpectralDistributions* | *Sequence* | *<MagicMock id='139666505459408'>* | *Signal* | *SpectralDistribution* | *None*) –
- **domain** (*ArrayLike* | *SpectralShape* | *None*) –
- **labels** (*Sequence* | *None*) –
- **kwargs** (*Any*) –

Return type

None

colour.colorimetry.RGB_ColourMatchingFunctions

```
class colour.colorimetry.RGB_ColourMatchingFunctions(data: ArrayLike | <MagicMock
id='139666505454096'> | dict |
~colour.continuous.multi_signals.MultiSignals
|
~colour.colorimetry.spectrum.MultiSpectralDistributions
| ~typing.Sequence | <MagicMock
id='139666505459408'> |
~colour.continuous.signal.Signal |
~colour.colorimetry.spectrum.SpectralDistribution
| None = None, domain: ArrayLike |
~colour.colorimetry.spectrum.SpectralShape
| None = None, labels: ~typing.Sequence |
None = None, **kwargs: ~typing.Any)
```

Bases: *MultiSpectralDistributions*

Implement support for the *CIE RGB* colour matching functions.

Parameters

- **data** (*Optional[Union[ArrayLike, DataFrame, dict, MultiSignals, MultiSpectralDistributions, Sequence, Series, Signal, SpectralDistribution]]*) – Data to be stored in the multi-spectral distributions.
- **domain** (*Optional[Union[ArrayLike, SpectralShape]]*) – Values to initialise the multiple *colour.SpectralDistribution* class instances *colour.continuous.Signal.wavelengths* attribute with. If both data and domain arguments are defined, the latter will be used to initialise the *colour.continuous.Signal.wavelengths* property.
- **labels** (*Optional[Sequence]*) – Names to use for the *colour.SpectralDistribution* class instances.

- **extrapolator** – Extrapolator class type to use as extrapolating function for the `colour.SpectralDistribution` class instances.
- **extrapolator_kwargs** – Arguments to use when instantiating the extrapolating function of the `colour.SpectralDistribution` class instances.
- **interpolator** – Interpolator class type to use as interpolating function for the `colour.SpectralDistribution` class instances.
- **interpolator_kwargs** – Arguments to use when instantiating the interpolating function of the `colour.SpectralDistribution` class instances.
- **name** – Multi-spectral distributions name.
- **display_labels** – Multi-spectral distributions labels for figures, default to `colour.colorimetry.RGB_ColourMatchingFunctions.labels` property value.
- **kwargs** (Any) –

```
__init__(data: ArrayLike | <MagicMock id='139666505454096'> | dict |
~colour.continuous.multi_signals.MultiSignals |
~colour.colorimetry.spectrum.MultiSpectralDistributions | ~typing.Sequence |
<MagicMock id='139666505459408'> | ~colour.continuous.signal.Signal |
~colour.colorimetry.spectrum.SpectralDistribution | None = None, domain: ArrayLike |
~colour.colorimetry.spectrum.SpectralShape | None = None, labels: ~typing.Sequence |
None = None, **kwargs: ~typing.Any) → None
```

Parameters

- **data** (ArrayLike | <MagicMock id='139666505454096'> | dict | MultiSignals | MultiSpectralDistributions | Sequence | <MagicMock id='139666505459408'> | Signal | SpectralDistribution | None) –
- **domain** (ArrayLike | SpectralShape | None) –
- **labels** (Sequence | None) –
- **kwargs** (Any) –

Return type

None

colour.colorimetry.XYZ_ColourMatchingFunctions

```
class colour.colorimetry.XYZ_ColourMatchingFunctions(data: ArrayLike | <MagicMock
id='139666505454096'> | dict |
~colour.continuous.multi_signals.MultiSignals
|
~colour.colorimetry.spectrum.MultiSpectralDistributions
| ~typing.Sequence | <MagicMock
id='139666505459408'> |
~colour.continuous.signal.Signal |
~colour.colorimetry.spectrum.SpectralDistribution
| None = None, domain: ArrayLike |
~colour.colorimetry.spectrum.SpectralShape
| None = None, labels: ~typing.Sequence |
None = None, **kwargs: ~typing.Any)
```

Bases: `MultiSpectralDistributions`

Implement support for the *CIE* Standard Observers *XYZ* colour matching functions.

Parameters

- **data** (Optional[Union[ArrayLike, DataFrame, dict, MultiSignals, MultiSpectralDistributions, Sequence, Series, Signal, SpectralDistribution]]) – Data to be stored in the multi-spectral distributions.
- **domain** (Optional[Union[ArrayLike, SpectralShape]]) – Values to initialise the multiple `colour.SpectralDistribution` class instances `colour.continuous.Signal.wavelengths` attribute with. If both data and domain arguments are defined, the latter will be used to initialise the `colour.continuous.Signal.wavelengths` property.
- **labels** (Optional[Sequence]) – Names to use for the `colour.SpectralDistribution` class instances.
- **extrapolator** – Extrapolator class type to use as extrapolating function for the `colour.SpectralDistribution` class instances.
- **extrapolator_kwargs** – Arguments to use when instantiating the extrapolating function of the `colour.SpectralDistribution` class instances.
- **interpolator** – Interpolator class type to use as interpolating function for the `colour.SpectralDistribution` class instances.
- **interpolator_kwargs** – Arguments to use when instantiating the interpolating function of the `colour.SpectralDistribution` class instances.
- **name** – Multi-spectral distributions name.
- **display_labels** – Multi-spectral distributions labels for figures, default to `colour.colorimetry.XYZ_ColourMatchingFunctions.labels` property value.
- **kwargs** (Any) –

```
__init__(data: ArrayLike | <MagicMock id='139666505454096'> | dict |
~colour.continuous.multi_signals.MultiSignals |
~colour.colorimetry.spectrum.MultiSpectralDistributions | ~typing.Sequence |
<MagicMock id='139666505459408'> | ~colour.continuous.signal.Signal |
~colour.colorimetry.spectrum.SpectralDistribution | None = None, domain: ArrayLike |
~colour.colorimetry.spectrum.SpectralShape | None = None, labels: ~typing.Sequence |
None = None, **kwargs: ~typing.Any) → None
```

Parameters

- **data** (ArrayLike | <MagicMock id='139666505454096'> | dict | MultiSignals | MultiSpectralDistributions | Sequence | <MagicMock id='139666505459408'> | Signal | SpectralDistribution | None) –
- **domain** (ArrayLike | SpectralShape | None) –
- **labels** (Sequence | None) –
- **kwargs** (Any) –

Return type

None

Dataset

colour

MSDS_CMFS

Multi-spectral distributions of the colour matching functions.

colour.MSDS_CMFS

```
colour.MSDS_CMFS = LazyCanonicalMapping({'Stockman & Sharpe 2 Degree Cone Fundamentals':
..., 'Stockman & Sharpe 10 Degree Cone Fundamentals': ..., 'Smith & Pokorny 1975 Normal
Trichromats': ..., 'Wright & Guild 1931 2 Degree RGB CMFs': ..., 'Stiles & Burch 1955 2
Degree RGB CMFs': ..., 'Stiles & Burch 1959 10 Degree RGB CMFs': ..., 'CIE 1931 2 Degree
Standard Observer': ..., 'CIE 1964 10 Degree Standard Observer': ..., 'CIE 2015 2 Degree
Standard Observer': ..., 'CIE 2015 10 Degree Standard Observer': ..., 'cie_2_1931': ...,
'cie_10_1964': ..., 'CIE 2012 2 Degree Standard Observer': ..., 'CIE 2012 10 Degree
Standard Observer': ...})
```

Multi-spectral distributions of the colour matching functions.

References

[Bro09], [CVRLb], [CVRLc], [CVRLd], [SS00], [CVRLe], [Mac10]

Ancillary Objects

colour.colorimetry

| | |
|-----------------------------|---|
| MSDS_CMFS_LMS | Multi-spectral distributions of the <i>LMS</i> colour matching functions. |
| MSDS_CMFS_RGB | Multi-spectral distributions of the <i>RGB</i> colour matching functions. |
| MSDS_CMFS_STANDARD_OBSERVER | Multi-spectral distributions of the <i>CIE</i> Standard Observer colour matching functions. |

colour.colorimetry.MSDS_CMFS_LMS

```
colour.colorimetry.MSDS_CMFS_LMS = LazyCanonicalMapping({'Stockman & Sharpe 2 Degree Cone
Fundamentals': ..., 'Stockman & Sharpe 10 Degree Cone Fundamentals': ..., 'Smith & Pokorny
1975 Normal Trichromats': ...})
```

Multi-spectral distributions of the *LMS* colour matching functions.

References

[SS00], [Mac10]

colour.colorimetry.MSDS_CMFS_RGB

```
colour.colorimetry.MSDS_CMFS_RGB = LazyCanonicalMapping({'Wright & Guild 1931 2 Degree RGB
CMFs': ..., 'Stiles & Burch 1955 2 Degree RGB CMFs': ..., 'Stiles & Burch 1959 10 Degree
RGB CMFs': ...})
```

Multi-spectral distributions of the *RGB* colour matching functions.

References

[Bro09], [CVRLd], [CVRLe]

colour.colorimetry.MSDS_CMFS_STANDARD_OBSERVER

```
colour.colorimetry.MSDS_CMFS_STANDARD_OBSERVER = LazyCanonicalMapping({'CIE 1931 2 Degree Standard Observer': ..., 'CIE 1964 10 Degree Standard Observer': ..., 'CIE 2015 2 Degree Standard Observer': ..., 'CIE 2015 10 Degree Standard Observer': ..., 'cie_2_1931': ..., 'cie_10_1964': ..., 'CIE 2012 2 Degree Standard Observer': ..., 'CIE 2012 10 Degree Standard Observer': ...})
```

Multi-spectral distributions of the *CIE* Standard Observer colour matching functions.

References

[CVRLb], [CVRLc]

Aliases:

- 'cie_2_1931': 'CIE 1931 2 Degree Standard Observer'
- 'cie_10_1964': 'CIE 1964 10 Degree Standard Observer'

Colour Matching Functions Transformations

Ancillary Objects

colour.colorimetry

| | |
|--|---|
| <code>RGB_2_degree_cmfs_to_XYZ_2_degree_cmfs(...)</code> | Convert <i>Wright & Guild 1931 2 Degree RGB CMFs</i> colour matching functions into the <i>CIE 1931 2 Degree Standard Observer</i> colour matching functions. |
| <code>RGB_10_degree_cmfs_to_XYZ_10_degree_cmfs(...)</code> | Convert <i>Stiles & Burch 1959 10 Degree RGB CMFs</i> colour matching functions into the <i>CIE 1964 10 Degree Standard Observer</i> colour matching functions. |
| <code>RGB_10_degree_cmfs_to_LMS_10_degree_cmfs(...)</code> | Convert <i>Stiles & Burch 1959 10 Degree RGB CMFs</i> colour matching functions into the <i>Stockman & Sharpe 10 Degree Cone Fundamentals</i> spectral sensitivity functions. |
| <code>LMS_2_degree_cmfs_to_XYZ_2_degree_cmfs(...)</code> | Convert <i>Stockman & Sharpe 2 Degree Cone Fundamentals</i> colour matching functions into the <i>CIE 2015 2 Degree Standard Observer</i> colour matching functions. |
| <code>LMS_10_degree_cmfs_to_XYZ_10_degree_cmfs(...)</code> | Convert <i>Stockman & Sharpe 10 Degree Cone Fundamentals</i> colour matching functions into the <i>CIE 2015 10 Degree Standard Observer</i> colour matching functions. |

colour.colorimetry.RGB_2_degree_cmfs_to_XYZ_2_degree_cmfs

`colour.colorimetry.RGB_2_degree_cmfs_to_XYZ_2_degree_cmfs(wavelength: FloatingOrArrayLike) → ndarray`

Convert *Wright & Guild 1931 2 Degree RGB CMFs* colour matching functions into the *CIE 1931 2 Degree Standard Observer* colour matching functions.

Parameters

wavelength (FloatingOrArrayLike) – Wavelength λ in nm.

Returns

CIE 1931 2 Degree Standard Observer spectral tristimulus values.

Return type

`numpy.ndarray`

Notes

- Data for the *CIE 1931 2 Degree Standard Observer* already exists, this definition is intended for educational purpose.

References

[WS00f]

Examples

```
>>> from colour.utilities import numpy_print_options
>>> with numpy_print_options(suppress=True):
...     RGB_2_degree_cmfs_to_XYZ_2_degree_cmfs(700)
...
array([ 0.0113577...,  0.004102 ,  0.          ])
```

colour.colorimetry.RGB_10_degree_cmfs_to_XYZ_10_degree_cmfs

`colour.colorimetry.RGB_10_degree_cmfs_to_XYZ_10_degree_cmfs(wavelength: FloatingOrArrayLike) → ndarray`

Convert *Stiles & Burch 1959 10 Degree RGB CMFs* colour matching functions into the *CIE 1964 10 Degree Standard Observer* colour matching functions.

Parameters

wavelength (FloatingOrArrayLike) – Wavelength λ in nm.

Returns

CIE 1964 10 Degree Standard Observer spectral tristimulus values.

Return type

`numpy.ndarray`

Notes

- Data for the *CIE 1964 10 Degree Standard Observer* already exists, this definition is intended for educational purpose.

References

[WS00j]

Examples

```
>>> from colour.utilities import numpy_print_options
>>> with numpy_print_options(suppress=True):
...     RGB_10_degree_cmfs_to_XYZ_10_degree_cmfs(700)
...
array([ 0.0096432...,  0.0037526..., -0.0000041...])
```

colour.colorimetry.RGB_10_degree_cmfs_to_LMS_10_degree_cmfs

colour.colorimetry.RGB_10_degree_cmfs_to_LMS_10_degree_cmfs(*wavelength: FloatingOrArrayLike*)
→ *ndarray*

Convert *Stiles & Burch 1959 10 Degree RGB CMFs* colour matching functions into the *Stockman & Sharpe 10 Degree Cone Fundamentals* spectral sensitivity functions.

Parameters

wavelength (*FloatingOrArrayLike*) – Wavelength λ in nm.

Returns

Stockman & Sharpe 10 Degree Cone Fundamentals spectral tristimulus values.

Return type

numpy.ndarray

Notes

- Data for the *Stockman & Sharpe 10 Degree Cone Fundamentals* already exists, this definition is intended for educational purpose.

References

[CIET13606]

Examples

```
>>> from colour.utilities import numpy_print_options
>>> with numpy_print_options(suppress=True):
...     RGB_10_degree_cmfs_to_LMS_10_degree_cmfs(700)
...
array([ 0.0052860...,  0.0003252...,  0.          ])
```

colour.colorimetry.LMS_2_degree_cmfs_to_XYZ_2_degree_cmfs

`colour.colorimetry.LMS_2_degree_cmfs_to_XYZ_2_degree_cmfs(wavelength: FloatingOrArrayLike) → ndarray`

Convert *Stockman & Sharpe 2 Degree Cone Fundamentals* colour matching functions into the *CIE 2015 2 Degree Standard Observer* colour matching functions.

Parameters

wavelength (FloatingOrArrayLike) – Wavelength λ in nm.

Returns

CIE 2015 2 Degree Standard Observer spectral tristimulus values.

Return type

`numpy.ndarray`

Notes

- Data for the *CIE 2015 2 Degree Standard Observer* already exists, this definition is intended for educational purpose.

References

[CVRLg]

Examples

```
>>> from colour.utilities import numpy_print_options
>>> with numpy_print_options(suppress=True):
...     LMS_2_degree_cmfs_to_XYZ_2_degree_cmfs(700)
...
array([ 0.0109677...,  0.0041959...,  0.          ])
```

colour.colorimetry.LMS_10_degree_cmfs_to_XYZ_10_degree_cmfs

`colour.colorimetry.LMS_10_degree_cmfs_to_XYZ_10_degree_cmfs(wavelength: FloatingOrArrayLike) → ndarray`

Convert *Stockman & Sharpe 10 Degree Cone Fundamentals* colour matching functions into the *CIE 2015 10 Degree Standard Observer* colour matching functions.

Parameters

wavelength (FloatingOrArrayLike) – Wavelength λ in nm.

Returns

CIE 2015 10 Degree Standard Observer spectral tristimulus values.

Return type

`numpy.ndarray`

Notes

- Data for the *CIE 2015 10 Degree Standard Observer* already exists, this definition is intended for educational purpose.

References

[CVRLf]

Examples

```
>>> from colour.utilities import numpy_print_options
>>> with numpy_print_options(suppress=True):
...     LMS_10_degree_cmfs_to_XYZ_10_degree_cmfs(700)
...
array([ 0.0098162...,  0.0037761...,  0.          ])
```

Illuminants and Light Sources

Dataset

colour

| | |
|---------------------------|--|
| CCS_ILLUMINANTS | Chromaticity coordinates of the illuminants. |
| SDS_ILLUMINANTS | Spectral distributions of the illuminants. |
| CCS_LIGHT_SOURCES | Chromaticity coordinates of the light sources. |
| SDS_LIGHT_SOURCES | Spectral distributions of the light sources. |
| TVS_ILLUMINANTS | <i>CIE XYZ</i> tristimulus values of the illuminants. |
| TVS_ILLUMINANTS_HUNTERLAB | <i>CIE XYZ</i> tristimulus values of the <i>HunterLab</i> illuminants. |

colour.CCS_ILLUMINANTS

colour.CCS_ILLUMINANTS = CanonicalMapping({'CIE 1931 2 Degree Standard Observer': ..., 'CIE 1964 10 Degree Standard Observer': ..., 'cie_2_1931': ..., 'cie_10_1964': ...})

Chromaticity coordinates of the illuminants.

Warning: *DCI-P3* illuminant has no associated spectral distribution. *DCI* has no official reference spectral measurement for this whitepoint. The closest matching spectral distribution is *Kinoton 75P* projector.

Notes

CIE Illuminant D Series D60 illuminant chromaticity coordinates were computed as follows:

```
CCT = 6000 * 1.4388 / 1.438
xy = colour.temperature.CCT_to_xy_CIE_D(CCT)

sd = colour.sd_CIE_illuminant_D_series(xy)
colour.XYZ_to_xy(
    colour.sd_to_XYZ(
        sd, colour.MSDS_CMFS['CIE 1964 10 Degree Standard Observer']) / 100.0)
```

- *CIE Illuminant D Series D50* illuminant and *CIE Standard Illuminant D Series D65* chromaticity coordinates are rounded to 4 decimals as given in the typical RGB colourspaces literature. Their chromaticity coordinates as given in [CIET14804f] are (0.34567, 0.35851) and (0.31272, 0.32903) respectively.
- *CIE* illuminants with chromaticity coordinates not defined in the reference [Wikipedia06b] have been calculated using their correlated colour temperature and `colour.temperature.CCT_to_xy_CIE_D()` `colour.sd_CIE_illuminant_D_series()` and / or `colour.sd_to_XYZ()` definitions.
- *ICC D50* chromaticity coordinates were computed with `colour.XYZ_to_xy()` definition from the *CIE XYZ* tristimulus values as given by ICC: [96.42, 100.00, 82.49].

References

[CIET14804f], [DigitalCInitiatives07], [InternationalOfStandardization02], [InternationalC-Consortium10], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14b], [Wikipedia06b]

Aliases:

- 'cie_2_1931': 'CIE 1931 2 Degree Standard Observer'
- 'cie_10_1964': 'CIE 1964 10 Degree Standard Observer'

colour.SDS_ILLUMINANTS

```
colour.SDS_ILLUMINANTS = LazyCanonicalMapping({'A': ..., 'B': ..., 'C': ..., 'D50': ...,
'D55': ..., 'D60': ..., 'D65': ..., 'D75': ..., 'E': ..., 'FL1': ..., 'FL2': ..., 'FL3':
..., 'FL4': ..., 'FL5': ..., 'FL6': ..., 'FL7': ..., 'FL8': ..., 'FL9': ..., 'FL10': ...,
'FL11': ..., 'FL12': ..., 'FL3.1': ..., 'FL3.2': ..., 'FL3.3': ..., 'FL3.4': ..., 'FL3.5':
..., 'FL3.6': ..., 'FL3.7': ..., 'FL3.8': ..., 'FL3.9': ..., 'FL3.10': ..., 'FL3.11': ...,
'FL3.12': ..., 'FL3.13': ..., 'FL3.14': ..., 'FL3.15': ..., 'HP1': ..., 'HP2': ..., 'HP3':
..., 'HP4': ..., 'HP5': ..., 'LED-B1': ..., 'LED-B2': ..., 'LED-B3': ..., 'LED-B4': ...,
'LED-B5': ..., 'LED-BH1': ..., 'LED-RGB1': ..., 'LED-V1': ..., 'LED-V2': ..., 'ID65': ...,
'ID50': ..., 'ISO 7589 Photographic Daylight': ..., 'ISO 7589 Sensitometric Daylight': ...,
'ISO 7589 Studio Tungsten': ..., 'ISO 7589 Sensitometric Studio Tungsten': ..., 'ISO 7589
Photoflood': ..., 'ISO 7589 Sensitometric Photoflood': ..., 'ISO 7589 Sensitometric
Printer': ...})
```

Spectral distributions of the illuminants.

Notes

- *CIE 15:2004* recommends using linear interpolation for *CIE Standard Illuminant D Series*, for consistency all the illuminants are using a linear interpolator.

References

[CSH+18], [CIE04], [CIE], [InternationalOfStandardization02]

colour.CCS_LIGHT_SOURCES

```
colour.CCS_LIGHT_SOURCES = CanonicalMapping({'CIE 1931 2 Degree Standard Observer': ...,
'CIE 1964 10 Degree Standard Observer': ..., 'cie_2_1931': ..., 'cie_10_1964': ...})
```

Chromaticity coordinates of the light sources.

Aliases:

- 'cie_2_1931': 'CIE 1931 2 Degree Standard Observer'
- 'cie_10_1964': 'CIE 1964 10 Degree Standard Observer'

colour.SDS_LIGHT_SOURCES

```
colour.SDS_LIGHT_SOURCES = LazyCanonicalMapping({'Natural': ..., 'Philips TL-84': ...,
'SA': ..., 'SC': ..., 'T8 Luxline Plus White': ..., 'T8 Polylux 3000': ..., 'T8 Polylux
4000': ..., 'Thorn Kolor-rite': ..., 'Cool White FL': ..., 'Daylight FL': ..., 'HPS': ...,
'Incandescent': ..., 'LPS': ..., 'Mercury': ..., 'Metal Halide': ..., 'Neodimium
Incandescent': ..., 'Super HPS': ..., 'Triphosphor FL': ..., '3-LED-1 (457/540/605)': ...,
'3-LED-2 (473/545/616)': ..., '3-LED-2 Yellow': ..., '3-LED-3 (465/546/614)': ...,
'3-LED-4 (455/547/623)': ..., '4-LED No Yellow': ..., '4-LED Yellow': ..., '4-LED-1
(461/526/576/624)': ..., '4-LED-2 (447/512/573/627)': ..., 'Luxeon WW 2880': ...,
'PHOS-1': ..., 'PHOS-2': ..., 'PHOS-3': ..., 'PHOS-4': ..., 'Phosphor LED YAG': ..., '60
A/W (Soft White)': ..., 'C100S54 (HPS)': ..., 'C100S54C (HPS)': ..., 'F32T8/TL830
(Triphosphor)': ..., 'F32T8/TL835 (Triphosphor)': ..., 'F32T8/TL841 (Triphosphor)': ...,
'F32T8/TL850 (Triphosphor)': ..., 'F32T8/TL865 /PLUS (Triphosphor)': ..., 'F34/CW/RS/EW
(Cool White FL)': ..., 'F34T12/LW/RS /EW': ..., 'F34T12WW/RS /EW (Warm White FL)': ...,
'F40/C50 (Broadband FL)': ..., 'F40/C75 (Broadband FL)': ..., 'F40/CWX (Broadband FL)':
..., 'F40/DX (Broadband FL)': ..., 'F40/DXTP (Delux FL)': ..., 'F40/N (Natural FL)': ...,
'H38HT-100 (Mercury)': ..., 'H38JA-100/DX (Mercury DX)': ..., 'MHC100/U/MP /3K': ...,
'MHC100/U/MP /4K': ..., 'SDW-T 100W/LV (Super HPS)': ..., 'Kinoton 75P': ...})
```

Spectral distributions of the light sources.

Notes

- *CIE 15:2004* recommends using linear interpolation for *CIE Standard Illuminant D Series*, for consistency all the illuminants are using a linear interpolator.

References

[Hou15], [OD08], [Poi80]

colour.TVS_ILLUMINANTS

```
colour.TVS_ILLUMINANTS = CanonicalMapping({'CIE 1931 2 Degree Standard Observer': ..., 'CIE 1964 10 Degree Standard Observer': ..., 'cie_2_1931': ..., 'cie_10_1964': ...})
```

CIE XYZ tristimulus values of the illuminants.

References

[CSH+18]

Aliases:

- 'cie_2_1931': 'CIE 1931 2 Degree Standard Observer'
- 'cie_10_1964': 'CIE 1964 10 Degree Standard Observer'

colour.TVS_ILLUMINANTS_HUNTERLAB

```
colour.TVS_ILLUMINANTS_HUNTERLAB = CanonicalMapping({'CIE 1931 2 Degree Standard Observer': ..., 'CIE 1964 10 Degree Standard Observer': ..., 'cie_2_1931': ..., 'cie_10_1964': ...})
```

CIE XYZ tristimulus values of the *HunterLab* illuminants.

References

[HunterLab08a], [HunterLab08b]

Aliases:

- 'cie_2_1931': 'CIE 1931 2 Degree Standard Observer'
- 'cie_10_1964': 'CIE 1964 10 Degree Standard Observer'

Ancillary Objects

colour.colorimetry

| | |
|---|--|
| SDS_BASIS_FUNCTIONS_CIE_ILLUMINANT_D_SERIES | <i>CIE Illuminant D Series $S_n(\lambda)$ spectral distributions.</i> |
|---|--|

colour.colorimetry.SDS_BASIS_FUNCTIONS_CIE_ILLUMINANT_D_SERIES

```
colour.colorimetry.SDS_BASIS_FUNCTIONS_CIE_ILLUMINANT_D_SERIES = LazyCanonicalMapping({'S0': ..., 'S1': ..., 'S2': ...})
```

CIE Illuminant D Series $S_n(\lambda)$ spectral distributions.

References

[Lin07], [WS00k]

Dominant Wavelength and Purity

colour

| | |
|---|--|
| <code>dominant_wavelength(xy, xy_n[, cmfs, inverse])</code> | Return the <i>dominant wavelength</i> λ_d for given colour stimulus xy and the related xy_{wl} first and xy_{cw} second intersection coordinates with the spectral locus. |
| <code>complementary_wavelength(xy, xy_n[, cmfs])</code> | Return the <i>complementary wavelength</i> λ_c for given colour stimulus xy and the related xy_{wl} first and xy_{cw} second intersection coordinates with the spectral locus. |
| <code>excitation_purity(xy, xy_n[, cmfs])</code> | Return the <i>excitation purity</i> P_e for given colour stimulus xy . |
| <code>colorimetric_purity(xy, xy_n[, cmfs])</code> | Return the <i>colorimetric purity</i> P_c for given colour stimulus xy . |

colour.dominant_wavelength

`colour.dominant_wavelength(xy: ArrayLike, xy_n: ArrayLike, cmfs: MultiSpectralDistributions | None = None, inverse: bool = False) → Tuple[ndarray, ndarray, ndarray]`

Return the *dominant wavelength* λ_d for given colour stimulus xy and the related xy_{wl} first and xy_{cw} second intersection coordinates with the spectral locus.

In the eventuality where the xy_{wl} first intersection coordinates are on the line of purples, the *complementary wavelength* will be computed in lieu.

The *complementary wavelength* is indicated by a negative sign and the xy_{cw} second intersection coordinates which are set by default to the same value as xy_{wl} first intersection coordinates will be set to the *complementary dominant wavelength* intersection coordinates with the spectral locus.

Parameters

- **xy** (ArrayLike) – Colour stimulus *CIE xy* chromaticity coordinates.
- **xy_n** (ArrayLike) – Achromatic stimulus *CIE xy* chromaticity coordinates.
- **cmfs** ([MultiSpectralDistributions](#) | None) – Standard observer colour matching functions, default to the *CIE 1931 2 Degree Standard Observer*.
- **inverse** (bool) – Inverse the computation direction to retrieve the *complementary wavelength*.

Returns

Dominant wavelength, first intersection point *CIE xy* chromaticity coordinates, second intersection point *CIE xy* chromaticity coordinates.

Return type

`tuple`

References

[CIET14804b], [Erdb]

Examples

Dominant wavelength computation:

```
>>> from colour.colorimetry import MSDS_CMFS
>>> from pprint import pprint
>>> cmfs = MSDS_CMFS["CIE 1931 2 Degree Standard Observer"]
>>> xy = np.array([0.54369557, 0.32107944])
>>> xy_n = np.array([0.31270000, 0.32900000])
>>> pprint(dominant_wavelength(xy, xy_n, cmfs))
(array(616...),
 array([ 0.6835474...,  0.3162840...]),
 array([ 0.6835474...,  0.3162840...]))
```

Complementary dominant wavelength is returned if the first intersection is located on the line of purples:

```
>>> xy = np.array([0.37605506, 0.24452225])
>>> pprint(dominant_wavelength(xy, xy_n))
(array(-509.0),
 array([ 0.4572314...,  0.1362814...]),
 array([ 0.0104096...,  0.7320745...]))
```

colour.complementary_wavelength

`colour.complementary_wavelength(xy: ArrayLike, xy_n: ArrayLike, cmfs: MultiSpectralDistributions | None = None) → Tuple[ndarray, ndarray, ndarray]`

Return the *complementary wavelength* λ_c for given colour stimulus xy and the related xy_wl first and xy_{cw} second intersection coordinates with the spectral locus.

In the eventuality where the xy_wl first intersection coordinates are on the line of purples, the *dominant wavelength* will be computed in lieu.

The *dominant wavelength* is indicated by a negative sign and the xy_{cw} second intersection coordinates which are set by default to the same value than xy_wl first intersection coordinates will be set to the *dominant wavelength* intersection coordinates with the spectral locus.

Parameters

- **xy** (ArrayLike) – Colour stimulus *CIE xy* chromaticity coordinates.
- **xy_n** (ArrayLike) – Achromatic stimulus *CIE xy* chromaticity coordinates.
- **cmfs** (MultiSpectralDistributions | None) – Standard observer colour matching functions, default to the *CIE 1931 2 Degree Standard Observer*.

Returns

Complementary wavelength, first intersection point *CIE xy* chromaticity coordinates, second intersection point *CIE xy* chromaticity coordinates.

Return type

tuple

References

[CIET14804b], [Erdb]

Examples

Complementary wavelength computation:

```
>>> from colour.colorimetry import MSDS_CMFS
>>> from pprint import pprint
>>> cmfs = MSDS_CMFS["CIE 1931 2 Degree Standard Observer"]
>>> xy = np.array([0.37605506, 0.24452225])
>>> xy_n = np.array([0.31270000, 0.32900000])
>>> pprint(complementary_wavelength(xy, xy_n, cmfs))
(array(509.0),
 array([ 0.0104096...,  0.7320745...]),
 array([ 0.0104096...,  0.7320745...]))
```

Dominant wavelength is returned if the first intersection is located on the line of purples:

```
>>> xy = np.array([0.54369557, 0.32107944])
>>> pprint(complementary_wavelength(xy, xy_n))
(array(492.0),
 array([ 0.0364795 ,  0.3384712...]),
 array([ 0.0364795 ,  0.3384712...]))
```

colour.excitation_purity

`colour.excitation_purity(xy: ArrayLike, xy_n: ArrayLike, cmfs: MultiSpectralDistributions | None = None) → FloatingOrNDArray`

Return the *excitation purity* P_e for given colour stimulus xy .

Parameters

- **xy** (ArrayLike) – Colour stimulus *CIE xy* chromaticity coordinates.
- **xy_n** (ArrayLike) – Achromatic stimulus *CIE xy* chromaticity coordinates.
- **cmfs** (MultiSpectralDistributions | None) – Standard observer colour matching functions, default to the *CIE 1931 2 Degree Standard Observer*.

Returns

Excitation purity P_e .

Return type

`np.floating` or `numpy.ndarray`

References

[CIET14804b], [Erdb]

Examples

```
>>> from colour.colorimetry import MSDS_CMFS
>>> cmfs = MSDS_CMFS["CIE 1931 2 Degree Standard Observer"]
>>> xy = np.array([0.54369557, 0.32107944])
>>> xy_n = np.array([0.31270000, 0.32900000])
>>> excitation_purity(xy, xy_n, cmfs)
0.6228856...
```

colour.colorimetric_purity

`colour.colorimetric_purity(xy: ArrayLike, xy_n: ArrayLike, cmfs: MultiSpectralDistributions | None = None) → FloatingOrNDArray`

Return the *colorimetric purity* P_c for given colour stimulus xy .

Parameters

- **xy** (ArrayLike) – Colour stimulus *CIE xy* chromaticity coordinates.
- **xy_n** (ArrayLike) – Achromatic stimulus *CIE xy* chromaticity coordinates.
- **cmfs** ([MultiSpectralDistributions](#) | None) – Standard observer colour matching functions, default to the *CIE 1931 2 Degree Standard Observer*.

Returns

Colorimetric purity P_c .

Return type

`np.floating` or `numpy.ndarray`

References

[CIET14804b], [ErdB]

Examples

```
>>> from colour.colorimetry import MSDS_CMFS
>>> cmfs = MSDS_CMFS["CIE 1931 2 Degree Standard Observer"]
>>> xy = np.array([0.54369557, 0.32107944])
>>> xy_n = np.array([0.31270000, 0.32900000])
>>> colorimetric_purity(xy, xy_n, cmfs)
0.6135828...
```

Luminous Efficiency Functions

colour

| | |
|---|---|
| <code>luminous_efficacy(sd[, lef])</code> | Return the <i>luminous efficacy</i> in $lm \cdot W^{-1}$ of given spectral distribution using given luminous efficiency function. |
| <code>luminous_efficiency(sd[, lef])</code> | Return the <i>luminous efficiency</i> of given spectral distribution using given luminous efficiency function. |
| <code>luminous_flux(sd[, lef, K_m])</code> | Return the <i>luminous flux</i> for given spectral distribution using given luminous efficiency function. |
| <code>sd_mesopic_luminous_efficiency_function(L_p)</code> | Return the mesopic luminous efficiency function $V_m(\lambda)$ for given photopic luminance L_p . |

`colour.luminous_efficacy`

`colour.luminous_efficacy(sd: SpectralDistribution, lef: SpectralDistribution | None = None) → float`

Return the *luminous efficacy* in $lm \cdot W^{-1}$ of given spectral distribution using given luminous efficiency function.

Parameters

- **sd** (`SpectralDistribution`) – test spectral distribution
- **lef** (`SpectralDistribution` | `None`) – $V(\lambda)$ luminous efficiency function, default to the *CIE 1924 Photopic Standard Observer*.

Returns

Luminous efficacy in $lm \cdot W^{-1}$.

Return type

`numpy.floating`

References

[Wikipedia05b]

Examples

```
>>> from colour import SDS_LIGHT_SOURCES
>>> sd = SDS_LIGHT_SOURCES["Neodimium Incandescent"]
>>> luminous_efficacy(sd)
136.2170803...
```

`colour.luminous_efficiency`

`colour.luminous_efficiency(sd: SpectralDistribution, lef: SpectralDistribution | None = None) → float`

Return the *luminous efficiency* of given spectral distribution using given luminous efficiency function.

Parameters

- **sd** (`SpectralDistribution`) – test spectral distribution
- **lef** (`SpectralDistribution` | `None`) – $V(\lambda)$ luminous efficiency function, default to the *CIE 1924 Photopic Standard Observer*.

Returns

Luminous efficiency.

Return type

`numpy.floating`

References

[Wikipedia03b]

Examples

```
>>> from colour import SDS_LIGHT_SOURCES
>>> sd = SDS_LIGHT_SOURCES["Neodimium Incandescent"]
>>> luminous_efficiency(sd)
0.1994393...
```

colour.luminous_flux

`colour.luminous_flux(sd: SpectralDistribution, lef: SpectralDistribution | None = None, K_m: float = CONSTANT_K_M) → float`

Return the *luminous flux* for given spectral distribution using given luminous efficiency function.

Parameters

- **sd** (`SpectralDistribution`) – test spectral distribution
- **lef** (`SpectralDistribution` | `None`) – $V(\lambda)$ luminous efficiency function, default to the *CIE 1924 Photopic Standard Observer*.
- **K_m** (`float`) – $lm \cdot W^{-1}$ maximum photopic luminous efficiency.

Returns

Luminous flux.

Return type

`numpy.floating`

References

[Wikipedia03b]

Examples

```
>>> from colour import SDS_LIGHT_SOURCES
>>> sd = SDS_LIGHT_SOURCES["Neodimium Incandescent"]
>>> luminous_flux(sd)
23807.6555273...
```

`colour.sd_mesopic_luminous_efficiency_function`

`colour.sd_mesopic_luminous_efficiency_function`(*L_p*: *float*, *source*: *Literal*['Blue Heavy', 'Red Heavy'] | *str* = 'Blue Heavy', *method*: *Literal*['MOVE', 'LRC'] | *str* = 'MOVE', *photopic_lef*: *SpectralDistribution* | *None* = *None*, *scotopic_lef*: *SpectralDistribution* | *None* = *None*) → *SpectralDistribution*

Return the mesopic luminous efficiency function $V_m(\lambda)$ for given photopic luminance L_p .

Parameters

- **L_p** (*float*) – Photopic luminance L_p .
- **source** (*Literal*['Blue Heavy', 'Red Heavy'] | *str*) – Light source colour temperature.
- **method** (*Literal*['MOVE', 'LRC'] | *str*) – Method to calculate the weighting factor.
- **photopic_lef** (*SpectralDistribution* | *None*) – $V(\lambda)$ photopic luminous efficiency function, default to the *CIE 1924 Photopic Standard Observer*.
- **scotopic_lef** (*SpectralDistribution* | *None*) – $V'(\lambda)$ scotopic luminous efficiency function, default to the *CIE 1951 Scotopic Standard Observer*.

Returns

Mesopic luminous efficiency function $V_m(\lambda)$.

Return type

`colour.SpectralDistribution`

References

[Wikipedia05c]

Examples

```
>>> from colour.utilities import numpy_print_options
>>> with numpy_print_options(suppress=True):
...     sd_mesopic_luminous_efficiency_function(0.2)
...
SpectralDistribution([[ 380.      ,  0.000424 ...],
                    [ 381.      ,  0.0004781...],
                    [ 382.      ,  0.0005399...],
                    [ 383.      ,  0.0006122...],
                    [ 384.      ,  0.0006961...],
                    [ 385.      ,  0.0007929...],
                    [ 386.      ,  0.000907 ...],
                    [ 387.      ,  0.0010389...],
                    [ 388.      ,  0.0011923...],
                    [ 389.      ,  0.0013703...],
                    [ 390.      ,  0.0015771...],
                    [ 391.      ,  0.0018167...],
                    [ 392.      ,  0.0020942...],
                    [ 393.      ,  0.0024160...],
                    [ 394.      ,  0.0027888...],
                    [ 395.      ,  0.0032196...],
                    [ 396.      ,  0.0037222...],
```

(continues on next page)

(continued from previous page)

| | | |
|--------|---|----------------|
| [397. | , | 0.0042957...], |
| [398. | , | 0.0049531...], |
| [399. | , | 0.0057143...], |
| [400. | , | 0.0065784...], |
| [401. | , | 0.0075658...], |
| [402. | , | 0.0086912...], |
| [403. | , | 0.0099638...], |
| [404. | , | 0.0114058...], |
| [405. | , | 0.0130401...], |
| [406. | , | 0.0148750...], |
| [407. | , | 0.0169310...], |
| [408. | , | 0.0192211...], |
| [409. | , | 0.0217511...], |
| [410. | , | 0.0245342...], |
| [411. | , | 0.0275773...], |
| [412. | , | 0.0309172...], |
| [413. | , | 0.0345149...], |
| [414. | , | 0.0383998...], |
| [415. | , | 0.0425744...], |
| [416. | , | 0.0471074...], |
| [417. | , | 0.0519322...], |
| [418. | , | 0.0570541...], |
| [419. | , | 0.0625466...], |
| [420. | , | 0.0683463...], |
| [421. | , | 0.0745255...], |
| [422. | , | 0.0809440...], |
| [423. | , | 0.0877344...], |
| [424. | , | 0.0948915...], |
| [425. | , | 0.1022731...], |
| [426. | , | 0.109877 ...], |
| [427. | , | 0.1178421...], |
| [428. | , | 0.1260316...], |
| [429. | , | 0.1343772...], |
| [430. | , | 0.143017 ...], |
| [431. | , | 0.1518128...], |
| [432. | , | 0.1608328...], |
| [433. | , | 0.1700088...], |
| [434. | , | 0.1792726...], |
| [435. | , | 0.1886934...], |
| [436. | , | 0.1982041...], |
| [437. | , | 0.2078032...], |
| [438. | , | 0.2174184...], |
| [439. | , | 0.2271147...], |
| [440. | , | 0.2368196...], |
| [441. | , | 0.2464623...], |
| [442. | , | 0.2561153...], |
| [443. | , | 0.2657160...], |
| [444. | , | 0.2753387...], |
| [445. | , | 0.2848520...], |
| [446. | , | 0.2944648...], |
| [447. | , | 0.3034902...], |
| [448. | , | 0.3132347...], |
| [449. | , | 0.3223257...], |
| [450. | , | 0.3314513...], |
| [451. | , | 0.3406129...], |
| [452. | , | 0.3498117...], |

(continues on next page)

(continued from previous page)

| | | |
|--------|---|----------------|
| [453. | , | 0.3583617...], |
| [454. | , | 0.3676377...], |
| [455. | , | 0.3762670...], |
| [456. | , | 0.3849392...], |
| [457. | , | 0.3936540...], |
| [458. | , | 0.4024077...], |
| [459. | , | 0.4111965...], |
| [460. | , | 0.4193298...], |
| [461. | , | 0.4281803...], |
| [462. | , | 0.4363804...], |
| [463. | , | 0.4453117...], |
| [464. | , | 0.4542949...], |
| [465. | , | 0.4626509...], |
| [466. | , | 0.4717570...], |
| [467. | , | 0.4809300...], |
| [468. | , | 0.4901776...], |
| [469. | , | 0.4995075...], |
| [470. | , | 0.5096145...], |
| [471. | , | 0.5191293...], |
| [472. | , | 0.5294259...], |
| [473. | , | 0.5391316...], |
| [474. | , | 0.5496217...], |
| [475. | , | 0.5602103...], |
| [476. | , | 0.5702197...], |
| [477. | , | 0.5810207...], |
| [478. | , | 0.5919093...], |
| [479. | , | 0.6028683...], |
| [480. | , | 0.6138806...], |
| [481. | , | 0.6249373...], |
| [482. | , | 0.6360619...], |
| [483. | , | 0.6465989...], |
| [484. | , | 0.6579538...], |
| [485. | , | 0.6687841...], |
| [486. | , | 0.6797939...], |
| [487. | , | 0.6909887...], |
| [488. | , | 0.7023827...], |
| [489. | , | 0.7133032...], |
| [490. | , | 0.7244513...], |
| [491. | , | 0.7358470...], |
| [492. | , | 0.7468118...], |
| [493. | , | 0.7580294...], |
| [494. | , | 0.7694964...], |
| [495. | , | 0.7805225...], |
| [496. | , | 0.7917805...], |
| [497. | , | 0.8026123...], |
| [498. | , | 0.8130793...], |
| [499. | , | 0.8239297...], |
| [500. | , | 0.8352251...], |
| [501. | , | 0.8456342...], |
| [502. | , | 0.8564818...], |
| [503. | , | 0.8676921...], |
| [504. | , | 0.8785021...], |
| [505. | , | 0.8881489...], |
| [506. | , | 0.8986405...], |
| [507. | , | 0.9079322...], |
| [508. | , | 0.9174255...], |

(continues on next page)

(continued from previous page)

| | | |
|--------|---|----------------|
| [509. | , | 0.9257739...], |
| [510. | , | 0.9350656...], |
| [511. | , | 0.9432365...], |
| [512. | , | 0.9509063...], |
| [513. | , | 0.9586931...], |
| [514. | , | 0.9658413...], |
| [515. | , | 0.9722825...], |
| [516. | , | 0.9779924...], |
| [517. | , | 0.9836106...], |
| [518. | , | 0.9883465...], |
| [519. | , | 0.9920964...], |
| [520. | , | 0.9954436...], |
| [521. | , | 0.9976202...], |
| [522. | , | 0.9993457...], |
| [523. | , | 1. ...], |
| [524. | , | 0.9996498...], |
| [525. | , | 0.9990487...], |
| [526. | , | 0.9975356...], |
| [527. | , | 0.9957615...], |
| [528. | , | 0.9930143...], |
| [529. | , | 0.9899559...], |
| [530. | , | 0.9858741...], |
| [531. | , | 0.9814453...], |
| [532. | , | 0.9766885...], |
| [533. | , | 0.9709363...], |
| [534. | , | 0.9648947...], |
| [535. | , | 0.9585832...], |
| [536. | , | 0.952012 ...], |
| [537. | , | 0.9444916...], |
| [538. | , | 0.9367089...], |
| [539. | , | 0.9293506...], |
| [540. | , | 0.9210429...], |
| [541. | , | 0.9124772...], |
| [542. | , | 0.9036604...], |
| [543. | , | 0.8945958...], |
| [544. | , | 0.8845999...], |
| [545. | , | 0.8750500...], |
| [546. | , | 0.8659457...], |
| [547. | , | 0.8559224...], |
| [548. | , | 0.8456846...], |
| [549. | , | 0.8352499...], |
| [550. | , | 0.8253229...], |
| [551. | , | 0.8152079...], |
| [552. | , | 0.8042205...], |
| [553. | , | 0.7944209...], |
| [554. | , | 0.7837466...], |
| [555. | , | 0.7735680...], |
| [556. | , | 0.7627808...], |
| [557. | , | 0.7522710...], |
| [558. | , | 0.7417549...], |
| [559. | , | 0.7312909...], |
| [560. | , | 0.7207983...], |
| [561. | , | 0.7101939...], |
| [562. | , | 0.6996362...], |
| [563. | , | 0.6890656...], |
| [564. | , | 0.6785599...], |

(continues on next page)

(continued from previous page)

| | | |
|--------|---|----------------|
| [565. | , | 0.6680593...], |
| [566. | , | 0.6575697...], |
| [567. | , | 0.6471578...], |
| [568. | , | 0.6368208...], |
| [569. | , | 0.6264871...], |
| [570. | , | 0.6161541...], |
| [571. | , | 0.6058896...], |
| [572. | , | 0.5957000...], |
| [573. | , | 0.5855937...], |
| [574. | , | 0.5754412...], |
| [575. | , | 0.5653883...], |
| [576. | , | 0.5553742...], |
| [577. | , | 0.5454680...], |
| [578. | , | 0.5355972...], |
| [579. | , | 0.5258267...], |
| [580. | , | 0.5160152...], |
| [581. | , | 0.5062322...], |
| [582. | , | 0.4965595...], |
| [583. | , | 0.4868746...], |
| [584. | , | 0.4773299...], |
| [585. | , | 0.4678028...], |
| [586. | , | 0.4583704...], |
| [587. | , | 0.4489722...], |
| [588. | , | 0.4397606...], |
| [589. | , | 0.4306131...], |
| [590. | , | 0.4215446...], |
| [591. | , | 0.4125681...], |
| [592. | , | 0.4037550...], |
| [593. | , | 0.3950359...], |
| [594. | , | 0.3864104...], |
| [595. | , | 0.3778777...], |
| [596. | , | 0.3694405...], |
| [597. | , | 0.3611074...], |
| [598. | , | 0.3528596...], |
| [599. | , | 0.3447056...], |
| [600. | , | 0.3366470...], |
| [601. | , | 0.3286917...], |
| [602. | , | 0.3208410...], |
| [603. | , | 0.3130808...], |
| [604. | , | 0.3054105...], |
| [605. | , | 0.2978225...], |
| [606. | , | 0.2903027...], |
| [607. | , | 0.2828727...], |
| [608. | , | 0.2755311...], |
| [609. | , | 0.2682900...], |
| [610. | , | 0.2611478...], |
| [611. | , | 0.2541176...], |
| [612. | , | 0.2471885...], |
| [613. | , | 0.2403570...], |
| [614. | , | 0.2336057...], |
| [615. | , | 0.2269379...], |
| [616. | , | 0.2203527...], |
| [617. | , | 0.2138465...], |
| [618. | , | 0.2073946...], |
| [619. | , | 0.2009789...], |
| [620. | , | 0.1945818...], |

(continues on next page)

(continued from previous page)

| | | |
|--------|---|----------------|
| [621. | , | 0.1881943...], |
| [622. | , | 0.1818226...], |
| [623. | , | 0.1754987...], |
| [624. | , | 0.1692476...], |
| [625. | , | 0.1630876...], |
| [626. | , | 0.1570257...], |
| [627. | , | 0.151071 ...], |
| [628. | , | 0.1452469...], |
| [629. | , | 0.1395845...], |
| [630. | , | 0.1341087...], |
| [631. | , | 0.1288408...], |
| [632. | , | 0.1237666...], |
| [633. | , | 0.1188631...], |
| [634. | , | 0.1141075...], |
| [635. | , | 0.1094766...], |
| [636. | , | 0.1049613...], |
| [637. | , | 0.1005679...], |
| [638. | , | 0.0962924...], |
| [639. | , | 0.0921296...], |
| [640. | , | 0.0880778...], |
| [641. | , | 0.0841306...], |
| [642. | , | 0.0802887...], |
| [643. | , | 0.0765559...], |
| [644. | , | 0.0729367...], |
| [645. | , | 0.0694345...], |
| [646. | , | 0.0660491...], |
| [647. | , | 0.0627792...], |
| [648. | , | 0.0596278...], |
| [649. | , | 0.0565970...], |
| [650. | , | 0.0536896...], |
| [651. | , | 0.0509068...], |
| [652. | , | 0.0482444...], |
| [653. | , | 0.0456951...], |
| [654. | , | 0.0432510...], |
| [655. | , | 0.0409052...], |
| [656. | , | 0.0386537...], |
| [657. | , | 0.0364955...], |
| [658. | , | 0.0344285...], |
| [659. | , | 0.0324501...], |
| [660. | , | 0.0305579...], |
| [661. | , | 0.0287496...], |
| [662. | , | 0.0270233...], |
| [663. | , | 0.0253776...], |
| [664. | , | 0.0238113...], |
| [665. | , | 0.0223226...], |
| [666. | , | 0.0209086...], |
| [667. | , | 0.0195688...], |
| [668. | , | 0.0183056...], |
| [669. | , | 0.0171216...], |
| [670. | , | 0.0160192...], |
| [671. | , | 0.0149986...], |
| [672. | , | 0.0140537...], |
| [673. | , | 0.0131784...], |
| [674. | , | 0.0123662...], |
| [675. | , | 0.0116107...], |
| [676. | , | 0.0109098...], |

(continues on next page)

(continued from previous page)

| | | |
|--------|---|----------------|
| [677. | , | 0.0102587...], |
| [678. | , | 0.0096476...], |
| [679. | , | 0.0090665...], |
| [680. | , | 0.0085053...], |
| [681. | , | 0.0079567...], |
| [682. | , | 0.0074229...], |
| [683. | , | 0.0069094...], |
| [684. | , | 0.0064213...], |
| [685. | , | 0.0059637...], |
| [686. | , | 0.0055377...], |
| [687. | , | 0.0051402...], |
| [688. | , | 0.00477 ...], |
| [689. | , | 0.0044263...], |
| [690. | , | 0.0041081...], |
| [691. | , | 0.0038149...], |
| [692. | , | 0.0035456...], |
| [693. | , | 0.0032984...], |
| [694. | , | 0.0030718...], |
| [695. | , | 0.0028639...], |
| [696. | , | 0.0026738...], |
| [697. | , | 0.0025000...], |
| [698. | , | 0.0023401...], |
| [699. | , | 0.0021918...], |
| [700. | , | 0.0020526...], |
| [701. | , | 0.0019207...], |
| [702. | , | 0.001796 ...], |
| [703. | , | 0.0016784...], |
| [704. | , | 0.0015683...], |
| [705. | , | 0.0014657...], |
| [706. | , | 0.0013702...], |
| [707. | , | 0.001281 ...], |
| [708. | , | 0.0011976...], |
| [709. | , | 0.0011195...], |
| [710. | , | 0.0010464...], |
| [711. | , | 0.0009776...], |
| [712. | , | 0.0009131...], |
| [713. | , | 0.0008525...], |
| [714. | , | 0.0007958...], |
| [715. | , | 0.0007427...], |
| [716. | , | 0.0006929...], |
| [717. | , | 0.0006462...], |
| [718. | , | 0.0006026...], |
| [719. | , | 0.0005619...], |
| [720. | , | 0.0005240...], |
| [721. | , | 0.0004888...], |
| [722. | , | 0.0004561...], |
| [723. | , | 0.0004255...], |
| [724. | , | 0.0003971...], |
| [725. | , | 0.0003704...], |
| [726. | , | 0.0003455...], |
| [727. | , | 0.0003221...], |
| [728. | , | 0.0003001...], |
| [729. | , | 0.0002796...], |
| [730. | , | 0.0002604...], |
| [731. | , | 0.0002423...], |
| [732. | , | 0.0002254...], |

(continues on next page)

(continued from previous page)

```

[ 733.      , 0.0002095...],
[ 734.      , 0.0001947...],
[ 735.      , 0.0001809...],
[ 736.      , 0.0001680...],
[ 737.      , 0.0001560...],
[ 738.      , 0.0001449...],
[ 739.      , 0.0001345...],
[ 740.      , 0.0001249...],
[ 741.      , 0.0001159...],
[ 742.      , 0.0001076...],
[ 743.      , 0.0000999...],
[ 744.      , 0.0000927...],
[ 745.      , 0.0000862...],
[ 746.      , 0.0000801...],
[ 747.      , 0.0000745...],
[ 748.      , 0.0000693...],
[ 749.      , 0.0000646...],
[ 750.      , 0.0000602...],
[ 751.      , 0.0000561...],
[ 752.      , 0.0000523...],
[ 753.      , 0.0000488...],
[ 754.      , 0.0000456...],
[ 755.      , 0.0000425...],
[ 756.      , 0.0000397...],
[ 757.      , 0.0000370...],
[ 758.      , 0.0000346...],
[ 759.      , 0.0000322...],
[ 760.      , 0.0000301...],
[ 761.      , 0.0000281...],
[ 762.      , 0.0000262...],
[ 763.      , 0.0000244...],
[ 764.      , 0.0000228...],
[ 765.      , 0.0000213...],
[ 766.      , 0.0000198...],
[ 767.      , 0.0000185...],
[ 768.      , 0.0000173...],
[ 769.      , 0.0000161...],
[ 770.      , 0.0000150...],
[ 771.      , 0.0000140...],
[ 772.      , 0.0000131...],
[ 773.      , 0.0000122...],
[ 774.      , 0.0000114...],
[ 775.      , 0.0000106...],
[ 776.      , 0.0000099...],
[ 777.      , 0.0000092...],
[ 778.      , 0.0000086...],
[ 779.      , 0.0000080...],
[ 780.      , 0.0000075...]],
SpragueInterpolator,
{}),
Extrapolator,
{'method': 'Constant', 'left': None, 'right': None})

```

Dataset

colour

| | |
|-----------------------|--|
| <code>SDS_LEFS</code> | Spectral distributions of the luminous efficiency functions. |
|-----------------------|--|

`colour.SDS_LEFS`

```
colour.SDS_LEFS = LazyCanonicalMapping({'CIE 1924 Photopic Standard Observer': ..., 'Judd Modified CIE 1951 Photopic Standard Observer': ..., 'Judd-Vos Modified CIE 1978 Photopic Standard Observer': ..., 'CIE 1964 Photopic 10 Degree Standard Observer': ..., 'CIE 2008 2 Degree Physiologically Relevant LEF': ..., 'CIE 2008 10 Degree Physiologically Relevant LEF': ..., 'cie_2_1924': ..., 'cie_10_1964': ..., 'CIE 1951 Scotopic Standard Observer': ..., 'cie_1951': ...})
```

Spectral distributions of the luminous efficiency functions.

References

[CVRLa], [CVRLc], [Wikipedia05c]

Ancillary Objects

`colour.colorimetry`

| | |
|--------------------------------|---|
| <code>SDS_LEFS_PHOTOPIC</code> | Spectral distributions of the photopic luminous efficiency functions. |
| <code>SDS_LEFS_SCOTOPIC</code> | Spectral distributions of the scotopic luminous efficiency functions. |

`colour.colorimetry.SDS_LEFS_PHOTOPIC`

```
colour.colorimetry.SDS_LEFS_PHOTOPIC = LazyCanonicalMapping({'CIE 1924 Photopic Standard Observer': ..., 'Judd Modified CIE 1951 Photopic Standard Observer': ..., 'Judd-Vos Modified CIE 1978 Photopic Standard Observer': ..., 'CIE 1964 Photopic 10 Degree Standard Observer': ..., 'CIE 2008 2 Degree Physiologically Relevant LEF': ..., 'CIE 2008 10 Degree Physiologically Relevant LEF': ..., 'cie_2_1924': ..., 'cie_10_1964': ...})
```

Spectral distributions of the photopic luminous efficiency functions.

References

[CVRLa], [CVRLc]

Aliases:

- 'cie_2_1924': 'CIE 1931 2 Degree Standard Observer'
- 'cie_10_1964': 'CIE 1964 Photopic 10 Degree Standard Observer'

colour.colorimetry.SDS_LEFS_SCOTOPIC

```
colour.colorimetry.SDS_LEFS_SCOTOPIC = LazyCanonicalMapping({'CIE 1951 Scotopic Standard Observer': ..., 'cie_1951': ...})
```

Spectral distributions of the scotopic luminous efficiency functions.

References

[CVRLc]

Aliases:

- 'cie_1951': 'CIE 1951 Scotopic Standard Observer'

Spectral Uniformity

colour

| | |
|--|--|
| <code>spectral_uniformity(sds[, ...])</code> | Compute the <i>spectral uniformity</i> (or <i>spectral flatness</i>) of given spectral distributions. |
|--|--|

colour.spectral_uniformity

```
colour.spectral_uniformity(sds: List[SpectralDistribution | MultiSpectralDistributions] |
                           MultiSpectralDistributions, use_second_order_derivatives: bool = False)
    → ndarray
```

Compute the *spectral uniformity* (or *spectral flatness*) of given spectral distributions.

Spectral uniformity $(r')^2$ is computed as follows:

$$\text{mean}((r'_1)^2, (r'_2)^2, \dots, (r'_n)^2)$$

where $(r'_i)^2$ is the first-order derivative, squared, of the reflectance r_i of a test sample.

Parameters

- **sds** (`List[SpectralDistribution | MultiSpectralDistributions] | MultiSpectralDistributions`) – Spectral distributions or multi-spectral distributions to compute the spectral uniformity of. `sds` can be a single `colour.MultiSpectralDistributions` class instance, a list of `colour.MultiSpectralDistributions` class instances or a list of `colour.SpectralDistribution` class instances.
- **use_second_order_derivatives** (`bool`) – Whether to use the second-order derivatives in the computations.

Returns

Spectral uniformity.

Return type

`numpy.ndarray`

| |
|---|
| Warning: The spectral distributions must have the same spectral shape. |
|---|

References

[DFH+15]

Examples

```
>>> from colour.quality.datasets import SDS_TCS
>>> spectral_uniformity(SDS_TCS.values())
array([[ 9.5514285...e-06,   1.1482142...e-05,   1.8784285...e-05,
        2.8711428...e-05,   3.1971428...e-05,   3.2342857...e-05,
        3.3850000...e-05,   3.9925714...e-05,   4.1333571...e-05,
        2.4002142...e-05,   5.7621428...e-06,   1.4757142...e-06,
        9.7928571...e-07,   2.0057142...e-06,   3.7157142...e-06,
        5.7678571...e-06,   7.5557142...e-06,   7.4635714...e-06,
        5.7492857...e-06,   3.8692857...e-06,   3.5407142...e-06,
        4.4742857...e-06,   5.6435714...e-06,   7.6371428...e-06,
        1.0171428...e-05,   1.2254285...e-05,   1.4810000...e-05,
        1.6517142...e-05,   1.5430714...e-05,   1.4536428...e-05,
        1.4037857...e-05,   1.1587857...e-05,   1.0743571...e-05,
        1.0979285...e-05,   1.0398571...e-05,   8.2971428...e-06,
        6.3057142...e-06,   5.0942857...e-06,   4.8500000...e-06,
        5.5371428...e-06,   6.4128571...e-06,   7.2592857...e-06,
        7.7750000...e-06,   7.1607142...e-06,   6.6635714...e-06,
        6.7328571...e-06,   7.5307142...e-06,   1.0733571...e-05,
        1.6234285...e-05,   2.2570714...e-05,   2.7056428...e-05,
        2.7781428...e-05,   2.5025714...e-05,   1.7966428...e-05,
        1.0505000...e-05,   5.9657142...e-06,   3.6421428...e-06,
        2.1664285...e-06,   1.2935714...e-06,   8.3642857...e-07,
        7.2500000...e-07,   6.3928571...e-07,   6.6285714...e-07,
        8.5571428...e-07,   1.4507142...e-06,   2.2542857...e-06,
        3.4142857...e-06,   4.9864285...e-06,   6.4907142...e-06,
        7.8928571...e-06,   9.1664285...e-06,   9.9521428...e-06,
        9.7664285...e-06,   9.3150000...e-06,   8.9092857...e-06,
        8.1578571...e-06,   6.8935714...e-06,   5.5721428...e-06,
        4.4592857...e-06,   3.4778571...e-06,   2.7650000...e-06,
        2.3114285...e-06,   1.7092857...e-06,   1.1771428...e-06,
        9.8428571...e-07,   8.8285714...e-07,   7.4142857...e-07,
        7.0142857...e-07,   7.0857142...e-07,   6.6642857...e-07,
        7.5928571...e-07,   8.7000000...e-07,   8.2714285...e-07,
        7.1714285...e-07,   6.6000000...e-07]])
```

Lightness Computation

colour

| | |
|-------------------------------------|---|
| <code>lightness(Y[, method])</code> | Return the <i>Lightness</i> L of given <i>luminance</i> Y using given method. |
| <code>LIGHTNESS_METHODS</code> | Supported <i>Lightness</i> computation methods. |

colour.lightness

`colour.lightness`(*Y*: *FloatingOrArrayLike*, *method*: *Literal*['Abebe 2017', 'CIE 1976', 'Glasser 1958', 'Fairchild 2010', 'Fairchild 2011', 'Wyszecki 1963'] | *str* = 'CIE 1976', ***kwargs*: *Any*)
 → *FloatingOrNDArray*

Return the *Lightness* L of given *luminance* Y using given method.

Parameters

- *Y* (*FloatingOrArrayLike*) – *Luminance* Y .
- *method* (*Literal*['Abebe 2017', 'CIE 1976', 'Glasser 1958', 'Fairchild 2010', 'Fairchild 2011', 'Wyszecki 1963'] | *str*) – Computation method.
- *Y_n* – {`colour.colorimetry.lightness_Abebe2017()`, `colour.colorimetry.lightness_CIE1976()`}, White reference *luminance* Y_n .
- *epsilon* – {`colour.colorimetry.lightness_Fairchild2010()`, `colour.colorimetry.lightness_Fairchild2011()`}, ϵ exponent.
- *kwargs* (*Any*) –

Returns

Lightness L .

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| Y | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| L | [0, 100] | [0, 1] |

References

[APLR17], [CIET14804h], [FW10], [FC11], [GMR58], [Wikipedia07a], [Wys63], [WS00]

Examples

```
>>> lightness(12.19722535)
41.5278758...
>>> lightness(12.19722535, Y_n=100)
41.5278758...
>>> lightness(12.19722535, Y_n=95)
42.5199307...
>>> lightness(12.19722535, method="Glasser 1958")
39.8351264...
>>> lightness(12.19722535, method="Wyszecki 1963")
40.5475745...
>>> lightness(12.19722535, epsilon=0.710, method="Fairchild 2011")
...

```

(continues on next page)

(continued from previous page)

```
29.8295108...
>>> lightness(12.19722535, epsilon=0.710, method="Fairchild 2011")
...
29.8295108...
>>> lightness(12.19722535, method="Abebe 2017")
...
48.6955571...
```

colour.LIGHTNESS_METHODS

```
colour.LIGHTNESS_METHODS = CanonicalMapping({'Glasser 1958': ..., 'Wyszecki 1963': ...,
'CIIE 1976': ..., 'Fairchild 2010': ..., 'Fairchild 2011': ..., 'Abebe 2017': ...,
'Lstar1976': ...})
```

Supported *Lightness* computation methods.

References

[CIET14804h], [FW10], [FC11], [GMRS58], [Wys63], [WS001]

Aliases:

- 'Lstar1976': 'CIE 1976'

Glasser, Mckinney, Reilly and Schnelle (1958)

colour.colorimetry

| | |
|---------------------------------------|--|
| <code>lightness_Glasser1958(Y)</code> | Return the <i>Lightness</i> L of given <i>luminance</i> Y using <i>Glasser et al. (1958)</i> method. |
|---------------------------------------|--|

colour.colorimetry.lightness_Glasser1958

colour.colorimetry.**lightness_Glasser1958**(Y : *FloatingOrArrayLike*) \rightarrow *FloatingOrNDArray*

Return the *Lightness* L of given *luminance* Y using *Glasser et al. (1958)* method.

Parameters

Y (*FloatingOrArrayLike*) – *Luminance* Y .

Returns

Lightness L .

Return type

`numpy.float64` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| Y | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| L | [0, 100] | [0, 1] |

References

[GMRS58]

Examples

```
>>> lightness_Glasser1958(12.19722535)
39.8351264...
```

Wyszecki (1963)

colour.colorimetry

| | |
|--|--|
| <code>lightness_Wyszecki1963(Y)</code> | Return the <i>Lightness W</i> of given <i>luminance Y</i> using <i>Wyszecki (1963)</i> method. |
|--|--|

colour.colorimetry.lightness_Wyszecki1963

colour.colorimetry.**lightness_Wyszecki1963**(Y: *FloatingOrArrayLike*) → *FloatingOrNDArray*

Return the *Lightness W* of given *luminance Y* using *Wyszecki (1963)* method.

Parameters

Y (*FloatingOrArrayLike*) – *Luminance Y*.

Returns

Lightness W.

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| Y | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| W | [0, 100] | [0, 1] |

References

[Wys63]

Examples

```
>>> lightness_Wyszecki1963(12.19722535)
40.5475745...
```

CIE 1976

colour.colorimetry

| | |
|--|--|
| <code>lightness_CIE1976(Y[, Y_n])</code> | Return the <i>Lightness</i> L^* of given <i>luminance</i> Y using given reference white <i>luminance</i> Y_n as per CIE 1976 recommendation. |
| <code>intermediate_lightness_function_CIE1976(Y[, Y_n])</code> | Return the intermediate value $f(Y/Y_n)$ in the <i>Lightness</i> L^* computation for given <i>luminance</i> Y using given reference white <i>luminance</i> Y_n as per CIE 1976 recommendation. |

colour.colorimetry.lightness_CIE1976

colour.colorimetry.**lightness_CIE1976**(Y : *FloatingOrArrayLike*, Y_n : *FloatingOrArrayLike* = 100) → *FloatingOrNDArray*

Return the *Lightness* L^* of given *luminance* Y using given reference white *luminance* Y_n as per CIE 1976 recommendation.

Parameters

- **Y** (*FloatingOrArrayLike*) – *Luminance* Y .
- **Y_n** (*FloatingOrArrayLike*) – White reference *luminance* Y_n .

Returns

Lightness L^* .

Return type

`numpy.float64` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| Y | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|------------|-------------------|-----------|
| L_{star} | [0, 100] | [0, 1] |

References

[CIET14804h], [WS00l]

Examples

```
>>> lightness_CIE1976(12.19722535)
41.5278758...
```

colour.colorimetry.intermediate_lightness_function_CIE1976

colour.colorimetry.intermediate_lightness_function_CIE1976(*Y*: *FloatingOrArrayLike*, *Y_n*: *FloatingOrArrayLike* = 100) → *FloatingOrNDArray*

Return the intermediate value $f(Y/Y_n)$ in the *Lightness* L^* computation for given *luminance* Y using given reference white *luminance* Y_n as per *CIE 1976* recommendation.

Parameters

- **Y** (*FloatingOrArrayLike*) – *Luminance* Y .
- **Y_n** (*FloatingOrArrayLike*) – White reference *luminance* Y_n .

Returns

Intermediate value $f(Y/Y_n)$.

Return type

`numpy.float64` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| Y | [0, 100] | [0, 100] |

| Range | Scale - Reference | Scale - 1 |
|-------------|-------------------|-----------|
| f_{Y/Y_n} | [0, 1] | [0, 1] |

References

[CIET14804h], [WS00l]

Examples

```
>>> intermediate_lightness_function_CIE1976(12.19722535)
...
0.4959299...
>>> intermediate_lightness_function_CIE1976(12.19722535, 95)
...
0.5044821...
```

Fairchild and Wyble (2010)

colour.colorimetry

| | |
|--|--|
| <code>lightness_Fairchild2010(Y[, epsilon])</code> | Compute <i>Lightness</i> L_{hdr} of given <i>luminance</i> Y using <i>Fairchild and Wyble (2010)</i> method according to <i>Michaelis-Menten</i> kinetics. |
|--|--|

colour.colorimetry.lightness_Fairchild2010

colour.colorimetry.**lightness_Fairchild2010**(*Y: FloatingOrArrayLike*, *epsilon: FloatingOrArrayLike* = 1.836) → FloatingOrNDArray

Compute *Lightness* L_{hdr} of given *luminance* Y using *Fairchild and Wyble (2010)* method according to *Michaelis-Menten* kinetics.

Parameters

- **Y** (FloatingOrArrayLike) – *Luminance* Y .
- **epsilon** (FloatingOrArrayLike) – ϵ exponent.

Returns

Lightness L_{hdr} .

Return type

numpy.floating or numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| Y | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| L_hdr | [0, 100] | [0, 1] |

References

[FW10]

Examples

```
>>> lightness_Fairchild2010(12.19722535 / 100)
31.9963902...
```


Fairchild and Chen (2011)

colour.colorimetry

| | |
|--|---|
| <code>lightness_Fairchild2011(Y[, epsilon, method])</code> | Compute <i>Lightness</i> L_{hdr} of given <i>luminance</i> Y using <i>Fairchild and Chen (2011)</i> method according to <i>Michaelis-Menten</i> kinetics. |
|--|---|

colour.colorimetry.lightness_Fairchild2011

colour.colorimetry.**lightness_Fairchild2011**(Y : *FloatingOrArrayLike*, *epsilon*: *FloatingOrArrayLike* = 0.474, *method*: *Literal*['hdr-CIELAB', 'hdr-IPT'] | *str* = 'hdr-CIELAB') → *FloatingOrNDArray*

Compute *Lightness* L_{hdr} of given *luminance* Y using *Fairchild and Chen (2011)* method according to *Michaelis-Menten* kinetics.

Parameters

- **Y** (*FloatingOrArrayLike*) – *Luminance* Y .
- **epsilon** (*FloatingOrArrayLike*) – ϵ exponent.
- **method** (*Literal*['hdr-CIELAB', 'hdr-IPT'] | *str*) – *Lightness* L_{hdr} computation method.

Returns

Lightness L_{hdr} .

Return type

numpy.floating or *numpy.ndarray*

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| Y | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| L_hdr | [0, 100] | [0, 1] |

References

[FC11]

Examples

```
>>> lightness_Fairchild2011(12.19722535 / 100)
51.8529584...
>>> lightness_Fairchild2011(12.19722535 / 100, method="hdr-IPT")
...
51.6431084...
```

Abebe, Pouli, Larabi and Reinhard (2017)

colour.colorimetry

| | |
|--|---|
| <code>lightness_Abebe2017(Y[, Y_n, method])</code> | Compute <i>Lightness L</i> of given luminance <i>Y</i> using Abebe, Pouli, Larabi and Reinhard (2017) method according to Michaelis-Menten kinetics or Stevens's Power Law. |
|--|---|

colour.colorimetry.lightness_Abebe2017

colour.colorimetry.**lightness_Abebe2017**(*Y*: FloatingOrArrayLike, *Y_n*: FloatingOrArrayLike = 100, *method*: `Literal`['Michaelis-Menten', 'Stevens'] | *str* = 'Michaelis-Menten') → FloatingOrNDArray

Compute *Lightness L* of given luminance *Y* using Abebe, Pouli, Larabi and Reinhard (2017) method according to Michaelis-Menten kinetics or Stevens's Power Law.

Parameters

- **Y** (FloatingOrArrayLike) – Luminance *Y* in cd/m^2 .
- **Y_n** (FloatingOrArrayLike) – Adapting luminance Y_n in cd/m^2 .
- **method** (`Literal`['Michaelis-Menten', 'Stevens'] | *str*) – *Lightness L* computation method.

Returns

Lightness L.

Return type

`numpy.floating` or `numpy.ndarray`

Notes

- Abebe, Pouli, Larabi and Reinhard (2017) method uses absolute luminance levels, thus the domain and range values for the *Reference* and *1* scales are only indicative that the data is not affected by scale transformations.

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| Y | UN | UN |
| Y_n | UN | UN |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| L | UN | UN |

References

[APLR17]

Examples

```
>>> lightness_Abebe2017(12.19722535)
0.4869555...
>>> lightness_Abebe2017(12.19722535, method="Stevens")
...
0.4745447...
```

Luminance Computation

colour

| | |
|--------------------------------------|---|
| <code>luminance(LV[, method])</code> | Return the <i>luminance</i> Y of given <i>Lightness</i> L^* or given <i>Munsell</i> value V . |
| <code>LUMINANCE_METHODS</code> | Supported <i>luminance</i> computation methods. |

colour.luminance

`colour.luminance(LV: FloatingOrArrayLike, method: Literal['Abebe 2017', 'CIE 1976', 'Glasser 1958', 'Fairchild 2010', 'Fairchild 2011', 'Wyszecki 1963'] | str = 'CIE 1976', **kwargs: Any)`
→ FloatingOrNDArray

Return the *luminance* Y of given *Lightness* L^* or given *Munsell* value V .

Parameters

- LV** (FloatingOrArrayLike) – *Lightness* L^* or *Munsell* value V .
- method** ([Literal](#)['Abebe 2017', 'CIE 1976', 'Glasser 1958', 'Fairchild 2010', 'Fairchild 2011', 'Wyszecki 1963'] | str) – Computation method.
- Y_n** – {`colour.colorimetry.luminance_Abebe2017()`, `colour.colorimetry.luminance_CIE1976()`}, White reference *luminance* Y_n .
- epsilon** – {`colour.colorimetry.lightness_Fairchild2010()`, `colour.colorimetry.lightness_Fairchild2011()`}, ϵ exponent.
- kwargs** ([Any](#)) –

Returns

Luminance Y .

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| LV | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| Y | [0, 100] | [0, 1] |

References

[APLR17], [ASTMInternational08], [CIET14804h], [FW10], [FC11], [NNJ43], [Wikipedia01c], [WS00]

Examples

```
>>> luminance(41.527875844653451)
12.1972253...
>>> luminance(41.527875844653451, Y_n=100)
12.1972253...
>>> luminance(42.51993072812094, Y_n=95)
12.1972253...
>>> luminance(4.08244375 * 10, method="Newhall 1943")
...
12.5500788...
>>> luminance(4.08244375 * 10, method="ASTM D1535")
...
12.2363426...
>>> luminance(29.829510892279330, epsilon=0.710, method="Fairchild 2011")
...
12.1972253...
```

colour.LUMINANCE_METHODS

```
colour.LUMINANCE_METHODS = CanonicalMapping({'Newhall 1943': ..., 'ASTM D1535': ..., 'CIE
1976': ..., 'Fairchild 2010': ..., 'Fairchild 2011': ..., 'Abebe 2017': ..., 'astm2008':
..., 'cie1976': ...})
```

Supported *luminance* computation methods.

References

[ASTMInternational08], [CIET14804h], [FW10], [FC11], [NNJ43], [WS00]

Aliases:

- 'astm2008': 'ASTM D1535'
- 'cie1976': 'CIE 1976'

Newhall, Nickerson and Judd (1943)

colour.colorimetry

| | |
|---------------------------------------|--|
| <code>luminance_Newhall1943(V)</code> | Return the <i>luminance</i> R_Y of given <i>Munsell</i> value V using <i>Newhall et al. (1943)</i> method. |
|---------------------------------------|--|

colour.colorimetry.luminance_Newhall1943

colour.colorimetry.**luminance_Newhall1943**(V : *FloatingOrArrayLike*) → *FloatingOrNDArray*

Return the *luminance* R_Y of given *Munsell* value V using *Newhall et al. (1943)* method.

Parameters

V (*FloatingOrArrayLike*) – *Munsell* value V .

Returns

Luminance R_Y .

Return type

`numpy.float64` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| V | [0, 10] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| R_Y | [0, 100] | [0, 1] |

References

[NNJ43]

Examples

```
>>> luminance_Newhall1943(4.08244375)
12.5500788...
```

CIE 1976

colour.colorimetry

| | |
|---|---|
| <code>luminance_CIE1976(L_star[, Y_n])</code> | Return the <i>luminance</i> Y of given <i>Lightness</i> L^* with given reference white <i>luminance</i> Y_n . |
| <code>intermediate_luminance_function_CIE1976(f_Y_')</code> | Return the <i>luminance</i> Y in the <i>luminance</i> Y computation for given intermediate value $f(Y/Y_n)$ using given reference white <i>luminance</i> Y_n as per <i>CIE 1976</i> recommendation. |

colour.colorimetry.luminance_CIE1976

`colour.colorimetry.luminance_CIE1976(L_star: FloatingOrArrayLike, Y_n: FloatingOrArrayLike = 100) → FloatingOrNDArray`

Return the *luminance* Y of given *Lightness* L^* with given reference white *luminance* Y_n .

Parameters

- **L_star** (FloatingOrArrayLike) – *Lightness* L^*
- **Y_n** (FloatingOrArrayLike) – White reference *luminance* Y_n .

Returns

Luminance Y .

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|------------|-------------------|-----------|
| L_{star} | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| Y | [0, 100] | [0, 1] |

References

[CIET14804h], [WS00l]

Examples

```
>>> luminance_CIE1976(41.527875844653451)
12.1972253...
>>> luminance_CIE1976(41.527875844653451, 95)
11.5873640...
```

colour.colorimetry.intermediate_luminance_function_CIE1976

`colour.colorimetry.intermediate_luminance_function_CIE1976(f_Y_Y_n: FloatingOrArrayLike, Y_n: FloatingOrArrayLike = 100) → FloatingOrNDArray`

Return the *luminance* Y in the *luminance* Y computation for given intermediate value $f(Y/Y_n)$ using given reference white *luminance* Y_n as per CIE 1976 recommendation.

Parameters

- **f_Y_Y_n** (FloatingOrArrayLike) – Intermediate value $f(Y/Y_n)$.
- **Y_n** (FloatingOrArrayLike) – White reference *luminance* Y_n .

Returns

Luminance Y .

Return type`numpy.float64` or `numpy.ndarray`**Notes**

| Domain | Scale - Reference | Scale - 1 |
|-----------|-------------------|-----------|
| f_{Y_n} | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| Y | [0, 100] | [0, 100] |

References

[CIET14804h], [WS00l]

Examples

```
>>> intermediate_luminance_function_CIE1976(0.495929964178047)
...
12.1972253...
>>> intermediate_luminance_function_CIE1976(0.504482161449319, 95)
...
12.1972253...
```

ASTM D1535-08e1`colour.colorimetry`

| | |
|-------------------------------------|--|
| <code>luminance_ASTMD1535(V)</code> | Return the <i>luminance</i> Y of given <i>Munsell</i> value V using <i>ASTM D1535-08e1</i> method. |
|-------------------------------------|--|

`colour.colorimetry.luminance_ASTMD1535``colour.colorimetry.luminance_ASTMD1535(V: FloatingOrArrayLike) → FloatingOrNDArray`Return the *luminance* Y of given *Munsell* value V using *ASTM D1535-08e1* method.**Parameters** V (`FloatingOrArrayLike`) – *Munsell* value V .**Returns***Luminance* Y .**Return type**`numpy.float64` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| V | [0, 10] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| Y | [0, 100] | [0, 1] |

References

[ASTMInternational08]

Examples

```
>>> luminance_ASTMD1535(4.08244375)
12.2363426...
```

Fairchild and Wyble (2010)

colour.colorimetry

| | |
|--|--|
| <code>luminance_Fairchild2010(L_hdr[, epsilon])</code> | Compute <i>luminance</i> Y of given <i>Lightness</i> L_{hdr} using <i>Fairchild and Wyble (2010)</i> method according to <i>Michaelis-Menten</i> kinetics. |
|--|--|

colour.colorimetry.luminance_Fairchild2010

colour.colorimetry.**luminance_Fairchild2010**(*L_hdr*: *FloatingOrArrayLike*, *epsilon*: *FloatingOrArrayLike* = 1.836) → *FloatingOrNDArray*
Compute *luminance* Y of given *Lightness* L_{hdr} using *Fairchild and Wyble (2010)* method according to *Michaelis-Menten* kinetics.

Parameters

- **L_hdr** (*FloatingOrArrayLike*) – *Lightness* L_{hdr} .
- **epsilon** (*FloatingOrArrayLike*) – ϵ exponent.

Returns

Luminance Y .

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| L_hdr | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| Y | [0, 1] | [0, 1] |

References

[FW10]

Examples

```
>>> luminance_Fairchild2010(31.996390226262736, 1.836)
...
0.1219722...
```

Fairchild and Chen (2011)

colour.colorimetry

| | |
|---|---|
| <code>luminance_Fairchild2011(L_hdr[, method])</code> | <code>epsilon</code> , Compute <i>luminance</i> Y of given <i>Lightness</i> L_{hdr} using <i>Fairchild and Chen (2011)</i> method according to <i>Michaelis-Menten</i> kinetics. |
|---|---|

colour.colorimetry.luminance_Fairchild2011

colour.colorimetry.**luminance_Fairchild2011**(*L_hdr*: *FloatingOrArrayLike*, *epsilon*: *FloatingOrArrayLike* = 0.474, *method*: *Literal*['hdr-CIELAB', 'hdr-IPT'] | *str* = 'hdr-CIELAB') → *FloatingOrNDArray*

Compute *luminance* Y of given *Lightness* L_{hdr} using *Fairchild and Chen (2011)* method according to *Michaelis-Menten* kinetics.

Parameters

- **L_hdr** (*FloatingOrArrayLike*) – *Lightness* L_{hdr} .
- **epsilon** (*FloatingOrArrayLike*) – ϵ exponent.
- **method** (*Literal*['hdr-CIELAB', 'hdr-IPT'] | *str*) – *Lightness* L_{hdr} computation method.

Returns

Luminance Y .

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| L_hdr | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| Y | [0, 1] | [0, 1] |

References

[FC11]

Examples

```
>>> luminance_Fairchild2011(51.852958445912506)
0.1219722...
>>> luminance_Fairchild2011(51.643108411718522, method="hdr-IPT")
...
0.1219722...
```

Whiteness Computation

colour

| | |
|--|---|
| <code>whiteness(XYZ, XYZ_0[, method])</code> | Return the <i>whiteness</i> W using given method. |
| <code>WHITENESS_METHODS</code> | Supported <i>whiteness</i> computation methods. |

colour.whiteness

`colour.whiteness(XYZ: ArrayLike, XYZ_0: ArrayLike, method: Literal['ASTM E313', 'CIE 2004', 'Berger 1959', 'Ganz 1979', 'Stensby 1968', 'Taube 1960'] | str = 'CIE 2004', **kwargs: Any)`
→ FloatingOrNDArray

Return the *whiteness* W using given method.

Parameters

- **XYZ** (ArrayLike) – CIE XYZ tristimulus values of the sample.
- **XYZ_0** (ArrayLike) – CIE XYZ tristimulus values of the reference white.
- **method** (*Literal*['ASTM E313', 'CIE 2004', 'Berger 1959', 'Ganz 1979', 'Stensby 1968', 'Taube 1960'] | str) – Computation method.
- **observer** – {`colour.colorimetry.whiteness_CIE2004()`}, CIE Standard Observer used for computations, *tint* T or T_{10} value is dependent on viewing field angular subtense.
- **kwargs** (Any) –

Returns

Whiteness W .

Return type

np.float64 or numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |
| XYZ_0 | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| W | [0, 100] | [0, 1] |

References

[CIET14804d], [WS00i], [XRitePantone12], [Wikipedia04c]

Examples

```
>>> import numpy as np
>>> from colour.models import xyY_to_XYZ
>>> XYZ = xyY_to_XYZ(np.array([0.3167, 0.3334, 100]))
>>> XYZ_0 = xyY_to_XYZ(np.array([0.3139, 0.3311, 100]))
>>> whiteness(XYZ, XYZ_0)
array([ 93.85..., -1.305...])
>>> XYZ = np.array([95.00000000, 100.00000000, 105.00000000])
>>> XYZ_0 = np.array([94.80966767, 100.00000000, 107.30513595])
>>> whiteness(XYZ, XYZ_0, method="Taube 1960")
91.4071738...
```

colour.WHITENESS_METHODS

```
colour.WHITENESS_METHODS = CanonicalMapping({'Berger 1959': ..., 'Taube 1960': ...,
'Stensby 1968': ..., 'ASTM E313': ..., 'Ganz 1979': ..., 'CIE 2004': ..., 'cie2004': ...})
```

Supported *whiteness* computation methods.**References**

[CIET14804d], [XRitePantone12]

Aliases:

- 'cie2004': 'CIE 2004'

Berger (1959)

`colour.colorimetry`

| | |
|---|---|
| <code>whiteness_Berger1959(XYZ, XYZ_0)</code> | Return the <i>whiteness</i> index <i>WI</i> of given sample CIE XYZ tristimulus values using <i>Berger (1959)</i> method. |
|---|---|

`colour.colorimetry.whiteness_Berger1959`

`colour.colorimetry.whiteness_Berger1959(XYZ: ArrayLike, XYZ_0: ArrayLike) → FloatingOrNDArray`

Return the *whiteness* index *WI* of given sample CIE XYZ tristimulus values using *Berger (1959)* method.

Parameters

- **XYZ** (ArrayLike) – CIE XYZ tristimulus values of the sample.
- **XYZ_0** (ArrayLike) – CIE XYZ tristimulus values of the reference white.

Returns

Whiteness WI.

Return type

`np.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |
| XYZ_0 | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| WI | [0, 100] | [0, 1] |

- *Whiteness WI* values larger than 33.33 indicate a bluish white and values smaller than 33.33 indicate a yellowish white.

References

[XRitePantone12]

Examples

```
>>> import numpy as np
>>> XYZ = np.array([95.00000000, 100.00000000, 105.00000000])
>>> XYZ_0 = np.array([94.80966767, 100.00000000, 107.30513595])
>>> whiteness_Berger1959(XYZ, XYZ_0)
30.3638017...
```

Taube (1960)

colour.colorimetry

| | |
|--|--|
| <code>whiteness-Taube1960(XYZ, XYZ_0)</code> | Return the <i>whiteness</i> index <i>WI</i> of given sample CIE XYZ tristimulus values using <i>Taube (1960)</i> method. |
|--|--|

colour.colorimetry.whiteness-Taube1960

colour.colorimetry.**whiteness-Taube1960**(XYZ: ArrayLike, XYZ_0: ArrayLike) → FloatingOrNDArray
Return the *whiteness* index *WI* of given sample CIE XYZ tristimulus values using *Taube (1960)* method.

Parameters

- **XYZ** (ArrayLike) – CIE XYZ tristimulus values of the sample.
- **XYZ_0** (ArrayLike) – CIE XYZ tristimulus values of the reference white.

Returns

Whiteness WI.

Return type

np.floating or numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |
| XYZ_0 | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| WI | [0, 100] | [0, 1] |

- *Whiteness WI* values larger than 100 indicate a bluish white and values smaller than 100 indicate a yellowish white.

References

[XRitePantone12]

Examples

```
>>> import numpy as np
>>> XYZ = np.array([95.00000000, 100.00000000, 105.00000000])
>>> XYZ_0 = np.array([94.80966767, 100.00000000, 107.30513595])
>>> whiteness-Taube1960(XYZ, XYZ_0)
91.4071738...
```

Stensby (1968)

colour.colorimetry

`whiteness_Stensby1968(Lab)`

Return the *whiteness* index *WI* of given sample CIE $L^*a^*b^*$ colourspace array using *Stensby (1968)* method.

colour.colorimetry.whiteness_Stensby1968

colour.colorimetry.**whiteness_Stensby1968**(Lab: ArrayLike) → FloatingOrNDArray

Return the *whiteness* index *WI* of given sample CIE $L^*a^*b^*$ colourspace array using *Stensby (1968)* method.

Parameters

Lab (ArrayLike) – CIE $L^*a^*b^*$ colourspace array of the sample.

Returns

Whiteness WI.

Return type

np.floating or numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-------------|
| Lab | L : [0, 100] | L : [0, 1] |
| | a : [-100, 100] | a : [-1, 1] |
| | b : [-100, 100] | b : [-1, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| WI | [0, 100] | [0, 1] |

- *Whiteness WI* values larger than 100 indicate a bluish white and values smaller than 100 indicate a yellowish white.

References

[XRitePantone12]

Examples

```
>>> import numpy as np
>>> Lab = np.array([100.00000000, -2.46875131, -16.72486654])
>>> whiteness_Stensby1968(Lab)
142.7683456...
```

ASTM E313

colour.colorimetry

| | |
|--------------------------------------|--|
| <code>whiteness_ASTME313(XYZ)</code> | Return the <i>whiteness</i> index <i>WI</i> of given sample <i>CIE XYZ</i> tristimulus values using <i>ASTM E313</i> method. |
|--------------------------------------|--|

colour.colorimetry.whiteness_ASTME313

colour.colorimetry.**whiteness_ASTME313**(XYZ: *ArrayLike*) → *FloatingOrNDArray*

Return the *whiteness* index *WI* of given sample *CIE XYZ* tristimulus values using *ASTM E313* method.

Parameters

XYZ (*ArrayLike*) – *CIE XYZ* tristimulus values of the sample.

Returns

Whiteness WI.

Return type

`np.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| WI | [0, 100] | [0, 1] |

References

[XRitePantone12]

Examples

```
>>> import numpy as np
>>> XYZ = np.array([95.00000000, 100.00000000, 105.00000000])
>>> whiteness_ASTME313(XYZ)
55.740000...
```

Ganz and Griesser (1979)

colour.colorimetry

| | |
|--|--|
| <code>whiteness_Ganz1979(xy, Y)</code> | Return the <i>whiteness</i> index <i>W</i> and <i>tint</i> <i>T</i> of given sample <i>CIE xy</i> chromaticity coordinates using <i>Ganz and Griesser (1979)</i> method. |
|--|--|

colour.colorimetry.whiteness_Ganz1979

colour.colorimetry.**whiteness_Ganz1979**(xy: ArrayLike, Y: FloatingOrNDArray) → ndarray

Return the *whiteness* index *W* and *tint* *T* of given sample *CIE xy* chromaticity coordinates using *Ganz and Griesser (1979)* method.

Parameters

- **xy** (ArrayLike) – Chromaticity coordinates *CIE xy* of the sample.
- **Y** (FloatingOrNDArray) – Tristimulus *Y* value of the sample.

Returns

Whiteness W and *tint T*.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| Y | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| WT | [0, 100] | [0, 1] |

- The formula coefficients are valid for *CIE Standard Illuminant D Series D65* and *CIE 1964 10 Degree Standard Observer*.
- Positive output *tint T* values indicate a greener tint while negative values indicate a redder tint.

- Whiteness differences of less than 5 Ganz units appear to be indistinguishable to the human eye.
- Tint differences of less than 0.5 Ganz units appear to be indistinguishable to the human eye.

References

[XRitePantone12]

Examples

```
>>> import numpy as np
>>> xy = np.array([0.3167, 0.3334])
>>> whiteness_Ganz1979(xy, 100)
array([ 85.6003766...,  0.6789003...])
```

CIE 2004

colour.colorimetry

| | |
|---|--|
| <code>whiteness_CIE2004(xy, Y, xy_n[, observer])</code> | Return the <i>whiteness</i> W or W_{10} and <i>tint</i> T or T_{10} of given sample <i>CIE</i> xy chromaticity coordinates using <i>CIE 2004</i> method. |
|---|--|

colour.colorimetry.whiteness_CIE2004

colour.colorimetry.**whiteness_CIE2004**(*xy*: ArrayLike, *Y*: FloatingOrNDArray, *xy_n*: ArrayLike, *observer*: Literal['CIE 1931 2 Degree Standard Observer', 'CIE 1964 10 Degree Standard Observer'] = 'CIE 1931 2 Degree Standard Observer') → ndarray

Return the *whiteness* W or W_{10} and *tint* T or T_{10} of given sample *CIE* xy chromaticity coordinates using *CIE 2004* method.

Parameters

- **xy** (ArrayLike) – Chromaticity coordinates *CIE* xy of the sample.
- **Y** (FloatingOrNDArray) – Tristimulus Y value of the sample.
- **xy_n** (ArrayLike) – Chromaticity coordinates xy_n of a perfect diffuser.
- **observer** (Literal['CIE 1931 2 Degree Standard Observer', 'CIE 1964 10 Degree Standard Observer']) – *CIE Standard Observer* used for computations, *tint* T or T_{10} value is dependent on viewing field angular subtense.

Returns

Whiteness W or W_{10} and *tint* T or T_{10} of given sample.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| Y | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| WT | [0, 100] | [0, 1] |

- This method may be used only for samples whose values of W or W_{10} lie within the following limits: greater than 40 and less than 5Y - 280, or 5Y10 - 280.
- This method may be used only for samples whose values of T or T_{10} lie within the following limits: greater than -4 and less than +2.
- Output *whiteness* W or W_{10} values larger than 100 indicate a bluish white while values smaller than 100 indicate a yellowish white.
- Positive output *tint* T or T_{10} values indicate a greener tint while negative values indicate a redder tint.

References

[CIET14804d]

Examples

```
>>> import numpy as np
>>> xy = np.array([0.3167, 0.3334])
>>> xy_n = np.array([0.3139, 0.3311])
>>> whiteness_CIE2004(xy, 100, xy_n)
array([ 93.85..., -1.305...])
```

Yellowness Computation

colour

| | |
|--|--|
| <code>yellowness(XYZ[, method])</code> | Return the <i>yellowness</i> W using given method. |
| <code>YELLOWNESS_METHODS</code> | Supported <i>yellowness</i> computation methods. |

colour.yellowness

`colour.yellowness(XYZ: ArrayLike, method: Literal['ASTM D1925', 'ASTM E313', 'ASTM E313 Alternative'] | str = 'ASTM E313', **kwargs: Any)` → *FloatingOrNDArray*

Return the *yellowness* W using given method.

Parameters

- **XYZ** (*ArrayLike*) – CIE XYZ tristimulus values of the sample.
- **method** (*Literal*['ASTM D1925', 'ASTM E313', 'ASTM E313 Alternative'] | *str*) – Computation method.

- **C_XZ** – {`colour.colorimetry.yellowness_ASTME313()`}, Coefficients C_X and C_Z for the *CIE 1931 2 Degree Standard Observer* and *CIE 1964 10 Degree Standard Observer* and *CIE Illuminant C* and *CIE Standard Illuminant D65*.
- **kwargs** (*Any*) –

Returns*Yellowness Y.***Return type**np.floating or `numpy.ndarray`**Notes**

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| YI | [0, 100] | [0, 1] |

References

[ASTMInternational15b], [XRitePantone12]

Examples

```
>>> XYZ = np.array([95.00000000, 100.00000000, 105.00000000])
>>> yellowness(XYZ)
4.3400000...
>>> yellowness(XYZ, method="ASTM E313 Alternative")
11.0650000...
>>> yellowness(XYZ, method="ASTM D1925")
10.2999999...
```

colour.YELLOWNESS_METHODS

```
colour.YELLOWNESS_METHODS = CanonicalMapping({'ASTM D1925': ..., 'ASTM E313 Alternative':
..., 'ASTM E313': ...})
```

Supported *yellowness* computation methods.**References**

[ASTMInternational15b], [XRitePantone12]

ASTM D1925

`colour.colorimetry`

`yellowness_ASTMD1925(XYZ)`

Return the *yellowness* index *YI* of given sample *CIE XYZ* tristimulus values using *ASTM D1925* method.

`colour.colorimetry.yellowness_ASTMD1925`

`colour.colorimetry.yellowness_ASTMD1925(XYZ: ArrayLike) → FloatingOrNDArray`

Return the *yellowness* index *YI* of given sample *CIE XYZ* tristimulus values using *ASTM D1925* method.

ASTM D1925 has been specifically developed for the definition of the yellowness of homogeneous, non-fluorescent, almost neutral-transparent, white-scattering or opaque plastics as they will be reviewed under daylight condition. It can be other materials as well, as long as they fit into this description.

Parameters

XYZ (ArrayLike) – *CIE XYZ* tristimulus values of the sample.

Returns

Yellowness YI.

Return type

`np.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| YI | [0, 100] | [0, 1] |

- Input *CIE XYZ* tristimulus values must be adapted to *CIE Illuminant C*.

References

[ASTMInternational15b], [XRitePantone12]

Examples

```
>>> XYZ = np.array([95.00000000, 100.00000000, 105.00000000])
>>> yellowness_ASTMD1925(XYZ)
10.2999999...
```

ASTM E313

colour.colorimetry

| | |
|---|---|
| <code>yellowness_ASTME313_alternative(XYZ)</code> | Return the <i>yellowness</i> index <i>YI</i> of given sample <i>CIE XYZ</i> tristimulus values using the alternative <i>ASTM E313</i> method. |
| <code>YELLOWNESS_COEFFICIENTS_ASTME313</code> | Coefficients C_X and C_Z for the <i>ASTM E313 yellowness</i> index <i>YI</i> computation method. |
| <code>yellowness_ASTME313(XYZ[, C_XZ])</code> | Return the <i>yellowness</i> index <i>YI</i> of given sample <i>CIE XYZ</i> tristimulus values using <i>ASTM E313</i> method. |

colour.colorimetry.yellowness_ASTME313_alternative

colour.colorimetry.**yellowness_ASTME313_alternative**(XYZ: *ArrayLike*) → *FloatingOrNDArray*

Return the *yellowness* index *YI* of given sample *CIE XYZ* tristimulus values using the alternative *ASTM E313* method.

In the original form of *Test Method E313*, an alternative equation was recommended for a *yellowness* index. In terms of colorimeter readings, it was $YI = 100(1?B/G)$ where *B* and *G* are, respectively, blue and green colorimeter readings. Its derivation assumed that, because of the limitation of the concept to yellow (or blue) colors, it was not necessary to take account of variations in the amber or red colorimeter reading *A*. This equation is no longer recommended.

Parameters

XYZ (*ArrayLike*) – *CIE XYZ* tristimulus values of the sample.

Returns

Yellowness YI.

Return type

np.floating or numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| YI | [0, 100] | [0, 1] |

- Input *CIE XYZ* tristimulus values must be adapted to *CIE Illuminant C*.

References

[ASTMInternational15b], [XRitePantone12]

Examples

```
>>> XYZ = np.array([95.00000000, 100.00000000, 105.00000000])
>>> yellowness_ASTME313_alternative(XYZ)
11.0650000...
```

colour.colorimetry.YELLOWNESS_COEFFICIENTS_ASTME313

colour.colorimetry.YELLOWNESS_COEFFICIENTS_ASTME313 = CanonicalMapping({'CIE 1931 2 Degree Standard Observer': ..., 'CIE 1964 10 Degree Standard Observer': ..., 'cie_2_1931': ..., 'cie_10_1964': ...})

Coefficients C_X and C_Z for the ASTM E313 yellowness index YI computation method.

References

[ASTMInternational15b]

Aliases:

- 'cie_2_1931': 'CIE 1931 2 Degree Standard Observer'
- 'cie_10_1964': 'CIE 1964 10 Degree Standard Observer'

colour.colorimetry.yellowness_ASTME313

colour.colorimetry.yellowness_ASTME313(*XYZ: ArrayLike, C_XZ: ArrayLike* = YELLOWNESS_COEFFICIENTS_ASTME313['CIE 1931 2 Degree Standard Observer']['D65']) → FloatingOrNDArray

Return the yellowness index YI of given sample CIE XYZ tristimulus values using ASTM E313 method.

ASTM E313 has successfully been used for a variety of white or near white materials. This includes coatings, plastics, textiles.

Parameters

- **XYZ** (ArrayLike) – CIE XYZ tristimulus values of the sample.
- **C_XZ** (ArrayLike) – Coefficients C_X and C_Z for the CIE 1931 2 Degree Standard Observer and CIE 1964 10 Degree Standard Observer and CIE Illuminant C and CIE Standard Illuminant D65.

Returns

Yellowness YI .

Return type

np.floating or numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| YI | [0, 100] | [0, 1] |

References

[ASTMInternational15b]

Examples

```
>>> XYZ = np.array([95.00000000, 100.00000000, 105.00000000])
>>> yellowness_ASTME313(XYZ)
4.3400000...
```

Constants

CIE

`colour.constants`

| | |
|----------------------------|--|
| <code>CONSTANT_K_M</code> | Rounded maximum photopic luminous efficiency K_m value in $lm \cdot W^{-1}$. |
| <code>CONSTANT_KP_M</code> | Rounded maximum scotopic luminous efficiency K'_m value in $lm \cdot W^{-1}$. |

`colour.constants.CONSTANT_K_M`

`colour.constants.CONSTANT_K_M = 683.0`

Rounded maximum photopic luminous efficiency K_m value in $lm \cdot W^{-1}$.

Notes

- To be adequate for all practical applications the K_m value has been rounded from the original 683.002 value.

References

[WS00d]

`colour.constants.CONSTANT_KP_M`

`colour.constants.CONSTANT_KP_M = 1700.0`

Rounded maximum scotopic luminous efficiency K'_m value in $lm \cdot W^{-1}$.

Notes

- To be adequate for all practical applications the K'_m value has been rounded from the original 1700.06 value.

References

[WS00d]

CODATA

`colour.constants`

| | |
|-----------------------------------|---------------------------|
| <code>CONSTANT_AVOGADRO</code> | Avogadro constant. |
| <code>CONSTANT_BOLTZMANN</code> | Boltzmann constant. |
| <code>CONSTANT_LIGHT_SPEED</code> | Speed of light in vacuum. |
| <code>CONSTANT_PLANCK</code> | Planck constant. |

`colour.constants.CONSTANT_AVOGADRO`

`colour.constants.CONSTANT_AVOGADRO = 6.02214179e+23`

Avogadro constant.

`colour.constants.CONSTANT_BOLTZMANN`

`colour.constants.CONSTANT_BOLTZMANN = 1.38065e-23`

Boltzmann constant.

`colour.constants.CONSTANT_LIGHT_SPEED`

`colour.constants.CONSTANT_LIGHT_SPEED = 299792458.0`

Speed of light in vacuum.

colour.constants.CONSTANT_PLANCK

`colour.constants.CONSTANT_PLANCK = 6.62607e-34`

Planck constant.

Common

`colour.constants`

| | |
|--|--|
| <code>DEFAULT_INT_DTYPE</code> | alias of <code>int64</code> |
| <code>DEFAULT_FLOAT_DTYPE</code> | alias of <code>float64</code> |
| <code>EPSILON</code> | Double-precision floating-point number type, compatible with Python <i>float</i> and C <i>double</i> . |
| <code>FLOATING_POINT_NUMBER_PATTERN</code> | <code>str(object="") -> str str(bytes_or_buffer[, encoding[, errors]]) -> str</code> |
| <code>INTEGER_THRESHOLD</code> | Integer threshold value when checking if a floating point number is almost an integer. |

colour.constants.DEFAULT_INT_DTYPE

`colour.constants.DEFAULT_INT_DTYPE`

alias of `int64`

colour.constants.DEFAULT_FLOAT_DTYPE

`colour.constants.DEFAULT_FLOAT_DTYPE`

alias of `float64`

colour.constants.EPSILON

`colour.constants.EPSILON = 2.2204460492503131e-16`

Double-precision floating-point number type, compatible with Python *float* and C *double*.

Character code

`'d'`

Canonical name

`numpy.double`

Alias

`numpy.float_`

Alias on this platform (Linux x86_64)

`numpy.float64`: 64-bit precision floating-point number type: sign bit, 11 bits exponent, 52 bits mantissa.

colour.constants.FLOATING_POINT_NUMBER_PATTERN

```
colour.constants.FLOATING_POINT_NUMBER_PATTERN = '[0-9]*\.\?[0-9]+([eE][-+]?[0-9]+)?'
str(object='') -> str
str(bytes_or_buffer[, encoding[, errors]]) -> str
```

Create a new string object from the given object. If encoding or errors is specified, then the object must expose a data buffer that will be decoded using the given encoding and error handler. Otherwise, returns the result of object.__str__() (if defined) or repr(object). encoding defaults to sys.getdefaultencoding(). errors defaults to 'strict'.

colour.constants.INTEGER_THRESHOLD

```
colour.constants.INTEGER_THRESHOLD = 0.001
```

Integer threshold value when checking if a floating point number is almost an integer.

Contrast Sensitivity

Contrast Sensitivity

colour

| | |
|--|--|
| <code>contrast_sensitivity_function([method])</code> | Return the contrast sensitivity S of the human eye according to the contrast sensitivity function (CSF) described by given method. |
| <code>CONTRAST_SENSITIVITY_METHODS</code> | Supported contrast sensitivity methods. |

colour.contrast_sensitivity_function

```
colour.contrast_sensitivity_function(method: Literal['Barten 1999'] | str = 'Barten 1999',
                                    **kwargs) -> FloatingOrNDArray
```

Return the contrast sensitivity S of the human eye according to the contrast sensitivity function (CSF) described by given method.

Parameters

- **method** (`Literal['Barten 1999'] | str`) – Computation method.
- **E** – `{colour.contrast.contrast_sensitivity_function_Barten1999()}`, Retinal illuminance E in Trolands.
- **k** – `{colour.contrast.contrast_sensitivity_function_Barten1999()}`, Signal-to-noise (SNR) ratio k .
- **n** – `{colour.contrast.contrast_sensitivity_function_Barten1999()}`, Quantum efficiency of the eye n .
- **N_max** – `{colour.contrast.contrast_sensitivity_function_Barten1999()}`, Maximum number of cycles N_{max} over which the eye can integrate the information.
- **p** – `{colour.contrast.contrast_sensitivity_function_Barten1999()}`, Photon conversion factor p in $photons \div seconds \div degrees^2 \div Trolands$ that depends on the light source.
- **phi_0** – `{colour.contrast.contrast_sensitivity_function_Barten1999()}`, Spectral density ϕ_0 in $secondsdegrees^2$ of the neural noise.

- **sigma** – `{colour.contrast.contrast_sensitivity_function_Barten1999()}`, Standard deviation σ of the line-spread function resulting from the convolution of the different elements of the convolution process.
- **T** – `{colour.contrast.contrast_sensitivity_function_Barten1999()}`, Integration time T in seconds of the eye.
- **u** – `{colour.contrast.contrast_sensitivity_function_Barten1999()}`, Spatial frequency u , the cycles per degree.
- **u_0** – `{colour.contrast.contrast_sensitivity_function_Barten1999()}`, Spatial frequency u_0 in *cycles ÷ degrees* above which the lateral inhibition ceases.
- **X_0** – `{colour.contrast.contrast_sensitivity_function_Barten1999()}`, Angular size X_0 in degrees of the object in the x direction.
- **Y_0** – `{colour.contrast.contrast_sensitivity_function_Barten1999()}`, Angular size Y_0 in degrees of the object in the y direction.
- **X_max** – `{colour.contrast.contrast_sensitivity_function_Barten1999()}`, Maximum angular size X_{max} in degrees of the integration area in the x direction.
- **Y_max** – `{colour.contrast.contrast_sensitivity_function_Barten1999()}`, Maximum angular size Y_{max} in degrees of the integration area in the y direction.

ReturnsContrast sensitivity S .**Return type**`numpy.floating` or `numpy.ndarray`**References**

[Bar99], [Bar03], [CKMW04], [InternationalTUnion15c],

Examples

```
>>> contrast_sensitivity_function(u=4)
360.8691122...
>>> contrast_sensitivity_function("Barten 1999", u=4)
360.8691122...
```

colour.CONTRAST_SENSITIVITY_METHODS

```
colour.CONTRAST_SENSITIVITY_METHODS = CanonicalMapping({'Barten 1999': ...})
```

Supported contrast sensitivity methods.

References

[Bar99], [Bar03], [CKMW04], [InternationalTUnion15c],

Barten (1999) Contrast Sensitivity Function

`colour.contrast`

| | |
|--|---|
| <code>contrast_sensitivity_function_Barten1999(u)</code> | Return the contrast sensitivity S of the human eye according to the contrast sensitivity function (CSF) described by <i>Barten (1999)</i> . |
|--|---|

`colour.contrast.contrast_sensitivity_function_Barten1999`

`colour.contrast.contrast_sensitivity_function_Barten1999`(*u*: *FloatingOrArrayLike*, *sigma*: *FloatingOrArrayLike* = *sigma_Barten1999*(0.5 / 60, 0.08 / 60, 2.1), *k*: *FloatingOrArrayLike* = 3.0, *T*: *FloatingOrArrayLike* = 0.1, *X_0*: *FloatingOrArrayLike* = 60, *Y_0*: *FloatingOrArrayLike* | *None* = *None*, *X_max*: *FloatingOrArrayLike* = 12, *Y_max*: *FloatingOrArrayLike* | *None* = *None*, *N_max*: *FloatingOrArrayLike* = 15, *n*: *FloatingOrArrayLike* = 0.03, *p*: *FloatingOrArrayLike* = 1.2274 * 10**6, *E*: *FloatingOrArrayLike* = *retinal_illuminance_Barten1999*(20, 2.1), *phi_0*: *FloatingOrArrayLike* = 3 * 10**-8, *u_0*: *FloatingOrArrayLike* = 7) → *FloatingOrNDArray*

Return the contrast sensitivity S of the human eye according to the contrast sensitivity function (CSF) described by *Barten (1999)*.

Contrast sensitivity is defined as the inverse of the modulation threshold of a sinusoidal luminance pattern. The modulation threshold of this pattern is generally defined by 50% probability of detection. The contrast sensitivity function or CSF gives the contrast sensitivity as a function of spatial frequency. In the CSF, the spatial frequency is expressed in angular units with respect to the eye. It reaches a maximum between 1 and 10 cycles per degree with a fall off at higher and lower spatial frequencies.

Parameters

- **u** (*FloatingOrArrayLike*) – Spatial frequency u , the cycles per degree.
- **sigma** (*FloatingOrArrayLike*) – Standard deviation σ of the line-spread function resulting from the convolution of the different elements of the convolution process.
- **k** (*FloatingOrArrayLike*) – Signal-to-noise (SNR) ratio k .
- **T** (*FloatingOrArrayLike*) – Integration time T in seconds of the eye.
- **X_0** (*FloatingOrArrayLike*) – Angular size X_0 in degrees of the object in the x direction.
- **Y_0** (*FloatingOrArrayLike* | *None*) – Angular size Y_0 in degrees of the object in the y direction.

- **X_max** (FloatingOrArrayLike) – Maximum angular size X_{max} in degrees of the integration area in the x direction.
- **Y_max** (FloatingOrArrayLike | None) – Maximum angular size Y_{max} in degrees of the integration area in the y direction.
- **N_max** (FloatingOrArrayLike) – Maximum number of cycles N_{max} over which the eye can integrate the information.
- **n** (FloatingOrArrayLike) – Quantum efficiency of the eye n .
- **p** (FloatingOrArrayLike) – Photon conversion factor p in $photons \div seconds \div degrees^2 \div Trolands$ that depends on the light source.
- **E** (FloatingOrArrayLike) – Retinal illuminance E in Trolands.
- **phi_0** (FloatingOrArrayLike) – Spectral density ϕ_0 in $secondsdegrees^2$ of the neural noise.
- **u_0** (FloatingOrArrayLike) – Spatial frequency u_0 in $cycles \div degrees$ above which the lateral inhibition ceases.

Returns

Contrast sensitivity S .

Return type

`numpy.float64` or `numpy.ndarray`

Warning: This definition expects σ_0 and C_{ab} used in the computation of σ to be given in degrees and $degrees \div mm$ respectively. However, in the literature, the values for σ_0 and C_{ab} are usually given in $arcmin$ and $arcmin \div mm$ respectively, thus they need to be divided by 60.

Notes

- The formula holds for bilateral viewing and for equal dimensions of the object in x and y direction. For monocular vision, the contrast sensitivity is a factor $\sqrt{2}$ smaller.
- *Barten (1999)* CSF default values for the k , σ_0 , C_{ab} , T , X_{max} , N_{max} , n , ϕ_0 and u_0 constants are valid for a standard observer with good vision and with an age between 20 and 30 years.
- The other constants have been filled using reference data from *Figure 31* in [InternationalTUnion15c] but must be adapted to the current use case.
- The product of u , the cycles per degree, and X_0 , the number of degrees, gives the number of cycles P_c in a pattern. Therefore, X_0 can be made a variable dependent on u such as $X_0 = P_c/u$.

References

[Bar99], [Bar03], [CKMW04], [InternationalTUnion15c],

Examples

```
>>> contrast_sensitivity_function_Barten1999(4)
360.8691122...
```

Reproducing *Figure 31* in [InternationalUnion15c] illustrating the minimum detectable contrast according to *Barten (1999)* model with the assumed conditions for UHDTV applications. The minimum detectable contrast *MDC* is then defined as follows:

```
:math:`MDC = 1 / CSF * 2 * (1 / 1.27)`
```

where 2 is used for the conversion from modulation to contrast and 1/1.27 is used for the conversion from sinusoidal to rectangular waves.

```
>>> from scipy.optimize import fmin
>>> settings_BT2246 = {
...     "k": 3.0,
...     "T": 0.1,
...     "X_max": 12,
...     "N_max": 15,
...     "n": 0.03,
...     "p": 1.2274 * 10**6,
...     "phi_0": 3 * 10**-8,
...     "u_0": 7,
... }
>>>
>>> def maximise_spatial_frequency(L):
...     maximised_spatial_frequency = []
...     for L_v in L:
...         X_0 = 60
...         d = pupil_diameter_Barten1999(L_v, X_0)
...         sigma = sigma_Barten1999(0.5 / 60, 0.08 / 60, d)
...         E = retinal_illuminance_Barten1999(L_v, d, True)
...         maximised_spatial_frequency.append(
...             fmin(
...                 lambda x: (
...                     -contrast_sensitivity_function_Barten1999(
...                         u=x,
...                         sigma=sigma,
...                         X_0=X_0,
...                         E=E,
...                         **settings_BT2246
...                     )
...                 ),
...                 0,
...                 disp=False,
...             )[0]
...         )
...     return as_float(np.array(maximised_spatial_frequency))
>>>
>>> L = np.logspace(np.log10(0.01), np.log10(100), 10)
>>> X_0 = Y_0 = 60
>>> d = pupil_diameter_Barten1999(L, X_0, Y_0)
>>> sigma = sigma_Barten1999(0.5 / 60, 0.08 / 60, d)
>>> E = retinal_illuminance_Barten1999(L, d)
>>> u = maximise_spatial_frequency(L)
```

(continues on next page)

(continued from previous page)

```
>>> (
...     1
...     / contrast_sensitivity_function_Barten1999(
...         u=u, sigma=sigma, E=E, X_0=X_0, Y_0=Y_0, **settings_BT2246
...     )
...     * 2
...     * (1 / 1.27)
... )
...
array([ 0.0218764...,  0.0141848...,  0.0095244...,  0.0066805...,  0.0049246...,
        0.0038228...,  0.0031188...,  0.0026627...,  0.0023674...,  0.0021814...])
```

Ancillary Objects

`colour.contrast`

| | |
|---|---|
| <code>optical_MTF_Barten1999(u[, sigma])</code> | Return the optical modulation transfer function (MTF) M_{opt} of the eye using <i>Barten (1999)</i> method. |
| <code>pupil_diameter_Barten1999(L[, X_0, Y_0])</code> | Return the pupil diameter for given luminance and object or stimulus angular size using <i>Barten (1999)</i> method. |
| <code>sigma_Barten1999([sigma_0, C_ab, d])</code> | Return the standard deviation σ of the line-spread function resulting from the convolution of the different elements of the convolution process using <i>Barten (1999)</i> method. |
| <code>retinal_illuminance_Barten1999(L[, d, ...])</code> | Return the retinal illuminance E in Trolands for given average luminance L and pupil diameter d using <i>Barten (1999)</i> method. |
| <code>maximum_angular_size_Barten1999(u[, X_0, ...])</code> | Return the maximum angular size X of the object considered using <i>Barten (1999)</i> method. |

`colour.contrast.optical_MTF_Barten1999`

`colour.contrast.optical_MTF_Barten1999(u: FloatingOrArrayLike, sigma: FloatingOrArrayLike = 0.01) → FloatingOrNDArray`

Return the optical modulation transfer function (MTF) M_{opt} of the eye using *Barten (1999)* method.

Parameters

- **u** (FloatingOrArrayLike) – Spatial frequency u , the cycles per degree.
- **sigma** (FloatingOrArrayLike) – Standard deviation σ of the line-spread function resulting from the convolution of the different elements of the convolution process.

Returns

Optical modulation transfer function (MTF) M_{opt} of the eye.

Return type

`numpy.floating` or `numpy.ndarray`

References

[Bar99], [Bar03], [CKMW04], [InternationalTUnion15c],

Examples

```
>>> optical_MTF_Barten1999(4, 0.01)
0.9689107...
```

colour.contrast.pupil_diameter_Barten1999

`colour.contrast.pupil_diameter_Barten1999`(*L*: *FloatingOrArrayLike*, *X_0*: *FloatingOrArrayLike* = 60, *Y_0*: *FloatingOrArrayLike* | *None* = *None*) → *FloatingOrNDArray*

Return the pupil diameter for given luminance and object or stimulus angular size using *Barten (1999)* method.

Parameters

- **L** (*FloatingOrArrayLike*) – Average luminance L in cd/m^2 .
- **X_0** (*FloatingOrArrayLike*) – Angular size of the object X_0 in degrees in the x direction.
- **Y_0** (*FloatingOrArrayLike* | *None*) – Angular size of the object X_0 in degrees in the y direction.

Returns

Pupil diameter.

Return type

`numpy.floating` or `numpy.ndarray`

References

[Bar99], [Bar03], [CKMW04], [InternationalTUnion15c], [WY12]

Notes

- The *Log* function is using base 10 as indicated by [WY12].

Examples

```
>>> pupil_diameter_Barten1999(100, 60, 60)
2.7931307...
```


colour.contrast.sigma_Barten1999

```
colour.contrast.sigma_Barten1999(sigma_0: FloatingOrArrayLike = 0.5 / 60, C_ab:
    FloatingOrArrayLike = 0.08 / 60, d: FloatingOrArrayLike = 2.1)
    → FloatingOrNDArray
```

Return the standard deviation σ of the line-spread function resulting from the convolution of the different elements of the convolution process using *Barten (1999)* method.

The σ quantity depends on the pupil diameter d of the eye lens. For very small pupil diameters, σ increases inversely proportionally with pupil size because of diffraction, and for large pupil diameters, σ increases about linearly with pupil size because of chromatic aberration and others aberrations.

Parameters

- **sigma_0** (FloatingOrArrayLike) – Constant σ_0 in degrees.
- **C_ab** (FloatingOrArrayLike) – Spherical aberration of the eye C_{ab} in *degrees ÷ mm*.
- **d** (FloatingOrArrayLike) – Pupil diameter d in millimeters.

Returns

Standard deviation σ of the line-spread function resulting from the convolution of the different elements of the convolution process.

Return type

`numpy.float64` or `numpy.ndarray`

Warning: This definition expects σ_0 and C_{ab} to be given in degrees and *degrees ÷ mm* respectively. However, in the literature, the values for σ_0 and C_{ab} are usually given in *arcmin* and *arcmin ÷ mm* respectively, thus they need to be divided by 60.

References

[Bar99], [Bar03], [CKMW04], [InternationalTUnion15c],

Examples

```
>>> sigma_Barten1999(0.5 / 60, 0.08 / 60, 2.1)
0.0087911...
```

colour.contrast.retinal_illuminance_Barten1999

```
colour.contrast.retinal_illuminance_Barten1999(L: FloatingOrArrayLike, d: FloatingOrArrayLike =
    2.1, apply_stiles_crawford_effect_correction: bool
    = True) → FloatingOrNDArray
```

Return the retinal illuminance E in Trolands for given average luminance L and pupil diameter d using *Barten (1999)* method.

Parameters

- **L** (FloatingOrArrayLike) – Average luminance L in cd/m^2 .
- **d** (FloatingOrArrayLike) – Pupil diameter d in millimeters.
- **apply_stiles_crawford_effect_correction** (bool) – Whether to apply the correction for *Stiles-Crawford* effect.

Returns

Retinal illuminance E in Trolands.

Return type

`numpy.float64` or `numpy.ndarray`

Notes

- This definition is for use with photopic viewing conditions and thus corrects for the Stiles-Crawford effect by default, i.e. directional sensitivity of the cone cells with lower response of cone cells receiving light from the edge of the pupil.

References

[Bar99], [Bar03], [CKMW04], [InternationalTUnion15c],

Examples

```
>>> retinal_illuminance_Barten1999(100, 2.1)
330.4115803...
>>> retinal_illuminance_Barten1999(100, 2.1, False)
346.3605900...
```

colour.contrast.maximum_angular_size_Barten1999

`colour.contrast.maximum_angular_size_Barten1999`(*u*: *FloatingOrArrayLike*, *X_0*: *FloatingOrArrayLike* = 60, *X_max*: *FloatingOrArrayLike* = 12, *N_max*: *FloatingOrArrayLike* = 15) → *FloatingOrNDArray*

Return the maximum angular size X of the object considered using *Barten (1999)* method.

Parameters

- **u** (*FloatingOrArrayLike*) – Spatial frequency u , the cycles per degree.
- **X_0** (*FloatingOrArrayLike*) – Angular size X_0 in degrees of the object in the x direction.
- **X_max** (*FloatingOrArrayLike*) – Maximum angular size X_{max} in degrees of the integration area in the x direction.
- **N_max** (*FloatingOrArrayLike*) – Maximum number of cycles N_{max} over which the eye can integrate the information.

Returns

Maximum angular size X of the object considered.

Return type

`numpy.float64` or `numpy.ndarray`

References

[Bar99], [Bar03], [CKMW04], [InternationalTUnion15c],

Examples

```
>>> maximum_angular_size_Barten1999(4)
3.5729480...
```

Continuous Signal

Continuous Signal

`colour.continuous`

| | |
|---|---|
| <code>AbstractContinuousFunction([name])</code> | Define the base class for abstract continuous function. |
| <code>Signal(data, domain, **kwargs)</code> | Define the base class for continuous signal. |
| <code>MultiSignals(data, domain, labels, **kwargs)</code> | Define the base class for multi-continuous signals, a container for multiple <code>colour.continuous.Signal</code> sub-class instances. |

`colour.continuous.AbstractContinuousFunction`

class `colour.continuous.AbstractContinuousFunction(name: str | None = None)`

Bases: `ABC`

Define the base class for abstract continuous function.

This is an ABCMeta abstract class that must be inherited by sub-classes.

The sub-classes are expected to implement the `colour.continuous.AbstractContinuousFunction.function()` method so that evaluating the function for any independent domain variable $x \in \mathbb{R}$ returns a corresponding range variable $y \in \mathbb{R}$. A conventional implementation adopts an interpolating function encapsulated inside an extrapolating function. The resulting function independent domain, stored as discrete values in the `colour.continuous.AbstractContinuousFunction.domain` attribute corresponds with the function dependent and already known range stored in the `colour.continuous.AbstractContinuousFunction.range` property.

Parameters

name (Optional[str]) – Continuous function name.

Attributes

- `name`
- `dtype`
- `domain`
- `range`
- `interpolator`
- `interpolator_kwargs`
- `extrapolator`

- `extrapolator_kwargs`
- `function`

Methods

- `__init__()`
- `__str__()`
- `__repr__()`
- `__hash__()`
- `__getitem__()`
- `__setitem__()`
- `__contains__()`
- `__len__()`
- `__eq__()`
- `__ne__()`
- `__iadd__()`
- `__add__()`
- `__isub__()`
- `__sub__()`
- `__imul__()`
- `__mul__()`
- `__idiv__()`
- `__div__()`
- `__ipow__()`
- `__pow__()`
- `arithmetical_operation()`
- `fill_nan()`
- `domain_distance()`
- `is_uniform()`
- `copy()`

`__init__(name: str | None = None) → None`

Parameters

name (*str* | *None*) –

Return type

None

property name: *str*

Getter and setter property for the abstract continuous function name.

Parameters

value – Value to set the abstract continuous function name with.

Returns

Abstract continuous function name.

Return type`str`**abstract property dtype:** `Type[DTypeFloating]`

Getter and setter property for the abstract continuous function dtype, must be reimplemented by sub-classes.

Parameters

value – Value to set the abstract continuous function dtype with.

Returns

Abstract continuous function dtype.

Return type`Type[DTypeFloating]`**abstract property domain:** `ndarray`

Getter and setter property for the abstract continuous function independent domain variable x , must be reimplemented by sub-classes.

Parameters

value – Value to set the abstract continuous function independent domain variable x with.

Returns

Abstract continuous function independent domain variable x .

Return type`numpy.ndarray`**abstract property range:** `ndarray`

Getter and setter property for the abstract continuous function corresponding range variable y , must be reimplemented by sub-classes.

Parameters

value – Value to set the abstract continuous function corresponding range variable y with.

Returns

Abstract continuous function corresponding range variable y .

Return type`numpy.ndarray`**abstract property interpolator:** `Type[TypeInterpolator]`

Getter and setter property for the abstract continuous function interpolator type, must be reimplemented by sub-classes.

Parameters

value – Value to set the abstract continuous function interpolator type with.

Returns

Abstract continuous function interpolator type.

Return type`Type[TypeInterpolator]`**abstract property interpolator_kwargs:** `Dict`

Getter and setter property for the abstract continuous function interpolator instantiation time arguments, must be reimplemented by sub-classes.

Parameters

value – Value to set the abstract continuous function interpolator instantiation time arguments to.

Returns

Abstract continuous function interpolator instantiation time arguments.

Return type

`dict`

abstract property extrapolator: `Type[TypeExtrapolator]`

Getter and setter property for the abstract continuous function extrapolator type, must be reimplemented by sub-classes.

Parameters

value – Value to set the abstract continuous function extrapolator type with.

Returns

Abstract continuous function extrapolator type.

Return type

`Type[TypeExtrapolator]`

abstract property extrapolator_kwargs: `Dict`

Getter and setter property for the abstract continuous function extrapolator instantiation time arguments, must be reimplemented by sub-classes.

Parameters

value – Value to set the abstract continuous function extrapolator instantiation time arguments to.

Returns

Abstract continuous function extrapolator instantiation time arguments.

Return type

`dict`

abstract property function: `Callable`

Getter property for the abstract continuous function callable, must be reimplemented by sub-classes.

Returns

Abstract continuous function callable.

Return type

`Callable`

abstract __str__() → `str`

Return a formatted string representation of the abstract continuous function, must be reimplemented by sub-classes.

Returns

Formatted string representation.

Return type

`str`

abstract __repr__() → `str`

Return an evaluable string representation of the abstract continuous function, must be reimplemented by sub-classes.

Returns

Evaluable string representation.

Return type

`str`

abstract __hash__() → `int`

Return the abstract continuous function hash.

Returns

Object hash.

Return type

`numpy.integer`

abstract `__getitem__(x: FloatingOrArrayLike | slice) → FloatingOrNDArray`

Return the corresponding range variable y for independent domain variable x , must be reimplemented by sub-classes.

Parameters

x (FloatingOrArrayLike | slice) – Independent domain variable x .

Returns

Variable y range value.

Return type

`numpy.floating` or `numpy.ndarray`

abstract `__setitem__(x: FloatingOrArrayLike | slice, y: FloatingOrArrayLike)`

Set the corresponding range variable y for independent domain variable x , must be reimplemented by sub-classes.

Parameters

- x (FloatingOrArrayLike | slice) – Independent domain variable x .
- y (FloatingOrArrayLike) – Corresponding range variable y .

abstract `__contains__(x: FloatingOrArrayLike | slice) → bool`

Return whether the abstract continuous function contains given independent domain variable x , must be reimplemented by sub-classes.

Parameters

x (FloatingOrArrayLike | slice) – Independent domain variable x .

Returns

Whether x domain value is contained.

Return type

`bool`

`__len__() → int`

Return the abstract continuous function independent domain x variable elements count.

Returns

Independent domain variable x elements count.

Return type

`numpy.integer`

abstract `__eq__(other: Any) → bool`

Return whether the abstract continuous function is equal to given other object, must be reimplemented by sub-classes.

Parameters

other (Any) – Object to test whether it is equal to the abstract continuous function.

Returns

Whether given object is equal to the abstract continuous function.

Return type

`bool`

abstract `__ne__(other: Any) → bool`

Return whether the abstract continuous function is not equal to given other object, must be reimplemented by sub-classes.

Parameters

other (*Any*) – Object to test whether it is not equal to the abstract continuous function.

Returns

Whether given object is not equal to the abstract continuous function.

Return type

`bool`

__add__(*a: FloatingOrArrayLike | AbstractContinuousFunction*) → *AbstractContinuousFunction*

Implement support for addition.

Parameters

a (*FloatingOrArrayLike | AbstractContinuousFunction*) – Variable *a* to add.

Returns

Variable added abstract continuous function.

Return type

`colour.continuous.AbstractContinuousFunction`

__iadd__(*a: FloatingOrArrayLike | AbstractContinuousFunction*) → *AbstractContinuousFunction*

Implement support for in-place addition.

Parameters

a (*FloatingOrArrayLike | AbstractContinuousFunction*) – Variable *a* to add in-place.

Returns

In-place variable added abstract continuous function.

Return type

`colour.continuous.AbstractContinuousFunction`

__sub__(*a: FloatingOrArrayLike | AbstractContinuousFunction*) → *AbstractContinuousFunction*

Implement support for subtraction.

Parameters

a (*FloatingOrArrayLike | AbstractContinuousFunction*) – Variable *a* to subtract.

Returns

Variable subtracted abstract continuous function.

Return type

`colour.continuous.AbstractContinuousFunction`

__isub__(*a: FloatingOrArrayLike | AbstractContinuousFunction*) → *AbstractContinuousFunction*

Implement support for in-place subtraction.

Parameters

a (*FloatingOrArrayLike | AbstractContinuousFunction*) – Variable *a* to subtract in-place.

Returns

In-place variable subtracted abstract continuous function.

Return type

`colour.continuous.AbstractContinuousFunction`

__mul__(*a: FloatingOrArrayLike | AbstractContinuousFunction*) → *AbstractContinuousFunction*

Implement support for multiplication.

Parameters

a (*FloatingOrArrayLike | AbstractContinuousFunction*) – Variable *a* to multiply by.

Returns

Variable multiplied abstract continuous function.

Return type

`colour.continuous.AbstractContinuousFunction`

`--imul__`(*a*: *FloatingOrArrayLike* | *AbstractContinuousFunction*) → *AbstractContinuousFunction*

Implement support for in-place multiplication.

Parameters

a (*FloatingOrArrayLike* | *AbstractContinuousFunction*) – Variable *a* to multiply by in-place.

Returns

In-place variable multiplied abstract continuous function.

Return type

`colour.continuous.AbstractContinuousFunction`

`--div__`(*a*: *FloatingOrArrayLike* | *AbstractContinuousFunction*) → *AbstractContinuousFunction*

Implement support for division.

Parameters

a (*FloatingOrArrayLike* | *AbstractContinuousFunction*) – Variable *a* to divide by.

Returns

Variable divided abstract continuous function.

Return type

`colour.continuous.AbstractContinuousFunction`

`--idiv__`(*a*: *FloatingOrArrayLike* | *AbstractContinuousFunction*) → *AbstractContinuousFunction*

Implement support for in-place division.

Parameters

a (*FloatingOrArrayLike* | *AbstractContinuousFunction*) – Variable *a* to divide by in-place.

Returns

In-place variable divided abstract continuous function.

Return type

`colour.continuous.AbstractContinuousFunction`

`--itruediv__`(*a*: *FloatingOrArrayLike* | *AbstractContinuousFunction*) → *AbstractContinuousFunction*

Implement support for in-place division.

Parameters

a (*FloatingOrArrayLike* | *AbstractContinuousFunction*) – Variable *a* to divide by in-place.

Returns

In-place variable divided abstract continuous function.

Return type

`colour.continuous.AbstractContinuousFunction`

`--weakref__`

list of weak references to the object (if defined)

`--truediv__`(*a*: *FloatingOrArrayLike* | *AbstractContinuousFunction*) → *AbstractContinuousFunction*

Implement support for division.

Parameters

a (*FloatingOrArrayLike* | *AbstractContinuousFunction*) – Variable *a* to divide by.

Returns

Variable divided abstract continuous function.

Return type

colour.continuous.AbstractContinuousFunction

__pow__(*a: FloatingOrArrayLike* | *AbstractContinuousFunction*) → *AbstractContinuousFunction*

Implement support for exponentiation.

Parameters

a (*FloatingOrArrayLike* | *AbstractContinuousFunction*) – Variable *a* to exponentiate by.

Returns

Variable exponentiated abstract continuous function.

Return type

colour.continuous.AbstractContinuousFunction

__ipow__(*a: FloatingOrArrayLike* | *AbstractContinuousFunction*) → *AbstractContinuousFunction*

Implement support for in-place exponentiation.

Parameters

a (*FloatingOrArrayLike* | *AbstractContinuousFunction*) – Variable *a* to exponentiate by in-place.

Returns

In-place variable exponentiated abstract continuous function.

Return type

colour.continuous.AbstractContinuousFunction

abstract arithmetical_operation(*a: FloatingOrArrayLike* | *AbstractContinuousFunction*,
operation: Literal['+', '-', '', '/', '**']*, *in_place: bool = False*)
→ *AbstractContinuousFunction*

Perform given arithmetical operation with operand *a*, the operation can be either performed on a copy or in-place, must be reimplemented by sub-classes.

Parameters

- **a** (*FloatingOrArrayLike* | *AbstractContinuousFunction*) – Operand *a*.
- **operation** (*Literal['+', '-', '*', '/', '**']*) – Operation to perform.
- **in_place** (*bool*) – Operation happens in place.

Returns

Abstract continuous function.

Return type

colour.continuous.AbstractContinuousFunction

abstract fill_nan(*method: Literal['Interpolation', 'Constant']* | *str = 'Interpolation'*, *default: Number = 0*) → *AbstractContinuousFunction*

Fill NaNs in independent domain variable *x* and corresponding range variable *y* using given method, must be reimplemented by sub-classes.

Parameters

- **method** (*Literal['Interpolation', 'Constant']* | *str*) – *Interpolation* method linearly interpolates through the NaNs, *Constant* method replaces NaNs with default.
- **default** (*Number*) – Value to use with the *Constant* method.

Returns

NaNs filled abstract continuous function.

Return type

`colour.continuous.AbstractContinuousFunction`

domain_distance(*a*: *FloatingOrArrayLike*) → *FloatingOrNDArray*

Return the euclidean distance between given array and independent domain *x* closest element.

Parameters

a (*FloatingOrArrayLike*) – Variable *a* to compute the euclidean distance with independent domain variable *x*.

Returns

Euclidean distance between independent domain variable *x* and given variable *a*.

Return type

`numpy.floating` or `numpy.ndarray`

is_uniform() → *bool*

Return if independent domain variable *x* is uniform.

Returns

Is independent domain variable *x* uniform.

Return type

bool

copy() → *AbstractContinuousFunction*

Return a copy of the sub-class instance.

Returns

Abstract continuous function copy.

Return type

`colour.continuous.AbstractContinuousFunction`

`colour.continuous.Signal`

```
class colour.continuous.Signal(data: ArrayLike | dict | <MagicMock id='139666560192912'> |
    ~colour.continuous.signal.Signal | None = None, domain: ArrayLike
    | None = None, **kwargs: ~typing.Any)
```

Bases: *AbstractContinuousFunction*

Define the base class for continuous signal.

The class implements the `Signal.function()` method so that evaluating the function for any independent domain variable $x \in \mathbb{R}$ returns a corresponding range variable $y \in \mathbb{R}$. It adopts an interpolating function encapsulated inside an extrapolating function. The resulting function independent domain, stored as discrete values in the `colour.continuous.Signal.domain` property corresponds with the function dependent and already known range stored in the `colour.continuous.Signal.range` property.

Important: Specific documentation about getting, setting, indexing and slicing the continuous signal values is available in the *Spectral Representation and Continuous Signal* section.

Parameters

- **data** (Optional[Union[ArrayLike, dict, Series, Signal]]) – Data to be stored in the continuous signal.

- **domain** (Optional[ArrayLike]) – Values to initialise the `colour.continuous.Signal.domain` attribute with. If both data and domain arguments are defined, the latter will be used to initialise the `colour.continuous.Signal.domain` property.
- **dtype** – Floating point data type.
- **extrapolator** – Extrapolator class type to use as extrapolating function.
- **extrapolator_kwargs** – Arguments to use when instantiating the extrapolating function.
- **interpolator** – Interpolator class type to use as interpolating function.
- **interpolator_kwargs** – Arguments to use when instantiating the interpolating function.
- **name** – Continuous signal name.
- **kwargs** (Any) –

Attributes

- dtype
- domain
- range
- interpolator
- interpolator_kwargs
- extrapolator
- extrapolator_kwargs
- function

Methods

- `__init__()`
- `__str__()`
- `__repr__()`
- `__hash__()`
- `__getitem__()`
- `__setitem__()`
- `__contains__()`
- `__eq__()`
- `__ne__()`
- `arithmetical_operation()`
- `signal_unpack_data()`
- `fill_nan()`
- `to_series()`

Examples

Instantiation with implicit *domain*:

```
>>> range_ = np.linspace(10, 100, 10)
>>> print(Signal(range_))
[[ 0.  10.]
 [ 1.  20.]
 [ 2.  30.]
 [ 3.  40.]
 [ 4.  50.]
 [ 5.  60.]
 [ 6.  70.]
 [ 7.  80.]
 [ 8.  90.]
 [ 9. 100.]]
```

Instantiation with explicit *domain*:

```
>>> domain = np.arange(100, 1100, 100)
>>> print(Signal(range_, domain))
[[ 100.  10.]
 [ 200.  20.]
 [ 300.  30.]
 [ 400.  40.]
 [ 500.  50.]
 [ 600.  60.]
 [ 700.  70.]
 [ 800.  80.]
 [ 900.  90.]
 [1000. 100.]]
```

Instantiation with a *dict*:

```
>>> print(Signal(dict(zip(domain, range_))))
[[ 100.  10.]
 [ 200.  20.]
 [ 300.  30.]
 [ 400.  40.]
 [ 500.  50.]
 [ 600.  60.]
 [ 700.  70.]
 [ 800.  80.]
 [ 900.  90.]
 [1000. 100.]]
```

Instantiation with a *Pandas pandas.Series*:

```
>>> if is_pandas_installed():
...     from pandas import Series
...     print(Signal(Series(dict(zip(domain, range_)))))
...
[[ 100.  10.]
 [ 200.  20.]
 [ 300.  30.]
 [ 400.  40.]
 [ 500.  50.]
```

(continues on next page)

(continued from previous page)

```
[ 600.  60.]
[ 700.  70.]
[ 800.  80.]
[ 900.  90.]
[1000. 100.]
```

Retrieving domain y variable for arbitrary range x variable:

```
>>> x = 150
>>> range_ = np.sin(np.linspace(0, 1, 10))
>>> Signal(range_, domain)[x]
0.0359701...
>>> x = np.linspace(100, 1000, 3)
>>> Signal(range_, domain)[x]
array([ ...,  4.7669395...e-01,  8.4147098...e-01])
```

Using an alternative interpolating function:

```
>>> x = 150
>>> from colour.algebra import CubicSplineInterpolator
>>> Signal(range_, domain, interpolator=CubicSplineInterpolator)[
...     x
... ]
0.0555274...
>>> x = np.linspace(100, 1000, 3)
>>> Signal(range_, domain, interpolator=CubicSplineInterpolator)[
...     x
... ]
array([ 0.          ,  0.4794253...,  0.8414709...])
```

```
__init__(data: ArrayLike | dict | <MagicMock id='139666560192912'> |
~colour.continuous.signal.Signal | None = None, domain: ArrayLike | None = None,
**kwargs: ~typing.Any) → None
```

Parameters

- **data** (ArrayLike | dict | <MagicMock id='139666560192912'> | Signal | None) –
- **domain** (ArrayLike | None) –
- **kwargs** (Any) –

Return type

None

property dtype: Type[DTypeFloating]

Getter and setter property for the continuous signal dtype.

Parameters

value – Value to set the continuous signal dtype with.

Returns

Continuous signal dtype.

Return type

DTypeFloating

property domain: ndarray

Getter and setter property for the continuous signal independent domain variable x .

Parameters

value – Value to set the continuous signal independent domain variable x with.

Returns

Continuous signal independent domain variable x .

Return type

`numpy.ndarray`

property range: `ndarray`

Getter and setter property for the continuous signal corresponding range variable y .

Parameters

value – Value to set the continuous signal corresponding range y variable with.

Returns

Continuous signal corresponding range variable y .

Return type

`numpy.ndarray`

property interpolator: `Type[TypeInterpolator]`

Getter and setter property for the continuous signal interpolator type.

Parameters

value – Value to set the continuous signal interpolator type with.

Returns

Continuous signal interpolator type.

Return type

`Type[TypeInterpolator]`

property interpolator_kwargs: `Dict`

Getter and setter property for the continuous signal interpolator instantiation time arguments.

Parameters

value – Value to set the continuous signal interpolator instantiation time arguments to.

Returns

Continuous signal interpolator instantiation time arguments.

Return type

`dict`

property extrapolator: `Type[TypeExtrapolator]`

Getter and setter property for the continuous signal extrapolator type.

Parameters

value – Value to set the continuous signal extrapolator type with.

Returns

Continuous signal extrapolator type.

Return type

`Type[TypeExtrapolator]`

property extrapolator_kwargs: `Dict`

Getter and setter property for the continuous signal extrapolator instantiation time arguments.

Parameters

value – Value to set the continuous signal extrapolator instantiation time arguments to.

Returns

Continuous signal extrapolator instantiation time arguments.

Return type`dict`**property function:** `Callable`

Getter property for the continuous signal callable.

Returns

Continuous signal callable.

Return type`Callable``__str__()` → `str`

Return a formatted string representation of the continuous signal.

Returns

Formatted string representation.

Return type`str`**Examples**

```
>>> range_ = np.linspace(10, 100, 10)
>>> print(Signal(range_))
[[ 0.  10.]
 [ 1.  20.]
 [ 2.  30.]
 [ 3.  40.]
 [ 4.  50.]
 [ 5.  60.]
 [ 6.  70.]
 [ 7.  80.]
 [ 8.  90.]
 [ 9. 100.]]
```

`__repr__()` → `str`

Return an evaluable string representation of the continuous signal.

Returns

Evaluable string representation.

Return type`str`**Examples**

```
>>> range_ = np.linspace(10, 100, 10)
>>> Signal(range_)
Signal([[ 0.,  10.],
        [ 1.,  20.],
        [ 2.,  30.],
        [ 3.,  40.],
        [ 4.,  50.],
        [ 5.,  60.],
        [ 6.,  70.],
        [ 7.,  80.],
        [ 8.,  90.]
```

(continues on next page)

(continued from previous page)

```
[ 9., 100.]],
KernelInterpolator,
{},
Extrapolator,
{'method': 'Constant', 'left': nan, 'right': nan})
```

__hash__() → `int`

Return the abstract continuous function hash.

Returns

Object hash.

Return type`numpy.integer`**__getitem__**(*x*: *FloatingOrArrayLike* | *slice*) → *FloatingOrNDArray*Return the corresponding range variable *y* for independent domain variable *x*.**Parameters***x* (*FloatingOrArrayLike* | *slice*) – Independent domain variable *x*.**Returns**Variable *y* range value.**Return type**`numpy.floating` or `numpy.ndarray`**Examples**

```
>>> range_ = np.linspace(10, 100, 10)
>>> signal = Signal(range_)
>>> print(signal)
[[ 0.  10.]
 [ 1.  20.]
 [ 2.  30.]
 [ 3.  40.]
 [ 4.  50.]
 [ 5.  60.]
 [ 6.  70.]
 [ 7.  80.]
 [ 8.  90.]
 [ 9. 100.]]
>>> signal[0]
10.0
>>> signal[np.array([0, 1, 2])]
array([ 10.,  20.,  30.])
>>> signal[0:3]
array([ 10.,  20.,  30.])
>>> signal[np.linspace(0, 5, 5)]
array([ 10.          , 22.8348902..., 34.8004492..., 47.5535392..., 60.
↵])
```

__setitem__(*x*: *FloatingOrArrayLike* | *slice*, *y*: *FloatingOrArrayLike*)Set the corresponding range variable *y* for independent domain variable *x*.**Parameters**

- *x* (*FloatingOrArrayLike* | *slice*) – Independent domain variable *x*.
- *y* (*FloatingOrArrayLike*) – Corresponding range variable *y*.

Examples

```
>>> range_ = np.linspace(10, 100, 10)
>>> signal = Signal(range_)
>>> print(signal)
[[ 0.  10.]
 [ 1.  20.]
 [ 2.  30.]
 [ 3.  40.]
 [ 4.  50.]
 [ 5.  60.]
 [ 6.  70.]
 [ 7.  80.]
 [ 8.  90.]
 [ 9. 100.]]
>>> signal[0] = 20
>>> signal[0]
20.0
>>> signal[np.array([0, 1, 2])] = 30
>>> signal[np.array([0, 1, 2])]
array([ 30.,  30.,  30.])
>>> signal[0:3] = 40
>>> signal[0:3]
array([ 40.,  40.,  40.])
>>> signal[np.linspace(0, 5, 5)] = 50
>>> print(signal)
[[ 0.   50. ]
 [ 1.   40. ]
 [ 1.25  50. ]
 [ 2.   40. ]
 [ 2.5   50. ]
 [ 3.   40. ]
 [ 3.75  50. ]
 [ 4.   50. ]
 [ 5.   50. ]
 [ 6.   70. ]
 [ 7.   80. ]
 [ 8.   90. ]
 [ 9.  100. ]]
>>> signal[np.array([0, 1, 2])] = np.array([10, 20, 30])
>>> print(signal)
[[ 0.   10. ]
 [ 1.   20. ]
 [ 1.25  50. ]
 [ 2.   30. ]
 [ 2.5   50. ]
 [ 3.   40. ]
 [ 3.75  50. ]
 [ 4.   50. ]
 [ 5.   50. ]
 [ 6.   70. ]
 [ 7.   80. ]
 [ 8.   90. ]
 [ 9.  100. ]]
```

`__contains__`(*x*: *FloatingOrArrayLike* | *slice*) → bool

Return whether the continuous signal contains given independent domain variable *x*.

Parameters

x (FloatingOrArrayLike | slice) – Independent domain variable x .

Returns

Whether x domain value is contained.

Return type

bool

Examples

```
>>> range_ = np.linspace(10, 100, 10)
>>> signal = Signal(range_)
>>> 0 in signal
True
>>> 0.5 in signal
True
>>> 1000 in signal
False
```

__eq__(other: Any) → bool

Return whether the continuous signal is equal to given other object.

Parameters

other (Any) – Object to test whether it is equal to the continuous signal.

Returns

Whether given object is equal to the continuous signal.

Return type

bool

Examples

```
>>> range_ = np.linspace(10, 100, 10)
>>> signal_1 = Signal(range_)
>>> signal_2 = Signal(range_)
>>> signal_1 == signal_2
True
>>> signal_2[0] = 20
>>> signal_1 == signal_2
False
>>> signal_2[0] = 10
>>> signal_1 == signal_2
True
>>> from colour.algebra import CubicSplineInterpolator
>>> signal_2.interpolator = CubicSplineInterpolator
>>> signal_1 == signal_2
False
```

__ne__(other: Any) → bool

Return whether the continuous signal is not equal to given other object.

Parameters

other (Any) – Object to test whether it is not equal to the continuous signal.

Returns

Whether given object is not equal to the continuous signal.

Return type

`bool`

Examples

```
>>> range_ = np.linspace(10, 100, 10)
>>> signal_1 = Signal(range_)
>>> signal_2 = Signal(range_)
>>> signal_1 != signal_2
False
>>> signal_2[0] = 20
>>> signal_1 != signal_2
True
>>> signal_2[0] = 10
>>> signal_1 != signal_2
False
>>> from colour.algebra import CubicSplineInterpolator
>>> signal_2.interpolator = CubicSplineInterpolator
>>> signal_1 != signal_2
True
```

arithmetical_operation(*a*: *FloatingOrArrayLike* | *AbstractContinuousFunction*, *operation*: *Literal*['+', '-', '*', '/', '**'], *in_place*: *bool* = *False*) → *AbstractContinuousFunction*

Perform given arithmetical operation with operand *a*, the operation can be either performed on a copy or in-place.

Parameters

- **a** (*FloatingOrArrayLike* | *AbstractContinuousFunction*) – Operand *a*.
- **operation** (*Literal*['+', '-', '*', '/', '**']) – Operation to perform.
- **in_place** (*bool*) – Operation happens in place.

Returns

Continuous signal.

Return type

`colour.continuous.Signal`

Examples

Adding a single *numeric* variable:

```
>>> range_ = np.linspace(10, 100, 10)
>>> signal_1 = Signal(range_)
>>> print(signal_1)
[[ 0.  10.]
 [ 1.  20.]
 [ 2.  30.]
 [ 3.  40.]
 [ 4.  50.]
 [ 5.  60.]
 [ 6.  70.]
 [ 7.  80.]
 [ 8.  90.]
 [ 9. 100.]]
```

(continues on next page)

(continued from previous page)

```
>>> print(signal_1.arithmetical_operation(10, "+", True))
[[ 0.  20.]
 [ 1.  30.]
 [ 2.  40.]
 [ 3.  50.]
 [ 4.  60.]
 [ 5.  70.]
 [ 6.  80.]
 [ 7.  90.]
 [ 8. 100.]
 [ 9. 110.]]
```

Adding an *ArrayLike* variable:

```
>>> a = np.linspace(10, 100, 10)
>>> print(signal_1.arithmetical_operation(a, "+", True))
[[ 0.  30.]
 [ 1.  50.]
 [ 2.  70.]
 [ 3.  90.]
 [ 4. 110.]
 [ 5. 130.]
 [ 6. 150.]
 [ 7. 170.]
 [ 8. 190.]
 [ 9. 210.]]
```

Adding a `colour.continuous.Signal` class:

```
>>> signal_2 = Signal(range_)
>>> print(signal_1.arithmetical_operation(signal_2, "+", True))
[[ 0.  40.]
 [ 1.  70.]
 [ 2. 100.]
 [ 3. 130.]
 [ 4. 160.]
 [ 5. 190.]
 [ 6. 220.]
 [ 7. 250.]
 [ 8. 280.]
 [ 9. 310.]]
```

static `signal_unpack_data`(*data*=Optional[Union[ArrayLike, dict, Series, 'Signal']], *domain*: ArrayLike | None = None, *dtype*: Type[DTypeFloating] | None = None) → Tuple

Unpack given data for continuous signal instantiation.

Parameters

- **data** – Data to unpack for continuous signal instantiation.
- **domain** (ArrayLike | None) – Values to initialise the `colour.continuous.Signal.domain` attribute with. If both data and domain arguments are defined, the latter will be used to initialise the `colour.continuous.Signal.domain` property.
- **dtype** (Type[DTypeFloating] | None) – Floating point data type.

Returns

Independent domain variable x and corresponding range variable y unpacked for continuous signal instantiation.

Return type

tuple

Examples

Unpacking using implicit *domain*:

```
>>> range_ = np.linspace(10, 100, 10)
>>> domain, range_ = Signal.signal_unpack_data(range_)
>>> print(domain)
[ 0.  1.  2.  3.  4.  5.  6.  7.  8.  9.]
>>> print(range_)
[ 10.  20.  30.  40.  50.  60.  70.  80.  90. 100.]
```

Unpacking using explicit *domain*:

```
>>> domain = np.arange(100, 1100, 100)
>>> domain, range_ = Signal.signal_unpack_data(range_, domain)
>>> print(domain)
[ 100.  200.  300.  400.  500.  600.  700.  800.  900. 1000.]
>>> print(range_)
[ 10.  20.  30.  40.  50.  60.  70.  80.  90. 100.]
```

Unpacking using a *dict*:

```
>>> domain, range_ = Signal.signal_unpack_data(
...     dict(zip(domain, range_))
... )
>>> print(domain)
[ 100.  200.  300.  400.  500.  600.  700.  800.  900. 1000.]
>>> print(range_)
[ 10.  20.  30.  40.  50.  60.  70.  80.  90. 100.]
```

Unpacking using a *Pandas pandas.Series*:

```
>>> if is_pandas_installed():
...     from pandas import Series
...
...     domain, range_ = Signal.signal_unpack_data(
...         Series(dict(zip(domain, range_)))
...     )
...
...
>>> print(domain)
[ 100.  200.  300.  400.  500.  600.  700.  800.  900. 1000.]
>>> print(range_)
[ 10.  20.  30.  40.  50.  60.  70.  80.  90. 100.]
```

Unpacking using a `colour.continuous.Signal` class:

```
>>> domain, range_ = Signal.signal_unpack_data(Signal(range_, domain))
>>> print(domain)
[ 100.  200.  300.  400.  500.  600.  700.  800.  900. 1000.]
>>> print(range_)
[ 10.  20.  30.  40.  50.  60.  70.  80.  90. 100.]
```

fill_nan(method: *Literal*['Interpolation', 'Constant'] | str = 'Interpolation', default: Number = 0)
→ *AbstractContinuousFunction*

Fill NaNs in independent domain variable x and corresponding range variable y using given method.

Parameters

- **method** (*Literal*['Interpolation', 'Constant'] | str) – *Interpolation* method linearly interpolates through the NaNs, *Constant* method replaces NaNs with default.
- **default** (Number) – Value to use with the *Constant* method.

Returns

NaNs filled continuous signal.

Return type

`colour.continuous.Signal`

Examples

```
>>> range_ = np.linspace(10, 100, 10)
>>> signal = Signal(range_)
>>> signal[3:7] = np.nan
>>> print(signal)
[[ 0.  10.]
 [ 1.  20.]
 [ 2.  30.]
 [ 3.  nan]
 [ 4.  nan]
 [ 5.  nan]
 [ 6.  nan]
 [ 7.  80.]
 [ 8.  90.]
 [ 9. 100.]]
>>> print(signal.fill_nan())
[[ 0.  10.]
 [ 1.  20.]
 [ 2.  30.]
 [ 3.  40.]
 [ 4.  50.]
 [ 5.  60.]
 [ 6.  70.]
 [ 7.  80.]
 [ 8.  90.]
 [ 9. 100.]]
>>> signal[3:7] = np.nan
>>> print(signal.fill_nan(method="Constant"))
[[ 0.  10.]
 [ 1.  20.]
 [ 2.  30.]
 [ 3.   0.]
 [ 4.   0.]
 [ 5.   0.]
 [ 6.   0.]
 [ 7.  80.]
 [ 8.  90.]
 [ 9. 100.]]
```

`to_series()` → <MagicMock id='139666560192912'>

Convert the continuous signal to a *Pandas* `pandas.Series` class instance.

Returns

Continuous signal as a *Pandas* `pandas.Series` class instance.

Return type

`pandas.Series`

Examples

```
>>> if is_pandas_installed():
...     range_ = np.linspace(10, 100, 10)
...     signal = Signal(range_)
...     print(signal.to_series())
...
0.0    10.0
1.0    20.0
2.0    30.0
3.0    40.0
4.0    50.0
5.0    60.0
6.0    70.0
7.0    80.0
8.0    90.0
9.0   100.0
Name: Signal (...), dtype: float64
```

`colour.continuous.MultiSignals`

```
class colour.continuous.MultiSignals(data: ArrayLike | <MagicMock id='139666505410000'> |
    dict | ~colour.continuous.multi_signals.MultiSignals |
    ~typing.Sequence | <MagicMock id='139666653476432'> |
    ~colour.continuous.signal.Signal | None = None, domain:
    ArrayLike | None = None, labels: ~typing.Sequence | None =
    None, **kwargs: ~typing.Any)
```

Bases: `AbstractContinuousFunction`

Define the base class for multi-continuous signals, a container for multiple `colour.continuous.Signal` sub-class instances.

Important: Specific documentation about getting, setting, indexing and slicing the multi-continuous signals values is available in the [Spectral Representation and Continuous Signal](#) section.

Parameters

- **data** (Optional[Union[ArrayLike, DataFrame, dict, MultiSignals, Sequence, Series, Signal]]) – Data to be stored in the multi-continuous signals.
- **domain** (Optional[ArrayLike]) – Values to initialise the multiple `colour.continuous.Signal` sub-class instances `colour.continuous.Signal.domain` attribute with. If both data and domain arguments are defined, the latter will be used to initialise the `colour.continuous.Signal.domain` attribute.
- **labels** (Optional[Sequence]) – Names to use for the `colour.continuous.Signal` sub-class instances.

- **dtype** – Floating point data type.
- **extrapolator** – Extrapolator class type to use as extrapolating function for the `colour.continuous.Signal` sub-class instances.
- **extrapolator_kwargs** – Arguments to use when instantiating the extrapolating function of the `colour.continuous.Signal` sub-class instances.
- **interpolator** – Interpolator class type to use as interpolating function for the `colour.continuous.Signal` sub-class instances.
- **interpolator_kwargs** – Arguments to use when instantiating the interpolating function of the `colour.continuous.Signal` sub-class instances.
- **name** – multi-continuous signals name.
- **signal_type** – The `colour.continuous.Signal` sub-class type used for instances.
- **kwargs** (*Any*) –

Attributes

- dtype
- domain
- range
- interpolator
- interpolator_kwargs
- extrapolator
- extrapolator_kwargs
- function
- signals
- labels
- signal_type

Methods

- `__init__()`
- `__str__()`
- `__repr__()`
- `__hash__()`
- `__getitem__()`
- `__setitem__()`
- `__contains__()`
- `__eq__()`
- `__ne__()`
- `arithmetical_operation()`
- `multi_signals_unpack_data()`
- `fill_nan()`
- `to_dataframe()`

Examples

Instantiation with implicit *domain* and a single signal:

```
>>> range_ = np.linspace(10, 100, 10)
>>> print(MultiSignals(range_))
[[ 0.  10.]
 [ 1.  20.]
 [ 2.  30.]
 [ 3.  40.]
 [ 4.  50.]
 [ 5.  60.]
 [ 6.  70.]
 [ 7.  80.]
 [ 8.  90.]
 [ 9. 100.]]
```

Instantiation with explicit *domain* and a single signal:

```
>>> domain = np.arange(100, 1100, 100)
>>> print(MultiSignals(range_, domain))
[[ 100.  10.]
 [ 200.  20.]
 [ 300.  30.]
 [ 400.  40.]
 [ 500.  50.]
 [ 600.  60.]
 [ 700.  70.]
 [ 800.  80.]
 [ 900.  90.]
 [1000. 100.]]
```

Instantiation with multiple signals:

```
>>> range_ = tstack([np.linspace(10, 100, 10)] * 3)
>>> range_ += np.array([0, 10, 20])
>>> print(MultiSignals(range_, domain))
[[ 100.  10.  20.  30.]
 [ 200.  20.  30.  40.]
 [ 300.  30.  40.  50.]
 [ 400.  40.  50.  60.]
 [ 500.  50.  60.  70.]
 [ 600.  60.  70.  80.]
 [ 700.  70.  80.  90.]
 [ 800.  80.  90. 100.]
 [ 900.  90. 100. 110.]
 [1000. 100. 110. 120.]]
```

Instantiation with a *dict*:

```
>>> print(MultiSignals(dict(zip(domain, range_))))
[[ 100.  10.  20.  30.]
 [ 200.  20.  30.  40.]
 [ 300.  30.  40.  50.]
 [ 400.  40.  50.  60.]
 [ 500.  50.  60.  70.]
 [ 600.  60.  70.  80.]
 [ 700.  70.  80.  90.]
```

(continues on next page)

(continued from previous page)

```
[ 800.    80.    90.   100.]
[ 900.    90.   100.   110.]
[1000.   100.   110.   120.]
```

Instantiation using a *Signal* sub-class:

```
>>> class NotSignal(Signal):
...     pass
... 
```

```
>>> multi_signals = MultiSignals(range_, domain, signal_type=NotSignal)
>>> print(multi_signals)
[[ 100.    10.    20.    30.]
 [ 200.    20.    30.    40.]
 [ 300.    30.    40.    50.]
 [ 400.    40.    50.    60.]
 [ 500.    50.    60.    70.]
 [ 600.    60.    70.    80.]
 [ 700.    70.    80.    90.]
 [ 800.    80.    90.   100.]
 [ 900.    90.   100.   110.]
 [1000.   100.   110.   120.]
>>> type(multi_signals.signals[0])
<class 'multi_signals.NotSignal'>
```

Instantiation with a *Pandas Series*:

```
>>> if is_pandas_installed():
...     from pandas import Series
...
...     print(
...         MultiSignals(
...             Series(dict(zip(domain, np.linspace(10, 100, 10))))
...         )
...     )
...
[[ 100.    10.]
 [ 200.    20.]
 [ 300.    30.]
 [ 400.    40.]
 [ 500.    50.]
 [ 600.    60.]
 [ 700.    70.]
 [ 800.    80.]
 [ 900.    90.]
 [1000.   100.]
```

Instantiation with a *Pandas pandas.DataFrame*:

```
>>> if is_pandas_installed():
...     from pandas import DataFrame
...
...     data = dict(zip(["a", "b", "c"], tsplit(range_)))
...     print(MultiSignals(DataFrame(data, domain)))
...
[[ 100.    10.    20.    30.]
```

(continues on next page)

(continued from previous page)

```
[ 200.  20.  30.  40.]
[ 300.  30.  40.  50.]
[ 400.  40.  50.  60.]
[ 500.  50.  60.  70.]
[ 600.  60.  70.  80.]
[ 700.  70.  80.  90.]
[ 800.  80.  90. 100.]
[ 900.  90. 100. 110.]
[1000. 100. 110. 120.]
```

Retrieving domain y variable for arbitrary range x variable:

```
>>> x = 150
>>> range_ = tstack([np.sin(np.linspace(0, 1, 10))] * 3)
>>> range_ += np.array([0.0, 0.25, 0.5])
>>> MultiSignals(range_, domain)[x]
array([ 0.0359701...,  0.2845447...,  0.5331193...])
>>> x = np.linspace(100, 1000, 3)
>>> MultiSignals(range_, domain)[x]
array([[ 4.4085384...e-20,  2.5000000...e-01,  5.0000000...e-01],
       [ 4.7669395...e-01,  7.2526859...e-01,  9.7384323...e-01],
       [ 8.4147098...e-01,  1.0914709...e+00,  1.3414709...e+00]])
```

Using an alternative interpolating function:

```
>>> x = 150
>>> from colour.algebra import CubicSplineInterpolator
>>> MultiSignals(range_, domain, interpolator=CubicSplineInterpolator)[
...     x
... ]
array([ 0.0555274...,  0.3055274...,  0.5555274...])
>>> x = np.linspace(100, 1000, 3)
>>> MultiSignals(range_, domain, interpolator=CubicSplineInterpolator)[
...     x
... ]
array([[ 0.          ...,  0.25      ...,  0.5          ...],
       [ 0.4794253...,  0.7294253...,  0.9794253...],
       [ 0.8414709...,  1.0914709...,  1.3414709...]])
```

```
__init__(data: ArrayLike | <MagicMock id='139666505410000'> | dict |
~colour.continuous.multi_signals.MultiSignals | ~typing.Sequence | <MagicMock
id='13966653476432'> | ~colour.continuous.signal.Signal | None = None, domain:
ArrayLike | None = None, labels: ~typing.Sequence | None = None, **kwargs:
~typing.Any) → None
```

Parameters

- **data** (ArrayLike | <MagicMock id='139666505410000'> | dict | MultiSignals | Sequence | <MagicMock id='13966653476432'> | Signal | None) –
- **domain** (ArrayLike | None) –
- **labels** (Sequence | None) –
- **kwargs** (Any) –

Return type

None

property dtype: `Type[DTypeFloating]`

Getter and setter property for the continuous signal dtype.

Parameters

value – Value to set the continuous signal dtype with.

Returns

Continuous signal dtype.

Return type

`Type[DTypeFloating]`

property domain: `ndarray`

Getter and setter property for the `colour.continuous.Signal` sub-class instances independent domain variable x .

Parameters

value – Value to set the `colour.continuous.Signal` sub-class instances independent domain variable x with.

Returns

`colour.continuous.Signal` sub-class instances independent domain variable x .

Return type

`numpy.ndarray`

property range: `ndarray`

Getter and setter property for the `colour.continuous.Signal` sub-class instances corresponding range variable y .

Parameters

value – Value to set the `colour.continuous.Signal` sub-class instances corresponding range variable y with.

Returns

`colour.continuous.Signal` sub-class instances corresponding range variable y .

Return type

`numpy.ndarray`

property interpolator: `Type[TypeInterpolator]`

Getter and setter property for the `colour.continuous.Signal` sub-class instances interpolator type.

Parameters

value – Value to set the `colour.continuous.Signal` sub-class instances interpolator type with.

Returns

`colour.continuous.Signal` sub-class instances interpolator type.

Return type

`Type[TypeInterpolator]`

property interpolator_kwargs: `Dict`

Getter and setter property for the `colour.continuous.Signal` sub-class instances interpolator instantiation time arguments.

Parameters

value – Value to set the `colour.continuous.Signal` sub-class instances interpolator instantiation time arguments to.

Returns

`colour.continuous.Signal` sub-class instances interpolator instantiation time arguments.

Return type`dict`**property extrapolator:** `Type[TypeExtrapolator]`

Getter and setter property for the `colour.continuous.Signal` sub-class instances extrapolator type.

Parameters

value – Value to set the `colour.continuous.Signal` sub-class instances extrapolator type with.

Returns

`colour.continuous.Signal` sub-class instances extrapolator type.

Return type`Type[TypeExtrapolator]`**property extrapolator_kwargs:** `Dict`

Getter and setter property for the `colour.continuous.Signal` sub-class instances extrapolator instantiation time arguments.

Parameters

value – Value to set the `colour.continuous.Signal` sub-class instances extrapolator instantiation time arguments to.

Returns

`colour.continuous.Signal` sub-class instances extrapolator instantiation time arguments.

Return type`dict`**property function:** `Callable`

Getter property for the `colour.continuous.Signal` sub-class instances callable.

Returns

`colour.continuous.Signal` sub-class instances callable.

Return type`Callable`**property signals:** `Dict[str, Signal]`

Getter and setter property for the `colour.continuous.Signal` sub-class instances.

Parameters

value – Attribute value.

Returns

`colour.continuous.Signal` sub-class instances.

Return type`dict`**property labels:** `List[str]`

Getter and setter property for the `colour.continuous.Signal` sub-class instance names.

Parameters

value – Value to set the `colour.continuous.Signal` sub-class instance names.

Returns

`colour.continuous.Signal` sub-class instance names.

Return type`list`

property `signal_type`: `Type[Signal]`

Getter property for the `colour.continuous.Signal` sub-class instances type.

Returns

`colour.continuous.Signal` sub-class instances type.

Return type

`Type[Signal]`

`__str__()` → `str`

Return a formatted string representation of the multi-continuous signals.

Returns

Formatted string representation.

Return type

`str`

Examples

```
>>> domain = np.arange(0, 10, 1)
>>> range_ = tstack([np.linspace(10, 100, 10)] * 3)
>>> range_ += np.array([0, 10, 20])
>>> print(MultiSignals(range_))
[[ 0.  10.  20.  30.]
 [ 1.  20.  30.  40.]
 [ 2.  30.  40.  50.]
 [ 3.  40.  50.  60.]
 [ 4.  50.  60.  70.]
 [ 5.  60.  70.  80.]
 [ 6.  70.  80.  90.]
 [ 7.  80.  90. 100.]
 [ 8.  90. 100. 110.]
 [ 9. 100. 110. 120.]]
```

`__repr__()` → `str`

Return an evaluable string representation of the multi-continuous signals.

Returns

Evaluable string representation.

Return type

`str`

Examples

```
>>> domain = np.arange(0, 10, 1)
>>> range_ = tstack([np.linspace(10, 100, 10)] * 3)
>>> range_ += np.array([0, 10, 20])
>>> MultiSignals(range_)
MultiSignals([[ 0.,  10.,  20.,  30.],
               [ 1.,  20.,  30.,  40.],
               [ 2.,  30.,  40.,  50.],
               [ 3.,  40.,  50.,  60.],
               [ 4.,  50.,  60.,  70.],
               [ 5.,  60.,  70.,  80.],
               [ 6.,  70.,  80.,  90.],
               [ 7.,  80.,  90., 100.]])
```

(continues on next page)

(continued from previous page)

```
[ 8., 90., 100., 110.],
[ 9., 100., 110., 120.]],
['0', '1', '2'],
KernelInterpolator,
{},
Extrapolator,
{'method': 'Constant', 'left': nan, 'right': nan})
```

__hash__() → int

Return the abstract continuous function hash.

Returns

Object hash.

Return type

numpy.integer

__getitem__(*x*: FloatingOrArrayLike | slice) → FloatingOrNDArrayReturn the corresponding range variable *y* for independent domain variable *x*.**Parameters***x* (FloatingOrArrayLike | slice) – Independent domain variable *x*.**Returns**Variable *y* range value.**Return type**

numpy.floating or numpy.ndarray

Examples

```
>>> range_ = tstack([np.linspace(10, 100, 10)] * 3)
>>> range_ += np.array([0, 10, 20])
>>> multi_signals = MultiSignals(range_)
>>> print(multi_signals)
[[ 0. 10. 20. 30.]
 [ 1. 20. 30. 40.]
 [ 2. 30. 40. 50.]
 [ 3. 40. 50. 60.]
 [ 4. 50. 60. 70.]
 [ 5. 60. 70. 80.]
 [ 6. 70. 80. 90.]
 [ 7. 80. 90. 100.]
 [ 8. 90. 100. 110.]
 [ 9. 100. 110. 120.]]
>>> multi_signals[0]
array([ 10., 20., 30.])
>>> multi_signals[np.array([0, 1, 2])]
array([[ 10., 20., 30.],
       [ 20., 30., 40.],
       [ 30., 40., 50.]])
>>> multi_signals[np.linspace(0, 5, 5)]
array([[ 10. ..., 20. ..., 30. ...],
       [22.8348902..., 32.8046056..., 42.774321 ...],
       [34.8004492..., 44.7434347..., 54.6864201...],
       [47.5535392..., 57.5232546..., 67.4929700...],
       [ 60. ..., 70. ..., 80. ...]])
```

(continues on next page)

(continued from previous page)

```
>>> multi_signals[0:3]
array([[ 10.,  20.,  30.],
       [ 20.,  30.,  40.],
       [ 30.,  40.,  50.]])
>>> multi_signals[:, 0:2]
array([[ 10.,  20.],
       [ 20.,  30.],
       [ 30.,  40.],
       [ 40.,  50.],
       [ 50.,  60.],
       [ 60.,  70.],
       [ 70.,  80.],
       [ 80.,  90.],
       [ 90., 100.],
       [100., 110.]])
```

__setitem__(*x*: *FloatingOrArrayLike* | *slice*, *y*: *FloatingOrArrayLike*)

Set the corresponding range variable *y* for independent domain variable *x*.

Parameters

- **x** (*FloatingOrArrayLike* | *slice*) – Independent domain variable *x*.
- **y** (*FloatingOrArrayLike*) – Corresponding range variable *y*.

Examples

```
>>> domain = np.arange(0, 10, 1)
>>> range_ = tstack([np.linspace(10, 100, 10)] * 3)
>>> range_ += np.array([0, 10, 20])
>>> multi_signals = MultiSignals(range_)
>>> print(multi_signals)
[[ 0.  10.  20.  30.]
 [ 1.  20.  30.  40.]
 [ 2.  30.  40.  50.]
 [ 3.  40.  50.  60.]
 [ 4.  50.  60.  70.]
 [ 5.  60.  70.  80.]
 [ 6.  70.  80.  90.]
 [ 7.  80.  90. 100.]
 [ 8.  90. 100. 110.]
 [ 9. 100. 110. 120.]]
>>> multi_signals[0] = 20
>>> multi_signals[0]
array([ 20.,  20.,  20.])
>>> multi_signals[np.array([0, 1, 2])] = 30
>>> multi_signals[np.array([0, 1, 2])]
array([[ 30.,  30.,  30.],
       [ 30.,  30.,  30.],
       [ 30.,  30.,  30.]])
>>> multi_signals[np.linspace(0, 5, 5)] = 50
>>> print(multi_signals)
[[ 0.  50.  50.  50. ]
 [ 1.  30.  30.  30. ]
 [ 1.25 50.  50.  50. ]
 [ 2.  30.  30.  30. ]
```

(continues on next page)

(continued from previous page)

```

[ 2.5  50.  50.  50. ]
[ 3.   40.  50.  60. ]
[ 3.75 50.  50.  50. ]
[ 4.   50.  60.  70. ]
[ 5.   50.  50.  50. ]
[ 6.   70.  80.  90. ]
[ 7.   80.  90. 100. ]
[ 8.   90. 100. 110. ]
[ 9.  100. 110. 120. ]]
>>> multi_signals[np.array([0, 1, 2])] = np.array([10, 20, 30])
>>> print(multi_signals)
[[ 0.   10.  20.  30. ]
 [ 1.   10.  20.  30. ]
 [ 1.25 50.  50.  50. ]
 [ 2.   10.  20.  30. ]
 [ 2.5  50.  50.  50. ]
 [ 3.   40.  50.  60. ]
 [ 3.75 50.  50.  50. ]
 [ 4.   50.  60.  70. ]
 [ 5.   50.  50.  50. ]
 [ 6.   70.  80.  90. ]
 [ 7.   80.  90. 100. ]
 [ 8.   90. 100. 110. ]
 [ 9.  100. 110. 120. ]]
>>> y = np.arange(1, 10, 1).reshape(3, 3)
>>> multi_signals[np.array([0, 1, 2])] = y
>>> print(multi_signals)
[[ 0.   1.   2.   3. ]
 [ 1.   4.   5.   6. ]
 [ 1.25 50.  50.  50. ]
 [ 2.   7.   8.   9. ]
 [ 2.5  50.  50.  50. ]
 [ 3.   40.  50.  60. ]
 [ 3.75 50.  50.  50. ]
 [ 4.   50.  60.  70. ]
 [ 5.   50.  50.  50. ]
 [ 6.   70.  80.  90. ]
 [ 7.   80.  90. 100. ]
 [ 8.   90. 100. 110. ]
 [ 9.  100. 110. 120. ]]
>>> multi_signals[0:3] = 40
>>> multi_signals[0:3]
array([[ 40.,  40.,  40.],
       [ 40.,  40.,  40.],
       [ 40.,  40.,  40.]])
>>> multi_signals[:, 0:2] = 50
>>> print(multi_signals)
[[ 0.   50.  50.  40. ]
 [ 1.   50.  50.  40. ]
 [ 1.25 50.  50.  40. ]
 [ 2.   50.  50.   9. ]
 [ 2.5  50.  50.  50. ]
 [ 3.   50.  50.  60. ]
 [ 3.75 50.  50.  50. ]
 [ 4.   50.  50.  70. ]
 [ 5.   50.  50.  50. ]

```

(continues on next page)

(continued from previous page)

```
[ 6.   50.   50.   90.  ]
[ 7.   50.   50.  100.  ]
[ 8.   50.   50.  110.  ]
[ 9.   50.   50.  120.  ]]
```

__contains__(*x*: *FloatingOrArrayLike* | *slice*) → *bool*

Return whether the multi-continuous signals contains given independent domain variable *x*.

Parameters

x (*FloatingOrArrayLike* | *slice*) – Independent domain variable *x*.

Returns

Whether *x* domain value is contained.

Return type

bool

Examples

```
>>> range_ = np.linspace(10, 100, 10)
>>> multi_signals = MultiSignals(range_)
>>> 0 in multi_signals
True
>>> 0.5 in multi_signals
True
>>> 1000 in multi_signals
False
```

__eq__(*other*: *Any*) → *bool*

Return whether the multi-continuous signals is equal to given other object.

Parameters

other (*Any*) – Object to test whether it is equal to the multi-continuous signals.

Returns

Whether given object is equal to the multi-continuous signals.

Return type

bool

Examples

```
>>> range_ = np.linspace(10, 100, 10)
>>> multi_signals_1 = MultiSignals(range_)
>>> multi_signals_2 = MultiSignals(range_)
>>> multi_signals_1 == multi_signals_2
True
>>> multi_signals_2[0] = 20
>>> multi_signals_1 == multi_signals_2
False
>>> multi_signals_2[0] = 10
>>> multi_signals_1 == multi_signals_2
True
>>> from colour.algebra import CubicSplineInterpolator
>>> multi_signals_2.interpolator = CubicSplineInterpolator
>>> multi_signals_1 == multi_signals_2
False
```

`__ne__(other: Any) → bool`

Return whether the multi-continuous signals is not equal to given other object.

Parameters

other (Any) – Object to test whether it is not equal to the multi-continuous signals.

Returns

Whether given object is not equal to the multi-continuous signals.

Return type

bool

Examples

```
>>> range_ = np.linspace(10, 100, 10)
>>> multi_signals_1 = MultiSignals(range_)
>>> multi_signals_2 = MultiSignals(range_)
>>> multi_signals_1 != multi_signals_2
False
>>> multi_signals_2[0] = 20
>>> multi_signals_1 != multi_signals_2
True
>>> multi_signals_2[0] = 10
>>> multi_signals_1 != multi_signals_2
False
>>> from colour.algebra import CubicSplineInterpolator
>>> multi_signals_2.interpolator = CubicSplineInterpolator
>>> multi_signals_1 != multi_signals_2
True
```

`arithmetical_operation(a: FloatingOrArrayLike | AbstractContinuousFunction, operation: Literal['+', '-', '*', '/', '**'], in_place: bool = False) → AbstractContinuousFunction`

Perform given arithmetical operation with operand *a*, the operation can be either performed on a copy or in-place.

Parameters

- **a** (FloatingOrArrayLike | AbstractContinuousFunction) – Operand *a*.
- **operation** (Literal['+', '-', '*', '/', '**']) – Operation to perform.
- **in_place** (bool) – Operation happens in place.

Returns

multi-continuous signals.

Return type

colour.continuous.MultiSignals

Examples

Adding a single *numeric* variable:

```
>>> domain = np.arange(0, 10, 1)
>>> range_ = tstack([np.linspace(10, 100, 10)] * 3)
>>> range_ += np.array([0, 10, 20])
>>> multi_signals_1 = MultiSignals(range_)
>>> print(multi_signals_1)
[[ 0.  10.  20.  30.]
 [ 1.  20.  30.  40.]
 [ 2.  30.  40.  50.]
 [ 3.  40.  50.  60.]
 [ 4.  50.  60.  70.]
 [ 5.  60.  70.  80.]
 [ 6.  70.  80.  90.]
 [ 7.  80.  90. 100.]
 [ 8.  90. 100. 110.]
 [ 9. 100. 110. 120.]]
>>> print(multi_signals_1.arithmetical_operation(10, "+", True))
[[ 0.  20.  30.  40.]
 [ 1.  30.  40.  50.]
 [ 2.  40.  50.  60.]
 [ 3.  50.  60.  70.]
 [ 4.  60.  70.  80.]
 [ 5.  70.  80.  90.]
 [ 6.  80.  90. 100.]
 [ 7.  90. 100. 110.]
 [ 8. 100. 110. 120.]
 [ 9. 110. 120. 130.]]
```

Adding an *ArrayLike* variable:

```
>>> a = np.linspace(10, 100, 10)
>>> print(multi_signals_1.arithmetical_operation(a, "+", True))
[[ 0.  30.  40.  50.]
 [ 1.  50.  60.  70.]
 [ 2.  70.  80.  90.]
 [ 3.  90. 100. 110.]
 [ 4. 110. 120. 130.]
 [ 5. 130. 140. 150.]
 [ 6. 150. 160. 170.]
 [ 7. 170. 180. 190.]
 [ 8. 190. 200. 210.]
 [ 9. 210. 220. 230.]]
```

```
>>> a = np.array([[10, 20, 30]])
>>> print(multi_signals_1.arithmetical_operation(a, "+", True))
[[ 0.  40.  60.  80.]
 [ 1.  60.  80. 100.]
 [ 2.  80. 100. 120.]
 [ 3. 100. 120. 140.]
 [ 4. 120. 140. 160.]
 [ 5. 140. 160. 180.]
 [ 6. 160. 180. 200.]
 [ 7. 180. 200. 220.]
 [ 8. 200. 220. 240.]
 [ 9. 220. 240. 260.]]
```

```
>>> a = np.arange(0, 30, 1).reshape([10, 3])
>>> print(multi_signals_1.arithmetical_operation(a, "+", True))
[[ 0.  40.  61.  82.]
 [ 1.  63.  84. 105.]
 [ 2.  86. 107. 128.]
 [ 3. 109. 130. 151.]
 [ 4. 132. 153. 174.]
 [ 5. 155. 176. 197.]
 [ 6. 178. 199. 220.]
 [ 7. 201. 222. 243.]
 [ 8. 224. 245. 266.]
 [ 9. 247. 268. 289.]]
```

Adding a `colour.continuous.Signal` sub-class:

```
>>> multi_signals_2 = MultiSignals(range_)
>>> print(
...     multi_signals_1.arithmetical_operation(
...         multi_signals_2, "+", True
...     )
... )
[[ 0.  50.  81. 112.]
 [ 1.  83. 114. 145.]
 [ 2. 116. 147. 178.]
 [ 3. 149. 180. 211.]
 [ 4. 182. 213. 244.]
 [ 5. 215. 246. 277.]
 [ 6. 248. 279. 310.]
 [ 7. 281. 312. 343.]
 [ 8. 314. 345. 376.]
 [ 9. 347. 378. 409.]]
```

```
static multi_signals_unpack_data(data: ArrayLike | <MagicMock id='139666505410000'> |
                                dict | ~colour.continuous.multi_signals.MultiSignals |
                                ~typing.Sequence | <MagicMock id='139666653476432'> |
                                ~colour.continuous.signal.Signal | None = None, domain:
                                ArrayLike | None = None, labels: ~typing.Sequence | None =
                                None, dtype: ~typing.Type[DTypeFloating] | None = None,
                                signal_type: ~typing.Type[~colour.continuous.signal.Signal]
                                = Signal, **kwargs: ~typing.Any) → Dict[str, Signal]
```

Unpack given data for multi-continuous signals instantiation.

Parameters

- **data** (ArrayLike | <MagicMock id='139666505410000'> | dict | MultiSignals | Sequence | <MagicMock id='139666653476432'> | Signal | None) – Data to unpack for multi-continuous signals instantiation.
- **domain** (ArrayLike | None) – Values to initialise the multiple `colour.continuous.Signal` sub-class instances `colour.continuous.Signal.domain` attribute with. If both data and domain arguments are defined, the latter will be used to initialise the `colour.continuous.Signal.domain` property.
- **labels** (Sequence | None) – Names to use for the `colour.continuous.Signal` sub-class instances.
- **dtype** (Type[DTypeFloating] | None) – Floating point data type.
- **signal_type** (Type[Signal]) – A `colour.continuous.Signal` sub-class type.

- **extrapolator** – Extrapolator class type to use as extrapolating function for the `colour.continuous.Signal` sub-class instances.
- **extrapolator_kwargs** – Arguments to use when instantiating the extrapolating function of the `colour.continuous.Signal` sub-class instances.
- **interpolator** – Interpolator class type to use as interpolating function for the `colour.continuous.Signal` sub-class instances.
- **interpolator_kwargs** – Arguments to use when instantiating the interpolating function of the `colour.continuous.Signal` sub-class instances.
- **name** – multi-continuous signals name.
- **kwargs** (*Any*) –

Returns

Mapping of labeled `colour.continuous.Signal` sub-class instances.

Return type

`dict`

Examples

Unpacking using implicit *domain* and data for a single signal:

```
>>> range_ = np.linspace(10, 100, 10)
>>> signals = MultiSignals.multi_signals_unpack_data(range_)
>>> list(signals.keys())
['0']
>>> print(signals["0"])
[[ 0.  10.]
 [ 1.  20.]
 [ 2.  30.]
 [ 3.  40.]
 [ 4.  50.]
 [ 5.  60.]
 [ 6.  70.]
 [ 7.  80.]
 [ 8.  90.]
 [ 9. 100.]]
```

Unpacking using explicit *domain* and data for a single signal:

```
>>> domain = np.arange(100, 1100, 100)
>>> signals = MultiSignals.multi_signals_unpack_data(range_, domain)
>>> list(signals.keys())
['0']
>>> print(signals["0"])
[[ 100.  10.]
 [ 200.  20.]
 [ 300.  30.]
 [ 400.  40.]
 [ 500.  50.]
 [ 600.  60.]
 [ 700.  70.]
 [ 800.  80.]
 [ 900.  90.]
 [1000. 100.]]
```

Unpacking using data for multiple signals:

```
>>> range_ = tstack([np.linspace(10, 100, 10)] * 3)
>>> range_ += np.array([0, 10, 20])
>>> signals = MultiSignals.multi_signals_unpack_data(range_, domain)
>>> list(signals.keys())
['0', '1', '2']
>>> print(signals["2"])
[[ 100.   30.]
 [ 200.   40.]
 [ 300.   50.]
 [ 400.   60.]
 [ 500.   70.]
 [ 600.   80.]
 [ 700.   90.]
 [ 800.  100.]
 [ 900.  110.]
 [1000.  120.]]
```

Unpacking using a *dict*:

```
>>> signals = MultiSignals.multi_signals_unpack_data(
...     dict(zip(domain, range_))
... )
>>> list(signals.keys())
['0', '1', '2']
>>> print(signals["2"])
[[ 100.   30.]
 [ 200.   40.]
 [ 300.   50.]
 [ 400.   60.]
 [ 500.   70.]
 [ 600.   80.]
 [ 700.   90.]
 [ 800.  100.]
 [ 900.  110.]
 [1000.  120.]]
```

Unpacking using a sequence of *Signal* instances, note how the keys are *str* instances because the *Signal* names are used:

```
>>> signals = MultiSignals.multi_signals_unpack_data(
...     dict(zip(domain, range_))
... ).values()
>>> signals = MultiSignals.multi_signals_unpack_data(signals)
>>> list(signals.keys())
['0', '1', '2']
>>> print(signals["2"])
[[ 100.   30.]
 [ 200.   40.]
 [ 300.   50.]
 [ 400.   60.]
 [ 500.   70.]
 [ 600.   80.]
 [ 700.   90.]
 [ 800.  100.]
 [ 900.  110.]
 [1000.  120.]]
```

Unpacking using *MultiSignals.multi_signals_unpack_data* method output:


```
>>> signals = MultiSignals.multi_signals_unpack_data(
...     dict(zip(domain, range_))
... )
>>> signals = MultiSignals.multi_signals_unpack_data(signals)
>>> list(signals.keys())
['0', '1', '2']
>>> print(signals["2"])
[[ 100.   30.]
 [ 200.   40.]
 [ 300.   50.]
 [ 400.   60.]
 [ 500.   70.]
 [ 600.   80.]
 [ 700.   90.]
 [ 800.  100.]
 [ 900.  110.]
 [1000.  120.]]
```

Unpacking using a *Pandas Series*:

```
>>> if is_pandas_installed():
...     from pandas import Series
...
...     signals = MultiSignals.multi_signals_unpack_data(
...         Series(dict(zip(domain, np.linspace(10, 100, 10))))
...     )
...     print(signals[0])
...
[[ 100.   10.]
 [ 200.   20.]
 [ 300.   30.]
 [ 400.   40.]
 [ 500.   50.]
 [ 600.   60.]
 [ 700.   70.]
 [ 800.   80.]
 [ 900.   90.]
 [1000.  100.]]
```

Unpacking using a *Pandas pandas.DataFrame*:

```
>>> if is_pandas_installed():
...     from pandas import DataFrame
...
...     data = dict(zip(["a", "b", "c"], tsplit(range_)))
...     signals = MultiSignals.multi_signals_unpack_data(
...         DataFrame(data, domain)
...     )
...     print(signals["c"])
...
[[ 100.   30.]
 [ 200.   40.]
 [ 300.   50.]
 [ 400.   60.]
 [ 500.   70.]
 [ 600.   80.]
 [ 700.   90.]
```

(continues on next page)

(continued from previous page)

```
[ 800.  100.]
[ 900.  110.]
[1000.  120.]
```

fill_nan(method: *Literal*['Interpolation', 'Constant'] | str = 'Interpolation', default: Number = 0)
→ *AbstractContinuousFunction*

Fill NaNs in independent domain variable x and corresponding range variable y using given method.

Parameters

- **method** (*Literal*['Interpolation', 'Constant'] | str) – *Interpolation* method linearly interpolates through the NaNs, *Constant* method replaces NaNs with default.
- **default** (Number) – Value to use with the *Constant* method.

Returns

- `colour.continuous.MultiSignals` – NaNs filled multi-continuous signals.
- ```
>>> domain = np.arange(0, 10, 1)
```
- ```
>>> range_ = tstack([np.linspace(10, 100, 10)] * 3)
```
- ```
>>> range_ += np.array([0, 10, 20])
```
- ```
>>> multi_signals = MultiSignals(range_)
```
- ```
>>> multi_signals[3 (7)] = np.nan
```
- ```
>>> print(multi_signals)
```
- ```
[[0. 10. 20. 30.] - [1. 20. 30. 40.] [2. 30. 40. 50.] [3. nan nan nan] [4.
nan nan nan] [5. nan nan nan] [6. nan nan nan] [7. 80. 90. 100.] [8. 90.
100. 110.] [9. 100. 110. 120.]]
```
- ```
>>> print(multi_signals.fill_nan())
```
- ```
[[0. 10. 20. 30.] - [1. 20. 30. 40.] [2. 30. 40. 50.] [3. 40. 50. 60.] [4.
50. 60. 70.] [5. 60. 70. 80.] [6. 70. 80. 90.] [7. 80. 90. 100.] [8. 90. 100.
110.] [9. 100. 110. 120.]]
```
- ```
>>> multi_signals[3 (7)] = np.nan
```
- ```
>>> print(multi_signals.fill_nan(method="Constant"))
```
- ```
[[ 0. 10. 20. 30.] - [ 1. 20. 30. 40.] [ 2. 30. 40. 50.] [ 3. 0. 0. 0.] [ 4. 0. 0.
0.] [ 5. 0. 0. 0.] [ 6. 0. 0. 0.] [ 7. 80. 90. 100.] [ 8. 90. 100. 110.] [ 9. 100.
110. 120.]]
```

Return type

AbstractContinuousFunction

to_dataframe() → <MagicMock id='139666505410000'>

Convert the continuous signal to a *Pandas pandas.DataFrame* class instance.

Returns

Continuous signal as a *Pandas pandas.DataFrame* class instance.

Return type

pandas.DataFrame

Examples

```
>>> if is_pandas_installed():
...     domain = np.arange(0, 10, 1)
...     range_ = tstack([np.linspace(10, 100, 10)] * 3)
...     range_ += np.array([0, 10, 20])
...     multi_signals = MultiSignals(range_)
...     print(multi_signals.to_dataframe())
...
      0      1      2
0.0  10.0  20.0  30.0
1.0  20.0  30.0  40.0
2.0  30.0  40.0  50.0
3.0  40.0  50.0  60.0
4.0  50.0  60.0  70.0
5.0  60.0  70.0  80.0
6.0  70.0  80.0  90.0
7.0  80.0  90.0  100.0
8.0  90.0  100.0  110.0
9.0  100.0  110.0  120.0
```

Corresponding Chromaticities

Prediction

colour

| | |
|---|--|
| <code>corresponding_chromaticities_prediction(...)</code> | Return the corresponding chromaticities prediction for given chromatic adaptation model. |
| <code>CORRESPONDING_CHROMATICITIES_PREDICTION_MODE</code> | Aggregated corresponding chromaticities prediction models. |
| <code>CorrespondingColourDataset(name, XYZ_r, ...)</code> | Define a corresponding colour dataset. |
| <code>CorrespondingChromaticitiesPrediction(name, ...)</code> | Define a chromatic adaptation model prediction. |

colour.corresponding_chromaticities_prediction

`colour.corresponding_chromaticities_prediction(experiment: Literal[1, 2, 3, 4, 6, 8, 9, 11, 12] | CorrespondingColourDataset = 1, model: Literal['CIE 1994', 'CMCCAT2000', 'Fairchild 1990', 'Zhai 2018', 'Von Kries'] | str = 'Von Kries', **kwargs: Any) → Tuple[CorrespondingChromaticitiesPrediction, ...]`

Return the corresponding chromaticities prediction for given chromatic adaptation model.

Parameters

- **experiment** (*Literal*[1, 2, 3, 4, 6, 8, 9, 11, 12] | ~colour.corresponding.prediction.*CorrespondingColourDataset*) – *Breneman (1987)* experiment number or `colour.CorrespondingColourDataset` class instance.
- **model** (*Literal*['CIE 1994', 'CMCCAT2000', 'Fairchild 1990', 'Zhai 2018', 'Von Kries'] | str) – Chromatic adaptation model.
- **D_b** – {colour.corresponding.corresponding_chromaticities_prediction_Zhai2018()}, Degree of adaptation D_β of input illuminant β .

- **D_d** – {colour.corresponding.corresponding_chromaticities_prediction_Zhai2018()}, Degree of adaptation D_δ of output illuminant δ .
- **transform** – {colour.corresponding.corresponding_chromaticities_prediction_VonKries(), colour.corresponding.corresponding_chromaticities_prediction_Zhai2018()}, Chromatic adaptation transform.
- **XYZ_wo** – {colour.corresponding.corresponding_chromaticities_prediction_Zhai2018()}, Baseline illuminant (BI) o .
- **kwargs** (*Any*) –

Returns

Corresponding chromaticities prediction.

Return type

`tuple`

References

[Bre87], [CIET13294], [Fai91], [Fai13f], [Fai13a], [LLRH02], [WRC12d], [ZL18]

Examples

```
>>> from pprint import pprint
>>> pr = corresponding_chromaticities_prediction(2, "CMCCAT2000")
>>> pr = [(p.uv_m, p.uv_p) for p in pr]
>>> pprint(pr)
[((0.207, 0.486), (0.2083210..., 0.4727168...)),
 ((0.449, 0.511), (0.4459270..., 0.5077735...)),
 ((0.263, 0.505), (0.2640262..., 0.4955361...)),
 ((0.322, 0.545), (0.3316884..., 0.5431580...)),
 ((0.316, 0.537), (0.3222624..., 0.5357624...)),
 ((0.265, 0.553), (0.2710705..., 0.5501997...)),
 ((0.221, 0.538), (0.2261826..., 0.5294740...)),
 ((0.135, 0.532), (0.1439693..., 0.5190984...)),
 ((0.145, 0.472), (0.1494835..., 0.4556760...)),
 ((0.163, 0.331), (0.1563172..., 0.3164151...)),
 ((0.176, 0.431), (0.1763199..., 0.4127589...)),
 ((0.244, 0.349), (0.2287638..., 0.3499324...))]
```

colour.CORRESPONDING_CHROMATICITIES_PREDICTION_MODELS

```
colour.CORRESPONDING_CHROMATICITIES_PREDICTION_MODELS = CanonicalMapping({'CIE 1994': ...,
 'CMCCAT2000': ..., 'Fairchild 1990': ..., 'Von Kries': ..., 'Zhai 2018': ..., 'vonkries':
 ...})
```

Aggregated corresponding chromaticities prediction models.

References

[Bre87], [CIET13294], [Fai91], [Fai13f], [Fai13a], [LLRH02], [WRC12d], [ZL18]

Aliases:

- ‘vonkries’: ‘Von Kries’

colour.CorrespondingColourDataset

class colour.**CorrespondingColourDataset**(name, XYZ_r, XYZ_t, XYZ_cr, XYZ_ct, Y_r, Y_t, B_r, B_t, metadata)

Define a corresponding colour dataset.

Parameters

- **name** – Corresponding colour dataset name.
- **XYZ_r** – *CIE XYZ* tristimulus values of the reference illuminant.
- **XYZ_t** – *CIE XYZ* tristimulus values of the test illuminant.
- **XYZ_cr** – Corresponding *CIE XYZ* tristimulus values under the reference illuminant.
- **XYZ_ct** – Corresponding *CIE XYZ* tristimulus values under the test illuminant.
- **Y_r** – Reference white luminance Y_r in cd/m^2 .
- **Y_t** – Test white luminance Y_t in cd/m^2 .
- **B_r** – Luminance factor B_r of reference achromatic background as percentage.
- **B_t** – Luminance factor B_t of test achromatic background as percentage.
- **metadata** – Dataset metadata.

Notes

- This class is compatible with *Luo and Rhodes (1999) Corresponding-Colour Datasets* datasets.

References

[LR99]

Create new instance of CorrespondingColourDataset(name, XYZ_r, XYZ_t, XYZ_cr, XYZ_ct, Y_r, Y_t, B_r, B_t, metadata)

`__init__()`

Methods

| | |
|--|--|
| <code>__init__()</code> | |
| <code>count(value, /)</code> | Return number of occurrences of value. |
| <code>index(value[, start, stop])</code> | Return first index of value. |

Attributes

| | |
|----------|--------------------------|
| B_r | Alias for field number 7 |
| B_t | Alias for field number 8 |
| XYZ_cr | Alias for field number 3 |
| XYZ_ct | Alias for field number 4 |
| XYZ_r | Alias for field number 1 |
| XYZ_t | Alias for field number 2 |
| Y_r | Alias for field number 5 |
| Y_t | Alias for field number 6 |
| metadata | Alias for field number 9 |
| name | Alias for field number 0 |

colour.CorrespondingChromaticitiesPrediction

class colour.**CorrespondingChromaticitiesPrediction**(name, uv_t, uv_m, uv_p)

Define a chromatic adaptation model prediction.

Parameters

- **name** – Test colour name.
- **uv_t** – Chromaticity coordinates uv_t^p of test colour.
- **uv_m** – Chromaticity coordinates uv_m^p of matching colour.
- **uv_p** – Chromaticity coordinates uv_p^p of predicted colour.

Create new instance of CorrespondingChromaticitiesPrediction(name, uv_t, uv_m, uv_p)

`__init__()`

Methods

| | |
|--|--|
| <code>__init__()</code> | |
| <code>count(value, /)</code> | Return number of occurrences of value. |
| <code>index(value[, start, stop])</code> | Return first index of value. |

Attributes

| | |
|------|--------------------------|
| name | Alias for field number 0 |
| uv_m | Alias for field number 2 |
| uv_p | Alias for field number 3 |
| uv_t | Alias for field number 1 |

Dataset

colour

| | |
|--|---|
| BRENEMAN_EXPERIMENTS | Breneman (1987) experiments. |
| BRENEMAN_EXPERIMENT_PRIMARIES_CHROMATICITIES | Breneman (1987) experiments primaries chromaticities. |

colour.BRENEMAN_EXPERIMENTS

```

colour.BRENEMAN_EXPERIMENTS = {1: (BrenemanExperimentResult(name='Illuminant',
uv_t=array([ 0.259, 0.526]), uv_m=array([ 0.2 , 0.475]), s_uv=array(None, dtype=object),
d_uv_i=array(None, dtype=object), d_uv_g=array(None, dtype=object)),
BrenemanExperimentResult(name='Gray', uv_t=array([ 0.259, 0.524]), uv_m=array([ 0.199,
0.487]), s_uv=array([4, 4]), d_uv_i=array([2, 3]), d_uv_g=array([0, 0])),
BrenemanExperimentResult(name='Red', uv_t=array([ 0.459, 0.522]), uv_m=array([ 0.42 ,
0.509]), s_uv=array([19, 4]), d_uv_i=array([-10, -7]), d_uv_g=array([-19, -3])),
BrenemanExperimentResult(name='Skin', uv_t=array([ 0.307, 0.526]), uv_m=array([ 0.249,
0.497]), s_uv=array([7, 4]), d_uv_i=array([-1, 1]), d_uv_g=array([-6, -1])),
BrenemanExperimentResult(name='Orange', uv_t=array([ 0.36 , 0.544]), uv_m=array([ 0.302,
0.548]), s_uv=array([12, 1]), d_uv_i=array([ 1, -2]), d_uv_g=array([-7, -6])),
BrenemanExperimentResult(name='Brown', uv_t=array([ 0.35 , 0.541]), uv_m=array([ 0.29 ,
0.537]), s_uv=array([11, 4]), d_uv_i=array([3, 0]), d_uv_g=array([-5, -3])),
BrenemanExperimentResult(name='Yellow', uv_t=array([ 0.318, 0.55 ]), uv_m=array([ 0.257,
0.554]), s_uv=array([8, 2]), d_uv_i=array([0, 2]), d_uv_g=array([-5, -5])),
BrenemanExperimentResult(name='Foliage', uv_t=array([ 0.258, 0.542]), uv_m=array([ 0.192,
0.529]), s_uv=array([4, 6]), d_uv_i=array([3, 2]), d_uv_g=array([ 3, -6])),
BrenemanExperimentResult(name='Green', uv_t=array([ 0.193, 0.542]), uv_m=array([ 0.129,
0.521]), s_uv=array([7, 5]), d_uv_i=array([3, 2]), d_uv_g=array([ 9, -7])),
BrenemanExperimentResult(name='Blue-green', uv_t=array([ 0.18 , 0.516]), uv_m=array([
0.133, 0.469]), s_uv=array([4, 6]), d_uv_i=array([-3, -2]), d_uv_g=array([ 2, -5])),
BrenemanExperimentResult(name='Blue', uv_t=array([ 0.186, 0.445]), uv_m=array([ 0.158,
0.34 ]), s_uv=array([13, 33]), d_uv_i=array([2, 7]), d_uv_g=array([ 1, 13])),
BrenemanExperimentResult(name='Sky', uv_t=array([ 0.226, 0.491]), uv_m=array([ 0.178,
0.426]), s_uv=array([ 3, 14]), d_uv_i=array([ 1, -3]), d_uv_g=array([ 0, -1])),
BrenemanExperimentResult(name='Purple', uv_t=array([ 0.278, 0.456]), uv_m=array([ 0.231,
0.365]), s_uv=array([ 4, 25]), d_uv_i=array([0, 2]), d_uv_g=array([-5, 7]))), 2:
(BrenemanExperimentResult(name='Illuminant', uv_t=array([ 0.222, 0.521]), uv_m=array([
0.204, 0.479]), s_uv=array(None, dtype=object), d_uv_i=array(None, dtype=object),
d_uv_g=array(None, dtype=object)), BrenemanExperimentResult(name='Gray', uv_t=array([
0.227, 0.517]), uv_m=array([ 0.207, 0.486]), s_uv=array([2, 5]), d_uv_i=array([-1, 0]),
d_uv_g=array([0, 0])), BrenemanExperimentResult(name='Red', uv_t=array([ 0.464, 0.52 ]),
uv_m=array([ 0.449, 0.511]), s_uv=array([22, 3]), d_uv_i=array([-8, -8]),
d_uv_g=array([-7, -2])), BrenemanExperimentResult(name='Skin', uv_t=array([ 0.286,
0.526]), uv_m=array([ 0.263, 0.505]), s_uv=array([7, 2]), d_uv_i=array([ 0, -1]),
d_uv_g=array([ 0, -1])), BrenemanExperimentResult(name='Orange', uv_t=array([ 0.348,
0.546]), uv_m=array([ 0.322, 0.545]), s_uv=array([13, 3]), d_uv_i=array([ 3, -1]),
d_uv_g=array([ 3, -2])), BrenemanExperimentResult(name='Brown', uv_t=array([ 0.34 ,
0.543]), uv_m=array([ 0.316, 0.537]), s_uv=array([11, 3]), d_uv_i=array([1, 1]),
d_uv_g=array([0, 0])), BrenemanExperimentResult(name='Yellow', uv_t=array([ 0.288,
0.554]), uv_m=array([ 0.265, 0.553]), s_uv=array([5, 2]), d_uv_i=array([-2, 2]),
d_uv_g=array([-1, -2])), BrenemanExperimentResult(name='Foliage', uv_t=array([ 0.244,
0.547]), uv_m=array([ 0.221, 0.538]), s_uv=array([4, 3]), d_uv_i=array([-2, 1]),
d_uv_g=array([ 0, -3])), BrenemanExperimentResult(name='Green', uv_t=array([ 0.156,
0.548]), uv_m=array([ 0.135, 0.532]), s_uv=array([4, 3]), d_uv_i=array([-1, 3]),
d_uv_g=array([ 3, -4])), BrenemanExperimentResult(name='Blue-green', uv_t=array([ 0.159,
0.511]), uv_m=array([ 0.145, 0.472]), s_uv=array([9, 7]), d_uv_i=array([-1, 2]),
d_uv_g=array([2, 1])), BrenemanExperimentResult(name='Blue', uv_t=array([ 0.16 , 0.406]),
uv_m=array([ 0.163, 0.331]), s_uv=array([23, 31]), d_uv_i=array([ 2, -3]),
d_uv_g=array([-1, 3])), BrenemanExperimentResult(name='Sky', uv_t=array([ 0.19 , 0.481]),
uv_m=array([ 0.176, 0.431]), s_uv=array([ 5, 24]), d_uv_i=array([ 2, -2]), d_uv_g=array([2,
0])), BrenemanExperimentResult(name='Purple', uv_t=array([ 0.258, 0.431]), uv_m=array([
0.244, 0.349]), s_uv=array([ 4, 19]), d_uv_i=array([-3, 13]), d_uv_g=array([-4, 19]))), 3:
(BrenemanExperimentResult(name='Illuminant', uv_t=array([ 0.223, 0.521]), uv_m=array([
0.206, 0.478]), s_uv=array(None, dtype=object), d_uv_i=array(None, dtype=object),
d_uv_g=array(None, dtype=object)), BrenemanExperimentResult(name='Gray', uv_t=array([
0.228, 0.517]), uv_m=array([ 0.211, 0.494]), s_uv=array([1, 3]), d_uv_i=array([0, 2]),
d_uv_g=array([0, 0])), BrenemanExperimentResult(name='Red', uv_t=array([ 0.462, 0.519]),
uv_m=array([ 0.448, 0.505]), s_uv=array([11, 4]), d_uv_i=array([-3, 6]), d_uv_g=array([-4,
6])), BrenemanExperimentResult(name='Skin', uv_t=array([ 0.285, 0.524]), uv_m=array([
0.267, 0.507]), s_uv=array([6, 3]), d_uv_i=array([-1, 1]), d_uv_g=array([4, 5])),
BrenemanExperimentResult(name='Orange', uv_t=array([ 0.346, 0.546]), uv_m=array([ 0.325,
0.541]), s_uv=array([11, 3]), d_uv_i=array([ 1, -2]), d_uv_g=array([2, 3])),
BrenemanExperimentResult(name='Brown', uv_t=array([ 0.338, 0.543]), uv_m=array([ 0.321,
0.537]), s_uv=array([11, 3]), d_uv_i=array([ 1, -2]), d_uv_g=array([2, 3]))),

```


Breneman (1987) experiments.

References

[Bre87]

colour.BRENEMAN_EXPERIMENT_PRIMARIES_CHROMATICITIES

```
colour.BRENEMAN_EXPERIMENT_PRIMARIES_CHROMATICITIES = {1:
PrimariesChromaticityCoordinates(experiment=1, illuminants=array(['A', 'D65'],
dtype='<U3'), Y=array(1500), P_uvp=array([ 0.671, 0.519]), D_uvp=array([-0.586, 0.627]),
T_uvp=array([ 0.253, 0.016])), 2: PrimariesChromaticityCoordinates(experiment=2,
illuminants=array(['Projector', 'D55'], dtype='<U9'), Y=array(1500), P_uvp=array([ 0.675,
0.523]), D_uvp=array([-0.466, 0.617]), T_uvp=array([ 0.255, 0.018])), 3:
PrimariesChromaticityCoordinates(experiment=3, illuminants=array(['Projector', 'D55'],
dtype='<U9'), Y=array(75), P_uvp=array([ 0.664, 0.51 ]), D_uvp=array([-0.256, 0.729]),
T_uvp=array([ 0.244, 0.003])), 4: PrimariesChromaticityCoordinates(experiment=4,
illuminants=array(['A', 'D65'], dtype='<U3'), Y=array(75), P_uvp=array([ 0.674, 0.524]),
D_uvp=array([-0.172, 0.628]), T_uvp=array([ 0.218, -0.026])), 6:
PrimariesChromaticityCoordinates(experiment=6, illuminants=array(['A', 'D55'],
dtype='<U3'), Y=array(11100), P_uvp=array([ 0.659, 0.506]), D_uvp=array([-0.141, 0.615]),
T_uvp=array([ 0.249, 0.009])), 8: PrimariesChromaticityCoordinates(experiment=8,
illuminants=array(['A', 'D65'], dtype='<U3'), Y=array(350), P_uvp=array([ 0.659, 0.505]),
D_uvp=array([-0.246, 0.672]), T_uvp=array([ 0.235, -0.006])), 9:
PrimariesChromaticityCoordinates(experiment=9, illuminants=array(['A', 'D65'],
dtype='<U3'), Y=array(15), P_uvp=array([ 0.693, 0.546]), D_uvp=array([-0.446, 0.773]),
T_uvp=array([ 0.221, -0.023])), 11: PrimariesChromaticityCoordinates(experiment=11,
illuminants=array(['D55', 'green'], dtype='<U5'), Y=array(1560), P_uvp=array([ 0.68 ,
0.529]), D_uvp=array([ 0.018, 0.576]), T_uvp=array([ 0.307, 0.08 ])), 12:
PrimariesChromaticityCoordinates(experiment=12, illuminants=array(['D55', 'green'],
dtype='<U5'), Y=array(75), P_uvp=array([ 0.661, 0.505]), D_uvp=array([ 0.039, 0.598]),
T_uvp=array([ 0.345, 0.127]))}
```

Breneman (1987) experiments primaries chromaticities.

References

[Bre87]

BRENEMAN_EXPERIMENT_PRIMARIES_CHROMATICITIES : dict

Fairchild (1990)

colour.corresponding

| | |
|---|--|
| <code>corresponding_chromaticities_prediction_Fair</code> | Return the corresponding chromaticities prediction for <i>Fairchild (1990)</i> chromatic adaptation model. |
|---|--|

colour.corresponding.corresponding_chromaticities_prediction_Fairchild1990

```
colour.corresponding.corresponding_chromaticities_prediction_Fairchild1990(experiment:
    Literal[1, 2, 3, 4, 6, 8, 9, 11, 12] |
    CorrespondingColourDataset =
    1) → Tuple[CorrespondingChromaticitiesPrediction, ...]
```

Return the corresponding chromaticities prediction for *Fairchild (1990)* chromatic adaptation model.

Parameters

experiment (`Literal[1, 2, 3, 4, 6, 8, 9, 11, 12]` | `~colour.corresponding.prediction.CorrespondingColourDataset`) – *Breneman (1987)* experiment number or `colour.CorrespondingColourDataset` class instance.

Returns

Corresponding chromaticities prediction.

Return type

`tuple`

References

[Bre87], [Fai91], [Fai13f]

Examples

```
>>> from pprint import pprint
>>> pr = corresponding_chromaticities_prediction_Fairchild1990(2)
>>> pr = [(p.uv_m, p.uv_p) for p in pr]
>>> pprint(pr)
[(array([ 0.207,  0.486]), array([ 0.2089528...,  0.4724034...])),
 (array([ 0.449,  0.511]), array([ 0.4375652...,  0.5121030...])),
 (array([ 0.263,  0.505]), array([ 0.2621362...,  0.4972538...])),
 (array([ 0.322,  0.545]), array([ 0.3235312...,  0.5475665...])),
 (array([ 0.316,  0.537]), array([ 0.3151391...,  0.5398333...])),
 (array([ 0.265,  0.553]), array([ 0.2634745...,  0.5544335...])),
 (array([ 0.221,  0.538]), array([ 0.2211595...,  0.5324470...])),
 (array([ 0.135,  0.532]), array([ 0.1396949...,  0.5207234...])),
 (array([ 0.145,  0.472]), array([ 0.1512288...,  0.4533041...])),
 (array([ 0.163,  0.331]), array([ 0.1715691...,  0.3026264...])),
 (array([ 0.176,  0.431]), array([ 0.1825792...,  0.4077892...])),
 (array([ 0.244,  0.349]), array([ 0.2418905...,  0.3413401...]))]
```

CIE 1994

`colour.corresponding`

| | |
|---|--|
| <code>corresponding_chromaticities_prediction_CIE1</code> | Return the corresponding chromaticities prediction for <i>CIE 1994</i> chromatic adaptation model. |
|---|--|

`colour.corresponding.corresponding_chromaticities_prediction_CIE1994`

`colour.corresponding.corresponding_chromaticities_prediction_CIE1994`(*experiment*: [Literal](#)[1, 2, 3, 4, 6, 8, 9, 11, 12] | [CorrespondingColourDataset](#) = 1) → [Tuple](#)[[CorrespondingChromaticitiesPrediction](#)...]

Return the corresponding chromaticities prediction for *CIE 1994* chromatic adaptation model.

Parameters

experiment ([Literal](#)[1, 2, 3, 4, 6, 8, 9, 11, 12] | `~colour.corresponding.prediction.CorrespondingColourDataset`) – *Breneman (1987)* experiment number or `colour.CorrespondingColourDataset` class instance.

Returns

Corresponding chromaticities prediction.

Return type

`tuple`

References

[Bre87], [CIET13294]

Examples

```
>>> from pprint import pprint
>>> pr = corresponding_chromaticities_prediction_CIE1994(2)
>>> pr = [(p.uv_m, p.uv_p) for p in pr]
>>> pprint(pr)
[(array([ 0.207,  0.486]), array([ 0.2273130...,  0.5267609...])),
 (array([ 0.449,  0.511]), array([ 0.4612181...,  0.5191849...])),
 (array([ 0.263,  0.505]), array([ 0.2872404...,  0.5306938...])),
 (array([ 0.322,  0.545]), array([ 0.3489822...,  0.5454398...])),
 (array([ 0.316,  0.537]), array([ 0.3371612...,  0.5421567...])),
 (array([ 0.265,  0.553]), array([ 0.2889416...,  0.5534074...])),
 (array([ 0.221,  0.538]), array([ 0.2412195...,  0.5464301...])),
 (array([ 0.135,  0.532]), array([ 0.1530344...,  0.5488239...])),
 (array([ 0.145,  0.472]), array([ 0.1568709...,  0.5258835...])),
 (array([ 0.163,  0.331]), array([ 0.1499762...,  0.4401747...])),
 (array([ 0.176,  0.431]), array([ 0.1876711...,  0.5039627...])),
 (array([ 0.244,  0.349]), array([ 0.2560012...,  0.4546263...]))]
```

CMCCAT2000

`colour.corresponding`

| |
|--|
| <code>corresponding_chromaticities_prediction_CMCCAT2000</code> Return the corresponding chromaticities prediction for <i>CMCCAT2000</i> chromatic adaptation model. |
|--|

`colour.corresponding.corresponding_chromaticities_prediction_CMCCAT2000`

`colour.corresponding.corresponding_chromaticities_prediction_CMCCAT2000`(*experiment*: *Literal*[1, 2, 3, 4, 6, 8, 9, 11, 12] | *CorrespondingColourDataset* = 1) → *Tuple*[*CorrespondingChromaticitiesPrediction*, ...]

Return the corresponding chromaticities prediction for *CMCCAT2000* chromatic adaptation model.

Parameters

experiment (*Literal*[1, 2, 3, 4, 6, 8, 9, 11, 12] | `~colour.corresponding.prediction.CorrespondingColourDataset`) – *Breneman (1987)* experiment number or `colour.CorrespondingColourDataset` class instance.

Returns

Corresponding chromaticities prediction.

Return type

tuple

References

[Bre87], [LLRH02], [WRC12d]

Examples

```
>>> from pprint import pprint
>>> pr = corresponding_chromaticities_prediction_CMCCAT2000(2)
>>> pr = [(p.uv_m, p.uv_p) for p in pr]
>>> pprint(pr)
[(array([ 0.207,  0.486]), array([ 0.2083210...,  0.4727168...])),
 (array([ 0.449,  0.511]), array([ 0.4459270...,  0.5077735...])),
 (array([ 0.263,  0.505]), array([ 0.2640262...,  0.4955361...])),
 (array([ 0.322,  0.545]), array([ 0.3316884...,  0.5431580...])),
 (array([ 0.316,  0.537]), array([ 0.3222624...,  0.5357624...])),
 (array([ 0.265,  0.553]), array([ 0.2710705...,  0.5501997...])),
 (array([ 0.221,  0.538]), array([ 0.2261826...,  0.5294740...])),
 (array([ 0.135,  0.532]), array([ 0.1439693...,  0.5190984...])),
 (array([ 0.145,  0.472]), array([ 0.1494835...,  0.4556760...])),
 (array([ 0.163,  0.331]), array([ 0.1563172...,  0.3164151...])),
 (array([ 0.176,  0.431]), array([ 0.1763199...,  0.4127589...])),
 (array([ 0.244,  0.349]), array([ 0.2287638...,  0.3499324...]))]
```

Von Kries

`colour.corresponding`

| | |
|---|---|
| <code>corresponding_chromaticities_prediction_VonK</code> | Return the corresponding chromaticities prediction for <i>Von Kries</i> chromatic adaptation model using given transform. |
|---|---|

`colour.corresponding.corresponding_chromaticities_prediction_VonKries`

```
colour.corresponding.corresponding_chromaticities_prediction_VonKries(experiment: Literal[1,
2, 3, 4, 6, 8, 9, 11, 12]
| CorrespondingColourDataset = 1,
transform: Literal['Bianco 2010',
'Bianco PC 2010',
'Bradford', 'CAT02 Brill
2008', 'CAT02', 'CAT16',
'CMCCAT2000',
'CMCCAT97', 'Fairchild',
'Sharp', 'Von Kries', 'XYZ
Scaling'] | str =
'CAT02') → Tuple[CorrespondingChromaticitiesPrediction
...]
```

Return the corresponding chromaticities prediction for *Von Kries* chromatic adaptation model using given transform.

Parameters

- **experiment** (`Literal[1, 2, 3, 4, 6, 8, 9, 11, 12]` | `~colour.corresponding.prediction.CorrespondingColourDataset`) – *Breneman (1987)* experiment number or `colour.CorrespondingColourDataset` class instance.
- **transform** (`Literal['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling']` | `str`) – Chromatic adaptation transform.

Returns

Corresponding chromaticities prediction.

Return type

`tuple`

References

[Bre87], [Fai13a]

Examples

```
>>> from pprint import pprint
>>> pr = corresponding_chromaticities_prediction_VonKries(2, "Bradford")
>>> pr = [(p.uv_m, p.uv_p) for p in pr]
>>> pprint(pr)
[(array([ 0.207,  0.486]), array([ 0.2082014...,  0.4722922...])),
 (array([ 0.449,  0.511]), array([ 0.4489102...,  0.5071602...])),
 (array([ 0.263,  0.505]), array([ 0.2643545...,  0.4959631...])),
 (array([ 0.322,  0.545]), array([ 0.3348730...,  0.5471220...])),
 (array([ 0.316,  0.537]), array([ 0.3248758...,  0.5390589...])),
 (array([ 0.265,  0.553]), array([ 0.2733105...,  0.5555028...])),
 (array([ 0.221,  0.538]), array([ 0.227148 ...,  0.5331318...])),
 (array([ 0.135,  0.532]), array([ 0.1442730...,  0.5226804...])),
 (array([ 0.145,  0.472]), array([ 0.1498745...,  0.4550785...])),
 (array([ 0.163,  0.331]), array([ 0.1564975...,  0.3148796...])),
 (array([ 0.176,  0.431]), array([ 0.1760593...,  0.4103772...])),
 (array([ 0.244,  0.349]), array([ 0.2259805...,  0.3465291...]))]
```

Colour Difference

Delta E

colour

| | |
|--------------------------------------|--|
| <code>delta_E(a, b[, method])</code> | Return the difference ΔE_{ab} between two given CIE $L^*a^*b^*$, $IC_T C_P$, or $J'a'b'$ colour space arrays using given method. |
| <code>DELTA_E_METHODS</code> | Supported ΔE_{ab} computation methods. |

colour.delta_E

`colour.delta_E(a: ArrayLike, b: ArrayLike, method: Literal['CIE 1976', 'CIE 1994', 'CIE 2000', 'CMC', 'ITP', 'CAM02-LCD', 'CAM02-SCD', 'CAM02-UCS', 'CAM16-LCD', 'CAM16-SCD', 'CAM16-UCS', 'DIN99'] | str = 'CIE 2000', **kwargs: Any)` → `FloatingOrNDArray`

Return the difference ΔE_{ab} between two given CIE $L^*a^*b^*$, $IC_T C_P$, or $J'a'b'$ colour space arrays using given method.

Parameters

- **a** (`ArrayLike`) – CIE $L^*a^*b^*$, $IC_T C_P$, or $J'a'b'$ colour space array a .
- **b** (`ArrayLike`) – CIE $L^*a^*b^*$, $IC_T C_P$, or $J'a'b'$ colour space array b .
- **method** (`Literal`['CIE 1976', 'CIE 1994', 'CIE 2000', 'CMC', 'ITP', 'CAM02-LCD', 'CAM02-SCD', 'CAM02-UCS', 'CAM16-LCD', 'CAM16-SCD', 'CAM16-UCS', 'DIN99'] | `str`) – Computation method.
- **c** – {`colour.difference.delta_E_CIE2000()`}, Chroma weighting factor.
- **l** – {`colour.difference.delta_E_CIE2000()`}, Lightness weighting factor.
- **textiles** – {`colour.difference.delta_E_CIE1994()`, `colour.difference.delta_E_CIE2000()`, `colour.difference.delta_E_DIN99()`}, Textiles application specific parametric factors $k_L = 2$, $k_C = k_H = 1$, $k_1 = 0.048$, $k_2 = 0.014$, $k_E = 2$, $k_C H = 0.5$ weights are used instead of $k_L = k_C = k_H = 1$, $k_1 = 0.045$, $k_2 = 0.015$, $k_E = k_C H = 1.0$.

- **kwargs** (*Any*) –

Returns

Colour difference ΔE_{ab} .

Return type

`numpy.float64` or `numpy.ndarray`

References

[ASTMInternational07], [InternationalTUnion19], [LLW+17], [Lin03a], [Lin11], [Lin09b], [Lin09c], [LCL06], [Mel13], [Wikipedia08a]

Examples

```
>>> import numpy as np
>>> a = np.array([100.00000000, 21.57210357, 272.22819350])
>>> b = np.array([100.00000000, 426.67945353, 72.39590835])
>>> delta_E(a, b)
94.0356490...
>>> delta_E(a, b, method="CIE 2000")
94.0356490...
>>> delta_E(a, b, method="CIE 1976")
451.7133019...
>>> delta_E(a, b, method="CIE 1994")
83.7792255...
>>> delta_E(a, b, method="CIE 1994", textiles=False)
...
83.7792255...
>>> delta_E(a, b, method="DIN99")
66.1119282...
>>> a = np.array([0.4885468072, -0.04739350675, 0.07475401302])
>>> b = np.array([0.4899203231, -0.04567508203, 0.07361341775])
>>> delta_E(a, b, method="ITP")
1.42657228...
>>> a = np.array([54.90433134, -0.08450395, -0.06854831])
>>> b = np.array([54.90433134, -0.08442362, -0.06848314])
>>> delta_E(a, b, method="CAM02-UCS")
0.0001034...
>>> delta_E(a, b, method="CAM16-LCD")
0.0001034...
```

colour.DELTA_E_METHODS

```
colour.DELTA_E_METHODS = CanonicalMapping({'CIE 1976': ..., 'CIE 1994': ..., 'CIE 2000': ...,
..., 'CMC': ..., 'ITP': ..., 'CAM02-LCD': ..., 'CAM02-SCD': ..., 'CAM02-UCS': ...,
'CAM16-LCD': ..., 'CAM16-SCD': ..., 'CAM16-UCS': ..., 'DIN99': ..., 'cie1976': ...,
'cie1994': ..., 'cie2000': ...})
```

Supported ΔE_{ab} computation methods.

References

[ASTMInternational07], [LLW+17], [Lin03a], [Lin11], [Lin09b], [Lin09c], [LCL06], [Mel13], [Wikipedia08a]

Aliases:

- ‘cie1976’: ‘CIE 1976’
- ‘cie1994’: ‘CIE 1994’
- ‘cie2000’: ‘CIE 2000’

CIE 1976

`colour.difference`

| | |
|--|--|
| <code>JND_CIE1976</code> | Just Noticeable Difference (JND) according to <i>CIE 1976</i> colour difference formula, i.e. Euclidean distance in <i>CIE L*a*b*</i> colourspace. |
| <code>delta_E_CIE1976(Lab_1, Lab_2)</code> | Return the difference ΔE_{76} between two given <i>CIE L*a*b*</i> colourspace arrays using <i>CIE 1976</i> recommendation. |

`colour.difference.JND_CIE1976`

`colour.difference.JND_CIE1976 = 2.3`

Just Noticeable Difference (JND) according to *CIE 1976* colour difference formula, i.e. Euclidean distance in *CIE L*a*b** colourspace.

Notes

A standard observer sees the difference in colour as follows:

- $0 < \Delta E_{ab}^* < 1$: Observer does not notice the difference.
- $1 < \Delta E_{ab}^* < 2$: Only experienced observer can notice the difference.
- $2 < \Delta E_{ab}^* < 3.5$: Unexperienced observer also notices the difference.
- $3.5 < \Delta E_{ab}^* < 5$: Clear difference in colour is noticed.
- $5 < \Delta E_{ab}^*$: Observer notices two different colours.

References

[MT11]

colour.difference.delta_E_CIE1976

`colour.difference.delta_E_CIE1976(Lab_1: ArrayLike, Lab_2: ArrayLike) → FloatingOrNDArray`

Return the difference ΔE_{76} between two given CIE $L^*a^*b^*$ colourspace arrays using CIE 1976 recommendation.

Parameters

- **Lab_1** (ArrayLike) – CIE $L^*a^*b^*$ colourspace array 1.
- **Lab_2** (ArrayLike) – CIE $L^*a^*b^*$ colourspace array 2.

Returns

Colour difference ΔE_{76} .

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Do-main | Scale - Reference | Scale - 1 |
|---------|--|--|
| Lab_1 | L_1 : [0, 100] a_1 : [-100, 100] b_1 : [-100, 100] | L_1 : [0, 1] a_1 : [-1, 1] b_1 : [-1, 1] |
| Lab_2 | L_2 : [0, 100] a_2 : [-100, 100] b_2 : [-100, 100] | L_2 : [0, 1] a_2 : [-1, 1] b_2 : [-1, 1] |

References

[Lin03a]

Examples

```
>>> Lab_1 = np.array([100.00000000, 21.57210357, 272.22819350])
>>> Lab_2 = np.array([100.00000000, 426.67945353, 72.39590835])
>>> delta_E_CIE1976(Lab_1, Lab_2)
451.7133019...
```

CIE 1994

`colour.difference`

| | |
|--|---|
| <code>delta_E_CIE1994(Lab_1, Lab_2[, textiles])</code> | Return the difference ΔE_{94} between two given CIE $L^*a^*b^*$ colourspace arrays using CIE 1994 recommendation. |
|--|---|

colour.difference.delta_E_CIE1994

`colour.difference.delta_E_CIE1994(Lab_1: ArrayLike, Lab_2: ArrayLike, textiles: bool = False) → FloatingOrNDArray`

Return the difference ΔE_{94} between two given CIE $L^*a^*b^*$ colourspace arrays using CIE 1994 recommendation.

Parameters

- **Lab_1** (ArrayLike) – CIE $L^*a^*b^*$ colourspace array 1.
- **Lab_2** (ArrayLike) – CIE $L^*a^*b^*$ colourspace array 2.
- **textiles** (bool) – Textiles application specific parametric factors, $k_L = 2$, $k_C = k_H = 1$, $k_1 = 0.048$, $k_2 = 0.014$ weights are used instead of $k_L = k_C = k_H = 1$, $k_1 = 0.045$, $k_2 = 0.015$.

Returns

Colour difference ΔE_{94} .

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Do-main | Scale - Reference | Scale - 1 |
|---------|-------------------|---------------|
| Lab_1 | L_1 : [0, 100] | L_1 : [0, 1] |
| | a_1 : [-100, 100] | a_1 : [-1, 1] |
| | b_1 : [-100, 100] | b_1 : [-1, 1] |
| Lab_2 | L_2 : [0, 100] | L_2 : [0, 1] |
| | a_2 : [-100, 100] | a_2 : [-1, 1] |
| | b_2 : [-100, 100] | b_2 : [-1, 1] |

- CIE 1994 colour differences are not symmetrical: difference between Lab_1 and Lab_2 may not be the same as difference between Lab_2 and Lab_1 thus one colour must be understood to be the reference against which a sample colour is compared.

References

[Lin11]

Examples

```
>>> Lab_1 = np.array([100.00000000, 21.57210357, 272.22819350])
>>> Lab_2 = np.array([100.00000000, 426.67945353, 72.39590835])
>>> delta_E_CIE1994(Lab_1, Lab_2)
83.7792255...
>>> delta_E_CIE1994(Lab_1, Lab_2, textiles=True)
88.3355530...
```

CIE 2000

colour.difference

| | |
|--|---|
| <code>delta_E_CIE2000(Lab_1, Lab_2[, textiles])</code> | Return the difference ΔE_{00} between two given CIE $L^*a^*b^*$ colourspace arrays using CIE 2000 recommendation. |
|--|---|

colour.difference.delta_E_CIE2000

colour.difference.**delta_E_CIE2000**(Lab_1: ArrayLike, Lab_2: ArrayLike, textiles: bool = False) → FloatingOrNDArray

Return the difference ΔE_{00} between two given CIE $L^*a^*b^*$ colourspace arrays using CIE 2000 recommendation.

Parameters

- **Lab_1** (ArrayLike) – CIE $L^*a^*b^*$ colourspace array 1.
- **Lab_2** (ArrayLike) – CIE $L^*a^*b^*$ colourspace array 2.
- **textiles** (bool) – Textiles application specific parametric factors. $k_L = 2$, $k_C = k_H = 1$ weights are used instead of $k_L = k_C = k_H = 1$.

Returns

Colour difference ΔE_{00} .

Return type

numpy.floating or numpy.ndarray

Notes

| Do-main | Scale - Reference | Scale - 1 |
|---------|-------------------|---------------|
| Lab_1 | L_1 : [0, 100] | L_1 : [0, 1] |
| | a_1 : [-100, 100] | a_1 : [-1, 1] |
| | b_1 : [-100, 100] | b_1 : [-1, 1] |
| Lab_2 | L_2 : [0, 100] | L_2 : [0, 1] |
| | a_2 : [-100, 100] | a_2 : [-1, 1] |
| | b_2 : [-100, 100] | b_2 : [-1, 1] |

- Parametric factors $k_L = k_C = k_H = 1$ weights under *reference conditions*:
 - Illumination: D65 source
 - Illuminance: 1000 lx
 - Observer: Normal colour vision
 - Background field: Uniform, neutral gray with $L^* = 50$
 - Viewing mode: Object
 - Sample size: Greater than 4 degrees
 - Sample separation: Direct edge contact
 - Sample colour-difference magnitude: Lower than 5.0 ΔE_{00}
 - Sample structure: Homogeneous (without texture)

References

[Lin09b], [Mel13]

Examples

```
>>> Lab_1 = np.array([100.00000000, 21.57210357, 272.22819350])
>>> Lab_2 = np.array([100.00000000, 426.67945353, 72.39590835])
>>> delta_E_CIE2000(Lab_1, Lab_2)
94.0356490...
>>> Lab_2 = np.array([50.00000000, 426.67945353, 72.39590835])
>>> delta_E_CIE2000(Lab_1, Lab_2)
100.8779470...
>>> delta_E_CIE2000(Lab_1, Lab_2, textiles=True)
95.7920535...
```

CMC

colour.difference

`delta_E_CMC(Lab_1, Lab_2[, l, c])`

Return the difference ΔE_{CMC} between two given CIE $L^*a^*b^*$ colourspace arrays using *Colour Measurement Committee* recommendation.

colour.difference.delta_E_CMC

colour.difference.**delta_E_CMC**(Lab_1: ArrayLike, Lab_2: ArrayLike, l: float = 2, c: float = 1) → FloatingOrNDArray

Return the difference ΔE_{CMC} between two given CIE $L^*a^*b^*$ colourspace arrays using *Colour Measurement Committee* recommendation.

The quasimetric has two parameters: *Lightness* (l) and *chroma* (c), allowing the users to weight the difference based on the ratio of l:c. Commonly used values are 2:1 for acceptability and 1:1 for the threshold of imperceptibility.

Parameters

- **Lab_1** (ArrayLike) – CIE $L^*a^*b^*$ colourspace array 1.
- **Lab_2** (ArrayLike) – CIE $L^*a^*b^*$ colourspace array 2.
- **l** (float) – Lightness weighting factor.
- **c** (float) – Chroma weighting factor.

Returns

Colour difference ΔE_{CMC} .

Return type

numpy.floating or numpy.ndarray

Notes

| Do-main | Scale - Reference | Scale - 1 |
|---------|--|--|
| Lab_1 | L_1 : [0, 100] a_1 : [-100, 100] b_1 : [-100, 100] | L_1 : [0, 1] a_1 : [-1, 1] b_1 : [-1, 1] |
| Lab_2 | L_2 : [0, 100] a_2 : [-100, 100] b_2 : [-100, 100] | L_2 : [0, 1] a_2 : [-1, 1] b_2 : [-1, 1] |

References

[Lin09c]

Examples

```
>>> Lab_1 = np.array([100.00000000, 21.57210357, 272.22819350])
>>> Lab_2 = np.array([100.00000000, 426.67945353, 72.39590835])
>>> delta_E_CMC(Lab_1, Lab_2)
172.7047712...
```

ITP

colour.difference

| | |
|--|--|
| <code>delta_E_ITP(ICtCp_1, ICtCp_2)</code> | Return the difference ΔE_{ITP} between two given $IC_T C_P$ colour encoding arrays using <i>Recommendation ITU-R BT.2124</i> . |
|--|--|

colour.difference.delta_E_ITP

colour.difference.**delta_E_ITP**(ICtCp_1: ArrayLike, ICtCp_2: ArrayLike) → FloatingOrNDArrayReturn the difference ΔE_{ITP} between two given $IC_T C_P$ colour encoding arrays using *Recommendation ITU-R BT.2124*.

Parameters

- **ICtCp_1** (ArrayLike) – $IC_T C_P$ colour encoding array 1.
- **ICtCp_2** (ArrayLike) – $IC_T C_P$ colour encoding array 2.

Returns

Colour difference ΔE_{ITP} .

Return type

numpy.floating or numpy.ndarray

Notes

- A value of 1 is equivalent to a just noticeable difference when viewed in the most critical adaptation state.

References

[InternationalTUnion19]

Examples

```
>>> ICtCp_1 = np.array([0.4885468072, -0.04739350675, 0.07475401302])
>>> ICtCp_2 = np.array([0.4899203231, -0.04567508203, 0.07361341775])
>>> delta_E_ITP(ICtCp_1, ICtCp_2)
1.42657228...
```

Luo, Cui and Li (2006)

colour.difference

| | |
|---|--|
| <code>delta_E_CAM02LCD(Jpapbp_1, Jpapbp_2)</code> | Return the difference $\Delta E'$ between two given Luo <i>et al. (2006)</i> CAM02-LCD colourspaces $J'a'b'$ arrays. |
| <code>delta_E_CAM02SCD(Jpapbp_1, Jpapbp_2)</code> | Return the difference $\Delta E'$ between two given Luo <i>et al. (2006)</i> CAM02-SCD colourspaces $J'a'b'$ arrays. |
| <code>delta_E_CAM02UCS(Jpapbp_1, Jpapbp_2)</code> | Return the difference $\Delta E'$ between two given Luo <i>et al. (2006)</i> CAM02-UCS colourspaces $J'a'b'$ arrays. |

colour.difference.delta_E_CAM02LCD

colour.difference.**delta_E_CAM02LCD**(*Jpapbp_1*: ArrayLike, *Jpapbp_2*: ArrayLike) → FloatingOrNDArray

Return the difference $\Delta E'$ between two given Luo *et al. (2006)* CAM02-LCD colourspaces $J'a'b'$ arrays.

Parameters

- **Jpapbp_1** (ArrayLike) – Standard / reference Luo *et al. (2006)* CAM02-LCD colourspaces $J'a'b'$ array.
- **Jpapbp_2** (ArrayLike) – Sample / test Luo *et al. (2006)* CAM02-LCD colourspaces $J'a'b'$ array.

Returns

Colour difference $\Delta E'$.

Return type

numpy.floating or numpy.ndarray

Warning: The $J'a'b'$ array should have been computed with a Luo *et al. (2006)* CAM02-LCD, CAM02-SCD, or CAM02-UCS colourspace and not with the CIE $L^*a^*b^*$ colourpace.

Notes

| Domain | Scale - Reference | Scale - 1 |
|----------|--------------------|----------------|
| Jpapbp_1 | Jp_1 : [0, 100] | Jp_1 : [0, 1] |
| | ap_1 : [-100, 100] | ap_1 : [-1, 1] |
| | bp_1 : [-100, 100] | bp_1 : [-1, 1] |
| Jpapbp_2 | Jp_2 : [0, 100] | Jp_2 : [0, 1] |
| | ap_2 : [-100, 100] | ap_2 : [-1, 1] |
| | bp_2 : [-100, 100] | bp_2 : [-1, 1] |

References

[LCL06]

Examples

```
>>> Jpapbp_1 = np.array([54.90433134, -0.08450395, -0.06854831])
>>> Jpapbp_2 = np.array([54.80352754, -3.96940084, -13.57591013])
>>> delta_E_CAM02LCD(Jpapbp_1, Jpapbp_2)
14.0555464...
```

colour.difference.delta_E_CAM02SCD

`colour.difference.delta_E_CAM02SCD(Jpapbp_1: ArrayLike, Jpapbp_2: ArrayLike) → FloatingOrNDArray`

Return the difference $\Delta E'$ between two given *Luo et al. (2006) CAM02-SCD* colourspaces $J'a'b'$ arrays.

Parameters

- **Jpapbp_1** (ArrayLike) – Standard / reference *Luo et al. (2006) CAM02-SCD* colourspaces $J'a'b'$ array.
- **Jpapbp_2** (ArrayLike) – Sample / test *Luo et al. (2006) CAM02-SCD* colourspaces $J'a'b'$ array.

Returns

Colour difference $\Delta E'$.

Return type

`numpy.floating` or `numpy.ndarray`

Warning: The $J'a'b'$ array should have been computed with a *Luo et al. (2006) CAM02-LCD*, *CAM02-SCD*, or *CAM02-UCS* colourspace and not with the *CIE $L^*a^*b^*$* colourpace.

Notes

| Domain | Scale - Reference | Scale - 1 |
|----------|--------------------|----------------|
| Jpapbp_1 | Jp_1 : [0, 100] | Jp_1 : [0, 1] |
| | ap_1 : [-100, 100] | ap_1 : [-1, 1] |
| | bp_1 : [-100, 100] | bp_1 : [-1, 1] |
| Jpapbp_2 | Jp_2 : [0, 100] | Jp_2 : [0, 1] |
| | ap_2 : [-100, 100] | ap_2 : [-1, 1] |
| | bp_2 : [-100, 100] | bp_2 : [-1, 1] |

References

[LCL06]

Examples

```
>>> Jpapbp_1 = np.array([54.90433134, -0.08450395, -0.06854831])
>>> Jpapbp_2 = np.array([54.80352754, -3.96940084, -13.57591013])
>>> delta_E_CAM02SCD(Jpapbp_1, Jpapbp_2)
14.0551718...
```

colour.difference.delta_E_CAM02UCS

`colour.difference.delta_E_CAM02UCS(Jpapbp_1: ArrayLike, Jpapbp_2: ArrayLike) → FloatingOrNDArray`

Return the difference $\Delta E'$ between two given *Luo et al. (2006) CAM02-UCS* colourspaces $J'a'b'$ arrays.

Parameters

- **Jpapbp_1** (ArrayLike) – Standard / reference *Luo et al. (2006) CAM02-UCS* colourspaces $J'a'b'$ array.
- **Jpapbp_2** (ArrayLike) – Sample / test *Luo et al. (2006) CAM02-UCS* colourspaces $J'a'b'$ array.

Returns

Colour difference $\Delta E'$.

Return type

`numpy.floating` or `numpy.ndarray`

Warning: The $J'a'b'$ array should have been computed with a *Luo et al. (2006) CAM02-LCD*, *CAM02-SCD*, or *CAM02-UCS* colourspace and not with the *CIE $L^*a^*b^*$* colourpace.

Notes

| Domain | Scale - Reference | Scale - 1 |
|----------|--------------------|----------------|
| Jpapbp_1 | Jp_1 : [0, 100] | Jp_1 : [0, 1] |
| | ap_1 : [-100, 100] | ap_1 : [-1, 1] |
| | bp_1 : [-100, 100] | bp_1 : [-1, 1] |
| Jpapbp_2 | Jp_2 : [0, 100] | Jp_2 : [0, 1] |
| | ap_2 : [-100, 100] | ap_2 : [-1, 1] |
| | bp_2 : [-100, 100] | bp_2 : [-1, 1] |

References

[LCL06]

Examples

```
>>> Jpapbp_1 = np.array([54.90433134, -0.08450395, -0.06854831])
>>> Jpapbp_2 = np.array([54.80352754, -3.96940084, -13.57591013])
>>> delta_E_CAM02UCS(Jpapbp_1, Jpapbp_2)
14.0552982...
```

Li, Li, Wang, Zu, Luo, Cui, Melgosa, Brill and Pointer (2017)

colour.difference

| | |
|---|---|
| <code>delta_E_CAM16LCD(Jpapbp_1, Jpapbp_2)</code> | Return the difference $\Delta E'$ between two given <i>Li et al. (2017) CAM16-LCD</i> colourspaces $J'a'b'$ arrays. |
| <code>delta_E_CAM16SCD(Jpapbp_1, Jpapbp_2)</code> | Return the difference $\Delta E'$ between two given <i>Li et al. (2017) CAM16-SCD</i> colourspaces $J'a'b'$ arrays. |
| <code>delta_E_CAM16UCS(Jpapbp_1, Jpapbp_2)</code> | Return the difference $\Delta E'$ between two given <i>Li et al. (2017) CAM16-UCS</i> colourspaces $J'a'b'$ arrays. |

colour.difference.delta_E_CAM16LCD

colour.difference.**delta_E_CAM16LCD**(Jpapbp_1, Jpapbp_2)

Return the difference $\Delta E'$ between two given *Li et al. (2017) CAM16-LCD* colourspaces $J'a'b'$ arrays.

Parameters

- **Jpapbp_1** – Standard / reference *Li et al. (2017) CAM16-LCD* colourspaces $J'a'b'$ array.
- **Jpapbp_2** – Sample / test *Li et al. (2017) CAM16-LCD* colourspaces $J'a'b'$ array.

Returns

Colour difference $\Delta E'$.

Return type

`numpy.float64` or `numpy.ndarray`

Warning: The $J'a'b'$ array should have been computed with a *Li et al. (2017) CAM16-LCD*, *CAM16-SCD*, or *CAM16-UCS* colour space and not with the *CIE $L^*a^*b^*$* colour space.

Notes

| Domain | Scale - Reference | Scale - 1 |
|----------|--------------------|----------------|
| Jpapbp_1 | Jp_1 : [0, 100] | Jp_1 : [0, 1] |
| | ap_1 : [-100, 100] | ap_1 : [-1, 1] |
| | bp_1 : [-100, 100] | bp_1 : [-1, 1] |
| Jpapbp_2 | Jp_2 : [0, 100] | Jp_2 : [0, 1] |
| | ap_2 : [-100, 100] | ap_2 : [-1, 1] |
| | bp_2 : [-100, 100] | bp_2 : [-1, 1] |

References

[LLW+17]

colour.difference.delta_E_CAM16SCD

`colour.difference.delta_E_CAM16SCD(Jpapbp_1, Jpapbp_2)`

Return the difference $\Delta E'$ between two given *Li et al. (2017) CAM16-SCD* colour spaces $J'a'b'$ arrays.

Parameters

- **Jpapbp_1** – Standard / reference *Li et al. (2017) CAM16-SCD* colour spaces $J'a'b'$ array.
- **Jpapbp_2** – Sample / test *Li et al. (2017) CAM16-SCD* colour spaces $J'a'b'$ array.

Returns

Colour difference $\Delta E'$.

Return type

`numpy.float64` or `numpy.ndarray`

Warning: The $J'a'b'$ array should have been computed with a *Li et al. (2017) CAM16-LCD*, *CAM16-SCD*, or *CAM16-UCS* colour space and not with the *CIE $L^*a^*b^*$* colour space.

Notes

| Domain | Scale - Reference | Scale - 1 |
|----------|--------------------|----------------|
| Jpapbp_1 | Jp_1 : [0, 100] | Jp_1 : [0, 1] |
| | ap_1 : [-100, 100] | ap_1 : [-1, 1] |
| | bp_1 : [-100, 100] | bp_1 : [-1, 1] |
| Jpapbp_2 | Jp_2 : [0, 100] | Jp_2 : [0, 1] |
| | ap_2 : [-100, 100] | ap_2 : [-1, 1] |
| | bp_2 : [-100, 100] | bp_2 : [-1, 1] |

References

[LLW+17]

colour.difference.delta_E_CAM16UCS

colour.difference.**delta_E_CAM16UCS**(*Jpapbp_1*, *Jpapbp_2*)

Return the difference $\Delta E'$ between two given *Li et al. (2017) CAM16-UCS* colourspaces $J'a'b'$ arrays.

Parameters

- **Jpapbp_1** – Standard / reference *Li et al. (2017) CAM16-UCS* colourspaces $J'a'b'$ array.
- **Jpapbp_2** – Sample / test *Li et al. (2017) CAM16-UCS* colourspaces $J'a'b'$ array.

Returns

Colour difference $\Delta E'$.

Return type

`numpy.floating` or `numpy.ndarray`

Warning: The $J'a'b'$ array should have been computed with a *Li et al. (2017) CAM16-LCD*, *CAM16-SCD*, or *CAM16-UCS* colourspace and not with the *CIE $L^*a^*b^*$* colourspace.

Notes

| Domain | Scale - Reference | Scale - 1 |
|----------|--------------------|----------------|
| Jpapbp_1 | Jp_1 : [0, 100] | Jp_1 : [0, 1] |
| | ap_1 : [-100, 100] | ap_1 : [-1, 1] |
| | bp_1 : [-100, 100] | bp_1 : [-1, 1] |
| Jpapbp_2 | Jp_2 : [0, 100] | Jp_2 : [0, 1] |
| | ap_2 : [-100, 100] | ap_2 : [-1, 1] |
| | bp_2 : [-100, 100] | bp_2 : [-1, 1] |

References

[LLW+17]

DIN99

colour.difference

| | |
|--|---|
| <code>delta_E_DIN99(Lab_1, Lab_2[, textiles])</code> | Return the difference ΔE_{DIN99} between two given <i>CIE $L^*a^*b^*$</i> colourspace arrays using <i>DIN99</i> formula. |
|--|---|

colour.difference.delta_E_DIN99

`colour.difference.delta_E_DIN99(Lab_1: ArrayLike, Lab_2: ArrayLike, textiles: bool = False) → FloatingOrNDArray`

Return the difference ΔE_{DIN99} between two given CIE $L^*a^*b^*$ colourspace arrays using DIN99 formula.

Parameters

- **Lab_1** (ArrayLike) – CIE $L^*a^*b^*$ colourspace array 1.
- **Lab_2** (ArrayLike) – CIE $L^*a^*b^*$ colourspace array 2.
- **textiles** (bool) – Textiles application specific parametric factors, $k_E = 2$, $k_{CH} = 0.5$ weights are used instead of $k_E = 1$, $k_{CH} = 1$.

Returns

Colour difference ΔE_{DIN99} .

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Do-main | Scale - Reference | Scale - 1 |
|---------|-------------------|---------------|
| Lab_1 | L_1 : [0, 100] | L_1 : [0, 1] |
| | a_1 : [-100, 100] | a_1 : [-1, 1] |
| | b_1 : [-100, 100] | b_1 : [-1, 1] |
| Lab_2 | L_2 : [0, 100] | L_2 : [0, 1] |
| | a_2 : [-100, 100] | a_2 : [-1, 1] |
| | b_2 : [-100, 100] | b_2 : [-1, 1] |

References

[ASTMInternational07]

Examples

```
>>> import numpy as np
>>> Lab_1 = np.array([60.2574, -34.0099, 36.2677])
>>> Lab_2 = np.array([60.4626, -34.1751, 39.4387])
>>> delta_E_DIN99(Lab_1, Lab_2)
1.1772166...
```

Standardized Residual Sum of Squares (STRESS) Index

colour

| | |
|---|---|
| <code>index_stress(d_E, d_V[, method])</code> | Compute the <i>Kruskal's Standardized Residual Sum of Squares</i> (:math: `STRESS`) index according to given method. |
| <code>INDEX_STRESS_METHODS</code> | Supported <i>STRESS</i> index computation methods. |

colour.index_stress

`colour.index_stress(d_E: FloatingOrArrayLike, d_V: FloatingOrArrayLike, method: Literal['Garcia 2007'] | str = 'Garcia 2007') → FloatingOrNDArray`

Compute the *Kruskal's Standardized Residual Sum of Squares* (:math: `STRESS`) index according to given method.

Parameters

- **d_E** (FloatingOrArrayLike) – Computed colour difference array ΔE .
- **d_V** (FloatingOrArrayLike) – Computed colour difference array ΔV .
- **method** (*Literal*['Garcia 2007'] | str) – Computation method.

Returns

STRESS index.

Return type

`numpy.floating` or `numpy.ndarray`

References

[GarciaHMC07]

Examples

```
>>> d_E = np.array([2.0425, 2.8615, 3.4412])
>>> d_V = np.array([1.2644, 1.2630, 1.8731])
>>> index_stress(d_E, d_V)
0.1211709...
```

colour.INDEX_STRESS_METHODS

`colour.INDEX_STRESS_METHODS = CanonicalMapping({'Garcia 2007': ...})`

Supported *STRESS* index computation methods.

References

[GarciaHMC07]

`colour.difference`

| | |
|--|--|
| <code>index_stress_Garcia2007(d_E, d_V)</code> | Compute the <i>Kruskal's Standardized Residual Sum of Squares</i> (`STRESS') index according to Garcia ^a , Huertas, Melgosa and Cui (2007) method. |
|--|--|

`colour.difference.index_stress_Garcia2007`

`colour.difference.index_stress_Garcia2007(d_E: FloatingOrArrayLike, d_V: FloatingOrArrayLike) → FloatingOrNDArray`

Compute the *Kruskal's Standardized Residual Sum of Squares* (`STRESS') index according to Garcia^a, Huertas, Melgosa and Cui (2007) method.

Parameters

- **d_E** (FloatingOrArrayLike) – Computed colour difference array ΔE .
- **d_V** (FloatingOrArrayLike) – Computed colour difference array ΔV .

Returns

STRESS index.

Return type

`numpy.floating` or `numpy.ndarray`

References

[GarciaHMC07]

Examples

```
>>> d_E = np.array([2.0425, 2.8615, 3.4412])
>>> d_V = np.array([1.2644, 1.2630, 1.8731])
>>> index_stress_Garcia2007(d_E, d_V)
0.1211709...
```

Huang et al. (2015) Power-Functions

`colour.difference`

| | |
|--|--|
| <code>power_function_Huang2015(d_E[, coefficients])</code> | Improve the performance of the ΔE value for given coefficients using Huang, Cui, Melgosa, Sanchez-Maranon, Li, Luo and Liu (2015) power-function: $d'_E = a * d_E^b$. |
|--|--|

colour.difference.power_function_Huang2015

`colour.difference.power_function_Huang2015(d_E: FloatingOrArrayLike, coefficients: Literal['CIE 1976', 'CIE 1994', 'CIE 2000', 'CMC', 'CAM02-LCD', 'CAM02-SCD', 'CAM16-UCS', 'DIN99d', 'OSA', 'OSA-GP-Euclidean', 'ULAB'] | str = 'CIE 2000') → FloatingOrNDArray`

Improve the performance of the ΔE value for given coefficients using *Huang, Cui, Melgosa, Sanchez-Maranon, Li, Luo and Liu (2015)* power-function: $d'_E = a * d_{E^b}$.

Parameters

- **d_E** (`FloatingOrArrayLike`) – Computed colour difference array ΔE .
- **coefficients** (`Literal`['CIE 1976', 'CIE 1994', 'CIE 2000', 'CMC', 'CAM02-LCD', 'CAM02-SCD', 'CAM16-UCS', 'DIN99d', 'OSA', 'OSA-GP-Euclidean', 'ULAB'] | str) – Coefficients for the power-function.

Returns

Improved math: *Delta E* value.

Return type

`numpy.floating` or `numpy.ndarray`

References

[HCM+15], [LLW+17]

Examples

```
>>> d_E = np.array([2.0425, 2.8615, 3.4412])
>>> power_function_Huang2015(d_E)
array([ 2.3574879...,  2.9850503...,  3.3965106...])
```

Geometry Computations

Ellipse

`colour.geometry`

| | |
|--|--|
| <code>ellipse_coefficients_general_form(coefficients)</code> | Return the general form ellipse coefficients from given canonical form ellipse coefficients. |
| <code>ellipse_coefficients_canonical_form(coefficients)</code> | Return the canonical form ellipse coefficients from given general form ellipse coefficients. |
| <code>point_at_angle_on_ellipse(phi, coefficients)</code> | Return the coordinates of the point at angle ϕ in degrees on the ellipse with given canonical form coefficients. |
| <code>ELLIPSE_FITTING_METHODS</code> | Supported ellipse fitting methods. |
| <code>ellipse_fitting(a[, method])</code> | Return the coefficients of the implicit second-order polynomial/quadratic curve that fits given point array <i>a</i> using given method. |

colour.geometry.ellipse_coefficients_general_form

colour.geometry.ellipse_coefficients_general_form(coefficients: ArrayLike) → ndarray

Return the general form ellipse coefficients from given canonical form ellipse coefficients.

The canonical form ellipse coefficients are as follows: the center coordinates x_c and y_c , semi-major axis length a_a , semi-minor axis length a_b and rotation angle θ in degrees of its semi-major axis a_a .

Parameters

coefficients (ArrayLike) – Canonical form ellipse coefficients.

Returns

General form ellipse coefficients.

Return type

numpy.ndarray

References

[Wikipedia]

Examples

```
>>> coefficients = np.array([0.5, 0.5, 2, 1, 45])
>>> ellipse_coefficients_general_form(coefficients)
array([ 2.5, -3. ,  2.5, -1. , -1. , -3.5])
```

colour.geometry.ellipse_coefficients_canonical_form

colour.geometry.ellipse_coefficients_canonical_form(coefficients: ArrayLike) → ndarray

Return the canonical form ellipse coefficients from given general form ellipse coefficients.

The general form ellipse coefficients are the coefficients of the implicit second-order polynomial/quadratic curve expressed as follows:

$$F(x, y) = ax^2 + bxy + cy^2 + dx + ey + f = 0$$

with an ellipse-specific constraint such as $b^2 - 4ac < 0$ and where a, b, c, d, e, f are coefficients of the ellipse and $F(x, y)$ are coordinates of points lying on it.

Parameters

coefficients (ArrayLike) – General form ellipse coefficients.

Returns

Canonical form ellipse coefficients.

Return type

numpy.ndarray

References

[Wikipedia]

Examples

```
>>> coefficients = np.array([2.5, -3.0, 2.5, -1.0, -1.0, -3.5])
>>> ellipse_coefficients_canonical_form(coefficients)
array([ 0.5,  0.5,  2. ,  1. , 45. ])
```

colour.geometry.point_at_angle_on_ellipse

colour.geometry.point_at_angle_on_ellipse(*phi*: ArrayLike, *coefficients*: ArrayLike) → ndarray

Return the coordinates of the point at angle ϕ in degrees on the ellipse with given canonical form coefficients.

Parameters

- **phi** (ArrayLike) – Point at angle ϕ in degrees to retrieve the coordinates of.
- **coefficients** (ArrayLike) – General form ellipse coefficients as follows: the center coordinates x_c and y_c , semi-major axis length a_a , semi-minor axis length a_b and rotation angle θ in degrees of its semi-major axis a_a .

Returns

Coordinates of the point at angle ϕ

Return type

numpy.ndarray

Examples

```
>>> coefficients = np.array([0.5, 0.5, 2, 1, 45])
>>> point_at_angle_on_ellipse(45, coefficients)
array([ 1.,  2.])
```

colour.geometry.ELLIPSE_FITTING_METHODS

colour.geometry.ELLIPSE_FITTING_METHODS = CanonicalMapping({'Halir 1998': ...})

Supported ellipse fitting methods.

References

[HF98]

colour.geometry.ellipse_fitting

`colour.geometry.ellipse_fitting(a: ArrayLike, method: Literal['Halir 1998'] | str = 'Halir 1998') → ndarray`

Return the coefficients of the implicit second-order polynomial/quadratic curve that fits given point array *a* using given method.

The implicit second-order polynomial is expressed as follows:

$$F(x, y) = ax^2 + bxy + cy^2 + dx + ey + f = 0$$

with an ellipse-specific constraint such as $b^2 - 4ac < 0$ and where a, b, c, d, e, f are coefficients of the ellipse and $F(x, y)$ are coordinates of points lying on it.

Parameters

- **a** (ArrayLike) – Point array *a* to be fitted.
- **method** (*Literal*['Halir 1998'] | str) – Computation method.

Returns

Coefficients of the implicit second-order polynomial/quadratic curve that fits given point array *a*.

Return type

`numpy.ndarray`

References

[HF98]

Examples

```
>>> a = np.array([[2, 0], [0, 1], [-2, 0], [0, -1]])
>>> ellipse_fitting(a)
array([ 0.2425356...,  0.          ,  0.9701425...,  0.          ,  0.          ,
        -0.9701425...])
>>> ellipse_coefficients_canonical_form(ellipse_fitting(a))
array([-0., -0.,  2.,  1.,  0.])
```

Ancillary Objects

`colour.geometry`

`ellipse_fitting_Halir1998(a)`

Return the coefficients of the implicit second-order polynomial/quadratic curve that fits given point array *a* using *Halir and Flusser (1998)* method.

colour.geometry.ellipse_fitting_Halir1998

colour.geometry.ellipse_fitting_Halir1998(*a*: ArrayLike) → ndarray

Return the coefficients of the implicit second-order polynomial/quadratic curve that fits given point array *a* using *Halir and Flusser (1998)* method.

The implicit second-order polynomial is expressed as follows:

$$F(x, y) = ax^2 + bxy + cy^2 + dx + ey + f = 0$$

with an ellipse-specific constraint such as $b^2 - 4ac < 0$ and where a, b, c, d, e, f are coefficients of the ellipse and $F(x, y)$ are coordinates of points lying on it.

Parameters

a (ArrayLike) – Point array *a* to be fitted.

Returns

Coefficients of the implicit second-order polynomial/quadratic curve that fits given point array *a*.

Return type

numpy.ndarray

References

[HF98]

Examples

```
>>> a = np.array([[2, 0], [0, 1], [-2, 0], [0, -1]])
>>> ellipse_fitting_Halir1998(a)
array([ 0.2425356...,  0.          ,  0.9701425...,  0.          ,  0.          ,
        -0.9701425...])
>>> ellipse_coefficients_canonical_form(ellipse_fitting_Halir1998(a))
array([-0., -0.,  2.,  1.,  0.])
```

Intersection

colour.geometry

| | |
|--|---|
| <code>extend_line_segment(a, b[, distance])</code> | Extend the line segment defined by point arrays <i>a</i> and <i>b</i> by given distance and return the new end point. |
| <code>intersect_line_segments(l_1, l_2)</code> | Compute l_1 line segments intersections with l_2 line segments. |

colour.geometry.extend_line_segment

colour.geometry.**extend_line_segment**(*a*: ArrayLike, *b*: ArrayLike, *distance*: float = 1) → ndarray

Extend the line segment defined by point arrays *a* and *b* by given distance and return the new end point.

Parameters

- **a** (ArrayLike) – Point array *a*.
- **b** (ArrayLike) – Point array *b*.
- **distance** (float) – Distance to extend the line segment.

Returns

New end point.

Return type

numpy.ndarray

References

[Saeedn]

Notes

- Input line segment points coordinates are 2d coordinates.

Examples

```
>>> a = np.array([0.95694934, 0.13720932])
>>> b = np.array([0.28382835, 0.60608318])
>>> extend_line_segment(a, b)
array([-0.5367248..., 1.1776534...])
```

colour.geometry.intersect_line_segments

colour.geometry.**intersect_line_segments**(*l_1*: ArrayLike, *l_2*: ArrayLike) → *LineSegmentsIntersections_Specification*

Compute l_1 line segments intersections with l_2 line segments.

Parameters

- **l_1** (ArrayLike) – l_1 line segments array, each row is a line segment such as (x_1, y_1, x_2, y_2) where (x_1, y_1) and (x_2, y_2) are respectively the start and end points of l_1 line segments.
- **l_2** (ArrayLike) – l_2 line segments array, each row is a line segment such as (x_3, y_3, x_4, y_4) where (x_3, y_3) and (x_4, y_4) are respectively the start and end points of l_2 line segments.

Returns

Line segments intersections specification.

Return type

colour.algebra.LineSegmentsIntersections_Specification

References

[Boua], [Erda]

Notes

- Input line segments points coordinates are 2d coordinates.

Examples

```
>>> l_1 = np.array(
...     [
...         [[0.15416284, 0.7400497], [0.26331502, 0.53373939]],
...         [[0.01457496, 0.91874701], [0.90071485, 0.03342143]],
...     ]
... )
>>> l_2 = np.array(
...     [
...         [[0.95694934, 0.13720932], [0.28382835, 0.60608318]],
...         [[0.94422514, 0.85273554], [0.00225923, 0.52122603]],
...         [[0.55203763, 0.48537741], [0.76813415, 0.16071675]],
...     ]
... )
>>> s = intersect_line_segments(l_1, l_2)
>>> s.xy
array([[ [ nan, nan],
        [ 0.2279184..., 0.6006430...],
        [ nan, nan]],
       [[ 0.4281451..., 0.5055568...],
        [ 0.3056055..., 0.6279838...],
        [ 0.7578749..., 0.1761301...]])
>>> s.intersect
array([[False,  True, False],
       [ True,  True,  True]], dtype=bool)
>>> s.parallel
array([[False, False, False],
       [False, False, False]], dtype=bool)
>>> s.coincident
array([[False, False, False],
       [False, False, False]], dtype=bool)
```

Ancillary Objects

colour.geometry

| | |
|---|--|
| <code>LineSegmentsIntersections_Specification(xy, ...)</code> | Define the specification for intersection of line segments l_1 and l_2 returned by <code>colour.algebra.intersect_line_segments()</code> definition. |
|---|--|

colour.geometry.LineSegmentsIntersections_Specification

class colour.geometry.LineSegmentsIntersections_Specification(xy: *ndarray*, intersect: *ndarray*, parallel: *ndarray*, coincident: *ndarray*)

Define the specification for intersection of line segments l_1 and l_2 returned by colour.algebra.intersect_line_segments() definition.

Parameters

- **xy** (*numpy.ndarray*) – Array of l_1 and l_2 line segments intersections coordinates. Non existing segments intersections coordinates are set with *np.nan*.
- **intersect** (*numpy.ndarray*) – Array of *bool* indicating if line segments l_1 and l_2 intersect.
- **parallel** (*numpy.ndarray*) – Array of *bool* indicating if line segments l_1 and l_2 are parallel.
- **coincident** (*numpy.ndarray*) – Array of *bool* indicating if line segments l_1 and l_2 are coincident.

__init__(xy: *ndarray*, intersect: *ndarray*, parallel: *ndarray*, coincident: *ndarray*) → *None*

Parameters

- **xy** (*ndarray*) –
- **intersect** (*ndarray*) –
- **parallel** (*ndarray*) –
- **coincident** (*ndarray*) –

Return type

None

Methods

```
__init__(xy, intersect, parallel, coincident)
```

Attributes

xy

intersect

parallel

coincident

Primitives

colour

| | |
|---------------------|--|
| PRIMITIVE_METHODS | Supported geometry primitive generation methods. |
| primitive([method]) | Return a geometry primitive using given method. |

colour.PRIMITIVE_METHODS

colour.PRIMITIVE_METHODS = CanonicalMapping({'Grid': ..., 'Cube': ...})

Supported geometry primitive generation methods.

colour.primitive

colour.primitive(method: *Literal*['Cube', 'Grid'] | str = 'Cube', **kwargs: Any) → Tuple[ndarray, ndarray, ndarray]

Return a geometry primitive using given method.

Parameters

- **method** (*Literal*['Cube', 'Grid'] | str) – Generation method.
- **axis** – {colour.geometry.primitive_grid()}, Axis the primitive will be normal to, or plane the primitive will be co-planar with.
- **depth** – {colour.geometry.primitive_grid(), colour.geometry.primitive_cube()}, Primitive depth.
- **depth_segments** – {colour.geometry.primitive_grid(), colour.geometry.primitive_cube()}, Primitive segments count along the depth.
- **dtype_indexes** – {colour.geometry.primitive_grid(), colour.geometry.primitive_cube()}, numpy.dtype to use for the grid indexes, default to the numpy.dtype defined by the colour.constant.DEFAULT_INT_DTYPE attribute.
- **dtype_vertices** – {colour.geometry.primitive_grid(), colour.geometry.primitive_cube()}, numpy.dtype to use for the grid vertices, default to the numpy.dtype defined by the colour.constant.DEFAULT_FLOAT_DTYPE attribute.
- **height** – {colour.geometry.primitive_grid(), colour.geometry.primitive_cube()}, Primitive height.
- **planes** – {colour.geometry.primitive_cube()}, Included grid primitives in the cube construction.
- **width** – {colour.geometry.primitive_grid(), colour.geometry.primitive_cube()}, Primitive width.
- **width_segments** – {colour.geometry.primitive_grid(), colour.geometry.primitive_cube()}, Primitive segments count along the width.
- **height_segments** – {colour.geometry.primitive_grid(), colour.geometry.primitive_cube()}, Primitive segments count along the height.
- **kwargs** (Any) –

Returns

Tuple of primitive vertices, face indexes to produce a filled primitive and outline indexes to produce an outline of the faces of the primitive.

Return type

tuple

References

[Cab]

Examples

```

>>> vertices, faces, outline = primitive()
>>> print(vertices)
[([-0.5, 0.5, -0.5], [0., 1.], [-0., -0., -1.], [0., 1., 0., 1.])
 ([0.5, 0.5, -0.5], [1., 1.], [-0., -0., -1.], [1., 1., 0., 1.])
 ([-0.5, -0.5, -0.5], [0., 0.], [-0., -0., -1.], [0., 0., 0., 1.])
 ([0.5, -0.5, -0.5], [1., 0.], [-0., -0., -1.], [1., 0., 0., 1.])
 ([-0.5, 0.5, 0.5], [0., 1.], [0., 0., 1.], [0., 1., 1., 1.])
 ([0.5, 0.5, 0.5], [1., 1.], [0., 0., 1.], [1., 1., 1., 1.])
 ([-0.5, -0.5, 0.5], [0., 0.], [0., 0., 1.], [0., 0., 1., 1.])
 ([0.5, -0.5, 0.5], [1., 0.], [0., 0., 1.], [1., 0., 1., 1.])
 ([0.5, -0.5, -0.5], [0., 1.], [-0., -1., -0.], [1., 0., 0., 1.])
 ([0.5, -0.5, 0.5], [1., 1.], [-0., -1., -0.], [1., 0., 1., 1.])
 ([-0.5, -0.5, -0.5], [0., 0.], [-0., -1., -0.], [0., 0., 0., 1.])
 ([-0.5, -0.5, 0.5], [1., 0.], [-0., -1., -0.], [0., 0., 1., 1.])
 ([0.5, 0.5, -0.5], [0., 1.], [0., 1., 0.], [1., 1., 0., 1.])
 ([0.5, 0.5, 0.5], [1., 1.], [0., 1., 0.], [1., 1., 1., 1.])
 ([-0.5, 0.5, -0.5], [0., 0.], [0., 1., 0.], [0., 1., 0., 1.])
 ([-0.5, 0.5, 0.5], [1., 0.], [0., 1., 0.], [0., 1., 1., 1.])
 ([-0.5, -0.5, 0.5], [0., 1.], [-1., -0., -0.], [0., 0., 1., 1.])
 ([-0.5, 0.5, 0.5], [1., 1.], [-1., -0., -0.], [0., 1., 1., 1.])
 ([-0.5, -0.5, -0.5], [0., 0.], [-1., -0., -0.], [0., 0., 0., 1.])
 ([-0.5, 0.5, -0.5], [1., 0.], [-1., -0., -0.], [0., 1., 0., 1.])
 ([0.5, -0.5, 0.5], [0., 1.], [1., 0., 0.], [1., 0., 1., 1.])
 ([0.5, 0.5, 0.5], [1., 1.], [1., 0., 0.], [1., 1., 1., 1.])
 ([0.5, -0.5, -0.5], [0., 0.], [1., 0., 0.], [1., 0., 0., 1.])
 ([0.5, 0.5, -0.5], [1., 0.], [1., 0., 0.], [1., 1., 0., 1.])]
>>> print(faces)
[[1 2 0]
 [1 3 2]
 [4 6 5]
 [6 7 5]
 [9 10 8]
 [9 11 10]
 [12 14 13]
 [14 15 13]
 [17 18 16]
 [17 19 18]
 [20 22 21]
 [22 23 21]]
>>> print(outline)
[[0 2]
 [2 3]
 [3 1]
 [1 0]
 [4 6]
 [6 7]
 [7 5]]

```

(continues on next page)

(continued from previous page)

```

[ 5  4]
[ 8 10]
[10 11]
[11  9]
[ 9  8]
[12 14]
[14 15]
[15 13]
[13 12]
[16 18]
[18 19]
[19 17]
[17 16]
[20 22]
[22 23]
[23 21]
[21 20]]
>>> vertices, faces, outline = primitive("Grid")
>>> print(vertices)
[([-0.5,  0.5,  0. ], [ 0.,  1.], [ 0.,  0.,  1.], [ 0.,  1.,  0.,  1.])
 ([ 0.5,  0.5,  0. ], [ 1.,  1.], [ 0.,  0.,  1.], [ 1.,  1.,  0.,  1.])
 ([-0.5, -0.5,  0. ], [ 0.,  0.], [ 0.,  0.,  1.], [ 0.,  0.,  0.,  1.])
 ([ 0.5, -0.5,  0. ], [ 1.,  0.], [ 0.,  0.,  1.], [ 1.,  0.,  0.,  1.])]
>>> print(faces)
[[0 2 1]
 [2 3 1]]
>>> print(outline)
[[0 2]
 [2 3]
 [3 1]
 [1 0]]

```

Ancillary Objects

colour.geometry

| | |
|---|--|
| MAPPING_PLANE_TO_AXIS | Plane to axis mapping. |
| primitive_grid([width, height, ...]) | Generate vertices and indexes for a filled and out-lined grid primitive. |
| primitive_cube([width, height, depth, ...]) | Generate vertices and indexes for a filled and out-lined cube primitive. |

colour.geometry.MAPPING_PLANE_TO_AXIS

`colour.geometry.MAPPING_PLANE_TO_AXIS = CanonicalMapping({'yz': ..., 'zy': ..., 'xz': ..., 'zx': ..., 'xy': ..., 'yx': ...})`

Plane to axis mapping.

colour.geometry.primitive_grid

`colour.geometry.primitive_grid(width: float = 1, height: float = 1, width_segments: int = 1, height_segments: int = 1, axis: Literal['-x', '+x', '-y', '+y', '-z', '+z', 'xy', 'xz', 'yz', 'yx', 'zx', 'zy'] = '+z', dtype_vertices: Type[DTypeFloating] | None = None, dtype_indexes: Type[DTypeInteger] | None = None) → Tuple[ndarray, ndarray, ndarray]`

Generate vertices and indexes for a filled and outlined grid primitive.

Parameters

- **width** (`float`) – Grid width.
- **height** (`float`) – Grid height.
- **width_segments** (`int`) – Grid segments count along the width.
- **height_segments** (`int`) – Grid segments count along the height.
- **axis** (`Literal['-x', '+x', '-y', '+y', '-z', '+z', 'xy', 'xz', 'yz', 'yx', 'zx', 'zy']`) – Axis the primitive will be normal to, or plane the primitive will be co-planar with.
- **dtype_vertices** (`Type[DTypeFloating] | None`) – `numpy.dtype` to use for the grid vertices, default to the `numpy.dtype` defined by the `colour.constant.DEFAULT_FLOAT_DTYPE` attribute.
- **dtype_indexes** (`Type[DTypeInteger] | None`) – `numpy.dtype` to use for the grid indexes, default to the `numpy.dtype` defined by the `colour.constant.DEFAULT_INT_DTYPE` attribute.

Returns

Tuple of grid vertices, face indexes to produce a filled grid and outline indexes to produce an outline of the faces of the grid.

Return type

`tuple`

References

[Cab]

Examples

```
>>> vertices, faces, outline = primitive_grid()
>>> print(vertices)
[[-0.5,  0.5,  0. ], [ 0.,  1.,  0. ], [ 0.,  0.,  1.], [ 0.,  1.,  0.,  1.]]
[ 0.5,  0.5,  0. ], [ 1.,  1.,  0. ], [ 0.,  0.,  1.], [ 1.,  1.,  0.,  1.]]
[[-0.5, -0.5,  0. ], [ 0.,  0.], [ 0.,  0.,  1.], [ 0.,  0.,  0.,  1.]]
[ 0.5, -0.5,  0. ], [ 1.,  0.], [ 0.,  0.,  1.], [ 1.,  0.,  0.,  1.]]]
>>> print(faces)
[[0 2 1]
 [2 3 1]]
```

(continues on next page)

(continued from previous page)

```
>>> print(outline)
[[0 2]
 [2 3]
 [3 1]
 [1 0]]
```

colour.geometry.primitive_cube

`colour.geometry.primitive_cube`(width: float = 1, height: float = 1, depth: float = 1, width_segments: int = 1, height_segments: int = 1, depth_segments: int = 1, planes: Literal['-x', '+x', '-y', '+y', '-z', '+z', 'xy', 'xz', 'yz', 'yx', 'zx', 'zy'] | None = None, dtype_vertices: Type[DTypeFloating] | None = None, dtype_indexes: Type[DTypeInteger] | None = None) → Tuple[ndarray, ndarray, ndarray]

Generate vertices and indexes for a filled and outlined cube primitive.

Parameters

- **width** (float) – Cube width.
- **height** (float) – Cube height.
- **depth** (float) – Cube depth.
- **width_segments** (int) – Cube segments count along the width.
- **height_segments** (int) – Cube segments count along the height.
- **depth_segments** (int) – Cube segments count along the depth.
- **planes** (Literal['-x', '+x', '-y', '+y', '-z', '+z', 'xy', 'xz', 'yz', 'yx', 'zx', 'zy'] | None) – Grid primitives to include in the cube construction.
- **dtype_vertices** (Type[DTypeFloating] | None) – `numpy.dtype` to use for the grid vertices, default to the `numpy.dtype` defined by the `colour.constant.DEFAULT_FLOAT_DTYPE` attribute.
- **dtype_indexes** (Type[DTypeInteger] | None) – `numpy.dtype` to use for the grid indexes, default to the `numpy.dtype` defined by the `colour.constant.DEFAULT_INT_DTYPE` attribute.

Returns

Tuple of cube vertices, face indexes to produce a filled cube and outline indexes to produce an outline of the faces of the cube.

Return type

tuple

Examples

```
>>> vertices, faces, outline = primitive_cube()
>>> print(vertices)
[[-0.5,  0.5, -0.5], [ 0.,  1.], [-0., -0., -1.], [ 0.,  1.,  0.,  1.]]
[ 0.5,  0.5, -0.5], [ 1.,  1.], [-0., -0., -1.], [ 1.,  1.,  0.,  1.]]
[-0.5, -0.5, -0.5], [ 0.,  0.], [-0., -0., -1.], [ 0.,  0.,  0.,  1.]]
[ 0.5, -0.5, -0.5], [ 1.,  0.], [-0., -0., -1.], [ 1.,  0.,  0.,  1.]]
[-0.5,  0.5,  0.5], [ 0.,  1.], [ 0.,  0.,  1.], [ 0.,  1.,  1.,  1.]]
[ 0.5,  0.5,  0.5], [ 1.,  1.], [ 0.,  0.,  1.], [ 1.,  1.,  1.,  1.]]
[-0.5, -0.5,  0.5], [ 0.,  0.], [ 0.,  0.,  1.], [ 0.,  0.,  1.,  1.]]
```

(continues on next page)

(continued from previous page)

```

([ 0.5, -0.5,  0.5], [ 1.,  0.], [ 0.,  0.,  1.], [ 1.,  0.,  1.,  1.])
([ 0.5, -0.5, -0.5], [ 0.,  1.], [-0., -1., -0.], [ 1.,  0.,  0.,  1.])
([ 0.5, -0.5,  0.5], [ 1.,  1.], [-0., -1., -0.], [ 1.,  0.,  1.,  1.])
([-0.5, -0.5, -0.5], [ 0.,  0.], [-0., -1., -0.], [ 0.,  0.,  0.,  1.])
([-0.5, -0.5,  0.5], [ 1.,  0.], [-0., -1., -0.], [ 0.,  0.,  1.,  1.])
([ 0.5,  0.5, -0.5], [ 0.,  1.], [ 0.,  1.,  0.], [ 1.,  1.,  0.,  1.])
([ 0.5,  0.5,  0.5], [ 1.,  1.], [ 0.,  1.,  0.], [ 1.,  1.,  1.,  1.])
([-0.5,  0.5, -0.5], [ 0.,  0.], [ 0.,  1.,  0.], [ 0.,  1.,  0.,  1.])
([-0.5,  0.5,  0.5], [ 1.,  0.], [ 0.,  1.,  0.], [ 0.,  1.,  1.,  1.])
([-0.5, -0.5,  0.5], [ 0.,  1.], [-1., -0., -0.], [ 0.,  0.,  1.,  1.])
([-0.5,  0.5,  0.5], [ 1.,  1.], [-1., -0., -0.], [ 0.,  1.,  1.,  1.])
([-0.5, -0.5, -0.5], [ 0.,  0.], [-1., -0., -0.], [ 0.,  0.,  0.,  1.])
([-0.5,  0.5, -0.5], [ 1.,  0.], [-1., -0., -0.], [ 0.,  1.,  0.,  1.])
([ 0.5, -0.5,  0.5], [ 0.,  1.], [ 1.,  0.,  0.], [ 1.,  0.,  1.,  1.])
([ 0.5,  0.5,  0.5], [ 1.,  1.], [ 1.,  0.,  0.], [ 1.,  1.,  1.,  1.])
([ 0.5, -0.5, -0.5], [ 0.,  0.], [ 1.,  0.,  0.], [ 1.,  0.,  0.,  1.])
([ 0.5,  0.5, -0.5], [ 1.,  0.], [ 1.,  0.,  0.], [ 1.,  1.,  0.,  1.])
>>> print(faces)
[[ 1  2  0]
 [ 1  3  2]
 [ 4  6  5]
 [ 6  7  5]
 [ 9 10  8]
 [ 9 11 10]
 [12 14 13]
 [14 15 13]
 [17 18 16]
 [17 19 18]
 [20 22 21]
 [22 23 21]]
>>> print(outline)
[[ 0  2]
 [ 2  3]
 [ 3  1]
 [ 1  0]
 [ 4  6]
 [ 6  7]
 [ 7  5]
 [ 5  4]
 [ 8 10]
 [10 11]
 [11  9]
 [ 9  8]
 [12 14]
 [14 15]
 [15 13]
 [13 12]
 [16 18]
 [18 19]
 [19 17]
 [17 16]
 [20 22]
 [22 23]
 [23 21]
 [21 20]]

```

Primitive Vertices

colour

| | |
|---|---|
| <code>PRIMITIVE_VERTICES_METHODS</code> | Supported geometry primitive vertices generation methods. |
| <code>primitive_vertices([method])</code> | Return the vertices of a geometry primitive using given method. |

colour.PRIMITIVE_VERTICES_METHODS

`colour.PRIMITIVE_VERTICES_METHODS = CanonicalMapping({'Quad MPL': ..., 'Grid MPL': ..., 'Cube MPL': ..., 'Sphere': ...})`

Supported geometry primitive vertices generation methods.

colour.primitive_vertices

`colour.primitive_vertices(method: Literal['Cube MPL', 'Quad MPL', 'Grid MPL', 'Sphere'] | str = 'Cube MPL', **kwargs: Any) → ndarray`

Return the vertices of a geometry primitive using given method.

Parameters

- **method** (*Literal*['Cube MPL', 'Quad MPL', 'Grid MPL', 'Sphere'] | str) – Vertices generation method.
- **axis** – {colour.geometry.primitive_vertices_quad_mpl(), colour.geometry.primitive_vertices_grid_mpl(), colour.geometry.primitive_vertices_sphere()}, {'+z', '+x', '+y', 'yz', 'xz', 'xy'}, Axis the primitive will be normal to, or plane the primitive will be co-planar with.
- **depth** – {colour.geometry.primitive_vertices_quad_mpl(), colour.geometry.primitive_vertices_grid_mpl(), colour.geometry.primitive_vertices_cube_mpl()}, Primitive depth.
- **depth_segments** – {colour.geometry.primitive_vertices_grid_mpl(), colour.geometry.primitive_vertices_cube_mpl()}, Primitive depth segments, quad primitive counts along the depth.
- **height** – {colour.geometry.primitive_vertices_quad_mpl(), colour.geometry.primitive_vertices_grid_mpl(), colour.geometry.primitive_vertices_cube_mpl()}, Primitive height.
- **height_segments** – {colour.geometry.primitive_vertices_grid_mpl(), colour.geometry.primitive_vertices_cube_mpl()}, Primitive height segments, quad primitive counts along the height.
- **intermediate** – {colour.geometry.primitive_vertices_sphere()}, Whether to generate the sphere vertices at the center of the faces outlined by the segments of a regular sphere generated without the intermediate argument set to *True*. The resulting sphere is inscribed on the regular sphere faces but possesses the same poles.
- **origin** – {colour.geometry.primitive_vertices_quad_mpl(), colour.geometry.primitive_vertices_grid_mpl(), colour.geometry.primitive_vertices_cube_mpl(), colour.geometry.primitive_vertices_sphere()}, Primitive origin on the construction plane.

- **planes** – {colour.geometry.primitive_vertices_cube_mpl()}, {'-x', '+x', '-y', '+y', '-z', '+z', 'xy', 'xz', 'yz', 'yx', 'zx', 'zy'}, Included grid primitives in the cube construction.
- **radius** – {colour.geometry.primitive_vertices_sphere()}, Sphere radius.
- **segments** – {colour.geometry.primitive_vertices_sphere()}, Latitude-longitude segments, if the intermediate argument is *True*, then the sphere will have one less segment along its longitude.
- **width** – {colour.geometry.primitive_vertices_quad_mpl(), colour.geometry.primitive_vertices_grid_mpl(), colour.geometry.primitive_vertices_cube_mpl()}, Primitive width.
- **width_segments** – {colour.geometry.primitive_vertices_grid_mpl(), colour.geometry.primitive_vertices_cube_mpl()}, Primitive width segments, quad primitive counts along the width.
- **kwargs** (Any) –

Returns

Primitive vertices.

Return type

numpy.ndarray

Examples

```
>>> primitive_vertices()
array([[ 0.,  0.,  0.],
       [ 1.,  0.,  0.],
       [ 1.,  1.,  0.],
       [ 0.,  1.,  0.]],

      [[ 0.,  0.,  1.],
       [ 1.,  0.,  1.],
       [ 1.,  1.,  1.],
       [ 0.,  1.,  1.]],

      [[ 0.,  0.,  0.],
       [ 1.,  0.,  0.],
       [ 1.,  0.,  1.],
       [ 0.,  0.,  1.]],

      [[ 0.,  1.,  0.],
       [ 1.,  1.,  0.],
       [ 1.,  1.,  1.],
       [ 0.,  1.,  1.]],

      [[ 0.,  0.,  0.],
       [ 0.,  1.,  0.],
       [ 0.,  1.,  1.],
       [ 0.,  0.,  1.]],

      [[ 1.,  0.,  0.],
       [ 1.,  1.,  0.],
       [ 1.,  1.,  1.],
       [ 1.,  0.,  1.]])
>>> primitive_vertices("Quad MPL")
array([[ 0.,  0.,  0.],
```

(continues on next page)

(continued from previous page)

```

[ 1., 0., 0.],
[ 1., 1., 0.],
[ 0., 1., 0.]]
>>> primitive_vertices("Sphere", segments=4)
array([[ 0.0000000...e+00,  0.0000000...e+00,  5.0000000...e-01],
       [-3.5355339...e-01, -4.3297802...e-17,  3.5355339...e-01],
       [-5.0000000...e-01, -6.1232340...e-17,  3.0616170...e-17],
       [-3.5355339...e-01, -4.3297802...e-17, -3.5355339...e-01],
       [-6.1232340...e-17, -7.4987989...e-33, -5.0000000...e-01]],

       [[ 0.0000000...e+00,  0.0000000...e+00,  5.0000000...e-01],
       [ 2.1648901...e-17, -3.5355339...e-01,  3.5355339...e-01],
       [ 3.0616170...e-17, -5.0000000...e-01,  3.0616170...e-17],
       [ 2.1648901...e-17, -3.5355339...e-01, -3.5355339...e-01],
       [ 3.7493994...e-33, -6.1232340...e-17, -5.0000000...e-01]],

       [[ 0.0000000...e+00,  0.0000000...e+00,  5.0000000...e-01],
       [ 3.5355339...e-01,  0.0000000...e+00,  3.5355339...e-01],
       [ 5.0000000...e-01,  0.0000000...e+00,  3.0616170...e-17],
       [ 3.5355339...e-01,  0.0000000...e+00, -3.5355339...e-01],
       [ 6.1232340...e-17,  0.0000000...e+00, -5.0000000...e-01]],

       [[ 0.0000000...e+00,  0.0000000...e+00,  5.0000000...e-01],
       [ 2.1648901...e-17,  3.5355339...e-01,  3.5355339...e-01],
       [ 3.0616170...e-17,  5.0000000...e-01,  3.0616170...e-17],
       [ 2.1648901...e-17,  3.5355339...e-01, -3.5355339...e-01],
       [ 3.7493994...e-33,  6.1232340...e-17, -5.0000000...e-01]]])

```

colour.geometry

| | |
|--|--|
| <code>primitive_vertices_quad_mpl([width, height, ...])</code> | Return the vertices of a quad primitive for use with <i>Matplotlib</i> <code>mpl_toolkits.mplot3d.art3d.Poly3DCollection</code> class. |
| <code>primitive_vertices_grid_mpl([width, height, ...])</code> | Return the vertices of a grid primitive made of quad primitives for use with <i>Matplotlib</i> <code>mpl_toolkits.mplot3d.art3d.Poly3DCollection</code> class. |
| <code>primitive_vertices_cube_mpl([width, height, ...])</code> | Return the vertices of a cube primitive made of grid primitives for use with <i>Matplotlib</i> <code>mpl_toolkits.mplot3d.art3d.Poly3DCollection</code> class. |
| <code>primitive_vertices_sphere([radius, ...])</code> | Return the vertices of a latitude-longitude sphere primitive. |

colour.geometry.primitive_vertices_quad_mpl

`colour.geometry.primitive_vertices_quad_mpl`(width: *float* = 1, height: *float* = 1, depth: *float* = 0, origin: *ArrayLike* = `np.array([0, 0])`, axis: *Literal*['+z', '+x', '+y', 'yz', 'xz', 'xy'] | *str* = '+z') → *ndarray*

Return the vertices of a quad primitive for use with *Matplotlib* `mpl_toolkits.mplot3d.art3d.Poly3DCollection` class.

Parameters

- **width** (*float*) – Quad width.
- **height** (*float*) – Quad height.
- **depth** (*float*) – Quad depth.
- **origin** (*ArrayLike*) – Quad origin on the construction plane.
- **axis** (*Literal*['+z', '+x', '+y', 'yz', 'xz', 'xy'] | *str*) – Axis the quad will be normal to, or plane the quad will be co-planar with.

Returns

Quad primitive vertices.

Return type

numpy.ndarray

Examples

```
>>> primitive_vertices_quad_mpl()
array([[ 0.,  0.,  0.],
       [ 1.,  0.,  0.],
       [ 1.,  1.,  0.],
       [ 0.,  1.,  0.]])
```

colour.geometry.primitive_vertices_grid_mpl

`colour.geometry.primitive_vertices_grid_mpl`(*width*: *float* = 1, *height*: *float* = 1, *depth*: *float* = 0, *width_segments*: *int* = 1, *height_segments*: *int* = 1, *origin*: *ArrayLike* = *np.array*([0, 0]), *axis*: *Literal*['+z', '+x', '+y', 'yz', 'xz', 'xy'] | *str* = '+z') → *ndarray*

Return the vertices of a grid primitive made of quad primitives for use with *Matplotlib* *mpl_toolkits.mplot3d.art3d.Poly3DCollection* class.

Parameters

- **width** (*float*) – Grid width.
- **height** (*float*) – Grid height.
- **depth** (*float*) – Grid depth.
- **width_segments** (*int*) – Grid width segments, quad primitive counts along the width.
- **height_segments** (*int*) – Grid height segments, quad primitive counts along the height.
- **origin** (*ArrayLike*) – Grid origin on the construction plane.
- **axis** (*Literal*['+z', '+x', '+y', 'yz', 'xz', 'xy'] | *str*) – Axis the grid will be normal to, or plane the grid will be co-planar with.

Returns

Grid primitive vertices.

Return type

numpy.ndarray

Examples

```
>>> primitive_vertices_grid_mpl(width_segments=2, height_segments=2)
array([[ 0. ,  0. ,  0. ],
       [ 0.5,  0. ,  0. ],
       [ 0.5,  0.5,  0. ],
       [ 0. ,  0.5,  0. ]],

      [[ 0. ,  0.5,  0. ],
       [ 0.5,  0.5,  0. ],
       [ 0.5,  1. ,  0. ],
       [ 0. ,  1. ,  0. ]],

      [[ 0.5,  0. ,  0. ],
       [ 1. ,  0. ,  0. ],
       [ 1. ,  0.5,  0. ],
       [ 0.5,  0.5,  0. ]],

      [[ 0.5,  0.5,  0. ],
       [ 1. ,  0.5,  0. ],
       [ 1. ,  1. ,  0. ],
       [ 0.5,  1. ,  0. ]])
```

colour.geometry.primitive_vertices_cube_mpl

colour.geometry.primitive_vertices_cube_mpl(*width: float = 1, height: float = 1, depth: float = 1, width_segments: int = 1, height_segments: int = 1, depth_segments: int = 1, origin: ArrayLike = np.array([0, 0, 0]), planes: Literal['-x', '+x', '-y', '+y', '-z', '+z', 'xy', 'xz', 'yz', 'yx', 'zx', 'zy'] | None = None*) → ndarray

Return the vertices of a cube primitive made of grid primitives for use with *Matplotlib* `mpl_toolkits.mplot3d.art3d.Poly3DCollection` class.

Parameters

- **width** (*float*) – Cube width.
- **height** (*float*) – Cube height.
- **depth** (*float*) – Cube depth.
- **width_segments** (*int*) – Cube segments count along the width.
- **height_segments** (*int*) – Cube segments count along the height.
- **depth_segments** (*int*) – Cube segments count along the depth.
- **origin** (*ArrayLike*) – Cube origin.
- **planes** (*Literal*['-x', '+x', '-y', '+y', '-z', '+z', 'xy', 'xz', 'yz', 'yx', 'zx', 'zy'] | *None*) – Grid primitives to include in the cube construction.

Returns

Cube primitive vertices.

Return type

numpy.ndarray

Examples

```
>>> primitive_vertices_cube_mpl()
array([[ 0.,  0.,  0.],
       [ 1.,  0.,  0.],
       [ 1.,  1.,  0.],
       [ 0.,  1.,  0.]],

      [[ 0.,  0.,  1.],
       [ 1.,  0.,  1.],
       [ 1.,  1.,  1.],
       [ 0.,  1.,  1.]],

      [[ 0.,  0.,  0.],
       [ 1.,  0.,  0.],
       [ 1.,  0.,  1.],
       [ 0.,  0.,  1.]],

      [[ 0.,  1.,  0.],
       [ 1.,  1.,  0.],
       [ 1.,  1.,  1.],
       [ 0.,  1.,  1.]],

      [[ 0.,  0.,  0.],
       [ 0.,  1.,  0.],
       [ 0.,  1.,  1.],
       [ 0.,  0.,  1.]],

      [[ 1.,  0.,  0.],
       [ 1.,  1.,  0.],
       [ 1.,  1.,  1.],
       [ 1.,  0.,  1.]])
```

colour.geometry.primitive_vertices_sphere

colour.geometry.primitive_vertices_sphere(radius: float = 0.5, segments: int = 8, intermediate: bool = False, origin: ArrayLike = np.array([0, 0, 0]), axis: Literal['+z', '+x', '+y', 'yz', 'xz', 'xy'] | str = '+z') → ndarray

Return the vertices of a latitude-longitude sphere primitive.

Parameters

- **radius** (float) – Sphere radius.
- **segments** (int) – Latitude-longitude segments, if the intermediate argument is *True*, then the sphere will have one less segment along its longitude.
- **intermediate** (bool) – Whether to generate the sphere vertices at the center of the faces outlined by the segments of a regular sphere generated without the intermediate argument set to *True*. The resulting sphere is inscribed on the regular sphere faces but possesses the same poles.
- **origin** (ArrayLike) – Sphere origin on the construction plane.
- **axis** (Literal['+z', '+x', '+y', 'yz', 'xz', 'xy'] | str) – Axis (or normal of the plane) the poles of the sphere will be aligned with.

Returns

Sphere primitive vertices.

Return type

numpy.ndarray

Notes

- The sphere poles have latitude segments count - 1 co-located vertices.

Examples

```
>>> primitive_vertices_sphere(segments=4)
array([[ 0.0000000...e+00,  0.0000000...e+00,  5.0000000...e-01],
       [-3.5355339...e-01, -4.3297802...e-17,  3.5355339...e-01],
       [-5.0000000...e-01, -6.1232340...e-17,  3.0616170...e-17],
       [-3.5355339...e-01, -4.3297802...e-17, -3.5355339...e-01],
       [-6.1232340...e-17, -7.4987989...e-33, -5.0000000...e-01]],

       [[ 0.0000000...e+00,  0.0000000...e+00,  5.0000000...e-01],
       [ 2.1648901...e-17, -3.5355339...e-01,  3.5355339...e-01],
       [ 3.0616170...e-17, -5.0000000...e-01,  3.0616170...e-17],
       [ 2.1648901...e-17, -3.5355339...e-01, -3.5355339...e-01],
       [ 3.7493994...e-33, -6.1232340...e-17, -5.0000000...e-01]],

       [[ 0.0000000...e+00,  0.0000000...e+00,  5.0000000...e-01],
       [ 3.5355339...e-01,  0.0000000...e+00,  3.5355339...e-01],
       [ 5.0000000...e-01,  0.0000000...e+00,  3.0616170...e-17],
       [ 3.5355339...e-01,  0.0000000...e+00, -3.5355339...e-01],
       [ 6.1232340...e-17,  0.0000000...e+00, -5.0000000...e-01]],

       [[ 0.0000000...e+00,  0.0000000...e+00,  5.0000000...e-01],
       [ 2.1648901...e-17,  3.5355339...e-01,  3.5355339...e-01],
       [ 3.0616170...e-17,  5.0000000...e-01,  3.0616170...e-17],
       [ 2.1648901...e-17,  3.5355339...e-01, -3.5355339...e-01],
       [ 3.7493994...e-33,  6.1232340...e-17, -5.0000000...e-01]])
```

Hull Section

colour.geometry

| | |
|--|--|
| <code>hull_section(hull[, axis, origin, normalise])</code> | Compute the hull section for given axis at given origin. |
|--|--|

colour.geometry.hull_section

colour.geometry.hull_section(hull: trimesh.Trimesh, axis: Literal['+z', '+x', '+y'] | str = '+z', origin: Floating = 0.5, normalise: Boolean = False) → NDArray

Compute the hull section for given axis at given origin.

Parameters

- **hull** (trimesh.Trimesh) – Trimesh hull.
- **axis** (Union[Literal['+z', '+x', '+y'], str]) – Axis the hull section will be normal to.
- **origin** (Floating) – Coordinate along axis at which to plot the hull section.

- **normalise** (Boolean) – Whether to normalise axis to the extent of the hull along it.

Returns

Hull section vertices.

Return type

`numpy.ndarray`

Examples

```
>>> from colour.geometry import primitive_cube
>>> from colour.utilities import is_trimesh_installed
>>> vertices, faces, outline = primitive_cube(1, 1, 1, 2, 2, 2)
>>> if is_trimesh_installed:
...     import trimesh
...
...     hull = trimesh.Trimesh(vertices["position"], faces, process=False)
...     hull_section(hull, origin=0)
...
array([[ -0. , -0.5,  0. ],
       [ 0.5, -0.5,  0. ],
       [ 0.5,  0. , -0. ],
       [ 0.5,  0.5, -0. ],
       [ -0. ,  0.5,  0. ],
       [ -0.5,  0.5,  0. ],
       [ -0.5,  0. , -0. ],
       [ -0.5, -0.5, -0. ],
       [ -0. , -0.5,  0. ]])
```

Automatic Colour Conversion Graph

Conversion

`colour`

| | |
|--|--|
| <code>convert(a, source, target, **kwargs)</code> | Convert given object <i>a</i> from source colour representation to target colour representation using the automatic colour conversion graph. |
| <code>describe_conversion_path(source, target[, ...])</code> | Describe the conversion path from source colour representation to target colour representation using the automatic colour conversion graph. |

`colour.convert`

`colour.convert(a: Any, source: str, target: str, **kwargs: Any) → Any`

Convert given object *a* from source colour representation to target colour representation using the automatic colour conversion graph.

The conversion is performed by finding the shortest path in a `NetworkX` DiGraph class instance.

The conversion path adopts the ‘1’ domain-range scale and the object *a* is expected to be *soft* normalised accordingly. For example, *CIE XYZ* tristimulus values arguments for use with the *CAM16* colour appearance model should be in domain *[0, 1]* instead of the domain *[0, 100]* used with the ‘Reference’ domain-range scale. The arguments are typically converted as follows:

- *Scalars* in domain-range $[0, 10]$, e.g *Munsell Value* are scaled by 10.
- *Percentages* in domain-range $[0, 100]$ are scaled by 100.
- *Degrees* in domain-range $[0, 360]$ are scaled by 360.
- *Integers* in domain-range $[0, 2^n - 1]$ where n is the bit depth are scaled by $2^n - 1$.

See the [Domain-Range Scales](#) page for more information.

Parameters

- **a** (*Any*) – Object a to convert. If a represents a reflectance, transmittance or absorptance value, the expectation is that it is viewed under *CIE Standard Illuminant D Series D65*. The illuminant can be changed on a per-definition basis along the conversion path.
- **source** (*str*) – Source colour representation, i.e. the source node in the automatic colour conversion graph.
- **target** (*str*) – Target colour representation, i.e. the target node in the automatic colour conversion graph.
- **kwargs** (*Any*) – See the documentation of the supported conversion definitions.

Arguments for the conversion definitions are passed as keyword arguments whose names is those of the conversion definitions and values set as dictionaries. For example, in the conversion from spectral distribution to *sRGB* colourspace, passing arguments to the `colour.sd_to_XYZ()` definition is done as follows:

```
convert(sd, 'Spectral Distribution', 'sRGB', sd_to_XYZ={'illuminant':
↳ SDS_ILLUMINANTS['FL2']})
```

It is also possible to pass keyword arguments directly to the various conversion definitions irrespective of their name. This is dangerous and could cause unexpected behaviour, consider the following conversion:

```
convert(sd, 'Spectral Distribution', 'sRGB', 'illuminant': SDS_
↳ ILLUMINANTS['FL2'])
```

Because both the `colour.sd_to_XYZ()` and `colour.XYZ_to_sRGB()` definitions have an *illuminant* argument, `SDS_ILLUMINANTS['FL2']` will be passed to both of them and will raise an exception in the `colour.XYZ_to_sRGB()` definition. This will be addressed in the future by either catching the exception and trying a new time without the keyword argument or more elegantly via type checking.

With that in mind, this mechanism offers some good benefits: For example, it allows defining a conversion from *CIE XYZ* colourspace to n different colour models while passing an illuminant argument but without having to explicitly define all the explicit conversion definition arguments:

```
a = np.array([0.20654008, 0.12197225, 0.05136952])
illuminant = CCS_ILLUMINANTS['CIE 1931 2 Degree Standard Observer']
↳ ['D65']
for model in ('CIE xyY', 'CIE Lab'):
    convert(a, 'CIE XYZ', model, illuminant=illuminant)
```

Instead of:

```
for model in ('CIE xyY', 'CIE Lab'):
    convert(a, 'CIE XYZ', model, XYZ_to_xyY={'illuminant':
↳ illuminant}, XYZ_to_Lab={'illuminant': illuminant})
```

Mixing both approaches is possible for the brevity benefits. It is made possible because the keyword arguments directly passed are filtered first and then the resulting dict is updated with the explicit conversion definition arguments:

```
illuminant = CCS_ILLUMINANTS['CIE 1931 2 Degree Standard Observer'][:↪
↪ 'D65']
convert(sd, 'Spectral Distribution', 'sRGB', 'illuminant': SDS_↪
↪ ILLUMINANTS['FL2'], XYZ_to_sRGB={'illuminant': illuminant})
```

For inspection purposes, verbose is enabled by passing arguments to the `colour.describe_conversion_path()` definition via the `verbose` keyword argument as follows:

```
convert(sd, 'Spectral Distribution', 'sRGB', verbose={'mode': 'Long'})↪
↪ )
```

Returns

Converted object *a*.

Return type

Any

Warning: The domain-range scale is ‘1’ and cannot be changed.

Notes

- The **RGB** colour representation is assumed to be linear and representing *scene-referred* imagery, i.e. **Scene-Referred RGB** representation. To encode such *RGB* values as *output-referred* (*display-referred*) imagery, i.e. encode the *RGB* values using an encoding colour component transfer function (Encoding CCTF) / opto-electronic transfer function (OETF), the **Output-Referred RGB** representation must be used:

```
convert(RGB, 'Scene-Referred RGB', 'Output-Referred RGB')
```

Likewise, encoded *output-referred RGB* values can be decoded with the **Scene-Referred RGB** representation:

```
convert(RGB, 'Output-Referred RGB', 'Scene-Referred RGB')
```

- The following defaults have been adopted:
 - The default illuminant for the computation is *CIE Standard Illuminant D Series D65*. It can be changed on a per-definition basis along the conversion path. Note that the conversion from spectral to *CIE XYZ* tristimulus values remains unchanged.
 - The default *RGB* colourspace primaries and whitepoint are that of the *BT.709/sRGB* colourspace. They can be changed on a per-definition basis along the conversion path.
 - When using **sRGB** as a source or target colour representation, the convenient `colour.sRGB_to_XYZ()` and `colour.XYZ_to_sRGB()` definitions are used, respectively. Thus, decoding and encoding using the *sRGB* electro-optical transfer function (EOTF) and its inverse will be applied by default.
 - Most of the colour appearance models have defaults set according to *IEC 61966-2-1:1999* viewing conditions, i.e. *sRGB* 64 Lux ambient illumination, 80 *cd/m²*, adapting field luminance about 20% of a white object in the scene.

Examples

```

>>> import numpy as np
>>> from colour import SDS_COLOURCHECKERS, SDS_ILLUMINANTS
>>> sd = SDS_COLOURCHECKERS["ColorChecker N Ohta"]["dark skin"]
>>> convert(
...     sd,
...     "Spectral Distribution",
...     "sRGB",
...     verbose={"mode": "Short", "width": 75},
... )
...
=====
*                                     *
* [ Conversion Path ]                 *
*                                     *
* "sd_to_XYZ" --> "XYZ_to_sRGB"       *
*                                     *
=====
array([ 0.4903477..., 0.3018587..., 0.2358768...])
>>> illuminant = SDS_ILLUMINANTS["FL2"]
>>> convert(
...     sd,
...     "Spectral Distribution",
...     "sRGB",
...     sd_to_XYZ={"illuminant": illuminant},
... )
...
array([ 0.4792457..., 0.3167696..., 0.1736272...])
>>> a = np.array([0.45675795, 0.30986982, 0.24861924])
>>> convert(a, "Output-Referred RGB", "CAM16UCS")
...
array([ 0.3999481..., 0.0920655..., 0.0812752...])
>>> a = np.array([0.39994811, 0.09206558, 0.08127526])
>>> convert(a, "CAM16UCS", "sRGB", verbose={"mode": "Short", "width": 75})
...
=====
*                                     *
* [ Conversion Path ]                 *
*                                     *
* "UCS_Li2017_to_JMh_CAM16" --> "JMh_CAM16_to_CAM16" -->
* "CAM16_to_XYZ" --> "XYZ_to_sRGB"   *
*                                     *
=====
array([ 0.4567576..., 0.3098826..., 0.2486222...])

```

colour.describe_conversion_path

```
colour.describe_conversion_path(source: str, target: str, mode: Literal['Short', 'Long', 'Extended'] | str
                               = 'Short', width: int = 79, padding: int = 3, print_callable: Callable
                               = print, **kwargs: Any)
```

Describe the conversion path from source colour representation to target colour representation using the automatic colour conversion graph.

Parameters

- **source** (`str`) – Source colour representation, i.e. the source node in the automatic colour conversion graph.
- **target** (`str`) – Target colour representation, i.e. the target node in the automatic colour conversion graph.
- **mode** (`Literal['Short', 'Long', 'Extended'] | str`) – Verbose mode: *Short* describes the conversion path, *Long* provides details about the arguments, definitions signatures and output values, *Extended* appends the definitions' documentation.
- **width** (`int`) – Message box width.
- **padding** (`int`) – Padding on each side of the message.
- **print_callable** (`Callable`) – Callable used to print the message box.
- **kwargs** (`Any`) – {`colour.convert()`}, See the documentation of the previously listed definition.

Examples

```
>>> describe_conversion_path("Spectral Distribution", "sRGB", width=75)
=====
*                                                                    *
*   [ Conversion Path ]                                              *
*                                                                    *
*   "sd_to_XYZ" --> "XYZ_to_sRGB"                                     *
*                                                                    *
=====
```

Annotation Type Hints

colour.hints

| | |
|-----------------------------------|--|
| <code>Any(*args, **kwargs)</code> | Special type indicating an unconstrained type. |
| <code>Callable</code> | Callable type; <code>Callable[[int], str]</code> is a function of <code>(int) -> str</code> . |
| <code>Dict</code> | A generic version of dict. |
| <code>Generator</code> | A generic version of <code>collections.abc.Generator</code> . |
| <code>Iterable</code> | A generic version of <code>collections.abc.Iterable</code> . |
| <code>Iterator</code> | A generic version of <code>collections.abc.Iterator</code> . |
| <code>List</code> | A generic version of list. |
| <code>Mapping</code> | A generic version of <code>collections.abc.Mapping</code> . |
| <code>ModuleType</code> | alias of module |
| <code>Optional</code> | Optional type. |
| <code>Union</code> | Union type; <code>Union[X, Y]</code> means either X or Y. |
| <code>Sequence</code> | A generic version of <code>collections.abc.Sequence</code> . |

continues on next page

Table 1 – continued from previous page

| | |
|--|--|
| <code>SupportsIndex(*args, **kwargs)</code> | An ABC with one abstract method <code>__index__</code> . |
| <code>TextIO()</code> | Typed version of the return of <code>open()</code> in text mode. |
| <code>Tuple</code> | Tuple type; <code>Tuple[X, Y]</code> is the cross-product type of X and Y. |
| <code>Type</code> | A special construct usable to annotate class objects. |
| <code>TypedDict(typename[, fields, total])</code> | A simple typed namespace. |
| <code>TypeVar(name, *constraints[, bound, ...])</code> | Type variable. |
| <code>RegexFlag</code> | <code>NewType</code> creates simple unique types with almost zero runtime overhead. <code>NewType(name, tp)</code> is considered a subtype of <code>tp</code> by static type checkers. At runtime, <code>NewType(name, tp)</code> returns a dummy callable that simply returns its argument. Usage:: |
| <code>DTypeBoolean</code> | alias of <code>bool_</code> |
| <code>DTypeInteger</code> | alias of <code>Union[int8, int16, int32, int64, uint8, uint16, uint32, uint64]</code> |
| <code>DTypeFloating</code> | alias of <code>Union[float16, float32, float64]</code> |
| <code>DTypeNumber</code> | alias of <code>Union[int8, int16, int32, int64, uint8, uint16, uint32, uint64, float16, float32, float64]</code> |
| <code>DTypeComplex</code> | alias of <code>Union[complex64, complex128]</code> |
| <code>DType</code> | alias of <code>Union[bool_, int8, int16, int32, int64, uint8, uint16, uint32, uint64, float16, float32, float64, complex64, complex128]</code> |
| <code>Integer</code> | alias of <code>int</code> |
| <code>Floating</code> | alias of <code>float</code> |
| <code>Number</code> | alias of <code>Union[int, float]</code> |
| <code>Complex</code> | alias of <code>complex</code> |
| <code>Boolean</code> | alias of <code>bool</code> |
| <code>Literal</code> | Special typing form to define literal types (a.k.a. |
| <code>Dataclass</code> | alias of <code>Any</code> |
| <code>NestedSequence(*args, **kwargs)</code> | A protocol for representing nested sequences. |
| <code>ArrayLike</code> | alias of <code>Union[_SupportsArray[dtype[Any]], _NestedSequence[_SupportsArray[dtype[Any]]], bool, int, float, complex, str, bytes, _NestedSequence[Union[bool, int, float, complex, str, bytes]]]</code> |
| <code>IntegerOrArrayLike</code> | alias of <code>Union[int, _SupportsArray[dtype[Any]], _NestedSequence[_SupportsArray[dtype[Any]]], bool, float, complex, str, bytes, _NestedSequence[Union[bool, int, float, complex, str, bytes]]]</code> |
| <code>FloatingOrArrayLike</code> | alias of <code>Union[float, _SupportsArray[dtype[Any]], _NestedSequence[_SupportsArray[dtype[Any]]], bool, int, complex, str, bytes, _NestedSequence[Union[bool, int, float, complex, str, bytes]]]</code> |
| <code>NumberOrArrayLike</code> | alias of <code>Union[int, float, _SupportsArray[dtype[Any]], _NestedSequence[_SupportsArray[dtype[Any]]], bool, complex, str, bytes, _NestedSequence[Union[bool, int, float, complex, str, bytes]]]</code> |

continues on next page

Table 1 – continued from previous page

| | |
|---|--|
| <code>ComplexOrArrayLike</code> | alias of <code>Union[complex, _SupportsArray[dtype[Any]], _NestedSequence[_SupportsArray[dtype[Any]]], bool, int, float, str, bytes, _NestedSequence[Union[bool, int, float, complex, str, bytes]]]</code> |
| <code>BooleanOrArrayLike</code> | alias of <code>Union[bool, _SupportsArray[dtype[Any]], _NestedSequence[_SupportsArray[dtype[Any]]], int, float, complex, str, bytes, _NestedSequence[Union[bool, int, float, complex, str, bytes]]]</code> |
| <code>ScalarType</code> | Type variable. |
| <code>StrOrArrayLike</code> | alias of <code>Union[str, _SupportsArray[dtype[Any]], _NestedSequence[_SupportsArray[dtype[Any]]], bool, int, float, complex, bytes, _NestedSequence[Union[bool, int, float, complex, str, bytes]]]</code> |
| <code>NDArray</code> | alias of <code>ndarray</code> |
| <code>IntegerOrNDArray</code> | alias of <code>Union[int, ndarray]</code> |
| <code>FloatingOrNDArray</code> | alias of <code>Union[float, ndarray]</code> |
| <code>NumberOrNDArray</code> | alias of <code>Union[int, float, ndarray]</code> |
| <code>ComplexOrNDArray</code> | alias of <code>Union[complex, ndarray]</code> |
| <code>BooleanOrNDArray</code> | alias of <code>Union[bool, ndarray]</code> |
| <code>StrOrNDArray</code> | alias of <code>Union[str, ndarray]</code> |
| <code>TypeInterpolator(*args, **kwargs)</code> | |
| <code>TypeExtrapolator(*args, **kwargs)</code> | |
| <code>TypeLUTSequenceItem(*args, **kwargs)</code> | |
| <code>LiteralWarning</code> | alias of <code>Literal['default', 'error', 'ignore', 'always', 'module', 'once']</code> |
| <code>cast(typ, val)</code> | Cast a value to a type. |

colour.hints.Any

class `colour.hints.Any(*args, **kwargs)`

Special type indicating an unconstrained type.

- Any is compatible with every type.
- Any assumed to have all methods.
- All values assumed to be instances of Any.

Note that all the above statements are true from the point of view of static type checkers. At runtime, Any should not be used with instance checks.

`__init__()`

Methods

```
__init__()
```

`colour.hints.Callable`

`colour.hints.Callable`

Callable type; Callable[[int], str] is a function of (int) -> str.

The subscription syntax must always be used with exactly two values: the argument list and the return type. The argument list must be a list of types or ellipsis; the return type must be a single type.

There is no syntax to indicate optional or keyword arguments, such function types are rarely used as callback types.

alias of `Callable`

`colour.hints.Dict`

`colour.hints.Dict`

A generic version of dict.

alias of `Dict`

`colour.hints.Generator`

`colour.hints.Generator`

A generic version of `collections.abc.Generator`.

alias of `Generator`

`colour.hints.Iterable`

`colour.hints.Iterable`

A generic version of `collections.abc.Iterable`.

alias of `Iterable`

`colour.hints.Iterator`

`colour.hints.Iterator`

A generic version of `collections.abc.Iterator`.

alias of `Iterator`

colour.hints.List

colour.hints.**List**

A generic version of list.

alias of `List`

colour.hints.Mapping

colour.hints.**Mapping**

A generic version of `collections.abc.Mapping`.

alias of `Mapping`

colour.hints.ModuleType

colour.hints.**ModuleType**

alias of `module`

colour.hints.Optional

colour.hints.**Optional** = `typing.Optional`

Optional type.

`Optional[X]` is equivalent to `Union[X, None]`.

colour.hints.Union

colour.hints.**Union** = `typing.Union`

Union type; `Union[X, Y]` means either X or Y.

To define a union, use e.g. `Union[int, str]`. Details: - The arguments must be types and there must be at least one. - `None` as an argument is a special case and is replaced by

`type(None)`.

- Unions of unions are flattened, e.g.:

```
Union[Union[int, str], float] == Union[int, str, float]
```

- Unions of a single argument vanish, e.g.:

```
Union[int] == int # The constructor actually returns int
```

- Redundant arguments are skipped, e.g.:

```
Union[int, str, int] == Union[int, str]
```

- When comparing unions, the argument order is ignored, e.g.:

```
Union[int, str] == Union[str, int]
```

- You cannot subclass or instantiate a union.
- You can use `Optional[X]` as a shorthand for `Union[X, None]`.

`colour.hints.Sequence`

`colour.hints.Sequence`

A generic version of `collections.abc.Sequence`.

alias of `Sequence`

`colour.hints.SupportsIndex`

class `colour.hints.SupportsIndex(*args, **kwargs)`

An ABC with one abstract method `__index__`.

`__init__(*args, **kwargs)`

Methods

```
__init__(*args, **kwargs)
```

`colour.hints.TextIO`

class `colour.hints.TextIO`

Typed version of the return of `open()` in text mode.

`__init__()`

Methods

| |
|-------------------------------------|
| <code>__init__()</code> |
| <code>close()</code> |
| <code>fileno()</code> |
| <code>flush()</code> |
| <code>isatty()</code> |
| <code>read([n])</code> |
| <code>readable()</code> |
| <code>readline([limit])</code> |
| <code>readlines([hint])</code> |
| <code>seek(offset[, whence])</code> |
| <code>seekable()</code> |
| <code>tell()</code> |
| <code>truncate([size])</code> |
| <code>writable()</code> |
| <code>write(s)</code> |
| <code>writelines(lines)</code> |

Attributes

| |
|-----------------------------|
| <code>buffer</code> |
| <code>closed</code> |
| <code>encoding</code> |
| <code>errors</code> |
| <code>line_buffering</code> |
| <code>mode</code> |
| <code>name</code> |
| <code>newlines</code> |

colour.hints.Tuple

colour.hints.Tuple

Tuple type; `Tuple[X, Y]` is the cross-product type of `X` and `Y`.

Example: `Tuple[T1, T2]` is a tuple of two elements corresponding to type variables `T1` and `T2`.
`Tuple[int, float, str]` is a tuple of an int, a float and a string.

To specify a variable-length tuple of homogeneous type, use `Tuple[T, ...]`.

alias of `Tuple`

colour.hints.Type

colour.hints.Type

A special construct usable to annotate class objects.

For example, suppose we have the following classes:

```
class User: ... # Abstract base for User classes
class BasicUser(User): ...
class ProUser(User): ...
class TeamUser(User): ...
```

And a function that takes a class argument that's a subclass of `User` and returns an instance of the corresponding class:

```
U = TypeVar('U', bound=User)
def new_user(user_class: Type[U]) -> U:
    user = user_class()
    # (Here we could write the user object to a database)
    return user

joe = new_user(BasicUser)
```

At this point the type checker knows that `joe` has type `BasicUser`.

alias of `Type`

colour.hints.TypedDict

colour.hints.TypedDict(*typename*, *fields=None*, */*, ***, *total=True*, ***kwargs*)

A simple typed namespace. At runtime it is equivalent to a plain dict.

`TypedDict` creates a dictionary type that expects all of its instances to have a certain set of keys, where each key is associated with a value of a consistent type. This expectation is not checked at runtime but is only enforced by type checkers. Usage:

```
class Point2D(TypedDict):
    x: int
    y: int
    label: str

a: Point2D = {'x': 1, 'y': 2, 'label': 'good'} # OK
b: Point2D = {'z': 3, 'label': 'bad'}          # Fails type check

assert Point2D(x=1, y=2, label='first') == dict(x=1, y=2, label='first')
```

The type info can be accessed via the `Point2D.__annotations__` dict, and the `Point2D.__required_keys__` and `Point2D.__optional_keys__` frozensets. `TypedDict` supports an additional equivalent form:

```
Point2D = TypedDict('Point2D', {'x': int, 'y': int, 'label': str})
```

By default, all keys must be present in a `TypedDict`. It is possible to override this by specifying totality. Usage:

```
class point2D(TypedDict, total=False):
    x: int
    y: int
```

This means that a `point2D TypedDict` can have any of the keys omitted. A type checker is only expected to support a literal `False` or `True` as the value of the `total` argument. `True` is the default, and makes all items defined in the class body be required.

The class syntax is only supported in Python 3.6+, while the other syntax form works for Python 2.7 and 3.2+

colour.hints.TypeVar

class `colour.hints.TypeVar`(*name*, **constraints*, *bound*=None, *covariant*=False, *contravariant*=False)
Type variable.

Usage:

```
T = TypeVar('T') # Can be anything
A = TypeVar('A', str, bytes) # Must be str or bytes
```

Type variables exist primarily for the benefit of static type checkers. They serve as the parameters for generic types as well as for generic function definitions. See class `Generic` for more information on generic types. Generic functions work as follows:

```
def repeat(x: T, n: int) -> List[T]:
    """Return a list containing n references to x.""" return [x]*n

def longest(x: A, y: A) -> A:
    """Return the longest of two strings.""" return x if len(x) >= len(y) else y
```

The latter example's signature is essentially the overloading of `(str, str) -> str` and `(bytes, bytes) -> bytes`. Also note that if the arguments are instances of some subclass of `str`, the return type is still plain `str`.

At runtime, `isinstance(x, T)` and `issubclass(C, T)` will raise `TypeError`.

Type variables defined with `covariant=True` or `contravariant=True` can be used to declare covariant or contravariant generic types. See PEP 484 for more details. By default generic types are invariant in all type variables.

Type variables can be introspected. e.g.:

```
T.__name__ == 'T' T.__constraints__ == () T.__covariant__ == False
T.__contravariant__ = False A.__constraints__ == (str, bytes)
```

Note that only type variables defined in global scope can be pickled.

```
__init__(name, *constraints, bound=None, covariant=False, contravariant=False)
```


Methods

```
__init__(name, *constraints[, bound, ...])
```

`colour.hints.RegexFlag`

`colour.hints.RegexFlag = colour.hints.RegexFlag`

`NewType` creates simple unique types with almost zero runtime overhead. `NewType(name, tp)` is considered a subtype of `tp` by static type checkers. At runtime, `NewType(name, tp)` returns a dummy callable that simply returns its argument. Usage:

```
UserId = NewType('UserId', int)

def name_by_id(user_id: UserId) -> str:
    ...

UserId('user')           # Fails type check

name_by_id(42)           # Fails type check
name_by_id(UserId(42))   # OK

num = UserId(5) + 1      # type: int
```

`colour.hints.DTypeBoolean`

`colour.hints.DTypeBoolean`

alias of `bool_`

`colour.hints.DTypeInteger`

`colour.hints.DTypeInteger`

alias of `Union[int8, int16, int32, int64, uint8, uint16, uint32, uint64]`

`colour.hints.DTypeFloating`

`colour.hints.DTypeFloating`

alias of `Union[float16, float32, float64]`

`colour.hints.DTypeNumber`

`colour.hints.DTypeNumber`

alias of `Union[int8, int16, int32, int64, uint8, uint16, uint32, uint64, float16, float32, float64]`

`colour.hints.DTypeComplex`

`colour.hints.DTypeComplex`
alias of `Union[complex64, complex128]`

`colour.hints.DType`

`colour.hints.DType`
alias of `Union[bool_, int8, int16, int32, int64, uint8, uint16, uint32, uint64, float16, float32, float64, complex64, complex128]`

`colour.hints.Integer`

`colour.hints.Integer`
alias of `int`

`colour.hints.Floating`

`colour.hints.Floating`
alias of `float`

`colour.hints.Number`

`colour.hints.Number`
alias of `Union[int, float]`

`colour.hints.Complex`

`colour.hints.Complex`
alias of `complex`

`colour.hints.Boolean`

`colour.hints.Boolean`
alias of `bool`

`colour.hints.Literal`

`colour.hints.Literal = typing.Literal`

Special typing form to define literal types (a.k.a. value types).

This form can be used to indicate to type checkers that the corresponding variable or function parameter has a value equivalent to the provided literal (or one of several literals):

```
def validate_simple(data: Any) -> Literal[True]: # always returns True
    ...
MODE = Literal['r', 'rb', 'w', 'wb'] def open_helper(file: str, mode: MODE) -> str:
    ...
```

```
open_helper('/some/path', 'r') # Passes type check open_helper('/other/path', 'typo') #
Error in type checker
```

`Literal[...]` cannot be subclassed. At runtime, an arbitrary value is allowed as type argument to `Literal[...]`, but type checkers may impose restrictions.

`colour.hints.Dataclass`

`colour.hints.Dataclass`

alias of `Any`

`colour.hints.NestedSequence`

class `colour.hints.NestedSequence(*args, **kwargs)`

A protocol for representing nested sequences.

Warning: `NestedSequence` currently does not work in combination with typevars, e.g. `def func(a: _NestedSequence[T]) -> T: ...`

See also:

`collections.abc.Sequence`

ABCs for read-only and mutable sequences.

Examples

```
>>> from __future__ import annotations
```

```
>>> from typing import TYPE_CHECKING
>>> import numpy as np
```

```
>>> def get_dtype(seq: NestedSequence[float]) -> np.dtype[np.float64]:
...     return np.asarray(seq).dtype
```

```
>>> a = get_dtype([1.0])
>>> b = get_dtype([[1.0]])
>>> c = get_dtype([[[1.0]]])
>>> d = get_dtype([[[[1.0]]]])
```

```
>>> if TYPE_CHECKING:
...     reveal_locals()
...     # note: Revealed local types are:
...     # note:     a: numpy.dtype[numpy.floating[numpy._typing._64Bit]]
...     # note:     b: numpy.dtype[numpy.floating[numpy._typing._64Bit]]
...     # note:     c: numpy.dtype[numpy.floating[numpy._typing._64Bit]]
...     # note:     d: numpy.dtype[numpy.floating[numpy._typing._64Bit]]
...     ...
```

```
__init__(*args, **kwargs)
```

Methods

| | |
|--|--|
| <code>__init__(*args, **kwargs)</code> | |
| <code>count(value)</code> | Return the number of occurrences of <i>value</i> . |
| <code>index(value)</code> | Return the first index of <i>value</i> . |

`colour.hints.ArrayLike`

`colour.hints.ArrayLike`

alias of `Union[_SupportsArray[dtype[Any]], _NestedSequence[_SupportsArray[dtype[Any]]], bool, int, float, complex, str, bytes, _NestedSequence[Union[bool, int, float, complex, str, bytes]]]`

`colour.hints.IntegerOrArrayLike`

`colour.hints.IntegerOrArrayLike`

alias of `Union[int, _SupportsArray[dtype[Any]], _NestedSequence[_SupportsArray[dtype[Any]]], bool, float, complex, str, bytes, _NestedSequence[Union[bool, int, float, complex, str, bytes]]]`

`colour.hints.FloatingOrArrayLike`

`colour.hints.FloatingOrArrayLike`

alias of `Union[float, _SupportsArray[dtype[Any]], _NestedSequence[_SupportsArray[dtype[Any]]], bool, int, complex, str, bytes, _NestedSequence[Union[bool, int, float, complex, str, bytes]]]`

`colour.hints.NumberOrArrayLike`

`colour.hints.NumberOrArrayLike`

alias of `Union[int, float, _SupportsArray[dtype[Any]], _NestedSequence[_SupportsArray[dtype[Any]]], bool, complex, str, bytes, _NestedSequence[Union[bool, int, float, complex, str, bytes]]]`

`colour.hints.ComplexOrArrayLike`

`colour.hints.ComplexOrArrayLike`

alias of `Union[complex, _SupportsArray[dtype[Any]], _NestedSequence[_SupportsArray[dtype[Any]]], bool, int, float, str, bytes, _NestedSequence[Union[bool, int, float, complex, str, bytes]]]`

`colour.hints.BooleanOrArrayLike`

`colour.hints.BooleanOrArrayLike`

alias of `Union[bool, _SupportsArray[dtype[Any]], _NestedSequence[_SupportsArray[dtype[Any]]], int, float, complex, str, bytes, _NestedSequence[Union[bool, int, float, complex, str, bytes]]]`

colour.hints.ScalarType

colour.hints.ScalarType = +ScalarType

Type variable.

Usage:

```
T = TypeVar('T') # Can be anything
A = TypeVar('A', str, bytes) # Must be str or bytes
```

Type variables exist primarily for the benefit of static type checkers. They serve as the parameters for generic types as well as for generic function definitions. See class `Generic` for more information on generic types. Generic functions work as follows:

```
def repeat(x: T, n: int) -> List[T]:
    """Return a list containing n references to x.""" return [x]*n

def longest(x: A, y: A) -> A:
    """Return the longest of two strings.""" return x if len(x) >= len(y) else y
```

The latter example's signature is essentially the overloading of `(str, str) -> str` and `(bytes, bytes) -> bytes`. Also note that if the arguments are instances of some subclass of `str`, the return type is still plain `str`.

At runtime, `isinstance(x, T)` and `issubclass(C, T)` will raise `TypeError`.

Type variables defined with `covariant=True` or `contravariant=True` can be used to declare covariant or contravariant generic types. See PEP 484 for more details. By default generic types are invariant in all type variables.

Type variables can be introspected. e.g.:

```
T.__name__ == 'T'    T.__constraints__ == ()    T.__covariant__ == False
T.__contravariant__ = False A.__constraints__ == (str, bytes)
```

Note that only type variables defined in global scope can be pickled.

colour.hints.StrOrArrayLike

colour.hints.StrOrArrayLike

```
alias of Union[str, _SupportsArray[dtype[Any]], _NestedSequence[_SupportsArray[dtype[Any]]],
bool, int, float, complex, bytes, _NestedSequence[Union[bool, int, float, complex, str, bytes]]]
```

colour.hints.NDArray

colour.hints.NDArray

alias of `ndarray`

colour.hints.IntegerOrNDArray

colour.hints.IntegerOrNDArray

alias of `Union[int, ndarray]`

`colour.hints.FloatingOrNDArray`

`colour.hints.FloatingOrNDArray`
alias of `Union[float, ndarray]`

`colour.hints.NumberOrNDArray`

`colour.hints.NumberOrNDArray`
alias of `Union[int, float, ndarray]`

`colour.hints.ComplexOrNDArray`

`colour.hints.ComplexOrNDArray`
alias of `Union[complex, ndarray]`

`colour.hints.BooleanOrNDArray`

`colour.hints.BooleanOrNDArray`
alias of `Union[bool, ndarray]`

`colour.hints.StrOrNDArray`

`colour.hints.StrOrNDArray`
alias of `Union[str, ndarray]`

`colour.hints.TypeInterpolator`

class `colour.hints.TypeInterpolator(*args: Any, **kwargs: Any)`

Parameters

- `args` (`Any`) –
- `kwargs` (`Any`) –

`__init__(*args: Any, **kwargs: Any) → None`

Parameters

- `args` (`Any`) –
- `kwargs` (`Any`) –

Return type

`None`

Methods

```
__init__(*args, **kwargs)
```

Attributes

```
x
```

```
y
```

colour.hints.TypeExtrapolator

```
class colour.hints.TypeExtrapolator(*args: Any, **kwargs: Any)
```

Parameters

- **args** (*Any*) –
- **kwargs** (*Any*) –

```
__init__(*args: Any, **kwargs: Any) → None
```

Parameters

- **args** (*Any*) –
- **kwargs** (*Any*) –

Return type

None

Methods

```
__init__(*args, **kwargs)
```

Attributes

```
interpolator
```

colour.hints.TypeLUTSequenceItem

```
class colour.hints.TypeLUTSequenceItem(*args, **kwargs)
```

```
    __init__(*args, **kwargs)
```

Methods

```
    __init__(*args, **kwargs)
```

```
    apply(RGB, **kwargs)
```

colour.hints.LiteralWarning

```
colour.hints.LiteralWarning
```

```
    alias of Literal['default', 'error', 'ignore', 'always', 'module', 'once']
```

colour.hints.cast

```
colour.hints.cast(typ, val)
```

Cast a value to a type.

This returns the value unchanged. To the type checker this signals that the return value has the designated type, but at runtime we intentionally don't check anything (we want this to be as fast as possible).

Input and Output

Image Data

colour

| | |
|--|--|
| <code>READ_IMAGE_METHODS</code> | Supported image read methods. |
| <code>read_image(path[, bit_depth, method])</code> | Read the image data at given path using given method. |
| <code>WRITE_IMAGE_METHODS</code> | Supported image write methods. |
| <code>write_image(image, path[, bit_depth, method])</code> | Write given image data at given path using given method. |

colour.READ_IMAGE_METHODS

```
colour.READ_IMAGE_METHODS = CanonicalMapping({'Imageio': ..., 'OpenImageIO': ...})
```

Supported image read methods.

colour.read_image

`colour.read_image(path: str, bit_depth: Literal['uint8', 'uint16', 'float16', 'float32', 'float64', 'float128'] = 'float32', method: Literal['Imageio', 'OpenImageIO'] | str = 'OpenImageIO', **kwargs: Any) → ndarray`

Read the image data at given path using given method.

Parameters

- **path** (`str`) – Image path.
- **bit_depth** (`Literal['uint8', 'uint16', 'float16', 'float32', 'float64', 'float128']`) – Returned image bit depth, for the *Imageio* method, the image data is converted with `colour.io.convert_bit_depth()` definition after reading the image, for the *OpenImageIO* method, the bit depth conversion behaviour is driven directly by the library, this definition only converts to the relevant data type after reading.
- **method** (`Literal['Imageio', 'OpenImageIO'] | str`) – Read method, i.e. the image library used for reading images.
- **attributes** – `{colour.io.read_image_OpenImageIO()}`, Whether to return the image attributes.
- **kwargs** (`Any`) –

Returns

Image data.

Return type

`class`numpy.ndarray``

Notes

- If the given method is *OpenImageIO* but the library is not available writing will be performed by *Imageio*.
- If the given method is *Imageio*, `kwargs` is passed directly to the wrapped definition.
- For convenience, single channel images are squeezed to 2D arrays.

Examples

```
>>> import os
>>> import colour
>>> path = os.path.join(
...     colour.__path__[0],
...     "io",
...     "tests",
...     "resources",
...     "CMS_Test_Pattern.exr",
... )
>>> image = read_image(path)
>>> image.shape
(1267, 1274, 3)
>>> image.dtype
dtype('float32')
```

colour.WRITE_IMAGE_METHODS

`colour.WRITE_IMAGE_METHODS = CanonicalMapping({'Imageio': ..., 'OpenImageIO': ...})`
Supported image write methods.

colour.write_image

`colour.write_image(image: ArrayLike, path: str, bit_depth: Literal['uint8', 'uint16', 'float16', 'float32', 'float64', 'float128'] = 'float32', method: Literal['Imageio', 'OpenImageIO'] | str = 'OpenImageIO', **kwargs: Any) → bool`

Write given image data at given path using given method.

Parameters

- **image** (ArrayLike) – Image data.
- **path** (str) – Image path.
- **bit_depth** (Literal['uint8', 'uint16', 'float16', 'float32', 'float64', 'float128']) – Bit depth to write the image at, for the *Imageio* method, the image data is converted with `colour.io.convert_bit_depth()` definition prior to writing the image.
- **method** (Literal['Imageio', 'OpenImageIO'] | str) – Write method, i.e. the image library used for writing images.
- **attributes** – {`colour.io.write_image_OpenImageIO()`}, An array of `colour.io.ImageAttribute_Specification` class instances used to set attributes of the image.
- **kwargs** (Any) –

Returns

Definition success.

Return type

bool

Notes

- If the given method is *OpenImageIO* but the library is not available writing will be performed by *Imageio*.
- If the given method is *Imageio*, `kwargs` is passed directly to the wrapped definition.
- It is possible to control how the image are saved by the *Freeimage* backend by using the `flags` keyword argument and passing a desired value. See the *Load / Save flag constants* section in <https://sourceforge.net/p/freeimage/svn/HEAD/tree/FreeImage/trunk/Source/FreeImage.h>

Examples

Basic image writing:

```
>>> import os
>>> import colour
>>> path = os.path.join(
...     colour.__path__[0],
...     "io",
...     "tests",
...     "resources",
...     "CMS_Test_Pattern.exr",
... )
>>> image = read_image(path)
>>> path = os.path.join(
...     colour.__path__[0],
...     "io",
...     "tests",
...     "resources",
...     "CMSTestPattern.tif",
... )
>>> write_image(image, path)
True
```

Advanced image writing while setting attributes using *OpenImageIO*:

```
>>> compression = ImageAttribute_Specification("Compression", "none")
>>> write_image(image, path, bit_depth="uint8", attributes=[compression])
...
True
```

Ancillary Objects

colour.io

| | |
|---|--|
| <code>ImageAttribute_Specification(name, value, type_)</code> | Define an image specification attribute. |
| <code>convert_bit_depth(a[, bit_depth])</code> | Convert given array to given bit depth, the current bit depth of the array is used to determine the appropriate conversion path. |
| <code>read_image_OpenImageIO(path[, bit_depth, ...])</code> | Read the image data at given path using <i>OpenImageIO</i> . |
| <code>write_image_OpenImageIO(image, path[, ...])</code> | Write given image data at given path using <i>OpenImageIO</i> . |
| <code>read_image_Imageio(path[, bit_depth])</code> | Read the image data at given path using <i>Imageio</i> . |
| <code>write_image_Imageio(image, path[, bit_depth])</code> | Write given image data at given path using <i>Imageio</i> . |
| <code>as_3_channels_image(a)</code> | Convert given array <i>a</i> to a 3-channels image-like representation. |

colour.io.ImageAttribute_Specification

```
class colour.io.ImageAttribute_Specification(name: str, value: Any, type_:
                                         Optional[OpenImageIO.TypeDesc] = <factory>)
```

Define an image specification attribute.

Parameters

- **name** (*str*) – Attribute name.
- **value** (*Any*) – Attribute value.
- **type** (*Optional[OpenImageIO.TypeDesc]*) – Attribute type as an *OpenImageIO.TypeDesc* class instance.
- **type_** (*Optional[OpenImageIO.TypeDesc]*) –

```
__init__(name: str, value: Any, type_: Optional[OpenImageIO.TypeDesc] = <factory>) → None
```

Parameters

- **name** (*str*) –
- **value** (*Any*) –
- **type_** (*Optional[OpenImageIO.TypeDesc]*) –

Return type

None

Methods

```
__init__(name, value[, type_])
```

Attributes

| |
|-------|
| name |
| value |
| type_ |

colour.io.convert_bit_depth

```
colour.io.convert_bit_depth(a: ArrayLike, bit_depth: Literal['uint8', 'uint16', 'float16', 'float32',
                                                             'float64', 'float128'] = 'float32') → ndarray
```

Convert given array to given bit depth, the current bit depth of the array is used to determine the appropriate conversion path.

Parameters

- **a** (*ArrayLike*) – Array to convert to given bit depth.
- **bit_depth** (*Literal*['uint8', 'uint16', 'float16', 'float32', 'float64', 'float128']) – Bit depth.

Returns

Converted array.

Return type

class` numpy.ndarray`

Examples

```
>>> a = np.array([0.0, 0.5, 1.0])
>>> convert_bit_depth(a, "uint8")
array([  0, 128, 255], dtype=uint8)
>>> convert_bit_depth(a, "uint16")
array([   0, 32768, 65535], dtype=uint16)
>>> convert_bit_depth(a, "float16")
array([ 0. ,  0.5,  1. ], dtype=float16)
>>> a = np.array([0, 128, 255], dtype=np.uint8)
>>> convert_bit_depth(a, "uint16")
array([   0, 32896, 65535], dtype=uint16)
>>> convert_bit_depth(a, "float32")
array([ 0.          ,  0.501960...,  1.          ], dtype=float32)
```

colour.io.read_image_OpenImageIO

`colour.io.read_image_OpenImageIO(path: str, bit_depth: Literal['uint8', 'uint16', 'float16', 'float32', 'float64', 'float128'] = 'float32', attributes: bool = False) → ndarray | Tuple[ndarray, List]`

Read the image data at given path using *OpenImageIO*.

Parameters

- **path** (str) – Image path.
- **bit_depth** (Literal['uint8', 'uint16', 'float16', 'float32', 'float64', 'float128']) – Returned image bit depth, the bit depth conversion behaviour is driven directly by *OpenImageIO*, this definition only converts to the relevant data type after reading.
- **attributes** (bool) – Whether to return the image attributes.

Returns

Image data or tuple of image data and list of `colour.io.ImageAttributeSpecification` class instances.

Return type

class` numpy.ndarray` or tuple

Notes

- For convenience, single channel images are squeezed to 2D arrays.

Examples

```
>>> import os
>>> import colour
>>> path = os.path.join(
...     colour.__path__[0],
...     "io",
...     "tests",
...     "resources",
...     "CMS_Test_Pattern.exr",
... )
>>> image = read_image_OpenImageIO(path)
```

colour.io.write_image_OpenImageIO

`colour.io.write_image_OpenImageIO(image: ArrayLike, path: str, bit_depth: Literal['uint8', 'uint16', 'float16', 'float32', 'float64', 'float128'] = 'float32', attributes: Sequence | None = None) → bool`

Write given image data at given path using *OpenImageIO*.

Parameters

- **image** (ArrayLike) – Image data.
- **path** (str) – Image path.
- **bit_depth** (Literal['uint8', 'uint16', 'float16', 'float32', 'float64', 'float128']) – Bit depth to write the image at, the bit depth conversion behaviour is ruled directly by *OpenImageIO*.
- **attributes** (Sequence | None) – An array of `colour.io.ImageAttributeSpecification` class instances used to set attributes of the image.

Returns

Definition success.

Return type

bool

Examples

Basic image writing:

```
>>> import os
>>> import colour
>>> path = os.path.join(
...     colour.__path__[0],
...     "io",
...     "tests",
...     "resources",
...     "CMS_Test_Pattern.exr",
... )
>>> image = read_image(path)
>>> path = os.path.join(
...     colour.__path__[0],
...     "io",
...     "tests",
```

(continues on next page)

(continued from previous page)

```
...     "resources",
...     "CMSTestPattern.tif",
... )
>>> write_image_OpenImageIO(image, path)
True
```

Advanced image writing while setting attributes:

```
>>> compression = ImageAttribute_Specification("Compression", "none")
>>> write_image_OpenImageIO(image, path, "uint8", [compression])
...
True
```

Writing an “ACES” compliant “EXR” file:

```
>>> if is_openimageio_installed():
...     from OpenImageIO import TypeDesc
...
...     chromaticities = (
...         0.7347,
...         0.2653,
...         0.0,
...         1.0,
...         0.0001,
...         -0.077,
...         0.32168,
...         0.33767,
...     )
...     attributes = [
...         ImageAttribute_Specification("acesImageContainerFlag", True),
...         ImageAttribute_Specification(
...             "chromaticities", chromaticities, TypeDesc("float[8]")
...         ),
...         ImageAttribute_Specification("compression", "none"),
...     ]
...     write_image_OpenImageIO(image, path, attributes=attributes)
...
... 
```

colour.io.read_image_Imageio

`colour.io.read_image_Imageio(path: str, bit_depth: Literal['uint8', 'uint16', 'float16', 'float32', 'float64', 'float128'] = 'float32', **kwargs: Any) → ndarray`

Read the image data at given path using *Imageio*.

Parameters

- **path** (str) – Image path.
- **bit_depth** (Literal['uint8', 'uint16', 'float16', 'float32', 'float64', 'float128']) – Returned image bit depth, the image data is converted with `colour.io.convert_bit_depth()` definition after reading the image.
- **kwargs** (Any) – Keywords arguments.

Returns

Image data.

Return type

class`numpy.ndarray`

Notes

- For convenience, single channel images are squeezed to 2D arrays.

Examples

```
>>> import os
>>> import colour
>>> path = os.path.join(
...     colour.__path__[0],
...     "io",
...     "tests",
...     "resources",
...     "CMS_Test_Pattern.exr",
... )
>>> image = read_image_Imageio(path)
>>> image.shape
(1267, 1274, 3)
>>> image.dtype
dtype('float32')
```

colour.io.write_image_Imageio

`colour.io.write_image_Imageio(image: ArrayLike, path: str, bit_depth: Literal['uint8', 'uint16', 'float16', 'float32', 'float64', 'float128'] = 'float32', **kwargs: Any) → bytes | None`

Write given image data at given path using *Imageio*.

Parameters

- **image** (ArrayLike) – Image data.
- **path** (str) – Image path.
- **bit_depth** (Literal['uint8', 'uint16', 'float16', 'float32', 'float64', 'float128']) – Bit depth to write the image at, the image data is converted with `colour.io.convert_bit_depth()` definition prior to writing the image.
- **kwargs** (Any) – Keywords arguments.

Returns

Definition success.

Return type

bool

Notes

- It is possible to control how the image are saved by the *Freeimage* backend by using the `flags` keyword argument and passing a desired value. See the *Load / Save flag constants* section in <https://sourceforge.net/p/freeimage/svn/HEAD/tree/FreeImage/trunk/Source/FreeImage.h>

Examples

```
>>> import os
>>> import colour
>>> path = os.path.join(
...     colour.__path__[0],
...     "io",
...     "tests",
...     "resources",
...     "CMS_Test_Pattern.exr",
... )
>>> image = read_image(path)
>>> path = os.path.join(
...     colour.__path__[0],
...     "io",
...     "tests",
...     "resources",
...     "CMSTestPattern.tif",
... )
>>> write_image_Imageio(image, path)
True
```

colour.io.as_3_channels_image

colour.io.as_3_channels_image(*a*: ArrayLike) → ndarray

Convert given array *a* to a 3-channels image-like representation.

Parameters

a (ArrayLike) – Array *a* to convert to a 3-channels image-like representation.

Returns

3-channels image-like representation of array *a*.

Return type

class`numpy.ndarray`

Examples

```
>>> as_3_channels_image(0.18)
array([[ 0.18,  0.18,  0.18]])
>>> as_3_channels_image([0.18])
array([[ 0.18,  0.18,  0.18]])
>>> as_3_channels_image([0.18, 0.18, 0.18])
array([[ 0.18,  0.18,  0.18]])
>>> as_3_channels_image([[0.18, 0.18, 0.18]])
array([[ 0.18,  0.18,  0.18]])
>>> as_3_channels_image([[[0.18, 0.18, 0.18]]])
array([[ 0.18,  0.18,  0.18]])
```

OpenColorIO Processing

colour.io

| | |
|--|--|
| <code>process_image_OpenColorIO(a, *args, **kwargs)</code> | Process given image data with <i>OpenColorIO</i> . |
|--|--|

colour.io.process_image_OpenColorIO

`colour.io.process_image_OpenColorIO(a: ArrayLike, *args: Any, **kwargs: Any) → FloatingOrNDArray`

Process given image data with *OpenColorIO*.

Parameters

- **a** (ArrayLike) – Image data to process with *OpenColorIO*.
- **config** – *OpenColorIO* config to use for processing. If not defined, the *OpenColorIO* set defined by the \$OCIO environment variable is used.
- **args** (Any) – Arguments for *Config.getProcessor* method. See <https://opencolorio.readthedocs.io/en/latest/api/config.html> for more information.
- **kwargs** (Any) –

Returns

Processed image data.

Return type

`numpy.ndarray`

Examples

```
>>> import os
>>> import PyOpenColorIO as ocio
>>> from colour.utilities import full
>>> config = os.path.join(
...     os.path.dirname(__file__),
...     "tests",
...     "resources",
...     "config-aces-reference.ocio.yaml",
... )
>>> a = 0.18
>>> process_image_OpenColorIO(
...     a, "ACES - ACES2065-1", "ACES - ACEScct", config=config
... )
0.4135884...
>>> a = np.array([0.18])
>>> process_image_OpenColorIO(
...     a, "ACES - ACES2065-1", "ACES - ACEScct", config=config
... )
array([ 0.4135884...])
>>> a = np.array([0.18, 0.18, 0.18])
>>> process_image_OpenColorIO(
...     a, "ACES - ACES2065-1", "ACES - ACEScct", config=config
... )
array([ 0.4135884...,  0.4135884...,  0.4135884...])
>>> a = np.array([[0.18, 0.18, 0.18]])
```

(continues on next page)

(continued from previous page)

```

>>> process_image_OpenColorIO(
...     a, "ACES - ACES2065-1", "ACES - ACEScct", config=config
... )
array([[ 0.4135884...,  0.4135884...,  0.4135884...]])
>>> a = np.array([[[0.18, 0.18, 0.18]]])
>>> process_image_OpenColorIO(
...     a, "ACES - ACES2065-1", "ACES - ACEScct", config=config
... )
array([[[ 0.4135884...,  0.4135884...,  0.4135884...]]])
>>> a = full([4, 2, 3], 0.18)
>>> process_image_OpenColorIO(
...     a, "ACES - ACES2065-1", "ACES - ACEScct", config=config
... )
array([[[ 0.4135884...,  0.4135884...,  0.4135884...],
        [ 0.4135884...,  0.4135884...,  0.4135884...]],
       [[ 0.4135884...,  0.4135884...,  0.4135884...],
        [ 0.4135884...,  0.4135884...,  0.4135884...]],
       [[ 0.4135884...,  0.4135884...,  0.4135884...],
        [ 0.4135884...,  0.4135884...,  0.4135884...]],
       [[ 0.4135884...,  0.4135884...,  0.4135884...],
        [ 0.4135884...,  0.4135884...,  0.4135884...]]])
>>> process_image_OpenColorIO(
...     a,
...     "ACES - ACES2065-1",
...     "Display - sRGB",
...     "Output - SDR Video - ACES 1.0",
...     ocio.TRANSFORM_DIR_FORWARD,
...     config=config,
... )
array([[[ 0.3559542...,  0.3559542...,  0.3559542...],
        [ 0.3559542...,  0.3559542...,  0.3559542...]],
       [[ 0.3559542...,  0.3559542...,  0.3559542...],
        [ 0.3559542...,  0.3559542...,  0.3559542...]],
       [[ 0.3559542...,  0.3559542...,  0.3559542...],
        [ 0.3559542...,  0.3559542...,  0.3559542...]],
       [[ 0.3559542...,  0.3559542...,  0.3559542...],
        [ 0.3559542...,  0.3559542...,  0.3559542...]]])

```

Look Up Table (LUT) Data

colour

| | |
|---|--|
| <code>LUT1D([table, name, domain, size, comments])</code> | Define the base class for a 1D <i>LUT</i> . |
| <code>LUT3x1D([table, name, domain, size, comments])</code> | Define the base class for a 3x1D <i>LUT</i> . |
| <code>LUT3D([table, name, domain, size, comments])</code> | Define the base class for a 3D <i>LUT</i> . |
| <code>LUTOperatorMatrix([matrix, offset])</code> | Define the <i>LUT</i> operator supporting a 3x3 or 4x4 matrix and an offset vector. |
| <code>LUTSequence(*args)</code> | Define the base class for a <i>LUT</i> sequence, i.e. a series of <i>LUT</i> s, <i>LUT</i> operators or objects implementing the <code>colour.hints.TypeLUTSequenceItem</code> protocol. |

colour.LUT1D

```
class colour.LUT1D(table: ArrayLike | None = None, name: str | None = None, domain: ArrayLike |
                    None = None, size: IntegerOrArrayLike | None = None, comments: Sequence | None
                    = None)
```

Bases: `AbstractLUT`

Define the base class for a 1D *LUT*.

Parameters

- **table** (Optional[ArrayLike]) – Underlying *LUT* table.
- **name** (Optional[str]) – *LUT* name.
- **domain** (Optional[ArrayLike]) – *LUT* domain, also used to define the instantiation time default table domain.
- **size** (Optional[IntegerOrArrayLike]) – Size of the instantiation time default table, default to 10.
- **comments** (Optional[Sequence]) – Comments to add to the *LUT*.

Methods

- `__init__()`
- `is_domain_explicit()`
- `linear_table()`
- `invert()`
- `apply()`
- `convert()`

Examples

Instantiating a unity LUT with a table with 16 elements:

```
>>> print(LUT1D(size=16))
LUT1D - Unity 16
-----

Dimensions : 1
Domain      : [ 0.  1.]
Size        : (16,)
```

Instantiating a LUT using a custom table with 16 elements:

```
>>> print(LUT1D(LUT1D.linear_table(16) ** (1 / 2.2)))
LUT1D - ...
-----...

Dimensions : 1
Domain      : [ 0.  1.]
Size        : (16,)
```

Instantiating a LUT using a custom table with 16 elements, custom name, custom domain and comments:

```
>>> from colour.algebra import spow
>>> domain = np.array([-0.1, 1.5])
>>> print(
...     LUT1D(
...         spow(LUT1D.linear_table(16, domain), 1 / 2.2),
...         "My LUT",
...         domain,
...         comments=["A first comment.", "A second comment."],
...     )
... )
LUT1D - My LUT
-----

Dimensions : 1
Domain      : [-0.1  1.5]
Size        : (16,)
Comment 01  : A first comment.
Comment 02  : A second comment.
```

```
__init__(table: ArrayLike | None = None, name: str | None = None, domain: ArrayLike | None =
None, size: IntegerOrArrayLike | None = None, comments: Sequence | None = None) →
None
```

Parameters

- **table** (ArrayLike | None) –
- **name** (str | None) –
- **domain** (ArrayLike | None) –
- **size** (IntegerOrArrayLike | None) –
- **comments** (Sequence | None) –

Return type

None

is_domain_explicit() → `bool`

Return whether the *LUT* domain is explicit (or implicit).

An implicit domain is defined by its shape only:

```
[0 1]
```

While an explicit domain defines every single discrete samples:

```
[0.0 0.1 0.2 0.4 0.8 1.0]
```

Returns

Is *LUT* domain explicit.

Return type

`bool`

Examples

```
>>> LUT1D().is_domain_explicit()
False
>>> table = domain = np.linspace(0, 1, 10)
>>> LUT1D(table, domain=domain).is_domain_explicit()
True
```

static linear_table(*size: IntegerOrArrayLike | None = None, domain: ArrayLike | None = None*) → `ndarray`

Return a linear table, the number of output samples *n* is equal to size.

Parameters

- **size** (`IntegerOrArrayLike | None`) – Expected table size, default to 10.
- **domain** (`ArrayLike | None`) – Domain of the table.

Returns

Linear table with size samples.

Return type

`numpy.ndarray`

Examples

```
>>> LUT1D.linear_table(5, np.array([-0.1, 1.5]))
array([-0.1,  0.3,  0.7,  1.1,  1.5])
>>> LUT1D.linear_table(domain=np.linspace(-0.1, 1.5, 5))
array([-0.1,  0.3,  0.7,  1.1,  1.5])
```

invert(***kwargs: Any*) → `LUT1D`

Compute and returns an inverse copy of the *LUT*.

Parameters

kwargs (`Any`) – Keywords arguments, only given for signature compatibility with the `AbstractLUT.invert()` method.

Returns

Inverse *LUT* class instance.

Return type

`colour.LUT1D`

Examples

```
>>> LUT = LUT1D(LUT1D.linear_table() ** (1 / 2.2))
>>> print(LUT.table)
[ 0.          ... 0.3683438... 0.5047603... 0.6069133... 0.6916988... 0.
↪ 7655385...
  0.8316843... 0.8920493... 0.9478701... 1.          ]
>>> print(LUT.invert())
LUT1D - ... - Inverse
-----...-----

Dimensions : 1
Domain      : [ 0.          0.3683438... 0.5047603... 0.6069133... 0.6916988...
↪ 0.7655385...
              0.8316843... 0.8920493... 0.9478701... 1.          ]
Size        : (10,)
>>> print(LUT.invert().table)
[ 0.          ... 0.1111111... 0.2222222... 0.3333333... 0.4444444... 0.
↪ 5555555...
  0.6666666... 0.7777777... 0.8888888... 1.          ]
```

apply(*RGB*: *ArrayLike*, ***kwargs*: *Any*) → *ndarray*

Apply the *LUT* to given *RGB* colourspace array using given method.

Parameters

- **RGB** (*ArrayLike*) – *RGB* colourspace array to apply the *LUT* onto.
- **direction** – Whether the *LUT* should be applied in the forward or inverse direction.
- **extrapolator** – Extrapolator class type or object to use as extrapolating function.
- **extrapolator_kwargs** – Arguments to use when instantiating or calling the extrapolating function.
- **interpolator** – Interpolator class type to use as interpolating function.
- **interpolator_kwargs** – Arguments to use when instantiating the interpolating function.
- **kwargs** (*Any*) –

Returns

Interpolated *RGB* colourspace array.

Return type

numpy.ndarray

Examples

```
>>> LUT = LUT1D(LUT1D.linear_table() ** (1 / 2.2))
>>> RGB = np.array([0.18, 0.18, 0.18])
```

LUT applied to the given *RGB* colourspace in the forward direction:

```
>>> LUT.apply(RGB)
array([ 0.4529220...,  0.4529220...,  0.4529220...])
```

LUT applied to the modified *RGB* colourspace in the inverse direction:

```
>>> LUT.apply(LUT.apply(RGB), direction="Inverse")
...
array([ 0.18...,  0.18...,  0.18...])
```

convert(cls: *Type*[AbstractLUT], force_conversion: *bool* = False, **kwargs: *Any*) → AbstractLUT
Convert the *LUT* to given cls class instance.

Parameters

- **cls** (*Type*[AbstractLUT]) – *LUT* class instance.
- **force_conversion** (*bool*) – Whether to force the conversion as it might be destructive.
- **interpolator** – Interpolator class type to use as interpolating function.
- **interpolator_kwargs** – Arguments to use when instantiating the interpolating function.
- **size** – Expected table size in case of an upcast to a *LUT3D* class instance.
- **kwargs** (*Any*) –

Returns

Converted *LUT* class instance.

Return type

colour.LUT1D or *colour.LUT3x1D* or *colour.LUT3D*

Warning: Some conversions are destructive and raise a *ValueError* exception by default.

Raises

ValueError – If the conversion is destructive.

Parameters

- **cls** (*Type*[AbstractLUT]) –
- **force_conversion** (*bool*) –
- **kwargs** (*Any*) –

Return type

AbstractLUT

Examples

```
>>> LUT = LUT1D()
>>> print(LUT.convert(LUT1D))
LUT1D - Unity 10 - Converted 1D to 1D
-----

Dimensions : 1
Domain      : [ 0.  1.]
Size        : (10,)
>>> print(LUT.convert(LUT3x1D))
LUT3x1D - Unity 10 - Converted 1D to 3x1D
-----

Dimensions : 2
Domain      : [[ 0.  0.  0.]
```

(continues on next page)

(continued from previous page)

```

        [ 1.  1.  1.]]
Size      : (10, 3)
>>> print(LUT.convert(LUT3D, force_conversion=True))
LUT3D - Unity 10 - Converted 1D to 3D
-----

Dimensions : 3
Domain      : [[ 0.  0.  0.]
               [ 1.  1.  1.]]
Size        : (33, 33, 33, 3)

```

colour.LUT3x1D

class colour.LUT3x1D(table: ArrayLike | *None* = *None*, name: str | *None* = *None*, domain: ArrayLike | *None* = *None*, size: IntegerOrArrayLike | *None* = *None*, comments: Sequence | *None* = *None*)

Bases: AbstractLUT

Define the base class for a 3x1D LUT.

Parameters

- **table** (Optional[ArrayLike]) – Underlying LUT table.
- **name** (Optional[str]) – LUT name.
- **domain** (Optional[ArrayLike]) – LUT domain, also used to define the instantiation time default table domain.
- **size** (Optional[IntegerOrArrayLike]) – Size of the instantiation time default table, default to 10.
- **comments** (Optional[Sequence]) – Comments to add to the LUT.

Methods

- `__init__()`
- `is_domain_explicit()`
- `linear_table()`
- `invert()`
- `apply()`
- `convert()`

Examples

Instantiating a unity LUT with a table with 16x3 elements:

```

>>> print(LUT3x1D(size=16))
LUT3x1D - Unity 16
-----

Dimensions : 2
Domain      : [[ 0.  0.  0.]

```

(continues on next page)

(continued from previous page)

```

      [ 1.  1.  1.]]
Size      : (16, 3)

```

Instantiating a LUT using a custom table with 16x3 elements:

```

>>> print(LUT3x1D(LUT3x1D.linear_table(16) ** (1 / 2.2)))
...
LUT3x1D - ...
-----...

Dimensions : 2
Domain      : [[ 0.  0.  0.]
               [ 1.  1.  1.]]
Size        : (16, 3)

```

Instantiating a LUT using a custom table with 16x3 elements, custom name, custom domain and comments:

```

>>> from colour.algebra import spow
>>> domain = np.array([[-0.1, -0.2, -0.4], [1.5, 3.0, 6.0]])
>>> print(
...     LUT3x1D(
...         spow(LUT3x1D.linear_table(16), 1 / 2.2),
...         "My LUT",
...         domain,
...         comments=["A first comment.", "A second comment."],
...     )
... )
LUT3x1D - My LUT
-----

Dimensions : 2
Domain      : [[-0.1 -0.2 -0.4]
               [ 1.5  3.   6. ]]
Size        : (16, 3)
Comment 01 : A first comment.
Comment 02 : A second comment.

```

```

__init__(table: ArrayLike | None = None, name: str | None = None, domain: ArrayLike | None =
None, size: IntegerOrArrayLike | None = None, comments: Sequence | None = None) →
None

```

Parameters

- **table** (ArrayLike | None) –
- **name** (str | None) –
- **domain** (ArrayLike | None) –
- **size** (IntegerOrArrayLike | None) –
- **comments** (Sequence | None) –

Return type

None

is_domain_explicit() → bool

Return whether the *LUT* domain is explicit (or implicit).

An implicit domain is defined by its shape only:

```
[[0 1]
 [0 1]
 [0 1]]
```

While an explicit domain defines every single discrete samples:

```
[[0.0 0.0 0.0]
 [0.1 0.1 0.1]
 [0.2 0.2 0.2]
 [0.3 0.3 0.3]
 [0.4 0.4 0.4]
 [0.8 0.8 0.8]
 [1.0 1.0 1.0]]
```

Returns

Is *LUT* domain explicit.

Return type

`bool`

Examples

```
>>> LUT3x1D().is_domain_explicit()
False
>>> samples = np.linspace(0, 1, 10)
>>> table = domain = tstack([samples, samples, samples])
>>> LUT3x1D(table, domain=domain).is_domain_explicit()
True
```

static linear_table(*size*: *IntegerOrArrayLike* | *None* = *None*, *domain*: *ArrayLike* | *None* = *None*) → *ndarray*

Return a linear table, the number of output samples *n* is equal to *size* * 3 or *size*[0] + *size*[1] + *size*[2].

Parameters

- **size** (*IntegerOrArrayLike* | *None*) – Expected table size, default to 10.
- **domain** (*ArrayLike* | *None*) – Domain of the table.

Returns

Linear table with *size* * 3 or *size*[0] + *size*[1] + *size*[2] samples.

Return type

`numpy.ndarray`

Warning: If *size* is non uniform, the linear table will be padded accordingly.

Examples

```
>>> LUT3x1D.linear_table(  
...     5, np.array([[ -0.1, -0.2, -0.4], [1.5, 3.0, 6.0]])  
... )  
array([[ -0.1, -0.2, -0.4],  
       [ 0.3, 0.6, 1.2],  
       [ 0.7, 1.4, 2.8],  
       [ 1.1, 2.2, 4.4],  
       [ 1.5, 3. , 6. ]])  
>>> LUT3x1D.linear_table(  
...     np.array([5, 3, 2]),  
...     np.array([[ -0.1, -0.2, -0.4], [1.5, 3.0, 6.0]]),  
... )  
array([[ -0.1, -0.2, -0.4],  
       [ 0.3, 1.4, 6. ],  
       [ 0.7, 3. , nan],  
       [ 1.1, nan, nan],  
       [ 1.5, nan, nan]])  
>>> domain = np.array(  
...     [  
...         [-0.1, -0.2, -0.4],  
...         [0.3, 1.4, 6.0],  
...         [0.7, 3.0, np.nan],  
...         [1.1, np.nan, np.nan],  
...         [1.5, np.nan, np.nan],  
...     ]  
... )  
>>> LUT3x1D.linear_table(domain=domain)  
array([[ -0.1, -0.2, -0.4],  
       [ 0.3, 1.4, 6. ],  
       [ 0.7, 3. , nan],  
       [ 1.1, nan, nan],  
       [ 1.5, nan, nan]])
```

invert(**kwargs: [Any](#)) → [LUT3x1D](#)

Compute and returns an inverse copy of the *LUT*.

Parameters

kwargs ([Any](#)) – Keywords arguments, only given for signature compatibility with the `AbstractLUT.invert()` method.

Returns

Inverse *LUT* class instance.

Return type

[colour.LUT3x1D](#)

Examples

```
>>> LUT = LUT3x1D(LUT3x1D.linear_table() ** (1 / 2.2))
>>> print(LUT.table)
[[ 0.          0.          0.          ]
 [ 0.36834383  0.36834383  0.36834383]
 [ 0.50476034  0.50476034  0.50476034]
 [ 0.60691337  0.60691337  0.60691337]
 [ 0.69169882  0.69169882  0.69169882]
 [ 0.76553851  0.76553851  0.76553851]
 [ 0.83168433  0.83168433  0.83168433]
 [ 0.89204934  0.89204934  0.89204934]
 [ 0.94787016  0.94787016  0.94787016]
 [ 1.          1.          1.          ]]
>>> print(LUT.invert())
LUT3x1D - ... - Inverse
-----...-----

Dimensions : 2
Domain      : [[ 0.          ... 0.          ... 0.          ...]
               [ 0.3683438... 0.3683438... 0.3683438...]
               [ 0.5047603... 0.5047603... 0.5047603...]
               [ 0.6069133... 0.6069133... 0.6069133...]
               [ 0.6916988... 0.6916988... 0.6916988...]
               [ 0.7655385... 0.7655385... 0.7655385...]
               [ 0.8316843... 0.8316843... 0.8316843...]
               [ 0.8920493... 0.8920493... 0.8920493...]
               [ 0.9478701... 0.9478701... 0.9478701...]
               [ 1.          ... 1.          ... 1.          ...]]
Size        : (10, 3)
>>> print(LUT.invert().table)
[[ 0.          ... 0.          ... 0.          ...]
 [ 0.1111111... 0.1111111... 0.1111111...]
 [ 0.2222222... 0.2222222... 0.2222222...]
 [ 0.3333333... 0.3333333... 0.3333333...]
 [ 0.4444444... 0.4444444... 0.4444444...]
 [ 0.5555555... 0.5555555... 0.5555555...]
 [ 0.6666666... 0.6666666... 0.6666666...]
 [ 0.7777777... 0.7777777... 0.7777777...]
 [ 0.8888888... 0.8888888... 0.8888888...]
 [ 1.          ... 1.          ... 1.          ...]]
```

apply(*RGB*: ArrayLike, ***kwargs*: Any) → ndarray

Apply the *LUT* to given *RGB* colourspace array using given method.

Parameters

- **RGB** (ArrayLike) – *RGB* colourspace array to apply the *LUT* onto.
- **direction** – Whether the *LUT* should be applied in the forward or inverse direction.
- **extrapolator** – Extrapolator class type or object to use as extrapolating function.
- **extrapolator_kwargs** – Arguments to use when instantiating or calling the extrapolating function.
- **interpolator** – Interpolator class type to use as interpolating function.

- **interpolator_kwargs** – Arguments to use when instantiating the interpolating function.
- **kwargs** (*Any*) –

Returns

Interpolated *RGB* colourspace array.

Return type

`numpy.ndarray`

Examples

```
>>> LUT = LUT3x1D(LUT3x1D.linear_table() ** (1 / 2.2))
>>> RGB = np.array([0.18, 0.18, 0.18])
>>> LUT.apply(RGB)
array([ 0.4529220...,  0.4529220...,  0.4529220...])
>>> LUT.apply(LUT.apply(RGB), direction="Inverse")
...
array([ 0.18...,  0.18...,  0.18...])
>>> from colour.algebra import spow
>>> domain = np.array([[ -0.1, -0.2, -0.4], [1.5, 3.0, 6.0]])
>>> table = spow(LUT3x1D.linear_table(domain=domain), 1 / 2.2)
>>> LUT = LUT3x1D(table, domain=domain)
>>> RGB = np.array([0.18, 0.18, 0.18])
>>> LUT.apply(RGB)
array([ 0.4423903...,  0.4503801...,  0.3581625...])
>>> domain = np.array(
...     [
...         [-0.1, -0.2, -0.4],
...         [0.3, 1.4, 6.0],
...         [0.7, 3.0, np.nan],
...         [1.1, np.nan, np.nan],
...         [1.5, np.nan, np.nan],
...     ]
... )
>>> table = spow(LUT3x1D.linear_table(domain=domain), 1 / 2.2)
>>> LUT = LUT3x1D(table, domain=domain)
>>> RGB = np.array([0.18, 0.18, 0.18])
>>> LUT.apply(RGB)
array([ 0.2996370..., -0.0901332..., -0.3949770...])
```

convert(cls: *Type*[*AbstractLUT*], force_conversion: *bool* = *False*, **kwargs: *Any*) → *AbstractLUT*

Convert the *LUT* to given cls class instance.

Parameters

- **cls** (*Type*[*AbstractLUT*]) – *LUT* class instance.
- **force_conversion** (*bool*) – Whether to force the conversion as it might be destructive.
- **interpolator** – Interpolator class type to use as interpolating function.
- **interpolator_kwargs** – Arguments to use when instantiating the interpolating function.
- **size** – Expected table size in case of an upcast to a *LUT3D* class instance.
- **kwargs** (*Any*) –

Returns

Converted *LUT* class instance.

Return type

`colour.LUT1D` or `colour.LUT3x1D` or `colour.LUT3D`

Warning: Some conversions are destructive and raise a `ValueError` exception by default.

Raises

`ValueError` – If the conversion is destructive.

Parameters

- **`cls`** (`Type[AbstractLUT]`) –
- **`force_conversion`** (`bool`) –
- **`kwargs`** (`Any`) –

Return type

AbstractLUT

Examples

```
>>> LUT = LUT3x1D()
>>> print(LUT.convert(LUT1D, force_conversion=True))
LUT1D - Unity 10 - Converted 3x1D to 1D
-----

Dimensions : 1
Domain      : [ 0.  1.]
Size        : (10,)
>>> print(LUT.convert(LUT3x1D))
LUT3x1D - Unity 10 - Converted 3x1D to 3x1D
-----

Dimensions : 2
Domain      : [[ 0.  0.  0.]
               [ 1.  1.  1.]]
Size        : (10, 3)
>>> print(LUT.convert(LUT3D, force_conversion=True))
LUT3D - Unity 10 - Converted 3x1D to 3D
-----

Dimensions : 3
Domain      : [[ 0.  0.  0.]
               [ 1.  1.  1.]]
Size        : (33, 33, 33, 3)
```

colour.LUT3D

```
class colour.LUT3D(table: ArrayLike | None = None, name: str | None = None, domain: ArrayLike |  
                  None = None, size: IntegerOrArrayLike | None = None, comments: Sequence | None  
                  = None)
```

Bases: AbstractLUT

Define the base class for a 3D *LUT*.

Parameters

- **table** (Optional[ArrayLike]) – Underlying *LUT* table.
- **name** (Optional[str]) – *LUT* name.
- **domain** (Optional[ArrayLike]) – *LUT* domain, also used to define the instantiation time default table domain.
- **size** (Optional[IntegerOrArrayLike]) – Size of the instantiation time default table, default to 33.
- **comments** (Optional[Sequence]) – Comments to add to the *LUT*.

Methods

- `__init__()`
- `is_domain_explicit()`
- `linear_table()`
- `invert()`
- `apply()`
- `convert()`

Examples

Instantiating a unity *LUT* with a table with 16x16x16x3 elements:

```
>>> print(LUT3D(size=16))  
LUT3D - Unity 16  
-----  
  
Dimensions : 3  
Domain      : [[ 0.  0.  0.]  
               [ 1.  1.  1.]]  
Size        : (16, 16, 16, 3)
```

Instantiating a *LUT* using a custom table with 16x16x16x3 elements:

```
>>> print(LUT3D(LUT3D.linear_table(16) ** (1 / 2.2)))  
LUT3D - ...  
-----...  
  
Dimensions : 3  
Domain      : [[ 0.  0.  0.]  
               [ 1.  1.  1.]]  
Size        : (16, 16, 16, 3)
```


Instantiating a LUT using a custom table with 16x16x16x3 elements, custom name, custom domain and comments:

```
>>> from colour.algebra import spow
>>> domain = np.array([[-0.1, -0.2, -0.4], [1.5, 3.0, 6.0]])
>>> print(
...     LUT3D(
...         spow(LUT3D.linear_table(16), 1 / 2.2),
...         "My LUT",
...         domain,
...         comments=["A first comment.", "A second comment."],
...     )
... )
LUT3D - My LUT
-----

Dimensions : 3
Domain      : [[-0.1 -0.2 -0.4]
               [ 1.5  3.   6.  ]]
Size        : (16, 16, 16, 3)
Comment 01  : A first comment.
Comment 02  : A second comment.
```

__init__(table: ArrayLike | None = None, name: str | None = None, domain: ArrayLike | None = None, size: IntegerOrArrayLike | None = None, comments: Sequence | None = None) → None

Parameters

- **table** (ArrayLike | None) –
- **name** (str | None) –
- **domain** (ArrayLike | None) –
- **size** (IntegerOrArrayLike | None) –
- **comments** (Sequence | None) –

Return type

None

is_domain_explicit() → bool

Return whether the *LUT* domain is explicit (or implicit).

An implicit domain is defined by its shape only:

```
[[0 0 0]
 [1 1 1]]
```

While an explicit domain defines every single discrete samples:

```
[[0.0 0.0 0.0]
 [0.1 0.1 0.1]
 [0.2 0.2 0.2]
 [0.3 0.3 0.3]
 [0.4 0.4 0.4]
 [0.8 0.8 0.8]
 [1.0 1.0 1.0]]
```

Returns

Is *LUT* domain explicit.

Return type`bool`**Examples**

```
>>> LUT3D().is_domain_explicit()
False
>>> domain = np.array(
...     [[-0.1, -0.2, -0.4], [0.7, 1.4, 6.0], [1.5, 3.0, np.nan]]
... )
>>> LUT3D(domain=domain).is_domain_explicit()
True
```

static `linear_table`(*size*: *IntegerOrArrayLike* | *None* = *None*, *domain*: *ArrayLike* | *None* = *None*) → `ndarray`

Return a linear table, the number of output samples *n* is equal to `size**3 * 3` or `size[0] * size[1] * size[2] * 3`.

Parameters

- **size** (*IntegerOrArrayLike* | *None*) – Expected table size, default to 33.
- **domain** (*ArrayLike* | *None*) – Domain of the table.

Returns

Linear table with `size**3 * 3` or `size[0] * size[1] * size[2] * 3` samples.

Return type`numpy.ndarray`**Examples**

```
>>> LUT3D.linear_table(
...     3, np.array([[-0.1, -0.2, -0.4], [1.5, 3.0, 6.0]])
... )
array([[[[-0.1, -0.2, -0.4],
          [-0.1, -0.2,  2.8],
          [-0.1, -0.2,  6. ]],
        [[[-0.1,  1.4, -0.4],
          [-0.1,  1.4,  2.8],
          [-0.1,  1.4,  6. ]],
        [[[-0.1,  3. , -0.4],
          [-0.1,  3. ,  2.8],
          [-0.1,  3. ,  6. ]]],
        [[[-0.7, -0.2, -0.4],
          [-0.7, -0.2,  2.8],
          [-0.7, -0.2,  6. ]],
        [[[-0.7,  1.4, -0.4],
          [-0.7,  1.4,  2.8],
          [-0.7,  1.4,  6. ]],
        [[[-0.7,  3. , -0.4],
          [-0.7,  3. ,  2.8],
          [-0.7,  3. ,  6. ]]]],
      dtype=float64)
```

(continues on next page)

(continued from previous page)

```

    [ 0.7,  3. ,  2.8],
    [ 0.7,  3. ,  6. ]]],

    [[[ 1.5, -0.2, -0.4],
      [ 1.5, -0.2,  2.8],
      [ 1.5, -0.2,  6. ]],

     [[ 1.5,  1.4, -0.4],
      [ 1.5,  1.4,  2.8],
      [ 1.5,  1.4,  6. ]],

     [[ 1.5,  3. , -0.4],
      [ 1.5,  3. ,  2.8],
      [ 1.5,  3. ,  6. ]]]])
>>> LUT3D.linear_table(
...     np.array([3, 3, 2]),
...     np.array([[-0.1, -0.2, -0.4], [1.5, 3.0, 6.0]]),
... )
array([[[[-0.1, -0.2, -0.4],
        [-0.1, -0.2,  6. ]],

       [[-0.1,  1.4, -0.4],
        [-0.1,  1.4,  6. ]],

       [[-0.1,  3. , -0.4],
        [-0.1,  3. ,  6. ]]],

      [[[ 0.7, -0.2, -0.4],
        [ 0.7, -0.2,  6. ]],

       [[ 0.7,  1.4, -0.4],
        [ 0.7,  1.4,  6. ]],

       [[ 0.7,  3. , -0.4],
        [ 0.7,  3. ,  6. ]]],

      [[[ 1.5, -0.2, -0.4],
        [ 1.5, -0.2,  6. ]],

       [[ 1.5,  1.4, -0.4],
        [ 1.5,  1.4,  6. ]],

       [[ 1.5,  3. , -0.4],
        [ 1.5,  3. ,  6. ]]]]])
>>> domain = np.array(
...     [[-0.1, -0.2, -0.4], [0.7, 1.4, 6.0], [1.5, 3.0, np.nan]]
... )
>>> LUT3D.linear_table(domain=domain)
array([[[[-0.1, -0.2, -0.4],
        [-0.1, -0.2,  6. ]],

       [[-0.1,  1.4, -0.4],
        [-0.1,  1.4,  6. ]],

```

(continues on next page)

(continued from previous page)

```

    [[-0.1,  3. , -0.4],
     [-0.1,  3. ,  6. ]],

    [[[ 0.7, -0.2, -0.4],
      [ 0.7, -0.2,  6. ]],

     [[ 0.7,  1.4, -0.4],
      [ 0.7,  1.4,  6. ]],

     [[ 0.7,  3. , -0.4],
      [ 0.7,  3. ,  6. ]]],

    [[[ 1.5, -0.2, -0.4],
      [ 1.5, -0.2,  6. ]],

     [[ 1.5,  1.4, -0.4],
      [ 1.5,  1.4,  6. ]],

     [[ 1.5,  3. , -0.4],
      [ 1.5,  3. ,  6. ]]]])

```

invert(**kwargs: [Any](#)) → [LUT3D](#)

Compute and returns an inverse copy of the *LUT*.

Parameters

- **extrapolate** – Whether to extrapolate the *LUT* when computing its inverse. Extrapolation is performed by reflecting the *LUT* cube along its 8 faces. Note that the domain is extended beyond [0, 1], thus the *LUT* might not be handled properly in other software.
- **interpolator** – Interpolator class type or object to use as interpolating function.
- **query_size** – Number of points to query in the KDTree, their mean is computed, resulting in a smoother result.
- **size** – Size of the inverse *LUT*. With the given implementation, it is good practise to double the size of the inverse *LUT* to provide a smoother result. If size is not given, $2^{\sqrt{\text{size}_{LUT}+1}} + 1$ will be used instead.
- **kwargs** ([Any](#)) –

Returns

Inverse *LUT* class instance.

Return type

[colour.LUT3D](#)

Examples

```
>>> LUT = LUT3D()
>>> print(LUT)
LUT3D - Unity 33
-----

Dimensions : 3
Domain      : [[ 0.  0.  0.]
               [ 1.  1.  1.]]
Size        : (33, 33, 33, 3)
>>> print(LUT.invert())
LUT3D - Unity 33 - Inverse
-----

Dimensions : 3
Domain      : [[ 0.  0.  0.]
               [ 1.  1.  1.]]
Size        : (108, 108, 108, 3)
```

apply(*RGB*: *ArrayLike*, ***kwargs*: *Any*) → *ndarray*

Apply the *LUT* to given *RGB* colourspace array using given method.

Parameters

- **RGB** (*ArrayLike*) – *RGB* colourspace array to apply the *LUT* onto.
- **direction** – Whether the *LUT* should be applied in the forward or inverse direction.
- **extrapolate** – Whether to extrapolate the *LUT* when computing its inverse. Extrapolation is performed by reflecting the *LUT* cube along its 8 faces.
- **interpolator** – Interpolator object to use as interpolating function.
- **interpolator_kwargs** – Arguments to use when calling the interpolating function.
- **query_size** – Number of points to query in the KDTree, their mean is computed, resulting in a smoother result.
- **size** – Size of the inverse *LUT*. With the given implementation, it is good practise to double the size of the inverse *LUT* to provide a smoother result. If size is not given, $2^{\sqrt{\text{size}_{LUT}+1}} + 1$ will be used instead.
- **kwargs** (*Any*) –

Returns

Interpolated *RGB* colourspace array.

Return type

numpy.ndarray

Examples

```
>>> LUT = LUT3D(LUT3D.linear_table() ** (1 / 2.2))
>>> RGB = np.array([0.18, 0.18, 0.18])
>>> LUT.apply(RGB)
array([ 0.4583277...,  0.4583277...,  0.4583277...])
>>> LUT.apply(LUT.apply(RGB), direction="Inverse")
...
array([ 0.1781995...,  0.1809414...,  0.1809513...])
>>> from colour.algebra import spow
>>> domain = np.array(
...     [
...         [-0.1, -0.2, -0.4],
...         [0.3, 1.4, 6.0],
...         [0.7, 3.0, np.nan],
...         [1.1, np.nan, np.nan],
...         [1.5, np.nan, np.nan],
...     ]
... )
>>> table = spow(LUT3D.linear_table(domain=domain), 1 / 2.2)
>>> LUT = LUT3D(table, domain=domain)
>>> RGB = np.array([0.18, 0.18, 0.18])
>>> LUT.apply(RGB)
array([ 0.2996370..., -0.0901332..., -0.3949770...])
```

convert(cls: [Type\[AbstractLUT\]](#), force_conversion: [bool](#) = False, **kwargs: [Any](#)) → [AbstractLUT](#)
 Convert the *LUT* to given cls class instance.

Parameters

- **cls** ([Type\[AbstractLUT\]](#)) – *LUT* class instance.
- **force_conversion** ([bool](#)) – Whether to force the conversion as it might be destructive.
- **interpolator** – Interpolator class type to use as interpolating function.
- **interpolator_kwargs** – Arguments to use when instantiating the interpolating function.
- **size** – Expected table size in case of a downcast from a [LUT3D](#) class instance.
- **kwargs** ([Any](#)) –

Returns

Converted *LUT* class instance.

Return type

[colour.LUT1D](#) or [colour.LUT3x1D](#) or [colour.LUT3D](#)

Warning: Some conversions are destructive and raise a [ValueError](#) exception by default.

Raises

[ValueError](#) – If the conversion is destructive.

Parameters

- **cls** ([Type\[AbstractLUT\]](#)) –
- **force_conversion** ([bool](#)) –
- **kwargs** ([Any](#)) –

Return type*AbstractLUT***Examples**

```

>>> LUT = LUT3D()
>>> print(LUT.convert(LUT1D, force_conversion=True))
LUT1D - Unity 33 - Converted 3D to 1D
-----

Dimensions : 1
Domain      : [ 0.  1.]
Size        : (10,)
>>> print(LUT.convert(LUT3x1D, force_conversion=True))
LUT3x1D - Unity 33 - Converted 3D to 3x1D
-----

Dimensions : 2
Domain      : [[ 0.  0.  0.]
               [ 1.  1.  1.]]
Size        : (10, 3)
>>> print(LUT.convert(LUT3D))
LUT3D - Unity 33 - Converted 3D to 3D
-----

Dimensions : 3
Domain      : [[ 0.  0.  0.]
               [ 1.  1.  1.]]
Size        : (33, 33, 33, 3)

```

colour.LUTOperatorMatrix

class colour.LUTOperatorMatrix(matrix: ArrayLike | *None* = None, offset: ArrayLike | *None* = None, *args: Any, **kwargs: Any)

Bases: AbstractLUTSequenceOperator

Define the *LUT* operator supporting a 3x3 or 4x4 matrix and an offset vector.

Parameters

- **matrix** (Optional[ArrayLike]) – 3x3 or 4x4 matrix for the operator.
- **offset** (Optional[ArrayLike]) – Offset for the operator.
- **name** – *LUT* operator name.
- **comments** – Comments to add to the *LUT* operator.
- **args** (Any) –
- **kwargs** (Any) –

Attributes

- `matrix()`
- `offset()`

Methods

- `__str__()`
- `__repr__()`
- `__eq__()`
- `__ne__()`
- `apply()`

Notes

- The internal `colour.io.Matrix.matrix` and `colour.io.Matrix.offset` properties are reshaped to (4, 4) and (4,) respectively.

Examples

Instantiating an identity matrix:

```
>>> print(LUTOperatorMatrix(name="Identity"))
LUTOperatorMatrix - Identity
-----
Matrix      : [[ 1.  0.  0.  0.]
                [ 0.  1.  0.  0.]
                [ 0.  0.  1.  0.]
                [ 0.  0.  0.  1.]]
Offset      : [ 0.  0.  0.  0.]
```

Instantiating a matrix with comments:

```
>>> matrix = np.array(
...     [
...         [1.45143932, -0.23651075, -0.21492857],
...         [-0.07655377, 1.1762297, -0.09967593],
...         [0.00831615, -0.00603245, 0.9977163],
...     ]
... )
>>> print(
...     LUTOperatorMatrix(
...         matrix,
...         name="AP0 to AP1",
...         comments=["A first comment.", "A second comment."],
...     )
... )
LUTOperatorMatrix - AP0 to AP1
-----
Matrix      : [[ 1.45143932 -0.23651075 -0.21492857  0.
                [-0.07655377  1.1762297 -0.09967593  0.]
```

(continues on next page)

(continued from previous page)

```

        [ 0.00831615 -0.00603245  0.9977163  0.
         [ 0.          0.          0.          1.
Offset   : [ 0.  0.  0.  0.]

```

A first comment.

A second comment.

__init__(*matrix*: ArrayLike | *None* = *None*, *offset*: ArrayLike | *None* = *None*, **args*: Any, ***kwargs*: Any) → *None*

Parameters

- **matrix** (ArrayLike | *None*) –
- **offset** (ArrayLike | *None*) –
- **args** (Any) –
- **kwargs** (Any) –

Return type

None

__hash__ = *None*

property **matrix**: *ndarray*

Getter and setter property for the *LUT* operator matrix.

Parameters

value – Value to set the *LUT* operator matrix with.

Returns

Operator matrix.

Return type

numpy.ndarray

property **offset**: *ndarray*

Getter and setter property for the *LUT* operator offset.

Parameters

value – Value to set the *LUT* operator offset with.

Returns

Operator offset.

Return type

numpy.ndarray

__str__() → *str*

Return a formatted string representation of the *LUT* operator.

Returns

Formatted string representation.

Return type

str

Examples

```
>>> print(LUTOperatorMatrix())
LUTOperatorMatrix - LUT Sequence Operator ...
-----...

Matrix      : [[ 1.  0.  0.  0.]
                [ 0.  1.  0.  0.]
                [ 0.  0.  1.  0.]
                [ 0.  0.  0.  1.]]
Offset      : [ 0.  0.  0.  0.]
```

`__repr__()` → `str`

Return an evaluable string representation of the *LUT* operator.

Returns

Evaluable string representation.

Return type

`str`

Examples

```
>>> LUTOperatorMatrix(
...     comments=["A first comment.", "A second comment."]
... )
...
LUTOperatorMatrix([[ 1.,  0.,  0.,  0.],
                   [ 0.,  1.,  0.,  0.],
                   [ 0.,  0.,  1.,  0.],
                   [ 0.,  0.,  0.,  1.]],
                   [ 0.,  0.,  0.,  0.],
                   name='LUT Sequence Operator ...',
                   comments=['A first comment.', 'A second comment.'])
```

`__eq__(other: Any)` → `bool`

Return whether the *LUT* operator is equal to given other object.

Parameters

other (`Any`) – Object to test whether it is equal to the *LUT* operator.

Returns

Whether given object equal to the *LUT* operator.

Return type

`bool`

Examples

```
>>> LUTOperatorMatrix() == LUTOperatorMatrix()
True
```

`__ne__(other: Any)` → `bool`

Return whether the *LUT* operator is not equal to given other object.

Parameters

other (`Any`) – Object to test whether it is not equal to the *LUT* operator.

Returns

Whether given object is not equal to the *LUT* operator.

Return type

`bool`

Examples

```
>>> LUTOperatorMatrix() != LUTOperatorMatrix(
...     np.linspace(0, 1, 16).reshape([4, 4])
... )
True
```

apply(*RGB*: *ArrayLike*, **args*: *Any*, ***kwargs*: *Any*) → *ndarray*

Apply the *LUT* operator to given *RGB* array.

Parameters

- *RGB* (*ArrayLike*) – *RGB* array to apply the *LUT* operator transform to.
- **apply_offset_first** – Whether to apply the offset first and then the matrix.
- *args* (*Any*) –
- *kwargs* (*Any*) –

Returns

Transformed *RGB* array.

Return type

`numpy.ndarray`

Examples

```
>>> matrix = np.array(
...     [
...         [1.45143932, -0.23651075, -0.21492857],
...         [-0.07655377, 1.1762297, -0.09967593],
...         [0.00831615, -0.00603245, 0.9977163],
...     ]
... )
>>> M = LUTOperatorMatrix(matrix)
>>> RGB = np.array([0.3, 0.4, 0.5])
>>> M.apply(RGB)
array([ 0.2333632...,  0.3976877...,  0.4989400...])
```

colour.LUTSequence

class `colour.LUTSequence`(**args*: *TypeLUTSequenceItem*)

Bases: `MutableSequence`

Define the base class for a *LUT* sequence, i.e. a series of *LUTs*, *LUT* operators or objects implementing the `colour.hints.TypeLUTSequenceItem` protocol.

The `colour.LUTSequence` class can be used to model series of *LUTs* such as when a shaper *LUT* is combined with a 3D *LUT*.

Parameters

args (*TypeLUTSequenceItem*) – Sequence of objects implementing the `colour.hints.TypeLUTSequenceItem` protocol.

Attributes

- sequence

Methods

- `__init__()`
- `__getitem__()`
- `__setitem__()`
- `__delitem__()`
- `__len__()`
- `__str__()`
- `__repr__()`
- `__eq__()`
- `__ne__()`
- `insert()`
- `apply()`
- `copy()`

Examples

```
>>> from colour.io.luts import LUT1D, LUT3x1D, LUT3D
>>> LUT_1 = LUT1D()
>>> LUT_2 = LUT3D(size=3)
>>> LUT_3 = LUT3x1D()
>>> print(LUTSequence(LUT_1, LUT_2, LUT_3))
LUT Sequence
-----
```

Overview

LUT1D --> LUT3D --> LUT3x1D

Operations

LUT1D - Unity 10

Dimensions : 1
Domain : [0. 1.]
Size : (10,)

LUT3D - Unity 3

Dimensions : 3
Domain : [[0. 0. 0.]
 [1. 1. 1.]]
Size : (3, 3, 3, 3)

(continues on next page)

(continued from previous page)

```
LUT3x1D - Unity 10
-----

Dimensions : 2
Domain      : [[ 0.  0.  0.]
               [ 1.  1.  1.]]
Size        : (10, 3)
```

__init__(*args: [TypeLUTSequenceItem](#)) → None

Parameters

args ([TypeLUTSequenceItem](#)) –

Return type

None

property sequence: [List\[TypeLUTSequenceItem\]](#)

Getter and setter property for the underlying *LUT* sequence.

Parameters

value – Value to set the underlying *LUT* sequence with.

Returns

Underlying *LUT* sequence.

Return type

[list](#)

__getitem__(index: [int](#) | [slice](#)) → [Any](#)

Return the *LUT* sequence item(s) at given index (or slice).

Parameters

index ([int](#) | [slice](#)) – Index (or slice) to return the *LUT* sequence item(s) at.

Returns

LUT sequence item(s) at given index (or slice).

Return type

[TypeLUTSequenceItem](#)

__setitem__(index: [int](#) | [slice](#), value: [Any](#))

Set the *LUT* sequence at given index (or slice) with given value.

Parameters

- **index** ([int](#) | [slice](#)) – Index (or slice) to set the *LUT* sequence value at.
- **value** ([Any](#)) – Value to set the *LUT* sequence with.

__delitem__(index: [int](#) | [slice](#))

Delete the *LUT* sequence item(s) at given index (or slice).

Parameters

index ([int](#) | [slice](#)) – Index (or slice) to delete the *LUT* sequence items at.

__len__() → [int](#)

Return the *LUT* sequence items count.

Returns

LUT sequence items count.

Return type

[numpy.integer](#)

`__str__()` → `str`

Return a formatted string representation of the *LUT* sequence.

Returns

Formatted string representation.

Return type

`str`

`__repr__()` → `str`

Return an evaluable string representation of the *LUT* sequence.

Returns

Evaluable string representation.

Return type

`str`

`__eq__(other)` → `bool`

Return whether the *LUT* sequence is equal to given other object.

Parameters

other – Object to test whether it is equal to the *LUT* sequence.

Returns

Whether given object is equal to the *LUT* sequence.

Return type

`bool`

`__ne__(other)` → `bool`

Return whether the *LUT* sequence is not equal to given other object.

Parameters

other – Object to test whether it is not equal to the *LUT* sequence.

Returns

Whether given object is not equal to the *LUT* sequence.

Return type

`bool`

`insert(index: int, item: TypeLUTSequenceItem)`

Insert given *LUT* at given index into the *LUT* sequence.

Parameters

- **index** (`int`) – Index to insert the item at into the *LUT* sequence.
- **item** (`TypeLUTSequenceItem`) – *LUT* to insert into the *LUT* sequence.

`__hash__` = `None`

`__weakref__`

list of weak references to the object (if defined)

`apply(RGB: ArrayLike, **kwargs: Any)` → `ndarray`

Apply the *LUT* sequence sequentially to given *RGB* colourspace array.

Parameters

- **RGB** (`ArrayLike`) – *RGB* colourspace array to apply the *LUT* sequence sequentially onto.
- **kwargs** (`Any`) – Keywords arguments, the keys must be the class type names for which they are intended to be used with. There is no implemented way to discriminate which class instance the keyword arguments should be used with,

thus if many class instances of the same type are members of the sequence, any matching keyword arguments will be used with all the class instances.

Returns

Processed *RGB* colourspace array.

Return type

`numpy.ndarray`

Examples

```
>>> import numpy as np
>>> from colour.io.luts import LUT1D, LUT3x1D, LUT3D
>>> from colour.utilities import tstack
>>> LUT_1 = LUT1D(LUT1D.linear_table(16) + 0.125)
>>> LUT_2 = LUT3D(LUT3D.linear_table(16) ** (1 / 2.2))
>>> LUT_3 = LUT3x1D(LUT3x1D.linear_table(16) * 0.750)
>>> LUT_sequence = LUTSequence(LUT_1, LUT_2, LUT_3)
>>> samples = np.linspace(0, 1, 5)
>>> RGB = tstack([samples, samples, samples])
>>> LUT_sequence.apply(RGB, LUT1D={"direction": "Inverse"})
...
array([[ 0.          ...,  0.          ...,  0.          ...],
       [ 0.2899886...,  0.2899886...,  0.2899886...],
       [ 0.4797662...,  0.4797662...,  0.4797662...],
       [ 0.6055328...,  0.6055328...,  0.6055328...],
       [ 0.7057779...,  0.7057779...,  0.7057779...]])
```

`copy()` → *LUTSequence*

Return a copy of the *LUT* sequence.

Returns

LUT sequence copy.

Return type

`colour.LUTSequence`

| | |
|---|--|
| <code>read_LUT(path[, method])</code> | Read given <i>LUT</i> file using given method. |
| <code>write_LUT(LUT, path[, decimals, method])</code> | Write given <i>LUT</i> to given file using given method. |

colour.read_LUT

`colour.read_LUT(path: str, method: Literal['Cinespace', 'Iridas Cube', 'Resolve Cube', 'Sony SPI1D', 'Sony SPI3D', 'Sony SPImtx'] | str | None = None, **kwargs: Any) → LUT1D | LUT3x1D | LUT3D | LUTSequence | LUTOperatorMatrix`

Read given *LUT* file using given method.

Parameters

- **path** (`str`) – *LUT* path.
- **method** (`Literal['Cinespace', 'Iridas Cube', 'Resolve Cube', 'Sony SPI1D', 'Sony SPI3D', 'Sony SPImtx'] | str | None`) – Reading method, if *None*, the method will be auto-detected according to extension.
- **kwargs** (`Any`) –

Returns

`colour.LUT1D` or `colour.LUT3x1D` or `colour.LUT3D` or `colour.LUTSequence` or `colour.LUTOperatorMatrix` class instance.

Return type

`colour.LUT1D` or `colour.LUT3x1D` or `colour.LUT3D` or `colour.LUTSequence` or `colour.LUTOperatorMatrix`

References

[AdobeSystems13c], [Cha15], [RisingSResearch]

Examples

Reading a 3x1D *Iridas* .cube LUT:

```
>>> path = os.path.join(
...     os.path.dirname(__file__),
...     "tests",
...     "resources",
...     "iridas_cube",
...     "ACES_Proxy_10_to_ACES.cube",
... )
>>> print(read_LUT(path))
LUT3x1D - ACES Proxy 10 to ACES
-----

Dimensions : 2
Domain      : [[ 0.  0.  0.]
               [ 1.  1.  1.]]
Size        : (32, 3)
```

Reading a 1D Sony .spi1d LUT:

```
>>> path = os.path.join(
...     os.path.dirname(__file__),
...     "tests",
...     "resources",
...     "sony_spi1d",
...     "eotf_sRGB_1D.spi1d",
... )
>>> print(read_LUT(path))
LUT1D - eotf sRGB 1D
-----

Dimensions : 1
Domain      : [-0.1  1.5]
Size        : (16,)
Comment 01 : Generated by "Colour 0.3.11".
Comment 02 : "colour.models.eotf_sRGB".
```

Reading a 3D Sony .spi3d LUT:

```
>>> path = os.path.join(
...     os.path.dirname(__file__),
...     "tests",
...     "resources",
```

(continues on next page)

(continued from previous page)

```

...     "sony_spi3d",
...     "Colour_Correct.spi3d",
... )
>>> print(read_LUT(path))
LUT3D - Colour Correct
-----

Dimensions : 3
Domain      : [[ 0.  0.  0.]
               [ 1.  1.  1.]]
Size        : (4, 4, 4, 3)
Comment 01 : Adapted from a LUT generated by Foundry::LUT.

```

Reading a Sony *.spimtx* LUT:

```

>>> path = os.path.join(
...     os.path.dirname(__file__),
...     "tests",
...     "resources",
...     "sony_spimtx",
...     "dt.spimtx",
... )
>>> print(read_LUT(path))
LUTOperatorMatrix - dt
-----

Matrix      : [[ 0.864274  0.         0.         0.         ]
               [ 0.         0.864274  0.         0.         ]
               [ 0.         0.         0.864274  0.         ]
               [ 0.         0.         0.         1.         ]]
Offset      : [ 0.  0.  0.  0.]

```

colour.write_LUT

`colour.write_LUT(LUT: LUT1D | LUT3x1D | LUT3D | LUTSequence | LUTOperatorMatrix, path: str, decimals: int = 7, method: Literal['Cinespace', 'Iridas Cube', 'Resolve Cube', 'Sony SPI1D', 'Sony SPI3D', 'Sony SPImtx'] | str | None = None, **kwargs: Any) → bool`

Write given *LUT* to given file using given method.

Parameters

- **LUT** (`LUT1D` | `LUT3x1D` | `LUT3D` | `LUTSequence` | `LUTOperatorMatrix`) – `colour.LUT1D` or `colour.LUT3x1D` or `colour.LUT3D` or `colour.LUTSequence` or `colour.LUTOperatorMatrix` class instance to write at given path.
- **path** (`str`) – *LUT* path.
- **decimals** (`int`) – Formatting decimals.
- **method** (`Literal`['Cinespace', 'Iridas Cube', 'Resolve Cube', 'Sony SPI1D', 'Sony SPI3D', 'Sony SPImtx'] | `str` | `None`) – Writing method, if `None`, the method will be auto-detected according to extension.
- **kwargs** (`Any`) –

Returns

Definition success.

Return type`bool`**References**[\[AdobeSystems13c\]](#), [\[Cha15\]](#), [\[RisingSResearch\]](#)**Examples**

Writing a 3x1D *Iridas* .cube LUT:

```
>>> import numpy as np
>>> from colour.algebra import spow
>>> domain = np.array([[ -0.1, -0.2, -0.4], [1.5, 3.0, 6.0]])
>>> LUT = LUT3x1D(
...     spow(LUT3x1D.linear_table(16, domain), 1 / 2.2),
...     "My LUT",
...     domain,
...     comments=["A first comment.", "A second comment."],
... )
>>> write_LUT(LUT, "My_LUT.cube")
```

Writing a 1D *Sony* .spi1d LUT:

```
>>> domain = np.array([ -0.1, 1.5])
>>> LUT = LUT1D(
...     spow(LUT1D.linear_table(16, domain), 1 / 2.2),
...     "My LUT",
...     domain,
...     comments=["A first comment.", "A second comment."],
... )
>>> write_LUT(LUT, "My_LUT.spi1d")
```

Writing a 3D *Sony* .spi3d LUT:

```
>>> LUT = LUT3D(
...     LUT3D.linear_table(16) ** (1 / 2.2),
...     "My LUT",
...     np.array([[0, 0, 0], [1, 1, 1]]),
...     comments=["A first comment.", "A second comment."],
... )
>>> write_LUT(LUT, "My_LUT.cube")
```

Ancillary Objects`colour.io`

| | |
|--|--|
| <code>AbstractLUTSequenceOperator</code> | ([name, com- Define the base class for <i>LUT</i> sequence operators. ments]) |
|--|--|

colour.io.AbstractLUTSequenceOperator

```
class colour.io.AbstractLUTSequenceOperator(name: str | None = None, comments: Sequence[str] |
                                             None = None)
```

Bases: ABC

Define the base class for *LUT* sequence operators.

This is an ABCMeta abstract class that must be inherited by sub-classes.

Parameters

- **name** (Optional[str]) – *LUT* sequence operator name.
- **comments** (Optional[Sequence[str]]) – Comments to add to the *LUT* sequence operator.

Attributes

- name
- comments

Methods

- apply()

```
__init__(name: str | None = None, comments: Sequence[str] | None = None) → None
```

Parameters

- **name** (str | None) –
- **comments** (Sequence[str] | None) –

Return type

None

property name: str

Getter and setter property for the *LUT* name.

Parameters

value – Value to set the *LUT* name with.

Returns

LUT name.

Return type

str

property comments: List[str]

Getter and setter property for the *LUT* comments.

Parameters

value – Value to set the *LUT* comments with.

Returns

LUT comments.

Return type

list

abstract apply(*RGB*: ArrayLike, *args: Any, **kwargs: Any) → ndarray

Apply the *LUT* sequence operator to given *RGB* colourspace array.

Parameters

- **RGB** (ArrayLike) – *RGB* colourspace array to apply the *LUT* sequence operator onto.
- **args** (Any) – Arguments.
- **kwargs** (Any) – Keywords arguments.

Returns

Processed *RGB* colourspace array.

Return type

numpy.ndarray

__weakref__

list of weak references to the object (if defined)

| | |
|--|--|
| <code>LUT_to_LUT(LUT, cls[, force_conversion])</code> | Convert given <i>LUT</i> to given <i>cls</i> class instance. |
| <code>read_LUT_Cinespace(path)</code> | Read given <i>Cinespace</i> .csp <i>LUT</i> file. |
| <code>write_LUT_Cinespace(LUT, path[, decimals])</code> | Write given <i>LUT</i> to given <i>Cinespace</i> .csp <i>LUT</i> file. |
| <code>read_LUT_IridasCube(path)</code> | Read given <i>Iridas</i> .cube <i>LUT</i> file. |
| <code>write_LUT_IridasCube(LUT, path[, decimals])</code> | Write given <i>LUT</i> to given <i>Iridas</i> .cube <i>LUT</i> file. |
| <code>read_LUT_SonySPI1D(path)</code> | Read given <i>Sony</i> .spi1d <i>LUT</i> file. |
| <code>write_LUT_SonySPI1D(LUT, path[, decimals])</code> | Write given <i>LUT</i> to given <i>Sony</i> .spi1d <i>LUT</i> file. |
| <code>read_LUT_SonySPI3D(path)</code> | Read given <i>Sony</i> .spi3d <i>LUT</i> file. |
| <code>write_LUT_SonySPI3D(LUT, path[, decimals])</code> | Write given <i>LUT</i> to given <i>Sony</i> .spi3d <i>LUT</i> file. |

colour.io.LUT_to_LUT

`colour.io.LUT_to_LUT(LUT, cls: Type[AbstractLUT], force_conversion: bool = False, **kwargs: Any) → AbstractLUT`

Convert given *LUT* to given *cls* class instance.

Parameters

- **cls** (Type[AbstractLUT]) – *LUT* class instance.
- **force_conversion** (bool) – Whether to force the conversion if destructive.
- **channel_weights** – Channel weights in case of a downcast from a LUT3x1D or LUT3D class instance.
- **interpolator** – Interpolator class type to use as interpolating function.
- **interpolator_kwargs** – Arguments to use when instantiating the interpolating function.
- **size** – Expected table size in case of an upcast to or a downcast from a LUT3D class instance.
- **kwargs** (Any) –

Returns

Converted *LUT* class instance.

Return type

colour.LUT1D or colour.LUT3x1D or colour.LUT3D

Warning: Some conversions are destructive and raise a `ValueError` exception by default.

Raises

`ValueError` – If the conversion is destructive.

Parameters

- `cls` (`Type[AbstractLUT]`) –
- `force_conversion` (`bool`) –
- `kwargs` (`Any`) –

Return type

`AbstractLUT`

Examples

```
>>> print(LUT_to_LUT(LUT1D(), LUT3D, force_conversion=True))
LUT3D - Unity 10 - Converted 1D to 3D
-----

Dimensions : 3
Domain      : [[ 0.  0.  0.]
               [ 1.  1.  1.]]
Size        : (33, 33, 33, 3)
>>> print(LUT_to_LUT(LUT3x1D(), LUT1D, force_conversion=True))
LUT1D - Unity 10 - Converted 3x1D to 1D
-----

Dimensions : 1
Domain      : [ 0.  1.]
Size        : (10,)
>>> print(LUT_to_LUT(LUT3D(), LUT1D, force_conversion=True))
LUT1D - Unity 33 - Converted 3D to 1D
-----

Dimensions : 1
Domain      : [ 0.  1.]
Size        : (10,)
```

`colour.io.read_LUT_Cinespace`

`colour.io.read_LUT_Cinespace(path: str) → LUT3x1D | LUT3D | LUTSequence`

Read given *Cinespace* .csp LUT file.

Parameters

`path` (`str`) – LUT path.

Returns

LUT3x1D or LUT3D or LUTSequence class instance.

Return type

`colour.LUT3x1D` or `colour.LUT3D` or `colour.LUTSequence`

References

[RisingSResearch]

Examples

Reading a 3x1D *Cinespace* .csp LUT:

```
>>> import os
>>> path = os.path.join(
...     os.path.dirname(__file__),
...     "tests",
...     "resources",
...     "cinespace",
...     "ACES_Proxy_10_to_ACES.csp",
... )
>>> print(read_LUT_Cinespace(path))
LUT3x1D - ACES Proxy 10 to ACES
-----

Dimensions : 2
Domain      : [[ 0.  0.  0.]
               [ 1.  1.  1.]]
Size        : (32, 3)
```

Reading a 3D *Cinespace* .csp LUT:

```
>>> path = os.path.join(
...     os.path.dirname(__file__),
...     "tests",
...     "resources",
...     "cinespace",
...     "Colour_Correct.csp",
... )
>>> print(read_LUT_Cinespace(path))
LUT3D - Generated by Foundry::LUT
-----

Dimensions : 3
Domain      : [[ 0.  0.  0.]
               [ 1.  1.  1.]]
Size        : (4, 4, 4, 3)
```

colour.io.write_LUT_Cinespace

`colour.io.write_LUT_Cinespace(LUT: LUT3x1D | LUT3D | LUTSequence, path: str, decimals: int = 7)`
→ bool

Write given *LUT* to given *Cinespace* .csp LUT file.

Parameters

- **LUT** (LUT3x1D | LUT3D | LUTSequence) – LUT1D, LUT3x1D or LUT3D or LUTSequence class instance to write at given path.
- **path** (str) – LUT path.
- **decimals** (int) – Formatting decimals.

Returns

Definition success.

Return type`bool`**References**[\[RisingSResearch\]](#)**Examples**Writing a 3x1D *Cinespace* .csp LUT:

```
>>> from colour.algebra import spow
>>> domain = np.array([[ -0.1, -0.2, -0.4], [1.5, 3.0, 6.0]])
>>> LUT = LUT3x1D(
...     spow(LUT3x1D.linear_table(16, domain), 1 / 2.2),
...     "My LUT",
...     domain,
...     comments=["A first comment.", "A second comment."],
... )
>>> write_LUT_Cinespace(LUT, "My_LUT.cube")
```

Writing a 3D *Cinespace* .csp LUT:

```
>>> domain = np.array([[ -0.1, -0.2, -0.4], [1.5, 3.0, 6.0]])
>>> LUT = LUT3D(
...     spow(LUT3D.linear_table(16, domain), 1 / 2.2),
...     "My LUT",
...     domain,
...     comments=["A first comment.", "A second comment."],
... )
>>> write_LUT_Cinespace(LUT, "My_LUT.cube")
```

colour.io.read_LUT_IridasCube`colour.io.read_LUT_IridasCube(path: str) → LUT3x1D | LUT3D`Read given *Iridas* .cube LUT file.**Parameters****path** (`str`) – LUT path.**Returns**

LUT3x1D or LUT3D class instance.

Return type

LUT3x1D or LUT3D.

References

[AdobeSystems13c]

Examples

Reading a 3x1D *Iridas* .cube LUT:

```
>>> import os
>>> path = os.path.join(
...     os.path.dirname(__file__),
...     "tests",
...     "resources",
...     "iridas_cube",
...     "ACES_Proxy_10_to_ACES.cube",
... )
>>> print(read_LUT_IridasCube(path))
LUT3x1D - ACES Proxy 10 to ACES
-----

Dimensions : 2
Domain      : [[ 0.  0.  0.]
               [ 1.  1.  1.]]
Size        : (32, 3)
```

Reading a 3D *Iridas* .cube LUT:

```
>>> path = os.path.join(
...     os.path.dirname(__file__),
...     "tests",
...     "resources",
...     "iridas_cube",
...     "Colour_Correct.cube",
... )
>>> print(read_LUT_IridasCube(path))
LUT3D - Generated by Foundry::LUT
-----

Dimensions : 3
Domain      : [[ 0.  0.  0.]
               [ 1.  1.  1.]]
Size        : (4, 4, 4, 3)
```

Reading a 3D *Iridas* .cube LUT with comments:

```
>>> path = os.path.join(
...     os.path.dirname(__file__),
...     "tests",
...     "resources",
...     "iridas_cube",
...     "Demo.cube",
... )
>>> print(read_LUT_IridasCube(path))
LUT3x1D - Demo
-----

Dimensions : 2
```

(continues on next page)

(continued from previous page)

```

Domain      : [[ 0.  0.  0.]
               [ 1.  2.  3.]]
Size        : (3, 3)
Comment 01  : Comments can go anywhere

```

colour.io.write_LUT_IridasCube

`colour.io.write_LUT_IridasCube(LUT: LUT3x1D | LUT3D | LUTSequence, path: str, decimals: int = 7) → bool`

Write given *LUT* to given *Iridas .cube LUT* file.

Parameters

- **LUT** (`LUT3x1D` | `LUT3D` | `LUTSequence`) – `LUT3x1D`, `LUT3D` or `LUTSequence` class instance to write at given path.
- **path** (`str`) – *LUT* path.
- **decimals** (`int`) – Formatting decimals.

Returns

Definition success.

Return type

`bool`

Warning:

- If a `LUTSequence` class instance is passed as *LUT*, the first *LUT* in the *LUT* sequence will be used.

References

[AdobeSystems13c]

Examples

Writing a 3x1D *Iridas .cube LUT*:

```

>>> from colour.algebra import spow
>>> domain = np.array([[-0.1, -0.2, -0.4], [1.5, 3.0, 6.0]])
>>> LUT = LUT3x1D(
...     spow(LUT3x1D.linear_table(16, domain), 1 / 2.2),
...     "My LUT",
...     domain,
...     comments=["A first comment.", "A second comment."],
... )
>>> write_LUT_IridasCube(LUTxD, "My_LUT.cube")

```

Writing a 3D *Iridas .cube LUT*:

```

>>> domain = np.array([[-0.1, -0.2, -0.4], [1.5, 3.0, 6.0]])
>>> LUT = LUT3D(
...     spow(LUT3D.linear_table(16, domain), 1 / 2.2),
...     "My LUT",

```

(continues on next page)

(continued from previous page)

```
...     np.array([[ -0.1, -0.2, -0.4], [1.5, 3.0, 6.0]]),
...     comments=["A first comment.", "A second comment."],
... )
>>> write_LUT_IridasCube(LUTxD, "My_LUT.cube")
```

colour.io.read_LUT_SonySPI1D

colour.io.read_LUT_SonySPI1D(path: str) → LUT1D | LUT3x1D

Read given Sony .spi1d LUT file.

Parameters

path (str) – LUT path.

Returns

LUT1D or LUT3x1D class instance.

Return type

colour.LUT1D or colour.LUT3x1D

Examples

Reading a 1D Sony .spi1d LUT:

```
>>> import os
>>> path = os.path.join(
...     os.path.dirname(__file__),
...     "tests",
...     "resources",
...     "sony_spi1d",
...     "eotf_sRGB_1D.spi1d",
... )
>>> print(read_LUT_SonySPI1D(path))
LUT1D - eotf sRGB 1D
-----

Dimensions : 1
Domain      : [-0.1  1.5]
Size        : (16,)
Comment 01 : Generated by "Colour 0.3.11".
Comment 02 : "colour.models.eotf_sRGB".
```

Reading a 3x1D Sony .spi1d LUT:

```
>>> path = os.path.join(
...     os.path.dirname(__file__),
...     "tests",
...     "resources",
...     "sony_spi1d",
...     "eotf_sRGB_3x1D.spi1d",
... )
>>> print(read_LUT_SonySPI1D(path))
LUT3x1D - eotf sRGB 3x1D
-----

Dimensions : 2
```

(continues on next page)

(continued from previous page)

```

Domain      : [[-0.1 -0.1 -0.1]
               [ 1.5  1.5  1.5]]
Size        : (16, 3)
Comment 01  : Generated by "Colour 0.3.11".
Comment 02  : "colour.models.eotf_sRGB".

```

colour.io.write_LUT_SonySPI1D

```
colour.io.write_LUT_SonySPI1D(LUT: LUT1D | LUT3x1D | LUTSequence, path: str, decimals: int = 7)
                             → bool
```

Write given *LUT* to given Sony *.spi1d* LUT file.

Parameters

- **LUT** (*LUT1D* | *LUT3x1D* | *LUTSequence*) – LUT1D, LUT3x1D or LUTSequence class instance to write at given path.
- **path** (*str*) – LUT path.
- **decimals** (*int*) – Formatting decimals.

Returns

Definition success.

Return type

bool

Warning:

- If a LUTSequence class instance is passed as LUT, the first *LUT* in the *LUT* sequence will be used.

Examples

Writing a 1D Sony *.spi1d* LUT:

```

>>> from colour.algebra import spow
>>> domain = np.array([-0.1, 1.5])
>>> LUT = LUT1D(
...     spow(LUT1D.linear_table(16), 1 / 2.2),
...     "My LUT",
...     domain,
...     comments=["A first comment.", "A second comment."],
... )
>>> write_LUT_SonySPI1D(LUT, "My_LUT.cube")

```

Writing a 3x1D Sony *.spi1d* LUT:

```

>>> domain = np.array([[-0.1, -0.1, -0.1], [1.5, 1.5, 1.5]])
>>> LUT = LUT3x1D(
...     spow(LUT3x1D.linear_table(16), 1 / 2.2),
...     "My LUT",
...     domain,
...     comments=["A first comment.", "A second comment."],
... )
>>> write_LUT_SonySPI1D(LUT, "My_LUT.cube")

```

colour.io.read_LUT_SonySPI3D

colour.io.read_LUT_SonySPI3D(path: str) → LUT3D

Read given Sony .spi3d LUT file.

Parameters

path (str) – LUT path.

Returns

LUT3D class instance.

Return type

colour.LUT3D

Examples

Reading an ordered and an unordered 3D Sony .spi3d LUT:

```
>>> import os
>>> path = os.path.join(
...     os.path.dirname(__file__),
...     "tests",
...     "resources",
...     "sony_spi3d",
...     "Colour_Correct.spi3d",
... )
>>> print(read_LUT_SonySPI3D(path))
LUT3D - Colour Correct
-----

Dimensions : 3
Domain      : [[ 0.  0.  0.]
               [ 1.  1.  1.]]
Size        : (4, 4, 4, 3)
Comment 01 : Adapted from a LUT generated by Foundry::LUT.
>>> path = os.path.join(
...     os.path.dirname(__file__),
...     "tests",
...     "resources",
...     "sony_spi3d",
...     "Colour_Correct_Unordered.spi3d",
... )
>>> print(read_LUT_SonySPI3D(path))
LUT3D - Colour Correct Unordered
-----

Dimensions : 3
Domain      : [[ 0.  0.  0.]
               [ 1.  1.  1.]]
Size        : (4, 4, 4, 3)
Comment 01 : Adapted from a LUT generated by Foundry::LUT.
```

colour.io.write_LUT_SonySPI3D

`colour.io.write_LUT_SonySPI3D(LUT: LUT3D | LUTSequence, path: str, decimals: int = 7) → bool`

Write given *LUT* to given *Sony .spi3d LUT* file.

Parameters

- **LUT** (`LUT3D` | `LUTSequence`) – `LUT3D` or `LUTSequence` class instance to write at given path.
- **path** (`str`) – *LUT* path.
- **decimals** (`int`) – Formatting decimals.

Returns

Definition success.

Return type

`bool`

Warning:

- If a `LUTSequence` class instance is passed as *LUT*, the first *LUT* in the *LUT* sequence will be used.

Examples

Writing a 3D *Sony .spi3d LUT*:

```
>>> LUT = LUT3D(
...     LUT3D.linear_table(16) ** (1 / 2.2),
...     "My LUT",
...     np.array([[0, 0, 0], [1, 1, 1]]),
...     comments=["A first comment.", "A second comment."],
... )
>>> write_LUT_SonySPI3D(LUT, "My_LUT.cube")
```

CSV Tabular Data

colour

| | |
|---|---|
| <code>read_sds_from_csv_file(path, **kwargs)</code> | Read the spectral data from given <i>CSV</i> file and returns its content as a <i>dict</i> of <code>colour.SpectralDistribution</code> class instances. |
| <code>read_spectral_data_from_csv_file(path, **kwargs)</code> | Read the spectral data from given <i>CSV</i> file in the following form. |
| <code>write_sds_to_csv_file(sds, path)</code> | Write the given spectral distributions to given <i>CSV</i> file. |

colour.read_sds_from_csv_file

`colour.read_sds_from_csv_file(path: str, **kwargs: Any) → Dict[str, SpectralDistribution]`

Read the spectral data from given CSV file and returns its content as a *dict* of `colour.SpectralDistribution` class instances.

Parameters

- **path** (*str*) – CSV file path.
- **kwargs** (*Any*) – Keywords arguments passed to `numpy.recfromcsv()` definition.

Returns

Dict of `colour.SpectralDistribution` class instances.

Return type

dict

Examples

```
>>> from colour.utilities import numpy_print_options
>>> import os
>>> csv_file = os.path.join(
...     os.path.dirname(__file__),
...     "tests",
...     "resources",
...     "colorchecker_n_ohda.csv",
... )
>>> sds = read_sds_from_csv_file(csv_file)
>>> print(tuple(sds.keys()))
('1', '2', '3', '4', '5', '6', '7', '8', '9', '10', '11', '12', '13', '14', '15', '16',
↳ '17', '18', '19', '20', '21', '22', '23', '24')
>>> with numpy_print_options(suppress=True):
...     sds["1"]
...
SpectralDistribution([[ 380.    ,  0.048],
                    [ 385.    ,  0.051],
                    [ 390.    ,  0.055],
                    [ 395.    ,  0.06 ],
                    [ 400.    ,  0.065],
                    [ 405.    ,  0.068],
                    [ 410.    ,  0.068],
                    [ 415.    ,  0.067],
                    [ 420.    ,  0.064],
                    [ 425.    ,  0.062],
                    [ 430.    ,  0.059],
                    [ 435.    ,  0.057],
                    [ 440.    ,  0.055],
                    [ 445.    ,  0.054],
                    [ 450.    ,  0.053],
                    [ 455.    ,  0.053],
                    [ 460.    ,  0.052],
                    [ 465.    ,  0.052],
                    [ 470.    ,  0.052],
                    [ 475.    ,  0.053],
                    [ 480.    ,  0.054],
                    [ 485.    ,  0.055],
                    [ 490.    ,  0.057],
```

(continues on next page)

(continued from previous page)

```

[ 495. , 0.059],
[ 500. , 0.061],
[ 505. , 0.062],
[ 510. , 0.065],
[ 515. , 0.067],
[ 520. , 0.07 ],
[ 525. , 0.072],
[ 530. , 0.074],
[ 535. , 0.075],
[ 540. , 0.076],
[ 545. , 0.078],
[ 550. , 0.079],
[ 555. , 0.082],
[ 560. , 0.087],
[ 565. , 0.092],
[ 570. , 0.1 ],
[ 575. , 0.107],
[ 580. , 0.115],
[ 585. , 0.122],
[ 590. , 0.129],
[ 595. , 0.134],
[ 600. , 0.138],
[ 605. , 0.142],
[ 610. , 0.146],
[ 615. , 0.15 ],
[ 620. , 0.154],
[ 625. , 0.158],
[ 630. , 0.163],
[ 635. , 0.167],
[ 640. , 0.173],
[ 645. , 0.18 ],
[ 650. , 0.188],
[ 655. , 0.196],
[ 660. , 0.204],
[ 665. , 0.213],
[ 670. , 0.222],
[ 675. , 0.231],
[ 680. , 0.242],
[ 685. , 0.251],
[ 690. , 0.261],
[ 695. , 0.271],
[ 700. , 0.282],
[ 705. , 0.294],
[ 710. , 0.305],
[ 715. , 0.318],
[ 720. , 0.334],
[ 725. , 0.354],
[ 730. , 0.372],
[ 735. , 0.392],
[ 740. , 0.409],
[ 745. , 0.42 ],
[ 750. , 0.436],
[ 755. , 0.45 ],
[ 760. , 0.462],
[ 765. , 0.465],
[ 770. , 0.448],

```

(continues on next page)

(continued from previous page)

```
[ 775.    ,    0.432],  
[ 780.    ,    0.421]],  
SpragueInterpolator,  
{},  
Extrapolator,  
{'method': 'Constant', 'left': None, 'right': None})
```

colour.read_spectral_data_from_csv_file

colour.read_spectral_data_from_csv_file(path: str, **kwargs: Any) → Dict[str, ndarray]

Read the spectral data from given CSV file in the following form:

```
390, 4.15003E-04, 3.68349E-04, 9.54729E-03  
395, 1.05192E-03, 9.58658E-04, 2.38250E-02  
400, 2.40836E-03, 2.26991E-03, 5.66498E-02  
...  
830, 9.74306E-07, 9.53411E-08, 0.00000
```

and returns it as an *dict* as follows:

```
{  
    'wavelength': ndarray,  
    'field 1': ndarray,  
    'field 2': ndarray,  
    ...,  
    'field n': ndarray  
}
```

Parameters

- **path** (str) – CSV file path.
- **kwargs** (Any) – Keywords arguments passed to `numpy.recfromcsv()` definition.

Returns

CSV file content.

Return type

dict

Notes

- A CSV spectral data file should define at least define two fields: one for the wavelengths and one for the associated values of one spectral distribution.

Examples

```
>>> import os
>>> from pprint import pprint
>>> csv_file = os.path.join(
...     os.path.dirname(__file__),
...     "tests",
...     "resources",
...     "colorchecker_n_ohda.csv",
... )
>>> sds_data = read_spectral_data_from_csv_file(csv_file)
>>> pprint(list(sds_data.keys()))
['wavelength',
 '1',
 '2',
 '3',
 '4',
 '5',
 '6',
 '7',
 '8',
 '9',
 '10',
 '11',
 '12',
 '13',
 '14',
 '15',
 '16',
 '17',
 '18',
 '19',
 '20',
 '21',
 '22',
 '23',
 '24']
```

colour.write_sds_to_csv_file

colour.write_sds_to_csv_file(sds: Dict[str, SpectralDistribution], path: str) → bool

Write the given spectral distributions to given CSV file.

Parameters

- **sds** (Dict[str, SpectralDistribution]) – Spectral distributions to write to given CSV file.
- **path** (str) – CSV file path.

Returns

Definition success.

Return type

bool

Raises

ValueError – If the given spectral distributions have different shapes.

IES TM-27-14 Data

colour

| | |
|--|---|
| <code>SpectralDistribution_IESTM2714([path, ...])</code> | Define a <i>IES TM-27-14</i> spectral distribution. |
|--|---|

`colour.SpectralDistribution_IESTM2714`

```
class colour.SpectralDistribution_IESTM2714(path: str | None = None, header: Header_IESTM2714
    | None = None, spectral_quantity:
    Literal['absorptance', 'exitance', 'flux', 'intensity',
    'irradiance', 'radiance', 'reflectance', 'relative',
    'transmittance', 'R-Factor', 'T-Factor', 'other'] | None =
    None, reflection_geometry: Literal['di:8', 'de:8', '8:di',
    '8:de', 'd:d', 'd:0', '45a:0', '45c:0', '0:45a', '45x:0',
    '0:45x', 'other'] | None = None,
    transmission_geometry: Literal['0:0', 'di:0', 'de:0',
    '0:di', '0:de', 'd:d', 'other'] | None = None,
    bandwidth_FWHM: float | None = None,
    bandwidth_corrected: bool | None = None, **kwargs)
```

Bases: `SpectralDistribution`Define a *IES TM-27-14* spectral distribution.This class can read and write *IES TM-27-14* spectral data XML files.**Parameters**

- **path** (Optional[str]) – Spectral data XML file path.
- **header** (Optional[Header_IESTM2714]) – *IES TM-27-14* spectral distribution header.
- **spectral_quantity** (Optional[Literal['absorptance', 'exitance', 'flux', 'intensity', 'irradiance', 'radiance', 'reflectance', 'relative', 'transmittance', 'R-Factor', 'T-Factor', 'other']]) – Quantity of measurement for each element of the spectral data.
- **reflection_geometry** (Optional[Literal['di:8', 'de:8', '8:di', '8:de', 'd:d', 'd:0', '45a:0', '45c:0', '0:45a', '45x:0', '0:45x', 'other']]) – Spectral reflectance factors geometric conditions.
- **transmission_geometry** (Optional[Literal['0:0', 'di:0', 'de:0', '0:di', '0:de', 'd:d', 'other']]) – Spectral transmittance factors geometric conditions.
- **bandwidth_FWHM** (Optional[Floating]) – Spectroradiometer full-width half-maximum bandwidth in nanometers.
- **bandwidth_corrected** (Optional[Boolean]) – Specifies if bandwidth correction has been applied to the measured data.
- **data** – Data to be stored in the spectral distribution.
- **domain** – Values to initialise the `colour.SpectralDistribution.wavelength` property with. If both data and domain arguments are defined, the latter will be used to initialise the `colour.SpectralDistribution.wavelength` property.
- **extrapolator** – Extrapolator class type to use as extrapolating function.
- **extrapolator_kwargs** – Arguments to use when instantiating the extrapolating function.

- **interpolator** – Interpolator class type to use as interpolating function.
- **interpolator_kwargs** – Arguments to use when instantiating the interpolating function.
- **name** – Spectral distribution name.
- **display_name** – Spectral distribution name for figures, default to colour. `SpectralDistribution.name` property value.

Notes

Reflection Geometry

- di:8: Diffuse / eight-degree, specular component included.
- de:8: Diffuse / eight-degree, specular component excluded.
- 8:di: Eight-degree / diffuse, specular component included.
- 8:de: Eight-degree / diffuse, specular component excluded.
- d:d: Diffuse / diffuse.
- d:0: Alternative diffuse.
- 45a:0: Forty-five degree annular / normal.
- 45c:0: Forty-five degree circumferential / normal.
- 0:45a: Normal / forty-five degree annular.
- 45x:0: Forty-five degree directional / normal.
- 0:45x: Normal / forty-five degree directional.
- other: User-specified in comments.

Transmission Geometry

- 0:0: Normal / normal.
- di:0: Diffuse / normal, regular component included.
- de:0: Diffuse / normal, regular component excluded.
- 0:di: Normal / diffuse, regular component included.
- 0:de: Normal / diffuse, regular component excluded.
- d:d: Diffuse / diffuse.
- other: User-specified in comments.

Attributes

- `mapping`
- `path`
- `header`
- `spectral_quantity`
- `reflection_geometry`
- `transmission_geometry`
- `bandwidth_FWHM`
- `bandwidth_corrected`

Methods

- `__init__()`
- `__str__()`
- `__repr__()`
- `read()`
- `write()`

References

[IESCCommitteeTM2714WGroup14]

Examples

```
>>> from os.path import dirname, join
>>> directory = join(dirname(__file__), "tests", "resources")
>>> sd = SpectralDistribution_IESTM2714(
...     join(directory, "Fluorescent.spdx")
... ).read()
>>> sd.name
'Unknown - N/A - Rare earth fluorescent lamp'
>>> sd.header.comments
'Ambient temperature 25 degrees C.'
>>> sd[501.7]
0.0950000...
```

`__init__`(*path*: *str* | *None* = *None*, *header*: *Header_IESTM2714* | *None* = *None*, *spectral_quantity*: *Literal*['absorptance', 'exitance', 'flux', 'intensity', 'irradiance', 'radiance', 'reflectance', 'relative', 'transmittance', 'R-Factor', 'T-Factor', 'other'] | *None* = *None*, *reflection_geometry*: *Literal*['di:8', 'de:8', '8:di', '8:de', 'd:d', 'd:0', '45a:0', '45c:0', '0:45a', '45x:0', '0:45x', 'other'] | *None* = *None*, *transmission_geometry*: *Literal*['0:0', 'di:0', 'de:0', '0:di', '0:de', 'd:d', 'other'] | *None* = *None*, *bandwidth_FWHM*: *float* | *None* = *None*, *bandwidth_corrected*: *bool* | *None* = *None*, ***kwargs*) → *None*

Parameters

- **path** (*str* | *None*) –
- **header** (*Header_IESTM2714* | *None*) –
- **spectral_quantity** (*Literal*['absorptance', 'exitance', 'flux', 'intensity', 'irradiance', 'radiance', 'reflectance', 'relative', 'transmittance', 'R-Factor', 'T-Factor', 'other'] | *None*) –
- **reflection_geometry** (*Literal*['di:8', 'de:8', '8:di', '8:de', 'd:d', 'd:0', '45a:0', '45c:0', '0:45a', '45x:0', '0:45x', 'other'] | *None*) –
- **transmission_geometry** (*Literal*['0:0', 'di:0', 'de:0', '0:di', '0:de', 'd:d', 'other'] | *None*) –
- **bandwidth_FWHM** (*float* | *None*) –
- **bandwidth_corrected** (*bool* | *None*) –

Return type

None

property mapping: `Structure`

Getter property for the mapping structure.

Returns

Mapping structure.

Return type

`colour.utilities.Structure`

property path: `str | None`

Getter and setter property for the path.

Parameters

value – Value to set the path with.

Returns

Path.

Return type

`None` or `str`

property header: `Header_IESTM2714`

Getter and setter property for the header.

Parameters

value – Value to set the header with.

Returns

Header.

Return type

`colour.io.tm2714.Header_IESTM2714`

property spectral_quantity: `Literal['absorptance', 'exitance', 'flux', 'intensity', 'irradiance', 'radiance', 'reflectance', 'relative', 'transmittance', 'R-Factor', 'T-Factor', 'other'] | None`

Getter and setter property for the spectral quantity.

Parameters

value – Value to set the spectral quantity with.

Returns

Spectral quantity.

Return type

`None` or `str`

property reflection_geometry: `Literal['di:8', 'de:8', '8:di', '8:de', 'd:d', 'd:0', '45a:0', '45c:0', '0:45a', '45x:0', '0:45x', 'other'] | None`

Getter and setter property for the reflection geometry.

Parameters

value – Value to set the reflection geometry with.

Returns

Reflection geometry.

Return type

`None` or `str`

property transmission_geometry: `Literal['0:0', 'di:0', 'de:0', '0:di', '0:de', 'd:d', 'other'] | None`

Getter and setter property for the transmission geometry.

Parameters

value – Value to set the transmission geometry with.

Returns

Transmission geometry.

Return type

`None` or `str`

property `bandwidth_FWHM`: `float` | `None`

Getter and setter property for the full-width half-maximum bandwidth.

Parameters

value – Value to set the full-width half-maximum bandwidth with.

Returns

Full-width half-maximum bandwidth.

Return type

`None` or `numpy.floating`

property `bandwidth_corrected`: `bool` | `None`

Getter and setter property for whether bandwidth correction has been applied to the measured data.

Parameters

value – Whether bandwidth correction has been applied to the measured data.

Returns

Whether bandwidth correction has been applied to the measured data.

Return type

`None` or `bool`

`__str__()` → `str`

Return a formatted string representation of the *IES TM-27-14* spectral distribution.

Returns

Formatted string representation.

Return type

`str`

Examples

```
>>> from os.path import dirname, join
>>> directory = join(dirname(__file__), "tests", "resources")
>>> print(
...     SpectralDistribution_IESTM2714(
...         join(directory, "Fluorescent.spdx")
...     ).read()
... )
...
IES TM-27-14 Spectral Distribution
=====

Path           : ...
Spectral Quantity : relative
Reflection Geometry : other
Transmission Geometry : other
Bandwidth (FWHM) : 2.0
Bandwidth Corrected : True

Header
```

(continues on next page)

(continued from previous page)

Manufacturer : Unknown
 Catalog Number : N/A
 Description : Rare earth fluorescent lamp
 Document Creator : byHeart Consultants
 Unique Identifier : C3567553-C75B-4354-961E-35CEB9FEB42C
 Measurement Equipment : None
 Laboratory : N/A
 Report Number : N/A
 Report Date : N/A
 Document Creation Date : 2014-06-23
 Comments : Ambient temperature 25 degrees C.

Spectral Data

```

[[ 4.00000000e+02 3.40000000e-02]
 [ 4.03100000e+02 3.70000000e-02]
 [ 4.05500000e+02 6.90000000e-02]
 [ 4.07500000e+02 3.70000000e-02]
 [ 4.20600000e+02 4.20000000e-02]
 [ 4.31000000e+02 4.90000000e-02]
 [ 4.33700000e+02 6.00000000e-02]
 [ 4.37000000e+02 3.57000000e-01]
 [ 4.38900000e+02 6.00000000e-02]
 [ 4.60000000e+02 6.80000000e-02]
 [ 4.77000000e+02 7.50000000e-02]
 [ 4.81000000e+02 8.50000000e-02]
 [ 4.88200000e+02 2.04000000e-01]
 [ 4.92600000e+02 1.66000000e-01]
 [ 5.01700000e+02 9.50000000e-02]
 [ 5.07600000e+02 7.80000000e-02]
 [ 5.17600000e+02 7.10000000e-02]
 [ 5.29900000e+02 7.60000000e-02]
 [ 5.35400000e+02 9.90000000e-02]
 [ 5.39900000e+02 4.23000000e-01]
 [ 5.43200000e+02 8.02000000e-01]
 [ 5.44400000e+02 7.13000000e-01]
 [ 5.47200000e+02 9.99000000e-01]
 [ 5.48700000e+02 5.73000000e-01]
 [ 5.50200000e+02 3.40000000e-01]
 [ 5.53800000e+02 2.08000000e-01]
 [ 5.57300000e+02 1.39000000e-01]
 [ 5.63700000e+02 1.29000000e-01]
 [ 5.74800000e+02 1.31000000e-01]
 [ 5.78000000e+02 1.98000000e-01]
 [ 5.79200000e+02 1.90000000e-01]
 [ 5.80400000e+02 2.05000000e-01]
 [ 5.84800000e+02 2.44000000e-01]
 [ 5.85900000e+02 2.36000000e-01]
 [ 5.87500000e+02 2.56000000e-01]
 [ 5.90300000e+02 1.80000000e-01]
 [ 5.93500000e+02 2.18000000e-01]
 [ 5.95500000e+02 1.59000000e-01]
 [ 5.97000000e+02 1.47000000e-01]

```

(continues on next page)

(continued from previous page)

```
[ 5.99400000e+02 1.70000000e-01]
[ 6.02200000e+02 1.34000000e-01]
[ 6.04600000e+02 1.21000000e-01]
[ 6.07400000e+02 1.40000000e-01]
[ 6.09400000e+02 2.29000000e-01]
[ 6.10200000e+02 4.65000000e-01]
[ 6.12000000e+02 9.52000000e-01]
[ 6.14600000e+02 4.77000000e-01]
[ 6.16900000e+02 2.08000000e-01]
[ 6.18500000e+02 1.35000000e-01]
[ 6.22100000e+02 1.50000000e-01]
[ 6.25600000e+02 1.55000000e-01]
[ 6.28400000e+02 1.34000000e-01]
[ 6.31200000e+02 1.68000000e-01]
[ 6.33200000e+02 8.70000000e-02]
[ 6.35600000e+02 6.80000000e-02]
[ 6.42700000e+02 5.80000000e-02]
[ 6.48700000e+02 5.80000000e-02]
[ 6.50700000e+02 7.40000000e-02]
[ 6.52600000e+02 6.30000000e-02]
[ 6.56200000e+02 5.30000000e-02]
[ 6.57000000e+02 5.60000000e-02]
[ 6.60600000e+02 4.90000000e-02]
[ 6.62600000e+02 5.90000000e-02]
[ 6.64200000e+02 4.80000000e-02]
[ 6.86000000e+02 4.10000000e-02]
[ 6.87600000e+02 4.80000000e-02]
[ 6.89200000e+02 3.90000000e-02]
[ 6.92400000e+02 3.80000000e-02]
[ 6.93500000e+02 4.40000000e-02]
[ 6.95500000e+02 3.40000000e-02]
[ 7.02300000e+02 3.60000000e-02]
[ 7.06700000e+02 4.20000000e-02]
[ 7.07100000e+02 6.10000000e-02]
[ 7.10200000e+02 6.10000000e-02]
[ 7.11000000e+02 4.10000000e-02]
[ 7.12200000e+02 5.20000000e-02]
[ 7.14200000e+02 3.30000000e-02]
[ 7.48400000e+02 3.40000000e-02]
[ 7.57900000e+02 3.10000000e-02]
[ 7.60700000e+02 3.90000000e-02]
[ 7.63900000e+02 2.90000000e-02]
[ 8.08800000e+02 2.90000000e-02]
[ 8.10700000e+02 3.90000000e-02]
[ 8.12700000e+02 3.00000000e-02]
[ 8.50100000e+02 3.00000000e-02]]
```

__repr__() → *str*Return an evaluable string representation of the *IES TM-27-14* spectral distribution.**Returns**

Evaluable string representation.

Return type*str*

Examples

```

>>> from os.path import dirname, join
>>> directory = join(dirname(__file__), "tests", "resources")
>>> SpectralDistribution_IESTM2714(
...     join(directory, "Fluorescent.spdx")
... ).read()
...
SpectralDistribution_IESTM2714('...',
                               Header_IESTM2714('Unknown',
                                                  'N/A',
                                                  'Rare earth ...',
                                                  'byHeart Consultants',
                                                  'C3567553-C75B-...',
                                                  None,
                                                  'N/A',
                                                  'N/A',
                                                  'N/A',
                                                  '2014-06-23',
                                                  'Ambient ...'),
                               'relative',
                               'other',
                               'other',
                               2.0,
                               True,
                               [[ 4.00000000e+02,  3.40000000e-02],
                                [ 4.03100000e+02,  3.70000000e-02],
                                [ 4.05500000e+02,  6.90000000e-02],
                                [ 4.07500000e+02,  3.70000000e-02],
                                [ 4.20600000e+02,  4.20000000e-02],
                                [ 4.31000000e+02,  4.90000000e-02],
                                [ 4.33700000e+02,  6.00000000e-02],
                                [ 4.37000000e+02,  3.57000000e-01],
                                [ 4.38900000e+02,  6.00000000e-02],
                                [ 4.60000000e+02,  6.80000000e-02],
                                [ 4.77000000e+02,  7.50000000e-02],
                                [ 4.81000000e+02,  8.50000000e-02],
                                [ 4.88200000e+02,  2.04000000e-01],
                                [ 4.92600000e+02,  1.66000000e-01],
                                [ 5.01700000e+02,  9.50000000e-02],
                                [ 5.07600000e+02,  7.80000000e-02],
                                [ 5.17600000e+02,  7.10000000e-02],
                                [ 5.29900000e+02,  7.60000000e-02],
                                [ 5.35400000e+02,  9.90000000e-02],
                                [ 5.39900000e+02,  4.23000000e-01],
                                [ 5.43200000e+02,  8.02000000e-01],
                                [ 5.44400000e+02,  7.13000000e-01],
                                [ 5.47200000e+02,  9.99000000e-01],
                                [ 5.48700000e+02,  5.73000000e-01],
                                [ 5.50200000e+02,  3.40000000e-01],
                                [ 5.53800000e+02,  2.08000000e-01],
                                [ 5.57300000e+02,  1.39000000e-01],
                                [ 5.63700000e+02,  1.29000000e-01],
                                [ 5.74800000e+02,  1.31000000e-01],
                                [ 5.78000000e+02,  1.98000000e-01],
                                [ 5.79200000e+02,  1.90000000e-01],
                                [ 5.80400000e+02,  2.05000000e-01],

```

(continues on next page)

(continued from previous page)

```

[ 5.84800000e+02, 2.44000000e-01],
[ 5.85900000e+02, 2.36000000e-01],
[ 5.87500000e+02, 2.56000000e-01],
[ 5.90300000e+02, 1.80000000e-01],
[ 5.93500000e+02, 2.18000000e-01],
[ 5.95500000e+02, 1.59000000e-01],
[ 5.97000000e+02, 1.47000000e-01],
[ 5.99400000e+02, 1.70000000e-01],
[ 6.02200000e+02, 1.34000000e-01],
[ 6.04600000e+02, 1.21000000e-01],
[ 6.07400000e+02, 1.40000000e-01],
[ 6.09400000e+02, 2.29000000e-01],
[ 6.10200000e+02, 4.65000000e-01],
[ 6.12000000e+02, 9.52000000e-01],
[ 6.14600000e+02, 4.77000000e-01],
[ 6.16900000e+02, 2.08000000e-01],
[ 6.18500000e+02, 1.35000000e-01],
[ 6.22100000e+02, 1.50000000e-01],
[ 6.25600000e+02, 1.55000000e-01],
[ 6.28400000e+02, 1.34000000e-01],
[ 6.31200000e+02, 1.68000000e-01],
[ 6.33200000e+02, 8.70000000e-02],
[ 6.35600000e+02, 6.80000000e-02],
[ 6.42700000e+02, 5.80000000e-02],
[ 6.48700000e+02, 5.80000000e-02],
[ 6.50700000e+02, 7.40000000e-02],
[ 6.52600000e+02, 6.30000000e-02],
[ 6.56200000e+02, 5.30000000e-02],
[ 6.57000000e+02, 5.60000000e-02],
[ 6.60600000e+02, 4.90000000e-02],
[ 6.62600000e+02, 5.90000000e-02],
[ 6.64200000e+02, 4.80000000e-02],
[ 6.86000000e+02, 4.10000000e-02],
[ 6.87600000e+02, 4.80000000e-02],
[ 6.89200000e+02, 3.90000000e-02],
[ 6.92400000e+02, 3.80000000e-02],
[ 6.93500000e+02, 4.40000000e-02],
[ 6.95500000e+02, 3.40000000e-02],
[ 7.02300000e+02, 3.60000000e-02],
[ 7.06700000e+02, 4.20000000e-02],
[ 7.07100000e+02, 6.10000000e-02],
[ 7.10200000e+02, 6.10000000e-02],
[ 7.11000000e+02, 4.10000000e-02],
[ 7.12200000e+02, 5.20000000e-02],
[ 7.14200000e+02, 3.30000000e-02],
[ 7.48400000e+02, 3.40000000e-02],
[ 7.57900000e+02, 3.10000000e-02],
[ 7.60700000e+02, 3.90000000e-02],
[ 7.63900000e+02, 2.90000000e-02],
[ 8.08800000e+02, 2.90000000e-02],
[ 8.10700000e+02, 3.90000000e-02],
[ 8.12700000e+02, 3.00000000e-02],
[ 8.50100000e+02, 3.00000000e-02]],
CubicSplineInterpolator,
{}},
Extrapolator,

```

(continues on next page)

(continued from previous page)

{...})

read() → *SpectralDistribution_IESTM2714*Read and parses the spectral data *XML* file path.**Returns***IES TM-27-14* spectral distribution.**Return type**`colour.SpectralDistribution_IESTM2714`**Raises****ValueError** – If the *IES TM-27-14* spectral distribution path is undefined.**Examples**

```
>>> from os.path import dirname, join
>>> directory = join(dirname(__file__), "tests", "resources")
>>> sd = SpectralDistribution_IESTM2714(
...     join(directory, "Fluorescent.spdx")
... ).read()
>>> sd.name
'Unknown - N/A - Rare earth fluorescent lamp'
>>> sd.header.comments
'Ambient temperature 25 degrees C.'
>>> sd[400]
0.0340000...
```

write() → `bool`Write the spectral distribution spectral data to *XML* file path.**Returns**

Definition success.

Return type`bool`**Examples**

```
>>> from os.path import dirname, join
>>> from shutil import rmtree
>>> from tempfile import mkdtemp
>>> directory = join(dirname(__file__), "tests", "resources")
>>> sd = SpectralDistribution_IESTM2714(
...     join(directory, "Fluorescent.spdx")
... ).read()
>>> temporary_directory = mkdtemp()
>>> sd.path = join(temporary_directory, "Fluorescent.spdx")
>>> sd.write()
True
>>> rmtree(temporary_directory)
```

UPRTek and Sekonic Spectral Data

colour

| | |
|---|--|
| <code>SpectralDistribution_UPRTek(path, **kwargs)</code> | Implement support to read and write <i>IES TM-27-14</i> spectral data XML file from a <i>UPRTek Pseudo-XLS</i> file. |
| <code>SpectralDistribution_Sekonic(path, **kwargs)</code> | Implement support to read and write <i>IES TM-27-14</i> spectral data XML file from a <i>Sekonic CSV</i> file. |

colour.SpectralDistribution_UPRTek

class colour.SpectralDistribution_UPRTek(path: str, **kwargs: Any)

Bases: SpectralDistribution_IESTM2714

Implement support to read and write *IES TM-27-14* spectral data XML file from a *UPRTek Pseudo-XLS* file.

Parameters

- **path** (str) – Path for *UPRTek Pseudo-XLS* file.
- **kwargs** (Any) –

Attributes

- metadata

Methods

- `__init__()`
- `__str__()`
- `read()`

Examples

```
>>> from os.path import dirname, join
>>> from colour import SpectralShape
>>> directory = join(dirname(__file__), "tests", "resources")
>>> sd = SpectralDistribution_UPRTek(
...     join(directory, "ESPD2021_0104_231446.xls")
... )
>>> print(sd.read().align(SpectralShape(380, 780, 10)))
...
UPRTek
=====

Path                : ...
Spectral Quantity    : irradiance
Reflection Geometry  : None
Transmission Geometry : None
Bandwidth (FWHM)     : None
Bandwidth Corrected  : None
```

(continues on next page)

(continued from previous page)

Header

```

Manufacturer      : UPRTek
Catalog Number    : None
Description        : None
Document Creator   : None
Unique Identifier  : None
Measurement Equipment : CV600
Laboratory         : None
Report Number      : None
Report Date        : 2021/01/04_23:14:46
Document Creation Date : None
Comments           : {...}

```

Spectral Data

```

[[ 3.80000000e+02 3.02670000e-02]
 [ 3.90000000e+02 3.52230000e-02]
 [ 4.00000000e+02 1.93250000e-02]
 [ 4.10000000e+02 2.94260000e-02]
 [ 4.20000000e+02 8.76780000e-02]
 [ 4.30000000e+02 6.32578000e-01]
 [ 4.40000000e+02 3.62565900e+00]
 [ 4.50000000e+02 1.42069180e+01]
 [ 4.60000000e+02 1.70112970e+01]
 [ 4.70000000e+02 1.19673130e+01]
 [ 4.80000000e+02 8.42736200e+00]
 [ 4.90000000e+02 7.97729800e+00]
 [ 5.00000000e+02 8.71903600e+00]
 [ 5.10000000e+02 9.55321500e+00]
 [ 5.20000000e+02 9.90610500e+00]
 [ 5.30000000e+02 9.91394400e+00]
 [ 5.40000000e+02 9.74738000e+00]
 [ 5.50000000e+02 9.53404900e+00]
 [ 5.60000000e+02 9.27392200e+00]
 [ 5.70000000e+02 9.02323400e+00]
 [ 5.80000000e+02 8.91788800e+00]
 [ 5.90000000e+02 9.11454600e+00]
 [ 6.00000000e+02 9.55787100e+00]
 [ 6.10000000e+02 1.00600760e+01]
 [ 6.20000000e+02 1.04846200e+01]
 [ 6.30000000e+02 1.05679540e+01]
 [ 6.40000000e+02 1.04359870e+01]
 [ 6.50000000e+02 9.82122300e+00]
 [ 6.60000000e+02 8.77578300e+00]
 [ 6.70000000e+02 7.56471800e+00]
 [ 6.80000000e+02 6.29808600e+00]
 [ 6.90000000e+02 5.15623400e+00]
 [ 7.00000000e+02 4.05390600e+00]
 [ 7.10000000e+02 3.06638600e+00]
 [ 7.20000000e+02 2.19250000e+00]
 [ 7.30000000e+02 1.53922800e+00]
 [ 7.40000000e+02 1.14938200e+00]

```

(continues on next page)

(continued from previous page)

```
[ 7.500000000e+02 9.050950000e-01]
[ 7.600000000e+02 6.909470000e-01]
[ 7.700000000e+02 5.084260000e-01]
[ 7.800000000e+02 4.117660000e-01]]
```

```
>>> sd.header.comments
{'Model Name': "CV600", "Serial Number": "19J00789", "Time": "2021/01/04_23:14:46",
↪ "Memo": [], "LUX": 695.154907, "fc": 64.605476, "CCT": 5198.0, "Duv": -0.00062, "I-
↪ Time": 12000.0, "X": 682.470886, "Y": 695.154907, "Z": 631.635071, "x": 0.339663,
↪ "y": 0.345975, "u\\'": 0.209915, "v\\'": 0.481087, "LambdaP": 456.0, "LambdaPValue": 1
↪ 18.404581, "CRI": 92.956993, "R1": 91.651062, "R2": 93.014732, "R3": 97.032013, "R4
↪ ": 93.513229, "R5": 92.48259, "R6": 91.48687, "R7": 93.016129, "R8": 91.459312, "R9
↪ ": 77.613075, "R10": 86.981613, "R11": 94.841324, "R12": 74.139542, "R13": 91.
↪ 073837, "R14": 97.064323, "R15": 88.615669, "TLCI": 97.495056, "TLMF-A": 1.270032,
↪ "SSI-A": 44.881924, "Rf": 87.234917, "Rg": 98.510712, "IRR": 2.607891}'
>>> sd.metadata.keys()
dict_keys(['Model Name', 'Serial Number', 'Time', 'Memo', 'LUX', 'fc', 'CCT', 'Duv',
↪ 'I-Time', 'X', 'Y', 'Z', 'x', 'y', 'u\\', 'v\\', 'LambdaP', 'LambdaPValue', 'CRI',
↪ 'R1', 'R2', 'R3', 'R4', 'R5', 'R6', 'R7', 'R8', 'R9', 'R10', 'R11', 'R12', 'R13',
↪ 'R14', 'R15', 'TLCI', 'TLMF-A', 'SSI-A', 'Rf', 'Rg', 'IRR'])
>>> sd.write(join(directory, "ESPD2021_0104_231446.spdx"))
...
```

__init__(*path*: *str*, ***kwargs*: *Any*) → *None*

Parameters

- *path* (*str*) –
- *kwargs* (*Any*) –

Return type

None

property metadata: *Dict*

Getter property for the metadata.

Returns

Metadata.

Return type

dict

__str__() → *str*

Return a formatted string representation of the *UPRTek* spectral distribution.

Returns

Formatted string representation.

Return type

str

Examples

```
>>> from os.path import dirname, join
>>> from colour import SpectralShape
>>> directory = join(dirname(__file__), "tests", "resources")
>>> sd = SpectralDistribution_UPRTek(
...     join(directory, "ESPD2021_0104_231446.xls")
... )
>>> print(sd.read().align(SpectralShape(380, 780, 10)))
...
UPRTek
=====

Path                : ...
Spectral Quantity    : irradiance
Reflection Geometry  : None
Transmission Geometry : None
Bandwidth (FWHM)     : None
Bandwidth Corrected  : None

Header
-----

Manufacturer         : UPRTek
Catalog Number       : None
Description           : None
Document Creator      : None
Unique Identifier     : None
Measurement Equipment : CV600
Laboratory           : None
Report Number        : None
Report Date          : 2021/01/04_23:14:46
Document Creation Date : None
Comments              : {...}

Spectral Data
-----

[[ 3.80000000e+02  3.02670000e-02]
 [ 3.90000000e+02  3.52230000e-02]
 [ 4.00000000e+02  1.93250000e-02]
 [ 4.10000000e+02  2.94260000e-02]
 [ 4.20000000e+02  8.76780000e-02]
 [ 4.30000000e+02  6.32578000e-01]
 [ 4.40000000e+02  3.62565900e+00]
 [ 4.50000000e+02  1.42069180e+01]
 [ 4.60000000e+02  1.70112970e+01]
 [ 4.70000000e+02  1.19673130e+01]
 [ 4.80000000e+02  8.42736200e+00]
 [ 4.90000000e+02  7.97729800e+00]
 [ 5.00000000e+02  8.71903600e+00]
 [ 5.10000000e+02  9.55321500e+00]
 [ 5.20000000e+02  9.90610500e+00]
 [ 5.30000000e+02  9.91394400e+00]
 [ 5.40000000e+02  9.74738000e+00]
 [ 5.50000000e+02  9.53404900e+00]
 [ 5.60000000e+02  9.27392200e+00]
```

(continues on next page)

(continued from previous page)

```
[ 5.70000000e+02 9.02323400e+00]
[ 5.80000000e+02 8.91788800e+00]
[ 5.90000000e+02 9.11454600e+00]
[ 6.00000000e+02 9.55787100e+00]
[ 6.10000000e+02 1.00600760e+01]
[ 6.20000000e+02 1.04846200e+01]
[ 6.30000000e+02 1.05679540e+01]
[ 6.40000000e+02 1.04359870e+01]
[ 6.50000000e+02 9.82122300e+00]
[ 6.60000000e+02 8.77578300e+00]
[ 6.70000000e+02 7.56471800e+00]
[ 6.80000000e+02 6.29808600e+00]
[ 6.90000000e+02 5.15623400e+00]
[ 7.00000000e+02 4.05390600e+00]
[ 7.10000000e+02 3.06638600e+00]
[ 7.20000000e+02 2.19250000e+00]
[ 7.30000000e+02 1.53922800e+00]
[ 7.40000000e+02 1.14938200e+00]
[ 7.50000000e+02 9.05095000e-01]
[ 7.60000000e+02 6.90947000e-01]
[ 7.70000000e+02 5.08426000e-01]
[ 7.80000000e+02 4.11766000e-01]]
```

read() → *SpectralDistribution_UPRTek*Read and parses the spectral data from a given *UPRTek* CSV file.**Returns***UPRTek* spectral distribution.**Return type**`colour.SpectralDistribution_UPRTek`**Examples**

```
>>> from os.path import dirname, join
>>> from colour import SpectralShape
>>> directory = join(dirname(__file__), "tests", "resources")
>>> sd = SpectralDistribution_UPRTek(
...     join(directory, "ESPD2021_0104_231446.xls")
... )
>>> print(sd.read().align(SpectralShape(380, 780, 10)))
...
UPRTek
=====

Path                : ...
Spectral Quantity    : irradiance
Reflection Geometry  : None
Transmission Geometry : None
Bandwidth (FWHM)     : None
Bandwidth Corrected  : None

Header
-----

Manufacturer         : UPRTek
```

(continues on next page)

(continued from previous page)

```

Catalog Number      : None
Description          : None
Document Creator     : None
Unique Identifier    : None
Measurement Equipment : CV600
Laboratory           : None
Report Number        : None
Report Date          : 2021/01/04_23:14:46
Document Creation Date : None
Comments             : {...}

```

Spectral Data

```

[[ 3.80000000e+02  3.02670000e-02]
 [ 3.90000000e+02  3.52230000e-02]
 [ 4.00000000e+02  1.93250000e-02]
 [ 4.10000000e+02  2.94260000e-02]
 [ 4.20000000e+02  8.76780000e-02]
 [ 4.30000000e+02  6.32578000e-01]
 [ 4.40000000e+02  3.62565900e+00]
 [ 4.50000000e+02  1.42069180e+01]
 [ 4.60000000e+02  1.70112970e+01]
 [ 4.70000000e+02  1.19673130e+01]
 [ 4.80000000e+02  8.42736200e+00]
 [ 4.90000000e+02  7.97729800e+00]
 [ 5.00000000e+02  8.71903600e+00]
 [ 5.10000000e+02  9.55321500e+00]
 [ 5.20000000e+02  9.90610500e+00]
 [ 5.30000000e+02  9.91394400e+00]
 [ 5.40000000e+02  9.74738000e+00]
 [ 5.50000000e+02  9.53404900e+00]
 [ 5.60000000e+02  9.27392200e+00]
 [ 5.70000000e+02  9.02323400e+00]
 [ 5.80000000e+02  8.91788800e+00]
 [ 5.90000000e+02  9.11454600e+00]
 [ 6.00000000e+02  9.55787100e+00]
 [ 6.10000000e+02  1.00600760e+01]
 [ 6.20000000e+02  1.04846200e+01]
 [ 6.30000000e+02  1.05679540e+01]
 [ 6.40000000e+02  1.04359870e+01]
 [ 6.50000000e+02  9.82122300e+00]
 [ 6.60000000e+02  8.77578300e+00]
 [ 6.70000000e+02  7.56471800e+00]
 [ 6.80000000e+02  6.29808600e+00]
 [ 6.90000000e+02  5.15623400e+00]
 [ 7.00000000e+02  4.05390600e+00]
 [ 7.10000000e+02  3.06638600e+00]
 [ 7.20000000e+02  2.19250000e+00]
 [ 7.30000000e+02  1.53922800e+00]
 [ 7.40000000e+02  1.14938200e+00]
 [ 7.50000000e+02  9.05095000e-01]
 [ 7.60000000e+02  6.90947000e-01]
 [ 7.70000000e+02  5.08426000e-01]
 [ 7.80000000e+02  4.11766000e-01]]

```

colour.SpectralDistribution_Sekonic

class colour.SpectralDistribution_Sekonic(path: str, **kwargs: Any)

Bases: SpectralDistribution_UPRTek

Implement support to read and write *IES TM-27-14* spectral data XML file from a *Sekonic* CSV file.

Parameters

- **path** (str) – Path for *Sekonic* CSV file.
- **kwargs** (Any) –

Attributes

- metadata

Methods

- `__init__()`
- `__str__()`
- `read()`

Examples

```
>>> from os.path import dirname, join
>>> from colour import SpectralShape
>>> directory = join(dirname(__file__), "tests", "resources")
>>> sd = SpectralDistribution_Sekonic(
...     join(directory, "RANDOM_001_02._3262K.csv")
... )
>>> print(sd.read().align(SpectralShape(380, 780, 10)))
...
Sekonic
=====

Path                : ...
Spectral Quantity    : irradiance
Reflection Geometry  : None
Transmission Geometry : None
Bandwidth (FWHM)     : None
Bandwidth Corrected  : None

Header
-----

Manufacturer         : Sekonic
Catalog Number       : None
Description           : None
Document Creator     : None
Unique Identifier     : None
Measurement Equipment : None
Laboratory           : None
Report Number        : None
Report Date          : 15/03/2021 3:44:14 p.m.
```

(continues on next page)

(continued from previous page)

```

Document Creation Date : None
Comments                : {...}

Spectral Data
-----

[[ 3.80000000e+02  1.69406589e-21]
 [ 3.90000000e+02  2.11758237e-22]
 [ 4.00000000e+02  1.19813650e-05]
 [ 4.10000000e+02  1.97110530e-05]
 [ 4.20000000e+02  2.99661440e-05]
 [ 4.30000000e+02  6.38192720e-05]
 [ 4.40000000e+02  1.68909683e-04]
 [ 4.50000000e+02  3.31902935e-04]
 [ 4.60000000e+02  3.33143020e-04]
 [ 4.70000000e+02  2.30227481e-04]
 [ 4.80000000e+02  1.66981976e-04]
 [ 4.90000000e+02  1.64439844e-04]
 [ 5.00000000e+02  2.01534538e-04]
 [ 5.10000000e+02  2.57840526e-04]
 [ 5.20000000e+02  3.04612651e-04]
 [ 5.30000000e+02  3.41368344e-04]
 [ 5.40000000e+02  3.63639323e-04]
 [ 5.50000000e+02  3.87050648e-04]
 [ 5.60000000e+02  4.21619130e-04]
 [ 5.70000000e+02  4.58150520e-04]
 [ 5.80000000e+02  5.01176575e-04]
 [ 5.90000000e+02  5.40883630e-04]
 [ 6.00000000e+02  5.71256795e-04]
 [ 6.10000000e+02  5.83703280e-04]
 [ 6.20000000e+02  5.57688472e-04]
 [ 6.30000000e+02  5.17328095e-04]
 [ 6.40000000e+02  4.39994939e-04]
 [ 6.50000000e+02  3.62766819e-04]
 [ 6.60000000e+02  2.96465587e-04]
 [ 6.70000000e+02  2.43966802e-04]
 [ 6.80000000e+02  2.04134776e-04]
 [ 6.90000000e+02  1.75304012e-04]
 [ 7.00000000e+02  1.52887544e-04]
 [ 7.10000000e+02  1.29795619e-04]
 [ 7.20000000e+02  1.03122693e-04]
 [ 7.30000000e+02  8.77607820e-05]
 [ 7.40000000e+02  7.61524130e-05]
 [ 7.50000000e+02  7.06516880e-05]
 [ 7.60000000e+02  3.72199210e-05]
 [ 7.70000000e+02  3.63058860e-05]
 [ 7.80000000e+02  3.55755470e-05]]
>>> sd.header.comments
>>> sd.metadata.keys()
>>> sd.write(join(directory, "RANDOM_001_02._3262K.spdx"))
...

```

`--init__`(*path*: *str*, ***kwargs*: *Any*) → *None*

Parameters

- *path* (*str*) –

- **kwargs** (*Any*) –

Return type

None

__str__() → *str*

Return a formatted string representation of the *Sekonic* spectral distribution.

Returns

Formatted string representation.

Return type*str***Examples**

```
>>> from os.path import dirname, join
>>> from colour import SpectralShape
>>> directory = join(dirname(__file__), "tests", "resources")
>>> sd = SpectralDistribution_UPRTek(
...     join(directory, "ESPD2021_0104_231446.xls")
... )
>>> print(sd.read().align(SpectralShape(380, 780, 10)))
...
UPRTek
=====

Path                : ...
Spectral Quantity    : irradiance
Reflection Geometry  : None
Transmission Geometry : None
Bandwidth (FWHM)     : None
Bandwidth Corrected  : None

Header
-----

Manufacturer         : UPRTek
Catalog Number       : None
Description           : None
Document Creator      : None
Unique Identifier     : None
Measurement Equipment : CV600
Laboratory           : None
Report Number        : None
Report Date          : 2021/01/04_23:14:46
Document Creation Date : None
Comments              : {...}

Spectral Data
-----

[[ 3.80000000e+02  3.02670000e-02]
 [ 3.90000000e+02  3.52230000e-02]
 [ 4.00000000e+02  1.93250000e-02]
 [ 4.10000000e+02  2.94260000e-02]
 [ 4.20000000e+02  8.76780000e-02]
 [ 4.30000000e+02  6.32578000e-01]
```

(continues on next page)

(continued from previous page)

```
[ 4.40000000e+02 3.62565900e+00]
[ 4.50000000e+02 1.42069180e+01]
[ 4.60000000e+02 1.70112970e+01]
[ 4.70000000e+02 1.19673130e+01]
[ 4.80000000e+02 8.42736200e+00]
[ 4.90000000e+02 7.97729800e+00]
[ 5.00000000e+02 8.71903600e+00]
[ 5.10000000e+02 9.55321500e+00]
[ 5.20000000e+02 9.90610500e+00]
[ 5.30000000e+02 9.91394400e+00]
[ 5.40000000e+02 9.74738000e+00]
[ 5.50000000e+02 9.53404900e+00]
[ 5.60000000e+02 9.27392200e+00]
[ 5.70000000e+02 9.02323400e+00]
[ 5.80000000e+02 8.91788800e+00]
[ 5.90000000e+02 9.11454600e+00]
[ 6.00000000e+02 9.55787100e+00]
[ 6.10000000e+02 1.00600760e+01]
[ 6.20000000e+02 1.04846200e+01]
[ 6.30000000e+02 1.05679540e+01]
[ 6.40000000e+02 1.04359870e+01]
[ 6.50000000e+02 9.82122300e+00]
[ 6.60000000e+02 8.77578300e+00]
[ 6.70000000e+02 7.56471800e+00]
[ 6.80000000e+02 6.29808600e+00]
[ 6.90000000e+02 5.15623400e+00]
[ 7.00000000e+02 4.05390600e+00]
[ 7.10000000e+02 3.06638600e+00]
[ 7.20000000e+02 2.19250000e+00]
[ 7.30000000e+02 1.53922800e+00]
[ 7.40000000e+02 1.14938200e+00]
[ 7.50000000e+02 9.05095000e-01]
[ 7.60000000e+02 6.90947000e-01]
[ 7.70000000e+02 5.08426000e-01]
[ 7.80000000e+02 4.11766000e-01]]
```

read() → *SpectralDistribution_Sekonic*Read and parses the spectral data from a given *Sekonic Pseudo-XLS* file.**Returns***Sekonic* spectral distribution.**Return type**`colour.SpectralDistribution_Sekonic`**Examples**

```
>>> from os.path import dirname, join
>>> from colour import SpectralShape
>>> directory = join(dirname(__file__), "tests", "resources")
>>> sd = SpectralDistribution_Sekonic(
...     join(directory, "RANDOM_001_02._3262K.csv")
... )
>>> print(sd.read().align(SpectralShape(380, 780, 10)))
...
Sekonic
```

(continues on next page)

(continued from previous page)

=====

```

Path          : ...
Spectral Quantity : irradiance
Reflection Geometry : None
Transmission Geometry : None
Bandwidth (FWHM) : None
Bandwidth Corrected : None

```

Header

```

Manufacturer      : Sekonic
Catalog Number    : None
Description        : None
Document Creator   : None
Unique Identifier  : None
Measurement Equipment : None
Laboratory         : None
Report Number      : None
Report Date        : 15/03/2021 3:44:14 p.m.
Document Creation Date : None
Comments           : {...}

```

Spectral Data

```

[[ 3.80000000e+02 1.69406589e-21]
 [ 3.90000000e+02 2.11758237e-22]
 [ 4.00000000e+02 1.19813650e-05]
 [ 4.10000000e+02 1.97110530e-05]
 [ 4.20000000e+02 2.99661440e-05]
 [ 4.30000000e+02 6.38192720e-05]
 [ 4.40000000e+02 1.68909683e-04]
 [ 4.50000000e+02 3.31902935e-04]
 [ 4.60000000e+02 3.33143020e-04]
 [ 4.70000000e+02 2.30227481e-04]
 [ 4.80000000e+02 1.66981976e-04]
 [ 4.90000000e+02 1.64439844e-04]
 [ 5.00000000e+02 2.01534538e-04]
 [ 5.10000000e+02 2.57840526e-04]
 [ 5.20000000e+02 3.04612651e-04]
 [ 5.30000000e+02 3.41368344e-04]
 [ 5.40000000e+02 3.63639323e-04]
 [ 5.50000000e+02 3.87050648e-04]
 [ 5.60000000e+02 4.21619130e-04]
 [ 5.70000000e+02 4.58150520e-04]
 [ 5.80000000e+02 5.01176575e-04]
 [ 5.90000000e+02 5.40883630e-04]
 [ 6.00000000e+02 5.71256795e-04]
 [ 6.10000000e+02 5.83703280e-04]
 [ 6.20000000e+02 5.57688472e-04]
 [ 6.30000000e+02 5.17328095e-04]
 [ 6.40000000e+02 4.39994939e-04]
 [ 6.50000000e+02 3.62766819e-04]
 [ 6.60000000e+02 2.96465587e-04]

```

(continues on next page)

(continued from previous page)

```
[ 6.70000000e+02 2.43966802e-04]
[ 6.80000000e+02 2.04134776e-04]
[ 6.90000000e+02 1.75304012e-04]
[ 7.00000000e+02 1.52887544e-04]
[ 7.10000000e+02 1.29795619e-04]
[ 7.20000000e+02 1.03122693e-04]
[ 7.30000000e+02 8.77607820e-05]
[ 7.40000000e+02 7.61524130e-05]
[ 7.50000000e+02 7.06516880e-05]
[ 7.60000000e+02 3.72199210e-05]
[ 7.70000000e+02 3.63058860e-05]
[ 7.80000000e+02 3.55755470e-05]]
```

X-Rite Data

colour

| | |
|---|---|
| <code>read_sds_from_xrite_file(path)</code> | Read the spectral data from given <i>X-Rite</i> file and returns it as a <i>dict</i> of <code>colour.SpectralDistribution</code> class instances. |
|---|---|

colour.read_sds_from_xrite_file

`colour.read_sds_from_xrite_file(path: str) → Dict[str, SpectralDistribution]`

Read the spectral data from given *X-Rite* file and returns it as a *dict* of `colour.SpectralDistribution` class instances.

Parameters

path (`str`) – Absolute *X-Rite* file path.

Returns

Dict of `colour.SpectralDistribution` class instances.

Return type

`dict`

Notes

- This parser is minimalistic and absolutely not bullet-proof.

Examples

```
>>> import os
>>> from pprint import pprint
>>> xrite_file = os.path.join(
...     os.path.dirname(__file__),
...     "tests",
...     "resources",
...     "X-Rite_Digital_Colour_Checker.txt",
... )
>>> sds_data = read_sds_from_xrite_file(xrite_file)
```

(continues on next page)

(continued from previous page)

```
>>> pprint(list(sds_data.keys()))
['X1', 'X2', 'X3', 'X4', 'X5', 'X6', 'X7', 'X8', 'X9', 'X10']
```

Colour Models

Tristimulus Values, CIE xyY Colourspace and Chromaticity Coordinates

colour

| | |
|--|--|
| <code>XYZ_to_xyY(XYZ[, illuminant])</code> | Convert from <i>CIE XYZ</i> tristimulus values to <i>CIE xyY</i> colourspace and reference <i>illuminant</i> . |
| <code>xyY_to_XYZ(xyY)</code> | Convert from <i>CIE xyY</i> colourspace to <i>CIE XYZ</i> tristimulus values. |
| <code>XYZ_to_xy(XYZ[, illuminant])</code> | Return the <i>CIE xy</i> chromaticity coordinates from given <i>CIE XYZ</i> tristimulus values. |
| <code>xy_to_XYZ(xy)</code> | Return the <i>CIE XYZ</i> tristimulus values from given <i>CIE xy</i> chromaticity coordinates. |
| <code>xyY_to_xy(xyY)</code> | Convert from <i>CIE xyY</i> colourspace to <i>CIE xy</i> chromaticity coordinates. |
| <code>xy_to_xyY(xy[, Y])</code> | Convert from <i>CIE xy</i> chromaticity coordinates to <i>CIE xyY</i> colourspace by extending the array last dimension with given <i>Y</i> luminance. |

colour.XYZ_to_xyY

`colour.XYZ_to_xyY(XYZ: ArrayLike, illuminant: ArrayLike = CCS_ILLUMINANTS['CIE 1931 2 Degree Standard Observer']['D65']) → ndarray`

Convert from *CIE XYZ* tristimulus values to *CIE xyY* colourspace and reference *illuminant*.

Parameters

- **XYZ** (ArrayLike) – *CIE XYZ* tristimulus values.
- **illuminant** (ArrayLike) – Reference *illuminant* chromaticity coordinates.

Returns

CIE xyY colourspace array.

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| xyY | [0, 1] | [0, 1] |

References

[Lin03b], [Wikipedia05d]

Examples

```
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> XYZ_to_xyY(XYZ)
array([ 0.5436955...,  0.3210794...,  0.1219722...])
```

colour.xyY_to_XYZ

colour.xyY_to_XYZ(xyY: *ArrayLike*) → ndarray

Convert from *CIE xyY* colourspace to *CIE XYZ* tristimulus values.

Parameters

xyY (ArrayLike) – *CIE xyY* colourspace array.

Returns

CIE XYZ tristimulus values.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| xyY | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

References

[Lin09d], [Wikipedia05d]

Examples

```
>>> xyY = np.array([0.54369557, 0.32107944, 0.12197225])
>>> xyY_to_XYZ(xyY)
array([ 0.2065400...,  0.1219722...,  0.0513695...])
```

colour.XYZ_to_xy

colour.XYZ_to_xy(XYZ: ArrayLike, illuminant: ArrayLike = CCS_ILLUMINANTS['CIE 1931 2 Degree Standard Observer']['D65']) → ndarray

Return the CIE xy chromaticity coordinates from given CIE XYZ tristimulus values.

Parameters

- **XYZ** (ArrayLike) – CIE XYZ tristimulus values.
- **illuminant** (ArrayLike) – Reference *illuminant* chromaticity coordinates.

Returns

CIE xy chromaticity coordinates.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

References

[Wikipedia05d]

Examples

```
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> XYZ_to_xy(XYZ)
array([ 0.5436955...,  0.3210794...])
```

colour.xy_to_XYZ

colour.xy_to_XYZ(xy: ArrayLike) → ndarray

Return the CIE XYZ tristimulus values from given CIE xy chromaticity coordinates.

Parameters

xy (ArrayLike) – CIE xy chromaticity coordinates.

Returns

CIE XYZ tristimulus values.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| xy | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

References

[Wikipedia05d]

Examples

```
>>> xy = np.array([0.54369557, 0.32107944])
>>> xy_to_XYZ(xy)
array([ 1.6933366..., 1.          , 0.4211574...])
```

colour.xyY_to_xy

colour.**xyY_to_xy**(xyY: *ArrayLike*) → *ndarray*

Convert from *CIE xyY* colourspace to *CIE xy* chromaticity coordinates.

xyY argument with last dimension being equal to 2 will be assumed to be a *CIE xy* chromaticity coordinates argument and will be returned directly by the definition.

Parameters

xyY (*ArrayLike*) – *CIE xyY* colourspace array or *CIE xy* chromaticity coordinates.

Returns

CIE xy chromaticity coordinates.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| xyY | [0, 1] | [0, 1] |

References

[Wikipedia05d]

Examples

```
>>> xyY = np.array([0.54369557, 0.32107944, 0.12197225])
>>> xyY_to_xy(xyY)
array([ 0.54369557...,  0.32107944...])
>>> xy = np.array([0.54369557, 0.32107944])
>>> xyY_to_xy(xy)
array([ 0.54369557...,  0.32107944...])
```

colour.xy_to_xyY

colour.**xy_to_xyY**(xy: ArrayLike, Y: float = 1) → ndarray

Convert from *CIE xy* chromaticity coordinates to *CIE xyY* colourspace by extending the array last dimension with given *Y luminance*.

xy argument with last dimension being equal to 3 will be assumed to be a *CIE xyY* colourspace array argument and will be returned directly by the definition.

Parameters

- **xy** (ArrayLike) – *CIE xy* chromaticity coordinates or *CIE xyY* colourspace array.
- **Y** (float) – Optional *Y luminance* value used to construct the *CIE xyY* colourspace array, the default *Y luminance* value is 1.

Returns

CIE xyY colourspace array.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| xy | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| xyY | [0, 1] | [0, 1] |

- This definition is a convenient object provided to implement support of illuminant argument *luminance* value in various colour.models package objects such as colour.Lab_to_XYZ() or colour.Luv_to_XYZ().

References

[Wikipedia05d]

Examples

```
>>> xy = np.array([0.54369557, 0.32107944])
>>> xy_to_xyY(xy)
array([ 0.5436955..., 0.3210794..., 1.          ])
>>> xy = np.array([0.54369557, 0.32107944, 1.00000000])
>>> xy_to_xyY(xy)
array([ 0.5436955..., 0.3210794..., 1.          ])
>>> xy = np.array([0.54369557, 0.32107944])
>>> xy_to_xyY(xy, 100)
array([ 0.5436955..., 0.3210794..., 100.         ])
```

Common Models

colour

COLOURSPACE_MODELS

Colourspace models supporting a direct conversion to *CIE XYZ* tristimulus values.

colour.COLOURSPACE_MODELS

```
colour.COLOURSPACE_MODELS = ('CAM02LCD', 'CAM02SCD', 'CAM02UCS', 'CAM16LCD', 'CAM16SCD',
                              'CAM16UCS', 'CIE XYZ', 'CIE xyY', 'CIE Lab', 'CIE Luv', 'CIE UCS', 'CIE UVW', 'DIN99',
                              'Hunter Lab', 'Hunter Rdab', 'ICaCb', 'ICtCp', 'IPT', 'IPT Munish 2021', 'IgPgTg',
                              'Jzazbz', 'OSA UCS', 'Oklab', 'hdr-CIELAB', 'hdr-IPT')
```

Colourspace models supporting a direct conversion to *CIE XYZ* tristimulus values.

colour.models

Jab_to_JCh(Jab)

Convert from *Jab* colour representation to *JCh* colour representation.

JCh_to_Jab(JCh)

Convert from *JCh* colour representation to *Jab* colour representation.

XYZ_to_Iab(XYZ, LMS_to_LMS_p_callable, ...)

Convert from *CIE XYZ* tristimulus values to *IPT*-like *Iab* colour representation.

Iab_to_XYZ(Iab, LMS_p_to_LMS_callable, ...)

Convert from *IPT*-like *Iab* colour representation to *CIE XYZ* tristimulus values.

colour.models.Jab_to_JCh`colour.models.Jab_to_JCh(Jab: ArrayLike) → ndarray`

Convert from *Jab* colour representation to *JCh* colour representation.

This definition is used to perform conversion from *CIE L*a*b** colourspace to *CIE L*C*Hab* colourspace and for other similar conversions. It implements a generic transformation from *Lightness J*, *a* and *b* opponent colour dimensions to the correlates of *Lightness J*, chroma *C* and hue angle *h*.

Parameters

Jab (ArrayLike) – *Jab* colour representation array.

Returns

JCh colour representation array.

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|--|--|
| Jab | J : [0, 100] a : [-100, 100] b : [-100, 100] | J : [0, 1] a : [-1, 1] b : [-1, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|--|--|
| JCh | J : [0, 100] C : [0, 100] h : [0, 360] | J : [0, 1] C : [0, 1] h : [0, 1] |

References

[CIET14804h]

Examples

```
>>> Jab = np.array([41.52787529, 52.63858304, 26.92317922])
>>> Jab_to_JCh(Jab)
array([ 41.5278752...,  59.1242590...,  27.0884878...])
```

colour.models.JCh_to_Jab`colour.models.JCh_to_Jab(JCh: ArrayLike) → ndarray`

Convert from *JCh* colour representation to *Jab* colour representation.

This definition is used to perform conversion from *CIE L*C*Hab* colourspace to *CIE L*a*b** colourspace and for other similar conversions. It implements a generic transformation from the correlates of *Lightness J*, chroma *C* and hue angle *h* to *Lightness J*, *a* and *b* opponent colour dimensions.

Parameters

JCh (ArrayLike) – *JCh* colour representation array.

Returns*Jab* colour representation array.**Return type**`numpy.ndarray`**Notes**

| Domain | Scale - Reference | Scale - 1 |
|--------|--|--|
| JCh | J : [0, 100] C : [0, 100] h : [0, 360] | J : [0, 1] C : [0, 1] h : [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|--|--|
| Jab | J : [0, 100] a : [-100, 100] b : [-100, 100] | J : [0, 1] a : [-1, 1] b : [-1, 1] |

References[\[CIET14804h\]](#)**Examples**

```
>>> JCh = np.array([41.52787529, 59.12425901, 27.08848784])
>>> JCh_to_Jab(JCh)
array([ 41.5278752...,  52.6385830...,  26.9231792...])
```

colour.models.XYZ_to_lab

`colour.models.XYZ_to_Iab`(XYZ: *ArrayLike*, LMS_to_LMS_p_callable: *Callable*, matrix_XYZ_to_LMS: *ArrayLike*, matrix_LMS_p_to_Iab: *ArrayLike*) → `ndarray`

Convert from *CIE XYZ* tristimulus values to *IPT*-like *Iab* colour representation.

This definition is used to perform conversion from *CIE XYZ* tristimulus values to *IPT* colourspace and for other similar conversions. It implements a generic transformation from *CIE XYZ* tristimulus values to *Lightness I*, *a* and *b* representing red-green dimension, i.e. the dimension lost by protanopes and the yellow-blue dimension, i.e. the dimension lost by tritanopes, respectively.

Parameters

- **XYZ** (*ArrayLike*) – *CIE XYZ* tristimulus values.
- **LMS_to_LMS_p_callable** (*Callable*) – Callable applying the forward non-linearity to the *LMS* colourspace array.
- **matrix_XYZ_to_LMS** (*ArrayLike*) – Matrix converting from *CIE XYZ* tristimulus values to *LMS* colourspace.
- **matrix_LMS_p_to_Iab** (*ArrayLike*) – Matrix converting from non-linear *LMS_p* colourspace to *IPT*-like *Iab* colour representation.

Returns*IPT*-like *Iab* colour representation.

Return type`numpy.ndarray`**Notes**

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|--|--|
| Iab | I : [0, 1] a : [-1, 1] b : [-1, 1] | I : [0, 1] a : [-1, 1] b : [-1, 1] |

Examples

```
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> LMS_to_LMS_p = lambda x: x**0.43
>>> M_XYZ_to_LMS = np.array(
...     [
...         [0.4002, 0.7075, -0.0807],
...         [-0.2280, 1.1500, 0.0612],
...         [0.0000, 0.0000, 0.9184],
...     ]
... )
>>> M_LMS_p_to_Iab = np.array(
...     [
...         [0.4000, 0.4000, 0.2000],
...         [4.4550, -4.8510, 0.3960],
...         [0.8056, 0.3572, -1.1628],
...     ]
... )
>>> XYZ_to_Iab(XYZ, LMS_to_LMS_p, M_XYZ_to_LMS, M_LMS_p_to_Iab)
...
array([ 0.3842619...,  0.3848730...,  0.1888683...])
```

colour.models.lab_to_XYZ

`colour.models.Iab_to_XYZ(Iab: ArrayLike, LMS_p_to_LMS_callable: Callable, matrix_Iab_to_LMS_p: ArrayLike, matrix_LMS_to_XYZ: ArrayLike) → ndarray`

Convert from *IPT*-like *Iab* colour representation to *CIE XYZ* tristimulus values.

This definition is used to perform conversion from *IPT* colourspace to *CIE XYZ* tristimulus values and for other similar conversions. It implements a generic transformation from *Lightness I*, *a* and *b* representing red-green dimension, i.e. the dimension lost by protanopes and the yellow-blue dimension, i.e. the dimension lost by tritanopes, respectively to *CIE XYZ* tristimulus values.

Parameters

- **Iab** (ArrayLike) – *IPT*-like *Iab* colour representation.
- **LMS_p_to_LMS_callable** (Callable) – Callable applying the reverse non-linearity to the LMS_p colourspace array.

- **matrix_Iab_to_LMS_p** (ArrayLike) – Matrix converting from *IPT*-like *Iab* colour representation to non-linear *LMS_p* colourspace.
- **matrix_LMS_to_XYZ** (ArrayLike) – Matrix converting from *LMS* colourspace to *CIE XYZ* tristimulus values.

Returns

CIE XYZ tristimulus values.

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|--|--|
| Iab | I : [0, 1] a : [-1, 1] b : [-1, 1] | I : [0, 1] a : [-1, 1] b : [-1, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

Examples

```
>>> Iab = np.array([0.38426191, 0.38487306, 0.18886838])
>>> LMS_p_to_LMS = lambda x: x ** (1 / 0.43)
>>> M_Iab_to_LMS_p = np.linalg.inv(
...     np.array(
...         [
...             [0.4000, 0.4000, 0.2000],
...             [4.4550, -4.8510, 0.3960],
...             [0.8056, 0.3572, -1.1628],
...         ]
...     )
... )
>>> M_LMS_to_XYZ = np.linalg.inv(
...     np.array(
...         [
...             [0.4002, 0.7075, -0.0807],
...             [-0.2280, 1.1500, 0.0612],
...             [0.0000, 0.0000, 0.9184],
...         ]
...     )
... )
>>> Iab_to_XYZ(Iab, LMS_p_to_LMS, M_Iab_to_LMS_p, M_LMS_to_XYZ)
...
array([ 0.2065400...,  0.1219722...,  0.0513695...])
```

CIE $L^*a^*b^*$ Colourspace

colour

| | |
|--|--|
| <code>XYZ_to_Lab(XYZ[, illuminant])</code> | Convert from <i>CIE XYZ</i> tristimulus values to <i>CIE $L^*a^*b^*$</i> colourspace. |
| <code>Lab_to_XYZ(Lab[, illuminant])</code> | Convert from <i>CIE $L^*a^*b^*$</i> colourspace to <i>CIE XYZ</i> tristimulus values. |
| <code>Lab_to_LCHab(Lab)</code> | Convert from <i>CIE $L^*a^*b^*$</i> colourspace to <i>CIE L^*C^*Hab</i> colourspace. |
| <code>LCHab_to_Lab(LCHab)</code> | Convert from <i>CIE L^*C^*Hab</i> colourspace to <i>CIE $L^*a^*b^*$</i> colourspace. |

colour.XYZ_to_Lab

`colour.XYZ_to_Lab(XYZ: ArrayLike, illuminant: ArrayLike = CCS_ILLUMINANTS['CIE 1931 2 Degree Standard Observer']['D65']) → ndarray`

Convert from *CIE XYZ* tristimulus values to *CIE $L^*a^*b^*$* colourspace.

Parameters

- **XYZ** (ArrayLike) – *CIE XYZ* tristimulus values.
- **illuminant** (ArrayLike) – Reference *illuminant CIE xy* chromaticity coordinates or *CIE xyY* colourspace array.

Returns

*CIE $L^*a^*b^*$* colourspace array.

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|------------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |
| illuminant | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-------------|
| Lab | L : [0, 100] | L : [0, 1] |
| | a : [-100, 100] | a : [-1, 1] |
| | b : [-100, 100] | b : [-1, 1] |

References

[CIET14804h]

Examples

```
>>> import numpy as np
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> XYZ_to_Lab(XYZ)
array([ 41.5278752...,  52.6385830...,  26.9231792...])
```

colour.Lab_to_XYZ

`colour.Lab_to_XYZ(Lab: ArrayLike, illuminant: ArrayLike = CCS_ILLUMINANTS['CIE 1931 2 Degree Standard Observer']['D65'])` → `ndarray`

Convert from *CIE L*a*b** colourspace to *CIE XYZ* tristimulus values.

Parameters

- **Lab** (ArrayLike) – *CIE L*a*b** colourspace array.
- **illuminant** (ArrayLike) – Reference *illuminant CIE xy* chromaticity coordinates or *CIE xyY* colourspace array.

Returns

CIE XYZ tristimulus values.

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|------------|-------------------|-------------|
| Lab | L : [0, 100] | L : [0, 1] |
| | a : [-100, 100] | a : [-1, 1] |
| | b : [-100, 100] | b : [-1, 1] |
| illuminant | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

References

[CIET14804h]

Examples

```
>>> import numpy as np
>>> Lab = np.array([41.52787529, 52.63858304, 26.92317922])
>>> Lab_to_XYZ(Lab)
array([ 0.2065400...,  0.1219722...,  0.0513695...])
```

colour.Lab_to_LCHab

colour.Lab_to_LCHab(Lab: ArrayLike) → ndarray

Convert from CIE $L^*a^*b^*$ colourspace to CIE L^*C^*Hab colourspace.

Parameters

Lab (ArrayLike) – CIE $L^*a^*b^*$ colourspace array.

Returns

CIE L^*C^*Hab colourspace array.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-------------|
| Lab | L : [0, 100] | L : [0, 1] |
| | a : [-100, 100] | a : [-1, 1] |
| | b : [-100, 100] | b : [-1, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|--------------|
| LCHab | L : [0, 100] | L : [0, 1] |
| | C : [0, 100] | C : [0, 1] |
| | Hab : [0, 360] | Hab : [0, 1] |

References

[CIET14804h]

Examples

```
>>> import numpy as np
>>> Lab = np.array([41.52787529, 52.63858304, 26.92317922])
>>> Lab_to_LCHab(Lab)
array([ 41.5278752...,  59.1242590...,  27.0884878...])
```

colour.LCHab_to_Lab

`colour.LCHab_to_Lab(LCHab: ArrayLike) → ndarray`

Convert from *CIE L*C*Hab* colourspace to *CIE L*a*b** colourspace.

Parameters

LCHab (ArrayLike) – *CIE L*C*Hab* colourspace array.

Returns

*CIE L*a*b** colourspace array.

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|--|--|
| LCHab | L : [0, 100] C : [0, 100] Hab : [0, 360] | L : [0, 1] C : [0, 1] Hab : [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|--|--|
| Lab | L : [0, 100] a : [-100, 100] b : [-100, 100] | L : [0, 1] a : [-1, 1] b : [-1, 1] |

References

[CIET14804h]

Examples

```
>>> import numpy as np
>>> LCHab = np.array([41.52787529, 59.12425901, 27.08848784])
>>> LCHab_to_Lab(LCHab)
array([ 41.5278752...,  52.6385830...,  26.9231792...])
```

CIE L*u*v* Colourspace

colour

| | |
|---|---|
| <code>XYZ_to_Luv(XYZ[, illuminant])</code> | Convert from <i>CIE XYZ</i> tristimulus values to <i>CIE L*u*v*</i> colourspace. |
| <code>Luv_to_XYZ(Luv[, illuminant])</code> | Convert from <i>CIE L*u*v*</i> colourspace to <i>CIE XYZ</i> tristimulus values. |
| <code>Luv_to_LCHuv(Luv)</code> | Convert from <i>CIE L*u*v*</i> colourspace to <i>CIE L*C*Huv</i> colourspace. |
| <code>LCHuv_to_Luv(LCHuv)</code> | Convert from <i>CIE L*C*Huv</i> colourspace to <i>CIE L*u*v*</i> colourspace. |
| <code>Luv_to_uv(Luv[, illuminant])</code> | Return the uv^p chromaticity coordinates from given <i>CIE L*u*v*</i> colourspace array. |
| <code>uv_to_Luv(uv[, illuminant, Y])</code> | Return the <i>CIE L*u*v*</i> colourspace array from given uv^p chromaticity coordinates by extending the array last dimension with given <i>L Lightness</i> . |
| <code>Luv_uv_to_xy(uv)</code> | Return the <i>CIE xy</i> chromaticity coordinates from given <i>CIE L*u*v*</i> colourspace uv^p chromaticity coordinates. |
| <code>xy_to_Luv_uv(xy)</code> | Return the <i>CIE L*u*v*</i> colourspace uv^p chromaticity coordinates from given <i>CIE xy</i> chromaticity coordinates. |

colour.XYZ_to_Luv

`colour.XYZ_to_Luv(XYZ: ArrayLike, illuminant: ArrayLike = CCS_ILLUMINANTS['CIE 1931 2 Degree Standard Observer']['D65']) → ndarray`

Convert from *CIE XYZ* tristimulus values to *CIE L*u*v** colourspace.

Parameters

- **XYZ** (ArrayLike) – *CIE XYZ* tristimulus values.
- **illuminant** (ArrayLike) – Reference *illuminant CIE xy* chromaticity coordinates or *CIE xyY* colourspace array.

Returns

*CIE L*u*v** colourspace array.

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|------------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |
| illuminant | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|--|--|
| Luv | L : [0, 100] u : [-100, 100] v : [-100, 100] | L : [0, 1] u : [-1, 1] v : [-1, 1] |

References

[CIET14804h], [Wikipedia07e]

Examples

```
>>> import numpy as np
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> XYZ_to_Luv(XYZ)
array([ 41.5278752...,  96.8362605...,  17.7521014...])
```

colour.Luv_to_XYZ

`colour.Luv_to_XYZ(Luv: ArrayLike, illuminant: ArrayLike = CCS_ILLUMINANTS['CIE 1931 2 Degree Standard Observer']['D65'])` → `ndarray`

Convert from *CIE L*u*v** colourspace to *CIE XYZ* tristimulus values.

Parameters

- **Luv** (ArrayLike) – *CIE L*u*v** colourspace array.
- **illuminant** (ArrayLike) – Reference *illuminant CIE xy* chromaticity coordinates or *CIE xyY* colourspace array.

Returns

CIE XYZ tristimulus values.

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|------------|-------------------|-------------|
| Luv | L : [0, 100] | L : [0, 1] |
| | u : [-100, 100] | u : [-1, 1] |
| | v : [-100, 100] | v : [-1, 1] |
| illuminant | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

References

[CIET14804h], [Wikipedia07e]

Examples

```
>>> import numpy as np
>>> Luv = np.array([41.52787529, 96.83626054, 17.75210149])
>>> Luv_to_XYZ(Luv)
array([ 0.2065400...,  0.1219722...,  0.0513695...])
```

colour.Luv_to_LCHuv

colour.Luv_to_LCHuv(Luv: ArrayLike) → ndarray

Convert from CIE $L^*u^*v^*$ colourspace to CIE L^*C^*Huv colourspace.

Parameters

Luv (ArrayLike) – CIE $L^*u^*v^*$ colourspace array.

Returns

CIE L^*C^*Huv colourspace array.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-------------|
| Luv | L : [0, 100] | L : [0, 1] |
| | u : [-100, 100] | u : [-1, 1] |
| | v : [-100, 100] | v : [-1, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|--------------|
| LCHuv | L : [0, 100] | L : [0, 1] |
| | C : [0, 100] | C : [0, 1] |
| | Huv : [0, 360] | Huv : [0, 1] |

References

[CIET14804h]

Examples

```
>>> import numpy as np
>>> Luv = np.array([41.52787529, 96.83626054, 17.75210149])
>>> Luv_to_LCHuv(Luv)
array([ 41.5278752...,  98.4499795...,  10.3881634...])
```


colour.LCHuv_to_Luv

`colour.LCHuv_to_Luv(LCHuv: ArrayLike) → ndarray`

Convert from *CIE L*C*Huv* colourspace to *CIE L*u*v** colourspace.

Parameters

LCHuv (ArrayLike) – *CIE L*C*Huv* colourspace array.

Returns

*CIE L*u*v** colourspace array.

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|--|--|
| LCHuv | L : [0, 100] C : [0, 100] Huv : [0, 360] | L : [0, 1] C : [0, 1] Huv : [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|--|--|
| Luv | L : [0, 100] u : [-100, 100] v : [-100, 100] | L : [0, 1] u : [-1, 1] v : [-1, 1] |

References

[CIET14804h]

Examples

```
>>> import numpy as np
>>> LCHuv = np.array([41.52787529, 98.44997950, 10.38816348])
>>> LCHuv_to_Luv(LCHuv)
array([ 41.5278752...,  96.8362605...,  17.7521014...])
```

colour.Luv_to_uv

`colour.Luv_to_uv(Luv: ArrayLike, illuminant: ArrayLike = CCS_ILLUMINANTS['CIE 1931 2 Degree Standard Observer']['D65']) → ndarray`

Return the uv^p chromaticity coordinates from given *CIE L*u*v** colourspace array.

Parameters

- **Luv** (ArrayLike) – *CIE L*u*v** colourspace array.
- **illuminant** (ArrayLike) – Reference *illuminant CIE xy* chromaticity coordinates or *CIE xyY* colourspace array.

Returns

uv^p chromaticity coordinates.

Return type`numpy.ndarray`**Notes**

| Domain | Scale - Reference | Scale - 1 |
|------------|-------------------|-------------|
| Luv | L : [0, 100] | L : [0, 1] |
| | u : [-100, 100] | u : [-1, 1] |
| | v : [-100, 100] | v : [-1, 1] |
| illuminant | [0, 1] | [0, 1] |

References[\[CIET14804g\]](#)**Examples**

```
>>> import numpy as np
>>> Luv = np.array([41.52787529, 96.83626054, 17.75210149])
>>> Luv_to_uv(Luv)
array([ 0.3772021...,  0.5012026...])
```

colour.uv_to_Luv

`colour.uv_to_Luv(uv: ArrayLike, illuminant: ArrayLike = CCS_ILLUMINANTS['CIE 1931 2 Degree Standard Observer']['D65'], Y: float = 1) → ndarray`

Return the *CIE* $L^*u^*v^*$ colourspace array from given uv^p chromaticity coordinates by extending the array last dimension with given L Lightness.

Parameters

- **uv** (ArrayLike) – uv^p chromaticity coordinates.
- **illuminant** (ArrayLike) – Reference *illuminant* *CIE* xy chromaticity coordinates or *CIE* xyY colourspace array.
- **Y** (float) – Optional Y *luminance* value used to construct the intermediate *CIE* XYZ colourspace array, the default Y *luminance* value is 1.

Returns

CIE $L^*u^*v^*$ colourspace array.

Return type`numpy.ndarray`

Notes

| Range | Scale - Reference | Scale - 1 |
|------------|--|--|
| Luv | L : [0, 100] u : [-100, 100] v : [-100, 100] | L : [0, 1] u : [-1, 1] v : [-1, 1] |
| illuminant | [0, 1] | [0, 1] |

References

[CIET14804g]

Examples

```
>>> import numpy as np
>>> uv = np.array([0.37720213, 0.50120264])
>>> uv_to_Luv(uv)
array([ 100.          , 233.1837603...,  42.7474385...])
```

colour.Luv_uv_to_xy

colour.Luv_uv_to_xy(uv: ArrayLike) → ndarray

Return the CIE xy chromaticity coordinates from given CIE $L^*u^*v^*$ colourspace uv^p chromaticity coordinates.

Parameters

uv (ArrayLike) – CIE $L^*u^*v^*$ u^*v^* chromaticity coordinates.

Returns

CIE xy chromaticity coordinates.

Return type

numpy.ndarray

References

[Wikipedia07b]

Examples

```
>>> import numpy as np
>>> uv = np.array([0.37720213, 0.50120264])
>>> Luv_uv_to_xy(uv)
array([ 0.5436955...,  0.3210794...])
```

colour.xy_to_Luv_uv

colour.xy_to_Luv_uv(xy: ArrayLike) → ndarray

Return the *CIE L*u*v** colourspace uv^p chromaticity coordinates from given *CIE xy* chromaticity coordinates.

Parameters

xy (ArrayLike) – *CIE xy* chromaticity coordinates.

Returns

*CIE L*u*v* u”v”* chromaticity coordinates.

Return type

numpy.ndarray

References

[Wikipedia07e]

Examples

```
>>> import numpy as np
>>> xy = np.array([0.54369558, 0.32107944])
>>> xy_to_Luv_uv(xy)
array([ 0.3772021...,  0.5012026...])
```

CIE 1960 UCS Colourspace

colour

| | |
|--------------------|--|
| XYZ_to_UCS(XYZ) | Convert from <i>CIE XYZ</i> tristimulus values to <i>CIE 1960 UCS</i> colourspace. |
| UCS_to_XYZ(UVW) | Convert from <i>CIE 1960 UCS</i> colourspace to <i>CIE XYZ</i> tristimulus values. |
| UCS_to_uv(UVW) | Return the <i>uv</i> chromaticity coordinates from given <i>CIE 1960 UCS</i> colourspace array. |
| uv_to_UCS(uv[, V]) | Return the <i>CIE 1960 UCS</i> colourspace array from given <i>uv</i> chromaticity coordinates. |
| UCS_uv_to_xy(uv) | Return the <i>CIE xy</i> chromaticity coordinates from given <i>CIE 1960 UCS</i> colourspace <i>uv</i> chromaticity coordinates. |
| xy_to_UCS_uv(xy) | Return the <i>CIE 1960 UCS</i> colourspace <i>uv</i> chromaticity coordinates from given <i>CIE xy</i> chromaticity coordinates. |

colour.XYZ_to_UCS

colour.XYZ_to_UCS(*XYZ: ArrayLike*) → ndarray

Convert from *CIE XYZ* tristimulus values to *CIE 1960 UCS* colourspace.

Parameters

XYZ (ArrayLike) – *CIE XYZ* tristimulus values.

Returns

CIE 1960 UCS colourspace array.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| UVW | [0, 1] | [0, 1] |

References

[Wikipedia08b], [Wikipedia08c]

Examples

```
>>> import numpy as np
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> XYZ_to_UCS(XYZ)
array([ 0.1376933...,  0.1219722...,  0.1053731...])
```

colour.UCS_to_XYZ

colour.UCS_to_XYZ(*UVW: ArrayLike*) → ndarray

Convert from *CIE 1960 UCS* colourspace to *CIE XYZ* tristimulus values.

Parameters

UVW (ArrayLike) – *CIE 1960 UCS* colourspace array.

Returns

CIE XYZ tristimulus values.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| UVW | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

References

[Wikipedia08b], [Wikipedia08c]

Examples

```
>>> import numpy as np
>>> UVW = np.array([0.13769339, 0.12197225, 0.10537310])
>>> UCS_to_XYZ(UVW)
array([ 0.2065400...,  0.1219722...,  0.0513695...])
```

colour.UCS_to_uv

colour.UCS_to_uv(UVW: *ArrayLike*) → *ndarray*

Return the *uv* chromaticity coordinates from given *CIE 1960 UCS* colourspace array.

Parameters

UVW (*ArrayLike*) – *CIE 1960 UCS* colourspace array.

Returns

uv chromaticity coordinates.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| UVW | [0, 1] | [0, 1] |

References

[Wikipedia08b]

Examples

```
>>> import numpy as np
>>> UVW = np.array([0.13769339, 0.12197225, 0.10537310])
>>> UCS_to_uv(UVW)
array([ 0.3772021...,  0.3341350...])
```

colour.uv_to_UCS

colour.uv_to_UCS(*uv*: ArrayLike, *V*: float = 1) → ndarray

Return the CIE 1960 UCS colourspace array from given *uv* chromaticity coordinates.

Parameters

- **uv** (ArrayLike) – *uv* chromaticity coordinates.
- **V** (float) – Optional *V luminance* value used to construct the CIE 1960 UCS colourspace array, the default *V luminance* is set to 1.

Returns

CIE 1960 UCS colourspace array.

Return type

numpy.ndarray

References

[Wikipedia08b]

Examples

```
>>> import numpy as np
>>> uv = np.array([0.37720213, 0.33413508])
>>> uv_to_UCS(uv)
array([ 1.1288911...,  1.          ,  0.8639104...])
```

colour.UCS_uv_to_xy

colour.UCS_uv_to_xy(*uv*: ArrayLike) → ndarray

Return the CIE *xy* chromaticity coordinates from given CIE 1960 UCS colourspace *uv* chromaticity coordinates.

Parameters

uv (ArrayLike) – CIE UCS *uv* chromaticity coordinates.

Returns

CIE *xy* chromaticity coordinates.

Return type

numpy.ndarray

References

[Wikipedia08b]

Examples

```
>>> import numpy as np
>>> uv = np.array([0.37720213, 0.33413508])
>>> UCS_uv_to_xy(uv)
array([ 0.5436955..., 0.3210794...])
```

colour.xy_to_UCS_uv

colour.xy_to_UCS_uv(xy: ArrayLike) → ndarray

Return the *CIE 1960 UCS* colourspace *uv* chromaticity coordinates from given *CIE xy* chromaticity coordinates.

Parameters

xy (ArrayLike) – *CIE xy* chromaticity coordinates.

Returns

CIE UCS uv chromaticity coordinates.

Return type

numpy.ndarray

References

[Wikipedia08b]

Examples

```
>>> import numpy as np
>>> xy = np.array([0.54369555, 0.32107941])
>>> xy_to_UCS_uv(xy)
array([ 0.3772021..., 0.3341350...])
```

CIE 1964 U*V*W* Colourspace

colour

| | |
|-------------------------------|---|
| XYZ_to_UVW(XYZ[, illuminant]) | Convert from <i>CIE XYZ</i> tristimulus values to <i>CIE 1964 U*V*W*</i> colourspace. |
| UVW_to_XYZ(UVW[, illuminant]) | Convert <i>CIE 1964 U*V*W*</i> colourspace to <i>CIE XYZ</i> tristimulus values. |

colour.XYZ_to_UVW

`colour.XYZ_to_UVW(XYZ: ArrayLike, illuminant: ArrayLike = CCS_ILLUMINANTS['CIE 1931 2 Degree Standard Observer']['D65']) → ndarray`

Convert from CIE XYZ tristimulus values to CIE 1964 $U^*V^*W^*$ colourspace.

Parameters

- **XYZ** (ArrayLike) – CIE XYZ tristimulus values.
- **illuminant** (ArrayLike) – Reference *illuminant* CIE xy chromaticity coordinates or CIE xyY colourspace array.

Returns

CIE 1964 $U^*V^*W^*$ colourspace array.

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|------------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |
| illuminant | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-------------|
| UVW | U : [-100, 100] | U : [-1, 1] |
| | V : [-100, 100] | V : [-1, 1] |
| | W : [0, 100] | W : [0, 1] |

References

[Wikipedia08d]

Examples

```
>>> import numpy as np
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952]) * 100
>>> XYZ_to_UVW(XYZ)
array([ 94.5503572..., 11.5553652..., 40.5475740...])
```

colour.UVW_to_XYZ

`colour.UVW_to_XYZ(UVW: ArrayLike, illuminant: ArrayLike = CCS_ILLUMINANTS['CIE 1931 2 Degree Standard Observer']['D65']) → ndarray`

Convert CIE 1964 $U^*V^*W^*$ colourspace to CIE XYZ tristimulus values.

Parameters

- **UVW** (ArrayLike) – CIE 1964 $U^*V^*W^*$ colourspace array.
- **illuminant** (ArrayLike) – Reference *illuminant* CIE xy chromaticity coordinates or CIE xyY colourspace array.

Returns

CIE XYZ tristimulus values.

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|------------|-------------------|-------------|
| UVW | U : [-100, 100] | U : [-1, 1] |
| | V : [-100, 100] | V : [-1, 1] |
| | W : [0, 100] | W : [0, 1] |
| illuminant | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |

References

[Wikipedia08d]

Examples

```
>>> import numpy as np
>>> UVW = np.array([94.55035725, 11.55536523, 40.54757405])
>>> UVW_to_XYZ(UVW)
array([ 20.654008,  12.197225,   5.136952])
```

Hunter L,a,b Colour Scale

colour

| | |
|--|---|
| <code>XYZ_to_Hunter_Lab(XYZ[, XYZ_n, K_ab])</code> | Convert from <i>CIE XYZ</i> tristimulus values to <i>Hunter L,a,b</i> colour scale. |
| <code>Hunter_Lab_to_XYZ(Lab[, XYZ_n, K_ab])</code> | Convert from <i>Hunter L,a,b</i> colour scale to <i>CIE XYZ</i> tristimulus values. |
| <code>XYZ_to_K_ab_HunterLab1966(XYZ)</code> | Convert from <i>whitepoint CIE XYZ</i> tristimulus values to <i>Hunter L,a,b</i> K_a and K_b chromaticity coefficients. |

colour.XYZ_to_Hunter_Lab

`colour.XYZ_to_Hunter_Lab(XYZ: ArrayLike, XYZ_n: ArrayLike = TVS_ILLUMINANTS_HUNTERLAB['CIE 1931 2 Degree Standard Observer']['D65'].XYZ_n, K_ab: ArrayLike = TVS_ILLUMINANTS_HUNTERLAB['CIE 1931 2 Degree Standard Observer']['D65'].K_ab) → ndarray`

Convert from CIE XYZ tristimulus values to Hunter L, a, b colour scale.

Parameters

- **XYZ** (ArrayLike) – CIE XYZ tristimulus values.
- **XYZ_n** (ArrayLike) – Reference *illuminant* tristimulus values.
- **K_ab** (ArrayLike) – Reference *illuminant* chromaticity coefficients, if K_ab is set to *None* it will be computed using `colour.XYZ_to_K_ab_HunterLab1966()`.

Returns

Hunter L, a, b colour scale array.

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |
| XYZ_n | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|--|--|
| Lab | L : [0, 100] a : [-100, 100] b : [-100, 100] | L : [0, 1] a : [-1, 1] b : [-1, 1] |

References

[HunterLab08a]

Examples

```
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952]) * 100
>>> D65 = TVS_ILLUMINANTS_HUNTERLAB["CIE 1931 2 Degree Standard Observer"][
...     "D65"
... ]
>>> XYZ_to_Hunter_Lab(XYZ, D65.XYZ_n, D65.K_ab)
array([ 34.9245257...,  47.0618985...,  14.3861510...])
```

colour.Hunter_Lab_to_XYZ

`colour.Hunter_Lab_to_XYZ(Lab: ArrayLike, XYZ_n: ArrayLike = TVS_ILLUMINANTS_HUNTERLAB['CIE 1931 2 Degree Standard Observer']['D65'].XYZ_n, K_ab: ArrayLike = TVS_ILLUMINANTS_HUNTERLAB['CIE 1931 2 Degree Standard Observer']['D65'].K_ab) → ndarray`

Convert from *Hunter L,a,b* colour scale to *CIE XYZ* tristimulus values.

Parameters

- **Lab** (ArrayLike) – *Hunter L,a,b* colour scale array.
- **XYZ_n** (ArrayLike) – Reference *illuminant* tristimulus values.
- **K_ab** (ArrayLike) – Reference *illuminant* chromaticity coefficients, if **K_ab** is set to *None* it will be computed using `colour.XYZ_to_K_ab_HunterLab1966()`.

Returns

CIE XYZ tristimulus values.

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-------------|
| Lab | L : [0, 100] | L : [0, 1] |
| | a : [-100, 100] | a : [-1, 1] |
| | b : [-100, 100] | b : [-1, 1] |
| XYZ_n | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |

References

[HunterLab08a]

Examples

```
>>> Lab = np.array([34.92452577, 47.06189858, 14.38615107])
>>> D65 = TVS_ILLUMINANTS_HUNTERLAB["CIE 1931 2 Degree Standard Observer"][
...     "D65"
... ]
>>> Hunter_Lab_to_XYZ(Lab, D65.XYZ_n, D65.K_ab)
array([ 20.654008,  12.197225,   5.136952])
```

colour.XYZ_to_K_ab_HunterLab1966

colour.XYZ_to_K_ab_HunterLab1966(XYZ: ArrayLike) → ndarray

Convert from *whitepoint CIE XYZ* tristimulus values to *Hunter L,a,b K_a* and *K_b* chromaticity coefficients.

Parameters

XYZ (ArrayLike) – *Whitepoint CIE XYZ* tristimulus values.

Returns

Hunter L,a,b K_a and *K_b* chromaticity coefficients.

Return type

numpy.ndarray

References

[HunterLab08b]

Examples

```
>>> XYZ = np.array([109.850, 100.000, 35.585])
>>> XYZ_to_K_ab_HunterLab1966(XYZ)
array([ 185.2378721...,  38.4219142...])
```

Hunter Rd,a,b Colour Scale

colour

| | |
|---|--|
| XYZ_to_Hunter_Rdab(XYZ[, XYZ_n, K_ab]) | Convert from <i>CIE XYZ</i> tristimulus values to <i>Hunter Rd,a,b</i> colour scale. |
| Hunter_Rdab_to_XYZ(R_d_ab[, XYZ_n, K_ab]) | Convert from <i>Hunter Rd,a,b</i> colour scale to <i>CIE XYZ</i> tristimulus values. |

colour.XYZ_to_Hunter_Rdab

colour.XYZ_to_Hunter_Rdab(XYZ: ArrayLike, XYZ_n: ArrayLike = TVS_ILLUMINANTS_HUNTERLAB['CIE 1931 2 Degree Standard Observer']['D65'], XYZ_n, K_ab: ArrayLike = TVS_ILLUMINANTS_HUNTERLAB['CIE 1931 2 Degree Standard Observer']['D65'].K_ab) → ndarray

Convert from *CIE XYZ* tristimulus values to *Hunter Rd,a,b* colour scale.

Parameters

- **XYZ** (ArrayLike) – *CIE XYZ* tristimulus values.
- **XYZ_n** (ArrayLike) – Reference *illuminant* tristimulus values.
- **K_ab** (ArrayLike) – Reference *illuminant* chromaticity coefficients, if *K_ab* is set to *None* it will be computed using `colour.XYZ_to_K_ab_HunterLab1966()`.

Returns

Hunter Rd,a,b colour scale array.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |
| XYZ_n | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|--------|--------------------|----------------|
| R_d_ab | R_d : [0, 100] | R_d : [0, 1] |
| | a_Rd : [-100, 100] | a_Rd : [-1, 1] |
| | b_Rd : [-100, 100] | b_Rd : [-1, 1] |

References

[HunterLab12]

Examples

```
>>> import numpy as np
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952]) * 100
>>> D65 = TVS_ILLUMINANTS_HUNTERLAB["CIE 1931 2 Degree Standard Observer"]["D65"]
...
... ]
>>> XYZ_to_Hunter_Rdab(XYZ, D65.XYZ_n, D65.K_ab)
...
array([ 12.197225 ...,  57.1253787...,  17.4624134...])
```

`colour.Hunter_Rdab_to_XYZ`

```
colour.Hunter_Rdab_to_XYZ(R_d_ab: ArrayLike, XYZ_n: ArrayLike =
    TVS_ILLUMINANTS_HUNTERLAB["CIE 1931 2 Degree Standard
    Observer"]['D65'].XYZ_n, K_ab: ArrayLike =
    TVS_ILLUMINANTS_HUNTERLAB["CIE 1931 2 Degree Standard
    Observer"]['D65'].K_ab) → ndarray
```

Convert from *Hunter Rd,a,b* colour scale to *CIE XYZ* tristimulus values.

Parameters

- **R_d_ab** (ArrayLike) – *Hunter Rd,a,b* colour scale array.
- **XYZ_n** (ArrayLike) – Reference *illuminant* tristimulus values.
- **K_ab** (ArrayLike) – Reference *illuminant* chromaticity coefficients, if *K_ab* is set to *None* it will be computed using `colour.XYZ_to_K_ab_HunterLab1966()`.

Returns

CIE XYZ tristimulus values.

Return type

`numpy.ndarray`

Notes

| Do-main | Scale - Reference | Scale - 1 |
|---------|--|--|
| R_d_ab | R_d : [0, 100] a_Rd : [-100, 100] b_Rd : [-100, 100] | R_d : [0, 1] a_Rd : [-1, 1] b_Rd : [-1, 1] |
| XYZ_n | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |

References

[HunterLab12]

Examples

```
>>> import numpy as np
>>> R_d_ab = np.array([12.19722500, 57.12537874, 17.46241341])
>>> D65 = TVS_ILLUMINANTS_HUNTERLAB["CIE 1931 2 Degree Standard Observer"]
...     "D65"
... ]
>>> Hunter_Rdab_to_XYZ(R_d_ab, D65.XYZ_n, D65.K_ab)
array([ 20.654008, 12.197225,  5.136952])
```

DIN99 Colourspace and DIN99b, DIN99c, DIN99d Refined Formulas

colour

| | |
|--|---|
| <code>Lab_to_DIN99(Lab[, k_E, k_CH, method])</code> | Convert from <i>CIE L*a*b*</i> colourspace to <i>DIN99</i> colourspace or one of the <i>DIN99b</i> , <i>DIN99c</i> , <i>DIN99d</i> refined formulas according to <i>Cui et al. (2002)</i> . |
| <code>DIN99_to_Lab(Lab_99[, k_E, k_CH, method])</code> | Convert from <i>DIN99</i> colourspace or one of the <i>DIN99b</i> , <i>DIN99c</i> , <i>DIN99d</i> refined formulas according to <i>Cui et al. (2002)</i> to <i>CIE L*a*b*</i> colourspace. |
| <code>XYZ_to_DIN99(XYZ[, illuminant, k_E, k_CH, ...])</code> | Convert from <i>CIE XYZ</i> tristimulus values to <i>DIN99</i> colourspace or one of the <i>DIN99b</i> , <i>DIN99c</i> , <i>DIN99d</i> refined formulas according to <i>Cui et al. (2002)</i> . |
| <code>DIN99_to_XYZ(Lab_99[, illuminant, k_E, ...])</code> | Convert from <i>DIN99</i> colourspace or one of the <i>DIN99b</i> , <i>DIN99c</i> , <i>DIN99d</i> refined formulas according to <i>Cui et al. (2002)</i> to <i>CIE XYZ</i> tristimulus values. |

colour.Lab_to_DIN99

`colour.Lab_to_DIN99(Lab: ArrayLike, k_E: float = 1, k_CH: float = 1, method: Literal['ASTMD2244-07', 'DIN99', 'DIN99b', 'DIN99c', 'DIN99d'] | str = 'DIN99') → ndarray`

Convert from CIE $L^*a^*b^*$ colourspace to DIN99 colourspace or one of the DIN99b, DIN99c, DIN99d refined formulas according to Cui et al. (2002).

Parameters

- **Lab** (ArrayLike) – CIE $L^*a^*b^*$ colourspace array.
- **k_E** (float) – Parametric factor K_E used to compensate for texture and other specimen presentation effects.
- **k_CH** (float) – Parametric factor K_{CH} used to compensate for texture and other specimen presentation effects.
- **method** (Literal['ASTMD2244-07', 'DIN99', 'DIN99b', 'DIN99c', 'DIN99d'] | str) – Computation method to choose between the [ASTMInternational07] formula and the refined formulas according to Cui et al. (2002).

Returns

DIN99 colourspace array.

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|--|--|
| Lab | L : [0, 100] a : [-100, 100] b : [-100, 100] | L : [0, 1] a : [-1, 1] b : [-1, 1] |

| Range | Scale - Reference | Scale - 1 |
|--------|---|---|
| Lab_99 | L_99 : [0, 100] a_99 : [-100, 100] b_99 : [-100, 100] | L_99 : [0, 1] a_99 : [-1, 1] b_99 : [-1, 1] |

References

[ASTMInternational07], [CLR+02]

Examples

```
>>> import numpy as np
>>> Lab = np.array([41.52787529, 52.63858304, 26.92317922])
>>> Lab_to_DIN99(Lab)
array([ 53.2282198...,  28.4163465...,   3.8983955...])
```


colour.DIN99_to_Lab

`colour.DIN99_to_Lab(Lab_99: ArrayLike, k_E: float = 1, k_CH: float = 1, method: Literal['ASTMD2244-07', 'DIN99', 'DIN99b', 'DIN99c', 'DIN99d'] | str = 'DIN99') → ndarray`

Convert from *DIN99* colourspace or one of the *DIN99b*, *DIN99c*, *DIN99d* refined formulas according to Cui *et al.* (2002) to CIE $L^*a^*b^*$ colourspace.

Parameters

- **Lab_99** (ArrayLike) – *DIN99* colourspace array.
- **k_E** (float) – Parametric factor K_E used to compensate for texture and other specimen presentation effects.
- **k_CH** (float) – Parametric factor K_{CH} used to compensate for texture and other specimen presentation effects.
- **method** (Literal['ASTMD2244-07', 'DIN99', 'DIN99b', 'DIN99c', 'DIN99d'] | str) – Computation method to choose between the [ASTMInternational07] formula and the refined formulas according to Cui *et al.* (2002).

Returns

CIE $L^*a^*b^*$ colourspace array.

Return type

`numpy.ndarray`

Notes

| Do-main | Scale - Reference | Scale - 1 |
|---------|---|---|
| Lab_99 | L_99 : [0, 100] a_99 : [-100, 100] b_99 : [-100, 100] | L_99 : [0, 1] a_99 : [-1, 1] b_99 : [-1, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|--|--|
| Lab | L : [0, 100] a : [-100, 100] b : [-100, 100] | L : [0, 1] a : [-1, 1] b : [-1, 1] |

References

[ASTMInternational07], [CLR+02]

Examples

```
>>> import numpy as np
>>> Lab_99 = np.array([53.22821988, 28.41634656, 3.89839552])
>>> DIN99_to_Lab(Lab_99)
array([ 41.5278752...,  52.6385830...,  26.9231792...])
```

colour.XYZ_to_DIN99

`colour.XYZ_to_DIN99(XYZ: ArrayLike, illuminant: ArrayLike = CCS_ILLUMINANTS['CIE 1931 2 Degree Standard Observer']['D65'], k_E: float = 1, k_CH: float = 1, method: Literal['ASTMD2244-07', 'DIN99', 'DIN99b', 'DIN99c', 'DIN99d'] | str = 'DIN99') → ndarray`

Convert from *CIE XYZ* tristimulus values to *DIN99* colourspace or one of the *DIN99b*, *DIN99c*, *DIN99d* refined formulas according to Cui et al. (2002).

Parameters

- **XYZ** (ArrayLike) – *CIE XYZ* tristimulus values.
- **illuminant** (ArrayLike) – Reference *illuminant CIE xy* chromaticity coordinates or *CIE xyY* colourspace array.
- **k_E** (float) – Parametric factor K_E used to compensate for texture and other specimen presentation effects.
- **k_CH** (float) – Parametric factor K_{CH} used to compensate for texture and other specimen presentation effects.
- **method** (Literal['ASTMD2244-07', 'DIN99', 'DIN99b', 'DIN99c', 'DIN99d'] | str) – Computation method to choose between the [ASTMInternational07] formula and the refined formulas according to Cui et al. (2002).

Returns

DIN99 colourspace array.

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|------------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |
| illuminant | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|--------|---|---|
| Lab_99 | L_99 : [0, 100] a_99 : [-100, 100] b_99 : [-100, 100] | L_99 : [0, 1] a_99 : [-1, 1] b_99 : [-1, 1] |

References

[ASTMInternational07]

Examples

```
>>> import numpy as np
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> XYZ_to_DIN99(XYZ)
array([ 53.2282198...,  28.4163465...,  3.8983955...])
```

colour.DIN99_to_XYZ

`colour.DIN99_to_XYZ(Lab_99: ArrayLike, illuminant: ArrayLike = CCS_ILLUMINANTS['CIE 1931 2 Degree Standard Observer']['D65'], k_E: float = 1, k_CH: float = 1, method: Literal['ASTMD2244-07', 'DIN99', 'DIN99b', 'DIN99c', 'DIN99d'] | str = 'DIN99') → ndarray`

Convert from *DIN99* colourspace or one of the *DIN99b*, *DIN99c*, *DIN99d* refined formulas according to Cui et al. (2002) to CIE XYZ tristimulus values.

Parameters

- **Lab_99** (ArrayLike) – *DIN99* colourspace array.
- **illuminant** (ArrayLike) – Reference *illuminant* CIE xy chromaticity coordinates or CIE xyY colourspace array.
- **k_E** (float) – Parametric factor K_E used to compensate for texture and other specimen presentation effects.
- **k_CH** (float) – Parametric factor K_{CH} used to compensate for texture and other specimen presentation effects.
- **method** (Literal['ASTMD2244-07', 'DIN99', 'DIN99b', 'DIN99c', 'DIN99d'] | str) – Computation method to choose between the [ASTMInternational07] formula and the refined formulas according to Cui et al. (2002).

Returns

CIE XYZ tristimulus values.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|------------|--------------------|----------------|
| Lab_99 | L_99 : [0, 100] | L_99 : [0, 1] |
| | a_99 : [-100, 100] | a_99 : [-1, 1] |
| | b_99 : [-100, 100] | b_99 : [-1, 1] |
| illuminant | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

References

[ASTMInternational07]

Examples

```
>>> import numpy as np
>>> Lab_99 = np.array([53.22821989, 28.41634656, 3.89839552])
>>> DIN99_to_XYZ(Lab_99)
array([ 0.2065400...,  0.1219722...,  0.0513695...])
```

CAM02-LCD, CAM02-SCD, and CAM02-UCS Colourspaces - Luo, Cui and Li (2006)

colour

| | |
|-----------------------------------|---|
| JMh_CIECAM02_to_CAM02LCD(JMh) | Convert from CIECAM02 JMh correlates array to Luo et al. (2006) CAM02-LCD colourspace J'a'b' array. |
| CAM02LCD_to_JMh_CIECAM02(Jpapbp) | Convert from Luo et al. (2006) CAM02-LCD colourspace J'a'b' array to CIECAM02 JMh correlates array. |
| JMh_CIECAM02_to_CAM02SCD(JMh) | Convert from CIECAM02 JMh correlates array to Luo et al. (2006) CAM02-SCD colourspace J'a'b' array. |
| CAM02SCD_to_JMh_CIECAM02(Jpapbp) | Convert from Luo et al. (2006) CAM02-SCD colourspace J'a'b' array to CIECAM02 JMh correlates array. |
| JMh_CIECAM02_to_CAM02UCS(JMh) | Convert from CIECAM02 JMh correlates array to Luo et al. (2006) CAM02-UCS colourspace J'a'b' array. |
| CAM02UCS_to_JMh_CIECAM02(Jpapbp) | Convert from Luo et al. (2006) CAM02-UCS colourspace J'a'b' array to CIECAM02 JMh correlates array. |
| XYZ_to_CAM02LCD(XYZ, **kwargs) | Convert from CIE XYZ tristimulus values to Luo et al. (2006) CAM02-LCD colourspace J'a'b' array. |
| CAM02LCD_to_XYZ(Jpapbp, **kwargs) | Convert from Luo et al. (2006) CAM02-LCD colourspace J'a'b' array to CIE XYZ tristimulus values. |
| XYZ_to_CAM02SCD(XYZ, **kwargs) | Convert from CIE XYZ tristimulus values to Luo et al. (2006) CAM02-SCD colourspace J'a'b' array. |
| CAM02SCD_to_XYZ(Jpapbp, **kwargs) | Convert from Luo et al. (2006) CAM02-SCD colourspace J'a'b' array to CIE XYZ tristimulus values. |
| XYZ_to_CAM02UCS(XYZ, **kwargs) | Convert from CIE XYZ tristimulus values to Luo et al. (2006) CAM02-UCS colourspace J'a'b' array. |
| CAM02UCS_to_XYZ(Jpapbp, **kwargs) | Convert from Luo et al. (2006) CAM02-UCS colourspace J'a'b' array to CIE XYZ tristimulus values. |

colour.JMh_CIECAM02_to_CAM02LCD

`colour.JMh_CIECAM02_to_CAM02LCD(JMh: ArrayLike) → ndarray`

Convert from *CIECAM02 JMh* correlates array to *Luo et al. (2006) CAM02-LCD* colourspace $J'a'b'$ array.

Parameters

JMh (ArrayLike) – *CIECAM02* correlates array *JMh*.

Returns

Luo et al. (2006) CAM02-LCD colourspace $J'a'b'$ array.

Return type

`numpy.ndarray`

Notes

- LCD* in *CAM02-LCD* stands for *Large Colour Differences*.

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|------------|
| JMh | J : [0, 100] | J : [0, 1] |
| | M : [0, 100] | M : [0, 1] |
| | h : [0, 360] | h : [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|--------|-------------------|--------------|
| Jpapbp | Jp : [0, 100] | Jp : [0, 1] |
| | ap : [-100, 100] | ap : [-1, 1] |
| | bp : [-100, 100] | bp : [-1, 1] |

References

[LCL06]

Examples

```
>>> from colour.appearance import (
...     VIEWING_CONDITIONS_CIECAM02,
...     XYZ_to_CIECAM02,
... )
>>> XYZ = np.array([19.01, 20.00, 21.78])
>>> XYZ_w = np.array([95.05, 100.00, 108.88])
>>> L_A = 318.31
>>> Y_b = 20.0
>>> surround = VIEWING_CONDITIONS_CIECAM02["Average"]
>>> specification = XYZ_to_CIECAM02(XYZ, XYZ_w, L_A, Y_b, surround)
>>> JMh = (specification.J, specification.M, specification.h)
>>> JMh_CIECAM02_to_CAM02LCD(JMh)
array([ 54.9043313..., -0.0845039..., -0.0685483...])
```

colour.CAM02LCD_to_JMh_CIECAM02

`colour.CAM02LCD_to_JMh_CIECAM02(Jpapbp: ArrayLike) → ndarray`

Convert from Luo et al. (2006) CAM02-LCD colourspace $J'a'b'$ array to CIECAM02 JMh correlates array.

Parameters

Jpapbp (ArrayLike) – Luo et al. (2006) CAM02-LCD colourspace $J'a'b'$ array.

Returns

CIECAM02 correlates array JMh .

Return type

`numpy.ndarray`

Notes

- LCD in CAM02-LCD stands for *Large Colour Differences*.

| Domain | Scale - Reference | Scale - 1 |
|--------|---|---|
| Jpapbp | Jp : [0, 100] ap : [-100, 100] bp : [-100, 100] | Jp : [0, 1] ap : [-1, 1] bp : [-1, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|--|--|
| JMh | J : [0, 100] M : [0, 100] h : [0, 360] | J : [0, 1] M : [0, 1] h : [0, 1] |

References

[LCL06]

Examples

```
>>> Jpapbp = np.array([54.90433134, -0.08450395, -0.06854831])
>>> CAM02LCD_to_JMh_CIECAM02(Jpapbp)
array([ 4.1731091...e+01,  1.0884217...e-01,  2.1904843...e+02])
```

colour.JMh_CIECAM02_to_CAM02SCD

`colour.JMh_CIECAM02_to_CAM02SCD(JMh: ArrayLike) → ndarray`

Convert from CIECAM02 JMh correlates array to Luo et al. (2006) CAM02-SCD colourspace $J'a'b'$ array.

Parameters

JMh (ArrayLike) – CIECAM02 correlates array JMh .

Returns

Luo et al. (2006) CAM02-SCD colourspace $J'a'b'$ array.

Return type

`numpy.ndarray`

Notes

- *SCD* in *CAM02-SCD* stands for *Small Colour Differences*.

| Domain | Scale - Reference | Scale - 1 |
|--------|--|--|
| JMh | J : [0, 100] M : [0, 100] h : [0, 360] | J : [0, 1] M : [0, 1] h : [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|--------|---|---|
| Jpapbp | Jp : [0, 100] ap : [-100, 100] bp : [-100, 100] | Jp : [0, 1] ap : [-1, 1] bp : [-1, 1] |

References

[LCL06]

Examples

```
>>> from colour.appearance import (
...     VIEWING_CONDITIONS_CIECAM02,
...     XYZ_to_CIECAM02,
... )
>>> XYZ = np.array([19.01, 20.00, 21.78])
>>> XYZ_w = np.array([95.05, 100.00, 108.88])
>>> L_A = 318.31
>>> Y_b = 20.0
>>> surround = VIEWING_CONDITIONS_CIECAM02["Average"]
>>> specification = XYZ_to_CIECAM02(XYZ, XYZ_w, L_A, Y_b, surround)
>>> JMh = (specification.J, specification.M, specification.h)
>>> JMh_CIECAM02_to_CAM02SCD(JMh)
array([ 54.9043313..., -0.0843617..., -0.0684329...])
```

colour.CAM02SCD_to_JMh_CIECAM02

colour.CAM02SCD_to_JMh_CIECAM02(*Jpapbp*: ArrayLike) → ndarray

Convert from Luo et al. (2006) CAM02-SCD colourspace $J'a'b'$ array to CIECAM02 JMh correlates array.

Parameters

Jpapbp (ArrayLike) – Luo et al. (2006) CAM02-SCD colourspace $J'a'b'$ array.

Returns

CIECAM02 correlates array JMh .

Return type

numpy.ndarray

Notes

- *SCD* in *CAM02-SCD* stands for *Small Colour Differences*.

| Domain | Scale - Reference | Scale - 1 |
|--------|---|---|
| Jpapbp | Jp : [0, 100] ap : [-100, 100] bp : [-100, 100] | Jp : [0, 1] ap : [-1, 1] bp : [-1, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|--|--|
| JMh | J : [0, 100] M : [0, 100] h : [0, 360] | J : [0, 1] M : [0, 1] h : [0, 1] |

References

[LCL06]

Examples

```
>>> Jpapbp = np.array([54.90433134, -0.08436178, -0.06843298])
>>> CAM02SCD_to_JMh_CIECAM02(Jpapbp)
array([ 4.1731091...e+01,  1.0884217...e-01,  2.1904843...e+02])
```

colour.JMh_CIECAM02_to_CAM02UCS

colour.JMh_CIECAM02_to_CAM02UCS(JMh: ArrayLike) → ndarray

Convert from *CIECAM02 JMh* correlates array to *Luo et al. (2006) CAM02-UCS* colourspace *J'a'b'* array.

Parameters

JMh (ArrayLike) – *CIECAM02* correlates array *JMh*.

Returns

Luo et al. (2006) CAM02-UCS colourspace *J'a'b'* array.

Return type

numpy.ndarray

Notes

- *UCS* in *CAM02-UCS* stands for *Uniform Colour Colourspace*.

| Domain | Scale - Reference | Scale - 1 |
|--------|--|--|
| JMh | J : [0, 100] M : [0, 100] h : [0, 360] | J : [0, 1] M : [0, 1] h : [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|--------|---|---|
| Jpapbp | Jp : [0, 100] ap : [-100, 100] bp : [-100, 100] | Jp : [0, 1] ap : [-1, 1] bp : [-1, 1] |

References

[LCL06]

Examples

```
>>> from colour.appearance import (
...     VIEWING_CONDITIONS_CIECAM02,
...     XYZ_to_CIECAM02,
... )
>>> XYZ = np.array([19.01, 20.00, 21.78])
>>> XYZ_w = np.array([95.05, 100.00, 108.88])
>>> L_A = 318.31
>>> Y_b = 20.0
>>> surround = VIEWING_CONDITIONS_CIECAM02["Average"]
>>> specification = XYZ_to_CIECAM02(XYZ, XYZ_w, L_A, Y_b, surround)
>>> JMh = (specification.J, specification.M, specification.h)
>>> JMh_CIECAM02_to_CAM02UCS(JMh)
array([ 54.9043313..., -0.0844236..., -0.0684831...])
```

colour.CAM02UCS_to_JMh_CIECAM02

colour.CAM02UCS_to_JMh_CIECAM02(Jpapbp: ArrayLike) → ndarray

Convert from Luo et al. (2006) CAM02-UCS colourspace $J'a'b'$ array to CIECAM02 JMh correlates array.

Parameters

Jpapbp (ArrayLike) – Luo et al. (2006) CAM02-UCS colourspace $J'a'b'$ array.

Returns

CIECAM02 correlates array JMh .

Return type

numpy.ndarray

Notes

- UCS in CAM02-UCS stands for *Uniform Colour Colourspace*.

| Domain | Scale - Reference | Scale - 1 |
|--------|---|---|
| Jpapbp | Jp : [0, 100] ap : [-100, 100] bp : [-100, 100] | Jp : [0, 1] ap : [-1, 1] bp : [-1, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|--|--|
| JMh | J : [0, 100] M : [0, 100] h : [0, 360] | J : [0, 1] M : [0, 1] h : [0, 1] |

References

[LCL06]

Examples

```
>>> Jpabp = np.array([54.90433134, -0.08442362, -0.06848314])
>>> CAM02UCS_to_JMh_CIECAM02(Jpabp)
array([ 4.1731091...e+01,  1.0884217...e-01,  2.1904843...e+02])
```

colour.XYZ_to_CAM02LCD

`colour.XYZ_to_CAM02LCD(XYZ: ArrayLike, **kwargs: Any) → ndarray`

Convert from CIE XYZ tristimulus values to Luo et al. (2006) CAM02-LCD colourspace $J'a'b'$ array.

Parameters

- **XYZ** (ArrayLike) – CIE XYZ tristimulus values.
- **kwargs** (Any) – {`colour.XYZ_to_CIECAM02()`}, See the documentation of the previously listed definition. The default viewing conditions are that of IEC 61966-2-1:1999, i.e. sRGB 64 Lux ambient illumination, 80 cd/m^2 , adapting field luminance about 20% of a white object in the scene.

Returns

Luo et al. (2006) CAM02-LCD colourspace $J'a'b'$ array.

Return type

`numpy.ndarray`

Warning: The XYZ_w parameter for `colour.XYZ_to_CAM16()` definition must be given in the same domain-range scale than the XYZ parameter.

Notes

- LCD in CAM02-LCD stands for *Large Colour Differences*.

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|---|---|
| Jpabp | Jp : [0, 100] ap : [-100, 100] bp : [-100, 100] | Jp : [0, 1] ap : [-1, 1] bp : [-1, 1] |

References

[LCL06]

Examples

```
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> XYZ_to_CAM02LCD(XYZ)
array([ 46.6138615...,  39.3576023...,  15.9673043...])
```

colour.CAM02LCD_to_XYZ

colour.CAM02LCD_to_XYZ(*Jpabp*: ArrayLike, ***kwargs*: Any) → ndarray

Convert from *Luo et al. (2006) CAM02-LCD* colourspace $J'a'b'$ array to CIE XYZ tristimulus values.

Parameters

- **Jpabp** (ArrayLike) – *Luo et al. (2006) CAM02-LCD* colourspace $J'a'b'$ array.
- **kwargs** (Any) – {colour.CIECAM02_to_XYZ()}, See the documentation of the previously listed definition. The default viewing conditions are that of IEC 61966-2-1:1999, i.e. sRGB 64 Lux ambient illumination, 80 cd/m², adapting field luminance about 20% of a white object in the scene.

Returns

CIE XYZ tristimulus values.

Return type

numpy.ndarray

Warning: The XYZ_w parameter for colour.XYZ_to_CAM16() definition must be given in the same domain-range scale than the XYZ parameter.

Notes

- LCD in CAM02-LCD stands for *Large Colour Differences*.

| Domain | Scale - Reference | Scale - 1 |
|--------|---|---|
| Jpabp | Jp : [0, 100] ap : [-100, 100] bp : [-100, 100] | Jp : [0, 1] ap : [-1, 1] bp : [-1, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

References

[LCL06]

Examples

```
>>> Jpabp = np.array([46.61386154, 39.35760236, 15.96730435])
>>> CAM02LCD_to_XYZ(Jpabp)
array([ 0.2065400...,  0.1219722...,  0.0513695...])
```

colour.XYZ_to_CAM02SCD

colour.XYZ_to_CAM02SCD(XYZ: ArrayLike, **kwargs: Any) → ndarray

Convert from CIE XYZ tristimulus values to Luo et al. (2006) CAM02-SCD colourspace $J'a'b'$ array.

Parameters

- **XYZ** (ArrayLike) – CIE XYZ tristimulus values.
- **kwargs** (Any) – {colour.XYZ_to_CIECAM02()}, See the documentation of the previously listed definition. The default viewing conditions are that of IEC 61966-2-1:1999, i.e. sRGB 64 Lux ambient illumination, 80 cd/m², adapting field luminance about 20% of a white object in the scene.

Returns

Luo et al. (2006) CAM02-SCD colourspace $J'a'b'$ array.

Return type

numpy.ndarray

Warning: The XYZ_w parameter for colour.XYZ_to_CAM16() definition must be given in the same domain-range scale than the XYZ parameter.

Notes

- SCD in CAM02-SCD stands for *Small Colour Differences*.

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|---|---|
| Jpabp | Jp : [0, 100] ap : [-100, 100] bp : [-100, 100] | Jp : [0, 1] ap : [-1, 1] bp : [-1, 1] |

References

[LCL06]

Examples

```
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> XYZ_to_CAM02SCD(XYZ)
array([ 46.6138615..., 25.6287988..., 10.3975548...])
```

colour.CAM02SCD_to_XYZ

colour.CAM02SCD_to_XYZ(*Jpapbp*: ArrayLike, ***kwargs*: Any) → ndarray

Convert from *Luo et al. (2006) CAM02-SCD* colourspace $J'a'b'$ array to CIE XYZ tristimulus values.

Parameters

- **Jpapbp** (ArrayLike) – *Luo et al. (2006) CAM02-SCD* colourspace $J'a'b'$ array.
- **kwargs** (Any) – {colour.CIECAM02_to_XYZ()}, See the documentation of the previously listed definition. The default viewing conditions are that of *IEC 61966-2-1:1999*, i.e. sRGB 64 Lux ambient illumination, 80 cd/m², adapting field luminance about 20% of a white object in the scene.

Returns

CIE XYZ tristimulus values.

Return type

numpy.ndarray

Warning: The XYZ_w parameter for colour.XYZ_to_CAM16() definition must be given in the same domain-range scale than the XYZ parameter.

Notes

- SCD in CAM02-SCD stands for *Small Colour Differences*.

| Domain | Scale - Reference | Scale - 1 |
|--------|---|---|
| Jpapbp | Jp : [0, 100] ap : [-100, 100] bp : [-100, 100] | Jp : [0, 1] ap : [-1, 1] bp : [-1, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

References

[LCL06]

Examples

```
>>> Jpabp = np.array([46.61386154, 25.62879882, 10.39755489])
>>> CAM02SCD_to_XYZ(Jpabp)
array([ 0.2065400...,  0.1219722...,  0.0513695...])
```

colour.XYZ_to_CAM02UCS

colour.XYZ_to_CAM02UCS(XYZ: ArrayLike, **kwargs: Any) → ndarray

Convert from CIE XYZ tristimulus values to Luo et al. (2006) CAM02-UCS colourspace $J'a'b'$ array.

Parameters

- **XYZ** (ArrayLike) – CIE XYZ tristimulus values.
- **kwargs** (Any) – {colour.XYZ_to_CIECAM02()}, See the documentation of the previously listed definition. The default viewing conditions are that of IEC 61966-2-1:1999, i.e. sRGB 64 Lux ambient illumination, 80 cd/m², adapting field luminance about 20% of a white object in the scene.

Returns

Luo et al. (2006) CAM02-UCS colourspace $J'a'b'$ array.

Return type

numpy.ndarray

Warning: The XYZ_w parameter for colour.XYZ_to_CAM16() definition must be given in the same domain-range scale than the XYZ parameter.

Notes

- UCS in CAM02-UCS stands for *Uniform Colour Space*.

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|---|---|
| Jpabp | Jp : [0, 100] ap : [-100, 100] bp : [-100, 100] | Jp : [0, 1] ap : [-1, 1] bp : [-1, 1] |

References

[LCL06]

Examples

```
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> XYZ_to_CAM02UCS(XYZ)
array([ 46.6138615..., 29.8831001..., 12.1235168...])
```

colour.CAM02UCS_to_XYZ

colour.CAM02UCS_to_XYZ(*Jpapbp*: ArrayLike, ***kwargs*: Any) → ndarray

Convert from *Luo et al. (2006)* CAM02-UCS colourspace $J'a'b'$ array to CIE XYZ tristimulus values.

Parameters

- **Jpapbp** (ArrayLike) – *Luo et al. (2006)* CAM02-UCS colourspace $J'a'b'$ array.
- **kwargs** (Any) – {colour.CIECAM02_to_XYZ()}, See the documentation of the previously listed definition. The default viewing conditions are that of *IEC 61966-2-1:1999*, i.e. sRGB 64 Lux ambient illumination, 80 cd/m², adapting field luminance about 20% of a white object in the scene.

Returns

CIE XYZ tristimulus values.

Return type

numpy.ndarray

Warning: The XYZ_w parameter for colour.XYZ_to_CAM16() definition must be given in the same domain-range scale than the XYZ parameter.

Notes

- UCS in CAM02-UCS stands for *Uniform Colour Space*.

| Domain | Scale - Reference | Scale - 1 |
|--------|---|---|
| Jpapbp | Jp : [0, 100] ap : [-100, 100] bp : [-100, 100] | Jp : [0, 1] ap : [-1, 1] bp : [-1, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

References

[LCL06]

Examples

```
>>> Jpabpp = np.array([46.61386154, 29.88310013, 12.12351683])
>>> CAM02UCS_to_XYZ(Jpabpp)
array([ 0.2065400...,  0.1219722...,  0.0513695...])
```

CAM16-LCD, CAM16-SCD, and CAM16-UCS Colourspaces - Li et al. (2017)

colour

| | |
|---|---|
| JMh_CAM16_to_CAM16LCD(JMh, *, coefficients)) | Convert from CAM16 JMh correlates array to Li et al. (2017) CAM16-LCD colourspace J'a'b' array. |
| CAM16LCD_to_JMh_CAM16(Jpabpp, *, coefficients)) | Convert from Li et al. (2017) CAM16-LCD colourspace J'a'b' array to CAM16 JMh correlates array. |
| JMh_CAM16_to_CAM16SCD(JMh, *, coefficients)) | Convert from CAM16 JMh correlates array to Li et al. (2017) CAM16-SCD colourspace J'a'b' array. |
| CAM16SCD_to_JMh_CAM16(Jpabpp, *, coefficients)) | Convert from Li et al. (2017) CAM16-SCD colourspace J'a'b' array to CAM16 JMh correlates array. |
| JMh_CAM16_to_CAM16UCS(JMh, *, coefficients)) | Convert from CAM16 JMh correlates array to Li et al. (2017) CAM16-UCS colourspace J'a'b' array. |
| CAM16UCS_to_JMh_CAM16(Jpabpp, *, coefficients)) | Convert from Li et al. (2017) CAM16-UCS colourspace J'a'b' array to CAM16 JMh correlates array. |
| XYZ_to_CAM16LCD(XYZ, *, coefficients)) | Convert from CIE XYZ tristimulus values to Li et al. (2017) CAM16-LCD colourspace J'a'b' array. |
| CAM16LCD_to_XYZ(Jpabpp, *, coefficients)) | Convert from Li et al. (2017) CAM16-LCD colourspace J'a'b' array to CIE XYZ tristimulus values. |
| XYZ_to_CAM16SCD(XYZ, *, coefficients)) | Convert from CIE XYZ tristimulus values to Li et al. (2017) CAM16-SCD colourspace J'a'b' array. |
| CAM16SCD_to_XYZ(Jpabpp, *, coefficients)) | Convert from Li et al. (2017) CAM16-SCD colourspace J'a'b' array to CIE XYZ tristimulus values. |
| XYZ_to_CAM16UCS(XYZ, *, coefficients)) | Convert from CIE XYZ tristimulus values to Li et al. (2017) CAM16-UCS colourspace J'a'b' array. |
| CAM16UCS_to_XYZ(Jpabpp, *, coefficients)) | Convert from Li et al. (2017) CAM16-UCS colourspace J'a'b' array to CIE XYZ tristimulus values. |

colour.JMh_CAM16_to_CAM16LCD

```
colour.JMh_CAM16_to_CAM16LCD(JMh, *, coefficients=Coefficients_UCS_Luo2006(K_L=0.77, c_1=0.007,
c_2=0.0053))
```

Convert from CAM16 JMh correlates array to Li et al. (2017) CAM16-LCD colourspace $J'a'b'$ array.

Parameters

JMh – CAM16 correlates array JMh.

Returns

Li et al. (2017) CAM16-LCD colourspace $J'a'b'$ array.

Return type

numpy.ndarray

Notes

- LCD in CAM16-LCD stands for Large Colour Differences.

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|------------|
| JMh | J : [0, 100] | J : [0, 1] |
| | M : [0, 100] | M : [0, 1] |
| | h : [0, 360] | h : [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|--------|-------------------|--------------|
| Jpapbp | Jp : [0, 100] | Jp : [0, 1] |
| | ap : [-100, 100] | ap : [-1, 1] |
| | bp : [-100, 100] | bp : [-1, 1] |

References

[LLW+17]

colour.CAM16LCD_to_JMh_CAM16

```
colour.CAM16LCD_to_JMh_CAM16(Jpapbp, *, coefficients=Coefficients_UCS_Luo2006(K_L=0.77,
c_1=0.007, c_2=0.0053))
```

Convert from Li et al. (2017) CAM16-LCD colourspace $J'a'b'$ array to CAM16 JMh correlates array.

Parameters

Jpapbp – Li et al. (2017) CAM16-LCD colourspace $J'a'b'$ array.

Returns

CAM16 correlates array JMh.

Return type

numpy.ndarray

Notes

- *LCD* in *CAM16-LCD* stands for *Large Colour Differences*.

| Domain | Scale - Reference | Scale - 1 |
|--------|---|---|
| Jpapbp | Jp : [0, 100] ap : [-100, 100] bp : [-100, 100] | Jp : [0, 1] ap : [-1, 1] bp : [-1, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|--|--|
| JMh | J : [0, 100] M : [0, 100] h : [0, 360] | J : [0, 1] M : [0, 1] h : [0, 1] |

References

[LLW+17]

colour.JMh_CAM16_to_CAM16SCD

`colour.JMh_CAM16_to_CAM16SCD(JMh, *, coefficients=Coefficients_UCS_Luo2006(K_L=1.24, c_1=0.007, c_2=0.0363))`

Convert from *CAM16 JMh* correlates array to *Li et al. (2017) CAM16-SCD* colourspace *J'a'b'* array.

Parameters

JMh – *CAM16* correlates array *JMh*.

Returns

Li et al. (2017) CAM16-SCD colourspace *J'a'b'* array.

Return type

`numpy.ndarray`

Notes

- *SCD* in *CAM16-SCD* stands for *Small Colour Differences*.

| Domain | Scale - Reference | Scale - 1 |
|--------|--|--|
| JMh | J : [0, 100] M : [0, 100] h : [0, 360] | J : [0, 1] M : [0, 1] h : [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|--------|---|---|
| Jpapbp | Jp : [0, 100] ap : [-100, 100] bp : [-100, 100] | Jp : [0, 1] ap : [-1, 1] bp : [-1, 1] |

References

[LLW+17]

colour.CAM16SCD_to_JMh_CAM16

```
colour.CAM16SCD_to_JMh_CAM16(Jpapbp, *, coefficients=Coefficients_UCS_Luo2006(K_L=1.24,
c_1=0.007, c_2=0.0363))
```

Convert from *Li et al. (2017) CAM16-SCD* colourspace $J'a'b'$ array to *CAM16 JMh* correlates array.

Parameters

Jpapbp – *Li et al. (2017) CAM16-SCD* colourspace $J'a'b'$ array.

Returns

CAM16 correlates array *JMh*.

Return type

`numpy.ndarray`

Notes

- *SCD* in *CAM16-SCD* stands for *Small Colour Differences*.

| Domain | Scale - Reference | Scale - 1 |
|--------|---|---|
| Jpapbp | Jp : [0, 100] ap : [-100, 100] bp : [-100, 100] | Jp : [0, 1] ap : [-1, 1] bp : [-1, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|--|--|
| JMh | J : [0, 100] M : [0, 100] h : [0, 360] | J : [0, 1] M : [0, 1] h : [0, 1] |

References

[LLW+17]

colour.JMh_CAM16_to_CAM16UCS

```
colour.JMh_CAM16_to_CAM16UCS(JMh, *, coefficients=Coefficients_UCS_Luo2006(K_L=1.0, c_1=0.007,
c_2=0.0228))
```

Convert from *CAM16 JMh* correlates array to *Li et al. (2017) CAM16-UCS* colourspace $J'a'b'$ array.

Parameters

JMh – *CAM16* correlates array *JMh*.

Returns

Li et al. (2017) CAM16-UCS colourspace $J'a'b'$ array.

Return type

`numpy.ndarray`

Notes

- UCS in CAM16-UCS stands for *Uniform Colour Colourspace*.

| Domain | Scale - Reference | Scale - 1 |
|--------|--|--|
| JMh | J : [0, 100] M : [0, 100] h : [0, 360] | J : [0, 1] M : [0, 1] h : [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|--------|---|---|
| Jpapbp | Jp : [0, 100] ap : [-100, 100] bp : [-100, 100] | Jp : [0, 1] ap : [-1, 1] bp : [-1, 1] |

References

[LLW+17]

colour.CAM16UCS_to_JMh_CAM16

`colour.CAM16UCS_to_JMh_CAM16(Jpapbp, *, coefficients=Coefficients_UCS_Luo2006(K_L=1.0, c_1=0.007, c_2=0.0228))`

Convert from *Li et al. (2017)* CAM16-UCS colourspace $J'a'b'$ array to CAM16 JMh correlates array.

Parameters

Jpapbp – *Li et al. (2017)* CAM16-UCS colourspace $J'a'b'$ array.

Returns

CAM16 correlates array JMh .

Return type

`numpy.ndarray`

Notes

- UCS in CAM16-UCS stands for *Uniform Colour Colourspace*.

| Domain | Scale - Reference | Scale - 1 |
|--------|---|---|
| Jpapbp | Jp : [0, 100] ap : [-100, 100] bp : [-100, 100] | Jp : [0, 1] ap : [-1, 1] bp : [-1, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|--|--|
| JMh | J : [0, 100] M : [0, 100] h : [0, 360] | J : [0, 1] M : [0, 1] h : [0, 1] |

References

[LLW+17]

colour.XYZ_to_CAM16LCD

`colour.XYZ_to_CAM16LCD(XYZ: ArrayLike, *, coefficients: ArrayLike = Coefficients_UCS_Luo2006(K_L=0.77, c_1=0.007, c_2=0.0053), **kwargs: Any) → NDArray`

Convert from CIE XYZ tristimulus values to *Li et al. (2017) CAM16-LCD* colourspace $J'a'b'$ array.

Parameters

- **XYZ** (ArrayLike) – CIE XYZ tristimulus values.
- **kwargs** (Any) – {`colour.XYZ_to_CAM16()`}, See the documentation of the previously listed definition. The default viewing conditions are that of *IEC 61966-2-1:1999*, i.e. *sRGB* 64 Lux ambient illumination, 80 cd/m^2 , adapting field luminance about 20% of a white object in the scene.
- **coefficients** (ArrayLike) –

Returns

Li et al. (2017) CAM16-LCD colourspace $J'a'b'$ array.

Return type

`numpy.ndarray`

Warning: The `XYZ_w` parameter for `colour.XYZ_to_CAM16()` definition must be given in the same domain-range scale than the `XYZ` parameter.

Notes

- *LCD* in *CAM16-LCD* stands for *Large Colour Differences*.

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|--------|-------------------|--------------|
| Jpapbp | Jp : [0, 100] | Jp : [0, 1] |
| | ap : [-100, 100] | ap : [-1, 1] |
| | bp : [-100, 100] | bp : [-1, 1] |

References

[LLW+17]

`colour.CAM16LCD_to_XYZ`

`colour.CAM16LCD_to_XYZ(Jpapbp: ArrayLike, *, coefficients: ArrayLike = Coefficients_UCS_Luo2006(K_L=0.77, c_1=0.007, c_2=0.0053), **kwargs: Any) → NDArray`

Convert from *Li et al. (2017) CAM16-LCD* colourspace $J'a'b'$ array to CIE XYZ tristimulus values.

Parameters

- **Jpapbp** (ArrayLike) – *Li et al. (2017) CAM16-LCD* colourspace $J'a'b'$ array.
- **kwargs** (Any) – {`colour.CAM16_to_XYZ()`}, See the documentation of the previously listed definition. The default viewing conditions are that of *IEC 61966-2-1:1999*, i.e. *sRGB* 64 Lux ambient illumination, 80 cd/m^2 , adapting field luminance about 20% of a white object in the scene.
- **coefficients** (ArrayLike) –

Returns

CIE XYZ tristimulus values.

Return type

`numpy.ndarray`

Warning: The `XYZ_w` parameter for `colour.XYZ_to_CAM16()` definition must be given in the same domain-range scale than the XYZ parameter.

Notes

- LCD in CAM16-LCD stands for *Large Colour Differences*.

| Domain | Scale - Reference | Scale - 1 |
|--------|---|---|
| Jpapbp | Jp : [0, 100] ap : [-100, 100] bp : [-100, 100] | Jp : [0, 1] ap : [-1, 1] bp : [-1, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

References

[LLW+17]

colour.XYZ_to_CAM16SCD

`colour.XYZ_to_CAM16SCD(XYZ: ArrayLike, *, coefficients: ArrayLike = Coefficients_UCS_Luo2006(K_L=1.24, c_1=0.007, c_2=0.0363), **kwargs: Any) → NDArray`

Convert from CIE XYZ tristimulus values to *Li et al. (2017) CAM16-SCD* colourspace $J'a'b'$ array.

Parameters

- **XYZ** (ArrayLike) – CIE XYZ tristimulus values.
- **kwargs** (Any) – {`colour.XYZ_to_CAM16()`}, See the documentation of the previously listed definition. The default viewing conditions are that of *IEC 61966-2-1:1999*, i.e. *sRGB* 64 Lux ambient illumination, 80 cd/m^2 , adapting field luminance about 20% of a white object in the scene.
- **coefficients** (ArrayLike) –

Returns

Li et al. (2017) CAM16-SCD colourspace $J'a'b'$ array.

Return type

`numpy.ndarray`

Warning: The `XYZ_w` parameter for `colour.XYZ_to_CAM16()` definition must be given in the same domain-range scale than the `XYZ` parameter.

Notes

- *SCD* in *CAM16-SCD* stands for *Small Colour Differences*.

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|--------|-------------------|--------------|
| Jpapbp | Jp : [0, 100] | Jp : [0, 1] |
| | ap : [-100, 100] | ap : [-1, 1] |
| | bp : [-100, 100] | bp : [-1, 1] |

References

[LLW+17]

colour.CAM16SCD_to_XYZ

```
colour.CAM16SCD_to_XYZ(Jpapbp: ArrayLike, *, coefficients: ArrayLike =
    Coefficients_UCS_Luo2006(K_L=1.24, c_1=0.007, c_2=0.0363), **kwargs:
    Any) → NDArray
```

Convert from *Li et al. (2017)* CAM16-SCD colourspace $J'a'b'$ array to CIE XYZ tristimulus values.

Parameters

- **Jpapbp** (ArrayLike) – *Li et al. (2017)* CAM16-SCD colourspace $J'a'b'$ array.
- **kwargs** (Any) – {`colour.CAM16_to_XYZ()`}, See the documentation of the previously listed definition. The default viewing conditions are that of *IEC 61966-2-1:1999*, i.e. *sRGB* 64 Lux ambient illumination, 80 cd/m^2 , adapting field luminance about 20% of a white object in the scene.
- **coefficients** (ArrayLike) –

Returns

CIE XYZ tristimulus values.

Return type

`numpy.ndarray`

Warning: The `XYZ_w` parameter for `colour.XYZ_to_CAM16()` definition must be given in the same domain-range scale than the XYZ parameter.

Notes

- SCD in CAM16-SCD stands for *Small Colour Differences*.

| Domain | Scale - Reference | Scale - 1 |
|--------|---|---|
| Jpapbp | Jp : [0, 100] ap : [-100, 100] bp : [-100, 100] | Jp : [0, 1] ap : [-1, 1] bp : [-1, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

References

[LLW+17]

colour.XYZ_to_CAM16UCS

`colour.XYZ_to_CAM16UCS(XYZ: ArrayLike, *, coefficients: ArrayLike = Coefficients_UCS_Luo2006(K_L=1.0, c_1=0.007, c_2=0.0228), **kwargs: Any) → NDArray`

Convert from CIE XYZ tristimulus values to *Li et al. (2017) CAM16-UCS* colourspace $J'a'b'$ array.

Parameters

- **XYZ** (ArrayLike) – CIE XYZ tristimulus values.
- **kwargs** (Any) – {`colour.XYZ_to_CAM16()`}, See the documentation of the previously listed definition. The default viewing conditions are that of *IEC 61966-2-1:1999*, i.e. *sRGB* 64 Lux ambient illumination, 80 cd/m^2 , adapting field luminance about 20% of a white object in the scene.
- **coefficients** (ArrayLike) –

Returns

Li et al. (2017) CAM16-UCS colourspace $J'a'b'$ array.

Return type

`numpy.ndarray`

Warning: The `XYZ_w` parameter for `colour.XYZ_to_CAM16()` definition must be given in the same domain-range scale than the `XYZ` parameter.

Notes

- UCS in *CAM16-UCS* stands for *Uniform Colour Space*.

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|--------|-------------------|--------------|
| Jpapbp | Jp : [0, 100] | Jp : [0, 1] |
| | ap : [-100, 100] | ap : [-1, 1] |
| | bp : [-100, 100] | bp : [-1, 1] |

References

[LLW+17]

`colour.CAM16UCS_to_XYZ`

```
colour.CAM16UCS_to_XYZ(Jpapbp: ArrayLike, *, coefficients: ArrayLike =
    Coefficients_UCS_Luo2006(K_L=1.0, c_1=0.007, c_2=0.0228), **kwargs:
    Any) → NDArray
```

Convert from *Li et al. (2017)* CAM16-UCS colourspace $J'a'b'$ array to CIE XYZ tristimulus values.

Parameters

- **Jpapbp** (ArrayLike) – *Li et al. (2017)* CAM16-UCS colourspace $J'a'b'$ array.
- **kwargs** (Any) – {`colour.CAM16_to_XYZ()`}, See the documentation of the previously listed definition. The default viewing conditions are that of *IEC 61966-2-1:1999*, i.e. *sRGB* 64 Lux ambient illumination, 80 cd/m^2 , adapting field luminance about 20% of a white object in the scene.
- **coefficients** (ArrayLike) –

Returns

CIE XYZ tristimulus values.

Return type

`numpy.ndarray`

Warning: The `XYZ_w` parameter for `colour.XYZ_to_CAM16()` definition must be given in the same domain-range scale than the XYZ parameter.

Notes

- UCS in CAM16-UCS stands for *Uniform Colour Space*.

| Domain | Scale - Reference | Scale - 1 |
|--------|---|---|
| Jpapbp | Jp : [0, 100] ap : [-100, 100] bp : [-100, 100] | Jp : [0, 1] ap : [-1, 1] bp : [-1, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

References

[LLW+17]

$IC_A C_B$ Colourspace

colour

| | |
|----------------------------------|---|
| <code>XYZ_to_ICaCb(XYZ)</code> | Convert from <i>CIE XYZ</i> tristimulus values to $IC_A C_B$ colourspace. |
| <code>ICaCb_to_XYZ(ICaCb)</code> | Convert from $IC_A C_B$ tristimulus values to <i>CIE XYZ</i> colourspace. |

colour.XYZ_to_ICaCb

colour.XYZ_to_ICaCb(*XYZ: ArrayLike*) → `ndarray`

Convert from *CIE XYZ* tristimulus values to $IC_A C_B$ colourspace.

Parameters

XYZ (`ArrayLike`) – *CIE XYZ* tristimulus values.

Returns

$IC_A C_B$ colourspace array.

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-------------|
| ICaCb | I : [0, 1] | I : [0, 1] |
| | Ca : [-1, 1] | Ca: [-1, 1] |
| | Cb : [-1, 1] | Cb: [-1, 1] |

- Input *CIE XYZ* tristimulus values must be adapted to *CIE Standard Illuminant D Series D65*.

References

[Frohlich17]

Examples

```
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> XYZ_to_ICaCb(XYZ)
array([ 0.06875297,  0.05753352,  0.02081548])
```

colour.ICaCb_to_XYZ

colour.**ICaCb_to_XYZ**(ICaCb: *ArrayLike*) → *ndarray*

Convert from $IC_A C_B$ tristimulus values to *CIE XYZ* colourspace.

Parameters

ICaCb (*ArrayLike*) – $IC_A C_B$ tristimulus values.

Returns

CIE XYZ colourspace array.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-------------|
| ICaCb | I : [0, 1] | I : [0, 1] |
| | Ca : [-1, 1] | Ca: [-1, 1] |
| | Cb : [-1, 1] | Cb: [-1, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

References

[Frohlich17]

Examples

```
>>> XYZ = np.array([0.06875297, 0.05753352, 0.02081548])
>>> ICaCb_to_XYZ(XYZ)
array([ 0.20654008,  0.12197225,  0.05136951])
```

*I*_G*P*_G*T*_G Colourspace

colour

| | |
|------------------------------------|--|
| <code>XYZ_to_IgPgTg(XYZ)</code> | Convert from <i>CIE XYZ</i> tristimulus values to <i>I</i> _G <i>P</i> _G <i>T</i> _G colourspace. |
| <code>IgPgTg_to_XYZ(IgPgTg)</code> | Convert from <i>I</i> _G <i>P</i> _G <i>T</i> _G colourspace to <i>CIE XYZ</i> tristimulus values. |

`colour.XYZ_to_IgPgTg``colour.XYZ_to_IgPgTg(XYZ: ArrayLike) → ndarray`Convert from *CIE XYZ* tristimulus values to *I*_G*P*_G*T*_G colourspace.**Parameters***XYZ* (ArrayLike) – *CIE XYZ* tristimulus values.**Returns***I*_G*P*_G*T*_G colourspace array.**Return type**`numpy.ndarray`**Notes**

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|--------|-------------------|--------------|
| IgPgTg | IG : [0, 1] | IG : [0, 1] |
| | PG : [-1, 1] | PG : [-1, 1] |
| | TG : [-1, 1] | TG : [-1, 1] |

- Input *CIE XYZ* tristimulus values must be adapted to *CIE Standard Illuminant D Series D65*.

References[\[HF20\]](#)**Examples**

```
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> XYZ_to_IgPgTg(XYZ)
array([ 0.4242125...,  0.1863249...,  0.1068922...])
```

colour.IgPgTg_to_XYZ

colour.IgPgTg_to_XYZ(IgPgTg: ArrayLike) → ndarray

Convert from $I_G P_G T_G$ colourspace to CIE XYZ tristimulus values.

Parameters

IgPgTg (ArrayLike) – $I_G P_G T_G$ colourspace array.

Returns

 CIE XYZ tristimulus values.

Return type

 numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|--------------|
| IgPgTg | IG : [0, 1] | IG : [0, 1] |
| | PG : [-1, 1] | PG : [-1, 1] |
| | TG : [-1, 1] | TG : [-1, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

References

[HF20]

Examples

```
>>> IgPgTg = np.array([0.42421258, 0.18632491, 0.10689223])
>>> IgPgTg_to_XYZ(IgPgTg)
array([ 0.2065400...,  0.1219722...,  0.0513695...])
```

IPT Colourspace

colour

| | |
|--------------------|---|
| XYZ_to_IPT(XYZ) | Convert from CIE XYZ tristimulus values to IPT colourspace. |
| IPT_to_XYZ(IPT) | Convert from IPT colourspace to CIE XYZ tristimulus values. |
| IPT_hue_angle(IPT) | Compute the hue angle in degrees from IPT colourspace. |

colour.XYZ_to_IPT

colour.XYZ_to_IPT(XYZ: ArrayLike) → ndarray

Convert from *CIE XYZ* tristimulus values to *IPT* colourspace.

Parameters

XYZ (ArrayLike) – *CIE XYZ* tristimulus values.

Returns

IPT colourspace array.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-------------|
| IPT | I : [0, 1] | I : [0, 1] |
| | P : [-1, 1] | P : [-1, 1] |
| | T : [-1, 1] | T : [-1, 1] |

- Input *CIE XYZ* tristimulus values must be adapted to *CIE Standard Illuminant D Series D65*.

References

[Fai13g]

Examples

```
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> XYZ_to_IPT(XYZ)
array([ 0.3842619...,  0.3848730...,  0.1888683...])
```

colour.IPT_to_XYZ

colour.IPT_to_XYZ(IPT: ArrayLike) → ndarray

Convert from *IPT* colourspace to *CIE XYZ* tristimulus values.

Parameters

IPT (ArrayLike) – *IPT* colourspace array.

Returns

CIE XYZ tristimulus values.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-------------|
| IPT | I : [0, 1] | I : [0, 1] |
| | P : [-1, 1] | P : [-1, 1] |
| | T : [-1, 1] | T : [-1, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

References

[Fai13g]

Examples

```
>>> IPT = np.array([0.38426191, 0.38487306, 0.18886838])
>>> IPT_to_XYZ(IPT)
array([ 0.2065400...,  0.1219722...,  0.0513695...])
```

colour.IPT_hue_angle

`colour.IPT_hue_angle(IPT: ArrayLike) → FloatingOrNDArray`

Compute the hue angle in degrees from *IPT* colourspace.

Parameters

IPT (ArrayLike) – *IPT* colourspace array.

Returns

Hue angle in degrees.

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-------------|
| IPT | I : [0, 1] | I : [0, 1] |
| | P : [-1, 1] | P : [-1, 1] |
| | T : [-1, 1] | T : [-1, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| hue | [0, 360] | [0, 1] |

References

[Fai13g]

Examples

```
>>> IPT = np.array([0.96907232, 1, 1.12179215])
>>> IPT_hue_angle(IPT)
48.2852074...
```

Munish Ragoo and Farup (2021) Optimised IPT Colourspace

colour

| | |
|---|---|
| <code>XYZ_to_IPT_Munish2021(XYZ)</code> | Convert from <i>CIE XYZ</i> tristimulus values to <i>Munish Ragoo and Farup (2021) Optimised IPT</i> colourspace. |
| <code>IPT_Munish2021_to_XYZ(IPT)</code> | Convert from <i>Munish Ragoo and Farup (2021) Optimised IPT</i> colourspace to <i>CIE XYZ</i> tristimulus values. |

colour.XYZ_to_IPT_Munish2021

colour.XYZ_to_IPT_Munish2021(XYZ: ArrayLike) → ndarray

Convert from *CIE XYZ* tristimulus values to *Munish Ragoo and Farup (2021) Optimised IPT* colourspace.

Parameters

XYZ (ArrayLike) – *CIE XYZ* tristimulus values.

Returns

Munish Ragoo and Farup (2021) Optimised IPT colourspace array.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-------------|
| IPT | I : [0, 1] | I : [0, 1] |
| | P : [-1, 1] | P : [-1, 1] |
| | T : [-1, 1] | T : [-1, 1] |

- Input *CIE XYZ* tristimulus values must be adapted to *CIE Standard Illuminant D Series D65*.

References

[MRF21]

Examples

```
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> XYZ_to_IPT_Munish2021(XYZ)
array([ 0.4224824...,  0.2910514...,  0.2041066...])
```

colour.IPT_Munish2021_to_XYZ

colour.IPT_Munish2021_to_XYZ(*IPT*: ArrayLike) → ndarray

Convert from *Munish Ragoo and Farup (2021) Optimised IPT* colourspace to *CIE XYZ* tristimulus values.

Parameters

IPT (ArrayLike) – *Munish Ragoo and Farup (2021) Optimised IPT* colourspace array.

Returns

CIE XYZ tristimulus values.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-------------|
| IPT | I : [0, 1] | I : [0, 1] |
| | P : [-1, 1] | P : [-1, 1] |
| | T : [-1, 1] | T : [-1, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

References

[MRF21]

Examples

```
>>> IPT = np.array([0.42248243, 0.2910514, 0.20410663])
>>> IPT_Munish2021_to_XYZ(IPT)
array([ 0.2065400...,  0.1219722...,  0.0513695...])
```

hdr-CIELAB Colourspace

colour

| | |
|---|--|
| <code>XYZ_to_hdr_CIELab(XYZ[, illuminant, Y_s, ...])</code> | Convert from <i>CIE XYZ</i> tristimulus values to <i>hdr-CIELAB</i> colourspace. |
| <code>hdr_CIELab_to_XYZ(Lab_hdr[, illuminant, ...])</code> | Convert from <i>hdr-CIELAB</i> colourspace to <i>CIE XYZ</i> tristimulus values. |
| <code>HDR_CIELAB_METHODS</code> | Supported <i>hdr-CIELAB</i> colourspace computation methods. |

colour.XYZ_to_hdr_CIELab

`colour.XYZ_to_hdr_CIELab(XYZ: ArrayLike, illuminant: ArrayLike = CCS_ILLUMINANTS['CIE 1931 2 Degree Standard Observer']['D65'], Y_s: FloatingOrArrayLike = 0.2, Y_abs: FloatingOrArrayLike = 100, method: Literal['Fairchild 2011', 'Fairchild 2010'] | str = 'Fairchild 2011') → ndarray`

Convert from *CIE XYZ* tristimulus values to *hdr-CIELAB* colourspace.

Parameters

- **XYZ** (ArrayLike) – *CIE XYZ* tristimulus values.
- **illuminant** (ArrayLike) – Reference *illuminant CIE xy* chromaticity coordinates or *CIE xyY* colourspace array.
- **Y_s** (FloatingOrArrayLike) – Relative luminance Y_s of the surround.
- **Y_abs** (FloatingOrArrayLike) – Absolute luminance Y_{abs} of the scene diffuse white in cd/m^2 .
- **method** (Literal['Fairchild 2011', 'Fairchild 2010'] | str) – Computation method.

Returns

hdr-CIELAB colourspace array.

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|------------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |
| illuminant | [0, 1] | [0, 1] |
| Y_s | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|---------|--|--|
| Lab_hdr | L_hdr : [0, 100] a_hdr : [-100, 100] b_hdr : [-100, 100] | L_hdr : [0, 1] a_hdr : [-1, 1] b_hdr : [-1, 1] |

- Conversion to polar coordinates to compute the *chroma* C_{hdr} and *hue* h_{hdr} correlates can be safely performed with `colour.Lab_to_LCHab()` definition.

- Conversion to cartesian coordinates from the *Lightness* L_{hdr} , *chroma* C_{hdr} and *hue* h_{hdr} correlates can be safely performed with `colour.LCHab_to_Lab()` definition.

References

[FW10], [FC11]

Examples

```
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> XYZ_to_hdr_CIELab(XYZ)
array([ 51.8700206...,  60.4763385...,  32.1455191...])
>>> XYZ_to_hdr_CIELab(XYZ, method="Fairchild 2010")
array([ 31.9962111..., 128.0076303...,  48.7695230...])
```

colour.hdr_CIELab_to_XYZ

`colour.hdr_CIELab_to_XYZ(Lab_hdr: ArrayLike, illuminant: ArrayLike = CCS_ILLUMINANTS['CIE 1931 2 Degree Standard Observer']['D65'], Y_s: FloatingOrArrayLike = 0.2, Y_abs: FloatingOrArrayLike = 100, method: Literal['Fairchild 2011', 'Fairchild 2010'] | str = 'Fairchild 2011') → ndarray`

Convert from *hdr-CIELAB* colourspace to *CIE XYZ* tristimulus values.

Parameters

- **Lab_hdr** (ArrayLike) – *hdr-CIELAB* colourspace array.
- **illuminant** (ArrayLike) – Reference *illuminant CIE xy* chromaticity coordinates or *CIE xyY* colourspace array.
- **Y_s** (FloatingOrArrayLike) – Relative luminance Y_s of the surround.
- **Y_abs** (FloatingOrArrayLike) – Absolute luminance Y_{abs} of the scene diffuse white in cd/m^2 .
- **method** (Literal['Fairchild 2011', 'Fairchild 2010'] | str) – Computation method.

Returns

CIE XYZ tristimulus values.

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|-----------|---------------------|-----------------|
| Lab_hdr | L_hdr : [0, 100] | L_hdr : [0, 1] |
| | a_hdr : [-100, 100] | a_hdr : [-1, 1] |
| | b_hdr : [-100, 100] | b_hdr : [-1, 1] |
| illuminan | [0, 1] | [0, 1] |
| Y_s | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

References

[FW10], [FC11]

Examples

```
>>> Lab_hdr = np.array([51.87002062, 60.4763385, 32.14551912])
>>> hdr_CIELab_to_XYZ(Lab_hdr)
array([ 0.2065400...,  0.1219722...,  0.0513695...])
>>> Lab_hdr = np.array([31.99621114, 128.00763036, 48.76952309])
>>> hdr_CIELab_to_XYZ(Lab_hdr, method="Fairchild 2010")
...
array([ 0.2065400...,  0.1219722...,  0.0513695...])
```

colour.HDR_CIELAB_METHODS

colour.HDR_CIELAB_METHODS = ('Fairchild 2010', 'Fairchild 2011')

Supported *hdr-CIELAB* colourspace computation methods.

References

[FW10], [FC11]

hdr-IPT Colourspace

colour

| | |
|--|---|
| <code>XYZ_to_hdr_IPT(XYZ[, Y_s, Y_abs, method])</code> | Convert from <i>CIE XYZ</i> tristimulus values to <i>hdr-IPT</i> colourspace. |
| <code>hdr_IPT_to_XYZ(IPT_hdr[, Y_s, Y_abs, method])</code> | Convert from <i>hdr-IPT</i> colourspace to <i>CIE XYZ</i> tristimulus values. |
| <code>HDR_IPT_METHODS</code> | Supported <i>hdr-IPT</i> colourspace computation methods. |

colour.XYZ_to_hdr_IPT

colour.XYZ_to_hdr_IPT(XYZ: ArrayLike, Y_s: FloatingOrArrayLike = 0.2, Y_abs: FloatingOrArrayLike = 100, method: Literal['Fairchild 2011', 'Fairchild 2010'] | str = 'Fairchild 2011') → ndarray

Convert from *CIE XYZ* tristimulus values to *hdr-IPT* colourspace.

Parameters

- **XYZ** (ArrayLike) – *CIE XYZ* tristimulus values.
- **Y_s** (FloatingOrArrayLike) – Relative luminance Y_s of the surround.
- **Y_abs** (FloatingOrArrayLike) – Absolute luminance Y_{abs} of the scene diffuse white in cd/m^2 .
- **method** (Literal['Fairchild 2011', 'Fairchild 2010'] | str) – Computation method.

Returns*hdr-IPT* colourspace array.**Return type**`numpy.ndarray`**Notes**

| Domain | Scale - Reference | Scale - 1 |
|----------------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |
| Y _s | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|---------|---------------------|-----------------|
| IPT_hdr | I_hdr : [0, 100] | I_hdr : [0, 1] |
| | P_hdr : [-100, 100] | P_hdr : [-1, 1] |
| | T_hdr : [-100, 100] | T_hdr : [-1, 1] |

- Input *CIE XYZ* tristimulus values must be adapted to *CIE Standard Illuminant D Series D65*.

References

[FW10], [FC11]

Examples

```
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> XYZ_to_hdr_IPT(XYZ)
array([ 48.3937634...,  42.4499020...,  22.0195403...])
>>> XYZ_to_hdr_IPT(XYZ, method="Fairchild 2010")
array([ 30.0287314...,  83.9384506...,  34.9028738...])
```

colour.hdr_IPT_to_XYZ

`colour.hdr_IPT_to_XYZ(IPT_hdr: ArrayLike, Ys: FloatingOrArrayLike = 0.2, Yabs: FloatingOrArrayLike = 100, method: Literal['Fairchild 2011', 'Fairchild 2010'] | str = 'Fairchild 2011') → ndarray`

Convert from *hdr-IPT* colourspace to *CIE XYZ* tristimulus values.

Parameters

- IPT_hdr** (ArrayLike) – *hdr-IPT* colourspace array.
- Y_s** (FloatingOrArrayLike) – Relative luminance Y_s of the surround.
- Y_{abs}** (FloatingOrArrayLike) – Absolute luminance Y_{abs} of the scene diffuse white in cd/m^2 .
- method** (*Literal*['Fairchild 2011', 'Fairchild 2010'] | str) – Computation method.

Returns*CIE XYZ* tristimulus values.

Return type`numpy.ndarray`**Notes**

| Do-main | Scale - Reference | Scale - 1 |
|---------|---------------------|-----------------|
| IPT_hdr | I_hdr : [0, 100] | I_hdr : [0, 1] |
| | P_hdr : [-100, 100] | P_hdr : [-1, 1] |
| | T_hdr : [-100, 100] | T_hdr : [-1, 1] |
| Y_s | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

References[\[FW10\]](#), [\[FC11\]](#)**Examples**

```
>>> IPT_hdr = np.array([48.39376346, 42.44990202, 22.01954033])
>>> hdr_IPT_to_XYZ(IPT_hdr)
array([ 0.2065400...,  0.1219722...,  0.0513695...])
>>> IPT_hdr = np.array([30.02873147, 83.93845061, 34.90287382])
>>> hdr_IPT_to_XYZ(IPT_hdr, method="Fairchild 2010")
...
array([ 0.2065400...,  0.1219722...,  0.0513695...])
```

colour.HDR_IPT_METHODS

```
colour.HDR_IPT_METHODS = ('Fairchild 2010', 'Fairchild 2011')
```

Supported *hdr-IPT* colourspace computation methods.**References**[\[FW10\]](#), [\[FC11\]](#)**Oklab Colourspace**

colour

| | |
|--------------------------------|---|
| <code>XYZ_to_Oklab(XYZ)</code> | Convert from <i>CIE XYZ</i> tristimulus values to <i>Oklab</i> colourspace. |
| <code>Oklab_to_XYZ(Lab)</code> | Convert from <i>Oklab</i> colourspace to <i>CIE XYZ</i> tristimulus values. |

colour.XYZ_to_Oklab

colour.XYZ_to_Oklab(XYZ: ArrayLike) → ndarray

Convert from *CIE XYZ* tristimulus values to *Oklab* colourspace.

Parameters

XYZ (ArrayLike) – *CIE XYZ* tristimulus values.

Returns

Oklab colourspace array.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-------------|
| Lab | L : [0, 1] | L : [0, 1] |
| | a : [-1, 1] | a : [-1, 1] |
| | b : [-1, 1] | b : [-1, 1] |

- Input *CIE XYZ* tristimulus values must be adapted to *CIE Standard Illuminant D Series D65*.

References

[Ott20]

Examples

```
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> XYZ_to_Oklab(XYZ)
array([ 0.5163401...,  0.154695 ...,  0.0628957...])
```

colour.Oklab_to_XYZ

colour.Oklab_to_XYZ(Lab: ArrayLike) → ndarray

Convert from *Oklab* colourspace to *CIE XYZ* tristimulus values.

Parameters

Lab (ArrayLike) – *Oklab* colourspace array.

Returns

CIE XYZ tristimulus values.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|--|--|
| Lab | L : [0, 1] a : [-1, 1] b : [-1, 1] | L : [0, 1] a : [-1, 1] b : [-1, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

References

[Ott20]

Examples

```
>>> Lab = np.array([0.51634019, 0.15469500, 0.06289579])
>>> Oklab_to_XYZ(Lab)
array([ 0.2065400...,  0.1219722...,  0.0513695...])
```

OSA UCS Colourspace

colour

| | |
|---|--|
| <code>XYZ_to_OSA_UCS(XYZ)</code> | Convert from <i>CIE XYZ</i> tristimulus values under the <i>CIE 1964 10 Degree Standard Observer</i> to <i>OSA UCS</i> colourspace. |
| <code>OSA_UCS_to_XYZ(Ljg[, optimisation_kwargs])</code> | Convert from <i>OSA UCS</i> colourspace to <i>CIE XYZ</i> tristimulus values under the <i>CIE 1964 10 Degree Standard Observer</i> . |

colour.XYZ_to_OSA_UCS

`colour.XYZ_to_OSA_UCS(XYZ: ArrayLike) → ndarray`

Convert from *CIE XYZ* tristimulus values under the *CIE 1964 10 Degree Standard Observer* to *OSA UCS* colourspace.

The lightness axis, *L* is usually in range [-9, 5] and centered around middle gray (Munsell N/6). The yellow-blue axis, *j* is usually in range [-15, 15]. The red-green axis, *g* is usually in range [-20, 15].

Parameters

XYZ (ArrayLike) – *CIE XYZ* tristimulus values under the *CIE 1964 10 Degree Standard Observer*.

Returns

OSA UCS *Ljg* lightness, jaune (yellowness), and greenness.

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|---|---|
| Ljg | L : [-100, 100] j : [-100, 100] g : [-100, 100] | L : [-1, 1] j : [-1, 1] g : [-1, 1] |

- OSA UCS uses the CIE 1964 10 Degree Standard Observer.

References

[CTS13], [Mor03]

Examples

```
>>> import numpy as np
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952]) * 100
>>> XYZ_to_OSA_UCS(XYZ)
array([-3.0049979...,  2.9971369..., -9.6678423...])
```

colour.OSA_UCS_to_XYZ

colour.OSA_UCS_to_XYZ(Ljg: ArrayLike, optimisation_kwargs: Dict | None = None) → ndarray

Convert from OSA UCS colourspace to CIE XYZ tristimulus values under the CIE 1964 10 Degree Standard Observer.

Parameters

- **Ljg** (ArrayLike) – OSA UCS *Ljg* lightness, jaune (yellowness), and greenness.
- **optimisation_kwargs** (Dict | None) – Parameters for `scipy.optimize.fmin()` definition.

Returns

CIE XYZ tristimulus values under the CIE 1964 10 Degree Standard Observer.

Return type

`numpy.ndarray`

Warning: There is no analytical inverse transformation from OSA UCS to *Ljg* lightness, jaune (yellowness), and greenness to CIE XYZ tristimulus values, the current implementation relies on optimization using `scipy.optimize.fmin()` definition and thus has reduced precision and poor performance.

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|---|---|
| Ljg | L : [-100, 100] j : [-100, 100] g : [-100, 100] | L : [-1, 1] j : [-1, 1] g : [-1, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 100] | [0, 1] |

- OSA UCS uses the CIE 1964 10 Degree Standard Observer.

References

[CTS13], [Mor03]

Examples

```
>>> import numpy as np
>>> Ljg = np.array([-3.00499790, 2.99713697, -9.66784231])
>>> OSA_UCS_to_XYZ(Ljg)
array([ 20.6540240..., 12.1972369...,  5.1369372...])
```

ProLab Colourspace

colour

| | |
|--|--|
| <code>XYZ_to_ProLab(XYZ[, illuminant])</code> | Convert from CIE XYZ tristimulus values to ProLab colourspace. |
| <code>ProLab_to_XYZ(ProLab[, illuminant])</code> | Convert from ProLab colourspace to CIE XYZ tristimulus values. |

colour.XYZ_to_ProLab

`colour.XYZ_to_ProLab(XYZ: ArrayLike, illuminant: ArrayLike = CCS_ILLUMINANTS['CIE 1931 2 Degree Standard Observer']['D65']) → ndarray`

Convert from CIE XYZ tristimulus values to ProLab colourspace.

Parameters

- **XYZ** (ArrayLike) – CIE XYZ tristimulus values.
- **illuminant** (ArrayLike) – Reference *illuminant* CIE xy chromaticity coordinates or CIE xyY colourspace array.

Returns

ProLab colourspace array.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|--------|--|--|
| ProLab | L : [0, 1] a : [-1, 1] b : [-1, 1] | L : [0, 1] a : [-1, 1] b : [-1, 1] |

References

[KSNN21]

Examples

```
>>> Lab = np.array([0.51634019, 0.15469500, 0.06289579])
>>> XYZ_to_ProLab(Lab)
array([ 59.846628... , 115.039635... , 20.1251035...])
```

colour.ProLab_to_XYZ

`colour.ProLab_to_XYZ(ProLab: ArrayLike, illuminant: ArrayLike = CCS_ILLUMINANTS['CIE 1931 2 Degree Standard Observer']['D65'])` → `ndarray`

Convert from *ProLab* colourspace to *CIE XYZ* tristimulus values.

Parameters

- **ProLab** (ArrayLike) – *ProLab* colourspace array.
- **illuminant** (ArrayLike) – Reference *illuminant CIE xy* chromaticity coordinates or *CIE xyY* colourspace array.

Returns

CIE XYZ tristimulus values.

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|--|--|
| Lab | L : [0, 1] a : [-1, 1] b : [-1, 1] | L : [0, 1] a : [-1, 1] b : [-1, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

References

[KSNN21]

Examples

```
>>> ProLab = np.array([59.8466286, 115.0396354, 20.12510352])
>>> ProLab_to_XYZ(ProLab)
array([ 0.5163401...,  0.154695 ...,  0.0628957...])
```

Jzazbz Colourspace

colour

| | |
|--|--|
| <code>XYZ_to_Jzazbz(XYZ_D65[, constants])</code> | Convert from <i>CIE XYZ</i> tristimulus values to $J_z a_z b_z$ colourspace. |
| <code>Jzazbz_to_XYZ(Jzazbz[, constants])</code> | Convert from $J_z a_z b_z$ colourspace to <i>CIE XYZ</i> tristimulus values. |

colour.XYZ_to_Jzazbz

colour.XYZ_to_Jzazbz(XYZ_D65: ArrayLike, constants: Structure = CONSTANTS_JZAZBZ_SAFDAR2017) → ndarray

Convert from *CIE XYZ* tristimulus values to $J_z a_z b_z$ colourspace.

Parameters

- **XYZ_D65** (ArrayLike) – *CIE XYZ* tristimulus values under *CIE Standard Illuminant D Series D65*.
- **constants** (Structure) – $J_z a_z b_z$ colourspace constants.

Returns

$J_z a_z b_z$ colourspace array where J_z is Lightness, a_z is redness-greenness and b_z is yellowness-blueness.

Return type

numpy.ndarray

Warning: The underlying *SMPTE ST 2084:2014* transfer function is an absolute transfer function.

Notes

- The underlying *SMPTE ST 2084:2014* transfer function is an absolute transfer function, thus the domain and range values for the *Reference* and *1* scales are only indicative that the data is not affected by scale transformations. The effective domain of *SMPTE ST 2084:2014* inverse electro-optical transfer function (EOTF) is [0.0001, 10000].

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | UN | UN |

| Range | Scale - Reference | Scale - 1 |
|--------|---|---|
| Jzazbz | Jz : [0, 1] az : [-1, 1] bz : [-1, 1] | Jz : [0, 1] az : [-1, 1] bz : [-1, 1] |

References

[SCKL17]

Examples

```
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> XYZ_to_Jzazbz(XYZ)
array([ 0.0053504...,  0.0092430...,  0.0052600...])
```

colour.Jzazbz_to_XYZ

`colour.Jzazbz_to_XYZ(Jzazbz: ArrayLike, constants: Structure = CONSTANTS_JZAZBZ_SAFDAR2017)`
 \rightarrow ndarray

Convert from $J_z a_z b_z$ colourspace to CIE XYZ tristimulus values.

Parameters

- **Jzazbz** (ArrayLike) – $J_z a_z b_z$ colourspace array where J_z is Lightness, a_z is redness-greenness and b_z is yellowness-blueness.
- **constants** (Structure) – $J_z a_z b_z$ colourspace constants.

Returns

CIE XYZ tristimulus values under CIE Standard Illuminant D Series D65.

Return type

numpy.ndarray

Warning: The underlying *SMPTE ST 2084:2014* transfer function is an absolute transfer function.

Notes

- The underlying *SMPTE ST 2084:2014* transfer function is an absolute transfer function, thus the domain and range values for the *Reference* and *1* scales are only indicative that the data is not affected by scale transformations.

| Domain | Scale - Reference | Scale - 1 |
|--------|---|---|
| Jzazbz | Jz : [0, 1] az : [-1, 1] bz : [-1, 1] | Jz : [0, 1] az : [-1, 1] bz : [-1, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | UN | UN |

References

[SCKL17]

Examples

```
>>> Jzazbz = np.array([0.00535048, 0.00924302, 0.00526007])
>>> Jzazbz_to_XYZ(Jzazbz)
array([ 0.2065402...,  0.1219723...,  0.0513696...])
```

Ancillary Objects

`colour.models`

| | |
|--|--|
| <code>IZAZBZ_METHODS</code> | Supported $I_z a_z b_z$ computation methods. |
| <code>XYZ_to_Izazbz(XYZ_D65[, constants, method])</code> | Convert from <i>CIE XYZ</i> tristimulus values to $I_z a_z b_z$ colourspace. |
| <code>Izazbz_to_XYZ(Izazbz[, constants, method])</code> | Convert from $I_z a_z b_z$ colourspace to <i>CIE XYZ</i> tristimulus values. |

`colour.models.IZAZBZ_METHODS`

`colour.models.IZAZBZ_METHODS = ('Safdar 2017', 'Safdar 2021', 'ZCAM')`

Supported $I_z a_z b_z$ computation methods.

References

[SCKL17], [SHRL21]

`colour.models.XYZ_to_Izazbz`

`colour.models.XYZ_to_Izazbz(XYZ_D65: ArrayLike, constants: Structure | None = None, method: Literal['Safdar 2017', 'Safdar 2021', 'ZCAM'] | str = 'Safdar 2017') → ndarray`

Convert from *CIE XYZ* tristimulus values to $I_z a_z b_z$ colourspace.

Parameters

- **XYZ_D65** (ArrayLike) – *CIE XYZ* tristimulus values under *CIE Standard Illuminant D Series D65*.
- **constants** (Structure | None) – $I_z a_z b_z$ colourspace constants.
- **method** (Literal['Safdar 2017', 'Safdar 2021', 'ZCAM'] | str) – Computation method, *Safdar 2021* and *ZCAM* methods are equivalent.

Returns

$I_z a_z b_z$ colourspace array where I_z is the achromatic response, a_z is redness-greenness and b_z is yellowness-blueness.

Return type

`numpy.ndarray`

Warning: The underlying *SMPTE ST 2084:2014* transfer function is an absolute transfer function.

Notes

- The underlying *SMPTE ST 2084:2014* transfer function is an absolute transfer function, thus the domain and range values for the *Reference* and *1* scales are only indicative that the data is not affected by scale transformations. The effective domain of *SMPTE ST 2084:2014* inverse electro-optical transfer function (EOTF) is [0.0001, 10000].

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | UN | UN |

| Range | Scale - Reference | Scale - 1 |
|--------|---|---|
| Izazbz | Iz : [0, 1] az : [-1, 1] bz : [-1, 1] | Iz : [0, 1] az : [-1, 1] bz : [-1, 1] |

References

[SCKL17], [SHRL21]

Examples

```
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> XYZ_to_Izazbz(XYZ)
array([ 0.0120779...,  0.0092430...,  0.0052600...])
```

colour.models.Izazbz_to_XYZ

colour.models.**Izazbz_to_XYZ**(Izazbz: ArrayLike, constants: Structure | None = None, method: Literal['Safdar 2017', 'Safdar 2021', 'ZCAM'] | str = 'Safdar 2017') → ndarray

Convert from $I_z a_z b_z$ colourspace to CIE XYZ tristimulus values.

Parameters

- Izazbz** (ArrayLike) – $I_z a_z b_z$ colourspace array where I_z is the achromatic response, a_z is redness-greenness and b_z is yellowness-blueness.
- constants** (Structure | None) – $J_z a_z b_z$ colourspace constants.
- method** (Literal['Safdar 2017', 'Safdar 2021', 'ZCAM'] | str) – Computation method, *Safdar 2021* and *ZCAM* methods are equivalent.

Returns

CIE XYZ tristimulus values under CIE Standard Illuminant D Series D65.

Return type

numpy.ndarray

Warning: The underlying *SMPTE ST 2084:2014* transfer function is an absolute transfer function.

Notes

- The underlying *SMPTE ST 2084:2014* transfer function is an absolute transfer function, thus the domain and range values for the *Reference* and *1* scales are only indicative that the data is not affected by scale transformations.

| Domain | Scale - Reference | Scale - 1 |
|--------|---|---|
| Izazbz | Iz : [0, 1] az : [-1, 1] bz : [-1, 1] | Iz : [0, 1] az : [-1, 1] bz : [-1, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | UN | UN |

References

[SCKL17], [SHRL21]

Examples

```
>>> Izazbz = np.array([0.01207793, 0.00924302, 0.00526007])
>>> Izazbz_to_XYZ(Izazbz)
array([ 0.2065401...,  0.1219723...,  0.0513696...])
```

RGB Colourspace and Transformations

colour

| | |
|---|---|
| <code>XYZ_to_RGB(XYZ, illuminant_XYZ, ...[, ...])</code> | Convert from <i>CIE XYZ</i> tristimulus values to <i>RGB</i> colourspace array. |
| <code>RGB_to_XYZ(RGB, illuminant_RGB, ...[, ...])</code> | Convert given <i>RGB</i> colourspace array to <i>CIE XYZ</i> tristimulus values. |
| <code>RGB_to_RGB(RGB, input_colourspace, ...[, ...])</code> | Convert given <i>RGB</i> colourspace array from given input <i>RGB</i> colourspace to output <i>RGB</i> colourspace using given <i>chromatic adaptation</i> method. |
| <code>matrix_RGB_to_RGB(input_colourspace, ...[, ...])</code> | Compute the matrix <i>M</i> converting from given input <i>RGB</i> colourspace to output <i>RGB</i> colourspace using given <i>chromatic adaptation</i> method. |

colour.XYZ_to_RGB

`colour.XYZ_to_RGB(XYZ: ArrayLike, illuminant_XYZ: ArrayLike, illuminant_RGB: ArrayLike, matrix_XYZ_to_RGB: ArrayLike, chromatic_adaptation_transform: Literal['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling'] | str | None = 'CAT02', ctf_encoding: Callable | None = None)` → *ndarray*

Convert from *CIE XYZ* tristimulus values to *RGB* colourspace array.

Parameters

- **XYZ** (ArrayLike) – CIE XYZ tristimulus values.
- **illuminant_XYZ** (ArrayLike) – CIE xy chromaticity coordinates or CIE xyY colourspace array of the *illuminant* for the input CIE XYZ tristimulus values.
- **illuminant_RGB** (ArrayLike) – CIE xy chromaticity coordinates or CIE xyY colourspace array of the *illuminant* for the output RGB colourspace array.
- **matrix_XYZ_to_RGB** (ArrayLike) – Matrix converting the CIE XYZ tristimulus values to RGB colourspace array, i.e. the inverse *Normalised Primary Matrix* (NPM).
- **chromatic_adaptation_transform** (Literal['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling'] | str | None) – Chromatic adaptation transform, if *None* no chromatic adaptation is performed.
- **cctf_encoding** (Callable | None) – Encoding colour component transfer function (Encoding CCTF) or opto-electronic transfer function (OETF).

Returns

RGB colourspace array.

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|----------------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |
| illuminant_XYZ | [0, 1] | [0, 1] |
| illuminant_RGB | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| RGB | [0, 1] | [0, 1] |

Examples

```
>>> XYZ = np.array([0.21638819, 0.12570000, 0.03847493])
>>> illuminant_XYZ = np.array([0.34570, 0.35850])
>>> illuminant_RGB = np.array([0.31270, 0.32900])
>>> chromatic_adaptation_transform = "Bradford"
>>> matrix_XYZ_to_RGB = np.array(
...     [
...         [3.24062548, -1.53720797, -0.49862860],
...         [-0.96893071, 1.87575606, 0.04151752],
...         [0.05571012, -0.20402105, 1.05699594],
...     ]
... )
>>> XYZ_to_RGB(
...     XYZ,
...     illuminant_XYZ,
...     illuminant_RGB,
...     matrix_XYZ_to_RGB,
...     chromatic_adaptation_transform,
```

(continues on next page)

(continued from previous page)

```
... )
array([ 0.4559557...,  0.0303970...,  0.0408724...])
```

colour.RGB_to_XYZ

`colour.RGB_to_XYZ`(*RGB*: *ArrayLike*, *illuminant_RGB*: *ArrayLike*, *illuminant_XYZ*: *ArrayLike*, *matrix_RGB_to_XYZ*: *ArrayLike*, *chromatic_adaptation_transform*: *Literal*['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling'] | *str* | *None* = 'CAT02', *cctf_decoding*: *Callable* | *None* = *None*) → *ndarray*

Convert given *RGB* colourspace array to *CIE XYZ* tristimulus values.

Parameters

- **RGB** (*ArrayLike*) – *RGB* colourspace array.
- **illuminant_RGB** (*ArrayLike*) – *CIE xy* chromaticity coordinates or *CIE xyY* colourspace array of the *illuminant* for the input *RGB* colourspace array.
- **illuminant_XYZ** (*ArrayLike*) – *CIE xy* chromaticity coordinates or *CIE xyY* colourspace array of the *illuminant* for the output *CIE XYZ* tristimulus values.
- **matrix_RGB_to_XYZ** (*ArrayLike*) – Matrix converting the *RGB* colourspace array to *CIE XYZ* tristimulus values, i.e. the *Normalised Primary Matrix* (NPM).
- **chromatic_adaptation_transform** (*Literal*['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling'] | *str* | *None*) – *Chromatic adaptation* transform, if *None* no chromatic adaptation is performed.
- **cctf_decoding** (*Callable* | *None*) – Decoding colour component transfer function (Decoding CCTF) or electro-optical transfer function (EOTF).

Returns

CIE XYZ tristimulus values.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|----------------|-------------------|-----------|
| RGB | [0, 1] | [0, 1] |
| illuminant_XYZ | [0, 1] | [0, 1] |
| illuminant_RGB | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

Examples

```
>>> RGB = np.array([0.45595571, 0.03039702, 0.04087245])
>>> illuminant_RGB = np.array([0.31270, 0.32900])
>>> illuminant_XYZ = np.array([0.34570, 0.35850])
>>> chromatic_adaptation_transform = "Bradford"
>>> matrix_RGB_to_XYZ = np.array(
...     [
...         [0.41240000, 0.35760000, 0.18050000],
...         [0.21260000, 0.71520000, 0.07220000],
...         [0.01930000, 0.11920000, 0.95050000],
...     ]
... )
>>> RGB_to_XYZ(
...     RGB,
...     illuminant_RGB,
...     illuminant_XYZ,
...     matrix_RGB_to_XYZ,
...     chromatic_adaptation_transform,
... )
array([ 0.2163881...,  0.1257      ,  0.0384749...])
```

colour.RGB_to_RGB

`colour.RGB_to_RGB`(*RGB*: *ArrayLike*, *input_colourspace*: [RGB_Colourspace](#), *output_colourspace*: [RGB_Colourspace](#), *chromatic_adaptation_transform*: *Literal*['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling'] | *str* | *None* = 'CAT02', *apply_cctf_decoding*: *bool* = *False*, *apply_cctf_encoding*: *bool* = *False*, ***kwargs*: *Any*) → *ndarray*

Convert given *RGB* colourspace array from given input *RGB* colourspace to output *RGB* colourspace using given *chromatic adaptation* method.

Parameters

- **RGB** (*ArrayLike*) – *RGB* colourspace array.
- **input_colourspace** ([RGB_Colourspace](#)) – *RGB* input colourspace.
- **output_colourspace** ([RGB_Colourspace](#)) – *RGB* output colourspace.
- **chromatic_adaptation_transform** (*Literal*['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling'] | *str* | *None*) – *Chromatic adaptation* transform, if *None* no chromatic adaptation is performed.
- **apply_cctf_decoding** (*bool*) – Apply input colourspace decoding colour component transfer function / electro-optical transfer function.
- **apply_cctf_encoding** (*bool*) – Apply output colourspace encoding colour component transfer function / opto-electronic transfer function.
- **kwargs** (*Any*) – Keywords arguments for the colour component transfer functions.

Returns

RGB colourspace array.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| RGB | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| RGB | [0, 1] | [0, 1] |

Examples

```
>>> from colour.models import (
...     RGB_COLOURSPACE_sRGB,
...     RGB_COLOURSPACE_PROPHOTO_RGB,
... )
>>> RGB = np.array([0.45595571, 0.03039702, 0.04087245])
>>> RGB_to_RGB(RGB, RGB_COLOURSPACE_sRGB, RGB_COLOURSPACE_PROPHOTO_RGB)
...
array([ 0.2568891...,  0.0721446...,  0.0465553...])
```

colour.matrix_RGB_to_RGB

`colour.matrix_RGB_to_RGB(input_colourspace: RGB_Colourspace, output_colourspace: RGB_Colourspace, chromatic_adaptation_transform: Literal['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling'] | str | None = 'CAT02') → ndarray`

Compute the matrix M converting from given input RGB colourspace to output RGB colourspace using given *chromatic adaptation* method.

Parameters

- **input_colourspace** ([RGB_Colourspace](#)) – RGB input colourspace.
- **output_colourspace** ([RGB_Colourspace](#)) – RGB output colourspace.
- **chromatic_adaptation_transform** ([Literal](#)['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling'] | [str](#) | [None](#)) – *Chromatic adaptation* transform, if [None](#) no chromatic adaptation is performed.

Returns

Conversion matrix M .

Return type

[numpy.ndarray](#)

Examples

```
>>> from colour.models import (
...     RGB_COLOURSPACE_sRGB,
...     RGB_COLOURSPACE_PROPHOTO_RGB,
... )
>>> matrix_RGB_to_RGB(RGB_COLOURSPACE_sRGB, RGB_COLOURSPACE_PROPHOTO_RGB)
...
array([[ 0.5288241...,  0.3340609...,  0.1373616...],
       [ 0.0975294...,  0.8790074...,  0.0233981...],
       [ 0.0163599...,  0.1066124...,  0.8772485...]])
```

Ancillary Objects

colour

| | |
|--|--|
| <code>XYZ_to_sRGB(XYZ[, illuminant, ...])</code> | Convert from <i>CIE XYZ</i> tristimulus values to <i>sRGB</i> colourspace. |
| <code>sRGB_to_XYZ(RGB[, illuminant, ...])</code> | Convert from <i>sRGB</i> colourspace to <i>CIE XYZ</i> tristimulus values. |

colour.XYZ_to_sRGB

`colour.XYZ_to_sRGB(XYZ: ArrayLike, illuminant: ArrayLike = CCS_ILLUMINANTS['CIE 1931 2 Degree Standard Observer']['D65'], chromatic_adaptation_transform: Literal['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling'] | str | None = 'CAT02', apply_cctf_encoding: bool = True) → ndarray`

Convert from *CIE XYZ* tristimulus values to *sRGB* colourspace.

Parameters

- **XYZ** (ArrayLike) – *CIE XYZ* tristimulus values.
- **illuminant** (ArrayLike) – Source illuminant chromaticity coordinates.
- **chromatic_adaptation_transform** (Literal['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling'] | str | None) – *Chromatic adaptation* transform.
- **apply_cctf_encoding** (bool) – Whether to apply the *sRGB* encoding colour component transfer function / inverse electro-optical transfer function.

Returns

sRGB colour array.

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| RGB | [0, 1] | [0, 1] |

Examples

```
>>> import numpy as np
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> XYZ_to_sRGB(XYZ)
array([ 0.7057393...,  0.1924826...,  0.2235416...])
```

colour.sRGB_to_XYZ

`colour.sRGB_to_XYZ`(*RGB*: *ArrayLike*, *illuminant*: *ArrayLike* = *CCS_ILLUMINANTS*['CIE 1931 2 Degree Standard Observer'] ['D65'], *chromatic_adaptation_transform*: *Literal*['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling'] | *str* | *None* = 'CAT02', *apply_cctf_decoding*: *bool* = *True*) → *ndarray*

Convert from *sRGB* colourspace to *CIE XYZ* tristimulus values.

Parameters

- **RGB** (*ArrayLike*) – *sRGB* colourspace array.
- **illuminant** (*ArrayLike*) – Source illuminant chromaticity coordinates.
- **chromatic_adaptation_transform** (*Literal*['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling'] | *str* | *None*) – *Chromatic adaptation* transform.
- **apply_cctf_decoding** (*bool*) – Whether to apply the *sRGB* decoding colour component transfer function / electro-optical transfer function.

Returns

CIE XYZ tristimulus values.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| RGB | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

Examples

```
>>> import numpy as np
>>> RGB = np.array([0.70573936, 0.19248266, 0.22354169])
>>> sRGB_to_XYZ(RGB)
array([ 0.2065429...,  0.1219794...,  0.0513714...])
```

RGB Colourspace Derivation

colour

| | |
|--|---|
| <code>normalised_primary_matrix</code> (primaries, whitepoint) | Compute the <i>Normalised Primary Matrix</i> (NPM) converting a <i>RGB</i> colourspace array to <i>CIE XYZ</i> tristimulus values using given <i>primaries</i> and <i>whitepoint xy</i> chromaticity coordinates. |
| <code>chromatically_adapted_primaries</code> (primaries, ...) | Chromatically adapt given <i>primaries xy</i> chromaticity coordinates from test <i>whitepoint_t</i> to reference <i>whitepoint_r</i> . |
| <code>primaries_whitepoint</code> (npm) | Compute the <i>primaries</i> and <i>whitepoint xy</i> chromaticity coordinates using given <i>Normalised Primary Matrix</i> (NPM). |
| <code>RGB_luminance</code> (RGB, primaries, whitepoint) | Return the <i>luminance Y</i> of given <i>RGB</i> components from given <i>primaries</i> and <i>whitepoint</i> . |
| <code>RGB_luminance_equation</code> (primaries, whitepoint) | Return the <i>luminance equation</i> from given <i>primaries</i> and <i>whitepoint</i> . |

colour.normalised_primary_matrix

colour.normalised_primary_matrix(primaries: ArrayLike, whitepoint: ArrayLike) → ndarray

Compute the *Normalised Primary Matrix* (NPM) converting a *RGB* colourspace array to *CIE XYZ* tristimulus values using given *primaries* and *whitepoint xy* chromaticity coordinates.

Parameters

- **primaries** (ArrayLike) – Primaries *xy* chromaticity coordinates.
- **whitepoint** (ArrayLike) – Illuminant / whitepoint *xy* chromaticity coordinates.

Returns

Normalised Primary Matrix (NPM).

Return type

numpy.ndarray

References

[SocietyoMPaTEngineers93]

Examples

```
>>> p = np.array([0.73470, 0.26530, 0.00000, 1.00000, 0.00010, -0.07700])
>>> w = np.array([0.32168, 0.33767])
>>> normalised_primary_matrix(p, w)
array([[ 9.5255239...e-01,  0.0000000...e+00,  9.3678631...e-05],
       [ 3.4396645...e-01,  7.2816609...e-01, -7.2132546...e-02],
       [ 0.0000000...e+00,  0.0000000...e+00,  1.0088251...e+00]])
```

colour.chromatically_adapted_primaries

`colour.chromatically_adapted_primaries(primaries: ArrayLike, whitepoint_t: ArrayLike, whitepoint_r: ArrayLike, chromatic_adaptation_transform: Literal['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling'] | str = 'CAT02') → ndarray`

Chromatically adapt given *primaries* *xy* chromaticity coordinates from test whitepoint_t to reference whitepoint_r.

Parameters

- **primaries** (ArrayLike) – Primaries *xy* chromaticity coordinates.
- **whitepoint_t** (ArrayLike) – Test illuminant / whitepoint *xy* chromaticity coordinates.
- **whitepoint_r** (ArrayLike) – Reference illuminant / whitepoint *xy* chromaticity coordinates.
- **chromatic_adaptation_transform** (*Literal*['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling'] | str) – *Chromatic adaptation* transform.

Returns

Chromatically adapted primaries *xy* chromaticity coordinates.

Return type

`numpy.ndarray`

Examples

```
>>> p = np.array([0.64, 0.33, 0.30, 0.60, 0.15, 0.06])
>>> w_t = np.array([0.31270, 0.32900])
>>> w_r = np.array([0.34570, 0.35850])
>>> chromatic_adaptation_transform = "Bradford"
>>> chromatically_adapted_primaries(
...     p, w_t, w_r, chromatic_adaptation_transform
... )
...
array([[ 0.6484414...,  0.3308533...],
```

(continues on next page)

(continued from previous page)

```
[ 0.3211951..., 0.5978443...],
 [ 0.1558932..., 0.0660492...]])
```

colour primaries_whitepoint

`colour.primitives_whitepoint(npm: ArrayLike) → Tuple[ndarray, ndarray]`

Compute the *primaries* and *whitepoint* *xy* chromaticity coordinates using given *Normalised Primary Matrix* (NPM).

Parameters

npm (ArrayLike) – *Normalised Primary Matrix*.

Returns

Primaries and *whitepoint* *xy* chromaticity coordinates.

Return type

`tuple`

References

[Tri15]

Examples

```
>>> npm = np.array(
...     [
...         [9.52552396e-01, 0.00000000e00, 9.36786317e-05],
...         [3.43966450e-01, 7.28166097e-01, -7.21325464e-02],
...         [0.00000000e00, 0.00000000e00, 1.00882518e00],
...     ]
... )
>>> p, w = primaries_whitepoint(npm)
>>> p
array([[ 7.3470000...e-01,  2.6530000...e-01],
       [ 0.0000000...e+00,  1.0000000...e+00],
       [ 1.0000000...e-04, -7.7000000...e-02]])
>>> w
array([ 0.32168,  0.33767])
```

colour.RGB_luminance

`colour.RGB_luminance(RGB: ArrayLike, primaries: ArrayLike, whitepoint: ArrayLike) → FloatingOrNDArray`

Return the *luminance* *Y* of given *RGB* components from given *primaries* and *whitepoint*.

Parameters

- **RGB** (ArrayLike) – *RGB* chromaticity coordinate matrix.
- **primaries** (ArrayLike) – *Primaries* chromaticity coordinate matrix.
- **whitepoint** (ArrayLike) – *Illuminant / whitepoint* chromaticity coordinates.

Returns

Luminance *Y*.

Return type`numpy.float64` or `numpy.ndarray`**Examples**

```
>>> RGB = np.array([0.21959402, 0.06986677, 0.04703877])
>>> p = np.array([0.73470, 0.26530, 0.00000, 1.00000, 0.00010, -0.07700])
>>> whitepoint = np.array([0.32168, 0.33767])
>>> RGB_luminance(RGB, p, whitepoint)
0.1230145...
```

colour.RGB_luminance_equation

`colour.RGB_luminance_equation(primaries: ArrayLike, whitepoint: ArrayLike) → str`

Return the *luminance equation* from given *primaries* and *whitepoint*.

Parameters

- **primaries** (ArrayLike) – Primaries chromaticity coordinates.
- **whitepoint** (ArrayLike) – Illuminant / whitepoint chromaticity coordinates.

Returns

Luminance equation.

Return type`str`**Examples**

```
>>> p = np.array([0.73470, 0.26530, 0.00000, 1.00000, 0.00010, -0.07700])
>>> whitepoint = np.array([0.32168, 0.33767])
>>> RGB_luminance_equation(p, whitepoint)
'Y = 0.3439664...(R) + 0.7281660...(G) + -0.0721325...(B)'
```

RGB Colourspaces

colour

| | |
|---|--|
| <code>RGB_Colourspace(name, primaries, whitepoint)</code> | Implement support for the <i>RGB</i> colourspaces datasets from <code>colour.models.datasets.aces_rgb</code> , etc.... |
|---|--|

colour.RGB_Colourspace

```
class colour.RGB_Colourspace(name: str, primaries: ArrayLike, whitepoint: ArrayLike,
                             whitepoint_name: str | None = None, matrix_RGB_to_XYZ: ArrayLike |
                             None = None, matrix_XYZ_to_RGB: ArrayLike | None = None,
                             cctf_encoding: Callable | None = None, cctf_decoding: Callable | None
                             = None, use_derived_matrix_RGB_to_XYZ: bool = False,
                             use_derived_matrix_XYZ_to_RGB: bool = False)
```

Bases: `object`

Implement support for the *RGB* colourspaces datasets from `colour.models.datasets.aces_rgb`, etc. ...

Colour science literature related to *RGB* colourspaces and encodings defines their dataset using different degree of precision or rounding. While instances where a whitepoint is being defined with a value different than its canonical agreed one are rare, it is however very common to have normalised primary matrices rounded at different decimals. This can yield large discrepancies in computations.

Such an occurrence is the *V-Gamut* colourspace white paper, that defines the *V-Gamut* to *ITU-R BT.709* conversion matrix as follows:

```
[[ 1.806576 -0.695697 -0.110879]
 [-0.170090  1.305955 -0.135865]
 [-0.025206 -0.154468  1.179674]]
```

Computing this matrix using *ITU-R BT.709* colourspace derived normalised primary matrix yields:

```
[[ 1.8065736 -0.6956981 -0.1108786]
 [-0.1700890  1.3059548 -0.1358648]
 [-0.0252057 -0.1544678  1.1796737]]
```

The latter matrix is almost equals with the former, however performing the same computation using *IEC 61966-2-1:1999 sRGB* colourspace normalised primary matrix introduces severe disparities:

```
[[ 1.8063853 -0.6956147 -0.1109453]
 [-0.1699311  1.3058387 -0.1358616]
 [-0.0251630 -0.1544899  1.1797117]]
```

In order to provide support for both literature defined dataset and accurate computations enabling transformations without loss of precision, the `colour.RGB_Colourspace` class provides two sets of transformation matrices:

- Instantiation transformation matrices
- Derived transformation matrices

Upon instantiation, the `colour.RGB_Colourspace` class stores the given `matrix_RGB_to_XYZ` and `matrix_XYZ_to_RGB` arguments and also computes their derived counterpart using the primaries and whitepoint arguments.

Whether the initialisation or derived matrices are used in subsequent computations is dependent on the `colour.RGB_Colourspace.use_derived_matrix_RGB_to_XYZ` and `colour.RGB_Colourspace.use_derived_matrix_XYZ_to_RGB` attribute values.

Parameters

- **name** (`str`) – *RGB* colourspace name.
- **primaries** (`ArrayLike`) – *RGB* colourspace primaries.
- **whitepoint** (`ArrayLike`) – *RGB* colourspace whitepoint.
- **whitepoint_name** (`Optional[str]`) – *RGB* colourspace whitepoint name.
- **matrix_RGB_to_XYZ** (`Optional[ArrayLike]`) – Transformation matrix from colourspace to *CIE XYZ* tristimulus values.
- **matrix_XYZ_to_RGB** (`Optional[ArrayLike]`) – Transformation matrix from *CIE XYZ* tristimulus values to colourspace.

- **cctf_encoding** (Optional[Callable]) – Encoding colour component transfer function (Encoding CCTF) / opto-electronic transfer function (OETF) that maps estimated tristimulus values in a scene to $R'G'B'$ video component signal value.
- **cctf_decoding** (Optional[Callable]) – Decoding colour component transfer function (Decoding CCTF) / electro-optical transfer function (EOTF) that maps an $R'G'B'$ video component signal value to tristimulus values at the display.
- **use_derived_matrix_RGB_to_XYZ** (Boolean) – Whether to use the instantiation time normalised primary matrix or to use a computed derived normalised primary matrix.
- **use_derived_matrix_XYZ_to_RGB** (Boolean) – Whether to use the instantiation time inverse normalised primary matrix or to use a computed derived inverse normalised primary matrix.

Attributes

- name
- primaries
- whitepoint
- whitepoint_name
- matrix_RGB_to_XYZ
- matrix_XYZ_to_RGB
- cctf_encoding
- cctf_decoding
- use_derived_matrix_RGB_to_XYZ
- use_derived_matrix_XYZ_to_RGB

Methods

- `__init__`
- `__str__`
- `__repr__`
- `use_derived_transformation_matrices`
- `chromatically_adapt`
- `copy`

Notes

- The normalised primary matrix defined by `colour.RGB_Colourspace.matrix_RGB_to_XYZ` property is treated as the prime matrix from which the inverse will be calculated as required by the internal derivation mechanism. This behaviour has been chosen in accordance with literature where commonly a *RGB* colourspace is defined by its normalised primary matrix as it is directly computed from the chosen primaries and whitepoint.

References

[InternationalECommission99], [Panasonic14]

Examples

```
>>> p = np.array([0.73470, 0.26530, 0.00000, 1.00000, 0.00010, -0.07700])
>>> whitepoint = np.array([0.32168, 0.33767])
>>> matrix_RGB_to_XYZ = np.identity(3)
>>> matrix_XYZ_to_RGB = np.identity(3)
>>> colourspace = RGB_Colourspace(
...     "RGB Colourspace",
...     p,
...     whitepoint,
...     "ACES",
...     matrix_RGB_to_XYZ,
...     matrix_XYZ_to_RGB,
... )
>>> colourspace.matrix_RGB_to_XYZ
array([[ 1.,  0.,  0.],
       [ 0.,  1.,  0.],
       [ 0.,  0.,  1.]])
>>> colourspace.matrix_XYZ_to_RGB
array([[ 1.,  0.,  0.],
       [ 0.,  1.,  0.],
       [ 0.,  0.,  1.]])
>>> colourspace.use_derived_transformation_matrices(True)
>>> colourspace.matrix_RGB_to_XYZ
array([[ 9.5255239...e-01,  0.0000000...e+00,  9.3678631...e-05],
       [ 3.4396645...e-01,  7.2816609...e-01, -7.2132546...e-02],
       [ 0.0000000...e+00,  0.0000000...e+00,  1.0088251...e+00]])
>>> colourspace.matrix_XYZ_to_RGB
array([[ 1.0498110...e+00,  0.0000000...e+00, -9.7484540...e-05],
       [-4.9590302...e-01,  1.3733130...e+00,  9.8240036...e-02],
       [ 0.0000000...e+00,  0.0000000...e+00,  9.9125201...e-01]])
>>> colourspace.use_derived_matrix_RGB_to_XYZ = False
>>> colourspace.matrix_RGB_to_XYZ
array([[ 1.,  0.,  0.],
       [ 0.,  1.,  0.],
       [ 0.,  0.,  1.]])
>>> colourspace.use_derived_matrix_XYZ_to_RGB = False
>>> colourspace.matrix_XYZ_to_RGB
array([[ 1.,  0.,  0.],
       [ 0.,  1.,  0.],
       [ 0.,  0.,  1.]])
```

__init__(name: *str*, primaries: *ArrayLike*, whitepoint: *ArrayLike*, whitepoint_name: *str* | *None* = *None*, matrix_RGB_to_XYZ: *ArrayLike* | *None* = *None*, matrix_XYZ_to_RGB: *ArrayLike* | *None* = *None*, cctf_encoding: *Callable* | *None* = *None*, cctf_decoding: *Callable* | *None* = *None*, use_derived_matrix_RGB_to_XYZ: *bool* = *False*, use_derived_matrix_XYZ_to_RGB: *bool* = *False*) → *None*

Parameters

- **name** (*str*) –
- **primaries** (*ArrayLike*) –
- **whitepoint** (*ArrayLike*) –

- `whitepoint_name` (`str` | `None`) –
- `matrix_RGB_to_XYZ` (`ArrayLike` | `None`) –
- `matrix_XYZ_to_RGB` (`ArrayLike` | `None`) –
- `cctf_encoding` (`Callable` | `None`) –
- `cctf_decoding` (`Callable` | `None`) –
- `use_derived_matrix_RGB_to_XYZ` (`bool`) –
- `use_derived_matrix_XYZ_to_RGB` (`bool`) –

Return type`None`**property name:** `str`

Getter and setter property for the name.

Parameters**value** – Value to set the name with.**Returns***RGB* colourspace name.**Return type**`str`**property primaries:** `ndarray`

Getter and setter property for the primaries.

Parameters**value** – Value to set the primaries with.**Returns***RGB* colourspace primaries.**Return type**`numpy.ndarray`**property whitepoint:** `ndarray`

Getter and setter property for the whitepoint.

Parameters**value** – Value to set the whitepoint with.**Returns***RGB* colourspace whitepoint.**Return type**`numpy.ndarray`**property whitepoint_name:** `str` | `None`

Getter and setter property for the whitepoint_name.

Parameters**value** – Value to set the whitepoint_name with.**Returns***RGB* colourspace whitepoint name.**Return type**`None` or `str`**property matrix_RGB_to_XYZ:** `ndarray`Getter and setter property for the transformation matrix from colourspace to *CIE XYZ* tristimulus values.

Parameters

value – Transformation matrix from colourspace to *CIE XYZ* tristimulus values.

Returns

Transformation matrix from colourspace to *CIE XYZ* tristimulus values.

Return type

`numpy.ndarray`

__weakref__

list of weak references to the object (if defined)

property matrix_XYZ_to_RGB: ndarray

Getter and setter property for the transformation matrix from *CIE XYZ* tristimulus values to colourspace.

Parameters

value – Transformation matrix from *CIE XYZ* tristimulus values to colourspace.

Returns

Transformation matrix from *CIE XYZ* tristimulus values to colourspace.

Return type

`numpy.ndarray`

property cctf_encoding: Callable | None

Getter and setter property for the encoding colour component transfer function (Encoding CCTF) / opto-electronic transfer function (OETF).

Parameters

value – Encoding colour component transfer function (Encoding CCTF) / opto-electronic transfer function (OETF).

Returns

Encoding colour component transfer function (Encoding CCTF) / opto-electronic transfer function (OETF).

Return type

`None` or `Callable`

property cctf_decoding: Callable | None

Getter and setter property for the decoding colour component transfer function (Decoding CCTF) / electro-optical transfer function (EOTF).

Parameters

value – Decoding colour component transfer function (Decoding CCTF) / electro-optical transfer function (EOTF).

Returns

Decoding colour component transfer function (Decoding CCTF) / electro-optical transfer function (EOTF).

Return type

`None` or `Callable`

property use_derived_matrix_RGB_to_XYZ: bool

Getter and setter property for whether to use the instantiation time normalised primary matrix or to use a computed derived normalised primary matrix.

Parameters

value – Whether to use the instantiation time normalised primary matrix or to use a computed derived normalised primary matrix.

Returns

Whether to use the instantiation time normalised primary matrix or to use a computed derived normalised primary matrix.

Return type`bool`**property** `use_derived_matrix_XYZ_to_RGB`: `bool`

Getter and setter property for Whether to use the instantiation time inverse normalised primary matrix or to use a computed derived inverse normalised primary matrix.

Parameters

value – Whether to use the instantiation time inverse normalised primary matrix or to use a computed derived inverse normalised primary matrix.

Returns

Whether to use the instantiation time inverse normalised primary matrix or to use a computed derived inverse normalised primary matrix.

Return type`bool`**__str__**() → `str`

Return a formatted string representation of the *RGB* colourspace.

Returns

Formatted string representation.

Return type`str`**Examples**

```
>>> p = np.array(
...     [0.73470, 0.26530, 0.00000, 1.00000, 0.00010, -0.07700]
... )
>>> whitepoint = np.array([0.32168, 0.33767])
>>> matrix_RGB_to_XYZ = np.identity(3)
>>> matrix_XYZ_to_RGB = np.identity(3)
>>> cctf_encoding = lambda x: x
>>> cctf_decoding = lambda x: x
>>> print(
...     RGB_Colourspace(
...         "RGB Colourspace",
...         p,
...         whitepoint,
...         "ACES",
...         matrix_RGB_to_XYZ,
...         matrix_XYZ_to_RGB,
...         cctf_encoding,
...         cctf_decoding,
...     )
... )
...
RGB Colourspace
-----

Primaries      : [[ 7.34700000e-01  2.65300000e-01]
                  [ 0.00000000e+00  1.00000000e+00]
                  [ 1.00000000e-04 -7.70000000e-02]]
Whitepoint     : [ 0.32168  0.33767]
Whitepoint Name : ACES
Encoding CCTF   : <function <lambda> at 0x...>
```

(continues on next page)

(continued from previous page)

```

Decoding CCTF      : <function <lambda> at 0x...>
NPM                : [[ 1.  0.  0.]
                      [ 0.  1.  0.]
                      [ 0.  0.  1.]]
NPM -1             : [[ 1.  0.  0.]
                      [ 0.  1.  0.]
                      [ 0.  0.  1.]]
Derived NPM        : [[ 9.5255239...e-01  0.0000000...e+00  9.3678631...e-05]
                      [ 3.4396645...e-01  7.2816609...e-01 -7.2132546...e-02]
                      [ 0.0000000...e+00  0.0000000...e+00  1.0088251...e+00]]
Derived NPM -1     : [[ 1.0498110...e+00  0.0000000...e+00 -9.7484540...e-05]
                      [-4.9590302...e-01  1.3733130...e+00  9.8240036...e-02]
                      [ 0.0000000...e+00  0.0000000...e+00  9.9125201...e-01]]
Use Derived NPM    : False
Use Derived NPM -1 : False

```

`__repr__()` → `str`Return an (almost) evaluable string representation of the *RGB* colourspace.**Returns**

(Almost) evaluable string representation.

Return type`class`str``**Examples**

```

>>> from colour.models import linear_function
>>> p = np.array(
...     [0.73470, 0.26530, 0.00000, 1.00000, 0.00010, -0.07700]
... )
>>> whitepoint = np.array([0.32168, 0.33767])
>>> matrix_RGB_to_XYZ = np.identity(3)
>>> matrix_XYZ_to_RGB = np.identity(3)
>>> RGB_Colourspace(
...     "RGB Colourspace",
...     p,
...     whitepoint,
...     "ACES",
...     matrix_RGB_to_XYZ,
...     matrix_XYZ_to_RGB,
...     linear_function,
...     linear_function,
... )
...
RGB_Colourspace('RGB Colourspace',
                [[ 7.34700000e-01,  2.65300000e-01],
                 [ 0.00000000e+00,  1.00000000e+00],
                 [ 1.00000000e-04, -7.70000000e-02]],
                [ 0.32168,  0.33767],
                'ACES',
                [[ 1.,  0.,  0.],
                 [ 0.,  1.,  0.],
                 [ 0.,  0.,  1.]],
                [[ 1.,  0.,  0.],
                 [ 0.,  1.,  0.],

```

(continues on next page)

(continued from previous page)

```
[ 0., 0., 1.]],
linear_function,
linear_function,
False,
False)
```

use_derived_transformation_matrices(usage: *bool* = *True*)

Enable or disables usage of both derived transformations matrices, the normalised primary matrix and its inverse in subsequent computations.

Parameters

usage (*bool*) – Whether to use the derived transformations matrices.

chromatically_adapt(whitepoint: *ArrayLike*, whitepoint_name: *str* | *None* = *None*, chromatic_adaptation_transform: *Literal*['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling'] | *str* = 'CAT02') → *RGB_Colourspace*

Chromatically adapt the *RGB* colourspace *primaries xy* chromaticity coordinates from *RGB* colourspace whitepoint to reference whitepoint.

Parameters

- **whitepoint** (*ArrayLike*) – Reference illuminant / whitepoint *xy* chromaticity coordinates.
- **whitepoint_name** (*str* | *None*) – Reference illuminant / whitepoint name.
- **chromatic_adaptation_transform** (*Literal*['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling'] | *str*) – *Chromatic adaptation* transform.

Returns

Chromatically adapted *RGB* colourspace.

Return type

colour.RGB_Colourspace

Examples

```
>>> p = np.array(
...     [0.73470, 0.26530, 0.00000, 1.00000, 0.00010, -0.07700]
... )
>>> w_t = np.array([0.32168, 0.33767])
>>> w_r = np.array([0.31270, 0.32900])
>>> colourspace = RGB_Colourspace("RGB Colourspace", p, w_t, "D65")
>>> print(colourspace.chromatically_adapt(w_r, "D50", "Bradford"))
...
RGB Colourspace - Chromatically Adapted to 'D50'
-----

Primaries      : [[ 0.73485524  0.26422533]
                  [-0.00617091  1.01131496]
                  [ 0.01596756 -0.0642355 ]]
Whitepoint     : [ 0.3127  0.329 ]
Whitepoint Name : D50
Encoding CTF   : None
```

(continues on next page)

(continued from previous page)

```

Decoding CCTF      : None
NPM                : None
NPM -1             : None
Derived NPM        : [[ 0.93827985 -0.00445145  0.01662752]
                      [ 0.33736889  0.72952157 -0.06689046]
                      [ 0.00117395 -0.00371071  1.09159451]]
Derived NPM -1     : [[ 1.06349549  0.00640891 -0.01580679]
                      [-0.49207413  1.36822341  0.09133709]
                      [-0.00281646  0.00464417  0.91641857]]
Use Derived NPM    : True
Use Derived NPM -1 : True

```

copy() → *RGB_Colourspace*Return a copy of the *RGB* colourspace.**Returns***RGB* colourspace copy.**Return type***colour.RGB_Colourspace***RGB_COLOURSPACES**Aggregated *RGB* colourspaces.**colour.RGB_COLOURSPACES**

```

colour.RGB_COLOURSPACES = LazyCanonicalMapping({'ACES2065-1': ..., 'ACEScc': ...,
'ACEScct': ..., 'ACEScg': ..., 'ACESproxy': ..., 'ARRI Wide Gamut 3': ..., 'ARRI Wide Gamut
4': ..., 'Adobe RGB (1998)': ..., 'Adobe Wide Gamut RGB': ..., 'Apple RGB': ..., 'Best
RGB': ..., 'Beta RGB': ..., 'Blackmagic Wide Gamut': ..., 'CIE RGB': ..., 'Cinema Gamut':
..., 'ColorMatch RGB': ..., 'DCDM XYZ': ..., 'DCI-P3': ..., 'DCI-P3-P': ..., 'DJI D-Gamut':
..., 'DRAGONcolor': ..., 'DRAGONcolor2': ..., 'DaVinci Wide Gamut': ..., 'Display P3': ...,
'Don RGB 4': ..., 'EBU Tech. 3213-E': ..., 'ECI RGB v2': ..., 'ERIMM RGB': ..., 'Ekta Space
PS 5': ..., 'F-Gamut': ..., 'FilmLight E-Gamut': ..., 'ITU-R BT.2020': ..., 'ITU-R BT.470 -
525': ..., 'ITU-R BT.470 - 625': ..., 'ITU-R BT.709': ..., 'ITU-T H.273 - 22 Unspecified':
..., 'ITU-T H.273 - Generic Film': ..., 'Max RGB': ..., 'N-Gamut': ..., 'NTSC (1953)': ...,
'NTSC (1987)': ..., 'P3-D65': ..., 'Pal/Secam': ..., 'ProPhoto RGB': ..., 'Protune Native':
..., 'REDWideGamutRGB': ..., 'REDcolor': ..., 'REDcolor2': ..., 'REDcolor3': ...,
'REDcolor4': ..., 'RIMM RGB': ..., 'ROMM RGB': ..., 'Russell RGB': ..., 'S-Gamut': ...,
'S-Gamut3': ..., 'S-Gamut3.Cine': ..., 'SMPTE 240M': ..., 'SMPTE C': ..., 'Sharp RGB': ...,
'V-Gamut': ..., 'Venice S-Gamut3': ..., 'Venice S-Gamut3.Cine': ..., 'Xtreme RGB': ...,
'sRGB': ..., 'aces': ..., 'adobe1998': ..., 'prophoto': ..., 'ALEXA Wide Gamut': ...})

```

Aggregated *RGB* colourspaces.

Aliases:

- 'aces': `RGB_COLOURSPACE_ACES2065_1.name`
- 'adobe1998': `RGB_COLOURSPACE_ADOBE_RGB1998.name`
- 'prophoto': `RGB_COLOURSPACE_PROPHOTO_RGB.name`

`colour.models`**RGB_COLOURSPACE_ACES2065_1***ACES2065-1* colourspace, base encoding, used for exchange of full fidelity images and archiving.

continues on next page

Table 2 – continued from previous page

| | |
|---------------------------------------|---|
| RGB_COLOURSPACE_ACESCC | <i>ACEScc</i> colourspace, a working space for color correctors, target for ASC-CDL values created on-set. |
| RGB_COLOURSPACE_ACESCCT | <i>ACEScct</i> colourspace, an alternative working space for colour correctors, intended to be transient and internal to software or hardware systems, and is specifically not intended for interchange or archiving. |
| RGB_COLOURSPACE_ACESPROXY | <i>ACESproxy</i> colourspace, a lightweight encoding for transmission over HD-SDI (or other production transmission schemes), onset look management. |
| RGB_COLOURSPACE_ACESCG | <i>ACEScg</i> colourspace, a working space for paint/compositor applications that don't support ACES2065-1 or ACEScc. |
| RGB_COLOURSPACE_ADOBE_RGB1998 | <i>Adobe RGB (1998)</i> colourspace. |
| RGB_COLOURSPACE_ADOBE_WIDE_GAMUT_RGB | <i>Adobe Wide Gamut RGB</i> colourspace. |
| RGB_COLOURSPACE_ARRI_WIDE_GAMUT_3 | <i>ARRI Wide Gamut 3</i> colourspace. |
| RGB_COLOURSPACE_ARRI_WIDE_GAMUT_4 | <i>ARRI Wide Gamut 4</i> colourspace. |
| RGB_COLOURSPACE_APPLE_RGB | <i>Apple RGB</i> colourspace. |
| RGB_COLOURSPACE_BEST_RGB | <i>Best RGB</i> colourspace. |
| RGB_COLOURSPACE_BETA_RGB | <i>Beta RGB</i> colourspace. |
| RGB_COLOURSPACE_BLACKMAGIC_WIDE_GAMUT | <i>Blackmagic Wide Gamut</i> colourspace. |
| RGB_COLOURSPACE_BT470_525 | <i>Recommendation ITU-R BT.470 - 525</i> colourspace. |
| RGB_COLOURSPACE_BT470_625 | <i>Recommendation ITU-R BT.470 - 625</i> colourspace. |
| RGB_COLOURSPACE_BT709 | <i>Recommendation ITU-R BT.709</i> colourspace. |
| RGB_COLOURSPACE_BT2020 | <i>Recommendation ITU-R BT.2020</i> colourspace. |
| RGB_COLOURSPACE_CIE_RGB | <i>CIE RGB</i> colourspace. |
| RGB_COLOURSPACE_CINEMA_GAMUT | <i>Canon Cinema Gamut</i> colourspace. |
| RGB_COLOURSPACE_COLOR_MATCH_RGB | <i>ColorMatch RGB</i> colourspace. |
| RGB_COLOURSPACE_DAVINCI_WIDE_GAMUT | <i>DaVinci Wide Gamut</i> colourspace. |
| RGB_COLOURSPACE_DCDM_XYZ | <i>DCDM XYZ</i> colourspace. |
| RGB_COLOURSPACE_DCI_P3 | <i>DCI-P3</i> colourspace. |
| RGB_COLOURSPACE_DCI_P3_P | <i>DCI-P3+</i> colourspace. |
| RGB_COLOURSPACE_DISPLAY_P3 | <i>Display P3</i> colourspace. |
| RGB_COLOURSPACE_DON_RGB_4 | <i>Don RGB 4</i> colourspace. |
| RGB_COLOURSPACE_EBU_3213_E | <i>*EBU Tech.</i> |
| RGB_COLOURSPACE_ECI_RGB_V2 | <i>ECI RGB v2</i> colourspace. |
| RGB_COLOURSPACE_EKTA_SPACE_PS_5 | <i>Ekta Space PS 5</i> colourspace. |
| RGB_COLOURSPACE_F_GAMUT | <i>Fujifilm F-Gamut</i> colourspace. |
| RGB_COLOURSPACE_H273_GENERIC_FILM | <i>Recommendation ITU-T H.273 Generic Film</i> (colour filters using Illuminant C) colourspace. |
| RGB_COLOURSPACE_H273_22_UNSPECIFIED | <i>Recommendation ITU-T H.273 row 22</i> colourspace as given in <i>Table 2 - Interpretation of colour primaries (ColourPrimaries)</i> value. |
| RGB_COLOURSPACE_PROTUNE_NATIVE | <i>Protune Native</i> colourspace. |
| RGB_COLOURSPACE_MAX_RGB | <i>Max RGB</i> colourspace. |
| RGB_COLOURSPACE_NTSC1953 | <i>NTSC (1953)</i> colourspace. |
| RGB_COLOURSPACE_NTSC1987 | <i>NTSC (1987)</i> colourspace. |
| RGB_COLOURSPACE_P3_D65 | <i>P3-D65</i> colourspace. |
| RGB_COLOURSPACE_PAL_SECAM | <i>Pal/Secam</i> colourspace. |
| RGB_COLOURSPACE_RED_COLOR | <i>REDcolor</i> colourspace. |
| RGB_COLOURSPACE_RED_COLOR_2 | <i>REDcolor2</i> colourspace. |
| RGB_COLOURSPACE_RED_COLOR_3 | <i>REDcolor3</i> colourspace. |
| RGB_COLOURSPACE_RED_COLOR_4 | <i>REDcolor4</i> colourspace. |
| RGB_COLOURSPACE_RED_WIDE_GAMUT_RGB | <i>REDWideGamutRGB</i> colourspace. |

continues on next page

Table 2 – continued from previous page

| | |
|--------------------------------------|---|
| RGB_COLOURSPACE_DRAGON_COLOR | <i>DRAGONcolor</i> colourspace. |
| RGB_COLOURSPACE_DRAGON_COLOR_2 | <i>DRAGONcolor2</i> colourspace. |
| RGB_COLOURSPACE_ROMM_RGB | <i>ROMM RGB</i> colourspace. |
| RGB_COLOURSPACE_RIMM_RGB | <i>RIMM RGB</i> colourspace. |
| RGB_COLOURSPACE_ERIMM_RGB | <i>ERIMM RGB</i> colourspace. |
| RGB_COLOURSPACE_PROPHOTO_RGB | <i>ProPhoto RGB</i> colourspace, an alias colourspace for <i>ROMM RGB</i> . |
| RGB_COLOURSPACE_RUSSELL_RGB | <i>Russell RGB</i> colourspace. |
| RGB_COLOURSPACE_SMPTE_240M | <i>SMPTE 240M</i> colourspace. |
| RGB_COLOURSPACE_SMPTE_C | Implement support for the <i>RGB</i> colourspace datasets from <code>colour.models.datasets.aces_rgb</code> , etc.... |
| RGB_COLOURSPACE_S_GAMUT | <i>S-Gamut</i> colourspace. |
| RGB_COLOURSPACE_S_GAMUT3 | <i>S-Gamut3</i> colourspace. |
| RGB_COLOURSPACE_S_GAMUT3_CINE | <i>S-Gamut3.Cine</i> colourspace. |
| RGB_COLOURSPACE_VENICE_S_GAMUT3 | <i>Venice S-Gamut3</i> colourspace. |
| RGB_COLOURSPACE_VENICE_S_GAMUT3_CINE | <i>Venice S-Gamut3.Cine</i> colourspace. |
| RGB_COLOURSPACE_sRGB | <i>sRGB</i> colourspace. |
| RGB_COLOURSPACE_V_GAMUT | <i>Panasonic V-Gamut</i> colourspace. |
| RGB_COLOURSPACE_XTREME_RGB | <i>Xtreme RGB</i> colourspace. |

colour.models.RGB_COLOURSPACE_ACES2065_1

```
colour.models.RGB_COLOURSPACE_ACES2065_1 = RGB_Colourspace('ACES2065-1', [[
7.34700000e-01, 2.65300000e-01], [ 0.00000000e+00, 1.00000000e+00], [ 1.00000000e-04,
-7.70000000e-02]], [ 0.32168, 0.33767], 'ACES', [[ 9.52552396e-01, 0.00000000e+00,
9.36786000e-05], [ 3.43966450e-01, 7.28166097e-01, -7.21325464e-02], [ 0.00000000e+00,
0.00000000e+00, 1.00882518e+00]], [[ 1.04981102e+00, 0.00000000e+00, -9.74845000e-05], [
-4.95903023e-01, 1.37331305e+00, 9.82400361e-02], [ 0.00000000e+00, 0.00000000e+00,
9.91252018e-01]], linear_function, linear_function, False, False)
```

ACES2065-1 colourspace, base encoding, used for exchange of full fidelity images and archiving.

References

[TheAoMPAAsciencesScienceaTCouncilAcademyCESACESPSubcommittee14b], [TheAoMPAA-
SciencesScienceaTCouncilAcademyCESACESPSubcommittee14c], [TheAoMPAAsciencesS-
cienceaTCouncilAcademyCESACESPSubmitteea]

colour.models.RGB_COLOURSPACE_ACESCC

```
colour.models.RGB_COLOURSPACE_ACESCC = RGB_Colourspace('ACEScc', [[ 0.713, 0.293], [
0.165, 0.83 ], [ 0.128, 0.044]], [ 0.32168, 0.33767], 'ACES', [[ 0.66245418, 0.13400421,
0.15618769], [ 0.27222872, 0.67408177, 0.05368952], [-0.00557465, 0.00406073, 1.0103391 ]],
[[ 1.64102338, -0.32480329, -0.2364247 ], [-0.66366286, 1.61533159, 0.01675635], [
0.01172189, -0.00828444, 0.98839486]], log_encoding_ACEScc, log_decoding_ACEScc, False,
False)
```

ACEScc colourspace, a working space for color correctors, target for ASC-CDL values created on-set.

References

[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14b], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14c], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14a], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommitteea]

colour.models.RGB_COLOURSPACE_ACESCCT

```
colour.models.RGB_COLOURSPACE_ACESCCT = RGB_Colourspace('ACEScct', [[ 0.713, 0.293], [
0.165, 0.83 ], [ 0.128, 0.044]], [ 0.32168, 0.33767], 'ACES', [[ 0.66245418, 0.13400421,
0.15618769], [ 0.27222872, 0.67408177, 0.05368952], [-0.00557465, 0.00406073, 1.0103391 ]],
[[ 1.64102338, -0.32480329, -0.2364247 ], [-0.66366286, 1.61533159, 0.01675635], [
0.01172189, -0.00828444, 0.98839486]], log_encoding_ACESCct, log_decoding_ACESCct, False,
False)
```

ACEScct colourspace, an alternative working space for colour correctors, intended to be transient and internal to software or hardware systems, and is specifically not intended for interchange or archiving.

References

[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14b], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14c], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESProject16], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommitteea]

colour.models.RGB_COLOURSPACE_ACESPROXY

```
colour.models.RGB_COLOURSPACE_ACESPROXY = RGB_Colourspace('ACESproxy', [[ 0.713, 0.293], [
0.165, 0.83 ], [ 0.128, 0.044]], [ 0.32168, 0.33767], 'ACES', [[ 0.66245418, 0.13400421,
0.15618769], [ 0.27222872, 0.67408177, 0.05368952], [-0.00557465, 0.00406073, 1.0103391 ]],
[[ 1.64102338, -0.32480329, -0.2364247 ], [-0.66366286, 1.61533159, 0.01675635], [
0.01172189, -0.00828444, 0.98839486]], log_encoding_ACESproxy, log_decoding_ACESproxy,
False, False)
```

ACESproxy colourspace, a lightweight encoding for transmission over HD-SDI (or other production transmission schemes), onset look management. Not intended to be stored or used in production imagery or for final colour grading / mastering.

References

[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14b], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14c], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee13], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommitteea]

colour.models.RGB_COLOURSPACE_ACESCG

```
colour.models.RGB_COLOURSPACE_ACESCG = RGB_Colourspace('ACEScg', [[ 0.713, 0.293], [
0.165, 0.83 ], [ 0.128, 0.044]], [ 0.32168, 0.33767], 'ACES', [[ 0.66245418, 0.13400421,
0.15618769], [ 0.27222872, 0.67408177, 0.05368952], [-0.00557465, 0.00406073, 1.0103391 ]],
[[ 1.64102338, -0.32480329, -0.2364247 ], [-0.66366286, 1.61533159, 0.01675635], [
0.01172189, -0.00828444, 0.98839486]], linear_function, linear_function, False, False)
```

ACEScg colourspace, a working space for paint/compositor applications that don't support ACES2065-1 or ACEScc.

References

[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14b], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14c], [TheAoMPAaSciencesScienceandTCouncilAcademyCESACESPSubcommittee15], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommitteea]

colour.models.RGB_COLOURSPACE_ADOBE_RGB1998

```
colour.models.RGB_COLOURSPACE_ADOBE_RGB1998 = RGB_Colourspace('Adobe RGB (1998)', [[ 0.64,
0.33], [ 0.21, 0.71], [ 0.15, 0.06]], [ 0.3127, 0.329 ], 'D65', [[ 0.57667, 0.18556,
0.18823], [ 0.29734, 0.62736, 0.07529], [ 0.02703, 0.07069, 0.99134]], [[ 2.04159,
-0.56501, -0.34473], [-0.96924, 1.87597, 0.04156], [ 0.01344, -0.11836, 1.01517]],
functools.partial(<function gamma_function>, exponent=0.4547069271758437),
functools.partial(<function gamma_function>, exponent=2.19921875), False, False)
```

Adobe RGB (1998) colourspace.

References

[AdobeSystems05]

colour.models.RGB_COLOURSPACE_ADOBE_WIDE_GAMUT_RGB

```
colour.models.RGB_COLOURSPACE_ADOBE_WIDE_GAMUT_RGB = RGB_Colourspace('Adobe Wide Gamut
RGB', [[ 0.7347, 0.2653], [ 0.1152, 0.8264], [ 0.1566, 0.0177]], [ 0.3457, 0.3585], 'D50',
[[ 0.71650072, 0.10102057, 0.14677439], [ 0.25872824, 0.72468231, 0.01658944], [ 0. ,
0.05121182, 0.77389278]], [[ 1.46230418, -0.18452564, -0.27338105], [-0.52286828,
1.4479884 , 0.06812617], [ 0.03460045, -0.09581963, 1.28766046]],
functools.partial(<function gamma_function>, exponent=0.4547069271758437),
functools.partial(<function gamma_function>, exponent=2.19921875), False, False)
```

Adobe Wide Gamut RGB colourspace.

References

[Wikipedia04d]

colour.models.RGB_COLOURSPACE_ARRI_WIDE_GAMUT_3

```
colour.models.RGB_COLOURSPACE_ARRI_WIDE_GAMUT_3 = RGB_Colourspace('ARRI Wide Gamut 3', [[
0.684 , 0.313 ], [ 0.221 , 0.848 ], [ 0.0861, -0.102 ]], [ 0.3127, 0.329 ], 'D65', [[
0.638008, 0.214704, 0.097744], [ 0.291954, 0.823841, -0.115795], [ 0.002798, -0.067034,
1.153294]], [[ 1.789066, -0.482534, -0.200076], [-0.639849, 1.3964 , 0.194432], [-0.041532,
0.082335, 0.878868]], log_encoding_ARRILogC3, log_decoding_ARRILogC3, False, False)
```

ARRI Wide Gamut 3 colourspace.

References

[ARRI12]

colour.models.RGB_COLOURSPACE_ARRI_WIDE_GAMUT_4

```
colour.models.RGB_COLOURSPACE_ARRI_WIDE_GAMUT_4 = RGB_Colourspace('ARRI Wide Gamut 4', [[
0.7347, 0.2653], [ 0.1424, 0.8576], [ 0.0991, -0.0308]], [ 0.3127, 0.329 ], 'D65', [[
0.70485832, 0.1297603 , 0.11583731], [ 0.25452418, 0.78147773, -0.03600191], [ 0. , 0. ,
1.08905775]], [[ 1.50921547, -0.25059735, -0.16881148], [-0.49154545, 1.36124555,
0.09728294], [ 0. , 0. , 0.91822495]], log_encoding_ARRILogC4, log_decoding_ARRILogC4,
False, False)
```

ARRI Wide Gamut 4 colourspace.

References

[CB22]

colour.models.RGB_COLOURSPACE_APPLE_RGB

```
colour.models.RGB_COLOURSPACE_APPLE_RGB = RGB_Colourspace('Apple RGB', [[ 0.625, 0.34 ], [
0.28 , 0.595], [ 0.155, 0.07 ]], [ 0.3127, 0.329 ], 'D65', [[ 0.44966162, 0.31625612,
0.18453819], [ 0.24461592, 0.67204425, 0.08333983], [ 0.02518105, 0.14118577, 0.92269093]],
[[ 2.95197848, -1.2896043 , -0.47391531], [-1.08508357, 1.99080934, 0.03720168], [
0.08547221, -0.26942971, 1.09102767]], functools.partial(<function gamma_function>,
exponent=0.5555555555555556), functools.partial(<function gamma_function>, exponent=1.8),
False, False)
```

Apple RGB colourspace.

References

[SBS99]

colour.models.RGB_COLOURSPACE_BEST_RGB

```
colour.models.RGB_COLOURSPACE_BEST_RGB = RGB_Colourspace('Best RGB', [[ 0.73519164,
0.26480836], [ 0.21533613, 0.77415966], [ 0.13012295, 0.03483607]], [ 0.3457, 0.3585],
'D50', [[ 0.6318944 , 0.20538793, 0.12701335], [ 0.22760177, 0.73839465, 0.03400357], [ 0.
, 0.01001892, 0.81508568]], [[ 1.75737181, -0.48538023, -0.25359913], [-0.54199672,
1.50475404, 0.02168337], [ 0.00666215, -0.01849623, 1.22659836]],
functools.partial(<function gamma_function>, exponent=0.45454545454545453),
functools.partial(<function gamma_function>, exponent=2.2), False, False)
```

Best RGB colourspace.

References

[[HutchColora](#)]

colour.models.RGB_COLOURSPACE_BETA_RGB

```
colour.models.RGB_COLOURSPACE_BETA_RGB = RGB_Colourspace('Beta RGB', [[ 0.6888, 0.3112], [
0.1986, 0.7551], [ 0.1265, 0.0352]], [ 0.3457, 0.3585], 'D50', [[ 6.71355903e-01,
1.74572381e-01, 1.18367393e-01], [ 3.03318753e-01, 6.63744233e-01, 3.29370136e-02], [
5.41053122e-17, 4.06983949e-02, 7.84406208e-01]], [[ 1.68297071, -0.42817109,
-0.23598255], [-0.77107152, 1.70666472, 0.04469277], [ 0.04000653, -0.08854917,
1.27253082]], functools.partial(<function gamma_function>, exponent=0.45454545454545453),
functools.partial(<function gamma_function>, exponent=2.2), False, False)
```

Beta RGB colourspace.

References

[[Lin14](#)]

colour.models.RGB_COLOURSPACE_BLACKMAGIC_WIDE_GAMUT

```
colour.models.RGB_COLOURSPACE_BLACKMAGIC_WIDE_GAMUT = RGB_Colourspace('Blackmagic Wide
Gamut', [[ 0.7177215, 0.3171181], [ 0.228041 , 0.861569 ], [ 0.1005841, -0.0820452]], [
0.312717 , 0.3290312], 'Blackmagic Wide Gamut', [[ 0.60653037, 0.2204081 , 0.123479 ], [
0.26798941, 0.83273088, -0.10072029], [-0.02944217, -0.08661061, 1.20486076]], [[
1.86638234, -0.51839734, -0.23460981], [-0.60034249, 1.37814896, 0.17673183], [
0.00245199, 0.08639967, 0.83694271]], oetf_BlackmagicFilmGeneration5,
oetf_inverse_BlackmagicFilmGeneration5, True, True)
```

Blackmagic Wide Gamut colourspace.

References

[[BlackmagicDesign21](#)]

colour.models.RGB_COLOURSPACE_BT470_525

```
colour.models.RGB_COLOURSPACE_BT470_525 = RGB_Colourspace('ITU-R BT.470 - 525', [[ 0.67,
0.33], [ 0.21, 0.71], [ 0.14, 0.08]], [ 0.31006, 0.31616], 'C', [[ 6.06863809e-01,
1.73507281e-01, 2.00334881e-01], [ 2.98903070e-01, 5.86619855e-01, 1.14477075e-01], [
-5.02801622e-17, 6.60980118e-02, 1.11615148e+00]], [[ 1.91008143, -0.53247794,
-0.28822201], [-0.98463135, 1.99910001, -0.02830719], [ 0.05830945, -0.11838584,
0.89761208]], functools.partial(<function gamma_function>, exponent=0.35714285714285715),
functools.partial(<function gamma_function>, exponent=2.8), False, False)
```

Recommendation ITU-R BT.470 - 525 colourspace.

References

[[InternationalTUnion98b](#)]

colour.models.RGB_COLOURSPACE_BT470_625

```
colour.models.RGB_COLOURSPACE_BT470_625 = RGB_Colourspace('ITU-R BT.470 - 625', [[ 0.64,
0.33], [ 0.29, 0.6 ], [ 0.15, 0.06]], [ 0.3127, 0.329 ], 'D65', [[ 0.43055381, 0.3415498 ,
0.17835231], [ 0.22200431, 0.70665477, 0.07134092], [ 0.02018221, 0.12955337, 0.93932217]],
[[ 3.06336109, -1.39339017, -0.47582374], [-0.96924364, 1.8759675 , 0.04155506], [
0.06786105, -0.22879927, 1.06908962]], functools.partial(<function gamma_function>,
exponent=0.35714285714285715), functools.partial(<function gamma_function>, exponent=2.8),
False, False)
```

Recommendation ITU-R BT.470 - 625 colourspace.

References

[[InternationalTUnion98b](#)]

colour.models.RGB_COLOURSPACE_BT709

```
colour.models.RGB_COLOURSPACE_BT709 = RGB_Colourspace('ITU-R BT.709', [[ 0.64, 0.33], [ 0.3
, 0.6 ], [ 0.15, 0.06]], [ 0.3127, 0.329 ], 'D65', [[ 0.4123908 , 0.35758434, 0.18048079],
[ 0.21263901, 0.71516868, 0.07219232], [ 0.01933082, 0.11919478, 0.95053215]], [[
3.24096994, -1.53738318, -0.49861076], [-0.96924364, 1.8759675 , 0.04155506], [ 0.05563008,
-0.20397696, 1.05697151]], oetf_BT709, oetf_inverse_BT709, False, False)
```

Recommendation ITU-R BT.709 colourspace.

References

[[InternationalTUnion15b](#)]

colour.models.RGB_COLOURSPACE_BT2020

```
colour.models.RGB_COLOURSPACE_BT2020 = RGB_Colourspace('ITU-R BT.2020', [[ 0.708, 0.292],  
[ 0.17, 0.797], [ 0.131, 0.046]], [ 0.3127, 0.329 ], 'D65', [[ 6.36958048e-01,  
1.44616904e-01, 1.68880975e-01], [ 2.62700212e-01, 6.77998072e-01, 5.93017165e-02], [  
4.99410657e-17, 2.80726930e-02, 1.06098506e+00]], [[ 1.71665119, -0.35567078,  
-0.25336628], [-0.66668435, 1.61648124, 0.01576855], [ 0.01763986, -0.04277061,  
0.94210312]], oetf_BT2020, oetf_inverse_BT2020, False, False)
```

RecommendationITU-R BT.2020 colourspace.

The wavelength of the *RecommendationITU-R BT.2020* primary colours are:

- 630nm for the red primary colour
- 532nm for the green primary colour
- 467nm for the blue primary colour.

References

[[InternationalTUnion15a](#)]

colour.models.RGB_COLOURSPACE_CIE_RGB

```
colour.models.RGB_COLOURSPACE_CIE_RGB = RGB_Colourspace('CIE RGB', [[ 0.73474284,  
0.26525716], [ 0.27377903, 0.7174777 ], [ 0.16655563, 0.00891073]], [ 0.33333333,  
0.33333333], 'E', [[ 0.49, 0.31, 0.2 ], [ 0.1769, 0.8124, 0.0107], [ 0. , 0.0099,  
0.9901]], [[ 2.36449012, -0.89655263, -0.46793749], [-0.51493525, 1.42633279, 0.08860245],  
[ 0.00514883, -0.01426189, 1.00911305]], functools.partial(<function gamma_function>,  
exponent=0.45454545454545453), functools.partial(<function gamma_function>, exponent=2.2),  
False, False)
```

CIE RGB colourspace.

References

[[FBH97](#)]

colour.models.RGB_COLOURSPACE_CINEMA_GAMUT

```
colour.models.RGB_COLOURSPACE_CINEMA_GAMUT = RGB_Colourspace('Cinema Gamut', [[ 0.74,  
0.27], [ 0.17, 1.14], [ 0.08, -0.1 ]], [ 0.3127, 0.329 ], 'D65', [[ 0.71604965, 0.12968348,  
0.1047228 ], [ 0.26126136, 0.86964215, -0.1309035 ], [-0.00967635, -0.23648164,  
1.33521573]], [[ 1.48981827, -0.2608959, -0.14242652], [-0.45816657, 1.26162778,  
0.15962363], [-0.07034967, 0.22155767, 0.7761816 ]], linear_function, linear_function,  
False, False)
```

Canon Cinema Gamut colourspace.

References

[Canon14]

colour.models.RGB_COLOURSPACE_COLOR_MATCH_RGB

```
colour.models.RGB_COLOURSPACE_COLOR_MATCH_RGB = RGB_Colourspace('ColorMatch RGB', [[ 0.63
, 0.34 ], [ 0.295, 0.605], [ 0.15 , 0.075]], [ 0.3457, 0.3585], 'D50', [[ 0.5094668 ,
0.32087954, 0.13394933], [ 0.27495034, 0.658075 , 0.06697467], [ 0.02426032, 0.10877273,
0.69207155]], [[ 2.64164976, -1.22313179, -0.39291946], [-1.11207173, 2.05919502,
0.01596275], [ 0.08218196, -0.28076676, 1.45620209]], functools.partial(<function
gamma_function>, exponent=0.5555555555555556), functools.partial(<function
gamma_function>, exponent=1.8), False, False)
```

ColorMatch RGB colourspace.

References

[Lin14]

colour.models.RGB_COLOURSPACE_DAVINCI_WIDE_GAMUT

```
colour.models.RGB_COLOURSPACE_DAVINCI_WIDE_GAMUT = RGB_Colourspace('DaVinci Wide Gamut',
[[ 0.8 , 0.313 ], [ 0.1682, 0.9877], [ 0.079 , -0.1155]], [ 0.3127, 0.329 ], 'D65', [[
0.70062239, 0.14877482, 0.10105872], [ 0.27411851, 0.8736319 , -0.14775041], [-0.09896291,
-0.13789533, 1.32591599]], [[ 1.51667204, -0.28147805, -0.14696363], [-0.4649171 ,
1.25142378, 0.17488461], [ 0.06484905, 0.10913934, 0.76141462]], oetf_DaVinciIntermediate,
oetf_inverse_DaVinciIntermediate, True, True)
```

DaVinci Wide Gamut colourspace.

References

[BlackmagicDesign20b], [BlackmagicDesign20a]

colour.models.RGB_COLOURSPACE_DCDM_XYZ

```
colour.models.RGB_COLOURSPACE_DCDM_XYZ = RGB_Colourspace('DCDM XYZ', [[ 1., 0.], [ 0., 1.],
[ 0., 0.]], [ 0.33333333, 0.33333333], 'E', [[ 1., 0., 0.], [ 0., 1., 0.], [ 0., 0., 1.]],
[[ 1., 0., 0.], [ 0., 1., 0.], [ 0., 0., 1.]], eotf_inverse_DCDM, eotf_DCDM, False, False)
```

DCDM XYZ colourspace.

References

[DigitalCInitiatives07]

colour.models.RGB_COLOURSPACE_DCI_P3

```
colour.models.RGB_COLOURSPACE_DCI_P3 = RGB_Colourspace('DCI-P3', [[ 0.68 , 0.32 ], [ 0.265, 0.69 ], [ 0.15 , 0.06 ]], [ 0.314, 0.351], 'DCI-P3', [[ 4.45169816e-01, 2.77134409e-01, 1.72282670e-01], [ 2.09491678e-01, 7.21595254e-01, 6.89130679e-02], [ -3.63410132e-17, 4.70605601e-02, 9.07355394e-01]], [[ 2.72539403, -1.01800301, -0.4401632 ], [-0.79516803, 1.68973205, 0.02264719], [ 0.04124189, -0.08763902, 1.10092938]],  
functools.partial(<function gamma_function>, exponent=0.3846153846153846),  
functools.partial(<function gamma_function>, exponent=2.6), False, False)
```

DCI-P3 colourspace.

References

[[DigitalCInitiatives07](#)], [[HewlettPDCompany09](#)]

colour.models.RGB_COLOURSPACE_DCI_P3_P

```
colour.models.RGB_COLOURSPACE_DCI_P3_P = RGB_Colourspace('DCI-P3-P', [[ 0.74, 0.27], [ 0.22, 0.78], [ 0.09, -0.09]], [ 0.314, 0.351], 'DCI-P3', [[ 0.55907356, 0.24893595, 0.08657739], [ 0.2039863 , 0.88259109, -0.08657739], [-0.00755505, 0. , 0.961971 ]], [[ 1.99040349, -0.56139586, -0.22966194], [-0.45849279, 1.262346 , 0.15487549], [ 0.01563207, -0.00440904, 1.03772867]], functools.partial(<function gamma_function>,  
exponent=0.3846153846153846), functools.partial(<function gamma_function>, exponent=2.6),  
False, False)
```

DCI-P3+ colourspace.

Notes

- The actual *DCI-P3+* colourspace name is *DCI-P3-P* to avoid canonical key collisions in the *colour.utilities.CanonicalMapping* class.

References

[[Canon14](#)]

colour.models.RGB_COLOURSPACE_DISPLAY_P3

```
colour.models.RGB_COLOURSPACE_DISPLAY_P3 = RGB_Colourspace('Display P3', [[ 0.68 , 0.32 ], [ 0.265, 0.69 ], [ 0.15 , 0.06 ]], [ 0.3127, 0.329 ], 'D65', [[ 4.86570949e-01, 2.65667693e-01, 1.98217285e-01], [ 2.28974564e-01, 6.91738522e-01, 7.92869141e-02], [ -3.97207552e-17, 4.51133819e-02, 1.04394437e+00]], [[ 2.49349691, -0.93138362, -0.40271078], [-0.82948897, 1.76266406, 0.02362469], [ 0.03584583, -0.07617239, 0.95688452]], eotf_inverse_sRGB, eotf_sRGB, False, False)
```

Display P3 colourspace.

References

[AppleInc19]

colour.models.RGB_COLOURSPACE_DON_RGB_4

```
colour.models.RGB_COLOURSPACE_DON_RGB_4 = RGB_Colourspace('Don RGB 4', [[ 0.69612069,
0.29956897], [ 0.21468298, 0.76529477], [ 0.12993763, 0.03534304]], [ 0.3457, 0.3585],
'D50', [[ 0.64631888, 0.19296024, 0.12501655], [ 0.27813723, 0.68785827, 0.0340045 ], [
0.00400197, 0.01799629, 0.80310634]], [[ 1.75819127, -0.48659205, -0.25308814],
[-0.7112839 , 1.65225302, 0.04076449], [ 0.00717743, -0.03459953, 1.24551283]],
functools.partial(<function gamma_function>, exponent=0.45454545454545453),
functools.partial(<function gamma_function>, exponent=2.2), False, False)
```

Don RGB 4 colourspace.

References

[HutchColorb]

colour.models.RGB_COLOURSPACE_EBU_3213_E

```
colour.models.RGB_COLOURSPACE_EBU_3213_E = RGB_Colourspace('EBU Tech. 3213-E', [[ 0.64,
0.33], [ 0.29, 0.6 ], [ 0.15, 0.06]], [ 0.313, 0.329], 'D65', [[ 0.43194331, 0.341235 ,
0.17818948], [ 0.22272077, 0.70600344, 0.07127579], [ 0.02024734, 0.12943396, 0.93846459]],
[[ 3.05350675, -1.38890786, -0.47429309], [-0.97013781, 1.87769818, 0.04159339], [
0.06792306, -0.22900835, 1.07006656]], linear_function, linear_function, False, False)
```

EBU Tech. 3213-E colourspace.

References

[EuropeanBUnion75]

colour.models.RGB_COLOURSPACE_ECI_RGB_V2

```
colour.models.RGB_COLOURSPACE_ECI_RGB_V2 = RGB_Colourspace('ECI RGB v2', [[ 0.67010309,
0.32989691], [ 0.20990566, 0.70990566], [ 0.14006179, 0.08032956]], [ 0.3457, 0.3585],
'D50', [[ 0.65032438, 0.177949 , 0.13602229], [ 0.3201597 , 0.60182752, 0.07801279], [ 0. ,
0.06798052, 0.75712409]], [[ 1.78215602, -0.49656317, -0.26901095], [-0.95923427,
1.94844461, -0.02843173], [ 0.08612755, -0.17494658, 1.32334029]],
functools.partial(<function _scale_domain_0_100_range_0_1>, callable_=<function
lightness_CIE1976>), functools.partial(<function _scale_domain_0_100_range_0_1>,
callable_=<function luminance_CIE1976>), False, False)
```

ECI RGB v2 colourspace.

References

[[EuropeanCInitiative02](#)]

colour.models.RGB_COLOURSPACE_EKTA_SPACE_PS_5

```
colour.models.RGB_COLOURSPACE_EKTA_SPACE_PS_5 = RGB_Colourspace('Ekta Space PS 5', [[
0.69473684, 0.30526316], [ 0.26 , 0.7 ], [ 0.10972851, 0.00452489]], [ 0.3457, 0.3585],
'D50', [[ 0.59433686, 0.27294481, 0.09701401], [ 0.26114801, 0.73485141, 0.00400058], [ 0.
, 0.04199151, 0.78311309]], [[ 2.00336603, -0.73013869, -0.24445204], [-0.71215462,
1.62076569, 0.07994372], [ 0.03818663, -0.08690749, 1.27266809]],
functools.partial(<function gamma_function>, exponent=0.45454545454545453),
functools.partial(<function gamma_function>, exponent=2.2), False, False)
```

Ekta Space PS 5 colourspace.

References

[[Hol](#)]

colour.models.RGB_COLOURSPACE_F_GAMUT

```
colour.models.RGB_COLOURSPACE_F_GAMUT = RGB_Colourspace('F-Gamut', [[ 0.708, 0.292], [
0.17 , 0.797], [ 0.131, 0.046]], [ 0.3127, 0.329 ], 'D65', [[ 6.36958048e-01,
1.44616904e-01, 1.68880975e-01], [ 2.62700212e-01, 6.77998072e-01, 5.93017165e-02], [
4.99410657e-17, 2.80726930e-02, 1.06098506e+00]], [[ 1.71665119, -0.35567078,
-0.25336628], [-0.66668435, 1.61648124, 0.01576855], [ 0.01763986, -0.04277061,
0.94210312]], log_encoding_FLog, log_decoding_FLog, False, False)
```

Fujifilm F-Gamut colourspace.

References

[[Fujifilm16](#)]

colour.models.RGB_COLOURSPACE_H273_GENERIC_FILM

```
colour.models.RGB_COLOURSPACE_H273_GENERIC_FILM = RGB_Colourspace('ITU-T H.273 - Generic
Film', [[ 0.681, 0.319], [ 0.243, 0.692], [ 0.145, 0.049]], [ 0.31 , 0.316], 'C', [[
5.41353080e-01, 2.38201725e-01, 2.01457854e-01], [ 2.53585363e-01, 6.78335776e-01,
6.80788609e-02], [ -4.41279481e-17, 6.37165107e-02, 1.11982779e+00]], [[ 2.19248548,
-0.73706449, -0.34962064], [-0.82433417, 1.75978548, 0.04131385], [ 0.04690337,
-0.10012914, 0.89064375]], linear_function, linear_function, False, False)
```

Recommendation ITU-T H.273 Generic Film (colour filters using Illuminant C) colourspace.

References

[[InternationalTUnion21](#)]

colour.models.RGB_COLOURSPACE_H273_22_UNSPECIFIED

```
colour.models.RGB_COLOURSPACE_H273_22_UNSPECIFIED = RGB_Colourspace('ITU-T H.273 - 22
Unspecified', [[ 0.63 , 0.34 ], [ 0.295, 0.605], [ 0.155, 0.077]], [ 0.3127, 0.329 ],
'D65', [[ 0.42942013, 0.3277917 , 0.1932441 ], [ 0.23175055, 0.67225077, 0.09599868], [
0.02044858, 0.11111583, 0.95749334]], [[ 3.13288278, -1.44707454, -0.48720324],
[-1.08850877, 2.01538781, 0.01762239], [ 0.05941301, -0.20297883, 1.05275352]],
linear_function, linear_function, False, False)
```

Recommendation ITU-T H.273 row 22 colourspace as given in Table 2 - Interpretation of colour primaries (ColourPrimaries) value.

References

[[InternationalTUnion21](#)]

colour.models.RGB_COLOURSPACE_PROTUNE_NATIVE

```
colour.models.RGB_COLOURSPACE_PROTUNE_NATIVE = RGB_Colourspace('Protune Native', [[
0.69848046, 0.19302645], [ 0.32955538, 1.02459662], [ 0.10844263, -0.03467857]], [ 0.3127,
0.329 ], 'D65', [[ 0.50225719, 0.29296671, 0.15523203], [ 0.13879976, 0.91084146,
-0.04964122], [ 0.07801426, -0.31483251, 1.325876 ]], [[ 2.2668965 , -0.83163359,
-0.29654225], [-0.35733783, 1.24337315, 0.08838899], [-0.21823445, 0.34417515,
0.79265501]], log_encoding_Protune, log_decoding_Protune, False, False)
```

Protune Native colourspace.

References

[[GoProDM16](#)], [[Man15](#)]

colour.models.RGB_COLOURSPACE_MAX_RGB

```
colour.models.RGB_COLOURSPACE_MAX_RGB = RGB_Colourspace('Max RGB', [[ 0.73413379,
0.26586621], [ 0.10039113, 0.89960887], [ 0.03621495, 0. ]], [ 0.3457, 0.3585], 'D50', [[
0.85630404, 0.07698771, 0.03100393], [ 0.31011011, 0.68988989, 0. ], [ 0. , 0. , 0.8251046
]], [[ 1.2169928 , -0.13580933, -0.04572942], [-0.54704638, 1.51055387, 0.02055568], [ 0. ,
0. , 1.21196755]], functools.partial(<function gamma_function>,
exponent=0.45454545454545453), functools.partial(<function gamma_function>, exponent=2.2),
False, False)
```

Max RGB colourspace.

References

[[HutchColorc](#)]

colour.models.RGB_COLOURSPACE_NTSC1953

```
colour.models.RGB_COLOURSPACE_NTSC1953 = RGB_Colourspace('NTSC (1953)', [[ 0.67, 0.33], [ 0.21, 0.71], [ 0.14, 0.08]], [ 0.31006, 0.31616], 'C', [[ 6.06863809e-01, 1.73507281e-01, 2.00334881e-01], [ 2.98903070e-01, 5.86619855e-01, 1.14477075e-01], [ -5.02801622e-17, 6.60980118e-02, 1.11615148e+00]], [[ 1.91008143, -0.53247794, -0.28822201], [-0.98463135, 1.99910001, -0.02830719], [ 0.05830945, -0.11838584, 0.89761208]],  
functools.partial(<function gamma_function>, exponent=0.35714285714285715),  
functools.partial(<function gamma_function>, exponent=2.8), False, False)
```

NTSC (1953) colourspace.

References

[[InternationalTUnion98b](#)]

colour.models.RGB_COLOURSPACE_NTSC1987

```
colour.models.RGB_COLOURSPACE_NTSC1987 = RGB_Colourspace('NTSC (1987)', [[ 0.63 , 0.34 ], [ 0.31 , 0.595], [ 0.155, 0.07 ]], [ 0.3127, 0.329 ], 'D65', [[ 0.3935209 , 0.36525808, 0.19167695], [ 0.21237636, 0.70105986, 0.08656378], [ 0.01873909, 0.11193393, 0.95838473]], [[ 3.50600328, -1.73979073, -0.54405827], [-1.06904756, 1.97777888, 0.03517142], [ 0.05630659, -0.19697565, 1.04995233]], functools.partial(<function gamma_function>, exponent=0.45454545454545453), functools.partial(<function gamma_function>, exponent=2.2), False, False)
```

NTSC (1987) colourspace.

References

[[SocietyoMPaTEngineers04](#)]

colour.models.RGB_COLOURSPACE_P3_D65

```
colour.models.RGB_COLOURSPACE_P3_D65 = RGB_Colourspace('P3-D65', [[ 0.68 , 0.32 ], [ 0.265, 0.69 ], [ 0.15 , 0.06 ]], [ 0.3127, 0.329 ], 'D65', [[ 4.86570949e-01, 2.65667693e-01, 1.98217285e-01], [ 2.28974564e-01, 6.91738522e-01, 7.92869141e-02], [ -3.97207552e-17, 4.51133819e-02, 1.04394437e+00]], [[ 2.49349691, -0.93138362, -0.40271078], [-0.82948897, 1.76266406, 0.02362469], [ 0.03584583, -0.07617239, 0.95688452]],  
functools.partial(<function gamma_function>, exponent=0.3846153846153846),  
functools.partial(<function gamma_function>, exponent=2.6), False, False)
```

P3-D65 colourspace.

colour.models.RGB_COLOURSPACE_PAL_SECAM

```
colour.models.RGB_COLOURSPACE_PAL_SECAM = RGB_Colourspace('Pal/Secam', [[ 0.64, 0.33], [
0.29, 0.6 ], [ 0.15, 0.06]], [ 0.3127, 0.329 ], 'D65', [[ 0.43055381, 0.3415498 ,
0.17835231], [ 0.22200431, 0.70665477, 0.07134092], [ 0.02018221, 0.12955337, 0.93932217]],
[[ 3.06336109, -1.39339017, -0.47582374], [-0.96924364, 1.8759675 , 0.04155506], [
0.06786105, -0.22879927, 1.06908962]], functools.partial(<function gamma_function>,
exponent=0.35714285714285715), functools.partial(<function gamma_function>, exponent=2.8),
False, False)
```

Pal/Secam colourspace.

References

[[InternationalTUnion98b](#)]

colour.models.RGB_COLOURSPACE_RED_COLOR

```
colour.models.RGB_COLOURSPACE_RED_COLOR = RGB_Colourspace('REDcolor', [[ 0.70105856,
0.33018098], [ 0.29881132, 0.62516925], [ 0.13503868, 0.03526178]], [ 0.3127, 0.329 ],
'D65', [[ 0.42302331, 0.36210731, 0.16532531], [ 0.19923335, 0.75759632, 0.04317033],
[-0.01885014, 0.09212233, 1.01578557]], [[ 2.99433635, -1.37906534, -0.42873703],
[-0.79472663, 1.69283865, 0.0574019 ], [ 0.12764085, -0.17911636, 0.97129776]],
log_encoding_REDLogFilm, log_decoding_REDLogFilm, False, False)
```

REDcolor colourspace.

References

[[Man15](#)], [[SonyImageworks12](#)]

colour.models.RGB_COLOURSPACE_RED_COLOR_2

```
colour.models.RGB_COLOURSPACE_RED_COLOR_2 = RGB_Colourspace('REDcolor2', [[ 0.89740722,
0.33077623], [ 0.29602209, 0.68463555], [ 0.09979951, -0.02300051]], [ 0.3127, 0.329 ],
'D65', [[ 0.44957762, 0.3734296 , 0.12744871], [ 0.16571026, 0.86366248, -0.02937275],
[-0.11431396, 0.02440023, 1.17897148]], [[ 2.55060735, -1.09426927, -0.30298724],
[-0.48063394, 1.36324834, 0.0859211 ], [ 0.2572561 , -0.13431523, 0.81704083]],
log_encoding_REDLogFilm, log_decoding_REDLogFilm, False, False)
```

REDcolor2 colourspace.

References

[[Man15](#)], [[SonyImageworks12](#)]

colour.models.RGB_COLOURSPACE_RED_COLOR_3

```
colour.models.RGB_COLOURSPACE_RED_COLOR_3 = RGB_Colourspace('REDcolor3', [[ 0.70259866,
0.33018559], [ 0.29578224, 0.68974826], [ 0.11109053, -0.00433232]], [ 0.3127, 0.329 ],
'D65', [[ 0.47986312, 0.33439883, 0.13619398], [ 0.22551123, 0.77980008, -0.00531131],
[-0.02239109, 0.01635861, 1.09509023]], [[ 2.58673915, -1.10240102, -0.32705386],
[-0.74762558, 1.6008681 , 0.10074495], [ 0.06405867, -0.04645456, 0.90497461]],
log_encoding_REDLogFilm, log_decoding_REDLogFilm, False, False)
```

REDcolor3 colourspace.

References

[[Man15](#)], [[SonyImageworks12](#)]

colour.models.RGB_COLOURSPACE_RED_COLOR_4

```
colour.models.RGB_COLOURSPACE_RED_COLOR_4 = RGB_Colourspace('REDcolor4', [[ 0.70259815,
0.3301851 ], [ 0.29578233, 0.68974825], [ 0.14445924, 0.05083772]], [ 0.3127, 0.329 ],
'D65', [[ 0.44431783, 0.30962925, 0.19650885], [ 0.20880659, 0.72203852, 0.06915489],
[-0.02073188, 0.0151468 , 1.09464284]], [[ 2.78855329, -1.18687705, -0.42561558],
[-0.81255797, 1.73265028, 0.03640786], [ 0.06405707, -0.04645378, 0.9049753 ]],
log_encoding_REDLogFilm, log_decoding_REDLogFilm, False, False)
```

REDcolor4 colourspace.

References

[[Man15](#)], [[SonyImageworks12](#)]

colour.models.RGB_COLOURSPACE_RED_WIDE_GAMUT_RGB

```
colour.models.RGB_COLOURSPACE_RED_WIDE_GAMUT_RGB = RGB_Colourspace('REDWideGamutRGB', [[
0.780308, 0.304253], [ 0.121595, 1.493994], [ 0.095612, -0.084589]], [ 0.3127, 0.329 ],
'D65', [[ 0.735275, 0.068609, 0.146571], [ 0.286694, 0.842979, -0.129673], [-0.079681,
-0.347343, 1.516082]], [[ 1.41280661, -0.17752237, -0.15177038], [-0.48620319, 1.29069621,
0.15740028], [-0.03713878, 0.28637576, 0.68767961]], log_encoding_Log3G10,
log_decoding_Log3G10, False, False)
```

REDWideGamutRGB colourspace.

References

[[Man15](#)], [[Nat16](#)], [[SonyImageworks12](#)]

colour.models.RGB_COLOURSPACE_DRAGON_COLOR

```
colour.models.RGB_COLOURSPACE_DRAGON_COLOR = RGB_Colourspace('DRAGONcolor', [[ 0.75865589,
0.33035535], [ 0.29492362, 0.70805324], [ 0.0859616 , -0.04587944]], [ 0.3127, 0.329 ],
'D65', [[ 0.49831915, 0.34905932, 0.10307746], [ 0.21699218, 0.83802234, -0.05501452],
[-0.05846657, -0.00352329, 1.15104761]], [[ 2.41407671, -1.00664042, -0.26429553],
[-0.61715986, 1.45087355, 0.12461203], [ 0.12073206, -0.04669048, 0.85573054]],
log_encoding_REDLogFilm, log_decoding_REDLogFilm, False, False)
```

DRAGONcolor colourspace.

References

[Man15], [SonyImageworks12]

colour.models.RGB_COLOURSPACE_DRAGON_COLOR_2

```
colour.models.RGB_COLOURSPACE_DRAGON_COLOR_2 = RGB_Colourspace('DRAGONcolor2', [[
0.75865621, 0.33035584], [ 0.29492389, 0.70805336], [ 0.14416873, 0.05035738]], [ 0.3127,
0.329 ], 'D65', [[ 0.43856251, 0.30720212, 0.2046913 ], [ 0.19097146, 0.73753094, 0.0714976
], [-0.05145591, -0.0031012 , 1.14361486]], [[ 2.72655873, -1.13744045, -0.41690486],
[-0.71770143, 1.654923 , 0.02499461], [ 0.12073281, -0.04669036, 0.85572978]],
log_encoding_REDLogFilm, log_decoding_REDLogFilm, False, False)
```

DRAGONcolor2 colourspace.

References

[Man15], [SonyImageworks12]

colour.models.RGB_COLOURSPACE_ROMM_RGB

```
colour.models.RGB_COLOURSPACE_ROMM_RGB = RGB_Colourspace('ROMM RGB', [[ 7.34700000e-01,
2.65300000e-01], [ 1.59600000e-01, 8.40400000e-01], [ 3.66000000e-02, 1.00000000e-04]], [
0.3457, 0.3585], 'D50', [[ 7.97700000e-01, 1.35200000e-01, 3.13000000e-02], [
2.88000000e-01, 7.11900000e-01, 1.00000000e-04], [ 0.00000000e+00, 0.00000000e+00,
8.24900000e-01]], [[ 1.346 , -0.2556, -0.0511], [-0.5446, 1.5082, 0.0205], [ 0. , 0. ,
1.2123]], cctf_encoding_ROMMRGB, cctf_decoding_ROMMRGB, False, False)
```

ROMM RGB colourspace.

References

[ANSI03], [SWG00]

colour.models.RGB_COLOURSPACE_RIMM_RGB

```
colour.models.RGB_COLOURSPACE_RIMM_RGB = RGB_Colourspace('RIMM RGB', [[ 7.34700000e-01,
2.65300000e-01], [ 1.59600000e-01, 8.40400000e-01], [ 3.66000000e-02, 1.00000000e-04]], [
0.3457, 0.3585], 'D50', [[ 7.97700000e-01, 1.35200000e-01, 3.13000000e-02], [
2.88000000e-01, 7.11900000e-01, 1.00000000e-04], [ 0.00000000e+00, 0.00000000e+00,
8.24900000e-01]], [[ 1.346 , -0.2556, -0.0511], [-0.5446, 1.5082, 0.0205], [ 0. , 0. ,
1.2123]], cctf_encoding_RIMMRGB, cctf_decoding_RIMMRGB, False, False)
```

RIMM RGB colourspace. In cases in which it is necessary to identify a specific precision level, the notation *RIMM8 RGB*, *RIMM12 RGB* and *RIMM16 RGB* is used.

References

[SWG00]

colour.models.RGB_COLOURSPACE_ERIMM_RGB

```
colour.models.RGB_COLOURSPACE_ERIMM_RGB = RGB_Colourspace('ERIMM RGB', [[ 7.34700000e-01,
2.65300000e-01], [ 1.59600000e-01, 8.40400000e-01], [ 3.66000000e-02, 1.00000000e-04]], [
0.3457, 0.3585], 'D50', [[ 7.97700000e-01, 1.35200000e-01, 3.13000000e-02], [
2.88000000e-01, 7.11900000e-01, 1.00000000e-04], [ 0.00000000e+00, 0.00000000e+00,
8.24900000e-01]], [[ 1.346 , -0.2556, -0.0511], [-0.5446, 1.5082, 0.0205], [ 0. , 0. ,
1.2123]], log_encoding_ERIMMRGB, log_decoding_ERIMMRGB, False, False)
```

ERIMM RGB colourspace.

References

[SWG00]

colour.models.RGB_COLOURSPACE_PROPHOTO_RGB

```
colour.models.RGB_COLOURSPACE_PROPHOTO_RGB = RGB_Colourspace('ProPhoto RGB', [[
7.34700000e-01, 2.65300000e-01], [ 1.59600000e-01, 8.40400000e-01], [ 3.66000000e-02,
1.00000000e-04]], [ 0.3457, 0.3585], 'D50', [[ 7.97700000e-01, 1.35200000e-01,
3.13000000e-02], [ 2.88000000e-01, 7.11900000e-01, 1.00000000e-04], [ 0.00000000e+00,
0.00000000e+00, 8.24900000e-01]], [[ 1.346 , -0.2556, -0.0511], [-0.5446, 1.5082, 0.0205],
[ 0. , 0. , 1.2123]], cctf_encoding_ROMMRGB, cctf_decoding_ROMMRGB, False, False)
```

ProPhoto RGB colourspace, an alias colourspace for *ROMM RGB*.

References

[ANSI03], [SWG00]

colour.models.RGB_COLOURSPACE_RUSSELL_RGB

```
colour.models.RGB_COLOURSPACE_RUSSELL_RGB = RGB_Colourspace('Russell RGB', [[ 0.69, 0.31],
[ 0.18, 0.77], [ 0.1 , 0.02]], [ 0.33243, 0.34744], 'D55', [[ 7.01583746e-01,
1.55416218e-01, 9.97983328e-02], [ 3.15204292e-01, 6.64836042e-01, 1.99596666e-02], [
5.64430745e-17, 4.31711716e-02, 8.78225329e-01]], [[ 1.58699918, -0.35980738,
-0.17216338], [-0.75352154, 1.67719311, 0.04750942], [ 0.03704107, -0.08244626,
1.13632451]], functools.partial(<function gamma_function>, exponent=0.454545454545453),
functools.partial(<function gamma_function>, exponent=2.2), False, False)
```

Russell RGB colourspace.

References

[Cot]

colour.models.RGB_COLOURSPACE_SMPTE_240M

```
colour.models.RGB_COLOURSPACE_SMPTE_240M = RGB_Colourspace('SMPTE 240M', [[ 0.63 , 0.34 ],
[ 0.31 , 0.595], [ 0.155, 0.07 ]], [ 0.3127, 0.329 ], 'D65', [[ 0.3935209 , 0.36525808,
0.19167695], [ 0.21237636, 0.70105986, 0.08656378], [ 0.01873909, 0.11193393, 0.95838473]],
[[ 3.50600328, -1.73979073, -0.54405827], [-1.06904756, 1.97777888, 0.03517142], [
0.05630659, -0.19697565, 1.04995233]], oetf_SMPTE240M, eotf_SMPTE240M, False, False)
```

SMPTE 240M colourspace.

References

[SocietyMPaTEngineers99],

colour.models.RGB_COLOURSPACE_SMPTE_C

```
colour.models.RGB_COLOURSPACE_SMPTE_C = RGB_Colourspace('SMPTE C', [[ 0.63 , 0.34 ], [ 0.31
, 0.595], [ 0.155, 0.07 ]], [ 0.3127, 0.329 ], 'D65', [[ 0.3935209 , 0.36525808,
0.19167695], [ 0.21237636, 0.70105986, 0.08656378], [ 0.01873909, 0.11193393, 0.95838473]],
[[ 3.50600328, -1.73979073, -0.54405827], [-1.06904756, 1.97777888, 0.03517142], [
0.05630659, -0.19697565, 1.04995233]], functools.partial(<function gamma_function>,
exponent=0.454545454545453), functools.partial(<function gamma_function>, exponent=2.2),
False, False)
```

Implement support for the *RGB* colourspace datasets from `colour.models.datasets.aces_rgb`, etc....

Colour science literature related to *RGB* colourspace and encodings defines their dataset using different degree of precision or rounding. While instances where a whitepoint is being defined with a value different than its canonical agreed one are rare, it is however very common to have normalised primary matrices rounded at different decimals. This can yield large discrepancies in computations.

Such an occurrence is the *V-Gamut* colourspace white paper, that defines the *V-Gamut* to *ITU-R BT.709* conversion matrix as follows:

```
[[ 1.806576 -0.695697 -0.110879]
[-0.170090 1.305955 -0.135865]
[-0.025206 -0.154468 1.179674]]
```

Computing this matrix using *ITU-R BT.709* colourspace derived normalised primary matrix yields:

```
[[ 1.8065736 -0.6956981 -0.1108786]
 [-0.1700890  1.3059548 -0.1358648]
 [-0.0252057 -0.1544678  1.1796737]]
```

The latter matrix is almost equals with the former, however performing the same computation using *IEC 61966-2-1:1999 sRGB* colourspace normalised primary matrix introduces severe disparities:

```
[[ 1.8063853 -0.6956147 -0.1109453]
 [-0.1699311  1.3058387 -0.1358616]
 [-0.0251630 -0.1544899  1.1797117]]
```

In order to provide support for both literature defined dataset and accurate computations enabling transformations without loss of precision, the `colour.RGB_Colourspace` class provides two sets of transformation matrices:

- Instantiation transformation matrices
- Derived transformation matrices

Upon instantiation, the `colour.RGB_Colourspace` class stores the given `matrix_RGB_to_XYZ` and `matrix_XYZ_to_RGB` arguments and also computes their derived counterpart using the primaries and whitepoint arguments.

Whether the initialisation or derived matrices are used in subsequent computations is dependent on the `colour.RGB_Colourspace.use_derived_matrix_RGB_to_XYZ` and `colour.RGB_Colourspace.use_derived_matrix_XYZ_to_RGB` attribute values.

Parameters

- **name** – *RGB* colourspace name.
- **primaries** – *RGB* colourspace primaries.
- **whitepoint** – *RGB* colourspace whitepoint.
- **whitepoint_name** – *RGB* colourspace whitepoint name.
- **matrix_RGB_to_XYZ** – Transformation matrix from colourspace to *CIE XYZ* tristimulus values.
- **matrix_XYZ_to_RGB** – Transformation matrix from *CIE XYZ* tristimulus values to colourspace.
- **cctf_encoding** – Encoding colour component transfer function (Encoding CCTF) / opto-electronic transfer function (OETF) that maps estimated tristimulus values in a scene to $R'G'B'$ video component signal value.
- **cctf_decoding** – Decoding colour component transfer function (Decoding CCTF) / electro-optical transfer function (EOTF) that maps an $R'G'B'$ video component signal value to tristimulus values at the display.
- **use_derived_matrix_RGB_to_XYZ** – Whether to use the instantiation time normalised primary matrix or to use a computed derived normalised primary matrix.
- **use_derived_matrix_XYZ_to_RGB** – Whether to use the instantiation time inverse normalised primary matrix or to use a computed derived inverse normalised primary matrix.

Attributes

- `name`
- `primaries`
- `whitepoint`
- `whitepoint_name`
- `matrix_RGB_to_XYZ`
- `matrix_XYZ_to_RGB`
- `cctf_encoding`
- `cctf_decoding`
- `use_derived_matrix_RGB_to_XYZ`
- `use_derived_matrix_XYZ_to_RGB`

Methods

- `__init__`
- `__str__`
- `__repr__`
- `use_derived_transformation_matrices`
- `chromatically_adapt`
- `copy`

Notes

- The normalised primary matrix defined by `colour.RGB_Colourspace.matrix_RGB_to_XYZ` property is treated as the prime matrix from which the inverse will be calculated as required by the internal derivation mechanism. This behaviour has been chosen in accordance with literature where commonly a *RGB* colourspace is defined by its normalised primary matrix as it is directly computed from the chosen primaries and whitepoint.

References

[[InternationalECommission99](#)], [[Panasonic14](#)]

Examples

```
>>> p = np.array([0.73470, 0.26530, 0.00000, 1.00000, 0.00010, -0.07700])
>>> whitepoint = np.array([0.32168, 0.33767])
>>> matrix_RGB_to_XYZ = np.identity(3)
>>> matrix_XYZ_to_RGB = np.identity(3)
>>> colourspace = RGB_Colourspace(
...     "RGB Colourspace",
...     p,
...     whitepoint,
...     "ACES",
...     matrix_RGB_to_XYZ,
...     matrix_XYZ_to_RGB,
```

(continues on next page)

(continued from previous page)

```

... )
>>> colourspace.matrix_RGB_to_XYZ
array([[ 1.,  0.,  0.],
       [ 0.,  1.,  0.],
       [ 0.,  0.,  1.]])
>>> colourspace.matrix_XYZ_to_RGB
array([[ 1.,  0.,  0.],
       [ 0.,  1.,  0.],
       [ 0.,  0.,  1.]])
>>> colourspace.use_derived_transformation_matrices(True)
>>> colourspace.matrix_RGB_to_XYZ
array([[ 9.5255239...e-01,  0.0000000...e+00,  9.3678631...e-05],
       [ 3.4396645...e-01,  7.2816609...e-01, -7.2132546...e-02],
       [ 0.0000000...e+00,  0.0000000...e+00,  1.0088251...e+00]])
>>> colourspace.matrix_XYZ_to_RGB
array([[ 1.0498110...e+00,  0.0000000...e+00, -9.7484540...e-05],
       [-4.9590302...e-01,  1.3733130...e+00,  9.8240036...e-02],
       [ 0.0000000...e+00,  0.0000000...e+00,  9.9125201...e-01]])
>>> colourspace.use_derived_matrix_RGB_to_XYZ = False
>>> colourspace.matrix_RGB_to_XYZ
array([[ 1.,  0.,  0.],
       [ 0.,  1.,  0.],
       [ 0.,  0.,  1.]])
>>> colourspace.use_derived_matrix_XYZ_to_RGB = False
>>> colourspace.matrix_XYZ_to_RGB
array([[ 1.,  0.,  0.],
       [ 0.,  1.,  0.],
       [ 0.,  0.,  1.]])

```

colour.models.RGB_COLOURSPACE_S_GAMUT

```

colour.models.RGB_COLOURSPACE_S_GAMUT = RGB_Colourspace('S-Gamut', [[ 0.73 , 0.28 ], [ 0.14
, 0.855], [ 0.1 , -0.05 ]], [ 0.3127, 0.329 ], 'D65', [[ 0.70648271, 0.12880105,
0.11517216], [ 0.27097967, 0.78660641, -0.05758608], [-0.00967785, 0.00460004,
1.09413556]], [[ 1.5073999 , -0.24582214, -0.17161168], [-0.51815173, 1.35539124,
0.12587867], [ 0.0155117 , -0.00787277, 0.91191637]], log_encoding_SLog2,
log_decoding_SLog2, False, False)

```

S-Gamut colourspace.

References

[GDY+], [SonyCorporationb]

colour.models.RGB_COLOURSPACE_S_GAMUT3

```
colour.models.RGB_COLOURSPACE_S_GAMUT3 = RGB_Colourspace('S-Gamut3', [[ 0.73 , 0.28 ], [
0.14 , 0.855], [ 0.1 , -0.05 ]], [ 0.3127, 0.329 ], 'D65', [[ 0.70648271, 0.12880105,
0.11517216], [ 0.27097967, 0.78660641, -0.05758608], [-0.00967785, 0.00460004,
1.09413556]], [[ 1.5073999 , -0.24582214, -0.17161168], [-0.51815173, 1.35539124,
0.12587867], [ 0.0155117 , -0.00787277, 0.91191637]], log_encoding_SLog3,
log_decoding_SLog3, False, False)
```

S-Gamut3 colourspace.

References

[SonyCorporationc]

colour.models.RGB_COLOURSPACE_S_GAMUT3_CINE

```
colour.models.RGB_COLOURSPACE_S_GAMUT3_CINE = RGB_Colourspace('S-Gamut3.Cine', [[ 0.766,
0.275], [ 0.225, 0.8 ], [ 0.089, -0.087]], [ 0.3127, 0.329 ], 'D65', [[ 0.59908392,
0.24892552, 0.10244649], [ 0.21507582, 0.8850685 , -0.10014432], [-0.03206585, -0.02765839,
1.14878199]], [[ 1.84677897, -0.52598612, -0.21054521], [-0.44415326, 1.2594429 ,
0.14939997], [ 0.04085542, 0.01564089, 0.86820725]], log_encoding_SLog3,
log_decoding_SLog3, False, False)
```

S-Gamut3.Cine colourspace.

References

[SonyCorporationa]

colour.models.RGB_COLOURSPACE_VENICE_S_GAMUT3

```
colour.models.RGB_COLOURSPACE_VENICE_S_GAMUT3 = RGB_Colourspace('Venice S-Gamut3', [[
0.74046426, 0.27936437], [ 0.08924115, 0.89380953], [ 0.11048824, -0.05257933]], [ 0.3127,
0.329 ], 'D65', [[ 0.74422299, 0.07790652, 0.12832642], [ 0.28078248, 0.78028572,
-0.0610682 ], [-0.01992929, 0.01479657, 1.09419047]], [[ 1.39026398, -0.13557353,
-0.17061639], [-0.49777193, 1.32876782, 0.13253885], [ 0.03205319, -0.02043803, 0.9090178
]], log_encoding_SLog3, log_decoding_SLog3, False, False)
```

Venice S-Gamut3 colourspace.

References

[SonyECorporation20b]

colour.models.RGB_COLOURSPACE_VENICE_S_GAMUT3_CINE

```
colour.models.RGB_COLOURSPACE_VENICE_S_GAMUT3_CINE = RGB_Colourspace('Venice
S-Gamut3.Cine', [[ 0.77590187, 0.27450239], [ 0.1886829 , 0.82868494], [ 0.10133738,
-0.08918752]], [ 0.3127, 0.329 ], 'D65', [[ 0.63226084, 0.20037001, 0.11782508], [
0.22368436, 0.88001406, -0.10369842], [-0.04107303, -0.01844361, 1.14857439]], [[
1.70701129, -0.39308248, -0.21060088], [-0.42750858, 1.23694441, 0.1555323 ], [ 0.05417788,
0.00580601, 0.86561094]], log_encoding_SLog3, log_decoding_SLog3, False, False)
```

Venice S-Gamut3.Cine colourspace.

References

[SonyECorporation20a]

colour.models.RGB_COLOURSPACE_sRGB

```
colour.models.RGB_COLOURSPACE_sRGB = RGB_Colourspace('sRGB', [[ 0.64, 0.33], [ 0.3 , 0.6 ],
[ 0.15, 0.06]], [ 0.3127, 0.329 ], 'D65', [[ 0.4124, 0.3576, 0.1805], [ 0.2126, 0.7152,
0.0722], [ 0.0193, 0.1192, 0.9505]], [[ 3.2406, -1.5372, -0.4986], [-0.9689, 1.8758,
0.0415], [ 0.0557, -0.204 , 1.057 ]], eotf_inverse_sRGB, eotf_sRGB, False, False)
```

sRGB colourspace.

References

[InternationalECommission99], [InternationalTUnion15b]

colour.models.RGB_COLOURSPACE_V_GAMUT

```
colour.models.RGB_COLOURSPACE_V_GAMUT = RGB_Colourspace('V-Gamut', [[ 0.73 , 0.28 ], [
0.165, 0.84 ], [ 0.1 , -0.03 ]], [ 0.3127, 0.329 ], 'D65', [[ 0.679644, 0.152211, 0.1186 ],
[ 0.260686, 0.774894, -0.03558 ], [-0.00931 , -0.004612, 1.10298 ]], [[ 1.589012,
-0.313204, -0.180965], [-0.534053, 1.396011, 0.102458], [ 0.011179, 0.003194, 0.905535]],
log_encoding_VLog, log_decoding_VLog, False, False)
```

Panasonic V-Gamut colourspace.

References

[Panasonic14]

colour.models.RGB_COLOURSPACE_XTREME_RGB

```
colour.models.RGB_COLOURSPACE_XTREME_RGB = RGB_Colourspace('Xtreme RGB', [[ 1., 0.], [ 0., 1.], [ 0., 0.]], [ 0.3457, 0.3585], 'D50', [[ 0.96429568, 0., 0. ], [ 0., 1., 0. ], [ 0., 0., 0.8251046 ]], [[ 1.03702632, 0., 0. ], [ 0., 1., 0. ], [ 0., 0., 1.21196755]],
functools.partial(<function gamma_function>, exponent=0.45454545454545453),
functools.partial(<function gamma_function>, exponent=2.2), False, False)
```

Xtreme RGB colourspace.

References

[[HutchColord](#)]

Colour Component Transfer Functions

colour

| | |
|---|--|
| <code>cctf_encoding(value[, function])</code> | Encode linear <i>RGB</i> values to non-linear <i>R'G'B'</i> values using given encoding colour component transfer function (Encoding CCTF). |
| <code>CCTF_ENCODINGS</code> | Supported encoding colour component transfer functions (Encoding CCTFs), a collection of the functions defined by <code>colour.LOG_ENCODINGS</code> , <code>colour.OETFs</code> , <code>colour.EOTF_INVERSES</code> attributes, the <code>colour.models.cctf_encoding_ProPhotoRGB()</code> , <code>colour.models.cctf_encoding_RIMMRGB()</code> , <code>colour.models.cctf_encoding_ROMMRGB()</code> definitions and 3 gamma encoding functions (1 / 2.2, 1 / 2.4, 1 / 2.6). |
| <code>cctf_decoding(value[, function])</code> | Decode non-linear <i>R'G'B'</i> values to linear <i>RGB</i> values using given decoding colour component transfer function (Decoding CCTF). |
| <code>CCTF_DECODINGS</code> | Supported decoding colour component transfer functions (Decoding CCTFs), a collection of the functions defined by <code>colour.LOG_DECODINGS</code> , <code>colour.EOTFs</code> , <code>colour.OETF_INVERSES</code> attributes, the <code>colour.models.cctf_decoding_ProPhotoRGB()</code> , <code>colour.models.cctf_decoding_RIMMRGB()</code> , <code>colour.models.cctf_decoding_ROMMRGB()</code> definitions and 3 gamma decoding functions (2.2, 2.4, 2.6). |
| <code>gamma_function(a[, exponent, ...])</code> | Define a typical gamma encoding / decoding function. |
| <code>linear_function(a)</code> | Define a typical linear encoding / decoding function, essentially a pass-through function. |

`colour.cctf_encoding`

```
colour.cctf_encoding(value: float | _SupportsArray[dtype[Any]] |
    _NestedSequence[_SupportsArray[dtype[Any]]] | bool | int | complex | str |
    bytes | _NestedSequence[bool | int | float | complex | str | bytes], function:
    Literal['ACEScc', 'ACEScct', 'ACESproxy', 'ARRI LogC3', 'ARRI LogC4', 'ARIB
    STD-B67', 'Blackmagic Film Generation 5', 'Canon Log 2', 'Canon Log 3', 'Canon
    Log', 'Cineon', 'D-Log', 'DCDM', 'DICOM GSDF', 'DaVinci Intermediate', 'ERIMM
    RGB', 'F-Log', 'Filmic Pro 6', 'Gamma 2.2', 'Gamma 2.4', 'Gamma 2.6', 'ITU-R
    BT.1886', 'ITU-R BT.2020', 'ITU-R BT.2100 HLG', 'ITU-R BT.2100 PQ', 'ITU-R
    BT.601', 'ITU-R BT.709', 'Log2', 'Log3G10', 'Log3G12', 'N-Log', 'PLog', 'Panalog',
    'ProPhoto RGB', 'Protune', 'REDLog', 'REDLogFilm', 'RIMM RGB', 'ROMM RGB',
    'S-Log', 'S-Log2', 'S-Log3', 'SMPTE 240M', 'ST 2084', 'T-Log', 'V-Log', 'ViperLog',
    'sRGB'] | str = 'sRGB', **kwargs: Any) → float | ndarray | int
```

Encode linear RGB values to non-linear $R'G'B'$ values using given encoding colour component transfer function (Encoding CCTF).

Parameters

- **value** (`float` | `_SupportsArray[dtype[Any]]` | `_NestedSequence[_SupportsArray[dtype[Any]]]` | `bool` | `int` | `complex` | `str` | `bytes` | `_NestedSequence[bool | int | float | complex | str | bytes]`) – Linear RGB values.
- **function** (`Literal['ACEScc', 'ACEScct', 'ACESproxy', 'ARRI LogC3', 'ARRI LogC4', 'ARIB STD-B67', 'Blackmagic Film Generation 5', 'Canon Log 2', 'Canon Log 3', 'Canon Log', 'Cineon', 'D-Log', 'DCDM', 'DICOM GSDF', 'DaVinci Intermediate', 'ERIMM RGB', 'F-Log', 'Filmic Pro 6', 'Gamma 2.2', 'Gamma 2.4', 'Gamma 2.6', 'ITU-R BT.1886', 'ITU-R BT.2020', 'ITU-R BT.2100 HLG', 'ITU-R BT.2100 PQ', 'ITU-R BT.601', 'ITU-R BT.709', 'Log2', 'Log3G10', 'Log3G12', 'N-Log', 'PLog', 'Panalog', 'ProPhoto RGB', 'Protune', 'REDLog', 'REDLogFilm', 'RIMM RGB', 'ROMM RGB', 'S-Log', 'S-Log2', 'S-Log3', 'SMPTE 240M', 'ST 2084', 'T-Log', 'V-Log', 'ViperLog', 'sRGB']` | `str`) – `{colour.CCTF_ENCODINGS}`, Encoding colour component transfer function.
- **kwargs** (`Any`) – Keywords arguments for the relevant encoding CCTF of the `colour.CCTF_ENCODINGS` attribute collection.

Return type

`float` | `ndarray` | `int`

Warning: For *ITU-R BT.2100*, only the inverse electro-optical transfer functions (EOTFs / EOCFs) are exposed by this definition, See the `colour.oetf()` definition for the opto-electronic transfer functions (OETF).

Returns

Non-linear $R'G'B'$ values.

Return type

`numpy.floating` or `numpy.ndarray`

Parameters

- **value** (`float` | `_SupportsArray[dtype[Any]]` | `_NestedSequence[_SupportsArray[dtype[Any]]]` | `bool` | `int` | `complex` | `str` | `bytes` | `_NestedSequence[bool | int | float | complex | str | bytes]`) –
- **function** (`Literal['ACEScc', 'ACEScct', 'ACESproxy', 'ARRI LogC3', 'ARRI LogC4', 'ARIB STD-B67', 'Blackmagic Film Generation 5', 'Canon Log`

```
2', 'Canon Log 3', 'Canon Log', 'Cineon', 'D-Log', 'DCDM', 'DICOM
GSDF', 'DaVinci Intermediate', 'ERIMM RGB', 'F-Log', 'Filmic Pro 6',
'Gamma 2.2', 'Gamma 2.4', 'Gamma 2.6', 'ITU-R BT.1886', 'ITU-R BT.
2020', 'ITU-R BT.2100 HLG', 'ITU-R BT.2100 PQ', 'ITU-R BT.601', 'ITU-R
BT.709', 'Log2', 'Log3G10', 'Log3G12', 'N-Log', 'PLog', 'Panalog',
'ProPhoto RGB', 'Protune', 'REDLog', 'REDLogFilm', 'RIMM RGB', 'ROMM
RGB', 'S-Log', 'S-Log2', 'S-Log3', 'SMPTE 240M', 'ST 2084', 'T-Log',
'V-Log', 'ViperLog', 'sRGB'] | str) -
```

- **kwargs** (*Any*) –

Examples

```
>>> cctf_encoding(0.18, function="PLog", log_reference=400)
...
0.3910068...
>>> cctf_encoding(0.18, function="ST 2084", L_p=1000)
...
0.1820115...
>>> cctf_encoding(
...     0.11699185725296059, function="ITU-R BT.1886"
... )
0.4090077...
```

colour.CCTF_ENCODINGS

```
colour.CCTF_ENCODINGS = CanonicalMapping({'Gamma 2.2': ..., 'Gamma 2.4': ..., 'Gamma 2.6':
..., 'ProPhoto RGB': ..., 'RIMM RGB': ..., 'ROMM RGB': ..., 'ACEScc': ..., 'ACEScct': ...,
'ACESproxy': ..., 'ARRI LogC3': ..., 'ARRI LogC4': ..., 'Canon Log 2': ..., 'Canon Log 3':
..., 'Canon Log': ..., 'Cineon': ..., 'D-Log': ..., 'ERIMM RGB': ..., 'F-Log': ..., 'Filmic
Pro 6': ..., 'L-Log': ..., 'Log2': ..., 'Log3G10': ..., 'Log3G12': ..., 'N-Log': ...,
'PLog': ..., 'Panalog': ..., 'Protune': ..., 'REDLog': ..., 'REDLogFilm': ..., 'S-Log':
..., 'S-Log2': ..., 'S-Log3': ..., 'T-Log': ..., 'V-Log': ..., 'ViperLog': ..., 'ARIB
STD-B67': ..., 'Blackmagic Film Generation 5': ..., 'DaVinci Intermediate': ..., 'ITU-R
BT.2020': ..., 'ITU-R BT.2100 HLG': ..., 'ITU-R BT.2100 PQ': ..., 'ITU-R BT.601': ...,
'ITU-R BT.709': ..., 'ITU-T H.273 Log': ..., 'ITU-T H.273 Log Sqrt': ..., 'ITU-T H.273 IEC
61966-2': ..., 'SMPTE 240M': ..., 'DCDM': ..., 'DICOM GSDF': ..., 'ITU-R BT.1886': ...,
'ITU-T H.273 ST.428-1': ..., 'ST 2084': ..., 'sRGB': ...})
```

Supported encoding colour component transfer functions (Encoding CCTFs), a collection of the functions defined by `colour.LOG_ENCODINGS`, `colour.OETFs`, `colour.EOTF_INVERSES` attributes, the `colour.models.cctf_encoding_ProPhotoRGB()`, `colour.models.cctf_encoding_RIMMRGB()`, `colour.models.cctf_encoding_ROMMRGB()` definitions and 3 gamma encoding functions (1 / 2.2, 1 / 2.4, 1 / 2.6).

Warning: For *ITU-R BT.2100*, only the inverse electro-optical transfer functions (EOTFs / EOCFs) are exposed by this attribute, See the `colour.OETFs` attribute for the opto-electronic transfer functions (OETF).

`colour.cctf_decoding`

```
colour.cctf_decoding(value: float | _SupportsArray[dtype[Any]] |
    _NestedSequence[_SupportsArray[dtype[Any]]] | bool | int | complex | str |
    bytes | _NestedSequence[bool | int | float | complex | str | bytes], function:
    Literal['ACEScc', 'ACEScct', 'ACESproxy', 'ARRI LogC3', 'ARRI LogC4', 'ARIB
    STD-B67', 'Blackmagic Film Generation 5', 'Canon Log 2', 'Canon Log 3', 'Canon
    Log', 'Cineon', 'D-Log', 'DCDM', 'DICOM GSDF', 'DaVinci Intermediate', 'ERIMM
    RGB', 'F-Log', 'Filmic Pro 6', 'Gamma 2.2', 'Gamma 2.4', 'Gamma 2.6', 'ITU-R
    BT.1886', 'ITU-R BT.2020', 'ITU-R BT.2100 HLG', 'ITU-R BT.2100 PQ', 'ITU-R
    BT.601', 'ITU-R BT.709', 'Log2', 'Log3G10', 'Log3G12', 'N-Log', 'PLog', 'Panalog',
    'ProPhoto RGB', 'Protune', 'REDLog', 'REDLogFilm', 'RIMM RGB', 'ROMM RGB',
    'S-Log', 'S-Log2', 'S-Log3', 'SMPTE 240M', 'ST 2084', 'T-Log', 'V-Log', 'ViperLog',
    'sRGB'] | str = 'sRGB', **kwargs: Any) → float | ndarray
```

Decode non-linear $R'G'B'$ values to linear RGB values using given decoding colour component transfer function (Decoding CCTF).

Parameters

- **value** (`float` | `_SupportsArray[dtype[Any]]` | `_NestedSequence[_SupportsArray[dtype[Any]]]` | `bool` | `int` | `complex` | `str` | `bytes` | `_NestedSequence[bool | int | float | complex | str | bytes]`) – Non-linear $R'G'B'$ values.
- **function** (`Literal['ACEScc', 'ACEScct', 'ACESproxy', 'ARRI LogC3', 'ARRI LogC4', 'ARIB STD-B67', 'Blackmagic Film Generation 5', 'Canon Log 2', 'Canon Log 3', 'Canon Log', 'Cineon', 'D-Log', 'DCDM', 'DICOM GSDF', 'DaVinci Intermediate', 'ERIMM RGB', 'F-Log', 'Filmic Pro 6', 'Gamma 2.2', 'Gamma 2.4', 'Gamma 2.6', 'ITU-R BT.1886', 'ITU-R BT.2020', 'ITU-R BT.2100 HLG', 'ITU-R BT.2100 PQ', 'ITU-R BT.601', 'ITU-R BT.709', 'Log2', 'Log3G10', 'Log3G12', 'N-Log', 'PLog', 'Panalog', 'ProPhoto RGB', 'Protune', 'REDLog', 'REDLogFilm', 'RIMM RGB', 'ROMM RGB', 'S-Log', 'S-Log2', 'S-Log3', 'SMPTE 240M', 'ST 2084', 'T-Log', 'V-Log', 'ViperLog', 'sRGB']` | `str`) – `{colour.CCTF_DECODINGS}`, Decoding colour component transfer function.
- **kwargs** (`Any`) – Keywords arguments for the relevant decoding CCTF of the `colour.CCTF_DECODINGS` attribute collection.

Return type

`float` | `ndarray`

Warning: For *ITU-R BT.2100*, only the electro-optical transfer functions (EOTFs / EOCFs) are exposed by this definition, See the `colour.oetf_inverse()` definition for the inverse opto-electronic transfer functions (OETF).

Returns

Linear RGB values.

Return type

`numpy.floating` or `numpy.ndarray`

Parameters

- **value** (`float` | `_SupportsArray[dtype[Any]]` | `_NestedSequence[_SupportsArray[dtype[Any]]]` | `bool` | `int` | `complex` | `str` | `bytes` | `_NestedSequence[bool | int | float | complex | str | bytes]`) –
- **function** (`Literal['ACEScc', 'ACEScct', 'ACESproxy', 'ARRI LogC3', 'ARRI LogC4', 'ARIB STD-B67', 'Blackmagic Film Generation 5', 'Canon Log`


```
2', 'Canon Log 3', 'Canon Log', 'Cineon', 'D-Log', 'DCDM', 'DICOM
GSDF', 'DaVinci Intermediate', 'ERIMM RGB', 'F-Log', 'Filmic Pro 6',
'Gamma 2.2', 'Gamma 2.4', 'Gamma 2.6', 'ITU-R BT.1886', 'ITU-R BT.
2020', 'ITU-R BT.2100 HLG', 'ITU-R BT.2100 PQ', 'ITU-R BT.601', 'ITU-R
BT.709', 'Log2', 'Log3G10', 'Log3G12', 'N-Log', 'PLog', 'Panalog',
'ProPhoto RGB', 'Protune', 'REDLog', 'REDLogFilm', 'RIMM RGB', 'ROMM
RGB', 'S-Log', 'S-Log2', 'S-Log3', 'SMPTE 240M', 'ST 2084', 'T-Log',
'V-Log', 'ViperLog', 'sRGB'] | str) -
```

- **kwargs** (*Any*) –

Examples

```
>>> cctf_decoding(0.391006842619746, function="PLog", log_reference=400)
...
0.1...
>>> cctf_decoding(0.182011532850008, function="ST 2084", L_p=1000)
...
0.1...
>>> cctf_decoding(
...     0.461356129500442, function="ITU-R BT.1886"
... )
0.1...
```

colour.CCTF_DECODINGS

```
colour.CCTF_DECODINGS = CanonicalMapping({'Gamma 2.2': ..., 'Gamma 2.4': ..., 'Gamma 2.6':
..., 'ProPhoto RGB': ..., 'RIMM RGB': ..., 'ROMM RGB': ..., 'ACEScc': ..., 'ACEScct': ...,
'ACESproxy': ..., 'ARRI LogC3': ..., 'ARRI LogC4': ..., 'Canon Log 2': ..., 'Canon Log 3':
..., 'Canon Log': ..., 'Cineon': ..., 'D-Log': ..., 'ERIMM RGB': ..., 'F-Log': ..., 'Filmic
Pro 6': ..., 'L-Log': ..., 'Log2': ..., 'Log3G10': ..., 'Log3G12': ..., 'N-Log': ...,
'PLog': ..., 'Panalog': ..., 'Protune': ..., 'REDLog': ..., 'REDLogFilm': ..., 'S-Log':
..., 'S-Log2': ..., 'S-Log3': ..., 'T-Log': ..., 'V-Log': ..., 'ViperLog': ..., 'ARIB
STD-B67': ..., 'Blackmagic Film Generation 5': ..., 'DaVinci Intermediate': ..., 'ITU-R
BT.2020': ..., 'ITU-R BT.2100 HLG': ..., 'ITU-R BT.2100 PQ': ..., 'ITU-R BT.601': ...,
'ITU-R BT.709': ..., 'ITU-T H.273 Log': ..., 'ITU-T H.273 Log Sqrt': ..., 'ITU-T H.273 IEC
61966-2': ..., 'DCDM': ..., 'DICOM GSDF': ..., 'ITU-R BT.1886': ..., 'ITU-T H.273
ST.428-1': ..., 'SMPTE 240M': ..., 'ST 2084': ..., 'sRGB': ...})
```

Supported decoding colour component transfer functions (Decoding CCTFs), a collection of the functions defined by `colour.LOG_DECODINGS`, `colour.EOTFS`, `colour.OETF_INVERSES` attributes, the `colour.models.cctf_decoding_ProPhotoRGB()`, `colour.models.cctf_decoding_RIMMRGB()`, `colour.models.cctf_decoding_ROMMRGB()` definitions and 3 gamma decoding functions (2.2, 2.4, 2.6).

Warning: For *ITU-R BT.2100*, only the electro-optical transfer functions (EOTFs / EOCFs) are exposed by this attribute, See the `colour.OETF_INVERSES` attribute for the inverse opto-electronic transfer functions (OETF).

Notes

- The order by which this attribute is defined and updated is critically important to ensure that *ITU-R BT.2100* definitions are reciprocal.

colour.gamma_function

`colour.gamma_function(a: FloatingOrArrayLike, exponent: FloatingOrArrayLike = 1, negative_number_handling: Literal['Clamp', 'Indeterminate', 'Mirror', 'Preserve'] | str = 'Indeterminate') → FloatingOrNDArray`

Define a typical gamma encoding / decoding function.

Parameters

- **a** (`FloatingOrArrayLike`) – Array to encode / decode.
- **exponent** (`FloatingOrArrayLike`) – Encoding / decoding exponent.
- **negative_number_handling** (`Literal['Clamp', 'Indeterminate', 'Mirror', 'Preserve'] | str`) – Defines the behaviour for a negative numbers and / or the definition return value:
 - *Indeterminate*: The behaviour will be indeterminate and definition return value might contain *nans*.
 - *Mirror*: The definition return value will be mirrored around abscissa and ordinate axis, i.e. Blackmagic Design: Davinci Resolve behaviour.
 - *Preserve*: The definition will preserve any negative number in a, i.e. The Foundry Nuke behaviour.
 - *Clamp*: The definition will clamp any negative number in a to 0.

Returns

Encoded / decoded array.

Return type

`numpy.floating` or `numpy.ndarray`

Examples

```
>>> gamma_function(0.18, 2.2)
0.0229932...
>>> gamma_function(-0.18, 2.0)
0.0323999...
>>> gamma_function(-0.18, 2.2)
nan
>>> gamma_function(-0.18, 2.2, "Mirror")
-0.0229932...
>>> gamma_function(-0.18, 2.2, "Preserve")
-0.1...
>>> gamma_function(-0.18, 2.2, "Clamp")
0.0
```

colour.linear_function

`colour.linear_function(a: FloatingOrArrayLike) → FloatingOrNDArray`

Define a typical linear encoding / decoding function, essentially a pass-through function.

Parameters

a (FloatingOrArrayLike) – Array to encode / decode.

Returns

Encoded / decoded array.

Return type

`numpy.floating` or `numpy.ndarray`

Examples

```
>>> linear_function(0.18)
0.1799999...
```

colour.models

| | |
|--|---|
| <code>cctf_encoding_ROMMRGB(X[, bit_depth, out_int])</code> | Define the <i>ROMM RGB</i> encoding colour component transfer function (Encoding CCTF). |
| <code>cctf_decoding_ROMMRGB(X_p[, bit_depth, in_int])</code> | Define the <i>ROMM RGB</i> decoding colour component transfer function (Encoding CCTF). |
| <code>cctf_encoding_RIMMRGB(X[, bit_depth, ...])</code> | Define the <i>RIMM RGB</i> encoding colour component transfer function (Encoding CCTF). |
| <code>cctf_decoding_RIMMRGB(X_p[, bit_depth, ...])</code> | Define the <i>RIMM RGB</i> decoding colour component transfer function (Encoding CCTF). |

colour.models.cctf_encoding_ROMMRGB

`colour.models.cctf_encoding_ROMMRGB(X: FloatingOrArrayLike, bit_depth: int = 8, out_int: bool = False) → FloatingOrNDArray | IntegerOrNDArray`

Define the *ROMM RGB* encoding colour component transfer function (Encoding CCTF).

Parameters

- **X** (FloatingOrArrayLike) – Linear data X_{ROMM} .
- **bit_depth** (`int`) – Bit depth used for conversion.
- **out_int** (`bool`) – Whether to return value as integer code value or float equivalent of a code value at a given bit depth.

Returns

Non-linear data X'_{ROMM} .

Return type

`numpy.floating` or `numpy.integer` or `numpy.ndarray`

Notes

| Domain * | Scale - Reference | Scale - 1 |
|----------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

| Range * | Scale - Reference | Scale - 1 |
|---------|-------------------|-----------|
| x_p | [0, 1] | [0, 1] |

* This definition has an output integer switch, thus the domain-range scale information is only given for the floating point mode.

References

[ANSI03], [SWG00]

Examples

```
>>> cctf_encoding_ROMMRGB(0.18)
0.3857114...
>>> cctf_encoding_ROMMRGB(0.18, out_int=True)
98
```

colour.models.cctf_decoding_ROMMRGB

`colour.models.cctf_decoding_ROMMRGB(X_p: FloatingOrArrayLike | IntegerOrArrayLike, bit_depth: int = 8, in_int: bool = False) → FloatingOrNDArray`

Define the *ROMM* RGB decoding colour component transfer function (Encoding CCTF).

Parameters

- ***X_p*** (FloatingOrArrayLike | IntegerOrArrayLike) – Non-linear data X'_{ROMM} .
- ***bit_depth*** (int) – Bit depth used for conversion.
- ***in_int*** (bool) – Whether to treat the input value as integer code value or float equivalent of a code value at a given bit depth.

Returns

Linear data X_{ROMM} .

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain * | Scale - Reference | Scale - 1 |
|----------|-------------------|-----------|
| X_p | [0, 1] | [0, 1] |

| Range * | Scale - Reference | Scale - 1 |
|---------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

* This definition has an input integer switch, thus the domain-range scale information is only given for the floating point mode.

References

[ANSI03], [SWG00]

Examples

```
>>> cctf_decoding_ROMMRGB(0.385711424751138)
0.1...
>>> cctf_decoding_ROMMRGB(98, in_int=True)
0.1...
```

colour.models.cctf_encoding_RIMMRGB

`colour.models.cctf_encoding_RIMMRGB(X: FloatingOrArrayLike, bit_depth: int = 8, out_int: bool = False, E_clip: float = 2.0) → FloatingOrNDArray | IntegerOrNDArray`

Define the *RIMM* RGB encoding colour component transfer function (Encoding CCTF).

RIMM RGB encoding non-linearity is based on that specified by *Recommendation ITU-R BT.709-6*.

Parameters

- **X** (FloatingOrArrayLike) – Linear data X_{RIMM} .
- **bit_depth** (int) – Bit depth used for conversion.
- **out_int** (bool) – Whether to return value as integer code value or float equivalent of a code value at a given bit depth.
- **E_clip** (float) – Maximum exposure level.

Returns

Non-linear data X'_{RIMM} .

Return type

`numpy.floating` or `numpy.integer` or `numpy.ndarray`

Notes

| Domain * | Scale - Reference | Scale - 1 |
|----------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

| Range * | Scale - Reference | Scale - 1 |
|---------|-------------------|-----------|
| x_p | [0, 1] | [0, 1] |

* This definition has an output integer switch, thus the domain-range scale information is only given for the floating point mode.

References

[SWG00]

Examples

```
>>> cctf_encoding_RIMMRGB(0.18)
0.2916737...
>>> cctf_encoding_RIMMRGB(0.18, out_int=True)
74
```

colour.models.cctf_decoding_RIMMRGB

`colour.models.cctf_decoding_RIMMRGB(X_p: FloatingOrArrayLike | IntegerOrArrayLike, bit_depth: int = 8, in_int: bool = False, E_clip: float = 2.0) → FloatingOrNDArray`

Define the *RIMM* RGB decoding colour component transfer function (Encoding CCTF).

Parameters

- ***X_p*** (FloatingOrArrayLike | IntegerOrArrayLike) – Non-linear data X'_{RIMM} .
- ***bit_depth*** (int) – Bit depth used for conversion.
- ***in_int*** (bool) – Whether to treat the input value as integer code value or float equivalent of a code value at a given bit depth.
- ***E_clip*** (float) – Maximum exposure level.

Returns

Linear data X_{RIMM} .

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain * | Scale - Reference | Scale - 1 |
|----------|-------------------|-----------|
| X_p | [0, 1] | [0, 1] |

| Range * | Scale - Reference | Scale - 1 |
|---------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

* This definition has an input integer switch, thus the domain-range scale information is only given for the floating point mode.

References

[SWG00]

Examples

```
>>> cctf_decoding_RIMMRGB(0.291673732475746)
0.1...
>>> cctf_decoding_RIMMRGB(74, in_int=True)
0.1...
```

Aliases

`colour.models`

| | |
|---|---|
| <code>cctf_encoding_ProPhotoRGB(X[, bit_depth, ...])</code> | Define the <i>ProPhoto</i> RGB encoding colour component transfer function (Encoding CCTF). |
| <code>cctf_decoding_ProPhotoRGB(X_p[, bit_depth, ...])</code> | Define the <i>ProPhoto</i> RGB decoding colour component transfer function (Encoding CCTF). |

`colour.models.cctf_encoding_ProPhotoRGB`

`colour.models.cctf_encoding_ProPhotoRGB(X, bit_depth=8, out_int=False)`

Define the *ProPhoto* RGB encoding colour component transfer function (Encoding CCTF).

Parameters

- X – Linear data X_{ROMM} .
- `bit_depth` – Bit depth used for conversion.
- `out_int` – Whether to return value as integer code value or float equivalent of a code value at a given bit depth.

Returns

Non-linear data X'_{ROMM} .

Return type

`numpy.float64` or `numpy.int64` or `numpy.ndarray`

Notes

| Domain * | Scale - Reference | Scale - 1 |
|----------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

| Range * | Scale - Reference | Scale - 1 |
|---------|-------------------|-----------|
| x_p | [0, 1] | [0, 1] |

* This definition has an output integer switch, thus the domain-range scale information is only given for the floating point mode.

References

[ANSI03], [SWG00]

Examples

```
>>> cctf_encoding_ROMMRGB(0.18)
0.3857114...
>>> cctf_encoding_ROMMRGB(0.18, out_int=True)
98
```

colour.models.cctf_decoding_ProPhotoRGB

colour.models.cctf_decoding_ProPhotoRGB(X_p , bit_depth=8, in_int=False)

Define the *ProPhoto* RGB decoding colour component transfer function (Encoding CCTF).

Parameters

- x_p – Non-linear data X'_{ROMM} .
- **bit_depth** – Bit depth used for conversion.
- **in_int** – Whether to treat the input value as integer code value or float equivalent of a code value at a given bit depth.

Returns

Linear data X_{ROMM} .

Return type

numpy.floating or numpy.ndarray

Notes

| Domain * | Scale - Reference | Scale - 1 |
|----------|-------------------|-----------|
| x_p | [0, 1] | [0, 1] |

| Range * | Scale - Reference | Scale - 1 |
|---------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

* This definition has an input integer switch, thus the domain-range scale information is only given for the floating point mode.

References

[ANSI03], [SWG00]

Examples

```
>>> cctf_decoding_ROMMRGB(0.385711424751138)
0.1...
>>> cctf_decoding_ROMMRGB(98, in_int=True)
0.1...
```

Ancillary Objects

`colour.models`

| | |
|---|---|
| <code>exponent_function_basic(x[, exponent, style])</code> | Define the <i>basic</i> exponent transfer function. |
| <code>exponent_function_monitor_curve(x[, ...])</code> | Define the <i>Monitor Curve</i> exponent transfer function. |
| <code>logarithmic_function_basic(x[, style, base])</code> | Define the basic logarithmic function. |
| <code>logarithmic_function_quasilog(x[, style, ...])</code> | Define the quasilog logarithmic function. |
| <code>logarithmic_function_camera(x[, style, ...])</code> | Define the camera logarithmic function. |

`colour.models.exponent_function_basic`

`colour.models.exponent_function_basic(x: FloatingOrArrayLike, exponent: FloatingOrArrayLike = 1, style: Literal['basicFwd', 'basicRev', 'basicMirrorFwd', 'basicMirrorRev', 'basicPassThruFwd', 'basicPassThruRev'] | str = 'basicFwd') → FloatingOrNDArray`

Define the *basic* exponent transfer function.

Parameters

- **x** (`FloatingOrArrayLike`) – Data to undergo the basic exponent conversion.
- **exponent** (`FloatingOrArrayLike`) – Exponent value used for the conversion.
- **style** (`Literal['basicFwd', 'basicRev', 'basicMirrorFwd', 'basicMirrorRev', 'basicPassThruFwd', 'basicPassThruRev'] | str`) – Defines the behaviour for the transfer function to operate:
 - *basicFwd*: *Basic Forward* exponential behaviour where the definition applies a basic power law using the exponent. Values less than zero are clamped.
 - *basicRev*: *Basic Reverse* exponential behaviour where the definition applies a basic power law using the exponent. Values less than zero are clamped.
 - *basicMirrorFwd*: *Basic Mirror Forward* exponential behaviour where the definition applies a basic power law using the exponent for values greater than or equal to zero and mirrors the function for values less than zero (i.e. rotationally symmetric around the origin).
 - *basicMirrorRev*: *Basic Mirror Reverse* exponential behaviour where the definition applies a basic power law using the exponent for values greater than or equal to zero and mirrors the function for values less than zero (i.e. rotationally symmetric around the origin).

- *basicPassThruFwd*: *Basic Pass Forward* exponential behaviour where the definition applies a basic power law using the exponent for values greater than or equal to zero and passes values less than zero unchanged.
- *basicPassThruRev*: *Basic Pass Reverse* exponential behaviour where the definition applies a basic power law using the exponent for values greater than or equal to zero and passes values less than zero unchanged.

Returns

Exponentially converted data.

Return type

`numpy.float64` or `numpy.ndarray`

Examples

```
>>> exponent_function_basic(0.18, 2.2)
0.0229932...
>>> exponent_function_basic(-0.18, 2.2)
0.0
>>> exponent_function_basic(0.18, 2.2, "basicRev")
0.4586564...
>>> exponent_function_basic(-0.18, 2.2, "basicRev")
0.0
>>> exponent_function_basic(
...     0.18, 2.2, "basicMirrorFwd"
... )
0.0229932...
>>> exponent_function_basic(
...     -0.18, 2.2, "basicMirrorFwd"
... )
-0.0229932...
>>> exponent_function_basic(
...     0.18, 2.2, "basicMirrorRev"
... )
0.4586564...
>>> exponent_function_basic(
...     -0.18, 2.2, "basicMirrorRev"
... )
-0.4586564...
>>> exponent_function_basic(
...     0.18, 2.2, "basicPassThruFwd"
... )
0.0229932...
>>> exponent_function_basic(
...     -0.18, 2.2, "basicPassThruFwd"
... )
-0.1799999...
>>> exponent_function_basic(
...     0.18, 2.2, "basicPassThruRev"
... )
0.4586564...
>>> exponent_function_basic(
...     -0.18, 2.2, "basicPassThruRev"
... )
-0.1799999...
```

`colour.models.exponent_function_monitor_curve`

```
colour.models.exponent_function_monitor_curve(x: FloatingOrArrayLike, exponent:
                                             FloatingOrArrayLike = 1, offset:
                                             FloatingOrArrayLike = 0, style:
                                             Literal['monCurveFwd', 'monCurveRev',
                                             'monCurveMirrorFwd', 'monCurveMirrorRev'] | str
                                             = 'monCurveFwd') → FloatingOrNDArray
```

Define the *Monitor Curve* exponent transfer function.

Parameters

- **x** (FloatingOrArrayLike) – Data to undergo the monitor curve exponential conversion.
- **exponent** (FloatingOrArrayLike) – Exponent value used for the conversion.
- **offset** (FloatingOrArrayLike) – Offset value used for the conversion.
- **style** (Literal['monCurveFwd', 'monCurveRev', 'monCurveMirrorFwd', 'monCurveMirrorRev'] | str) – Defines the behaviour for the transfer function to operate:
 - *monCurveFwd*: *Monitor Curve Forward* exponential behaviour where the definition applies a power law function with a linear segment near the origin.
 - *monCurveRev*: *Monitor Curve Reverse* exponential behaviour where the definition applies a power law function with a linear segment near the origin.
 - *monCurveMirrorFwd*: *Monitor Curve Mirror Forward* exponential behaviour where the definition applies a power law function with a linear segment near the origin and mirrors the function for values less than zero (i.e. rotationally symmetric around the origin).
 - *monCurveMirrorRev*: *Monitor Curve Mirror Reverse* exponential behaviour where the definition applies a power law function with a linear segment near the origin and mirrors the function for values less than zero (i.e. rotationally symmetric around the origin).

Returns

Exponentially converted data.

Return type

`numpy.floating` or `numpy.ndarray`

Examples

```
>>> exponent_function_monitor_curve(0.18, 2.2, 0.001)
0.0232240...
>>> exponent_function_monitor_curve(
...     -0.18, 2.2, 0.001
... )
-0.0002054...
>>> exponent_function_monitor_curve(
...     0.18, 2.2, 0.001, "monCurveRev"
... )
0.4581151...
>>> exponent_function_monitor_curve(
...     -0.18, 2.2, 0.001, "monCurveRev"
... )
-157.7302795...
```

(continues on next page)

(continued from previous page)

```
>>> exponent_function_monitor_curve(
...     0.18, 2.2, 2, "monCurveMirrorFwd"
... )
0.1679399...
>>> exponent_function_monitor_curve(
...     -0.18, 2.2, 0.001, "monCurveMirrorFwd"
... )
-0.0232240...
>>> exponent_function_monitor_curve(
...     0.18, 2.2, 0.001, "monCurveMirrorRev"
... )
0.4581151...
>>> exponent_function_monitor_curve(
...     -0.18, 2.2, 0.001, "monCurveMirrorRev"
... )
-0.4581151...
```

colour.models.logarithmic_function_basic

`colour.models.logarithmic_function_basic(x: FloatingOrArrayLike, style: Literal['log10', 'antiLog10', 'log2', 'antiLog2', 'logB', 'antiLogB'] | str = 'log2', base: int = 2) → FloatingOrNDArray`

Define the basic logarithmic function.

Parameters

- **x** (*FloatingOrArrayLike*) – The data to undergo basic logarithmic conversion.
- **style** (*Literal*['log10', 'antiLog10', 'log2', 'antiLog2', 'logB', 'antiLogB'] | str) – Defines the behaviour for the logarithmic function to operate:
 - *log10*: Applies a base 10 logarithm to the passed value.
 - *antiLog10*: Applies a base 10 anti-logarithm to the passed value.
 - *log2*: Applies a base 2 logarithm to the passed value.
 - *antiLog2*: Applies a base 2 anti-logarithm to the passed value.
 - *logB*: Applies an arbitrary base logarithm to the passed value.
 - *antiLogB*: Applies an arbitrary base anti-logarithm to the passed value.
- **base** (int) – Logarithmic base used for the conversion.

Returns

Logarithmically converted data.

Return type

numpy.floating or *numpy.ndarray*

Examples

The basic logarithmic function *styles* operate as follows:

```
>>> logarithmic_function_basic(0.18)
-2.4739311...
>>> logarithmic_function_basic(0.18, "log10")
-0.7447274...
>>> logarithmic_function_basic(0.18, "logB", 3)
-1.5608767...
>>> logarithmic_function_basic(
...     -2.473931188332412, "antiLog2"
... )
0.18000000...
>>> logarithmic_function_basic(
...     -0.7447274948966939, "antiLog10"
... )
0.18000000...
>>> logarithmic_function_basic(
...     -1.5608767950073117, "antiLogB", 3
... )
0.18000000...
```

colour.models.logarithmic_function_quasilog

`colour.models.logarithmic_function_quasilog(x: FloatingOrArrayLike, style: Literal['linToLog', 'logToLin'] | str = 'linToLog', base: int = 2, log_side_slope: float = 1, lin_side_slope: float = 1, log_side_offset: float = 0, lin_side_offset: float = 0) → FloatingOrNDArray`

Define the quasilog logarithmic function.

Parameters

- **x** (`FloatingOrArrayLike`) – Linear/non-linear data to undergo encoding/decoding.
- **style** (`Literal['linToLog', 'logToLin'] | str`) – Defines the behaviour for the logarithmic function to operate:
 - *linToLog*: Applies a logarithm to convert linear data to logarithmic data.
 - *logToLin*: Applies an anti-logarithm to convert logarithmic data to linear data.
- **base** (`int`) – Logarithmic base used for the conversion.
- **log_side_slope** (`float`) – Slope (or gain) applied to the log side of the logarithmic function. The default value is 1.
- **lin_side_slope** (`float`) – Slope of the linear side of the logarithmic function. The default value is 1.
- **log_side_offset** (`float`) – Offset applied to the log side of the logarithmic function. The default value is 0.
- **lin_side_offset** (`float`) – Offset applied to the linear side of the logarithmic function. The default value is 0.

Returns

Encoded/Decoded data.

Return type

`numpy.float64` or `numpy.ndarray`

Examples

```
>>> logarithmic_function_quasilog(0.18, "linToLog")
-2.4739311...
>>> logarithmic_function_quasilog(
...     -2.473931188332412, "logToLin"
... )
0.18000000...
```

colour.models.logarithmic_function_camera

`colour.models.logarithmic_function_camera(x: FloatingOrArrayLike, style: Literal['cameraLinToLog', 'cameraLogToLin'] | str = 'cameraLinToLog', base: int = 2, log_side_slope: float = 1, lin_side_slope: float = 1, log_side_offset: float = 0, lin_side_offset: float = 0, lin_side_break: float = 0.005, linear_slope: float | None = None) → FloatingOrNDArray`

Define the camera logarithmic function.

Parameters

- **x** (`FloatingOrArrayLike`) – Linear/non-linear data to undergo encoding/decoding.
- **style** (`Literal['cameraLinToLog', 'cameraLogToLin'] | str`) – Defines the behaviour for the logarithmic function to operate:
 - *cameraLinToLog*: Applies a piece-wise function with logarithmic and linear segments on linear values, converting them to non-linear values.
 - *cameraLogToLin*: Applies a piece-wise function with logarithmic and linear segments on non-linear values, converting them to linear values.
- **base** (`int`) – Logarithmic base used for the conversion.
- **log_side_slope** (`float`) – Slope (or gain) applied to the log side of the logarithmic segment. The default value is 1.
- **lin_side_slope** (`float`) – Slope of the linear side of the logarithmic segment. The default value is 1.
- **log_side_offset** (`float`) – Offset applied to the log side of the logarithmic segment. The default value is 0.
- **lin_side_offset** (`float`) – Offset applied to the linear side of the logarithmic segment. The default value is 0.
- **lin_side_break** (`float`) – Break-point, defined in linear space, at which the piece-wise function transitions between the logarithmic and linear segments.
- **linear_slope** (`float | None`) – Slope of the linear portion of the curve. The default value is *None*.

Returns

Encoded/Decoded data.

Return type

`numpy.float64` or `numpy.ndarray`

Examples

```
>>> logarithmic_function_camera(
...     0.18, "cameraLinToLog"
... )
-2.4739311...
>>> logarithmic_function_camera(
...     -2.4739311883324122, "cameraLogToLin"
... )
0.1800000...
```

Opto-Electronic Transfer Functions

colour

| | |
|--|---|
| <code>oetf(value[, function])</code> | Encode estimated tristimulus values in a scene to $R'G'B'$ video component signal value using given opto-electronic transfer function (OETF). |
| <code>OETFS</code> | Supported opto-electrical transfer functions (OETFs / OECFs). |
| <code>oetf_inverse(value[, function])</code> | Decode $R'G'B'$ video component signal value to tristimulus values at the display using given inverse opto-electronic transfer function (OETF). |
| <code>OETF_INVERSES</code> | Supported inverse opto-electrical transfer functions (OETFs / OECFs). |

colour.oetf

`colour.oetf(value: float | _SupportsArray[dtype[Any]] | _NestedSequence[_SupportsArray[dtype[Any]]] | bool | int | complex | str | bytes | _NestedSequence[bool | int | float | complex | str | bytes], function: Literal['ARIB STD-B67', 'Blackmagic Film Generation 5', 'DaVinci Intermediate', 'ITU-R BT.2020', 'ITU-R BT.2100 HLG', 'ITU-R BT.2100 PQ', 'ITU-R BT.601', 'ITU-R BT.709', 'ITU-T H.273 Log', 'ITU-T H.273 Log Sqrt', 'ITU-T H.273 IEC 61966-2', 'SMPTE 240M'] | str = 'ITU-R BT.709', **kwargs: Any) → float | ndarray`

Encode estimated tristimulus values in a scene to $R'G'B'$ video component signal value using given opto-electronic transfer function (OETF).

Parameters

- **value** (float | _SupportsArray[dtype[Any]] | _NestedSequence[_SupportsArray[dtype[Any]]] | bool | int | complex | str | bytes | _NestedSequence[bool | int | float | complex | str | bytes]) – Value.
- **function** (Literal['ARIB STD-B67', 'Blackmagic Film Generation 5', 'DaVinci Intermediate', 'ITU-R BT.2020', 'ITU-R BT.2100 HLG', 'ITU-R BT.2100 PQ', 'ITU-R BT.601', 'ITU-R BT.709', 'ITU-T H.273 Log', 'ITU-T H.273 Log Sqrt', 'ITU-T H.273 IEC 61966-2', 'SMPTE 240M'] | str) – Opto-electronic transfer function (OETF).
- **kwargs** (Any) – {colour.models.oetf_ARIBSTDB67(), colour.models.oetf_BlackmagicFilmGeneration5(), colour.models.oetf_DaVinciIntermediate(), colour.models.oetf_BT2020(), colour.models.oetf_BT2100_HLG(), colour.models.oetf_BT2100_PQ(), colour.

```
models.oetf_BT601(), colour.models.oetf_BT709(), colour.models.oetf_SMPTE240M()), See the documentation of the previously listed definitions.
```

Returns

$R'G'B'$ video component signal value.

Return type

`numpy.float64` or `numpy.ndarray`

Examples

```
>>> oetf(0.18)
0.4090077...
>>> oetf(0.18, function="ITU-R BT.601")
0.4090077...
```

colour.OETFs

```
colour.OETFs = CanonicalMapping({'ARIB STD-B67': ..., 'Blackmagic Film Generation 5': ...,
'DaVinci Intermediate': ..., 'ITU-R BT.2020': ..., 'ITU-R BT.2100 HLG': ..., 'ITU-R BT.2100 PQ': ...,
'ITU-R BT.601': ..., 'ITU-R BT.709': ..., 'ITU-T H.273 Log': ..., 'ITU-T H.273 Log Sqrt': ...,
'ITU-T H.273 IEC 61966-2': ..., 'SMPTE 240M': ...})
```

Supported opto-electrical transfer functions (OETFs / OECFs).

colour.oetf_inverse

```
colour.oetf_inverse(value: float | _SupportsArray[dtype[Any]] |
    _NestedSequence[_SupportsArray[dtype[Any]]] | bool | int | complex | str | bytes
    | _NestedSequence[bool | int | float | complex | str | bytes], function:
    Literal['ARIB STD-B67', 'Blackmagic Film Generation 5', 'DaVinci Intermediate',
    'ITU-R BT.2020', 'ITU-R BT.2100 HLG', 'ITU-R BT.2100 PQ', 'ITU-R BT.601', 'ITU-R
    BT.709', 'ITU-T H.273 Log', 'ITU-T H.273 Log Sqrt', 'ITU-T H.273 IEC 61966-2'] |
    str = 'ITU-R BT.709', **kwargs: Any) → float | ndarray
```

Decode $R'G'B'$ video component signal value to tristimulus values at the display using given inverse opto-electronic transfer function (OETF).

Parameters

- **value** (`float` | `_SupportsArray[dtype[Any]]` | `_NestedSequence[_SupportsArray[dtype[Any]]]` | `bool` | `int` | `complex` | `str` | `bytes` | `_NestedSequence[bool | int | float | complex | str | bytes]`) – Value.
- **function** (`Literal['ARIB STD-B67', 'Blackmagic Film Generation 5', 'DaVinci Intermediate', 'ITU-R BT.2020', 'ITU-R BT.2100 HLG', 'ITU-R BT.2100 PQ', 'ITU-R BT.601', 'ITU-R BT.709', 'ITU-T H.273 Log', 'ITU-T H.273 Log Sqrt', 'ITU-T H.273 IEC 61966-2']` | `str`) – Inverse opto-electronic transfer function (OETF).
- **kwargs** (`Any`) – {`colour.models.oetf_inverse_ARIBSTD67()`, `colour.models.oetf_inverse_BlackmagicFilmGeneration5()`, `colour.models.oetf_inverse_DaVinciIntermediate()`, `colour.models.oetf_inverse_BT2020()`, `colour.models.oetf_inverse_BT2100_HLG()`, `colour.models.oetf_inverse_BT2100_PQ()`, `colour.models.oetf_inverse_BT601()`, `colour.models.oetf_inverse_BT709()`}, See the documentation of the previously listed definitions.

Returns

Tristimulus values at the display.

Return type

`numpy.float64` or `numpy.ndarray`

Examples

```
>>> oetf_inverse(0.409007728864150)
0.1...
>>> oetf_inverse(
...     0.409007728864150, function="ITU-R BT.601"
... )
0.1...
```

colour.OETF_INVERSES

```
colour.OETF_INVERSES = CanonicalMapping({'ARIB STD-B67': ..., 'Blackmagic Film Generation
5': ..., 'DaVinci Intermediate': ..., 'ITU-R BT.2020': ..., 'ITU-R BT.2100 HLG': ...,
'ITU-R BT.2100 PQ': ..., 'ITU-R BT.601': ..., 'ITU-R BT.709': ..., 'ITU-T H.273 Log': ...,
'ITU-T H.273 Log Sqrt': ..., 'ITU-T H.273 IEC 61966-2': ...})
```

Supported inverse opto-electrical transfer functions (OETFs / OECFs).

`colour.models`

| | |
|---|--|
| <code>oetf_ARIBSTDB67(E[, r, constants])</code> | Define <i>ARIB STD-B67 (Hybrid Log-Gamma)</i> opto-electrical transfer function (OETF). |
| <code>oetf_inverse_ARIBSTDB67(E_p[, r, constants])</code> | Define <i>ARIB STD-B67 (Hybrid Log-Gamma)</i> inverse opto-electrical transfer function (OETF). |
| <code>oetf_BlackmagicFilmGeneration5(x[, constants])</code> | Define the <i>Blackmagic Film Generation 5</i> opto-electronic transfer function (OETF). |
| <code>oetf_inverse_BlackmagicFilmGeneration5(y[, ...])</code> | Define the <i>Blackmagic Film Generation 5</i> inverse opto-electronic transfer function (OETF). |
| <code>oetf_DaVinciIntermediate(L[, constants])</code> | Define the <i>DaVinci Intermediate</i> opto-electronic transfer function. |
| <code>oetf_inverse_DaVinciIntermediate(V[, constants])</code> | Define the <i>DaVinci Intermediate</i> inverse opto-electronic transfer function (OETF). |
| <code>oetf_BT2020(E[, is_12_bits_system, constants])</code> | Define <i>Recommendation ITU-R BT.2020</i> opto-electronic transfer function (OETF). |
| <code>oetf_inverse_BT2020(E_p[, ...])</code> | Define <i>Recommendation ITU-R BT.2020</i> inverse opto-electronic transfer function (OETF). |
| <code>oetf_BT2100_HLG(E[, constants])</code> | Define <i>Recommendation ITU-R BT.2100 Reference HLG</i> opto-electrical transfer function (OETF). |
| <code>oetf_inverse_BT2100_HLG(E_p[, constants])</code> | Define <i>Recommendation ITU-R BT.2100 Reference HLG</i> inverse opto-electrical transfer function (OETF). |
| <code>oetf_BT2100_PQ(E)</code> | Define <i>Recommendation ITU-R BT.2100 Reference PQ</i> opto-electrical transfer function (OETF). |
| <code>oetf_inverse_BT2100_PQ(E_p)</code> | Define <i>Recommendation ITU-R BT.2100 Reference PQ</i> inverse opto-electrical transfer function (OETF). |
| <code>oetf_BT601(L)</code> | Define <i>Recommendation ITU-R BT.601-7</i> opto-electronic transfer function (OETF). |
| <code>oetf_inverse_BT601(E)</code> | Define <i>Recommendation ITU-R BT.601-7</i> inverse opto-electronic transfer function (OETF). |
| <code>oetf_BT709(L)</code> | Define <i>Recommendation ITU-R BT.709-6</i> opto-electronic transfer function (OETF). |
| <code>oetf_inverse_BT709(V)</code> | Define <i>Recommendation ITU-R BT.709-6</i> inverse opto-electronic transfer function (OETF). |
| <code>oetf_H273_Log(L_c)</code> | Define <i>Recommendation ITU-T H.273</i> opto-electronic transfer function (OETF) for logarithmic encoding (100:1 range). |
| <code>oetf_inverse_H273_Log(V)</code> | Define <i>Recommendation ITU-T H.273</i> inverse-opto-electronic transfer function (OETF) for logarithmic encoding (100:1 range). |
| <code>oetf_H273_LogSqrt(L_c)</code> | Define <i>Recommendation ITU-T H.273</i> opto-electronic transfer function (OETF) for logarithmic encoding (100* $\sqrt{10}$:1 range). |
| <code>oetf_inverse_H273_LogSqrt(V)</code> | Define <i>Recommendation ITU-T H.273</i> inverse-opto-electronic transfer function (OETF) for logarithmic encoding (100* $\sqrt{10}$:1 range). |
| <code>oetf_H273_IEC61966_2(L_c)</code> | Define <i>Recommendation ITU-T H.273</i> opto-electronic transfer function (OETF) for <i>IEC 61966-2</i> family of transfer functions (2-1 sRGB, 2-1 sYCC, 2-4 xvYCC). |
| <code>oetf_inverse_H273_IEC61966_2(V)</code> | Define <i>Recommendation ITU-T H.273</i> inverse opto-electronic transfer function (OETF) for <i>IEC 61966-2</i> family of transfer functions (2-1 sRGB, 2-1 sYCC, 2-4 xvYCC). |
| <code>oetf_SMPTE240M(L_c)</code> | Define <i>SMPTE 240M</i> opto-electrical transfer function (OETF). |

colour.models.oetf_ARIBSTDB67

`colour.models.oetf_ARIBSTDB67` (*E*: *FloatingOrArrayLike*, *r*: *FloatingOrArrayLike* = 0.5, *constants*: *Structure* = *CONSTANTS_ARIBSTDB67*) → *FloatingOrNDArray*

Define ARIB STD-B67 (Hybrid Log-Gamma) opto-electrical transfer function (OETF).

Parameters

- **E** (*FloatingOrArrayLike*) – Voltage normalised by the reference white level and proportional to the implicit light intensity that would be detected with a reference camera color channel R, G, B.
- **r** (*FloatingOrArrayLike*) – Video level corresponding to reference white level.
- **constants** (*Structure*) – ARIB STD-B67 (Hybrid Log-Gamma) constants.

Returns

Resulting non-linear signal E' .

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| E | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|----------------|-------------------|-----------|
| E _p | [0, 1] | [0, 1] |

- This definition uses the *mirror* negative number handling mode of `colour.models.gamma_function()` definition to the sign of negative numbers.

References

[Association of RIA Businesses 15]

Examples

```
>>> oetf_ARIBSTDB67(0.18)
0.2121320...
```

colour.models.oetf_inverse_ARIBSTDB67

`colour.models.oetf_inverse_ARIBSTDB67` (*E_p*: *FloatingOrArrayLike*, *r*: *FloatingOrArrayLike* = 0.5, *constants*: *Structure* = *CONSTANTS_ARIBSTDB67*) → *FloatingOrNDArray*

Define ARIB STD-B67 (Hybrid Log-Gamma) inverse opto-electrical transfer function (OETF).

Parameters

- **E_p** (*FloatingOrArrayLike*) – Non-linear signal E' .
- **r** (*FloatingOrArrayLike*) – Video level corresponding to reference white level.

- **constants** ([Structure](#)) – *ARIB STD-B67 (Hybrid Log-Gamma)* constants.

Returns

Voltage E normalised by the reference white level and proportional to the implicit light intensity that would be detected with a reference camera color channel R, G, B.

Return type

[numpy.floating](#) or [numpy.ndarray](#)

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| E_p | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| E | [0, 1] | [0, 1] |

- This definition uses the *mirror* negative number handling mode of `colour.models.gamma_function()` definition to the sign of negative numbers.

References

[[Association of RIAs Businesses](#)15]

Examples

```
>>> oetf_inverse_ARIBSTD67(0.212132034355964)
0.1799999...
```

colour.models.oetf_BlackmagicFilmGeneration5

`colour.models.oetf_BlackmagicFilmGeneration5`(x : *FloatingOrArrayLike*, constants: [Structure](#) = `CONSTANTS_BLACKMAGIC_FILM_GENERATION_5`)
→ *FloatingOrNDArray*

Define the *Blackmagic Film Generation 5* opto-electronic transfer function (OETF).

Parameters

- x (*FloatingOrArrayLike*) – Linear light value x .
- **constants** ([Structure](#)) – *Blackmagic Film Generation 5* constants.

Returns

Encoded value y .

Return type

[numpy.floating](#) or [numpy.ndarray](#)

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| y | [0, 1] | [0, 1] |

References

[BlackmagicDesign21]

Examples

```
>>> oetf_BlackmagicFilmGeneration5(0.18)
0.3835616...
```

colour.models.oetf_inverse_BlackmagicFilmGeneration5

`colour.models.oetf_inverse_BlackmagicFilmGeneration5`(*y*: *FloatingOrArrayLike*, *constants*: *Structure* = *CONSTANTS_BLACKMAGIC_FILM_GENERATION_5*)
→ *FloatingOrNDArray*

Define the *Blackmagic Film Generation 5* inverse opto-electronic transfer function (OETF).

Parameters

- **y** (*FloatingOrArrayLike*) – Encoded value *y*.
- **constants** (*Structure*) – *Blackmagic Film Generation 5* constants.

Returns

Linear light value :math`x`.

Return type

`numpy.float64` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| y | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

References

[BlackmagicDesign21]

Examples

```
>>> oetf_inverse_BlackmagicFilmGeneration5(0.38356164383561653)
...
0.1799999...
```

colour.models.oetf_DaVinciIntermediate

colour.models.oetf_DaVinciIntermediate(L: FloatingOrArrayLike, constants: Structure = CONSTANTS_DAVINCI_INTERMEDIATE) → FloatingOrNDArray

Define the *DaVinci Intermediate* opto-electronic transfer function.

Parameters

- **L** (FloatingOrArrayLike) – Linear light value :math`L`.
- **constants** (Structure) – *DaVinci Intermediate* colour component transfer function constants.

Returns

Encoded value *V*.

Return type

numpy.floating or numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| L | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| V | [0, 1] | [0, 1] |

References

[BlackmagicDesign20a]

Examples

```
>>> oetf_DaVinciIntermediate(0.18)
0.3360432...
```

colour.models.oetf_inverse_DaVinciIntermediate

colour.models.oetf_inverse_DaVinciIntermediate(*V*: *FloatingOrArrayLike*, *constants*: *Structure* = *CONSTANTS_DAVINCI_INTERMEDIATE*) → *FloatingOrNDArray*

Define the *DaVinci Intermediate* inverse opto-electronic transfer function (OETF).

Parameters

- **V** (*FloatingOrArrayLike*) – Encoded value *V*.
- **constants** (*Structure*) – *DaVinci Intermediate* colour component transfer function constants.

Returns

Linear light value :math`L`.

Return type

numpy.floating or *numpy.ndarray*

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| y | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

References

[BlackmagicDesign20a]

Examples

```
>>> oetf_inverse_DaVinciIntermediate(0.336043272384855)
...
0.1799999...
```

colour.models.oetf_BT2020

colour.models.oetf_BT2020(*E*: FloatingOrArrayLike, *is_12_bits_system*: bool = False, *constants*: Structure = CONSTANTS_BT2020) → FloatingOrNDArray

Define Recommendation ITU-R BT.2020 opto-electronic transfer function (OETF).

Parameters

- **E** (FloatingOrArrayLike) – Voltage E normalised by the reference white level and proportional to the implicit light intensity that would be detected with a reference camera colour channel R, G, B.
- **is_12_bits_system** (bool) – BT.709 *alpha* and *beta* constants are used if system is not 12-bit.
- **constants** (Structure) – Recommendation ITU-R BT.2020 constants.

Returns

Resulting non-linear signal E' .

Return type

numpy.float64 or numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| E | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|----------------|-------------------|-----------|
| E _p | [0, 1] | [0, 1] |

References

[InternationalTUnion15a]

Examples

```
>>> oetf_BT2020(0.18)
0.4090077...
```

colour.models.oetf_inverse_BT2020

colour.models.oetf_inverse_BT2020(*E_p*: FloatingOrArrayLike, *is_12_bits_system*: bool = False, *constants*: Structure = CONSTANTS_BT2020) → FloatingOrNDArray

Define Recommendation ITU-R BT.2020 inverse opto-electronic transfer function (OETF).

Parameters

- **E_p** (FloatingOrArrayLike) – Non-linear signal E' .
- **is_12_bits_system** (bool) – BT.709 *alpha* and *beta* constants are used if system is not 12-bit.

- **constants** ([Structure](#)) – *Recommendation ITU-R BT.2020* constants.

Returns

Resulting voltage E .

Return type

`numpy.float64` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| E_p | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| E | [0, 1] | [0, 1] |

References

[[InternationalTUnion15a](#)]

Examples

```
>>> oetf_inverse_BT2020(0.705515089922121)
0.4999999...
```

colour.models.oetf_BT2100_HLG

`colour.models.oetf_BT2100_HLG(E : FloatingOrArrayLike, constants: Structure = CONSTANTS_BT2100_HLG) → FloatingOrNDArray`

Define *Recommendation ITU-R BT.2100 Reference HLG* opto-electrical transfer function (OETF).

The OETF maps relative scene linear light into the non-linear *HLG* signal value.

Parameters

- **E** (*FloatingOrArrayLike*) – E is the signal for each colour component R_S, G_S, B_S proportional to scene linear light and scaled by camera exposure.
- **constants** ([Structure](#)) – *Recommendation ITU-R BT.2100 Reference HLG* constants.

Returns

E' is the resulting non-linear signal R', G', B' .

Return type

`numpy.float64` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| E | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| E_p | [0, 1] | [0, 1] |

References

[Bor17], [InternationalTUnion17]

Examples

```
>>> oetf_BT2100_HLG(0.18 / 12)
0.2121320...
```

colour.models.oetf_inverse_BT2100_HLG

`colour.models.oetf_inverse_BT2100_HLG(E_p: FloatingOrArrayLike, constants: Structure = CONSTANTS_BT2100_HLG) → FloatingOrNDArray`

Define *Recommendation ITU-R BT.2100 Reference HLG* inverse opto-electrical transfer function (OETF).

Parameters

- **E_p** (`FloatingOrArrayLike`) – E' is the resulting non-linear signal R', G', B' .
- **constants** (`Structure`) – *Recommendation ITU-R BT.2100 Reference HLG* constants.

Returns

E is the signal for each colour component R_S, G_S, B_S proportional to scene linear light and scaled by camera exposure.

Return type

`numpy.float64` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| E_p | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| E | [0, 1] | [0, 1] |

References

[Bor17], [InternationalTUnion17]

Examples

```
>>> oetf_inverse_BT2100_HLG(0.212132034355964)
0.0149999...
```

colour.models.oetf_BT2100_PQ

colour.models.**oetf_BT2100_PQ**(*E: FloatingOrArrayLike*) → FloatingOrNDArray

Define *Recommendation ITU-R BT.2100 Reference PQ* opto-electrical transfer function (OETF).

The OETF maps relative scene linear light into the non-linear *PQ* signal value.

Parameters

E (FloatingOrArrayLike) – $E = R_S, G_S, B_S; Y_S; \text{or } I_S$ is the signal determined by scene light and scaled by camera exposure.

Returns

E' is the resulting non-linear signal (R', G', B').

Return type

numpy.floating or numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| E | UN | UN |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| E_p | UN | UN |

References

[Bor17], [InternationalTUnion17]

Examples

```
>>> oetf_BT2100_PQ(0.1)
0.7247698...
```

`colour.models.oetf_inverse_BT2100_PQ`

`colour.models.oetf_inverse_BT2100_PQ(E_p: FloatingOrArrayLike) → FloatingOrNDArray`
Define *Recommendation ITU-R BT.2100 Reference PQ* inverse opto-electrical transfer function (OETF).

- Parameters**
`E_p` (`FloatingOrArrayLike`) – E' is the resulting non-linear signal (R' , G' , B').
- Returns**
 $E = R_S, G_S, B_S; Y_S$; or I_S is the signal determined by scene light and scaled by camera exposure.
- Return type**
`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| E_p | UN | UN |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| E | UN | UN |

References

[Bor17], [InternationalTUnion17]

Examples

```
>>> oetf_inverse_BT2100_PQ(0.724769816665726)
0.09999999...
```

`colour.models.oetf_BT601`

`colour.models.oetf_BT601(L: FloatingOrArrayLike) → FloatingOrNDArray`
Define *Recommendation ITU-R BT.601-7* opto-electronic transfer function (OETF).

- Parameters**
`L` (`FloatingOrArrayLike`) – Luminance L of the image.
- Returns**
Corresponding electrical signal E .
- Return type**
`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| L | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| E | [0, 1] | [0, 1] |

References

[[InternationalTUnion11b](#)]

Examples

```
>>> oetf_BT601(0.18)
0.4090077...
```

colour.models.oetf_inverse_BT601

colour.models.oetf_inverse_BT601(*E: FloatingOrArrayLike*) → FloatingOrNDArray

Define *Recommendation ITU-R BT.601-7* inverse opto-electronic transfer function (OETF).

Parameters

E (FloatingOrArrayLike) – Electrical signal *E*.

Returns

Corresponding *luminance L* of the image.

Return type

numpy.floating or numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| E | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| L | [0, 1] | [0, 1] |

References

[InternationalTUnion11b]

Examples

```
>>> oetf_inverse_BT601(0.409007728864150)
0.1...
```

colour.models.oetf_BT709

colour.models.**oetf_BT709**(*L: FloatingOrArrayLike*) → FloatingOrNDArray
Define *Recommendation ITU-R BT.709-6* opto-electronic transfer function (OETF).

Parameters
L (FloatingOrArrayLike) – *Luminance L* of the image.

Returns
Corresponding electrical signal *V*.

Return type
numpy.floating or numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| L | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| V | [0, 1] | [0, 1] |

References

[InternationalTUnion15b]

Examples

```
>>> oetf_BT709(0.18)
0.4090077...
```

colour.models.oetf_inverse_BT709

`colour.models.oetf_inverse_BT709(V: FloatingOrArrayLike) → FloatingOrNDArray`

Define *Recommendation ITU-R BT.709-6* inverse opto-electronic transfer function (OETF).

Parameters

V (FloatingOrArrayLike) – Electrical signal V .

Returns

Corresponding *luminance* L of the image.

Return type

`numpy.float64` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| V | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| L | [0, 1] | [0, 1] |

References

[[InternationalTUnion15b](#)]

Examples

```
>>> oetf_inverse_BT709(0.409007728864150)
0.1...
```

colour.models.oetf_H273_Log

`colour.models.oetf_H273_Log(L_c)`

Define *Recommendation ITU-T H.273* opto-electronic transfer function (OETF) for logarithmic encoding (100:1 range).

Parameters

L_c – Scene *Luminance* L_c .

Returns

Corresponding electrical signal V .

Return type

`numpy.float64` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| L_c | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| V | [0, 1] | [0, 1] |

References

[InternationalTUnion21]

Warning:

- The function is clamped to domain [0.01, np.inf].

Examples

```
>>> oetf_H273_Log(0.18)
0.6276362525516...
>>> oetf_H273_Log(0.01)
0.0
>>> oetf_H273_Log(0.001)
0.0
>>> oetf_H273_Log(1.0)
1.0
```

colour.models.oetf_inverse_H273_Log

colour.models.oetf_inverse_H273_Log(*V*)

Define *Recommendation ITU-T H.273* inverse-opto-electronic transfer function (OETF) for logarithmic encoding (100:1 range).

Parameters

V – Electrical signal *V*.

Returns

Corresponding scene *Luminance L_c*.

Return type

numpy.float64 or numpy.ndarray

Notes

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| V | [0, 1] | [0, 1] |

| Domain | Scale - Reference | Scale - 1 |
|----------------|-------------------|-----------|
| L _c | [0, 1] | [0, 1] |

References

[[InternationalTUnion21](#)]

Warning:

- The function is clamped to domain [`colour.models.oetf_H273_Log()` (0.01), `np.inf`].

Examples

```
>>> oetf_inverse_H273_Log(0.6276362525516)
0.17999999...
>>> oetf_inverse_H273_Log(0.0)
0.01
>>> oetf_inverse_H273_Log(1.0)
1.0
```

colour.models.oetf_H273_LogSqrt

`colour.models.oetf_H273_LogSqrt(Lc)`

Define *Recommendation ITU-T H.273* opto-electronic transfer function (OETF) for logarithmic encoding (100* $\sqrt{10}$:1 range).

Parameters

L_c – Scene Luminance L_c .

Returns

Corresponding electrical signal V .

Return type

`numpy.float64` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|----------------|-------------------|-----------|
| L _c | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| V | [0, 1] | [0, 1] |

References

[[InternationalTUnion21](#)]

Warning:

- The function is clamped to domain [`colour.models.oetf_H273_LogSqrt()` ($\sqrt{10}$ / 1000), np.inf].

Examples

```
>>> oetf_H273_LogSqrt(0.18)
0.702109002041...
>>> oetf_H273_LogSqrt(0.003162277660168)
0.0
>>> oetf_H273_LogSqrt(0.0001)
0.0
>>> oetf_H273_LogSqrt(1.0)
1.0
```

`colour.models.oetf_inverse_H273_LogSqrt`

`colour.models.oetf_inverse_H273_LogSqrt(V)`

Define *Recommendation ITU-T H.273* inverse-opto-electronic transfer function (OETF) for logarithmic encoding (100* $\sqrt{10}$:1 range).

Parameters

V – Electrical signal V .

Returns

Corresponding scene *Luminance* L_c .

Return type

`numpy.float64` or `numpy.ndarray`

Notes

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| V | [0, 1] | [0, 1] |

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| L_c | [0, 1] | [0, 1] |

References

[[InternationalTUnion21](#)]

Warning:

- The function is clamped to domain $[\sqrt{10} / 1000, \text{np.inf}]$.

Examples

```
>>> oetf_inverse_H273_LogSqrt(0.702109002041)
0.1799999999...
>>> oetf_inverse_H273_LogSqrt(0.0)
0.00316227766...
>>> oetf_inverse_H273_LogSqrt(1.0)
1.0
```

colour.models.oetf_H273_IEC61966_2

colour.models.oetf_H273_IEC61966_2(L_c)

Define *Recommendation ITU-T H.273* opto-electronic transfer function (OETF) for *IEC 61966-2* family of transfer functions (2-1 sRGB, 2-1 sYCC, 2-4 xYCC).

Parameters

L_c – Scene Luminance L_c .

Returns

Corresponding electrical signal V .

Return type

`numpy.float64` or `numpy.ndarray`

Notes

Usage in [[InternationalTUnion21](#)] is as follows:

- For *IEC 61966-2-1 sRGB* (*MatrixCoefficients=0*), the function is only defined for L_c in $[0, 1]$ range.
- For *IEC 61966-2-1 sYCC* (*MatrixCoefficients=5*) and *IEC 61966-2-4 xYCC*, the function is defined for any real-valued L_c .

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| L_c | $[0, 1]$ | $[0, 1]$ |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| V | $[0, 1]$ | $[0, 1]$ |

References

- [\[InternationalTUnion21\]](#)

Examples

```
>>> oetf_H273_IEC61966_2(0.18)
0.4613561295004...
>>> oetf_H273_IEC61966_2(-0.18)
-0.4613561295004...
```

`colour.models.oetf_inverse_H273_IEC61966_2`

`colour.models.oetf_inverse_H273_IEC61966_2(V)`

Define *Recommendation ITU-T H.273* inverse opto-electronic transfer function (OETF) for *IEC 61966-2* family of transfer functions (2-1 *sRGB*, 2-1 *sYCC*, 2-4 *xvYCC*).

Parameters

V – Electrical signal V .

Returns

Corresponding scene luminance L_c .

Return type

`numpy.float64` or `numpy.ndarray`

Notes

Usage in [\[InternationalTUnion21\]](#) is as follows:

- For *IEC 61966-2-1 sRGB* (*MatrixCoefficients=0*), the function is only defined for L_c in $[0, 1]$ range.
- For *IEC 61966-2-1 sYCC* (*MatrixCoefficients=5*) and *IEC 61966-2-4 xvYCC*, the function is defined for any real-valued L_c .

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| V | [0, 1] | [0, 1] |

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| L_c | [0, 1] | [0, 1] |

References

- [\[InternationalTUnion21\]](#)

Examples

```
>>> oetf_inverse_H273_IEC61966_2(0.461356129500)
0.1799999999...
>>> oetf_inverse_H273_IEC61966_2(-0.461356129500)
-0.1799999999...
```

colour.models.oetf_SMPTE240M

colour.models.oetf_SMPTE240M(*L_c*: *FloatingOrArrayLike*) → *FloatingOrNDArray*

Define *SMPTE 240M* opto-electrical transfer function (OETF).

Parameters

L_c (*FloatingOrArrayLike*) – Light input L_c to the reference camera normalised to the system reference white.

Returns

Video signal output V_c of the reference camera normalised to the system reference white.

Return type

numpy.floating or *numpy.ndarray*

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| L_c | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| V_c | [0, 1] | [0, 1] |

References

[SocietyoMPaTEngineers99]

Examples

```
>>> oetf_SMPTE240M(0.18)
0.4022857...
```

Electro-Optical Transfer Functions

colour

| | |
|--|---|
| <code>eotf(value[, function])</code> | Decode $R'G'B'$ video component signal value to tristimulus values at the display using given electro-optical transfer function (EOTF). |
| EOTFS | Supported electro-optical transfer functions (EOTFs / EOCFs). |
| <code>eotf_inverse(value[, function])</code> | Encode estimated tristimulus values in a scene to $R'G'B'$ video component signal value using given inverse electro-optical transfer function (EOTF). |
| EOTF_INVERSES | Supported inverse electro-optical transfer functions (EOTFs / EOCFs). |

colour.eotf

`colour.eotf(value: float | _SupportsArray[dtype[Any]] | _NestedSequence[_SupportsArray[dtype[Any]]] | bool | int | complex | str | bytes | _NestedSequence[bool | int | float | complex | str | bytes], function: Literal['DCDM', 'DICOM GSDF', 'ITU-R BT.1886', 'ITU-R BT.2100 HLG', 'ITU-R BT.2100 PQ', 'ITU-T H.273 ST.428-1', 'SMPTE 240M', 'ST 2084', 'sRGB'] | str = 'ITU-R BT.1886', **kwargs: Any) → float | ndarray`

Decode $R'G'B'$ video component signal value to tristimulus values at the display using given electro-optical transfer function (EOTF).

Parameters

- **value** (float | _SupportsArray[dtype[Any]] | _NestedSequence[_SupportsArray[dtype[Any]]] | bool | int | complex | str | bytes | _NestedSequence[bool | int | float | complex | str | bytes]) – Value.
- **function** (Literal['DCDM', 'DICOM GSDF', 'ITU-R BT.1886', 'ITU-R BT.2100 HLG', 'ITU-R BT.2100 PQ', 'ITU-T H.273 ST.428-1', 'SMPTE 240M', 'ST 2084', 'sRGB'] | str) – Electro-optical transfer function (EOTF).
- **kwargs** (Any) – {colour.models.eotf_DCDM(), colour.models.eotf_DICOMGSDF(), colour.models.eotf_BT1886(), colour.models.eotf_BT2100_HLG(), colour.models.eotf_BT2100_PQ(), colour.models.eotf_SMPTE240M(), colour.models.eotf_ST2084(), colour.models.eotf_sRGB()}, See the documentation of the previously listed definitions.

Returns

Tristimulus values at the display.

Return type

numpy.floating or numpy.ndarray

Examples

```
>>> eotf(0.461356129500442)
0.1...
>>> eotf(0.182011532850008, function="ST 2084", L_p=1000)
...
0.1...
```

colour.EOTFS

```
colour.EOTFS = CanonicalMapping({'DCDM': ..., 'DICOM GSDF': ..., 'ITU-R BT.1886': ...,
'ITU-R BT.2100 HLG': ..., 'ITU-R BT.2100 PQ': ..., 'ITU-T H.273 ST.428-1': ..., 'SMPTE
240M': ..., 'ST 2084': ..., 'sRGB': ...})
```

Supported electro-optical transfer functions (EOTFs / EOCFs).

colour.eotf_inverse

```
colour.eotf_inverse(value: float | _SupportsArray[dtype[Any]] |
    _NestedSequence[_SupportsArray[dtype[Any]]] | bool | int | complex | str | bytes
    | _NestedSequence[bool | int | float | complex | str | bytes], function:
    Literal['DCDM', 'DICOM GSDF', 'ITU-R BT.1886', 'ITU-R BT.2100 HLG', 'ITU-R
    BT.2100 PQ', 'ITU-T H.273 ST.428-1', 'ST 2084', 'sRGB'] | str = 'ITU-R BT.1886',
    **kwargs) → float | ndarray | int
```

Encode estimated tristimulus values in a scene to $R'G'B'$ video component signal value using given inverse electro-optical transfer function (EOTF).

Parameters

- **value** (float | _SupportsArray[dtype[Any]] | _NestedSequence[_SupportsArray[dtype[Any]]] | bool | int | complex | str | bytes | _NestedSequence[bool | int | float | complex | str | bytes]) – Value.
- **function** (Literal['DCDM', 'DICOM GSDF', 'ITU-R BT.1886', 'ITU-R BT.2100 HLG', 'ITU-R BT.2100 PQ', 'ITU-T H.273 ST.428-1', 'ST 2084', 'sRGB'] | str) – Inverse electro-optical transfer function (EOTF).
- **kwargs** – {colour.models.eotf_inverse_DCDM(), colour.models.eotf_inverse_DICOMGSDF(), colour.models.eotf_inverse_BT1886(), colour.models.eotf_inverse_BT2100_HLG(), colour.models.eotf_inverse_BT2100_PQ(), colour.models.eotf_inverse_ST2084(), colour.models.eotf_inverse_sRGB()}. See the documentation of the previously listed definitions.

Returns

$R'G'B'$ video component signal value.

Return type

numpy.floating or numpy.integer or numpy.ndarray

Examples

```
>>> eotf_inverse(0.11699185725296059)
0.4090077...
>>> eotf_inverse(
...     0.11699185725296059, function="ITU-R BT.1886"
... )
0.4090077...
```

colour.EOTF_INVERSES

```
colour.EOTF_INVERSES = CanonicalMapping({'DCDM': ..., 'DICOM GSDF': ..., 'ITU-R BT.1886':
..., 'ITU-R BT.2100 HLG': ..., 'ITU-R BT.2100 PQ': ..., 'ITU-T H.273 ST.428-1': ..., 'ST
2084': ..., 'sRGB': ...})
```

Supported inverse electro-optical transfer functions (EOTFs / EOCFs).

colour.models

| | |
|--|--|
| <code>eotf_DCDM(XYZ_p[, in_int])</code> | Define the <i>DCDM</i> electro-optical transfer function (EOTF). |
| <code>eotf_inverse_DCDM(XYZ[, out_int])</code> | Define the <i>DCDM</i> inverse electro-optical transfer function (EOTF). |
| <code>eotf_DICOMGSDF(J[, in_int, constants])</code> | Define the <i>DICOM - Grayscale Standard Display Function</i> electro-optical transfer function (EOTF). |
| <code>eotf_inverse_DICOMGSDF(L[, out_int, constants])</code> | Define the <i>DICOM - Grayscale Standard Display Function</i> inverse electro-optical transfer function (EOTF). |
| <code>eotf_BT1886(V[, L_B, L_W])</code> | Define <i>Recommendation ITU-R BT.1886</i> electro-optical transfer function (EOTF). |
| <code>eotf_inverse_BT1886(L[, L_B, L_W])</code> | Define <i>Recommendation ITU-R BT.1886</i> inverse electro-optical transfer function (EOTF). |
| <code>BT2100_HLG_EOTF_METHODS</code> | Supported <i>Recommendation ITU-R BT.2100 Reference HLG</i> electro-optical transfer function (EOTF). |
| <code>eotf_BT2100_HLG(E_p[, L_B, L_W, gamma, ...])</code> | Define <i>Recommendation ITU-R BT.2100 Reference HLG</i> electro-optical transfer function (EOTF). |
| <code>BT2100_HLG_EOTF_INVERSE_METHODS</code> | Supported <i>Recommendation ITU-R BT.2100 Reference HLG</i> inverse electro-optical transfer function (EOTF). |
| <code>eotf_inverse_BT2100_HLG(F_D[, L_B, L_W, ...])</code> | Define <i>Recommendation ITU-R BT.2100 Reference HLG</i> inverse electro-optical transfer function (EOTF). |
| <code>eotf_BT2100_PQ(E_p)</code> | Define <i>Recommendation ITU-R BT.2100 Reference PQ</i> electro-optical transfer function (EOTF). |
| <code>eotf_inverse_BT2100_PQ(F_D)</code> | Define <i>Recommendation ITU-R BT.2100 Reference PQ</i> inverse electro-optical transfer function (EOTF). |
| <code>eotf_H273_ST428_1(V)</code> | Define the <i>SMPTE ST 428-1 (2019)</i> electro-optical transfer function (EOTF). |
| <code>eotf_inverse_H273_ST428_1(L_o)</code> | Define <i>Recommendation ITU-T H.273</i> inverse electro-optical transfer function (EOTF) for <i>SMPTE ST 428-1 (2019)</i> . |
| <code>eotf_SMPTE240M(V_r)</code> | Define <i>SMPTE 240M</i> electro-optical transfer function (EOTF). |
| <code>eotf_ST2084(N[, L_p, constants])</code> | Define <i>SMPTE ST 2084:2014</i> optimised perceptual electro-optical transfer function (EOTF). |
| <code>eotf_inverse_ST2084(C[, L_p, constants])</code> | Define <i>SMPTE ST 2084:2014</i> optimised perceptual inverse electro-optical transfer function (EOTF). |
| <code>eotf_sRGB(V)</code> | Define the <i>IEC 61966-2-1:1999 sRGB</i> electro-optical transfer function (EOTF). |
| <code>eotf_inverse_sRGB(L)</code> | Define the <i>IEC 61966-2-1:1999 sRGB</i> inverse electro-optical transfer function (EOTF). |

colour.models.eotf_DCDM

colour.models.eotf_DCDM(*XYZ_p*: *FloatingOrArrayLike* | *IntegerOrArrayLike*, *in_int*: *bool* = *False*) → *FloatingOrNDArray*

Define the *DCDM* electro-optical transfer function (EOTF).

Parameters

- **XYZ_p** (*FloatingOrArrayLike* | *IntegerOrArrayLike*) – Non-linear *CIE XYZ'* tristimulus values.
- **in_int** (*bool*) – Whether to treat the input value as integer code value or float equivalent of a code value at a given bit depth.

Returns

CIE XYZ tristimulus values.

Return type

numpy.floating or *numpy.ndarray*

Warning: *DCDM* is an absolute transfer function.

Notes

- *DCDM* is an absolute transfer function, thus the domain and range values for the *Reference* and *1* scales are only indicative that the data is not affected by scale transformations.

| Domain * | Scale - Reference | Scale - 1 |
|----------|-------------------|-----------|
| XYZ_p | UN | UN |

| Range * | Scale - Reference | Scale - 1 |
|---------|-------------------|-----------|
| XYZ | UN | UN |

* This definition has an input integer switch, thus the domain-range scale information is only given for the floating point mode.

References

[DigitalCInitiatives07]

Examples

```
>>> eotf_DCDM(0.11281860951766724)
0.18...
>>> eotf_DCDM(462, in_int=True)
0.18...
```

`colour.models.eotf_inverse_DCDM`

`colour.models.eotf_inverse_DCDM(XYZ: FloatingOrArrayLike, out_int: bool = False) → FloatingOrNDArray | IntegerOrNDArray`

Define the *DCDM* inverse electro-optical transfer function (EOTF).

Parameters

- **XYZ** (`FloatingOrArrayLike`) – *CIE XYZ* tristimulus values.
- **out_int** (`bool`) – Whether to return value as integer code value or float equivalent of a code value at a given bit depth.

Returns

Non-linear *CIE XYZ'* tristimulus values.

Return type

`numpy.floating` or `numpy.integer` or `numpy.ndarray`

Warning: *DCDM* is an absolute transfer function.

Notes

- *DCDM* is an absolute transfer function, thus the domain and range values for the *Reference* and *1* scales are only indicative that the data is not affected by scale transformations.

| Domain * | Scale - Reference | Scale - 1 |
|----------|-------------------|-----------|
| XYZ | UN | UN |

| Range * | Scale - Reference | Scale - 1 |
|------------------|-------------------|-----------|
| XYZ _p | UN | UN |

* This definition has an output integer switch, thus the domain-range scale information is only given for the floating point mode.

References

[DigitalCInitiatives07]

Examples

```
>>> eotf_inverse_DCDM(0.18)
0.1128186...
>>> eotf_inverse_DCDM(0.18, out_int=True)
462
```

`colour.models.eotf_DICOMGSDF`

`colour.models.eotf_DICOMGSDF(J: FloatingOrArrayLike | IntegerOrArrayLike, in_int: bool = False, constants: Structure = CONSTANTS_DICOMGSDF) → FloatingOrNDArray`

Define the *DICOM - Grayscale Standard Display Function* electro-optical transfer function (EOTF).

Parameters

- **J** (`FloatingOrArrayLike | IntegerOrArrayLike`) – Just-Noticeable Difference (JND) Index, *j*.
- **in_int** (`bool`) – Whether to treat the input value as integer code value or float equivalent of a code value at a given bit depth.
- **constants** (`Structure`) – *DICOM - Grayscale Standard Display Function* constants.

Returns

Corresponding *luminance L*.

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| J | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| L | [0, 1] | [0, 1] |

References

[NationalEMAssociation04]

Examples

```
>>> eotf_DICOMGSDF(0.500486263438448)
130.0628647...
>>> eotf_DICOMGSDF(512, in_int=True)
130.0652840...
```

colour.models.eotf_inverse_DICOMGSDF

`colour.models.eotf_inverse_DICOMGSDF(L: FloatingOrArrayLike, out_int: bool = False, constants: Structure = CONSTANTS_DICOMGSDF) → FloatingOrNDArray | IntegerOrNDArray`

Define the *DICOM - Grayscale Standard Display Function* inverse electro-optical transfer function (EOTF).

Parameters

- **L** (FloatingOrArrayLike) – *Luminance L*.
- **out_int** (bool) – Whether to return value as integer code value or float equivalent of a code value at a given bit depth.
- **constants** (Structure) – *DICOM - Grayscale Standard Display Function* constants.

Returns

Just-Noticeable Difference (JND) Index, *j*.

Return type

`numpy.floating` or `numpy.integer` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| L | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| J | [0, 1] | [0, 1] |

References

[NationalEMAssociation04]

Examples

```
>>> eotf_inverse_DICOMGSDF(130.0662)
0.5004862...
>>> eotf_inverse_DICOMGSDF(130.0662, out_int=True)
512
```

colour.models.eotf_BT1886

colour.models.**eotf_BT1886**(*V: FloatingOrArrayLike*, *L_B: float = 0*, *L_W: float = 1*) →
FloatingOrNDArray

Define *Recommendation ITU-R BT.1886* electro-optical transfer function (EOTF).

Parameters

- **V** (FloatingOrArrayLike) – Input video signal level (normalised, black at $V = 0$, to white at $V = 1$. For content mastered per *Recommendation ITU-R BT.709*, 10-bit digital code values D map into values of V per the following equation:
$$V = (D - 64)/876$$
- **L_B** (float) – Screen luminance for black.
- **L_W** (float) – Screen luminance for white.

Returns

Screen luminance in cd/m^2 .

Return type

numpy.floating or numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| V | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| L | [0, 1] | [0, 1] |

References

[[InternationalTUnion11a](#)]

Examples

```
>>> eotf_BT1886(0.409007728864150)
0.1169918...
```

colour.models.eotf_inverse_BT1886

colour.models.**eotf_inverse_BT1886**(*L: FloatingOrArrayLike*, *L_B: float = 0*, *L_W: float = 1*) →
FloatingOrNDArray

Define *Recommendation ITU-R BT.1886* inverse electro-optical transfer function (EOTF).

Parameters

- **L** (FloatingOrArrayLike) – Screen luminance in cd/m^2 .
- **L_B** (float) – Screen luminance for black.
- **L_W** (float) – Screen luminance for white.

Returns

Input video signal level (normalised, black at $V = 0$, to white at $V = 1$).

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| L | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| V | [0, 1] | [0, 1] |

References

[InternationalTUnion11a]

Examples

```
>>> eotf_inverse_BT1886(0.11699185725296059)
0.4090077...
```

colour.models.BT2100_HLG_EOTF_METHODS

```
colour.models.BT2100_HLG_EOTF_METHODS = CanonicalMapping({'ITU-R BT.2100-1': ..., 'ITU-R BT.2100-2': ...})
```

Supported *Recommendation ITU-R BT.2100 Reference HLG* electro-optical transfer function (EOTF).

References

[Bor17], [InternationalTUnion17], [InternationalTUnion18]

colour.models.eotf_BT2100_HLG

```
colour.models.eotf_BT2100_HLG(E_p: FloatingOrArrayLike, L_B: float = 0, L_W: float = 1000, gamma: float | None = None, constants: Structure = CONSTANTS_BT2100_HLG, method: Literal['ITU-R BT.2100-1', 'ITU-R BT.2100-2'] | str = 'ITU-R BT.2100-2') → FloatingOrNDArray
```

Define *Recommendation ITU-R BT.2100 Reference HLG* electro-optical transfer function (EOTF).

The EOTF maps the non-linear *HLG* signal into display light.

Parameters

- **E_p** (`FloatingOrArrayLike`) – E' denotes a non-linear colour value R', G', B' or L', M', S' in *HLG* space.
- **L_B** (`float`) – L_B is the display luminance for black in cd/m^2 .

- **L_W** (`float`) – L_W is nominal peak luminance of the display in cd/m^2 for achromatic pixels.
- **gamma** (`float` | `None`) – System gamma value, 1.2 at the nominal display peak luminance of $1000cd/m^2$.
- **constants** (`Structure`) – *Recommendation ITU-R BT.2100 Reference HLG* constants.
- **method** (`Literal`['ITU-R BT.2100-1', 'ITU-R BT.2100-2'] | `str`) – Computation method.

Returns

Luminance F_D of a displayed linear component R_D, G_D, B_D or Y_D or I_D , in cd/m^2 .

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| E_p | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| F_D | [0, 1] | [0, 1] |

References

[Bor17], [InternationalTUnion17], [InternationalTUnion18]

Examples

```
>>> eotf_BT2100_HLG(0.212132034355964)
6.4760398...
>>> eotf_BT2100_HLG(0.212132034355964, method="ITU-R BT.2100-1")
...
6.4760398...
>>> eotf_BT2100_HLG(0.212132034355964, 0.01)
...
7.3321975...
```

colour.models.BT2100_HLG_EOTF_INVERSE_METHODS

`colour.models.BT2100_HLG_EOTF_INVERSE_METHODS = CanonicalMapping({'ITU-R BT.2100-1': ..., 'ITU-R BT.2100-2': ...})`

Supported *Recommendation ITU-R BT.2100 Reference HLG* inverse electro-optical transfer function (EOTF).

References

[Bor17], [InternationalTUnion17], [InternationalTUnion18]

colour.models.eotf_inverse_BT2100_HLG

```
colour.models.eotf_inverse_BT2100_HLG(F_D: FloatingOrArrayLike, L_B: float = 0, L_W: float =
    1000, gamma: float | None = None, constants: Structure =
    CONSTANTS_BT2100_HLG, method: Literal['ITU-R
    BT.2100-1', 'ITU-R BT.2100-2'] | str = 'ITU-R BT.2100-2') →
    FloatingOrNDArray
```

Define *Recommendation ITU-R BT.2100 Reference HLG* inverse electro-optical transfer function (EOTF).

Parameters

- **F_D** (FloatingOrArrayLike) – Luminance F_D of a displayed linear component R_D, G_D, B_D or Y_D or I_D , in cd/m^2 .
- **L_B** (float) – L_B is the display luminance for black in cd/m^2 .
- **L_W** (float) – L_W is nominal peak luminance of the display in cd/m^2 for achromatic pixels.
- **gamma** (float | None) – System gamma value, 1.2 at the nominal display peak luminance of $1000\text{cd}/\text{m}^2$.
- **constants** (Structure) – *Recommendation ITU-R BT.2100 Reference HLG* constants.
- **method** (Literal['ITU-R BT.2100-1', 'ITU-R BT.2100-2'] | str) – Computation method.

Returns

E' denotes a non-linear colour value R', G', B' or L', M', S' in HLG space.

Return type

numpy.floating or numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| F_D | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| E_p | [0, 1] | [0, 1] |

References

[Bor17], [InternationalTUnion17], [InternationalTUnion18]

Examples

```
>>> eotf_inverse_BT2100_HLG(6.476039825649814)
0.2121320...
>>> eotf_inverse_BT2100_HLG(6.476039825649814, method="ITU-R BT.2100-1")
...
0.2121320...
>>> eotf_inverse_BT2100_HLG(7.332197528353875, 0.01)
0.2121320...
```

colour.models.eotf_BT2100_PQ

colour.models.eotf_BT2100_PQ(E_p : FloatingOrArrayLike) \rightarrow FloatingOrNDArray

Define Recommendation ITU-R BT.2100 Reference PQ electro-optical transfer function (EOTF).

The EOTF maps the non-linear PQ signal into display light.

Parameters

E_p (FloatingOrArrayLike) – E' denotes a non-linear colour value R', G', B' or L', M', S' in PQ space [0, 1].

Returns

F_D is the luminance of a displayed linear component R_D, G_D, B_D or Y_D or I_D , in cd/m^2 .

Return type

numpy.float64 or numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| E_p | UN | UN |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| F_D | UN | UN |

References

[Bor17], [InternationalTUnion17]

Examples

```
>>> eotf_BT2100_PQ(0.724769816665726)
779.9883608...
```

colour.models.eotf_inverse_BT2100_PQ

colour.models.eotf_inverse_BT2100_PQ(*F_D*: FloatingOrArrayLike) → FloatingOrNDArray

Define *Recommendation ITU-R BT.2100 Reference PQ* inverse electro-optical transfer function (EOTF).

Parameters

F_D (FloatingOrArrayLike) – F_D is the luminance of a displayed linear component R_D, G_D, B_D or Y_D or I_D , in cd/m^2 .

Returns

E' denotes a non-linear colour value R', G', B' or L', M', S' in PQ space [0, 1].

Return type

numpy.floating or numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| F_D | UN | UN |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| E_p | UN | UN |

References

[Bor17], [InternationalTUnion17]

Examples

```
>>> eotf_inverse_BT2100_PQ(779.988360834085370)
0.7247698...
```

colour.models.eotf_H273_ST428_1

colour.models.eotf_H273_ST428_1(*V*)

Define the *SMPTE ST 428-1 (2019)* electro-optical transfer function (EOTF).

Parameters

V – Electrical signal V .

Returns

Corresponding output display *Luminance* L_o of the image.

Return type

numpy.floating or numpy.ndarray

Notes

- The function given in [InternationalTUnion21] divides L_o by 48 contrary to what is given in [SocietyoMPaTEngineers19] and `colour.models.eotf_DCDM()`.

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| V | [0, 1] | [0, 1] |

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| L_o | [0, 1] | [0, 1] |

References

- [InternationalTUnion21], [SocietyoMPaTEngineers19]

Examples

```
>>> eotf_H273_ST428_1(0.5000483377172)
0.1799999...
```

`colour.models.eotf_inverse_H273_ST428_1`

`colour.models.eotf_inverse_H273_ST428_1(L_o)`

Define *Recommendation ITU-T H.273* inverse electro-optical transfer function (EOTF) for *SMPTE ST 428-1 (2019)*.

Parameters

L_o – Output display *Luminance* L_o of the image.

Returns

Corresponding electrical signal V .

Return type

`numpy.float64` or `numpy.ndarray`

Notes

- The function given in [InternationalTUnion21] multiplies L_o by 48 contrary to what is given in [SocietyoMPaTEngineers19] and `colour.models.eotf_inverse_DCDM()`.

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| L_o | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| V | [0, 1] | [0, 1] |

References

- [InternationalUnion21], [SocietyoMPaTEngineers19]

Examples

```
>>> eotf_inverse_H273_ST428_1(0.18)
0.5000483...
```

colour.models.eotf_SMPTE240M

colour.models.eotf_SMPTE240M(*V_r*: *FloatingOrArrayLike*) → *FloatingOrNDArray*

Define *SMPTE 240M* electro-optical transfer function (EOTF).

Parameters

V_r (*FloatingOrArrayLike*) – Video signal level V_r driving the reference reproducer normalised to the system reference white.

Returns

Light output L_r from the reference reproducer normalised to the system reference white.

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| V_c | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| L_c | [0, 1] | [0, 1] |

References

[SocietyoMPaTEngineers99]

Examples

```
>>> eotf_SMPTE240M(0.402285796753870)
0.1...
```

`colour.models.eotf_ST2084`

`colour.models.eotf_ST2084(N: FloatingOrArrayLike, L_p: float = 10000, constants: Structure = CONSTANTS_ST2084) → FloatingOrNDArray`

Define *SMPTE ST 2084:2014* optimised perceptual electro-optical transfer function (EOTF).

This perceptual quantizer (PQ) has been modeled by Dolby Laboratories using *Barten (1999)* contrast sensitivity function.

Parameters

- **N** (`FloatingOrArrayLike`) – Color value abbreviated as *N*, that is directly proportional to the encoded signal representation, and which is not directly proportional to the optical output of a display device.
- **L_p** (`float`) – System peak luminance cd/m^2 , this parameter should stay at its default $10000cd/m^2$ value for practical applications. It is exposed so that the definition can be used as a fitting function.
- **constants** (`Structure`) – *SMPTE ST 2084:2014* constants.

Returns

Target optical output *C* in cd/m^2 of the ideal reference display.

Return type

`numpy.float64` or `numpy.ndarray`

Warning: *SMPTE ST 2084:2014* is an absolute transfer function.

Notes

- *SMPTE ST 2084:2014* is an absolute transfer function, thus the domain and range values for the *Reference* and *1* scales are only indicative that the data is not affected by scale transformations.

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| N | UN | UN |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| C | UN | UN |

References

[Mil14], [SocietyofMPaTEngineers14]

Examples

```
>>> eotf_ST2084(0.508078421517399)
100.0000000...
```

colour.models.eotf_inverse_ST2084

colour.models.eotf_inverse_ST2084(*C*: FloatingOrArrayLike, *L_p*: float = 10000, constants: Structure = CONSTANTS_ST2084) → FloatingOrNDArray

Define *SMPTE ST 2084:2014* optimised perceptual inverse electro-optical transfer function (EOTF).

Parameters

- **C** (FloatingOrArrayLike) – Target optical output C in cd/m^2 of the ideal reference display.
- **L_p** (float) – System peak luminance cd/m^2 , this parameter should stay at its default $10000cd/m^2$ value for practical applications. It is exposed so that the definition can be used as a fitting function.
- **constants** (Structure) – *SMPTE ST 2084:2014* constants.

Returns

Color value abbreviated as N , that is directly proportional to the encoded signal representation, and which is not directly proportional to the optical output of a display device.

Return type

numpy.floating or numpy.ndarray

Warning: *SMPTE ST 2084:2014* is an absolute transfer function.

Notes

- *SMPTE ST 2084:2014* is an absolute transfer function, thus the domain and range values for the *Reference* and *1* scales are only indicative that the data is not affected by scale transformations. The effective domain of *SMPTE ST 2084:2014* inverse electro-optical transfer function (EOTF) is [0.0001, 10000].

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| C | UN | UN |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| N | UN | UN |

References

[Mil14], [SocietyoMPaTEngineers14]

Examples

```
>>> eotf_inverse_ST2084(100)
0.5080784...
```

colour.models.eotf_sRGB

colour.models.**eotf_sRGB**(*V: FloatingOrArrayLike*) → FloatingOrNDArray
Define the *IEC 61966-2-1:1999 sRGB* electro-optical transfer function (EOTF).

Parameters
V (FloatingOrArrayLike) – Electrical signal *V*.

Returns
Corresponding *luminance L* of the image.

Return type
`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|----------|-------------------|-----------|
| <i>V</i> | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|----------|-------------------|-----------|
| <i>L</i> | [0, 1] | [0, 1] |

References

[InternationalECommission99], [InternationalTUnion15b]

Examples

```
>>> eotf_sRGB(0.461356129500442)
0.1...
```


colour.models.eotf_inverse_sRGB

`colour.models.eotf_inverse_sRGB(L: FloatingOrArrayLike) → FloatingOrNDArray`

Define the *IEC 61966-2-1:1999 sRGB* inverse electro-optical transfer function (EOTF).

Parameters

L (FloatingOrArrayLike) – Luminance *L* of the image.

Returns

Corresponding electrical signal *V*.

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|----------|-------------------|-----------|
| <i>L</i> | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|----------|-------------------|-----------|
| <i>V</i> | [0, 1] | [0, 1] |

References

[InternationalECommission99], [InternationalTUnion15b]

Examples

```
>>> eotf_inverse_sRGB(0.18)
0.4613561...
```

Opto-Optical Transfer Functions

colour

| | |
|--|---|
| <code>ootf(value[, function])</code> | Map relative scene linear light to display linear light using given opto-optical transfer function (OOTF / OOCF). |
| <code>OOTFS</code> | Supported opto-optical transfer functions (OOTFs / OOCFs). |
| <code>ootf_inverse(value[, function])</code> | Map relative display linear light to scene linear light using given inverse opto-optical transfer function (OOTF / OOCF). |
| <code>OOTF_INVERSES</code> | Supported inverse opto-optical transfer functions (OOTFs / OOCFs). |

colour.ootf

`colour.ootf(value: float | _SupportsArray[dtype[Any]] | _NestedSequence[_SupportsArray[dtype[Any]]] | bool | int | complex | str | bytes | _NestedSequence[bool | int | float | complex | str | bytes], function: Literal['ITU-R BT.2100 HLG', 'ITU-R BT.2100 PQ'] | str = 'ITU-R BT.2100 PQ', **kwargs: Any) → float | ndarray`

Map relative scene linear light to display linear light using given opto-optical transfer function (OOTF / OOCF).

Parameters

- **value** (float | _SupportsArray[dtype[Any]] | _NestedSequence[_SupportsArray[dtype[Any]]] | bool | int | complex | str | bytes | _NestedSequence[bool | int | float | complex | str | bytes]) – Value.
- **function** (Literal['ITU-R BT.2100 HLG', 'ITU-R BT.2100 PQ'] | str) – Opto-optical transfer function (OOTF / OOCF).
- **kwargs** (Any) – {colour.models.ootf_BT2100_HLG(), colour.models.ootf_BT2100_PQ()}, See the documentation of the previously listed definitions.

Returns

Luminance of a displayed linear component.

Return type

numpy.floating or numpy.ndarray

Examples

```
>>> ootf(0.1)
779.9883608...
>>> ootf(0.1, function="ITU-R BT.2100 HLG")
63.0957344...
```

colour.OOTFS

`colour.OOTFS = CanonicalMapping({'ITU-R BT.2100 HLG': ..., 'ITU-R BT.2100 PQ': ...})`
Supported opto-optical transfer functions (OOTFs / OOCFs).

colour.ootf_inverse

`colour.ootf_inverse(value: float | _SupportsArray[dtype[Any]] | _NestedSequence[_SupportsArray[dtype[Any]]] | bool | int | complex | str | bytes | _NestedSequence[bool | int | float | complex | str | bytes], function: Literal['ITU-R BT.2100 HLG', 'ITU-R BT.2100 PQ'] | str = 'ITU-R BT.2100 PQ', **kwargs: Any) → float | ndarray`

Map relative display linear light to scene linear light using given inverse opto-optical transfer function (OOTF / OOCF).

Parameters

- **value** (float | _SupportsArray[dtype[Any]] | _NestedSequence[_SupportsArray[dtype[Any]]] | bool | int | complex | str | bytes | _NestedSequence[bool | int | float | complex | str | bytes]) – Value.

- **function** (`Literal['ITU-R BT.2100 HLG', 'ITU-R BT.2100 PQ'] | str`) – Inverse opto-optical transfer function (OOTF / OOCF).
- **kwargs** (`Any`) – {`colour.models.ootf_inverse_BT2100_HLG()`, `colour.models.ootf_inverse_BT2100_PQ()`}, See the documentation of the previously listed definitions.

Returns

Luminance of scene linear light.

Return type

`numpy.float64` or `numpy.ndarray`

Examples

```
>>> ootf_inverse(779.988360834115840)
0.1000000...
>>> ootf_inverse(
...     63.095734448019336, function="ITU-R BT.2100 HLG"
... )
0.1000000...
```

colour.OOTF_INVERSES

```
colour.OOTF_INVERSES = CanonicalMapping({'ITU-R BT.2100 HLG': ..., 'ITU-R BT.2100 PQ':
...})
```

Supported inverse opto-optical transfer functions (OOTFs / OOCFs).

`colour.models`

| | |
|--|---|
| <code>BT2100_HLG_OOTF_METHODS</code> | Supported <i>Recommendation ITU-R BT.2100 Reference HLG</i> opto-optical transfer function (OOTF / OOCF). |
| <code>ootf_BT2100_HLG(E[, L_B, L_W, gamma, method])</code> | Define <i>Recommendation ITU-R BT.2100 Reference HLG</i> opto-optical transfer function (OOTF / OOCF). |
| <code>BT2100_HLG_OOTF_INVERSE_METHODS</code> | Supported <i>Recommendation ITU-R BT.2100 Reference HLG</i> inverse opto-optical transfer function (OOTF / OOCF). |
| <code>ootf_inverse_BT2100_HLG(F_D[, L_B, L_W, ...])</code> | Define <i>Recommendation ITU-R BT.2100 Reference HLG</i> inverse opto-optical transfer function (OOTF / OOCF). |
| <code>ootf_BT2100_PQ(E)</code> | Define <i>Recommendation ITU-R BT.2100 Reference PQ</i> opto-optical transfer function (OOTF / OOCF). |
| <code>ootf_inverse_BT2100_PQ(F_D)</code> | Define <i>Recommendation ITU-R BT.2100 Reference PQ</i> inverse opto-optical transfer function (OOTF / OOCF). |

colour.models.BT2100_HLG_OOTF_METHODS

```
colour.models.BT2100_HLG_OOTF_METHODS = CanonicalMapping({'ITU-R BT.2100-1': ..., 'ITU-R BT.2100-2': ...})
```

Supported *Recommendation ITU-R BT.2100 Reference HLG* opto-optical transfer function (OOTF / OOCF).

References

[Bor17], [InternationalTUnion17], [InternationalTUnion18]

colour.models.ootf_BT2100_HLG

```
colour.models.ootf_BT2100_HLG(E: FloatingOrArrayLike, L_B: float = 0, L_W: float = 1000, gamma: float | None = None, method: Literal['ITU-R BT.2100-1', 'ITU-R BT.2100-2'] | str = 'ITU-R BT.2100-2') → FloatingOrNDArray
```

Define *Recommendation ITU-R BT.2100 Reference HLG* opto-optical transfer function (OOTF / OOCF).

The OOTF maps relative scene linear light to display linear light.

Parameters

- **E** (`FloatingOrArrayLike`) – E is the signal for each colour component R_S, G_S, B_S proportional to scene linear light and scaled by camera exposure.
- **L_B** (`float`) – L_B is the display luminance for black in cd/m^2 .
- **L_W** (`float`) – L_W is nominal peak luminance of the display in cd/m^2 for achromatic pixels.
- **gamma** (`float` | `None`) – System gamma value, 1.2 at the nominal display peak luminance of $1000\text{cd}/\text{m}^2$.
- **method** (`Literal`['ITU-R BT.2100-1', 'ITU-R BT.2100-2'] | `str`) – Computation method.

Returns

F_D is the luminance of a displayed linear component $R_D, G_D, \text{or } B_D$, in cd/m^2 .

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| E | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| F_D | [0, 1] | [0, 1] |

References

[Bor17], [InternationalTUnion17]

Examples

```
>>> ootf_BT2100_HLG(0.1)
63.0957344...
>>> ootf_BT2100_HLG(0.1, 0.01, method="ITU-R BT.2100-1")
...
63.1051034...
```

colour.models.BT2100_HLG_OOTF_INVERSE_METHODS

colour.models.BT2100_HLG_OOTF_INVERSE_METHODS = CanonicalMapping({'ITU-R BT.2100-1': ..., 'ITU-R BT.2100-2': ...})

Supported *Recommendation ITU-R BT.2100 Reference HLG* inverse opto-optical transfer function (OOTF / OOCF).

References

[Bor17], [InternationalTUnion17], [InternationalTUnion18]

colour.models.ootf_inverse_BT2100_HLG

colour.models.ootf_inverse_BT2100_HLG(*F_D*: FloatingOrArrayLike, *L_B*: float = 0, *L_W*: float = 1000, gamma: float | None = None, method: Literal['ITU-R BT.2100-1', 'ITU-R BT.2100-2'] | str = 'ITU-R BT.2100-2') → FloatingOrNDArray

Define *Recommendation ITU-R BT.2100 Reference HLG* inverse opto-optical transfer function (OOTF / OOCF).

Parameters

- **F_D** (FloatingOrArrayLike) – F_D is the luminance of a displayed linear component $R_D, G_D, \text{ or } B_D$, in cd/m^2 .
- **L_B** (float) – L_B is the display luminance for black in cd/m^2 .
- **L_W** (float) – L_W is nominal peak luminance of the display in cd/m^2 for achromatic pixels.
- **gamma** (float | None) – System gamma value, 1.2 at the nominal display peak luminance of $1000\text{cd}/\text{m}^2$.
- **method** (Literal['ITU-R BT.2100-1', 'ITU-R BT.2100-2'] | str) – Computation method.

Returns

E is the signal for each colour component R_S, G_S, B_S proportional to scene linear light and scaled by camera exposure.

Return type

numpy.floating or numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| F_D | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| E | [0, 1] | [0, 1] |

References

[Bor17], [InternationalTUnion17], [InternationalTUnion18]

Examples

```
>>> ootf_inverse_BT2100_HLG(63.095734448019336)
0.1000000...
>>> ootf_inverse_BT2100_HLG(
...     63.105103490674857, 0.01, method="ITU-R BT.2100-1"
... )
...
0.0999999...
```

colour.models.ootf_BT2100_PQ

colour.models.**ootf_BT2100_PQ**(*E*: *FloatingOrArrayLike*) → *FloatingOrNDArray*

Define *Recommendation ITU-R BT.2100 Reference PQ* opto-optical transfer function (OOTF / OOCF).

The OOTF maps relative scene linear light to display linear light.

Parameters

E (*FloatingOrArrayLike*) – $E = R_S, G_S, B_S; Y_S; \text{or } I_S$ is the signal determined by scene light and scaled by camera exposure.

Returns

F_D is the luminance of a displayed linear component ($R_D, G_D, B_D; Y_D; \text{or } I_D$).

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| E | UN | UN |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| F_D | UN | UN |

References

[Bor17], [InternationalTUnion17]

Examples

```
>>> ootf_BT2100_PQ(0.1)
779.9883608...
```

colour.models.ootf_inverse_BT2100_PQ

colour.models.**ootf_inverse_BT2100_PQ**(*F_D*: *FloatingOrArrayLike*) → *FloatingOrNDArray*

Define *Recommendation ITU-R BT.2100 Reference PQ* inverse opto-optical transfer function (OOTF / OOCF).

Parameters

F_D (*FloatingOrArrayLike*) – F_D is the luminance of a displayed linear component (R_D , G_D , B_D ; Y_D ; or I_D).

Returns

$E = R_S, G_S, B_S; Y_S$; or I_S is the signal determined by scene light and scaled by camera exposure.

Return type

`numpy.float64` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| F_D | UN | UN |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| E | UN | UN |

References

[Bor17], [InternationalTUnion17]

Examples

```
>>> ootf_inverse_BT2100_PQ(779.988360834115840)
0.1000000...
```

Log Encoding and Decoding

colour

| | |
|--|--|
| <code>log_encoding(value[, function])</code> | Encode <i>scene-referred</i> exposure values to <i>R'G'B'</i> video component signal value using given <i>log</i> encoding function. |
| <code>LOG_ENCODINGS</code> | Supported <i>log</i> encoding functions. |
| <code>log_decoding(value[, function])</code> | Decode <i>R'G'B'</i> video component signal value to <i>scene-referred</i> exposure values using given <i>log</i> decoding function. |
| <code>LOG_DECODINGS</code> | Supported <i>log</i> decoding functions. |

colour.log_encoding

`colour.log_encoding(value: float | _SupportsArray[dtype[Any]] | _NestedSequence[_SupportsArray[dtype[Any]]] | bool | int | complex | str | bytes | _NestedSequence[bool | int | float | complex | str | bytes], function: Literal['ACEScc', 'ACEScct', 'ACESproxy', 'ARRI LogC3', 'ARRI LogC4', 'Canon Log 2', 'Canon Log 3', 'Canon Log', 'Cineon', 'D-Log', 'ERIMM RGB', 'F-Log', 'Filmic Pro 6', 'L-Log', 'Log2', 'Log3G10', 'Log3G12', 'N-Log', 'PLog', 'Panalog', 'Protune', 'REDLog', 'REDLogFilm', 'S-Log', 'S-Log2', 'S-Log3', 'T-Log', 'V-Log', 'ViperLog'] | str = 'Cineon', **kwargs: Any) → float | ndarray | int`

Encode *scene-referred* exposure values to *R'G'B'* video component signal value using given *log* encoding function.

Parameters

- **value** (float | _SupportsArray[dtype[Any]] | _NestedSequence[_SupportsArray[dtype[Any]]] | bool | int | complex | str | bytes | _NestedSequence[bool | int | float | complex | str | bytes]) – *Scene-referred* exposure values.
- **function** (Literal['ACEScc', 'ACEScct', 'ACESproxy', 'ARRI LogC3', 'ARRI LogC4', 'Canon Log 2', 'Canon Log 3', 'Canon Log', 'Cineon', 'D-Log', 'ERIMM RGB', 'F-Log', 'Filmic Pro 6', 'L-Log', 'Log2', 'Log3G10', 'Log3G12', 'N-Log', 'PLog', 'Panalog', 'Protune', 'REDLog', 'REDLogFilm', 'S-Log', 'S-Log2', 'S-Log3', 'T-Log', 'V-Log', 'ViperLog'] | str) – *Log* encoding function.
- **kwargs** (Any) – {`colour.models.log_encoding_ACEScc()`, `colour.models.log_encoding_ACEScct()`, `colour.models.log_encoding_ACESproxy()`, `colour.models.log_encoding_ARRILogC3()`, `colour.models.log_encoding_ARRILogC4()`, `colour.models.log_encoding_CanonLog2()`, `colour.models.log_encoding_CanonLog3()`, `colour.models.log_encoding_CanonLog()`, `colour.models.log_encoding_Cineon()`, `colour.models.log_encoding_DJIDLog()`, `colour.models.log_encoding_ERIMMRGB()`, `colour.models.log_encoding_FLog()`, `colour.models.log_encoding_FilmicPro6()`, `colour.models.log_encoding_LLog()`, `colour.models.log_encoding_Log2()`, `colour.models.log_encoding_Log3G10()`, `colour.models.log_encoding_Log3G12()`, `colour.models.log_encoding_NLog()`, `colour.models.log_encoding_PivotedLog()`, `colour.models.log_encoding_Panalog()`, `colour.models.log_encoding_Protune()`, `colour.models.log_encoding_REDLog()`, `colour.models.log_encoding_REDLogFilm()`, `colour.models.log_encoding_SLog()`, `colour.models.log_encoding_SLog2()`, `colour.models.log_encoding_SLog3()`, `colour.models.log_encoding_FilmLightTLog()`, `colour.models.log_encoding_VLog()`, `colour.models.log_encoding_ViperLog()`}

`log_encoding_VLog()`, `colour.models.log_encoding_ViperLog()`}, See the documentation of the previously listed definitions.

Returns

Log values.

Return type

`numpy.float64` or `numpy.int64` or `numpy.ndarray`

Examples

```
>>> log_encoding(0.18)
0.4573196...
>>> log_encoding(0.18, function="ACEScsc")
0.4135884...
>>> log_encoding(0.18, function="PLog", log_reference=400)
...
0.3910068...
>>> log_encoding(0.18, function="S-Log")
0.3849708...
```

colour.LOG_ENCODINGS

`colour.LOG_ENCODINGS = CanonicalMapping({'ACEScsc': ..., 'ACEScct': ..., 'ACESproxy': ..., 'ARRI LogC3': ..., 'ARRI LogC4': ..., 'Canon Log 2': ..., 'Canon Log 3': ..., 'Canon Log', ..., 'Cineon': ..., 'D-Log': ..., 'ERIMM RGB': ..., 'F-Log': ..., 'Filmic Pro 6': ..., 'L-Log': ..., 'Log2': ..., 'Log3G10': ..., 'Log3G12': ..., 'N-Log': ..., 'PLog': ..., 'Panalog': ..., 'Protune': ..., 'REDLog': ..., 'REDLogFilm': ..., 'S-Log': ..., 'S-Log2': ..., 'S-Log3': ..., 'T-Log': ..., 'V-Log': ..., 'ViperLog': ...})`

Supported log encoding functions.

colour.log_decoding

`colour.log_decoding(value: float | _SupportsArray[dtype[Any]] | _NestedSequence[_SupportsArray[dtype[Any]]] | bool | int | complex | str | bytes | _NestedSequence[bool | int | float | complex | str | bytes], function: Literal['ACEScsc', 'ACEScct', 'ACESproxy', 'ARRI LogC3', 'ARRI LogC4', 'Canon Log 2', 'Canon Log 3', 'Canon Log', 'Cineon', 'D-Log', 'ERIMM RGB', 'F-Log', 'Filmic Pro 6', 'L-Log', 'Log2', 'Log3G10', 'Log3G12', 'N-Log', 'PLog', 'Panalog', 'Protune', 'REDLog', 'REDLogFilm', 'S-Log', 'S-Log2', 'S-Log3', 'T-Log', 'V-Log', 'ViperLog'] | str = 'Cineon', **kwargs: Any) → float | ndarray`

Decode $R'G'B'$ video component signal value to *scene-referred* exposure values using given log decoding function.

Parameters

- **value** (`float` | `_SupportsArray[dtype[Any]]` | `_NestedSequence[_SupportsArray[dtype[Any]]]` | `bool` | `int` | `complex` | `str` | `bytes` | `_NestedSequence[bool | int | float | complex | str | bytes]`) – Log values.
- **function** (`Literal['ACEScsc', 'ACEScct', 'ACESproxy', 'ARRI LogC3', 'ARRI LogC4', 'Canon Log 2', 'Canon Log 3', 'Canon Log', 'Cineon', 'D-Log', 'ERIMM RGB', 'F-Log', 'Filmic Pro 6', 'L-Log', 'Log2', 'Log3G10', 'Log3G12', 'N-Log', 'PLog', 'Panalog', 'Protune', 'REDLog', 'REDLogFilm', 'S-Log', 'S-Log2', 'S-Log3', 'T-Log', 'V-Log', 'ViperLog']` | `str`) – Log decoding function.

- **kwargs** (Any) – {colour.models.log_decoding_ACEScc(), colour.models.log_decoding_ACEScct(), colour.models.log_decoding_ACESproxy(), colour.models.log_decoding_ARRILogC3(), colour.models.log_decoding_ARRILogC4(), colour.models.log_decoding_CanonLog2(), colour.models.log_decoding_CanonLog3(), colour.models.log_decoding_CanonLog(), colour.models.log_decoding_Cineon(), colour.models.log_decoding_DJIDLog(), colour.models.log_decoding_ERIMMRGB(), colour.models.log_decoding_FLog(), colour.models.log_decoding_FilmicPro6(), colour.models.log_decoding_LLog(), colour.models.log_decoding_Log2(), colour.models.log_decoding_Log3G10(), colour.models.log_decoding_Log3G12(), colour.models.log_decoding_NLog(), colour.models.log_decoding_PivotedLog(), colour.models.log_decoding_Panalog(), colour.models.log_decoding_Protune(), colour.models.log_decoding_REDLog(), colour.models.log_decoding_REDLogFilm(), colour.models.log_decoding_SLog(), colour.models.log_decoding_SLog2(), colour.models.log_decoding_SLog3(), colour.models.log_decoding_FilmLightTLog(), colour.models.log_decoding_VLog(), colour.models.log_decoding_ViperLog()}, See the documentation of the previously listed definitions.

Returns

Scene-referred exposure values.

Return type

numpy.float64 or numpy.ndarray

Examples

```
>>> log_decoding(0.457319613085418)
0.1...
>>> log_decoding(0.413588402492442, function="ACEScc")
...
0.1...
>>> log_decoding(0.391006842619746, function="PLog", log_reference=400)
...
0.1...
>>> log_decoding(0.376512722254600, function="S-Log")
...
0.1...
```

colour.LOG_DECODINGS

```
colour.LOG_DECODINGS = CanonicalMapping({'ACEScc': ..., 'ACEScct': ..., 'ACESproxy': ...,
'ARRI LogC3': ..., 'ARRI LogC4': ..., 'Canon Log 2': ..., 'Canon Log 3': ..., 'Canon Log': ...,
' Cineon': ..., 'D-Log': ..., 'ERIMM RGB': ..., 'F-Log': ..., 'Filmic Pro 6': ...,
'L-Log': ..., 'Log2': ..., 'Log3G10': ..., 'Log3G12': ..., 'N-Log': ..., 'PLog': ...,
'Panalog': ..., 'Protune': ..., 'REDLog': ..., 'REDLogFilm': ..., 'S-Log': ..., 'S-Log2': ...,
'S-Log3': ..., 'T-Log': ..., 'V-Log': ..., 'ViperLog': ...})
```

Supported *log* decoding functions.

colour.models

| | |
|---|--|
| <code>log_encoding_ACEScc(lin_AP1)</code> | Define the <i>ACEScc</i> colourspace log encoding / opto-electronic transfer function. |
| <code>log_decoding_ACEScc(ACEScc)</code> | Define the <i>ACEScc</i> colourspace log decoding / electro-optical transfer function. |

continues on next page

Table 3 – continued from previous page

| | |
|--|---|
| <code>log_encoding_ACEScct(lin_AP1[, constants])</code> | Define the <i>ACEScct</i> colourspace log encoding / opto-electronic transfer function. |
| <code>log_decoding_ACEScct(ACEScct[, constants])</code> | Define the <i>ACEScct</i> colourspace log decoding / electro-optical transfer function. |
| <code>log_encoding_ACESproxy(lin_AP1[, bit_depth, ...])</code> | Define the <i>ACESproxy</i> colourspace log encoding curve / opto-electronic transfer function. |
| <code>log_decoding_ACESproxy(ACESproxy[, ...])</code> | Define the <i>ACESproxy</i> colourspace log decoding curve / electro-optical transfer function. |
| <code>log_encoding_ARRILogC3(x[, firmware, method, EI])</code> | Define the <i>ARRI LogC3</i> log encoding curve / opto-electronic transfer function. |
| <code>log_decoding_ARRILogC3(t[, firmware, method, EI])</code> | Define the <i>ARRI LogC3</i> log decoding curve / electro-optical transfer function. |
| <code>log_encoding_CanonLog2(x[, bit_depth, ...])</code> | Define the <i>Canon Log 2</i> log encoding curve / opto-electronic transfer function. |
| <code>log_decoding_CanonLog2(clog2[, bit_depth, ...])</code> | Define the <i>Canon Log 2</i> log decoding curve / electro-optical transfer function. |
| <code>log_encoding_CanonLog3(x[, bit_depth, ...])</code> | Define the <i>Canon Log 3</i> log encoding curve / opto-electronic transfer function. |
| <code>log_decoding_CanonLog3(clog3[, bit_depth, ...])</code> | Define the <i>Canon Log 3</i> log decoding curve / electro-optical transfer function. |
| <code>log_encoding_CanonLog(x[, bit_depth, ...])</code> | Define the <i>Canon Log</i> log encoding curve / opto-electronic transfer function. |
| <code>log_decoding_CanonLog(clog[, bit_depth, ...])</code> | Define the <i>Canon Log</i> log decoding curve / electro-optical transfer function. |
| <code>log_encoding_Cineon(x[, black_offset])</code> | Define the <i>Cineon</i> log encoding curve / opto-electronic transfer function. |
| <code>log_decoding_Cineon(y[, black_offset])</code> | Define the <i>Cineon</i> log decoding curve / electro-optical transfer function. |
| <code>log_encoding_ERIMMRGB(X[, bit_depth, ...])</code> | Define the <i>ERIMM RGB</i> log encoding curve / opto-electronic transfer function (OETF). |
| <code>log_decoding_ERIMMRGB(X_p[, bit_depth, ...])</code> | Define the <i>ERIMM RGB</i> log decoding curve / electro-optical transfer function (EOTF). |
| <code>log_encoding_FLog(in_r[, bit_depth, ...])</code> | Define the <i>Fujifilm F-Log</i> log encoding curve / opto-electronic transfer function. |
| <code>log_decoding_FLog(out_r[, bit_depth, ...])</code> | Define the <i>Fujifilm F-Log</i> log decoding curve / electro-optical transfer function. |
| <code>log_encoding_LLog(LSR[, bit_depth, ...])</code> | Define the <i>Leica L-Log</i> log encoding curve / opto-electronic transfer function. |
| <code>log_decoding_LLog(LLog[, bit_depth, ...])</code> | Define the <i>Leica L-Log</i> log decoding curve / electro-optical transfer function. |
| <code>log_encoding_Log2(lin[, middle_grey, ...])</code> | Define the common <i>Log2</i> encoding function. |
| <code>log_decoding_Log2(log_norm[, middle_grey, ...])</code> | Define the common <i>Log2</i> decoding function. |
| <code>LOG3G10_ENCODING_METHODS</code> | Supported <i>Log3G10</i> log encoding curve / opto-electronic transfer function methods. |
| <code>log_encoding_Log3G10(x[, method])</code> | Define the <i>Log3G10</i> log encoding curve / opto-electronic transfer function. |
| <code>LOG3G10_DECODING_METHODS</code> | Supported <i>Log3G10</i> log decoding curve / electro-optical transfer function methods. |
| <code>log_decoding_Log3G10(y[, method])</code> | Define the <i>Log3G10</i> log decoding curve / electro-optical transfer function. |
| <code>log_encoding_Log3G12(x)</code> | Define the <i>Log3G12</i> log encoding curve / opto-electronic transfer function. |
| <code>log_decoding_Log3G12(y)</code> | Define the <i>Log3G12</i> log decoding curve / electro-optical transfer function. |

continues on next page

Table 3 – continued from previous page

| | |
|---|---|
| <code>log_encoding_NLog(y[, bit_depth, ...])</code> | Define the <i>Nikon N-Log</i> log encoding curve / opto-electronic transfer function. |
| <code>log_decoding_NLog(x[, bit_depth, ...])</code> | Define the <i>Nikon N-Log</i> log decoding curve / electro-optical transfer function. |
| <code>log_encoding_Panalog(x[, black_offset])</code> | Define the <i>Panalog</i> log encoding curve / opto-electronic transfer function. |
| <code>log_decoding_Panalog(y[, black_offset])</code> | Define the <i>Panalog</i> log decoding curve / electro-optical transfer function. |
| <code>log_encoding_PivotedLog(x[, log_reference, ...])</code> | Define the <i>Josh Pines</i> style <i>Pivoted Log</i> log encoding curve / opto-electronic transfer function. |
| <code>log_decoding_PivotedLog(y[, log_reference, ...])</code> | Define the <i>Josh Pines</i> style <i>Pivoted Log</i> log decoding curve / electro-optical transfer function. |
| <code>log_encoding_Protune(x)</code> | Define the <i>Protune</i> log encoding curve / opto-electronic transfer function. |
| <code>log_decoding_Protune(y)</code> | Define the <i>Protune</i> log decoding curve / electro-optical transfer function. |
| <code>log_encoding_REDLog(x[, black_offset])</code> | Define the <i>REDLog</i> log encoding curve / opto-electronic transfer function. |
| <code>log_decoding_REDLog(y[, black_offset])</code> | Define the <i>REDLog</i> log decoding curve / electro-optical transfer function. |
| <code>log_encoding_REDLogFilm(x[, black_offset])</code> | Define the <i>REDLogFilm</i> log encoding curve / opto-electronic transfer function. |
| <code>log_decoding_REDLogFilm(y[, black_offset])</code> | Define the <i>REDLogFilm</i> log decoding curve / electro-optical transfer function. |
| <code>log_encoding_SLog(x[, bit_depth, ...])</code> | Define the <i>Sony S-Log</i> log encoding curve / opto-electronic transfer function. |
| <code>log_decoding_SLog(y[, bit_depth, ...])</code> | Define the <i>Sony S-Log</i> log decoding curve / electro-optical transfer function. |
| <code>log_encoding_SLog2(x[, bit_depth, ...])</code> | Define the <i>Sony S-Log2</i> log encoding curve / opto-electronic transfer function. |
| <code>log_decoding_SLog2(y[, bit_depth, ...])</code> | Define the <i>Sony S-Log2</i> log decoding curve / electro-optical transfer function. |
| <code>log_encoding_SLog3(x[, bit_depth, ...])</code> | Define the <i>Sony S-Log3</i> log encoding curve / opto-electronic transfer function. |
| <code>log_decoding_SLog3(y[, bit_depth, ...])</code> | Define the <i>Sony S-Log3</i> log decoding curve / electro-optical transfer function. |
| <code>log_encoding_VLog(L_in[, bit_depth, ...])</code> | Define the <i>Panasonic V-Log</i> log encoding curve / opto-electronic transfer function. |
| <code>log_decoding_VLog(V_out[, bit_depth, ...])</code> | Define the <i>Panasonic V-Log</i> log decoding curve / electro-optical transfer function. |
| <code>log_encoding_ViperLog(x)</code> | Define the <i>Viper Log</i> log encoding curve / opto-electronic transfer function. |
| <code>log_decoding_ViperLog(y)</code> | Define the <i>Viper Log</i> log decoding curve / electro-optical transfer function. |

colour.models.log_encoding_ACEScc

`colour.models.log_encoding_ACEScc(lin_AP1: FloatingOrArrayLike) → FloatingOrNDArray`

Define the *ACEScc* colourspace log encoding / opto-electronic transfer function.

Parameters

`lin_AP1` (*FloatingOrArrayLike*) – *lin_AP1* value.

Returns

ACEScc non-linear value.

Return type`numpy.float64` or `numpy.ndarray`**Notes**

| Domain | Scale - Reference | Scale - 1 |
|----------------------|-------------------|-----------|
| <code>lin_AP1</code> | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|---------------------|-------------------|-----------|
| <code>ACEScc</code> | [0, 1] | [0, 1] |

References

[TheAoMPAA Sciences ScienceaTCouncilAcademyCESACESPSubcommittee14b], [TheAoMPAA Sciences ScienceaTCouncilAcademyCESACESPSubcommittee14c], [TheAoMPAA Sciences ScienceaTCouncilAcademyCESACESPSubcommittee14a], [TheAoMPAA Sciences ScienceaTCouncilAcademyCESACESPSubcommittee14a]

Examples

```
>>> log_encoding_ACEScc(0.18)
0.4135884...
```

colour.models.log_decoding_ACEScc

`colour.models.log_decoding_ACEScc(ACEScc: FloatingOrArrayLike) → FloatingOrNDArray`

Define the *ACEScc* colourspace log decoding / electro-optical transfer function.

Parameters

ACEScc (`FloatingOrArrayLike`) – *ACEScc* non-linear value.

Returns

lin_AP1 value.

Return type`numpy.float64` or `numpy.ndarray`**Notes**

| Domain | Scale - Reference | Scale - 1 |
|---------------------|-------------------|-----------|
| <code>ACEScc</code> | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|----------------------|-------------------|-----------|
| <code>lin_AP1</code> | [0, 1] | [0, 1] |

References

[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14b], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14c], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14a], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommitteea]

Examples

```
>>> log_decoding_ACEScc(0.413588402492442)
0.1799999...
```

colour.models.log_encoding_ACEScct

colour.models.log_encoding_ACEScct(*lin_AP1*: FloatingOrArrayLike, *constants*: Structure = CONSTANTS_ACES_CCT) → FloatingOrNDArray

Define the ACEScct colourspace log encoding / opto-electronic transfer function.

Parameters

- **lin_AP1** (FloatingOrArrayLike) – *lin_AP1* value.
- **constants** (Structure) – ACEScct constants.

Returns

ACEScct non-linear value.

Return type

numpy.floating or numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|---------|-------------------|-----------|
| lin_AP1 | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|---------|-------------------|-----------|
| ACEScct | [0, 1] | [0, 1] |

References

[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14b], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14c], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESProject16], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommitteea]

Examples

```
>>> log_encoding_ACEScct(0.18)
0.4135884...
```

colour.models.log_decoding_ACEScct

colour.models.**log_decoding_ACEScct**(*ACEScct: FloatingOrArrayLike*, *constants: Structure = CONSTANTS_ACES_CCT*) → FloatingOrNDArray

Define the *ACEScct* colourspace log decoding / electro-optical transfer function.

Parameters

- **ACEScct** (FloatingOrArrayLike) – *ACEScct* non-linear value.
- **constants** (Structure) – *ACEScct* constants.

Returns

lin_AP1 value.

Return type

numpy.floating or numpy.ndarray

References

[TheAoMPAAsciencesScienceaTCouncilAcademyCESACESPSubcommittee14b], [TheAoMPAA-SciencesScienceaTCouncilAcademyCESACESPSubcommittee14c], [TheAoMPAAsciencesScienceaTCouncilAcademyCESACESProject16], [TheAoMPAAsciencesScienceaTCouncilAcademyCESACESPSubcommitteea]

Notes

| Domain | Scale - Reference | Scale - 1 |
|---------|-------------------|-----------|
| ACEScct | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|---------|-------------------|-----------|
| lin_AP1 | [0, 1] | [0, 1] |

Examples

```
>>> log_decoding_ACEScct(0.413588402492442)
0.1799999...
```

colour.models.log_encoding_ACESproxy

```
colour.models.log_encoding_ACESproxy(lin_AP1: FloatingOrArrayLike, bit_depth: Literal[10, 12] =
    10, out_int: bool = False, constants: Dict =
    CONSTANTS_ACES_PROXY) → FloatingOrNDArray |
    IntegerOrNDArray
```

Define the *ACESproxy* colourspace log encoding curve / opto-electronic transfer function.

Parameters

- **lin_AP1** (FloatingOrArrayLike) – *lin_AP1* value.
- **bit_depth** (Literal[10, 12]) – *ACESproxy* bit depth.
- **out_int** – Whether to return value as integer code value or float equivalent of a code value at a given bit depth.
- **constants** (Dict) – *ACESproxy* constants.
- **out_int** (bool) –

Returns

ACESproxy non-linear value.

Return type

numpy.floating or numpy.integer or numpy.ndarray

Notes

| Domain * | Scale - Reference | Scale - 1 |
|----------|-------------------|-----------|
| lin_AP1 | [0, 1] | [0, 1] |

| Range * | Scale - Reference | Scale - 1 |
|-----------|-------------------|-----------|
| ACESproxy | [0, 1] | [0, 1] |

* This definition has an output integer switch, thus the domain-range scale information is only given for the floating point mode.

References

[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14b], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14c], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee13], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubmitteea]

Examples

```
>>> log_encoding_ACESproxy(0.18)
0.4164222...
>>> log_encoding_ACESproxy(0.18, out_int=True)
426
```


colour.models.log_decoding_ACESproxy

`colour.models.log_decoding_ACESproxy`(*ACESproxy*: *FloatingOrArrayLike* | *IntegerOrArrayLike*,
bit_depth: *Literal*[10, 12] = 10, *in_int*: *bool* = False,
constants: *Dict* = *CONSTANTS_ACES_PROXY*) →
FloatingOrNDArray

Define the *ACESproxy* colourspace log decoding curve / electro-optical transfer function.

Parameters

- **ACESproxy** (*FloatingOrArrayLike* | *IntegerOrArrayLike*) – *ACESproxy* non-linear value.
- **bit_depth** (*Literal*[10, 12]) – *ACESproxy* bit depth.
- **in_int** (*bool*) – Whether to treat the input value as integer code value or float equivalent of a code value at a given bit depth.
- **constants** (*Dict*) – *ACESproxy* constants.

Returns

lin_AP1 value.

Return type

numpy.floating or *numpy.ndarray*

Notes

| Domain * | Scale - Reference | Scale - 1 |
|-----------|-------------------|-----------|
| ACESproxy | [0, 1] | [0, 1] |

| Range * | Scale - Reference | Scale - 1 |
|---------|-------------------|-----------|
| lin_AP1 | [0, 1] | [0, 1] |

* This definition has an input integer switch, thus the domain-range scale information is only given for the floating point mode.

References

[TheAoMPAAsciencesScienceaTCouncilAcademyCESACESPSubcommittee14b], [TheAoMPAAsciencesScienceaTCouncilAcademyCESACESPSubcommittee14c], [TheAoMPAAsciencesScienceaTCouncilAcademyCESACESPSubcommittee13], [TheAoMPAAsciencesScienceaTCouncilAcademyCESACESPSubcommitteea]

Examples

```
>>> log_decoding_ACESproxy(0.416422287390029)
0.1...
>>> log_decoding_ACESproxy(426, in_int=True)
0.1...
```

colour.models.log_encoding_ARRILogC3

```
colour.models.log_encoding_ARRILogC3(x: FloatingOrArrayLike, firmware: Literal['SUP 2.x', 'SUP 3.x']
    | str = 'SUP 3.x', method: Literal['Linear Scene Exposure
    Factor', 'Normalised Sensor Signal'] | str = 'Linear Scene
    Exposure Factor', EI: Literal[160, 200, 250, 320, 400, 500,
    640, 800, 1000, 1280, 1600] = 800) → FloatingOrNDArray
```

Define the *ARRI LogC3* log encoding curve / opto-electronic transfer function.

Parameters

- **x** (FloatingOrArrayLike) – Linear data x .
- **firmware** (Literal['SUP 2.x', 'SUP 3.x'] | str) – Alexa firmware version.
- **method** (Literal['Linear Scene Exposure Factor', 'Normalised Sensor Signal'] | str) – Conversion method.
- **EI** (Literal[160, 200, 250, 320, 400, 500, 640, 800, 1000, 1280, 1600]) – Exposure Index EI .

Returns

ARRI LogC3 encoded data t .

Return type

numpy.float64 or numpy.ndarray

References

[ARRI12]

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| t | [0, 1] | [0, 1] |

Examples

```
>>> log_encoding_ARRILogC3(0.18)
0.3910068...
```

colour.models.log_decoding_ARRILogC3

```
colour.models.log_decoding_ARRILogC3(t: FloatingOrArrayLike, firmware: Literal['SUP 2.x', 'SUP 3.x']
    | str = 'SUP 3.x', method: Literal['Linear Scene Exposure
    Factor', 'Normalised Sensor Signal'] | str = 'Linear Scene
    Exposure Factor', EI: Literal[160, 200, 250, 320, 400, 500,
    640, 800, 1000, 1280, 1600] = 800) → FloatingOrNDArray
```

Define the *ARRI LogC3* log decoding curve / electro-optical transfer function.

Parameters

- **t** (FloatingOrArrayLike) – *ARRI LogC3* encoded data *t*.
- **firmware** (Literal['SUP 2.x', 'SUP 3.x'] | *str*) – Alexa firmware version.
- **method** (Literal['Linear Scene Exposure Factor', 'Normalised Sensor Signal'] | *str*) – Conversion method.
- **EI** (Literal[160, 200, 250, 320, 400, 500, 640, 800, 1000, 1280, 1600]) – Exposure Index *EI*.

Returns

Linear data *x*.

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|----------|-------------------|-----------|
| <i>t</i> | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|----------|-------------------|-----------|
| <i>x</i> | [0, 1] | [0, 1] |

References

[ARRI12]

Examples

```
>>> log_decoding_ARRILogC3(0.391006832034084)
0.18...
```

colour.models.log_encoding_CanonLog2

```
colour.models.log_encoding_CanonLog2(x: FloatingOrArrayLike, bit_depth: int = 10,  
                                     out_normalised_code_value: bool = True, in_reflection: bool =  
                                     True) → FloatingOrNDArray
```

Define the *Canon Log 2* log encoding curve / opto-electronic transfer function.

Parameters

- **x** (FloatingOrArrayLike) – Linear data x .
- **bit_depth** (int) – Bit depth used for conversion.
- **out_normalised_code_value** (bool) – Whether the *Canon Log 2* non-linear data is encoded as normalised code values.
- **in_reflection** (bool) – Whether the light level x to a camera is reflection.

Returns

Canon Log 2 non-linear data.

Return type

numpy.floating or numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| clog2 | [0, 1] | [0, 1] |

References

[[Canon16](#)]

Examples

```
>>> log_encoding_CanonLog2(0.18) * 100  
39.8254694...
```

colour.models.log_decoding_CanonLog2

```
colour.models.log_decoding_CanonLog2(clog2: FloatingOrArrayLike, bit_depth: int = 10,  
                                       in_normalised_code_value: bool = True, out_reflection: bool =  
                                       True) → FloatingOrNDArray
```

Define the *Canon Log 2* log decoding curve / electro-optical transfer function.

Parameters

- **clog2** (FloatingOrArrayLike) – *Canon Log 2* non-linear data.
- **bit_depth** (int) – Bit depth used for conversion.

- **in_normalised_code_value** (`bool`) – Whether the *Canon Log 2* non-linear data is encoded with normalised code values.
- **out_reflection** (`bool`) – Whether the light level x to a camera is reflection.

Returns

Linear data x .

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| clog2 | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

References

[Canon16]

Examples

```
>>> log_decoding_CanonLog2(39.825469498316735 / 100)
0.1799999...
```

colour.models.log_encoding_CanonLog3

`colour.models.log_encoding_CanonLog3(x: FloatingOrArrayLike, bit_depth: int = 10, out_normalised_code_value: bool = True, in_reflection: bool = True) → FloatingOrNDArray`

Define the *Canon Log 3* log encoding curve / opto-electronic transfer function.

Parameters

- **x** (`FloatingOrArrayLike`) – Linear data x .
- **bit_depth** (`int`) – Bit depth used for conversion.
- **out_normalised_code_value** (`bool`) – Whether the *Canon Log 3* non-linear data is encoded as normalised code values.
- **in_reflection** (`bool`) – Whether the light level x to a camera is reflection.

Returns

Canon Log 3 non-linear data.

Return type

`numpy.floating` or `numpy.ndarray`

Notes

- Introspection of the grafting points by Shaw, N. (2018) shows that the *Canon Log 3* IDT was likely derived from its encoding curve as the latter is grafted at ± 0.014 :

```
>>> clog3 = 0.04076162
>>> (clog3 - 0.073059361) / 2.3069815
-0.014000000000000002
>>> clog3 = 0.105357102
>>> (clog3 - 0.073059361) / 2.3069815
0.013999999999999997
```

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| clog3 | [0, 1] | [0, 1] |

References

[Canon16]

Examples

```
>>> log_encoding_CanonLog3(0.18) * 100
34.3389369...
```

colour.models.log_decoding_CanonLog3

`colour.models.log_decoding_CanonLog3(clog3: FloatingOrArrayLike, bit_depth: int = 10, in_normalised_code_value: bool = True, out_reflection: bool = True) → FloatingOrNDArray`

Define the *Canon Log 3* log decoding curve / electro-optical transfer function.

Parameters

- **clog3** (`FloatingOrArrayLike`) – *Canon Log 3* non-linear data.
- **bit_depth** (`int`) – Bit depth used for conversion.
- **in_normalised_code_value** (`bool`) – Whether the *Canon Log 3* non-linear data is encoded with normalised code values.
- **out_reflection** (`bool`) – Whether the light level x to a camera is reflection.

Returns

Linear data x .

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| clog3 | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

References

[Canon16]

Examples

```
>>> log_decoding_CanonLog3(34.338936938868677 / 100)
0.1800000...
```

colour.models.log_encoding_CanonLog

`colour.models.log_encoding_CanonLog(x: FloatingOrArrayLike, bit_depth: int = 10, out_normalised_code_value: bool = True, in_reflection: bool = True) → FloatingOrNDArray`

Define the *Canon Log* log encoding curve / opto-electronic transfer function.

Parameters

- **x** (FloatingOrArrayLike) – Linear data x .
- **bit_depth** (int) – Bit depth used for conversion.
- **out_normalised_code_value** (bool) – Whether the *Canon Log* non-linear data is encoded as normalised code values.
- **in_reflection** (bool) – Whether the light level x to a camera is reflection.

Returns

Canon Log non-linear data.

Return type

`numpy.floating` or `numpy.ndarray`

References

[Tho12]

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| clog | [0, 1] | [0, 1] |

Examples

```
>>> log_encoding_CanonLog(0.18) * 100
34.3389651...
```

The values of *Table 2 Canon-Log Code Values* table in [Tho12] are obtained as follows:

```
>>> x = np.array([0, 2, 18, 90, 720]) / 100
>>> np.around(log_encoding_CanonLog(x) * (2**10 - 1)).astype(np.int)
array([ 128,  169,  351,  614, 1016])
>>> np.around(log_encoding_CanonLog(x, 10, False) * 100, 1)
array([  7.3,  12. ,  32.8,  62.7, 108.7])
```

colour.models.log_decoding_CanonLog

`colour.models.log_decoding_CanonLog(clog: FloatingOrArrayLike, bit_depth: int = 10, in_normalised_code_value: bool = True, out_reflection: bool = True) → FloatingOrNDArray`

Define the *Canon Log* log decoding curve / electro-optical transfer function.

Parameters

- **clog** (*FloatingOrArrayLike*) – *Canon Log* non-linear data.
- **bit_depth** (*int*) – Bit depth used for conversion.
- **in_normalised_code_value** (*bool*) – Whether the *Canon Log* non-linear data is encoded with normalised code values.
- **out_reflection** (*bool*) – Whether the light level x to a camera is reflection.

Returns

Linear data x .

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| clog | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

References

[Tho12]

Examples

```
>>> log_decoding_CanonLog(34.338965172606912 / 100)
0.17999999...
```

`colour.models.log_encoding_Cineon`

`colour.models.log_encoding_Cineon(x: FloatingOrArrayLike, black_offset: FloatingOrArrayLike = 10**95 - 685 / 300) → FloatingOrNDArray`

Define the *Cineon* log encoding curve / opto-electronic transfer function.

Parameters

- **x** (`FloatingOrArrayLike`) – Linear data x .
- **black_offset** (`FloatingOrArrayLike`) – Black offset.

Returns

Non-linear data y .

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| y | [0, 1] | [0, 1] |

References

[SonyImageworks12]

Examples

```
>>> log_encoding_Cineon(0.18)
0.4573196...
```

colour.models.log_decoding_Cineon

colour.models.**log_decoding_Cineon**(*y*: FloatingOrArrayLike, *black_offset*: FloatingOrArrayLike = $10^{**95} - 685 / 300$) → FloatingOrNDArray

Define the *Cineon* log decoding curve / electro-optical transfer function.

Parameters

- **y** (FloatingOrArrayLike) – Non-linear data *y*.
- **black_offset** (FloatingOrArrayLike) – Black offset.

Returns

Linear data *x*.

Return type

numpy.float64 or numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| y | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

References

[SonyImageworks12]

Examples

```
>>> log_decoding_Cineon(0.457319613085418)
0.1799999...
```

colour.models.log_encoding_ERIMMRGB

`colour.models.log_encoding_ERIMMRGB(X: FloatingOrArrayLike, bit_depth: int = 8, out_int: bool = False, E_min: float = 0.001, E_clip: float = 316.2) → FloatingOrNDArray | IntegerOrNDArray`

Define the *ERIMM* RGB log encoding curve / opto-electronic transfer function (OETF).

Parameters

- **X** (`FloatingOrArrayLike`) – Linear data X_{ERIMM} .
- **bit_depth** (`int`) – Bit depth used for conversion.
- **out_int** (`bool`) – Whether to return value as integer code value or float equivalent of a code value at a given bit depth.
- **E_min** (`float`) – Minimum exposure limit.
- **E_clip** (`float`) – Maximum exposure limit.

Returns

Non-linear data X'_{ERIMM} .

Return type

`numpy.floating` or `numpy.integer` or `numpy.ndarray`

Notes

| Domain * | Scale - Reference | Scale - 1 |
|----------|-------------------|-----------|
| X | [0, 1] | [0, 1] |

| Range * | Scale - Reference | Scale - 1 |
|----------------|-------------------|-----------|
| X _p | [0, 1] | [0, 1] |

* This definition has an output integer switch, thus the domain-range scale information is only given for the floating point mode.

References

[SWG00]

Examples

```
>>> log_encoding_ERIMMRGB(0.18)
0.4100523...
>>> log_encoding_ERIMMRGB(0.18, out_int=True)
105
```

colour.models.log_decoding_ERIMMRGB

`colour.models.log_decoding_ERIMMRGB`(*X_p*: *FloatingOrArrayLike* | *IntegerOrArrayLike*, *bit_depth*: *int* = 8, *in_int*: *bool* = False, *E_min*: *float* = 0.001, *E_clip*: *float* = 316.2) → *FloatingOrNDArray*

Define the *ERIMM* RGB log decoding curve / electro-optical transfer function (EOTF).

Parameters

- **X_p** (*FloatingOrArrayLike* | *IntegerOrArrayLike*) – Non-linear data X'_{ERIMM} .
- **bit_depth** (*int*) – Bit depth used for conversion.
- **in_int** (*bool*) – Whether to treat the input value as integer code value or float equivalent of a code value at a given bit depth.
- **E_min** (*float*) – Minimum exposure limit.
- **E_clip** (*float*) – Maximum exposure limit.

Returns

Linear data X_{ERIMM} .

Return type

numpy.floating or *numpy.ndarray*

Notes

| Domain * | Scale - Reference | Scale - 1 |
|----------|-------------------|-----------|
| X_p | [0, 1] | [0, 1] |

| Range * | Scale - Reference | Scale - 1 |
|---------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

* This definition has an input integer switch, thus the domain-range scale information is only given for the floating point mode.

References

[SWG00]

Examples

```
>>> log_decoding_ERIMMRGB(0.410052389492129)
0.1...
>>> log_decoding_ERIMMRGB(105, in_int=True)
0.1...
```

colour.models.log_encoding_FLog

```
colour.models.log_encoding_FLog(in_r: FloatingOrArrayLike, bit_depth: int = 10,
                                out_normalised_code_value: bool = True, in_reflection: bool = True,
                                constants: Structure = CONSTANTS_FLOG) → FloatingOrNDArray
```

Define the *Fujifilm F-Log* log encoding curve / opto-electronic transfer function.

Parameters

- **in_r** (FloatingOrArrayLike) – Linear reflection data in .
- **bit_depth** (int) – Bit depth used for conversion.
- **out_normalised_code_value** (bool) – Whether the non-linear *Fujifilm F-Log* data *out* is encoded as normalised code values.
- **in_reflection** (bool) – Whether the light level in to a camera is reflection.
- **constants** (Structure) – *Fujifilm F-Log* constants.

Returns

Non-linear data *out*.

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|-------------|-------------------|-----------|
| <i>in_r</i> | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|--------------|-------------------|-----------|
| <i>out_r</i> | [0, 1] | [0, 1] |

References

[Fujifilm16]

Examples

```
>>> log_encoding_FLog(0.18)
0.4593184...
```

The values of 2-2. *F-Log Code Value* table in [Fujifilm16] are obtained as follows:

```
>>> x = np.array([0, 18, 90]) / 100
>>> np.around(log_encoding_FLog(x, 10, False) * 100, 1)
array([ 3.5, 46.3, 73.2])
>>> np.around(log_encoding_FLog(x) * (2**10 - 1)).astype(np.int)
array([ 95, 470, 705])
```

colour.models.log_decoding_FLog

```
colour.models.log_decoding_FLog(out_r: FloatingOrArrayLike, bit_depth: int = 10,  
                                in_normalised_code_value: bool = True, out_reflection: bool = True,  
                                constants: Structure = CONSTANTS_FLOG) → FloatingOrNDArray
```

Define the *Fujifilm F-Log* log decoding curve / electro-optical transfer function.

Parameters

- **out_r** (FloatingOrArrayLike) – Non-linear data *out*.
- **bit_depth** (int) – Bit depth used for conversion.
- **in_normalised_code_value** (bool) – Whether the non-linear *Fujifilm F-Log* data *out* is encoded as normalised code values.
- **out_reflection** (bool) – Whether the light level in to a camera is reflection.
- **constants** (Structure) – *Fujifilm F-Log* constants.

Returns

Linear reflection data in .

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| out_r | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| in_r | [0, 1] | [0, 1] |

References

[Fujifilm16]

Examples

```
>>> log_decoding_FLog(0.45931845866162124)  
0.1800000...
```

colour.models.log_encoding_LLog

```
colour.models.log_encoding_LLog(LSR: FloatingOrArrayLike, bit_depth: int = 10,
                                out_normalised_code_value: bool = True, in_reflection: bool = True,
                                constants: Structure = CONSTANTS_LLOG) → FloatingOrNDArray
```

Define the *Leica L-Log* log encoding curve / opto-electronic transfer function.

Parameters

- **LSR** (FloatingOrArrayLike) – Linear scene reflection *LSR* values.
- **bit_depth** (int) – Bit depth used for conversion.
- **out_normalised_code_value** (bool) – Whether the non-linear *Leica L-Log* data $L - Log$ is encoded as normalised code values.
- **in_reflection** (bool) – Whether the light level in to a camera is reflection.
- **constants** (Structure) – *Leica L-Log* constants.

Returns

L-Log 10-bit equivalent code value $L - Log$.

Return type

numpy.floating or numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| LSR | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| LLog | [0, 1] | [0, 1] |

References

[LeicaCAG22]

Examples

```
>>> log_encoding_LLog(0.18)
0.4353139...
```

colour.models.log_decoding_LLog

colour.models.log_decoding_LLog(LLog: FloatingOrArrayLike, bit_depth: int = 10, in_normalised_code_value: bool = True, out_reflection: bool = True, constants: Structure = CONSTANTS_LLOG) → FloatingOrNDArray

Define the *Leica L-Log* log decoding curve / electro-optical transfer function.

Parameters

- **LLog** (FloatingOrArrayLike) – *L-Log* 10-bit equivalent code value $L - Log$.
- **bit_depth** (int) – Bit depth used for conversion.
- **in_normalised_code_value** (bool) – Whether the non-linear *Leica L-Log* data $L - Log$ is encoded as normalised code values.
- **out_reflection** (bool) – Whether the light level in to a camera is reflection.
- **constants** (Structure) – *Leica L-Log* constants.

Returns

Linear scene reflection *LSR* values.

Return type

numpy.floating or numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| LLog | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| LSR | [0, 1] | [0, 1] |

References

[LeicaCAG22]

Examples

```
>>> log_decoding_LLog(0.43531390404392656)
0.1800000...
```


colour.models.log_encoding_Log2

`colour.models.log_encoding_Log2`(*lin*: *FloatingOrArrayLike*, *middle_grey*: *float* = 0.18, *min_exposure*: *float* = -6.5, *max_exposure*: *float* = 6.5) → *FloatingOrNDArray*

Define the common *Log2* encoding function.

Parameters

- **lin** (*FloatingOrArrayLike*) – Linear data to undergo encoding.
- **middle_grey** (*float*) – *Middle Grey* exposure value.
- **min_exposure** (*float*) – Minimum exposure level.
- **max_exposure** (*float*) – Maximum exposure level.

Returns

Non-linear *Log2* encoded data.

Return type

numpy.floating or *numpy.ndarray*

Notes

- The common *Log2* encoding function can be used to build linear to logarithmic shapers in the *ACES OCIO configuration*.
- A (48-nits OCIO) shaper having values in a linear domain, can be encoded to a logarithmic domain:

| Shaper Domain | Shaper Range |
|-----------------|--------------|
| [0.002, 16.291] | [0, 1] |

References

[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommitteeb]

Examples

```
>>> log_encoding_Log2(0.18)
0.5
```

colour.models.log_decoding_Log2

`colour.models.log_decoding_Log2`(*log_norm*: *FloatingOrArrayLike*, *middle_grey*: *float* = 0.18, *min_exposure*: *float* = -6.5, *max_exposure*: *float* = 6.5) → *FloatingOrNDArray*

Define the common *Log2* decoding function.

Parameters

- **log_norm** (*FloatingOrArrayLike*) – Logarithmic data to undergo decoding.
- **middle_grey** (*float*) – *Middle Grey* exposure value.
- **min_exposure** (*float*) – Minimum exposure level.
- **max_exposure** (*float*) – Maximum exposure level.

Returns

Linear *Log2* decoded data.

Return type

`numpy.float64` or `numpy.ndarray`

Notes

- The common *Log2* decoding function can be used to build logarithmic to linear shapers in the *ACES OCIO configuration*.
- The shaper with logarithmic encoded values can be decoded back to linear domain:

| Shaper Range | Shaper Domain |
|--------------|-----------------|
| [0, 1] | [0.002, 16.291] |

References

[[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommitteec](#)]

Examples

```
>>> log_decoding_Log2(0.5)
0.1799999...
```

colour.models.LOG3G10_ENCODING_METHODS

```
colour.models.LOG3G10_ENCODING_METHODS = CanonicalMapping({'v1': ..., 'v2': ..., 'v3': ...})
```

Supported *Log3G10* log encoding curve / opto-electronic transfer function methods.

References

[[Nat16](#)], [[REDDCinema17](#)]

colour.models.log_encoding_Log3G10

```
colour.models.log_encoding_Log3G10(x: FloatingOrArrayLike, method: Literal['v1', 'v2', 'v3'] | str = 'v3') → FloatingOrNDArray
```

Define the *Log3G10* log encoding curve / opto-electronic transfer function.

Parameters

- **x** (`FloatingOrArrayLike`) – Linear data *x*.
- **method** (`Literal['v1', 'v2', 'v3'] | str`) – Computation method.

Returns

Non-linear data *y*.

Return type

`numpy.float64` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| y | [0, 1] | [0, 1] |

- The *Log3G10 v1* log encoding curve is the one used in *REDCINE-X Beta 42*. *Resolve 12.5.2* also uses the *v1* curve. *RED* is planning to use the *Log3G10 v2* log encoding curve in the release version of the *RED SDK*.
- The intent of the *Log3G10 v1* log encoding curve is that zero maps to zero, 0.18 maps to 1/3, and 10 stops above 0.18 maps to 1.0. The name indicates this in a similar way to the naming conventions of *Sony HyperGamma* curves.

The constants used in the functions do not in fact quite hit these values, but rather than use corrected constants, the functions here use the official *RED* values, in order to match the output of the *RED SDK*.

For those interested, solving for constants which exactly hit 1/3 and 1.0 yields the following values:

```
B = 25 * (np.sqrt(4093.0) - 3) / 9
A = 1 / np.log10(B * 184.32 + 1)
```

where the function takes the form:

```
Log3G10(x) = A * np.log10(B * x + 1)
```

Similarly for *Log3G12*, the values which hit exactly 1/3 and 1.0 are:

```
B = 25 * (np.sqrt(16381.0) - 3) / 9
A = 1 / np.log10(B * 737.28 + 1)
```

References

[Nat16], [REDDCinema17]

Examples

```
>>> log_encoding_Log3G10(0.0)
0.09155148...
>>> log_encoding_Log3G10(0.18, method="v1")
0.3333336...
```

colour.models.LOG3G10_DECODING_METHODS

```
colour.models.LOG3G10_DECODING_METHODS = CanonicalMapping({'v1': ..., 'v2': ..., 'v3': ...})
```

Supported *Log3G10* log decoding curve / electro-optical transfer function methods.

References

[Nat16], [REDDCinema17]

colour.models.log_decoding_Log3G10

```
colour.models.log_decoding_Log3G10(y, method: Literal['v1', 'v2', 'v3'] | str = 'v3') →  
FloatingOrNDArray
```

Define the *Log3G10* log decoding curve / electro-optical transfer function.

Parameters

- **y** – Non-linear data *y*.
- **method** (`Literal['v1', 'v2', 'v3'] | str`) – Computation method.

Returns

Linear data *x*.

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| y | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

References

[Nat16], [REDDCinema17]

Examples

```
>>> log_decoding_Log3G10(1.0)  
184.3223476...  
>>> log_decoding_Log3G10(1.0 / 3, method="v1")  
0.1799994...
```

colour.models.log_encoding_Log3G12

`colour.models.log_encoding_Log3G12(x: FloatingOrArrayLike) → FloatingOrNDArray`

Define the *Log3G12* log encoding curve / opto-electronic transfer function.

Parameters

x (*FloatingOrArrayLike*) – Linear data *x*.

Returns

Non-linear data *y*.

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| y | [0, 1] | [0, 1] |

References

[Nat16], [REDDCinema17]

Examples

```
>>> log_encoding_Log3G12(0.18)
0.3333326...
```

colour.models.log_decoding_Log3G12

`colour.models.log_decoding_Log3G12(y: FloatingOrArrayLike) → FloatingOrNDArray`

Define the *Log3G12* log decoding curve / electro-optical transfer function.

Parameters

y (*FloatingOrArrayLike*) – Non-linear data *y*.

Returns

Linear data *x*.

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| y | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

References

[Nat16], [REDDCinema17]

Examples

```
>>> log_decoding_Log3G12(1.0 / 3)
0.1800015...
```

colour.models.log_encoding_NLog

`colour.models.log_encoding_NLog(y: FloatingOrArrayLike, bit_depth: int = 10, out_normalised_code_value: bool = True, in_reflection: bool = True, constants: Structure = CONSTANTS_NLOG) → FloatingOrNDArray`

Define the *Nikon N-Log* log encoding curve / opto-electronic transfer function.

Parameters

- **y** (`FloatingOrArrayLike`) – Reflectance y , “ $y = 0.18$ ” is equivalent to Stop 0.
- **bit_depth** (`int`) – Bit depth used for conversion.
- **out_normalised_code_value** (`bool`) – Whether the non-linear *Nikon N-Log* data x is encoded as normalised code values.
- **in_reflection** (`bool`) – Whether the light level in to a camera is reflection.
- **constants** (`Structure`) – *Nikon N-Log* constants.

Returns

N-Log 10-bit equivalent code value x .

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| y | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

References

[Nikon18]

Examples

```
>>> log_encoding_NLog(0.18)
0.3636677...
```

colour.models.log_decoding_NLog

`colour.models.log_decoding_NLog(x: FloatingOrArrayLike, bit_depth: int = 10, in_normalised_code_value: bool = True, out_reflection: bool = True, constants: Structure = CONSTANTS_NLOG) → FloatingOrNDArray`

Define the *Nikon N-Log* log decoding curve / electro-optical transfer function.

Parameters

- **x** (`FloatingOrArrayLike`) – *N-Log* 10-bit equivalent code value x
- **bit_depth** (`int`) – Bit depth used for conversion.
- **in_normalised_code_value** (`bool`) – Whether the non-linear *Nikon N-Log* data x is encoded as normalised code values.
- **out_reflection** (`bool`) – Whether the light level in to a camera is reflection.
- **constants** (`Structure`) – *Nikon N-Log* constants.

Returns

Reflectance y .

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| y | [0, 1] | [0, 1] |

References

[Nikon18]

Examples

```
>>> log_decoding_NLog(0.36366777011713869)
0.1799999...
```

colour.models.log_encoding_Panalog

`colour.models.log_encoding_Panalog`(*x*: *FloatingOrArrayLike*, *black_offset*: *FloatingOrArrayLike* = $10^{**64} - 681 / 444$) → *FloatingOrNDArray*

Define the *Panalog* log encoding curve / opto-electronic transfer function.

Parameters

- **x** (*FloatingOrArrayLike*) – Linear data *x*.
- **black_offset** (*FloatingOrArrayLike*) – Black offset.

Returns

Non-linear data *y*.

Return type

`numpy.floating` or `numpy.ndarray`

Warning: These are estimations known to be close enough, the actual log encoding curves are not published.

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| y | [0, 1] | [0, 1] |

References

[SonyImageworks12]

Examples

```
>>> log_encoding_Panalog(0.18)
0.3745767...
```

colour.models.log_decoding_Panalog

`colour.models.log_decoding_Panalog(y: FloatingOrArrayLike, black_offset: FloatingOrArrayLike = 10**64 - 681 / 444) → FloatingOrNDArray`

Define the *Panalog* log decoding curve / electro-optical transfer function.

Parameters

- **y** (FloatingOrArrayLike) – Non-linear data *y*.
- **black_offset** (FloatingOrArrayLike) – Black offset.

Returns

Linear data *x*.

Return type

`numpy.floating` or `numpy.ndarray`

Warning: These are estimations known to be close enough, the actual log encoding curves are not published.

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| y | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

References

[SonyImageworks12]

Examples

```
>>> log_decoding_Panalog(0.374576791382298)
0.1...
```

colour.models.log_encoding_PivotedLog

```
colour.models.log_encoding_PivotedLog(x: FloatingOrArrayLike, log_reference: float = 445,
                                       linear_reference: float = 0.18, negative_gamma: float = 0.6,
                                       density_per_code_value: float = 0.002) →
                                       FloatingOrNDArray
```

Define the *Josh Pines* style *Pivoted Log* log encoding curve / opto-electronic transfer function.

Parameters

- **x** (FloatingOrArrayLike) – Linear data *x*.
- **log_reference** (float) – Log reference.
- **linear_reference** (float) – Linear reference.
- **negative_gamma** (float) – Negative gamma.
- **density_per_code_value** (float) – Density per code value.

Returns

Non-linear data *y*.

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| y | [0, 1] | [0, 1] |

References

[[SonyImageworks12](#)]

Examples

```
>>> log_encoding_PivotedLog(0.18)
0.4349951...
```

colour.models.log_decoding_PivotedLog

`colour.models.log_decoding_PivotedLog`(*y*: *FloatingOrArrayLike*, *log_reference*: *float* = 445, *linear_reference*: *float* = 0.18, *negative_gamma*: *float* = 0.6, *density_per_code_value*: *float* = 0.002) → *FloatingOrNDArray*

Define the *Josh Pines* style *Pivoted Log* log decoding curve / electro-optical transfer function.

Parameters

- *y* (*FloatingOrArrayLike*) – Non-linear data *y*.
- *log_reference* (*float*) – Log reference.
- *linear_reference* (*float*) – Linear reference.
- *negative_gamma* (*float*) – Negative gamma.
- *density_per_code_value* (*float*) – Density per code value.

Returns

Linear data *x*.

Return type

numpy.floating or *numpy.ndarray*

Notes

| Domain | Scale - Reference | Scale - 1 |
|----------|-------------------|-----------|
| <i>y</i> | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|----------|-------------------|-----------|
| <i>x</i> | [0, 1] | [0, 1] |

References

[SonyImageworks12]

Examples

```
>>> log_decoding_PivotedLog(0.434995112414467)
0.1...
```

colour.models.log_encoding_Protune

`colour.models.log_encoding_Protune`(*x*: *FloatingOrArrayLike*) → *FloatingOrNDArray*

Define the *Protune* log encoding curve / opto-electronic transfer function.

Parameters

x (*FloatingOrArrayLike*) – Linear data *x*.

Returns

Non-linear data *y*.

Return type`numpy.float64` or `numpy.ndarray`**Notes**

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| y | [0, 1] | [0, 1] |

References[\[GoProDM16\]](#)**Examples**

```
>>> log_encoding_Protune(0.18)
0.6456234...
```

colour.models.log_decoding_Protune

`colour.models.log_decoding_Protune(y: FloatingOrArrayLike)` → `FloatingOrNDArray`

Define the *Protune* log decoding curve / electro-optical transfer function.

Parameters

y (`FloatingOrArrayLike`) – Non-linear data *y*.

Returns

Linear data *x*.

Return type`numpy.float64` or `numpy.ndarray`**Notes**

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| y | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

References

[GoProDM16]

Examples

```
>>> log_decoding_Protune(0.645623486803636)
0.1...
```

colour.models.log_encoding_REDLog

`colour.models.log_encoding_REDLog(x: FloatingOrArrayLike, black_offset: FloatingOrArrayLike = $10^{*}0 - 1023 / 511$) → FloatingOrNDArray`

Define the *REDLog* log encoding curve / opto-electronic transfer function.

Parameters

- **x** (FloatingOrArrayLike) – Linear data x .
- **black_offset** (FloatingOrArrayLike) – Black offset.

Returns

Non-linear data y .

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| y | [0, 1] | [0, 1] |

References

[SonyImageworks12]

Examples

```
>>> log_encoding_REDLog(0.18)
0.6376218...
```

colour.models.log_decoding_REDLog

`colour.models.log_decoding_REDLog(y: FloatingOrArrayLike, black_offset: FloatingOrArrayLike = $10^{**0} - 1023 / 511$) → FloatingOrNDArray`

Define the *REDLog* log decoding curve / electro-optical transfer function.

Parameters

- **y** (FloatingOrArrayLike) – Non-linear data *y*.
- **black_offset** (FloatingOrArrayLike) – Black offset.

Returns

Linear data *x*.

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| y | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

References

[SonyImageworks12]

Examples

```
>>> log_decoding_REDLog(0.637621845988175)
0.1...
```

colour.models.log_encoding_REDLogFilm

`colour.models.log_encoding_REDLogFilm(x: FloatingOrArrayLike, black_offset: FloatingOrArrayLike = $10^{**95} - 685 / 300$) → FloatingOrNDArray`

Define the *REDLogFilm* log encoding curve / opto-electronic transfer function.

Parameters

- **x** (FloatingOrArrayLike) – Linear data *x*.
- **black_offset** (FloatingOrArrayLike) – Black offset.

Returns

Non-linear data *y*.

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| y | [0, 1] | [0, 1] |

References

[SonyImageworks12]

Examples

```
>>> log_encoding_REDLogFilm(0.18)
0.4573196...
```

`colour.models.log_decoding_REDLogFilm`

`colour.models.log_decoding_REDLogFilm(y: FloatingOrArrayLike, black_offset: FloatingOrArrayLike = $10^{**}95 - 685 / 300$) → FloatingOrNDArray`

Define the *REDLogFilm* log decoding curve / electro-optical transfer function.

Parameters

- **y** (FloatingOrArrayLike) – Non-linear data *y*.
- **black_offset** (FloatingOrArrayLike) – Black offset.

Returns

Linear data *x*.

Return type

`numpy.float64` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| y | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

References

[SonyImageworks12]

Examples

```
>>> log_decoding_REDLogFilm(0.457319613085418)
0.1799999...
```

colour.models.log_encoding_SLog

```
colour.models.log_encoding_SLog(x: FloatingOrArrayLike, bit_depth: int = 10,
                                out_normalised_code_value: bool = True, in_reflection: bool = True)
    → FloatingOrNDArray
```

Define the *Sony S-Log* log encoding curve / opto-electronic transfer function.

Parameters

- **x** (FloatingOrArrayLike) – Reflection or *IRE*/100 input light level x to a camera.
- **bit_depth** (int) – Bit depth used for conversion.
- **out_normalised_code_value** (bool) – Whether the non-linear *Sony S-Log* data y is encoded as normalised code values.
- **in_reflection** (bool) – Whether the light level x to a camera is reflection.

Returns

Non-linear *Sony S-Log* data y .

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| y | [0, 1] | [0, 1] |

References

[SonyCorporation12]

Examples

```
>>> log_encoding_SLog(0.18)
0.3849708...
```

The values of *IRE* and *CV* of *S-Log2 @ISO800* table in [SonyCorporation12] are obtained as follows:

```
>>> x = np.array([0, 18, 90]) / 100
>>> np.around(log_encoding_SLog(x, 10, False) * 100).astype(np.int)
array([ 3, 38, 65])
>>> np.around(log_encoding_SLog(x) * (2**10 - 1)).astype(np.int)
array([ 90, 394, 636])
```

colour.models.log_decoding_SLog

colour.models.log_decoding_SLog(y: FloatingOrArrayLike, bit_depth: int = 10, in_normalised_code_value: bool = True, out_reflection: bool = True) → FloatingOrNDArray

Define the Sony *S-Log* log decoding curve / electro-optical transfer function.

Parameters

- **y** (FloatingOrArrayLike) – Non-linear Sony *S-Log* data *y*.
- **bit_depth** (int) – Bit depth used for conversion.
- **in_normalised_code_value** (bool) – Whether the non-linear Sony *S-Log* data *y* is encoded as normalised code values.
- **out_reflection** (bool) – Whether the light level *x* to a camera is reflection.

Returns

Reflection or *IRE*/100 input light level *x* to a camera.

Return type

numpy.floating or numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|----------|-------------------|-----------|
| <i>y</i> | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|----------|-------------------|-----------|
| <i>x</i> | [0, 1] | [0, 1] |

References

[SonyCorporation12]

Examples

```
>>> log_decoding_SLog(0.384970815928670)
0.1...
```

colour.models.log_encoding_SLog2

```
colour.models.log_encoding_SLog2(x: FloatingOrArrayLike, bit_depth: int = 10,
                                  out_normalised_code_value: bool = True, in_reflection: bool =
                                  True) → FloatingOrNDArray
```

Define the Sony *S-Log2* log encoding curve / opto-electronic transfer function.

Parameters

- **x** (FloatingOrArrayLike) – Reflection or *IRE*/100 input light level x to a camera.
- **bit_depth** (int) – Bit depth used for conversion.
- **out_normalised_code_value** (bool) – Whether the non-linear Sony *S-Log2* data y is encoded as normalised code values.
- **in_reflection** (bool) – Whether the light level x to a camera is reflection.

Returns

Non-linear Sony *S-Log2* data y .

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| y | [0, 1] | [0, 1] |

References

[SonyCorporation12]

Examples

```
>>> log_encoding_SLog2(0.18)
0.3395325...
```

The values of *IRE* and *CV* of *S-Log2 @ISO800* table in [SonyCorporation12] are obtained as follows:

```
>>> x = np.array([0, 18, 90]) / 100
>>> np.around(log_encoding_SLog2(x, 10, False) * 100).astype(np.int)
array([ 3, 32, 59])
>>> np.around(log_encoding_SLog2(x) * (2**10 - 1)).astype(np.int)
array([ 90, 347, 582])
```

colour.models.log_decoding_SLog2

`colour.models.log_decoding_SLog2(y: FloatingOrArrayLike, bit_depth: int = 10, in_normalised_code_value: bool = True, out_reflection: bool = True) → FloatingOrNDArray`

Define the Sony *S-Log2* log decoding curve / electro-optical transfer function.

Parameters

- **y** (FloatingOrArrayLike) – Non-linear Sony *S-Log2* data *y*.
- **bit_depth** (int) – Bit depth used for conversion.
- **in_normalised_code_value** (bool) – Whether the non-linear Sony *S-Log2* data *y* is encoded as normalised code values.
- **out_reflection** (bool) – Whether the light level *x* to a camera is reflection.

Returns

Reflection or *IRE*/100 input light level *x* to a camera.

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|----------|-------------------|-----------|
| <i>y</i> | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|----------|-------------------|-----------|
| <i>x</i> | [0, 1] | [0, 1] |

References

[SonyCorporation12]

Examples

```
>>> log_decoding_SLog2(0.339532524633774)
0.1...
```

colour.models.log_encoding_SLog3

`colour.models.log_encoding_SLog3(x: FloatingOrArrayLike, bit_depth: int = 10, out_normalised_code_value: bool = True, in_reflection: bool = True) → FloatingOrNDArray`

Define the Sony *S-Log3* log encoding curve / opto-electronic transfer function.

Parameters

- **x** (FloatingOrArrayLike) – Reflection or *IRE*/100 input light level x to a camera.
- **bit_depth** (int) – Bit depth used for conversion.
- **out_normalised_code_value** (bool) – Whether the non-linear Sony *S-Log3* data y is encoded as normalised code values.
- **in_reflection** (bool) – Whether the light level x to a camera is reflection.

Returns

Non-linear Sony *S-Log3* data y .

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| y | [0, 1] | [0, 1] |

References

[SonyCorporationc]

Examples

```
>>> log_encoding_SLog3(0.18)
0.4105571...
```

The values of *S-Log3 10bit code values (18%, 90%)* table in [SonyCorporationc] are obtained as follows:

```
>>> x = np.array([0, 18, 90]) / 100
>>> np.around(log_encoding_SLog3(x, 10, False) * 100).astype(np.int)
array([ 4, 41, 61])
>>> np.around(log_encoding_SLog3(x) * (2**10 - 1)).astype(np.int)
array([ 95, 420, 598])
```

colour.models.log_decoding_SLog3

`colour.models.log_decoding_SLog3(y: FloatingOrArrayLike, bit_depth: int = 10, in_normalised_code_value: bool = True, out_reflection: bool = True) → FloatingOrNDArray`

Define the Sony *S-Log3* log decoding curve / electro-optical transfer function.

Parameters

- **y** (FloatingOrArrayLike) – Non-linear Sony *S-Log3* data *y*.
- **bit_depth** (int) – Bit depth used for conversion.
- **in_normalised_code_value** (bool) – Whether the non-linear Sony *S-Log3* data *y* is encoded as normalised code values.
- **out_reflection** (bool) – Whether the light level *x* to a camera is reflection.

Returns

Reflection or *IRE*/100 input light level *x* to a camera.

Return type

`numpy.float64` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|----------|-------------------|-----------|
| <i>y</i> | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|----------|-------------------|-----------|
| <i>x</i> | [0, 1] | [0, 1] |

References

[SonyCorporationc]

Examples

```
>>> log_decoding_SLog3(0.410557184750733)
0.1...
```

colour.models.log_encoding_VLog

`colour.models.log_encoding_VLog(L_in: FloatingOrArrayLike, bit_depth: int = 10, out_normalised_code_value: bool = True, in_reflection: bool = True, constants: Structure = CONSTANTS_VLOG) → FloatingOrNDArray`

Define the *Panasonic V-Log* log encoding curve / opto-electronic transfer function.

Parameters

- **L_in** (*FloatingOrArrayLike*) – Linear reflection data L_{in} .
- **bit_depth** (*int*) – Bit depth used for conversion.
- **out_normalised_code_value** (*bool*) – Whether the non-linear *Panasonic V-Log* data V_{out} is encoded as normalised code values.
- **in_reflection** (*bool*) – Whether the light level L_{in} to a camera is reflection.
- **constants** (*Structure*) – *Panasonic V-Log* constants.

Returns

Non-linear data V_{out} .

Return type

numpy.floating or *numpy.ndarray*

Notes

| Domain | Scale - Reference | Scale - 1 |
|----------|-------------------|-----------|
| L_{in} | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-----------|-------------------|-----------|
| V_{out} | [0, 1] | [0, 1] |

References

[Panasonic14]

Examples

```
>>> log_encoding_VLog(0.18)
0.4233114...
```

The values of Fig.2.2 V-Log Code Value table in [Panasonic14] are obtained as follows:

```
>>> L_in = np.array([0, 18, 90]) / 100
>>> np.around(log_encoding_VLog(L_in, 10, False) * 100).astype(np.int)
array([ 7, 42, 61])
>>> np.around(log_encoding_VLog(L_in) * (2**10 - 1)).astype(np.int)
array([128, 433, 602])
>>> np.around(log_encoding_VLog(L_in) * (2**12 - 1)).astype(np.int)
array([ 512, 1733, 2409])
```

Note that some values in the last column values of Fig.2.2 V-Log Code Value table in [Panasonic14] are different by a code: [512, 1732, 2408].

colour.models.log_decoding_VLog

colour.models.log_decoding_VLog(*V_out*: FloatingOrArrayLike, *bit_depth*: int = 10, *in_normalised_code_value*: bool = True, *out_reflection*: bool = True, *constants*: Structure = CONSTANTS_VLOG) → FloatingOrNDArray

Define the Panasonic V-Log log decoding curve / electro-optical transfer function.

Parameters

- **V_out** (FloatingOrArrayLike) – Non-linear data V_{out} .
- **bit_depth** (int) – Bit depth used for conversion.
- **in_normalised_code_value** (bool) – Whether the non-linear Panasonic V-Log data V_{out} is encoded as normalised code values.
- **out_reflection** (bool) – Whether the light level L_{in} to a camera is reflection.
- **constants** (Structure) – Panasonic V-Log constants.

Returns

Linear reflection data L_{in} .

Return type

numpy.floating or numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| V_out | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| L_in | [0, 1] | [0, 1] |

References

[Panasonic14]

Examples

```
>>> log_decoding_VLog(0.423311448760136)
0.1799999...
```

colour.models.log_encoding_ViperLog

colour.models.**log_encoding_ViperLog**(*x*: *FloatingOrArrayLike*) → *FloatingOrNDArray*

Define the *Viper Log* log encoding curve / opto-electronic transfer function.

Parameters

x (*FloatingOrArrayLike*) – Linear data *x*.

Returns

Non-linear data *y*.

Return type

numpy.floating or *numpy.ndarray*

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| x | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| y | [0, 1] | [0, 1] |

References

[SonyImageworks12]

Examples

```
>>> log_encoding_ViperLog(0.18)
0.6360080...
```

colour.models.log_decoding_ViperLog

colour.models.**log_decoding_ViperLog**(*y*: *FloatingOrArrayLike*) → *FloatingOrNDArray*

Define the *Viper Log* log decoding curve / electro-optical transfer function.

Parameters

y (*FloatingOrArrayLike*) – Non-linear data *y*.

Returns

Linear data *x*.

Return type

`numpy.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|----------|-------------------|-----------|
| <i>y</i> | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|----------|-------------------|-----------|
| <i>x</i> | [0, 1] | [0, 1] |

References

[SonyImageworks12]

Examples

```
>>> log_decoding_ViperLog(0.636008067010413)
0.1799999...
```

Colour Encodings

Y'CbCr Colour Encoding

colour

| | |
|---|--|
| <code>WEIGHTS_YCBCR</code> | Implement a delimiter and case-insensitive <code>dict</code> -like object with support for slugs, i.e. <i>SEO</i> friendly and human-readable version of the keys but also canonical keys, i.e. slugified keys without delimiters. |
| <code>matrix_YCbCr([K, bits, is_legal, is_int])</code> | Compute the <i>Y'CbCr</i> to <i>R'G'B'</i> matrix for given weights, bit depth, range legality and representation. |
| <code>offset_YCbCr([bits, is_legal, is_int])</code> | Compute the <i>R'G'B'</i> to <i>Y'CbCr</i> offsets for given bit depth, range legality and representation. |
| <code>RGB_to_YCbCr(RGB[, K, in_bits, in_legal, ...])</code> | Convert an array of <i>R'G'B'</i> values to the corresponding <i>Y'CbCr</i> colour encoding values array. |
| <code>YCbCr_to_RGB(YCbCr[, K, in_bits, in_legal, ...])</code> | Convert an array of <i>Y'CbCr</i> colour encoding values to the corresponding <i>R'G'B'</i> values array. |
| <code>RGB_to_YcCbCrc(RGB[, out_bits, out_legal, ...])</code> | Convert an array of <i>RGB</i> linear values to the corresponding <i>Yc'CbC'rc'</i> colour encoding values array. |
| <code>YcCbCrc_to_RGB(YcCbCrc[, in_bits, ...])</code> | Convert an array of <i>Yc'CbC'rc'</i> colour encoding values to the corresponding <i>RGB</i> array of linear values. |

colour.WEIGHTS_YCBCR

```
colour.WEIGHTS_YCBCR = CanonicalMapping({'ITU-R BT.601': ..., 'ITU-R BT.709': ..., 'ITU-R BT.2020': ..., 'SMPTE-240M': ...})
```

Implement a delimiter and case-insensitive `dict`-like object with support for slugs, i.e. *SEO* friendly and human-readable version of the keys but also canonical keys, i.e. slugified keys without delimiters.

The item keys are expected to be `str`-like objects thus supporting the `str.lower()` method. Setting items is done by using the given keys. Retrieving or deleting an item and testing whether an item exist is done by transforming the item's key in a sequence as follows:

- *Original Key*
- *Lowercase Key*
- *Slugified Key*
- *Canonical Key*

For example, given the McCamy 1992 key:

- *Original Key* : McCamy 1992
- *Lowercase Key* : mccamy 1992
- *Slugified Key* : mccamy-1992
- *Canonical Key* : mccamy1992

Parameters

- **data** – Data to store into the delimiter and case-insensitive `dict`-like object at initialisation.

- **kwargs** – Key / value pairs to store into the mapping at initialisation.

Attributes

- data

Methods

- `__init__()`
- `__repr__()`
- `__setitem__()`
- `__getitem__()`
- `__delitem__()`
- `__contains__()`
- `__iter__()`
- `__len__()`
- `__eq__()`
- `__ne__()`
- `copy()`
- `lower_keys()`
- `lower_items()`
- `slugified_keys()`
- `slugified_items()`
- `canonical_keys()`
- `canonical_items()`

Examples

```
>>> methods = CanonicalMapping({"McCamy 1992": 1, "Hernandez 1999": 2})
>>> methods["mccamy 1992"]
1
>>> methods["MCCAMY 1992"]
1
>>> methods["mccamy-1992"]
1
>>> methods["mccamy1992"]
1
```

colour.matrix_YCbCr

`colour.matrix_YCbCr(K: ndarray = WEIGHTS_YCBCR['ITU-R BT.709'], bits: int = 8, is_legal: bool = False, is_int: bool = False) → ndarray`

Compute the $Y'CbCr$ to $R'G'B'$ matrix for given weights, bit depth, range legality and representation.

The related offset for the $R'G'B'$ to $Y'CbCr$ matrix can be computed with the `colour.offset_YCbCr()` definition.

Parameters

- **K** (ndarray) – Luma weighting coefficients of red and blue. See `colour.WEIGHTS_YCBCR` for presets. Default is $(0.2126, 0.0722)$, the weightings for ITU-R BT.709.
- **bits** (int) – Bit depth of the $Y'CbCr$ colour encoding ranges array.
- **is_legal** (bool) – Whether the $Y'CbCr$ colour encoding ranges array is legal.
- **is_int** (bool) – Whether the $Y'CbCr$ colour encoding ranges array represents integer code values.

Returns

$Y'CbCr$ matrix.

Return type

`numpy.ndarray`

Examples

```
>>> matrix_YCbCr()
array([[ 1.0000000...e+00, ...,  1.5748000...e+00],
       [ 1.0000000...e+00, -1.8732427...e-01, -4.6812427...e-01],
       [ 1.0000000...e+00,  1.8556000...e+00, ...]])
>>> matrix_YCbCr(K=WEIGHTS_YCBCR["ITU-R BT.601"])
array([[ 1.0000000...e+00, ...,  1.4020000...e+00],
       [ 1.0000000...e+00, -3.4413628...e-01, -7.1413628...e-01],
       [ 1.0000000...e+00,  1.7720000...e+00, ...]])
>>> matrix_YCbCr(is_legal=True)
array([[ 1.1643835...e+00, ...,  1.7927410...e+00],
       [ 1.1643835...e+00, -2.1324861...e-01, -5.3290932...e-01],
       [ 1.1643835...e+00,  2.1124017...e+00, ...]])
```

Matching the default output of the `colour.RGB_to_YCbCr()` is done as follows:

```
>>> from colour.algebra import vector_dot
>>> from colour.utilities import as_int_array
>>> RGB = np.array([1.0, 1.0, 1.0])
>>> RGB_to_YCbCr(RGB)
array([ 0.9215686...,  0.5019607...,  0.5019607...])
>>> YCbCr = vector_dot(np.linalg.inv(matrix_YCbCr(is_legal=True)), RGB)
>>> YCbCr += offset_YCbCr(is_legal=True)
>>> YCbCr
array([ 0.9215686...,  0.5019607...,  0.5019607...])
```

Matching the int output of the `colour.RGB_to_YCbCr()` is done as follows:

```
>>> RGB = np.array([102, 0, 51])
>>> RGB_to_YCbCr(RGB, in_bits=8, in_int=True, out_bits=8, out_int=True)
...
```

(continues on next page)

(continued from previous page)

```

array([ 38, 140, 171])
>>> YCbCr = vector_dot(np.linalg.inv(matrix_YCbCr(is_legal=True)), RGB)
>>> YCbCr += offset_YCbCr(is_legal=True, is_int=True)
>>> as_int_array(np.around(YCbCr))
...
array([ 38, 140, 171])

```

colour.offset_YCbCr

`colour.offset_YCbCr(bits: int = 8, is_legal: bool = False, is_int: bool = False) → ndarray`

Compute the $R'G'B'$ to $YCbCr$ offsets for given bit depth, range legality and representation.

The related $R'G'B'$ to $YCbCr$ matrix can be computed with the `colour.matrix_YCbCr()` definition.

Parameters

- **bits** (*int*) – Bit depth of the $YCbCr$ colour encoding ranges array.
- **is_legal** (*bool*) – Whether the $YCbCr$ colour encoding ranges array is legal.
- **is_int** (*bool*) – Whether the $YCbCr$ colour encoding ranges array represents integer code values.

Returns

$YCbCr$ matrix.

Return type

`numpy.ndarray`

Examples

```

>>> offset_YCbCr()
array([ 0.,  0.,  0.])
>>> offset_YCbCr(is_legal=True)
array([ 0.0627451...,  0.5019607...,  0.5019607...])

```

colour.RGB_to_YCbCr

`colour.RGB_to_YCbCr(RGB: ArrayLike, K: ndarray = WEIGHTS_YCBCR['ITU-R BT.709'], in_bits: int = 10, in_legal: bool = False, in_int: bool = False, out_bits: int = 8, out_legal: bool = True, out_int: bool = False, clamp_int: bool = True, **kwargs: Any) → ndarray`

Convert an array of $R'G'B'$ values to the corresponding $YCbCr$ colour encoding values array.

Parameters

- **RGB** (ArrayLike) – Input $R'G'B'$ array of floats or integer values.
- **K** (ndarray) – Luma weighting coefficients of red and blue. See `colour.WEIGHTS_YCBCR` for presets. Default is $(0.2126, 0.0722)$, the weightings for ITU-R BT.709.
- **in_bits** (*int*) – Bit depth for integer input, or used in the calculation of the denominator for legal range float values, i.e. 8-bit means the float value for legal white is $235 / 255$. Default is 10.
- **in_legal** (*bool*) – Whether to treat the input values as legal range. Default is *False*.

- **in_int** (*bool*) – Whether to treat the input values as *in_bits* integer code values. Default is *False*.
- **out_bits** (*int*) – Bit depth for integer output, or used in the calculation of the denominator for legal range float values, i.e. 8-bit means the float value for legal white is $235 / 255$. Ignored if *out_legal* and *out_int* are both *False*. Default is 8.
- **out_legal** (*bool*) – Whether to return legal range values. Default is *True*.
- **out_int** (*bool*) – Whether to return values as *out_bits* integer code values. Default is *False*.
- **clamp_int** (*bool*) – Whether to clamp integer output to allowable range for *out_bits*. Default is *True*.
- **in_range** – Array overriding the computed range such as *in_range* = (*RGB_min*, *RGB_max*). If *in_range* is undefined, *RGB_min* and *RGB_max* will be computed using `colour.CV_range()` definition.
- **out_range** – Array overriding the computed range such as *out_range* = (*Y_min*, *Y_max*, *C_min*, *C_max*). If *out_range* is undefined, *Y_min*, *Y_max*, *C_min* and *C_max* will be computed using `colour.models.rgb.ycbcr.ranges_YCbCr()` definition.
- **kwargs** (*Any*) –

Returns

YCbCr colour encoding array of integer or float values.

Return type

`numpy.ndarray`

Warning: For Recommendation ITU-R BT.2020, `colour.RGB_to_YCbCr()` definition is only applicable to the non-constant luminance implementation. `colour.RGB_to_YcCbCrCrc()` definition should be used for the constant luminance case as per [InternationalTUnion15a].

Notes

| Domain * | Scale - Reference | Scale - 1 |
|----------|-------------------|-----------|
| RGB | [0, 1] | [0, 1] |

| Range * | Scale - Reference | Scale - 1 |
|---------|-------------------|-----------|
| YCbCr | [0, 1] | [0, 1] |

* This definition has input and output integer switches, thus the domain-range scale information is only given for the floating point mode.

- The default arguments, `**{'in_bits': 10, 'in_legal': False, 'in_int': False, 'out_bits': 8, 'out_legal': True, 'out_int': False}` transform a float *R'G'B'* input array normalised to domain [0, 1] (*in_bits* is ignored) to a float *YCbCr* output array where *Y* is normalised to range $[16 / 255, 235 / 255]$ and *Cb* and *Cr* are normalised to range $[16 / 255, 240./255]$. The float values are calculated based on an [0, 255] integer range, but no 8-bit quantisation or clamping are performed.

References

[InternationalTUnion11c], [InternationalTUnion15b], [SocietyoMPaTEngineers99],
[Wikipedia04e]

Examples

```
>>> RGB = np.array([1.0, 1.0, 1.0])
>>> RGB_to_YCbCr(RGB)
array([ 0.9215686...,  0.5019607...,  0.5019607...])
```

Matching the float output of *The Foundry Nuke's Colorspace* node set to YCbCr:

```
>>> RGB_to_YCbCr(
...     RGB, out_range=(16 / 255, 235 / 255, 15.5 / 255, 239.5 / 255)
... )
...
array([ 0.9215686...,  0.5      ,  0.5      ])
```

Matching the float output of *The Foundry Nuke's Colorspace* node set to YPbPr:

```
>>> RGB_to_YCbCr(RGB, out_legal=False, out_int=False)
...
array([ 1.,  0.,  0.] )
```

Creating integer code values as per standard 10-bit SDI:

```
>>> RGB_to_YCbCr(RGB, out_legal=True, out_bits=10, out_int=True)
...
array([940, 512, 512]...)
```

For *JFIF JPEG* conversion as per *Recommendation ITU-T T.871*

```
>>> RGB = np.array([102, 0, 51])
>>> RGB_to_YCbCr(
...     RGB,
...     K=WEIGHTS_YCBCR["ITU-R BT.601"],
...     in_range=(0, 255),
...     out_range=(0, 255, 0.5, 255.5),
...     out_int=True,
... )
...
array([ 36, 136, 175]...)
```

Note the use of [0.5, 255.5] for the *Cb* / *Cr* range, which is required so that the *Cb* and *Cr* output is centered about 128. Using 255 centres it about 127.5, meaning that there is no integer code value to represent achromatic colours. This does however create the possibility of output integer codes with value of 256, which cannot be stored in 8-bit integer representation. *Recommendation ITU-T T.871* specifies these should be clamped to 255, which is applied with the default `clamp_int=True`.

These *JFIF JPEG* ranges are also obtained as follows:

```
>>> RGB_to_YCbCr(
...     RGB,
...     K=WEIGHTS_YCBCR["ITU-R BT.601"],
...     in_bits=8,
...     in_int=True,
```

(continues on next page)

(continued from previous page)

```
...     out_legal=False,
...     out_int=True,
... )
...
array([ 36, 136, 175]...)
```

colour.YCbCr_to_RGB

`colour.YCbCr_to_RGB(YCbCr: ArrayLike, K: ndarray = WEIGHTS_YCBCR['ITU-R BT.709'], in_bits: int = 8, in_legal: bool = True, in_int: bool = False, out_bits: int = 10, out_legal: bool = False, out_int: bool = False, clamp_int: bool = True, **kwargs: Any) → ndarray`

Convert an array of *YCbCr* colour encoding values to the corresponding *R'G'B'* values array.

Parameters

- **YCbCr** (ArrayLike) – Input *YCbCr* colour encoding array of integer or float values.
- **K** (ndarray) – Luma weighting coefficients of red and blue. See `colour.WEIGHTS_YCBCR` for presets. Default is *(0.2126, 0.0722)*, the weightings for *ITU-R BT.709*.
- **in_bits** (int) – Bit depth for integer input, or used in the calculation of the denominator for legal range float values, i.e. 8-bit means the float value for legal white is $235 / 255$. Default is 8.
- **in_legal** (bool) – Whether to treat the input values as legal range. Default is *True*.
- **in_int** (bool) – Whether to treat the input values as *in_bits* integer code values. Default is *False*.
- **out_bits** (int) – Bit depth for integer output, or used in the calculation of the denominator for legal range float values, i.e. 8-bit means the float value for legal white is $235 / 255$. Ignored if *out_legal* and *out_int* are both *False*. Default is 10.
- **out_legal** (bool) – Whether to return legal range values. Default is *False*.
- **out_int** (bool) – Whether to return values as *out_bits* integer code values. Default is *False*.
- **clamp_int** (bool) – Whether to clamp integer output to allowable range for *out_bits*. Default is *True*.
- **in_range** – Array overriding the computed range such as *in_range = (Y_min, Y_max, C_min, C_max)*. If *in_range* is undefined, *Y_min*, *Y_max*, *C_min* and *C_max* will be computed using `colour.models.rgb.ycbcr.ranges_YCbCr()` definition.
- **out_range** – Array overriding the computed range such as *out_range = (RGB_min, RGB_max)*. If *out_range* is undefined, *RGB_min* and *RGB_max* will be computed using `colour.CV_range()` definition.
- **kwargs** (Any) –

Returns

R'G'B' array of integer or float values.

Return type

`numpy.ndarray`

Notes

| Domain * | Scale - Reference | Scale - 1 |
|----------|-------------------|-----------|
| YCbCr | [0, 1] | [0, 1] |

| Range * | Scale - Reference | Scale - 1 |
|---------|-------------------|-----------|
| RGB | [0, 1] | [0, 1] |

* This definition has input and output integer switches, thus the domain-range scale information is only given for the floating point mode.

Warning: For *Recommendation ITU-R BT.2020*, `colour.YCbCr_to_RGB()` definition is only applicable to the non-constant luminance implementation. `colour.YcCbCrCrc_to_RGB()` definition should be used for the constant luminance case as per [InternationalTUnion15a].

References

[InternationalTUnion11c], [InternationalTUnion15b], [SocietyoMPaTEngineers99],
[Wikipedia04e]

Examples

```
>>> YCbCr = np.array([502, 512, 512])
>>> YCbCr_to_RGB(YCbCr, in_bits=10, in_legal=True, in_int=True)
array([ 0.5,  0.5,  0.5])
```

`colour.RGB_to_YcCbCrCrc`

`colour.RGB_to_YcCbCrCrc(RGB: ArrayLike, out_bits: int = 10, out_legal: bool = True, out_int: bool = False, is_12_bits_system: bool = False, **kwargs: Any) → ndarray`

Convert an array of *RGB* linear values to the corresponding *Yc'Cb'Crc'* colour encoding values array.

Parameters

- **RGB** (ArrayLike) – Input *RGB* array of linear float values.
- **out_bits** (int) – Bit depth for integer output, or used in the calculation of the denominator for legal range float values, i.e. 8-bit means the float value for legal white is $235 / 255$. Ignored if `out_legal` and `out_int` are both *False*. Default is 10.
- **out_legal** (bool) – Whether to return legal range values. Default is *True*.
- **out_int** (bool) – Whether to return values as `out_bits` integer code values. Default is *False*.
- **is_12_bits_system** (bool) – *Recommendation ITU-R BT.2020* OETF (OECF) adopts different parameters for 10 and 12 bit systems. Default is *False*.
- **out_range** – Array overriding the computed range such as `out_range = (Y_min, Y_max, C_min, C_max)`. If `out_range` is undefined, `Y_min`, `Y_max`, `C_min` and `C_max` will be computed using `colour.models.rgb.ycbcr.ranges_YCbCr()` definition.

- **kwargs** (*Any*) –

Returns

Yc'Cb'Cr' colour encoding array of integer or float values.

Return type

`numpy.ndarray`

Notes

| Domain * | Scale - Reference | Scale - 1 |
|----------|-------------------|-----------|
| RGB | [0, 1] | [0, 1] |

| Range * | Scale - Reference | Scale - 1 |
|-----------|-------------------|-----------|
| YcCbCrCrc | [0, 1] | [0, 1] |

* This definition has input and output integer switches, thus the domain-range scale information is only given for the floating point mode.

Warning: This definition is specifically for usage with *Recommendation ITU-R BT.2020* when adopting the constant luminance implementation.

References

[[InternationalTUnion15a](#)], [[Wikipedia04e](#)]

Examples

```
>>> RGB = np.array([0.18, 0.18, 0.18])
>>> RGB_to_YcCbCrCrc(
...     RGB,
...     out_legal=True,
...     out_bits=10,
...     out_int=True,
...     is_12_bits_system=False,
... )
...
array([422, 512, 512]...)
```

colour.YcCbCrCrc_to_RGB

`colour.YcCbCrCrc_to_RGB`(*YcCbCrCrc*: *ArrayLike*, *in_bits*: *int* = 10, *in_legal*: *bool* = True, *in_int*: *bool* = False, *is_12_bits_system*: *bool* = False, ***kwargs*: *Any*) → *ndarray*

Convert an array of *Yc'Cb'Cr'* colour encoding values to the corresponding *RGB* array of linear values.

Parameters

- **YcCbCrCrc** (*ArrayLike*) – Input *Yc'Cb'Cr'* colour encoding array of linear float values.

- **in_bits** (`int`) – Bit depth for integer input, or used in the calculation of the denominator for legal range float values, i.e. 8-bit means the float value for legal white is $235 / 255$. Default is `10`.
- **in_legal** (`bool`) – Whether to treat the input values as legal range. Default is `False`.
- **in_int** (`bool`) – Whether to treat the input values as `in_bits` integer code values. Default is `False`.
- **is_12_bits_system** (`bool`) – *Recommendation ITU-R BT.2020* EOTF (EOCF) adopts different parameters for 10 and 12 bit systems. Default is `False`.
- **in_range** – Array overriding the computed range such as `in_range = (Y_min, Y_max, C_min, C_max)`. If `in_range` is undefined, `Y_min`, `Y_max`, `C_min` and `C_max` will be computed using `colour.models.rgb.ycbcr.ranges_YCbCr()` definition.
- **kwargs** (`Any`) –

Returns

RGB array of linear float values.

Return type

`numpy.ndarray`

Notes

| Domain * | Scale - Reference | Scale - 1 |
|----------|-------------------|-----------|
| YcCbCr | [0, 1] | [0, 1] |

| Range * | Scale - Reference | Scale - 1 |
|---------|-------------------|-----------|
| RGB | [0, 1] | [0, 1] |

* This definition has input and output integer switches, thus the domain-range scale information is only given for the floating point mode.

Warning: This definition is specifically for usage with *Recommendation ITU-R BT.2020* when adopting the constant luminance implementation.

References

[[InternationalTUnion15a](#)], [[Wikipedia04e](#)]

Examples

```
>>> YcCbCrCrc = np.array([1689, 2048, 2048])
>>> YcCbCrCrc_to_RGB(
...     YcCbCrCrc,
...     in_legal=True,
...     in_bits=12,
...     in_int=True,
...     is_12_bits_system=True,
... )
...
array([ 0.1800903...,  0.1800903...,  0.1800903...])
```

Ancillary Objects

colour

| | |
|--|---|
| <code>full_to_legal(CV[, bit_depth, in_int, out_int])</code> | Convert given code value <i>CV</i> or float equivalent of a code value at a given bit depth from full range (full swing) to legal range (studio swing). |
| <code>legal_to_full(CV[, bit_depth, in_int, out_int])</code> | Convert given code value <i>CV</i> or float equivalent of a code value at a given bit depth from legal range (studio swing) to full range (full swing). |
| <code>CV_range([bit_depth, is_legal, is_int])</code> | Return the code value <i>CV</i> range for given bit depth, range legality and representation. |

`colour.full_to_legal`

`colour.full_to_legal(CV: FloatingOrArrayLike | IntegerOrArrayLike, bit_depth: int = 10, in_int: bool = False, out_int: bool = False) → FloatingOrNDArray | IntegerOrNDArray`

Convert given code value *CV* or float equivalent of a code value at a given bit depth from full range (full swing) to legal range (studio swing).

Parameters

- **CV** (`FloatingOrArrayLike | IntegerOrArrayLike`) – Full range code value *CV* or float equivalent of a code value at a given bit depth.
- **bit_depth** (`int`) – Bit depth used for conversion.
- **in_int** (`bool`) – Whether to treat the input value as integer code value or float equivalent of a code value at a given bit depth.
- **out_int** (`bool`) – Whether to return value as integer code value or float equivalent of a code value at a given bit depth.

Returns

Legal range code value *CV* or float equivalent of a code value at a given bit depth.

Return type

`numpy.floating` or `numpy.integer` or `numpy.ndarray`

Examples

```
>>> full_to_legal(0.0)
0.0625610...
>>> full_to_legal(1.0)
0.9188660...
>>> full_to_legal(0.0, out_int=True)
64
>>> full_to_legal(1.0, out_int=True)
940
>>> full_to_legal(0, in_int=True)
0.0625610...
>>> full_to_legal(1023, in_int=True)
0.9188660...
>>> full_to_legal(0, in_int=True, out_int=True)
64
>>> full_to_legal(1023, in_int=True, out_int=True)
940
```

colour.legal_to_full

`colour.legal_to_full(CV: FloatingOrArrayLike | IntegerOrArrayLike, bit_depth: int = 10, in_int: bool = False, out_int: bool = False) → FloatingOrNDArray | IntegerOrNDArray`

Convert given code value *CV* or float equivalent of a code value at a given bit depth from legal range (studio swing) to full range (full swing).

Parameters

- **CV** (`FloatingOrArrayLike | IntegerOrArrayLike`) – Legal range code value *CV* or float equivalent of a code value at a given bit depth.
- **bit_depth** (`int`) – Bit depth used for conversion.
- **in_int** (`bool`) – Whether to treat the input value as integer code value or float equivalent of a code value at a given bit depth.
- **out_int** (`bool`) – Whether to return value as integer code value or float equivalent of a code value at a given bit depth.

Returns

Full range code value *CV* or float equivalent of a code value at a given bit depth.

Return type

`numpy.floating` or `numpy.integer` or `numpy.ndarray`

Examples

```
>>> legal_to_full(64 / 1023)
0.0
>>> legal_to_full(940 / 1023)
1.0
>>> legal_to_full(64 / 1023, out_int=True)
0
>>> legal_to_full(940 / 1023, out_int=True)
1023
>>> legal_to_full(64, in_int=True)
0.0
```

(continues on next page)

(continued from previous page)

```
>>> legal_to_full(940, in_int=True)
1.0
>>> legal_to_full(64, in_int=True, out_int=True)
0
>>> legal_to_full(940, in_int=True, out_int=True)
1023
```

colour.CV_range

colour.CV_range(*bit_depth*: int = 10, *is_legal*: bool = False, *is_int*: bool = False) → ndarray

Return the code value *CV* range for given bit depth, range legality and representation.

Parameters

- **bit_depth** (int) – Bit depth of the code value *CV* range.
- **is_legal** (bool) – Whether the code value *CV* range is legal.
- **is_int** (bool) – Whether the code value *CV* range represents integer code values.

Returns

Code value *CV* range.

Return type

numpy.ndarray

Examples

```
>>> CV_range(8, True, True)
array([ 16, 235])
>>> CV_range(8, True, False)
array([ 0.0627451...,  0.9215686...])
>>> CV_range(10, False, False)
array([ 0.,  1.]
```

YCoCg Colour Encoding

colour

| | |
|---------------------|--|
| RGB_to_YCoCg(RGB) | Convert an array of <i>R'G'B'</i> values to the corresponding <i>YCoCg</i> colour encoding values array. |
| YCoCg_to_RGB(YCoCg) | Convert an array of <i>YCoCg</i> colour encoding values to the corresponding <i>R'G'B'</i> values array. |

colour.RGB_to_YCoCg

colour.**RGB_to_YCoCg**(*RGB: ArrayLike*) → ndarray

Convert an array of $R'G'B'$ values to the corresponding $YCoCg$ colour encoding values array.

Parameters

RGB (ArrayLike) – Input $R'G'B'$ array.

Returns

$YCoCg$ colour encoding array.

Return type

numpy.ndarray

References

[MS03]

Examples

```
>>> RGB_to_YCoCg(np.array([1.0, 1.0, 1.0]))
array([ 1.,  0.,  0.])
>>> RGB_to_YCoCg(np.array([0.75, 0.5, 0.5]))
array([ 0.5625,  0.125, -0.0625])
```

colour.YCoCg_to_RGB

colour.**YCoCg_to_RGB**(*YCoCg: ArrayLike*) → ndarray

Convert an array of $YCoCg$ colour encoding values to the corresponding $R'G'B'$ values array.

Parameters

YCoCg (ArrayLike) – $YCoCg$ colour encoding array.

Returns

Output $R'G'B'$ array.

Return type

numpy.ndarray

References

[MS03]

Examples

```
>>> YCoCg_to_RGB(np.array([1.0, 0.0, 0.0]))
array([ 1.,  1.,  1.])
>>> YCoCg_to_RGB(np.array([0.5625, 0.125, -0.0625]))
array([ 0.75,  0.5,  0.5])
```

IC_TC_P Colour Encoding

colour

| | |
|---|---|
| <code>RGB_to_ICtCp(RGB[, method, L_p])</code> | Convert from <i>ITU-R BT.2020</i> colourspace to <i>IC_TC_P</i> colour encoding. |
| <code>ICtCp_to_RGB(ICtCp[, method, L_p])</code> | Convert from <i>IC_TC_P</i> colour encoding to <i>ITU-R BT.2020</i> colourspace. |
| <code>XYZ_to_ICtCp(XYZ[, illuminant, ...])</code> | Convert from <i>CIE XYZ</i> tristimulus values to <i>IC_TC_P</i> colour encoding. |
| <code>ICtCp_to_XYZ(ICtCp[, illuminant, ...])</code> | Convert from <i>IC_TC_P</i> colour encoding to <i>CIE XYZ</i> tristimulus values. |

colour.RGB_to_ICtCp

colour.**RGB_to_ICtCp**(*RGB*: ArrayLike, *method*: [Literal](#)['Dolby 2016', 'ITU-R BT.2100-1 HLG', 'ITU-R BT.2100-1 PQ', 'ITU-R BT.2100-2 HLG', 'ITU-R BT.2100-2 PQ'] | *str* = 'Dolby 2016', *L_p*: float = 10000) → ndarray

Convert from *ITU-R BT.2020* colourspace to *IC_TC_P* colour encoding.

Parameters

- **RGB** (ArrayLike) – *ITU-R BT.2020* colourspace array.
- **method** ([Literal](#)['Dolby 2016', 'ITU-R BT.2100-1 HLG', 'ITU-R BT.2100-1 PQ', 'ITU-R BT.2100-2 HLG', 'ITU-R BT.2100-2 PQ'] | *str*) – Computation method. *Recommendation ITU-R BT.2100* defines multiple variants of the *IC_TC_P* colour encoding:
 - *ITU-R BT.2100-1*
 - * *SMPTE ST 2084:2014* inverse electro-optical transfer function (EOTF) and the *IC_TC_P* matrix from [[Dolby16](#)]: *Dolby 2016*, *ITU-R BT.2100-1 PQ*, *ITU-R BT.2100-2 PQ* methods.
 - * *Recommendation ITU-R BT.2100 Reference HLG* opto-electrical transfer function (OETF) and the *IC_TC_P* matrix from [[Dolby16](#)]: *ITU-R BT.2100-1 HLG* method.
 - *ITU-R BT.2100-2*
 - * *SMPTE ST 2084:2014* inverse electro-optical transfer function (EOTF) and the *IC_TC_P* matrix from [[Dolby16](#)]: *Dolby 2016*, *ITU-R BT.2100-1 PQ*, *ITU-R BT.2100-2 PQ* methods.
 - * *Recommendation ITU-R BT.2100 Reference HLG* opto-electrical transfer function (OETF) and a custom *IC_TC_P* matrix from [[InternationalUnion18](#)]: *ITU-R BT.2100-2 HLG* method.
- **L_p** (float) – Display peak luminance cd/m^2 for *SMPTE ST 2084:2014* non-linear encoding. This parameter should stay at its default 10000cd/m^2 value for practical applications. It is exposed so that the definition can be used as a fitting function.

Returns

IC_TC_P colour encoding array.

Return type

[numpy.ndarray](#)

Warning: The underlying *SMPTE ST 2084:2014* transfer function is an absolute transfer function.

Notes

- The *ITU-R BT.2100-1 PQ* and *ITU-R BT.2100-2 PQ* methods are aliases for the *Dolby 2016* method.
- The underlying *SMPTE ST 2084:2014* transfer function is an absolute transfer function, thus the domain and range values for the *Reference* and *1* scales are only indicative that the data is not affected by scale transformations. The effective domain of *SMPTE ST 2084:2014* inverse electro-optical transfer function (EOTF) is [0.0001, 10000].

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| RGB | UN | UN |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|--------------|
| ICtCp | I : [0, 1] | I : [0, 1] |
| | CT : [-1, 1] | CT : [-1, 1] |
| | CP : [-1, 1] | CP : [-1, 1] |

References

[Dolby16], [LPY+16]

Examples

```
>>> RGB = np.array([0.45620519, 0.03081071, 0.04091952])
>>> RGB_to_ICtCp(RGB)
array([ 0.0735136...,  0.0047525...,  0.0935159...])
>>> RGB_to_ICtCp(RGB, method="ITU-R BT.2100-2 HLG")
array([ 0.6256789..., -0.0198449...,  0.3591125...])
```

colour.ICtCp_to_RGB

`colour.ICtCp_to_RGB(ICtCp: ArrayLike, method: Literal['Dolby 2016', 'ITU-R BT.2100-1 HLG', 'ITU-R BT.2100-1 PQ', 'ITU-R BT.2100-2 HLG', 'ITU-R BT.2100-2 PQ'] | str = 'Dolby 2016', L_p: float = 10000) → ndarray`

Convert from IC_{TC_P} colour encoding to *ITU-R BT.2020* colourspace.

Parameters

- **ICtCp** (ArrayLike) – IC_{TC_P} colour encoding array.
- **method** ([Literal](#)['Dolby 2016', 'ITU-R BT.2100-1 HLG', 'ITU-R BT.2100-1 PQ', 'ITU-R BT.2100-2 HLG', 'ITU-R BT.2100-2 PQ'] | str) – Computation method. *Recommendation ITU-R BT.2100* defines multiple variants of the IC_{TC_P} colour encoding:
 - *ITU-R BT.2100-1*

- * *SMPTE ST 2084:2014* inverse electro-optical transfer function (EOTF) and the $IC_T C_P$ matrix from [Dolby16]: *Dolby 2016*, *ITU-R BT.2100-1 PQ*, *ITU-R BT.2100-2 PQ* methods.
- * *Recommendation ITU-R BT.2100 Reference HLG* opto-electrical transfer function (OETF) and the $IC_T C_P$ matrix from [Dolby16]: *ITU-R BT.2100-1 HLG* method.
- *ITU-R BT.2100-2*
 - * *SMPTE ST 2084:2014* inverse electro-optical transfer function (EOTF) and the $IC_T C_P$ matrix from [Dolby16]: *Dolby 2016*, *ITU-R BT.2100-1 PQ*, *ITU-R BT.2100-2 PQ* methods.
 - * *Recommendation ITU-R BT.2100 Reference HLG* opto-electrical transfer function (OETF) and a custom $IC_T C_P$ matrix from [InternationalUnion18]: *ITU-R BT.2100-2 HLG* method.
- **L_p** (`float`) – Display peak luminance cd/m^2 for *SMPTE ST 2084:2014* non-linear encoding. This parameter should stay at its default $10000cd/m^2$ value for practical applications. It is exposed so that the definition can be used as a fitting function.

Returns

ITU-R BT.2020 colourspace array.

Return type

`numpy.ndarray`

Warning: The underlying *SMPTE ST 2084:2014* transfer function is an absolute transfer function.

Notes

- The *ITU-R BT.2100-1 PQ* and *ITU-R BT.2100-2 PQ* methods are aliases for the *Dolby 2016* method.
- The underlying *SMPTE ST 2084:2014* transfer function is an absolute transfer function, thus the domain and range values for the *Reference* and *1* scales are only indicative that the data is not affected by scale transformations.

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|--------------|
| ICtCp | I : [0, 1] | I : [0, 1] |
| | CT : [-1, 1] | CT : [-1, 1] |
| | CP : [-1, 1] | CP : [-1, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| RGB | UN | UN |

References

[Dolby16], [LPY+16]

Examples

```
>>> ICtCp = np.array([0.07351364, 0.00475253, 0.09351596])
>>> ICtCp_to_RGB(ICtCp)
array([ 0.4562052..., 0.0308107..., 0.0409195...])
>>> ICtCp = np.array([0.62567899, -0.01984490, 0.35911259])
>>> ICtCp_to_RGB(ICtCp, method="ITU-R BT.2100-2 HLG")
array([ 0.4562052..., 0.0308107..., 0.0409195...])
```

colour.XYZ_to_ICtCp

`colour.XYZ_to_ICtCp(XYZ: ArrayLike, illuminant=CCS_ILLUMINANTS['CIE 1931 2 Degree Standard Observer']['D65'], chromatic_adaptation_transform: Literal['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling'] | str | None = 'CAT02', method: Literal['Dolby 2016', 'ITU-R BT.2100-1 HLG', 'ITU-R BT.2100-1 PQ', 'ITU-R BT.2100-2 HLG', 'ITU-R BT.2100-2 PQ'] | str = 'Dolby 2016', L_p: float = 10000) → ndarray`

Convert from CIE XYZ tristimulus values to $IC_T C_P$ colour encoding.

Parameters

- **XYZ** (ArrayLike) – CIE XYZ tristimulus values.
- **illuminant** – Source illuminant chromaticity coordinates.
- **chromatic_adaptation_transform** (Literal['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling'] | str | None) – Chromatic adaptation transform.
- **method** (Literal['Dolby 2016', 'ITU-R BT.2100-1 HLG', 'ITU-R BT.2100-1 PQ', 'ITU-R BT.2100-2 HLG', 'ITU-R BT.2100-2 PQ'] | str) – Computation method. Recommendation ITU-R BT.2100 defines multiple variants of the $IC_T C_P$ colour encoding:
 - ITU-R BT.2100-1
 - * SMPTE ST 2084:2014 inverse electro-optical transfer function (EOTF) and the $IC_T C_P$ matrix from [Dolby16]: Dolby 2016, ITU-R BT.2100-1 PQ, ITU-R BT.2100-2 PQ methods.
 - * Recommendation ITU-R BT.2100 Reference HLG opto-electrical transfer function (OETF) and the $IC_T C_P$ matrix from [Dolby16]: ITU-R BT.2100-1 HLG method.
 - ITU-R BT.2100-2
 - * SMPTE ST 2084:2014 inverse electro-optical transfer function (EOTF) and the $IC_T C_P$ matrix from [Dolby16]: Dolby 2016, ITU-R BT.2100-1 PQ, ITU-R BT.2100-2 PQ methods.
 - * Recommendation ITU-R BT.2100 Reference HLG opto-electrical transfer function (OETF) and a custom $IC_T C_P$ matrix from [InternationalUnion18]: ITU-R BT.2100-2 HLG method.

- **L_p** (`float`) – Display peak luminance cd/m^2 for *SMPTE ST 2084:2014* non-linear encoding. This parameter should stay at its default $10000cd/m^2$ value for practical applications. It is exposed so that the definition can be used as a fitting function.

Returns

$IC_T C_P$ colour encoding array.

Return type

`numpy.ndarray`

Warning: The underlying *SMPTE ST 2084:2014* transfer function is an absolute transfer function.

Notes

- The underlying *SMPTE ST 2084:2014* transfer function is an absolute transfer function, thus the domain and range values for the *Reference*
- The *ITU-R BT.2100-1 PQ* and *ITU-R BT.2100-2 PQ* methods are aliases for the *Dolby 2016* method. and *1* scales are only indicative that the data is not affected by scale transformations. The effective domain of *SMPTE ST 2084:2014* inverse electro-optical transfer function (EOTF) is $[0.0001, 10000]$.

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | UN | UN |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|----------------|
| ICtCp | I : $[0, 1]$ | I : $[0, 1]$ |
| | CT : $[-1, 1]$ | CT : $[-1, 1]$ |
| | CP : $[-1, 1]$ | CP : $[-1, 1]$ |

References

[Dolby16], [LPY+16]

Examples

```
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> XYZ_to_ICtCp(XYZ)
array([ 0.0685809..., -0.0028384...,  0.0602098...])
>>> XYZ_to_ICtCp(XYZ, method="ITU-R BT.2100-2 HLG")
array([ 0.5924279..., -0.0374073...,  0.2512267...])
```

colour.ICtCp_to_XYZ

`colour.ICtCp_to_XYZ(ICtCp: ArrayLike, illuminant=CCS_ILLUMINANTS['CIE 1931 2 Degree Standard Observer'] ['D65'], chromatic_adaptation_transform: Literal['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling'] | str | None = 'CAT02', method: Literal['Dolby 2016', 'ITU-R BT.2100-1 HLG', 'ITU-R BT.2100-1 PQ', 'ITU-R BT.2100-2 HLG', 'ITU-R BT.2100-2 PQ'] | str = 'Dolby 2016', L_p: float = 10000) → ndarray`

Convert from IC_{TC_P} colour encoding to CIE XYZ tristimulus values.

Parameters

- **ICtCp** (ArrayLike) – IC_{TC_P} colour encoding array.
- **illuminant** – Source illuminant chromaticity coordinates.
- **chromatic_adaptation_transform** (Literal['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling'] | str | None) – Chromatic adaptation transform.
- **method** (Literal['Dolby 2016', 'ITU-R BT.2100-1 HLG', 'ITU-R BT.2100-1 PQ', 'ITU-R BT.2100-2 HLG', 'ITU-R BT.2100-2 PQ'] | str) – Computation method. *Recommendation ITU-R BT.2100* defines multiple variants of the IC_{TC_P} colour encoding:
 - *ITU-R BT.2100-1*
 - * *SMPTE ST 2084:2014* inverse electro-optical transfer function (EOTF) and the IC_{TC_P} matrix from [Dolby16]: *Dolby 2016*, *ITU-R BT.2100-1 PQ*, *ITU-R BT.2100-2 PQ* methods.
 - * *Recommendation ITU-R BT.2100 Reference HLG* opto-electrical transfer function (OETF) and the IC_{TC_P} matrix from [Dolby16]: *ITU-R BT.2100-1 HLG* method.
 - *ITU-R BT.2100-2*
 - * *SMPTE ST 2084:2014* inverse electro-optical transfer function (EOTF) and the IC_{TC_P} matrix from [Dolby16]: *Dolby 2016*, *ITU-R BT.2100-1 PQ*, *ITU-R BT.2100-2 PQ* methods.
 - * *Recommendation ITU-R BT.2100 Reference HLG* opto-electrical transfer function (OETF) and a custom IC_{TC_P} matrix from [InternationalUnion18]: *ITU-R BT.2100-2 HLG* method.
- **L_p** (float) – Display peak luminance cd/m^2 for *SMPTE ST 2084:2014* non-linear encoding. This parameter should stay at its default $10000cd/m^2$ value for practical applications. It is exposed so that the definition can be used as a fitting function.

Returns

CIE XYZ tristimulus values.

Return type

`numpy.ndarray`

Warning: The underlying *SMPTE ST 2084:2014* transfer function is an absolute transfer function.

Notes

- The *ITU-R BT.2100-1 PQ* and *ITU-R BT.2100-2 PQ* methods are aliases for the *Dolby 2016* method.
- The underlying *SMPTE ST 2084:2014* transfer function is an absolute transfer function, thus the domain and range values for the *Reference* and *1* scales are only indicative that the data is not affected by scale transformations.

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|--------------|
| ICtCp | I : [0, 1] | I : [0, 1] |
| | CT : [-1, 1] | CT : [-1, 1] |
| | CP : [-1, 1] | CP : [-1, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| XYZ | UN | UN |

References

[Dolby16], [LPY+16]

Examples

```
>>> ICtCp = np.array([0.06858097, -0.00283842, 0.06020983])
>>> ICtCp_to_XYZ(ICtCp)
array([ 0.2065400...,  0.1219722...,  0.0513695...])
>>> ICtCp = np.array([0.59242792, -0.03740730, 0.25122675])
>>> ICtCp_to_XYZ(ICtCp, method="ITU-R BT.2100-2 HLG")
array([ 0.2065400...,  0.1219722...,  0.0513695...])
```

RGB Representations

Prismatic Colourspace

colour

| | |
|-------------------------------------|--|
| <code>RGB_to_Prismatic(RGB)</code> | Convert from <i>RGB</i> colourspace to <i>Prismatic $L\rho\gamma\beta$</i> colourspace array. |
| <code>Prismatic_to_RGB(Lrgb)</code> | Convert from <i>Prismatic $L\rho\gamma\beta$</i> colourspace array to <i>RGB</i> colourspace. |

colour.RGB_to_Prismatic

colour.**RGB_to_Prismatic**(*RGB*: *ArrayLike*) → *ndarray*

Convert from *RGB* colourspace to *Prismatic* $L\rho\gamma\beta$ colourspace array.

Parameters

RGB (*ArrayLike*) – *RGB* colourspace array.

Returns

Prismatic $L\rho\gamma\beta$ colourspace array.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| RGB | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| Lrgb | [0, 1] | [0, 1] |

References

[SH15]

Examples

```
>>> RGB = np.array([0.25, 0.50, 0.75])
>>> RGB_to_Prismatic(RGB)
array([ 0.75...,  0.166666...,  0.333333...,  0.5...  ])
```

Adjusting saturation of given *RGB* colourspace array: >>> saturation = 0.5 >>> Lrgb = RGB_to_Prismatic(RGB) >>> Lrgb[..., 1:] = 1 / 3 + saturation * (Lrgb[..., 1:] - 1 / 3) >>> Prismatic_to_RGB(Lrgb) # doctest: +ELLIPSIS array([0.45..., 0.6..., 0.75...])

colour.Prismatic_to_RGB

colour.**Prismatic_to_RGB**(*Lrgb*: *ArrayLike*) → *ndarray*

Convert from *Prismatic* $L\rho\gamma\beta$ colourspace array to *RGB* colourspace.

Parameters

Lrgb (*ArrayLike*) – *Prismatic* $L\rho\gamma\beta$ colourspace array.

Returns

RGB colourspace array.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| Lrgb | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| RGB | [0, 1] | [0, 1] |

References

[SH15]

Examples

```
>>> Lrgb = np.array([0.75000000, 0.16666667, 0.33333333, 0.50000000])
>>> Prismatic_to_RGB(Lrgb)
array([ 0.25...,  0.4999999...,  0.75...  ])
```

HSV Colourspace

colour

| | |
|-------------------|--|
| RGB_to_HSV(RGB) | Convert from <i>RGB</i> colourspace to <i>HSV</i> colourspace. |
| HSV_to_RGB(HSV) | Convert from <i>HSV</i> colourspace to <i>RGB</i> colourspace. |

colour.RGB_to_HSV

colour.**RGB_to_HSV**(*RGB*: *ArrayLike*) → ndarray
Convert from *RGB* colourspace to *HSV* colourspace.

Parameters
 RGB (*ArrayLike*) – *RGB* colourspace array.

Returns
 HSV array.

Return type
 numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| RGB | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| HSV | [0, 1] | [0, 1] |

References

[[EasyRGBh](#)], [[Smi78](#)], [[Wikipedia03g](#)]

Examples

```
>>> RGB = np.array([0.45620519, 0.03081071, 0.04091952])
>>> RGB_to_HSV(RGB)
array([ 0.9960394...,  0.9324630...,  0.4562051...])
```

colour.HSV_to_RGB

`colour.HSV_to_RGB(HSV: ArrayLike) → ndarray`

Convert from *HSV* colourspace to *RGB* colourspace.

Parameters

HSV (ArrayLike) – *HSV* colourspace array.

Returns

RGB colourspace array.

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| HSV | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| RGB | [0, 1] | [0, 1] |

References

[EasyRGBe], [Smi78], [Wikipedia03g]

Examples

```
>>> HSV = np.array([0.99603944, 0.93246304, 0.45620519])
>>> HSV_to_RGB(HSV)
array([ 0.4562051...,  0.0308107...,  0.0409195...])
```

HSL Colourspace

colour

| | |
|-------------------|--|
| RGB_to_HSL(RGB) | Convert from <i>RGB</i> colourspace to <i>HSL</i> colourspace. |
| HSL_to_RGB(HSL) | Convert from <i>HSL</i> colourspace to <i>RGB</i> colourspace. |

colour.RGB_to_HSL

colour.**RGB_to_HSL**(*RGB*: *ArrayLike*) → ndarray
Convert from *RGB* colourspace to *HSL* colourspace.

Parameters
RGB (ArrayLike) – *RGB* colourspace array.

Returns
HSL array.

Return type
numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| RGB | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| HSL | [0, 1] | [0, 1] |

References

[EasyRGBg], [Smi78], [Wikipedia03g]

Examples

```
>>> RGB = np.array([0.45620519, 0.03081071, 0.04091952])
>>> RGB_to_HSL(RGB)
array([ 0.9960394...,  0.8734714...,  0.2435079...])
```

colour.HSL_to_RGB

colour.HSL_to_RGB(*HSL*: *ArrayLike*) → *ndarray*

Convert from *HSL* colourspace to *RGB* colourspace.

Parameters

HSL (*ArrayLike*) – *HSL* colourspace array.

Returns

RGB colourspace array.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| HSL | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| RGB | [0, 1] | [0, 1] |

References

[EasyRGBd], [Smi78], [Wikipedia03g]

Examples

```
>>> HSL = np.array([0.99603944, 0.87347144, 0.24350795])
>>> HSL_to_RGB(HSL)
array([ 0.4562051...,  0.0308107...,  0.0409195...])
```

HCL Colourspace

colour

| | |
|--|--|
| <code>RGB_to_HCL</code> (<code>RGB</code> [, <code>gamma</code> , <code>Y_0</code>]) | Convert from <i>RGB</i> colourspace to <i>HCL</i> colourspace according to <i>Sarifuddin and Missaoui (2005)</i> method. |
| <code>HCL_to_RGB</code> (<code>HCL</code> [, <code>gamma</code> , <code>Y_0</code>]) | Convert from <i>HCL</i> colourspace to <i>RGB</i> colourspace according to <i>Sarifuddin and Missaoui (2005)</i> method. |

colour.RGB_to_HCL

`colour.RGB_to_HCL`(*RGB*: *ArrayLike*, *gamma*: *float* = 3, *Y_0*: *float* = 100) → *ndarray*

Convert from *RGB* colourspace to *HCL* colourspace according to *Sarifuddin and Missaoui (2005)* method.

Parameters

- **RGB** (*ArrayLike*) – *RGB* colourspace array.
- **gamma** (*float*) – Non-linear lightness exponent matching *Lightness L**.
- **Y_0** (*float*) – White reference luminance Y_0 .

Returns

HCL array.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| RGB | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| HCL | [0, 1] | [0, 1] |

References

[SM05], [Wikipedia15]

Examples

```
>>> RGB = np.array([0.45620519, 0.03081071, 0.04091952])
>>> RGB_to_HCL(RGB)
array([-0.0316785..., 0.2841715..., 0.2285964...])
```

colour.HCL_to_RGB

`colour.HCL_to_RGB(HCL: ArrayLike, gamma: float = 3, Y_0: float = 100) → ndarray`

Convert from *HCL* colourspace to *RGB* colourspace according to *Sarifuddin and Missaoui (2005)* method.

Parameters

- **HCL** (ArrayLike) – *HCL* colourspace array.
- **gamma** (float) – Non-linear lightness exponent matching *Lightness* L^* .
- **Y_0** (float) – White reference luminance Y_0 .

Returns

RGB colourspace array.

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| HCL | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| RGB | [0, 1] | [0, 1] |

References

[SM05], [Wikipedia15]

Examples

```
>>> HCL = np.array([-0.03167854, 0.28417150, 0.22859647])
>>> HCL_to_RGB(HCL)
array([ 0.4562033..., 0.0308104..., 0.0409192...])
```

CMY Colourspace

colour

| | |
|--------------------------------|---|
| <code>RGB_to_CMY(RGB)</code> | Convert from <i>RGB</i> colourspace to <i>CMY</i> colourspace. |
| <code>CMY_to_RGB(CMY)</code> | Convert from <i>CMY</i> colourspace to <i>CMY</i> colourspace. |
| <code>CMY_to_CMYK(CMY)</code> | Convert from <i>CMY</i> colourspace to <i>CMYK</i> colourspace. |
| <code>CMYK_to_CMY(CMYK)</code> | Convert from <i>CMYK</i> colourspace to <i>CMY</i> colourspace. |

colour.RGB_to_CMY

colour.**RGB_to_CMY**(*RGB*: *ArrayLike*) → *ndarray*

Convert from *RGB* colourspace to *CMY* colourspace.

Parameters

RGB (*ArrayLike*) – *RGB* colourspace array.

Returns

CMY array.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| RGB | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| CMY | [0, 1] | [0, 1] |

References

[EasyRGBf]

Examples

```
>>> RGB = np.array([0.45620519, 0.03081071, 0.04091952])
>>> RGB_to_CMY(RGB)
array([ 0.5437948...,  0.9691892...,  0.9590804...])
```

colour.CMY_to_RGB

colour.CMY_to_RGB(CMY: ArrayLike) → ndarray

Convert from *CMY* colourspace to *CMY* colourspace.

Parameters

CMY (ArrayLike) – *CMY* colourspace array.

Returns

RGB colourspace array.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| CMY | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| RGB | [0, 1] | [0, 1] |

References

[EasyRGBc]

Examples

```
>>> CMY = np.array([0.54379481, 0.96918929, 0.95908048])
>>> CMY_to_RGB(CMY)
array([ 0.4562051...,  0.0308107...,  0.0409195...])
```

colour.CMY_to_CMYK

colour.CMY_to_CMYK(CMY: ArrayLike) → ndarray

Convert from *CMY* colourspace to *CMYK* colourspace.

Parameters

CMY (ArrayLike) – *CMY* colourspace array.

Returns

CMYK array.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| CMY | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| CMYK | [0, 1] | [0, 1] |

References

[[EasyRGBb](#)]

Examples

```
>>> CMY = np.array([0.54379481, 0.96918929, 0.95908048])
>>> CMY_to_CMYK(CMY)
array([ 0.          ,  0.9324630...,  0.9103045...,  0.5437948...])
```

colour.CMYK_to_CMY

colour.CMYK_to_CMY(*CMYK*: *ArrayLike*) → *ndarray*

Convert from *CMYK* colourspace to *CMY* colourspace.

Parameters

CMYK (*ArrayLike*) – *CMYK* colourspace array.

Returns

CMY array.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| CMYK | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| CMY | [0, 1] | [0, 1] |

References

[EasyRGBa]

Examples

```
>>> CMYK = np.array([0.50000000, 0.00000000, 0.74400000, 0.01960784])
>>> CMYK_to_CMY(CMYK)
array([ 0.5098039...,  0.0196078...,  0.7490196...])
```

IHLS - Hanbury (2003)

colour

| | |
|-------------------------------|--|
| <code>RGB_to_IHLS(RGB)</code> | Convert from <i>RGB</i> colourspace to <i>IHLS</i> (Improved HLS) colourspace. |
| <code>IHLS_to_RGB(HYS)</code> | Convert from <i>IHLS</i> (Improved HLS) colourspace to <i>RGB</i> colourspace. |

colour.RGB_to_IHLS

colour.**RGB_to_IHLS**(*RGB*: *ArrayLike*) → *ndarray*

Convert from *RGB* colourspace to *IHLS* (Improved HLS) colourspace.

Parameters

RGB (*ArrayLike*) – *RGB* colourspace array.

Returns

HYS colourspace array.

Return type

numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| RGB | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| HYS | [0, 1] | [0, 1] |

References

[Han03]

Examples

```
>>> RGB = np.array([0.45595571, 0.03039702, 0.04087245])
>>> RGB_to_IHLS(RGB)
array([ 6.2616051...,  0.1216271...,  0.4255586...])
```

colour.IHLS_to_RGB

colour.IHLS_to_RGB(*HYS*: *ArrayLike*) → ndarray
Convert from *IHLS* (Improved *HLS*) colourspace to *RGB* colourspace.

Parameters
HYS (*ArrayLike*) – *IHLS* colourspace array.

Returns
RGB colourspace array.

Return type
numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| HYS | [0, 1] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| RGB | [0, 1] | [0, 1] |

References

[Han03]

Examples

```
>>> HYS = np.array([6.26160518, 0.12162712, 0.42555869])
>>> IHLS_to_RGB(HYS)
array([ 0.4559557...,  0.0303970...,  0.0408724...])
```

Recommendation ITU-T H.273 Code points for Video Signal Type Identification

colour

| | |
|-----------------------------------|--|
| COLOUR_PRIMARIES_ITUTH273 | <i>ColourPrimaries</i> indicates the chromaticity coordinates of the source colour primaries as specified in Table 3 of [InternationalOfStandardization21] and [InternationalTUnion21] in terms of the CIE 1931 definition of x and y, which shall be interpreted as specified by <i>ISO/ CIE 11664-1</i> . |
| TRANSFER_CHARACTERISTICS_ITUTH273 | <i>TransferCharacteristics</i> , as specified in Table 3 of [InternationalOfStandardization21] and [InternationalTUnion21], either indicates the reference opto-electronic transfer characteristic function of the source picture as a function of a source input linear optical intensity input L_c with a nominal real-valued range of 0 to 1 or indicates the inverse of the reference electro-optical transfer characteristic function as a function of an output linear optical intensity L_o with a nominal real-valued range of 0 to 1. |
| MATRIX_COEFFICIENTS_ITUTH273 | <i>MatrixCoefficients</i> describes the matrix coefficients used in deriving luma and chroma signals from the green, blue and red or X, Y and Z primaries, as specified in Table 4 and equations 11 to 77 of [InternationalOfStandardization21] and [InternationalTUnion21]. |

colour.COLOUR_PRIMARIES_ITUTH273

```
colour.COLOUR_PRIMARIES_ITUTH273 = {0: array('Reserved', dtype='<U8'), 1: array([[ 0.64,
0.33], [ 0.3 , 0.6 ], [ 0.15, 0.06]]), 2: array('Unspecified', dtype='<U11'), 3:
array('Reserved', dtype='<U8'), 4: array([[ 0.67, 0.33], [ 0.21, 0.71], [ 0.14, 0.08]]), 5:
array([[ 0.64, 0.33], [ 0.29, 0.6 ], [ 0.15, 0.06]]), 6: array([[ 0.63 , 0.34 ], [ 0.31 ,
0.595], [ 0.155, 0.07 ]]), 7: array([[ 0.63 , 0.34 ], [ 0.31 , 0.595], [ 0.155, 0.07 ]]),
8: array([[ 0.681, 0.319], [ 0.243, 0.692], [ 0.145, 0.049]]), 9: array([[ 0.708, 0.292], [
0.17 , 0.797], [ 0.131, 0.046]]), 10: array([[ 1., 0.], [ 0., 1.], [ 0., 0.]]), 11:
array([[ 0.68 , 0.32 ], [ 0.265, 0.69 ], [ 0.15 , 0.06 ]]), 12: array([[ 0.68 , 0.32 ], [
0.265, 0.69 ], [ 0.15 , 0.06 ]]), 22: array([[ 0.63 , 0.34 ], [ 0.295, 0.605], [ 0.155,
0.077]]), 23: array('Reserved', dtype='<U8')}
```

ColourPrimaries indicates the chromaticity coordinates of the source colour primaries as specified in Table 3 of [InternationalOfStandardization21] and [InternationalTUnion21] in terms of the CIE 1931 definition of x and y, which shall be interpreted as specified by *ISO/ CIE 11664-1*.

References

[InternationalOfStandardization13] [InternationalOfStandardization20] [InternationalOfStandardization21], [InternationalTUnion21]

colour.TRANSFER_CHARACTERISTICS_ITUTH273

```
colour.TRANSFER_CHARACTERISTICS_ITUTH273 = {0: <function _reserved>, 1: <function
oetf_BT709>, 2: <function _unspecified>, 3: <function _reserved>, 4: <function
_clipped_domain_function.<locals>.wrapped>, 5: <function
_clipped_domain_function.<locals>.wrapped>, 6: <function oetf_BT601>, 7: <function
oetf_SMPTE240M>, 8: <function linear_function>, 9: <function oetf_H273_Log>, 10: <function
oetf_H273_LogSqrt>, 11: <function oetf_H273_IEC61966_2>, 12: <function oetf_BT1361>, 13:
<function oetf_H273_IEC61966_2>, 14: <function _clipped_domain_function.<locals>.wrapped>,
15: <function _clipped_domain_function.<locals>.wrapped>, 16: <function
eotf_inverse_ST2084>, 17: <function eotf_inverse_H273_ST428_1>, 18: <function
oetf_BT2100_HLG>, 19: <function _reserved>}
```

TransferCharacteristics, as specified in Table 3 of [InternationalOfStandardization21] and [InternationalTUnion21], either indicates the reference opto-electronic transfer characteristic function of the source picture as a function of a source input linear optical intensity input L_c with a nominal real-valued range of 0 to 1 or indicates the inverse of the reference electro-optical transfer characteristic function as a function of an output linear optical intensity L_o with a nominal real-valued range of 0 to 1.

Notes

- For simplicity, no clipping is implemented for *TransferCharacteristics* 13 as it is a function of whether the context is *sRGB* or *sYCC*.
- For *TransferCharacteristics* equal to 18, the equations given in Table 3 are normalized for a source input linear optical intensity L_c with a nominal real-valued range of 0 to 1. An alternative scaling that is mathematically equivalent is used in ARIB STD-B67 (2015) with the source input linear optical intensity having a nominal real-valued range of 0 to 12.

References

[InternationalOfStandardization13] [InternationalOfStandardization20] [InternationalOfStandardization21], [InternationalTUnion21]

colour.MATRIX_COEFFICIENTS_ITUTH273

```
colour.MATRIX_COEFFICIENTS_ITUTH273 = {0: array('Identity', dtype='<U8'), 1: array([
0.2126, 0.0722]), 2: array('Unspecified', dtype='<U11'), 3: array('Reserved',
dtype='<U8'), 4: array([ 0.3 , 0.11]), 5: array([ 0.299, 0.114]), 6: array([ 0.299,
0.114]), 7: array([ 0.212, 0.087]), 8: array('YCbCr', dtype='<U5'), 9: array([ 0.2627,
0.0593]), 10: array([ 0.2627, 0.0593]), 11: array("Y'D'Z'D'X", dtype='<U8'), 12: array('See
equations 32 to 37', dtype='<U22'), 13: array('See equations 32 to 37', dtype='<U22'), 14:
array('ICTCP', dtype='<U5'), 15: array('Reserved', dtype='<U8')}
```

MatrixCoefficients describes the matrix coefficients used in deriving luma and chroma signals from the green, blue and red or X, Y and Z primaries, as specified in Table 4 and equations 11 to 77 of [InternationalOfStandardization21] and [InternationalTUnion21].

Notes

- See `colour.WEIGHTS_YCBCR` attribute and the `colour.matrix_YCbCr()`, `colour.offset_YCbCr()`, `colour.RGB_to_YCbCr()`, `colour.YCbCr_to_RGB()`, `colour.RGB_to_YcBcCrC()`, `colour.YcBcCrC_to_RGB()` definitions for an implementation.

References

[InternationalOfStandardization13] [InternationalOfStandardization20] [InternationalOfStandardization21], [InternationalTUnion21]

Ancillary Objects

`colour.models`

| | |
|---|--|
| <code>describe_video_signal_colour primaries(...)</code> | Describe given video signal colour primaries code point. |
| <code>describe_video_signal_transfer_characteristi</code> | Describe given video signal transfer characteristics code point. |
| <code>describe_video_signal_matrix_coefficients(...)</code> | Describe given video signal matrix coefficients code point. |

`colour.models.describe_video_signal_colour_primaries`

`colour.models.describe_video_signal_colour_primaries(code_point: int, print_description: bool = True, **kwargs) → str`

Describe given video signal colour primaries code point.

Parameters

- **code_point** (`int`) – Video signal colour primaries code point to describe from `colour.COLOUR_PRIMARIES_ITUTH273` attribute.
- **print_description** (`bool`) – Whether to print the description.
- **padding** – `{colour.utilities.message_box()}`, Padding on each side of the message.
- **print_callable** – `{colour.utilities.message_box()}`, Callable used to print the message box.
- **width** – `{colour.utilities.message_box()}`, Message box width.

Returns

Video signal colour primaries code point description.

Return type

`str`

References

[FFmpegDevelopers22a], [InternationalOfStandardization13], [InternationalOfStandardization21], [InternationalOfStandardization20], [InternationalTUnion21]

Examples

```
>>> description = describe_video_signal_colour_primaries(1, width=75)
=====
*                                                                    *
* Colour Primaries: 1                                              *
* -----                                                         *
*                                                                    *
* Primaries      : [[ 0.64  0.33]                                  *
*                  [ 0.3   0.6 ]                                  *
*                  [ 0.15  0.06]]                                 *
* Whitepoint     : [ 0.3127  0.329 ]                               *
* Whitepoint Name : D65                                           *
* NPM            : [[ 0.4123908  0.35758434  0.18048079]          *
*                  [ 0.21263901  0.71516868  0.07219232]          *
*                  [ 0.01933082  0.11919478  0.95053215]]          *
* NPM -1         : [[ 3.24096994 -1.53738318 -0.49861076]         *
*                  [-0.96924364  1.8759675   0.04155506]          *
*                  [ 0.05563008 -0.20397696  1.05697151]]          *
* FFmpeg Constants : ['AVCOL_PRI_BT709', 'BT709']                 *
*                                                                    *
=====
>>> description = describe_video_signal_colour_primaries(2, width=75)
=====
*                                                                    *
* Colour Primaries: 2                                              *
* -----                                                         *
*                                                                    *
* Primaries      : Unspecified                                     *
* Whitepoint     : Unspecified                                     *
* Whitepoint Name : Unspecified                                     *
* NPM            : Unspecified                                     *
* NPM -1         : Unspecified                                     *
* FFmpeg Constants : ['AVCOL_PRI_UNSPECIFIED', 'UNSPECIFIED']      *
*                                                                    *
=====
>>> description = describe_video_signal_colour_primaries(
...     FFmpegConstantsColourPrimaries_ITUTH273.JEDEC_P22, width=75
... )
=====
*                                                                    *
* Colour Primaries: 22                                              *
* -----                                                         *
*                                                                    *
* Primaries      : [[ 0.63  0.34 ]                                  *
*                  [ 0.295  0.605]                                  *
*                  [ 0.155  0.077]]                                 *
* Whitepoint     : [ 0.3127  0.329 ]                               *
* Whitepoint Name : D65                                           *
* NPM            : [[ 0.42942013  0.3277917  0.1932441 ]          *
*                  [ 0.23175055  0.67225077  0.09599868]          *
*                                                                    *
```

(continues on next page)

(continued from previous page)

```

*          [ 0.02044858  0.11111583  0.95749334]]          *
*   NPM -1      : [[ 3.13288278 -1.44707454 -0.48720324]    *
*               [-1.08850877  2.01538781  0.01762239]      *
*               [ 0.05941301 -0.20297883  1.05275352]]      *
*   FFmpeg Constants : ['AVCOL_PRI_EBU3213', 'AVCOL_PRI_JEDEC_P22', *
*   'EBU3213', 'JEDEC_P22']                                *
*                                                         *
=====

```

colour.models.describe_video_signal_transfer_characteristics

`colour.models.describe_video_signal_transfer_characteristics`(*code_point*: *int*, *print_description*: *bool* = *True*, ***kwargs*) → *str*

Describe given video signal transfer characteristics code point.

Parameters

- **code_point** (*int*) – Video signal transfer characteristics code point to describe from `colour.TRANSFER_CHARACTERISTICS_ITUTH273` attribute.
- **print_description** (*bool*) – Whether to print the description.
- **padding** – {`colour.utilities.message_box()`}, Padding on each side of the message.
- **print_callable** – {`colour.utilities.message_box()`}, Callable used to print the message box.
- **width** – {`colour.utilities.message_box()`}, Message box width.

Returns

Video signal colour primaries code point description.

Return type

str

References

[FFmpegDevelopers22c], [InternationalOfStandardization13], [InternationalOfStandardization21], [InternationalOfStandardization20], [InternationalTUnion21]

Examples

```

>>> description = describe_video_signal_transfer_characteristics(
...     1, width=75
... )
...
=====
*          *
*   Transfer Characteristics: 1          *
*   -----                          *
*          *
*   Function          : <function oetf_BT709 at 0x...>...*
*   FFmpeg Constants : ['AVCOL_TRC_BT709', 'BT709']      *
*          *
=====

```

(continues on next page)

(continued from previous page)

```

>>> description = describe_video_signal_transfer_characteristics(
...     2, width=75
... )
...
=====
*                                     *
*  Transfer Characteristics: 2         *
*  -----                           *
*                                     *
*  Function      : <function _unspecified at 0x...>...*
*  Ffmpeg Constants : ['AVCOL_TRC_UNSPECIFIED', 'UNSPECIFIED']
*                                     *
=====
>>> description = describe_video_signal_transfer_characteristics(
...     FfmpegConstantsTransferCharacteristics_ITUTH273.SMPTE428, width=75
... )
...
=====
*                                     *
*  Transfer Characteristics: 17        *
*  -----                           *
*                                     *
*  Function      : <function eotf_inverse_H273_ST428_1 at
*  0x...>...*
*  Ffmpeg Constants : ['AVCOL_TRC_SMPTE428', 'AVCOL_TRC_SMPTEST428_1',
*  'SMPTE428', 'SMPTEST428_1']
*                                     *
=====

```

colour.models.describe_video_signal_matrix_coefficients

colour.models.describe_video_signal_matrix_coefficients(*code_point*: *int*, *print_description*: *bool*
= *True*, ***kwargs*) → *str*

Describe given video signal matrix coefficients code point.

Parameters

- **code_point** (*int*) – Video signal matrix coefficients code point to describe from `colour.MATRIX_COEFFICIENTS_ITUTH273` attribute.
- **print_description** (*bool*) – Whether to print the description.
- **padding** – {`colour.utilities.message_box()`}, Padding on each side of the message.
- **print_callable** – {`colour.utilities.message_box()`}, Callable used to print the message box.
- **width** – {`colour.utilities.message_box()`}, Message box width.

Returns

Video signal colour primaries code point description.

Return type

str

References

[FFmpegDevelopers22b], [InternationalOfStandardization13], [InternationalOfStandardization21], [InternationalOfStandardization20], [InternationalTUnion21]

Examples

```
>>> description = describe_video_signal_matrix_coefficients(1, width=75)
=====
*                                                                    *
*   Matrix Coefficients: 1                                           *
*   -----                                                         *
*                                                                    *
*   Matrix Coefficients : [ 0.2126  0.0722]                         *
*   Ffmpg Constants    : ['AVCOL_SPC_BT709', 'BT709']              *
*                                                                    *
=====

>>> description = describe_video_signal_matrix_coefficients(2, width=75)
=====
*                                                                    *
*   Matrix Coefficients: 2                                           *
*   -----                                                         *
*                                                                    *
*   Matrix Coefficients : Unspecified                               *
*   Ffmpg Constants    : ['AVCOL_SPC_UNSPECIFIED', 'UNSPECIFIED'] *
*                                                                    *
=====

>>> description = describe_video_signal_matrix_coefficients(
...     FfmpgConstantsMatrixCoefficients_ITUTH273.ICTCP, width=75
... )
...
=====
*                                                                    *
*   Matrix Coefficients: 14                                           *
*   -----                                                         *
*                                                                    *
*   Matrix Coefficients : ICTCP                                       *
*   Ffmpg Constants    : ['AVCOL_SPC_ICTCP', 'ICTCP']              *
*                                                                    *
=====
```

Pointer's Gamut

colour

| | |
|---|---|
| <code>CCS_ILLUMINANT_POINTER_GAMUT</code> | <code>ndarray(shape, dtype=float, buffer=None, offset=0,</code> |
| <code>DATA_POINTER_GAMUT_VOLUME</code> | <code>ndarray(shape, dtype=float, buffer=None, offset=0,</code> |
| <code>CCS_POINTER_GAMUT_BOUNDARY</code> | <code>ndarray(shape, dtype=float, buffer=None, offset=0,</code> |

colour.models.CCS_ILLUMINANT_POINTER_GAMUT

```
colour.models.CCS_ILLUMINANT_POINTER_GAMUT = array([ 0.31005673, 0.3161457 ])
```

ndarray(shape, dtype=float, buffer=None, offset=0, strides=None, order=None)

An array object represents a multidimensional, homogeneous array of fixed-size items. An associated data-type object describes the format of each element in the array (its byte-order, how many bytes it occupies in memory, whether it is an integer, a floating point number, or something else, etc.)

Arrays should be constructed using *array*, *zeros* or *empty* (refer to the See Also section below). The parameters given here refer to a low-level method (*ndarray(...)*) for instantiating an array.

For more information, refer to the *numpy* module and examine the methods and attributes of an array.

Parameters

- **below** ((for the `__new__` method; see Notes) –
- **shape** (tuple of ints) – Shape of created array.
- **dtype** (data-type, optional) – Any object that can be interpreted as a numpy data type.
- **buffer** (object exposing buffer interface, optional) – Used to fill the array with data.
- **offset** (int, optional) – Offset of array data in buffer.
- **strides** (tuple of ints, optional) – Strides of data in memory.
- **order** ({'C', 'F'}, optional) – Row-major (C-style) or column-major (Fortran-style) order.

Attributes

T

[ndarray] Transpose of the array.

data

[buffer] The array's elements, in memory.

dtype

[dtype object] Describes the format of the elements in the array.

flags

[dict] Dictionary containing information related to memory use, e.g., 'C_CONTIGUOUS', 'OWNDATA', 'WRITEABLE', etc.

flat

[numpy.flatiter object] Flattened version of the array as an iterator. The iterator allows assignments, e.g., `x.flat = 3` (See *ndarray.flat* for assignment examples; TODO).

imag

[ndarray] Imaginary part of the array.

real

[ndarray] Real part of the array.

size

[int] Number of elements in the array.

itemsize

[int] The memory use of each array element in bytes.

nbytes

[int] The total number of bytes required to store the array data, i.e., `itemsize * size`.

ndim

[int] The array's number of dimensions.

shape

[tuple of ints] Shape of the array.

strides

[tuple of ints] The step-size required to move from one element to the next in memory. For example, a contiguous (3, 4) array of type `int16` in C-order has strides (8, 2). This implies that to move from element to element in memory requires jumps of 2 bytes. To move from row-to-row, one needs to jump 8 bytes at a time ($2 * 4$).

ctypes

[ctypes object] Class containing properties of the array needed for interaction with ctypes.

base

[ndarray] If the array is a view into another array, that array is its *base* (unless that array is also a view). The *base* array is where the array data is actually stored.

See also:**array**

Construct an array.

zeros

Create an array, each element of which is zero.

empty

Create an array, but leave its allocated memory unchanged (i.e., it contains “garbage”).

dtype

Create a data-type.

numpy.typing.NDArray

An ndarray alias *generic* w.r.t. its `dtype.type` `<numpy.dtype.type>`.

Notes

There are two modes of creating an array using `__new__`:

1. If *buffer* is `None`, then only *shape*, *dtype*, and *order* are used.
2. If *buffer* is an object exposing the buffer interface, then all keywords are interpreted.

No `__init__` method is needed because the array is fully initialized after the `__new__` method.

Examples

These examples illustrate the low-level *ndarray* constructor. Refer to the *See Also* section above for easier ways of constructing an ndarray.

First mode, *buffer* is `None`:

```
>>> np.ndarray(shape=(2,2), dtype=float, order='F')
array([[0.0e+000, 0.0e+000], # random
       [      nan, 2.5e-323]])
```

Second mode:

```
>>> np.ndarray((2,), buffer=np.array([1,2,3]),
...           offset=np.int_().itemsize,
...           dtype=int) # offset = 1*itemsize, i.e. skip first element
array([2, 3])
```

colour.models.DATA_POINTER_GAMUT_VOLUME

```
colour.models.DATA_POINTER_GAMUT_VOLUME = array([[ 15, 10,  0], [ 15, 15, 10], [ 15, 14,
20], ..., [ 90,  9, 330], [ 90,  4, 340], [ 90,  6, 350]])
```

ndarray(shape, dtype=float, buffer=None, offset=0, strides=None, order=None)

An array object represents a multidimensional, homogeneous array of fixed-size items. An associated data-type object describes the format of each element in the array (its byte-order, how many bytes it occupies in memory, whether it is an integer, a floating point number, or something else, etc.)

Arrays should be constructed using *array*, *zeros* or *empty* (refer to the See Also section below). The parameters given here refer to a low-level method (*ndarray(...)*) for instantiating an array.

For more information, refer to the *numpy* module and examine the methods and attributes of an array.

Parameters

- **below** ((for the `__new__` method; see Notes) –
- **shape** (*tuple* of ints) – Shape of created array.
- **dtype** (data-type, optional) – Any object that can be interpreted as a numpy data type.
- **buffer** (object exposing buffer interface, optional) – Used to fill the array with data.
- **offset** (*int*, optional) – Offset of array data in buffer.
- **strides** (*tuple* of ints, optional) – Strides of data in memory.
- **order** ({'C', 'F'}, optional) – Row-major (C-style) or column-major (Fortran-style) order.

Attributes

T

[ndarray] Transpose of the array.

data

[buffer] The array's elements, in memory.

dtype

[dtype object] Describes the format of the elements in the array.

flags

[dict] Dictionary containing information related to memory use, e.g., 'C_CONTIGUOUS', 'OWNDATA', 'WRITEABLE', etc.

flat

[numpy.flatiter object] Flattened version of the array as an iterator. The iterator allows assignments, e.g., `x.flat = 3` (See *ndarray.flat* for assignment examples; TODO).

imag

[ndarray] Imaginary part of the array.

real

[ndarray] Real part of the array.

size

[int] Number of elements in the array.

itemsize

[int] The memory use of each array element in bytes.

nbytes

[int] The total number of bytes required to store the array data, i.e., `itemsize * size`.

ndim

[int] The array's number of dimensions.

shape

[tuple of ints] Shape of the array.

strides

[tuple of ints] The step-size required to move from one element to the next in memory. For example, a contiguous (3, 4) array of type `int16` in C-order has strides (8, 2). This implies that to move from element to element in memory requires jumps of 2 bytes. To move from row-to-row, one needs to jump 8 bytes at a time ($2 * 4$).

ctypes

[ctypes object] Class containing properties of the array needed for interaction with ctypes.

base

[ndarray] If the array is a view into another array, that array is its *base* (unless that array is also a view). The *base* array is where the array data is actually stored.

See also:**array**

Construct an array.

zeros

Create an array, each element of which is zero.

empty

Create an array, but leave its allocated memory unchanged (i.e., it contains “garbage”).

dtype

Create a data-type.

numpy.typing.NDArray

An ndarray alias *generic* w.r.t. its `dtype.type` `<numpy.dtype.type>`.

Notes

There are two modes of creating an array using `__new__`:

1. If *buffer* is `None`, then only *shape*, *dtype*, and *order* are used.
2. If *buffer* is an object exposing the buffer interface, then all keywords are interpreted.

No `__init__` method is needed because the array is fully initialized after the `__new__` method.

Examples

These examples illustrate the low-level *ndarray* constructor. Refer to the *See Also* section above for easier ways of constructing an *ndarray*.

First mode, *buffer* is *None*:

```
>>> np.ndarray(shape=(2,2), dtype=float, order='F')
array([[0.0e+000, 0.0e+000], # random
       [      nan, 2.5e-323]])
```

Second mode:

```
>>> np.ndarray((2,), buffer=np.array([1,2,3]),
...           offset=np.int_().itemsize,
...           dtype=int) # offset = 1*itemsize, i.e. skip first element
array([2, 3])
```

colour.models.CCS_POINTER_GAMUT_BOUNDARY

```
colour.models.CCS_POINTER_GAMUT_BOUNDARY = array([[ 0.659, 0.316], [ 0.634, 0.351], [
 0.594, 0.391], [ 0.557, 0.427], [ 0.523, 0.462], [ 0.482, 0.491], [ 0.444, 0.515], [ 0.409,
 0.546], [ 0.371, 0.558], [ 0.332, 0.573], [ 0.288, 0.584], [ 0.242, 0.576], [ 0.202, 0.53
], [ 0.177, 0.454], [ 0.151, 0.389], [ 0.151, 0.33 ], [ 0.162, 0.295], [ 0.157, 0.266], [
 0.159, 0.245], [ 0.142, 0.214], [ 0.141, 0.195], [ 0.129, 0.168], [ 0.138, 0.141], [ 0.145,
 0.129], [ 0.145, 0.106], [ 0.161, 0.094], [ 0.188, 0.084], [ 0.252, 0.104], [ 0.324,
 0.127], [ 0.393, 0.165], [ 0.451, 0.199], [ 0.508, 0.226]])
```

```
ndarray(shape, dtype=float, buffer=None, offset=0,
        strides=None, order=None)
```

An array object represents a multidimensional, homogeneous array of fixed-size items. An associated data-type object describes the format of each element in the array (its byte-order, how many bytes it occupies in memory, whether it is an integer, a floating point number, or something else, etc.)

Arrays should be constructed using *array*, *zeros* or *empty* (refer to the *See Also* section below). The parameters given here refer to a low-level method (*ndarray(...)*) for instantiating an array.

For more information, refer to the *numpy* module and examine the methods and attributes of an array.

Parameters

- **below** ((for the `__new__` method; see Notes) –
- **shape** (*tuple* of ints) – Shape of created array.
- **dtype** (data-type, optional) – Any object that can be interpreted as a numpy data type.
- **buffer** (object exposing buffer interface, optional) – Used to fill the array with data.
- **offset** (*int*, optional) – Offset of array data in buffer.
- **strides** (*tuple* of ints, optional) – Strides of data in memory.
- **order** ({'C', 'F'}, optional) – Row-major (C-style) or column-major (Fortran-style) order.

Attributes

T

[ndarray] Transpose of the array.

data

[buffer] The array's elements, in memory.

dtype

[dtype object] Describes the format of the elements in the array.

flags

[dict] Dictionary containing information related to memory use, e.g., 'C_CONTIGUOUS', 'OWNDATA', 'WRITEABLE', etc.

flat

[numpy.flatiter object] Flattened version of the array as an iterator. The iterator allows assignments, e.g., `x.flat = 3` (See `ndarray.flat` for assignment examples; TODO).

imag

[ndarray] Imaginary part of the array.

real

[ndarray] Real part of the array.

size

[int] Number of elements in the array.

itemsize

[int] The memory use of each array element in bytes.

nbytes

[int] The total number of bytes required to store the array data, i.e., `itemsize * size`.

ndim

[int] The array's number of dimensions.

shape

[tuple of ints] Shape of the array.

strides

[tuple of ints] The step-size required to move from one element to the next in memory. For example, a contiguous (3, 4) array of type `int16` in C-order has strides (8, 2). This implies that to move from element to element in memory requires jumps of 2 bytes. To move from row-to-row, one needs to jump 8 bytes at a time ($2 * 4$).

ctypes

[ctypes object] Class containing properties of the array needed for interaction with ctypes.

base

[ndarray] If the array is a view into another array, that array is its *base* (unless that array is also a view). The *base* array is where the array data is actually stored.

See also:

array

Construct an array.

zeros

Create an array, each element of which is zero.

empty

Create an array, but leave its allocated memory unchanged (i.e., it contains "garbage").

dtype

Create a data-type.

numpy.typing.NDArray

An ndarray alias `generic` w.r.t. its `dtype.type <numpy.dtype.type>`.

Notes

There are two modes of creating an array using `__new__`:

1. If `buffer` is `None`, then only `shape`, `dtype`, and `order` are used.
2. If `buffer` is an object exposing the buffer interface, then all keywords are interpreted.

No `__init__` method is needed because the array is fully initialized after the `__new__` method.

Examples

These examples illustrate the low-level `ndarray` constructor. Refer to the *See Also* section above for easier ways of constructing an ndarray.

First mode, `buffer` is `None`:

```
>>> np.ndarray(shape=(2,2), dtype=float, order='F')
array([[0.0e+000, 0.0e+000], # random
       [      nan, 2.5e-323]])
```

Second mode:

```
>>> np.ndarray((2,), buffer=np.array([1,2,3]),
...            offset=np.int_().itemsize,
...            dtype=int) # offset = 1*itemsize, i.e. skip first element
array([2, 3])
```

Colour Notation Systems**Munsell Renotation System**

colour

| | |
|--|--|
| <code>munsell_colour_to_xyY(munsell_colour)</code> | Convert given <i>Munsell</i> colour to <i>CIE xyY</i> colourspace. |
| <code>xyY_to_munsell_colour(xyY[, hue_decimals, ...])</code> | Convert from <i>CIE xyY</i> colourspace to <i>Munsell</i> colour. |

colour.munsell_colour_to_xyY

`colour.munsell_colour_to_xyY(munsell_colour: StrOrArrayLike) → ndarray`

Convert given *Munsell* colour to *CIE xyY* colourspace.

Parameters

munsell_colour (StrOrArrayLike) – *Munsell* colour.

Returns

CIE xyY colourspace array.

Return type

`numpy.ndarray`

Notes

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| xyY | [0, 1] | [0, 1] |

References

[Cen], [Cen12]

Examples

```
>>> munsell_colour_to_xyY("4.2YR 8.1/5.3")
array([ 0.3873694...,  0.3575165...,  0.59362   ])
>>> munsell_colour_to_xyY("N8.9")
array([ 0.31006 ,  0.31616 ,  0.7461345...])
```

colour.xyY_to_munsell_colour

`colour.xyY_to_munsell_colour(xyY: ArrayLike, hue_decimals: int = 1, value_decimals: int = 1, chroma_decimals: int = 1) → StrOrNDArray`

Convert from *CIE xyY* colourspace to *Munsell* colour.

Parameters

- **xyY** (ArrayLike) – *CIE xyY* colourspace array.
- **hue_decimals** (int) – Hue formatting decimals.
- **value_decimals** (int) – Value formatting decimals.
- **chroma_decimals** (int) – Chroma formatting decimals.

Returns

Munsell colour.

Return type

str or numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| xyY | [0, 1] | [0, 1] |

References

[Gen], [Gen12]

Examples

```
>>> xyY = np.array([0.38736945, 0.35751656, 0.59362000])
>>> xyY_to_munsell_colour(xyY)
'4.2YR 8.1/5.3'
```

Dataset

colour

| | |
|-----------------|---|
| MUNSELL_COLOURS | Define the <i>Munsell Renotation System</i> datasets. |
|-----------------|---|

colour.MUNSELL_COLOURS

```
colour.MUNSELL_COLOURS = CanonicalMapping({'Munsell Colours All': ..., 'Munsell Colours
1929': ..., 'Munsell Colours Real': ..., 'all': ..., '1929': ..., 'real': ...})
```

Define the *Munsell Renotation System* datasets.

- Munsell Colours All: *all* published *Munsell* colours, including the extrapolated colors.
- Munsell Colours 1929: the colours appearing in the 1929 *Munsell Book of Color*. These data has been used in the scaling experiments leading to the 1943 renotation.
- Munsell Colours Real: *real*, within MacAdam limits *Munsell* colours only. They are the colours listed in the original 1943 renotation article (*Newhall, Nickerson, & Judd, 1943*).

Notes

- The Munsell Renotation data commonly available within the *all.dat*, *experimental.dat* and *real.dat* files features *CIE xyY* colourspace values that are scaled by a $1/0.975 \simeq 1.02568$ factor. If you are performing conversions using *Munsell Colorlab* specification, e.g. 2.5R 9/2, according to *ASTM D1535-08e1* method, you should not scale the output *Y* Luminance. However, if you use directly the *CIE xyY* colourspace values from the Munsell Renotation data data, you should scale the *Y* Luminance before conversions by a 0.975 factor.

ASTM D1535-08e1 states that:

The coefficients of this equation are obtained from the 1943 equation by multiplying each coefficient by 0.975, the reflectance factor of magnesium oxide with respect to the perfect reflecting diffuser, and rounding to ve digits of precision.

- Chromaticities assume *CIE Illuminant C*, approximately 6700K, as neutral origin for both the hue and chroma loci.

References

- [MunsellCSscienceb] : Munsell Color Science. (n.d.). Munsell Colours Data. Retrieved August 20, 2014, from <http://www.cis.rit.edu/research/mcsl2/online/munsell.php>

Aliases:

- ‘all’: ‘Munsell Colours All’
- ‘1929’: ‘Munsell Colours 1929’
- ‘real’: ‘Munsell Colours Real’

Munsell Value

colour

| | |
|---|---|
| <code>munsell_value(Y[, method])</code> | Return the <i>Munsell</i> value V of given <i>luminance</i> Y using given method. |
| <code>MUNSELL_VALUE_METHODS</code> | Supported <i>Munsell</i> value computation methods. |

colour.munsell_value

`colour.munsell_value(Y: FloatingOrArrayLike, method: Literal['ASTM D1535', 'Ladd 1955', 'McCamy 1987', 'Moon 1943', 'Munsell 1933', 'Priest 1920', 'Saunderson 1944'] | str = 'ASTM D1535') → FloatingOrNDArray`

Return the *Munsell* value V of given *luminance* Y using given method.

Parameters

- **Y** (FloatingOrArrayLike) – *luminance* Y .
- **method** (Literal['ASTM D1535', 'Ladd 1955', 'McCamy 1987', 'Moon 1943', 'Munsell 1933', 'Priest 1920', 'Saunderson 1944'] | str) – Computation method.

Returns

Munsell value V .

Return type

`np.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| Y | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| V | [0, 10] | [0, 1] |

References

[ASTMInternational89], [Wikipedia07a]

Examples

```
>>> munsell_value(12.23634268)
4.0824437...
>>> munsell_value(12.23634268, method="Priest 1920")
3.4980484...
>>> munsell_value(12.23634268, method="Munsell 1933")
4.1627702...
>>> munsell_value(12.23634268, method="Moon 1943")
4.0688120...
>>> munsell_value(12.23634268, method="Saunderson 1944")
...
4.0444736...
>>> munsell_value(12.23634268, method="Ladd 1955")
4.0511633...
>>> munsell_value(12.23634268, method="McCamy 1987")
4.0814348...
```

colour.MUNSELL_VALUE_METHODS

colour.MUNSELL_VALUE_METHODS = CanonicalMapping({'Priest 1920': ..., 'Munsell 1933': ..., 'Moon 1943': ..., 'Saunderson 1944': ..., 'Ladd 1955': ..., 'McCamy 1987': ..., 'ASTM D1535': ..., 'astm2008': ...})

Supported *Munsell* value computation methods.

References

[ASTMInternational89], [Wikipedia07a]

Aliases:

- ‘astm2008’: ‘ASTM D1535’

Priest, Gibson and MacNicholas (1920)

colour.notation

| | |
|--|--|
| <code>munsell_value_Priest1920(Y)</code> | Return the <i>Munsell</i> value <i>V</i> of given <i>luminance Y</i> using <i>Priest et al. (1920)</i> method. |
|--|--|

colour.notation.munsell_value_Priest1920

`colour.notation.munsell_value_Priest1920(Y: FloatingOrArrayLike) → FloatingOrNDArray`

Return the *Munsell* value V of given luminance Y using *Priest et al. (1920)* method.

Parameters

Y (FloatingOrArrayLike) – luminance Y .

Returns

Munsell value V .

Return type

`np.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| Y | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| V | [0, 10] | [0, 1] |

References

[Wikipedia07a]

Examples

```
>>> munsell_value_Priest1920(12.23634268)
3.4980484...
```

Munsell, Sloan and Godlove (1933)

`colour.notation`

| | |
|---|---|
| <code>munsell_value_Munsell1933(Y)</code> | Return the <i>Munsell</i> value V of given luminance Y using <i>Munsell et al. (1933)</i> method. |
|---|---|

colour.notation.munsell_value_Munsell1933

`colour.notation.munsell_value_Munsell1933(Y: FloatingOrArrayLike) → FloatingOrNDArray`

Return the *Munsell* value V of given luminance Y using *Munsell et al. (1933)* method.

Parameters

Y (FloatingOrArrayLike) – luminance Y .

Returns

Munsell value V .

Return type

`np.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| Y | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| V | [0, 10] | [0, 1] |

References

[Wikipedia07a]

Examples

```
>>> munsell_value_Munsell1933(12.23634268)
4.1627702...
```

Moon and Spencer (1943)

colour.notation

| | |
|--|--|
| <code>munsell_value_Moon1943(Y)</code> | Return the <i>Munsell</i> value <i>V</i> of given <i>luminance</i> <i>Y</i> using <i>Moon and Spencer (1943)</i> method. |
|--|--|

colour.notation.munsell_value_Moon1943

colour.notation.**munsell_value_Moon1943**(*Y*: *FloatingOrArrayLike*) → *FloatingOrNDArray*

Return the *Munsell* value *V* of given *luminance* *Y* using *Moon and Spencer (1943)* method.

Parameters

Y (*FloatingOrArrayLike*) – *luminance* *Y*.

Returns

Munsell value *V*.

Return type

`np.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| Y | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| V | [0, 10] | [0, 1] |

References

[Wikipedia07a]

Examples

```
>>> munsell_value_Moon1943(12.23634268)
4.0688120...
```

Saunderson and Milner (1944)

colour.notation

| | |
|--|---|
| <code>munsell_value_Saunderson1944(Y)</code> | Return the <i>Munsell</i> value V of given <i>luminance</i> Y using <i>Saunderson and Milner (1944)</i> method. |
|--|---|

colour.notation.munsell_value_Saunderson1944

colour.notation.**munsell_value_Saunderson1944**(Y : *FloatingOrArrayLike*) → *FloatingOrNDArray*
 Return the *Munsell* value V of given *luminance* Y using *Saunderson and Milner (1944)* method.

Parameters

Y (*FloatingOrArrayLike*) – *luminance* Y .

Returns

Munsell value V .

Return type

np.floating or numpy.ndarray

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| Y | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| V | [0, 10] | [0, 1] |

References

[Wikipedia07a]

Examples

```
>>> munsell_value_Saunderson1944(12.23634268)
4.0444736...
```

Ladd and Pinney (1955)

colour.notation

| | |
|--|---|
| <code>munsell_value_Ladd1955(Y)</code> | Return the <i>Munsell</i> value V of given <i>luminance</i> Y using <i>Ladd and Pinney (1955)</i> method. |
|--|---|

colour.notation.munsell_value_Ladd1955

colour.notation.**munsell_value_Ladd1955**(Y : *FloatingOrArrayLike*) \rightarrow *FloatingOrNDArray*
Return the *Munsell* value V of given *luminance* Y using *Ladd and Pinney (1955)* method.

Parameters

Y (*FloatingOrArrayLike*) – *luminance* Y .

Returns

Munsell value V .

Return type

np.floating or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| Y | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| V | [0, 10] | [0, 1] |

References

[[Wikipedia07a](#)]

Examples

```
>>> munsell_value_Ladd1955(12.23634268)
4.0511633...
```


McCamy (1987)

`colour.notation`

| | |
|--|--|
| <code>munsell_value_McCamy1987(Y)</code> | Return the <i>Munsell</i> value V of given <i>luminance</i> Y using <i>McCamy (1987)</i> method. |
|--|--|

`colour.notation.munsell_value_McCamy1987`

`colour.notation.munsell_value_McCamy1987(Y: FloatingOrArrayLike) → FloatingOrNDArray`

Return the *Munsell* value V of given *luminance* Y using *McCamy (1987)* method.

Parameters

Y (FloatingOrArrayLike) – *luminance* Y .

Returns

Munsell value V .

Return type

`np.floating` or `numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| Y | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| V | [0, 10] | [0, 1] |

References

[ASTMInternational89]

Examples

```
>>> munsell_value_McCamy1987(12.23634268)
4.0814348...
```

ASTM D1535-08e1

`colour.notation`

| | |
|---|---|
| <code>munsell_value_ASTMD1535(Y)</code> | Return the <i>Munsell</i> value V of given <i>luminance</i> Y using an inverse lookup table from <i>ASTM D1535-08e1</i> method. |
|---|---|

colour.notation.munsell_value_ASTMD1535

colour.notation.munsell_value_ASTMD1535(*Y*: *FloatingOrArrayLike*) → *FloatingOrNDArray*
Return the *Munsell* value *V* of given *luminance Y* using an inverse lookup table from *ASTM D1535-08e1* method.

Parameters
Y (*FloatingOrArrayLike*) – *luminance Y*

Returns
Munsell value *V*.

Return type
np.floating or *numpy.ndarray*

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| Y | [0, 100] | [0, 1] |

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| V | [0, 10] | [0, 1] |

- The *Munsell* value* computation with *ASTM D1535-08e1* method is only defined for domain [0, 100].

References

[ASTMInternational89]

Examples

```
>>> munsell_value_ASTMD1535(12.23634268)
4.0824437...
```

Hexadecimal Representation

colour.notation

| | |
|--------------------------|--|
| RGB_to_HEX(<i>RGB</i>) | Convert from <i>RGB</i> colourspace to hexadecimal representation. |
| HEX_to_RGB(<i>HEX</i>) | Convert from hexadecimal representation to <i>RGB</i> colourspace. |

colour.notation.RGB_to_HEX

`colour.notation.RGB_to_HEX(RGB: ArrayLike) → StrOrNDArray`

Convert from *RGB* colourspace to hexadecimal representation.

Parameters

RGB (ArrayLike) – *RGB* colourspace array.

Returns

Hexadecimal representation.

Return type

`str` or `numpy.array`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| RGB | [0, 1] | [0, 1] |

Examples

```
>>> RGB = np.array([0.66666667, 0.86666667, 1.00000000])
>>> RGB_to_HEX(RGB)
'#aaddff'
```

colour.notation.HEX_to_RGB

`colour.notation.HEX_to_RGB(HEX: StrOrArrayLike) → ndarray`

Convert from hexadecimal representation to *RGB* colourspace.

Parameters

HEX (StrOrArrayLike) – Hexadecimal representation.

Returns

RGB colourspace array.

Return type

`numpy.array`

Notes

| Range | Scale - Reference | Scale - 1 |
|-------|-------------------|-----------|
| RGB | [0, 1] | [0, 1] |

Examples

```
>>> HEX = "#aaddff"
>>> HEX_to_RGB(HEX)
array([ 0.6666666...,  0.8666666...,  1.          ])
```

Optical Phenomena

Rayleigh Scattering

colour

| | |
|--|--|
| <code>rayleigh_scattering(wavelength[, ...])</code> | Return the <i>Rayleigh</i> optical depth $T_r(\lambda)$ as function of wavelength λ in centimeters (cm). |
| <code>sd_rayleigh_scattering([shape, ...])</code> | Return the <i>Rayleigh</i> spectral distribution for given spectral shape. |
| <code>scattering_cross_section(wavelength[, ...])</code> | Return the scattering cross section per molecule σ of dry air as function of wavelength λ in centimeters (cm) using given CO_2 concentration in parts per million (ppm) and temperature $T[K]$ in kelvin degrees following <i>Van de Hulst (1957)</i> method. |

colour.rayleigh_scattering

`colour.rayleigh_scattering(wavelength: FloatingOrArrayLike, CO2_concentration: FloatingOrArrayLike = CONSTANT_STANDARD_CO2_CONCENTRATION, temperature: FloatingOrArrayLike = CONSTANT_STANDARD_AIR_TEMPERATURE, pressure: FloatingOrArrayLike = CONSTANT_AVERAGE_PRESSURE_MEAN_SEA_LEVEL, latitude: FloatingOrArrayLike = CONSTANT_DEFAULT_LATITUDE, altitude: FloatingOrArrayLike = CONSTANT_DEFAULT_ALTITUDE, avogadro_constant: FloatingOrArrayLike = CONSTANT_AVOGADRO, n_s_function: Callable = air_refraction_index_Bodhaine1999, F_air_function: Callable = F_air_Bodhaine1999) → FloatingOrNDArray`

Return the *Rayleigh* optical depth $T_r(\lambda)$ as function of wavelength λ in centimeters (cm).

Parameters

- **wavelength** (FloatingOrArrayLike) – Wavelength λ in centimeters (cm).
- **CO2_concentration** (FloatingOrArrayLike) – CO_2 concentration in parts per million (ppm).
- **temperature** (FloatingOrArrayLike) – Air temperature $T[K]$ in kelvin degrees.
- **pressure** (FloatingOrArrayLike) – Surface pressure P of the measurement site.
- **latitude** (FloatingOrArrayLike) – Latitude of the site in degrees.
- **altitude** (FloatingOrArrayLike) – Altitude of the site in meters.
- **avogadro_constant** (FloatingOrArrayLike) – *Avogadro's* number (molecules mol^{-1}).
- **n_s_function** (Callable) – Air refraction index n_s computation method.

- **F_{air_function}** (*Callable*) – $(6 + 3_p)/(6 - 7_p)$, the depolarisation term $F(air)$ or *King Factor* computation method.

Returns

Rayleigh optical depth $T_r(\lambda)$.

Return type

`numpy.float64` or `numpy.ndarray`

Warning: Unlike most objects of `colour.phenomena.rayleigh` module, `colour.phenomena.rayleigh_optical_depth()` expects wavelength λ to be expressed in centimeters (cm).

References

[BWDS99], [Wikipedia01d]

Examples

```
>>> rayleigh_optical_depth(555 * 10e-8)
0.1004070...
```

colour.sd_rayleigh_scattering

`colour.sd_rayleigh_scattering`(*shape*: *SpectralShape* = `SPECTRAL_SHAPE_DEFAULT`,
CO2_concentration: *FloatingOrArrayLike* =
`CONSTANT_STANDARD_CO2_CONCENTRATION`, *temperature*:
FloatingOrArrayLike = `CONSTANT_STANDARD_AIR_TEMPERATURE`,
pressure: *FloatingOrArrayLike* =
`CONSTANT_AVERAGE_PRESSURE_MEAN_SEA_LEVEL`, *latitude*:
FloatingOrArrayLike = `CONSTANT_DEFAULT_LATITUDE`, *altitude*:
FloatingOrArrayLike = `CONSTANT_DEFAULT_ALTITUDE`,
avogadro_constant: *FloatingOrArrayLike* = `CONSTANT_AVOGADRO`,
n_s_function: *Callable* = `air_refraction_index_Bodhaine1999`,
F_air_function: *Callable* = `F_air_Bodhaine1999`) →
SpectralDistribution

Return the *Rayleigh* spectral distribution for given spectral shape.

Parameters

- **shape** (*SpectralShape*) – Spectral shape used to create the *Rayleigh* scattering spectral distribution.
- **CO2_concentration** (*FloatingOrArrayLike*) – CO_2 concentration in parts per million (ppm).
- **temperature** (*FloatingOrArrayLike*) – Air temperature $T[K]$ in kelvin degrees.
- **pressure** (*FloatingOrArrayLike*) – Surface pressure P of the measurement site.
- **latitude** (*FloatingOrArrayLike*) – Latitude of the site in degrees.
- **altitude** (*FloatingOrArrayLike*) – Altitude of the site in meters.
- **avogadro_constant** (*FloatingOrArrayLike*) – *Avogadro's* number (molecules mol^{-1}).
- **n_s_function** (*Callable*) – Air refraction index n_s computation method.

- **F_{air_function}** ([Callable](#)) – $(6 + 3_p)/(6 - 7_p)$, the depolarisation term $F(air)$ or *King Factor* computation method.

Returns

Rayleigh optical depth spectral distribution.

Return type

`colour.SpectralDistribution`

References

[BWDS99], [Wikipedia01d]

Examples

```
>>> from colour.utilities import numpy_print_options
>>> with numpy_print_options(suppress=True):
...     sd_rayleigh_scattering()
...
SpectralDistribution([[ 360.      ,  0.5991013...],
                    [ 361.      ,  0.5921706...],
                    [ 362.      ,  0.5853410...],
                    [ 363.      ,  0.5786105...],
                    [ 364.      ,  0.5719774...],
                    [ 365.      ,  0.5654401...],
                    [ 366.      ,  0.5589968...],
                    [ 367.      ,  0.5526460...],
                    [ 368.      ,  0.5463860...],
                    [ 369.      ,  0.5402153...],
                    [ 370.      ,  0.5341322...],
                    [ 371.      ,  0.5281354...],
                    [ 372.      ,  0.5222234...],
                    [ 373.      ,  0.5163946...],
                    [ 374.      ,  0.5106476...],
                    [ 375.      ,  0.5049812...],
                    [ 376.      ,  0.4993939...],
                    [ 377.      ,  0.4938844...],
                    [ 378.      ,  0.4884513...],
                    [ 379.      ,  0.4830934...],
                    [ 380.      ,  0.4778095...],
                    [ 381.      ,  0.4725983...],
                    [ 382.      ,  0.4674585...],
                    [ 383.      ,  0.4623891...],
                    [ 384.      ,  0.4573889...],
                    [ 385.      ,  0.4524566...],
                    [ 386.      ,  0.4475912...],
                    [ 387.      ,  0.4427917...],
                    [ 388.      ,  0.4380568...],
                    [ 389.      ,  0.4333856...],
                    [ 390.      ,  0.4287771...],
                    [ 391.      ,  0.4242302...],
                    [ 392.      ,  0.4197439...],
                    [ 393.      ,  0.4153172...],
                    [ 394.      ,  0.4109493...],
                    [ 395.      ,  0.4066391...],
                    [ 396.      ,  0.4023857...],
                    [ 397.      ,  0.3981882...],
```

(continues on next page)

(continued from previous page)

| | | |
|--------|---|----------------|
| [398. | , | 0.3940458...], |
| [399. | , | 0.3899576...], |
| [400. | , | 0.3859227...], |
| [401. | , | 0.3819402...], |
| [402. | , | 0.3780094...], |
| [403. | , | 0.3741295...], |
| [404. | , | 0.3702996...], |
| [405. | , | 0.366519 ...], |
| [406. | , | 0.3627868...], |
| [407. | , | 0.3591025...], |
| [408. | , | 0.3554651...], |
| [409. | , | 0.3518740...], |
| [410. | , | 0.3483286...], |
| [411. | , | 0.344828 ...], |
| [412. | , | 0.3413716...], |
| [413. | , | 0.3379587...], |
| [414. | , | 0.3345887...], |
| [415. | , | 0.3312609...], |
| [416. | , | 0.3279747...], |
| [417. | , | 0.3247294...], |
| [418. | , | 0.3215245...], |
| [419. | , | 0.3183593...], |
| [420. | , | 0.3152332...], |
| [421. | , | 0.3121457...], |
| [422. | , | 0.3090962...], |
| [423. | , | 0.3060841...], |
| [424. | , | 0.3031088...], |
| [425. | , | 0.3001699...], |
| [426. | , | 0.2972668...], |
| [427. | , | 0.2943989...], |
| [428. | , | 0.2915657...], |
| [429. | , | 0.2887668...], |
| [430. | , | 0.2860017...], |
| [431. | , | 0.2832697...], |
| [432. | , | 0.2805706...], |
| [433. | , | 0.2779037...], |
| [434. | , | 0.2752687...], |
| [435. | , | 0.2726650...], |
| [436. | , | 0.2700922...], |
| [437. | , | 0.2675500...], |
| [438. | , | 0.2650377...], |
| [439. | , | 0.2625551...], |
| [440. | , | 0.2601016...], |
| [441. | , | 0.2576770...], |
| [442. | , | 0.2552807...], |
| [443. | , | 0.2529124...], |
| [444. | , | 0.2505716...], |
| [445. | , | 0.2482581...], |
| [446. | , | 0.2459713...], |
| [447. | , | 0.2437110...], |
| [448. | , | 0.2414768...], |
| [449. | , | 0.2392683...], |
| [450. | , | 0.2370851...], |
| [451. | , | 0.2349269...], |
| [452. | , | 0.2327933...], |
| [453. | , | 0.2306841...], |

(continues on next page)

(continued from previous page)

| | | |
|--------|---|----------------|
| [454. | , | 0.2285989...], |
| [455. | , | 0.2265373...], |
| [456. | , | 0.2244990...], |
| [457. | , | 0.2224838...], |
| [458. | , | 0.2204912...], |
| [459. | , | 0.2185211...], |
| [460. | , | 0.2165730...], |
| [461. | , | 0.2146467...], |
| [462. | , | 0.2127419...], |
| [463. | , | 0.2108583...], |
| [464. | , | 0.2089957...], |
| [465. | , | 0.2071536...], |
| [466. | , | 0.2053320...], |
| [467. | , | 0.2035304...], |
| [468. | , | 0.2017487...], |
| [469. | , | 0.1999865...], |
| [470. | , | 0.1982436...], |
| [471. | , | 0.1965198...], |
| [472. | , | 0.1948148...], |
| [473. | , | 0.1931284...], |
| [474. | , | 0.1914602...], |
| [475. | , | 0.1898101...], |
| [476. | , | 0.1881779...], |
| [477. | , | 0.1865633...], |
| [478. | , | 0.1849660...], |
| [479. | , | 0.1833859...], |
| [480. | , | 0.1818227...], |
| [481. | , | 0.1802762...], |
| [482. | , | 0.1787463...], |
| [483. | , | 0.1772326...], |
| [484. | , | 0.1757349...], |
| [485. | , | 0.1742532...], |
| [486. | , | 0.1727871...], |
| [487. | , | 0.1713365...], |
| [488. | , | 0.1699011...], |
| [489. | , | 0.1684809...], |
| [490. | , | 0.1670755...], |
| [491. | , | 0.1656848...], |
| [492. | , | 0.1643086...], |
| [493. | , | 0.1629468...], |
| [494. | , | 0.1615991...], |
| [495. | , | 0.1602654...], |
| [496. | , | 0.1589455...], |
| [497. | , | 0.1576392...], |
| [498. | , | 0.1563464...], |
| [499. | , | 0.1550668...], |
| [500. | , | 0.1538004...], |
| [501. | , | 0.1525470...], |
| [502. | , | 0.1513063...], |
| [503. | , | 0.1500783...], |
| [504. | , | 0.1488628...], |
| [505. | , | 0.1476597...], |
| [506. | , | 0.1464687...], |
| [507. | , | 0.1452898...], |
| [508. | , | 0.1441228...], |
| [509. | , | 0.1429675...], |

(continues on next page)

(continued from previous page)

| | | |
|--------|---|----------------|
| [510. | , | 0.1418238...], |
| [511. | , | 0.1406916...], |
| [512. | , | 0.1395707...], |
| [513. | , | 0.1384610...], |
| [514. | , | 0.1373624...], |
| [515. | , | 0.1362747...], |
| [516. | , | 0.1351978...], |
| [517. | , | 0.1341316...], |
| [518. | , | 0.1330759...], |
| [519. | , | 0.1320306...], |
| [520. | , | 0.1309956...], |
| [521. | , | 0.1299707...], |
| [522. | , | 0.1289559...], |
| [523. | , | 0.1279511...], |
| [524. | , | 0.1269560...], |
| [525. | , | 0.1259707...], |
| [526. | , | 0.1249949...], |
| [527. | , | 0.1240286...], |
| [528. | , | 0.1230717...], |
| [529. | , | 0.1221240...], |
| [530. | , | 0.1211855...], |
| [531. | , | 0.1202560...], |
| [532. | , | 0.1193354...], |
| [533. | , | 0.1184237...], |
| [534. | , | 0.1175207...], |
| [535. | , | 0.1166263...], |
| [536. | , | 0.1157404...], |
| [537. | , | 0.1148630...], |
| [538. | , | 0.1139939...], |
| [539. | , | 0.1131331...], |
| [540. | , | 0.1122804...], |
| [541. | , | 0.1114357...], |
| [542. | , | 0.1105990...], |
| [543. | , | 0.1097702...], |
| [544. | , | 0.1089492...], |
| [545. | , | 0.1081358...], |
| [546. | , | 0.1073301...], |
| [547. | , | 0.1065319...], |
| [548. | , | 0.1057411...], |
| [549. | , | 0.1049577...], |
| [550. | , | 0.1041815...], |
| [551. | , | 0.1034125...], |
| [552. | , | 0.1026507...], |
| [553. | , | 0.1018958...], |
| [554. | , | 0.1011480...], |
| [555. | , | 0.1004070...], |
| [556. | , | 0.0996728...], |
| [557. | , | 0.0989453...], |
| [558. | , | 0.0982245...], |
| [559. | , | 0.0975102...], |
| [560. | , | 0.0968025...], |
| [561. | , | 0.0961012...], |
| [562. | , | 0.0954062...], |
| [563. | , | 0.0947176...], |
| [564. | , | 0.0940352...], |
| [565. | , | 0.0933589...], |

(continues on next page)

(continued from previous page)

| | | |
|--------|---|----------------|
| [566. | , | 0.0926887...], |
| [567. | , | 0.0920246...], |
| [568. | , | 0.0913664...], |
| [569. | , | 0.0907141...], |
| [570. | , | 0.0900677...], |
| [571. | , | 0.0894270...], |
| [572. | , | 0.0887920...], |
| [573. | , | 0.0881627...], |
| [574. | , | 0.0875389...], |
| [575. | , | 0.0869207...], |
| [576. | , | 0.0863079...], |
| [577. | , | 0.0857006...], |
| [578. | , | 0.0850986...], |
| [579. | , | 0.0845019...], |
| [580. | , | 0.0839104...], |
| [581. | , | 0.0833242...], |
| [582. | , | 0.0827430...], |
| [583. | , | 0.082167 ...], |
| [584. | , | 0.0815959...], |
| [585. | , | 0.0810298...], |
| [586. | , | 0.0804687...], |
| [587. | , | 0.0799124...], |
| [588. | , | 0.0793609...], |
| [589. | , | 0.0788142...], |
| [590. | , | 0.0782722...], |
| [591. | , | 0.0777349...], |
| [592. | , | 0.0772022...], |
| [593. | , | 0.0766740...], |
| [594. | , | 0.0761504...], |
| [595. | , | 0.0756313...], |
| [596. | , | 0.0751166...], |
| [597. | , | 0.0746063...], |
| [598. | , | 0.0741003...], |
| [599. | , | 0.0735986...], |
| [600. | , | 0.0731012...], |
| [601. | , | 0.072608 ...], |
| [602. | , | 0.0721189...], |
| [603. | , | 0.0716340...], |
| [604. | , | 0.0711531...], |
| [605. | , | 0.0706763...], |
| [606. | , | 0.0702035...], |
| [607. | , | 0.0697347...], |
| [608. | , | 0.0692697...], |
| [609. | , | 0.0688087...], |
| [610. | , | 0.0683515...], |
| [611. | , | 0.0678981...], |
| [612. | , | 0.0674485...], |
| [613. | , | 0.0670026...], |
| [614. | , | 0.0665603...], |
| [615. | , | 0.0661218...], |
| [616. | , | 0.0656868...], |
| [617. | , | 0.0652555...], |
| [618. | , | 0.0648277...], |
| [619. | , | 0.0644033...], |
| [620. | , | 0.0639825...], |
| [621. | , | 0.0635651...], |

(continues on next page)

(continued from previous page)

| | | |
|--------|---|----------------|
| [622. | , | 0.0631512...], |
| [623. | , | 0.0627406...], |
| [624. | , | 0.0623333...], |
| [625. | , | 0.0619293...], |
| [626. | , | 0.0615287...], |
| [627. | , | 0.0611312...], |
| [628. | , | 0.0607370...], |
| [629. | , | 0.0603460...], |
| [630. | , | 0.0599581...], |
| [631. | , | 0.0595733...], |
| [632. | , | 0.0591917...], |
| [633. | , | 0.0588131...], |
| [634. | , | 0.0584375...], |
| [635. | , | 0.0580649...], |
| [636. | , | 0.0576953...], |
| [637. | , | 0.0573286...], |
| [638. | , | 0.0569649...], |
| [639. | , | 0.0566040...], |
| [640. | , | 0.0562460...], |
| [641. | , | 0.0558909...], |
| [642. | , | 0.0555385...], |
| [643. | , | 0.0551890...], |
| [644. | , | 0.0548421...], |
| [645. | , | 0.0544981...], |
| [646. | , | 0.0541567...], |
| [647. | , | 0.053818 ...], |
| [648. | , | 0.0534819...], |
| [649. | , | 0.0531485...], |
| [650. | , | 0.0528176...], |
| [651. | , | 0.0524894...], |
| [652. | , | 0.0521637...], |
| [653. | , | 0.0518405...], |
| [654. | , | 0.0515198...], |
| [655. | , | 0.0512017...], |
| [656. | , | 0.0508859...], |
| [657. | , | 0.0505726...], |
| [658. | , | 0.0502618...], |
| [659. | , | 0.0499533...], |
| [660. | , | 0.0496472...], |
| [661. | , | 0.0493434...], |
| [662. | , | 0.0490420...], |
| [663. | , | 0.0487428...], |
| [664. | , | 0.0484460...], |
| [665. | , | 0.0481514...], |
| [666. | , | 0.0478591...], |
| [667. | , | 0.0475689...], |
| [668. | , | 0.0472810...], |
| [669. | , | 0.0469953...], |
| [670. | , | 0.0467117...], |
| [671. | , | 0.0464302...], |
| [672. | , | 0.0461509...], |
| [673. | , | 0.0458737...], |
| [674. | , | 0.0455986...], |
| [675. | , | 0.0453255...], |
| [676. | , | 0.0450545...], |
| [677. | , | 0.0447855...], |

(continues on next page)

(continued from previous page)

| | | |
|--------|---|----------------|
| [678. | , | 0.0445185...], |
| [679. | , | 0.0442535...], |
| [680. | , | 0.0439905...], |
| [681. | , | 0.0437294...], |
| [682. | , | 0.0434703...], |
| [683. | , | 0.0432131...], |
| [684. | , | 0.0429578...], |
| [685. | , | 0.0427044...], |
| [686. | , | 0.0424529...], |
| [687. | , | 0.0422032...], |
| [688. | , | 0.0419553...], |
| [689. | , | 0.0417093...], |
| [690. | , | 0.0414651...], |
| [691. | , | 0.0412226...], |
| [692. | , | 0.0409820...], |
| [693. | , | 0.0407431...], |
| [694. | , | 0.0405059...], |
| [695. | , | 0.0402705...], |
| [696. | , | 0.0400368...], |
| [697. | , | 0.0398047...], |
| [698. | , | 0.0395744...], |
| [699. | , | 0.0393457...], |
| [700. | , | 0.0391187...], |
| [701. | , | 0.0388933...], |
| [702. | , | 0.0386696...], |
| [703. | , | 0.0384474...], |
| [704. | , | 0.0382269...], |
| [705. | , | 0.0380079...], |
| [706. | , | 0.0377905...], |
| [707. | , | 0.0375747...], |
| [708. | , | 0.0373604...], |
| [709. | , | 0.0371476...], |
| [710. | , | 0.0369364...], |
| [711. | , | 0.0367266...], |
| [712. | , | 0.0365184...], |
| [713. | , | 0.0363116...], |
| [714. | , | 0.0361063...], |
| [715. | , | 0.0359024...], |
| [716. | , | 0.0357000...], |
| [717. | , | 0.0354990...], |
| [718. | , | 0.0352994...], |
| [719. | , | 0.0351012...], |
| [720. | , | 0.0349044...], |
| [721. | , | 0.0347090...], |
| [722. | , | 0.0345150...], |
| [723. | , | 0.0343223...], |
| [724. | , | 0.0341310...], |
| [725. | , | 0.0339410...], |
| [726. | , | 0.0337523...], |
| [727. | , | 0.033565 ...], |
| [728. | , | 0.0333789...], |
| [729. | , | 0.0331941...], |
| [730. | , | 0.0330106...], |
| [731. | , | 0.0328284...], |
| [732. | , | 0.0326474...], |
| [733. | , | 0.0324677...], |

(continues on next page)

(continued from previous page)

```

[ 734.      , 0.0322893...],
[ 735.      , 0.0321120...],
[ 736.      , 0.0319360...],
[ 737.      , 0.0317611...],
[ 738.      , 0.0315875...],
[ 739.      , 0.0314151...],
[ 740.      , 0.0312438...],
[ 741.      , 0.0310737...],
[ 742.      , 0.0309048...],
[ 743.      , 0.0307370...],
[ 744.      , 0.0305703...],
[ 745.      , 0.0304048...],
[ 746.      , 0.0302404...],
[ 747.      , 0.0300771...],
[ 748.      , 0.0299149...],
[ 749.      , 0.0297538...],
[ 750.      , 0.0295938...],
[ 751.      , 0.0294349...],
[ 752.      , 0.0292771...],
[ 753.      , 0.0291203...],
[ 754.      , 0.0289645...],
[ 755.      , 0.0288098...],
[ 756.      , 0.0286561...],
[ 757.      , 0.0285035...],
[ 758.      , 0.0283518...],
[ 759.      , 0.0282012...],
[ 760.      , 0.0280516...],
[ 761.      , 0.0279030...],
[ 762.      , 0.0277553...],
[ 763.      , 0.0276086...],
[ 764.      , 0.027463 ...],
[ 765.      , 0.0273182...],
[ 766.      , 0.0271744...],
[ 767.      , 0.0270316...],
[ 768.      , 0.0268897...],
[ 769.      , 0.0267487...],
[ 770.      , 0.0266087...],
[ 771.      , 0.0264696...],
[ 772.      , 0.0263314...],
[ 773.      , 0.0261941...],
[ 774.      , 0.0260576...],
[ 775.      , 0.0259221...],
[ 776.      , 0.0257875...],
[ 777.      , 0.0256537...],
[ 778.      , 0.0255208...],
[ 779.      , 0.0253888...],
[ 780.      , 0.0252576...]],

```

```

SpragueInterpolator,
{}),
Extrapolator,
{'method': 'Constant', 'left': None, 'right': None})

```

colour.scattering_cross_section

```
colour.scattering_cross_section(wavelength: FloatingOrArrayLike, CO2_concentration:
    FloatingOrArrayLike =
    CONSTANT_STANDARD_CO2_CONCENTRATION, temperature:
    FloatingOrArrayLike =
    CONSTANT_STANDARD_AIR_TEMPERATURE, avogadro_constant:
    FloatingOrArrayLike = CONSTANT_AVOGADRO, n_s_function:
    Callable = air_refraction_index_Bodhaine1999, F_air_function:
    Callable = F_air_Bodhaine1999) → FloatingOrNDArray
```

Return the scattering cross section per molecule σ of dry air as function of wavelength λ in centimeters (cm) using given CO_2 concentration in parts per million (ppm) and temperature $T[K]$ in kelvin degrees following *Van de Hulst (1957)* method.

Parameters

- **wavelength** (FloatingOrArrayLike) – Wavelength λ in centimeters (cm).
- **CO2_concentration** (FloatingOrArrayLike) – CO_2 concentration in parts per million (ppm).
- **temperature** (FloatingOrArrayLike) – Air temperature $T[K]$ in kelvin degrees.
- **avogadro_constant** (FloatingOrArrayLike) – *Avogadro's* number (molecules mol^{-1}).
- **n_s_function** (Callable) – Air refraction index n_s computation method.
- **F_air_function** (Callable) – $(6 + 3_p)/(6 - 7_p)$, the depolarisation term $F(air)$ or *King Factor* computation method.

Returns

Scattering cross section per molecule σ of dry air.

Return type

`numpy.floating` or `numpy.ndarray`

Warning: Unlike most objects of `colour.phenomena.rayleigh` module, `colour.scattering_cross_section()` expects wavelength λ to be expressed in centimeters (cm).

References

[BWDS99], [Wikipedia01d]

Examples

```
>>> scattering_cross_section(555 * 10e-8)
4.6613309...e-27
```

`colour.phenomena`

| | |
|--|--|
| <code>rayleigh_optical_depth(wavelength[, ...])</code> | Return the <i>Rayleigh</i> optical depth $T_r(\lambda)$ as function of wavelength λ in centimeters (cm). |
|--|--|

`colour.phenomena.rayleigh_optical_depth`

```
colour.phenomena.rayleigh_optical_depth(wavelength: FloatingOrArrayLike, CO2_concentration:
    FloatingOrArrayLike =
    CONSTANT_STANDARD_CO2_CONCENTRATION,
    temperature: FloatingOrArrayLike =
    CONSTANT_STANDARD_AIR_TEMPERATURE, pressure:
    FloatingOrArrayLike =
    CONSTANT_AVERAGE_PRESSURE_MEAN_SEA_LEVEL,
    latitude: FloatingOrArrayLike =
    CONSTANT_DEFAULT_LATITUDE, altitude:
    FloatingOrArrayLike = CONSTANT_DEFAULT_ALTITUDE,
    avogadro_constant: FloatingOrArrayLike =
    CONSTANT_AVOGADRO, n_s_function: Callable =
    air_refraction_index_Bodhaine1999, F_air_function:
    Callable = F_air_Bodhaine1999) → FloatingOrNDArray
```

Return the *Rayleigh* optical depth $T_r(\lambda)$ as function of wavelength λ in centimeters (cm).

Parameters

- **wavelength** (FloatingOrArrayLike) – Wavelength λ in centimeters (cm).
- **CO2_concentration** (FloatingOrArrayLike) – CO_2 concentration in parts per million (ppm).
- **temperature** (FloatingOrArrayLike) – Air temperature $T[K]$ in kelvin degrees.
- **pressure** (FloatingOrArrayLike) – Surface pressure P of the measurement site.
- **latitude** (FloatingOrArrayLike) – Latitude of the site in degrees.
- **altitude** (FloatingOrArrayLike) – Altitude of the site in meters.
- **avogadro_constant** (FloatingOrArrayLike) – *Avogadro's* number (molecules mol^{-1}).
- **n_s_function** (Callable) – Air refraction index n_s computation method.
- **F_air_function** (Callable) – $(6 + 3_p)/(6 - 7_p)$, the depolarisation term $F(air)$ or *King Factor* computation method.

Returns

Rayleigh optical depth $T_r(\lambda)$.

Return type

`numpy.floating` or `numpy.ndarray`

Warning: Unlike most objects of `colour.phenomena.rayleigh` module, `colour.phenomena.rayleigh_optical_depth()` expects wavelength λ to be expressed in centimeters (cm).

References

[BWDS99], [Wikipedia01d]

Examples

```
>>> rayleigh_optical_depth(555 * 10e-8)
0.1004070...
```

Plotting

Common

`colour.plotting`

| | |
|--|--|
| <code>colour_style([use_style])</code> | Return <i>Colour</i> plotting style. |
| <code>colour_cycle(**kwargs)</code> | Return a colour cycle iterator using given colour map. |
| <code>artist(**kwargs)</code> | Return the current figure and its axes or creates a new one. |
| <code>camera(**kwargs)</code> | Set the camera settings. |
| <code>render(**kwargs)</code> | Render the current figure while adjusting various settings such as the bounding box, the title or background transparency. |
| <code>label_rectangles(labels, rectangles[, ...])</code> | Add labels above given rectangles. |
| <code>uniform_axes3d(**kwargs)</code> | Set equal aspect ratio to given 3d axes. |
| <code>plot_single_colour_swatch(colour_swatch, ...)</code> | Plot given colour swatch. |
| <code>plot_multi_colour_swatches(colour_swatches)</code> | Plot given colours swatches. |
| <code>plot_single_function(function[, samples, ...])</code> | Plot given function. |
| <code>plot_multi_functions(functions[, samples, ...])</code> | Plot given functions. |
| <code>plot_image(image[, imshow_kwargs, text_kwargs])</code> | Plot given image. |

`colour.plotting.colour_style`

`colour.plotting.colour_style(use_style: bool = True) → Dict`

Return *Colour* plotting style.

Parameters

`use_style` (*bool*) – Whether to use the style and load it into *Matplotlib*.

Returns

Colour style.

Return type

dict

`colour.plotting.colour_cycle`

`colour.plotting.colour_cycle(**kwargs: Any) → cycle`

Return a colour cycle iterator using given colour map.

Parameters

- **`colour_cycle_map`** – *Matplotlib* colourmap name.
- **`colour_cycle_count`** – Colours count to pick in the colourmap.
- **`kwargs`** (*Any*) –

Returns

Colour cycle iterator.

Return type

`itertools.cycle`

colour.plotting.artist

`colour.plotting.artist(**kwargs: KwargsArtist | Any) → Tuple[Figure, Axes]`

Return the current figure and its axes or creates a new one.

Parameters

kwargs (`KwargsArtist | Any`) – {`colour.plotting.common.KwargsArtist()`}, See the documentation of the previously listed class.

Returns

Current figure and axes.

Return type

`tuple`

colour.plotting.camera

`colour.plotting.camera(**kwargs: KwargsCamera | Any) → Tuple[Figure, Axes]`

Set the camera settings.

Parameters

kwargs (`KwargsCamera | Any`) – {`colour.plotting.common.KwargsCamera()`}, See the documentation of the previously listed class.

Returns

Current figure and axes.

Return type

`tuple`

colour.plotting.render

`colour.plotting.render(**kwargs: KwargsRender | Any) → Tuple[Figure, Axes]`

Render the current figure while adjusting various settings such as the bounding box, the title or background transparency.

Parameters

kwargs (`KwargsRender | Any`) – {`colour.plotting.common.KwargsRender()`}, See the documentation of the previously listed class.

Returns

Current figure and axes.

Return type

`tuple`

colour.plotting.label_rectangles

```
colour.plotting.label_rectangles(labels: ~typing.Sequence[str], rectangles:
    ~typing.Sequence[<module 'matplotlib.patches' from
    '/home/docs/checkouts/readthedocs.org/user_builds/colour/envs/v0.4.2/lib/python3.
    packages/matplotlib/patches.py'>], rotation:
    ~typing.Literal['horizontal', 'vertical'] | str = "vertical", text_size:
    float = 10, offset: ArrayLike | None = None, **kwargs:
    ~typing.Any) → Tuple[Figure, Axes]
```

Add labels above given rectangles.

Parameters

- **labels** (`Sequence[str]`) – Labels to display.
- **rectangles** (`Sequence[<module 'matplotlib.patches' from '/home/docs/checkouts/readthedocs.org/user_builds/colour/envs/v0.4.2/lib/python3.11/site-packages/matplotlib/patches.py'>]`) – Rectangles to used to set the labels value and position.
- **rotation** (`Literal['horizontal', 'vertical'] | str`) – Labels orientation.
- **text_size** (`float`) – Labels text size.
- **offset** (`ArrayLike | None`) – Labels offset as percentages of the largest rectangle dimensions.
- **figure** – Figure to apply the render elements onto.
- **axes** – Axes to apply the render elements onto.
- **kwargs** (`Any`) –

Returns

Current figure and axes.

Return type

`tuple`

colour.plotting.uniform_axes3d

```
colour.plotting.uniform_axes3d(**kwargs: Any) → Tuple[Figure, Axes]
```

Set equal aspect ratio to given 3d axes.

Parameters

- **figure** – Figure to apply the render elements onto.
- **axes** – Axes to apply the render elements onto.
- **kwargs** (`Any`) –

Returns

Current figure and axes.

Return type

`tuple`

colour.plotting.plot_single_colour_swatch

`colour.plotting.plot_single_colour_swatch`(*colour_swatch*: *ArrayLike* | *ColourSwatch*, ***kwargs*: *Any*) → *Tuple*[*Figure*, *Axes*]

Plot given colour swatch.

Parameters

- **colour_swatch** (*ArrayLike* | *ColourSwatch*) – Colour swatch, either a regular *ArrayLike* or a `colour.plotting.ColourSwatch` class instance.
- **kwargs** (*Any*) – {`colour.plotting.artist()`, `colour.plotting.plot_multi_colour_swatches()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

Current figure and axes.

Return type

tuple

Examples

```
>>> RGB = ColourSwatch((0.45620519, 0.03081071, 0.04091952))
>>> plot_single_colour_swatch(RGB)
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



colour.plotting.plot_multi_colour_swatches

```
colour.plotting.plot_multi_colour_swatches(colour_swatches: Sequence[ArrayLike | ColourSwatch],
width: float = 1, height: float = 1, spacing: float = 0,
columns: int | None = None, direction: Literal['+y',
'-y'] | str = '+y', text_kwargs: Dict | None = None,
background_colour: ArrayLike = (1.0, 1.0, 1.0),
compare_swatches: Literal['Diagonal', 'Stacked'] | str |
None = None, **kwargs: Any) → Tuple[Figure, Axes]
```

Plot given colours swatches.

Parameters

- **colour_swatches** (`Sequence[ArrayLike | ColourSwatch]`) – Colour swatch sequence, either a regular `ArrayLike` or a sequence of `colour.plotting.ColourSwatch` class instances.
- **width** (`float`) – Colour swatch width.
- **height** (`float`) – Colour swatch height.
- **spacing** (`float`) – Colour swatches spacing.
- **columns** (`int | None`) – Colour swatches columns count, defaults to the colour swatch count or half of it if comparing.
- **direction** (`Literal['+y', '-y'] | str`) – Row stacking direction.
- **text_kwargs** (`Dict | None`) – Keyword arguments for the `matplotlib.pyplot.text()` definition. The following special keywords can also be used:
 - `offset`: Sets the text offset.
 - `visible`: Sets the text visibility.
- **background_colour** (`ArrayLike`) – Background colour.
- **compare_swatches** (`Literal['Diagonal', 'Stacked'] | str | None`) – Whether to compare the swatches, in which case the colour swatch count must be an even number with alternating reference colour swatches and test colour swatches. *Stacked* will draw the test colour swatch in the center of the reference colour swatch, *Diagonal* will draw the reference colour swatch in the upper left diagonal area and the test colour swatch in the bottom right diagonal area.
- **kwargs** (`Any`) – `{colour.plotting.artist(), colour.plotting.render()}`, See the documentation of the previously listed definitions.

Returns

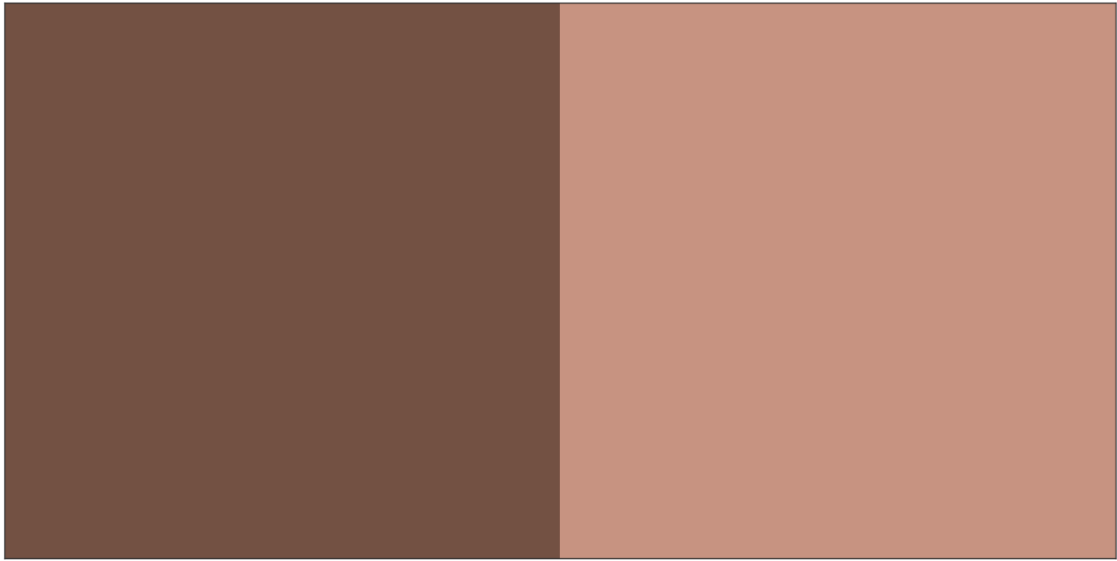
Current figure and axes.

Return type

`tuple`

Examples

```
>>> RGB_1 = ColourSwatch((0.45293517, 0.31732158, 0.26414773))
>>> RGB_2 = ColourSwatch((0.77875824, 0.57726450, 0.50453169))
>>> plot_multi_colour_swatches([RGB_1, RGB_2])
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



colour.plotting.plot_single_function

`colour.plotting.plot_single_function`(*function*: *Callable*, *samples*: *ArrayLike* | *None* = *None*, *log_x*: *int* | *None* = *None*, *log_y*: *int* | *None* = *None*, *plot_kwargs*: *Dict* | *List[Dict]* | *None* = *None*, ***kwargs*: *Any*) → *Tuple*[*Figure*, *Axes*]

Plot given function.

Parameters

- **function** (*Callable*) – Function to plot.
- **samples** (*ArrayLike* | *None*) – Samples to evaluate the functions with.
- **log_x** (*int* | *None*) – Log base to use for the *x* axis scale, if *None*, the *x* axis scale will be linear.
- **log_y** (*int* | *None*) – Log base to use for the *y* axis scale, if *None*, the *y* axis scale will be linear.
- **plot_kwargs** (*Dict* | *List[Dict]* | *None*) – Keyword arguments for the `matplotlib.pyplot.plot()` definition, used to control the style of the plotted function.
- **kwargs** (*Any*) – {`colour.plotting.artist()`, `colour.plotting.plot_multi_functions()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

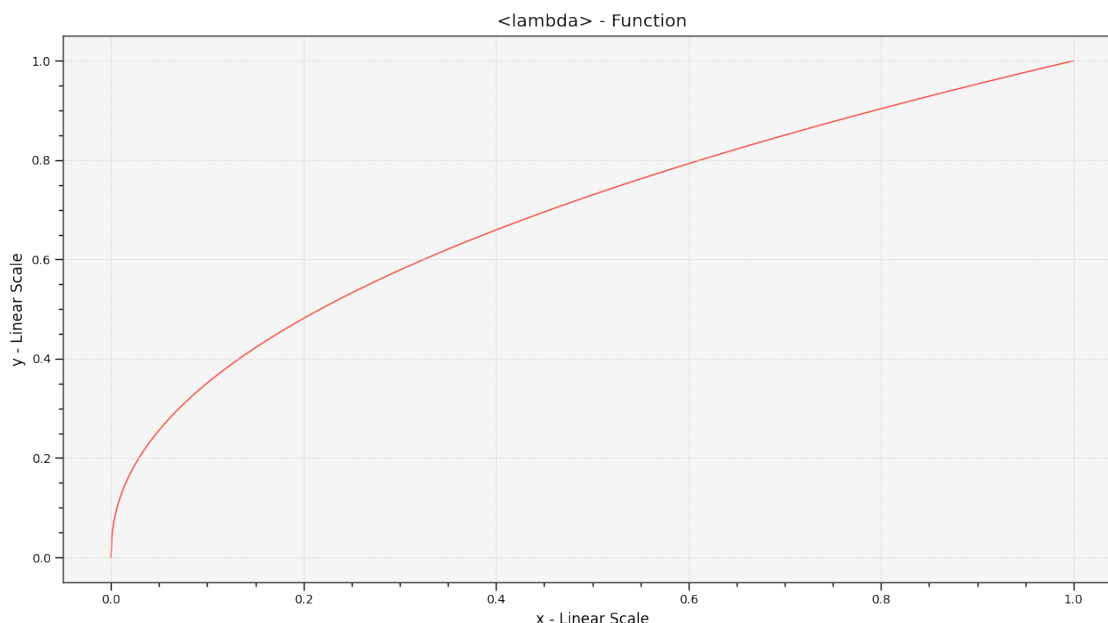
Current figure and axes.

Return type

tuple

Examples

```
>>> from colour.models import gamma_function
>>> plot_single_function(partial(gamma_function, exponent=1 / 2.2))
...
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



colour.plotting.plot_multi_functions

colour.plotting.plot_multi_functions(functions: Dict[str, Callable], samples: ArrayLike | None = None, log_x: int | None = None, log_y: int | None = None, plot_kwargs: Dict | List[Dict] | None = None, **kwargs: Any) → Tuple[Figure, Axes]

Plot given functions.

Parameters

- **functions** (Dict[str, Callable]) – Functions to plot.
- **samples** (ArrayLike | None) – Samples to evaluate the functions with.
- **log_x** (int | None) – Log base to use for the x axis scale, if None, the x axis scale will be linear.
- **log_y** (int | None) – Log base to use for the y axis scale, if None, the y axis scale will be linear.
- **plot_kwargs** (Dict | List[Dict] | None) – Keyword arguments for the matplotlib.pyplot.plot() definition, used to control the style of the plotted functions. plot_kwargs can be either a single dictionary applied to all the plotted functions with the same settings or a sequence of dictionaries with different settings for each plotted function.
- **kwargs** (Any) – {colour.plotting.artist(), colour.plotting.render()}, See the documentation of the previously listed definitions.

Returns

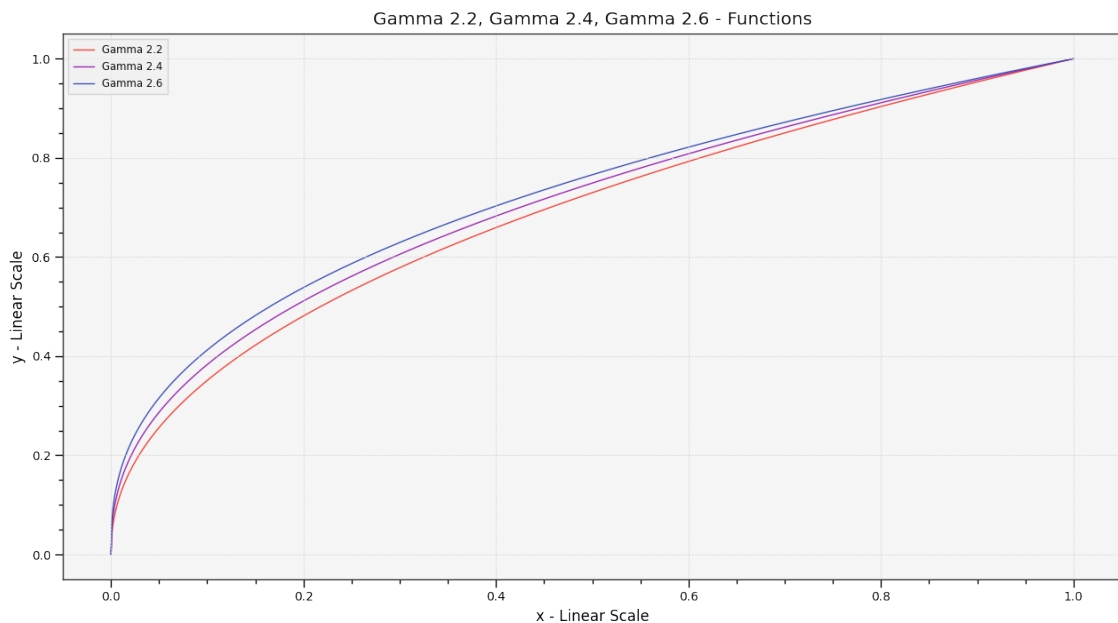
Current figure and axes.

Return type

tuple

Examples

```
>>> functions = {
...     "Gamma 2.2": lambda x: x ** (1 / 2.2),
...     "Gamma 2.4": lambda x: x ** (1 / 2.4),
...     "Gamma 2.6": lambda x: x ** (1 / 2.6),
... }
>>> plot_multi_functions(functions)
...
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```

**colour.plotting.plot_image**

colour.plotting.**plot_image**(image: ArrayLike, imshow_kwargs: Dict | None = None, text_kwargs: Dict | None = None, **kwargs: Any) → Tuple[Figure, Axes]

Plot given image.

Parameters

- **image** (ArrayLike) – Image to plot.
- **imshow_kwargs** (Dict | None) – Keyword arguments for the `matplotlib.pyplot.imshow()` definition.
- **text_kwargs** (Dict | None) – Keyword arguments for the `matplotlib.pyplot.text()` definition. The following special keyword arguments can also be used:
 - **offset** : Sets the text offset.
- **kwargs** (Any) – {`colour.plotting.artist()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

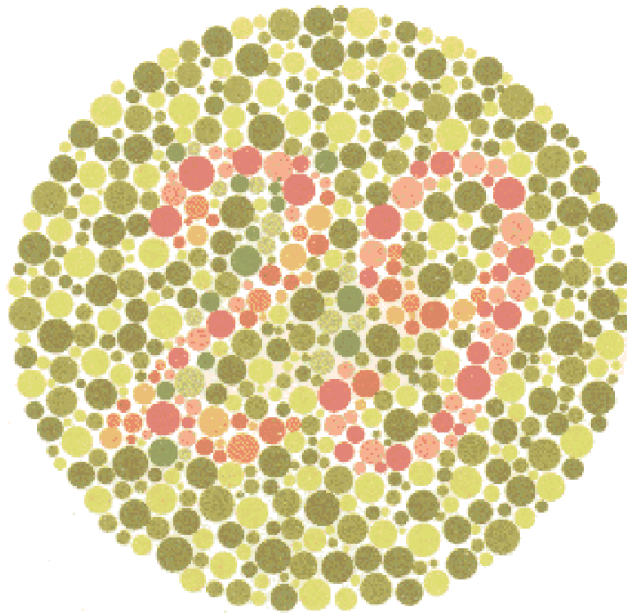
Current figure and axes.

Return type

tuple

Examples

```
>>> import os
>>> import colour
>>> from colour import read_image
>>> path = os.path.join(
...     colour.__path__[0],
...     "examples",
...     "plotting",
...     "resources",
...     "Ishihara_Colour_Blindness_Test_Plate_3.png",
... )
>>> plot_image(read_image(path))
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```

**Ancillary Objects**

colour.plotting.common

| | |
|--|---|
| <code>KwargsArtist</code> | Define the keyword argument types for the <code>colour.plotting.artist()</code> definition. |
| <code>KwargsCamera</code> | Define the keyword argument types for the <code>colour.plotting.camera()</code> definition. |
| <code>KwargsRender</code> | Define the keyword argument types for the <code>colour.plotting.render()</code> definition. |
| <code>filter_passthrough(mapping, filterers[, ...])</code> | Return mapping objects matching given filterers while passing through class instances whose type is one of the mapping element types. |
| <code>filter_RGB_colourspace(filterers[, ...])</code> | Return the <i>RGB</i> colourspaces matching given filterers. |
| <code>filter_cmfs(filterers[, allow_non_siblings])</code> | Return the colour matching functions matching given filterers. |
| <code>filter_illuminants(filterers[, ...])</code> | Return the illuminants matching given filterers. |
| <code>filter_colour_checkers(filterers[, ...])</code> | Return the colour checkers matching given filterers. |

`colour.plotting.common.KwargsArtist`

class `colour.plotting.common.KwargsArtist`

Define the keyword argument types for the `colour.plotting.artist()` definition.

Parameters

- **axes** (`matplotlib.axes._axes.Axes`) – Axes that will be passed through without creating a new figure.
- **uniform** (`bool`) – Whether to create the figure with an equal aspect ratio.

`__init__(*args, **kwargs)`

Methods

| | |
|---|--|
| <code>__init__(*args, **kwargs)</code> | |
| <code>clear()</code> | |
| <code>copy()</code> | |
| <code>fromkeys([value])</code> | Create a new dictionary with keys from iterable and values set to value. |
| <code>get(key[, default])</code> | Return the value for key if key is in the dictionary, else default. |
| <code>items()</code> | |
| <code>keys()</code> | |
| <code>pop(k[,d])</code> | If the key is not found, return the default if given; otherwise, raise a KeyError. |
| <code>popitem()</code> | Remove and return a (key, value) pair as a 2-tuple. |
| <code>setdefault(key[, default])</code> | Insert key with a value of default if key is not in the dictionary. |
| <code>update([E,]**F)</code> | If E is present and has a .keys() method, then does: for k in E: D[k] = E[k] If E is present and lacks a .keys() method, then does: for k, v in E: D[k] = v In either case, this is followed by: for k in F: D[k] = F[k] |
| <code>values()</code> | |

Attributes

| |
|----------------------|
| <code>axes</code> |
| <code>uniform</code> |

`colour.plotting.common.KwargsCamera`

class `colour.plotting.common.KwargsCamera`

Define the keyword argument types for the `colour.plotting.camera()` definition.

Parameters

- **figure** (`matplotlib.figure.Figure`) – Figure to apply the render elements onto.
- **axes** (`matplotlib.axes._axes.Axes`) – Axes to apply the render elements onto.
- **azimuth** (`float` | `None`) – Camera azimuth.
- **elevation** (`float` | `None`) – Camera elevation.
- **camera_aspect** (`Literal['equal']` | `str`) – Matplotlib axes aspect. Default is *equal*.

`__init__(*args, **kwargs)`

Methods

| | |
|---|--|
| <code>__init__(*args, **kwargs)</code> | |
| <code>clear()</code> | |
| <code>copy()</code> | |
| <code>fromkeys([value])</code> | Create a new dictionary with keys from iterable and values set to value. |
| <code>get(key[, default])</code> | Return the value for key if key is in the dictionary, else default. |
| <code>items()</code> | |
| <code>keys()</code> | |
| <code>pop(k[,d])</code> | If the key is not found, return the default if given; otherwise, raise a KeyError. |
| <code>popitem()</code> | Remove and return a (key, value) pair as a 2-tuple. |
| <code>setdefault(key[, default])</code> | Insert key with a value of default if key is not in the dictionary. |
| <code>update([E,]**F)</code> | If E is present and has a .keys() method, then does: for k in E: D[k] = E[k] If E is present and lacks a .keys() method, then does: for k, v in E: D[k] = v In either case, this is followed by: for k in F: D[k] = F[k] |
| <code>values()</code> | |

Attributes

| |
|----------------------------|
| <code>figure</code> |
| <code>axes</code> |
| <code>azimuth</code> |
| <code>elevation</code> |
| <code>camera_aspect</code> |

`colour.plotting.common.KwargsRender`

class `colour.plotting.common.KwargsRender`

Define the keyword argument types for the `colour.plotting.render()` definition.

Parameters

- **figure** (`matplotlib.figure.Figure`) – Figure to apply the render elements onto.
- **axes** (`matplotlib.axes._axes.Axes`) – Axes to apply the render elements onto.
- **filename** (`str`) – Figure will be saved using given filename argument.

- **standalone** (*bool*) – Whether to show the figure and call `matplotlib.pyplot.show()` definition.
- **aspect** (`Literal['auto', 'equal'] | float`) – Matplotlib axes aspect.
- **axes_visible** (*bool*) – Whether the axes are visible. Default is *True*.
- **bounding_box** (*ArrayLike*) – Array defining current axes limits such *bounding_box = (x min, x max, y min, y max)*.
- **tight_layout** (*bool*) – Whether to invoke the `matplotlib.pyplot.tight_layout()` definition.
- **legend** (*bool*) – Whether to display the legend. Default is *False*.
- **legend_columns** (*int*) – Number of columns in the legend. Default is *1*.
- **transparent_background** (*bool*) – Whether to turn off the background patch. Default is *True*.
- **title** (*str*) – Figure title.
- **wrap_title** (*bool*) – Whether to wrap the figure title. Default is *True*.
- **x_label** (*str*) – *X* axis label.
- **y_label** (*str*) – *Y* axis label.
- **x_ticker** (*bool*) – Whether to display the *X* axis ticker. Default is *True*.
- **y_ticker** (*bool*) – Whether to display the *Y* axis ticker. Default is *True*.

`__init__(*args, **kwargs)`

Methods

| | |
|---|--|
| <code>__init__(*args, **kwargs)</code> | |
| <code>clear()</code> | |
| <code>copy()</code> | |
| <code>fromkeys([value])</code> | Create a new dictionary with keys from iterable and values set to value. |
| <code>get(key[, default])</code> | Return the value for key if key is in the dictionary, else default. |
| <code>items()</code> | |
| <code>keys()</code> | |
| <code>pop(k[,d])</code> | If the key is not found, return the default if given; otherwise, raise a <code>KeyError</code> . |
| <code>popitem()</code> | Remove and return a (key, value) pair as a 2-tuple. |
| <code>setdefault(key[, default])</code> | Insert key with a value of default if key is not in the dictionary. |
| <code>update([E,]**F)</code> | If E is present and has a <code>.keys()</code> method, then does: for k in E: D[k] = E[k] If E is present and lacks a <code>.keys()</code> method, then does: for k, v in E: D[k] = v In either case, this is followed by: for k in F: D[k] = F[k] |
| <code>values()</code> | |

Attributes

| |
|------------------------|
| figure |
| axes |
| filename |
| standalone |
| aspect |
| axes_visible |
| bounding_box |
| tight_layout |
| legend |
| legend_columns |
| transparent_background |
| title |
| wrap_title |
| x_label |
| y_label |
| x_ticker |
| y_ticker |

`colour.plotting.common.filter_passthrough`

`colour.plotting.common.filter_passthrough(mapping: Mapping, filterers: Any | str | Sequence[Any | str], allow_non_siblings: bool = True) → Dict`

Return mapping objects matching given filterers while passing through class instances whose type is one of the mapping element types.

This definition allows passing custom but compatible objects to the various plotting definitions that by default expect the key from a dataset element.

For example, a typical call to `colour.plotting.plot_multi_illuminant_sds()` definition is as follows:

```
>>> import colour
>>> colour.plotting.plot_multi_illuminant_sds(["A"])
...
```

With the previous example, it is also possible to pass a custom spectral distribution as follows:

```
>>> data = {
...     500: 0.0651,
...     520: 0.0705,
...     540: 0.0772,
...     560: 0.0870,
...     580: 0.1128,
...     600: 0.1360,
... }
>>> colour.plotting.plot_multi_illuminant_sds(
...     ["A", colour.SpectralDistribution(data)]
... )
...
```

Similarly, a typical call to `colour.plotting.plot_planckian_locus_in_chromaticity_diagram_CIE1931()` definition is as follows:

```
>>> colour.plotting.plot_planckian_locus_in_chromaticity_diagram_CIE1931(
...     ["A"]
... )
...
```

But it is also possible to pass a custom whitepoint as follows:

```
>>> colour.plotting.plot_planckian_locus_in_chromaticity_diagram_CIE1931(
...     ["A", {"Custom": np.array([1 / 3 + 0.05, 1 / 3 + 0.05])}]
... )
...
```

Parameters

- **mapping** (`Mapping`) – Mapping to filter.
- **filterers** (`Any` | `str` | `Sequence[Any | str]`) – Filterer or object class instance (which is passed through directly if its type is one of the mapping element types) or list of filterers.
- **allow_non_siblings** (`bool`) – Whether to allow non-siblings to be also passed through.

Returns

Filtered mapping.

Return type

`dict`

Notes

- If the mapping passed is a `colour.utilities.CanonicalMapping` class instance, then the lower, slugified and canonical keys are also used for matching.

colour.plotting.common.filter_RGB_colourspaces

```
colour.plotting.common.filter_RGB_colourspaces(filterers: RGB_Colourspace | str |
                                                Sequence[RGB_Colourspace | str],
                                                allow_non_siblings: bool = True) → Dict[str,
                                                RGB_Colourspace]
```

Return the *RGB* colourspace matching given filterers.

Parameters

- **filterers** (*RGB_Colourspace* | *str* | *Sequence[RGB_Colourspace | str]*) – Filterer or *colour.RGB_Colourspace* class instance (which is passed through directly if its type is one of the mapping element types) or list of filterers. *filterers* elements can also be of any form supported by the *colour.plotting.common.filter_passthrough()* definition.
- **allow_non_siblings** (*bool*) – Whether to allow non-siblings to be also passed through.

Returns

Filtered *RGB* colourspace.

Return type

dict

colour.plotting.common.filter_cmfs

```
colour.plotting.common.filter_cmfs(filterers: MultiSpectralDistributions | str |
                                    Sequence[MultiSpectralDistributions | str], allow_non_siblings:
                                    bool = True) → Dict[str, MultiSpectralDistributions]
```

Return the colour matching functions matching given filterers.

Parameters

- **filterers** (*MultiSpectralDistributions* | *str* | *Sequence[MultiSpectralDistributions | str]*) – Filterer or *colour.LMS_ConeFundamentals*, *colour.RGB_ColourMatchingFunctions* or *colour.XYZ_ColourMatchingFunctions* class instance (which is passed through directly if its type is one of the mapping element types) or list of filterers. *filterers* elements can also be of any form supported by the *colour.plotting.common.filter_passthrough()* definition.
- **allow_non_siblings** (*bool*) – Whether to allow non-siblings to be also passed through.

Returns

Filtered colour matching functions.

Return type

dict

colour.plotting.common.filter_illuminants

```
colour.plotting.common.filter_illuminants(filterers: SpectralDistribution | str |  
                                           Sequence[SpectralDistribution | str],  
                                           allow_non_siblings: bool = True) → Dict[str,  
                                           SpectralDistribution]
```

Return the illuminants matching given filterers.

Parameters

- **filterers** (`SpectralDistribution` | `str` | `Sequence[SpectralDistribution | str]`) – Filterer or `colour.SpectralDistribution` class instance (which is passed through directly if its type is one of the mapping element types) or list of filterers. filterers elements can also be of any form supported by the `colour.plotting.common.filter_passthrough()` definition.
- **allow_non_siblings** (`bool`) – Whether to allow non-siblings to be also passed through.

Returns

Filtered illuminants.

Return type

`dict`

colour.plotting.common.filter_colour_checkers

```
colour.plotting.common.filter_colour_checkers(filterers: ColourChecker | str |  
                                                Sequence[ColourChecker | str], allow_non_siblings:  
                                                bool = True) → Dict[str, ColourChecker]
```

Return the colour checkers matching given filterers.

Parameters

- **filterers** (`ColourChecker` | `str` | `Sequence[ColourChecker | str]`) – Filterer or `colour.characterisation.ColourChecker` class instance (which is passed through directly if its type is one of the mapping element types) or list of filterers. filterers elements can also be of any form supported by the `colour.plotting.common.filter_passthrough()` definition.
- **allow_non_siblings** (`bool`) – Whether to allow non-siblings to be also passed through.

Returns

Filtered colour checkers.

Return type

`dict`

Colorimetry

colour.plotting

| | |
|---|---|
| <code>plot_single_sd(sd[, cmfs, ...])</code> | Plot given spectral distribution. |
| <code>plot_multi_sds(sds[, plot_kwargs])</code> | Plot given spectral distributions. |
| <code>plot_single_cmfs([cmfs])</code> | Plot given colour matching functions. |
| <code>plot_multi_cmfs(cmfs, **kwargs)</code> | Plot given colour matching functions. |
| <code>plot_single_illuminant_sd(illuminant[, cmfs])</code> | Plot given single illuminant spectral distribution. |
| <code>plot_multi_illuminant_sds(illuminants, **kwargs)</code> | Plot given illuminants spectral distributions. |
| <code>plot_visible_spectrum([cmfs, ...])</code> | Plot the visible colours spectrum using given standard observer <i>CIE XYZ</i> colour matching functions. |
| <code>plot_single_lightness_function(function, ...)</code> | Plot given <i>Lightness</i> function. |
| <code>plot_multi_lightness_functions(functions, ...)</code> | Plot given <i>Lightness</i> functions. |
| <code>plot_single_luminance_function(function, ...)</code> | Plot given <i>Luminance</i> function. |
| <code>plot_multi_luminance_functions(functions, ...)</code> | Plot given <i>Luminance</i> functions. |
| <code>plot_blackbody_spectral_radiance([...])</code> | Plot given blackbody spectral radiance. |
| <code>plot_blackbody_colours([shape, cmfs])</code> | Plot blackbody colours. |

colour.plotting.plot_single_sd

`colour.plotting.plot_single_sd(sd: SpectralDistribution, cmfs: MultiSpectralDistributions | str | Sequence[MultiSpectralDistributions | str] = 'CIE 1931 2 Degree Standard Observer', out_of_gamut_clipping: bool = True, modulate_colours_with_sd_amplitude: bool = False, equalize_sd_amplitude: bool = False, **kwargs: Any) → Tuple[Figure, Axes]`

Plot given spectral distribution.

Parameters

- **sd** (*SpectralDistribution*) – Spectral distribution to plot.
- **cmfs** (*MultiSpectralDistributions* | *str* | *Sequence[MultiSpectralDistributions | str]*) – Standard observer colour matching functions used for computing the spectrum domain and colours. *cmfs* can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
- **out_of_gamut_clipping** (*bool*) – Whether to clip out of gamut colours otherwise, the colours will be offset by the absolute minimal colour leading to a rendering on gray background, less saturated and smoother.
- **modulate_colours_with_sd_amplitude** (*bool*) – Whether to modulate the colours with the spectral distribution amplitude.
- **equalize_sd_amplitude** (*bool*) – Whether to equalize the spectral distribution amplitude. Equalization occurs after the colours modulation thus setting both arguments to *True* will generate a spectrum strip where each wavelength colour is modulated by the spectral distribution amplitude. The usual 5% margin above the spectral distribution is also omitted.
- **kwargs** (*Any*) – {`colour.plotting.artist()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

Current figure and axes.

Return type

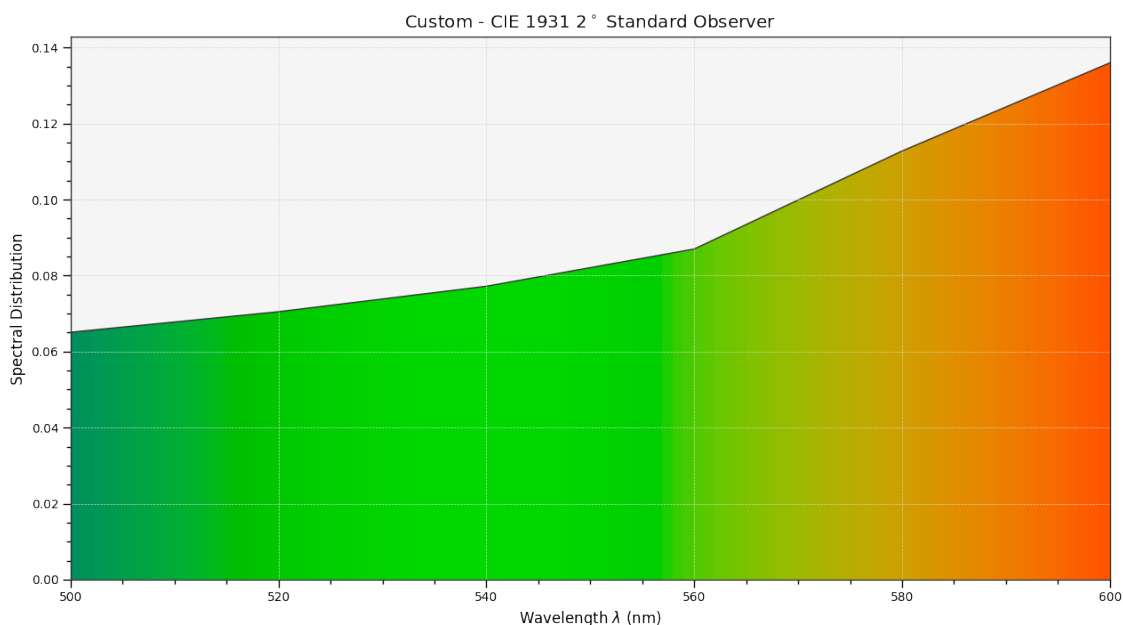
tuple

References

[Spi15]

Examples

```
>>> from colour import SpectralDistribution
>>> data = {
...     500: 0.0651,
...     520: 0.0705,
...     540: 0.0772,
...     560: 0.0870,
...     580: 0.1128,
...     600: 0.1360,
... }
>>> sd = SpectralDistribution(data, name="Custom")
>>> plot_single_sd(sd)
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



colour.plotting.plot_multi_sds

`colour.plotting.plot_multi_sds(sds: Sequence[SpectralDistribution | MultiSpectralDistributions] | MultiSpectralDistributions, plot_kwargs: Dict | List[Dict] | None = None, **kwargs: Any) → Tuple[Figure, Axes]`

Plot given spectral distributions.

Parameters

- **sds** (`Sequence[SpectralDistribution | MultiSpectralDistributions] | MultiSpectralDistributions`) – Spectral distributions or multi-spectral distributions to plot. *sds* can be a single `colour.MultiSpectralDistributions` class instance, a list of `colour.MultiSpectralDistributions` class instances or a list of `colour.SpectralDistribution` class instances.
- **plot_kwargs** (`Dict | List[Dict] | None`) – Keyword arguments for the `matplotlib.pyplot.plot()` definition, used to control the style of the plotted

spectral distributions. `plot_kwargs` can be either a single dictionary applied to all the plotted spectral distributions with the same settings or a sequence of dictionaries with different settings for each plotted spectral distributions. The following special keyword arguments can also be used:

- `illuminant` : The illuminant used to compute the spectral distributions colours. The default is the illuminant associated with the whitepoint of the default plotting colourspace. `illuminant` can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
- `cmfs` : The standard observer colour matching functions used for computing the spectral distributions colours. `cmfs` can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
- `normalise_sd_colours` : Whether to normalise the computed spectral distributions colours. The default is `True`.
- `use_sd_colours` : Whether to use the computed spectral distributions colours under the plotting colourspace illuminant. Alternatively, it is possible to use the `matplotlib.pyplot.plot()` definition `color` argument with pre-computed values. The default is `True`.
- **kwargs** (Any) – {`colour.plotting.artist()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

Current figure and axes.

Return type

tuple

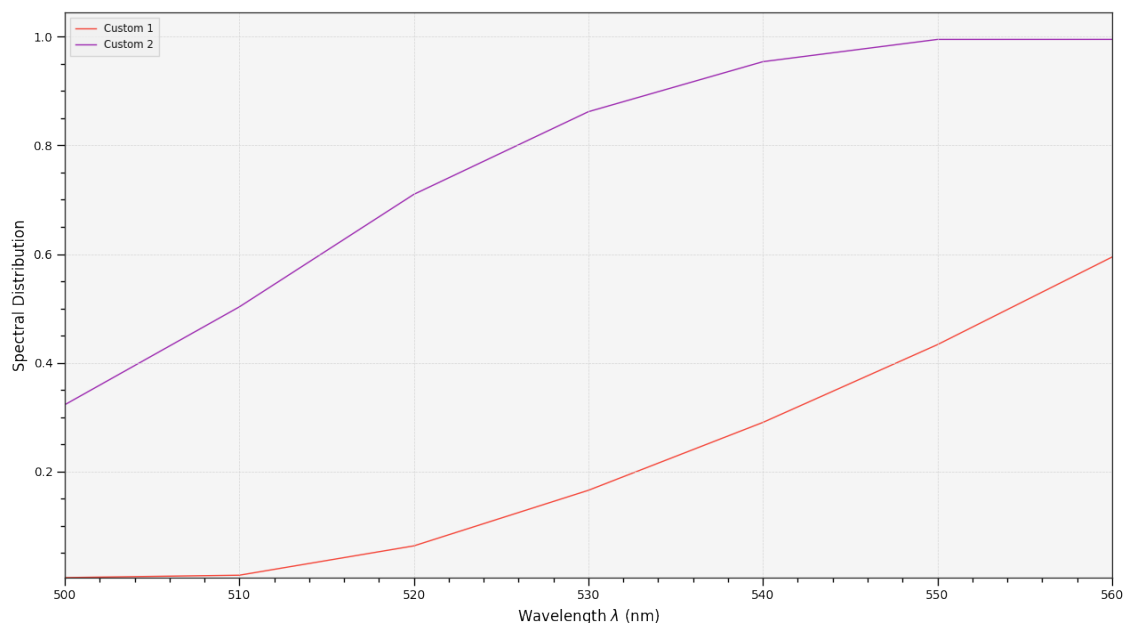
Examples

```
>>> from colour import SpectralDistribution
>>> data_1 = {
...     500: 0.004900,
...     510: 0.009300,
...     520: 0.063270,
...     530: 0.165500,
...     540: 0.290400,
...     550: 0.433450,
...     560: 0.594500,
... }
>>> data_2 = {
...     500: 0.323000,
...     510: 0.503000,
...     520: 0.710000,
...     530: 0.862000,
...     540: 0.954000,
...     550: 0.994950,
...     560: 0.995000,
... }
>>> sd_1 = SpectralDistribution(data_1, name="Custom 1")
>>> sd_2 = SpectralDistribution(data_2, name="Custom 2")
>>> plot_kwargs = [
...     {"use_sd_colours": True},
...     {"use_sd_colours": True, "linestyle": "dashed"},
... ]
>>> plot_multi_sds([sd_1, sd_2], plot_kwargs=plot_kwargs)
```

(continues on next page)

(continued from previous page)

```
...
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



colour.plotting.plot_single_cmfs

`colour.plotting.plot_single_cmfs(cmfs: MultiSpectralDistributions | str | Sequence[MultiSpectralDistributions | str] = 'CIE 1931 2 Degree Standard Observer', **kwargs: Any) → Tuple[Figure, Axes]`

Plot given colour matching functions.

Parameters

- **cmfs** (`MultiSpectralDistributions` | `str` | `Sequence[MultiSpectralDistributions | str]`) – Colour matching functions to plot. cmfs can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
- **kwargs** (`Any`) – {`colour.plotting.artist()`, `colour.plotting.plot_multi_cmfs()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

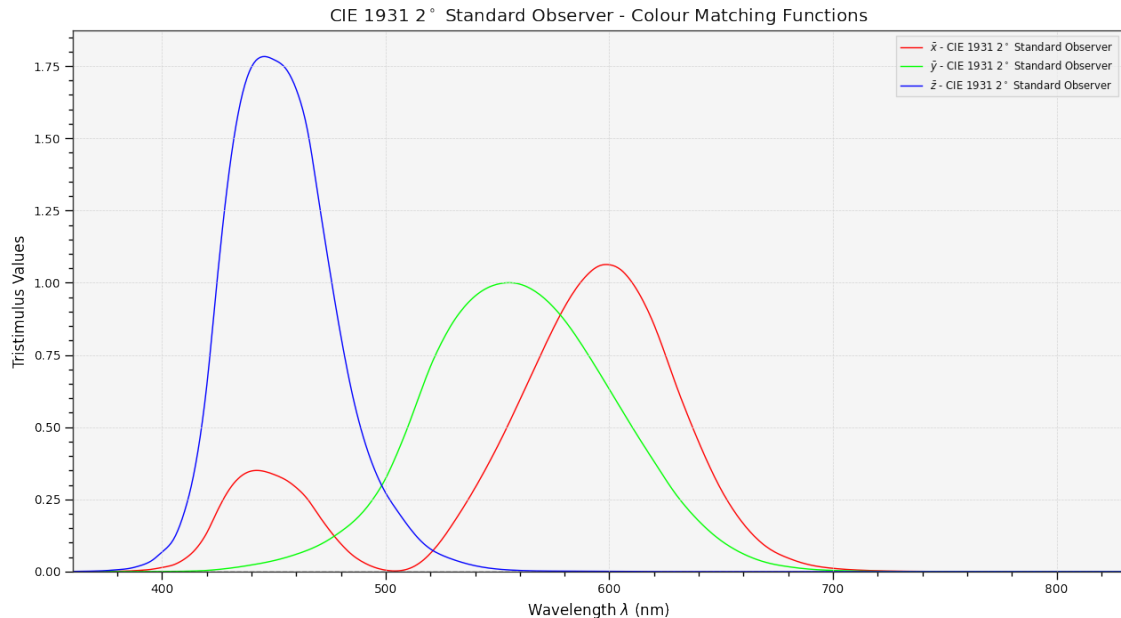
Current figure and axes.

Return type

`tuple`

Examples

```
>>> plot_single_cmfs("CIE 1931 2 Degree Standard Observer")
...
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```

`colour.plotting.plot_multi_cmfs`

`colour.plotting.plot_multi_cmfs`(*cmfs*: `MultiSpectralDistributions` | `str` | `Sequence`[`MultiSpectralDistributions` | `str`], ***kwargs*: `Any`) → `Tuple`[`Figure`, `Axes`]

Plot given colour matching functions.

Parameters

- **cmfs** (`MultiSpectralDistributions` | `str` | `Sequence`[`MultiSpectralDistributions` | `str`]) – Colour matching functions to plot. `cmfs` elements can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
- **kwargs** (`Any`) – {`colour.plotting.artist()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

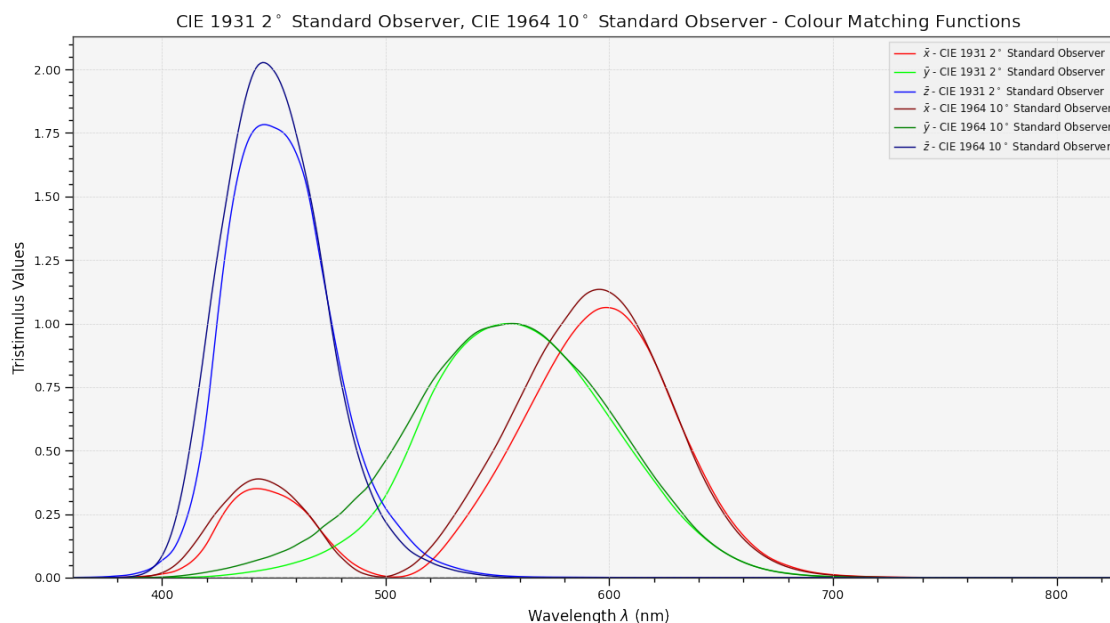
Current figure and axes.

Return type

`tuple`

Examples

```
>>> cmfs = [
...     "CIE 1931 2 Degree Standard Observer",
...     "CIE 1964 10 Degree Standard Observer",
... ]
>>> plot_multi_cmfs(cmfs)
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```

`colour.plotting.plot_single_illuminant_sd`

`colour.plotting.plot_single_illuminant_sd(illuminant: SpectralDistribution | str, cmfs: MultiSpectralDistributions | str | Sequence\[MultiSpectralDistributions | str\]) = 'CIE 1931 2 Degree Standard Observer', **kwargs: Any) → Tuple\[Figure, Axes\]`

Plot given single illuminant spectral distribution.

Parameters

- **illuminant** ([SpectralDistribution](#) | [str](#)) – Illuminant to plot. `illuminant` can be of any type or form supported by the `colour.plotting.common.filter_illuminants()` definition.
- **cmfs** ([MultiSpectralDistributions](#) | [str](#) | [Sequence\[MultiSpectralDistributions | str\]](#)) – Standard observer colour matching functions used for computing the spectrum domain and colours. `cmfs` can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
- **kwargs** ([Any](#)) – {`colour.plotting.artist()`, `colour.plotting.plot_single_sd()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

Current figure and axes.

Return type

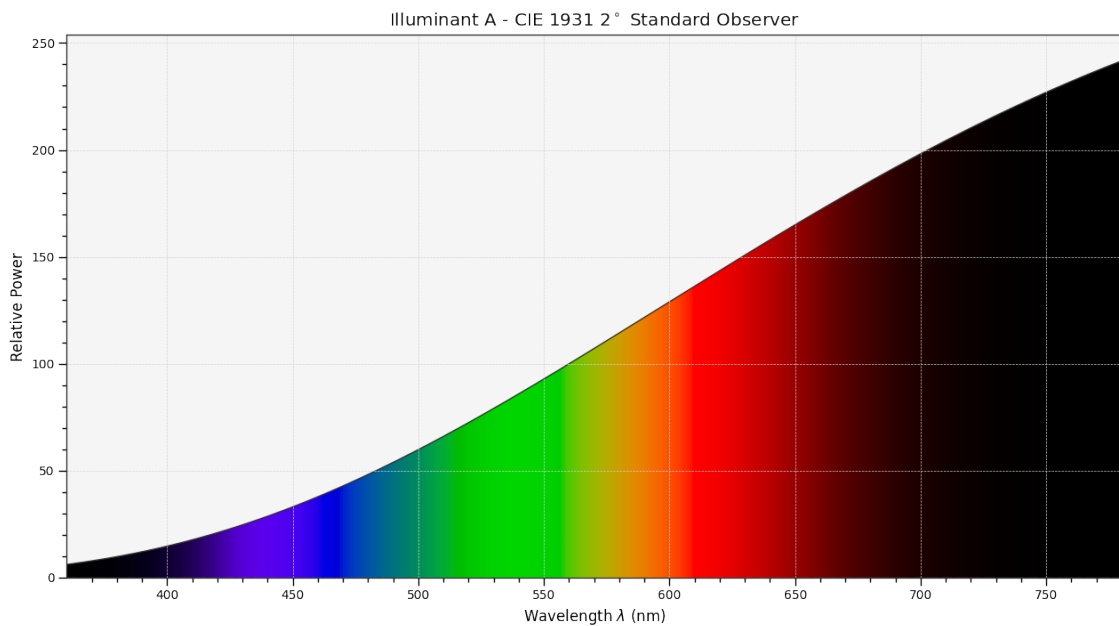
tuple

References

[Spi15]

Examples

```
>>> plot_single_illuminant_sd("A")
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```

**colour.plotting.plot_multi_illuminant_sds**

```
colour.plotting.plot_multi_illuminant_sds(illuminants: SpectralDistribution | str |
                                          Sequence[SpectralDistribution | str], **kwargs: Any) →
                                          Tuple[Figure, Axes]
```

Plot given illuminants spectral distributions.

Parameters

- **illuminants** (`SpectralDistribution` | `str` | `Sequence[SpectralDistribution | str]`) – Illuminants to plot. `illuminants` elements can be of any type or form supported by the `colour.plotting.common.filter_illuminants()` definition.
- **kwargs** (`Any`) – `{colour.plotting.artist(), colour.plotting.plot_multi_sds(), colour.plotting.render()}`, See the documentation of the previously listed definitions.`

Returns

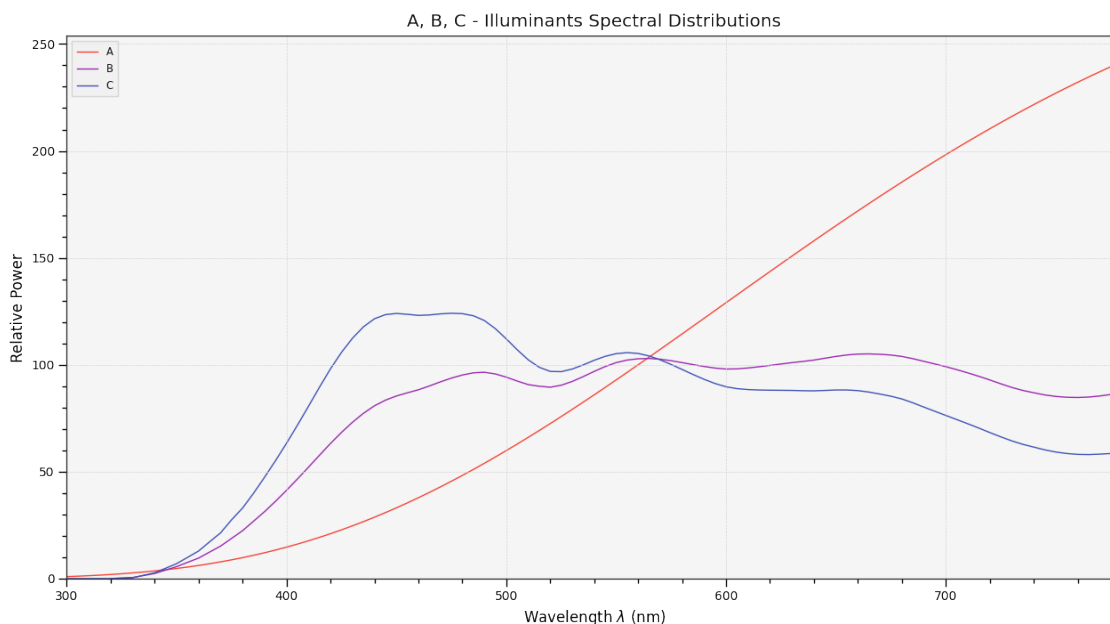
Current figure and axes.

Return type

tuple

Examples

```
>>> plot_multi_illuminant_sds(["A", "B", "C"])
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```

`colour.plotting.plot_visible_spectrum`

`colour.plotting.plot_visible_spectrum`(*cmfs*: [MultiSpectralDistributions](#) | *str* | [Sequence](#)[[MultiSpectralDistributions](#) | *str*]) = 'CIE 1931 2 Degree Standard Observer', *out_of_gamut_clipping*: *bool* = *True*, ***kwargs*: *Any*) → [Tuple](#)[[Figure](#), [Axes](#)]

Plot the visible colours spectrum using given standard observer *CIE XYZ* colour matching functions.

Parameters

- **cmfs** ([MultiSpectralDistributions](#) | *str* | [Sequence](#)[[MultiSpectralDistributions](#) | *str*]) – Standard observer colour matching functions used for computing the spectrum domain and colours. *cmfs* can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
- **out_of_gamut_clipping** (*bool*) – Whether to clip out of gamut colours otherwise, the colours will be offset by the absolute minimal colour leading to a rendering on gray background, less saturated and smoother.
- **kwargs** (*Any*) – {`colour.plotting.artist()`, `colour.plotting.plot_single_sd()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

Current figure and axes.

Return type

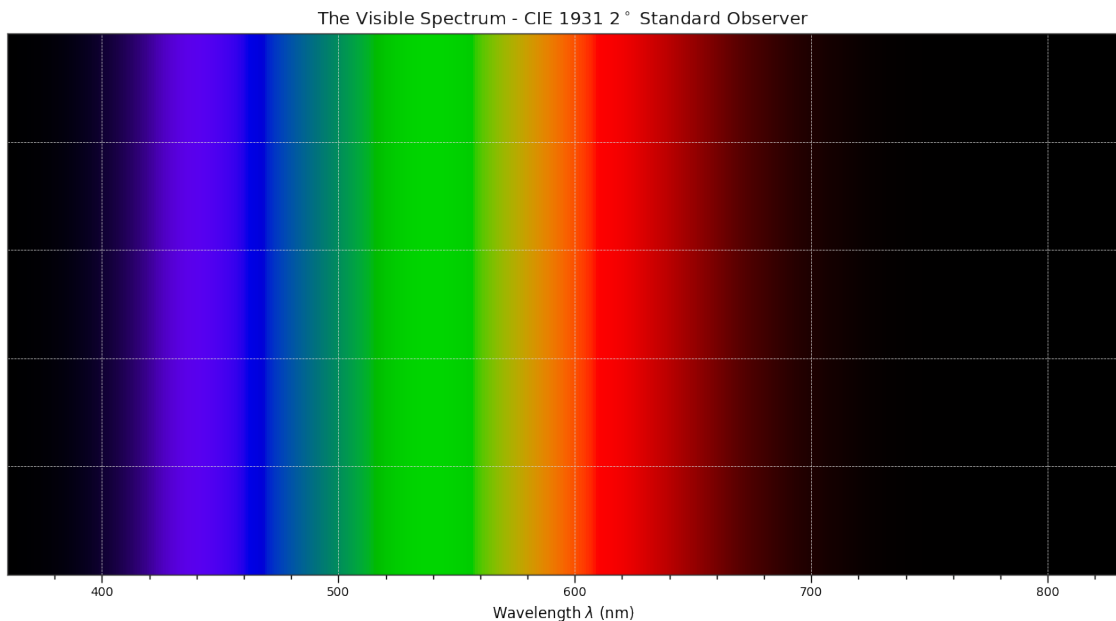
[tuple](#)

References

[Spi15]

Examples

```
>>> plot_visible_spectrum()
<Figure size ... with 1 Axes>, <...AxesSubplot...>
```



colour.plotting.plot_single_lightness_function

colour.plotting.plot_single_lightness_function(function: *Callable* | *str*, **kwargs: *Any*) → Tuple[Figure, Axes]

Plot given *Lightness* function.

Parameters

- **function** (*Callable* | *str*) – *Lightness* function to plot. function can be of any type or form supported by the `colour.plotting.common.filter_passthrough()` definition.
- **kwargs** (*Any*) – {`colour.plotting.artist()`, `colour.plotting.plot_multi_functions()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

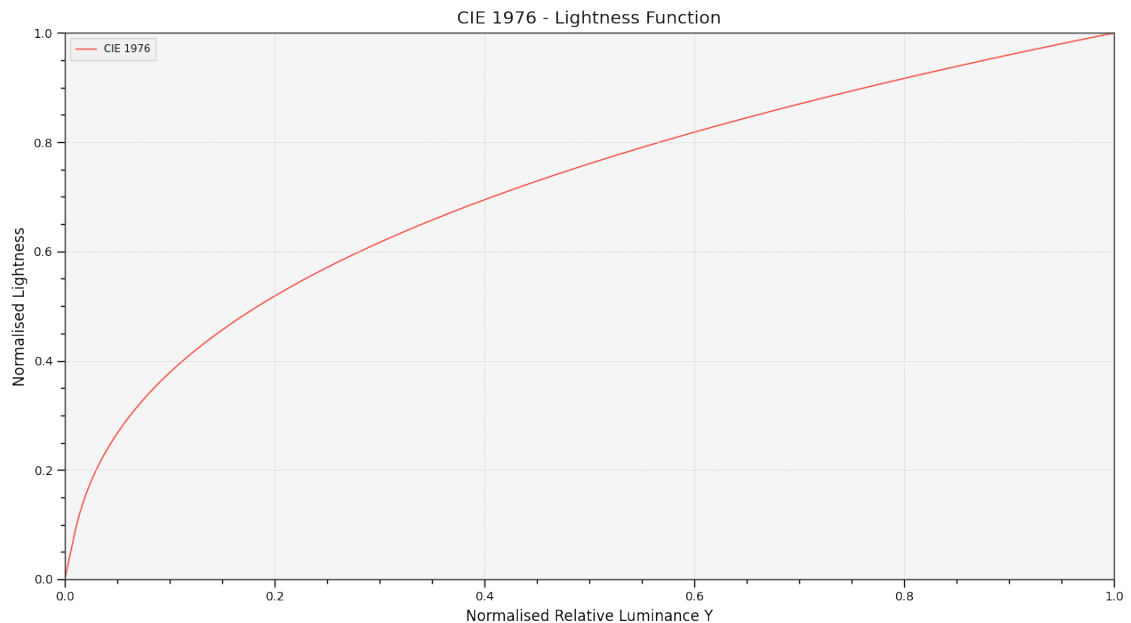
Current figure and axes.

Return type

tuple

Examples

```
>>> plot_single_lightness_function("CIE 1976")
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```

`colour.plotting.plot_multi_lightness_functions`

`colour.plotting.plot_multi_lightness_functions`(*functions*: *Callable* | *str* | *Sequence*[*Callable* | *str*],
***kwargs*: *Any*) → *Tuple*[*Figure*, *Axes*]

Plot given *Lightness* functions.

Parameters

- **functions** (*Callable* | *str* | *Sequence*[*Callable* | *str*]) – *Lightness* functions to plot. functions elements can be of any type or form supported by the `colour.plotting.common.filter_passthrough()` definition.
- **kwargs** (*Any*) – {`colour.plotting.artist()`, `colour.plotting.plot_multi_functions()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

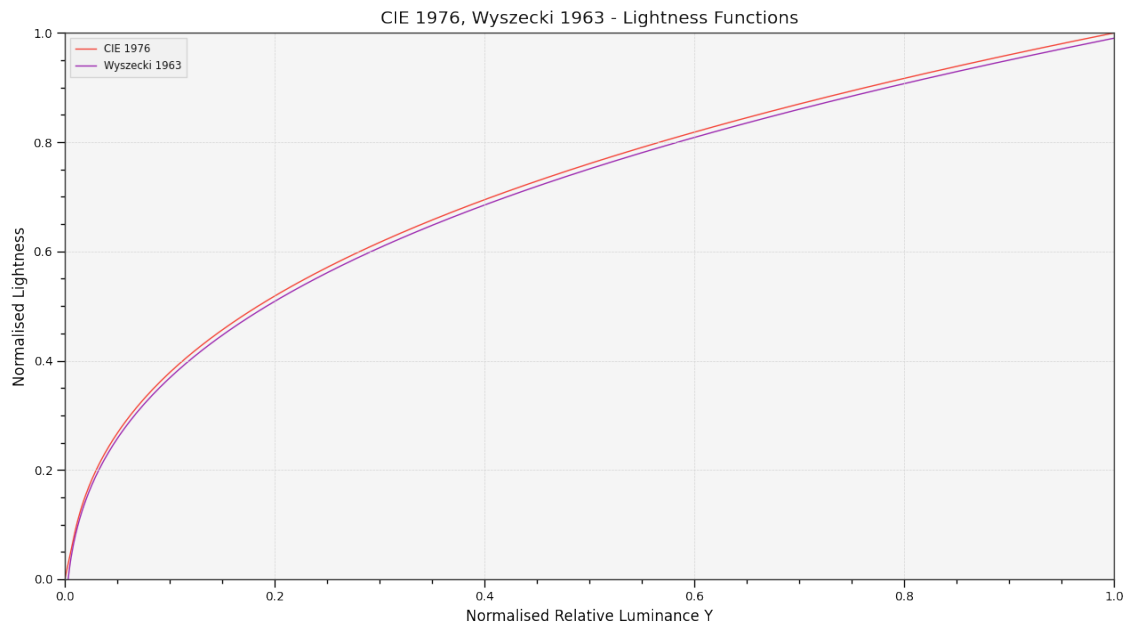
Current figure and axes.

Return type

tuple

Examples

```
>>> plot_multi_lightness_functions(["CIE 1976", "Wyszecki 1963"])
...
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



colour.plotting.plot_single_luminance_function

`colour.plotting.plot_single_luminance_function`(*function*: *Callable* | *str*, ***kwargs*: *Any*) → *Tuple*[*Figure*, *Axes*]

Plot given *Luminance* function.

Parameters

- **function** (*Callable* | *str*) – *Luminance* function to plot.
- **kwargs** (*Any*) – {`colour.plotting.artist()`, `colour.plotting.plot_multi_functions()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

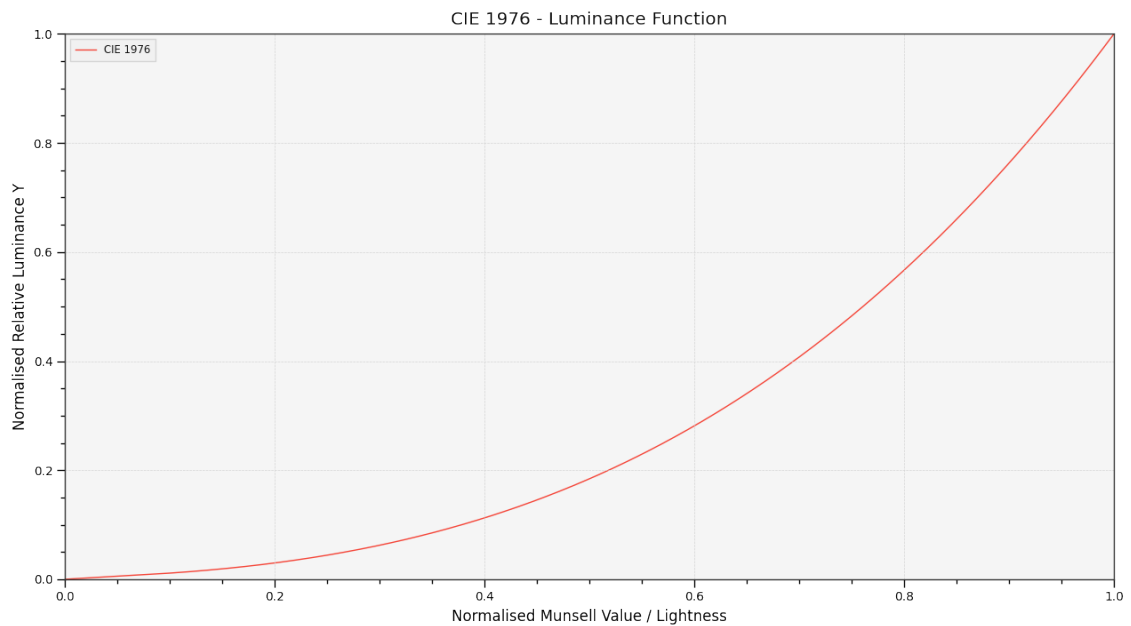
Current figure and axes.

Return type

tuple

Examples

```
>>> plot_single_luminance_function("CIE 1976")
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



colour.plotting.plot_multi_luminance_functions

`colour.plotting.plot_multi_luminance_functions`(*functions*: *Callable* | *str* | *Sequence*[*Callable* | *str*],
***kwargs*: *Any*) → *Tuple*[*Figure*, *Axes*]

Plot given *Luminance* functions.

Parameters

- **functions** (*Callable* | *str* | *Sequence*[*Callable* | *str*]) – *Luminance* functions to plot. functions elements can be of any type or form supported by the `colour.plotting.common.filter_passthrough()` definition.
- **kwargs** (*Any*) – {`colour.plotting.artist()`, `colour.plotting.plot_multi_functions()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

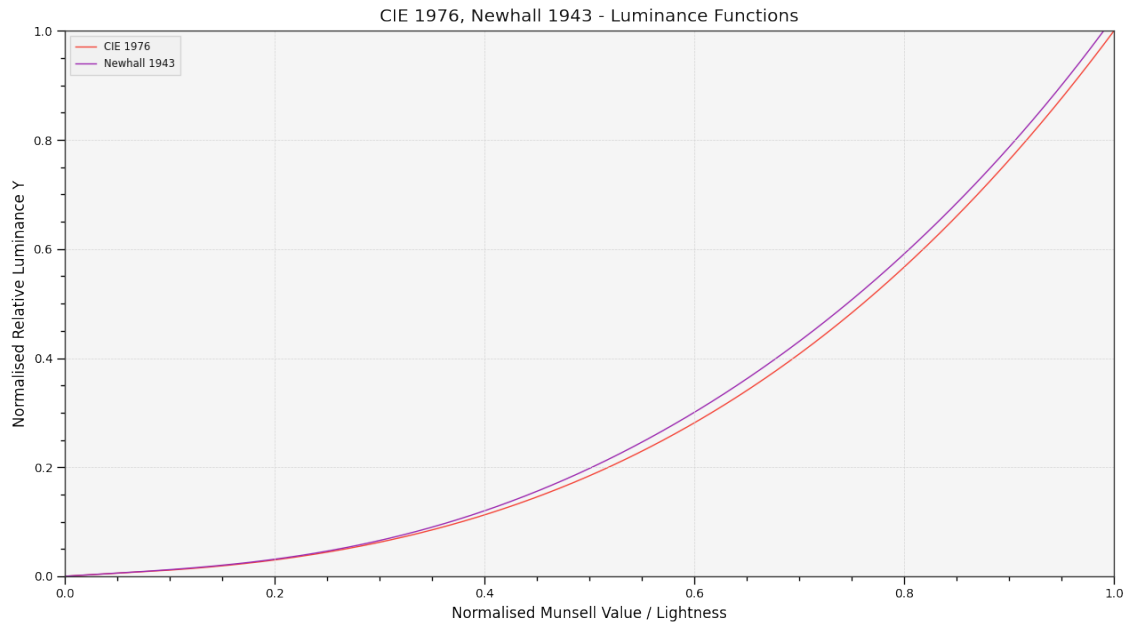
Current figure and axes.

Return type

tuple

Examples

```
>>> plot_multi_luminance_functions(["CIE 1976", "Newhall 1943"])
...
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



`colour.plotting.plot_blackbody_spectral_radiance`

`colour.plotting.plot_blackbody_spectral_radiance`(*temperature*: *float* = 3500, *cmfs*: *MultiSpectralDistributions* | *str* | *Sequence*[*MultiSpectralDistributions* | *str*] = 'CIE 1931 2 Degree Standard Observer', *blackbody*: *str* = 'VY Canis Major', ***kwargs*: *Any*) → *Tuple*[*Figure*, *Axes*]

Plot given blackbody spectral radiance.

Parameters

- **temperature** (*float*) – Blackbody temperature.
- **cmfs** (*MultiSpectralDistributions* | *str* | *Sequence*[*MultiSpectralDistributions* | *str*]) – Standard observer colour matching functions used for computing the spectrum domain and colours. *cmfs* can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
- **blackbody** (*str*) – Blackbody name.
- **kwargs** (*Any*) – {`colour.plotting.artist()`, `colour.plotting.plot_single_sd()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

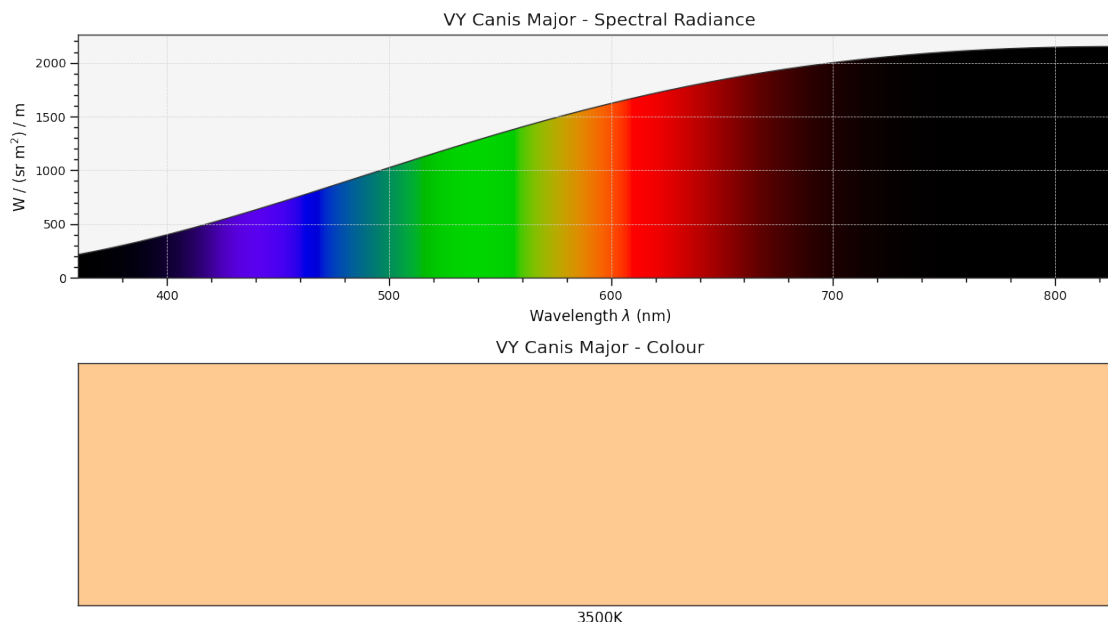
Current figure and axes.

Return type

tuple

Examples

```
>>> plot_blackbody_spectral_radiance(3500, blackbody="VY Canis Major")
...
(<Figure size ... with 2 Axes>, <...AxesSubplot...>)
```



colour.plotting.plot_blackbody_colours

```
colour.plotting.plot_blackbody_colours(shape: SpectralShape = SpectralShape(150, 12500, 50),
    cmfs: MultiSpectralDistributions | str |
    Sequence[MultiSpectralDistributions | str] = 'CIE 1931 2
    Degree Standard Observer', **kwargs: Any) →
    Tuple[Figure, Axes]
```

Plot blackbody colours.

Parameters

- **shape** (*SpectralShape*) – Spectral shape to use as plot boundaries.
- **cmfs** (*MultiSpectralDistributions* | *str* | *Sequence[MultiSpectralDistributions | str]*) – Standard observer colour matching functions used for computing the blackbody colours. *cmfs* can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
- **kwargs** (*Any*) – {`colour.plotting.artist()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

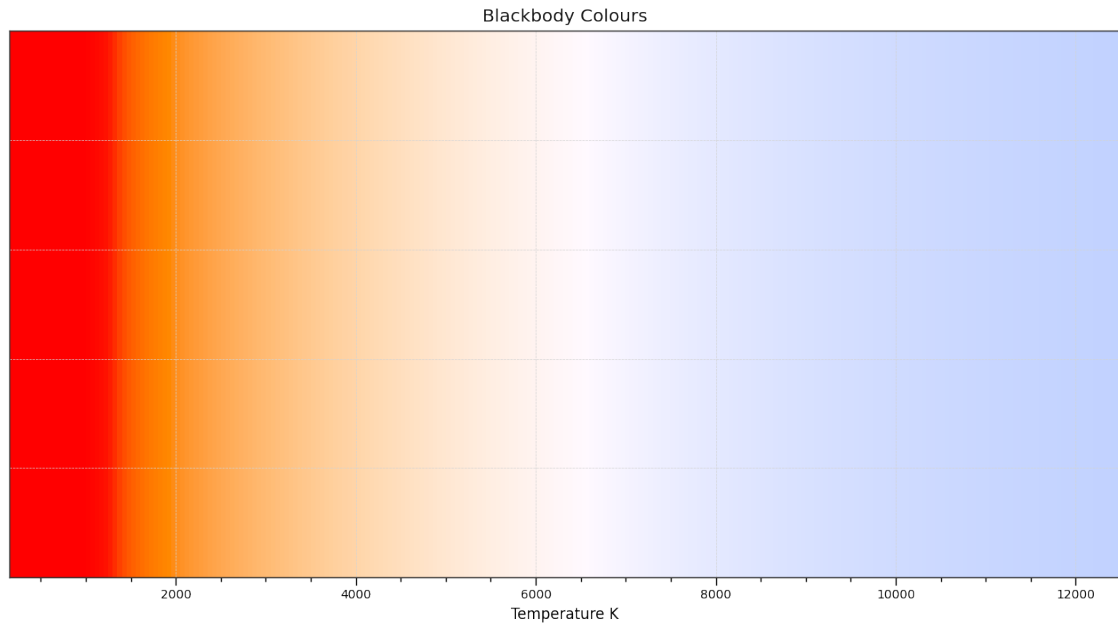
Current figure and axes.

Return type

tuple

Examples

```
>>> plot_blackbody_colours(SpectralShape(150, 12500, 50))
...
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



Colour Vision Deficiency

colour.plotting

| | |
|--|---|
| <code>plot_cvd_simulation_Machado2009(</code> <code>RGB[, ...]</code> <code>)</code> | Perform colour vision deficiency simulation on given <i>RGB</i> colourspace array using <i>Machado et al. (2009)</i> model. |
|--|---|

colour.plotting.plot_cvd_simulation_Machado2009

colour.plotting.plot_cvd_simulation_Machado2009(*RGB*: *ArrayLike*, *deficiency*: *Literal*['Deuteranomaly', 'Protanomaly', 'Tritanomaly'] | *str* = 'Protanomaly', *severity*: *float* = 0.5, *M_a*: *ArrayLike* | *None* = *None*, ****kwargs**: *Any*) → *Tuple*[*Figure*, *Axes*]

Perform colour vision deficiency simulation on given *RGB* colourspace array using *Machado et al. (2009)* model.

Parameters

- **RGB** (*ArrayLike*) – *RGB* colourspace array.
- **deficiency** (*Literal*['Deuteranomaly', 'Protanomaly', 'Tritanomaly'] | *str*) – Colour blindness / vision deficiency type.
- **severity** (*float*) – Severity of the colour vision deficiency in domain [0, 1].
- **M_a** (*ArrayLike* | *None*) – Anomalous trichromacy matrix to use instead of Machado (2010) pre-computed matrix.

- **kwargs** (Any) – {`colour.plotting.artist()`, `colour.plotting.plot_image()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Return type*Tuple[Figure, Axes]***Notes**

- Input *RGB* array is expected to be linearly encoded.

Returns

Current figure and axes.

Return type

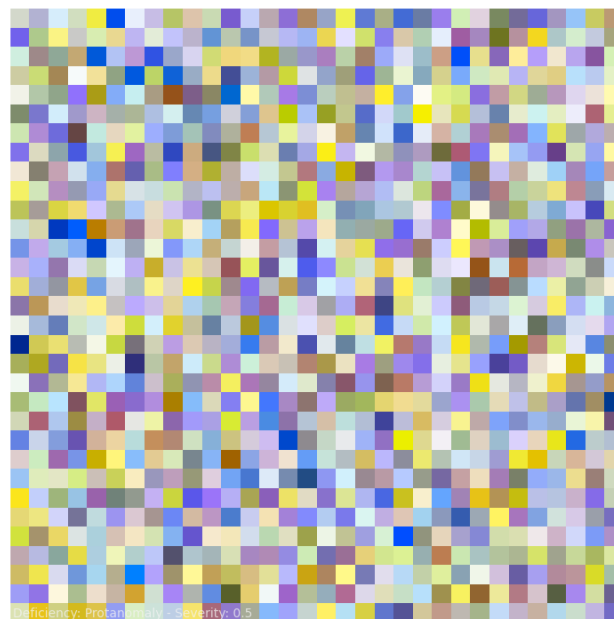
tuple

Parameters

- **RGB** (ArrayLike) –
- **deficiency** (Literal['Deuteranomaly', 'Protanomaly', 'Tritanomaly'] | str) –
- **severity** (float) –
- **M_a** (ArrayLike | None) –
- **kwargs** (Any) –

Examples

```
>>> import numpy as np
>>> RGB = np.random.rand(32, 32, 3)
>>> plot_cvd_simulation_Machado2009(RGB)
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



Colour Characterisation

`colour.plotting`

| | |
|---|--|
| <code>plot_single_colour_checker([colour_checker])</code> | Plot given colour checker. |
| <code>plot_multi_colour_checkers(colour_checkers, ...)</code> | Plot and compares given colour checkers. |

`colour.plotting.plot_single_colour_checker`

`colour.plotting.plot_single_colour_checker(colour_checker: ColourChecker | str = 'ColorChecker24' - After November 2014', **kwargs: Any) → Tuple[Figure, Axes]`

Plot given colour checker.

Parameters

- **colour_checker** (`ColourChecker` | `str`) – Color checker to plot. `colour_checker` can be of any type or form supported by the `colour.plotting.common.filter_colour_checkers()` definition.
- **kwargs** (`Any`) – {`colour.plotting.artist()`, `colour.plotting.plot_multi_colour_swatches()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

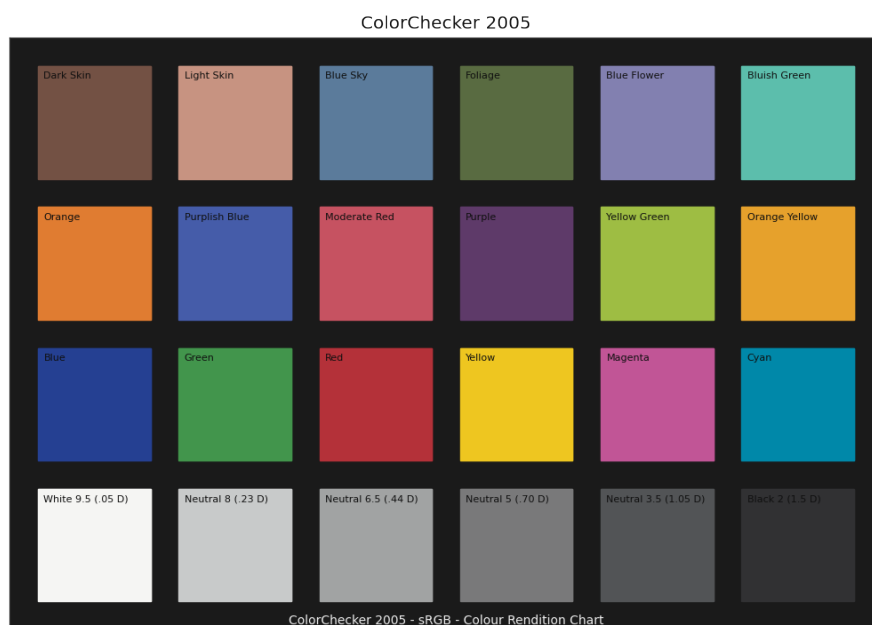
Current figure and axes.

Return type

`tuple`

Examples

```
>>> plot_single_colour_checker("ColorChecker 2005")
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



`colour.plotting.plot_multi_colour_checkers`

```
colour.plotting.plot_multi_colour_checkers(colour_checkers: ColourChecker | str |
                                          Sequence[ColourChecker | str], **kwargs: Any) →
                                          Tuple[Figure, Axes]
```

Plot and compares given colour checkers.

Parameters

- **colour_checkers** (`ColourChecker` | `str` | `Sequence[ColourChecker | str]`) – Color checker to plot, count must be less than or equal to 2. `colour_checkers` elements can be of any type or form supported by the `colour.plotting.common.filter_colour_checkers()` definition.
- **kwargs** (`Any`) – {`colour.plotting.artist()`, `colour.plotting.plot_multi_colour_swatches()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

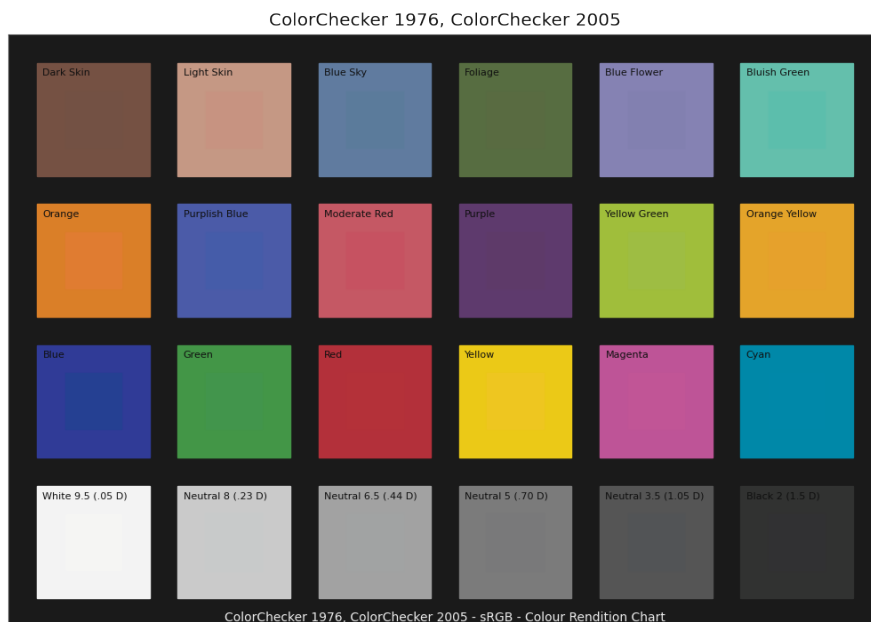
Current figure and axes.

Return type

`tuple`

Examples

```
>>> plot_multi_colour_checkers(["ColorChecker 1976", "ColorChecker 2005"])
...
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



Corresponding Chromaticities

colour.plotting

| |
|--|
| <code>plot_corresponding_chromaticities_prediction</code> Plot given chromatic adaptation model corresponding chromaticities prediction. |
|--|

colour.plotting.plot_corresponding_chromaticities_prediction

colour.plotting.plot_corresponding_chromaticities_prediction(*experiment*: *Literal*[1, 2, 3, 4, 6, 8, 9, 11, 12] | *CorrespondingColourDataset* = 1, *model*: *Literal*['CIE 1994', 'CMCCAT2000', 'Fairchild 1990', 'Zhai 2018', 'Von Kries'] | *str* = 'Von Kries', *corresponding_chromaticities_prediction_kwargs*: *Dict* | *None* = *None*, ***kwargs*: *Any*) → *Tuple*[*Figure*, *Axes*]

Plot given chromatic adaptation model corresponding chromaticities prediction.

Parameters

- **experiment** (*Literal*[1, 2, 3, 4, 6, 8, 9, 11, 12] | ~colour.corresponding.prediction.CorrespondingColourDataset) – *Breneman (1987)* experiment number or `colour.CorrespondingColourDataset` class instance.
- **model** (*Literal*['CIE 1994', 'CMCCAT2000', 'Fairchild 1990', 'Zhai 2018', 'Von Kries'] | *str*) – Corresponding chromaticities prediction model name.
- **corresponding_chromaticities_prediction_kwargs** (*Dict* | *None*) – Keyword arguments for the `colour.corresponding_chromaticities_prediction()` definition.
- **kwargs** (*Any*) – {`colour.plotting.artist()`, `colour.plotting.diagrams.plot_chromaticity_diagram()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

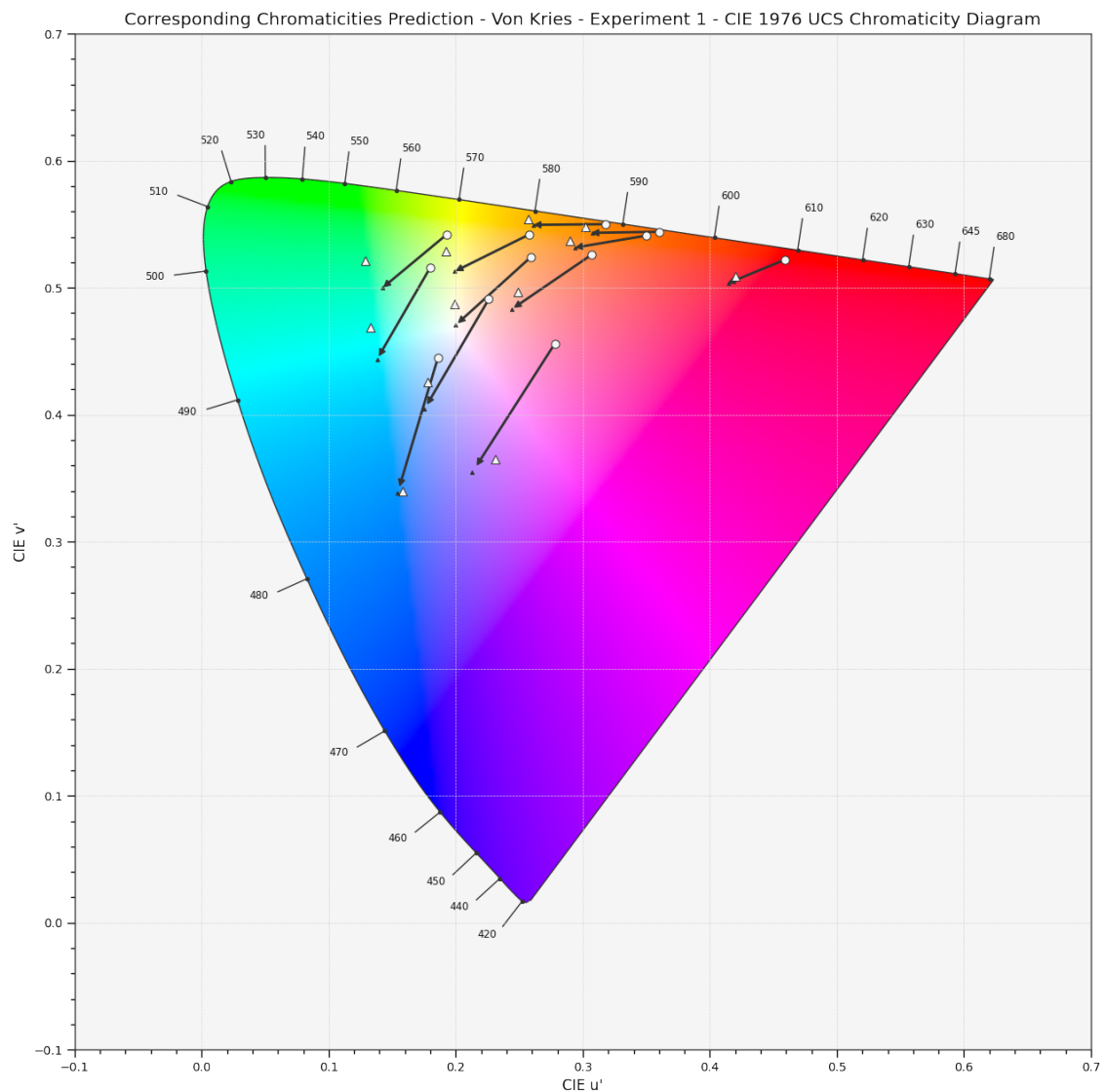
Current figure and axes.

Return type

tuple

Examples

```
>>> plot_corresponding_chromaticities_prediction(1, "Von Kries")
...
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



CIE Chromaticity Diagrams

colour.plotting

| | |
|--|---|
| <code>plot_chromaticity_diagram_CIE1931([cmfs,</code> | Plot the <i>CIE 1931 Chromaticity Diagram</i> . |
| <code>...])</code> | |
| <code>plot_chromaticity_diagram_CIE1960UCS([cmfs,</code> | Plot the <i>CIE 1960 UCS Chromaticity Diagram</i> . |
| <code>...])</code> | |
| <code>plot_chromaticity_diagram_CIE1976UCS([cmfs,</code> | Plot the <i>CIE 1976 UCS Chromaticity Diagram</i> . |
| <code>...])</code> | |
| <code>plot_sds_in_chromaticity_diagram_CIE1931(sds)</code> | Plot given spectral distribution chromaticity coordinates into the <i>CIE 1931 Chromaticity Diagram</i> . |
| <code>plot_sds_in_chromaticity_diagram_CIE1960UCS(</code> | Plot given spectral distribution chromaticity coordinates into the <i>CIE 1960 UCS Chromaticity Diagram</i> . |
| <code>...)</code> | |
| <code>plot_sds_in_chromaticity_diagram_CIE1976UCS(</code> | Plot given spectral distribution chromaticity coordinates into the <i>CIE 1976 UCS Chromaticity Diagram</i> . |
| <code>...)</code> | |

colour.plotting.plot_chromaticity_diagram_CIE1931

```
colour.plotting.plot_chromaticity_diagram_CIE1931(cmfs: MultiSpectralDistributions | str |
Sequence[MultiSpectralDistributions | str] =
'CIE 1931 2 Degree Standard Observer',
show_diagram_colours: bool = True,
show_spectral_locus: bool = True, **kwargs:
Any) → Tuple[Figure, Axes]
```

Plot the *CIE 1931 Chromaticity Diagram*.

Parameters

- **cmfs** (MultiSpectralDistributions | str | Sequence[MultiSpectralDistributions | str]) – Standard observer colour matching functions used for computing the spectral locus boundaries. `cmfs` can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
- **show_diagram_colours** (bool) – Whether to display the *Chromaticity Diagram* background colours.
- **show_spectral_locus** (bool) – Whether to display the *Spectral Locus*.
- **kwargs** (Any) – {`colour.plotting.artist()`, `colour.plotting.diagrams.plot_chromaticity_diagram()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

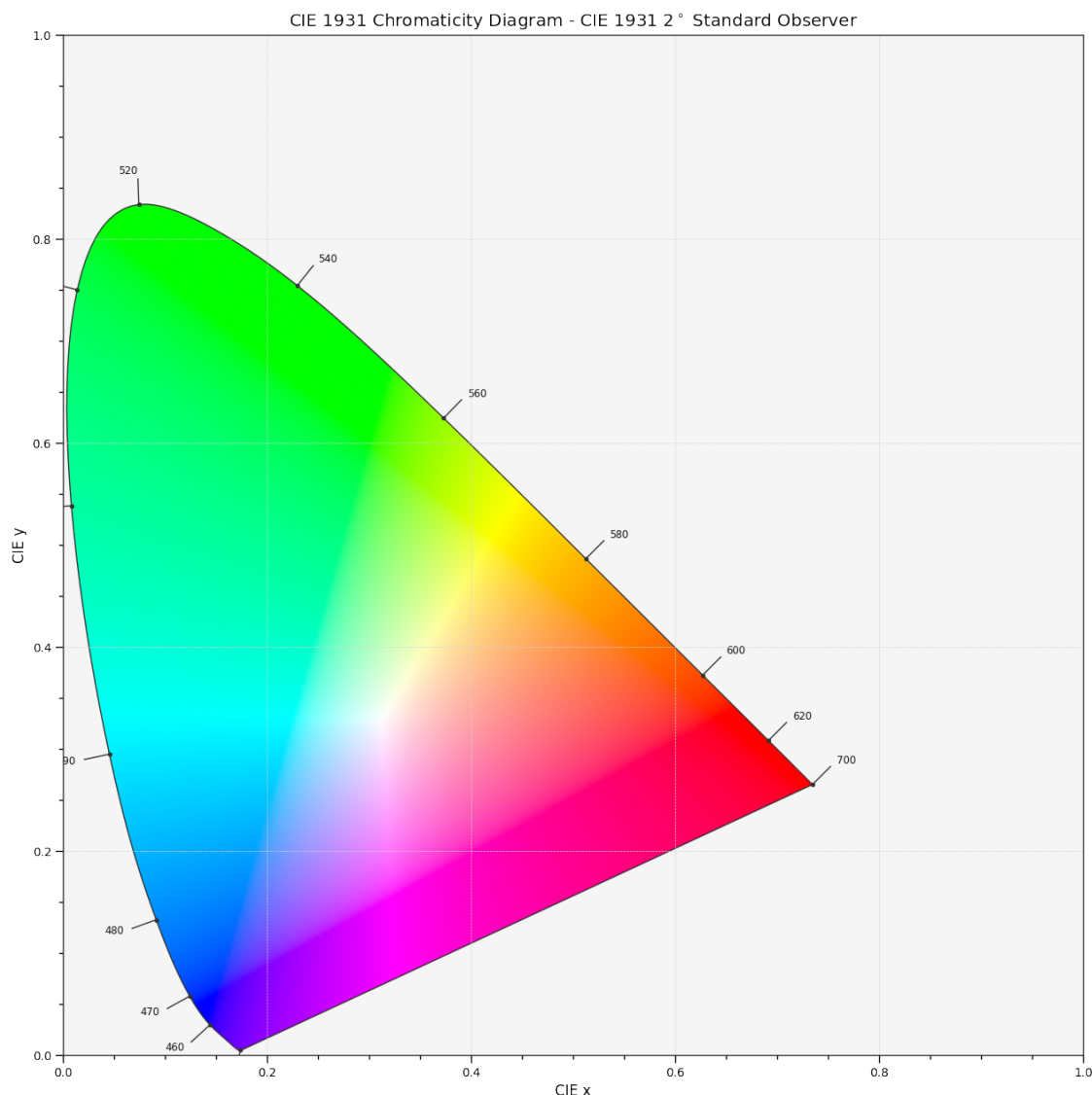
Current figure and axes.

Return type

tuple

Examples

```
>>> plot_chromaticity_diagram_CIE1931()
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



colour.plotting.plot_chromaticity_diagram_CIE1960UCS

```
colour.plotting.plot_chromaticity_diagram_CIE1960UCS(cmfs: MultiSpectralDistributions | str |
Sequence[MultiSpectralDistributions | str]
= 'CIE 1931 2 Degree Standard Observer',
show_diagram_colours: bool = True,
show_spectral_locus: bool = True,
**kwargs: Any) → Tuple[Figure, Axes]
```

Plot the *CIE 1960 UCS Chromaticity Diagram*.

Parameters

- **cmfs** (MultiSpectralDistributions | *str* | Sequence[MultiSpectralDistributions | *str*]) – Standard observer colour matching functions used for computing the spectral locus boundaries. *cmfs* can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
- **show_diagram_colours** (*bool*) – Whether to display the *Chromaticity Diagram* background colours.
- **show_spectral_locus** (*bool*) – Whether to display the *Spectral Locus*.

- **kwargs** (Any) – {`colour.plotting.artist()`, `colour.plotting.diagrams.plot_chromaticity_diagram()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

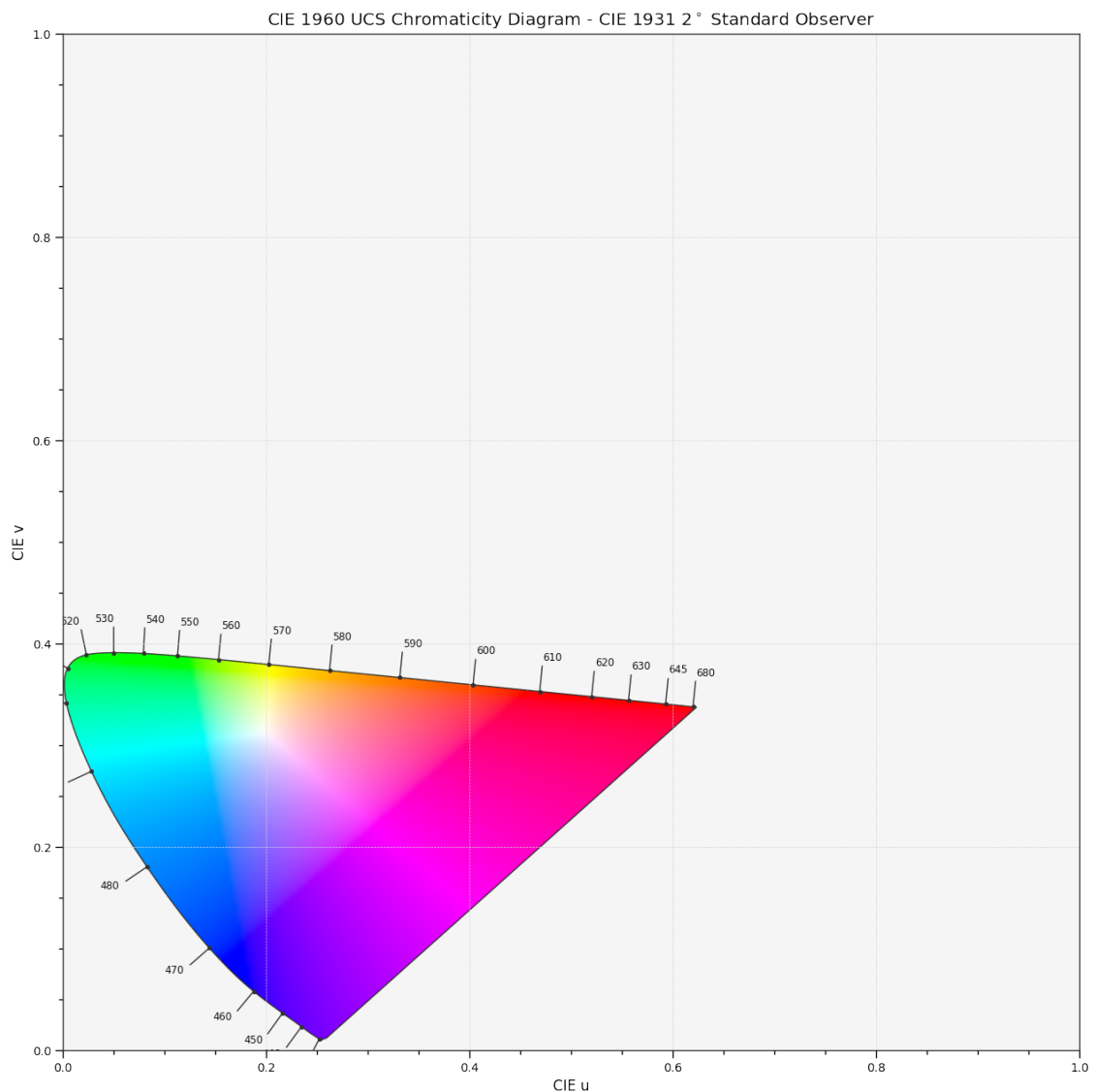
Current figure and axes.

Return type

`tuple`

Examples

```
>>> plot_chromaticity_diagram_CIE1960UCS()
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



colour.plotting.plot_chromaticity_diagram_CIE1976UCS

```
colour.plotting.plot_chromaticity_diagram_CIE1976UCS(cmfs: MultiSpectralDistributions | str |  
                                                    Sequence[MultiSpectralDistributions | str]  
                                                    = 'CIE 1931 2 Degree Standard Observer',  
                                                    show_diagram_colours: bool = True,  
                                                    show_spectral_locus: bool = True,  
                                                    **kwargs: Any) → Tuple[Figure, Axes]
```

Plot the *CIE 1976 UCS Chromaticity Diagram*.

Parameters

- **cmfs** (MultiSpectralDistributions | str | Sequence[MultiSpectralDistributions | str]) – Standard observer colour matching functions used for computing the spectral locus boundaries. `cmfs` can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
- **show_diagram_colours** (bool) – Whether to display the *Chromaticity Diagram* background colours.
- **show_spectral_locus** (bool) – Whether to display the *Spectral Locus*.
- **kwargs** (Any) – {`colour.plotting.artist()`, `colour.plotting.diagrams.plot_chromaticity_diagram()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

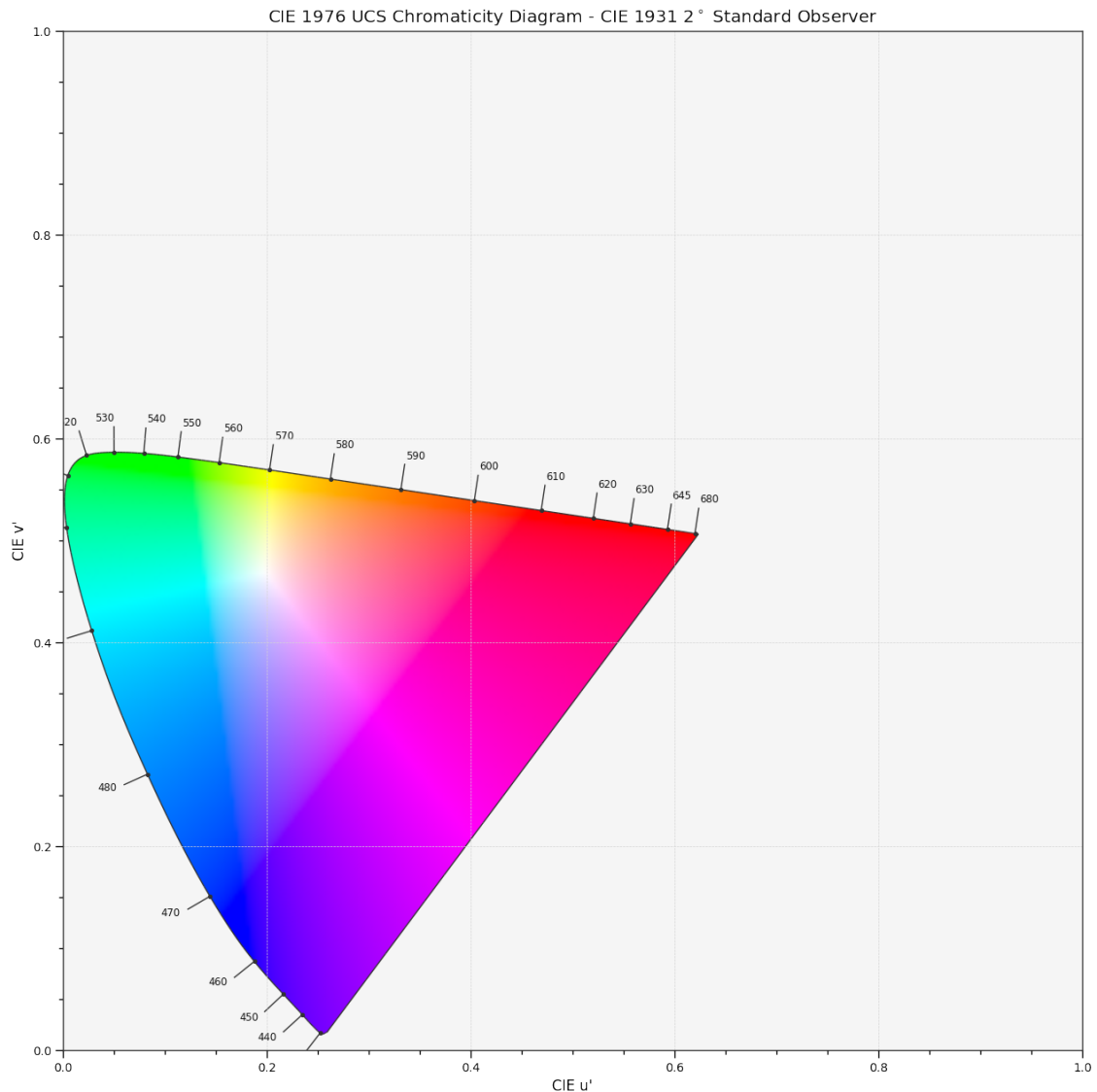
Current figure and axes.

Return type

tuple

Examples

```
>>> plot_chromaticity_diagram_CIE1976UCS()  
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```

`colour.plotting.plot_sds_in_chromaticity_diagram_CIE1931`

```
colour.plotting.plot_sds_in_chromaticity_diagram_CIE1931(sds: Sequence[SpectralDistribution |
    MultiSpectralDistributions] | MultiSpectralDistributions, cmfs:
    MultiSpectralDistributions | str | Sequence[MultiSpectralDistributions] |
    str] = 'CIE 1931 2 Degree Standard Observer', chromaticity_diagram_callable_CIE1931:
    Callable = plot_chromaticity_diagram_CIE1931,
    annotate_kwargs: Dict | List[Dict] | None = None, plot_kwargs: Dict |
    List[Dict] | None = None, **kwargs: Any) → Tuple[Figure, Axes]
```

Plot given spectral distribution chromaticity coordinates into the *CIE 1931 Chromaticity Diagram*.

Parameters

- `sds` (`Sequence[SpectralDistribution | MultiSpectralDistributions]` |

`MultiSpectralDistributions`) – Spectral distributions or multi-spectral distributions to plot. `sds` can be a single `colour.MultiSpectralDistributions` class instance, a list of `colour.MultiSpectralDistributions` class instances or a list of `colour.SpectralDistribution` class instances.

- **cmfs** (`MultiSpectralDistributions` | `str` | `Sequence[MultiSpectralDistributions | str]`) – Standard observer colour matching functions used for computing the spectral locus boundaries. `cmfs` can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
- **chromaticity_diagram_callable_CIE1931** (`Callable`) – Callable responsible for drawing the *CIE 1931 Chromaticity Diagram*.
- **annotate_kwargs** (`Dict` | `List[Dict]` | `None`) – Keyword arguments for the `matplotlib.pyplot.annotate()` definition, used to annotate the resulting chromaticity coordinates with their respective spectral distribution names. `annotate_kwargs` can be either a single dictionary applied to all the arrows with same settings or a sequence of dictionaries with different settings for each spectral distribution. The following special keyword arguments can also be used:
 - `annotate` : Whether to annotate the spectral distributions.
- **plot_kwargs** (`Dict` | `List[Dict]` | `None`) – Keyword arguments for the `matplotlib.pyplot.plot()` definition, used to control the style of the plotted spectral distributions. `plot_kwargs`` can be either a single dictionary applied to all the plotted spectral distributions with the same settings or a sequence of dictionaries with different settings for each plotted spectral distributions. The following special keyword arguments can also be used:
 - `illuminant` : The illuminant used to compute the spectral distributions colours. The default is the illuminant associated with the whitepoint of the default plotting colourspace. `illuminant` can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
 - `cmfs` : The standard observer colour matching functions used for computing the spectral distributions colours. `cmfs` can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
 - `normalise_sd_colours` : Whether to normalise the computed spectral distributions colours. The default is `True`.
 - `use_sd_colours` : Whether to use the computed spectral distributions colours under the plotting colourspace illuminant. Alternatively, it is possible to use the `matplotlib.pyplot.plot()` definition `color` argument with pre-computed values. The default is `True`.
- **kwargs** (`Any`) – `{colour.plotting.artist(), colour.plotting.diagrams.plot_chromaticity_diagram(), colour.plotting.render()}`, See the documentation of the previously listed definitions.`

Returns

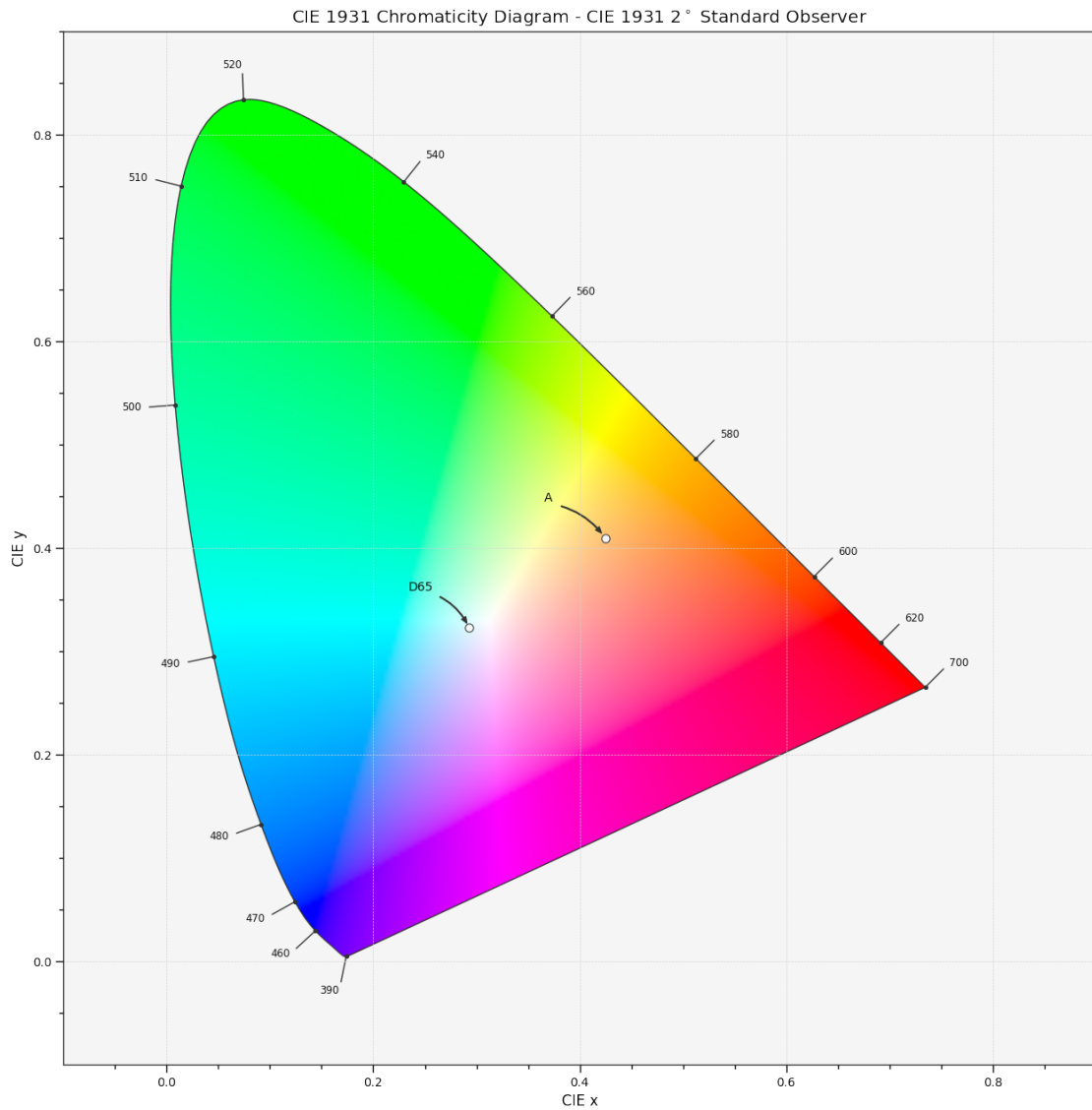
Current figure and axes.

Return type

`tuple`

Examples

```
>>> A = SDS_ILLUMINANTS["A"]  
>>> D65 = SDS_ILLUMINANTS["D65"]  
>>> plot_sds_in_chromaticity_diagram_CIE1931([A, D65])  
...  
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



colour.plotting.plot_sds_in_chromaticity_diagram_CIE1960UCS

```
colour.plotting.plot_sds_in_chromaticity_diagram_CIE1960UCS(sds: Sequence[SpectralDistribution
| MultiSpectralDistributions] |
MultiSpectralDistributions, cmfs:
MultiSpectralDistributions | str |
Se-
quence[MultiSpectralDistributions
| str] = 'CIE 1931 2 Degree
Standard Observer', chromatic-
ity_diagram_callable_CIE1960UCS:
Callable =
plot_chromaticity_diagram_CIE1960UCS,
annotate_kwargs: Dict | List[Dict]
| None = None, plot_kwargs: Dict |
List[Dict] | None = None,
**kwargs: Any) → Tuple[Figure,
Axes]
```

Plot given spectral distribution chromaticity coordinates into the *CIE 1960 UCS Chromaticity Diagram*.

Parameters

- **sds** (`Sequence[SpectralDistribution | MultiSpectralDistributions] | MultiSpectralDistributions`) – Spectral distributions or multi-spectral distributions to plot. *sds* can be a single `colour.MultiSpectralDistributions` class instance, a list of `colour.MultiSpectralDistributions` class instances or a list of `colour.SpectralDistribution` class instances.
- **cmfs** (`(MultiSpectralDistributions | str | Sequence[MultiSpectralDistributions | str])`) – Standard observer colour matching functions used for computing the spectral locus boundaries. *cmfs* can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
- **chromaticity_diagram_callable_CIE1960UCS** (`Callable`) – Callable responsible for drawing the *CIE 1960 UCS Chromaticity Diagram*.
- **annotate_kwargs** (`Dict | List[Dict] | None`) – Keyword arguments for the `matplotlib.pyplot.annotate()` definition, used to annotate the resulting chromaticity coordinates with their respective spectral distribution names. *annotate_kwargs* can be either a single dictionary applied to all the arrows with same settings or a sequence of dictionaries with different settings for each spectral distribution. The following special keyword arguments can also be used:
 - *annotate* : Whether to annotate the spectral distributions.
- **plot_kwargs** (`Dict | List[Dict] | None`) – Keyword arguments for the `matplotlib.pyplot.plot()` definition, used to control the style of the plotted spectral distributions. *plot_kwargs* can be either a single dictionary applied to all the plotted spectral distributions with the same settings or a sequence of dictionaries with different settings for each plotted spectral distributions. The following special keyword arguments can also be used:
 - *illuminant* : The illuminant used to compute the spectral distributions colours. The default is the illuminant associated with the whitepoint of the default plotting colourspace. *illuminant* can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
 - *cmfs* : The standard observer colour matching functions used for computing the spectral distributions colours. *cmfs* can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.

- `normalise_sd_colours` : Whether to normalise the computed spectral distributions colours. The default is *True*.
- `use_sd_colours` : Whether to use the computed spectral distributions colours under the plotting colourspace illuminant. Alternatively, it is possible to use the `matplotlib.pyplot.plot()` definition color argument with pre-computed values. The default is *True*.
- **kwargs** (Any) – {`colour.plotting.artist()`, `colour.plotting.diagrams.plot_chromaticity_diagram()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

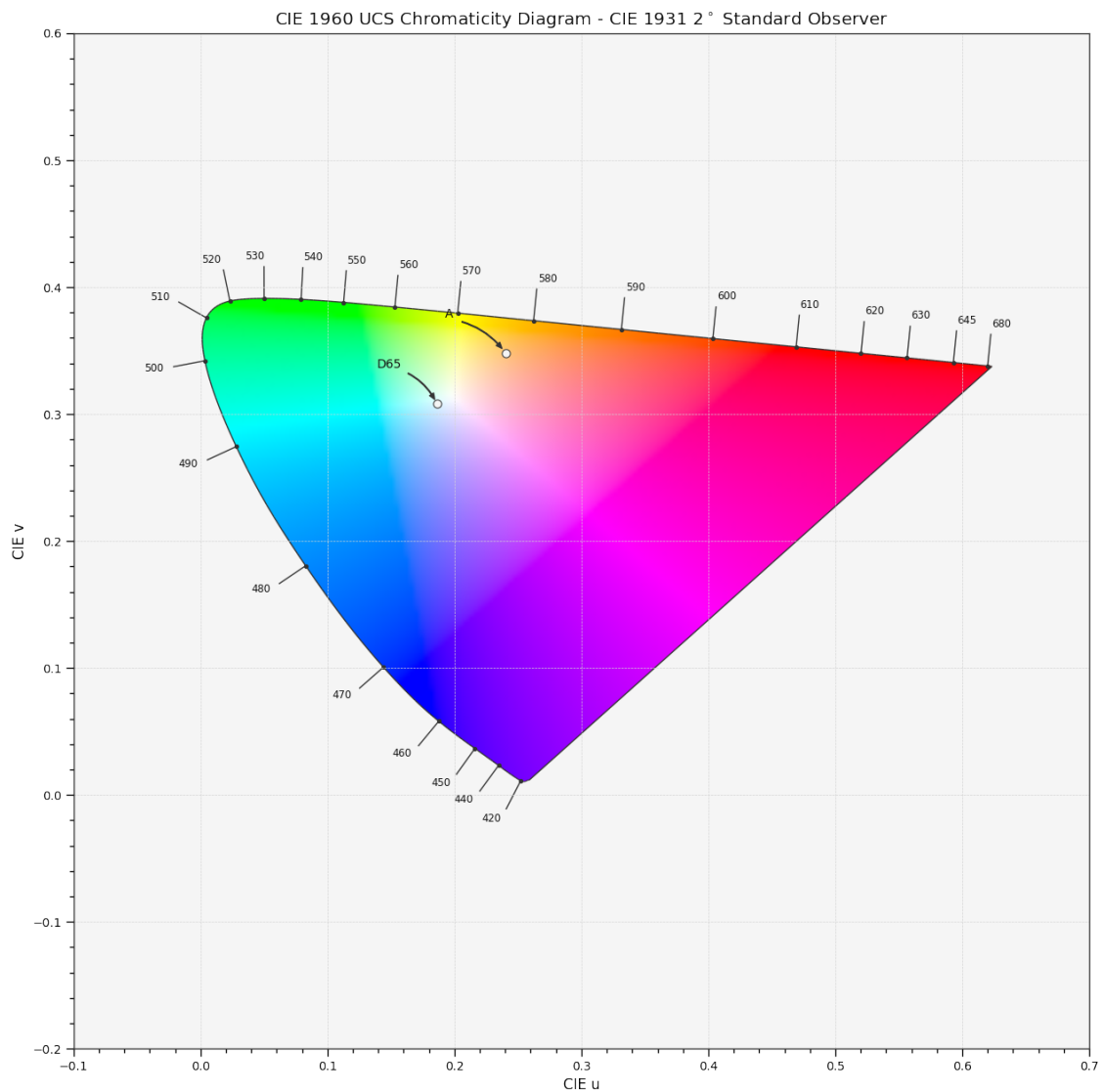
Current figure and axes.

Return type

`tuple`

Examples

```
>>> A = SDS_ILLUMINANTS["A"]
>>> D65 = SDS_ILLUMINANTS["D65"]
>>> plot_sds_in_chromaticity_diagram_CIE1960UCS([A, D65])
...
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



colour.plotting.plot_sds_in_chromaticity_diagram_CIE1976UCS

```
colour.plotting.plot_sds_in_chromaticity_diagram_CIE1976UCS(sds: Sequence[SpectralDistribution
| MultiSpectralDistributions] |
MultiSpectralDistributions, cmfs:
MultiSpectralDistributions | str |
Sequence[MultiSpectralDistributions
| str] = 'CIE 1931 2 Degree
Standard Observer', chromatic-
ity_diagram_callable_CIE1976UCS:
Callable =
plot_chromaticity_diagram_CIE1976UCS,
annotate_kwargs: Dict | List[Dict]
| None = None, plot_kwargs: Dict |
List[Dict] | None = None,
**kwargs: Any) → Tuple[Figure,
Axes]
```

Plot given spectral distribution chromaticity coordinates into the *CIE 1976 UCS Chromaticity Diagram*.

Parameters

- **sds** (`Sequence[SpectralDistribution | MultiSpectralDistributions] | MultiSpectralDistributions`) – Spectral distributions or multi-spectral distributions to plot. *sds* can be a single `colour.MultiSpectralDistributions` class instance, a list of `colour.MultiSpectralDistributions` class instances or a list of `colour.SpectralDistribution` class instances.
- **cmfs** (`(MultiSpectralDistributions | str | Sequence[MultiSpectralDistributions | str])`) – Standard observer colour matching functions used for computing the spectral locus boundaries. *cmfs* can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
- **chromaticity_diagram_callable_CIE1976UCS** (`Callable`) – Callable responsible for drawing the *CIE 1976 UCS Chromaticity Diagram*.
- **annotate_kwargs** (`Dict | List[Dict] | None`) – Keyword arguments for the `matplotlib.pyplot.annotate()` definition, used to annotate the resulting chromaticity coordinates with their respective spectral distribution names. *annotate_kwargs* can be either a single dictionary applied to all the arrows with same settings or a sequence of dictionaries with different settings for each spectral distribution. The following special keyword arguments can also be used:
 - *annotate* : Whether to annotate the spectral distributions.
- **plot_kwargs** (`Dict | List[Dict] | None`) – Keyword arguments for the `matplotlib.pyplot.plot()` definition, used to control the style of the plotted spectral distributions. *plot_kwargs* can be either a single dictionary applied to all the plotted spectral distributions with the same settings or a sequence of dictionaries with different settings for each plotted spectral distributions. The following special keyword arguments can also be used:
 - *illuminant* : The illuminant used to compute the spectral distributions colours. The default is the illuminant associated with the whitepoint of the default plotting colourspace. *illuminant* can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
 - *cmfs* : The standard observer colour matching functions used for computing the spectral distributions colours. *cmfs* can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
 - *normalise_sd_colours* : Whether to normalise the computed spectral distributions colours. The default is *True*.
 - *use_sd_colours* : Whether to use the computed spectral distributions colours under the plotting colourspace illuminant. Alternatively, it is possible to use the `matplotlib.pyplot.plot()` definition *color* argument with pre-computed values. The default is *True*.
- **kwargs** (`Any`) – {`colour.plotting.artist()`, `colour.plotting.diagrams.plot_chromaticity_diagram()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

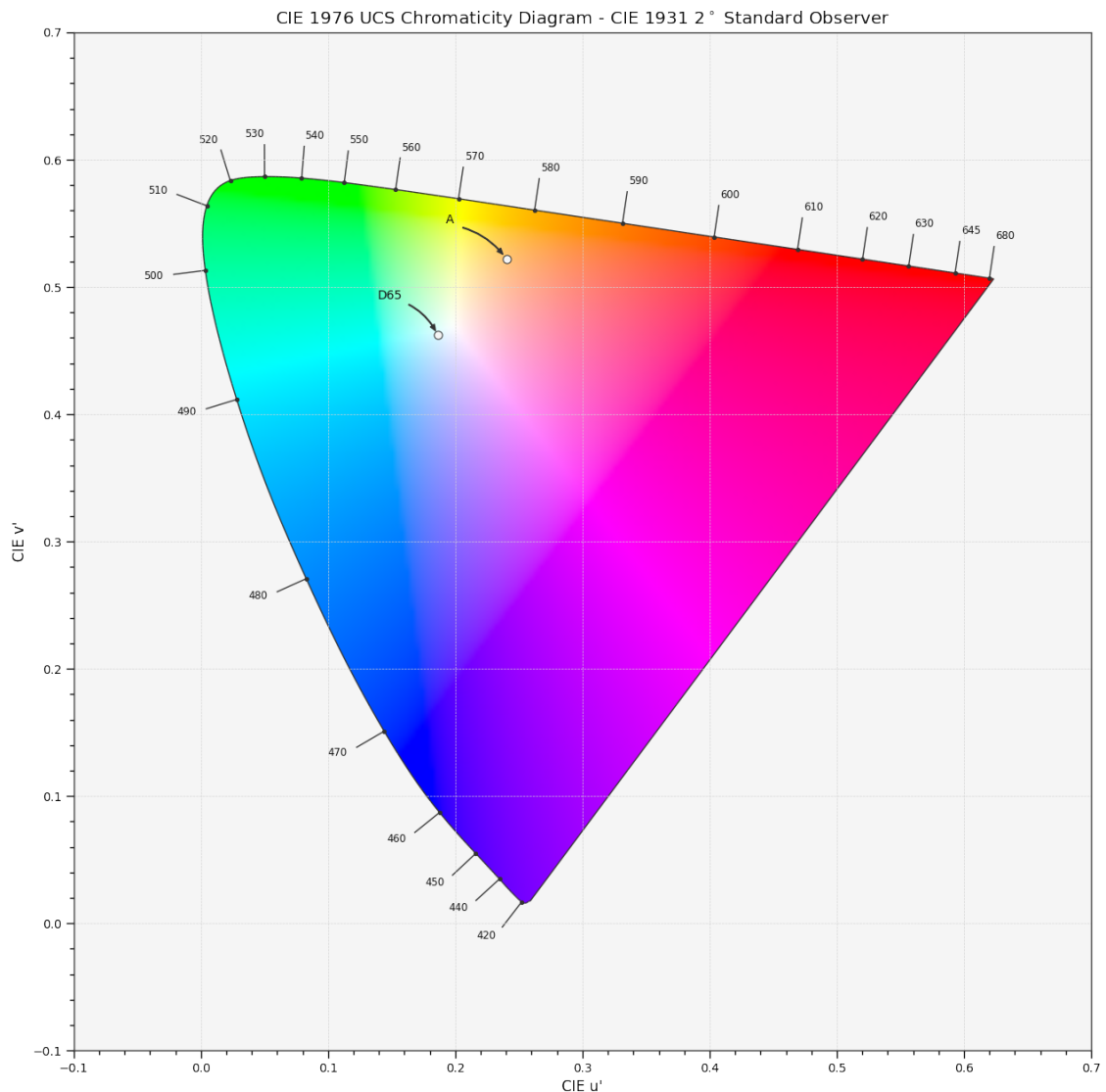
Current figure and axes.

Return type

`tuple`

Examples

```
>>> A = SDS_ILLUMINANTS["A"]
>>> D65 = SDS_ILLUMINANTS["D65"]
>>> plot_sds_in_chromaticity_diagram_CIE1976UCS([A, D65])
...
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



Ancillary Objects

colour.plotting.diagrams

| | |
|--|--|
| <code>plot_spectral_locus([cmfs, ...])</code> | Plot the <i>Spectral Locus</i> according to given method. |
| <code>plot_chromaticity_diagram_colours([samples, ...])</code> | Plot the <i>Chromaticity Diagram</i> colours according to given method. |
| <code>plot_chromaticity_diagram([cmfs, ...])</code> | Plot the <i>Chromaticity Diagram</i> according to given method. |
| <code>plot_sds_in_chromaticity_diagram(sds[, ...])</code> | Plot given spectral distribution chromaticity coordinates into the <i>Chromaticity Diagram</i> using given method. |

`colour.plotting.diagrams.plot_spectral_locus`

```
colour.plotting.diagrams.plot_spectral_locus(cmfs: MultiSpectralDistributions | str |
                                             Sequence[MultiSpectralDistributions | str] = 'CIE
                                             1931 2 Degree Standard Observer',
                                             spectral_locus_colours: ArrayLike | str | None =
                                             None, spectral_locus_opacity: float = 1,
                                             spectral_locus_labels: Sequence | None = None,
                                             method: Literal['CIE 1931', 'CIE 1960 UCS', 'CIE
                                             1976 UCS'] | str = 'CIE 1931', **kwargs: Any) →
                                             Tuple[Figure, Axes]
```

Plot the *Spectral Locus* according to given method.

Parameters

- **cmfs** (`MultiSpectralDistributions` | `str` | `Sequence[MultiSpectralDistributions | str]`) – Standard observer colour matching functions used for computing the spectral locus boundaries. `cmfs` can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
- **spectral_locus_colours** (`ArrayLike` | `str` | `None`) – Colours of the *Spectral Locus*, if `spectral_locus_colours` is set to *RGB*, the colours will be computed according to the corresponding chromaticity coordinates.
- **spectral_locus_opacity** (`float`) – Opacity of the *Spectral Locus*.
- **spectral_locus_labels** (`Sequence` | `None`) – Array of wavelength labels used to customise which labels will be drawn around the spectral locus. Passing an empty array will result in no wavelength labels being drawn.
- **method** (`Literal['CIE 1931', 'CIE 1960 UCS', 'CIE 1976 UCS']` | `str`) – *Chromaticity Diagram* method.
- **kwargs** (`Any`) – {`colour.plotting.artist()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

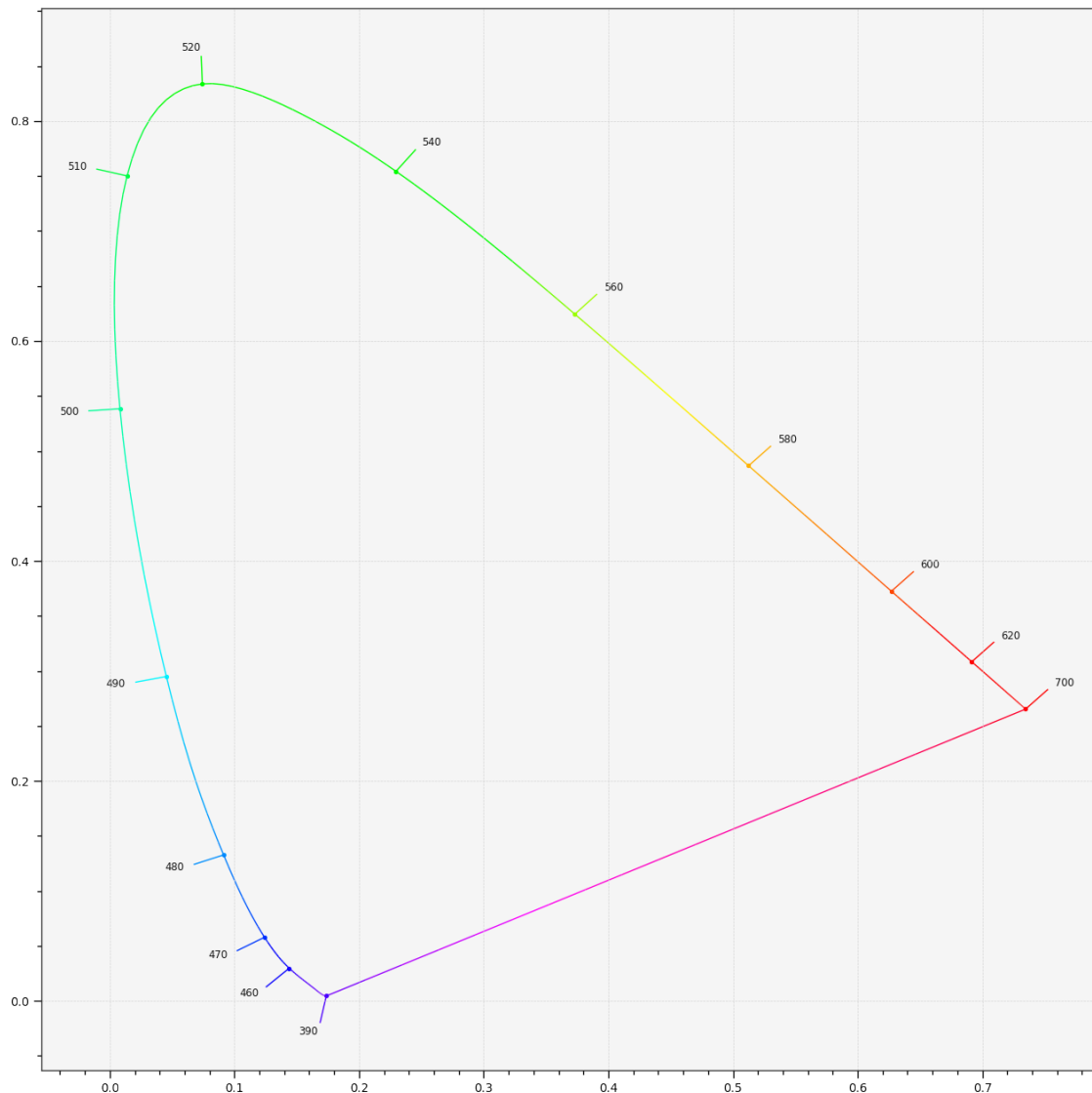
Current figure and axes.

Return type

`tuple`

Examples

```
>>> plot_spectral_locus(spectral_locus_colours="RGB")
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



colour.plotting.diagrams.plot_chromaticity_diagram_colours

```
colour.plotting.diagrams.plot_chromaticity_diagram_colours(samples: int = 256,
    diagram_colours: ArrayLike | str |
    None = None, diagram_opacity:
    float = 1, diagram_clipping_path:
    ArrayLike | None = None, cmfs:
    MultiSpectralDistributions | str |
    Sequence[MultiSpectralDistributions
    | str] = 'CIE 1931 2 Degree Standard
    Observer', method: Literal['CIE
    1931', 'CIE 1960 UCS', 'CIE 1976
    UCS'] | str = 'CIE 1931', **kwargs:
    Any) → Tuple[Figure, Axes]
```

Plot the *Chromaticity Diagram* colours according to given method.

Parameters

- **samples** (`int`) – Samples count on one axis when computing the *Chromaticity Diagram* colours.
- **diagram_colours** (`ArrayLike` | `str` | `None`) – Colours of the *Chromaticity Diagram*, if `diagram_colours` is set to *RGB*, the colours will be computed according to the corresponding coordinates.
- **diagram_opacity** (`float`) – Opacity of the *Chromaticity Diagram*.
- **diagram_clipping_path** (`ArrayLike` | `None`) – Path of points used to clip the *Chromaticity Diagram* colours.
- **cmfs** (`MultiSpectralDistributions` | `str` | `Sequence[MultiSpectralDistributions | str]`) – Standard observer colour matching functions used for computing the spectral locus boundaries. `cmfs` can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
- **method** (`Literal['CIE 1931', 'CIE 1960 UCS', 'CIE 1976 UCS']` | `str`) – *Chromaticity Diagram* method.
- **kwargs** (`Any`) – `{colour.plotting.artist(), colour.plotting.render()}`, See the documentation of the previously listed definitions.`

Returns

Current figure and axes.

Return type

`tuple`

Examples

```
>>> plot_chromaticity_diagram_colours(diagram_colours="RGB")
...
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



`colour.plotting.diagrams.plot_chromaticity_diagram`

`colour.plotting.diagrams.plot_chromaticity_diagram`(*cmfs*: `MultiSpectralDistributions` | `str` | `Sequence[MultiSpectralDistributions | str]` = `'CIE 1931 2 Degree Standard Observer'`, *show_diagram_colours*: `bool` = `True`, *show_spectral_locus*: `bool` = `True`, *method*: `Literal['CIE 1931', 'CIE 1960 UCS', 'CIE 1976 UCS']` | `str` = `'CIE 1931'`, ***kwargs*: `Any`) → `Tuple[Figure, Axes]`

Plot the *Chromaticity Diagram* according to given method.

Parameters

- **cmfs** (`MultiSpectralDistributions` | `str` | `Sequence[MultiSpectralDistributions | str]`) – Standard observer colour matching functions used for computing the spectral locus boundaries. *cmfs* can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
- **show_diagram_colours** (`bool`) – Whether to display the *Chromaticity Diagram* background colours.

- **show_spectral_locus** (`bool`) – Whether to display the *Spectral Locus*.
- **method** (`Literal['CIE 1931', 'CIE 1960 UCS', 'CIE 1976 UCS'] | str`) – *Chromaticity Diagram* method.
- **kwargs** (`Any`) – {`colour.plotting.artist()`, `colour.plotting.diagrams.plot_spectral_locus()`, `colour.plotting.diagrams.plot_chromaticity_diagram_colours()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

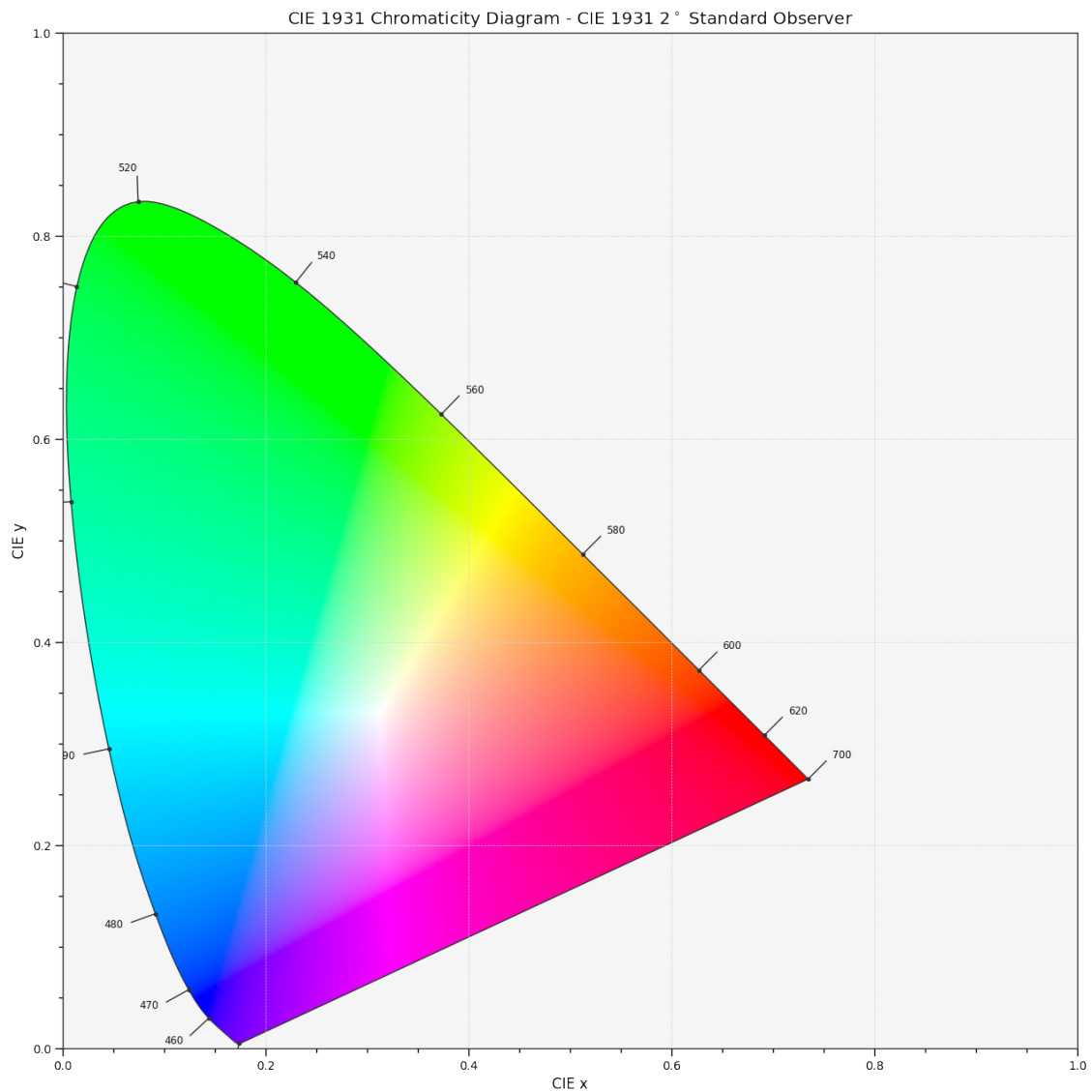
Current figure and axes.

Return type

`tuple`

Examples

```
>>> plot_chromaticity_diagram()
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



`colour.plotting.diagrams.plot_sds_in_chromaticity_diagram`

```
colour.plotting.diagrams.plot_sds_in_chromaticity_diagram(sds: Sequence[SpectralDistribution | MultiSpectralDistributions] | MultiSpectralDistributions, cmfs: MultiSpectralDistributions | str | Sequence[MultiSpectralDistributions | str] = 'CIE 1931 2 Degree Standard Observer', chromaticity_diagram_callable: Callable = plot_chromaticity_diagram, method: Literal['CIE 1931', 'CIE 1960 UCS', 'CIE 1976 UCS'] | str = 'CIE 1931', annotate_kwargs: Dict | List[Dict] | None = None, plot_kwargs: Dict | List[Dict] | None = None, **kwargs: Any) → Tuple[Figure, Axes]
```

Plot given spectral distribution chromaticity coordinates into the *Chromaticity Diagram* using given method.

Parameters

- **sds** (`Sequence[SpectralDistribution | MultiSpectralDistributions] | MultiSpectralDistributions`) – Spectral distributions or multi-spectral distributions to plot. *sds* can be a single `colour.MultiSpectralDistributions` class instance, a list of `colour.MultiSpectralDistributions` class instances or a list of `colour.SpectralDistribution` class instances.
- **cmfs** (`MultiSpectralDistributions | str | Sequence[MultiSpectralDistributions | str]`) – Standard observer colour matching functions used for computing the spectral locus boundaries. *cmfs* can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
- **chromaticity_diagram_callable** (`Callable`) – Callable responsible for drawing the *Chromaticity Diagram*.
- **method** (`Literal['CIE 1931', 'CIE 1960 UCS', 'CIE 1976 UCS'] | str`) – *Chromaticity Diagram* method.
- **annotate_kwargs** (`Dict | List[Dict] | None`) – Keyword arguments for the `matplotlib.pyplot.annotate()` definition, used to annotate the resulting chromaticity coordinates with their respective spectral distribution names. *annotate_kwargs* can be either a single dictionary applied to all the arrows with same settings or a sequence of dictionaries with different settings for each spectral distribution. The following special keyword arguments can also be used:
 - **annotate** : Whether to annotate the spectral distributions.
- **plot_kwargs** (`Dict | List[Dict] | None`) – Keyword arguments for the `matplotlib.pyplot.plot()` definition, used to control the style of the plotted spectral distributions. *plot_kwargs* can be either a single dictionary applied to all the plotted spectral distributions with the same settings or a sequence of dictionaries with different settings for each plotted spectral distributions. The following special keyword arguments can also be used:
 - **illuminant** : The illuminant used to compute the spectral distributions colours. The default is the illuminant associated with the whitepoint of the default plotting colourspace. *illuminant* can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.

- `cmfs` : The standard observer colour matching functions used for computing the spectral distributions colours. `cmfs` can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
- `normalise_sd_colours` : Whether to normalise the computed spectral distributions colours. The default is `True`.
- `use_sd_colours` : Whether to use the computed spectral distributions colours under the plotting colourspace illuminant. Alternatively, it is possible to use the `matplotlib.pyplot.plot()` definition `color` argument with pre-computed values. The default is `True`.
- **kwargs** (Any) – {`colour.plotting.artist()`, `colour.plotting.diagrams.plot_chromaticity_diagram()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

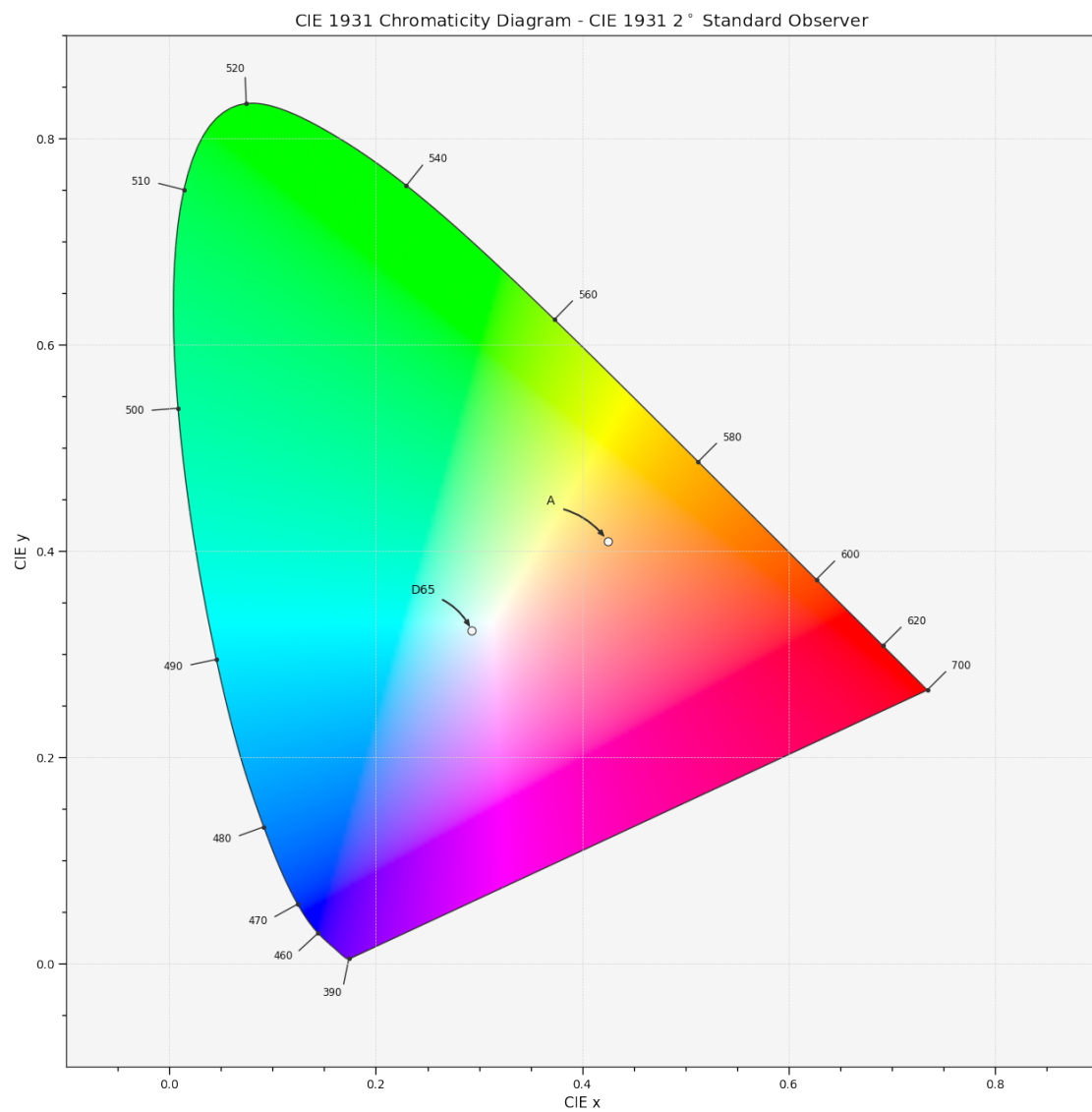
Current figure and axes.

Return type

`tuple`

Examples

```
>>> A = SDS_ILLUMINANTS["A"]
>>> D65 = SDS_ILLUMINANTS["D65"]
>>> annotate_kwargs = [
...     {"xytext": (-25, 15), "arrowprops": {"arrowstyle": "-"}},
...     {},
... ]
>>> plot_kwargs = [
...     {
...         "illuminant": SDS_ILLUMINANTS["E"],
...         "markersize": 15,
...         "normalise_sd_colours": True,
...         "use_sd_colours": True,
...     },
...     {"illuminant": SDS_ILLUMINANTS["E"]},
... ]
>>> plot_sds_in_chromaticity_diagram(
...     [A, D65], annotate_kwargs=annotate_kwargs, plot_kwargs=plot_kwargs
... )
...
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



Colour Models

`colour.plotting`

| | |
|--|---|
| <code>plot_RGB_colourspaces_in_chromaticity_diagram_CIE1931</code> | Plot given <i>RGB</i> colourspace in the <i>CIE 1931 Chromaticity Diagram</i> . |
| <code>plot_RGB_colourspaces_in_chromaticity_diagram_CIE1960</code> | Plot given <i>RGB</i> colourspace in the <i>CIE 1960 UCS Chromaticity Diagram</i> . |
| <code>plot_RGB_colourspaces_in_chromaticity_diagram_CIE1976</code> | Plot given <i>RGB</i> colourspace in the <i>CIE 1976 UCS Chromaticity Diagram</i> . |
| <code>plot_RGB_chromaticities_in_chromaticity_diagram_CIE1931</code> | Plot given <i>RGB</i> colour space array in the <i>CIE 1931 Chromaticity Diagram</i> . |
| <code>plot_RGB_chromaticities_in_chromaticity_diagram_CIE1960</code> | Plot given <i>RGB</i> colour space array in the <i>CIE 1960 UCS Chromaticity Diagram</i> . |
| <code>plot_RGB_chromaticities_in_chromaticity_diagram_CIE1976</code> | Plot given <i>RGB</i> colour space array in the <i>CIE 1976 UCS Chromaticity Diagram</i> . |
| <code>plot_ellipses_MacAdam1942_in_chromaticity_diagram_CIE1931</code> | Plot <i>MacAdam (1942) Ellipses (Observer PGN)</i> in the <i>CIE 1931 Chromaticity Diagram</i> . |
| <code>plot_ellipses_MacAdam1942_in_chromaticity_diagram_CIE1960</code> | Plot <i>MacAdam (1942) Ellipses (Observer PGN)</i> in the <i>CIE 1960 UCS Chromaticity Diagram</i> . |
| <code>plot_ellipses_MacAdam1942_in_chromaticity_diagram_CIE1976</code> | Plot <i>MacAdam (1942) Ellipses (Observer PGN)</i> in the <i>CIE 1976 UCS Chromaticity Diagram</i> . |
| <code>plot_single_cctf(cctf[, cctf_decoding])</code> | Plot given colour space colour component transfer function. |
| <code>plot_multi_cctfs(cctfs[, cctf_decoding])</code> | Plot given colour component transfer functions. |
| <code>plot_constant_hue_loci(data[, model, ...])</code> | Plot given constant hue loci colour matches data such as that from [HB95] or [EF98] that are easily loaded with Colour - Datasets . |

`colour.plotting.plot_RGB_colourspaces_in_chromaticity_diagram_CIE1931`

```
colour.plotting.plot_RGB_colourspaces_in_chromaticity_diagram_CIE1931(colourspaces:
    RGB_Colourspace | str
    | Sequence[RGB_Colourspace | str], cmfs: MultiSpectralDistributions | str
    | Sequence[MultiSpectralDistributions | str] = 'CIE 1931 2
    Degree Standard
    Observer', chromaticity_diagram_callable_CIE1931:
    Callable =
    plot_chromaticity_diagram_CIE1931,
    show_whitepoints: bool = True,
    show_pointer_gamut: bool = False,
    chromatically_adapt: bool = False,
    plot_kwargs: Dict | List[Dict] | None = None, **kwargs: Any)
    → Tuple[Figure, Axes]
```

Plot given *RGB* colourspace in the *CIE 1931 Chromaticity Diagram*.

Parameters

- **colourspaces** (*RGB_Colourspace* | *str* | *Sequence[RGB_Colourspace | str]*)

– *RGB* colourspaces to plot. colourspaces elements can be of any type or form supported by the `colour.plotting.common.filter_RGB_colourspaces()` definition.

- **cmfs** (`MultiSpectralDistributions` | `str` | `Sequence[MultiSpectralDistributions | str]`) – Standard observer colour matching functions used for computing the spectral locus boundaries. cmfs can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
- **chromaticity_diagram_callable_CIE1931** (`Callable`) – Callable responsible for drawing the *CIE 1931 Chromaticity Diagram*.
- **show_whitepoints** (`bool`) – Whether to display the *RGB* colourspaces whitepoints.
- **show_pointer_gamut** (`bool`) – Whether to display the *Pointer’s Gamut*.
- **chromatically_adapt** (`bool`) – Whether to chromatically adapt the *RGB* colourspaces given in colourspaces to the whitepoint of the default plotting colourspace.
- **plot_kwargs** (`Dict` | `List[Dict]` | `None`) – Keyword arguments for the `matplotlib.pyplot.plot()` definition, used to control the style of the plotted *RGB* colourspaces. plot_kwargs can be either a single dictionary applied to all the plotted *RGB* colourspaces with the same settings or a sequence of dictionaries with different settings for each plotted *RGB* colourspace.
- **kwargs** (`Any`) – {`colour.plotting.artist()`, `colour.plotting.diagrams.plot_chromaticity_diagram()`, `colour.plotting.models.plot_pointer_gamut()`, `colour.plotting.models.plot_RGB_colourspaces_in_chromaticity_diagram()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

Current figure and axes.

Return type

`tuple`

Examples

```
>>> plot_RGB_colourspaces_in_chromaticity_diagram_CIE1931(  
...     ["ITU-R BT.709", "ACEScg", "S-Gamut"]  
... )  
...  
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



`colour.plotting.plot_RGB_colourspace_in_chromaticity_diagram_CIE1960UCS`

```
colour.plotting.plot_RGB_colourspace_in_chromaticity_diagram_CIE1960UCS(colourspace:
    RGB_Colourspace |
    str | Sequence[RGB_Colourspace
    | str], cmfs:
    MultiSpectralDistributions | str |
    Sequence[MultiSpectralDistributions
    | str] = 'CIE 1931 2
    Degree Standard
    Observer',
    chromaticity_diagram_callable_CIE1960UCS:
    Callable =
    plot_chromaticity_diagram_CIE1960UCS,
    show_whitepoints:
    bool = True,
    show_pointer_gamut:
    bool = False, chromatically_adapt:
    bool = False,
    plot_kwarg: Dict | List[Dict] | None =
    None, **kwargs:
    Any) ->
    Tuple[Figure, Axes]
```

Plot given *RGB* colourspaces in the *CIE 1960 UCS Chromaticity Diagram*.

Parameters

- **colourspace** (*RGB_Colourspace* | *str* | *Sequence[RGB_Colourspace* | *str]*) – *RGB* colourspaces to plot. *colourspace* elements can be of any type or form supported by the `colour.plotting.common.filter_RGB_colourspace()` definition.
- **cmfs** (*MultiSpectralDistributions* | *str* | *Sequence[MultiSpectralDistributions* | *str]*) – Standard observer colour matching functions used for computing the spectral locus boundaries. *cmfs* can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
- **chromaticity_diagram_callable_CIE1960UCS** (*Callable*) – Callable responsible for drawing the *CIE 1960 UCS Chromaticity Diagram*.
- **show_whitepoints** (*bool*) – Whether to display the *RGB* colourspaces whitepoints.
- **show_pointer_gamut** (*bool*) – Whether to display the *Pointer's Gamut*.
- **chromatically_adapt** (*bool*) – Whether to chromatically adapt the *RGB* colourspaces given in *colourspace* to the whitepoint of the default plotting colourspace.
- **plot_kwarg** (*Dict* | *List[Dict]* | *None*) – Keyword arguments for the `matplotlib.pyplot.plot()` definition, used to control the style of the plotted *RGB* colourspaces. *plot_kwarg* can be either a single dictionary applied to all the plotted *RGB* colourspaces with the same settings or a sequence of dictionaries with different settings for each plotted *RGB* colourspace.
- **kwargs** (*Any*) – {`colour.plotting.artist()`, `colour.plotting.diagrams.plot_chromaticity_diagram()`, `colour.plotting.`

```
models.plot_pointer_gamut(), colour.plotting.models.  
plot_RGB_colourspace_in_chromaticity_diagram(), colour.plotting.  
render()}}, See the documentation of the previously listed definitions.
```

Returns

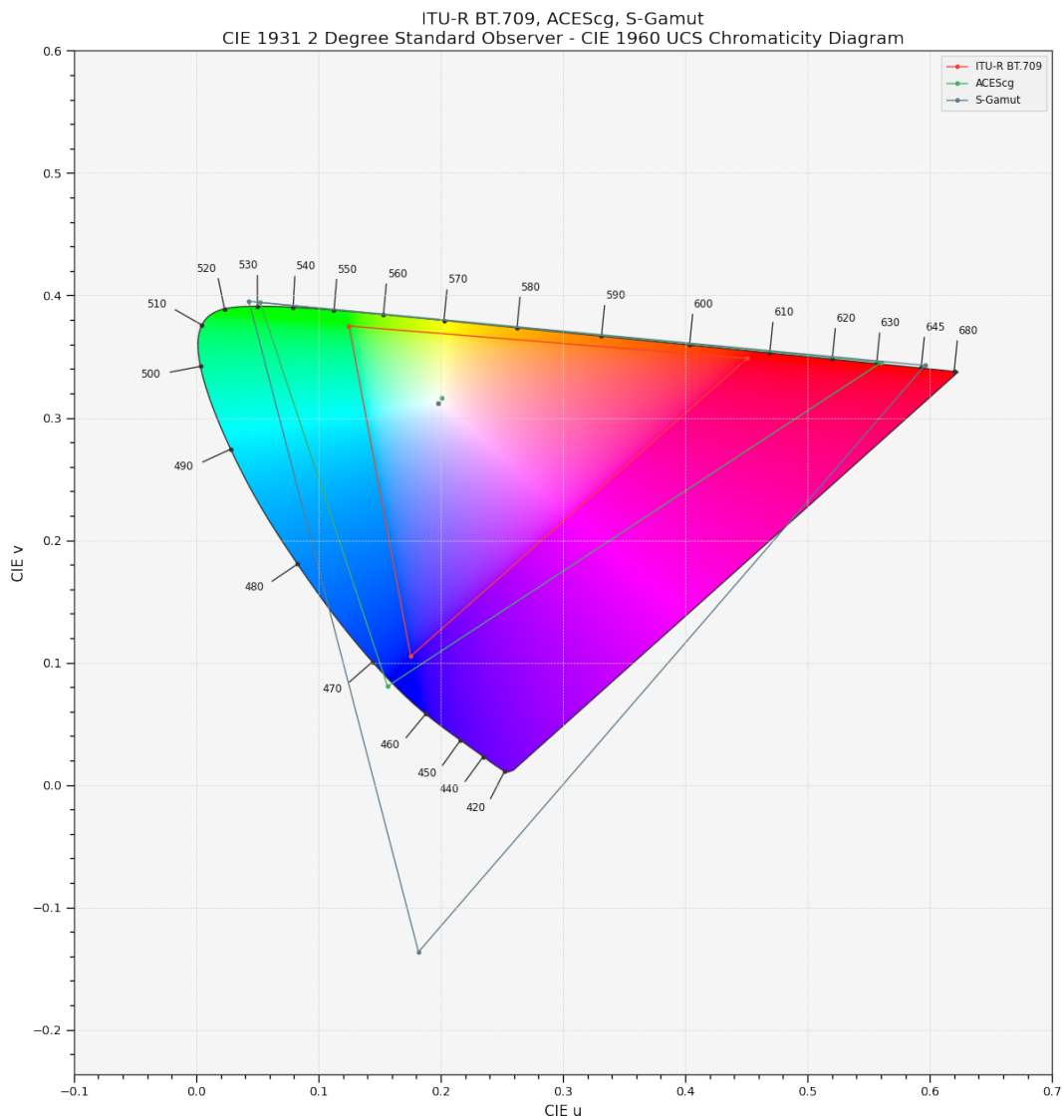
Current figure and axes.

Return type

tuple

Examples

```
>>> plot_RGB_colourspace_in_chromaticity_diagram_CIE1960UCS(  
...     ["ITU-R BT.709", "ACEScg", "S-Gamut"]  
... )  
...  
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



colour.plotting.plot_RGB_colourspace_in_chromaticity_diagram_CIE1976UCS

```
colour.plotting.plot_RGB_colourspace_in_chromaticity_diagram_CIE1976UCS(colourspace:
    RGB_Colourspace |
    str | Sequence[RGB_Colourspace
    | str], cmfs:
    MultiSpectralDistributions | str |
    Sequence[MultiSpectralDistributions
    | str] = 'CIE 1931 2
    Degree Standard
    Observer',
    chromaticity_diagram_callable_CIE1976UCS:
    Callable =
    plot_chromaticity_diagram_CIE1976UCS,
    show_whitepoints:
    bool = True,
    show_pointer_gamut:
    bool = False, chromatically_adapt:
    bool = False,
    plot_kwargs: Dict |
    List[Dict] | None =
    None, **kwargs:
    Any) →
    Tuple[Figure, Axes]
```

Plot given *RGB* colourspaces in the *CIE 1976 UCS Chromaticity Diagram*.

Parameters

- **colourspace** (*RGB_Colourspace* | *str* | *Sequence[RGB_Colourspace* | *str]*) – *RGB* colourspaces to plot. *colourspace* elements can be of any type or form supported by the `colour.plotting.common.filter_RGB_colourspace()` definition.
- **cmfs** (*MultiSpectralDistributions* | *str* | *Sequence[MultiSpectralDistributions* | *str]*) – Standard observer colour matching functions used for computing the spectral locus boundaries. *cmfs* can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
- **chromaticity_diagram_callable_CIE1976UCS** (*Callable*) – Callable responsible for drawing the *CIE 1976 UCS Chromaticity Diagram*.
- **show_whitepoints** (*bool*) – Whether to display the *RGB* colourspaces whitepoints.
- **show_pointer_gamut** (*bool*) – Whether to display the *Pointer's Gamut*.
- **chromatically_adapt** (*bool*) – Whether to chromatically adapt the *RGB* colourspaces given in *colourspace* to the whitepoint of the default plotting colourspace.
- **plot_kwargs** (*Dict* | *List[Dict]* | *None*) – Keyword arguments for the `matplotlib.pyplot.plot()` definition, used to control the style of the plotted *RGB* colourspaces. *plot_kwargs* can be either a single dictionary applied to all the plotted *RGB* colourspaces with the same settings or a sequence of dictionaries with different settings for each plotted *RGB* colourspace.

- **kwargs** (Any) – {colour.plotting.artist(), colour.plotting.diagrams.plot_chromaticity_diagram(), colour.plotting.models.plot_pointer_gamut(), colour.plotting.models.plot_RGB_colourspace_in_chromaticity_diagram(), colour.plotting.render()}, See the documentation of the previously listed definitions.

Returns

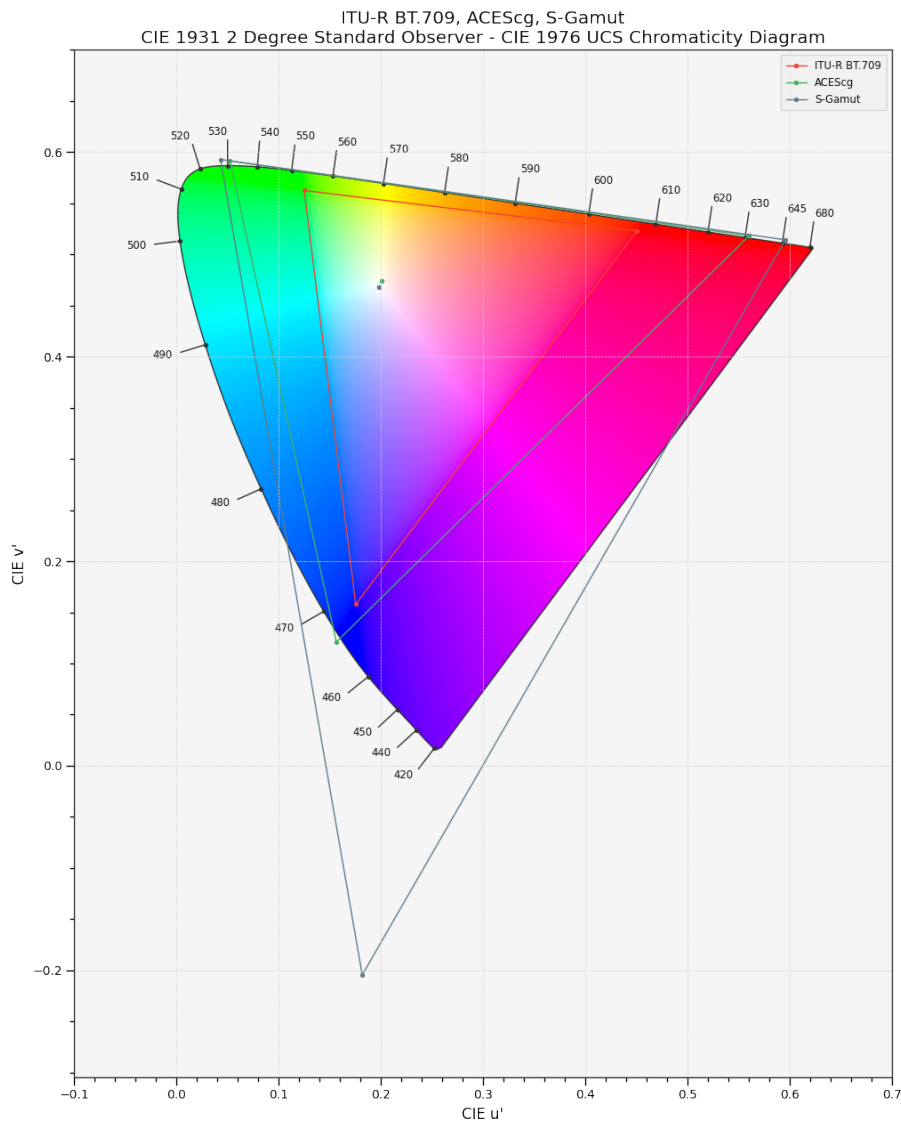
Current figure and axes.

Return type

tuple

Examples

```
>>> plot_RGB_colourspace_in_chromaticity_diagram_CIE1976UCS(
...     ["ITU-R BT.709", "ACEScg", "S-Gamut"]
... )
...
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



colour.plotting.plot_RGB_chromaticities_in_chromaticity_diagram_CIE1931

```
colour.plotting.plot_RGB_chromaticities_in_chromaticity_diagram_CIE1931(
    RGB: ArrayLike,
    colour_space:
        RGB_Colourspace |
        str | Sequence[RGB_Colourspace
            | str] = 'sRGB',
    chromaticity_diagram_callable_CIE1931:
        Callable =
        plot_RGB_colourspaces_in_chromaticity
        scatter_kwargs: Dict
            | None = None,
    **kwargs: Any) →
    Tuple[Figure, Axes]
```

Plot given *RGB* colour space array in the *CIE 1931 Chromaticity Diagram*.

Parameters

- **RGB** (ArrayLike) – *RGB* colour space array.
- **colour_space** (RGB_Colourspace | str | Sequence[RGB_Colourspace | str]) – *RGB* colour space of the *RGB* array. colour space can be of any type or form supported by the `colour.plotting.common.filter_RGB_colourspaces()` definition.
- **chromaticity_diagram_callable_CIE1931** (Callable) – Callable responsible for drawing the *CIE 1931 Chromaticity Diagram*.
- **scatter_kwargs** (Dict | None) – Keyword arguments for the `matplotlib.pyplot.scatter()` definition. The following special keyword arguments can also be used:
 - **c** : If **c** is set to *RGB*, the scatter will use the colours as given by the *RGB* argument.
- **kwargs** (Any) – {`colour.plotting.artist()`, `colour.plotting.diagrams.plot_chromaticity_diagram()`, `colour.plotting.models.plot_RGB_colourspaces_in_chromaticity_diagram()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

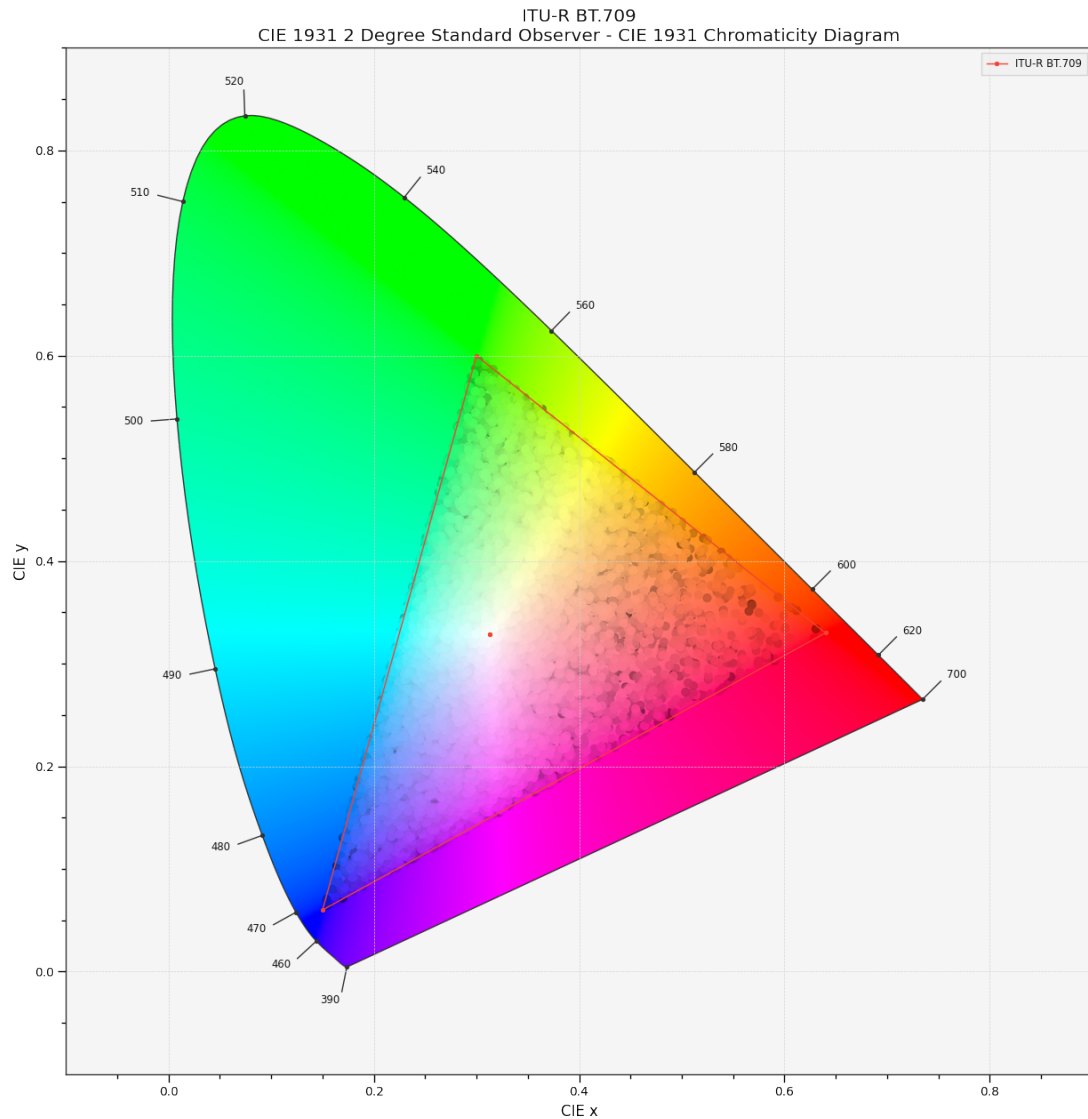
Current figure and axes.

Return type

tuple

Examples

```
>>> RGB = np.random.random((128, 128, 3))
>>> plot_RGB_chromaticities_in_chromaticity_diagram_CIE1931(
...     RGB, "ITU-R BT.709"
... )
...
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```

`colour.plotting.plot_RGB_chromaticities_in_chromaticity_diagram_CIE1960UCS`

`colour.plotting.plot_RGB_chromaticities_in_chromaticity_diagram_CIE1960UCS`(*RGB*: *ArrayLike*,
colourspace:
RGB_Colourspace
| *str* | *Sequence*[*RGB_Colourspace*
| *str*] = 'sRGB',
chromaticity_diagram_callable_CIE1960UCS:
Callable =
plot_RGB_colourspace_in_chromaticity_diagram_CIE1960UCS,
scatter_kwargs:
Dict | *None* =
None, ***kwargs*:
Any) →
Figure,
Axes]

Plot given *RGB* colourspace array in the *CIE 1960 UCS Chromaticity Diagram*.

Parameters

- **RGB** (`ArrayLike`) – *RGB* colourspace array.
- **colourspace** (`RGB_Colourspace` | `str` | `Sequence[RGB_Colourspace` | `str]`) – *RGB* colourspace of the *RGB* array. colourspace can be of any type or form supported by the `colour.plotting.common.filter_RGB_colourspaces()` definition.
- **chromaticity_diagram_callable_CIE1960UCS** (`Callable`) – Callable responsible for drawing the *CIE 1960 UCS Chromaticity Diagram*.
- **scatter_kwargs** (`Dict` | `None`) – Keyword arguments for the `matplotlib.pyplot.scatter()` definition. The following special keyword arguments can also be used:
 - **c** : If *c* is set to *RGB*, the scatter will use the colours as given by the *RGB* argument.
- **kwargs** (`Any`) – `{colour.plotting.artist(), colour.plotting.diagrams.plot_chromaticity_diagram(), colour.plotting.models.plot_RGB_colourspaces_in_chromaticity_diagram(), colour.plotting.render()}`, See the documentation of the previously listed definitions.`

Returns

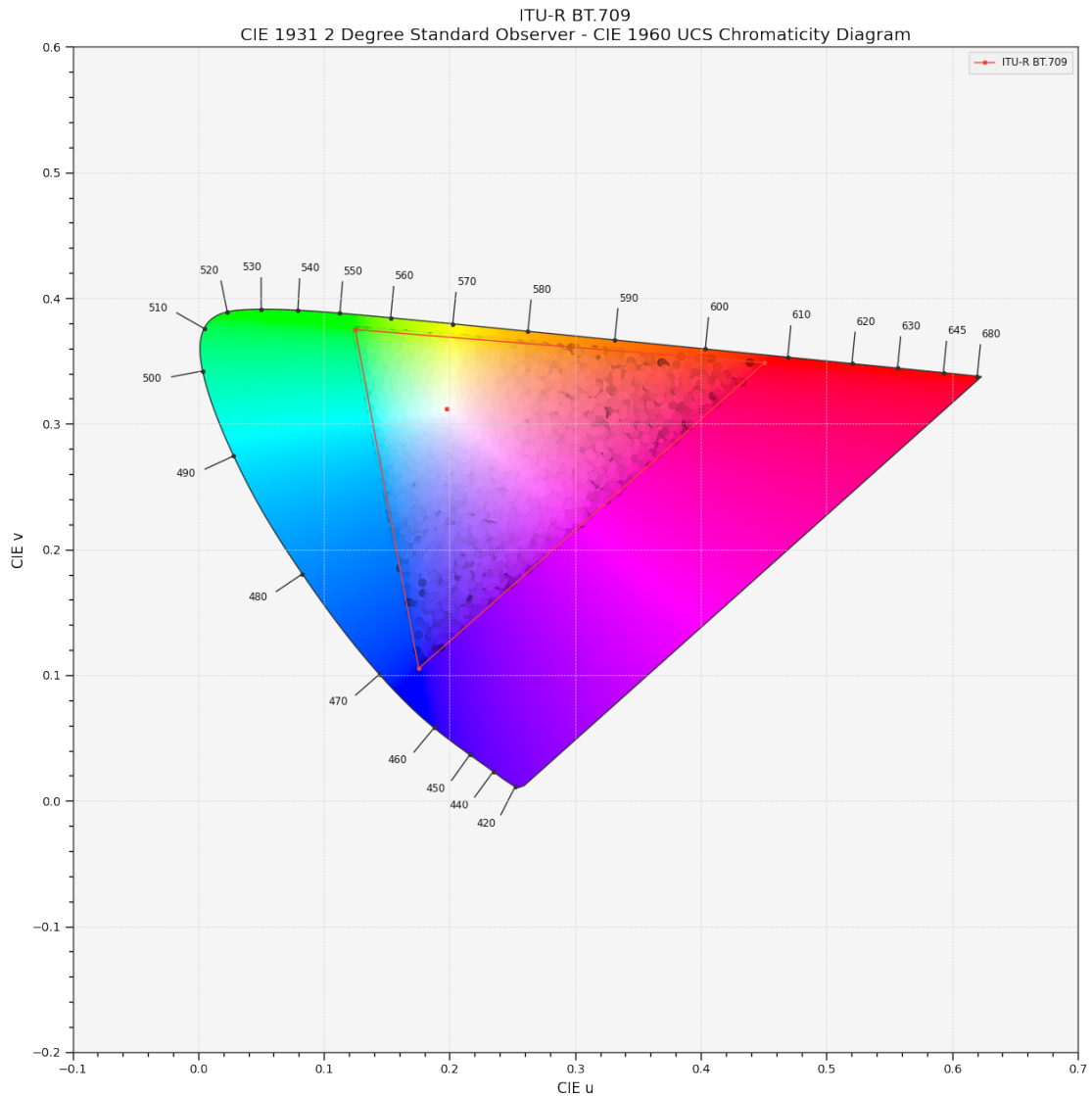
Current figure and axes.

Return type

`tuple`

Examples

```
>>> RGB = np.random.random((128, 128, 3))
>>> plot_RGB_chromaticities_in_chromaticity_diagram_CIE1960UCS(
...     RGB, "ITU-R BT.709"
... )
...
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



colour.plotting.plot_RGB_chromaticities_in_chromaticity_diagram_CIE1976UCS

`colour.plotting.plot_RGB_chromaticities_in_chromaticity_diagram_CIE1976UCS`(*RGB*: *ArrayLike*,
colourspace:
RGB_Colourspace
| *str* | *Sequence*[*RGB_Colourspace*
| *str*] = 'sRGB',
chromaticity_diagram_callable_CIE1976UCS:
Callable =
plot_RGB_colourspace_in_chromaticity_diagram_CIE1976UCS,
scatter_kwargs:
Dict | *None* =
None, ***kwargs*:
Any) →
Tuple[*Figure*,
Axes]

Plot given *RGB* colourspace array in the *CIE 1976 UCS Chromaticity Diagram*.

Parameters

- **RGB** (ArrayLike) – *RGB* colourspace array.
- **colourspace** (RGB_Colourspace | str | Sequence[RGB_Colourspace | str]) – *RGB* colourspace of the *RGB* array. colourspace can be of any type or form supported by the `colour.plotting.common.filter_RGB_colourspaces()` definition.
- **chromaticity_diagram_callable_CIE1976UCS** (Callable) – Callable responsible for drawing the *CIE 1976 UCS Chromaticity Diagram*.
- **scatter_kwargs** (Dict | None) – Keyword arguments for the `matplotlib.pyplot.scatter()` definition. The following special keyword arguments can also be used:
 - **c** : If *c* is set to *RGB*, the scatter will use the colours as given by the *RGB* argument.
- **kwargs** (Any) – {`colour.plotting.artist()`, `colour.plotting.diagrams.plot_chromaticity_diagram()`, `colour.plotting.models.plot_RGB_colourspace_in_chromaticity_diagram()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

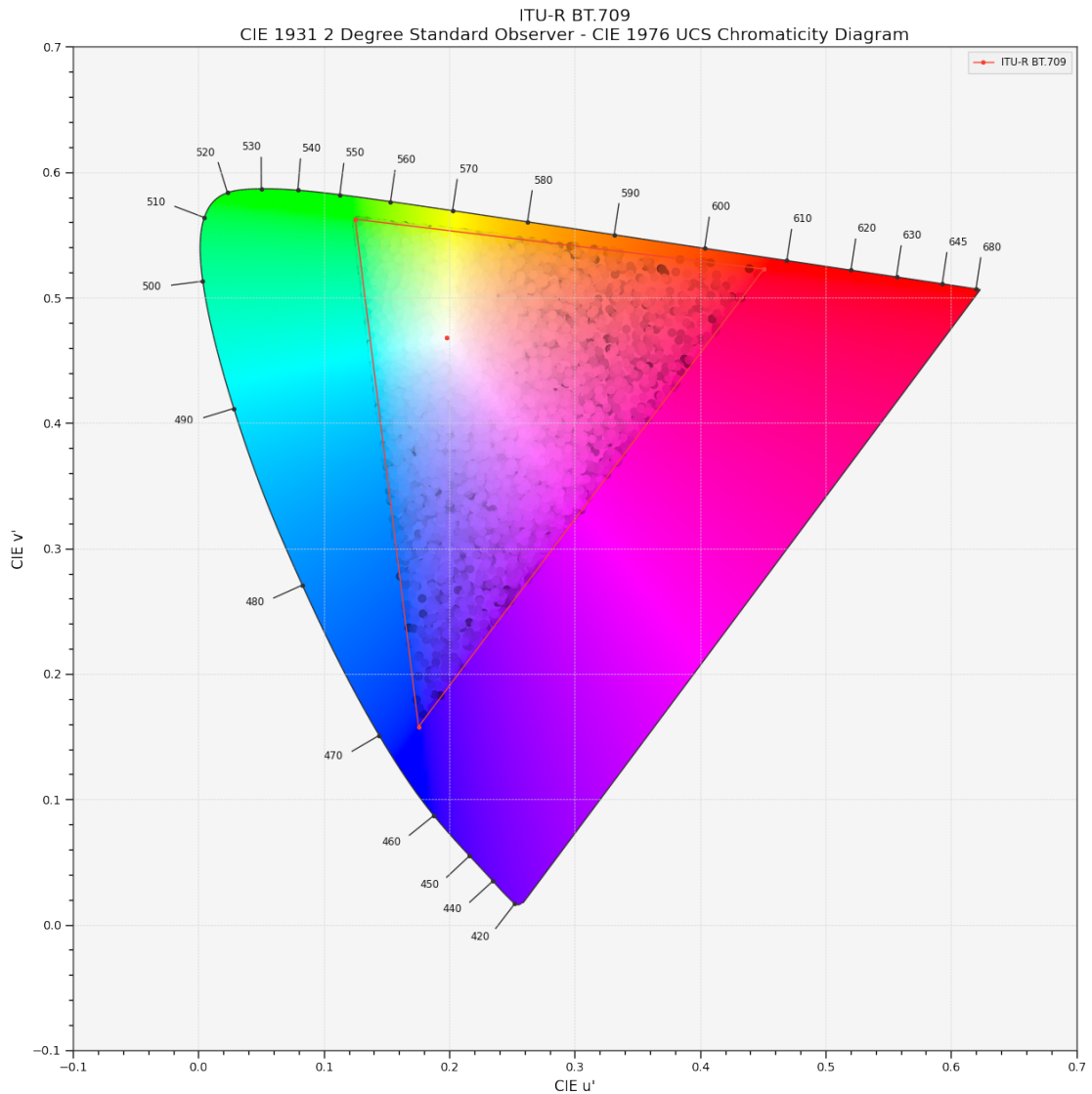
Current figure and axes.

Return type

tuple

Examples

```
>>> RGB = np.random.random((128, 128, 3))
>>> plot_RGB_chromaticities_in_chromaticity_diagram_CIE1976UCS(
...     RGB, "ITU-R BT.709"
... )
...
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



`colour.plotting.plot_ellipses_MacAdam1942_in_chromaticity_diagram_CIE1931`

`colour.plotting.plot_ellipses_MacAdam1942_in_chromaticity_diagram_CIE1931(chromaticity_diagram_callable_CIE1931, chromaticity_diagram_clipping: bool = False, ellipse_kwargs: Dict | List[Dict] | None = None, **kwargs: Any) → Tuple[Figure, Axes]`

Plot MacAdam (1942) Ellipses (Observer PGN) in the CIE 1931 Chromaticity Diagram.

Parameters

- **`chromaticity_diagram_callable_CIE1931`** (`Callable`) – Callable responsible for drawing the CIE 1931 Chromaticity Diagram.

- **chromaticity_diagram_clipping** (*bool*) – Whether to clip the *CIE 1931 Chromaticity Diagram* colours with the ellipses.
- **ellipse_kwargs** (*Dict* | *List[Dict]* | *None*) – Parameters for the *Ellipse* class, *ellipse_kwargs* can be either a single dictionary applied to all the ellipses with same settings or a sequence of dictionaries with different settings for each ellipse.
- **kwargs** (*Any*) – {*colour.plotting.artist()*, *colour.plotting.diagrams.plot_chromaticity_diagram()*, *colour.plotting.models.plot_ellipses_MacAdam1942_in_chromaticity_diagram()*}, *colour.plotting.render()*}, See the documentation of the previously listed definitions.

Returns

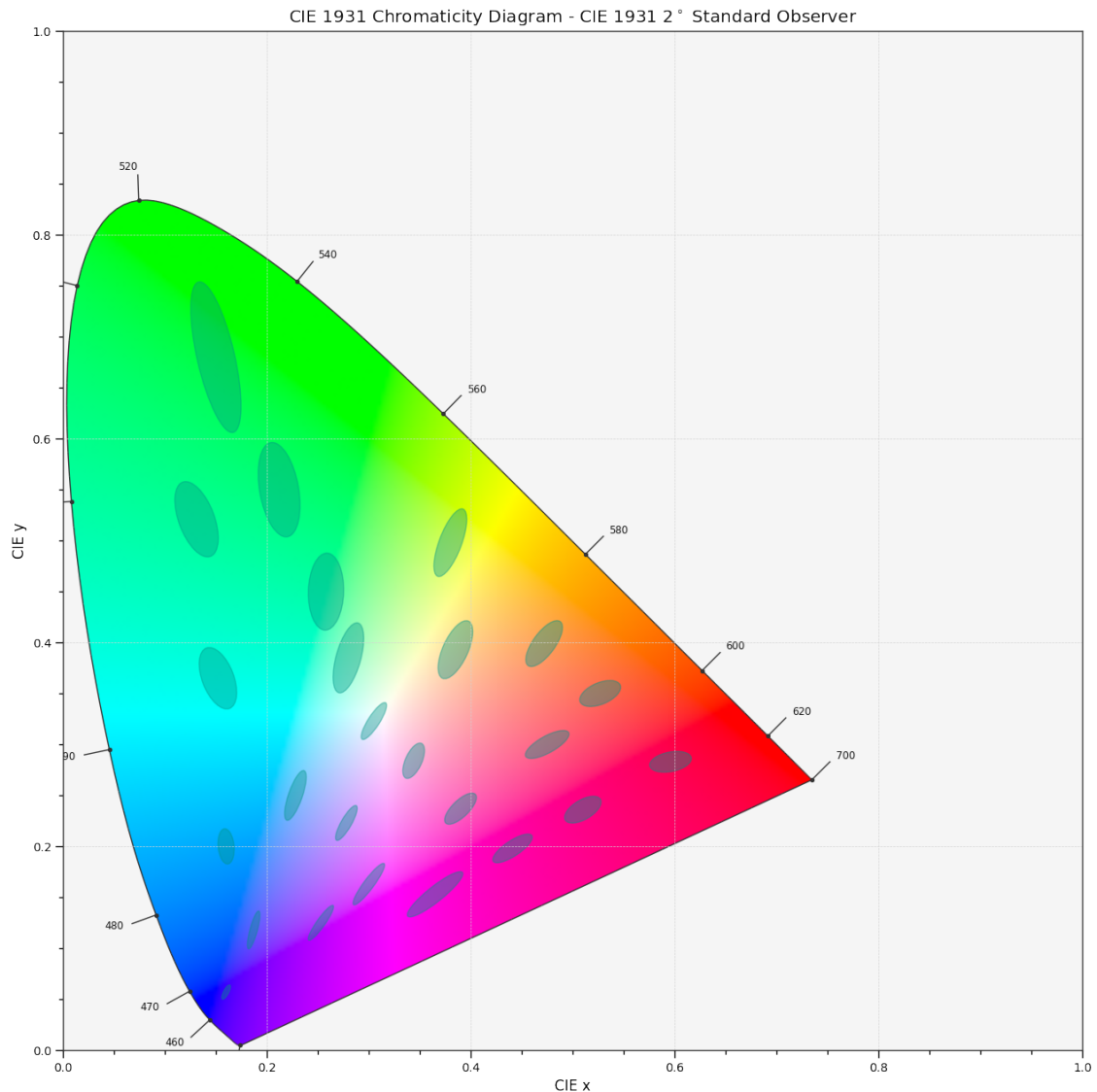
Current figure and axes.

Return type

tuple

Examples

```
>>> plot_ellipses_MacAdam1942_in_chromaticity_diagram_CIE1931()  
...  
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



`colour.plotting.plot_ellipses_MacAdam1942_in_chromaticity_diagram_CIE1960UCS`

```
colour.plotting.plot_ellipses_MacAdam1942_in_chromaticity_diagram_CIE1960UCS(chromaticity_diagram_callable_CIE1960UCS,
    chromaticity_diagram_callable_CIE1960UCS(Callable) =
    plot_chromaticity_diagram_CIE1960UCS(
        chromaticity_diagram_callable_CIE1960UCS(Callable),
        chromaticity_diagram_clipping:
        bool = False,
        ellipse_kwargs:
        Dict | List[Dict]
        | None = None,
        **kwargs:
        Any) →
        Tuple[Figure,
        Axes]
```

Plot MacAdam (1942) Ellipses (Observer PGN) in the CIE 1960 UCS Chromaticity Diagram.

Parameters

- `chromaticity_diagram_callable_CIE1960UCS` (`Callable`) – Callable responsible for drawing the CIE 1960 UCS Chromaticity Diagram.

- **chromaticity_diagram_clipping** (`bool`) – Whether to clip the *CIE 1960 UCS Chromaticity Diagram* colours with the ellipses.
- **ellipse_kwargs** (`Dict` | `List[Dict]` | `None`) – Parameters for the `Ellipse` class, `ellipse_kwargs` can be either a single dictionary applied to all the ellipses with same settings or a sequence of dictionaries with different settings for each ellipse.
- **kwargs** (`Any`) – `{colour.plotting.artist(), colour.plotting.diagrams.plot_chromaticity_diagram(), colour.plotting.models.plot_ellipses_MacAdam1942_in_chromaticity_diagram()}, colour.plotting.render()}`, See the documentation of the previously listed definitions.`

Returns

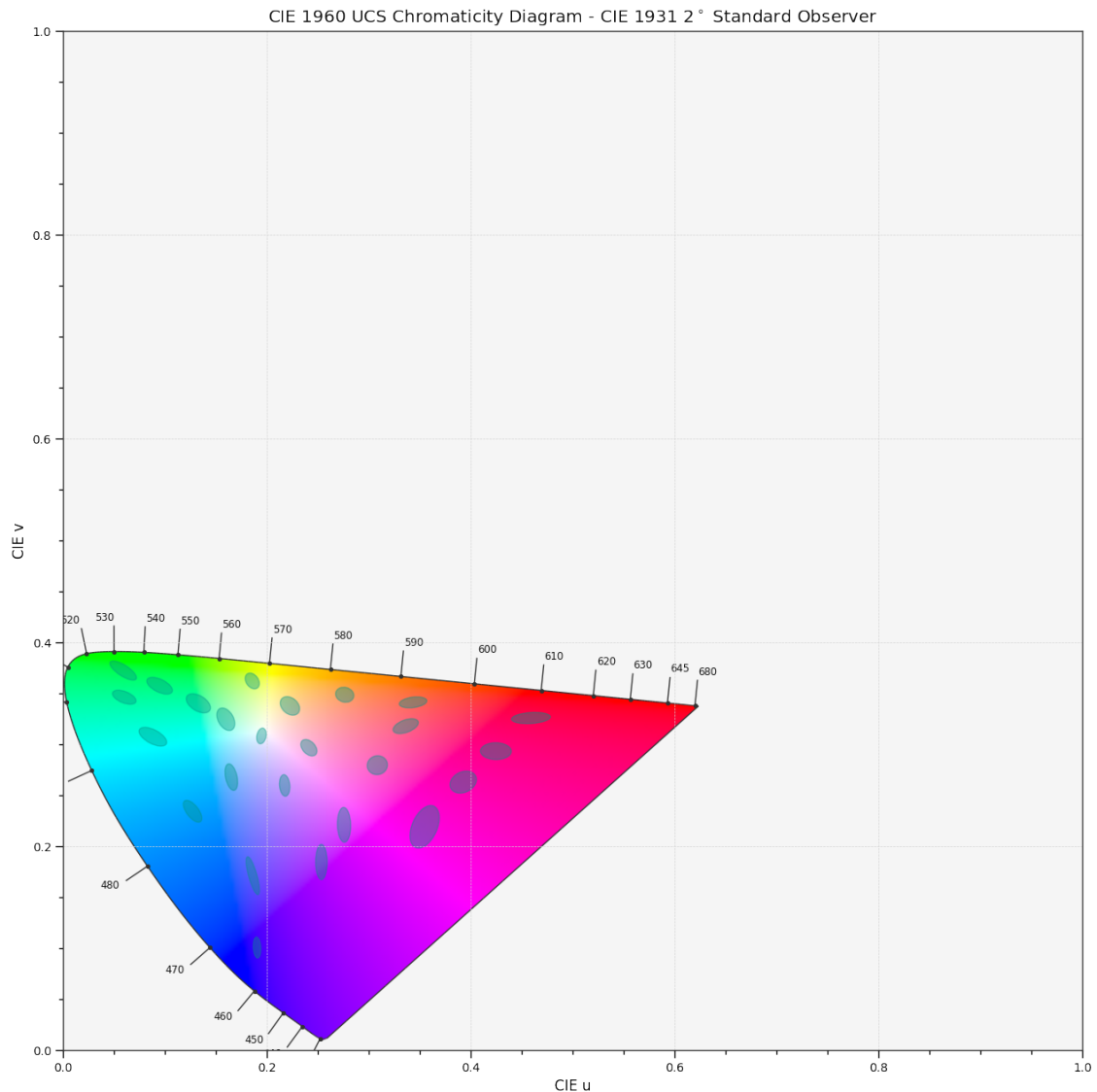
Current figure and axes.

Return type

`tuple`

Examples

```
>>> plot_ellipses_MacAdam1942_in_chromaticity_diagram_CIE1960UCS()  
...  
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```

`colour.plotting.plot_ellipses_MacAdam1942_in_chromaticity_diagram_CIE1976UCS`

```
colour.plotting.plot_ellipses_MacAdam1942_in_chromaticity_diagram_CIE1976UCS(chromaticity_diagram_callable_CIE1976UCS,
    chromaticity_diagram_callable_CIE1976UCS(Callable =
        plot_chromaticity_diagram_CIE1976UCS,
        chromaticity_diagram_clipping:
            bool = False,
            ellipse_kwargs:
                Dict | List[Dict]
                | None = None,
            **kwargs:
                Any) →
                Tuple[Figure,
                    Axes]
```

Plot MacAdam (1942) Ellipses (Observer PGN) in the CIE 1976 UCS Chromaticity Diagram.

Parameters

- `chromaticity_diagram_callable_CIE1976UCS` (`Callable`) – Callable responsible for drawing the CIE 1976 UCS Chromaticity Diagram.

- **chromaticity_diagram_clipping** (`bool`) – Whether to clip the *CIE 1976 UCS Chromaticity Diagram* colours with the ellipses.
- **ellipse_kwargs** (`Dict` | `List[Dict]` | `None`) – Parameters for the `Ellipse` class, `ellipse_kwargs` can be either a single dictionary applied to all the ellipses with same settings or a sequence of dictionaries with different settings for each ellipse.
- **kwargs** (`Any`) – {`colour.plotting.artist()`, `colour.plotting.diagrams.plot_chromaticity_diagram()`, `colour.plotting.models.plot_ellipses_MacAdam1942_in_chromaticity_diagram()`}, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

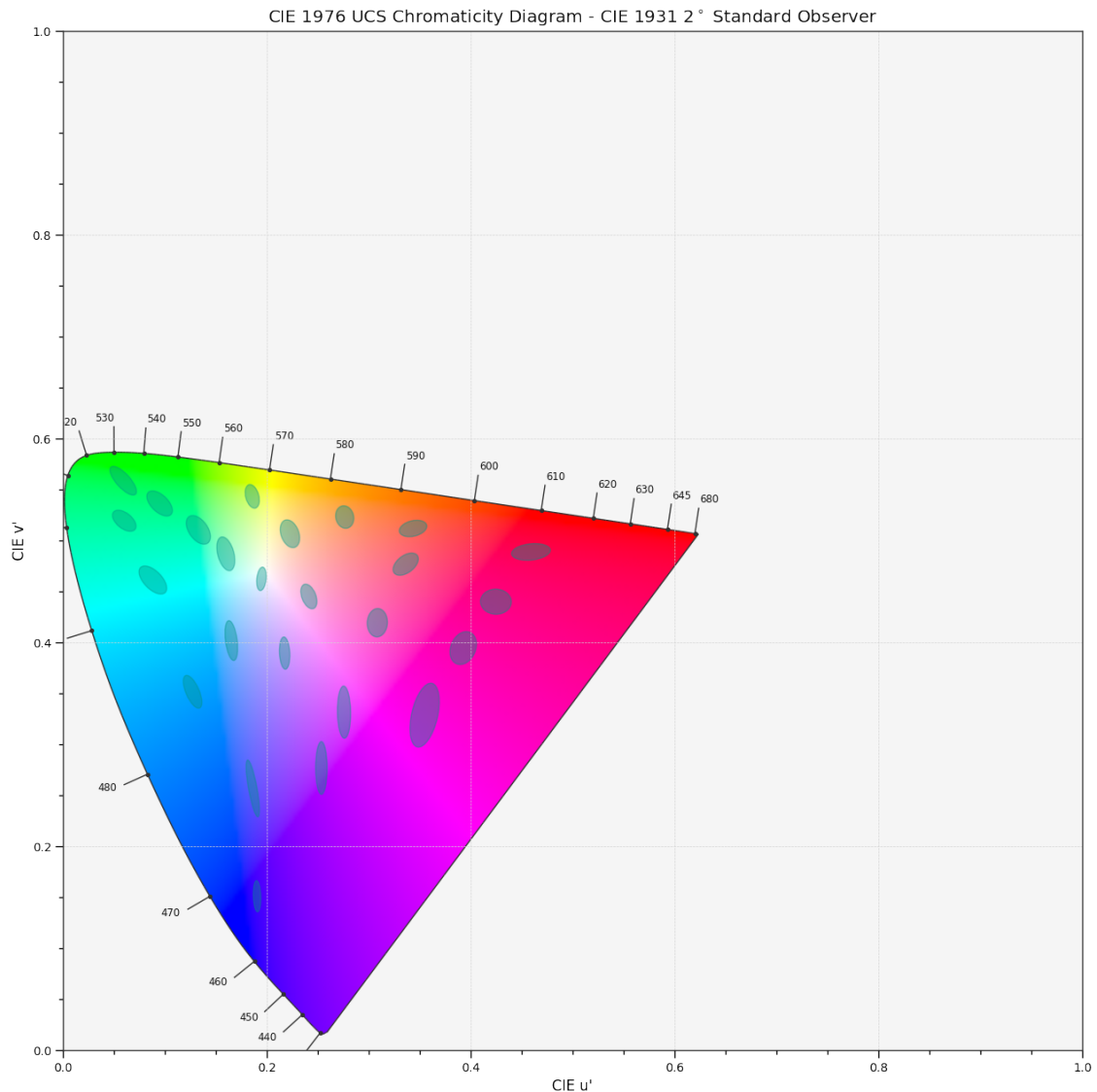
Current figure and axes.

Return type

`tuple`

Examples

```
>>> plot_ellipses_MacAdam1942_in_chromaticity_diagram_CIE1976UCS()  
...  
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



`colour.plotting.plot_single_cctf`

`colour.plotting.plot_single_cctf(cctf: Callable | str, cctf_decoding: bool = False, **kwargs: Any) → Tuple[Figure, Axes]`

Plot given colourspace colour component transfer function.

Parameters

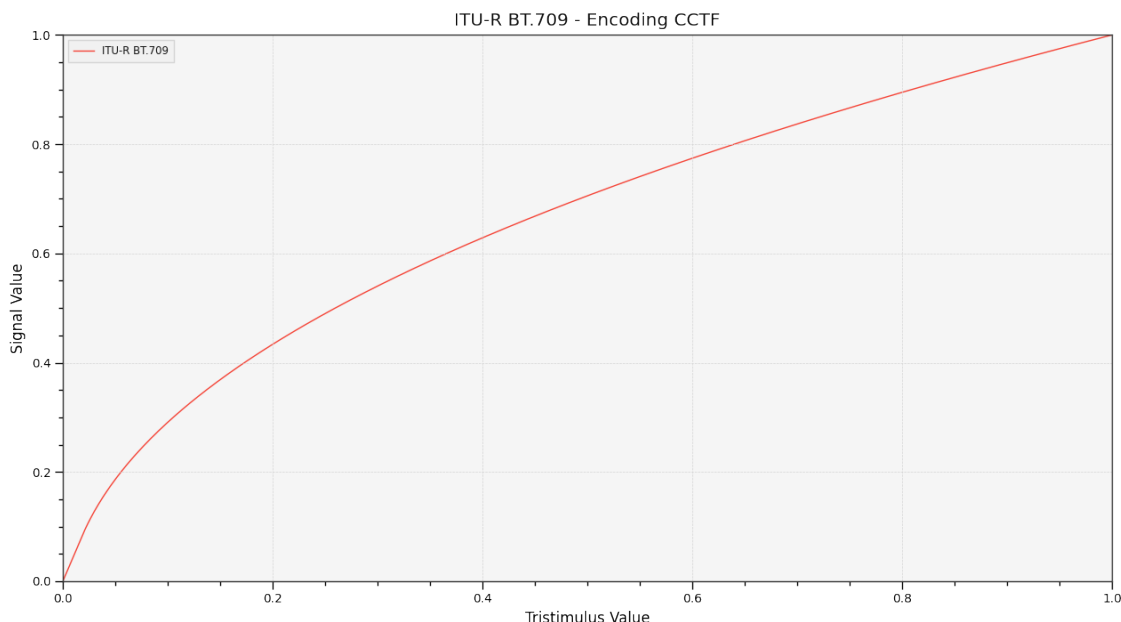
- **cctf** (`Callable` | `str`) – Colour component transfer function to plot. function can be of any type or form supported by the `colour.plotting.common.filter_passthrough()` definition.
- **cctf_decoding** (`bool`) – Plot the decoding colour component transfer function instead.
- **kwargs** (`Any`) – {`colour.plotting.artist()`, `colour.plotting.plot_multi_functions()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

Current figure and axes.

Return type`tuple`**Examples**

```
>>> plot_single_cctf("ITU-R BT.709")
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```

**colour.plotting.plot_multi_cctfs**

`colour.plotting.plot_multi_cctfs(cctfs: Callable | str | Sequence[Callable | str], cctf_decoding: bool = False, **kwargs: Any) → Tuple[Figure, Axes]`

Plot given colour component transfer functions.

Parameters

- **cctfs** (*Callable* | *str* | *Sequence*[*Callable* | *str*]) – Colour component transfer function to plot. cctfs elements can be of any type or form supported by the `colour.plotting.common.filter_passthrough()` definition.
- **cctf_decoding** (*bool*) – Plot the decoding colour component transfer function instead.
- **kwargs** (*Any*) – {`colour.plotting.artist()`, `colour.plotting.plot_multi_functions()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

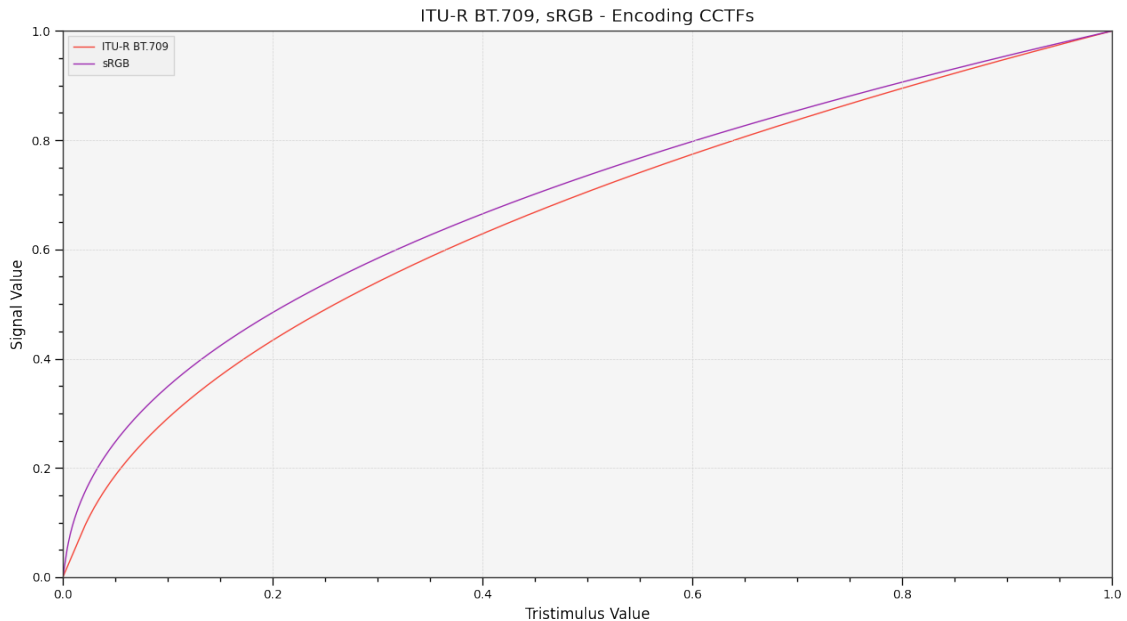
Returns

Current figure and axes.

Return type`tuple`

Examples

```
>>> plot_multi_cctfs(["ITU-R BT.709", "sRGB"])
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



colour.plotting.plot_constant_hue_loci

```
colour.plotting.plot_constant_hue_loci(data: ArrayLike, model: Literal['CAM02LCD', 'CAM02SCD',
    'CAM02UCS', 'CAM16LCD', 'CAM16SCD', 'CAM16UCS', 'CIE
    XYZ', 'CIE xyY', 'CIE Lab', 'CIE Luv', 'CIE UCS', 'CIE UVW',
    'DIN99', 'Hunter Lab', 'Hunter Rdab', 'ICaCb', 'ICtCp', 'IPT',
    'IPT Munish 2021', 'IgPgTg', 'Jzazbz', 'OSA UCS', 'Oklab',
    'hdr-CIELAB', 'hdr-IPT'] | str = 'CIE Lab', scatter_kwargs:
    Dict | None = None, convert_kwargs: Dict | None = None,
    **kwargs: Any) → Tuple[Figure, Axes]
```

Plot given constant hue loci colour matches data such as that from [HB95] or [EF98] that are easily loaded with [Colour - Datasets](#).

Parameters

- **data** (ArrayLike) – Constant hue loci colour matches data expected to be an *ArrayLike* as follows:

```
[
    ('name', XYZ_r, XYZ_cr, (XYZ_ct, XYZ_ct, XYZ_ct, ...),
    ↳{metadata}),
    ('name', XYZ_r, XYZ_cr, (XYZ_ct, XYZ_ct, XYZ_ct, ...),
    ↳{metadata}),
    ('name', XYZ_r, XYZ_cr, (XYZ_ct, XYZ_ct, XYZ_ct, ...),
    ↳{metadata}),
    ...
]
```

where *name* is the hue angle or name, *XYZ_r* the CIE XYZ tristimulus values of the reference illuminant, *XYZ_cr* the CIE XYZ tristimulus values of the reference colour under the reference illuminant, *XYZ_ct* the CIE XYZ tristimulus values

of the colour matches under the reference illuminant and metadata the dataset metadata.

- **model** (`Literal`['CAM02LCD', 'CAM02SCD', 'CAM02UCS', 'CAM16LCD', 'CAM16SCD', 'CAM16UCS', 'CIE XYZ', 'CIE xyY', 'CIE Lab', 'CIE Luv', 'CIE UCS', 'CIE UVW', 'DIN99', 'Hunter Lab', 'Hunter Rdab', 'ICaCb', 'ICtCp', 'IPT', 'IPT Munish 2021', 'IgPgTg', 'Jzazbz', 'OSA UCS', 'Oklab', 'hdr-CIELAB', 'hdr-IPT'] | `str`) – Colourspace model, see `colour.COLOURSPACE_MODELS` attribute for the list of supported colourspace models.
- **scatter_kwargs** (`Dict` | `None`) – Keyword arguments for the `matplotlib.pyplot.scatter()` definition. The following special keyword arguments can also be used:
 - `c` : If `c` is set to `RGB`, the scatter will use the colours as given by the `RGB` argument.
- **convert_kwargs** (`Dict` | `None`) – Keyword arguments for the `colour.convert()` definition.
- **kwargs** (`Any`) – {`colour.plotting.artist()`, `colour.plotting.plot_multi_functions()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

Current figure and axes.

Return type

`tuple`

References

[EF98], [HB95], [Man19]

Examples

```
>>> data = np.array(
...     [
...         [
...             None,
...             np.array([0.95010000, 1.00000000, 1.08810000]),
...             np.array([0.40920000, 0.28120000, 0.30600000]),
...             np.array(
...                 [
...                     [0.02495100, 0.01908600, 0.02032900],
...                     [0.10944300, 0.06235900, 0.06788100],
...                     [0.27186500, 0.18418700, 0.19565300],
...                     [0.48898900, 0.40749400, 0.44854600],
...                 ]
...             ),
...             None,
...         ],
...         [
...             None,
...             np.array([0.95010000, 1.00000000, 1.08810000]),
...             np.array([0.30760000, 0.48280000, 0.42770000]),
...             np.array(
...                 [

```

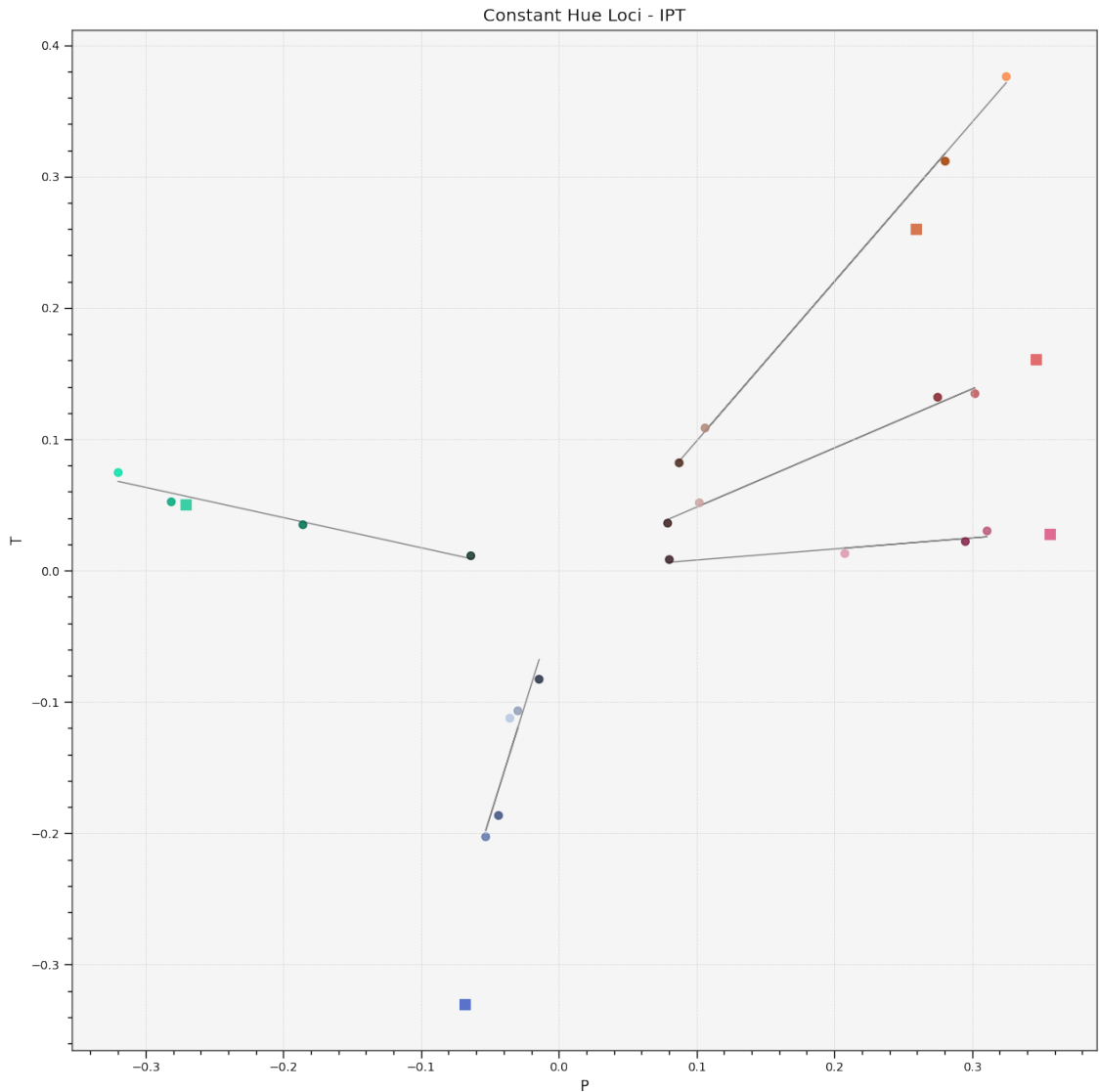
(continues on next page)

(continued from previous page)

```

...         [0.02108000, 0.02989100, 0.02790400],
...         [0.06194700, 0.11251000, 0.09334400],
...         [0.15255800, 0.28123300, 0.23234900],
...         [0.34157700, 0.56681300, 0.47035300],
...     ]
... ),
...     None,
... ],
... [
...     None,
...     np.array([0.95010000, 1.00000000, 1.08810000]),
...     np.array([0.39530000, 0.28120000, 0.18450000]),
...     np.array(
...         [
...             [0.02436400, 0.01908600, 0.01468800],
...             [0.10331200, 0.06235900, 0.02854600],
...             [0.26311900, 0.18418700, 0.12109700],
...             [0.43158700, 0.40749400, 0.39008600],
...         ]
...     ),
...     None,
... ],
... [
...     None,
...     np.array([0.95010000, 1.00000000, 1.08810000]),
...     np.array([0.20510000, 0.18420000, 0.57130000]),
...     np.array(
...         [
...             [0.03039800, 0.02989100, 0.06123300],
...             [0.08870000, 0.08498400, 0.21843500],
...             [0.18405800, 0.18418700, 0.40111400],
...             [0.32550100, 0.34047200, 0.50296900],
...             [0.53826100, 0.56681300, 0.80010400],
...         ]
...     ),
...     None,
... ],
... [
...     None,
...     np.array([0.95010000, 1.00000000, 1.08810000]),
...     np.array([0.35770000, 0.28120000, 0.11250000]),
...     np.array(
...         [
...             [0.03678100, 0.02989100, 0.01481100],
...             [0.17127700, 0.11251000, 0.01229900],
...             [0.30080900, 0.28123300, 0.21229800],
...             [0.52976000, 0.40749400, 0.11720000],
...         ]
...     ),
...     None,
... ],
... ]
... )
>>> plot_constant_hue_loci(data, "CIE Lab")
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)

```



Ancillary Objects

colour.plotting.models

| | | |
|--|---------------------------|---|
| <code>colourspace_model_axis_reorder(a, ...)</code> | <code>model[, ...]</code> | Reorder the axes of given colourspace model <i>a</i> array according to the most common volume plotting axes order. |
| <code>plot_pointer_gamut([pointer_gamut_colours, ...])</code> | | Plot <i>Pointer's Gamut</i> according to given method. |
| <code>plot_RGB_colourspace_in_chromaticity_diagram</code> | | Plot given <i>RGB</i> colourspace in the <i>Chromaticity Diagram</i> according to given method. |
| <code>plot_RGB_chromaticities_in_chromaticity_diagram</code> | | Plot given <i>RGB</i> colourspace array in the <i>Chromaticity Diagram</i> according to given method. |
| <code>plot_ellipses_MacAdam1942_in_chromaticity_diagram</code> | | Plot <i>MacAdam (1942) Ellipses (Observer PGN)</i> in the <i>Chromaticity Diagram</i> according to given method. |

colour.plotting.models.colourspace_model_axis_reorder

`colour.plotting.models.colourspace_model_axis_reorder`(*a*: ArrayLike, *model*: `Literal`['CAM02LCD', 'CAM02SCD', 'CAM02UCS', 'CAM16LCD', 'CAM16SCD', 'CAM16UCS', 'CIE XYZ', 'CIE xyY', 'CIE Lab', 'CIE LCHab', 'CIE Luv', 'CIE LCHuv', 'CIE UCS', 'CIE UVW', 'DIN99', 'Hunter Lab', 'Hunter Rdab', 'ICaCb', 'ICtCp', 'IPT', 'IPT Munish 2021', 'IgPgTg', 'Jzazbz', 'OSA UCS', 'Oklab', 'hdr-CIELAB', 'hdr-IPT'] | *str*, *direction*: `Literal`['Forward', 'Inverse'] | *str* = 'Forward') → ndarray

Reorder the axes of given colourspace model *a* array according to the most common volume plotting axes order.

Parameters

- **a** (ArrayLike) – Colourspace model *a* array.
- **model** (`Literal`['CAM02LCD', 'CAM02SCD', 'CAM02UCS', 'CAM16LCD', 'CAM16SCD', 'CAM16UCS', 'CIE XYZ', 'CIE xyY', 'CIE Lab', 'CIE LCHab', 'CIE Luv', 'CIE LCHuv', 'CIE UCS', 'CIE UVW', 'DIN99', 'Hunter Lab', 'Hunter Rdab', 'ICaCb', 'ICtCp', 'IPT', 'IPT Munish 2021', 'IgPgTg', 'Jzazbz', 'OSA UCS', 'Oklab', 'hdr-CIELAB', 'hdr-IPT'] | *str*) – Colourspace model, see `colour.COLOURSPACE_MODELS` attribute for the list of supported colourspace models.
- **direction** (`Literal`['Forward', 'Inverse'] | *str*) – Reordering direction.

Returns

Reordered colourspace model *a* array.

Return type

`numpy.ndarray`

Examples

```
>>> a = np.array([0, 1, 2])
>>> colourspace_model_axis_reorder(a, "CIE Lab")
array([ 1.,  2.,  0.])
>>> colourspace_model_axis_reorder(a, "IPT")
array([ 1.,  2.,  0.])
>>> colourspace_model_axis_reorder(a, "OSA UCS")
array([ 1.,  2.,  0.])
>>> b = np.array([1, 2, 0])
>>> colourspace_model_axis_reorder(b, "OSA UCS", "Inverse")
array([ 0.,  1.,  2.])
```

colour.plotting.models.plot_pointer_gamut

```
colour.plotting.models.plot_pointer_gamut(pointer_gamut_colours: ArrayLike | str | None = None,
                                           pointer_gamut_opacity: float = 1, method: Literal['CIE
1931', 'CIE 1960 UCS', 'CIE 1976 UCS'] | str = 'CIE
1931', **kwargs: Any) → Tuple[Figure, Axes]
```

Plot *Pointer's Gamut* according to given method.

Parameters

- **pointer_gamut_colours** (ArrayLike | str | None) – Colours of the *Pointer's Gamut*.
- **pointer_gamut_opacity** (float) – Opacity of the *Pointer's Gamut*.
- **method** (Literal['CIE 1931', 'CIE 1960 UCS', 'CIE 1976 UCS'] | str) – Plotting method.
- **kwargs** (Any) – {colour.plotting.artist(), colour.plotting.render()}, See the documentation of the previously listed definitions.

Returns

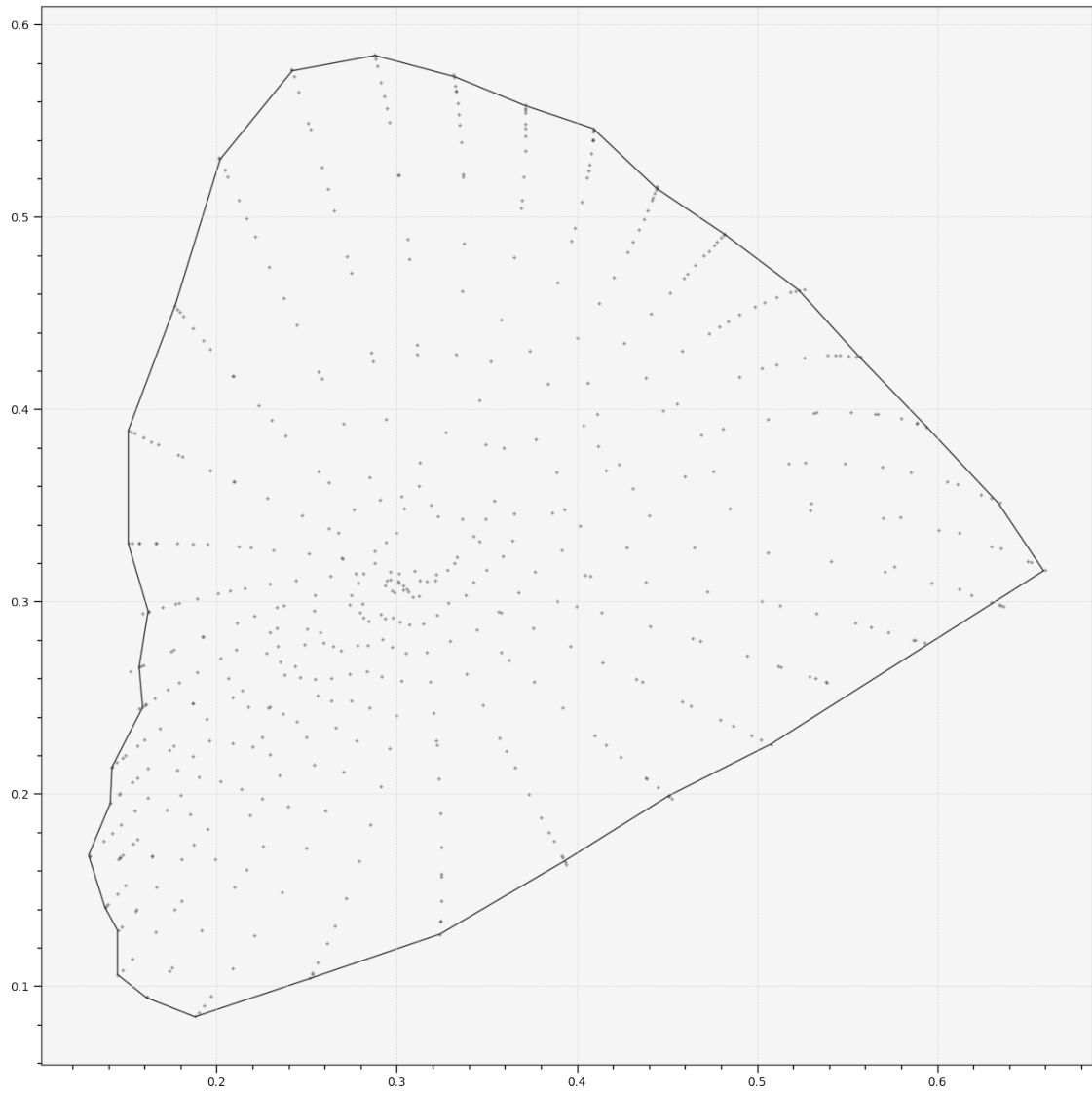
Current figure and axes.

Return type

tuple

Examples

```
>>> plot_pointer_gamut()
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



`colour.plotting.models.plot_RGB_colourspace_in_chromaticity_diagram`

```
colour.plotting.models.plot_RGB_colourspace_in_chromaticity_diagram(colourspace:
    RGB_Colourspace | str |
    Sequence[RGB_Colourspace
    | str], cmfs: MultiSpectralDistributions | str |
    Sequence[MultiSpectralDistributions
    | str] = 'CIE 1931 2
    Degree Standard
    Observer', chromaticity_diagram_callable:
    Callable =
    plot_chromaticity_diagram,
    method: Literal['CIE
    1931', 'CIE 1960 UCS',
    'CIE 1976 UCS'] | str =
    'CIE 1931',
    show_whitepoints: bool
    = True,
    show_pointer_gamut:
    bool = False,
    chromatically_adapt:
    bool = False,
    plot_kwargs: Dict |
    List[Dict] | None =
    None, **kwargs: Any)
    → Tuple[Figure, Axes]
```

Plot given *RGB* colourspace in the *Chromaticity Diagram* according to given method.

Parameters

- **colourspace** (*RGB_Colourspace* | *str* | *Sequence*[*RGB_Colourspace* | *str*]) – *RGB* colourspace to plot. *colourspace* elements can be of any type or form supported by the `colour.plotting.common.filter_RGB_colourspace()` definition.
- **cmfs** (*MultiSpectralDistributions* | *str* | *Sequence*[*MultiSpectralDistributions* | *str*]) – Standard observer colour matching functions used for computing the spectral locus boundaries. *cmfs* can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
- **chromaticity_diagram_callable** (*Callable*) – Callable responsible for drawing the *Chromaticity Diagram*.
- **method** (*Literal*['CIE 1931', 'CIE 1960 UCS', 'CIE 1976 UCS'] | *str*) – *Chromaticity Diagram* method.
- **show_whitepoints** (*bool*) – Whether to display the *RGB* colourspace whitepoints.
- **show_pointer_gamut** (*bool*) – Whether to display the *Pointer's Gamut*.
- **chromatically_adapt** (*bool*) – Whether to chromatically adapt the *RGB* colourspace given in *colourspace* to the whitepoint of the default plotting colourspace.
- **plot_kwargs** (*Dict* | *List*[*Dict*] | *None*) – Keyword arguments for the `matplotlib.pyplot.plot()` definition, used to control the style of the plotted *RGB* colourspace. *plot_kwargs* can be either a single dictionary applied to all

the plotted *RGB* colourspaces with the same settings or a sequence of dictionaries with different settings for each plotted *RGB* colourspace.

- **kwargs** (Any) – {colour.plotting.artist(), colour.plotting.diagrams.plot_chromaticity_diagram(), colour.plotting.models.plot_pointer_gamut(), colour.plotting.render()}, See the documentation of the previously listed definitions.

Returns

Current figure and axes.

Return type

tuple

Examples

```
>>> plot_kwargs = [
...     {"color": "r"},
...     {"linestyle": "dashed"},
...     {"marker": None},
... ]
>>> plot_RGB_colourspace_in_chromaticity_diagram(
...     ["ITU-R BT.709", "ACEScg", "S-Gamut"], plot_kwargs=plot_kwargs
... )
...
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



colour.plotting.models.plot_RGB_chromaticities_in_chromaticity_diagram

```
colour.plotting.models.plot_RGB_chromaticities_in_chromaticity_diagram(
    RGB: ArrayLike,
    colourspace:
        RGB_Colourspace |
        str | Sequence[RGB_Colourspace
            | str] = 'sRGB',
    chromaticity_diagram_callable:
        Callable =
        plot_RGB_colourspace_in_chromaticity_
        method: Literal['CIE
            1931', 'CIE 1960 UCS',
            'CIE 1976 UCS'] | str
            = 'CIE 1931',
    scatter_kwargs: Dict |
        None = None,
    **kwargs: Any) →
    Tuple[Figure, Axes]
```

Plot given *RGB* colourspace array in the *Chromaticity Diagram* according to given method.

Parameters

- **RGB** (`ArrayLike`) – *RGB* colourspace array.
- **colourspace** (`RGB_Colourspace` | `str` | `Sequence[RGB_Colourspace` | `str]`) – *RGB* colourspace of the *RGB* array. colourspace can be of any type or form supported by the `colour.plotting.common.filter_RGB_colourspaces()` definition.
- **chromaticity_diagram_callable** (`Callable`) – Callable responsible for drawing the *Chromaticity Diagram*.
- **method** (`Literal['CIE 1931', 'CIE 1960 UCS', 'CIE 1976 UCS']` | `str`) – *Chromaticity Diagram* method.
- **scatter_kwargs** (`Dict` | `None`) – Keyword arguments for the `matplotlib.pyplot.scatter()` definition. The following special keyword arguments can also be used:
 - **c** : If **c** is set to *RGB*, the scatter will use the colours as given by the *RGB* argument.
- **kwargs** (`Any`) – {`colour.plotting.artist()`, `colour.plotting.diagrams.plot_chromaticity_diagram()`, `colour.plotting.models.plot_RGB_colourspace_in_chromaticity_diagram()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

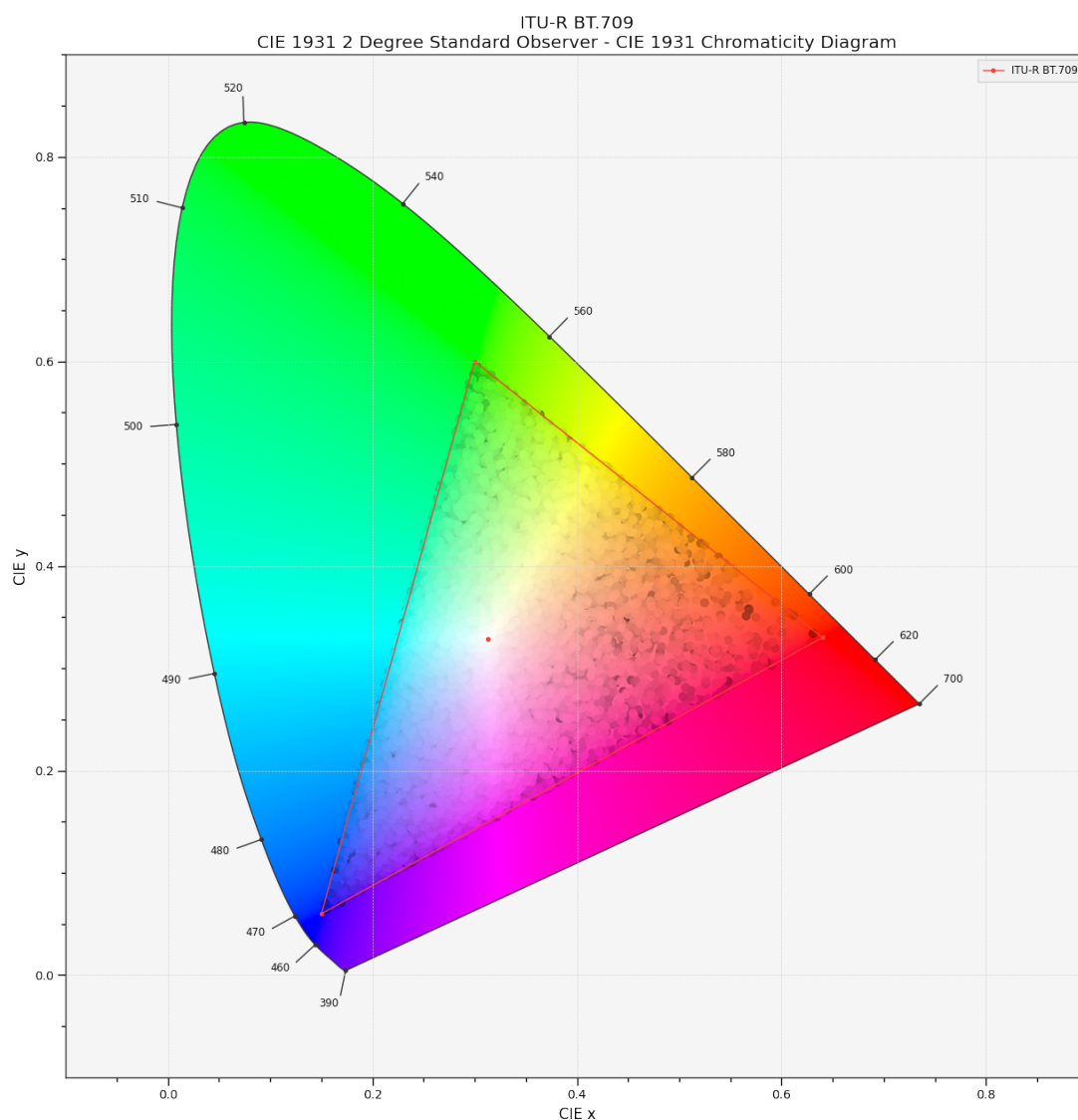
Current figure and axes.

Return type

`tuple`

Examples

```
>>> RGB = np.random.random((128, 128, 3))
>>> plot_RGB_chromaticities_in_chromaticity_diagram(RGB, "ITU-R BT.709")
...
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



colour.plotting.models.plot_ellipses_MacAdam1942_in_chromaticity_diagram

colour.plotting.models.plot_ellipses_MacAdam1942_in_chromaticity_diagram(*chromaticity_diagram_callable*:
Callable =
plot_chromaticity_diagram,
method: *Literal*['CIE
1931', 'CIE 1960
UCS', 'CIE 1976
UCS'] | *str* = 'CIE
1931', *chromaticity_diagram_clipping*:
bool = *False*,
ellipse_kwargs: *Dict*
| *List*[*Dict*] | *None*
= *None*, ***kwargs*:
Any) →
Tuple[*Figure*, *Axes*]

Plot MacAdam (1942) Ellipses (Observer PGN) in the Chromaticity Diagram according to given method.

Parameters

- **chromaticity_diagram_callable** (`Callable`) – Callable responsible for drawing the *Chromaticity Diagram*.
- **method** (`Literal['CIE 1931', 'CIE 1960 UCS', 'CIE 1976 UCS'] | str`) – *Chromaticity Diagram* method.
- **chromaticity_diagram_clipping** (`bool`) – Whether to clip the *Chromaticity Diagram* colours with the ellipses.
- **ellipse_kwargs** (`Dict | List[Dict] | None`) – Parameters for the `Ellipse` class, `ellipse_kwargs` can be either a single dictionary applied to all the ellipses with same settings or a sequence of dictionaries with different settings for each ellipse.
- **kwargs** (`Any`) – `{colour.plotting.artist(), colour.plotting.diagrams.plot_chromaticity_diagram(), colour.plotting.render()}`, See the documentation of the previously listed definitions.`

Returns

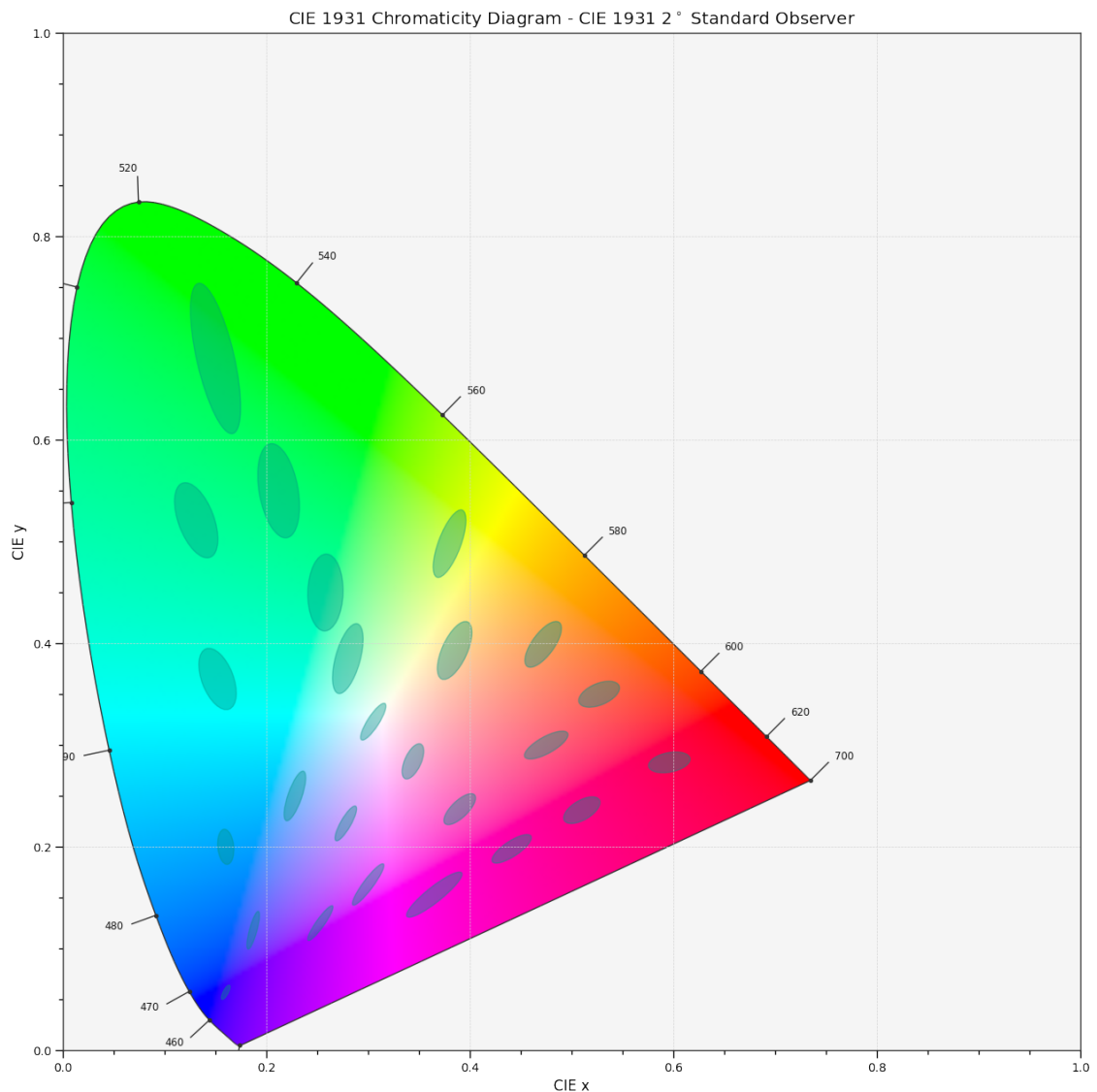
Current figure and axes.

Return type

`tuple`

Examples

```
>>> plot_ellipses_MacAdam1942_in_chromaticity_diagram()
...
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



Colour Notation Systems

colour.plotting

| | |
|--|--|
| <code>plot_single_munsell_value_function(function, ...)</code> | Plot given <i>Lightness</i> function. |
| <code>plot_multi_munsell_value_functions(...)</code> | Plot given <i>Munsell</i> value functions. |

colour.plotting.plot_single_munsell_value_function

`colour.plotting.plot_single_munsell_value_function(function: Callable | str, **kwargs: Any) → Tuple[Figure, Axes]`

Plot given *Lightness* function.

Parameters

- **function** (*Callable* | *str*) – *Munsell* value function to plot. *function* can be of any type or form supported by the `colour.plotting.common.filter_passthrough()` definition.

- **kwargs** (Any) – {colour.plotting.artist(), colour.plotting.plot_multi_functions(), colour.plotting.render()}, See the documentation of the previously listed definitions.

Returns

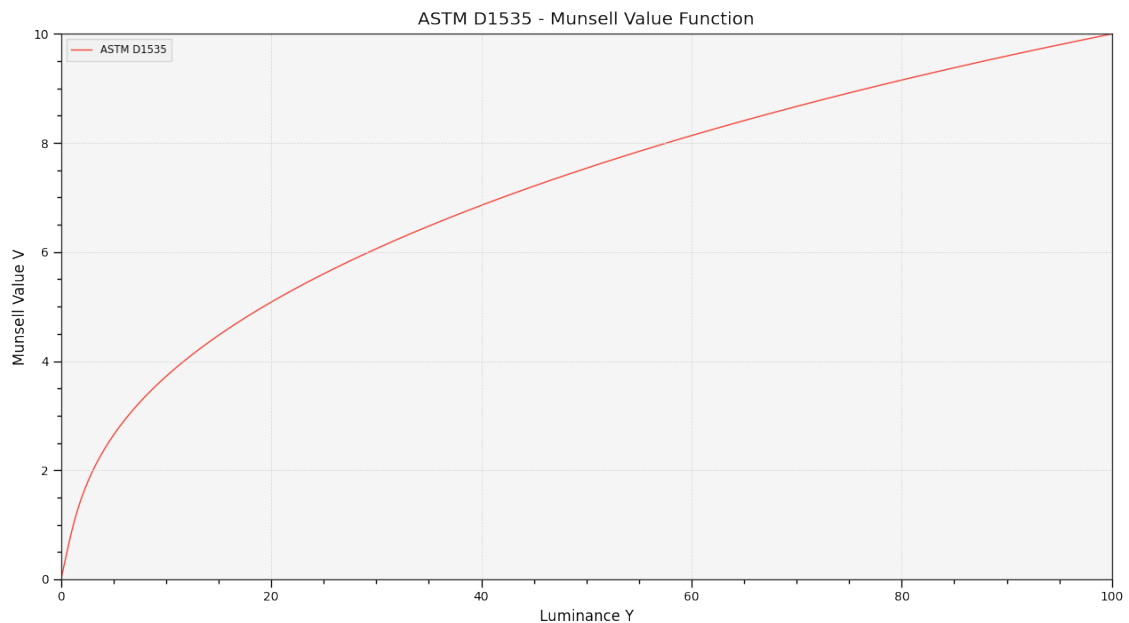
Current figure and axes.

Return type

tuple

Examples

```
>>> plot_single_munsell_value_function("ASTM D1535")
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```

**colour.plotting.plot_multi_munsell_value_functions**

colour.plotting.plot_multi_munsell_value_functions(functions: Callable | str | Sequence[Callable | str], **kwargs: Any) → Tuple[Figure, Axes]

Plot given *Munsell* value functions.

Parameters

- **functions** (Callable | str | Sequence[Callable | str]) – *Munsell* value functions to plot. functions elements can be of any type or form supported by the colour.plotting.common.filter_passthrough() definition.
- **kwargs** (Any) – {colour.plotting.artist(), colour.plotting.plot_multi_functions(), colour.plotting.render()}, See the documentation of the previously listed definitions.

Returns

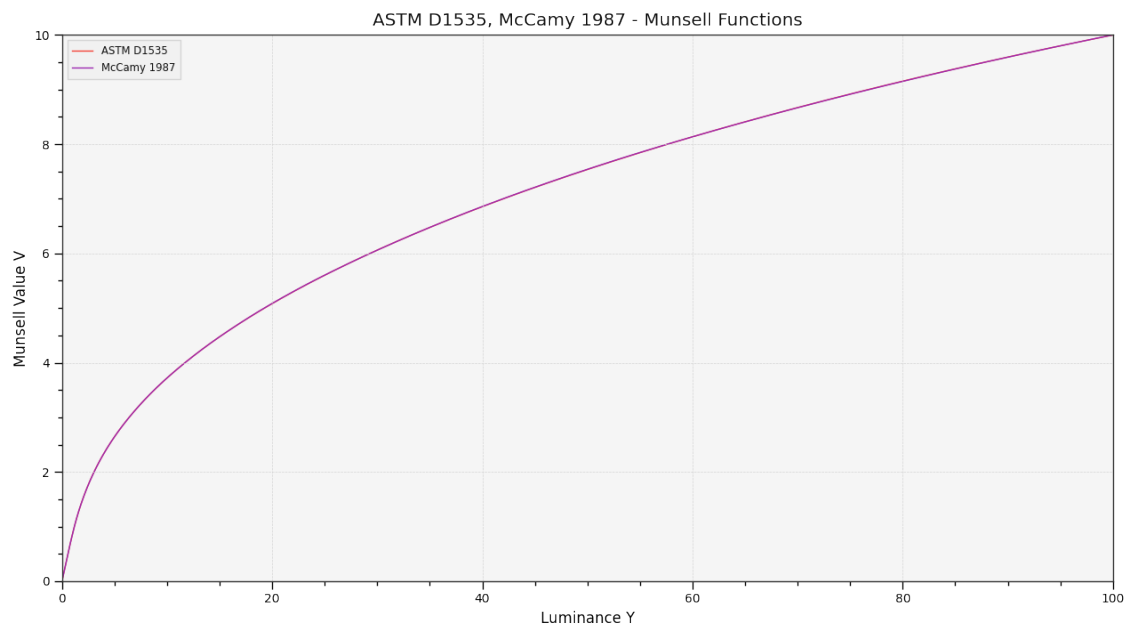
Current figure and axes.

Return type

tuple

Examples

```
>>> plot_multi_munsell_value_functions(["ASTM D1535", "McCamy 1987"])
...
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



Optical Phenomena

colour.plotting

| | |
|--|---|
| <code>plot_single_sd_rayleigh_scattering([...])</code> | Plot a single <i>Rayleigh</i> scattering spectral distribution. |
| <code>plot_the_blue_sky([cmfs])</code> | Plot the blue sky. |

colour.plotting.plot_single_sd_rayleigh_scattering

```
colour.plotting.plot_single_sd_rayleigh_scattering(CO2_concentration: FloatingOrArrayLike =
    CONSTANT_STANDARD_CO2_CONCENTRATION,
    temperature: FloatingOrArrayLike =
    CONSTANT_STANDARD_AIR_TEMPERATURE,
    pressure: FloatingOrArrayLike =
    CONSTANT_AVERAGE_PRESSURE_MEAN_SEA_LEVEL,
    latitude: FloatingOrArrayLike =
    CONSTANT_DEFAULT_LATITUDE, altitude:
    FloatingOrArrayLike =
    CONSTANT_DEFAULT_ALTITUDE, cmfs:
    MultiSpectralDistributions | str |
    Sequence[MultiSpectralDistributions | str] =
    'CIE 1931 2 Degree Standard Observer',
    **kwargs: Any) -> Tuple[Figure, Axes]
```

Plot a single *Rayleigh* scattering spectral distribution.

Parameters

- **C02_concentration** (FloatingOrArrayLike) – CO_2 concentration in parts per million (ppm).
- **temperature** (FloatingOrArrayLike) – Air temperature $T[K]$ in kelvin degrees.
- **pressure** (FloatingOrArrayLike) – Surface pressure P of the measurement site.
- **latitude** (FloatingOrArrayLike) – Latitude of the site in degrees.
- **altitude** (FloatingOrArrayLike) – Altitude of the site in meters.
- **cmfs** (MultiSpectralDistributions | str | Sequence[MultiSpectralDistributions | str]) – Standard observer colour matching functions used for computing the spectrum domain and colours. cmfs can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
- **kwargs** (Any) – {`colour.plotting.artist()`, `colour.plotting.plot_single_sd()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

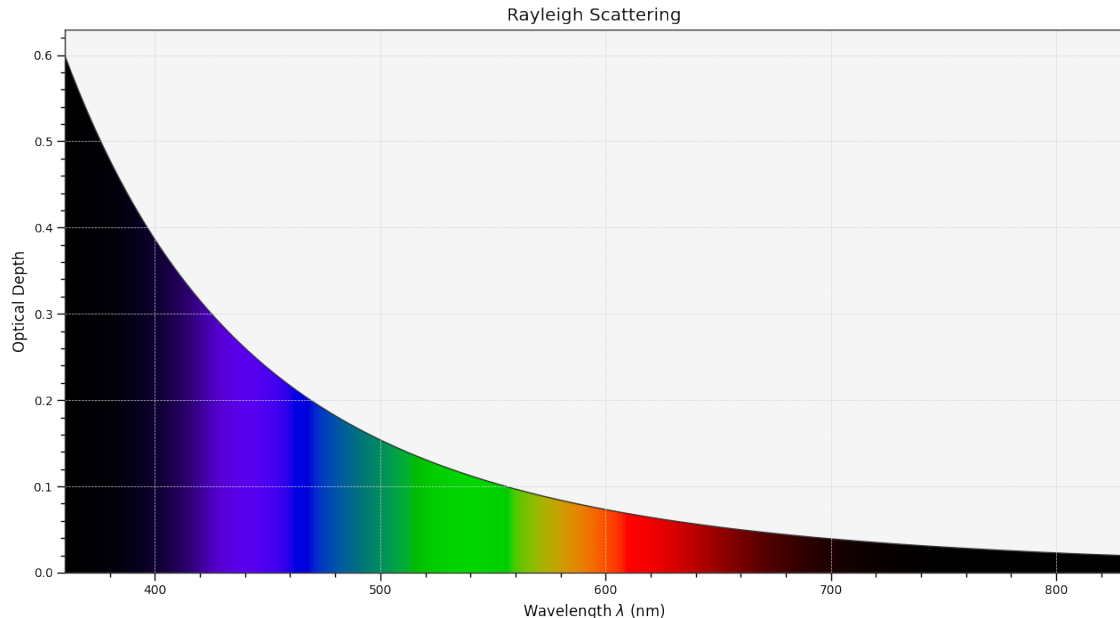
Current figure and axes.

Return type

tuple

Examples

```
>>> plot_single_sd_rayleigh_scattering()
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



`colour.plotting.plot_the_blue_sky`

`colour.plotting.plot_the_blue_sky`(*cmfs*: `MultiSpectralDistributions` | `str` | `Sequence[MultiSpectralDistributions` | `str]` = `'CIE 1931 2 Degree Standard Observer'`, ***kwargs*: `Any`) → `Tuple[Figure, Axes]`

Plot the blue sky.

Parameters

- **cmfs** (`MultiSpectralDistributions` | `str` | `Sequence[MultiSpectralDistributions` | `str]`) – Standard observer colour matching functions used for computing the spectrum domain and colours. *cmfs* can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
- **kwargs** (`Any`) – {`colour.plotting.artist()`, `colour.plotting.plot_single_sd()`, `colour.plotting.plot_multi_colour_swatches()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

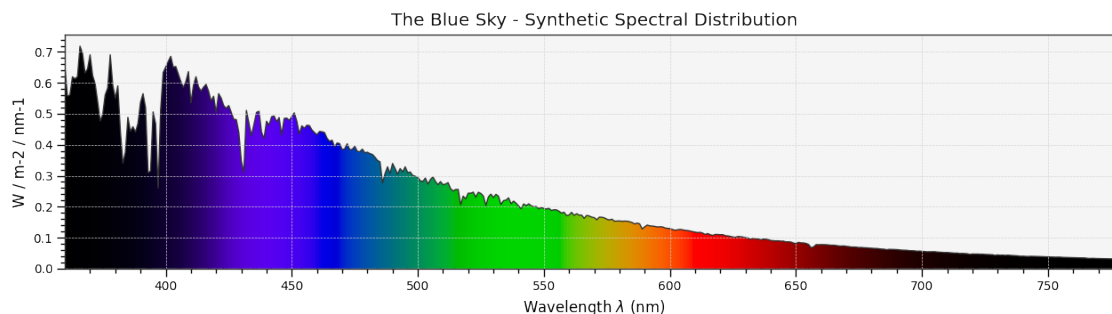
Current figure and axes.

Return type

`tuple`

Examples

```
>>> plot_the_blue_sky()
(<Figure size ... with 2 Axes>, <...AxesSubplot...>)
```



The sky is blue because molecules in the atmosphere scatter shorter wavelengths more than longer ones.
The synthetic spectral distribution is computed as follows: (ASTM G-173 ETR * Standard Air Rayleigh Scattering).

Colour Quality

colour.plotting

| | |
|---|--|
| <code>plot_single_sd_colour_rendering_index_bars(sd: SpectralDistribution, **kwargs: Any) → Tuple[Figure, Axes]</code> | Plot the <i>Colour Rendering Index</i> (CRI) of given illuminant or light source spectral distribution. |
| <code>plot_multi_sds_colour_rendering_indexes_bars(sds: List[SpectralDistribution], **kwargs: Any) → Tuple[Figure, Axes]</code> | Plot the <i>Colour Rendering Index</i> (CRI) of given illuminants or light sources spectral distributions. |
| <code>plot_single_sd_colour_quality_scale_bars(sd: SpectralDistribution, **kwargs: Any) → Tuple[Figure, Axes]</code> | Plot the <i>Colour Quality Scale</i> (CQS) of given illuminant or light source spectral distribution. |
| <code>plot_multi_sds_colour_quality_scales_bars(sds: List[SpectralDistribution], **kwargs: Any) → Tuple[Figure, Axes]</code> | Plot the <i>Colour Quality Scale</i> (CQS) of given illuminants or light sources spectral distributions. |

colour.plotting.plot_single_sd_colour_rendering_index_bars

colour.plotting.plot_single_sd_colour_rendering_index_bars(sd: SpectralDistribution, **kwargs: Any) → Tuple[Figure, Axes]

Plot the *Colour Rendering Index* (CRI) of given illuminant or light source spectral distribution.

Parameters

- **sd** (SpectralDistribution) – Illuminant or light source spectral distribution to plot the *Colour Rendering Index* (CRI).
- **kwargs** (Any) – {colour.plotting.artist(), colour.plotting.quality.plot_colour_quality_bars(), colour.plotting.render()}, See the documentation of the previously listed definitions.

Returns

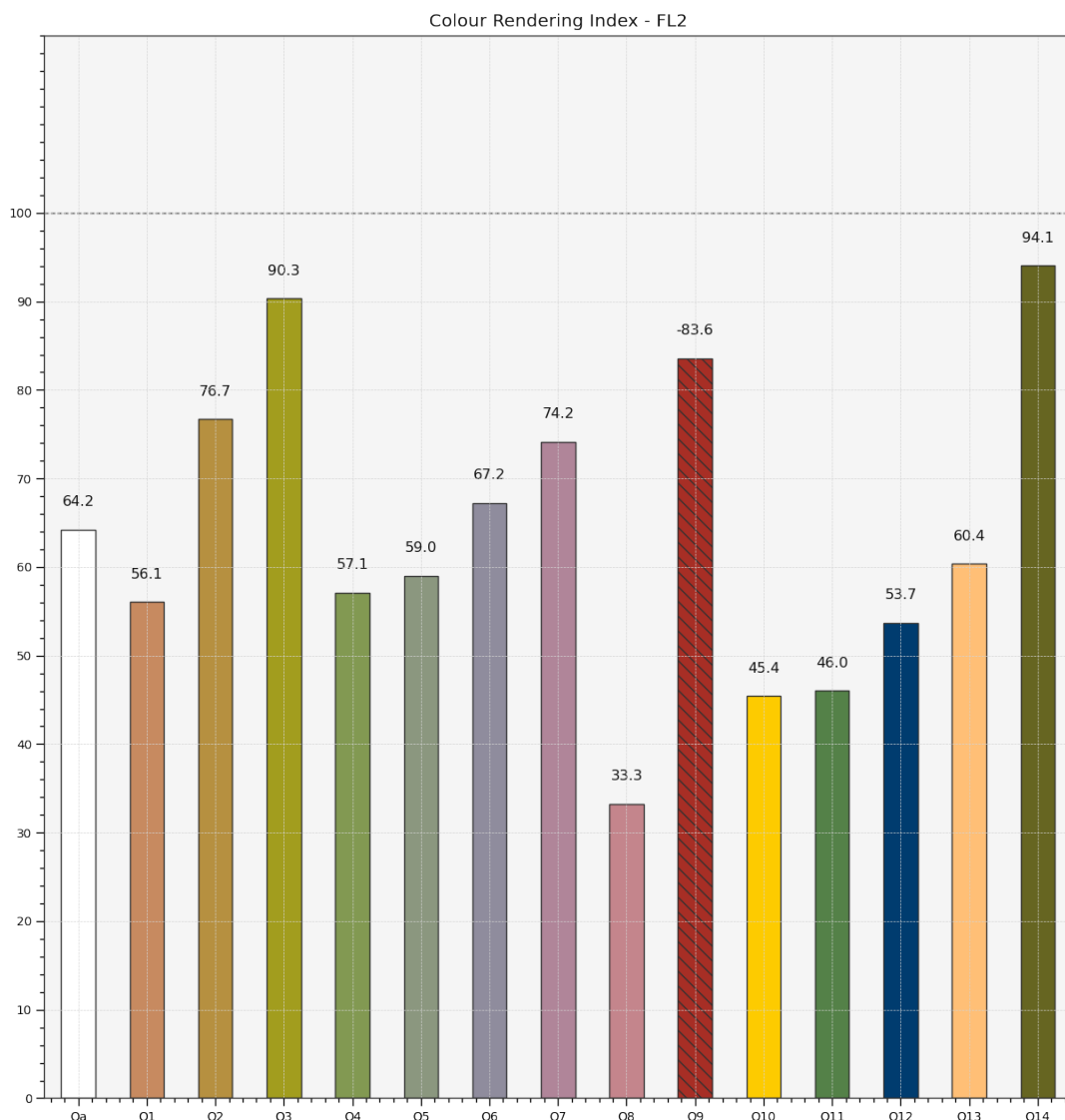
Current figure and axes.

Return type

tuple

Examples

```
>>> from colour import SDS_ILLUMINANTS
>>> illuminant = SDS_ILLUMINANTS["FL2"]
>>> plot_single_sd_colour_rendering_index_bars(illuminant)
...
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



`colour.plotting.plot_multi_sds_colour_rendering_indexes_bars`

```
colour.plotting.plot_multi_sds_colour_rendering_indexes_bars(sds:
    Sequence[SpectralDistribution | MultiSpectralDistributions] |
    MultiSpectralDistributions,
    **kwargs: Any) → Tuple[Figure,
    Axes]
```

Plot the *Colour Rendering Index* (CRI) of given illuminants or light sources spectral distributions.

Parameters

- **sds** (`Sequence[SpectralDistribution | MultiSpectralDistributions] | MultiSpectralDistributions`) – Spectral distributions or multi-spectral distributions to plot. *sds* can be a single `colour.MultiSpectralDistributions` class instance, a list of `colour.MultiSpectralDistributions` class instances or a list of `colour.SpectralDistribution` class instances.
- **kwargs** (`Any`) – {`colour.plotting.artist()`, `colour.plotting.quality.plot_colour_quality_bars()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

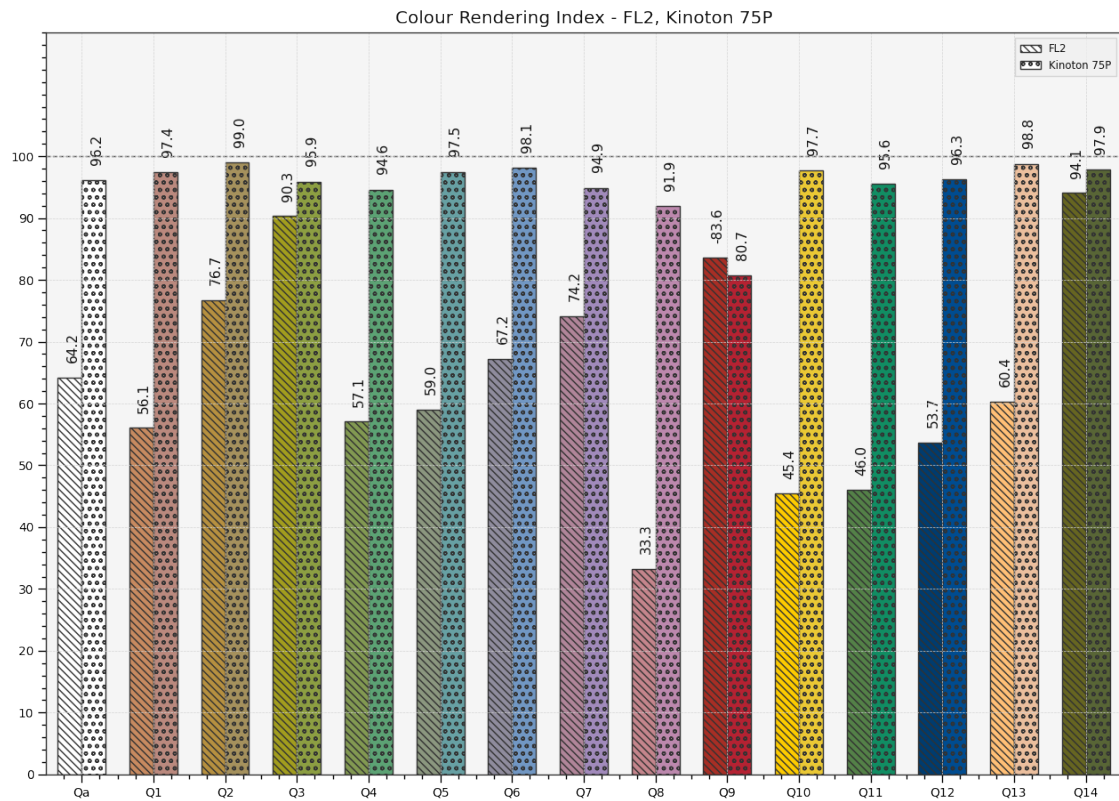
Current figure and axes.

Return type

tuple

Examples

```
>>> from colour import SDS_ILLUMINANTS, SDS_LIGHT_SOURCES
>>> illuminant = SDS_ILLUMINANTS["FL2"]
>>> light_source = SDS_LIGHT_SOURCES["Kinoton 75P"]
>>> plot_multi_sds_colour_rendering_indexes_bars(
...     [illuminant, light_source]
... )
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



colour.plotting.plot_single_sd_colour_quality_scale_bars

colour.plotting.plot_single_sd_colour_quality_scale_bars(sd: [SpectralDistribution](#), method: [Literal](#)['NIST CQS 7.4', 'NIST CQS 9.0'] | str = 'NIST CQS 9.0', **kwargs: Any) → [Tuple](#)[[Figure](#), [Axes](#)]

Plot the *Colour Quality Scale* (CQS) of given illuminant or light source spectral distribution.

Parameters

- **sd** ([SpectralDistribution](#)) – Illuminant or light source spectral distribution to plot the *Colour Quality Scale* (CQS).
- **method** ([Literal](#)['NIST CQS 7.4', 'NIST CQS 9.0'] | str) – *Colour Quality Scale* (CQS) computation method.
- **kwargs** (Any) – {colour.plotting.artist(), colour.plotting.quality.plot_colour_quality_bars(), colour.plotting.render()}, See the documentation of the previously listed definitions.

Returns

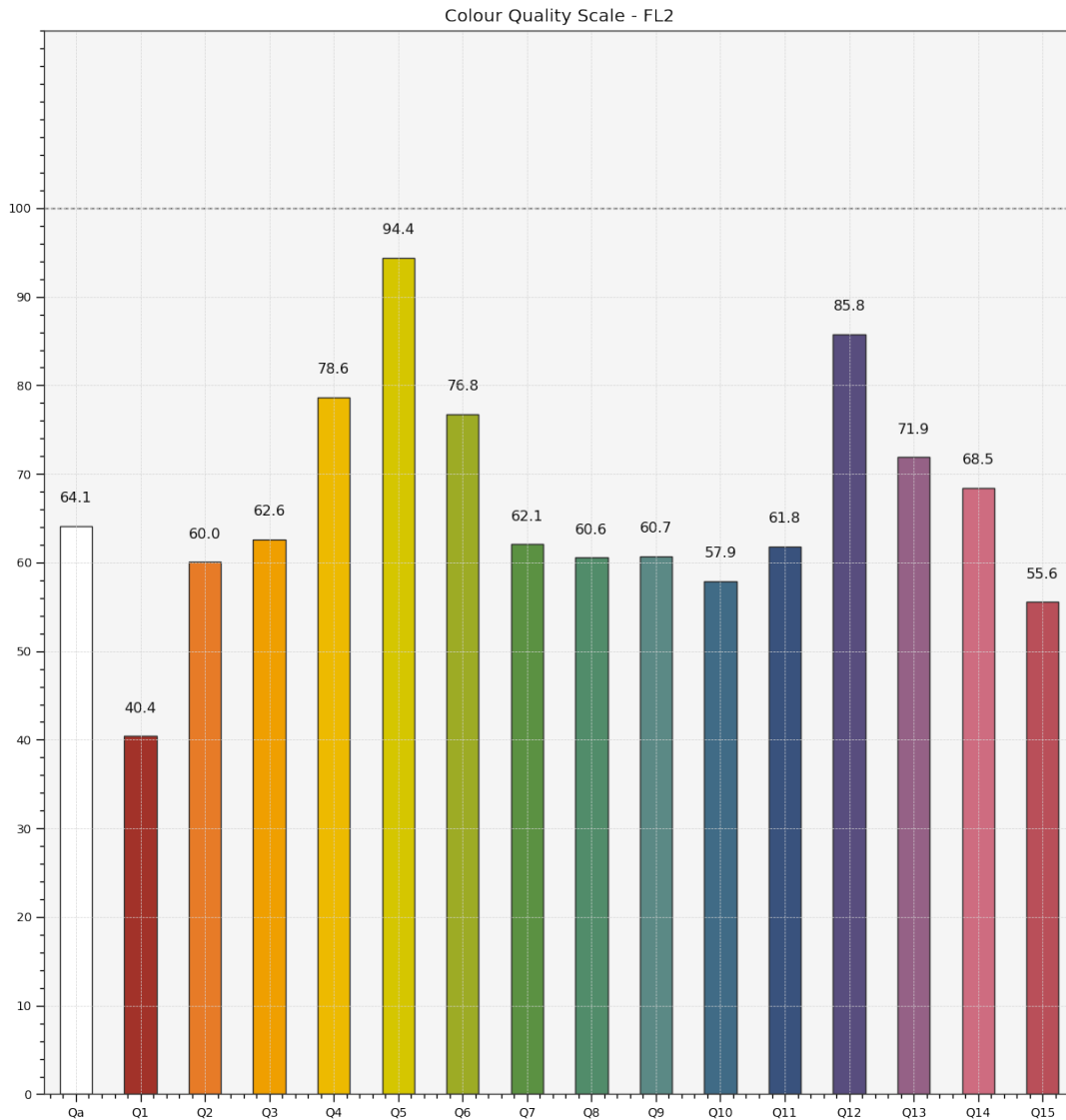
Current figure and axes.

Return type

[tuple](#)

Examples

```
>>> from colour import SDS_ILLUMINANTS
>>> illuminant = SDS_ILLUMINANTS["FL2"]
>>> plot_single_sd_colour_quality_scale_bars(illuminant)
...
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



`colour.plotting.plot_multi_sds_colour_quality_scales_bars`

`colour.plotting.plot_multi_sds_colour_quality_scales_bars(sds: Sequence[SpectralDistribution | MultiSpectralDistributions] | MultiSpectralDistributions, method: Literal['NIST CQS 7.4', 'NIST CQS 9.0'] | str = 'NIST CQS 9.0', **kwargs: Any) → Tuple[Figure, Axes]`

Plot the *Colour Quality Scale* (CQS) of given illuminants or light sources spectral distributions.

Parameters

- **sds** (*Sequence*[*SpectralDistribution* | *MultiSpectralDistributions*] | *MultiSpectralDistributions*) – Spectral distributions or multi-spectral distributions to plot. *sds* can be a single `colour.MultiSpectralDistributions` class instance, a list of `colour.MultiSpectralDistributions` class instances or a list of `colour.SpectralDistribution` class instances.
- **method** (*Literal*['NIST CQS 7.4', 'NIST CQS 9.0'] | str) – *Colour Quality Scale* (CQS) computation method.

- **kwargs** (Any) – {`colour.plotting.artist()`, `colour.plotting.quality.plot_colour_quality_bars()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

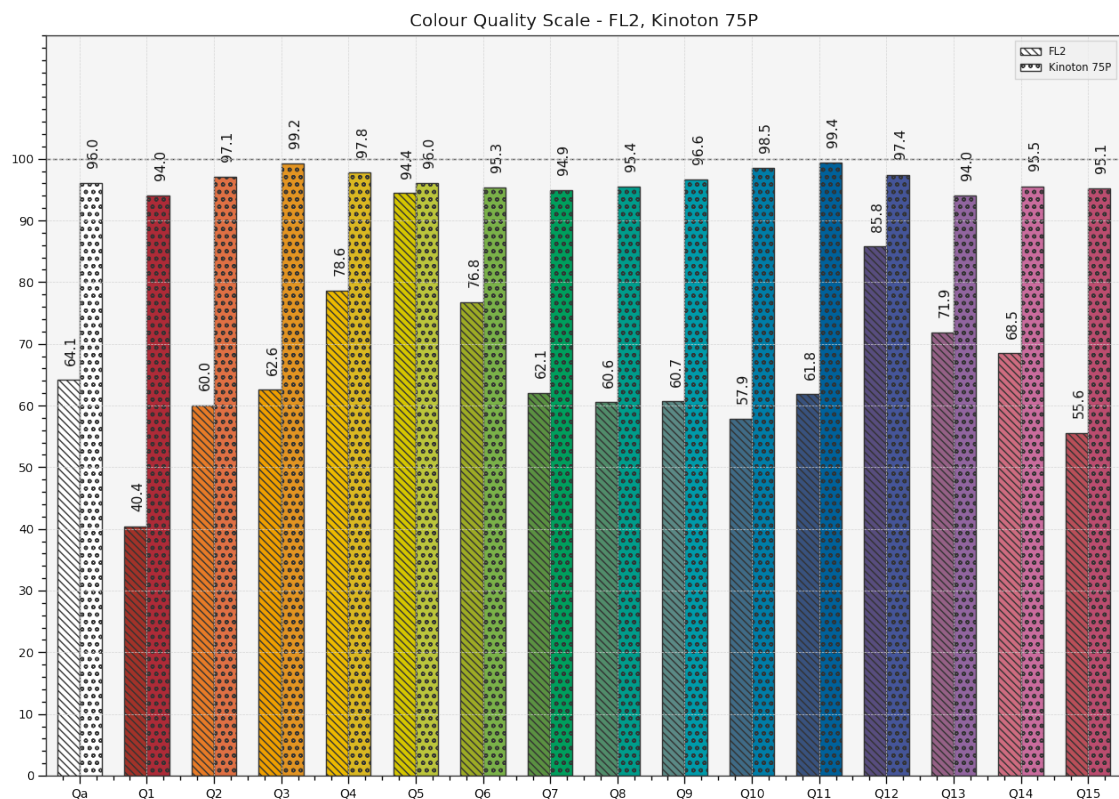
Current figure and axes.

Return type

`tuple`

Examples

```
>>> from colour import SDS_ILLUMINANTS, SDS_LIGHT_SOURCES
>>> illuminant = SDS_ILLUMINANTS["FL2"]
>>> light_source = SDS_LIGHT_SOURCES["Kinoton 75P"]
>>> plot_multi_sds_colour_quality_scales_bars([illuminant, light_source])
...
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



Ancillary Objects

`colour.plotting.quality`

| | |
|---|---|
| <code>plot_colour_qualityBars(specifications[, ...])</code> | Plot the colour quality data of given illuminants or light sources colour quality specifications. |
|---|---|

`colour.plotting.quality.plot_colour_qualityBars`

`colour.plotting.quality.plot_colour_qualityBars`(*specifications*: *Sequence*[*ColourRendering_Specification_CQS* | *ColourRendering_Specification_CRI*], *labels*: *bool* = *True*, *hatching*: *bool* | *None* = *None*, *hatching_repeat*: *int* = 2, ***kwargs*: *Any*) → *Tuple*[*Figure*, *Axes*]

Plot the colour quality data of given illuminants or light sources colour quality specifications.

Parameters

- **specifications** (*Sequence*[*ColourRendering_Specification_CQS* | *ColourRendering_Specification_CRI*]) – Array of illuminants or light sources colour quality specifications.
- **labels** (*bool*) – Add labels above bars.
- **hatching** (*bool* | *None*) – Use hatching for the bars.
- **hatching_repeat** (*int*) – Hatching pattern repeat.
- **kwargs** (*Any*) – {`colour.plotting.artist()`, `colour.plotting.quality.plot_colour_qualityBars()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

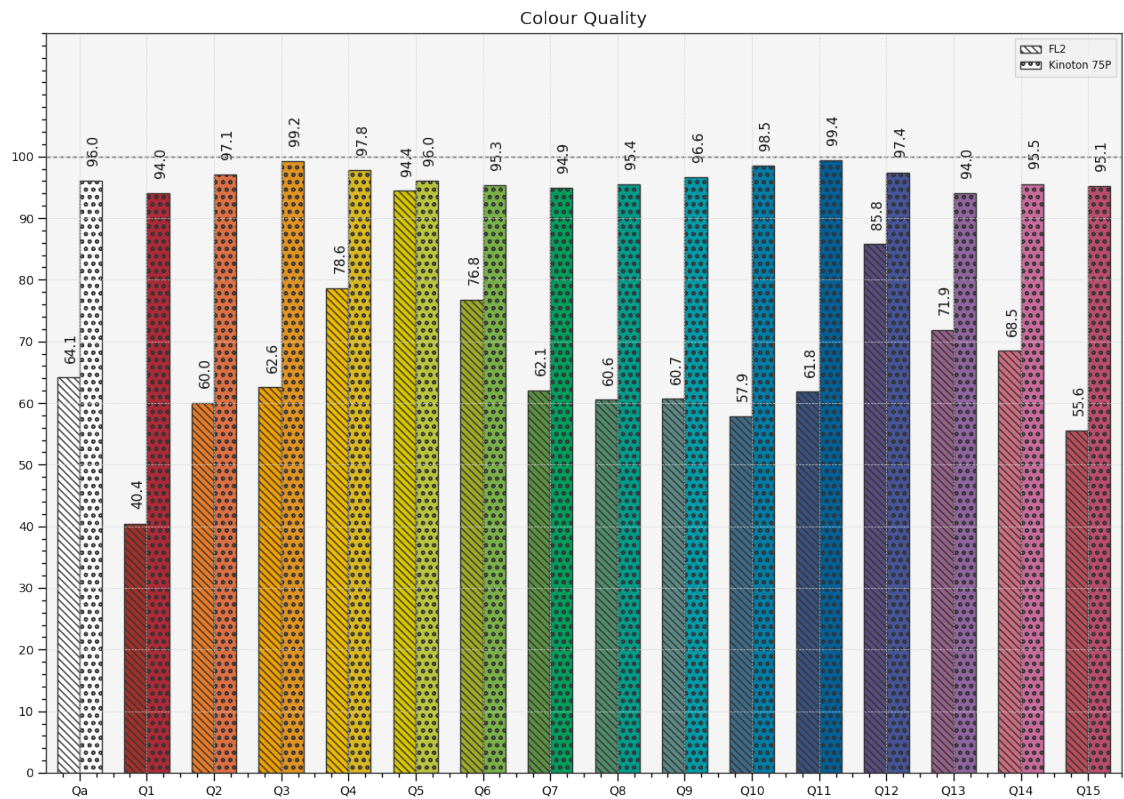
Current figure and axes.

Return type

tuple

Examples

```
>>> from colour import SDS_ILLUMINANTS, SDS_LIGHT_SOURCES, SpectralShape
>>> illuminant = SDS_ILLUMINANTS["FL2"]
>>> light_source = SDS_LIGHT_SOURCES["Kinoton 75P"]
>>> light_source = light_source.copy().align(SpectralShape(360, 830, 1))
>>> cqs_i = colour_quality_scale(illuminant, additional_data=True)
>>> cqs_l = colour_quality_scale(light_source, additional_data=True)
>>> plot_colour_qualityBars([cqs_i, cqs_l])
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



Gamut Section Plotting

`colour.plotting`

| | |
|---|---|
| <code>plot_visible_spectrum_section([cmfs, ...])</code> | Plot the visible spectrum volume, i.e. <i>Roßsch-MacAdam</i> colour solid, section colours along given axis and origin. |
| <code>plot_RGB_colourspace_section(colourspace[, ...])</code> | Plot given <i>RGB</i> colourspace section colours along given axis and origin. |

`colour.plotting.plot_visible_spectrum_section`

```
colour.plotting.plot_visible_spectrum_section(cmfs: MultiSpectralDistributions | str |
Sequence[MultiSpectralDistributions | str] = 'CIE
1931 2 Degree Standard Observer', illuminant:
SpectralDistribution | str = 'D65', model:
Literal['CAM02LCD', 'CAM02SCD', 'CAM02UCS',
'CAM16LCD', 'CAM16SCD', 'CAM16UCS', 'CIE XYZ',
'CIE xyY', 'CIE Lab', 'CIE Luv', 'CIE UCS', 'CIE UVW',
'DIN99', 'Hunter Lab', 'Hunter Rdab', 'ICaCb', 'ICtCp',
'IPT', 'IgPgTg', 'Jzazbz', 'OSA UCS', 'Oklab',
'hdr-CIELAB', 'hdr-IPT'] | str = 'CIE xyY', axis:
Literal['+z', '+x', '+y'] | str = '+z', origin: float =
0.5, normalise: bool = True, show_section_colours:
bool = True, show_section_contour: bool = True,
**kwargs: Any) → Tuple[Figure, Axes]
```

Plot the visible spectrum volume, i.e. *Ro?sch-MacAdam* colour solid, section colours along given axis and origin.

Parameters

- **cmfs** (`MultiSpectralDistributions` | `str` | `Sequence[MultiSpectralDistributions | str]`) – Standard observer colour matching functions, default to the *CIE 1931 2 Degree Standard Observer*. cmfs can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
- **illuminant** (`SpectralDistribution` | `str`) – Illuminant spectral distribution, default to *CIE Illuminant D65*. illuminant can be of any type or form supported by the `colour.plotting.common.filter_illuminants()` definition.
- **model** (`Literal['CAM02LCD', 'CAM02SCD', 'CAM02UCS', 'CAM16LCD', 'CAM16SCD', 'CAM16UCS', 'CIE XYZ', 'CIE xyY', 'CIE Lab', 'CIE Luv', 'CIE UCS', 'CIE UVW', 'DIN99', 'Hunter Lab', 'Hunter Rdab', 'ICaCb', 'ICtCp', 'IPT', 'IgPgTg', 'Jzazbz', 'OSA UCS', 'Oklab', 'hdr-CIELAB', 'hdr-IPT']` | `str`) – Colourspace model, see `colour.COLOURSPACE_MODELS` attribute for the list of supported colourspace models.
- **axis** (`Literal['+z', '+x', '+y']` | `str`) – Axis the hull section will be normal to.
- **origin** (`float`) – Coordinate along axis at which to plot the hull section.
- **normalise** (`bool`) – Whether to normalise axis to the extent of the hull along it.
- **show_section_colours** (`bool`) – Whether to show the hull section colours.
- **show_section_contour** (`bool`) – Whether to show the hull section contour.
- **kwargs** (`Any`) – {`colour.plotting.artist()`, `colour.plotting.render()`, `colour.plotting.section.plot_hull_section_colours()` `colour.plotting.section.plot_hull_section_contour()`}, See the documentation of the previously listed definitions.

Returns

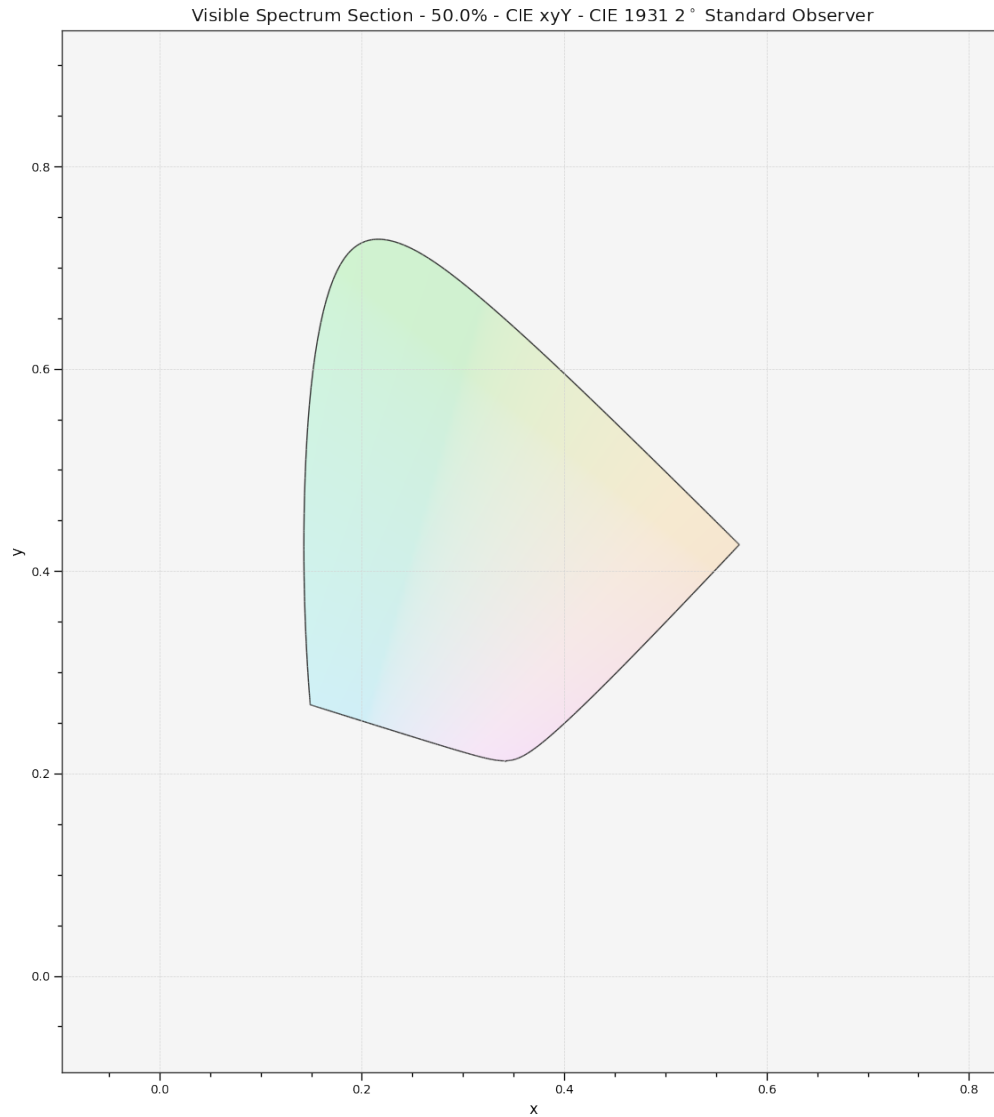
Current figure and axes.

Return type

`tuple`

Examples

```
>>> from colour.utilities import is_trimesh_installed
>>> if is_trimesh_installed:
...     plot_visible_spectrum_section(
...         section_colours="RGB", section_opacity=0.15
...     )
...
...
...
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



colour.plotting.plot_RGB_colourspace_section

```
colour.plotting.plot_RGB_colourspace_section(colourspace: RGB_Colourspace | str |
                                             Sequence[RGB_Colourspace | str], model:
                                             Literal['CAM02LCD', 'CAM02SCD', 'CAM02UCS',
                                             'CAM16LCD', 'CAM16SCD', 'CAM16UCS', 'CIE XYZ',
                                             'CIE xyY', 'CIE Lab', 'CIE Luv', 'CIE UCS', 'CIE UVW',
                                             'DIN99', 'Hunter Lab', 'Hunter Rdab', 'ICaCb', 'ICtCp',
                                             'IPT', 'IgPgTg', 'Jzazbz', 'OSA UCS', 'Oklab',
                                             'hdr-CIELAB', 'hdr-IPT'] | str = 'CIE xyY', axis:
                                             Literal['+z', '+x', '+y'] | str = '+z', origin: float =
                                             0.5, normalise: bool = True, show_section_colours:
                                             bool = True, show_section_contour: bool = True,
                                             **kwargs: Any) → Tuple[Figure, Axes]
```

Plot given *RGB* colourspace section colours along given axis and origin.

Parameters

- **colourspace** (*RGB_Colourspace* | *str* | *Sequence*[*RGB_Colourspace* | *str*]) – *RGB* colourspace of the *RGB* array. colourspace can be of any type or form supported by the `colour.plotting.common.filter_RGB_colourspaces()` definition.
- **model** (*Literal*['CAM02LCD', 'CAM02SCD', 'CAM02UCS', 'CAM16LCD', 'CAM16SCD', 'CAM16UCS', 'CIE XYZ', 'CIE xyY', 'CIE Lab', 'CIE Luv', 'CIE UCS', 'CIE UVW', 'DIN99', 'Hunter Lab', 'Hunter Rdab', 'ICaCb', 'ICtCp', 'IPT', 'IgPgTg', 'Jzazbz', 'OSA UCS', 'Oklab', 'hdr-CIELAB', 'hdr-IPT'] | *str*) – Colourspace model, see `colour.COLOURSPACE_MODELS` attribute for the list of supported colourspace models.
- **axis** (*Literal*['+z', '+x', '+y'] | *str*) – Axis the hull section will be normal to.
- **origin** (*float*) – Coordinate along axis at which to plot the hull section.
- **normalise** (*bool*) – Whether to normalise axis to the extent of the hull along it.
- **show_section_colours** (*bool*) – Whether to show the hull section colours.
- **show_section_contour** (*bool*) – Whether to show the hull section contour.
- **kwargs** (*Any*) – {`colour.plotting.artist()`, `colour.plotting.render()`, `colour.plotting.section.plot_hull_section_colours()` `colour.plotting.section.plot_hull_section_contour()`}, See the documentation of the previously listed definitions.

Returns

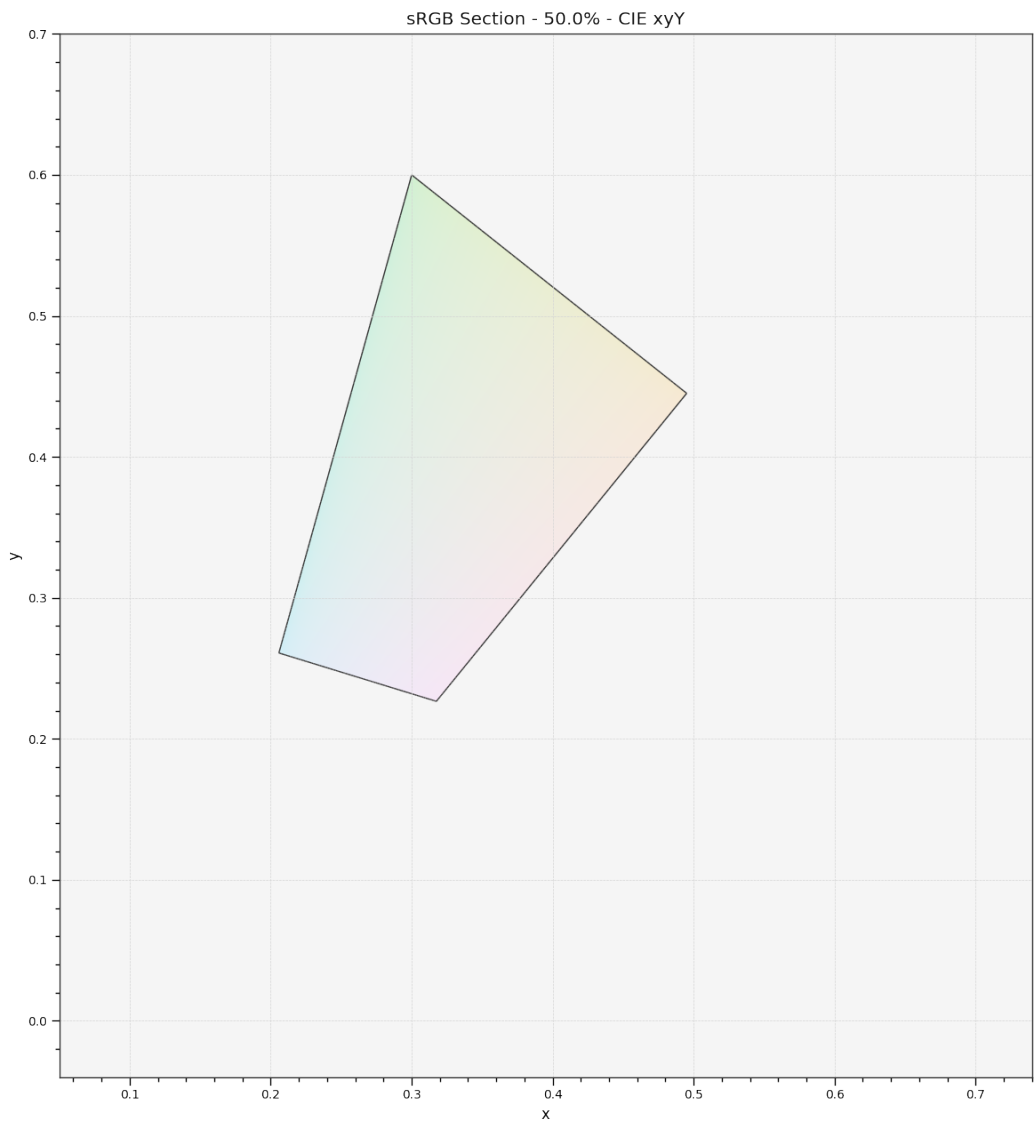
Current figure and axes.

Return type

tuple

Examples

```
>>> from colour.utilities import is_trimesh_installed
>>> if is_trimesh_installed:
...     plot_RGB_colourspace_section(
...         "sRGB", section_colours="RGB", section_opacity=0.15
...     )
...
...
...
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



Ancillary Objects

`colour.plotting.section`

| | |
|--|--|
| <code>plot_hull_section_colours(hull[, model, ...])</code> | Plot the section colours of given <i>trimesh</i> hull along given axis and origin. |
| <code>plot_hull_section_contour(hull[, model, ...])</code> | Plot the section contour of given <i>trimesh</i> hull along given axis and origin. |

colour.plotting.section.plot_hull_section_colours

```
colour.plotting.section.plot_hull_section_colours(hull: trimesh.Trimesh, model:
    Literal['CAM02LCD', 'CAM02SCD',
    'CAM02UCS', 'CAM16LCD', 'CAM16SCD',
    'CAM16UCS', 'CIE XYZ', 'CIE xyY', 'CIE Lab', 'CIE
    Luv', 'CIE UCS', 'CIE UVW', 'DIN99', 'Hunter
    Lab', 'Hunter Rdab', 'ICaCb', 'ICtCp', 'IPT',
    'IgPgTg', 'Jzazbz', 'OSA UCS', 'Oklab',
    'hdr-CIELAB', 'hdr-IPT'] | str = 'CIE xyY', axis:
    Literal['+z', '+x', '+y'] | str = '+z', origin:
    Floating = 0.5, normalise: Boolean = True,
    section_colours: ArrayLike | str | None = None,
    section_opacity: Floating = 1, convert_kwargs:
    Dict | None = None, samples: Integer = 256,
    **kwargs: Any) → Tuple[plt.Figure, plt.Axes]
```

Plot the section colours of given *trimesh* hull along given axis and origin.

Parameters

- **hull** (trimesh.Trimesh) – *Trimesh* hull.
- **model** (Union[Literal['CAM02LCD', 'CAM02SCD', 'CAM02UCS', 'CAM16LCD', 'CAM16SCD', 'CAM16UCS', 'CIE XYZ', 'CIE xyY', 'CIE Lab', 'CIE Luv', 'CIE UCS', 'CIE UVW', 'DIN99', 'Hunter Lab', 'Hunter Rdab', 'ICaCb', 'ICtCp', 'IPT', 'IgPgTg', 'Jzazbz', 'OSA UCS', 'Oklab', 'hdr-CIELAB', 'hdr-IPT'], str]) – Colourspace model, see [colour.COLOURSPACE_MODELS](#) attribute for the list of supported colourspace models.
- **axis** (Union[Literal['+z', '+x', '+y'], str]) – Axis the hull section will be normal to.
- **origin** (Floating) – Coordinate along axis at which to plot the hull section.
- **normalise** (Boolean) – Whether to normalise axis to the extent of the hull along it.
- **section_colours** (Optional[Union[ArrayLike, str]]) – Colours of the hull section, if `section_colours` is set to *RGB*, the colours will be computed according to the corresponding coordinates.
- **section_opacity** (Floating) – Opacity of the hull section colours.
- **convert_kwargs** (Optional[Dict]) – Keyword arguments for the [colour.convert\(\)](#) definition.
- **samples** (Integer) – Samples count on one axis when computing the hull section colours.
- **kwargs** (Any) – {[colour.plotting.artist\(\)](#), [colour.plotting.render\(\)](#)}, See the documentation of the previously listed definitions.

Returns

Current figure and axes.

Return type

`tuple`

Examples

```

>>> from colour.models import RGB_COLOURSPACE_sRGB
>>> from colour.utilities import is_trimesh_installed
>>> vertices, faces, _outline = primitive_cube(1, 1, 1, 64, 64, 64)
>>> XYZ_vertices = RGB_to_XYZ(
...     vertices["position"] + 0.5,
...     RGB_COLOURSPACE_sRGB.whitepoint,
...     RGB_COLOURSPACE_sRGB.whitepoint,
...     RGB_COLOURSPACE_sRGB.matrix_RGB_to_XYZ,
... )
>>> if is_trimesh_installed:
...     import trimesh
...
...     hull = trimesh.Trimesh(XYZ_vertices, faces, process=False)
...     plot_hull_section_colours(hull, section_colours="RGB")
...
...
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)

```



`colour.plotting.section.plot_hull_section_contour`

```
colour.plotting.section.plot_hull_section_contour(hull: trimesh.Trimesh, model:
    Literal['CAM02LCD', 'CAM02SCD',
    'CAM02UCS', 'CAM16LCD', 'CAM16SCD',
    'CAM16UCS', 'CIE XYZ', 'CIE xyY', 'CIE Lab', 'CIE
    Luv', 'CIE UCS', 'CIE UVW', 'DIN99', 'Hunter
    Lab', 'Hunter Rdab', 'ICaCb', 'ICtCp', 'IPT',
    'IgPgTg', 'Jzazbz', 'OSA UCS', 'Oklab',
    'hdr-CIELAB', 'hdr-IPT'] | str = 'CIE xyY', axis:
    Literal['+z', '+x', '+y'] | str = '+z', origin:
    Floating = 0.5, normalise: Boolean = True,
    contour_colours: ArrayLike | str | None =
    None, contour_opacity: Floating = 1,
    convert_kwargs: Dict | None = None,
    **kwargs: Any) → Tuple[plt.Figure, plt.Axes]
```

Plot the section contour of given *trimesh* hull along given axis and origin.

Parameters

- **hull** (`trimesh.Trimesh`) – *Trimesh* hull.
- **model** (`Union[Literal['CAM02LCD', 'CAM02SCD', 'CAM02UCS', 'CAM16LCD', 'CAM16SCD', 'CAM16UCS', 'CIE XYZ', 'CIE xyY', 'CIE Lab', 'CIE Luv', 'CIE UCS', 'CIE UVW', 'DIN99', 'Hunter Lab', 'Hunter Rdab', 'ICaCb', 'ICtCp', 'IPT', 'IgPgTg', 'Jzazbz', 'OSA UCS', 'Oklab', 'hdr-CIELAB', 'hdr-IPT'], str]`) – Colourspace model, see `colour.COLOURSPACE_MODELS` attribute for the list of supported colourspace models.
- **axis** (`Union[Literal['+z', '+x', '+y'], str]`) – Axis the hull section will be normal to.
- **origin** (`Floating`) – Coordinate along axis at which to plot the hull section.
- **normalise** (`Boolean`) – Whether to normalise axis to the extent of the hull along it.
- **contour_colours** (`Optional[Union[ArrayLike, str]]`) – Colours of the hull section contour, if `contour_colours` is set to *RGB*, the colours will be computed according to the corresponding coordinates.
- **contour_opacity** (`Floating`) – Opacity of the hull section contour.
- **convert_kwargs** (`Optional[Dict]`) – Keyword arguments for the `colour.convert()` definition.
- **kwargs** (*Any*) – `{colour.plotting.artist(), colour.plotting.render()}`, See the documentation of the previously listed definitions.

Returns

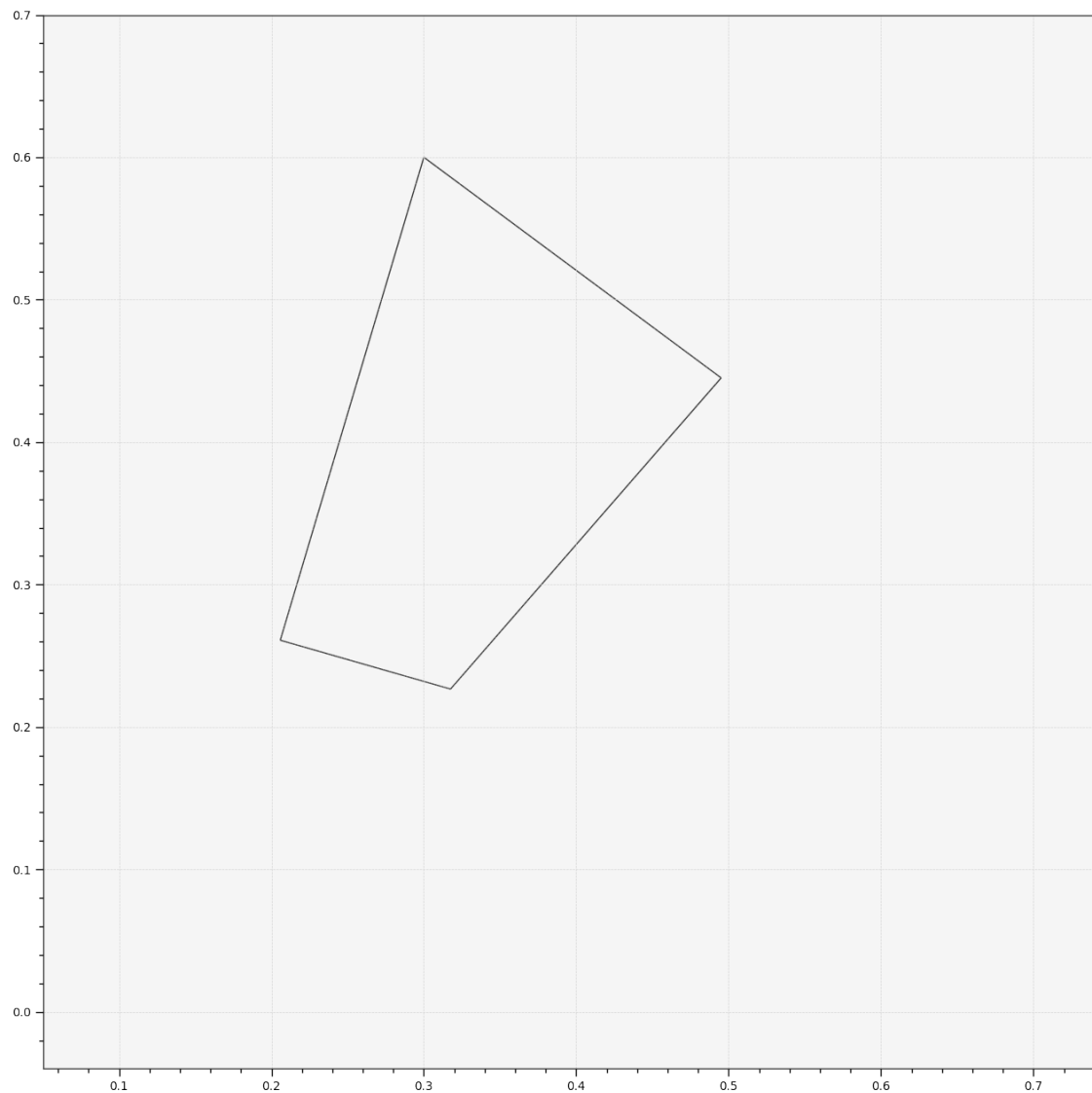
Current figure and axes.

Return type

`tuple`

Examples

```
>>> from colour.models import RGB_COLOURSPACE_sRGB
>>> from colour.utilities import is_trimesh_installed
>>> vertices, faces, _outline = primitive_cube(1, 1, 1, 64, 64, 64)
>>> XYZ_vertices = RGB_to_XYZ(
...     vertices["position"] + 0.5,
...     RGB_COLOURSPACE_sRGB.whitepoint,
...     RGB_COLOURSPACE_sRGB.whitepoint,
...     RGB_COLOURSPACE_sRGB.matrix_RGB_to_XYZ,
... )
>>> if is_trimesh_installed:
...     import trimesh
...
...     hull = trimesh.Trimesh(XYZ_vertices, faces, process=False)
...     plot_hull_section_contour(hull, contour_colours="RGB")
...
...
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



Colour Temperature & Correlated Colour Temperature

colour.plotting

| | |
|---|---|
| <code>plot_planckian_locus_in_chromaticity_diagram</code> | Plot the <i>Planckian Locus</i> and given illuminants in <i>CIE 1931 Chromaticity Diagram</i> . |
| <code>plot_planckian_locus_in_chromaticity_diagram</code> | Plot the <i>Planckian Locus</i> and given illuminants in <i>CIE 1960 UCS Chromaticity Diagram</i> . |

colour.plotting.plot_planckian_locus_in_chromaticity_diagram_CIE1931

```
colour.plotting.plot_planckian_locus_in_chromaticity_diagram_CIE1931(illuminants: str |
                                                                    Sequence[str], chromatic-
                                                                    ity_diagram_callable_CIE1931:
                                                                    Callable =
                                                                    plot_chromaticity_diagram_CIE1931,
                                                                    annotate_kwargs: Dict |
                                                                    List[Dict] | None =
                                                                    None, plot_kwargs: Dict
                                                                    | List[Dict] | None =
                                                                    None, **kwargs: Any)
                                                                    → Tuple[Figure, Axes]
```

Plot the *Planckian Locus* and given illuminants in *CIE 1931 Chromaticity Diagram*.

Parameters

- **illuminants** (str | Sequence[str]) – Illuminants to plot. illuminants elements can be of any type or form supported by the `colour.plotting.common.filter_passthrough()` definition.
- **chromaticity_diagram_callable_CIE1931** (Callable) – Callable responsible for drawing the *CIE 1931 Chromaticity Diagram*.
- **annotate_kwargs** (Dict | List[Dict] | None) – Keyword arguments for the `matplotlib.pyplot.annotate()` definition, used to annotate the resulting chromaticity coordinates with their respective spectral distribution names. `annotate_kwargs` can be either a single dictionary applied to all the arrows with same settings or a sequence of dictionaries with different settings for each spectral distribution. The following special keyword arguments can also be used:
 - `annotate` : Whether to annotate the spectral distributions.
- **plot_kwargs** (Dict | List[Dict] | None) – Keyword arguments for the `matplotlib.pyplot.plot()` definition, used to control the style of the plotted illuminants. `plot_kwargs` can be either a single dictionary applied to all the plotted illuminants with the same settings or a sequence of dictionaries with different settings for each plotted illuminant.
- **kwargs** (Any) – {`colour.plotting.artist()`, `colour.plotting.diagrams.plot_chromaticity_diagram()`, `colour.plotting.temperature.plot_planckian_locus()`, `colour.plotting.temperature.plot_planckian_locus_in_chromaticity_diagram()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

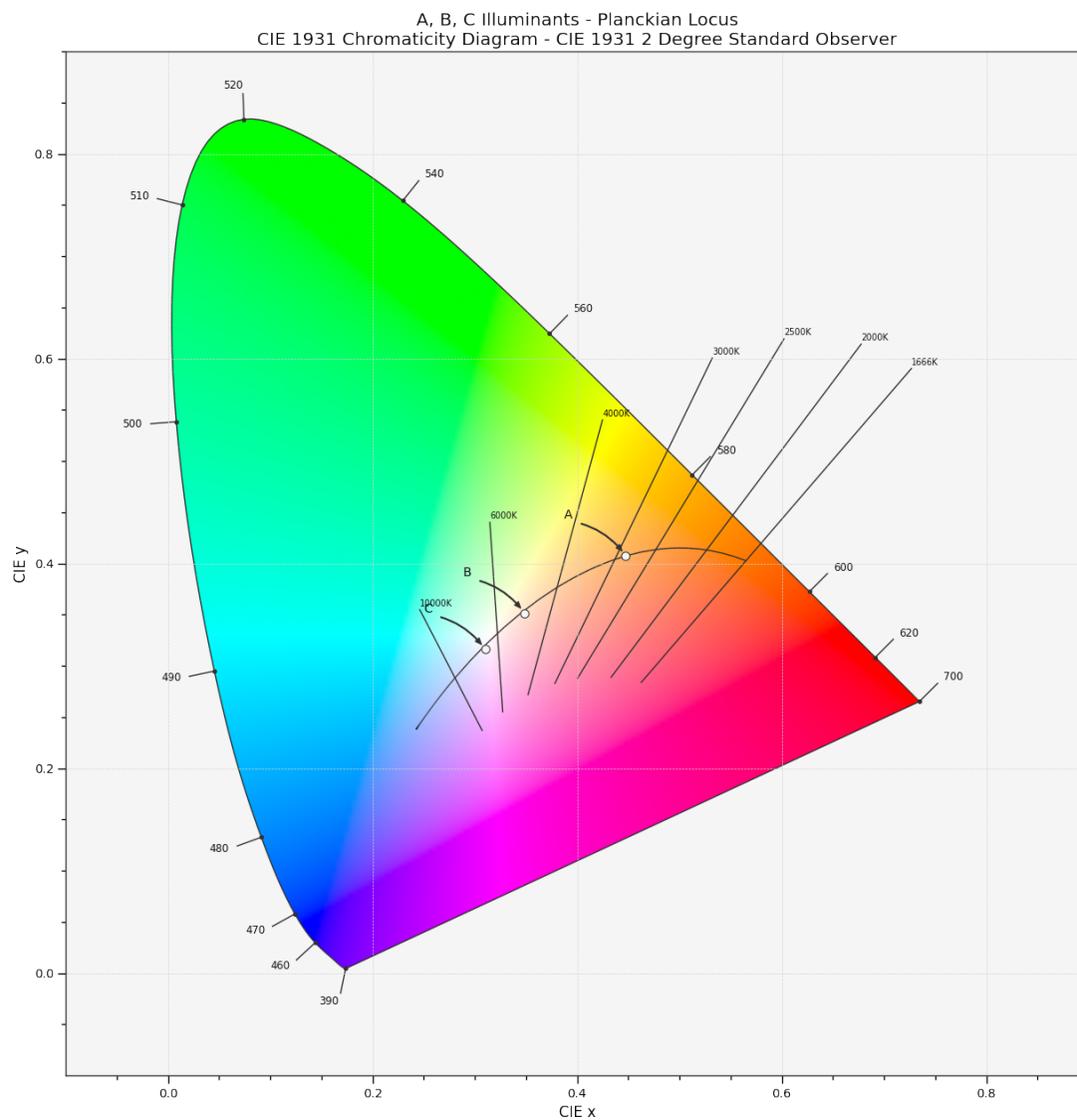
Current figure and axes.

Return type

tuple

Examples

```
>>> plot_planckian_locus_in_chromaticity_diagram_CIE1931(["A", "B", "C"])
...
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



`colour.plotting.plot_planckian_locus_in_chromaticity_diagram_CIE1960UCS`


```

colour.plotting.plot_planckian_locus_in_chromaticity_diagram_CIE1960UCS(illuminants: str |
                                                                    Sequence[str],
                                                                    chromatic-
                                                                    ity_diagram_callable_CIE1960UCS:
                                                                    Callable =
                                                                    plot_chromaticity_diagram_CIE1960UCS,
                                                                    annotate_kwargs:
                                                                    Dict | List[Dict] |
                                                                    None = None,
                                                                    plot_kwargs: Dict |
                                                                    List[Dict] | None =
                                                                    None, **kwargs:
                                                                    Any) →
                                                                    Tuple[Figure, Axes]

```

Plot the *Planckian Locus* and given illuminants in *CIE 1960 UCS Chromaticity Diagram*.

Parameters

- **illuminants** (str | Sequence[str]) – Illuminants to plot. illuminants elements can be of any type or form supported by the `colour.plotting.common.filter_passthrough()` definition.
- **chromaticity_diagram_callable_CIE1960UCS** (Callable) – Callable responsible for drawing the *CIE 1960 UCS Chromaticity Diagram*.
- **annotate_kwargs** (Dict | List[Dict] | None) – Keyword arguments for the `matplotlib.pyplot.annotate()` definition, used to annotate the resulting chromaticity coordinates with their respective spectral distribution names. `annotate_kwargs` can be either a single dictionary applied to all the arrows with same settings or a sequence of dictionaries with different settings for each spectral distribution. The following special keyword arguments can also be used:
 - `annotate` : Whether to annotate the spectral distributions.
- **plot_kwargs** (Dict | List[Dict] | None) – Keyword arguments for the `matplotlib.pyplot.plot()` definition, used to control the style of the plotted illuminants. `plot_kwargs` can be either a single dictionary applied to all the plotted illuminants with the same settings or a sequence of dictionaries with different settings for each plotted illuminant.
- **kwargs** (Any) – {`colour.plotting.artist()`, `colour.plotting.diagrams.plot_chromaticity_diagram()`, `colour.plotting.temperature.plot_planckian_locus()`, `colour.plotting.temperature.plot_planckian_locus_in_chromaticity_diagram()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

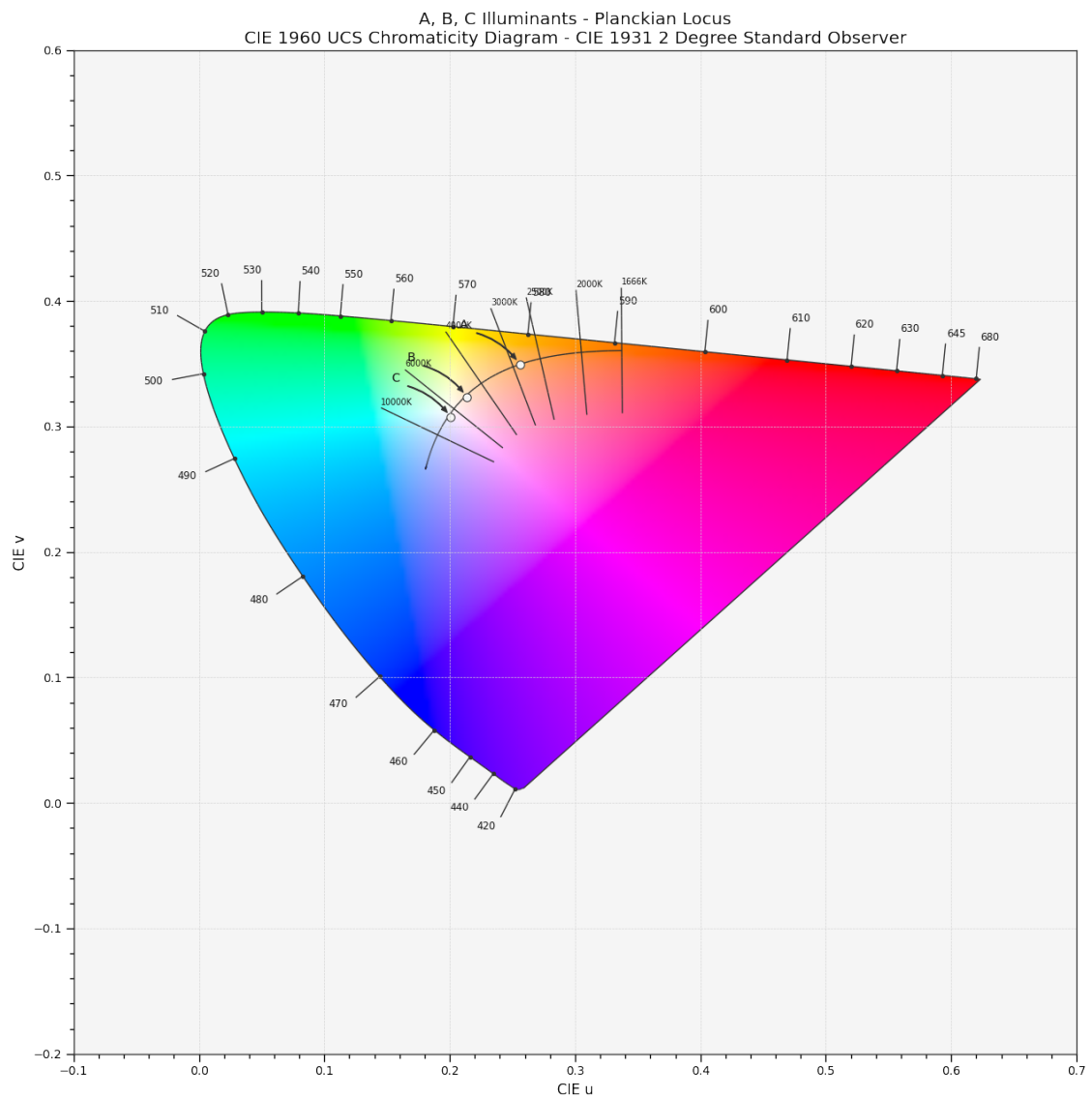
Current figure and axes.

Return type

tuple

Examples

```
>>> plot_planckian_locus_in_chromaticity_diagram_CIE1960UCS(
...     ["A", "C", "E"]
... )
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



Ancillary Objects

`colour.plotting.temperature`

`plot_planckian_locus([...])`

Plot the *Planckian Locus* according to given method.

`plot_planckian_locus_in_chromaticity_diagram`

Plot the *Planckian Locus* and given illuminants in the *Chromaticity Diagram* according to given method.

`colour.plotting.temperature.plot_planckian_locus`

`colour.plotting.temperature.plot_planckian_locus(planckian_locus_colours: ArrayLike | str | None = None, planckian_locus_opacity: float = 1, planckian_locus_labels: Sequence | None = None, method: Literal['CIE 1931', 'CIE 1960 UCS', 'CIE 1976 UCS'] | str = 'CIE 1931', **kwargs: Any) → Tuple[Figure, Axes]`

Plot the *Planckian Locus* according to given method.

Parameters

- **planckian_locus_colours** (ArrayLike | str | None) – Colours of the *Planckian Locus*, if `planckian_locus_colours` is set to `RGB`, the colours will be computed according to the corresponding chromaticity coordinates.
- **planckian_locus_opacity** (float) – Opacity of the *Planckian Locus*.
- **planckian_locus_labels** (Sequence | None) – Array of labels used to customise which iso-temperature lines will be drawn along the *Planckian Locus*. Passing an empty array will result in no iso-temperature lines being drawn.
- **method** (Literal['CIE 1931', 'CIE 1960 UCS', 'CIE 1976 UCS'] | str) – *Chromaticity Diagram* method.
- **kwargs** (Any) – {`colour.plotting.artist()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

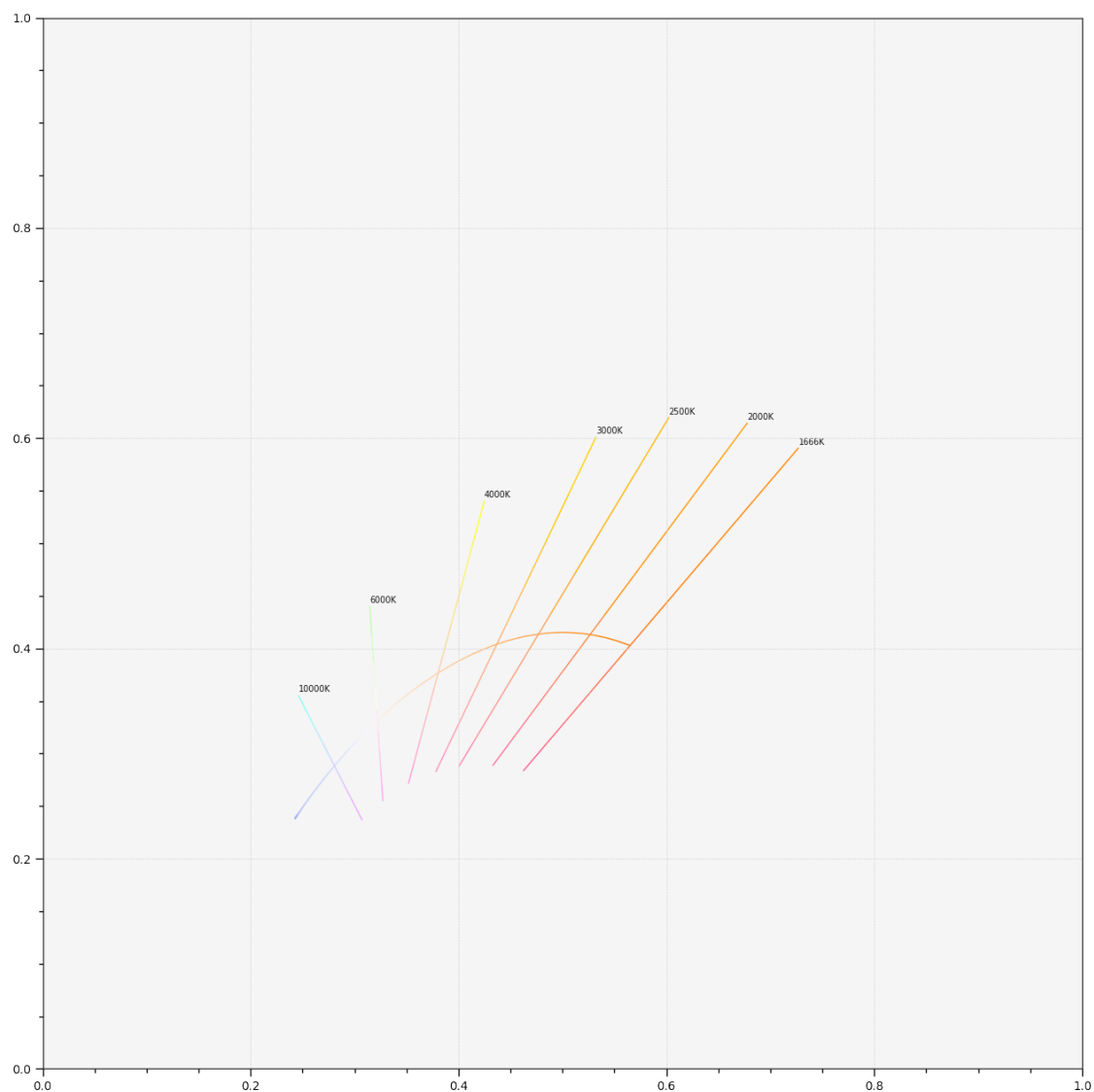
Current figure and axes.

Return type

tuple

Examples

```
>>> plot_planckian_locus(planckian_locus_colours="RGB")
...
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



colour.plotting.temperature.plot_planckian_locus_in_chromaticity_diagram

```
colour.plotting.temperature.plot_planckian_locus_in_chromaticity_diagram(illuminants: str |
    Sequence[str],
    chromatic-
    ity_diagram_callable:
    Callable =
    plot_chromaticity_diagram,
    method: Literal['CIE
    1931', 'CIE 1960
    UCS'] | str = 'CIE
    1931',
    annotate_kwargs:
    Dict | List[Dict] |
    None = None,
    plot_kwargs: Dict |
    List[Dict] | None =
    None, **kwargs:
    Any) →
    Tuple[Figure, Axes]
```

Plot the *Planckian Locus* and given illuminants in the *Chromaticity Diagram* according to given method.

Parameters

- **illuminants** (`str` | `Sequence[str]`) – Illuminants to plot. illuminants elements can be of any type or form supported by the `colour.plotting.common.filter_passthrough()` definition.
- **chromaticity_diagram_callable** (`Callable`) – Callable responsible for drawing the *Chromaticity Diagram*.
- **method** (`Literal['CIE 1931', 'CIE 1960 UCS']` | `str`) – *Chromaticity Diagram* method.
- **annotate_kwargs** (`Dict` | `List[Dict]` | `None`) – Keyword arguments for the `matplotlib.pyplot.annotate()` definition, used to annotate the resulting chromaticity coordinates with their respective spectral distribution names. `annotate_kwargs` can be either a single dictionary applied to all the arrows with same settings or a sequence of dictionaries with different settings for each spectral distribution. The following special keyword arguments can also be used:
 - `annotate` : Whether to annotate the spectral distributions.
- **plot_kwargs** (`Dict` | `List[Dict]` | `None`) – Keyword arguments for the `matplotlib.pyplot.plot()` definition, used to control the style of the plotted illuminants. `plot_kwargs` can be either a single dictionary applied to all the plotted illuminants with the same settings or a sequence of dictionaries with different settings for each plotted illuminant.
- **kwargs** (`Any`) – `{colour.plotting.artist(), colour.plotting.diagrams.plot_chromaticity_diagram(), colour.plotting.temperature.plot_planckian_locus(), colour.plotting.render()}`, See the documentation of the previously listed definitions.`

Returns

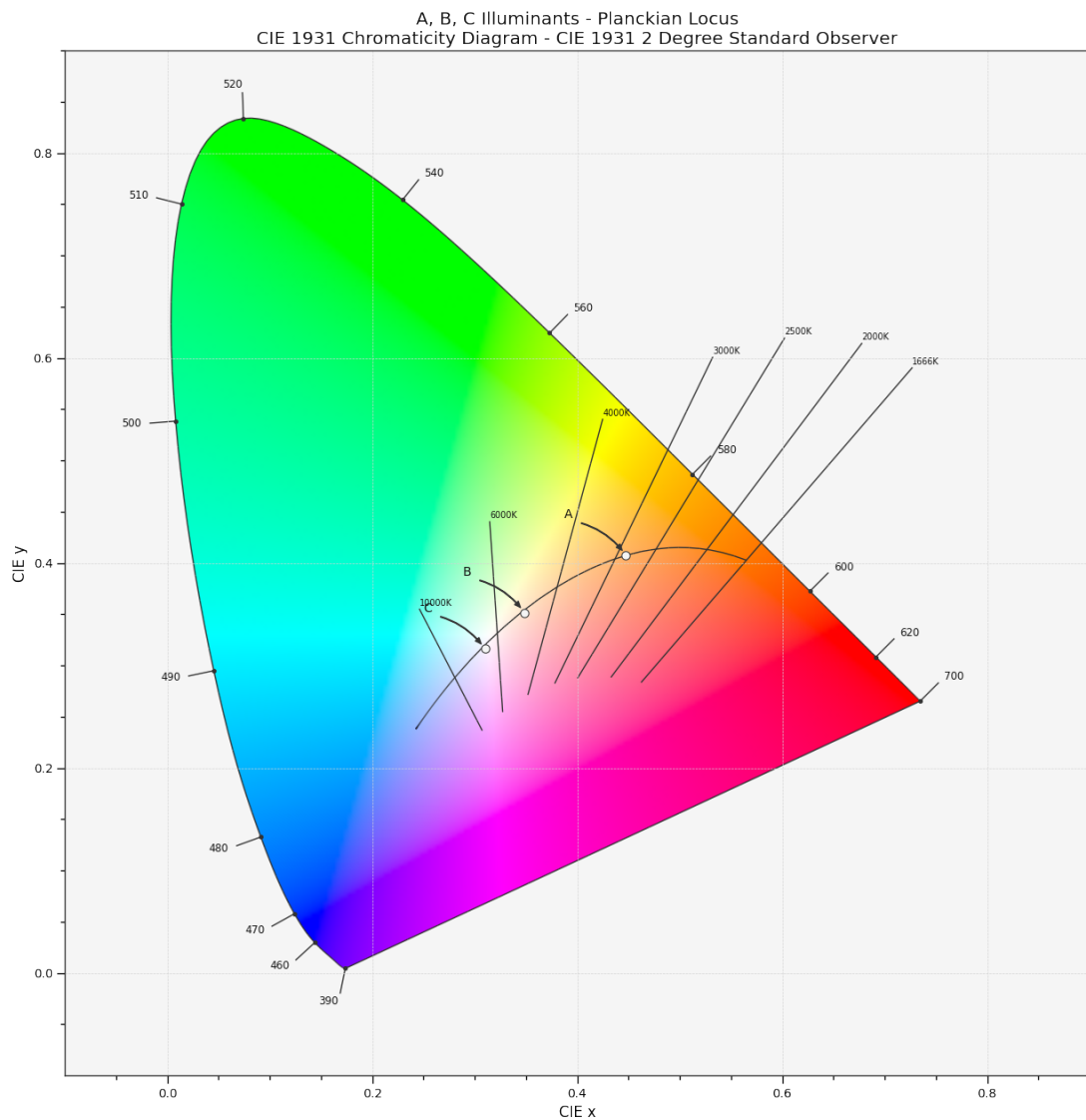
Current figure and axes.

Return type

`tuple`

Examples

```
>>> annotate_kwargs = [
...     {"xytext": (-25, 15), "arrowprops": {"arrowstyle": "-"},
...     {"arrowprops": {"arrowstyle": "-["}},
...     {}],
... ]
>>> plot_kwargs = [
...     {
...         "markersize": 15,
...     },
...     {"color": "r"},
...     {}],
... ]
>>> plot_planckian_locus_in_chromaticity_diagram(
...     ["A", "B", "C"],
...     annotate_kwargs=annotate_kwargs,
...     plot_kwargs=plot_kwargs,
... )
(<Figure size ... with 1 Axes>, <...AxesSubplot...>)
```



Colour Models Volume

colour.plotting

| | |
|---|---|
| <code>plot_RGB_colourspace_gamuts(colourspace[, ...])</code> | Plot given <i>RGB</i> colourspaces gamuts in given reference colourspace. |
| <code>plot_RGB_scatter(RGB[, colourspace, model, ...])</code> | Plot given <i>RGB</i> colourspace array in a scatter plot. |

colour.plotting.plot_RGB_colourspaces_gamuts

```
colour.plotting.plot_RGB_colourspaces_gamuts(colourspaces: RGB_Colourspace | str |
    Sequence[RGB_Colourspace | str], model:
    Literal['CAM02LCD', 'CAM02SCD', 'CAM02UCS',
    'CAM16LCD', 'CAM16SCD', 'CAM16UCS', 'CIE XYZ',
    'CIE xyY', 'CIE Lab', 'CIE Luv', 'CIE UCS', 'CIE UVW',
    'DIN99', 'Hunter Lab', 'Hunter Rdab', 'ICaCb', 'ICtCp',
    'IPT', 'IgPgTg', 'Jzazbz', 'OSA UCS', 'Oklab',
    'hdr-CIELAB', 'hdr-IPT'] | str = 'CIE xyY', segments:
    int = 8, show_grid: bool = True, grid_segments: int
    = 10, show_spectral_locus: bool = False,
    spectral_locus_colour: ArrayLike | str | None =
    None, cmfs: MultiSpectralDistributions | str |
    Sequence[MultiSpectralDistributions | str] = 'CIE
    1931 2 Degree Standard Observer',
    chromatically_adapt: bool = False, convert_kwargs:
    Dict | None = None, **kwargs: Any) →
    Tuple[Figure, Axes]
```

Plot given *RGB* colourspace gamuts in given reference colourspace.

Parameters

- **colourspaces** (*RGB_Colourspace* | *str* | *Sequence[RGB_Colourspace | str]*) – *RGB* colourspace to plot the gamuts. *colourspaces* elements can be of any type or form supported by the `colour.plotting.common.filter_RGB_colourspaces()` definition.
- **model** (*Literal['CAM02LCD', 'CAM02SCD', 'CAM02UCS', 'CAM16LCD', 'CAM16SCD', 'CAM16UCS', 'CIE XYZ', 'CIE xyY', 'CIE Lab', 'CIE Luv', 'CIE UCS', 'CIE UVW', 'DIN99', 'Hunter Lab', 'Hunter Rdab', 'ICaCb', 'ICtCp', 'IPT', 'IgPgTg', 'Jzazbz', 'OSA UCS', 'Oklab', 'hdr-CIELAB', 'hdr-IPT'] | str*) – Colourspace model, see `colour.COLOURSPACE_MODELS` attribute for the list of supported colourspace models.
- **segments** (*int*) – Edge segments count for each *RGB* colourspace cubes.
- **show_grid** (*bool*) – Whether to show a grid at the bottom of the *RGB* colourspace cubes.
- **grid_segments** (*int*) – Edge segments count for the grid.
- **show_spectral_locus** (*bool*) – Whether to show the spectral locus.
- **spectral_locus_colour** (*ArrayLike | str | None*) – Spectral locus colour.
- **cmfs** (*MultiSpectralDistributions | str | Sequence[MultiSpectralDistributions | str]*) – Standard observer colour matching functions used for computing the spectral locus boundaries. *cmfs* can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
- **chromatically_adapt** (*bool*) – Whether to chromatically adapt the *RGB* colourspace given in *colourspaces* to the whitepoint of the default plotting colourspace.
- **convert_kwargs** (*Dict | None*) – Keyword arguments for the `colour.convert()` definition.
- **edge_colours** – Edge colours array such as `edge_colours = (None, (0.5, 0.5, 1.0))`.
- **edge_alpha** – Edge opacity value such as `edge_alpha = (0.0, 1.0)`.

- **face_alpha** – Face opacity value such as *face_alpha = (0.5, 1.0)*.
- **face_colours** – Face colours array such as *face_colours = (None, (0.5, 0.5, 1.0))*.
- **kwargs** (*Any*) – {`colour.plotting.artist()`, `colour.plotting.volume.nadir_grid()`}, See the documentation of the previously listed definitions.

Returns

Current figure and axes.

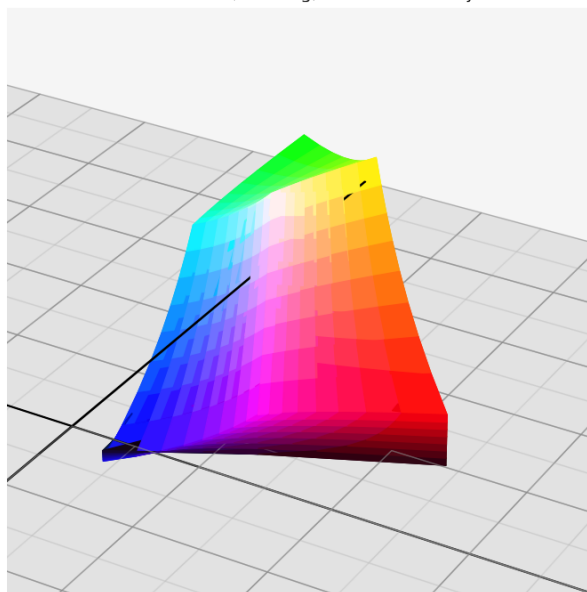
Return type

`tuple`

Examples

```
>>> plot_RGB_colourspace_gamuts(["ITU-R BT.709", "ACEScg", "S-Gamut"])
...
(<Figure size ... with 1 Axes>, <...Axes3DSubplot...>)
```

ITU-R BT.709, ACEScg, S-Gamut - CIE xyY

**colour.plotting.plot_RGB_scatter**

```
colour.plotting.plot_RGB_scatter(RGB: ArrayLike, colourspace: RGB_Colourspace | str |
    Sequence[RGB_Colourspace | str] = 'sRGB', model:
    Literal['CAM02LCD', 'CAM02SCD', 'CAM02UCS', 'CAM16LCD',
    'CAM16SCD', 'CAM16UCS', 'CIE XYZ', 'CIE xyY', 'CIE Lab', 'CIE Luv',
    'CIE UCS', 'CIE UVW', 'DIN99', 'Hunter Lab', 'Hunter Rdab', 'ICaCb',
    'ICtCp', 'IPT', 'IgPgTg', 'Jzazbz', 'OSA UCS', 'Oklab', 'hdr-CIELAB',
    'hdr-IPT'] | str = 'CIE xyY', colourspaces: RGB_Colourspace | str |
    Sequence[RGB_Colourspace | str] | None = None, segments: int =
    8, show_grid: bool = True, grid_segments: int = 10,
    show_spectral_locus: bool = False, spectral_locus_colour: ArrayLike
    | str | None = None, points_size: float = 12, cmfs:
    MultiSpectralDistributions | str |
    Sequence[MultiSpectralDistributions | str] = 'CIE 1931 2 Degree
    Standard Observer', chromatically_adapt: bool = False,
    convert_kwargs: Dict | None = None, **kwargs: Any) →
    Tuple[Figure, Axes]
```


Plot given *RGB* colourspace array in a scatter plot.

Parameters

- **RGB** (`ArrayLike`) – *RGB* colourspace array.
- **colourspace** (`RGB_Colourspace` | `str` | `Sequence[RGB_Colourspace | str]`) – *RGB* colourspace of the *RGB* array. colourspace can be of any type or form supported by the `colour.plotting.common.filter_RGB_colourspaces()` definition.
- **model** (`Literal['CAM02LCD', 'CAM02SCD', 'CAM02UCS', 'CAM16LCD', 'CAM16SCD', 'CAM16UCS', 'CIE XYZ', 'CIE xyY', 'CIE Lab', 'CIE Luv', 'CIE UCS', 'CIE UVW', 'DIN99', 'Hunter Lab', 'Hunter Rdab', 'ICaCb', 'ICtCp', 'IPT', 'IgPgTg', 'Jzazbz', 'OSA UCS', 'Oklab', 'hdr-CIELAB', 'hdr-IPT']` | `str`) – Colourspace model, see `colour.COLOURSPACE_MODELS` attribute for the list of supported colourspace models.
- **colourspace**s (`RGB_Colourspace` | `str` | `Sequence[RGB_Colourspace | str]` | `None`) – *RGB* colourspaces to plot the gamuts. colourspace elements can be of any type or form supported by the `colour.plotting.common.filter_RGB_colourspaces()` definition.
- **segments** (`int`) – Edge segments count for each *RGB* colourspace cubes.
- **show_grid** (`bool`) – Whether to show a grid at the bottom of the *RGB* colourspace cubes.
- **grid_segments** (`int`) – Edge segments count for the grid.
- **show_spectral_locus** (`bool`) – Whether to show the spectral locus.
- **spectral_locus_colour** (`ArrayLike` | `str` | `None`) – Spectral locus colour.
- **points_size** (`float`) – Scatter points size.
- **cmfs** (`MultiSpectralDistributions` | `str` | `Sequence[MultiSpectralDistributions | str]`) – Standard observer colour matching functions used for computing the spectral locus boundaries. cmfs can be of any type or form supported by the `colour.plotting.common.filter_cmfs()` definition.
- **chromatically_adapt** (`bool`) – Whether to chromatically adapt the *RGB* colourspaces given in colourspaces to the whitepoint of the default plotting colourspace.
- **convert_kwargs** (`Dict` | `None`) – Keyword arguments for the `colour.convert()` definition.
- **kwargs** (`Any`) – `{colour.plotting.artist(), colour.plotting.plot_RGB_colourspace_gamuts()}`, See the documentation of the previously listed definitions.

Returns

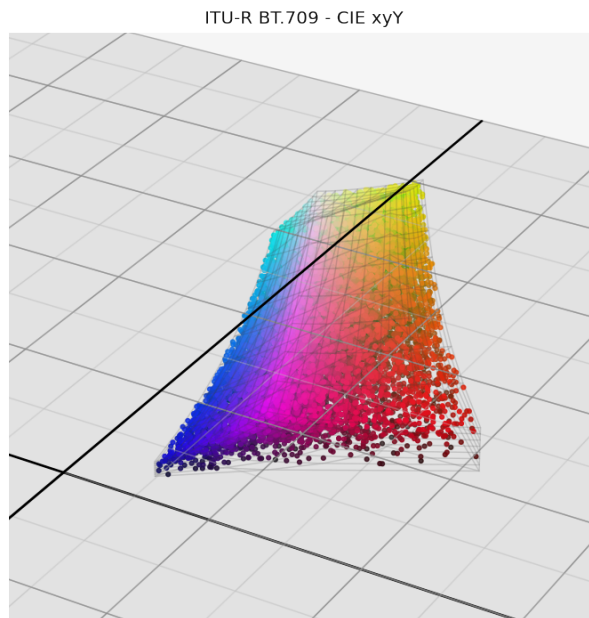
Current figure and axes.

Return type

`tuple`

Examples

```
>>> RGB = np.random.random((128, 128, 3))
>>> plot_RGB_scatter(RGB, "ITU-R BT.709")
(<Figure size ... with 1 Axes>, <...Axes3DSubplot...>)
```



ANSI/IES TM-30-18 Colour Rendition Report

colour.plotting

| | |
|--|--|
| <code>plot_single_sd_colour_rendition_report(sd[, ...])</code> | Generate the <i>ANSI/IES TM-30-18 Colour Rendition Report</i> for given spectral distribution according to given method. |
|--|--|

colour.plotting.plot_single_sd_colour_rendition_report

colour.plotting.plot_single_sd_colour_rendition_report(sd: [SpectralDistribution](#), method: [Literal\['Full', 'Intermediate', 'Simple'\]](#) | str = 'Full', **kwargs: Any) → [Tuple\[Figure, Axes\]](#)

Generate the *ANSI/IES TM-30-18 Colour Rendition Report* for given spectral distribution according to given method.

Parameters

- **sd** ([SpectralDistribution](#)) – Spectral distribution of the emission source to generate the report for.
- **method** ([Literal\['Full', 'Intermediate', 'Simple'\]](#) | str) – Report plotting method.
- **kwargs** (Any) – {colour.plotting.artist(), colour.plotting.render(), colour.plotting.tm3018.plot_single_sd_colour_rendition_report_full(), colour.plotting.tm3018.plot_single_sd_colour_rendition_report_intermediate(),

```
colour.plotting.tm3018.plot_single_sd_colour_rendition_report_simple()}
```

See the documentation of the previously listed definitions.

Returns

Current figure and axes.

Return type

`tuple`

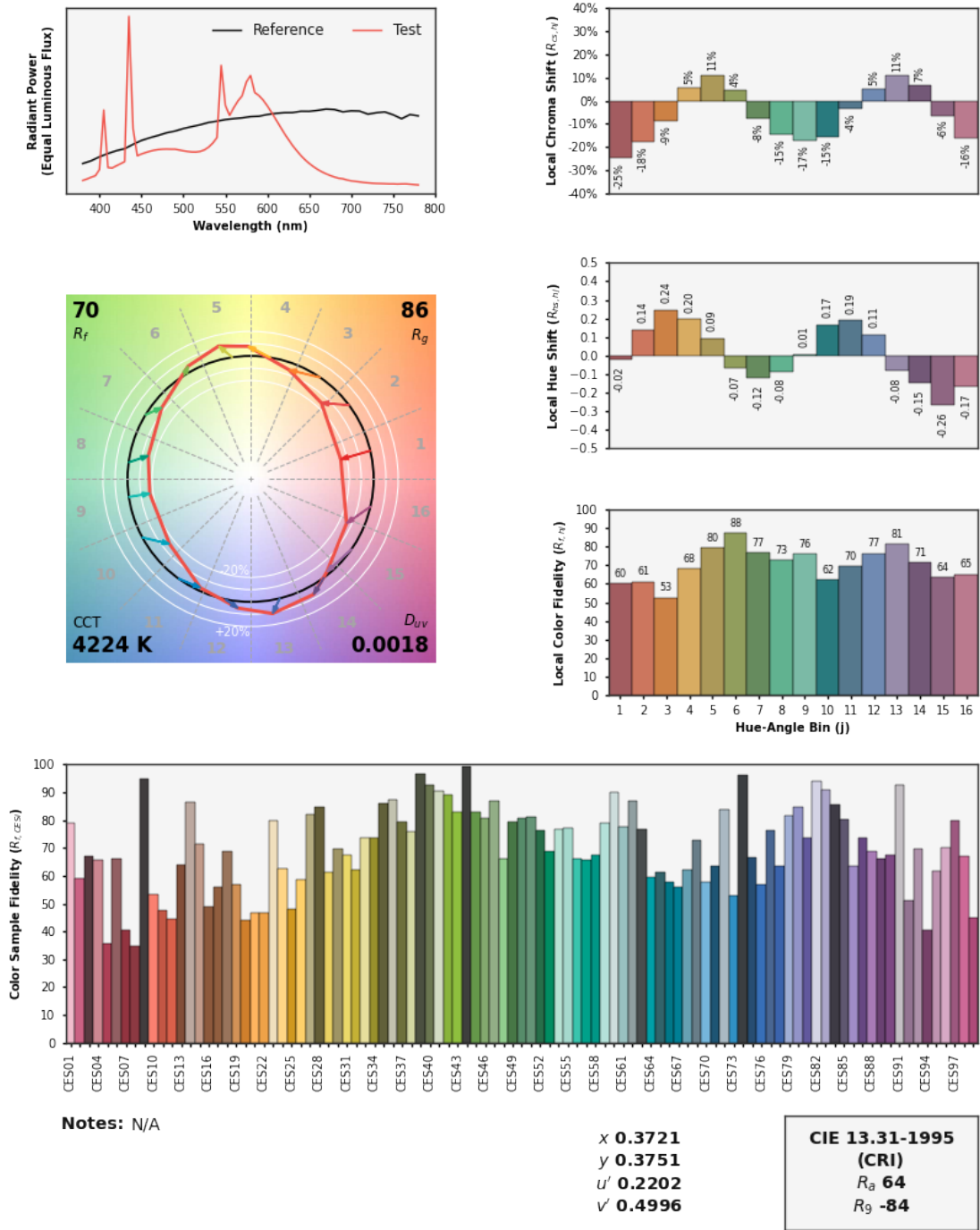
Examples

```
>>> from colour import SDS_ILLUMINANTS
>>> sd = SDS_ILLUMINANTS["FL2"]
>>> plot_single_sd_colour_rendition_report(sd)
...
(<Figure size ... with ... Axes>, <...AxesSubplot...>)
```

IES TM-30-18 Colour Rendition Report

Source: FL2
Date: N/A

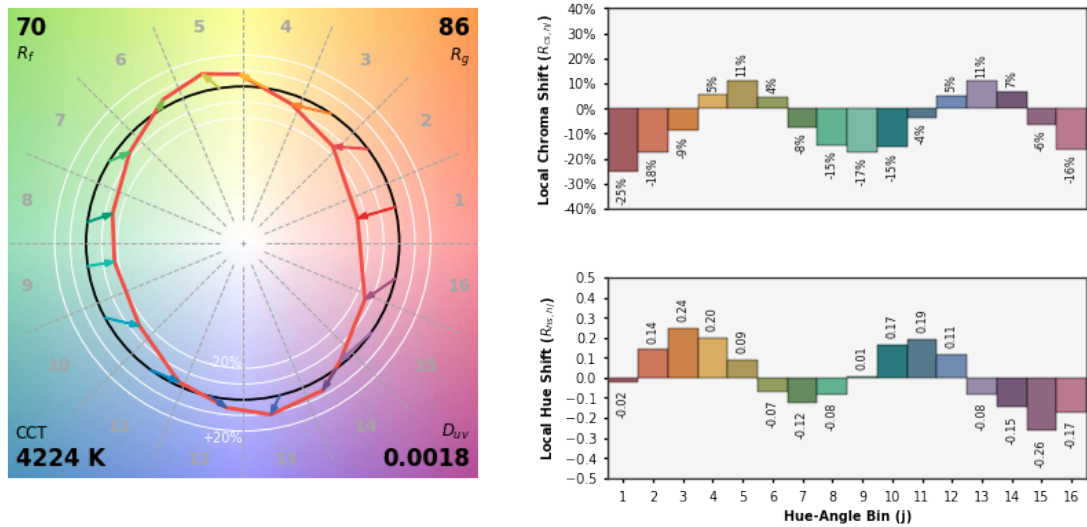
Manufacturer: N/A
Model: N/A



Colours are for visual orientation purposes only. Created with Colour v0.4.2-1-g2e84c889.

```
>>> plot_single_sd_colour_rendition_report(sd, "Intermediate")
...
(<Figure size ... with ... Axes>, <...AxesSubplot...>)
```

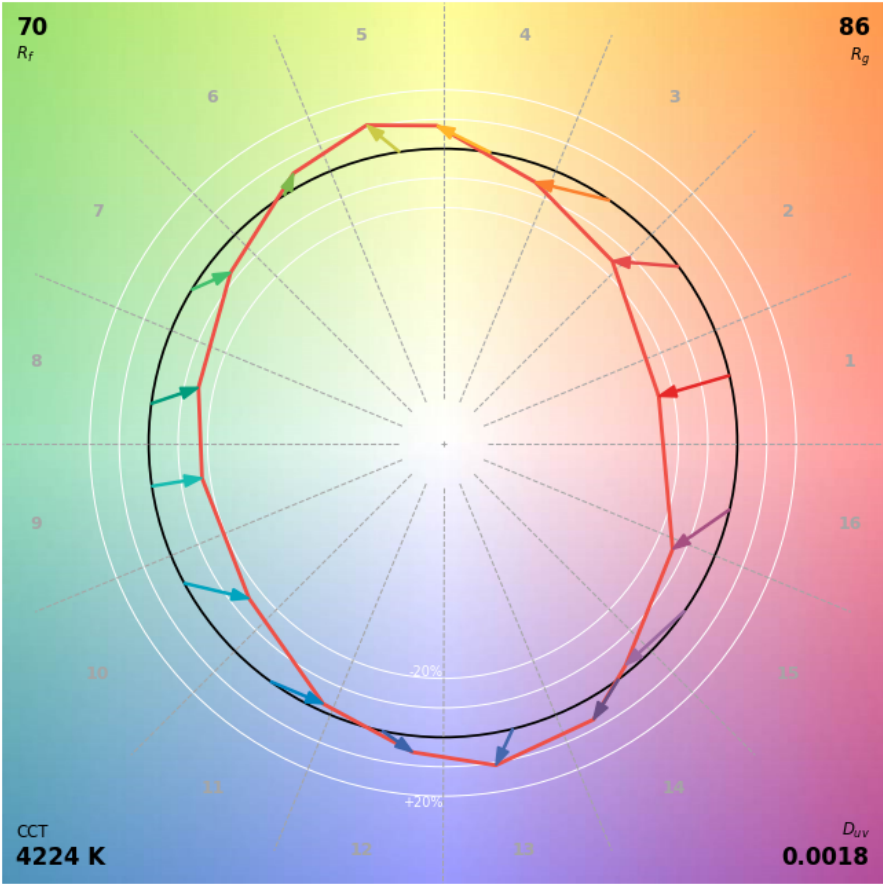
IES TM-30-18 Colour Rendition Report



Colours are for visual orientation purposes only. Created with Colour v0.4.2-1-g2e84c889.

```
>>> plot_single_sd_colour_rendition_report(sd, "Simple")
...
(<Figure size ... with ... Axes>, <...AxesSubplot...>)
```

IES TM-30-18 Colour Rendition Report



Colours are for visual orientation purposes only. Created with Colour v0.4.2-1-g2e84c889.

Ancillary Objects

colour.plotting.tm3018

| | |
|---|---|
| <code>plot_single_sd_colour_rendition_report_full(</code> | Generate the full <i>ANSI/IES TM-30-18 Colour Rendition Report</i> for given spectral distribution. |
| <code>plot_single_sd_colour_rendition_report_inter</code> | Generate the intermediate <i>ANSI/IES TM-30-18 Colour Rendition Report</i> for given spectral distribution. |
| <code>plot_single_sd_colour_rendition_report_simpl</code> | Generate the simple <i>ANSI/IES TM-30-18 Colour Rendition Report</i> for given spectral distribution. |

`colour.plotting.tm3018.plot_single_sd_colour_rendition_report_full`

```
colour.plotting.tm3018.plot_single_sd_colour_rendition_report_full(sd: SpectralDistribution,
                                                                    source: str | None = None,
                                                                    date: str | None = None,
                                                                    manufacturer: str | None
                                                                    = None, model: str | None
                                                                    = None, notes: str | None
                                                                    = None, report_size: Tuple
                                                                    = CON-
                                                                    STANT_REPORT_SIZE_FULL,
                                                                    report_row_height_ratios:
                                                                    Tuple = CON-
                                                                    STANT_REPORT_ROW_HEIGHT_RATIOS_FU
                                                                    report_box_padding: Dict |
                                                                    None = None, **kwargs:
                                                                    Any) → Tuple[Figure,
                                                                    Axes]
```

Generate the full ANSI/IES TM-30-18 Colour Rendition Report for given spectral distribution.

Parameters

- **sd** (`SpectralDistribution`) – Spectral distribution of the emission source to generate the report for.
- **source** (`str` | `None`) – Emission source name, defaults to `colour.SpectralDistribution_IESTM2714.header.description` or `colour.SpectralDistribution_IESTM2714.name` properties value.
- **date** (`str` | `None`) – Emission source measurement date, defaults to `colour.SpectralDistribution_IESTM2714.header.report_date` property value.
- **manufacturer** (`str` | `None`) – Emission source manufacturer, defaults to `colour.SpectralDistribution_IESTM2714.header.manufacturer` property value.
- **model** (`str` | `None`) – Emission source model, defaults to `colour.SpectralDistribution_IESTM2714.header.catalog_number` property value.
- **notes** (`str` | `None`) – Notes pertaining to the emission source, defaults to `colour.SpectralDistribution_IESTM2714.header.comments` property value.
- **report_size** (`Tuple`) – Report size, default to A4 paper size in inches.
- **report_row_height_ratios** (`Tuple`) – Report size row height ratios.
- **report_box_padding** (`Dict` | `None`) – Report box padding, tries to define the padding around the figure and in-between the axes.
- **kwargs** (`Any`) – {`colour.plotting.artist()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

Current figure and axes.

Return type

`tuple`

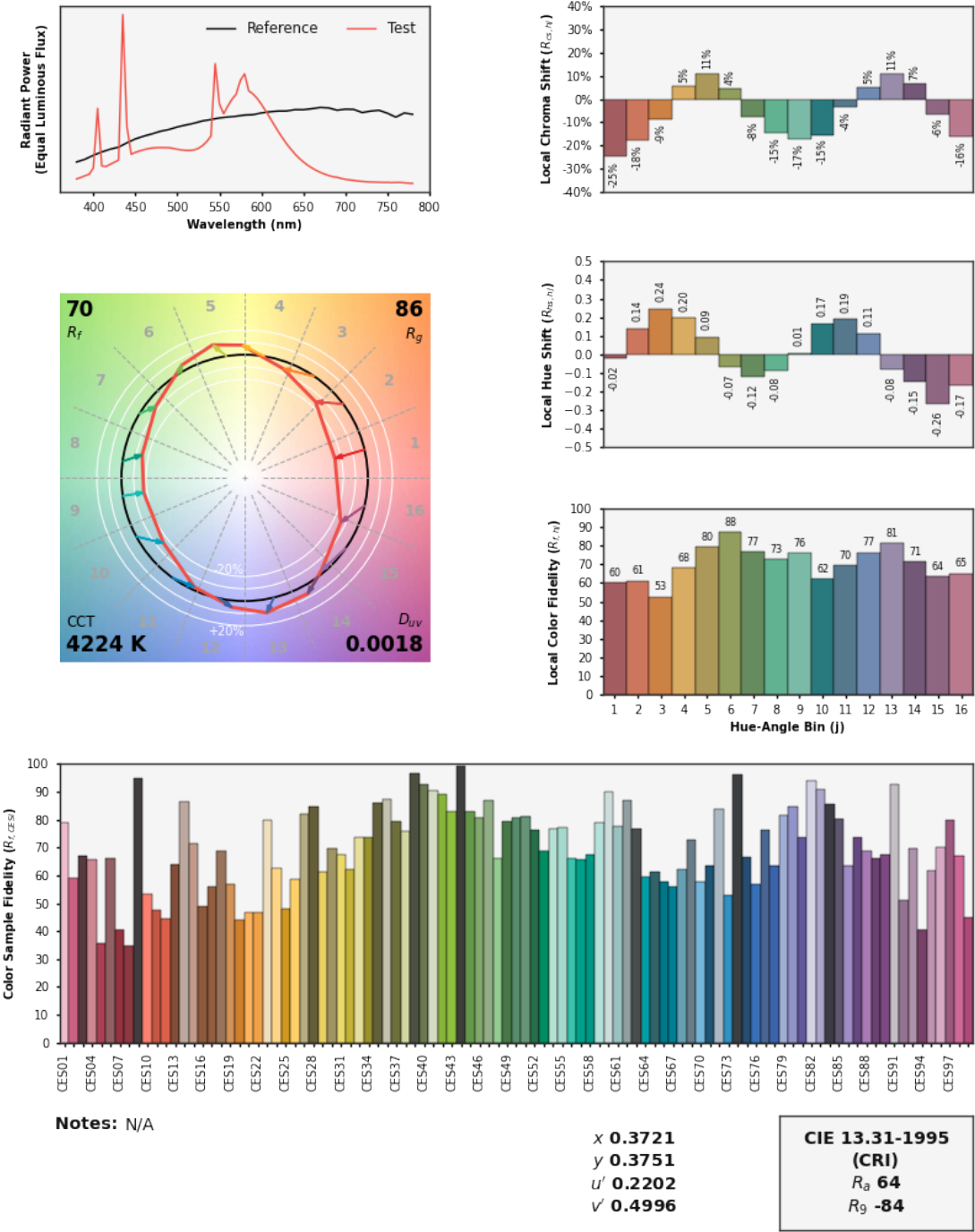
Examples

```
>>> from colour import SDS_ILLUMINANTS
>>> sd = SDS_ILLUMINANTS["FL2"]
>>> plot_single_sd_colour_rendition_report_full(sd)
...
(<Figure size ... with ... Axes>, <...AxesSubplot...>)
```


IES TM-30-18 Colour Rendition Report

Source: FL2
Date: N/A

Manufacturer: N/A
Model: N/A



Colours are for visual orientation purposes only. Created with Colour v0.4.2-1-g2e84c889.

colour.plotting.tm3018.plot_single_sd_colour_rendition_report_intermediate

```
colour.plotting.tm3018.plot_single_sd_colour_rendition_report_intermediate(sd: SpectralDistri-  
bution,  
report_size: Tuple  
= CON-  
STANT_REPORT_SIZE_INTERMEDIAL,  
re-  
port_row_height_ratios:  
Tuple = CON-  
STANT_REPORT_ROW_HEIGHT_RATIO,  
re-  
port_box_padding:  
Dict | None =  
None, **kwargs:  
Any) →  
Tuple[Figure,  
Axes]
```

Generate the intermediate *ANSI/IES TM-30-18 Colour Rendition Report* for given spectral distribution.

Parameters

- **sd** (`SpectralDistribution`) – Spectral distribution of the emission source to generate the report for.
- **report_size** (`Tuple`) – Report size, default to A4 paper size in inches.
- **report_row_height_ratios** (`Tuple`) – Report size row height ratios.
- **report_box_padding** (`Dict | None`) – Report box padding, tries to define the padding around the figure and in-between the axes.
- **kwargs** (`Any`) – {`colour.plotting.artist()`, `colour.plotting.render()`}, See the documentation of the previously listed definitions.

Returns

Current figure and axes.

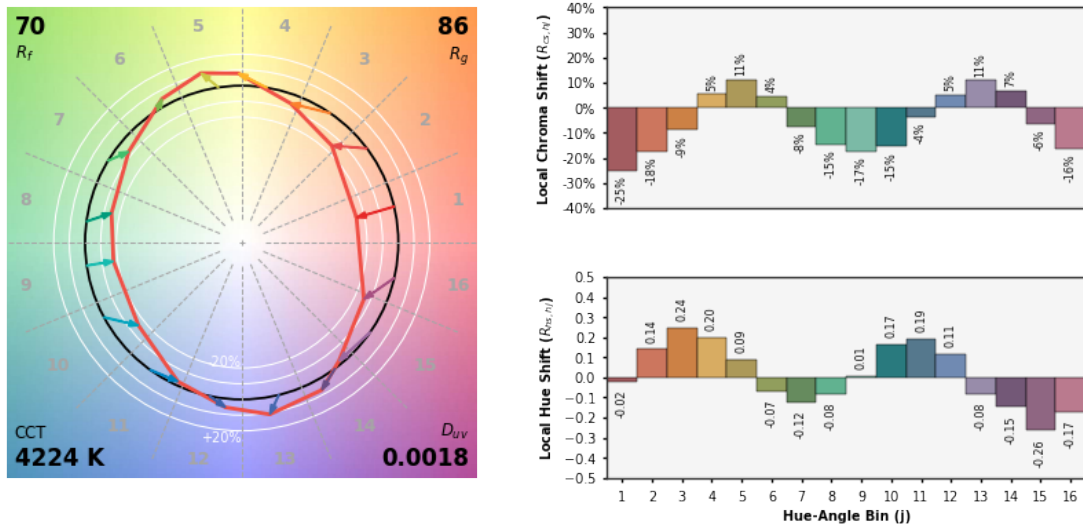
Return type

`tuple`

Examples

```
>>> from colour import SDS_ILLUMINANTS
>>> sd = SDS_ILLUMINANTS["FL2"]
>>> plot_single_sd_colour_rendition_report_intermediate(sd)
...
(<Figure size ... with ... Axes>, <...AxesSubplot...>)
```

IES TM-30-18 Colour Rendition Report



Colours are for visual orientation purposes only. Created with Colour v0.4.2-1-g2e84c889.

colour.plotting.tm3018.plot_single_sd_colour_rendition_report_simple

```
colour.plotting.tm3018.plot_single_sd_colour_rendition_report_simple(sd: SpectralDistribution,
    report_size: Tuple = CON-
    STANT_REPORT_SIZE_SIMPLE,
    re-
    port_row_height_ratios:
    Tuple = CON-
    STANT_REPORT_ROW_HEIGHT_RATIOS,
    report_box_padding:
    Dict | None = None,
    **kwargs: Any) →
    Tuple[Figure, Axes]
```

Generate the simple ANSI/IES TM-30-18 Colour Rendition Report for given spectral distribution.

Parameters

- sd** (*SpectralDistribution*) – Spectral distribution of the emission source to generate the report for.
- report_size** (*Tuple*) – Report size, default to A4 paper size in inches.
- report_row_height_ratios** (*Tuple*) – Report size row height ratios.
- report_box_padding** (*Dict* | *None*) – Report box padding, tries to define the padding around the figure and in-between the axes.

- **kwargs** (Any) – {colour.plotting.artist(), colour.plotting.render()}, See the documentation of the previously listed definitions.

Returns

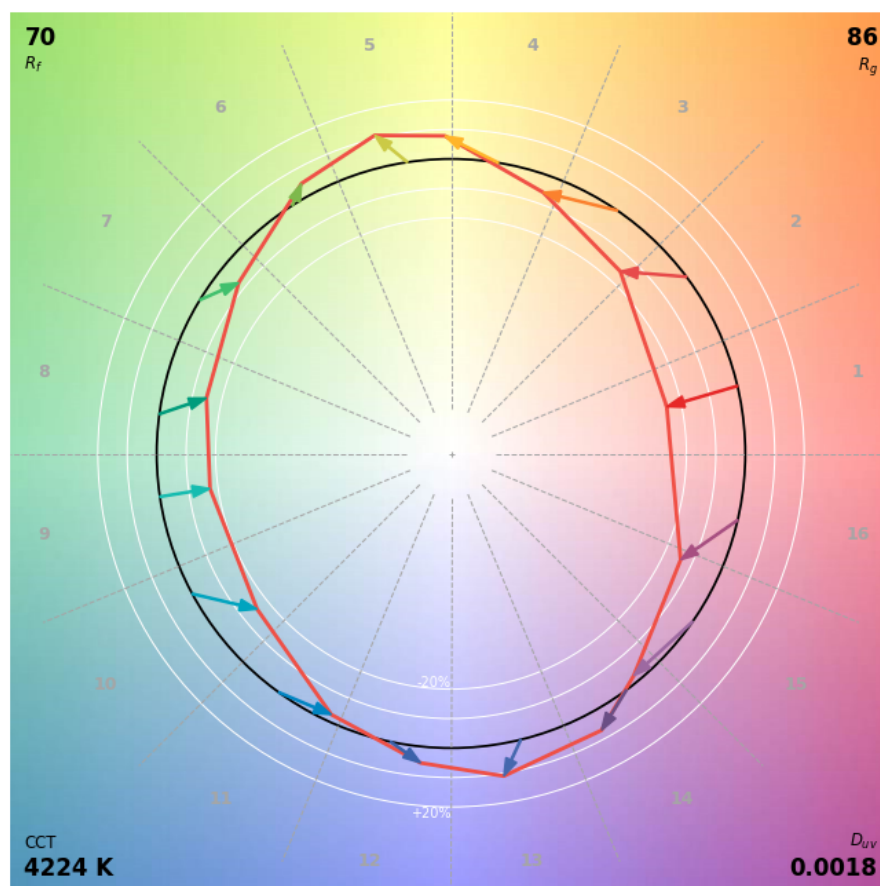
Current figure and axes.

Return type

tuple

Examples

```
>>> from colour import SDS_ILLUMINANTS
>>> sd = SDS_ILLUMINANTS["FL2"]
>>> plot_single_sd_colour_rendition_report_simple(sd)
...
(<Figure size ... with ... Axes>, <...AxesSubplot...>)
```

IES TM-30-18 Colour Rendition Report

Colours are for visual orientation purposes only. Created with Colour v0.4.2-1-g2e84c889.

Automatic Colour Conversion Graph

colour.plotting

```
plot_automatic_colour_conversion_graph(filename: str, prog: Literal['circo', 'dot', 'fdp', 'neato', 'nop', 'twopi'] | str = 'fdp', args: str = "") → AGraph
```

Plot *Colour* automatic colour conversion graph using *Graphviz* and *pygraphviz*.

colour.plotting.plot_automatic_colour_conversion_graph

colour.plotting.plot_automatic_colour_conversion_graph(filename: *str*, prog: *Literal*['circo', 'dot', 'fdp', 'neato', 'nop', 'twopi'] | *str* = 'fdp', args: *str* = "") → *AGraph*

Plot *Colour* automatic colour conversion graph using *Graphviz* and *pygraphviz*.

Parameters

- **filename** (*str*) – Filename to use to save the image.
- **prog** (*Union*[*Literal*['circo', 'dot', 'fdp', 'neato', 'nop', 'twopi'], *str*]) – *Graphviz* layout method.
- **args** (*str*) – Additional arguments for *Graphviz*.

Returns

Pygraphviz graph.

Return type

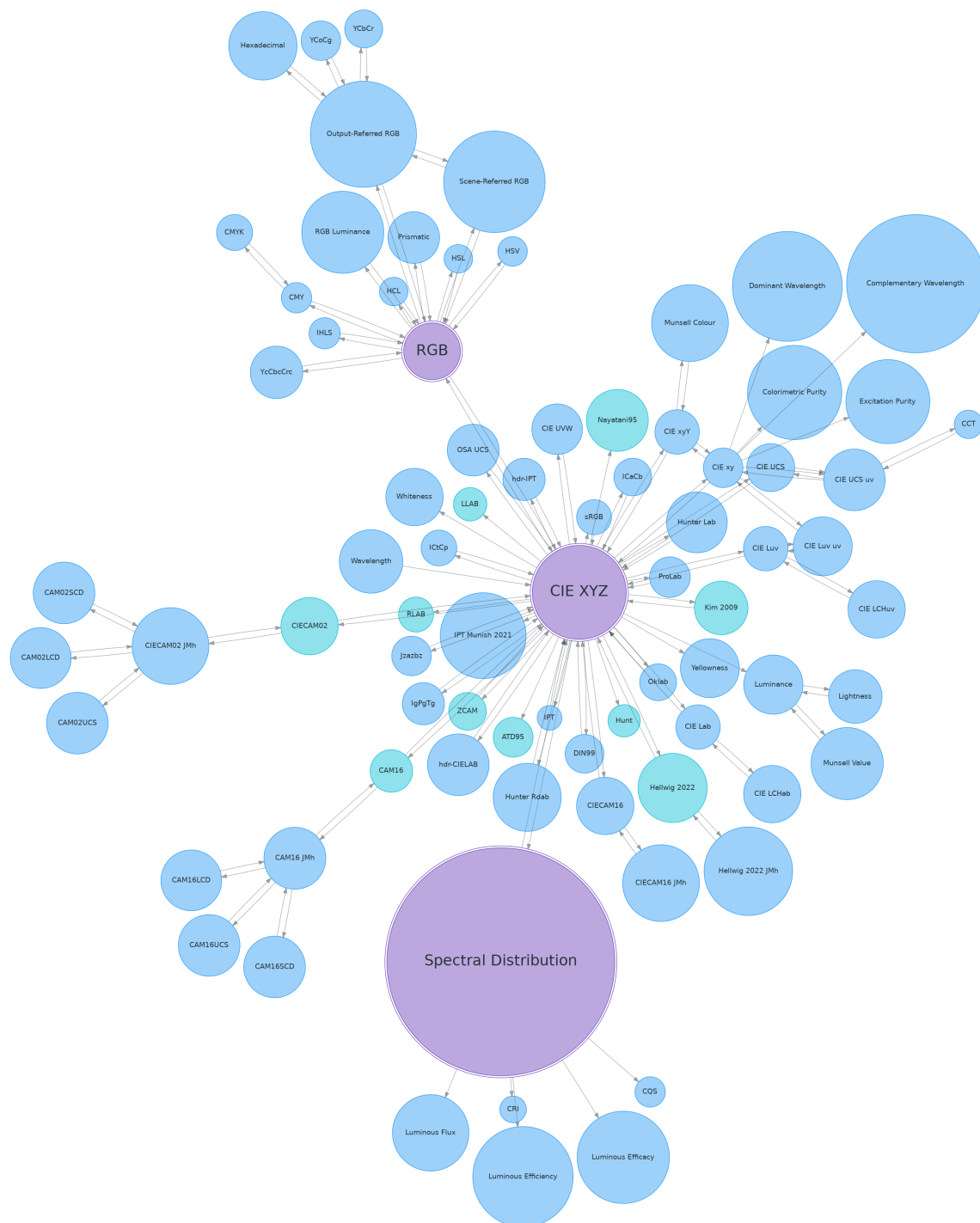
AGraph

Notes

- This definition does not directly plot the *Colour* automatic colour conversion graph but instead write it to an image.

Examples

```
>>> import tempfile
>>> import colour
>>> from colour import read_image
>>> from colour.plotting import plot_image
>>> filename = "{0}.png".format(tempfile.mkstemp()[-1])
>>> _ = plot_automatic_colour_conversion_graph(filename, "dot")
...
>>> plot_image(read_image(filename))
```



Colour Quality

Colour Fidelity Index

colour

| | |
|---------------------------------------|--|
| COLOUR_FIDELITY_INDEX_METHODS | Supported <i>Colour Fidelity Index</i> (CFI) computation methods. |
| colour_fidelity_index(sd_test[, ...]) | Return the <i>Colour Fidelity Index</i> (CFI) R_f of given spectral distribution using given method. |

colour.COLOUR_FIDELITY_INDEX_METHODS

```
colour.COLOUR_FIDELITY_INDEX_METHODS = CanonicalMapping({'CIE 2017': ..., 'ANSI/IES
TM-30-18': ...})
```

Supported *Colour Fidelity Index* (CFI) computation methods.

References

[CIET19017], [ANSIIESCCommittee18]

colour.colour_fidelity_index

```
colour.colour_fidelity_index(sd_test: SpectralDistribution, additional_data=False, method:
    Literal['CIE 2017', 'ANSI/IES TM-30-18'] | str = 'CIE 2017') → float |
    ColourRendering_Specification_CIE2017 |
    ColourQuality_Specification_ANSIESTM3018
```

Return the *Colour Fidelity Index* (CFI) R_f of given spectral distribution using given method.

Parameters

- **sd_test** (*SpectralDistribution*) – Test spectral distribution.
- **additional_data** – Whether to output additional data.
- **method** (*Literal*['CIE 2017', 'ANSI/IES TM-30-18'] | str) – Computation method.

Returns

Colour Fidelity Index (CFI) R_f .

Return type

numpy.floating or *colour.quality.ColourRendering_Specification_CIE2017* or *colour.quality.ColourQuality_Specification_ANSIESTM3018*

References

[CIET19017], [ANSIIESCCommittee18]

Examples

```
>>> from colour.colorimetry import SDS_ILLUMINANTS
>>> sd = SDS_ILLUMINANTS["FL2"]
>>> colour_fidelity_index(sd)
70.1208254...
```

colour.quality

| | |
|--|---|
| <i>ColourRendering_Specification_CIE2017</i> (name, ...) | Define the <i>CIE 2017 Colour Fidelity Index</i> (CFI) colour quality specification. |
| <i>colour_fidelity_index_CIE2017</i> (sd_test[, ...]) | Return the <i>CIE 2017 Colour Fidelity Index</i> (CFI) R_f of given spectral distribution. |
| <i>ColourQuality_Specification_ANSIESTM3018</i> (...) | Define the <i>ANSI/IES TM-30-18 Colour Fidelity Index</i> (CFI) colour quality specification. |
| <i>colour_fidelity_index_ANSIESTM3018</i> (sd_test) | Return the <i>ANSI/IES TM-30-18 Colour Fidelity Index</i> (CFI) R_f of given spectral distribution. |

colour.quality.ColourRendering_Specification_CIE2017

```
class colour.quality.ColourRendering_Specification_CIE2017(name: str, sd_reference:
    SpectralDistribution, R_f: float, R_s:
    ndarray, CCT: float, D_uv: float,
    colorimetry_data: Tu-
    ple[Tuple[DataColorimetry_TCS_CIE2017,
    ...], Tu-
    ple[DataColorimetry_TCS_CIE2017,
    ...]], delta_E_s: ndarray)
```

Define the *CIE 2017 Colour Fidelity Index* (CFI) colour quality specification.

Parameters

- **name** (str) – Name of the test spectral distribution.
- **sd_reference** (colour.colorimetry.spectrum.SpectralDistribution) – Spectral distribution of the reference illuminant.
- **R_f** (float) – *CIE 2017 Colour Fidelity Index* (CFI) R_f .
- **R_s** (numpy.ndarray) – Individual *colour fidelity indexes* data for each sample.
- **CCT** (float) – Correlated colour temperature T_{cp} .
- **D_uv** (float) – Distance from the Planckian locus Δ_{uv} .
- **colorimetry_data** (Tuple[Tuple[colour.quality.cfi2017.DataColorimetry_TCS_CIE2017, ...], Tuple[colour.quality.cfi2017.DataColorimetry_TCS_CIE2017, ...]]) – Colorimetry data for the test and reference computations.
- **delta_E_s** (numpy.ndarray) – Colour shifts of samples.

```
__init__(name: str, sd_reference: SpectralDistribution, R_f: float, R_s: ndarray, CCT: float, D_uv:
    float, colorimetry_data: Tuple[Tuple[DataColorimetry_TCS_CIE2017, ...],
    Tuple[DataColorimetry_TCS_CIE2017, ...]], delta_E_s: ndarray) → None
```

Parameters

- **name** (str) –
- **sd_reference** (SpectralDistribution) –
- **R_f** (float) –
- **R_s** (ndarray) –
- **CCT** (float) –
- **D_uv** (float) –
- **colorimetry_data** (Tuple[Tuple[DataColorimetry_TCS_CIE2017, ...], Tuple[DataColorimetry_TCS_CIE2017, ...]]) –
- **delta_E_s** (ndarray) –

Return type

None

Methods

```
__init__(name, sd_reference, R_f, R_s, CCT,
...)
```

Attributes

name

sd_reference

R_f

R_s

CCT

D_uv

colorimetry_data

delta_E_s

colour.quality.colour_fidelity_index_CIE2017

`colour.quality.colour_fidelity_index_CIE2017(sd_test: SpectralDistribution, additional_data: bool = False) → float | ColourRendering_Specification_CIE2017`

Return the *CIE 2017 Colour Fidelity Index* (CFI) R_f of given spectral distribution.

Parameters

- **sd_test** (*SpectralDistribution*) – Test spectral distribution.
- **additional_data** (*bool*) – Whether to output additional data.

Returns

CIE 2017 Colour Fidelity Index (CFI) R_f .

Return type

`numpy.floating` or `colour.quality.ColourRendering_Specification_CIE2017`

References

[CIET19017]

Examples

```
>>> from colour.colorimetry import SDS_ILLUMINANTS
>>> sd = SDS_ILLUMINANTS["FL2"]
>>> colour_fidelity_index_CIE2017(sd)
70.1208254...
```

colour.quality.ColourQuality_Specification_ANSIESTM3018

```
class colour.quality.ColourQuality_Specification_ANSIESTM3018(name: str, sd_test:
    SpectralDistribution,
    sd_reference:
    SpectralDistribution, R_f: float,
    R_s: ndarray, CCT: float, D_uv:
    float, colorimetry_data: Tu-
    ple[Tuple[DataColorimetry_TCS_CIE2017,
    ...], Tu-
    ple[DataColorimetry_TCS_CIE2017,
    ...]], R_g: float, bins:
    List[List[int]], averages_test:
    ndarray, averages_reference:
    ndarray, average_norms:
    ndarray, R_fs: ndarray, R_cs:
    ndarray, R_hs: ndarray)
```

Define the *ANSI/IES TM-30-18 Colour Fidelity Index* (CFI) colour quality specification.

Parameters

- **name** (str) – Name of the test spectral distribution.
- **sd_test** (colour.colorimetry.spectrum.SpectralDistribution) – Spectral distribution of the tested illuminant.
- **sd_reference** (colour.colorimetry.spectrum.SpectralDistribution) – Spectral distribution of the reference illuminant.
- **R_f** (float) – *Colour Fidelity Index* (CFI) R_f .
- **R_s** (numpy.ndarray) – Individual *colour fidelity indexes* data for each sample.
- **CCT** (float) – Correlated colour temperature T_{cp} .
- **D_uv** (float) – Distance from the Planckian locus Δ_{uv} .
- **colorimetry_data** (Tuple[Tuple[colour.quality.cfi2017.DataColorimetry_TCS_CIE2017, ...], Tuple[colour.quality.cfi2017.DataColorimetry_TCS_CIE2017, ...]]) – Colorimetry data for the test and reference computations.
- **R_g** (float) – Gamut index R_g .
- **bins** (List[List[int]]) – List of 16 lists, each containing the indexes of colour samples that lie in the respective hue bin.
- **averages_test** (numpy.ndarray) – Averages of *CAM02-UCS* a' , b' coordinates for each hue bin for test samples.
- **averages_reference** (numpy.ndarray) – Averages for reference samples.
- **average_norms** (numpy.ndarray) – Distance of averages for reference samples from the origin.
- **R_fs** (numpy.ndarray) – Local colour fidelities for each hue bin.

- **R_cs** (`numpy.ndarray`) – Local chromaticity shifts for each hue bin, in percents.
- **R_hs** (`numpy.ndarray`) – Local hue shifts for each hue bin.

__init__(*name*: `str`, *sd_test*: `SpectralDistribution`, *sd_reference*: `SpectralDistribution`, *R_f*: `float`, *R_s*: `ndarray`, *CCT*: `float`, *D_uv*: `float`, *colorimetry_data*: `Tuple[Tuple[DataColorimetry_TCS_CIE2017, ...], Tuple[DataColorimetry_TCS_CIE2017, ...]]`, *R_g*: `float`, *bins*: `List[List[int]]`, *averages_test*: `ndarray`, *averages_reference*: `ndarray`, *average_norms*: `ndarray`, *R_fs*: `ndarray`, *R_cs*: `ndarray`, *R_hs*: `ndarray`) → `None`

Parameters

- **name** (`str`) –
- **sd_test** (`SpectralDistribution`) –
- **sd_reference** (`SpectralDistribution`) –
- **R_f** (`float`) –
- **R_s** (`ndarray`) –
- **CCT** (`float`) –
- **D_uv** (`float`) –
- **colorimetry_data** (`Tuple[Tuple[DataColorimetry_TCS_CIE2017, ...], Tuple[DataColorimetry_TCS_CIE2017, ...]]`) –
- **R_g** (`float`) –
- **bins** (`List[List[int]]`) –
- **averages_test** (`ndarray`) –
- **averages_reference** (`ndarray`) –
- **average_norms** (`ndarray`) –
- **R_fs** (`ndarray`) –
- **R_cs** (`ndarray`) –
- **R_hs** (`ndarray`) –

Return type

`None`

Methods

```
__init__(name, sd_test, sd_reference, R_f, ...)
```

Attributes

| |
|--------------------|
| name |
| sd_test |
| sd_reference |
| R_f |
| R_s |
| CCT |
| D_uv |
| colorimetry_data |
| R_g |
| bins |
| averages_test |
| averages_reference |
| average_norms |
| R_fs |
| R_cs |
| R_hs |

colour.quality.colour_fidelity_index_ANSIESTM3018

`colour.quality.colour_fidelity_index_ANSIESTM3018(sd_test: SpectralDistribution,
additional_data: bool = False) → float |
ColourQuality_Specification_ANSIESTM3018
| ColourRendering_Specification_CIE2017`

Return the *ANSI/IES TM-30-18 Colour Fidelity Index* (CFI) R_f of given spectral distribution.

Parameters

- **sd_test** ([SpectralDistribution](#)) – Test spectral distribution.
- **additional_data** (*bool*) – Whether to output additional data.

Returns

ANSI/IES TM-30-18 Colour Fidelity Index (CFI).

Return type

`numpy.float64` or `colour.quality.ColourQuality_Specification_ANSIESTM3018`

References

[ANSIESCCommittee18]

Examples

```
>>> from colour import SDS_ILLUMINANTS
>>> sd = SDS_ILLUMINANTS["FL2"]
>>> colour_fidelity_index_ANSIESTM3018(sd)
70.1208254...
```

Colour Rendering Index

colour

| | |
|---|--|
| <code>colour_rendering_index(sd_test[, ...])</code> | Return the <i>Colour Rendering Index</i> (CRI) Q_a of given spectral distribution. |
|---|--|

colour.colour_rendering_index

`colour.colour_rendering_index(sd_test: SpectralDistribution, additional_data: bool = False) → float | ColourRenderingSpecification_CRI`

Return the *Colour Rendering Index* (CRI) Q_a of given spectral distribution.

Parameters

- **sd_test** (*SpectralDistribution*) – Test spectral distribution.
- **additional_data** (*bool*) – Whether to output additional data.

Returns

Colour Rendering Index (CRI).

Return type

numpy.floating or *colour.quality.ColourRenderingSpecification_CRI*

References

[OD08]

Examples

```
>>> from colour import SDS_ILLUMINANTS
>>> sd = SDS_ILLUMINANTS["FL2"]
>>> colour_rendering_index(sd)
64.2337241...
```

colour.quality

| | |
|---|--|
| <code>ColourRenderingSpecification_CRI(name, Q_a, ...)</code> | Define the <i>Colour Rendering Index</i> (CRI) colour quality specification. |
|---|--|

colour.quality.ColourRendering_Specification_CRI

```
class colour.quality.ColourRendering_Specification_CRI(name: str, Q_a: float, Q_as: Dict[int,
                                                    DataColourQualityScale_TCS],
                                                    colorimetry_data:
                                                    Tuple[Tuple[DataColorimetry_TCS, ...],
                                                    Tuple[DataColorimetry_TCS, ...]])
```

Define the *Colour Rendering Index* (CRI) colour quality specification.

Parameters

- **name** (`str`) – Name of the test spectral distribution.
- **Q_a** (`float`) – *Colour Rendering Index* (CRI) Q_a .
- **Q_as** (`Dict[int, colour.quality.cri.DataColourQualityScale_TCS]`) – Individual *colour rendering indexes* data for each sample.
- **colorimetry_data** (`Tuple[Tuple[colour.quality.cri.DataColorimetry_TCS, ...], Tuple[colour.quality.cri.DataColorimetry_TCS, ...]]`) – Colorimetry data for the test and reference computations.

References

[OD08]

```
__init__(name: str, Q_a: float, Q_as: Dict[int, DataColourQualityScale_TCS], colorimetry_data:
        Tuple[Tuple[DataColorimetry_TCS, ...], Tuple[DataColorimetry_TCS, ...]]) → None
```

Parameters

- **name** (`str`) –
- **Q_a** (`float`) –
- **Q_as** (`Dict[int, DataColourQualityScale_TCS]`) –
- **colorimetry_data** (`Tuple[Tuple[DataColorimetry_TCS, ...], Tuple[DataColorimetry_TCS, ...]]`) –

Return type

None

Methods

```
__init__(name, Q_a, Q_as, colorimetry_data)
```

Attributes

```
name
```

```
Q_a
```

```
Q_as
```

```
colorimetry_data
```

Colour Quality Scale

colour

| | |
|---|---|
| <code>COLOUR_QUALITY_SCALE_METHODS</code> | Supported <i>Colour Quality Scale</i> (CQS) computation methods. |
| <code>colour_quality_scale(sd_test[, ...])</code> | Return the <i>Colour Quality Scale</i> (CQS) of given spectral distribution using given method. |

colour.COLOUR_QUALITY_SCALE_METHODS

`colour.COLOUR_QUALITY_SCALE_METHODS = ('NIST CQS 7.4', 'NIST CQS 9.0')`

Supported *Colour Quality Scale* (CQS) computation methods.

References

[DO10], [OD08], [OD13]

colour.colour_quality_scale

`colour.colour_quality_scale(sd_test: SpectralDistribution, additional_data: bool = False, method: Literal['NIST CQS 7.4', 'NIST CQS 9.0'] | str = 'NIST CQS 9.0') → float | ColourRendering_Specification_CQS`

Return the *Colour Quality Scale* (CQS) of given spectral distribution using given method.

Parameters

- **sd_test** (*SpectralDistribution*) – Test spectral distribution.
- **additional_data** (*bool*) – Whether to output additional data.
- **method** (*Literal*['NIST CQS 7.4', 'NIST CQS 9.0'] | *str*) – Computation method.

Returns

Colour Quality Scale (CQS).

Return type

numpy.floating or *colour.quality.ColourRendering_Specification_CQS*

References

[DO10], [OD08], [OD13]

Examples

```
>>> from colour import SDS_ILLUMINANTS
>>> sd = SDS_ILLUMINANTS["FL2"]
>>> colour_quality_scale(sd)
64.1117031...
```

colour.quality

| | |
|--|--|
| <code>ColourRendering_Specification_CQS(name, Q_a, ...)</code> | Define the <i>Colour Quality Scale</i> (CQS) colour rendering (quality) specification. |
|--|--|

colour.quality.ColourRendering_Specification_CQS

```
class colour.quality.ColourRendering_Specification_CQS(name: str, Q_a: float, Q_f: float, Q_p: float | None, Q_g: float, Q_d: float | None, Q_as: Dict[int, DataColourQualityScale_VS], colorimetry_data: Tuple[Tuple[DataColorimetry_VS, ...], Tuple[DataColorimetry_VS, ...]])
```

Define the *Colour Quality Scale* (CQS) colour rendering (quality) specification.

Parameters

- **name** (`str`) – Name of the test spectral distribution.
- **Q_a** (`float`) – Colour quality scale Q_a .
- **Q_f** (`float`) – Colour fidelity scale Q_f intended to evaluate the fidelity of object colour appearances (compared to the reference illuminant of the same correlated colour temperature and illuminance).
- **Q_p** (`float` | `None`) – Colour preference scale Q_p similar to colour quality scale Q_a but placing additional weight on preference of object colour appearance, set to *None* in *NIST CQS 9.0* method. This metric is based on the notion that increases in chroma are generally preferred and should be rewarded.
- **Q_g** (`float`) – Gamut area scale Q_g representing the relative gamut formed by the (a^*, b^*) coordinates of the 15 samples illuminated by the test light source in the *CIE $L^*a^*b^*$* object colourspace.
- **Q_d** (`float` | `None`) – Relative gamut area scale Q_d , set to *None* in *NIST CQS 9.0* method.
- **Q_as** (`Dict[int, colour.quality.cqs.DataColourQualityScale_VS]`) – Individual *Colour Quality Scale* (CQS) data for each sample.
- **colorimetry_data** (`Tuple[Tuple[colour.quality.cqs.DataColorimetry_VS, ...], Tuple[colour.quality.cqs.DataColorimetry_VS, ...]]`) – Colorimetry data for the test and reference computations.

References

[DO10], [OD08], [OD13]

```
__init__(name: str, Q_a: float, Q_f: float, Q_p: float | None, Q_g: float, Q_d: float | None, Q_as: Dict[int, DataColourQualityScale_VS], colorimetry_data: Tuple[Tuple[DataColorimetry_VS, ...], Tuple[DataColorimetry_VS, ...]]) → None
```

Parameters

- **name** (`str`) –
- **Q_a** (`float`) –
- **Q_f** (`float`) –
- **Q_p** (`float` | `None`) –
- **Q_g** (`float`) –

- **Q_d** (`float` | `None`) –
- **Q_as** (`Dict[int, DataColourQualityScale_VS]`) –
- **colorimetry_data** (`Tuple[Tuple[DataColorimetry_VS, ...], Tuple[DataColorimetry_VS, ...]]`) –

Return type
None

Methods

```
__init__(name, Q_a, Q_f, Q_p, Q_g, Q_d, ...)
```

Attributes

name

Q_a

Q_f

Q_p

Q_g

Q_d

Q_as

colorimetry_data

Academy Spectral Similarity Index (SSI)

colour

| | |
|---|---|
| <code>spectral_similarity_index(sd_test, sd_reference)</code> | Return the <i>Academy Spectral Similarity Index</i> (SSI) of given test spectral distribution with given reference spectral distribution. |
|---|---|

colour.spectral_similarity_index

`colour.spectral_similarity_index(sd_test: SpectralDistribution, sd_reference: SpectralDistribution) → ndarray`

Return the *Academy Spectral Similarity Index* (SSI) of given test spectral distribution with given reference spectral distribution.

Parameters

- **sd_test** (`SpectralDistribution`) – Test spectral distribution.

- **sd_reference** ([SpectralDistribution](#)) – Reference spectral distribution.

Returns

Academy Spectral Similarity Index (SSI).

Return type

`numpy.ndarray`

References

[[TheAoMPAaSciences19](#)]

Examples

```
>>> from colour import SDS_ILLUMINANTS
>>> sd_test = SDS_ILLUMINANTS["C"]
>>> sd_reference = SDS_ILLUMINANTS["D65"]
>>> spectral_similarity_index(sd_test, sd_reference)
94.0
```

Spectral Recovery and Up-sampling**Reflectance Recovery****CIE XYZ Colourspace to Spectral**

`colour`

| | |
|---------------------------------------|--|
| <code>XYZ_to_sd(XYZ[, method])</code> | Recover the spectral distribution of given <i>CIE XYZ</i> tristimulus values using given method. |
| <code>XYZ_TO_SD_METHODS</code> | Supported spectral distribution recovery methods. |

`colour.XYZ_to_sd`

`colour.XYZ_to_sd(XYZ: ArrayLike, method: Literal['Jakob 2019', 'Mallett 2019', 'Meng 2015', 'Otsu 2018', 'Smits 1999'] | str = 'Meng 2015', **kwargs: Any) → SpectralDistribution`

Recover the spectral distribution of given *CIE XYZ* tristimulus values using given method.

Parameters

- **XYZ** (`ArrayLike`) – *CIE XYZ* tristimulus values to recover the spectral distribution from.
- **method** ([Literal](#)['Jakob 2019', 'Mallett 2019', 'Meng 2015', 'Otsu 2018', 'Smits 1999'] | `str`) – Computation method.
- **additional_data** – {`colour.recovery.XYZ_to_sd_Jakob2019()`}, If *True*, error will be returned alongside *sd*.
- **basis_functions** – {`colour.recovery.RGB_to_sd_Mallett2019()`}, Basis functions for the method. The default is to use the built-in *sRGB* basis functions, i.e. `colour.recovery.MSDS_BASIS_FUNCTIONS_sRGB_MALLETT2019`.

- **clip** – `{colour.recovery.XYZ_to_sd_Otsu2018()}`, If *True*, the default, values below zero and above unity in the recovered spectral distributions will be clipped. This ensures that the returned reflectance is physical and conserves energy, but will cause noticeable colour differences in case of very saturated colours.
- **cmfs** – `{colour.recovery.XYZ_to_sd_Meng2015()}`, Standard observer colour matching functions.
- **colourspace** – `{colour.recovery.XYZ_to_sd_Jakob2019()}`, *RGB* colourspace of the target colour. Note that no chromatic adaptation is performed between illuminant and the colourspace whitepoint.
- **dataset** – `{colour.recovery.XYZ_to_sd_Otsu2018()}`, Dataset to use for reconstruction. The default is to use the published data.
- **illuminant** – `{colour.recovery.XYZ_to_sd_Jakob2019(), colour.recovery.XYZ_to_sd_Meng2015()}`, Illuminant spectral distribution, default to *CIE Standard Illuminant D65*.
- **interval** – `{colour.recovery.XYZ_to_sd_Meng2015()}`, Wavelength λ_i range interval in nm. The smaller interval is, the longer the computations will be.
- **optimisation_kwargs** – `{colour.recovery.XYZ_to_sd_Jakob2019(), colour.recovery.XYZ_to_sd_Meng2015()}`, Parameters for `scipy.optimize.minimize()` and `colour.recovery.find_coefficients_Jakob2019()` definitions.
- **kwargs** (Any) –

Returns

Recovered spectral distribution.

Return type

`colour.SpectralDistribution`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

- *Smits (1999)* method will internally convert given *CIE XYZ* tristimulus values to *sRGB* colourspace array assuming equal energy illuminant *E*.

References

[JH19], [MY19], [MSHD15], [OYH18], [Smi99]

Examples

Jakob and Hanika (2009) reflectance recovery:

```
>>> import numpy as np
>>> from colour import MSDS_CMFS, SDS_ILLUMINANTS, SpectralShape
>>> from colour.colorimetry import sd_to_XYZ_integration
>>> from colour.utilities import numpy_print_options
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> cmfs = (
...     MSDS_CMFS["CIE 1931 2 Degree Standard Observer"]
```

(continues on next page)

(continued from previous page)

```

...     .copy()
...     .align(SpectralShape(360, 780, 10))
... )
>>> illuminant = SDS_ILLUMINANTS["D65"].copy().align(cmfs.shape)
>>> sd = XYZ_to_sd(
...     XYZ, method="Jakob 2019", cmfs=cmfs, illuminant=illuminant
... )
>>> with numpy_print_options(suppress=True):
...     sd
...
SpectralDistribution([[ 360.          ,  0.4893773...],
                    [ 370.          ,  0.3258214...],
                    [ 380.          ,  0.2147792...],
                    [ 390.          ,  0.1482413...],
                    [ 400.          ,  0.1086169...],
                    [ 410.          ,  0.0841255...],
                    [ 420.          ,  0.0683114...],
                    [ 430.          ,  0.0577144...],
                    [ 440.          ,  0.0504267...],
                    [ 450.          ,  0.0453552...],
                    [ 460.          ,  0.0418520...],
                    [ 470.          ,  0.0395259...],
                    [ 480.          ,  0.0381430...],
                    [ 490.          ,  0.0375741...],
                    [ 500.          ,  0.0377685...],
                    [ 510.          ,  0.0387432...],
                    [ 520.          ,  0.0405871...],
                    [ 530.          ,  0.0434783...],
                    [ 540.          ,  0.0477225...],
                    [ 550.          ,  0.0538256...],
                    [ 560.          ,  0.0626314...],
                    [ 570.          ,  0.0755869...],
                    [ 580.          ,  0.0952675...],
                    [ 590.          ,  0.1264265...],
                    [ 600.          ,  0.1779272...],
                    [ 610.          ,  0.2649393...],
                    [ 620.          ,  0.4039779...],
                    [ 630.          ,  0.5832105...],
                    [ 640.          ,  0.7445440...],
                    [ 650.          ,  0.8499970...],
                    [ 660.          ,  0.9094792...],
                    [ 670.          ,  0.9425378...],
                    [ 680.          ,  0.9616376...],
                    [ 690.          ,  0.9732481...],
                    [ 700.          ,  0.9806562...],
                    [ 710.          ,  0.9855873...],
                    [ 720.          ,  0.9889903...],
                    [ 730.          ,  0.9914117...],
                    [ 740.          ,  0.9931801...],
                    [ 750.          ,  0.9945009...],
                    [ 760.          ,  0.9955066...],
                    [ 770.          ,  0.9962855...],
                    [ 780.          ,  0.9968976...]],
                    interpolator=SpragueInterpolator,
                    interpolator_kwargs={},
                    extrapolator=Extrapolator,

```

(continues on next page)

(continued from previous page)

```

        extrapolator_kwargs={...})
>>> sd_to_XYZ_integration(sd, cmfs, illuminant) / 100
array([ 0.2066217...,  0.1220128...,  0.0513958...])

```

Mallett and Yuksel (2019) reflectance recovery:

```

>>> cmfs = (
...     MSDS_CMFS["CIE 1931 2 Degree Standard Observer"]
...     .copy()
...     .align(SPECTRAL_SHAPE_sRGB_MALLETT2019)
... )
>>> illuminant = SDS_ILLUMINANTS["D65"].copy().align(cmfs.shape)
>>> sd = XYZ_to_sd(XYZ, method="Mallett 2019")
>>> with numpy_print_options(suppress=True):
...     sd
...
SpectralDistribution([[ 380.          ,  0.1735531...],
                    [ 385.          ,  0.1720357...],
                    [ 390.          ,  0.1677721...],
                    [ 395.          ,  0.1576605...],
                    [ 400.          ,  0.1372829...],
                    [ 405.          ,  0.1170849...],
                    [ 410.          ,  0.0895694...],
                    [ 415.          ,  0.0706232...],
                    [ 420.          ,  0.0585765...],
                    [ 425.          ,  0.0523959...],
                    [ 430.          ,  0.0497598...],
                    [ 435.          ,  0.0476057...],
                    [ 440.          ,  0.0465079...],
                    [ 445.          ,  0.0460337...],
                    [ 450.          ,  0.0455839...],
                    [ 455.          ,  0.0452872...],
                    [ 460.          ,  0.0450981...],
                    [ 465.          ,  0.0448895...],
                    [ 470.          ,  0.0449257...],
                    [ 475.          ,  0.0448987...],
                    [ 480.          ,  0.0446834...],
                    [ 485.          ,  0.0441372...],
                    [ 490.          ,  0.0417137...],
                    [ 495.          ,  0.0373832...],
                    [ 500.          ,  0.0357657...],
                    [ 505.          ,  0.0348263...],
                    [ 510.          ,  0.0341953...],
                    [ 515.          ,  0.0337683...],
                    [ 520.          ,  0.0334979...],
                    [ 525.          ,  0.0332991...],
                    [ 530.          ,  0.0331909...],
                    [ 535.          ,  0.0332181...],
                    [ 540.          ,  0.0333387...],
                    [ 545.          ,  0.0334970...],
                    [ 550.          ,  0.0337381...],
                    [ 555.          ,  0.0341847...],
                    [ 560.          ,  0.0346447...],
                    [ 565.          ,  0.0353993...],
                    [ 570.          ,  0.0367367...],
                    [ 575.          ,  0.0392007...],

```

(continues on next page)

(continued from previous page)

```

[ 580.      ,    0.0445902...],
[ 585.      ,    0.0625633...],
[ 590.      ,    0.2965381...],
[ 595.      ,    0.4215576...],
[ 600.      ,    0.4347139...],
[ 605.      ,    0.4385134...],
[ 610.      ,    0.4385184...],
[ 615.      ,    0.4385249...],
[ 620.      ,    0.4374694...],
[ 625.      ,    0.4384672...],
[ 630.      ,    0.4368251...],
[ 635.      ,    0.4340867...],
[ 640.      ,    0.4303219...],
[ 645.      ,    0.4243257...],
[ 650.      ,    0.4159482...],
[ 655.      ,    0.4057443...],
[ 660.      ,    0.3919874...],
[ 665.      ,    0.3742784...],
[ 670.      ,    0.3518421...],
[ 675.      ,    0.3240127...],
[ 680.      ,    0.2955145...],
[ 685.      ,    0.2625658...],
[ 690.      ,    0.2343423...],
[ 695.      ,    0.2174830...],
[ 700.      ,    0.2060461...],
[ 705.      ,    0.1977437...],
[ 710.      ,    0.1916846...],
[ 715.      ,    0.1861020...],
[ 720.      ,    0.1823908...],
[ 725.      ,    0.1807923...],
[ 730.      ,    0.1795571...],
[ 735.      ,    0.1785623...],
[ 740.      ,    0.1775758...],
[ 745.      ,    0.1771614...],
[ 750.      ,    0.1767431...],
[ 755.      ,    0.1764319...],
[ 760.      ,    0.1762597...],
[ 765.      ,    0.1762209...],
[ 770.      ,    0.1761803...],
[ 775.      ,    0.1761195...],
[ 780.      ,    0.1760763...]],
interpolator=SpragueInterpolator,
interpolator_kwargs={},
extrapolator=Extrapolator,
extrapolator_kwargs={...})
>>> sd_to_XYZ_integration(sd, cmfs, illuminant) / 100
...
array([ 0.2065436...,  0.1219996...,  0.0513764...])

```

Meng (2015) reflectance recovery:

```

>>> cmfs = (
...     MSDS_CMFS["CIE 1931 2 Degree Standard Observer"]
...     .copy()
...     .align(SpectralShape(360, 780, 10))
... )

```

(continues on next page)

(continued from previous page)

```

>>> illuminant = SDS_ILLUMINANTS["D65"].copy().align(cmfs.shape)
>>> sd = XYZ_to_sd(
...     XYZ, method="Meng 2015", cmfs=cmfs, illuminant=illuminant
... )
>>> with numpy_print_options(suppress=True):
...     sd
...
SpectralDistribution([[ 360.          ,  0.0762005...],
                    [ 370.          ,  0.0761792...],
                    [ 380.          ,  0.0761363...],
                    [ 390.          ,  0.0761194...],
                    [ 400.          ,  0.0762539...],
                    [ 410.          ,  0.0761671...],
                    [ 420.          ,  0.0754649...],
                    [ 430.          ,  0.0731519...],
                    [ 440.          ,  0.0676701...],
                    [ 450.          ,  0.0577800...],
                    [ 460.          ,  0.0441993...],
                    [ 470.          ,  0.0285064...],
                    [ 480.          ,  0.0138728...],
                    [ 490.          ,  0.0033585...],
                    [ 500.          ,  0.          ],
                    [ 510.          ,  0.          ],
                    [ 520.          ,  0.          ],
                    [ 530.          ,  0.          ],
                    [ 540.          ,  0.0055767...],
                    [ 550.          ,  0.0317581...],
                    [ 560.          ,  0.0754491...],
                    [ 570.          ,  0.1314115...],
                    [ 580.          ,  0.1937649...],
                    [ 590.          ,  0.2559311...],
                    [ 600.          ,  0.3123173...],
                    [ 610.          ,  0.3584966...],
                    [ 620.          ,  0.3927335...],
                    [ 630.          ,  0.4159458...],
                    [ 640.          ,  0.4306660...],
                    [ 650.          ,  0.4391040...],
                    [ 660.          ,  0.4439497...],
                    [ 670.          ,  0.4463618...],
                    [ 680.          ,  0.4474625...],
                    [ 690.          ,  0.4479868...],
                    [ 700.          ,  0.4482116...],
                    [ 710.          ,  0.4482800...],
                    [ 720.          ,  0.4483472...],
                    [ 730.          ,  0.4484251...],
                    [ 740.          ,  0.4484633...],
                    [ 750.          ,  0.4485071...],
                    [ 760.          ,  0.4484969...],
                    [ 770.          ,  0.4484853...],
                    [ 780.          ,  0.4485134...]],
                    interpolator=SpragueInterpolator,
                    interpolator_kwargs={},
                    extrapolator=Extrapolator,
                    extrapolator_kwargs={...})
>>> sd_to_XYZ_integration(sd, cmfs, illuminant) / 100
array([ 0.2065400...,  0.1219722...,  0.0513695...])

```

Otsu, Yamamoto and Hachisuka (2018) reflectance recovery:

```
>>> cmfs = (
...     MSDS_CMFS["CIE 1931 2 Degree Standard Observer"]
...     .copy()
...     .align(SPECTRAL_SHAPE_OTSU2018)
... )
>>> illuminant = SDS_ILLUMINANTS["D65"].copy().align(cmfs.shape)
>>> sd = XYZ_to_sd(
...     XYZ, method="Otsu 2018", cmfs=cmfs, illuminant=illuminant
... )
>>> with numpy_print_options(suppress=True):
...     sd
...
SpectralDistribution([[ 380.          ,  0.0601939...],
                    [ 390.          ,  0.0568063...],
                    [ 400.          ,  0.0517429...],
                    [ 410.          ,  0.0495841...],
                    [ 420.          ,  0.0502007...],
                    [ 430.          ,  0.0506489...],
                    [ 440.          ,  0.0510020...],
                    [ 450.          ,  0.0493782...],
                    [ 460.          ,  0.0468046...],
                    [ 470.          ,  0.0437132...],
                    [ 480.          ,  0.0416957...],
                    [ 490.          ,  0.0403783...],
                    [ 500.          ,  0.0405197...],
                    [ 510.          ,  0.0406031...],
                    [ 520.          ,  0.0416912...],
                    [ 530.          ,  0.0430956...],
                    [ 540.          ,  0.0444474...],
                    [ 550.          ,  0.0459336...],
                    [ 560.          ,  0.0507631...],
                    [ 570.          ,  0.0628967...],
                    [ 580.          ,  0.0844661...],
                    [ 590.          ,  0.1334277...],
                    [ 600.          ,  0.2262428...],
                    [ 610.          ,  0.3599330...],
                    [ 620.          ,  0.4885571...],
                    [ 630.          ,  0.5752546...],
                    [ 640.          ,  0.6193023...],
                    [ 650.          ,  0.6450744...],
                    [ 660.          ,  0.6610548...],
                    [ 670.          ,  0.6688673...],
                    [ 680.          ,  0.6795426...],
                    [ 690.          ,  0.6887933...],
                    [ 700.          ,  0.7003469...],
                    [ 710.          ,  0.7084128...],
                    [ 720.          ,  0.7154674...],
                    [ 730.          ,  0.7234334...]],
                    interpolator=SpragueInterpolator,
                    interpolator_kwargs={},
                    extrapolator=Extrapolator,
                    extrapolator_kwargs={...})
>>> sd_to_XYZ_integration(sd, cmfs, illuminant) / 100
array([ 0.2065494...,  0.1219712...,  0.0514002...])
```

Smits (1999) reflectance recovery:


```

>>> cmfs = (
...     MSDS_CMFS["CIE 1931 2 Degree Standard Observer"]
...     .copy()
...     .align(SpectralShape(360, 780, 10))
... )
>>> illuminant = SDS_ILLUMINANTS["E"].copy().align(cmfs.shape)
>>> sd = XYZ_to_sd(XYZ, method="Smits 1999")
>>> with numpy_print_options(suppress=True):
...     sd
...
SpectralDistribution([[ 380.          ,  0.0787830...],
                    [ 417.7778      ,  0.0622018...],
                    [ 455.5556      ,  0.0446206...],
                    [ 493.3333      ,  0.0352220...],
                    [ 531.1111      ,  0.0324149...],
                    [ 568.8889      ,  0.0330105...],
                    [ 606.6667      ,  0.3207115...],
                    [ 644.4444      ,  0.3836164...],
                    [ 682.2222      ,  0.3836164...],
                    [ 720.          ,  0.3835649...]],
                    interpolator=LinearInterpolator,
                    interpolator_kwargs={},
                    extrapolator=Extrapolator,
                    extrapolator_kwargs={...})
>>> sd_to_XYZ_integration(sd, cmfs, illuminant) / 100
array([ 0.1894770...,  0.1126470...,  0.0474420...])

```

colour.XYZ_TO_SD_METHODS

colour.XYZ_TO_SD_METHODS = CanonicalMapping({'Jakob 2019': ..., 'Mallett 2019': ..., 'Meng 2015': ..., 'Otsu 2018': ..., 'Smits 1999': ...})

Supported spectral distribution recovery methods.

References

[JH19], [MY19], [MSHD15], [Smi99]

Jakob and Hanika (2019)

colour.recovery

| | |
|--|---|
| <code>XYZ_to_sd_Jakob2019(XYZ[, cmfs, illuminant, ...])</code> | Recover the spectral distribution of given RGB colourspace array using <i>Jakob and Hanika (2019)</i> method. |
| <code>LUT3D_Jakob2019()</code> | Define a class for working with pre-computed lookup tables for the <i>Jakob and Hanika (2019)</i> spectral upsampling method. |

colour.recovery.XYZ_to_sd_Jakob2019

`colour.recovery.XYZ_to_sd_Jakob2019`(XYZ: *ArrayLike*, cmfs: *MultiSpectralDistributions* | *None* = *None*, illuminant: *SpectralDistribution* | *None* = *None*, optimisation_kwargs: *Dict* | *None* = *None*, additional_data: *bool* = *False*) → *Tuple*[*SpectralDistribution*, *float*] | *SpectralDistribution*

Recover the spectral distribution of given RGB colourspace array using *Jakob and Hanika (2019)* method.

Parameters

- **XYZ** (*ArrayLike*) – CIE XYZ tristimulus values to recover the spectral distribution from.
- **cmfs** (*MultiSpectralDistributions* | *None*) – Standard observer colour matching functions, default to the *CIE 1931 2 Degree Standard Observer*.
- **illuminant** (*SpectralDistribution* | *None*) – Illuminant spectral distribution, default to *CIE Standard Illuminant D65*.
- **optimisation_kwargs** (*Dict* | *None*) – Parameters for `colour.recovery.find_coefficients_Jakob2019()` definition.
- **additional_data** (*bool*) – If *True*, error will be returned alongside the recovered spectral distribution.

Returns

Tuple of recovered spectral distribution and ΔE_{76} between the target colour and the colour corresponding to the computed coefficients or recovered spectral distribution.

Return type

tuple or `colour.SpectralDistribution`

References

[JH19]

Examples

```
>>> from colour import (
...     CCS_ILLUMINANTS,
...     MSDS_CMFS,
...     SDS_ILLUMINANTS,
...     XYZ_to_sRGB,
... )
>>> from colour.colorimetry import sd_to_XYZ_integration
>>> from colour.utilities import numpy_print_options
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> cmfs = (
...     MSDS_CMFS["CIE 1931 2 Degree Standard Observer"]
...     .copy()
...     .align(SpectralShape(360, 780, 10))
... )
>>> illuminant = SDS_ILLUMINANTS["D65"].copy().align(cmfs.shape)
>>> sd = XYZ_to_sd_Jakob2019(XYZ, cmfs, illuminant)
>>> with numpy_print_options(suppress=True):
...     sd
... 
```

(continues on next page)

(continued from previous page)

```

SpectralDistribution([[ 360.      , 0.4893773...],
                    [ 370.      , 0.3258214...],
                    [ 380.      , 0.2147792...],
                    [ 390.      , 0.1482413...],
                    [ 400.      , 0.1086169...],
                    [ 410.      , 0.0841255...],
                    [ 420.      , 0.0683114...],
                    [ 430.      , 0.0577144...],
                    [ 440.      , 0.0504267...],
                    [ 450.      , 0.0453552...],
                    [ 460.      , 0.0418520...],
                    [ 470.      , 0.0395259...],
                    [ 480.      , 0.0381430...],
                    [ 490.      , 0.0375741...],
                    [ 500.      , 0.0377685...],
                    [ 510.      , 0.0387432...],
                    [ 520.      , 0.0405871...],
                    [ 530.      , 0.0434783...],
                    [ 540.      , 0.0477225...],
                    [ 550.      , 0.0538256...],
                    [ 560.      , 0.0626314...],
                    [ 570.      , 0.0755869...],
                    [ 580.      , 0.0952675...],
                    [ 590.      , 0.1264265...],
                    [ 600.      , 0.1779272...],
                    [ 610.      , 0.2649393...],
                    [ 620.      , 0.4039779...],
                    [ 630.      , 0.5832105...],
                    [ 640.      , 0.7445440...],
                    [ 650.      , 0.8499970...],
                    [ 660.      , 0.9094792...],
                    [ 670.      , 0.9425378...],
                    [ 680.      , 0.9616376...],
                    [ 690.      , 0.9732481...],
                    [ 700.      , 0.9806562...],
                    [ 710.      , 0.9855873...],
                    [ 720.      , 0.9889903...],
                    [ 730.      , 0.9914117...],
                    [ 740.      , 0.9931801...],
                    [ 750.      , 0.9945009...],
                    [ 760.      , 0.9955066...],
                    [ 770.      , 0.9962855...],
                    [ 780.      , 0.9968976...]],
                    SpragueInterpolator,
                    {},
                    Extrapolator,
                    {'method': 'Constant', 'left': None, 'right': None})
>>> sd_to_XYZ_integration(sd, cmfs, illuminant) / 100
array([ 0.2066217..., 0.1220128..., 0.0513958...])

```

colour.recovery.LUT3D_Jakob2019

class colour.recovery.LUT3D_Jakob2019

Define a class for working with pre-computed lookup tables for the *Jakob and Hanika (2019)* spectral upsampling method. It allows significant time savings by performing the expensive numerical optimization ahead of time and storing the results in a file.

The file format is compatible with the code and **.coeff* files in the supplemental material published alongside the article. They are directly available from [Colour - Datasets](#) under the record 4050598.

Attributes

- size
- lightness_scale
- coefficients
- interpolator

Methods

- `__init__()`
- `generate()`
- `RGB_to_coefficients()`
- `RGB_to_sd()`
- `read()`
- `write()`

References

[JH19]

Examples

```
>>> import os
>>> import colour
>>> from colour import CCS_ILLUMINANTS, SDS_ILLUMINANTS, MSDS_CMFS
>>> from colour.colorimetry import sd_to_XYZ_integration
>>> from colour.models import RGB_COLOURSPACE_sRGB
>>> from colour.utilities import numpy_print_options
>>> cmfs = (
...     MSDS_CMFS["CIE 1931 2 Degree Standard Observer"]
...     .copy()
...     .align(SpectralShape(360, 780, 10))
... )
>>> illuminant = SDS_ILLUMINANTS["D65"].copy().align(cmfs.shape)
>>> LUT = LUT3D_Jakob2019()
>>> LUT.generate(RGB_COLOURSPACE_sRGB, cmfs, illuminant, 3, lambda x: x)
>>> path = os.path.join(
...     colour.__path__[0],
...     "recovery",
...     "tests",
```

(continues on next page)

(continued from previous page)

```

...     "resources",
...     "sRGB_Jakob2019.coeff",
... )
>>> LUT.write(path)
>>> LUT.read(path)
>>> RGB = np.array([0.70573936, 0.19248266, 0.22354169])
>>> with numpy_print_options(suppress=True):
...     LUT.RGB_to_sd(RGB, cmfs.shape)
...
SpectralDistribution([[ 360.          ,  0.7666803...],
 [ 370.          ,  0.6251547...],
 [ 380.          ,  0.4584310...],
 [ 390.          ,  0.3161633...],
 [ 400.          ,  0.2196155...],
 [ 410.          ,  0.1596575...],
 [ 420.          ,  0.1225525...],
 [ 430.          ,  0.0989784...],
 [ 440.          ,  0.0835782...],
 [ 450.          ,  0.0733535...],
 [ 460.          ,  0.0666049...],
 [ 470.          ,  0.0623569...],
 [ 480.          ,  0.06006   ...],
 [ 490.          ,  0.0594383...],
 [ 500.          ,  0.0604201...],
 [ 510.          ,  0.0631195...],
 [ 520.          ,  0.0678648...],
 [ 530.          ,  0.0752834...],
 [ 540.          ,  0.0864790...],
 [ 550.          ,  0.1033773...],
 [ 560.          ,  0.1293883...],
 [ 570.          ,  0.1706018...],
 [ 580.          ,  0.2374178...],
 [ 590.          ,  0.3439472...],
 [ 600.          ,  0.4950548...],
 [ 610.          ,  0.6604253...],
 [ 620.          ,  0.7914669...],
 [ 630.          ,  0.8738724...],
 [ 640.          ,  0.9213216...],
 [ 650.          ,  0.9486880...],
 [ 660.          ,  0.9650550...],
 [ 670.          ,  0.9752838...],
 [ 680.          ,  0.9819499...],
 [ 690.          ,  0.9864585...],
 [ 700.          ,  0.9896073...],
 [ 710.          ,  0.9918680...],
 [ 720.          ,  0.9935302...],
 [ 730.          ,  0.9947778...],
 [ 740.          ,  0.9957312...],
 [ 750.          ,  0.9964714...],
 [ 760.          ,  0.9970543...],
 [ 770.          ,  0.9975190...],
 [ 780.          ,  0.9978936...]],
 SpragueInterpolator,
 {},
 Extrapolator,
 {'method': 'Constant', 'left': None, 'right': None})

```

`__init__()` → `None`

Return type
None

Methods

| | |
|--|--|
| <code>RGB_to_coefficients(</code> RGB <code>)</code> | Look up a given <i>RGB</i> colourspace array and return corresponding coefficients. |
| <code>RGB_to_sd(</code> RGB[, shape <code>])</code> | Look up a given <i>RGB</i> colourspace array and return the corresponding spectral distribution. |
| <code>__init__()</code> | |
| <code>generate(</code> colourspace[, cmfs, illuminant, ... <code>])</code> | Generate the lookup table data for given <i>RGB</i> colourspace, colour matching functions, illuminant and given size. |
| <code>read(</code> path <code>)</code> | Load a lookup table from a <i>*.coeff</i> file. |
| <code>write(</code> path <code>)</code> | Write the lookup table to a <i>*.coeff</i> file. |

Attributes

| | |
|------------------------------|---|
| <code>coefficients</code> | Getter property for the <i>Jakob and Hanika (2019)</i> interpolator coefficients. |
| <code>interpolator</code> | Getter property for the <i>Jakob and Hanika (2019)</i> interpolator. |
| <code>lightness_scale</code> | Getter property for the <i>Jakob and Hanika (2019)</i> interpolator lightness scale. |
| <code>size</code> | Getter property for the <i>Jakob and Hanika (2019)</i> interpolator size, i.e. the samples count on one side of the 3D table. |

Ancillary Objects

`colour.recovery`

| | |
|---|---|
| <code>sd_Jakob2019(</code> coefficients[, shape <code>])</code> | Return a spectral distribution following the spectral model given by <i>Jakob and Hanika (2019)</i> . |
| <code>find_coefficients_Jakob2019(</code> XYZ[, cmfs, ... <code>])</code> | Compute the coefficients for <i>Jakob and Hanika (2019)</i> reflectance spectral model. |

`colour.recovery.sd_Jakob2019`

`colour.recovery.sd_Jakob2019(`coefficients: *ArrayLike*, shape: *SpectralShape* = *SPECTRAL_SHAPE_JAKOB2019*`)` → *SpectralDistribution*

Return a spectral distribution following the spectral model given by *Jakob and Hanika (2019)*.

Parameters

- **coefficients** (*ArrayLike*) – Dimensionless coefficients for *Jakob and Hanika (2019)* reflectance spectral model.
- **shape** (*SpectralShape*) – Shape used by the spectral distribution.

Returns*Jakob and Hanika (2019)* spectral distribution.**Return type**`colour.SpectralDistribution`**References**

[JH19]

Examples

```
>>> from colour.utilities import numpy_print_options
>>> with numpy_print_options(suppress=True):
...     sd_Jakob2019([-9e-05, 8.5e-02, -20], SpectralShape(400, 700, 20))
...
...
SpectralDistribution([[ 400.      ,  0.3143046...],
                    [ 420.      ,  0.4133320...],
                    [ 440.      ,  0.4880034...],
                    [ 460.      ,  0.5279562...],
                    [ 480.      ,  0.5319346...],
                    [ 500.      ,  0.5      ...],
                    [ 520.      ,  0.4326202...],
                    [ 540.      ,  0.3373544...],
                    [ 560.      ,  0.2353056...],
                    [ 580.      ,  0.1507665...],
                    [ 600.      ,  0.0931332...],
                    [ 620.      ,  0.0577434...],
                    [ 640.      ,  0.0367011...],
                    [ 660.      ,  0.0240879...],
                    [ 680.      ,  0.0163316...],
                    [ 700.      ,  0.0114118...]],
                    SpragueInterpolator,
                    {},
                    Extrapolator,
                    {'method': 'Constant', 'left': None, 'right': None})
```

colour.recovery.find_coefficients_Jakob2019

`colour.recovery.find_coefficients_Jakob2019`(XYZ: *ArrayLike*, cmfs: [MultiSpectralDistributions](#) | *None* = *None*, illuminant: [SpectralDistribution](#) | *None* = *None*, coefficients_0: *ArrayLike* = `zeros(3)`, max_error: *float* = `JND_CIE1976 / 100`, dimensionalise: *bool* = *True*) → *Tuple*[*ndarray*, *float*]

Compute the coefficients for *Jakob and Hanika (2019)* reflectance spectral model.

Parameters

- **XYZ** (*ArrayLike*) – CIE XYZ tristimulus values to find the coefficients for.
- **cmfs** ([MultiSpectralDistributions](#) | *None*) – Standard observer colour matching functions, default to the CIE 1931 2 Degree Standard Observer.
- **illuminant** ([SpectralDistribution](#) | *None*) – Illuminant spectral distribution, default to CIE Standard Illuminant D65.
- **coefficients_0** (*ArrayLike*) – Starting coefficients for the solver.

- **max_error** (`float`) – Maximal acceptable error. Set higher to save computational time. If *None*, the solver will keep going until it is very close to the minimum. The default is `ACCEPTABLE_DELTA_E`.
- **dimensionalise** (`bool`) – If *True*, returned coefficients are dimensionful and will not work correctly if fed back as `coefficients_0`. The default is *True*.

Returns

Tuple of computed coefficients that best fit the given colour and ΔE_{76} between the target colour and the colour corresponding to the computed coefficients.

Return type

`tuple`

References

[JH19]

Examples

```
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> find_coefficients_Jakob2019(XYZ)
(array([ 1.3723791...e-04, -1.3514399...e-01,  3.0838973...e+01]), 0.0141941...)
```

Mallett and Yuksel (2019)

`colour.recovery`

| | |
|--|--|
| <code>RGB_to_sd_Mallett2019(RGB[, basis_functions])</code> | Recover the spectral distribution of given <i>RGB</i> colourspace array using <i>Mallett and Yuksel (2019)</i> method. |
|--|--|

`colour.recovery.RGB_to_sd_Mallett2019`

`colour.recovery.RGB_to_sd_Mallett2019(RGB: ArrayLike, basis_functions: MultiSpectralDistributions = MSDS_BASIS_FUNCTIONS_sRGB_MALLETT2019) → SpectralDistribution`

Recover the spectral distribution of given *RGB* colourspace array using *Mallett and Yuksel (2019)* method.

Parameters

- **RGB** (`ArrayLike`) – *RGB* colourspace array.
- **basis_functions** (`MultiSpectralDistributions`) – Basis functions for the method. The default is to use the built-in *sRGB* basis functions, i.e. `colour.recovery.MSDS_BASIS_FUNCTIONS_sRGB_MALLETT2019`.

Returns

Recovered reflectance.

Return type

`colour.SpectralDistribution`

References

[MY19]

Notes

- In-addition to the *BT.709* primaries used by the *sRGB* colourspace, [MY19] tried *BT.2020*, *P3 D65*, *Adobe RGB 1998*, *NTSC (1987)*, *Pal/Secam*, *ProPhoto RGB*, and *Adobe Wide Gamut RGB* primaries, every one of which encompasses a larger (albeit not-always-enveloping) set of *CIE L*a*b** colours than *BT.709*. Of these, only *Pal/Secam* produces a feasible basis, which is relatively unsurprising since it is very similar to *BT.709*, whereas the others are significantly larger.

Examples

```
>>> from colour import MSDS_CMFS, SDS_ILLUMINANTS, XYZ_to_sRGB
>>> from colour.colorimetry import sd_to_XYZ_integration
>>> from colour.recovery import SPECTRAL_SHAPE_sRGB_MALLETT2019
>>> from colour.utilities import numpy_print_options
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> RGB = XYZ_to_sRGB(XYZ, apply_cctf_encoding=False)
>>> cmfs = (
...     MSDS_CMFS["CIE 1931 2 Degree Standard Observer"]
...     .copy()
...     .align(SPECTRAL_SHAPE_sRGB_MALLETT2019)
... )
>>> illuminant = SDS_ILLUMINANTS["D65"].copy().align(cmfs.shape)
>>> sd = RGB_to_sd_Mallett2019(RGB)
>>> with numpy_print_options(suppress=True):
...     sd
...
SpectralDistribution([[ 380.      ,  0.1735531...],
                    [ 385.      ,  0.1720357...],
                    [ 390.      ,  0.1677721...],
                    [ 395.      ,  0.1576605...],
                    [ 400.      ,  0.1372829...],
                    [ 405.      ,  0.1170849...],
                    [ 410.      ,  0.0895694...],
                    [ 415.      ,  0.0706232...],
                    [ 420.      ,  0.0585765...],
                    [ 425.      ,  0.0523959...],
                    [ 430.      ,  0.0497598...],
                    [ 435.      ,  0.0476057...],
                    [ 440.      ,  0.0465079...],
                    [ 445.      ,  0.0460337...],
                    [ 450.      ,  0.0455839...],
                    [ 455.      ,  0.0452872...],
                    [ 460.      ,  0.0450981...],
                    [ 465.      ,  0.0448895...],
                    [ 470.      ,  0.0449257...],
                    [ 475.      ,  0.0448987...],
                    [ 480.      ,  0.0446834...],
                    [ 485.      ,  0.0441372...],
                    [ 490.      ,  0.0417137...],
                    [ 495.      ,  0.0373832...],
```

(continues on next page)

(continued from previous page)

| | | |
|--------|---|----------------|
| [500. | , | 0.0357657...], |
| [505. | , | 0.0348263...], |
| [510. | , | 0.0341953...], |
| [515. | , | 0.0337683...], |
| [520. | , | 0.0334979...], |
| [525. | , | 0.0332991...], |
| [530. | , | 0.0331909...], |
| [535. | , | 0.0332181...], |
| [540. | , | 0.0333387...], |
| [545. | , | 0.0334970...], |
| [550. | , | 0.0337381...], |
| [555. | , | 0.0341847...], |
| [560. | , | 0.0346447...], |
| [565. | , | 0.0353993...], |
| [570. | , | 0.0367367...], |
| [575. | , | 0.0392007...], |
| [580. | , | 0.0445902...], |
| [585. | , | 0.0625633...], |
| [590. | , | 0.2965381...], |
| [595. | , | 0.4215576...], |
| [600. | , | 0.4347139...], |
| [605. | , | 0.4385134...], |
| [610. | , | 0.4385184...], |
| [615. | , | 0.4385249...], |
| [620. | , | 0.4374694...], |
| [625. | , | 0.4384672...], |
| [630. | , | 0.4368251...], |
| [635. | , | 0.4340867...], |
| [640. | , | 0.4303219...], |
| [645. | , | 0.4243257...], |
| [650. | , | 0.4159482...], |
| [655. | , | 0.4057443...], |
| [660. | , | 0.3919874...], |
| [665. | , | 0.3742784...], |
| [670. | , | 0.3518421...], |
| [675. | , | 0.3240127...], |
| [680. | , | 0.2955145...], |
| [685. | , | 0.2625658...], |
| [690. | , | 0.2343423...], |
| [695. | , | 0.2174830...], |
| [700. | , | 0.2060461...], |
| [705. | , | 0.1977437...], |
| [710. | , | 0.1916846...], |
| [715. | , | 0.1861020...], |
| [720. | , | 0.1823908...], |
| [725. | , | 0.1807923...], |
| [730. | , | 0.1795571...], |
| [735. | , | 0.1785623...], |
| [740. | , | 0.1775758...], |
| [745. | , | 0.1771614...], |
| [750. | , | 0.1767431...], |
| [755. | , | 0.1764319...], |
| [760. | , | 0.1762597...], |
| [765. | , | 0.1762209...], |
| [770. | , | 0.1761803...], |
| [775. | , | 0.1761195...], |

(continues on next page)

(continued from previous page)

```

        [ 780.          ,    0.1760763...]],
        SpragueInterpolator,
        {},
        Extrapolator,
        {'method': 'Constant', 'left': None, 'right': None})
>>> sd_to_XYZ_integration(sd, cmfs, illuminant) / 100
...
array([ 0.2065436...,  0.1219996...,  0.0513764...])

```

Ancillary Objects

`colour.recovery`

| | |
|--|--|
| <code>MSDS_BASIS_FUNCTIONS_sRGB_MALLETT2019</code> | the base object for multi spectral computations. |
| <code>SPECTRAL_SHAPE_sRGB_MALLETT2019</code> | Shape for <i>Mallett and Yuksel (2019) sRGB</i> colourspace basis functions: (380, 780, 5). |
| <code>spectral_primary_decomposition_Mallett2019(..</code> | Perform the spectral primary decomposition as described in <i>Mallett and Yuksel (2019)</i> for given RGB colourspace. |

`colour.recovery.MSDS_BASIS_FUNCTIONS_sRGB_MALLETT2019`

`colour.recovery.MSDS_BASIS_FUNCTIONS_sRGB_MALLETT2019 =`
`MultiSpectralDistributions(name='Basis Functions - sRGB - Mallett 2019', ...)`

the base object for multi spectral computations. It is used to model colour matching functions, display primaries, camera sensitivities, etc...

The multi-spectral distributions will be initialised according to *CIE 15:2004* recommendation: the method developed by *Sprague (1880)* will be used for interpolating functions having a uniformly spaced independent variable and the *Cubic Spline* method for non-uniformly spaced independent variable. Extrapolation is performed according to *CIE 167:2005* recommendation.

Important: Specific documentation about getting, setting, indexing and slicing the multi-spectral power distributions values is available in the [Spectral Representation and Continuous Signal](#) section.

Parameters

- **data** – Data to be stored in the multi-spectral distributions.
- **domain** – Values to initialise the multiple `colour.SpectralDistribution` class instances `colour.continuous.Signal.wavelengths` attribute with. If both data and domain arguments are defined, the latter will be used to initialise the `colour.continuous.Signal.wavelengths` property.
- **labels** – Names to use for the `colour.SpectralDistribution` class instances.
- **extrapolator** – Extrapolator class type to use as extrapolating function for the `colour.SpectralDistribution` class instances.
- **extrapolator_kwargs** – Arguments to use when instantiating the extrapolating function of the `colour.SpectralDistribution` class instances.
- **interpolator** – Interpolator class type to use as interpolating function for the `colour.SpectralDistribution` class instances.
- **interpolator_kwargs** – Arguments to use when instantiating the interpolating function of the `colour.SpectralDistribution` class instances.

- **name** – Multi-spectral distributions name.
- **display_labels** – Multi-spectral distributions labels for figures, default to `colour.MultiSpectralDistributions.labels` property value.

Warning: The *Cubic Spline* method might produce unexpected results with exceptionally noisy or non-uniformly spaced data.

Attributes

- `display_name`
- `display_labels`
- `wavelengths`
- `values`
- `shape`

Methods

- `__init__()`
- `interpolate()`
- `extrapolate()`
- `align()`
- `trim()`
- `normalise()`
- `to_sds()`

References

[CIET13805a], [CIET13805d], [CIET14804c]

Examples

Instantiating the multi-spectral distributions with a uniformly spaced independent variable:

```
>>> from colour.utilities import numpy_print_options
>>> data = {
...     500: (0.004900, 0.323000, 0.272000),
...     510: (0.009300, 0.503000, 0.158200),
...     520: (0.063270, 0.710000, 0.078250),
...     530: (0.165500, 0.862000, 0.042160),
...     540: (0.290400, 0.954000, 0.020300),
...     550: (0.433450, 0.994950, 0.008750),
...     560: (0.594500, 0.995000, 0.003900),
... }
>>> labels = ("x_bar", "y_bar", "z_bar")
>>> with numpy_print_options(suppress=True):
...     MultiSpectralDistributions(data, labels=labels)
... 
```

(continues on next page)

(continued from previous page)

```

...
MultiSpectral...([[ 500.      ,      0.0049 ,      0.323  ,      0.272  ],
... [ 510.      ,      0.0093 ,      0.503  ,      0.1582 ],
... [ 520.      ,      0.06327,      0.71   ,      0.07825],
... [ 530.      ,      0.1655 ,      0.862  ,      0.04216],
... [ 540.      ,      0.2904 ,      0.954  ,      0.0203  ],
... [ 550.      ,      0.43345,      0.99495,      0.00875],
... [ 560.      ,      0.5945 ,      0.995  ,      0.0039  ]],
... [...'x_bar', ...'y_bar', ...'z_bar'],
... SpragueInterpolator,
... {}),
... Extrapolator,
... {'method': 'Constant', 'left': None, 'right': None})

```

Instantiating a spectral distribution with a non-uniformly spaced independent variable:

```

>>> data[511] = (0.00314, 0.31416, 0.03142)
>>> with numpy_print_options(suppress=True):
...     MultiSpectralDistributions(data, labels=labels)
...
...
MultiSpectral...([[ 500.      ,      0.0049 ,      0.323  ,      0.272  ],
... [ 510.      ,      0.0093 ,      0.503  ,      0.1582 ],
... [ 511.      ,      0.00314,      0.31416,      0.03142],
... [ 520.      ,      0.06327,      0.71   ,      0.07825],
... [ 530.      ,      0.1655 ,      0.862  ,      0.04216],
... [ 540.      ,      0.2904 ,      0.954  ,      0.0203  ],
... [ 550.      ,      0.43345,      0.99495,      0.00875],
... [ 560.      ,      0.5945 ,      0.995  ,      0.0039  ]],
... [...'x_bar', ...'y_bar', ...'z_bar'],
... CubicSplineInterpolator,
... {}),
... Extrapolator,
... {'method': 'Constant', 'left': None, 'right': None})

```

Instantiation with a *Pandas DataFrame*:

```

>>> from colour.utilities import is_pandas_installed
>>> if is_pandas_installed():
...     from pandas import DataFrame
...
...     x_bar = [data[key][0] for key in sorted(data.keys())]
...     y_bar = [data[key][1] for key in sorted(data.keys())]
...     z_bar = [data[key][2] for key in sorted(data.keys())]
...     print(
...         MultiSignals(
...             DataFrame(
...                 dict(zip(labels, [x_bar, y_bar, z_bar])), data.keys()
...             )
...         )
...     )
...
[[ 5.0000000...e+02  4.9000000...e-03  3.2300000...e-01  2.7200000...e-01]
 [ 5.1000000...e+02  9.3000000...e-03  5.0300000...e-01  1.5820000...e-01]
 [ 5.2000000...e+02  3.1400000...e-03  3.1416000...e-01  3.1420000...e-02]
 [ 5.3000000...e+02  6.3270000...e-02  7.1000000...e-01  7.8250000...e-02]

```

(continues on next page)

(continued from previous page)

```
[ 5.4000000...e+02  1.6550000...e-01  8.6200000...e-01  4.2160000...e-02]
[ 5.5000000...e+02  2.9040000...e-01  9.5400000...e-01  2.0300000...e-02]
[ 5.6000000...e+02  4.3345000...e-01  9.9495000...e-01  8.7500000...e-03]
[ 5.1100000...e+02  5.9450000...e-01  9.9500000...e-01  3.9000000...e-03]]
```

Type

Define the multi-spectral distributions

colour.recovery.SPECTRAL_SHAPE_sRGB_MALLETT2019`colour.recovery.SPECTRAL_SHAPE_sRGB_MALLETT2019 = SpectralShape(380, 780, 5)`Shape for *Mallett and Yuksel (2019)* sRGB colourspace basis functions: (380, 780, 5).**References**

[MY19]

colour.recovery.spectral_primary_decomposition_Mallett2019

```
colour.recovery.spectral_primary_decomposition_Mallett2019(colourspace: RGB_Colourspace,
                                                           cmfs: MultiSpectralDistributions |
                                                           None = None, illuminant:
                                                           SpectralDistribution | None = None,
                                                           metric: Callable = np.linalg.norm,
                                                           metric_args: Tuple = tuple(),
                                                           optimisation_kwargs: Dict | None =
                                                           None) → MultiSpectralDistributions
```

Perform the spectral primary decomposition as described in *Mallett and Yuksel (2019)* for given RGB colourspace.**Parameters**

- **colourspace** (`RGB_Colourspace`) – RGB colourspace.
- **cmfs** (`MultiSpectralDistributions` | `None`) – Standard observer colour matching functions, default to the *CIE 1931 2 Degree Standard Observer*.
- **illuminant** (`SpectralDistribution` | `None`) – Illuminant spectral distribution, default to *CIE Standard Illuminant D65*.
- **metric** (`Callable`) – Function to be minimised, i.e. the objective function.
`metric(basis, *metric_args) -> float`
 where `basis` is three reflectances concatenated together, each with a shape matching shape.
- **metric_args** (`Tuple`) – Additional arguments passed to `metric`.
- **optimisation_kwargs** (`Dict` | `None`) – Parameters for `scipy.optimize.minimize()` definition.

Returns

Basis functions for given RGB colourspace.

Return type`colour.MultiSpectralDistributions`

References

[MY19]

Notes

- In-addition to the *BT.709* primaries used by the *sRGB* colourspace, [MY19] tried *BT.2020*, *P3 D65*, *Adobe RGB 1998*, *NTSC (1987)*, *Pal/Secam*, *ProPhoto RGB*, and *Adobe Wide Gamut RGB* primaries, every one of which encompasses a larger (albeit not-always-enveloping) set of *CIE L*a*b** colours than *BT.709*. Of these, only *Pal/Secam* produces a feasible basis, which is relatively unsurprising since it is very similar to *BT.709*, whereas the others are significantly larger.

Examples

```
>>> from colour import MSDS_CMFS, SDS_ILLUMINANTS, SpectralShape
>>> from colour.models import RGB_COLOURSPACE_PAL_SECAM
>>> from colour.utilities import numpy_print_options
>>> cmfs = (
...     MSDS_CMFS["CIE 1931 2 Degree Standard Observer"]
...     .copy()
...     .align(SpectralShape(360, 780, 10))
... )
>>> illuminant = SDS_ILLUMINANTS["D65"].copy().align(cmfs.shape)
>>> msds = spectral_primary_decomposition_Mallett2019(
...     RGB_COLOURSPACE_PAL_SECAM,
...     cmfs,
...     illuminant,
...     optimisation_kwargs={"options": {"ftol": 1e-5}},
... )
>>> with numpy_print_options(suppress=True):
...     print(msds)
...
[[ 360.          0.3395134...  0.3400214...  0.3204650...]
 [ 370.          0.3355246...  0.3338028...  0.3306724...]
 [ 380.          0.3376707...  0.3185578...  0.3437715...]
 [ 390.          0.3178866...  0.3351754...  0.3469378...]
 [ 400.          0.3045154...  0.3248376...  0.3706469...]
 [ 410.          0.2935652...  0.2919463...  0.4144884...]
 [ 420.          0.1875740...  0.1853729...  0.6270530...]
 [ 430.          0.0167983...  0.054483 ...  0.9287186...]
 [ 440.          0.          ...  0.          ...  1.          ...]
 [ 450.          0.          ...  0.          ...  1.          ...]
 [ 460.          0.          ...  0.          ...  1.          ...]
 [ 470.          0.          ...  0.0458044...  0.9541955...]
 [ 480.          0.          ...  0.2960917...  0.7039082...]
 [ 490.          0.          ...  0.5042592...  0.4957407...]
 [ 500.          0.          ...  0.6655795...  0.3344204...]
 [ 510.          0.          ...  0.8607541...  0.1392458...]
 [ 520.          0.          ...  0.9999998...  0.0000001...]
 [ 530.          0.          ...  1.          ...  0.          ...]
 [ 540.          0.          ...  1.          ...  0.          ...]
 [ 550.          0.          ...  1.          ...  0.          ...]
 [ 560.          0.          ...  0.9924229...  0.          ...]
 [ 570.          0.          ...  0.9970703...  0.0025673...]
```

(continues on next page)

(continued from previous page)

```
[ 580.      0.0396002...  0.9028231...  0.0575766...]
[ 590.      0.7058973...  0.2941026...  0.         ...]
[ 600.      1.         ...  0.         ...  0.         ...]
[ 610.      1.         ...  0.         ...  0.         ...]
[ 620.      1.         ...  0.         ...  0.         ...]
[ 630.      1.         ...  0.         ...  0.         ...]
[ 640.      0.9835925...  0.0100166...  0.0063908...]
[ 650.      0.7878949...  0.1265097...  0.0855953...]
[ 660.      0.5987994...  0.2051062...  0.1960942...]
[ 670.      0.4724493...  0.2649623...  0.2625883...]
[ 680.      0.3989806...  0.3007488...  0.3002704...]
[ 690.      0.3666586...  0.3164003...  0.3169410...]
[ 700.      0.3497806...  0.3242863...  0.3259329...]
[ 710.      0.3563736...  0.3232441...  0.3203822...]
[ 720.      0.3362624...  0.3326209...  0.3311165...]
[ 730.      0.3245015...  0.3365982...  0.3389002...]
[ 740.      0.3335520...  0.3320670...  0.3343808...]
[ 750.      0.3441287...  0.3291168...  0.3267544...]
[ 760.      0.3343705...  0.3330132...  0.3326162...]
[ 770.      0.3274633...  0.3305704...  0.3419662...]
[ 780.      0.3475263...  0.3262331...  0.3262404...]
```

Meng, Simon and Hanika (2015)`colour.recovery`

| | |
|---|--|
| <code>XYZ_to_sd_Meng2015(XYZ[, cmfs, illuminant, ...])</code> | Recover the spectral distribution of given <i>CIE</i> XYZ tristimulus values using <i>Meng et al. (2015)</i> method. |
|---|--|

`colour.recovery.XYZ_to_sd_Meng2015`

`colour.recovery.XYZ_to_sd_Meng2015`(*XYZ*: *ArrayLike*, *cmfs*: *MultiSpectralDistributions* | *None* = *None*, *illuminant*: *SpectralDistribution* | *None* = *None*, *optimisation_kwargs*: *Dict* | *None* = *None*) → *SpectralDistribution*

Recover the spectral distribution of given *CIE* XYZ tristimulus values using *Meng et al. (2015)* method.

Parameters

- **XYZ** (*ArrayLike*) – *CIE* XYZ tristimulus values to recover the spectral distribution from.
- **cmfs** (*MultiSpectralDistributions* | *None*) – Standard observer colour matching functions. The wavelength λ_i range interval of the colour matching functions affects directly the time the computations take. The current default interval of 5 is a good compromise between precision and time spent, default to the *CIE 1931 2 Degree Standard Observer*.
- **illuminant** (*SpectralDistribution* | *None*) – Illuminant spectral distribution, default to *CIE Standard Illuminant D65*.
- **optimisation_kwargs** (*Dict* | *None*) – Parameters for `scipy.optimize.minimize()` definition.

Returns

Recovered spectral distribution.

Return type

`colour.SpectralDistribution`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

- The definition used to convert spectrum to *CIE XYZ* tristimulus values is `colour.colorimetry.spectral_to_XYZ_integration()` definition because it processes any measurement interval opposed to `colour.colorimetry.sd_to_XYZ_ASTME308()` definition that handles only measurement interval of 1, 5, 10 or 20nm.

References

[MSHD15]

Examples

```
>>> from colour import MSDS_CMFS, SDS_ILLUMINANTS
>>> from colour.utilities import numpy_print_options
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> cmfs = (
...     MSDS_CMFS["CIE 1931 2 Degree Standard Observer"]
...     .copy()
...     .align(SpectralShape(360, 780, 10))
... )
>>> illuminant = SDS_ILLUMINANTS["D65"].copy().align(cmfs.shape)
>>> sd = XYZ_to_sd_Meng2015(XYZ, cmfs, illuminant)
>>> with numpy_print_options(suppress=True):
...     sd
...
SpectralDistribution([[ 360.      ,  0.0762005...],
                    [ 370.      ,  0.0761792...],
                    [ 380.      ,  0.0761363...],
                    [ 390.      ,  0.0761194...],
                    [ 400.      ,  0.0762539...],
                    [ 410.      ,  0.0761671...],
                    [ 420.      ,  0.0754649...],
                    [ 430.      ,  0.0731519...],
                    [ 440.      ,  0.0676701...],
                    [ 450.      ,  0.0577800...],
                    [ 460.      ,  0.0441993...],
                    [ 470.      ,  0.0285064...],
                    [ 480.      ,  0.0138728...],
                    [ 490.      ,  0.0033585...],
                    [ 500.      ,  0.      ...],
                    [ 510.      ,  0.      ...],
                    [ 520.      ,  0.      ...],
                    [ 530.      ,  0.      ...],
```

(continues on next page)

(continued from previous page)

```

[ 540.      , 0.0055767...],
[ 550.      , 0.0317581...],
[ 560.      , 0.0754491...],
[ 570.      , 0.1314115...],
[ 580.      , 0.1937649...],
[ 590.      , 0.2559311...],
[ 600.      , 0.3123173...],
[ 610.      , 0.3584966...],
[ 620.      , 0.3927335...],
[ 630.      , 0.4159458...],
[ 640.      , 0.4306660...],
[ 650.      , 0.4391040...],
[ 660.      , 0.4439497...],
[ 670.      , 0.4463618...],
[ 680.      , 0.4474625...],
[ 690.      , 0.4479868...],
[ 700.      , 0.4482116...],
[ 710.      , 0.4482800...],
[ 720.      , 0.4483472...],
[ 730.      , 0.4484251...],
[ 740.      , 0.4484633...],
[ 750.      , 0.4485071...],
[ 760.      , 0.4484969...],
[ 770.      , 0.4484853...],
[ 780.      , 0.4485134...]],
interpolator=SpragueInterpolator,
interpolator_kwargs={},
extrapolator=Extrapolator,
extrapolator_kwargs={...})
>>> sd_to_XYZ_integration(sd, cmfs, illuminant) / 100
array([ 0.2065400..., 0.1219722..., 0.0513695...])

```

Otsu, Yamamoto and Hachisuka (2018)

`colour.recovery`

| | |
|---|--|
| <code>XYZ_to_sd_Otsu2018(XYZ[, cmfs, illuminant, ...])</code> | Recover the spectral distribution of given <i>CIE</i> XYZ tristimulus values using <i>Otsu et al. (2018)</i> method. |
|---|--|

`colour.recovery.XYZ_to_sd_Otsu2018`

`colour.recovery.XYZ_to_sd_Otsu2018(XYZ: ArrayLike, cmfs: MultiSpectralDistributions | None = None, illuminant: SpectralDistribution | None = None, dataset: Dataset_Otsu2018 = DATASET_REFERENCE_OTSU2018, clip: bool = True) → SpectralDistribution`

Recover the spectral distribution of given *CIE* XYZ tristimulus values using *Otsu et al. (2018)* method.

Parameters

- **XYZ** (ArrayLike) – *CIE* XYZ tristimulus values to recover the spectral distribution from.

- **cmfs** ([MultiSpectralDistributions](#) | None) – Standard observer colour matching functions, default to the *CIE 1931 2 Degree Standard Observer*.
- **illuminant** ([SpectralDistribution](#) | None) – Illuminant spectral distribution, default to *CIE Standard Illuminant D65*.
- **dataset** ([Dataset_Otsu2018](#)) – Dataset to use for reconstruction. The default is to use the published data.
- **clip** ([bool](#)) – If *True*, the default, values below zero and above unity in the recovered spectral distributions will be clipped. This ensures that the returned reflectance is physical and conserves energy, but will cause noticeable colour differences in case of very saturated colours.

Returns

Recovered spectral distribution. Its shape is always that of the `colour.recovery.SPECTRAL_SHAPE_OTSU2018` class instance.

Return type

[colour.SpectralDistribution](#)

Raises

ValueError – If the dataset shape is undefined.

References

[OYH18]

Examples

```
>>> from colour import (
...     CCS_ILLUMINANTS,
...     SDS_ILLUMINANTS,
...     MSDS_CMFS,
...     XYZ_to_sRGB,
... )
>>> from colour.colorimetry import sd_to_XYZ_integration
>>> from colour.utilities import numpy_print_options
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> cmfs = (
...     MSDS_CMFS["CIE 1931 2 Degree Standard Observer"]
...     .copy()
...     .align(SPECTRAL_SHAPE_OTSU2018)
... )
>>> illuminant = SDS_ILLUMINANTS["D65"].copy().align(cmfs.shape)
>>> sd = XYZ_to_sd_Otsu2018(XYZ, cmfs, illuminant)
>>> with numpy_print_options(suppress=True):
...     sd
...
SpectralDistribution([[ 380.          ,  0.0601939...],
                    [ 390.          ,  0.0568063...],
                    [ 400.          ,  0.0517429...],
                    [ 410.          ,  0.0495841...],
                    [ 420.          ,  0.0502007...],
                    [ 430.          ,  0.0506489...],
                    [ 440.          ,  0.0510020...],
                    [ 450.          ,  0.0493782...],
                    [ 460.          ,  0.0468046...],
```

(continues on next page)

(continued from previous page)

```

[ 470.      , 0.0437132...],
[ 480.      , 0.0416957...],
[ 490.      , 0.0403783...],
[ 500.      , 0.0405197...],
[ 510.      , 0.0406031...],
[ 520.      , 0.0416912...],
[ 530.      , 0.0430956...],
[ 540.      , 0.0444474...],
[ 550.      , 0.0459336...],
[ 560.      , 0.0507631...],
[ 570.      , 0.0628967...],
[ 580.      , 0.0844661...],
[ 590.      , 0.1334277...],
[ 600.      , 0.2262428...],
[ 610.      , 0.3599330...],
[ 620.      , 0.4885571...],
[ 630.      , 0.5752546...],
[ 640.      , 0.6193023...],
[ 650.      , 0.6450744...],
[ 660.      , 0.6610548...],
[ 670.      , 0.6688673...],
[ 680.      , 0.6795426...],
[ 690.      , 0.6887933...],
[ 700.      , 0.7003469...],
[ 710.      , 0.7084128...],
[ 720.      , 0.7154674...],
[ 730.      , 0.7234334...]],
SpragueInterpolator,
{},
Extrapolator,
{'method': 'Constant', 'left': None, 'right': None})
>>> sd_to_XYZ_integration(sd, cmfs, illuminant) / 100
array([ 0.2065494..., 0.1219712..., 0.0514002...])

```

Ancillary Objects

colour.recovery

| | |
|--|--|
| <code>Dataset_Otsu2018([shape, basis_functions, ...])</code> | Store all the information needed for the <i>Otsu et al. (2018)</i> spectral upsampling method. |
| <code>Tree_Otsu2018(*args, **kwargs)</code> | A sub-class of <code>colour.recovery.otsu2018.Node</code> class representing the root node of a tree containing information shared with all the nodes, such as the standard observer colour matching functions and the illuminant, if any is used. |

colour.recovery.Dataset_Otsu2018

class colour.recovery.Dataset_Otsu2018(shape: SpectralShape | None = None, basis_functions: ndarray | None = None, means: ndarray | None = None, selector_array: ndarray | None = None)

Store all the information needed for the *Otsu et al. (2018)* spectral upsampling method.

Datasets can be either generated and converted as a `colour.recovery.Dataset_Otsu2018` class instance using the `colour.recovery.Tree_Otsu2018.to_dataset()` method or alternatively, loaded from disk with the `colour.recovery.Dataset_Otsu2018.read()` method.

Parameters

- **shape** (Optional[SpectralShape]) – Shape of the spectral data.
- **basis_functions** (Optional[NDArray]) – Three basis functions for every cluster.
- **means** (Optional[NDArray]) – Mean for every cluster.
- **selector_array** (Optional[NDArray]) – Array describing how to select the appropriate cluster. See `colour.recovery.Dataset_Otsu2018.select()` method for details.

Attributes

- shape
- basis_functions
- means
- selector_array

Methods

- `__init__()`
- `select()`
- `cluster()`
- `read()`
- `write()`

References

[OYH18]

Examples

```
>>> import os
>>> import colour
>>> from colour.characterisation import SDS_COLOURCHECKERS
>>> from colour.colorimetry import sds_and_msds_to_msds
>>> reflectances = sds_and_msds_to_msds(
...     SDS_COLOURCHECKERS["ColorChecker N 0hta"].values()
... )
>>> node_tree = Tree_Otsu2018(reflectances)
>>> node_tree.optimise(iterations=2, print_callable=lambda x: x)
```

(continues on next page)

(continued from previous page)

```

>>> dataset = node_tree.to_dataset()
>>> path = os.path.join(
...     colour.__path__[0],
...     "recovery",
...     "tests",
...     "resources",
...     "ColorChecker_Otsu2018.npz",
... )
>>> dataset.write(path)
>>> dataset = Dataset_Otsu2018()
>>> dataset.read(path)

```

__init__(shape: `SpectralShape` | `None` = `None`, basis_functions: `ndarray` | `None` = `None`, means: `ndarray` | `None` = `None`, selector_array: `ndarray` | `None` = `None`) → `None`

Parameters

- **shape** (`SpectralShape` | `None`) –
- **basis_functions** (`ndarray` | `None`) –
- **means** (`ndarray` | `None`) –
- **selector_array** (`ndarray` | `None`) –

Return type

`None`

Methods

| | |
|--|--|
| __init__ ([shape, basis_functions, means, ...]) | |
| cluster (xy) | Return the basis functions and dataset mean for the given <i>CIE xy</i> coordinates. |
| read (path) | Read and loads a dataset from an <i>.npz</i> file. |
| select (xy) | Return the cluster index appropriate for the given <i>CIE xy</i> coordinates. |
| write (path) | Write the dataset to an <i>.npz</i> file at given path. |

Attributes

| | |
|------------------------|---|
| basis_functions | Getter property for the basis functions of the <i>Otsu et al. (2018)</i> dataset. |
| means | Getter property for means of the <i>Otsu et al. (2018)</i> dataset. |
| selector_array | Getter property for the selector array of the <i>Otsu et al. (2018)</i> dataset. |
| shape | Getter property for the shape used by the <i>Otsu et al. (2018)</i> dataset. |

colour.recovery.Tree_Otsu2018

class colour.recovery.Tree_Otsu2018(*args: Any, **kwargs: Any)

A sub-class of colour.recovery.otsu2018.Node class representing the root node of a tree containing information shared with all the nodes, such as the standard observer colour matching functions and the illuminant, if any is used.

Global operations involving the entire tree, such as optimisation and conversion to dataset, are implemented in this sub-class.

Parameters

- **reflectances** (MultiSpectralDistributions) – Reference reflectances of the n reference colours to use for optimisation.
- **cmfs** (Optional[MultiSpectralDistributions]) – Standard observer colour matching functions, default to the *CIE 1931 2 Degree Standard Observer*.
- **illuminant** (Optional[SpectralDistribution]) – Illuminant spectral distribution, default to *CIE Standard Illuminant D65*.

Attributes

- reflectances
- cmfs
- illuminant

Methods

- `__init__()`
- `__str__()`
- `optimise()`
- `to_dataset()`

References

[OYH18]

Examples

```
>>> import os
>>> import colour
>>> from colour import MSDS_CMFS, SDS_COLOURCHECKERS, SDS_ILLUMINANTS
>>> from colour.colorimetry import sds_and_msds_to_msds
>>> from colour.utilities import numpy_print_options
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> cmfs = (
...     MSDS_CMFS["CIE 1931 2 Degree Standard Observer"]
...     .copy()
...     .align(SpectralShape(360, 780, 10))
... )
>>> illuminant = SDS_ILLUMINANTS["D65"].copy().align(cmfs.shape)
>>> reflectances = sds_and_msds_to_msds(
...     SDS_COLOURCHECKERS["ColorChecker N 0hta"].values()
```

(continues on next page)

(continued from previous page)

```

... )
>>> node_tree = Tree_Otsu2018(reflectances, cmfs, illuminant)
>>> node_tree.optimise(iterations=2, print_callable=lambda x: x)
>>> dataset = node_tree.to_dataset()
>>> path = os.path.join(
...     colour.__path__[0],
...     "recovery",
...     "tests",
...     "resources",
...     "ColorChecker_Otsu2018.npz",
... )
>>> dataset.write(path)
>>> dataset = Dataset_Otsu2018()
>>> dataset.read(path)
>>> sd = XYZ_to_sd_Otsu2018(XYZ, cmfs, illuminant, dataset)
>>> with numpy_print_options(suppress=True):
...     sd
...
SpectralDistribution([[ 360.      ,  0.0651341...],
                    [ 370.      ,  0.0651341...],
                    [ 380.      ,  0.0651341...],
                    [ 390.      ,  0.0749684...],
                    [ 400.      ,  0.0815578...],
                    [ 410.      ,  0.0776439...],
                    [ 420.      ,  0.0721897...],
                    [ 430.      ,  0.0649064...],
                    [ 440.      ,  0.0567185...],
                    [ 450.      ,  0.0484685...],
                    [ 460.      ,  0.0409768...],
                    [ 470.      ,  0.0358964...],
                    [ 480.      ,  0.0307857...],
                    [ 490.      ,  0.0270148...],
                    [ 500.      ,  0.0273773...],
                    [ 510.      ,  0.0303157...],
                    [ 520.      ,  0.0331285...],
                    [ 530.      ,  0.0363027...],
                    [ 540.      ,  0.0425987...],
                    [ 550.      ,  0.0513442...],
                    [ 560.      ,  0.0579256...],
                    [ 570.      ,  0.0653850...],
                    [ 580.      ,  0.0929522...],
                    [ 590.      ,  0.1600326...],
                    [ 600.      ,  0.2586159...],
                    [ 610.      ,  0.3701242...],
                    [ 620.      ,  0.4702243...],
                    [ 630.      ,  0.5396261...],
                    [ 640.      ,  0.5737561...],
                    [ 650.      ,  0.590848 ...],
                    [ 660.      ,  0.5935371...],
                    [ 670.      ,  0.5923295...],
                    [ 680.      ,  0.5956326...],
                    [ 690.      ,  0.5982513...],
                    [ 700.      ,  0.6017904...],
                    [ 710.      ,  0.6016419...],
                    [ 720.      ,  0.5996892...],
                    [ 730.      ,  0.6000018...],

```

(continues on next page)

(continued from previous page)

```
[ 740.      ,    0.5964443...],
[ 750.      ,    0.5868181...],
[ 760.      ,    0.5860973...],
[ 770.      ,    0.5614878...],
[ 780.      ,    0.5289331...]],
SpragueInterpolator,
{},
Extrapolator,
{'method': 'Constant', 'left': None, 'right': None})
```

Return a new instance of the `colour.utilities.Node` class.

Parameters

- **args** – Arguments.
- **kwargs** – Keywords arguments.
- **reflectances** (`MultiSpectralDistributions`) –
- **cmfs** (`Optional[MultiSpectralDistributions]`) –
- **illuminant** (`Optional[SpectralDistribution]`) –

__init__(*reflectances*: `MultiSpectralDistributions`, *cmfs*: `MultiSpectralDistributions` | `None` = `None`, *illuminant*: `SpectralDistribution` | `None` = `None`) → `None`

Parameters

- **reflectances** (`MultiSpectralDistributions`) –
- **cmfs** (`MultiSpectralDistributions` | `None`) –
- **illuminant** (`SpectralDistribution` | `None`) –

Return type

`None`

Methods

| | |
|--|--|
| <code>__init__(reflectances[, cmfs, illuminant])</code> | |
| <code>branch_reconstruction_error()</code> | Compute the reconstruction error for all the leaves data connected to the node or its children, i.e. the reconstruction errors summation for all the leaves in the branch. |
| <code>is_inner()</code> | Return whether the node is an inner node. |
| <code>is_leaf()</code> | Return whether the node is a leaf node. |
| <code>is_root()</code> | Return whether the node is a root node. |
| <code>leaf_reconstruction_error()</code> | Return the reconstruction error of the node data. |
| <code>minimise(minimum_cluster_size)</code> | Find the best partition for the node that minimises the leaf reconstruction error. |
| <code>optimise([iterations, minimum_cluster_size, ...])</code> | Optimise the tree by repeatedly performing optimal partitioning of the nodes, creating a tree that minimises the total reconstruction error. |
| <code>render([tab_level])</code> | Render the current node and its children as a string. |
| <code>split(children, axis)</code> | Convert the leaf node into an inner node using given children and partition axis. |
| <code>to_dataset()</code> | Create a <code>colour.recovery.Dataset_Otsu2018</code> class instance based on data stored in the tree. |
| <code>walk([ascendants])</code> | Return a generator used to walk into <code>colour.utilities.Node</code> trees. |

Attributes

| | |
|-----------------------------|--|
| <code>children</code> | Getter and setter property for the node children. |
| <code>cmfs</code> | Getter property for the standard observer colour matching functions. |
| <code>data</code> | Getter property for the node data. |
| <code>id</code> | Getter property for the node id. |
| <code>illuminant</code> | Getter property for the illuminant. |
| <code>leaves</code> | Getter property for the node leaves. |
| <code>name</code> | Getter and setter property for the name. |
| <code>parent</code> | Getter and setter property for the node parent. |
| <code>partition_axis</code> | Getter property for the node partition axis. |
| <code>reflectances</code> | Getter property for the reference reflectances. |
| <code>root</code> | Getter property for the node tree. |
| <code>row</code> | Getter property for the node row for the selector array. |
| <code>siblings</code> | Getter property for the node siblings. |

Smits (1999)

`colour.recovery`

| | |
|---|---|
| <code>RGB_to_sd_Smits1999(</code> <code>RGB)</code> | Recover the spectral distribution of given <i>RGB</i> colourspace array using <i>Smits (1999)</i> method. |
| <code>SDS_SMITS1999</code> | <i>Smits (1999)</i> spectral distributions. |

`colour.recovery.RGB_to_sd_Smits1999`

`colour.recovery.RGB_to_sd_Smits1999(`*RGB: ArrayLike*`) →` *SpectralDistribution*

Recover the spectral distribution of given *RGB* colourspace array using *Smits (1999)* method.

Parameters

RGB (ArrayLike) – *RGB* colourspace array to recover the spectral distribution from.

Returns

Recovered spectral distribution.

Return type

`colour.SpectralDistribution`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| RGB | [0, 1] | [0, 1] |

References

[Smi99]

Examples

```

>>> from colour import MSDS_CMFS, SDS_ILLUMINANTS, SpectralShape
>>> from colour.colorimetry import sd_to_XYZ_integration
>>> from colour.utilities import numpy_print_options
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> RGB = XYZ_to_RGB_Smits1999(XYZ)
>>> cmfs = (
...     MSDS_CMFS["CIE 1931 2 Degree Standard Observer"]
...     .copy()
...     .align(SpectralShape(360, 780, 10))
... )
>>> illuminant = SDS_ILLUMINANTS["E"].copy().align(cmfs.shape)
>>> sd = RGB_to_sd_Smits1999(RGB)
>>> with numpy_print_options(suppress=True):
...     sd
...
SpectralDistribution([[ 380.      ,  0.0787830...],
                    [ 417.7778 ,  0.0622018...],
                    [ 455.5556 ,  0.0446206...],
                    [ 493.3333 ,  0.0352220...],

```

(continues on next page)

(continued from previous page)

```

[ 531.1111      , 0.0324149...],
[ 568.8889      , 0.0330105...],
[ 606.6667      , 0.3207115...],
[ 644.4444      , 0.3836164...],
[ 682.2222      , 0.3836164...],
[ 720.          , 0.3835649...]],
LinearInterpolator,
{},
Extrapolator,
{'method': 'Constant', 'left': None, 'right': None})
>>> sd_to_XYZ_integration(sd, cmfs, illuminant) / 100
array([ 0.1894770..., 0.1126470..., 0.0474420...])

```

colour.recovery.SDS_SMITS1999

```
colour.recovery.SDS_SMITS1999 = CanonicalMapping({'white': ..., 'cyan': ..., 'magenta': ..., 'yellow': ..., 'red': ..., 'green': ..., 'blue': ...})
```

Smits (1999) spectral distributions.

References

[Smi99]

Camera RGB Sensitivities Recovery

Jiang, Liu, Gu and Süsstrunk (2013)

colour.recovery

| | |
|--|--|
| RGB_to_sd_camera_sensitivity_Jiang2013(RGB, ...) | Recover a single camera <i>RGB</i> sensitivity for given camera <i>RGB</i> values using <i>Jiang et al. (2013)</i> method. |
| RGB_to_msds_camera_sensitivities_Jiang2013(.. | Recover the camera <i>RGB</i> sensitivities for given camera <i>RGB</i> values using <i>Jiang et al. (2013)</i> method. |

colour.recovery.RGB_to_sd_camera_sensitivity_Jiang2013

```
colour.recovery.RGB_to_sd_camera_sensitivity_Jiang2013(RGB: ArrayLike, illuminant: SpectralDistribution, reflectances: MultiSpectralDistributions, eigen_w: ArrayLike, shape: SpectralShape | None = None) → SpectralDistribution
```

Recover a single camera *RGB* sensitivity for given camera *RGB* values using *Jiang et al. (2013)* method.

Parameters

- **RGB** (ArrayLike) – Camera *RGB* values corresponding with reflectances.
- **illuminant** (SpectralDistribution) – Illuminant spectral distribution used to produce the camera *RGB* values.

- **reflectances** ([MultiSpectralDistributions](#)) – Reflectance spectral distributions used to produce the camera *RGB* values.
- **eigen_w** (*ArrayLike*) – Eigen-vectors v for the particular camera *RGB* sensitivity being recovered.
- **shape** ([SpectralShape](#) | *None*) – Spectral shape of the recovered camera *RGB* sensitivity, illuminant and reflectances will be aligned to it if passed, otherwise, illuminant shape is used.

Returns

Recovered camera *RGB* sensitivities.

Return type

`colour.RGB_CameraSensitivities`

Examples

```
>>> from colour.colorimetry import (
...     SDS_ILLUMINANTS,
...     msds_to_XYZ,
...     sds_and_msds_to_msds,
... )
>>> from colour.characterisation import (
...     MSDS_CAMERA_SENSITIVITIES,
...     SDS_COLOURCHECKERS,
... )
>>> from colour.recovery import SPECTRAL_SHAPE_BASIS_FUNCTIONS_DYER2017
>>> illuminant = SDS_ILLUMINANTS["D65"]
>>> sensitivities = MSDS_CAMERA_SENSITIVITIES["Nikon 5100 (NPL)"]
>>> reflectances = [
...     sd.copy().align(SPECTRAL_SHAPE_BASIS_FUNCTIONS_DYER2017)
...     for sd in SDS_COLOURCHECKERS["BabelColor Average"].values()
... ]
>>> reflectances = sds_and_msds_to_msds(reflectances)
>>> R, G, B = tsplit(
...     msds_to_XYZ(
...         reflectances,
...         method="Integration",
...         cmfs=sensitivities,
...         illuminant=illuminant,
...         k=1,
...         shape=SPECTRAL_SHAPE_BASIS_FUNCTIONS_DYER2017,
...     )
... )
>>> R_w, G_w, B_w = tsplit(np.moveaxis(BASIS_FUNCTIONS_DYER2017, 0, 1))
>>> RGB_to_sd_camera_sensitivity_Jiang2013(
...     R,
...     illuminant,
...     reflectances,
...     R_w,
...     SPECTRAL_SHAPE_BASIS_FUNCTIONS_DYER2017,
... )
SpectralDistribution([[ 4.00000000e+02,  7.3976716...e-04],
                    [ 4.10000000e+02, -8.7040243...e-04],
                    [ 4.20000000e+02,  4.6893657...e-03],
                    [ 4.30000000e+02,  7.7522012...e-03],
                    [ 4.40000000e+02,  6.9238417...e-03],
```

(continues on next page)

(continued from previous page)

```
[ 4.50000000e+02, 5.3089422...e-03],
[ 4.60000000e+02, 4.4780109...e-03],
[ 4.70000000e+02, 4.6386816...e-03],
[ 4.80000000e+02, 5.1897663...e-03],
[ 4.90000000e+02, 4.3906620...e-03],
[ 5.00000000e+02, 4.2189259...e-03],
[ 5.10000000e+02, 5.4270976...e-03],
[ 5.20000000e+02, 9.6722601...e-03],
[ 5.30000000e+02, 1.4272520...e-02],
[ 5.40000000e+02, 7.9609053...e-03],
[ 5.50000000e+02, 4.5917460...e-03],
[ 5.60000000e+02, 5.2723695...e-03],
[ 5.70000000e+02, 1.0479224...e-02],
[ 5.80000000e+02, 5.3101298...e-02],
[ 5.90000000e+02, 9.8185490...e-02],
[ 6.00000000e+02, 9.9775094...e-02],
[ 6.10000000e+02, 8.3935824...e-02],
[ 6.20000000e+02, 6.9216733...e-02],
[ 6.30000000e+02, 5.6902763...e-02],
[ 6.40000000e+02, 4.2810635...e-02],
[ 6.50000000e+02, 3.0064003...e-02],
[ 6.60000000e+02, 2.3093789...e-02],
[ 6.70000000e+02, 1.3756855...e-02],
[ 6.80000000e+02, 4.1785101...e-03],
[ 6.90000000e+02, -3.8014848...e-04],
[ 7.00000000e+02, -5.7544253...e-04]],
SpragueInterpolator,
{},
Extrapolator,
{'method': 'Constant', 'left': None, 'right': None})
```

colour.recovery.RGB_to_msds_camera_sensitivities_Jiang2013

colour.recovery.RGB_to_msds_camera_sensitivities_Jiang2013(*RGB*: ArrayLike, *illuminant*: SpectralDistribution, *reflectances*: MultiSpectralDistributions, *basis_functions*=BASIS_FUNCTIONS_DYER2017, *shape*: SpectralShape | None = None) → MultiSpectralDistributions

Recover the camera *RGB* sensitivities for given camera *RGB* values using Jiang *et al.* (2013) method.

Parameters

- **RGB** (ArrayLike) – Camera *RGB* values corresponding with reflectances.
- **illuminant** (SpectralDistribution) – Illuminant spectral distribution used to produce the camera *RGB* values.
- **reflectances** (MultiSpectralDistributions) – Reflectance spectral distributions used to produce the camera *RGB* values.
- **basis_functions** – Basis functions for the method. The default is to use the built-in *sRGB* basis functions, i.e. colour.recovery.BASIS_FUNCTIONS_DYER2017.
- **shape** (SpectralShape | None) – Spectral shape of the recovered camera *RGB* sensitivities, illuminant and reflectances will be aligned to it if passed, otherwise, illuminant shape is used.

ReturnsRecovered camera *RGB* sensitivities.**Return type**`colour.RGB_CameraSensitivities`**Examples**

```

>>> from colour.colorimetry import (
...     SDS_ILLUMINANTS,
...     msds_to_XYZ,
...     sds_and_msds_to_msds,
... )
>>> from colour.characterisation import (
...     MSDS_CAMERA_SENSITIVITIES,
...     SDS_COLOURCHECKERS,
... )
>>> from colour.recovery import SPECTRAL_SHAPE_BASIS_FUNCTIONS_DYER2017
>>> illuminant = SDS_ILLUMINANTS["D65"]
>>> sensitivities = MSDS_CAMERA_SENSITIVITIES["Nikon 5100 (NPL)"]
>>> reflectances = [
...     sd.copy().align(SPECTRAL_SHAPE_BASIS_FUNCTIONS_DYER2017)
...     for sd in SDS_COLOURCHECKERS["BabelColor Average"].values()
... ]
>>> reflectances = sds_and_msds_to_msds(reflectances)
>>> RGB = msds_to_XYZ(
...     reflectances,
...     method="Integration",
...     cmfs=sensitivities,
...     illuminant=illuminant,
...     k=1,
...     shape=SPECTRAL_SHAPE_BASIS_FUNCTIONS_DYER2017,
... )
>>> RGB_to_msds_camera_sensitivities_Jiang2013(
...     RGB,
...     illuminant,
...     reflectances,
...     BASIS_FUNCTIONS_DYER2017,
...     SPECTRAL_SHAPE_BASIS_FUNCTIONS_DYER2017,
... ).values
array([[ 7.2281577...e-03,  9.2250648...e-03, -9.8836897...e-03],
       [-8.5045760...e-03,  1.1277748...e-02,  3.8624865...e-03],
       [ 4.5819113...e-02,  7.1552094...e-02,  4.0406829...e-01],
       [ 7.5745635...e-02,  1.1530030...e-01,  7.1177452...e-01],
       [ 6.7651854...e-02,  1.5311354...e-01,  8.5161378...e-01],
       [ 5.1872905...e-02,  1.8828774...e-01,  9.3658053...e-01],
       [ 4.3753995...e-02,  2.6093723...e-01,  9.7049828...e-01],
       [ 4.5323885...e-02,  3.7531459...e-01,  9.5883525...e-01],
       [ 5.0708454...e-02,  4.4750685...e-01,  8.8451412...e-01],
       [ 4.2900523...e-02,  4.5047800...e-01,  7.5069924...e-01],
       [ 4.1222513...e-02,  6.1672868...e-01,  5.5327277...e-01],
       [ 5.3027385...e-02,  7.8015416...e-01,  3.8368507...e-01],
       [ 9.4506252...e-02,  9.1751657...e-01,  2.4143664...e-01],
       [ 1.3945472...e-01,  1.0000000...e+00,  1.5616071...e-01],
       [ 7.7784852...e-02,  9.2719372...e-01,  1.0462050...e-01],
       [ 4.4865285...e-02,  8.5627976...e-01,  6.5035086...e-02],
       [ 5.1515558...e-02,  7.5193757...e-01,  3.3979292...e-02],

```

(continues on next page)

(continued from previous page)

```
[ 1.0239098...e-01, 6.2562412...e-01, 2.0583993...e-02],
[ 5.1884509...e-01, 4.9264953...e-01, 1.4571020...e-02],
[ 9.5935619...e-01, 3.4322427...e-01, 1.0656116...e-02],
[ 9.7488799...e-01, 2.0857245...e-01, 6.8892462...e-03],
[ 8.2012477...e-01, 1.1178699...e-01, 4.3808407...e-03],
[ 6.7630666...e-01, 6.5977834...e-02, 4.0420907...e-03],
[ 5.5598866...e-01, 4.4719007...e-02, 4.2502316...e-03],
[ 4.1829651...e-01, 3.3471790...e-02, 4.6139542...e-03],
[ 2.9375101...e-01, 2.4044889...e-02, 4.7376860...e-03],
[ 2.2564606...e-01, 1.8870707...e-02, 4.6336440...e-03],
[ 1.3441624...e-01, 1.0702974...e-02, 3.4919622...e-03],
[ 4.0827617...e-02, 5.5529047...e-03, 1.3990786...e-03],
[ -3.7143757...e-03, 2.5093564...e-03, 3.9765262...e-04],
[ -5.6225656...e-03, 1.5643397...e-03, 5.8472693...e-04]]
```

Ancillary Objects

`colour.recovery`

| | |
|--|---|
| <code>PCA_Jiang2013(msds_camera_sensitivities[, ...])</code> | Perform the <i>Principal Component Analysis</i> (PCA) on given camera <i>RGB</i> sensitivities. |
|--|---|

`colour.recovery.PCA_Jiang2013`

```
colour.recovery.PCA_Jiang2013(msds_camera_sensitivities: Mapping[str, MultiSpectralDistributions],
                               eigen_w_v_count: int | None = None, additional_data: bool = False)
    → Tuple[Tuple[ndarray, ndarray, ndarray], Tuple[ndarray, ndarray, ndarray]] | Tuple[ndarray, ndarray, ndarray]
```

Perform the *Principal Component Analysis* (PCA) on given camera *RGB* sensitivities.

Parameters

- **`msds_camera_sensitivities`** (`Mapping[str, MultiSpectralDistributions]`) – Camera *RGB* sensitivities.
- **`eigen_w_v_count`** (`int` | `None`) – Eigen-values *w* and eigen-vectors *v* count.
- **`additional_data`** (`bool`) – Whether to return both the eigen-values *w* and eigen-vectors *v*.

Returns

Tuple of camera *RGB* sensitivities eigen-values *w* and eigen-vectors *v* or tuple of camera *RGB* sensitivities eigen-vectors *v*.

Return type

`tuple`

Examples

```
>>> from colour.colorimetry import SpectralShape
>>> from colour.characterisation import MSDS_CAMERA_SENSITIVITIES
>>> shape = SpectralShape(400, 700, 10)
>>> camera_sensitivities = {
...     camera: msds.copy().align(shape)
...     for camera, msds in MSDS_CAMERA_SENSITIVITIES.items()
... }
>>> np.array(PCA_Jiang2013(camera_sensitivities)).shape
(3, 31, 31)
```

Colour Temperature

Correlated Colour Temperature

colour

| | |
|--|--|
| <code>uv_to_CCT(uv[, method])</code> | Return the correlated colour temperature T_{cp} and Δ_{uv} from given <i>CIE UCS</i> colourspace <i>uv</i> chromaticity coordinates using given method. |
| <code>UV_TO_CCT_METHODS</code> | Supported <i>CIE UCS</i> colourspace <i>uv</i> chromaticity coordinates to correlated colour temperature T_{cp} computation methods. |
| <code>CCT_to_uv(CCT_D_uv[, method])</code> | Return the <i>CIE UCS</i> colourspace <i>uv</i> chromaticity coordinates from given correlated colour temperature T_{cp} using given method. |
| <code>CCT_TO_UV_METHODS</code> | Supported correlated colour temperature T_{cp} to <i>CIE UCS</i> colourspace <i>uv</i> chromaticity coordinates computation methods. |
| <code>xy_to_CCT(xy[, method])</code> | Return the correlated colour temperature T_{cp} from given <i>CIE xy</i> chromaticity coordinates using given method. |
| <code>XY_TO_CCT_METHODS</code> | Supported <i>CIE xy</i> chromaticity coordinates to correlated colour temperature T_{cp} computation methods. |
| <code>CCT_to_xy(CCT[, method])</code> | Return the <i>CIE xy</i> chromaticity coordinates from given correlated colour temperature T_{cp} using given method. |
| <code>CCT_TO_XY_METHODS</code> | Supported correlated colour temperature T_{cp} to <i>CIE xy</i> chromaticity coordinates computation methods. |

colour.uv_to_CCT

`colour.uv_to_CCT(uv: ArrayLike, method: Literal['Krystek 1985', 'Ohno 2013', 'Planck 1900', 'Robertson 1968'] | str = 'Ohno 2013', **kwargs: Any) → ndarray`

Return the correlated colour temperature T_{cp} and Δ_{uv} from given *CIE UCS* colourspace *uv* chromaticity coordinates using given method.

Parameters

- uv** (ArrayLike) – *CIE UCS* colourspace *uv* chromaticity coordinates.
- method** ([Literal](#)['Krystek 1985', 'Ohno 2013', 'Planck 1900', 'Robertson 1968'] | str) – Computation method.

- **cmfs** – {`colour.temperature.uv_to_CCT_Ohno2013()`, `colour.temperature.uv_to_CCT_Planck1900()`}, Standard observer colour matching functions.
- **count** – {`colour.temperature.uv_to_CCT_Ohno2013()`}, Temperatures count in the planckian tables.
- **end** – {`colour.temperature.uv_to_CCT_Ohno2013()`}, Temperature range end in kelvins.
- **iterations** – {`colour.temperature.uv_to_CCT_Ohno2013()`}, Number of planckian tables to generate.
- **optimisation_kwargs** – {`colour.temperature.uv_to_CCT_Krystek1985()`}, Parameters for `scipy.optimize.minimize()` definition.
- **start** – {`colour.temperature.uv_to_CCT_Ohno2013()`}, Temperature range start in kelvins.
- **kwargs** (Any) –

Returns

Correlated colour temperature T_{cp} , Δ_{uv} .

Return type

`numpy.ndarray`

References

[AdobeSystems13b], [AdobeSystems13a], [CIET14804e], [Kry85], [Ohn14], [WS00m]

Examples

```
>>> import numpy as np
>>> uv = np.array([0.1978, 0.3122])
>>> uv_to_CCT(uv)
array([ 6.507473...e+03,  3.223346...e-03])
```

colour.UV_TO_CCT_METHODS

```
colour.UV_TO_CCT_METHODS = CanonicalMapping({'Krystek 1985': ..., 'Ohno 2013': ...,
'Planck 1900': ..., 'Robertson 1968': ..., 'ohno2013': ..., 'robertson1968': ...})
```

Supported *CIE UCS* colourspace *uv* chromaticity coordinates to correlated colour temperature T_{cp} computation methods.

References

[AdobeSystems13b], [AdobeSystems13a], [CIET14804e], [Kry85], [Ohn14], [WS00m]

Aliases:

- 'ohno2013': 'Ohno 2013'
- 'robertson1968': 'Robertson 1968'

colour.CCT_to_uv

`colour.CCT_to_uv(CCT_D_uv: ArrayLike, method: Literal['Krystek 1985', 'Ohno 2013', 'Planck 1900', 'Robertson 1968'] | str = 'Ohno 2013', **kwargs: Any) → ndarray`

Return the *CIE UCS* colour space *uv* chromaticity coordinates from given correlated colour temperature T_{cp} using given method.

Parameters

- **CCT_D_uv** (ArrayLike) – Correlated colour temperature T_{cp} , Δ_{uv} .
- **method** (*Literal*['Krystek 1985', 'Ohno 2013', 'Planck 1900', 'Robertson 1968'] | str) – Computation method.
- **cmfs** – {`colour.temperature.CCT_to_uv_Ohno2013()`, `colour.temperature.CCT_to_uv_Planck1900()`}, Standard observer colour matching functions.
- **kwargs** (Any) –

Returns

CIE UCS colour space *uv* chromaticity coordinates.

Return type

`numpy.ndarray`

References

[AdobeSystems13b], [AdobeSystems13a], [CIET14804e], [Kry85], [Ohn14], [WS00m]

Examples

```
>>> import numpy as np
>>> CCT_D_uv = np.array([6507.47380460, 0.00322335])
>>> CCT_to_uv(CCT_D_uv)
array([ 0.1977999...,  0.3121999...])
```

colour.CCT_TO_UV_METHODS

`colour.CCT_TO_UV_METHODS = CanonicalMapping({'Krystek 1985': ..., 'Ohno 2013': ..., 'Planck 1900': ..., 'Robertson 1968': ..., 'ohno2013': ..., 'robertson1968': ...})`

Supported correlated colour temperature T_{cp} to *CIE UCS* colour space *uv* chromaticity coordinates computation methods.

References

[AdobeSystems13b], [AdobeSystems13a], [CIET14804e], [Kry85], [Ohn14], [WS00m]

Aliases:

- 'ohno2013': 'Ohno 2013'
- 'robertson1968': 'Robertson 1968'

colour.xy_to_CCT

`colour.xy_to_CCT(xy: ArrayLike, method: Literal['CIE Illuminant D Series', 'Kang 2002', 'Hernandez 1999', 'McCamy 1992'] | str = 'CIE Illuminant D Series') → FloatingOrNDArray`

Return the correlated colour temperature T_{cp} from given CIE xy chromaticity coordinates using given method.

Parameters

- **xy** (ArrayLike) – CIE xy chromaticity coordinates.
- **method** (*Literal*['CIE Illuminant D Series', 'Kang 2002', 'Hernandez 1999', 'McCamy 1992'] | str) – Computation method.
- **optimisation_kwargs** – {`colour.temperature.xy_to_CCT_CIE_D()`, `colour.temperature.xy_to_CCT_Kang2002()`}, Parameters for `scipy.optimize.minimize()` definition.

Returns

Correlated colour temperature T_{cp} .

Return type

`numpy.floating` or `numpy.ndarray`

References

[HernandezAndresLR99], [KMH+02], [Wikipedia01a], [Wikipedia01b], [WS00k]

Examples

```
>>> import numpy as np
>>> xy_to_CCT(np.array([0.31270, 0.32900]))
6508.1175148...
>>> xy_to_CCT(np.array([0.31270, 0.32900]), "Hernandez 1999")
...
6500.7420431...
```

colour.XY_TO_CCT_METHODS

`colour.XY_TO_CCT_METHODS = CanonicalMapping({'CIE Illuminant D Series': ..., 'Hernandez 1999': ..., 'Kang 2002': ..., 'McCamy 1992': ..., 'daylight': ..., 'kang2002': ..., 'mccamy1992': ..., 'hernandez1999': ...})`

Supported CIE xy chromaticity coordinates to correlated colour temperature T_{cp} computation methods.

References

[HernandezAndresLR99], [KMH+02], [Wikipedia01a], [Wikipedia01b], [WS00k]

Aliases:

- 'daylight': 'CIE Illuminant D Series'
- 'kang2002': 'Kang 2002'
- 'mccamy1992': 'McCamy 1992'
- 'hernandez1999': 'Hernandez 1999'

colour.CCT_to_xy

`colour.CCT_to_xy(CCT: FloatingOrArrayLike, method: Literal['CIE Illuminant D Series', 'Kang 2002', 'Hernandez 1999', 'McCamy 1992'] | str = 'CIE Illuminant D Series') → ndarray`

Return the *CIE* *xy* chromaticity coordinates from given correlated colour temperature T_{cp} using given method.

Parameters

- **CCT** ([FloatingOrArrayLike](#)) – Correlated colour temperature T_{cp} .
- **method** ([Literal](#)['CIE Illuminant D Series', 'Kang 2002', 'Hernandez 1999', 'McCamy 1992'] | *str*) – Computation method.
- **optimisation_kwargs** – {`colour.temperature.CCT_to_xy_Hernandez1999()`, `colour.temperature.CCT_to_xy_McCamy1992()`}, Parameters for `scipy.optimize.minimize()` definition.

Returns

CIE xy chromaticity coordinates.

Return type

[numpy.ndarray](#)

References

[[HernandezAndresLR99](#)], [[KMH+02](#)], [[Wikipedia01a](#)], [[Wikipedia01b](#)], [[WS00k](#)]

Examples

```
>>> CCT_to_xy(6504.38938305)
array([ 0.3127077...,  0.3291128...])
>>> CCT_to_xy(6504.38938305, "Kang 2002")
...
array([ 0.313426 ...,  0.3235959...])
```

colour.CCT_TO_XY_METHODS

`colour.CCT_TO_XY_METHODS = CanonicalMapping({'CIE Illuminant D Series': ..., 'Hernandez 1999': ..., 'Kang 2002': ..., 'McCamy 1992': ..., 'daylight': ..., 'kang2002': ..., 'mccamy1992': ..., 'hernandez1999': ...})`

Supported correlated colour temperature T_{cp} to *CIE xy* chromaticity coordinates computation methods.

References

[[HernandezAndresLR99](#)], [[KMH+02](#)], [[Wikipedia01a](#)], [[Wikipedia01b](#)], [[WS00k](#)]

Aliases:

- 'daylight': 'CIE Illuminant D Series'
- 'kang2002': 'Kang 2002'
- 'mccamy1992': 'McCamy 1992'
- 'hernandez1999': 'Hernandez 1999'

Robertson (1968)

`colour.temperature`

| | |
|--|--|
| <code>uv_to_CCT_Robertson1968(uv)</code> | Return the correlated colour temperature T_{cp} and Δ_{uv} from given <i>CIE UCS</i> colourspace <i>uv</i> chromaticity coordinates using <i>Roberston (1968)</i> method. |
| <code>CCT_to_uv_Robertson1968(CCT_D_uv)</code> | Return the <i>CIE UCS</i> colourspace <i>uv</i> chromaticity coordinates from given correlated colour temperature T_{cp} and Δ_{uv} using <i>Roberston (1968)</i> method. |

`colour.temperature.uv_to_CCT_Robertson1968`

`colour.temperature.uv_to_CCT_Robertson1968(uv: ArrayLike) → ndarray`

Return the correlated colour temperature T_{cp} and Δ_{uv} from given *CIE UCS* colourspace *uv* chromaticity coordinates using *Roberston (1968)* method.

Parameters

uv (ArrayLike) – *CIE UCS* colourspace *uv* chromaticity coordinates.

Returns

Correlated colour temperature T_{cp} , Δ_{uv} .

Return type

`numpy.ndarray`

References

[AdobeSystems13b], [WS00m]

Examples

```
>>> uv = np.array([0.193741375998230, 0.315221043940594])
>>> uv_to_CCT_Robertson1968(uv)
array([ 6.5000162...e+03,  8.3333289...e-03])
```

`colour.temperature.CCT_to_uv_Robertson1968`

`colour.temperature.CCT_to_uv_Robertson1968(CCT_D_uv: ArrayLike) → ndarray`

Return the *CIE UCS* colourspace *uv* chromaticity coordinates from given correlated colour temperature T_{cp} and Δ_{uv} using *Roberston (1968)* method.

Parameters

CCT_D_uv (ArrayLike) – Correlated colour temperature T_{cp} , Δ_{uv} .

Returns

CIE UCS colourspace *uv* chromaticity coordinates.

Return type

`numpy.ndarray`

References

[AdobeSystems13a], [WS00m]

Examples

```
>>> CCT_D_uv = np.array([6500.0081378199056, 0.008333331244225])
>>> CCT_to_uv_Robertson1968(CCT_D_uv)
array([ 0.1937413...,  0.3152210...])
```

Krystek (1985)

colour.temperature

| | | |
|---|-----------|--|
| <code>uv_to_CCT_Krystek1985(uv[, optimisation_kwargs])</code> | optimisa- | Return the correlated colour temperature T_{cp} from given <i>CIE UCS</i> colourspace <i>uv</i> chromaticity coordinates using <i>Krystek (1985)</i> method. |
| <code>CCT_to_uv_Krystek1985(CCT)</code> | | Return the <i>CIE UCS</i> colourspace <i>uv</i> chromaticity coordinates from given correlated colour temperature T_{cp} using <i>Krystek (1985)</i> method. |

colour.temperature.uv_to_CCT_Krystek1985

colour.temperature.uv_to_CCT_Krystek1985(*uv*: ArrayLike, *optimisation_kwargs*: Dict | None = None) → FloatingOrNDArray

Return the correlated colour temperature T_{cp} from given *CIE UCS* colourspace *uv* chromaticity coordinates using *Krystek (1985)* method.

Parameters

- **uv** (ArrayLike) – *CIE UCS* colourspace *uv* chromaticity coordinates.
- **optimisation_kwargs** (Dict | None) – Parameters for `scipy.optimize.minimize()` definition.

Returns

Correlated colour temperature T_{cp} .

Return type

`numpy.floating` or `numpy.ndarray`

Warning: *Krystek (1985)* does not give an analytical inverse transformation to compute the correlated colour temperature T_{cp} from given *CIE UCS* colourspace *uv* chromaticity coordinates, the current implementation relies on optimization using `scipy.optimize.minimize()` definition and thus has reduced precision and poor performance.

Notes

- *Krystek (1985)* method computations are valid for correlated colour temperature T_{cp} normalised to domain [1000, 15000].

References

[Kry85]

Examples

```
>>> uv_to_CCT_Krystek1985(np.array([0.20047203, 0.31029290]))
...
6504.3894290...
```

colour.temperature.CCT_to_uv_Krystek1985

colour.temperature.CCT_to_uv_Krystek1985(*CCT: FloatingOrArrayLike*) → *ndarray*

Return the *CIE UCS* colourspace *uv* chromaticity coordinates from given correlated colour temperature T_{cp} using *Krystek (1985)* method.

Parameters

CCT (*FloatingOrArrayLike*) – Correlated colour temperature T_{cp} .

Returns

CIE UCS colourspace *uv* chromaticity coordinates.

Return type

numpy.ndarray

Notes

- *Krystek (1985)* method computations are valid for correlated colour temperature T_{cp} normalised to domain [1000, 15000].

References

[Kry85]

Examples

```
>>> CCT_to_uv_Krystek1985(6504.38938305)
array([ 0.2004720...,  0.3102929...])
```


Ohno (2013)

`colour.temperature`

| | |
|--|--|
| <code>uv_to_CCT_Ohno2013(uv[, cmfs, start, end, ...])</code> | Return the correlated colour temperature T_{cp} and Δ_{uv} from given <i>CIE UCS</i> colourspace <i>uv</i> chromaticity coordinates, colour matching functions and temperature range using <i>Ohno (2013)</i> method. |
| <code>CCT_to_uv_Ohno2013(CCT_D_uv[, cmfs])</code> | Return the <i>CIE UCS</i> colourspace <i>uv</i> chromaticity coordinates from given correlated colour temperature T_{cp} , Δ_{uv} and colour matching functions using <i>Ohno (2013)</i> method. |

`colour.temperature.uv_to_CCT_Ohno2013`

`colour.temperature.uv_to_CCT_Ohno2013(uv: ArrayLike, cmfs: MultiSpectralDistributions | None = None, start: float | None = None, end: float | None = None, count: int | None = None, iterations: int | None = None) → ndarray`

Return the correlated colour temperature T_{cp} and Δ_{uv} from given *CIE UCS* colourspace *uv* chromaticity coordinates, colour matching functions and temperature range using *Ohno (2013)* method.

The iterations parameter defines the calculations' precision: The higher its value, the more planckian tables will be generated through cascade expansion in order to converge to the exact solution.

Parameters

- **uv** (ArrayLike) – *CIE UCS* colourspace *uv* chromaticity coordinates.
- **cmfs** (MultiSpectralDistributions | None) – Standard observer colour matching functions, default to the *CIE 1931 2 Degree Standard Observer*.
- **start** (float | None) – Temperature range start in kelvin degrees, default to 1000.
- **end** (float | None) – Temperature range end in kelvin degrees, default to 100000.
- **count** (int | None) – Temperatures count/samples in the planckian tables, default to 10.
- **iterations** (int | None) – Number of planckian tables to generate, default to 6.

Returns

Correlated colour temperature T_{cp} , Δ_{uv} .

Return type

`numpy.ndarray`

References

[Ohn14]

Examples

```
>>> from pprint import pprint
>>> from colour import MSDS_CMFS, SPECTRAL_SHAPE_DEFAULT
>>> cmfs = (
...     MSDS_CMFS["CIE 1931 2 Degree Standard Observer"]
...     .copy()
...     .align(SPECTRAL_SHAPE_DEFAULT)
... )
>>> uv = np.array([0.1978, 0.3122])
>>> uv_to_CCT_Ohno2013(uv, cmfs)
array([ 6.50747...e+03,  3.22334...e-03])
```

colour.temperature.CCT_to_uv_Ohno2013

colour.temperature.CCT_to_uv_Ohno2013(*CCT_D_uv*: ArrayLike, *cmfs*: MultiSpectralDistributions | None = None) → ndarray

Return the *CIE UCS* colourspace *uv* chromaticity coordinates from given correlated colour temperature T_{cp} , Δ_{uv} and colour matching functions using *Ohno (2013)* method.

Parameters

- **CCT_D_uv** (ArrayLike) – Correlated colour temperature T_{cp} , Δ_{uv} .
- **cmfs** (MultiSpectralDistributions | None) – Standard observer colour matching functions, default to the *CIE 1931 2 Degree Standard Observer*.

Returns

CIE UCS colourspace *uv* chromaticity coordinates.

Return type

numpy.ndarray

References

[Ohn14]

Examples

```
>>> from pprint import pprint
>>> from colour import MSDS_CMFS, SPECTRAL_SHAPE_DEFAULT
>>> cmfs = (
...     MSDS_CMFS["CIE 1931 2 Degree Standard Observer"]
...     .copy()
...     .align(SPECTRAL_SHAPE_DEFAULT)
... )
>>> CCT_D_uv = np.array([6507.4342201047066, 0.003223690901513])
>>> CCT_to_uv_Ohno2013(CCT_D_uv, cmfs)
array([ 0.1977999...,  0.3122004...])
```

Planck (1900)

`colour.temperature`

| | |
|--|---|
| <code>uv_to_CCT_Planck1900(uv[, cmfs, ...])</code> | Return the correlated colour temperature T_{cp} of a blackbody from given <i>CIE UCS</i> colourspace <i>uv</i> chromaticity coordinates and colour matching functions. |
| <code>CCT_to_uv_Planck1900(CCT[, cmfs])</code> | Return the <i>CIE UCS</i> colourspace <i>uv</i> chromaticity coordinates from given correlated colour temperature T_{cp} and colour matching functions using the spectral radiance of a blackbody at the given thermodynamic temperature. |

`colour.temperature.uv_to_CCT_Planck1900`

`colour.temperature.uv_to_CCT_Planck1900(uv: ArrayLike, cmfs: MultiSpectralDistributions | None = None, optimisation_kwargs: Dict | None = None) → FloatingOrNDArray`

Return the correlated colour temperature T_{cp} of a blackbody from given *CIE UCS* colourspace *uv* chromaticity coordinates and colour matching functions.

Parameters

- **uv** (ArrayLike) – *CIE UCS* colourspace *uv* chromaticity coordinates.
- **cmfs** (MultiSpectralDistributions | None) – Standard observer colour matching functions, default to the *CIE 1931 2 Degree Standard Observer*.
- **optimisation_kwargs** (Dict | None) – Parameters for `scipy.optimize.minimize()` definition.

Returns

Correlated colour temperature T_{cp} .

Return type

`numpy.floating` or `numpy.ndarray`

Warning: The current implementation relies on optimization using `scipy.optimize.minimize()` definition and thus has reduced precision and poor performance.

References

[CIET14804e]

Examples

```
>>> uv_to_CCT_Planck1900(np.array([0.20042808, 0.31033343]))
...
6504.0000617...
```

colour.temperature.CCT_to_uv_Planck1900

colour.temperature.CCT_to_uv_Planck1900(*CCT*: *FloatingOrArrayLike*, *cmfs*: *MultiSpectralDistributions* | *None* = *None*) → *ndarray*

Return the *CIE UCS* colourspace *uv* chromaticity coordinates from given correlated colour temperature T_{cp} and colour matching functions using the spectral radiance of a blackbody at the given thermodynamic temperature.

Parameters

- **CCT** (*FloatingOrArrayLike*) – Colour temperature T_{cp} .
- **cmfs** (*MultiSpectralDistributions* | *None*) – Standard observer colour matching functions, default to the *CIE 1931 2 Degree Standard Observer*.

Returns

CIE UCS colourspace *uv* chromaticity coordinates.

Return type

numpy.ndarray

References

[CIET14804e]

Examples

```
>>> CCT_to_uv_Planck1900(6504)
array([ 0.2004280...,  0.3103334...])
```

McCamy (1992)

colour.temperature

| | | |
|---|-----------|--|
| <code>xy_to_CCT_McCamy1992(xy)</code> | | Return the correlated colour temperature T_{cp} from given <i>CIE xy</i> chromaticity coordinates using <i>McCamy (1992)</i> method. |
| <code>CCT_to_xy_McCamy1992(CCT[, optimisation_kwargs])</code> | optimisa- | Return the <i>CIE xy</i> chromaticity coordinates from given correlated colour temperature T_{cp} using <i>McCamy (1992)</i> method. |

colour.temperature.xy_to_CCT_McCamy1992

colour.temperature.xy_to_CCT_McCamy1992(*xy*: *ArrayLike*) → *FloatingOrNDArray*

Return the correlated colour temperature T_{cp} from given *CIE xy* chromaticity coordinates using *McCamy (1992)* method.

Parameters

xy (*ArrayLike*) – *CIE xy* chromaticity coordinates.

Returns

Correlated colour temperature T_{cp} .

Return type

numpy.floating or *numpy.ndarray*

References

[Wikipedia01a]

Examples

```
>>> import numpy as np
>>> xy = np.array([0.31270, 0.32900])
>>> xy_to_CCT_McCamy1992(xy)
6505.0805913...
```

colour.temperature.CCT_to_xy_McCamy1992

colour.temperature.CCT_to_xy_McCamy1992(*CCT*: *FloatingOrArrayLike*, *optimisation_kwargs*: *Dict* | *None* = *None*) → *ndarray*

Return the *CIE xy* chromaticity coordinates from given correlated colour temperature T_{cp} using *McCamy (1992)* method.

Parameters

- **CCT** (*FloatingOrArrayLike*) – Correlated colour temperature T_{cp} .
- **optimisation_kwargs** (*Dict* | *None*) – Parameters for `scipy.optimize.minimize()` definition.

Returns

CIE xy chromaticity coordinates.

Return type

`numpy.ndarray`

Warning: *McCamy (1992)* method for computing *CIE xy* chromaticity coordinates from given correlated colour temperature is not a bijective function and might produce unexpected results. It is given for consistency with other correlated colour temperature computation methods but should be avoided for practical applications. The current implementation relies on optimization using `scipy.optimize.minimize()` definition and thus has reduced precision and poor performance.

References

[Wikipedia01a]

Examples

```
>>> CCT_to_xy_McCamy1992(6505.0805913074782)
array([ 0.3127...,  0.329...])
```

Hernandez-Andres, Lee and Romero (1999)`colour.temperature`

| | |
|--|---|
| <code>xy_to_CCT_Hernandez1999(xy)</code> | Return the correlated colour temperature T_{cp} from given <i>CIE xy</i> chromaticity coordinates using <i>Hernandez-Andres et al. (1999)</i> method. |
| <code>CCT_to_xy_Hernandez1999(CCT[, ...])</code> | Return the <i>CIE xy</i> chromaticity coordinates from given correlated colour temperature T_{cp} using <i>Hernandez-Andres et al. (1999)</i> method. |

`colour.temperature.xy_to_CCT_Hernandez1999``colour.temperature.xy_to_CCT_Hernandez1999(xy: ArrayLike) → FloatingOrNDArray`

Return the correlated colour temperature T_{cp} from given *CIE xy* chromaticity coordinates using *Hernandez-Andres et al. (1999)* method.

Parameters

xy (ArrayLike) – *CIE xy* chromaticity coordinates.

Returns

Correlated colour temperature T_{cp} .

Return type

`numpy.floating` or `numpy.ndarray`

References

[HernandezAndresLR99]

Examples

```
>>> xy = np.array([0.31270, 0.32900])
>>> xy_to_CCT_Hernandez1999(xy)
6500.7420431...
```

`colour.temperature.CCT_to_xy_Hernandez1999``colour.temperature.CCT_to_xy_Hernandez1999(CCT: FloatingOrArrayLike, optimisation_kwargs: Dict | None = None) → ndarray`

Return the *CIE xy* chromaticity coordinates from given correlated colour temperature T_{cp} using *Hernandez-Andres et al. (1999)* method.

Parameters

- **CCT** (FloatingOrArrayLike) – Correlated colour temperature T_{cp} .
- **optimisation_kwargs** (Dict | None) – Parameters for `scipy.optimize.minimize()` definition.

Returns

CIE xy chromaticity coordinates.

Return type

`numpy.ndarray`

Warning: *Hernandez-Andres et al. (1999)* method for computing *CIE xy* chromaticity coordinates from given correlated colour temperature is not a bijective function and might produce unexpected results. It is given for consistency with other correlated colour temperature computation methods but should be avoided for practical applications. The current implementation relies on optimization using `scipy.optimize.minimize()` definition and thus has reduced precision and poor performance.

References

[HernandezAndresLR99]

Examples

```
>>> CCT_to_xy_Hernandez1999(6500.7420431786531)
array([ 0.3127...,  0.329...])
```

Kang, Moon, Hong, Lee, Cho and Kim (2002)

`colour.temperature`

| | |
|--|---|
| <code>xy_to_CCT_Kang2002(xy[, optimisation_kwargs])</code> | Return the correlated colour temperature T_{cp} from given <i>CIE xy</i> chromaticity coordinates using <i>Kang et al. (2002)</i> method. |
| <code>CCT_to_xy_Kang2002(CCT)</code> | Return the <i>CIE xy</i> chromaticity coordinates from given correlated colour temperature T_{cp} using <i>Kang et al. (2002)</i> method. |

`colour.temperature.xy_to_CCT_Kang2002`

`colour.temperature.xy_to_CCT_Kang2002(xy: ArrayLike, optimisation_kwargs: Dict | None = None) → FloatingOrNDArray`

Return the correlated colour temperature T_{cp} from given *CIE xy* chromaticity coordinates using *Kang et al. (2002)* method.

Parameters

- **xy** (ArrayLike) – *CIE xy* chromaticity coordinates.
- **optimisation_kwargs** (Dict | None) – Parameters for `scipy.optimize.minimize()` definition.

Returns

Correlated colour temperature T_{cp} .

Return type

`numpy.floating` or `numpy.ndarray`

Warning: *Kang et al. (2002)* does not give an analytical inverse transformation to compute the correlated colour temperature T_{cp} from given *CIE xy* chromaticity coordinates, the current implementation relies on optimization using `scipy.optimize.minimize()` definition and thus has reduced precision and poor performance.

References

[KMH+02]

Examples

```
>>> xy_to_CCT_Kang2002(np.array([0.31342600, 0.32359597]))
...
6504.3893128...
```

`colour.temperature.CCT_to_xy_Kang2002`

`colour.temperature.CCT_to_xy_Kang2002(CCT: FloatingOrArrayLike) → ndarray`

Return the *CIE xy* chromaticity coordinates from given correlated colour temperature T_{cp} using *Kang et al. (2002)* method.

Parameters

CCT (*FloatingOrArrayLike*) – Correlated colour temperature T_{cp} .

Returns

CIE xy chromaticity coordinates.

Return type

`numpy.ndarray`

Raises

ValueError – If the correlated colour temperature is not in appropriate domain.

References

[KMH+02]

Examples

```
>>> CCT_to_xy_Kang2002(6504.38938305)
array([ 0.313426 ...,  0.3235959...])
```

CIE Illuminant D Series

`colour.temperature`

| | |
|---|---|
| <code>xy_to_CCT_CIE_D(xy[, optimisation_kwargs])</code> | Return the correlated colour temperature T_{cp} of a <i>CIE Illuminant D Series</i> from its <i>CIE xy</i> chromaticity coordinates. |
| <code>CCT_to_xy_CIE_D(CCT)</code> | Return the <i>CIE xy</i> chromaticity coordinates of a <i>CIE Illuminant D Series</i> from its correlated colour temperature T_{cp} . |

colour.temperature.xy_to_CCT_CIE_D

colour.temperature.xy_to_CCT_CIE_D(xy: ArrayLike, optimisation_kwargs: Dict | None = None) → FloatingOrNDArray

Return the correlated colour temperature T_{cp} of a *CIE Illuminant D Series* from its *CIE xy* chromaticity coordinates.

Parameters

- **xy** (ArrayLike) – *CIE xy* chromaticity coordinates.
- **optimisation_kwargs** (Dict | None) – Parameters for `scipy.optimize.minimize()` definition.

Returns

Correlated colour temperature T_{cp} .

Return type

`numpy.floating` or `numpy.ndarray`

Warning: The *CIE Illuminant D Series* method does not give an analytical inverse transformation to compute the correlated colour temperature T_{cp} from given *CIE xy* chromaticity coordinates, the current implementation relies on optimization using `scipy.optimize.minimize()` definition and thus has reduced precision and poor performance.

References

[WS00k]

Examples

```
>>> xy_to_CCT_CIE_D(np.array([0.31270775, 0.32911283]))
...
6504.3895840...
```

colour.temperature.CCT_to_xy_CIE_D

colour.temperature.CCT_to_xy_CIE_D(CCT: FloatingOrArrayLike) → ndarray

Return the *CIE xy* chromaticity coordinates of a *CIE Illuminant D Series* from its correlated colour temperature T_{cp} .

Parameters

CCT (FloatingOrArrayLike) – Correlated colour temperature T_{cp} .

Returns

CIE xy chromaticity coordinates.

Return type

`numpy.ndarray`

Raises

ValueError – If the correlated colour temperature is not in appropriate domain.

References

[WS00k]

Examples

```
>>> CCT_to_xy_CIE_D(6504.38938305)
array([ 0.3127077...,  0.3291128...])
```

Utilities

Common

colour

| | |
|--|--|
| <code>domain_range_scale(scale)</code> | Define context manager and decorator temporarily setting <i>Colour</i> domain-range scale. |
| <code>get_domain_range_scale()</code> | Return the current <i>Colour</i> domain-range scale. |
| <code>set_domain_range_scale([scale])</code> | Set the current <i>Colour</i> domain-range scale. |

colour.domain_range_scale

class colour.domain_range_scale(scale: *Literal*['ignore', 'reference', 'Ignore', 'Reference', '1', '100'] | *str*)

Define context manager and decorator temporarily setting *Colour* domain-range scale.

The following scales are available:

- **‘Reference’**, the default *Colour* domain-range scale which varies depending on the referenced algorithm, e.g. [0, 1], [0, 10], [0, 100], [0, 255], etc. . .
- **‘1’**, a domain-range scale normalised to [0, 1], it is important to acknowledge that this is a soft normalisation and it is possible to use negative out of gamut values or high dynamic range data exceeding 1.

Parameters

scale (Union[*Literal*['ignore', 'reference', 'Ignore', 'Reference', '1', '100'], *str*]) – *Colour* domain-range scale to set.

Warning:

- The **‘Ignore’** and **‘100’** domain-range scales are for internal usage only!

Examples

With *Colour* domain-range scale set to **‘Reference’**:

```
>>> with domain_range_scale("1"):
...     to_domain_1(1)
...
array(1.0)
>>> with domain_range_scale("Reference"):
...     from_range_1(1)
```

(continues on next page)

(continued from previous page)

```
...
array(1.0)
```

With *Colour* domain-range scale set to ‘1’:

```
>>> with domain_range_scale("1"):
...     to_domain_1(1)
...
array(1.0)
>>> with domain_range_scale("1"):
...     from_range_1(1)
...
array(1.0)
```

With *Colour* domain-range scale set to ‘100’ (unsupported):

```
>>> with domain_range_scale("100"):
...     to_domain_1(1)
...
array(0.01)
>>> with domain_range_scale("100"):
...     from_range_1(1)
...
array(100.0)
```

`__init__(scale: Literal['ignore', 'reference', 'Ignore', 'Reference', '1', '100'] | str) → None`

Parameters

scale ([Literal](#)['ignore', 'reference', 'Ignore', 'Reference', '1', '100'] | str) –

Return type

None

Methods

```
__init__(scale)
```

`colour.get_domain_range_scale`

`colour.get_domain_range_scale() → Literal['ignore', 'reference', '1', '100'] | str`

Return the current *Colour* domain-range scale. The following scales are available:

- ‘**Reference**’, the default *Colour* domain-range scale which varies depending on the referenced algorithm, e.g. [0, 1], [0, 10], [0, 100], [0, 255], etc...
- ‘**1**’, a domain-range scale normalised to [0, 1], it is important to acknowledge that this is a soft normalisation and it is possible to use negative out of gamut values or high dynamic range data exceeding 1.

Returns

Colour domain-range scale.

Return type

[str](#)

Warning:

- The ‘Ignore’ and ‘100’ domain-range scales are for internal usage only!

colour.set_domain_range_scale

```
colour.set_domain_range_scale(scale: Literal['ignore', 'reference', 'Ignore', 'Reference', '1', '100'] | str = 'reference')
```

Set the current *Colour* domain-range scale. The following scales are available:

- ‘Reference’, the default *Colour* domain-range scale which varies depending on the referenced algorithm, e.g. [0, 1], [0, 10], [0, 100], [0, 255], etc. . .
- ‘1’, a domain-range scale normalised to [0, 1], it is important to acknowledge that this is a soft normalisation and it is possible to use negative out of gamut values or high dynamic range data exceeding 1.

Parameters

scale (`Literal['ignore', 'reference', 'Ignore', 'Reference', '1', '100'] | str`) – *Colour* domain-range scale to set.

Warning:

- The ‘Ignore’ and ‘100’ domain-range scales are for internal usage only!

colour.utilities

| | |
|------------------------------|--------------------------------------|
| <code>CacheRegistry()</code> | A registry for mapping-based caches. |
|------------------------------|--------------------------------------|

colour.utilities.CacheRegistry

class colour.utilities.CacheRegistry

Bases: `object`

A registry for mapping-based caches.

Attributes

- `registry`

Methods

- `__init__()`
- `__str__()`
- `register_cache()`
- `unregister_cache()`
- `clear_cache()`
- `clear_all_caches()`

Examples

```
>>> cache_registry = CacheRegistry()
>>> cache_a = cache_registry.register_cache("Cache A")
>>> cache_a["Foo"] = "Bar"
>>> cache_b = cache_registry.register_cache("Cache B")
>>> cache_b["John"] = "Doe"
>>> cache_b["Luke"] = "Skywalker"
>>> print(cache_registry)
{'Cache A': '1 item(s)', 'Cache B': '2 item(s)'}
>>> cache_registry.clear_cache("Cache A")
>>> print(cache_registry)
{'Cache A': '0 item(s)', 'Cache B': '2 item(s)'}
>>> cache_registry.unregister_cache("Cache B")
>>> print(cache_registry)
{'Cache A': '0 item(s)'}
>>> print(cache_b)
{}
```

`__init__()` → `None`

Return type

`None`

property `registry`: `Dict`

Getter property for the cache registry.

Returns

Cache registry.

Return type

`dict`

`__str__()` → `str`

Return a formatted string representation of the cache registry.

Returns

Formatted string representation.

Return type

`str`

`register_cache(name: str)` → `Dict`

Register a new cache with given name in the registry.

Parameters

name (`str`) – Cache name for the registry.

Returns

Registered cache.

Return type

`dict`

Examples

```
>>> cache_registry = CacheRegistry()
>>> cache_a = cache_registry.register_cache("Cache A")
>>> cache_a["Foo"] = "Bar"
>>> cache_b = cache_registry.register_cache("Cache B")
>>> cache_b["John"] = "Doe"
>>> cache_b["Luke"] = "Skywalker"
>>> print(cache_registry)
{'Cache A': '1 item(s)', 'Cache B': '2 item(s)'}
```

`unregister_cache(name: str)`

Unregister cache with given name in the registry.

Parameters

name (`str`) – Cache name in the registry.

Notes

- The cache is cleared before being unregistered.

Examples

```
>>> cache_registry = CacheRegistry()
>>> cache_a = cache_registry.register_cache("Cache A")
>>> cache_a["Foo"] = "Bar"
>>> cache_b = cache_registry.register_cache("Cache B")
>>> cache_b["John"] = "Doe"
>>> cache_b["Luke"] = "Skywalker"
>>> print(cache_registry)
{'Cache A': '1 item(s)', 'Cache B': '2 item(s)'}
>>> cache_registry.unregister_cache("Cache B")
>>> print(cache_registry)
{'Cache A': '1 item(s)'}
>>> print(cache_b)
{}
```

`clear_cache(name: str)`

Clear the cache with given name.

Parameters

name (`str`) – Cache name in the registry.

Examples

```
>>> cache_registry = CacheRegistry()
>>> cache_a = cache_registry.register_cache("Cache A")
>>> cache_a["Foo"] = "Bar"
>>> print(cache_registry)
{'Cache A': '1 item(s)'}
>>> cache_registry.clear_cache("Cache A")
>>> print(cache_registry)
{'Cache A': '0 item(s)'}
```

`clear_all_caches()`

Clear all the caches in the registry.

Examples

```
>>> cache_registry = CacheRegistry()
>>> cache_a = cache_registry.register_cache("Cache A")
>>> cache_a["Foo"] = "Bar"
>>> cache_b = cache_registry.register_cache("Cache B")
>>> cache_b["John"] = "Doe"
>>> cache_b["Luke"] = "Skywalker"
>>> print(cache_registry)
{'Cache A': '1 item(s)', 'Cache B': '2 item(s)'}
>>> cache_registry.clear_all_caches()
>>> print(cache_registry)
{'Cache A': '0 item(s)', 'Cache B': '0 item(s)'}
```

`__weakref__`

list of weak references to the object (if defined)

| | |
|--|---|
| <code>CACHE_REGISTRY</code> | A registry for mapping-based caches. |
| <code>handle_numpy_errors(**kwargs)</code> | Decorate a function to handle <i>Numpy</i> errors. |
| <code>ignore_numpy_errors(function)</code> | Wrap given function wrapper. |
| <code>raise_numpy_errors(function)</code> | Wrap given function wrapper. |
| <code>print_numpy_errors(function)</code> | Wrap given function wrapper. |
| <code>warn_numpy_errors(function)</code> | Wrap given function wrapper. |
| <code>ignore_python_warnings(function)</code> | Decorate a function to ignore <i>Python</i> warnings. |
| <code>attest(condition[, message])</code> | Provide the <i>assert</i> statement functionality without being disabled by optimised Python execution. |
| <code>batch(sequence[, k])</code> | Return a batch generator from given sequence. |
| <code>disable_multiprocessing()</code> | Define a context manager and decorator to temporarily disabling <i>Colour</i> multiprocessing state. |
| <code>multiprocessing_pool(*args, **kwargs)</code> | Define a context manager providing a multiprocessing pool. |
| <code>is_ctlrender_installed([raise_exception])</code> | Return whether <i>ctlrender</i> is installed and available. |
| <code>is_graphviz_installed([raise_exception])</code> | Return whether <i>Graphviz</i> is installed and available. |
| <code>is_matplotlib_installed([raise_exception])</code> | Return whether <i>Matplotlib</i> is installed and available. |
| <code>is_networkx_installed([raise_exception])</code> | Return whether <i>NetworkX</i> is installed and available. |
| <code>is_opencolorio_installed([raise_exception])</code> | Return whether <i>OpenColorIO</i> is installed and available. |
| <code>is_openimageio_installed([raise_exception])</code> | Return whether <i>OpenImageIO</i> is installed and available. |
| <code>is_pandas_installed([raise_exception])</code> | Return whether <i>Pandas</i> is installed and available. |
| <code>is_tqdm_installed([raise_exception])</code> | Return whether <i>tqdm</i> is installed and available. |
| <code>is_trimesh_installed([raise_exception])</code> | Return whether <i>Trimesh</i> is installed and available. |
| <code>required(*requirements)</code> | Decorate a function to check whether various ancillary package requirements are satisfied. |
| <code>is_iterable(a)</code> | Return whether given variable <i>a</i> is iterable. |
| <code>is_string(a)</code> | Return whether given variable <i>a</i> is a <i>str</i> -like variable. |
| <code>is_numeric(a)</code> | Return whether given variable <i>a</i> is a Number-like variable. |
| <code>is_integer(a)</code> | Return whether given variable <i>a</i> is an <i>numpy.integer</i> -like variable under given threshold. |

continues on next page

Table 4 – continued from previous page

| | |
|--|---|
| <code>is_sibling(element, mapping)</code> | Return whether given element type is present in given mapping types. |
| <code>filter_kwargs(function, **kwargs)</code> | Filter keyword arguments incompatible with the given function signature. |
| <code>filter_mapping(mapping, names)</code> | Filter given mapping with given names. |
| <code>first_item(a)</code> | Return the first item of given iterable. |
| <code>copy_definition(definition[, name])</code> | Copy a definition using the same code, globals, defaults, closure, and name. |
| <code>validate_method(method, valid_methods[, message])</code> | Validate whether given method exists in the given valid methods and returns the method lower cased. |
| <code>optional(value, default)</code> | Handle optional argument value by providing a default value. |
| <code>slugify(object[, allow_unicode])</code> | Generate a <i>SEO</i> friendly and human-readable slug from given object. |

colour.utilities.CACHE_REGISTRY

`colour.utilities.CACHE_REGISTRY = <colour.utilities.common.CacheRegistry object>`

A registry for mapping-based caches.

Attributes

- `registry`

Methods

- `__init__()`
- `__str__()`
- `register_cache()`
- `unregister_cache()`
- `clear_cache()`
- `clear_all_caches()`

Examples

```
>>> cache_registry = CacheRegistry()
>>> cache_a = cache_registry.register_cache("Cache A")
>>> cache_a["Foo"] = "Bar"
>>> cache_b = cache_registry.register_cache("Cache B")
>>> cache_b["John"] = "Doe"
>>> cache_b["Luke"] = "Skywalker"
>>> print(cache_registry)
{'Cache A': '1 item(s)', 'Cache B': '2 item(s)'}
>>> cache_registry.clear_cache("Cache A")
>>> print(cache_registry)
{'Cache A': '0 item(s)', 'Cache B': '2 item(s)'}
>>> cache_registry.unregister_cache("Cache B")
>>> print(cache_registry)
```

(continues on next page)

(continued from previous page)

```
{'Cache A': '0 item(s)'}
>>> print(cache_b)
{}
```

colour.utilities.handle_numpy_errors

colour.utilities.**handle_numpy_errors**(**kwargs: *Any*) → *Callable*

Decorate a function to handle *Numpy* errors.

Parameters

kwargs (*Any*) – Keywords arguments.

Return type

Callable

References

[KPK11]

Examples

```
>>> import numpy
>>> @handle_numpy_errors(all="ignore")
... def f():
...     1 / numpy.zeros(3)
...
>>> f()
```

colour.utilities.ignore_numpy_errors

colour.utilities.**ignore_numpy_errors**(function: *Callable*) → *Callable*

Wrap given function wrapper.

Parameters

function (*Callable*) –

Return type

Callable

colour.utilities.raise_numpy_errors

colour.utilities.**raise_numpy_errors**(function: *Callable*) → *Callable*

Wrap given function wrapper.

Parameters

function (*Callable*) –

Return type

Callable

colour.utilities.print_numpy_errors

colour.utilities.**print_numpy_errors**(function: *Callable*) → *Callable*

Wrap given function wrapper.

Parameters

function (*Callable*) –

Return type

Callable

colour.utilities.warn_numpy_errors

colour.utilities.**warn_numpy_errors**(function: *Callable*) → *Callable*

Wrap given function wrapper.

Parameters

function (*Callable*) –

Return type

Callable

colour.utilities.ignore_python_warnings

colour.utilities.**ignore_python_warnings**(function: *Callable*) → *Callable*

Decorate a function to ignore *Python* warnings.

Parameters

function (*Callable*) – Function to decorate.

Return type

Callable

Examples

```
>>> @ignore_python_warnings
... def f():
...     warnings.warn("This is an ignored warning!")
...
>>> f()
```

colour.utilities.attest

colour.utilities.**attest**(condition: *bool* | *DTypeBoolean*, message: *str* = "")

Provide the *assert* statement functionality without being disabled by optimised Python execution.

Parameters

- **condition** (*bool* | *DTypeBoolean*) – Condition to attest/assert.
- **message** (*str*) – Message to display when the assertion fails.

colour.utilities.batch

`colour.utilities.batch(sequence: Sequence, k: int | Literal[3] = 3) → Generator`

Return a batch generator from given sequence.

Parameters

- **sequence** (*Sequence*) – Sequence to create batches from.
- **k** (*int* | *Literal[3]*) – Batch size.

Yields

Generator – Batch generator.

Return type

Generator

Examples

```
>>> batch(tuple(range(10)), 3)
<generator object batch at 0x...>
```

colour.utilities.disable_multiprocessing

class `colour.utilities.disable_multiprocessing`

Define a context manager and decorator to temporarily disabling *Colour* multiprocessing state.

`__init__()`

Methods

```
__init__()
```

colour.utilities.multiprocessing_pool

`colour.utilities.multiprocessing_pool(*args: Any, **kwargs: Any) → Generator`

Define a context manager providing a multiprocessing pool.

Parameters

- **args** (*Any*) – Arguments.
- **kwargs** (*Any*) – Keywords arguments.

Yields

Generator – Multiprocessing pool.

Return type

Generator

Examples

```
>>> from functools import partial
>>> def _add(a, b):
...     return a + b
...
>>> with multiprocessing_pool() as pool:
...     pool.map(partial(_add, b=2), range(10))
...
...
[2, 3, 4, 5, 6, 7, 8, 9, 10, 11]
```

colour.utilities.is_ctlrender_installed

colour.utilities.is_ctlrender_installed(raise_exception: *bool* = *False*) → *bool*

Return whether *ctlrender* is installed and available.

Parameters

raise_exception (*bool*) – Whether to raise an exception if *ctlrender* is unavailable.

Returns

Whether *ctlrender* is installed.

Return type

bool

Raises

ImportError – If *ctlrender* is not installed.

colour.utilities.is_graphviz_installed

colour.utilities.is_graphviz_installed(raise_exception: *bool* = *False*) → *bool*

Return whether *Graphviz* is installed and available.

Parameters

raise_exception (*bool*) – Whether to raise an exception if *Graphviz* is unavailable.

Returns

Whether *Graphviz* is installed.

Return type

bool

Raises

ImportError – If *Graphviz* is not installed.

colour.utilities.is_matplotlib_installed

colour.utilities.is_matplotlib_installed(raise_exception: *bool* = *False*) → *bool*

Return whether *Matplotlib* is installed and available.

Parameters

raise_exception (*bool*) – Whether to raise an exception if *Matplotlib* is unavailable.

Returns

Whether *Matplotlib* is installed.

Return type

bool

Raises**ImportError** – If *Matplotlib* is not installed.**colour.utilities.is_networkx_installed**`colour.utilities.is_networkx_installed(raise_exception: bool = False) → bool`Return whether *NetworkX* is installed and available.**Parameters****raise_exception** (bool) – Whether to raise an exception if *NetworkX* is unavailable.**Returns**Whether *NetworkX* is installed.**Return type**

bool

Raises**ImportError** – If *NetworkX* is not installed.**colour.utilities.is_opencolorio_installed**`colour.utilities.is_opencolorio_installed(raise_exception: bool = False) → bool`Return whether *OpenColorIO* is installed and available.**Parameters****raise_exception** (bool) – Whether to raise an exception if *OpenColorIO* is unavailable.**Returns**Whether *OpenColorIO* is installed.**Return type**

bool

Raises**ImportError** – If *OpenColorIO* is not installed.**colour.utilities.is_openimageio_installed**`colour.utilities.is_openimageio_installed(raise_exception: bool = False) → bool`Return whether *OpenImageIO* is installed and available.**Parameters****raise_exception** (bool) – Whether to raise an exception if *OpenImageIO* is unavailable.**Returns**Whether *OpenImageIO* is installed.**Return type**

bool

Raises**ImportError** – If *OpenImageIO* is not installed.

colour.utilities.is_pandas_installed

`colour.utilities.is_pandas_installed(raise_exception: bool = False) → bool`

Return whether *Pandas* is installed and available.

Parameters

raise_exception (bool) – Whether to raise an exception if *Pandas* is unavailable.

Returns

Whether *Pandas* is installed.

Return type

bool

Raises

ImportError – If *Pandas* is not installed.

colour.utilities.is_tqdm_installed

`colour.utilities.is_tqdm_installed(raise_exception: bool = False) → bool`

Return whether *tqdm* is installed and available.

Parameters

raise_exception (bool) – Whether to raise an exception if *tqdm* is unavailable.

Returns

Whether *tqdm* is installed.

Return type

bool

Raises

ImportError – If *tqdm* is not installed.

colour.utilities.is_trimesh_installed

`colour.utilities.is_trimesh_installed(raise_exception: bool = False) → bool`

Return whether *Trimesh* is installed and available.

Parameters

raise_exception (bool) – Whether to raise an exception if *Trimesh* is unavailable.

Returns

Whether *Trimesh* is installed.

Return type

bool

Raises

ImportError – If *Trimesh* is not installed.

colour.utilities.required

colour.utilities.required(*requirements: *Literal*['ctrender', 'Graphviz', 'Matplotlib', 'NetworkX', 'OpenColorIO', 'OpenImageIO', 'Pandas', 'tqdm', 'trimesh']) → *Callable*

Decorate a function to check whether various ancillary package requirements are satisfied.

Parameters

requirements (*Literal*['ctrender', 'Graphviz', 'Matplotlib', 'NetworkX', 'OpenColorIO', 'OpenImageIO', 'Pandas', 'tqdm', 'trimesh']) – Requirements to check whether they are satisfied.

Return type

Callable

colour.utilities.is_iterable

colour.utilities.is_iterable(*a*: *Any*) → *bool*

Return whether given variable *a* is iterable.

Parameters

a (*Any*) – Variable *a* to check the iterability.

Returns

Whether variable *a* is iterable.

Return type

bool

Examples

```
>>> is_iterable([1, 2, 3])
True
>>> is_iterable(1)
False
```

colour.utilities.is_string

colour.utilities.is_string(*a*: *Any*) → *bool*

Return whether given variable *a* is a *str*-like variable.

Parameters

a (*Any*) – Variable *a* to test.

Returns

Whether variable *a* is a *str*-like variable.

Return type

bool

Examples

```
>>> is_string("I'm a string!")
True
>>> is_string(["I'm a string!"])
False
```

colour.utilities.is_numeric

colour.utilities.is_numeric(*a*: Any) → bool

Return whether given variable *a* is a Number-like variable.

Parameters

a (Any) – Variable *a* to test.

Returns

Whether variable *a* is a Number-like variable.

Return type

bool

Examples

```
>>> is_numeric(1)
True
>>> is_numeric((1,))
False
```

colour.utilities.is_integer

colour.utilities.is_integer(*a*: Any) → bool

Return whether given variable *a* is an `numpy.integer`-like variable under given threshold.

Parameters

a (Any) – Variable *a* to test.

Returns

Whether variable *a* is an `numpy.integer`-like variable.

Return type

bool

Notes

- The determination threshold is defined by the `colour.algebra.common.INTEGER_THRESHOLD` attribute.

Examples

```
>>> is_integer(1)
True
>>> is_integer(1.01)
False
```

colour.utilities.is_sibling

colour.utilities.**is_sibling**(*element*: [Any](#), *mapping*: [Mapping](#)) → [bool](#)

Return whether given element type is present in given mapping types.

Parameters

- **element** ([Any](#)) – Element to check whether its type is present in the mapping types.
- **mapping** ([Mapping](#)) – Mapping types.

Returns

Whether given element type is present in given mapping types.

Return type

[bool](#)

colour.utilities.filter_kwargs

colour.utilities.**filter_kwargs**(*function*: [Callable](#), ***kwargs*: [Any](#)) → [Dict](#)

Filter keyword arguments incompatible with the given function signature.

Parameters

- **function** ([Callable](#)) – Callable to filter the incompatible keyword arguments.
- **kwargs** ([Any](#)) – Keywords arguments.

Returns

Filtered keyword arguments.

Return type

[dict](#)

Examples

```
>>> def fn_a(a):
...     return a
...
>>> def fn_b(a, b=0):
...     return a, b
...
>>> def fn_c(a, b=0, c=0):
...     return a, b, c
...
>>> fn_a(1, **filter_kwargs(fn_a, b=2, c=3))
1
>>> fn_b(1, **filter_kwargs(fn_b, b=2, c=3))
(1, 2)
```

(continues on next page)

(continued from previous page)

```
>>> fn_c(1, **filter_kwargs(fn_c, b=2, c=3))
(1, 2, 3)
```

colour.utilities.filter_mapping

colour.utilities.**filter_mapping**(mapping: *Mapping*, names: *str* | *Sequence[str]*) → *Dict*

Filter given mapping with given names.

Parameters

- **mapping** (*Mapping*) – Mapping to filter.
- **names** (*str* | *Sequence[str]*) – Name for given mapping elements or a list of names.

Returns

Filtered mapping elements.

Return type

dict

Notes

- If the mapping passed is a `colour.utilities.CanonicalMapping` class instance, then the lower, slugified and canonical keys are also used for matching.
- To honour the filterers ordering, the return value is a *dict* class instance.

Examples

```
>>> class Element:
...     pass
...
>>> mapping = {
...     "Element A": Element(),
...     "Element B": Element(),
...     "Element C": Element(),
...     "Not Element C": Element(),
... }
>>> filter_mapping(mapping, "Element A")
{'Element A': <colour.utilities.common.Element object at 0x...>}
```

colour.utilities.first_item

colour.utilities.**first_item**(a: *Iterable*) → *Any*

Return the first item of given iterable.

Parameters

- **a** (*Iterable*) – Iterable to get the first item from.

Return type

object

Raises

- **StopIteration** – If the iterable is empty.

Examples

```
>>> a = range(10)
>>> first_item(a)
0
```

colour.utilities.copy_definition

colour.utilities.**copy_definition**(definition: *Callable*, name: *str* | *None* = *None*) → *Callable*

Copy a definition using the same code, globals, defaults, closure, and name.

Parameters

- **definition** (*Callable*) – Definition to be copied.
- **name** (*str* | *None*) – Optional definition copy name.

Returns

Definition copy.

Return type

Callable

colour.utilities.validate_method

colour.utilities.**validate_method**(method: *str*, valid_methods: *Sequence* | *Mapping*, message: *str* = "{0}" method is invalid, it must be one of {1}!") → *str*

Validate whether given method exists in the given valid methods and returns the method lower cased.

Parameters

- **method** (*str*) – Method to validate.
- **valid_methods** (*Sequence* | *Mapping*) – Valid methods.
- **message** (*str*) – Message for the exception.

Returns

Method lower cased.

Return type

str

Raises

ValueError – If the method does not exist.

Examples

```
>>> validate_method("Valid", ["Valid", "Yes", "Ok"])
'valid'
```

colour.utilities.optional

colour.utilities.**optional**(value: *T* | *None*, default: *T*) → *T*

Handle optional argument value by providing a default value.

Parameters

- **value** (*T* | *None*) – Optional argument value.
- **default** (*T*) – Default argument value if value is *None*.

Returns

Argument value.

Return type

T

Examples

```
>>> optional("Foo", "Bar")
'Foo'
>>> optional(None, "Bar")
'Bar'
```

colour.utilities.slugify

colour.utilities.**slugify**(object_: *Any*, allow_unicode: *bool* = *False*) → *str*

Generate a *SEO* friendly and human-readable slug from given object.

Convert to ASCII if allow_unicode is *False*. Convert spaces or repeated dashes to single dashes. Remove characters that aren't alphanumerics, underscores, or hyphens. Convert to lowercase. Also strip leading and trailing whitespace, dashes, and underscores.

Parameters

- **object** – Object to convert to a slug.
- **allow_unicode** (*bool*) – Whether to allow unicode characters in the generated slug.
- **object_** (*Any*) –

Returns

Generated slug.

Return type

str

References

[[DjangoSFoundation22](#)]

Examples

```
>>> slugify(
...     " Jack & Jill like numbers 1,2,3 and 4 and silly characters ?%.$!/"
... )
'jack-jill-like-numbers-123-and-4-and-silly-characters'
```

Array

colour.utilities

| | |
|---|---|
| <code>MixinDataclassFields()</code> | A mixin providing fields introspection for the dataclass-like class fields. |
| <code>MixinDataclassIterable()</code> | A mixin providing iteration capabilities over the dataclass-like class fields. |
| <code>MixinDataclassArray()</code> | A mixin providing conversion methods for dataclass-like class conversion to <code>numpy.ndarray</code> class. |
| <code>MixinDataclassArithmetic()</code> | A mixin providing mathematical operations for dataclass-like class. |

colour.utilities.MixinDataclassFields

class colour.utilities.MixinDataclassFields

Bases: `object`

A mixin providing fields introspection for the dataclass-like class fields.

Attributes

- `fields()`

property fields: `Tuple`

Getter property for the fields of the dataclass-like class.

Returns

Tuple of dataclass-like class fields.

Return type

`tuple`

__weakref__

list of weak references to the object (if defined)

colour.utilities.MixinDataclassIterable

class colour.utilities.MixinDataclassIterable

Bases: `MixinDataclassFields`

A mixin providing iteration capabilities over the dataclass-like class fields.

Attributes

- `keys()`
- `values()`
- `items()`

Methods

- `__iter__()`

Notes

- The `colour.utilities.MixinDataclassIterable` class inherits the methods from the following class:
 - `colour.utilities.MixinDataclassFields`

property keys: `Tuple`

Getter property for the dataclass-like class keys, i.e. the field names.

Returns

dataclass-like class keys.

Return type

`tuple`

property values: `Tuple`

Getter property for the dataclass-like class values, i.e. the field values.

Returns

dataclass-like class values.

Return type

`tuple`

property items: `Tuple`

Getter property for the dataclass-like class items, i.e. the field names and values.

Returns

dataclass-like class items.

Return type

`tuple`

`__iter__()` → `Generator`

Return a generator for the dataclass-like class fields.

Yields

Generator – dataclass-like class field generator.

Return type

Generator

colour.utilities.MixinDataclassArray

class colour.utilities.MixinDataclassArray

Bases: `MixinDataclassIterable`

A mixin providing conversion methods for dataclass-like class conversion to `numpy.ndarray` class.

Methods

- `__array__()`

Notes

- The `colour.utilities.MixinDataclassArray` class inherits the methods from the following classes:
 - `colour.utilities.MixinDataclassIterable`
 - `colour.utilities.MixinDataclassFields`

`__array__(dtype: Type[DTypeNumber] | None = None)` → `ndarray`

Implement support for dataclass-like class conversion to `numpy.ndarray` class.

A field set to *None* will be filled with `np.nan` according to the shape of the first field not set with *None*.

Parameters

dtype (*Type*[DTypeNumber] | *None*) – `numpy.dtype` to use for conversion to `np.ndarray`, default to the `numpy.dtype` defined by `colour.constant.DEFAULT_FLOAT_DTYPE` attribute.

Returns

dataclass-like class converted to `numpy.ndarray`.

Return type

`numpy.ndarray`

colour.utilities.MixinDataclassArithmetic

class colour.utilities.MixinDataclassArithmetic

Bases: `MixinDataclassArray`

A mixin providing mathematical operations for dataclass-like class.

Methods

- `__iadd__()`
- `__add__()`
- `__isub__()`
- `__sub__()`
- `__imul__()`
- `__mul__()`
- `__idiv__()`
- `__div__()`

- `__ipow__()`
- `__pow__()`
- `arithmetical_operation()`

Notes

- The `colour.utilities.MixinDataclassArithmetic` class inherits the methods from the following classes:
 - `colour.utilities.MixinDataclassArray`
 - `colour.utilities.MixinDataclassIterable`
 - `colour.utilities.MixinDataclassFields`

`__add__(a: Any) → Any`

Implement support for addition.

Parameters

a (*Any*) – Variable *a* to add.

Returns

Variable added dataclass-like class.

Return type

dataclass

`__iadd__(a: Any) → Any`

Implement support for in-place addition.

Parameters

a (*Any*) – Variable *a* to add in-place.

Returns

In-place variable added dataclass-like class.

Return type

dataclass

`__sub__(a: Any) → Any`

Implement support for subtraction.

Parameters

a (*Any*) – Variable *a* to subtract.

Returns

Variable subtracted dataclass-like class.

Return type

dataclass

`__isub__(a: Any) → Any`

Implement support for in-place subtraction.

Parameters

a (*Any*) – Variable *a* to subtract in-place.

Returns

In-place variable subtracted dataclass-like class.

Return type

dataclass

`__mul__(a: Any) → Any`

Implement support for multiplication.

Parameters

a (Any) – Variable *a* to multiply by.

Returns

Variable multiplied dataclass-like class.

Return type

dataclass

`__imul__(a: Any) → Any`

Implement support for in-place multiplication.

Parameters

a (Any) – Variable *a* to multiply by in-place.

Returns

In-place variable multiplied dataclass-like class.

Return type

dataclass

`__div__(a: Any) → Any`

Implement support for division.

Parameters

a (Any) – Variable *a* to divide by.

Returns

Variable divided dataclass-like class.

Return type

dataclass

`__idiv__(a: Any) → Any`

Implement support for in-place division.

Parameters

a (Any) – Variable *a* to divide by in-place.

Returns

In-place variable divided dataclass-like class.

Return type

dataclass

`__itruediv__(a: Any) → Any`

Implement support for in-place division.

Parameters

a (Any) – Variable *a* to divide by in-place.

Returns

In-place variable divided dataclass-like class.

Return type

dataclass

`__truediv__(a: Any) → Any`

Implement support for division.

Parameters

a (Any) – Variable *a* to divide by.

Returns

Variable divided dataclass-like class.

Return type

dataclass

`__pow__(a: Any) → Any`

Implement support for exponentiation.

Parameters

a (Any) – Variable *a* to exponentiate by.

Returns

Variable exponentiated dataclass-like class.

Return type

dataclass

`__ipow__(a: Any) → Any`

Implement support for in-place exponentiation.

Parameters

a (Any) – Variable *a* to exponentiate by in-place.

Returns

In-place variable exponentiated dataclass-like class.

Return type

dataclass

`arithmetical_operation(a: Any, operation: str, in_place: bool = False) → Any`

Perform given arithmetical operation with *a* operand on the dataclass-like class.

Parameters

- **a** (Any) – Operand.
- **operation** (str) – Operation to perform.
- **in_place** (bool) – Operation happens in place.

Returns

dataclass-like class with arithmetical operation performed.

Return type

dataclass

| | |
|---|---|
| <code>as_array(a[, dtype])</code> | Convert given variable <i>a</i> to <code>numpy.ndarray</code> using given <code>numpy.dtype</code> . |
| <code>as_int(a[, dtype])</code> | Attempt to convert given variable <i>a</i> to <code>numpy.integer</code> using given <code>numpy.dtype</code> . |
| <code>as_float(a[, dtype])</code> | Attempt to convert given variable <i>a</i> to <code>numpy.floating</code> using given <code>numpy.dtype</code> . |
| <code>as_int_array(a[, dtype])</code> | Convert given variable <i>a</i> to <code>numpy.ndarray</code> using given <code>numpy.dtype</code> . |
| <code>as_float_array(a[, dtype])</code> | Convert given variable <i>a</i> to <code>numpy.ndarray</code> using given <code>numpy.dtype</code> . |
| <code>as_int_scalar(a[, dtype])</code> | Convert given <i>a</i> variable to <code>numpy.integer</code> using given <code>numpy.dtype</code> . |
| <code>as_float_scalar(a[, dtype])</code> | Convert given <i>a</i> variable to <code>numpy.floating</code> using given <code>numpy.dtype</code> . |
| <code>set_default_int_dtype([dtype])</code> | Set Colour default <code>numpy.integer</code> precision by setting <code>colour.constant.DEFAULT_INT_DTYPE</code> attribute with given <code>numpy.dtype</code> wherever the attribute is imported. |

continues on next page

Table 5 – continued from previous page

| | |
|---|---|
| <code>set_default_float_dtype([dtype])</code> | Set <i>Colour</i> default <code>numpy.floating</code> precision by setting <code>colour.constant.DEFAULT_FLOAT_DTYPE</code> attribute with given <code>numpy.dtype</code> wherever the attribute is imported. |
| <code>to_domain_1(a[, scale_factor, dtype])</code> | Scale given array <i>a</i> to domain '1'. |
| <code>to_domain_10(a[, scale_factor, dtype])</code> | Scale given array <i>a</i> to domain '10', used by <i>Munsell Renotation System</i> . |
| <code>to_domain_100(a[, scale_factor, dtype])</code> | Scale given array <i>a</i> to domain '100'. |
| <code>to_domain_degrees(a[, scale_factor, dtype])</code> | Scale given array <i>a</i> to degrees domain. |
| <code>to_domain_int(a[, bit_depth, dtype])</code> | Scale given array <i>a</i> to int domain. |
| <code>from_range_1(a[, scale_factor, dtype])</code> | Scale given array <i>a</i> from range '1'. |
| <code>from_range_10(a[, scale_factor, dtype])</code> | Scale given array <i>a</i> from range '10', used by <i>Munsell Renotation System</i> . |
| <code>from_range_100(a[, scale_factor, dtype])</code> | Scale given array <i>a</i> from range '100'. |
| <code>from_range_degrees(a[, scale_factor, dtype])</code> | Scale given array <i>a</i> from degrees range. |
| <code>from_range_int(a[, bit_depth, dtype])</code> | Scale given array <i>a</i> from int range. |
| <code>closest_indexes(a, b)</code> | Return the array <i>a</i> closest element indexes to the reference array <i>b</i> elements. |
| <code>closest(a, b)</code> | Return the array <i>a</i> closest elements to the reference array <i>b</i> elements. |
| <code>interval(distribution[, unique])</code> | Return the interval size of given distribution. |
| <code>is_uniform(distribution)</code> | Return whether given distribution is uniform. |
| <code>has_only_nan(a)</code> | Return whether given array <i>a</i> contains only NaN values. |
| <code>in_array(a, b[, tolerance])</code> | Return whether each element of the array <i>a</i> is also present in the array <i>b</i> within given tolerance. |
| <code>tstack(a[, dtype])</code> | Stack given array of arrays <i>a</i> along the last axis (tail) to produce a stacked array. |
| <code>tsplit(a[, dtype])</code> | Split given stacked array <i>a</i> along the last axis (tail) to produce an array of arrays. |
| <code>row_as_diagonal(a)</code> | Return the rows of given array <i>a</i> as diagonal matrices. |
| <code>orient(a[, orientation])</code> | Orient given array <i>a</i> according to given orientation. |
| <code>centroid(a)</code> | Return the centroid indexes of given array <i>a</i> . |
| <code>fill_nan(a[, method, default])</code> | Fill given array <i>a</i> NaN values according to given method. |
| <code>ndarray_write(a)</code> | Define a context manager setting given array <i>a</i> writeable to operate one and then read-only. |
| <code>zeros(shape[, dtype, order])</code> | Wrap <code>np.zeros()</code> definition to create an array with the active <code>numpy.dtype</code> defined by the <code>colour.constant.DEFAULT_FLOAT_DTYPE</code> attribute. |
| <code>ones(shape[, dtype, order])</code> | Wrap <code>np.ones()</code> definition to create an array with the active <code>numpy.dtype</code> defined by the <code>colour.constant.DEFAULT_FLOAT_DTYPE</code> attribute. |
| <code>full(shape, fill_value[, dtype, order])</code> | Wrap <code>np.full()</code> definition to create an array with the active type defined by the:attr:colour:constant.DEFAULT_FLOAT_DTYPE attribute. |
| <code>index_along_last_axis(a, indexes)</code> | Reduce the dimension of array <i>a</i> by one, by using an array of indexes to pick elements off the last axis. |

colour.utilities.as_array

colour.utilities.**as_array**(*a*: *NumberOrArrayLike* | *NestedSequence*[*NumberOrArrayLike*], *dtype*: *Type*[*DType*] | *None* = *None*) → *NDArray*

Convert given variable *a* to `numpy.ndarray` using given `numpy.dtype`.

Parameters

- **a** (*Union*[*NumberOrArrayLike*, *NestedSequence*[*NumberOrArrayLike*]]) – Variable to convert.
- **dtype** (*Optional*[*Type*[*DType*]]) – `numpy.dtype` to use for conversion, default to the `numpy.dtype` defined by the `colour.constant.DEFAULT_FLOAT_DTYPE` attribute.

Returns

Variable *a* converted to `numpy.ndarray`.

Return type

`numpy.ndarray`

Examples

```
>>> as_array([1, 2, 3])
array([1, 2, 3]...)
>>> as_array([1, 2, 3], dtype=DEFAULT_FLOAT_DTYPE)
array([ 1.,  2.,  3.]
```

colour.utilities.as_int

colour.utilities.**as_int**(*a*: *NumberOrArrayLike*, *dtype*: *Type*[*DTypeInteger*] | *None* = *None*) → *IntegerOrNDArray*

Attempt to convert given variable *a* to `numpy.integer` using given `numpy.dtype`. If variable *a* is not a scalar or 0-dimensional, it is converted to `numpy.ndarray`.

Parameters

- **a** (*NumberOrArrayLike*) – Variable to convert.
- **dtype** (*Type*[*DTypeInteger*] | *None*) – `numpy.dtype` to use for conversion, default to the `numpy.dtype` defined by the `colour.constant.DEFAULT_INT_DTYPE` attribute.

Returns

Variable *a* converted to `numpy.integer`.

Return type

`numpy.integer` or `numpy.ndarray`

Examples

```
>>> as_int(np.array([1]))
1
>>> as_int(np.arange(10))
array([0, 1, 2, 3, 4, 5, 6, 7, 8, 9]...)
```

colour.utilities.as_float

colour.utilities.**as_float**(*a*: NumberOrArrayLike, dtype: *Type*[DTypeFloating] | None = None) → FloatingOrNDArray

Attempt to convert given variable *a* to `numpy.floating` using given `numpy.dtype`. If variable *a* is not a scalar or 0-dimensional, it is converted to `numpy.ndarray`.

Parameters

- **a** (NumberOrArrayLike) – Variable to convert.
- **dtype** (*Type*[DTypeFloating] | None) – `numpy.dtype` to use for conversion, default to the `numpy.dtype` defined by the `colour.constant.DEFAULT_FLOAT_DTYPE` attribute.

Returns

Variable *a* converted to `numpy.floating`.

Return type

`numpy.floating` or `numpy.ndarray`

Examples

```
>>> as_float(np.array([1]))
1.0
>>> as_float(np.arange(10))
array([ 0.,  1.,  2.,  3.,  4.,  5.,  6.,  7.,  8.,  9.]...)
```

colour.utilities.as_int_array

colour.utilities.**as_int_array**(*a*: NumberOrArrayLike, dtype: *Type*[DTypeInteger] | None = None) → ndarray

Convert given variable *a* to `numpy.ndarray` using given `numpy.dtype`.

Parameters

- **a** (NumberOrArrayLike) – Variable to convert.
- **dtype** (*Type*[DTypeInteger] | None) – `numpy.dtype` to use for conversion, default to the `numpy.dtype` defined by the `colour.constant.DEFAULT_INT_DTYPE` attribute.

Returns

Variable *a* converted to `numpy.ndarray`.

Return type

`numpy.ndarray`

Examples

```
>>> as_int_array([1.0, 2.0, 3.0])
array([1, 2, 3]...)
```

colour.utilities.as_float_array

colour.utilities.**as_float_array**(*a*: *NumberOrArrayLike*, *dtype*: *Type[DTypeFloating]* | *None* = *None*)
→ *ndarray*

Convert given variable *a* to *numpy.ndarray* using given *numpy.dtype*.

Parameters

- **a** (*NumberOrArrayLike*) – Variable to convert.
- **dtype** (*Type[DTypeFloating]* | *None*) – *numpy.dtype* to use for conversion, default to the *numpy.dtype* defined by the *colour.constant.DEFAULT_FLOAT_DTYPE* attribute.

Returns

Variable *a* converted to *numpy.ndarray*.

Return type

numpy.ndarray

Examples

```
>>> as_float_array([1, 2, 3])
array([ 1.,  2.,  3.]
```

colour.utilities.as_int_scalar

colour.utilities.**as_int_scalar**(*a*: *NumberOrArrayLike*, *dtype*: *Type[DTypeInteger]* | *None* = *None*)
→ *int*

Convert given *a* variable to *numpy.integer* using given *numpy.dtype*.

Parameters

- **a** (*NumberOrArrayLike*) – Variable to convert.
- **dtype** (*Type[DTypeInteger]* | *None*) – *numpy.dtype* to use for conversion, default to the *numpy.dtype* defined by the *colour.constant.DEFAULT_INT_DTYPE* attribute.

Returns

a variable converted to *numpy.integer*.

Return type

numpy.integer

Examples

```
>>> as_int_scalar(np.array(1))
1
```

colour.utilities.as_float_scalar

colour.utilities.**as_float_scalar**(*a*: *NumberOrArrayLike*, *dtype*: *Type[DTypeFloating]* | *None* = *None*) → *float*

Convert given *a* variable to `numpy.floating` using given `numpy.dtype`.

Parameters

- **a** (*NumberOrArrayLike*) – Variable to convert.
- **dtype** (*Type[DTypeFloating]* | *None*) – `numpy.dtype` to use for conversion, default to the `numpy.dtype` defined by the `colour.constant.DEFAULT_FLOAT_DTYPE` attribute.

Returns

a variable converted to `numpy.floating`.

Return type

`numpy.floating`

Examples

```
>>> as_float_scalar(np.array(1))
1.0
```

colour.utilities.set_default_int_dtype

colour.utilities.**set_default_int_dtype**(*dtype*: *Type[DTypeInteger]* = *DEFAULT_INT_DTYPE*) → *None*

Set *Colour* default `numpy.integer` precision by setting `colour.constant.DEFAULT_INT_DTYPE` attribute with given `numpy.dtype` wherever the attribute is imported.

Parameters

dtype (*Type[DTypeInteger]*) – `numpy.dtype` to set `colour.constant.DEFAULT_INT_DTYPE` with.

Return type

None

Notes

- It is possible to define the int precision at import time by setting the `COLOUR_SCIENCE_DEFAULT_INT_DTYPE` environment variable, for example `set COLOUR_SCIENCE_DEFAULT_INT_DTYPE=int32`.

Warning: This definition is mostly given for consistency purposes with `colour.utilities.set_default_float_dtype()` definition but contrary to the latter, changing *integer* precision will almost certainly completely break *Colour*. With great power comes great responsibility.

Examples

```
>>> as_int_array(np.ones(3)).dtype
dtype('int64')
>>> set_default_int_dtype(np.int32)
>>> as_int_array(np.ones(3)).dtype
dtype('int32')
>>> set_default_int_dtype(np.int64)
>>> as_int_array(np.ones(3)).dtype
dtype('int64')
```

colour.utilities.set_default_float_dtype

colour.utilities.set_default_float_dtype(dtype: *Type[DTypeFloating]* = *DEFAULT_FLOAT_DTYPE*)
→ *None*

Set *Colour* default *numpy.floating* precision by setting *colour.constant.DEFAULT_FLOAT_DTYPE* attribute with given *numpy.dtype* wherever the attribute is imported.

Parameters

dtype (*Type[DTypeFloating]*) – *numpy.dtype* to set *colour.constant.DEFAULT_FLOAT_DTYPE* with.

Return type

None

Warning: Changing *float* precision might result in various *Colour* functionality breaking entirely: <https://github.com/numpy/numpy/issues/6860>. With great power comes great responsibility.

Notes

- It is possible to define the *float* precision at import time by setting the *COLOUR_SCIENCE_DEFAULT_FLOAT_DTYPE* environment variable, for example set *COLOUR_SCIENCE_DEFAULT_FLOAT_DTYPE=float32*.
- Some definition returning a single-scalar ndarray might not honour the given *float* precision: <https://github.com/numpy/numpy/issues/16353>

Examples

```
>>> as_float_array(np.ones(3)).dtype
dtype('float64')
>>> set_default_float_dtype(np.float16)
>>> as_float_array(np.ones(3)).dtype
dtype('float16')
>>> set_default_float_dtype(np.float64)
>>> as_float_array(np.ones(3)).dtype
dtype('float64')
```


colour.utilities.to_domain_1

colour.utilities.to_domain_1(*a*: ArrayLike, *scale_factor*: FloatingOrArrayLike = 100, *dtype*: Type[DTypeFloating] | None = None) → ndarray

Scale given array *a* to domain ‘1’. The behaviour is as follows:

- If *Colour* domain-range scale is ‘**Reference**’ or ‘**1**’, the definition is almost entirely by-passed and will conveniently convert array *a* to np.ndarray.
- If *Colour* domain-range scale is ‘**100**’ (currently unsupported private value only used for unit tests), array *a* is divided by *scale_factor*, typically 100.

Parameters

- **a** (ArrayLike) – Array *a* to scale to domain ‘1’.
- **scale_factor** (FloatingOrArrayLike) – Scale factor, usually *numeric* but can be a `numpy.ndarray` if some axis need different scaling to be brought to domain ‘1’.
- **dtype** (Type[DTypeFloating] | None) – Data type used for the conversion to np.ndarray.

Returns

Array *a* scaled to domain ‘1’.

Return type

`numpy.ndarray`

Examples

With *Colour* domain-range scale set to ‘**Reference**’:

```
>>> with domain_range_scale("Reference"):
...     to_domain_1(1)
...
array(1.0)
```

With *Colour* domain-range scale set to ‘**1**’:

```
>>> with domain_range_scale("1"):
...     to_domain_1(1)
...
array(1.0)
```

With *Colour* domain-range scale set to ‘**100**’ (unsupported):

```
>>> with domain_range_scale("100"):
...     to_domain_1(1)
...
array(0.01)
```

colour.utilities.to_domain_10

colour.utilities.to_domain_10(*a*: ArrayLike, *scale_factor*: FloatingOrArrayLike = 10, *dtype*: Type[DTypeFloating] | None = None) → ndarray

Scale given array *a* to domain ‘10’, used by *Munsell Renotation System*. The behaviour is as follows:

- If *Colour* domain-range scale is ‘Reference’, the definition is almost entirely by-passed and will conveniently convert array *a* to np.ndarray.
- If *Colour* domain-range scale is ‘1’, array *a* is multiplied by *scale_factor*, typically 10.
- If *Colour* domain-range scale is ‘100’ (currently unsupported private value only used for unit tests), array *a* is divided by *scale_factor*, typically 10.

Parameters

- **a** (ArrayLike) – Array *a* to scale to domain ‘10’.
- **scale_factor** (FloatingOrArrayLike) – Scale factor, usually *numeric* but can be a `numpy.ndarray` if some axis need different scaling to be brought to domain ‘10’.
- **dtype** (Type[DTypeFloating] | None) – Data type used for the conversion to np.ndarray.

Returns

Array *a* scaled to domain ‘10’.

Return type

`numpy.ndarray`

Examples

With *Colour* domain-range scale set to ‘Reference’:

```
>>> with domain_range_scale("Reference"):
...     to_domain_10(1)
...
array(1.0)
```

With *Colour* domain-range scale set to ‘1’:

```
>>> with domain_range_scale("1"):
...     to_domain_10(1)
...
array(10.0)
```

With *Colour* domain-range scale set to ‘100’ (unsupported):

```
>>> with domain_range_scale("100"):
...     to_domain_10(1)
...
array(0.1)
```

colour.utilities.to_domain_100

`colour.utilities.to_domain_100(a: ArrayLike, scale_factor: FloatingOrArrayLike = 100, dtype: Type[DTypeFloating] | None = None) → ndarray`

Scale given array *a* to domain ‘100’. The behaviour is as follows:

- If *Colour* domain-range scale is ‘Reference’ or ‘100’ (currently unsupported private value only used for unit tests), the definition is almost entirely by-passed and will conveniently convert array *a* to `np.ndarray`.
- If *Colour* domain-range scale is ‘1’, array *a* is multiplied by `scale_factor`, typically 100.

Parameters

- **a** (ArrayLike) – Array *a* to scale to domain ‘100’.
- **scale_factor** (FloatingOrArrayLike) – Scale factor, usually *numeric* but can be a `numpy.ndarray` if some axis need different scaling to be brought to domain ‘100’.
- **dtype** (Type[DTypeFloating] | None) – Data type used for the conversion to `np.ndarray`.

Returns

Array *a* scaled to domain ‘100’.

Return type

`numpy.ndarray`

Examples

With *Colour* domain-range scale set to ‘Reference’:

```
>>> with domain_range_scale("Reference"):
...     to_domain_100(1)
...
array(1.0)
```

With *Colour* domain-range scale set to ‘1’:

```
>>> with domain_range_scale("1"):
...     to_domain_100(1)
...
array(100.0)
```

With *Colour* domain-range scale set to ‘100’ (unsupported):

```
>>> with domain_range_scale("100"):
...     to_domain_100(1)
...
array(1.0)
```

colour.utilities.to_domain_degrees

`colour.utilities.to_domain_degrees(a: ArrayLike, scale_factor: FloatingOrArrayLike = 360, dtype: Type[DTypeFloating] | None = None) → ndarray`

Scale given array *a* to degrees domain. The behaviour is as follows:

- If *Colour* domain-range scale is **‘Reference’**, the definition is almost entirely by-passed and will conveniently convert array *a* to `np.ndarray`.
- If *Colour* domain-range scale is **‘1’**, array *a* is multiplied by `scale_factor`, typically 360.
- If *Colour* domain-range scale is **‘100’** (currently unsupported private value only used for unit tests), array *a* is multiplied by `scale_factor / 100`, typically 360 / 100.

Parameters

- **a** (ArrayLike) – Array *a* to scale to degrees domain.
- **scale_factor** (FloatingOrArrayLike) – Scale factor, usually *numeric* but can be a `numpy.ndarray` if some axis need different scaling to be brought to degrees domain.
- **dtype** (Type[DTypeFloating] | None) – Data type used for the conversion to `np.ndarray`.

Returns

Array *a* scaled to degrees domain.

Return type

`numpy.ndarray`

Examples

With *Colour* domain-range scale set to **‘Reference’**:

```
>>> with domain_range_scale("Reference"):
...     to_domain_degrees(1)
...
array(1.0)
```

With *Colour* domain-range scale set to **‘1’**:

```
>>> with domain_range_scale("1"):
...     to_domain_degrees(1)
...
array(360.0)
```

With *Colour* domain-range scale set to **‘100’** (unsupported):

```
>>> with domain_range_scale("100"):
...     to_domain_degrees(1)
...
array(3.6)
```

colour.utilities.to_domain_int

colour.utilities.to_domain_int(*a*: ArrayLike, *bit_depth*: IntegerOrArrayLike = 8, *dtype*: Type[DTypeFloating] | None = None) → ndarray

Scale given array *a* to int domain. The behaviour is as follows:

- If *Colour* domain-range scale is '**Reference**', the definition is almost entirely by-passed and will conveniently convert array *a* to np.ndarray.
- If *Colour* domain-range scale is '**1**', array *a* is multiplied by $2^{\text{bit_depth}} - 1$.
- If *Colour* domain-range scale is '**100**' (currently unsupported private value only used for unit tests), array *a* is multiplied by $2^{\text{bit_depth}} - 1$.

Parameters

- **a** (ArrayLike) – Array *a* to scale to int domain.
- **bit_depth** (IntegerOrArrayLike) – Bit depth, usually *integer* but can be a `numpy.ndarray` if some axis need different scaling to be brought to int domain.
- **dtype** (Type[DTypeFloating] | None) – Data type used for the conversion to np.ndarray.

Returns

Array *a* scaled to int domain.

Return type

`numpy.ndarray`

Notes

- To avoid precision issues and rounding, the scaling is performed on *float* numbers.

Examples

With *Colour* domain-range scale set to '**Reference**':

```
>>> with domain_range_scale("Reference"):
...     to_domain_int(1)
...
array(1.0)
```

With *Colour* domain-range scale set to '**1**':

```
>>> with domain_range_scale("1"):
...     to_domain_int(1)
...
array(255.0)
```

With *Colour* domain-range scale set to '**100**' (unsupported):

```
>>> with domain_range_scale("100"):
...     to_domain_int(1)
...
array(2.55)
```

colour.utilities.from_range_1

colour.utilities.from_range_1(*a*: ArrayLike, *scale_factor*: FloatingOrArrayLike = 100, *dtype*: Type[DTypeFloating] | None = None) → ndarray

Scale given array *a* from range ‘1’. The behaviour is as follows:

- If *Colour* domain-range scale is ‘Reference’ or ‘1’, the definition is entirely by-passed.
- If *Colour* domain-range scale is ‘100’ (currently unsupported private value only used for unit tests), array *a* is multiplied by *scale_factor*, typically 100.

Parameters

- **a** (ArrayLike) – Array *a* to scale from range ‘1’.
- **scale_factor** (FloatingOrArrayLike) – Scale factor, usually *numeric* but can be a `numpy.ndarray` if some axis need different scaling to be brought from range ‘1’.
- **dtype** (Type[DTypeFloating] | None) – Data type used for the conversion to `np.ndarray`.

Returns

Array *a* scaled from range ‘1’.

Return type

`numpy.ndarray`

Warning: The scale conversion of variable *a* happens in-place, i.e. *a* will be mutated!

Examples

With *Colour* domain-range scale set to ‘Reference’:

```
>>> with domain_range_scale("Reference"):
...     from_range_1(1)
...
array(1.0)
```

With *Colour* domain-range scale set to ‘1’:

```
>>> with domain_range_scale("1"):
...     from_range_1(1)
...
array(1.0)
```

With *Colour* domain-range scale set to ‘100’ (unsupported):

```
>>> with domain_range_scale("100"):
...     from_range_1(1)
...
array(100.0)
```

colour.utilities.from_range_10

colour.utilities.from_range_10(*a*: ArrayLike, *scale_factor*: FloatingOrArrayLike = 10, *dtype*: Type[DTypeFloating] | None = None) → ndarray

Scale given array *a* from range ‘10’, used by *Munsell Renotation System*. The behaviour is as follows:

- If *Colour* domain-range scale is ‘Reference’, the definition is entirely by-passed.
- If *Colour* domain-range scale is ‘1’, array *a* is divided by *scale_factor*, typically 10.
- If *Colour* domain-range scale is ‘100’ (currently unsupported private value only used for unit tests), array *a* is multiplied by *scale_factor*, typically 10.

Parameters

- **a** (ArrayLike) – Array *a* to scale from range ‘10’.
- **scale_factor** (FloatingOrArrayLike) – Scale factor, usually *numeric* but can be a `numpy.ndarray` if some axis need different scaling to be brought from range ‘10’.
- **dtype** (Type[DTypeFloating] | None) – Data type used for the conversion to `np.ndarray`.

Returns

Array *a* scaled from range ‘10’.

Return type

`numpy.ndarray`

Warning: The scale conversion of variable *a* happens in-place, i.e. *a* will be mutated!

Examples

With *Colour* domain-range scale set to ‘Reference’:

```
>>> with domain_range_scale("Reference"):
...     from_range_10(1)
...
array(1.0)
```

With *Colour* domain-range scale set to ‘1’:

```
>>> with domain_range_scale("1"):
...     from_range_10(1)
...
array(0.1)
```

With *Colour* domain-range scale set to ‘100’ (unsupported):

```
>>> with domain_range_scale("100"):
...     from_range_10(1)
...
array(10.0)
```

colour.utilities.from_range_100

colour.utilities.from_range_100(*a*: ArrayLike, *scale_factor*: FloatingOrArrayLike = 100, *dtype*: Type[DTypeFloating] | None = None) → ndarray

Scale given array *a* from range ‘100’. The behaviour is as follows:

- If *Colour* domain-range scale is ‘Reference’ or ‘100’ (currently unsupported private value only used for unit tests), the definition is entirely by-passed.
- If *Colour* domain-range scale is ‘1’, array *a* is divided by *scale_factor*, typically 100.

Parameters

- **a** (ArrayLike) – Array *a* to scale from range ‘100’.
- **scale_factor** (FloatingOrArrayLike) – Scale factor, usually *numeric* but can be a `numpy.ndarray` if some axis need different scaling to be brought from range ‘100’.
- **dtype** (Type[DTypeFloating] | None) – Data type used for the conversion to `np.ndarray`.

Returns

Array *a* scaled from range ‘100’.

Return type

`numpy.ndarray`

Warning: The scale conversion of variable *a* happens in-place, i.e. *a* will be mutated!

Examples

With *Colour* domain-range scale set to ‘Reference’:

```
>>> with domain_range_scale("Reference"):
...     from_range_100(1)
...
array(1.0)
```

With *Colour* domain-range scale set to ‘1’:

```
>>> with domain_range_scale("1"):
...     from_range_100(1)
...
array(0.01)
```

With *Colour* domain-range scale set to ‘100’ (unsupported):

```
>>> with domain_range_scale("100"):
...     from_range_100(1)
...
array(1.0)
```


colour.utilities.from_range_degrees

`colour.utilities.from_range_degrees(a: ArrayLike, scale_factor: FloatingOrArrayLike = 360, dtype: Type[DTypeFloating] | None = None) → ndarray`

Scale given array *a* from degrees range. The behaviour is as follows:

- If *Colour* domain-range scale is **‘Reference’**, the definition is entirely by-passed.
- If *Colour* domain-range scale is **‘1’**, array *a* is divided by `scale_factor`, typically 360.
- If *Colour* domain-range scale is **‘100’** (currently unsupported private value only used for unit tests), array *a* is divided by `scale_factor / 100`, typically 360 / 100.

Parameters

- **a** (ArrayLike) – Array *a* to scale from degrees range.
- **scale_factor** (FloatingOrArrayLike) – Scale factor, usually *numeric* but can be a `numpy.ndarray` if some axis need different scaling to be brought from degrees range.
- **dtype** (Type[DTypeFloating] | None) – Data type used for the conversion to `np.ndarray`.

Returns

Array *a* scaled from degrees range.

Return type

`numpy.ndarray`

Warning: The scale conversion of variable *a* happens in-place, i.e. *a* will be mutated!

Examples

With *Colour* domain-range scale set to **‘Reference’**:

```
>>> with domain_range_scale("Reference"):
...     from_range_degrees(1)
...
array(1.0)
```

With *Colour* domain-range scale set to **‘1’**:

```
>>> with domain_range_scale("1"):
...     from_range_degrees(1)
...
array(0.0027777...)
```

With *Colour* domain-range scale set to **‘100’** (unsupported):

```
>>> with domain_range_scale("100"):
...     from_range_degrees(1)
...
array(0.277777...)
```

colour.utilities.from_range_int

colour.utilities.from_range_int(*a*: ArrayLike, *bit_depth*: IntegerOrArrayLike = 8, *dtype*: Type[DTypeFloating] | None = None) → ndarray

Scale given array *a* from int range. The behaviour is as follows:

- If *Colour* domain-range scale is ‘**Reference**’, the definition is entirely by-passed.
- If *Colour* domain-range scale is ‘**1**’, array *a* is converted to np.ndarray and divided by $2^{bit_depth} - 1$.
- If *Colour* domain-range scale is ‘**100**’ (currently unsupported private value only used for unit tests), array *a* is converted to np.ndarray and divided by $2^{bit_depth} - 1$.

Parameters

- **a** (ArrayLike) – Array *a* to scale from int range.
- **bit_depth** (IntegerOrArrayLike) – Bit depth, usually *integer* but can be a `numpy.ndarray` if some axis need different scaling to be brought from int range.
- **dtype** (Type[DTypeFloating] | None) – Data type used for the conversion to np.ndarray.

Returns

Array *a* scaled from int range.

Return type

`numpy.ndarray`

Warning: The scale conversion of variable *a* happens in-place, i.e. *a* will be mutated!

Notes

- To avoid precision issues and rounding, the scaling is performed on *float* numbers.

Examples

With *Colour* domain-range scale set to ‘**Reference**’:

```
>>> with domain_range_scale("Reference"):
...     from_range_int(1)
...
array(1.0)
```

With *Colour* domain-range scale set to ‘**1**’:

```
>>> with domain_range_scale("1"):
...     from_range_int(1)
...
array(0.0039215...)
```

With *Colour* domain-range scale set to ‘**100**’ (unsupported):

```
>>> with domain_range_scale("100"):
...     from_range_int(1)
...
array(0.3921568...)
```

colour.utilities.closest_indexes

colour.utilities.**closest_indexes**(*a*: ArrayLike, *b*: ArrayLike) → ndarray

Return the array *a* closest element indexes to the reference array *b* elements.

Parameters

- **a** (ArrayLike) – Array *a* to search for the closest element indexes.
- **b** (ArrayLike) – Reference array *b*.

Returns

Closest array *a* element indexes.

Return type

numpy.ndarray

Examples

```
>>> a = np.array(  
...     [  
...         24.31357115,  
...         63.62396289,  
...         55.71528816,  
...         62.70988028,  
...         46.84480573,  
...         25.40026416,  
...     ]  
... )  
>>> print(closest_indexes(a, 63))  
[3]  
>>> print(closest_indexes(a, [63, 25]))  
[3 5]
```

colour.utilities.closest

colour.utilities.**closest**(*a*: ArrayLike, *b*: ArrayLike) → ndarray

Return the array *a* closest elements to the reference array *b* elements.

Parameters

- **a** (ArrayLike) – Array *a* to search for the closest element.
- **b** (ArrayLike) – Reference array *b*.

Returns

Closest array *a* elements.

Return type

numpy.ndarray

Examples

```
>>> a = np.array(
...     [
...         24.31357115,
...         63.62396289,
...         55.71528816,
...         62.70988028,
...         46.84480573,
...         25.40026416,
...     ]
... )
>>> closest(a, 63)
array([ 62.70988028])
>>> closest(a, [63, 25])
array([ 62.70988028,  25.40026416])
```

colour.utilities.interval

colour.utilities.**interval**(distribution: ArrayLike, unique: bool = True) → ndarray

Return the interval size of given distribution.

Parameters

- **distribution** (ArrayLike) – Distribution to retrieve the interval.
- **unique** (bool) – Whether to return unique intervals if the distribution is non-uniformly spaced or the complete intervals

Returns

Distribution interval.

Return type

numpy.ndarray

Examples

Uniformly spaced variable:

```
>>> y = np.array([1, 2, 3, 4, 5])
>>> interval(y)
array([ 1.])
>>> interval(y, False)
array([ 1.,  1.,  1.,  1.])
```

Non-uniformly spaced variable:

```
>>> y = np.array([1, 2, 3, 4, 8])
>>> interval(y)
array([ 1.,  4.])
>>> interval(y, False)
array([ 1.,  1.,  1.,  4.])
```

colour.utilities.is_uniform

colour.utilities.**is_uniform**(*distribution*: ArrayLike) → bool

Return whether given distribution is uniform.

Parameters

distribution (ArrayLike) – Distribution to check the uniformity of.

Returns

Whether distribution uniform.

Return type

bool

Examples

Uniformly spaced variable:

```
>>> a = np.array([1, 2, 3, 4, 5])
>>> is_uniform(a)
True
```

Non-uniformly spaced variable:

```
>>> a = np.array([1, 2, 3.1415, 4, 5])
>>> is_uniform(a)
False
```

colour.utilities.has_only_nan

colour.utilities.**has_only_nan**(*a*: ArrayLike) → bool

Return whether given array *a* contains only NaN values.

Parameters

a (ArrayLike) – Array *a* to check whether it contains only NaN values.

Returns

Whether array *a* contains only NaN values.

Return type

bool

Examples

```
>>> has_only_nan(None)
True
>>> has_only_nan([None, None])
True
>>> has_only_nan([True, None])
False
>>> has_only_nan([0.1, np.nan, 0.3])
False
```

colour.utilities.in_array

colour.utilities.**in_array**(*a*: ArrayLike, *b*: ArrayLike, *tolerance*: Number = EPSILON) → ndarray

Return whether each element of the array *a* is also present in the array *b* within given tolerance.

Parameters

- **a** (ArrayLike) – Array *a* to test the elements from.
- **b** (ArrayLike) – The array *b* against which to test the elements of array *a*.
- **tolerance** (Number) – Tolerance value.

Returns

A boolean array with array *a* shape describing whether an element of array *a* is present in array *b* within given tolerance.

Return type

numpy.ndarray

References

[Yor14]

Examples

```
>>> a = np.array([0.50, 0.60])
>>> b = np.linspace(0, 10, 101)
>>> np.in1d(a, b)
array([ True, False], dtype=bool)
>>> in_array(a, b)
array([ True,  True], dtype=bool)
```

colour.utilities.tstack

colour.utilities.**tstack**(*a*: ArrayLike | NestedSequence[NumberOrArrayLike], *dtype*: Type[DTypeBoolean] | Type[DTypeNumber] | None = None) → NDArray

Stack given array of arrays *a* along the last axis (tail) to produce a stacked array.

It is used to stack an array of arrays produced by the `colour.utilities.tsplit()` definition.

Parameters

- **a** (Union[ArrayLike, NestedSequence[NumberOrArrayLike]]) – Array of arrays *a* to stack along the last axis.
- **dtype** (Optional[Union[Type[DTypeBoolean], Type[DTypeNumber]]]) – `numpy.dtype` to use for initial conversion to `numpy.ndarray`, default to the `numpy.dtype` defined by `colour.constant.DEFAULT_FLOAT_DTYPE` attribute.

Returns

Stacked array.

Return type

numpy.ndarray

Examples

```
>>> a = 0
>>> tstack([a, a, a])
array([ 0.,  0.,  0.])
>>> a = np.arange(0, 6)
>>> tstack([a, a, a])
array([[ 0.,  0.,  0.],
       [ 1.,  1.,  1.],
       [ 2.,  2.,  2.],
       [ 3.,  3.,  3.],
       [ 4.,  4.,  4.],
       [ 5.,  5.,  5.]])
>>> a = np.reshape(a, (1, 6))
>>> tstack([a, a, a])
array([[[ 0.,  0.,  0.],
        [ 1.,  1.,  1.],
        [ 2.,  2.,  2.],
        [ 3.,  3.,  3.],
        [ 4.,  4.,  4.],
        [ 5.,  5.,  5.]])])
>>> a = np.reshape(a, (1, 1, 6))
>>> tstack([a, a, a])
array([[[[ 0.,  0.,  0.],
          [ 1.,  1.,  1.],
          [ 2.,  2.,  2.],
          [ 3.,  3.,  3.],
          [ 4.,  4.,  4.],
          [ 5.,  5.,  5.]])]])
```

colour.utilities.tsplit

colour.utilities.**tsplit**(*a*: ArrayLike | NestedSequence[NumberOrArrayLike], *dtype*: Type[DTypeBoolean] | Type[DTypeNumber] | None = None) → NDArray

Split given stacked array *a* along the last axis (tail) to produce an array of arrays.

It is used to split a stacked array produced by the `colour.utilities.tstack()` definition.

Parameters

- **a** (Union[ArrayLike, NestedSequence[NumberOrArrayLike]]) – Stacked array *a* to split.
- **dtype** (Optional[Union[Type[DTypeBoolean], Type[DTypeNumber]]]) – `numpy.dtype` to use for initial conversion to `numpy.ndarray`, default to the `numpy.dtype` defined by `colour.constant.DEFAULT_FLOAT_DTYPE` attribute.

Returns

Array of arrays.

Return type

`numpy.ndarray`

Examples

```
>>> a = np.array([0, 0, 0])
>>> tsplit(a)
array([ 0.,  0.,  0.])
>>> a = np.array(
...     [[0, 0, 0], [1, 1, 1], [2, 2, 2], [3, 3, 3], [4, 4, 4], [5, 5, 5]]
... )
>>> tsplit(a)
array([[ 0.,  1.,  2.,  3.,  4.,  5.],
       [ 0.,  1.,  2.,  3.,  4.,  5.],
       [ 0.,  1.,  2.,  3.,  4.,  5.]])
>>> a = np.array(
...     [
...         [
...             [0, 0, 0],
...             [1, 1, 1],
...             [2, 2, 2],
...             [3, 3, 3],
...             [4, 4, 4],
...             [5, 5, 5],
...         ]
...     ]
... )
>>> tsplit(a)
array([[[ 0.,  1.,  2.,  3.,  4.,  5.]],
       [[ 0.,  1.,  2.,  3.,  4.,  5.]],
       [[ 0.,  1.,  2.,  3.,  4.,  5.]])
```

colour.utilities.row_as_diagonal

colour.utilities.row_as_diagonal(*a*: *ArrayLike*) → *ndarray*

Return the rows of given array *a* as diagonal matrices.

Parameters

a (*ArrayLike*) – Array *a* to returns the rows of as diagonal matrices.

Returns

Array *a* rows as diagonal matrices.

Return type

numpy.ndarray

References

[Cas14]

Examples

```
>>> a = np.array(
...     [
...         [0.25891593, 0.07299478, 0.36586996],
...         [0.30851087, 0.37131459, 0.16274825],
...         [0.71061831, 0.67718718, 0.09562581],
...         [0.71588836, 0.76772047, 0.15476079],
...         [0.92985142, 0.22263399, 0.88027331],
...     ]
... )
>>> row_as_diagonal(a)
array([[ 0.25891593,  0.          ,  0.          ],
       [ 0.          ,  0.07299478,  0.          ],
       [ 0.          ,  0.          ,  0.36586996]],

      [[ 0.30851087,  0.          ,  0.          ],
       [ 0.          ,  0.37131459,  0.          ],
       [ 0.          ,  0.          ,  0.16274825]],

      [[ 0.71061831,  0.          ,  0.          ],
       [ 0.          ,  0.67718718,  0.          ],
       [ 0.          ,  0.          ,  0.09562581]],

      [[ 0.71588836,  0.          ,  0.          ],
       [ 0.          ,  0.76772047,  0.          ],
       [ 0.          ,  0.          ,  0.15476079]],

      [[ 0.92985142,  0.          ,  0.          ],
       [ 0.          ,  0.22263399,  0.          ],
       [ 0.          ,  0.          ,  0.88027331]]])
```

colour.utilities.orient

`colour.utilities.orient(a: ArrayLike, orientation: Literal['Ignore', 'Flip', 'Flop', '90 CW', '90 CCW', '180'] | str = 'Ignore') → ndarray`

Orient given array *a* according to given orientation.

Parameters

- **a** (ArrayLike) – Array *a* to orient.
- **orientation** (*Literal*['Ignore', 'Flip', 'Flop', '90 CW', '90 CCW', '180'] | str) – Orientation to perform.

Returns

Oriented array.

Return type

numpy.ndarray

Examples

```
>>> a = np.tile(np.arange(5), (5, 1))
>>> a
array([[0, 1, 2, 3, 4],
       [0, 1, 2, 3, 4],
       [0, 1, 2, 3, 4],
       [0, 1, 2, 3, 4],
       [0, 1, 2, 3, 4]])
>>> orient(a, "90 CW")
array([[ 0.,  0.,  0.,  0.,  0.],
       [ 1.,  1.,  1.,  1.,  1.],
       [ 2.,  2.,  2.,  2.,  2.],
       [ 3.,  3.,  3.,  3.,  3.],
       [ 4.,  4.,  4.,  4.,  4.]])
>>> orient(a, "Flip")
array([[ 4.,  3.,  2.,  1.,  0.],
       [ 4.,  3.,  2.,  1.,  0.],
       [ 4.,  3.,  2.,  1.,  0.],
       [ 4.,  3.,  2.,  1.,  0.],
       [ 4.,  3.,  2.,  1.,  0.]])
```

colour.utilities.centroid

colour.utilities.**centroid**(*a*: ArrayLike) → ndarray

Return the centroid indexes of given array *a*.

Parameters

a (ArrayLike) – Array *a* to returns the centroid indexes of.

Returns

Array *a* centroid indexes.

Return type

numpy.ndarray

Examples

```
>>> a = np.tile(np.arange(0, 5), (5, 1))
>>> centroid(a)
array([2, 3]...)
```

colour.utilities.fill_nan

colour.utilities.**fill_nan**(*a*: ArrayLike, *method*: Literal['Interpolation', 'Constant'] | *str* = 'Interpolation', *default*: Number = 0) → ndarray

Fill given array *a* NaN values according to given method.

Parameters

- **a** (ArrayLike) – Array *a* to fill the NaNs of.
- **method** (Literal['Interpolation', 'Constant'] | *str*) – *Interpolation* method linearly interpolates through the NaN values, *Constant* method replaces NaN values with default.
- **default** (Number) – Value to use with the *Constant* method.

Returns

NaNs filled array *a*.

Return type

`numpy.ndarray`

Examples

```
>>> a = np.array([0.1, 0.2, np.nan, 0.4, 0.5])
>>> fill_nan(a)
array([ 0.1, 0.2, 0.3, 0.4, 0.5])
>>> fill_nan(a, method="Constant")
array([ 0.1, 0.2, 0. , 0.4, 0.5])
```

colour.utilities.ndarray_write

`colour.utilities.ndarray_write(a: ArrayLike) → Generator`

Define a context manager setting given array *a* writeable to operate one and then read-only.

Parameters

a (ArrayLike) – Array *a* to operate on.

Yields

Generator – Array *a* operated.

Return type

Generator

Examples

```
>>> a = np.linspace(0, 1, 10)
>>> a.setflags(write=False)
>>> try:
...     a += 1
... except ValueError:
...     pass
...
>>> with ndarray_write(a):
...     a += 1
...
... 
```

colour.utilities.zeros

`colour.utilities.zeros(shape: int | Tuple[int, ...], dtype: Type[DTypeNumber] | None = None, order: Literal['C', 'F'] = 'C') → ndarray`

Wrap `np.zeros()` definition to create an array with the active `numpy.dtype` defined by the `colour.constant.DEFAULT_FLOAT_DTYPE` attribute.

Parameters

- **shape** (`int` | `Tuple[int, ...]`) – Shape of the new array, e.g., (2, 3) or 2.
- **dtype** (`Type[DTypeNumber]` | `None`) – `numpy.dtype` to use for conversion, default to the `numpy.dtype` defined by the `colour.constant.DEFAULT_FLOAT_DTYPE` attribute.

- **order** (`Literal['C', 'F']`) – Whether to store multi-dimensional data in row-major (C-style) or column-major (Fortran-style) order in memory.

Returns

Array of given shape and `numpy.dtype`, filled with zeros.

Return type

`numpy.ndarray`

Examples

```
>>> zeros(3)
array([ 0.,  0.,  0.]
```

colour.utilities.ones

`colour.utilities.ones(shape: int | Tuple[int, ...], dtype: Type[DTypeNumber] | None = None, order: Literal['C', 'F'] = 'C') → ndarray`

Wrap `np.ones()` definition to create an array with the active `numpy.dtype` defined by the `colour.constant.DEFAULT_FLOAT_DTYPE` attribute.

Parameters

- **shape** (`int` | `Tuple[int, ...]`) – Shape of the new array, e.g., (2, 3) or 2.
- **dtype** (`Type[DTypeNumber]` | *None*) – `numpy.dtype` to use for conversion, default to the `numpy.dtype` defined by the `colour.constant.DEFAULT_FLOAT_DTYPE` attribute.
- **order** (`Literal['C', 'F']`) – Whether to store multi-dimensional data in row-major (C-style) or column-major (Fortran-style) order in memory.

Returns

Array of given shape and type, filled with ones.

Return type

`numpy.ndarray`

Examples

```
>>> ones(3)
array([ 1.,  1.,  1.]
```

colour.utilities.full

`colour.utilities.full(shape: int | Tuple[int, ...], fill_value: Number, dtype: Type[DTypeNumber] | None = None, order: Literal['C', 'F'] = 'C') → ndarray`

Wrap `np.full()` definition to create an array with the active type defined by the `attr:colour.constant.DEFAULT_FLOAT_DTYPE` attribute.

Parameters

- **shape** (`int` | `Tuple[int, ...]`) – Shape of the new array, e.g., (2, 3) or 2.
- **fill_value** (*Number*) – Fill value.
- **dtype** (`Type[DTypeNumber]` | *None*) – `numpy.dtype` to use for conversion, default to the `numpy.dtype` defined by the `colour.constant.DEFAULT_FLOAT_DTYPE` attribute.

- **order** (`Literal['C', 'F']`) – Whether to store multi-dimensional data in row-major (C-style) or column-major (Fortran-style) order in memory.

Returns

Array of given shape and `numpy.dtype`, filled with given value.

Return type

`numpy.ndarray`

Examples

```
>>> ones(3)
array([ 1.,  1.,  1.])
```

`colour.utilities.index_along_last_axis`

`colour.utilities.index_along_last_axis(a: ArrayLike, indexes: ArrayLike) → ndarray`

Reduce the dimension of array *a* by one, by using an array of indexes to pick elements off the last axis.

Parameters

- **a** (`ArrayLike`) – Array *a* to be indexed.
- **indexes** (`ArrayLike`) – *Integer* array with the same shape as *a* but with one dimension fewer, containing indices to the last dimension of *a*. All elements must be numbers between 0 and *m* - 1.

Returns

Indexed array *a*.

Return type

`numpy.ndarray`

Raises

- **ValueError** – If the array *a* and indexes have incompatible shapes.
- **IndexError** – If indexes has elements outside of the allowed range of 0 to *m* - 1 or if it's not an *integer* array.

Examples

```
>>> a = np.array(
...     [
...         [
...             [0.3, 0.5, 6.9],
...             [3.3, 4.4, 1.6],
...             [4.4, 7.5, 2.3],
...             [2.3, 1.6, 7.4],
...         ],
...         [
...             [2.0, 5.9, 2.8],
...             [6.2, 4.9, 8.6],
...             [3.7, 9.7, 7.3],
...             [6.3, 4.3, 3.2],
...         ],
...     ]
... )
```

(continues on next page)

(continued from previous page)

```

...         [0.8, 1.9, 0.7],
...         [5.6, 4.0, 1.7],
...         [6.7, 8.2, 1.7],
...         [1.2, 7.1, 1.4],
...     ],
...     [
...         [4.0, 4.8, 8.9],
...         [4.0, 0.3, 6.9],
...         [3.5, 7.1, 4.5],
...         [1.4, 1.9, 1.6],
...     ],
... ]
... )
>>> indexes = np.array(
...     [[2, 0, 1, 1], [2, 1, 1, 0], [0, 0, 1, 2], [0, 0, 1, 2]]
... )
>>> index_along_last_axis(a, indexes)
array([[ 6.9,  3.3,  7.5,  1.6],
       [ 2.8,  4.9,  9.7,  6.3],
       [ 0.8,  5.6,  8.2,  1.4],
       [ 4. ,  4. ,  7.1,  1.6]])

```

This function can be used to compute the result of `np.min()` along the last axis given the corresponding `np.argmin()` indexes.

```

>>> indexes = np.argmin(a, axis=-1)
>>> np.array_equal(index_along_last_axis(a, indexes), np.min(a, axis=-1))
True

```

In particular, this can be used to manipulate the indexes given by functions like `np.min()` before indexing the array. For example, to get elements directly following the smallest elements:

```

>>> index_along_last_axis(a, (indexes + 1) % 3)
array([[ 0.5,  3.3,  4.4,  7.4],
       [ 5.9,  8.6,  9.7,  6.3],
       [ 0.8,  5.6,  6.7,  7.1],
       [ 4.8,  6.9,  7.1,  1.9]])

```

Metrics

`colour.utilities`

| | |
|---|--|
| <code>metric_mse(a, b[, axis])</code> | Compute the mean squared error (MSE) or mean squared deviation (MSD) between given variables <i>a</i> and <i>b</i> . |
| <code>metric_psnr(a, b[, max_a, axis])</code> | Compute the peak signal-to-noise ratio (PSNR) between given variables <i>a</i> and <i>b</i> . |

colour.utilities.metric_mse

`colour.utilities.metric_mse(a: ArrayLike, b: ArrayLike, axis: int | Tuple[int] | None = None) → FloatingOrNDArray`

Compute the mean squared error (MSE) or mean squared deviation (MSD) between given variables *a* and *b*.

Parameters

- **a** (ArrayLike) – Variable *a*.
- **b** (ArrayLike) – Variable *b*.
- **axis** (int | Tuple[int] | None) – Axis or axes along which the means are computed. The default is to compute the mean of the flattened array. If this is a tuple of ints, a mean is performed over multiple axes, instead of a single axis or all the axes as before.

Returns

Mean squared error (MSE).

Return type

`numpy.floating` or `numpy.ndarray`

References

[Wikipedia03c]

Examples

```
>>> a = np.array([0.48222001, 0.31654775, 0.22070353])
>>> b = a * 0.9
>>> metric_mse(a, b)
0.0012714...
```

colour.utilities.metric_psnr

`colour.utilities.metric_psnr(a: ArrayLike, b: ArrayLike, max_a: Number = 1, axis: int | Tuple[int] | None = None) → FloatingOrNDArray`

Compute the peak signal-to-noise ratio (PSNR) between given variables *a* and *b*.

Parameters

- **a** (ArrayLike) – Variable *a*.
- **b** (ArrayLike) – Variable *b*.
- **max_a** (Number) – Maximum possible pixel value of the *a* variable.
- **axis** (int | Tuple[int] | None) – Axis or axes along which the means are computed. The default is to compute the mean of the flattened array. If this is a tuple of ints, a mean is performed over multiple axes, instead of a single axis or all the axes as before.

Returns

Peak signal-to-noise ratio (PSNR).

Return type

`numpy.floating` or `numpy.ndarray`

References

[Wikipedia04a]

Examples

```
>>> a = np.array([0.48222001, 0.31654775, 0.22070353])
>>> b = a * 0.9
>>> metric_psnr(a, b)
28.9568515...
```

Data Structures

colour.utilities

| | |
|---|--|
| <code>CanonicalMapping([data])</code> | Implement a delimiter and case-insensitive <code>dict</code> -like object with support for slugs, i.e. <i>SEO</i> friendly and human-readable version of the keys but also canonical keys, i.e. slugified keys without delimiters. |
| <code>LazyCanonicalMapping([data])</code> | Implement a lazy delimiter and case-insensitive <code>dict</code> -like object inheriting from <code>colour.utilities.CanonicalMapping</code> class. |
| <code>Lookup</code> | Extend <code>dict</code> type to provide a lookup by value(s). |
| <code>Node(*args, **kwargs)</code> | Represent a basic node supporting the creation of basic node trees. |
| <code>Structure(*args, **kwargs)</code> | Define a <code>dict</code> -like object allowing to access key values using dot syntax. |

colour.utilities.CanonicalMapping

class colour.utilities.CanonicalMapping(data: *Generator* | *Mapping* | *None* = None, **kwargs: *Any*)

Bases: `MutableMapping`

Implement a delimiter and case-insensitive `dict`-like object with support for slugs, i.e. *SEO* friendly and human-readable version of the keys but also canonical keys, i.e. slugified keys without delimiters.

The item keys are expected to be `str`-like objects thus supporting the `str.lower()` method. Setting items is done by using the given keys. Retrieving or deleting an item and testing whether an item exist is done by transforming the item's key in a sequence as follows:

- *Original Key*
- *Lowercase Key*
- *Slugified Key*
- *Canonical Key*

For example, given the McCamy 1992 key:

- *Original Key* : McCamy 1992
- *Lowercase Key* : mccamy 1992
- *Slugified Key* : mccamy-1992

- *Canonical Key* : mccamy1992

Parameters

- **data** (Optional[Union[Generator, Mapping]]) – Data to store into the delimiter and case-insensitive `dict`-like object at initialisation.
- **kwargs** (Any) – Key / value pairs to store into the mapping at initialisation.

Attributes

- data

Methods

- `__init__()`
- `__repr__()`
- `__setitem__()`
- `__getitem__()`
- `__delitem__()`
- `__contains__()`
- `__iter__()`
- `__len__()`
- `__eq__()`
- `__ne__()`
- `copy()`
- `lower_keys()`
- `lower_items()`
- `slugified_keys()`
- `slugified_items()`
- `canonical_keys()`
- `canonical_items()`

Examples

```
>>> methods = CanonicalMapping({"McCamy 1992": 1, "Hernandez 1999": 2})
>>> methods["mccamy 1992"]
1
>>> methods["MCCAMY 1992"]
1
>>> methods["mccamy-1992"]
1
>>> methods["mccamy1992"]
1
```

`__init__(data: Generator | Mapping | None = None, **kwargs: Any) → None`

Parameters

- **data** (*Generator* | *Mapping* | *None*) –
- **kwargs** (*Any*) –

Return type

None

property data: *Dict*

Getter property for the delimiter and case-insensitive *dict*-like object data.

Returns

Data.

Return type

dict

`__repr__() → str`

Return an evaluable string representation of the delimiter and case-insensitive *dict*-like object.

Returns

Evaluable string representation.

Return type

str

`__setitem__(item: str | Any, value: Any)`

Set given item with given value in the delimiter and case-insensitive *dict*-like object.

Parameters

- **item** (*str* | *Any*) – Item to set in the delimiter and case-insensitive *dict*-like object.
- **value** (*Any*) – Value to store in the delimiter and case-insensitive *dict*-like object.

`__getitem__(item: str | Any) → Any`

Return the value of given item from the delimiter and case-insensitive *dict*-like object.

Parameters

item (*str* | *Any*) – Item to retrieve the value of from the delimiter and case-insensitive *dict*-like object.

Returns

Item value.

Return type

object

Notes

- The item value can be retrieved by using either its lower-case, slugified or canonical variant.

`__delitem__(item: str | Any)`

Delete given item from the delimiter and case-insensitive *dict*-like object.

Parameters

item (*str* | *Any*) – Item to delete from the delimiter and case-insensitive *dict*-like object.

Notes

- The item can be deleted by using either its lower-case, slugified or canonical variant.

`__contains__(item: str | Any) → bool`

Return whether the delimiter and case-insensitive `dict`-like object contains given item.

Parameters

item (`str` | `Any`) – Item to find whether it is in the delimiter and case-insensitive `dict`-like object.

Returns

Whether given item is in the delimiter and case-insensitive `dict`-like object.

Return type

`bool`

Notes

- The item presence can be checked by using either its lower-case, slugified or canonical variant.

`__iter__() → Generator`

Iterate over the items of the delimiter and case-insensitive `dict`-like object.

Yields

Generator – Item generator.

Return type

Generator

Notes

- The iterated items are the original items.

`__len__() → int`

Return the items count.

Returns

Items count.

Return type

`numpy.integer`

`__eq__(other: Any) → bool`

Return whether the delimiter and case-insensitive `dict`-like object is equal to given other object.

Parameters

other (`Any`) – Object to test whether it is equal to the delimiter and case-insensitive `dict`-like object

Returns

Whether given object is equal to the delimiter and case-insensitive `dict`-like object.

Return type

`bool`

`__ne__(other: Any) → bool`

Return whether the delimiter and case-insensitive `dict`-like object is not equal to given other object.

Parameters

other (Any) – Object to test whether it is not equal to the delimiter and case-insensitive `dict`-like object

Returns

Whether given object is not equal to the delimiter and case-insensitive `dict`-like object.

Return type

`bool`

`copy()` → *CanonicalMapping*

Return a copy of the delimiter and case-insensitive `dict`-like object.

Returns

Case-insensitive `dict`-like object copy.

Return type

CanonicalMapping

Warning:

- The *CanonicalMapping* class copy returned is a *copy* of the object not a *deepcopy*!

`lower_keys()` → *Generator*

Iterate over the lower-case keys of the delimiter and case-insensitive `dict`-like object.

Yields

Generator – Item generator.

Return type

Generator

`lower_items()` → *Generator*

Iterate over the lower-case items of the delimiter and case-insensitive `dict`-like object.

Yields

Generator – Item generator.

Return type

Generator

`slugified_keys()` → *Generator*

Iterate over the slugified keys of the delimiter and case-insensitive `dict`-like object.

Yields

Generator – Item generator.

Return type

Generator

`slugified_items()` → *Generator*

Iterate over the slugified items of the delimiter and case-insensitive `dict`-like object.

Yields

Generator – Item generator.

Return type

Generator

canonical_keys() → *Generator*

Iterate over the canonical keys of the delimiter and case-insensitive *dict*-like object.

Yields

Generator – Item generator.

Return type

Generator

canonical_items() → *Generator*

Iterate over the canonical items of the delimiter and case-insensitive *dict*-like object.

Yields

Generator – Item generator.

Return type

Generator

__hash__ = *None*

__weakref__

list of weak references to the object (if defined)

colour.utilities.LazyCanonicalMapping

class colour.utilities.LazyCanonicalMapping(*data: Generator | Mapping | None = None, **kwargs: Any*)

Bases: *CanonicalMapping*

Implement a lazy delimiter and case-insensitive *dict*-like object inheriting from `colour.utilities.CanonicalMapping` class.

The lazy retrieval is performed as follows: If the value is a callable, then it is evaluated and its return value is stored in place of the current value.

Parameters

- **data** (Optional[Union[Generator, Mapping]]) – Data to store into the lazy delimiter and case-insensitive *dict*-like object at initialisation.
- **kwargs** (*Any*) – Key / value pairs to store into the mapping at initialisation.

Methods

- `__getitem__()`

Examples

```
>>> def callable_a():
...     print(2)
...     return 2
...
>>> methods = LazyCanonicalMapping({"McCamy": 1, "Hernandez": callable_a})
>>> methods["mccamy"]
1
>>> methods["hernandez"]
2
2
```

__getitem__(*item*: *str* | *Any*) → *Any*

Return the value of given item from the lazy delimiter and case-insensitive *dict*-like object.

Parameters

item (*str* | *Any*) – Item to retrieve the value of from the lazy delimiter and case-insensitive *dict*-like object.

Returns

Item value.

Return type

object

colour.utilities.Lookup

class colour.utilities.Lookup

Bases: *dict*

Extend *dict* type to provide a lookup by value(s).

Methods

- `keys_from_value()`
- `first_key_from_value()`

References

[[Mana](#)]

Examples

```
>>> person = Lookup(first_name="John", last_name="Doe", gender="male")
>>> person.first_key_from_value("John")
'first_name'
>>> persons = Lookup(John="Doe", Jane="Doe", Luke="Skywalker")
>>> sorted(persons.keys_from_value("Doe"))
['Jane', 'John']
```

keys_from_value(*value*: *Any*) → *List*

Get the keys associated with given value.

Parameters

value (*Any*) – Value to find the associated keys.

Returns

Keys associated with given value.

Return type

list

first_key_from_value(*value*: *Any*) → *Any*

Get the first key associated with given value.

Parameters

value (*Any*) – Value to find the associated first key.

Returns

First key associated with given value.

Return type`object`**`__weakref__`**

list of weak references to the object (if defined)

`colour.utilities.Node`

class `colour.utilities.Node(*args: Any, **kwargs: Any)`

Bases: `object`

Represent a basic node supporting the creation of basic node trees.

Parameters

- **name** – Node name.
- **parent** – Parent of the node.
- **children** – Children of the node.
- **data** – The data belonging to this node.
- **args** (`Any`) –
- **kwargs** (`Any`) –

Return type`Node`**Attributes**

- `name`
- `parent`
- `children`
- `id`
- `root`
- `leaves`
- `siblings`
- `data`

Methods

- `__new__()`
- `__init__()`
- `__str__()`
- `__len__()`
- `is_root()`
- `is_inner()`
- `is_leaf()`
- `walk()`
- `render()`

Examples

```
>>> node_a = Node("Node A")
>>> node_b = Node("Node B", node_a)
>>> node_c = Node("Node C", node_a)
>>> node_d = Node("Node D", node_b)
>>> node_e = Node("Node E", node_b)
>>> node_f = Node("Node F", node_d)
>>> node_g = Node("Node G", node_f)
>>> node_h = Node("Node H", node_g)
>>> [node.name for node in node_a.leaves]
['Node H', 'Node E', 'Node C']
>>> print(node_h.root.name)
Node A
>>> len(node_a)
7
```

Return a new instance of the `colour.utilities.Node` class.

Parameters

- **args** (*Any*) – Arguments.
- **kwargs** (*Any*) – Keywords arguments.

Return type

Node

static `__new__(cls, *args: Any, **kwargs: Any) → Node`

Return a new instance of the `colour.utilities.Node` class.

Parameters

- **args** (*Any*) – Arguments.
- **kwargs** (*Any*) – Keywords arguments.

Return type

Node

__init__(*name: str | None = None, parent: Node | None = None, children: List[Node] | None = None, data: Any | None = None*) → *None*

Parameters

- **name** (*str | None*) –
- **parent** (*Node | None*) –
- **children** (*List[Node] | None*) –
- **data** (*Any | None*) –

Return type

None

property name: *str*

Getter and setter property for the name.

Parameters

value – Value to set the name with.

Returns

Node name.

Return type

str

property parent: `Node` | `None`

Getter and setter property for the node parent.

Parameters

value – Parent to set the node with.

Returns

Node parent.

Return type

`Node` or `None`

property children: `List[Node]`

Getter and setter property for the node children.

Parameters

value – Children to set the node with.

Returns

Node children.

Return type

`list`

property id: `int`

Getter property for the node id.

Returns

Node id.

Return type

`numpy.integer`

property root: `Node`

Getter property for the node tree.

Returns

Node root.

Return type

`Node`

property leaves: `Generator`

Getter property for the node leaves.

Yields

Generator – Node leaves.

property siblings: `Generator`

Getter property for the node siblings.

Returns

Node siblings.

Return type

`Generator`

__weakref__

list of weak references to the object (if defined)

property data: `Any`

Getter property for the node data.

Returns

Node data.

Return type`object``__str__()` → `str`

Return a formatted string representation of the node.

Returns

Formatted string representation.

Return type`class`str```__len__()` → `int`

Return the number of children of the node.

Returns

Number of children of the node.

Return type`numpy.integer``is_root()` → `bool`

Return whether the node is a root node.

Returns

Whether the node is a root node.

Return type`bool`**Examples**

```
>>> node_a = Node("Node A")
>>> node_b = Node("Node B", node_a)
>>> node_c = Node("Node C", node_b)
>>> node_a.is_root()
True
>>> node_b.is_root()
False
```

`is_inner()` → `bool`

Return whether the node is an inner node.

Returns

Whether the node is an inner node.

Return type`bool`**Examples**

```
>>> node_a = Node("Node A")
>>> node_b = Node("Node B", node_a)
>>> node_c = Node("Node C", node_b)
>>> node_a.is_inner()
False
>>> node_b.is_inner()
True
```

is_leaf() → *bool*

Return whether the node is a leaf node.

Returns

Whether the node is a leaf node.

Return type

bool

Examples

```
>>> node_a = Node("Node A")
>>> node_b = Node("Node B", node_a)
>>> node_c = Node("Node C", node_b)
>>> node_a.is_leaf()
False
>>> node_c.is_leaf()
True
```

walk(ascendants: *bool* = False) → *Generator*

Return a generator used to walk into `colour.utilities.Node` trees.

Parameters

ascendants (*bool*) – Whether to walk up the node tree.

Yields

Generator – Node tree walker.

Return type

Generator

Examples

```
>>> node_a = Node("Node A")
>>> node_b = Node("Node B", node_a)
>>> node_c = Node("Node C", node_a)
>>> node_d = Node("Node D", node_b)
>>> node_e = Node("Node E", node_b)
>>> node_f = Node("Node F", node_d)
>>> node_g = Node("Node G", node_f)
>>> node_h = Node("Node H", node_g)
>>> for node in node_a.walk():
...     print(node.name)
...
Node B
Node D
Node F
Node G
Node H
Node E
Node C
```

render(tab_level: *int* = 0)

Render the current node and its children as a string.

Parameters

tab_level (*int*) – Initial indentation level

Returns

Rendered node tree.

Return type

`str`

Examples

```
>>> node_a = Node("Node A")
>>> node_b = Node("Node B", node_a)
>>> node_c = Node("Node C", node_a)
>>> print(node_a.render())
|----"Node A"
|   |----"Node B"
|   |----"Node C"
```

colour.utilities.Structure

class colour.utilities.**Structure**(*args: [Any](#), **kwargs: [Any](#))

Bases: `dict`

Define a `dict`-like object allowing to access key values using dot syntax.

Parameters

- **args** ([Any](#)) – Arguments.
- **kwargs** ([Any](#)) – Key / value pairs.

Methods

- `__init__()`
- `__setattr__()`
- `__delattr__()`
- `__dir__()`
- `__getattr__()`
- `__setstate__()`

References

[[Rak17](#)]

Examples

```
>>> person = Structure(first_name="John", last_name="Doe", gender="male")
>>> person.first_name
'John'
>>> sorted(person.keys())
['first_name', 'gender', 'last_name']
>>> person["gender"]
'male'
```

`__init__(*args: Any, **kwargs: Any) → None`

Parameters

- **args** (Any) –
- **kwargs** (Any) –

Return type

None

`__setattr__(name: str, value: Any)`

Assign given value to the attribute with given name.

Parameters

- **name** (str) – Name of the attribute to assign the value to.
- **value** (Any) – Value to assign to the attribute.

`__delattr__(name: str)`

Delete the attribute with given name.

Parameters

name (str) – Name of the attribute to delete.

`__dir__() → Iterable`

Return a list of valid attributes for the dict-like object.

Returns

List of valid attributes for the dict-like object.

Return type

list

`__getattr__(name: str) → Any`

Return the value from the attribute with given name.

Parameters

name (str) – Name of the attribute to get the value from.

Return type

object

Raises

AttributeError – If the attribute is not defined.

`__setstate__(state)`

Set the object state when unpickling.

`__weakref__`

list of weak references to the object (if defined)

Verbose

colour.utilities

| | |
|--|---|
| <code>message_box(message[, width, padding, ...])</code> | Print a message inside a box. |
| <code>show_warning(message, category, filename, lineno)</code> | Alternative <code>warnings.showwarning()</code> definition that allows traceback printing. |
| <code>warning(*args, **kwargs)</code> | Issue a warning. |
| <code>filter_warnings([colour_runtime_warnings, ...])</code> | Filter <i>Colour</i> and also optionally overall Python warnings. |
| <code>suppress_warnings([colour_runtime_warnings, ...])</code> | Define a context manager filtering <i>Colour</i> and also optionally overall Python warnings. |
| <code>numpy_print_options(*args, **kwargs)</code> | Define a context manager implementing context changes to <i>Numpy</i> print behaviour. |
| <code>describe_environment([runtime_packages, ...])</code> | Describe <i>Colour</i> running environment, i.e. interpreter, runtime and development packages. |
| <code>multiline_str(object_, attributes[, ...])</code> | Return a formatted string representation of the given object. |
| <code>multiline_repr(object_, attributes[, ...])</code> | Return an (almost) evaluable string representation of the given object. |

colour.utilities.message_box

`colour.utilities.message_box(message: str, width: int = 79, padding: int = 3, print_callable: Callable = print)`

Print a message inside a box.

Parameters

- **message** (`str`) – Message to print.
- **width** (`int`) – Message box width.
- **padding** (`int`) – Padding on each side of the message.
- **print_callable** (`Callable`) – Callable used to print the message box.

Examples

```
>>> message = (
...     "Lorem ipsum dolor sit amet, consectetur adipiscing elit, "
...     "sed do eiusmod tempor incididunt ut labore et dolore magna "
...     "aliqua."
... )
>>> message_box(message, width=75)
=====
*                                                                    *
*  Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do  *
*  eiusmod tempor incididunt ut labore et dolore magna aliqua.      *
*                                                                    *
=====
>>> message_box(message, width=60)
=====
*                                                                    *
*  Lorem ipsum dolor sit amet, consectetur adipiscing                *
*  elit, sed do eiusmod tempor incididunt ut labore et              *
*  dolore magna aliqua.                                              *
*                                                                    *
=====
>>> message_box(message, width=75, padding=16)
```

(continues on next page)

(continued from previous page)

```
=====
*
*      Lorem ipsum dolor sit amet, consectetur
*      adipiscing elit, sed do eiusmod tempor
*      incididunt ut labore et dolore magna
*      aliqua.
*
=====
```

colour.utilities.show_warning

colour.utilities.**show_warning**(message: *Warning* | *str*, category: *Type[Warning]*, filename: *str*, lineno: *int*, file: *TextIO* | *None* = *None*, line: *str* | *None* = *None*) → *None*

Alternative `warnings.showwarning()` definition that allows traceback printing.

This definition is expected to be used by setting the `COLOUR_SCIENCE__COLOUR__SHOW_WARNINGS_WITH_TRACEBACK` environment variable prior to importing `colour`.

Parameters

- **message** (*Warning* | *str*) – Warning message.
- **category** (*Type[Warning]*) – Warning sub-class.
- **filename** (*str*) – File path to read the line at lineno from if line is None.
- **lineno** (*int*) – Line number to read the line at in filename if line is None.
- **file** (*TextIO* | *None*) – file object to write the warning to, defaults to `sys.stderr` attribute.
- **line** (*str* | *None*) – Source code to be included in the warning message.

Return type

None

Notes

- Setting the `COLOUR_SCIENCE__COLOUR__SHOW_WARNINGS_WITH_TRACEBACK` environment variable will result in the `warnings.showwarning()` definition to be replaced with the `colour.utilities.show_warning()` definition and thus providing complete traceback from the point where the warning occurred.

colour.utilities.warning

colour.utilities.**warning**(*args: *Any*, **kwargs: *Any*)

Issue a warning.

Parameters

- **args** (*Any*) – Arguments.
- **kwargs** (*Any*) – Keywords arguments.

Examples

```
>>> warning("This is a warning!")
```

colour.utilities.filter_warnings

```
colour.utilities.filter_warnings(colour_runtime_warnings: bool | Literal['default', 'error', 'ignore',  
                                'always', 'module', 'once'] | None = None, colour_usage_warnings:  
                                bool | Literal['default', 'error', 'ignore', 'always', 'module', 'once'] |  
                                None = None, colour_warnings: bool | Literal['default', 'error',  
                                'ignore', 'always', 'module', 'once'] | None = None,  
                                python_warnings: bool | Literal['default', 'error', 'ignore', 'always',  
                                'module', 'once'] | None = None)
```

Filter *Colour* and also optionally overall Python warnings.

The possible values for all the actions, i.e. each argument, are as follows:

- *None* (No action is taken)
- *True* (*ignore*)
- *False* (*default*)
- *error*
- *ignore*
- *always*
- *default*
- *module*
- *once*

Parameters

- **colour_runtime_warnings** (bool | Literal['default', 'error', 'ignore', 'always', 'module', 'once'] | None) – Whether to filter *Colour* runtime warnings according to the action value.
- **colour_usage_warnings** (bool | Literal['default', 'error', 'ignore', 'always', 'module', 'once'] | None) – Whether to filter *Colour* usage warnings according to the action value.
- **colour_warnings** (bool | Literal['default', 'error', 'ignore', 'always', 'module', 'once'] | None) – Whether to filter *Colour* warnings, this also filters *Colour* usage and runtime warnings according to the action value.
- **python_warnings** (bool | Literal['default', 'error', 'ignore', 'always', 'module', 'once'] | None) – Whether to filter *Python* warnings according to the action value.

Examples

Filtering *Colour* runtime warnings:

```
>>> filter_warnings(colour_runtime_warnings=True)
```

Filtering *Colour* usage warnings:

```
>>> filter_warnings(colour_usage_warnings=True)
```

Filtering *Colour* warnings:

```
>>> filter_warnings(colour_warnings=True)
```

Filtering all the *Colour* and also Python warnings:

```
>>> filter_warnings(python_warnings=True)
```

Enabling all the *Colour* and Python warnings:

```
>>> filter_warnings(*[False] * 4)
```

Enabling all the *Colour* and Python warnings using the *default* action:

```
>>> filter_warnings(*["default"] * 4)
```

Setting back the default state:

```
>>> filter_warnings(colour_runtime_warnings=True)
```

colour.utilities.suppress_warnings

```
colour.utilities.suppress_warnings(colour_runtime_warnings: bool | Literal['default', 'error', 'ignore',
'always', 'module', 'once'] | None = None,
colour_usage_warnings: bool | Literal['default', 'error', 'ignore',
'always', 'module', 'once'] | None = None, colour_warnings: bool
| Literal['default', 'error', 'ignore', 'always', 'module', 'once'] |
None = None, python_warnings: bool | Literal['default', 'error',
'ignore', 'always', 'module', 'once'] | None = None) → Generator
```

Define a context manager filtering *Colour* and also optionally overall Python warnings.

The possible values for all the actions, i.e. each argument, are as follows:

- *None* (No action is taken)
- *True* (*ignore*)
- *False* (*default*)
- *error*
- *ignore*
- *always*
- *default*
- *module*
- *once*

Parameters

- **colour_runtime_warnings** (`bool` | `Literal['default', 'error', 'ignore', 'always', 'module', 'once']` | `None`) – Whether to filter *Colour* runtime warnings according to the action value.
- **colour_usage_warnings** (`bool` | `Literal['default', 'error', 'ignore', 'always', 'module', 'once']` | `None`) – Whether to filter *Colour* usage warnings according to the action value.
- **colour_warnings** (`bool` | `Literal['default', 'error', 'ignore', 'always', 'module', 'once']` | `None`) – Whether to filter *Colour* warnings, this also filters *Colour* usage and runtime warnings according to the action value.
- **python_warnings** (`bool` | `Literal['default', 'error', 'ignore', 'always', 'module', 'once']` | `None`) – Whether to filter *Python* warnings according to the action value.

Return type*Generator***colour.utilities.numpy_print_options**`colour.utilities.numpy_print_options(*args: Any, **kwargs: Any) → Generator`Define a context manager implementing context changes to *Numpy* print behaviour.**Parameters**

- **args** (*Any*) – Arguments.
- **kwargs** (*Any*) – Keywords arguments.

Return type*Generator***Examples**

```
>>> np.array([np.pi])
array([ 3.1415926...])
>>> with numpy_print_options(formatter={"float": "{:0.1f}".format}):
...     np.array([np.pi])
array([3.1])
```

colour.utilities.describe_environment`colour.utilities.describe_environment(runtime_packages: bool = True, development_packages: bool = False, extras_packages: bool = False, print_environment: bool = True, **kwargs: Any) → defaultdict`Describe *Colour* running environment, i.e. interpreter, runtime and development packages.**Parameters**

- **runtime_packages** (`bool`) – Whether to return the runtime packages versions.
- **development_packages** (`bool`) – Whether to return the development packages versions.
- **extras_packages** (`bool`) – Whether to return the extras packages versions.
- **print_environment** (`bool`) – Whether to print the environment.
- **padding** – `{colour.utilities.message_box()}`, Padding on each side of the message.

- **print_callable** – {colour.utilities.message_box()}, Callable used to print the message box.
- **width** – {colour.utilities.message_box()}, Message box width.
- **kwargs** (Any) –

Returns

Environment.

Return type

collections.defaultdict

Examples

```
>>> environment = describe_environment(width=75)
=====
*                                     *
* Interpreter :                       *
*   python : 3.8.6 (default, Nov 20 2020, 18:29:40) *
*           [Clang 12.0.0 (clang-1200.0.32.27)] *
*                                     *
* colour-science.org :               *
*   colour : v0.3.16-3-gd8bac475 *
*                                     *
* Runtime :                           *
*   imageio : 2.9.0 *
*   matplotlib : 3.3.3 *
*   networkx : 2.5 *
*   numpy : 1.19.4 *
*   pandas : 0.25.3 *
*   pygraphviz : 1.6 *
*   scipy : 1.5.4 *
*   tqdm : 4.54.0 *
*                                     *
=====
>>> environment = describe_environment(True, True, True, width=75)
...
=====
*                                     *
* Interpreter :                       *
*   python : 3.8.6 (default, Nov 20 2020, 18:29:40) *
*           [Clang 12.0.0 (clang-1200.0.32.27)] *
*                                     *
* colour-science.org :               *
*   colour : v0.3.16-3-gd8bac475 *
*                                     *
* Runtime :                           *
*   imageio : 2.9.0 *
*   matplotlib : 3.3.3 *
*   networkx : 2.5 *
*   numpy : 1.19.4 *
*   pandas : 0.25.3 *
*   pygraphviz : 1.6 *
*   scipy : 1.5.4 *
*   tqdm : 4.54.0 *
*                                     *
* Development :                       *
```

(continues on next page)

(continued from previous page)

```
*      biblib-simple : 0.1.1      *
*      coverage : 5.3            *
*      coveralls : 2.2.0         *
*      flake8 : 3.8.4            *
*      invoke : 1.4.1            *
*      jupyter : 1.0.0           *
*      mock : 4.0.2              *
*      nose : 1.3.7              *
*      pre-commit : 2.1.1        *
*      pytest : 6.1.2            *
*      restructuredtext-lint : 1.3.2 *
*      sphinx : 3.1.2            *
*      sphinx_rtd_theme : 0.5.0   *
*      sphinxcontrib-bibtex : 1.0.0 *
*      toml : 0.10.2             *
*      twine : 3.2.0             *
*      yapf : 0.23.0             *
*                                *
*  Extras :                      *
*      ipywidgets : 7.5.1        *
*      notebook : 6.1.5         *
*                                *
=====
```

colour.utilities.multiline_str

`colour.utilities.multiline_str(object_: Any, attributes: List[Dict], header_underline: str = '=', section_underline: str = '-', separator: str = ': ') → str`

Return a formatted string representation of the given object.

Parameters

- **object** – Object to format.
- **attributes** (`List[Dict]`) – Attributes to format.
- **header_underline** (`str`) – Underline character to use for a header.
- **section_underline** (`str`) – Underline character to use for a section.
- **separator** (`str`) – Separator to use when formatting the attributes and their values.
- **object_** (`Any`) –

Returns

Formatted string representation.

Return type

`str`

Examples

```

>>> class Data:
...     def __init__(self, a: str, b: int, c: list):
...         self._a = a
...         self._b = b
...         self._c = c
...
...     def __str__(self) -> str:
...         return multiline_str(
...             self,
...             [
...                 {
...                     "formatter": lambda x: (
...                         f"Object - {self.__class__.__name__}"
...                     ),
...                     "header": True,
...                 },
...                 {"line_break": True},
...                 {"label": "Data", "section": True},
...                 {"line_break": True},
...                 {"label": "String", "section": True},
...                 {"name": "_a", "label": 'String "a"'},
...                 {"line_break": True},
...                 {"label": "Integer", "section": True},
...                 {"name": "_b", "label": 'Integer "b"'},
...                 {"line_break": True},
...                 {"label": "List", "section": True},
...                 {
...                     "name": "_c",
...                     "label": 'List "c"',
...                     "formatter": lambda x: "; ".join(x),
...                 },
...             ],
...         )
...
>>> print(Data("Foo", 1, ["John", "Doe"]))
Object - Data
=====

Data
----

String
-----
String "a" : Foo

Integer
-----
Integer "b" : 1

List
----
List "c" : John; Doe

```

colour.utilities.multiline_repr

colour.utilities.**multiline_repr**(object_: *Any*, attributes: *List[Dict]*, reduce_array_representation: *bool = True*) → *str*

Return an (almost) evaluable string representation of the given object.

Parameters

- **object** – Object to format.
- **attributes** (*List[Dict]*) – Attributes to format.
- **reduce_array_representation** (*bool*) – Whether to remove the *Numpy array*(and) affixes.
- **object_** (*Any*) –

Returns

(Almost) evaluable string representation.

Return type

class`str`

Examples

```
>>> class Data:
...     def __init__(self, a: str, b: int, c: list):
...         self._a = a
...         self._b = b
...         self._c = c
...
...     def __repr__(self) -> str:
...         return multiline_repr(
...             self,
...             [
...                 {"name": "_a"},
...                 {"name": "_b"},
...                 {
...                     "name": "_c",
...                     "formatter": lambda x: repr(x)
...                     .replace("[", "(")
...                     .replace("]", ")"),
...                 },
...             ],
...         )
...
>>> Data("Foo", 1, ["John", "Doe"])
Data('Foo',
     1,
     ('John', 'Doe'))
```

Ancillary Objects

colour.utilities

| | |
|----------------------|--|
| ColourWarning | Define the base class of <i>Colour</i> warnings. |
| ColourUsageWarning | Define the base class of <i>Colour</i> usage warnings. |
| ColourRuntimeWarning | Define the base class of <i>Colour</i> runtime warnings. |

colour.utilities.ColourWarning

class colour.utilities.ColourWarning

Bases: `Warning`

Define the base class of *Colour* warnings.

It is a subclass of the `Warning` class.

__weakref__

list of weak references to the object (if defined)

colour.utilities.ColourUsageWarning

class colour.utilities.ColourUsageWarning

Bases: `Warning`

Define the base class of *Colour* usage warnings.

It is a subclass of the `colour.utilities.ColourWarning` class.

__weakref__

list of weak references to the object (if defined)

colour.utilities.ColourRuntimeWarning

class colour.utilities.ColourRuntimeWarning

Bases: `Warning`

Define the base class of *Colour* runtime warnings.

It is a subclass of the `colour.utilities.ColourWarning` class.

__weakref__

list of weak references to the object (if defined)

Colour Volume

Optimal Colour Stimuli - MacAdam Limits

colour

| | |
|---|--|
| <code>is_within_macadam_limits(xyY[, illuminant, ...])</code> | Return whether given <i>CIE</i> <i>xyY</i> colourspace array is within MacAdam limits of given illuminant. |
| <code>OPTIMAL_COLOUR_STIMULI_ILLUMINANTS</code> | Illuminants <i>Optimal Colour Stimuli</i> . |

colour.is_within_macadam_limits

`colour.is_within_macadam_limits(xyY: ArrayLike, illuminant: Literal['A', 'C', 'D65'] | str = 'D65', tolerance: float | None = None) → ndarray`

Return whether given *CIE* *xyY* colourspace array is within MacAdam limits of given illuminant.

Parameters

- **xyY** (`ArrayLike`) – *CIE* *xyY* colourspace array.
- **illuminant** (`Literal`['A', 'C', 'D65'] | `str`) – Illuminant name.

- **tolerance** (`float` | `None`) – Tolerance allowed in the inside-triangle check.

Returns

Whether given CIE xyY colourspace array is within MacAdam limits.

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| xyY | [0, 1] | [0, 1] |

Examples

```
>>> is_within_macadam_limits(np.array([0.3205, 0.4131, 0.51]), "A")
array(True, dtype=bool)
>>> a = np.array([[0.3205, 0.4131, 0.51], [0.0005, 0.0031, 0.001]])
>>> is_within_macadam_limits(a, "A")
array([ True, False], dtype=bool)
```

colour.OPTIMAL_COLOUR_STIMULI_ILLUMINANTS

`colour.OPTIMAL_COLOUR_STIMULI_ILLUMINANTS = CanonicalMapping({'A': ..., 'C': ..., 'D65': ...})`

Illuminants *Optimal Colour Stimuli*.

References

[Wikipedia04b]

Mesh Volume

colour

| | |
|---|--|
| <code>is_within_mesh_volume(points, mesh[, tolerance])</code> | Return whether given points are within given mesh volume using Delaunay triangulation. |
|---|--|

colour.is_within_mesh_volume

`colour.is_within_mesh_volume(points: ArrayLike, mesh: ArrayLike, tolerance: float | None = None) → ndarray`

Return whether given points are within given mesh volume using Delaunay triangulation.

Parameters

- **points** (`ArrayLike`) – Points to check if they are within mesh volume.
- **mesh** (`ArrayLike`) – Points of the volume used to generate the Delaunay triangulation.
- **tolerance** (`float` | `None`) – Tolerance allowed in the inside-triangle check.

Returns

Whether given points are within given mesh volume.

Return type

`numpy.ndarray`

Examples

```
>>> mesh = np.array(
...     [
...         [-1.0, -1.0, 1.0],
...         [1.0, -1.0, 1.0],
...         [1.0, -1.0, -1.0],
...         [-1.0, -1.0, -1.0],
...         [0.0, 1.0, 0.0],
...     ]
... )
>>> is_within_mesh_volume(np.array([0.0005, 0.0031, 0.0010]), mesh)
array(True, dtype=bool)
>>> a = np.array([[0.0005, 0.0031, 0.0010], [0.3205, 0.4131, 0.5100]])
>>> is_within_mesh_volume(a, mesh)
array([ True, False], dtype=bool)
```

Pointer's Gamut

colour

| | |
|--|---|
| <code>is_within_pointer_gamut(XYZ[, tolerance])</code> | Return whether given <i>CIE XYZ</i> tristimulus values are within Pointer's Gamut volume. |
|--|---|

colour.is_within_pointer_gamut

colour.**is_within_pointer_gamut**(XYZ: *ArrayLike*, tolerance: *float* | *None* = *None*) → *ndarray*

Return whether given *CIE XYZ* tristimulus values are within Pointer's Gamut volume.

Parameters

- **XYZ** (*ArrayLike*) – *CIE XYZ* tristimulus values.
- **tolerance** (*float* | *None*) – Tolerance allowed in the inside-triangle check.

Returns

Whether given *CIE XYZ* tristimulus values are within Pointer's Gamut volume.

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

Examples

```
>>> import numpy as np
>>> is_within_pointer_gamut(np.array([0.3205, 0.4131, 0.5100]))
array(True, dtype=bool)
>>> a = np.array([[0.3205, 0.4131, 0.5100], [0.0005, 0.0031, 0.0010]])
>>> is_within_pointer_gamut(a)
array([ True, False], dtype=bool)
```

RGB Volume

colour

| | |
|--|---|
| <code>RGB_colourspace_limits(colourspace)</code> | Compute given <i>RGB</i> colourspace volume limits in <i>CIE L*a*b*</i> colourspace. |
| <code>RGB_colourspace_pointer_gamut_coverage_Monte</code> | Return given <i>RGB</i> colourspace percentage coverage of Pointer's Gamut volume using <i>Monte Carlo</i> method. |
| <code>RGB_colourspace_visible_spectrum_coverage_Mo</code> | Return given <i>RGB</i> colourspace percentage coverage of visible spectrum volume using <i>Monte Carlo</i> method. |
| <code>RGB_colourspace_volume_MonteCarlo(colourspace</code> | Perform given <i>RGB</i> colourspace volume computation using <i>Monte Carlo</i> method and multiprocessing. |
| <code>RGB_colourspace_volume_coverage_MonteCarlo(..</code> | Return given <i>RGB</i> colourspace percentage coverage of an arbitrary volume. |

colour.RGB_colourspace_limits

colour.**RGB_colourspace_limits**(colourspace: [RGB_Colourspace](#)) → [ndarray](#)

Compute given *RGB* colourspace volume limits in *CIE L*a*b** colourspace.

Parameters

colourspace ([RGB_Colourspace](#)) – *RGB* colourspace to compute the volume of.

Returns

RGB colourspace volume limits.

Return type

[numpy.ndarray](#)

Notes

The limits are computed for the given *RGB* colourspace illuminant. This is important to account for, if the intent is to compare various *RGB* colourspaces together. In this instance, they must be chromatically adapted to the same illuminant before-hand. See `colour.RGB_Colourspace.chromatically_adapt()` method for more information.

Examples

```
>>> from colour.models import RGB_COLOURSPACE_sRGB as sRGB
>>> RGB_colourspace_limits(sRGB)
array([[ 0.         ..., 100.         ...],
       [-86.182855 ...,  98.2563272...],
       [-107.8503557...,  94.4894974...]])
```

colour.RGB_colourspace_pointer_gamut_coverage_MonteCarlo

```
colour.RGB_colourspace_pointer_gamut_coverage_MonteCarlo(colourspace: RGB_Colourspace,
                                                           samples: int = 1000000,
                                                           random_generator: Callable =
                                                           random_triplet_generator,
                                                           random_state: RandomState | None =
                                                           None) → float
```

Return given *RGB* colourspace percentage coverage of Pointer's Gamut volume using *Monte Carlo* method.

Parameters

- **colourspace** (*RGB_Colourspace*) – *RGB* colourspace to compute the *Pointer's Gamut* coverage percentage.
- **samples** (*int*) – Samples count.
- **random_generator** (*Callable*) – Random triplet generator providing the random samples.
- **random_state** (*RandomState* | *None*) – Mersenne Twister pseudo-random number generator to use in the random number generator.

Returns

Percentage coverage of *Pointer's Gamut* volume.

Return type

`numpy.floating`

Examples

```
>>> from colour.models import RGB_COLOURSPACE_sRGB as sRGB
>>> prng = np.random.RandomState(2)
>>> RGB_colourspace_pointer_gamut_coverage_MonteCarlo(
...     sRGB, 10e3, random_state=prng
... )
81...
```

colour.RGB_colourspace_visible_spectrum_coverage_MonteCarlo

```
colour.RGB_colourspace_visible_spectrum_coverage_MonteCarlo(colourspace: RGB_Colourspace,
                                                             samples: int = 1000000,
                                                             random_generator: Callable =
                                                             random_triplet_generator,
                                                             random_state: RandomState |
                                                             None = None) → float
```

Return given *RGB* colourspace percentage coverage of visible spectrum volume using *Monte Carlo* method.

Parameters

- **colourspace** (*RGB_Colourspace*) – *RGB* colourspace to compute the visible spectrum coverage percentage.
- **samples** (*int*) – Samples count.
- **random_generator** (*Callable*) – Random triplet generator providing the random samples.
- **random_state** (*RandomState* | *None*) – Mersenne Twister pseudo-random number generator to use in the random number generator.

Returns

Percentage coverage of visible spectrum volume.

Return type

numpy.floating

Examples

```
>>> from colour.models import RGB_COLOURSPACE_sRGB as sRGB
>>> prng = np.random.RandomState(2)
>>> RGB_colourspace_visible_spectrum_coverage_MonteCarlo(
...     sRGB, 10e3, random_state=prng
... )
46...
```

colour.RGB_colourspace_volume_MonteCarlo

```
colour.RGB_colourspace_volume_MonteCarlo(colourspace: RGB_Colourspace, samples: int = 1000000,
                                           limits: ArrayLike = np.array([[0, 100], [-150, 150],
                                           [-150, 150]]), illuminant_Lab: ArrayLike =
                                           CCS_ILLUMINANTS['CIE 1931 2 Degree Standard
                                           Observer']['D65'], chromatic_adaptation_transform:
                                           Literal['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02
                                           Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000',
                                           'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling']
                                           | str | None = 'CAT02', random_generator: Callable =
                                           random_triplet_generator, random_state: RandomState |
                                           None = None) → float
```

Perform given *RGB* colourspace volume computation using *Monte Carlo* method and multiprocessing.

Parameters

- **of.** (colourspace *RGB* colourspace to compute the volume) –
- **count.** (samples *Samples*) –

- **volume.** (limits CIE $L^*a^*b^*$ colourspace) –
- **coordinates.** (illuminant_Lab CIE $L^*a^*b^*$ colourspace illuminant chromaticity) –
- **method.** (chromatic_adaptation_transform Chromatic adaptation) –
- **the** (random_generator Random triplet generator providing the random samples within) – CIE $L^*a^*b^*$ colourspace volume.
- **random** (random_state Mersenne Twister pseudo-random number generator to use in the) – number generator.
- **colourspace** (RGB_Colourspace) –
- **samples** (int) –
- **limits** (ArrayLike) –
- **illuminant_Lab** (ArrayLike) –
- **chromatic_adaptation_transform** (Literal['Bianco 2010', 'Bianco PC 2010', 'Bradford', 'CAT02 Brill 2008', 'CAT02', 'CAT16', 'CMCCAT2000', 'CMCCAT97', 'Fairchild', 'Sharp', 'Von Kries', 'XYZ Scaling'] | str | None) –
- **random_generator** (Callable) –
- **random_state** (RandomState | None) –

Returns

RGB colourspace volume.

Return type

numpy.floating

Notes

- The doctest is assuming that `np.random.RandomState()` definition will return the same sequence no matter which OS or *Python* version is used. There is however no formal promise about the *prng* sequence reproducibility of either *Python* or *Numpy* implementations: Laurent. (2012). Reproducibility of python pseudo-random numbers across systems and versions? Retrieved January 20, 2015, from <http://stackoverflow.com/questions/8786084/reproducibility-of-python-pseudo-random-numbers-across-systems-and-versions>

Examples

```
>>> from colour.models import RGB_COLOURSPACE_sRGB as sRGB
>>> from colour.utilities import disable_multiprocessing
>>> prng = np.random.RandomState(2)
>>> with disable_multiprocessing():
...     RGB_colourspace_volume_MonteCarlo(sRGB, 10e3, random_state=prng)
...
...
8...
```

colour.RGB_colourspace_volume_coverage_MonteCarlo

```
colour.RGB_colourspace_volume_coverage_MonteCarlo(colourspace: RGB_Colourspace,
                                                    coverage_sampler: Callable, samples: int =
                                                    1000000, random_generator: Callable =
                                                    random_triplet_generator, random_state:
                                                    RandomState | None = None) → float
```

Return given *RGB* colourspace percentage coverage of an arbitrary volume.

Parameters

- **colourspace** (*RGB_Colourspace*) – *RGB* colourspace to compute the volume coverage percentage.
- **coverage_sampler** (*Callable*) – Python object responsible for checking the volume coverage.
- **samples** (*int*) – Samples count.
- **random_generator** (*Callable*) – Random triplet generator providing the random samples.
- **random_state** (*RandomState* | *None*) – Mersenne Twister pseudo-random number generator to use in the random number generator.

Returns

Percentage coverage of volume.

Return type

`numpy.float64`

Examples

```
>>> from colour.models import RGB_COLOURSPACE_sRGB as sRGB
>>> prng = np.random.RandomState(2)
>>> RGB_colourspace_volume_coverage_MonteCarlo(
...     sRGB, is_within_pointer_gamut, 10e3, random_state=prng
... )
...
81...
```

Roßsch-MacAdam Colour solid - Visible Spectrum

colour

```
is_within_visible_spectrum(XYZ[, cmfs, ...])
```

Return whether given *CIE XYZ* tristimulus values are within the visible spectrum volume, i.e. *Roßsch-MacAdam* colour solid, for given colour matching functions and illuminant.

colour.is_within_visible_spectrum

`colour.is_within_visible_spectrum(XYZ: ArrayLike, cmfs: MultiSpectralDistributions | None = None, illuminant: SpectralDistribution | None = None, tolerance: float | None = None, **kwargs: Any) → ndarray`

Return whether given CIE XYZ tristimulus values are within the visible spectrum volume, i.e. *Ro?sch-MacAdam* colour solid, for given colour matching functions and illuminant.

Parameters

- **XYZ** (ArrayLike) – CIE XYZ tristimulus values.
- **cmfs** (MultiSpectralDistributions | None) – Standard observer colour matching functions, default to the CIE 1931 2 Degree Standard Observer.
- **illuminant** (SpectralDistribution | None) – Illuminant spectral distribution, default to CIE Illuminant E.
- **tolerance** (float | None) – Tolerance allowed in the inside-triangle check.
- **kwargs** (Any) – {`colour.msds_to_XYZ()`}, See the documentation of the previously listed definition.

Returns

Are CIE XYZ tristimulus values within the visible spectrum volume, i.e. *Ro?sch-MacAdam* colour solid.

Return type

`numpy.ndarray`

Notes

| Domain | Scale - Reference | Scale - 1 |
|--------|-------------------|-----------|
| XYZ | [0, 1] | [0, 1] |

Examples

```
>>> import numpy as np
>>> is_within_visible_spectrum(np.array([0.3205, 0.4131, 0.51]))
array(True, dtype=bool)
>>> a = np.array([[0.3205, 0.4131, 0.51], [-0.0005, 0.0031, 0.001]])
>>> is_within_visible_spectrum(a)
array([ True, False], dtype=bool)
```

Ancillary Objects

`colour.volume`

| | |
|---|---|
| <code>generate_pulse_waves(bins[, pulse_order, ...])</code> | Generate the pulse waves of given number of bins necessary to totally stimulate the colour matching functions and produce the <i>Rosch-MacAdam</i> colour solid. |
| <code>XYZ_outer_surface([cmfs, illuminant, ...])</code> | Generate the <i>Rosch-MacAdam</i> colour solid, i.e. <i>CIE XYZ</i> colourspace outer surface, for given colour matching functions using multi-spectral conversion of pulse waves to <i>CIE XYZ</i> tristimulus values. |
| <code>solid_RoschMacAdam([cmfs, illuminant, ...])</code> | Generate the <i>Rosch-MacAdam</i> colour solid, i.e. <i>CIE XYZ</i> colourspace outer surface, for given colour matching functions using multi-spectral conversion of pulse waves to <i>CIE XYZ</i> tristimulus values. |

colour.volume.generate_pulse_waves

`colour.volume.generate_pulse_waves(bins: int, pulse_order: Literal['Bins', 'Pulse Wave Width'] | str = 'Bins', filter_jagged_pulses: bool = False) → ndarray`

Generate the pulse waves of given number of bins necessary to totally stimulate the colour matching functions and produce the *Rosch-MacAdam* colour solid.

Assuming 5 bins, a first set of SPDs would be as follows:

```
1 0 0 0 0
0 1 0 0 0
0 0 1 0 0
0 0 0 1 0
0 0 0 0 1
```

The second one:

```
1 1 0 0 0
0 1 1 0 0
0 0 1 1 0
0 0 0 1 1
1 0 0 0 1
```

The third:

```
1 1 1 0 0 0 1 1 1 0 0 0 1 1 1 1 0 0 1 1 1 1 0 0 1
```

Etc...

Parameters

- **bins** (`int`) – Number of bins of the pulse waves.
- **pulse_order** (`Literal['Bins', 'Pulse Wave Width'] | str`) – Method for ordering the pulse waves. *Bins* is the default order, with *Pulse Wave Width* ordering, instead of iterating over the pulse wave widths first, iteration occurs over the bins, producing blocks of pulse waves with increasing width.
- **filter_jagged_pulses** (`bool`) – Whether to filter jagged pulses. When `pulse_order` is set to *Pulse Wave Width*, the pulses are ordered by increasing width. Because of the discrete nature of the underlying signal, the resulting pulses will be jagged. For example assuming 5 bins, the center block with the two extreme values added would be as follows:


```

0 0 0 0 0
0 0 1 0 0
0 0 1 1 0 <--
0 1 1 1 0
0 1 1 1 1 <--
1 1 1 1 1

```

Setting the `filter_jagged_pulses` parameter to *True* will result in the removal of the two marked pulse waves above thus avoiding jagged lines when plotting and having to resort to excessive bins values.

Returns

Pulse waves.

Return type

`numpy.ndarray`

References

[Lin15], [Man18], [MartinezVerduPC+07]

Examples

```

>>> generate_pulse_waves(5)
array([[ 0.,  0.,  0.,  0.,  0.],
       [ 1.,  0.,  0.,  0.,  0.],
       [ 0.,  1.,  0.,  0.,  0.],
       [ 0.,  0.,  1.,  0.,  0.],
       [ 0.,  0.,  0.,  1.,  0.],
       [ 0.,  0.,  0.,  0.,  1.],
       [ 1.,  1.,  0.,  0.,  0.],
       [ 0.,  1.,  1.,  0.,  0.],
       [ 0.,  0.,  1.,  1.,  0.],
       [ 0.,  0.,  0.,  1.,  1.],
       [ 1.,  0.,  0.,  0.,  1.],
       [ 1.,  1.,  1.,  0.,  0.],
       [ 0.,  1.,  1.,  1.,  0.],
       [ 0.,  0.,  1.,  1.,  1.],
       [ 1.,  0.,  0.,  1.,  1.],
       [ 1.,  1.,  0.,  0.,  1.],
       [ 1.,  1.,  1.,  1.,  0.],
       [ 0.,  1.,  1.,  1.,  1.],
       [ 1.,  0.,  1.,  1.,  1.],
       [ 1.,  1.,  0.,  1.,  1.],
       [ 1.,  1.,  1.,  0.,  1.],
       [ 1.,  1.,  1.,  1.,  1.]])
>>> generate_pulse_waves(5, "Pulse Wave Width")
array([[ 0.,  0.,  0.,  0.,  0.],
       [ 1.,  0.,  0.,  0.,  0.],
       [ 1.,  1.,  0.,  0.,  0.],
       [ 1.,  1.,  0.,  0.,  1.],
       [ 1.,  1.,  1.,  0.,  1.],
       [ 0.,  1.,  0.,  0.,  0.],
       [ 0.,  1.,  1.,  0.,  0.],
       [ 1.,  1.,  1.,  0.,  0.],
       [ 1.,  1.,  1.,  1.,  0.]])

```

(continues on next page)

(continued from previous page)

```

[ 0.,  0.,  1.,  0.,  0.],
[ 0.,  0.,  1.,  1.,  0.],
[ 0.,  1.,  1.,  1.,  0.],
[ 0.,  1.,  1.,  1.,  1.],
[ 0.,  0.,  0.,  1.,  0.],
[ 0.,  0.,  0.,  1.,  1.],
[ 0.,  0.,  1.,  1.,  1.],
[ 1.,  0.,  1.,  1.,  1.],
[ 0.,  0.,  0.,  0.,  1.],
[ 1.,  0.,  0.,  0.,  1.],
[ 1.,  0.,  0.,  1.,  1.],
[ 1.,  1.,  0.,  1.,  1.],
[ 1.,  1.,  1.,  1.,  1.]]
>>> generate_pulse_waves(5, "Pulse Wave Width", True)
array([[ 0.,  0.,  0.,  0.,  0.],
       [ 1.,  0.,  0.,  0.,  0.],
       [ 1.,  1.,  0.,  0.,  1.],
       [ 0.,  1.,  0.,  0.,  0.],
       [ 1.,  1.,  1.,  0.,  0.],
       [ 0.,  0.,  1.,  0.,  0.],
       [ 0.,  1.,  1.,  1.,  0.],
       [ 0.,  0.,  0.,  1.,  0.],
       [ 0.,  0.,  1.,  1.,  1.],
       [ 0.,  0.,  0.,  0.,  1.],
       [ 1.,  0.,  0.,  1.,  1.],
       [ 1.,  1.,  1.,  1.,  1.]])

```

colour.volume.XYZ_outer_surface

`colour.volume.XYZ_outer_surface`(*cmfs*: [MultiSpectralDistributions](#) | *None* = *None*, *illuminant*: [SpectralDistribution](#) | *None* = *None*, *point_order*: [Literal](#)['Bins', 'Pulse Wave Width'] | *str* = 'Bins', *filter_jagged_points*: *bool* = *False*, ***kwargs*: *Any*) → *ndarray*

Generate the *Ro?sch-MacAdam* colour solid, i.e. *CIE XYZ* colourspace outer surface, for given colour matching functions using multi-spectral conversion of pulse waves to *CIE XYZ* tristimulus values.

Parameters

- **cmfs** ([MultiSpectralDistributions](#) | *None*) – Standard observer colour matching functions, default to the *CIE 1931 2 Degree Standard Observer*.
- **illuminant** ([SpectralDistribution](#) | *None*) – Illuminant spectral distribution, default to *CIE Illuminant E*.
- **point_order** ([Literal](#)['Bins', 'Pulse Wave Width'] | *str*) – Method for ordering the underlying pulse waves used to generate the *Ro?sch-MacAdam* colour solid. *Bins* is the default order, with *Pulse Wave Width* ordering, instead of iterating over the pulse wave widths first, iteration occurs over the bins, producing blocks of pulse waves with increasing width.
- **filter_jagged_points** (*bool*) – Whether to filter the underlying jagged pulses. When *point_order* is set to *Pulse Wave Width*, the pulses are ordered by increasing width. Because of the discrete nature of the underlying signal, the resulting pulses will be jagged. For example assuming 5 bins, the center block with the two extreme values added would be as follows:

```

0 0 0 0 0
0 0 1 0 0
0 0 1 1 0 <--
0 1 1 1 0
0 1 1 1 1 <--
1 1 1 1 1

```

Setting the `filter_jagged_points` parameter to `True` will result in the removal of the two marked pulse waves above thus avoiding jagged lines when plotting and having to resort to excessive bins values.

- **kwargs** (Any) – {`colour.msds_to_XYZ()`}, See the documentation of the previously listed definition.

Returns

Ro?sch-MacAdam colour solid, *CIE XYZ* outer surface tristimulus values.

Return type

`numpy.ndarray`

References

[Lin15], [Man18], [MartinezVerduPC+07]

Examples

```

>>> from colour import MSDS_CMFS, SPECTRAL_SHAPE_DEFAULT
>>> shape = SpectralShape(
...     SPECTRAL_SHAPE_DEFAULT.start, SPECTRAL_SHAPE_DEFAULT.end, 84
... )
>>> cmfs = MSDS_CMFS["CIE 1931 2 Degree Standard Observer"]
>>> XYZ_outer_surface(cmfs.copy().align(shape))
array([[ 0.0000000...e+00,  0.0000000...e+00,  0.0000000...e+00],
       [ 9.6361381...e-05,  2.9056776...e-06,  4.4961226...e-04],
       [ 2.5910529...e-01,  2.1031298...e-02,  1.3207468...e+00],
       [ 1.0561021...e-01,  6.2038243...e-01,  3.5423571...e-02],
       [ 7.2647980...e-01,  3.5460869...e-01,  2.1005149...e-04],
       [ 1.0971874...e-02,  3.9635453...e-03,  0.0000000...e+00],
       [ 3.0792572...e-05,  1.1119762...e-05,  0.0000000...e+00],
       [ 2.5920165...e-01,  2.1034203...e-02,  1.3211965...e+00],
       [ 3.6471551...e-01,  6.4141373...e-01,  1.3561704...e+00],
       [ 8.3209002...e-01,  9.7499113...e-01,  3.5633622...e-02],
       [ 7.3745167...e-01,  3.5857224...e-01,  2.1005149...e-04],
       [ 1.1002667...e-02,  3.9746651...e-03,  0.0000000...e+00],
       [ 1.2715395...e-04,  1.4025439...e-05,  4.4961226...e-04],
       [ 3.6481187...e-01,  6.4141663...e-01,  1.3566200...e+00],
       [ 1.0911953...e+00,  9.9602242...e-01,  1.3563805...e+00],
       [ 8.4306189...e-01,  9.7895467...e-01,  3.5633622...e-02],
       [ 7.3748247...e-01,  3.5858336...e-01,  2.1005149...e-04],
       [ 1.1099028...e-02,  3.9775708...e-03,  4.4961226...e-04],
       [ 2.5923244...e-01,  2.1045323...e-02,  1.3211965...e+00],
       [ 1.0912916...e+00,  9.9602533...e-01,  1.3568301...e+00],
       [ 1.1021671...e+00,  9.998597...e-01,  1.3563805...e+00],
       [ 8.4309268...e-01,  9.7896579...e-01,  3.5633622...e-02],
       [ 7.3757883...e-01,  3.5858626...e-01,  6.5966375...e-04],
       [ 2.7020432...e-01,  2.5008868...e-02,  1.3211965...e+00],

```

(continues on next page)

(continued from previous page)

```
[ 3.6484266...e-01, 6.4142775...e-01, 1.3566200...e+00],
[ 1.1022635...e+00, 9.9998888...e-01, 1.3568301...e+00],
[ 1.1021979...e+00, 9.9999709...e-01, 1.3563805...e+00],
[ 8.4318905...e-01, 9.7896870...e-01, 3.6083235...e-02],
[ 9.9668412...e-01, 3.7961756...e-01, 1.3214065...e+00],
[ 3.7581454...e-01, 6.4539130...e-01, 1.3566200...e+00],
[ 1.0913224...e+00, 9.9603645...e-01, 1.3568301...e+00],
[ 1.1022943...e+00, 1.0000000...e+00, 1.3568301...e+00]])
```

colour.volume.solid_RoschMacAdam

`colour.volume.solid_RoschMacAdam`(*cmfs*: [MultiSpectralDistributions](#) | *None* = *None*, *illuminant*: [SpectralDistribution](#) | *None* = *None*, *point_order*: [Literal](#)['Bins', 'Pulse Wave Width'] | *str* = 'Bins', *filter_jagged_points*: *bool* = *False*, ***kwargs*: *Any*) → *ndarray*

Generate the *Ro?sch-MacAdam* colour solid, i.e. *CIE XYZ* colourspace outer surface, for given colour matching functions using multi-spectral conversion of pulse waves to *CIE XYZ* tristimulus values.

Parameters

- **cmfs** ([MultiSpectralDistributions](#) | *None*) – Standard observer colour matching functions, default to the *CIE 1931 2 Degree Standard Observer*.
- **illuminant** ([SpectralDistribution](#) | *None*) – Illuminant spectral distribution, default to *CIE Illuminant E*.
- **point_order** ([Literal](#)['Bins', 'Pulse Wave Width'] | *str*) – Method for ordering the underlying pulse waves used to generate the *Ro?sch-MacAdam* colour solid. *Bins* is the default order, with *Pulse Wave Width* ordering, instead of iterating over the pulse wave widths first, iteration occurs over the bins, producing blocks of pulse waves with increasing width.
- **filter_jagged_points** (*bool*) – Whether to filter the underlying jagged pulses. When *point_order* is set to *Pulse Wave Width*, the pulses are ordered by increasing width. Because of the discrete nature of the underlying signal, the resulting pulses will be jagged. For example assuming 5 bins, the center block with the two extreme values added would be as follows:

```
0 0 0 0 0
0 0 1 0 0
0 0 1 1 0 <--
0 1 1 1 0
0 1 1 1 1 <--
1 1 1 1 1
```

Setting the *filter_jagged_points* parameter to *True* will result in the removal of the two marked pulse waves above thus avoiding jagged lines when plotting and having to resort to excessive bins values.

- **kwargs** (*Any*) – {`colour.msds_to_XYZ()`}, See the documentation of the previously listed definition.

Returns

Ro?sch-MacAdam colour solid, *CIE XYZ* outer surface tristimulus values.

Return type

`numpy.ndarray`

References

[Lin15], [Man18], [MartinezVerduPC+07]

Examples

```
>>> from colour import MSDS_CMFS, SPECTRAL_SHAPE_DEFAULT
>>> shape = SpectralShape(
...     SPECTRAL_SHAPE_DEFAULT.start, SPECTRAL_SHAPE_DEFAULT.end, 84
... )
>>> cmfs = MSDS_CMFS["CIE 1931 2 Degree Standard Observer"]
>>> XYZ_outer_surface(cmfs.copy().align(shape))
array([[ 0.0000000...e+00,  0.0000000...e+00,  0.0000000...e+00],
       [ 9.6361381...e-05,  2.9056776...e-06,  4.4961226...e-04],
       [ 2.5910529...e-01,  2.1031298...e-02,  1.3207468...e+00],
       [ 1.0561021...e-01,  6.2038243...e-01,  3.5423571...e-02],
       [ 7.2647980...e-01,  3.5460869...e-01,  2.1005149...e-04],
       [ 1.0971874...e-02,  3.9635453...e-03,  0.0000000...e+00],
       [ 3.0792572...e-05,  1.1119762...e-05,  0.0000000...e+00],
       [ 2.5920165...e-01,  2.1034203...e-02,  1.3211965...e+00],
       [ 3.6471551...e-01,  6.4141373...e-01,  1.3561704...e+00],
       [ 8.3209002...e-01,  9.7499113...e-01,  3.5633622...e-02],
       [ 7.3745167...e-01,  3.5857224...e-01,  2.1005149...e-04],
       [ 1.1002667...e-02,  3.9746651...e-03,  0.0000000...e+00],
       [ 1.2715395...e-04,  1.4025439...e-05,  4.4961226...e-04],
       [ 3.6481187...e-01,  6.4141663...e-01,  1.3566200...e+00],
       [ 1.0911953...e+00,  9.9602242...e-01,  1.3563805...e+00],
       [ 8.4306189...e-01,  9.7895467...e-01,  3.5633622...e-02],
       [ 7.3748247...e-01,  3.5858336...e-01,  2.1005149...e-04],
       [ 1.1099028...e-02,  3.9775708...e-03,  4.4961226...e-04],
       [ 2.5923244...e-01,  2.1045323...e-02,  1.3211965...e+00],
       [ 1.0912916...e+00,  9.9602533...e-01,  1.3568301...e+00],
       [ 1.1021671...e+00,  9.998597...e-01,  1.3563805...e+00],
       [ 8.4309268...e-01,  9.7896579...e-01,  3.5633622...e-02],
       [ 7.3757883...e-01,  3.5858626...e-01,  6.5966375...e-04],
       [ 2.7020432...e-01,  2.5008868...e-02,  1.3211965...e+00],
       [ 3.6484266...e-01,  6.4142775...e-01,  1.3566200...e+00],
       [ 1.1022635...e+00,  9.998888...e-01,  1.3568301...e+00],
       [ 1.1021979...e+00,  9.999709...e-01,  1.3563805...e+00],
       [ 8.4318905...e-01,  9.7896870...e-01,  3.6083235...e-02],
       [ 9.9668412...e-01,  3.7961756...e-01,  1.3214065...e+00],
       [ 3.7581454...e-01,  6.4539130...e-01,  1.3566200...e+00],
       [ 1.0913224...e+00,  9.9603645...e-01,  1.3568301...e+00],
       [ 1.1022943...e+00,  1.0000000...e+00,  1.3568301...e+00]])
```

4.1.2 Indices and tables

- [genindex](#)
- [search](#)

6 SEE ALSO

5.1 6.1 Software

Python

- [Colorio](#) by Schlömer, N.
- [ColorPy](#) by Kness, M.
- [Colorspacious](#) by Smith, N. J., et al.
- [python-colormath](#) by Taylor, G., et al.

Go

- [go-colorful](#) by Beyer, L., et al.

.NET

- [Colourful](#) by Pažourek, T., et al.

Julia

- [Colors.jl](#) by Holy, T., et al.

Matlab & Octave

- [COLORLAB](#) by Malo, J., et al.
- [Psychtoolbox](#) by Brainard, D., et al.
- [The Munsell and Kubelka-Munk Toolbox](#) by Centore, P.

7 CODE OF CONDUCT

The *Code of Conduct*, adapted from the [Contributor Covenant 1.4](#), is available on the [Code of Conduct](#) page.

8 CONTACT & SOCIAL

The *Colour Developers* can be reached via different means:

- [Email](#)
- [Facebook](#)
- [Github Discussions](#)
- [Gitter](#)
- [Twitter](#)

9 ABOUT

Colour by Colour Developers

Copyright 2013 Colour Developers – colour-developers@colour-science.org

This software is released under terms of New BSD License:

<https://opensource.org/licenses/BSD-3-Clause>

<https://github.com/colour-science/colour>

BIBLIOGRAPHY

- [APLR17] Mekides Assefa Abebe, Tania Pouli, Mohamed-Chaker Larabi, and Erik Reinhard. Perceptual Lightness Modeling for High-Dynamic-Range Imaging. *ACM Transactions on Applied Perception*, 15(1):1–19, July 2017. doi:10.1145/3086577.
- [Bar99] Peter G. Barten. *Contrast Sensitivity of the Human Eye and Its Effects on Image Quality*. Number 1999. SPIE, December 1999. ISBN 978-0-8194-7849-8. doi:10.1117/3.353254.
- [Bar03] Peter G. J. Barten. Formula for the contrast sensitivity of the human eye. In Yoichi Miyake and D. Rene Rasmussen, editors, *Proceedings of SPIE*, volume 5294, 231–238. December 2003. doi:10.1117/12.537476.
- [BS10] S. Bianco and R. Schettini. Two new von Kries based chromatic adaptation transforms found by numerical optimization. *Color Research & Application*, 35(3):184–192, June 2010. doi:10.1002/col.20573.
- [BWDS99] Barry A. Bodhaine, Norman B. Wood, Ellsworth G. Dutton, and James R. Slusser. On Rayleigh Optical Depth Calculations. *Journal of Atmospheric and Oceanic Technology*, 16(11):1854–1861, November 1999. doi:10.1175/1520-0426(1999)016<1854:ORODC>2.0.CO;2.
- [Bor17] Tim Borer. Private Discussion with Mansencal, T. and Shaw, N. 2017.
- [Boua] Paul Bourke. Intersection point of two line segments in 2 dimensions. <http://paulbourke.net/geometry/pointlineplane/>.
- [Boub] Paul Bourke. Trilinear Interpolation. <http://paulbourke.net/miscellaneous/interpolation/>.
- [Bre87] Edwin J. Breneman. Corresponding chromaticities for different states of adaptation to complex visual fields. *Journal of the Optical Society of America A*, 4(6):1115, June 1987. doi:10.1364/JOSAA.4.001115.
- [BS08] Michael H. Brill and Sabine Susstrunk. Repairing gamut problems in CIECAM02: A progress report. *Color Research & Application*, 33(5):424–426, October 2008. doi:10.1002/col.20432.
- [Bro09] A. D. Broadbent. Calculation from the Original Experimental Data of the Cie 1931 RGB Standard Observer Spectral Chromaticity Co-Ordinates and Color Matching Functions. <http://www.cis.rit.edu/mcsl/research/1931.php>, 2009.
- [BB09] Wilhelm Burger and Mark James Burge. *Principles of Digital Image Processing*. Springer London, London, 2009. ISBN 978-1-84800-194-7. doi:10.1007/978-1-84800-195-4.
- [Cab] Ricardo Cabello. PlaneGeometry.js. <https://github.com/mrdoob/three.js/blob/dev/src/geometries/PlaneGeometry.js>.
- [CTS13] Renbo Cao, H Joel Trussell, and Renzo Shamey. Comparison of the performance of inverse transformation methods from OSA-UCS to CIEXYZ. *Journal of the Optical Society of America A*, 30(8):1508, August 2013. doi:10.1364/JOSAA.30.001508.
- [CSH+18] E.C. Carter, J.D. Schanda, R. Hirschler, S. Jost, M.R. Luo, M. Melgosa, Y. Ohno, M.R. Pointer, D.C. Rich, F. Vienot, L. Whitehead, and J.H. Wold. CIE 015:2018 Colorimetry,

- 4th Edition. Technical Report, International Commission on Illumination, Vienna, October 2018. doi:10.25039/TR.015.2018.
- [Cas14] Saullo Castro. Numpy: Fastest way of computing diagonal for each row of a 2d array. <http://stackoverflow.com/questions/26511401/numpy-fastest-way-of-computing-diagonal-for-each-row-of-a-2d-array/26517247#26517247>, 2014.
- [Cen] Paul Centore. The Munsell and Kubelka-Munk Toolbox. <http://www.munsellcoloursienceforpainters.com/MunsellAndKubelkaMunkToolbox/MunsellAndKubelkaMunkToolboxApr2014>
- [Cen12] Paul Centore. An open-source inversion algorithm for the Munsell renotation. *Color Research & Application*, 37(6):455–464, December 2012. doi:10.1002/col.20715.
- [Cen14a] Paul Centore. MunsellAndKubelkaMunkToolboxApr2014 - GeneralRoutines/CIELABtoApproxMunsellSpec.m. 2014.
- [Cen14b] Paul Centore. MunsellAndKubelkaMunkToolboxApr2014 - MunsellRenotationRoutines/ChromDiagHueAngleToMunsellHue.m. 2014.
- [Cen14c] Paul Centore. MunsellAndKubelkaMunkToolboxApr2014 - MunsellRenotationRoutines/FindHueOnRenotationOvoid.m. 2014.
- [Cen14d] Paul Centore. MunsellAndKubelkaMunkToolboxApr2014 - MunsellRenotationRoutines/MaxChromaForExtrapolatedRenotation.m. 2014.
- [Cen14e] Paul Centore. MunsellAndKubelkaMunkToolboxApr2014 - MunsellRenotationRoutines/MunsellHueToASTMHue.m. 2014.
- [Cen14f] Paul Centore. MunsellAndKubelkaMunkToolboxApr2014 - MunsellRenotationRoutines/MunsellHueToChromDiagHueAngle.m. 2014.
- [Cen14g] Paul Centore. MunsellAndKubelkaMunkToolboxApr2014 - MunsellRenotationRoutines/MunsellToxyForIntegerMunsellValue.m. 2014.
- [Cen14h] Paul Centore. MunsellAndKubelkaMunkToolboxApr2014 - MunsellRenotationRoutines/MunsellToxyY.m. 2014.
- [Cen14i] Paul Centore. MunsellAndKubelkaMunkToolboxApr2014 - MunsellRenotationRoutines/xyYtoMunsell.m. 2014.
- [Cen14j] Paul Centore. MunsellAndKubelkaMunkToolboxApr2014 - MunsellSystemRoutines/BoundingRenotationHues.m. 2014.
- [Cen14k] Paul Centore. MunsellAndKubelkaMunkToolboxApr2014 - MunsellSystemRoutines/LinearVsRadialInterpOnRenotationOvoid.m. 2014.
- [Cha15] Peter Chamberlain. LUT documentation (to create from another program). <https://forum.blackmagicdesign.com/viewtopic.php?f=21&t=40284#p232952>, 2015.
- [CWCRO4] Vien Cheung, Stephen Westland, David Connah, and Caterina Ripamonti. A comparative study of the characterisation of colour cameras by means of neural networks and polynomial transforms. *Coloration Technology*, 120(1):19–25, 2004. doi:10.1111/j.1478-4408.2004.tb00201.x.
- [CB22] Sean Cooper and Harald Brendel. ARRI LogC4 Logarithmic Color Space SPECIFICATION. 2022.
- [Cot] Russell Cottrell. The Russell RGB working color space.
- [CKMW04] Matthew Cowan, Glenn Kennel, Thomas Maier, and Brad Walker. Contrast Sensitivity Experiment to Determine the Bit Depth for Digital Cinema. *SMPTE Motion Imaging Journal*, 113(9):281–292, September 2004. doi:10.5594/j11549.
- [CLR+02] G. Cui, M. R. Luo, B. Rigg, G. Roesler, and K. Witt. Uniform colour spaces based on the DIN99 colour-difference formula. *Color Research & Application*, 27(4):282–290, 2002. doi:10.1002/col.10066.

- [DFGM15] Maryam Mohammadzadeh Darrodi, Graham Finlayson, Teresa Goodman, and Michal Mackiewicz. Reference data set for camera spectral sensitivity estimation. *Journal of the Optical Society of America A*, 32(3):381, March 2015. doi:10.1364/JOSAA.32.000381.
- [DFH+15] Aurelien David, Paul T. Fini, Kevin W. Houser, Yoshi Ohno, Michael P. Royer, Kevin A. G. Smet, Minchen Wei, and Lorne Whitehead. Development of the IES method for evaluating the color rendition of light sources. *Optics Express*, 23(12):15888, June 2015. doi:10.1364/OE.23.015888.
- [DO10] Wendy Davis and Yoshiro Ohno. Color quality scale. *Optical Engineering*, 49(3):033602, March 2010. doi:10.1117/1.3360335.
- [DFI+17] Scott Dyer, Alexander Forsythe, Jonathon Irons, Thomas Mansencal, and Miaoqi Zhu. RAW to ACES. 2017.
- [EF98] Fritz Ebner and Mark D. Fairchild. Finding constant hue surfaces in color space. In Giordano B. Beretta and Reiner Eschbach, editors, *Proc. SPIE 3300, Color Imaging: Device-Independent Color, Color Hardcopy, and Graphic Arts III*, (2 January 1998), 107–117. January 1998. doi:10.1117/12.298269.
- [Erda] U. Murat Erdem. Fast Line Segment Intersection. <http://www.mathworks.com/matlabcentral/fileexchange/fast-line-segment-intersection>.
- [Erdb] Turan Erdogan. How to Calculate Luminosity, Dominant Wavelength, and Excitation Purity.
- [FW98] M. Fairchild and D. Wyble. Colorimetric Characterization of The Apple Studio Display (flat panel LCD). 1998.
- [FC11] Mark D Fairchild and Ping-hsu Chen. Brightness, lightness, and specifying color in high-dynamic-range scenes and images. In Susan P. Farnand and Frans Gaykema, editors, *Proc. SPIE 7867, Image Quality and System Performance VIII*, 78670O. January 2011. doi:10.1117/12.872075.
- [FH22] Mark D Fairchild and Luke Hellwig. Private Discussion with Mansencal, T. 2022.
- [Fai] Mark D. Fairchild. Fairchild YSh.
- [Fai91] Mark D. Fairchild. Formulation and testing of an incomplete-chromatic-adaptation model. *Color Research & Application*, 16(4):243–250, August 1991. doi:10.1002/col.5080160406.
- [Fai96] Mark D. Fairchild. Refinement of the RLAB color space. *Color Research & Application*, 21(5):338–346, October 1996. doi:10.1002/(SICI)1520-6378(199610)21:5<338::AID-COL3>3.0.CO;2-Z.
- [Fai04] Mark D. Fairchild. CIECAM02. In *Color Appearance Models*, pages 289–301. Wiley, second edition, 2004.
- [Fai13a] Mark D. Fairchild. Chromatic Adaptation Models. In *Color Appearance Models*, pages 4179–4252. Wiley, third edition, 2013.
- [Fai13b] Mark D. Fairchild. The Hunt Model. In *Color Appearance Models*, pages 5094–5556. Wiley, third edition, 2013.
- [Fai13c] Mark D. Fairchild. The Nayatani et al. Model. In *Color Appearance Models*, pages 4810–5085. Wiley, third edition, 2013.
- [Fai13d] Mark D. Fairchild. The RLAB Model. In *Color Appearance Models*, pages 5563–5824. Wiley, third edition, 2013.
- [Fai13e] Mark D. Fairchild. ATD Model. In *Color Appearance Models*, pages 5852–5991. Wiley, third edition, 2013.
- [Fai13f] Mark D. Fairchild. FAIRCHILD'S 1990 MODEL. In *Color Appearance Models*, pages 4418–4495. Wiley, third edition, 2013.
- [Fai13g] Mark D. Fairchild. IPT Colourspace. In *Color Appearance Models*, pages 6197–6223. Wiley, third edition, 2013.

- [Fai13h] Mark D. Fairchild. LLAB Model. In *Color Appearance Models*, pages 6025–6178. Wiley, third edition, 2013.
- [FW10] Mark D. Fairchild and David R. Wyble. Hdr-CIELAB and hdr-IPT: Simple Models for Describing the Color of High-Dynamic-Range and Wide-Color-Gamut Images. In *Proc. of Color and Imaging Conference*, 322–326. 2010.
- [Fai85] Hugh S. Fairman. The calculation of weight factors for tristimulus integration. *Color Research & Application*, 10(4):199–203, 1985. doi:10.1002/col.5080100407.
- [FBH97] Hugh S. Fairman, Michael H. Brill, and Henry Hemmendinger. How the CIE 1931 color-matching functions were derived from Wright-Guild data. *Color Research & Application*, 22(1):11–23, February 1997. doi:10.1002/(SICI)1520-6378(199702)22:1<11::AID-COL4>3.0.CO;2-7.
- [FMH15] Graham D. Finlayson, Michal MacKiewicz, and Anya Hurlbert. Color Correction Using Root-Polynomial Regression. *IEEE Transactions on Image Processing*, 24(5):1460–1470, May 2015. doi:10.1109/TIP.2015.2405336.
- [For18] Alex Forsythe. Private Discussion with Mansencal, T. 2018.
- [Frohlich17] Jan Fröhlich. Encoding high dynamic range and wide color gamut imagery. 2017.
- [GDY+] Hugo Gaggioni, Patel Dhanendra, Jin Yamashita, N. Kawada, K. Endo, and Curtis Clark. S-Log: A new LUT for digital production mastering and interchange applications.
- [GarciaHMC07] Pedro A. García, Rafael Huertas, Manuel Melgosa, and Guihua Cui. Measurement of the relationship between perceived and computed color differences. *Journal of the Optical Society of America A*, 24(7):1823, July 2007. doi:10.1364/JOSAA.24.001823.
- [GMRS58] L. G. Glasser, A. H. McKinney, C. D. Reilly, and P. D. Schnelle. Cube-Root Color Coordinate System. *Journal of the Optical Society of America*, 48(10):736, October 1958. doi:10.1364/JOSA.48.000736.
- [Gut95] S. Lee Guth. Further applications of the ATD model for color vision. In Eric Walowit, editor, *Proc. SPIE 2414, Device-Independent Color Imaging II*, volume 2414, 12–26. April 1995. doi:10.1117/12.206546.
- [HF98] Radim Halir and Jan Flusser. Numerically Stable Direct Least Squares Fitting Of Ellipses. 1998. doi:10.1.1.1.7559.
- [Han03] Allan Hanbury. A 3D-Polar Coordinate Colour Representation Well Adapted to Image Analysis. In Josef Bigun and Tomas Gustavsson, editors, *Image Analysis*, 804–811. Berlin, Heidelberg, 2003. Springer Berlin Heidelberg.
- [HF20] Luke Hellwig and Mark D. Fairchild. Using Gaussian Spectra to Derive a Hue-linear Color Space. *Journal of Perceptual Imaging*, 2020. doi:10.2352/J.Percept.Imaging.2020.3.2.020401.
- [HF22] Luke Hellwig and Mark D. Fairchild. Brightness, lightness, colorfulness, and chroma in \textsc CIECAM02 and \textsc CAM16. *Color Research & Application*, pages col.22792, March 2022. doi:10.1002/col.22792.
- [HSF22] Luke Hellwig, Dale Stoltzka, and Mark D. Fairchild. Extending CIECAM02 and CAM16 for the Helmholtz–Kohlrausch effect. *Color Research & Application*, pages col.22793, June 2022. doi:10.1002/col.22793.
- [Hol] Joseph Holmes. Ekta Space PS 5.
- [Hou15] Jim Houston. Private Discussion with Mansencal, T. 2015.
- [HCM+15] Min Huang, Guihua Cui, Manuel Melgosa, Manuel Sánchez-Marañón, Changjun Li, M. Ronnier Luo, and Haoxue Liu. Power functions improving the performance of color-difference formulas. *Optical Society of America*, 23(1):597–610, 2015. doi:10.1364/OE.23.000597.

- [HB95] Po-Chieh Hung and Roy S. Berns. Determination of constant Hue Loci for a CRT gamut and their predictions using color appearance spaces. *Color Research & Application*, 20(5):285–295, October 1995. doi:10.1002/col.5080200506.
- [Hun04] R.W.G. Hunt. *The Reproduction of Colour*. John Wiley & Sons, Ltd, Chichester, UK, sixth edition, September 2004. ISBN 978-0-470-02427-0. doi:10.1002/0470024275.
- [JH19] Wenzel Jakob and Johannes Hanika. A Low-Dimensional Function Space for Efficient Spectral Upsampling. *Computer Graphics Forum*, 38(2):147–155, May 2019. doi:10.1111/cgf.13626.
- [JLGS13] Jun Jiang, Dengyu Liu, Jinwei Gu, and Sabine Susstrunk. What is the space of spectral sensitivity functions for digital color cameras? In *2013 IEEE Workshop on Applications of Computer Vision (WACV)*, 168–179. IEEE, January 2013. doi:10.1109/WACV.2013.6475015.
- [KMH+02] Bongsoon Kang, Ohak Moon, Changhee Hong, Honam Lee, Bonghwan Cho, and Youngsun Kim. Design of advanced color: Temperature control system for HDTV applications. *Journal of the Korean Physical Society*, 41(6):865–871, 2002.
- [KPK11] Paul Kienzle, Nikunj Patel, and James Krycka. Refl1d.numpyerrors - Refl1D v0.6.19 documentation. http://www.reflectometry.org/danse/docs/refl1d/_modules/refl1d/numpyerrors.html, 2011.
- [KWK09] Mh Kim, T Weyrich, and J Kautz. Modeling Human Color Perception under Extended Luminance Levels. *ACM Transactions on Graphics*, 28(3):27:1–27:9, 2009. doi:10.1145/1531326.1531333.
- [Kir06] Richard Kirk. Truelight Software Library 2.0. 2006.
- [Kon21] Ivan A. Konovalenko. proLab_param.m. 2021.
- [KSNN21] Ivan A. Konovalenko, Anna A. Smagina, Dmitry P. Nikolaev, and Petr P. Nikolaev. ProLab: perceptually uniform projective colour coordinate system. *arXiv:2012.07653 [cs]*, January 2021. arXiv:2012.07653.
- [Kry85] M Krystek. An algorithm to calculate correlated colour temperature. *Color Research & Application*, 10(1):38–40, 1985. doi:10.1002/col.5080100109.
- [LLW+17] Changjun Li, Zhiqiang Li, Zhifeng Wang, Yang Xu, Ming Ronnier Luo, Guihua Cui, Manuel Melgosa, Michael H Brill, and Michael Pointer. Comprehensive color solutions: CAM16, CAT16, and CAM16-UCS. *Color Research & Application*, 42(6):703–718, December 2017. doi:10.1002/col.22131.
- [LLRH02] Changjun Li, Ming Ronnier Luo, Bryan Rigg, and Robert W. G. Hunt. CMC 2000 chromatic adaptation transform: CMCCAT2000. *Color Research & Application*, 27(1):49–58, February 2002. doi:10.1002/col.10005.
- [LPLMartinezverdu07] Changjun Li, Esther Perales, Ming Ronnier Luo, and Francisco Martinez-verdu. The Problem with CAT02 and Its Correction. 2007.
- [Lin03a] Bruce Lindbloom. Delta E (CIE 1976). http://brucelindbloom.com/Equ_DeltaE_CIE76.html, 2003.
- [Lin03b] Bruce Lindbloom. XYZ to xyY. http://www.brucelindbloom.com/Equ_XYZ_to_xyY.html, 2003.
- [Lin07] Bruce Lindbloom. Spectral Power Distribution of a CIE D-Illuminant. http://www.brucelindbloom.com/Equ_DIlluminant.html, 2007.
- [Lin09a] Bruce Lindbloom. Chromatic Adaptation. http://brucelindbloom.com/Equ_ChromAdapt.html, 2009.
- [Lin09b] Bruce Lindbloom. Delta E (CIE 2000). http://brucelindbloom.com/Equ_DeltaE_CIE2000.html, 2009.
- [Lin09c] Bruce Lindbloom. Delta E (CMC). http://brucelindbloom.com/Equ_DeltaE_CMC.html, 2009.

- [Lin09d] Bruce Lindbloom. xyY to XYZ. http://www.brucelindbloom.com/Equ_xyY_to_XYZ.html, 2009.
- [Lin11] Bruce Lindbloom. Delta E (CIE 1994). http://brucelindbloom.com/Equ_DeltaE_CIE94.html, 2011.
- [Lin14] Bruce Lindbloom. RGB Working Space Information. <http://www.brucelindbloom.com/WorkingSpaceInfo.html>, 2014.
- [Lin15] Bruce Lindbloom. About the Lab Gamut. <http://www.brucelindbloom.com/LabGamutDisplayHelp.html>, 2015.
- [LPY+16] Taoran Lu, Fangjun Pu, Peng Yin, Tao Chen, Walt Husak, Jaclyn Pytlarz, Robin Atkins, Jan Froehlich, and Guan-Ming Su. ITP Colour Space and Its Compression Performance for High Dynamic Range and Wide Colour Gamut Video Distribution. *ZTE Communications*, 14(1):32–38, 2016.
- [LCL06] M. Ronnier Luo, Guihua Cui, and Changjun Li. Uniform colour spaces based on CIECAM02 colour appearance model. *Color Research & Application*, 31(4):320–330, August 2006. doi:10.1002/col.20227.
- [LR99] M. Ronnier Luo and Peter A. Rhodes. Corresponding-colour datasets. *Color Research & Application*, 24(4):295–296, August 1999. doi:10.1002/(SICI)1520-6378(199908)24:4<295::AID-COL10>3.0.CO;2-K.
- [LL13] Ming Ronnier Luo and Changjun Li. CIECAM02 and Its Recent Developments. In Christine Fernandez-Maloigne, editor, *Advanced Color Image Processing and Analysis*, pages 19–58. Springer New York, New York, NY, 2013. doi:10.1007/978-1-4419-6190-7.
- [LLK96] Ming Ronnier Luo, Mei-Chun Lo, and Wen-Guey Kuo. The LLAB (l:c) colour model. *Color Research & Application*, 21(6):412–429, December 1996. doi:10.1002/(SICI)1520-6378(199612)21:6<412::AID-COL4>3.0.CO;2-Z.
- [LM96] Ming Ronnier Luo and Ján Morovic. Two Unsolved Issues in Colour Management - Colour Appearance and Gamut Mapping. In *Conference: 5th International Conference on High Technology: Imaging Science and Technology – Evolution & Promise*, 136–147. 1996.
- [Mac35] David L. MacAdam. Maximum Visual Efficiency of Colored Materials. *Journal of the Optical Society of America*, 25(11):361–367, November 1935. doi:10.1364/JOSA.25.000361.
- [Mac42] David L. Macadam. Visual Sensitivities to Color Differences in Daylight. *Journal of the Optical Society of America*, 32(5):28, 1942. doi:10.1364/JOSA.32.000247.
- [MOF09] G.M. Machado, M.M. Oliveira, and L. Fernandes. A Physiologically-based Model for Simulation of Color Vision Deficiency. *IEEE Transactions on Visualization and Computer Graphics*, 15(6):1291–1298, November 2009. doi:10.1109/TVCG.2009.113.
- [Mac10] Gustavo Mello Machado. A model for simulation of color vision deficiency and a color contrast enhancement technique for dichromats. 2010.
- [MY19] Ian Mallett and Cem Yuksel. Spectral Primary Decomposition for Rendering with sRGB Reflectance. *Eurographics Symposium on Rendering - DL-only and Industry Track*, pages 7 pages, 2019. doi:10.2312/SR.20191216.
- [MS03] Henrique Malvar and Gary Sullivan. YCoCg-R: A Color Space with RGB Reversibility and Low Dynamic Range. 2003.
- [Mana] Thomas Mansencal. Lookup.
- [Manb] Thomas Mansencal. Structure.
- [Man15] Thomas Mansencal. RED Colourspace Derivation. <https://www.colour-science.org/posts/red-colourspace-derivation>, 2015.
- [Man18] Thomas Mansencal. How is the visible gamut bounded? <https://stackoverflow.com/a/48396021/931625>, 2018.
- [Man19] Thomas Mansencal. Colour - Datasets. 2019. doi:10.5281/zenodo.3362520.

- [Mel13] Manuel Melgosa. CIE / ISO new standard: CIEDE2000. 2013.
- [MSHD15] Johannes Meng, Florian Simon, Johannes Hanika, and Carsten Dachsbacher. Physically Meaningful Rendering using Tristimulus Colours. *Computer Graphics Forum*, 34(4):31–40, July 2015. doi:10.1111/cgf.12676.
- [Mil14] Scott Miller. A Perceptual EOTF for Extended Dynamic Range Imagery. 2014.
- [MT11] Wojciech Mokrzycki and Maciej Tatol. Color difference Delta E - A survey. *Machine Graphics and Vision*, 20:383–411, April 2011.
- [Mor03] Nathan Moroney. A Radial Sampling of the OSA Uniform Color Scales. *Color and Imaging Conference*, 2003(1):175–180, 2003.
- [MFH+02] Nathan Moroney, Mark D. Fairchild, Robert W. G. Hunt, Changjun Li, Ming Ronnier Luo, and Todd Newman. The CIECAM02 color appearance model. *Color and Imaging Conference*, pages 23–27, 2002.
- [MorovicL00] Ján Morovič and M. Ronnier Luo. Calculating medium and image gamut boundaries for gamut mapping. *Color Research and Application*, 25(6):394–401, 2000. doi:10.1002/1520-6378(200012)25:63.0.CO;2-Y.
- [MRF21] Luvin Munish Ragoo and Ivar Farup. Optimising a Euclidean Colour Space Transform for Colour Order and Perceptual Uniformity. *Color and Imaging Conference*, 29(1):282–287, November 2021. doi:10.2352/issn.2169-2629.2021.29.282.
- [Nat16] Graeme Nattress. Private Discussion with Shaw, N. 2016.
- [Nay97] Yoshinobu Nayatani. Simple estimation methods for the Helmholtz—Kohlrausch effect. *Color Research & Application*, 22(6):385–401, 1997. doi:10.1002/(SICI)1520-6378(199712)22:6<385::AID-COL6>3.0.CO;2-R.
- [NSY95] Yoshinobu Nayatani, Hiroaki Sobagaki, and Kenjiro Hashimoto Tadashi Yano. Lightness dependency of chroma scales of a nonlinear color-appearance model and its latest formulation. *Color Research & Application*, 20(3):156–167, June 1995. doi:10.1002/col.5080200305.
- [NNJ43] Sidney M. Newhall, Dorothy Nickerson, and Deane B. Judd. Final Report of the OSA Subcommittee on the Spacing of the Munsell Colors. *Journal of the Optical Society of America*, 33(7):385, July 1943. doi:10.1364/JOSA.33.000385.
- [Ohn05] Yoshi Ohno. Spectral design considerations for white LED color rendering. *Optical Engineering*, 44(11):111302, 2005. doi:10.1117/1.2130694.
- [Ohn14] Yoshiro Ohno. Practical Use and Calculation of CCT and Duv. *LEUKOS*, 10(1):47–55, January 2014. doi:10.1080/15502724.2014.839020.
- [OD08] Yoshiro Ohno and Wendy Davis. NIST CQS simulation. 2008.
- [OD13] Yoshiro Ohno and Wendy Davis. NIST CQS simulation. 2013.
- [Oht97] N. Ohta. The basis of color reproduction engineering. 1997.
- [OYH18] H. Otsu, M. Yamamoto, and T. Hachisuka. Reproducing Spectral Reflectances From Tristimulus Colours. *Computer Graphics Forum*, 37(6):370–381, September 2018. doi:10.1111/cgf.13332.
- [Ott20] Björn Ottosson. A perceptual color space for image processing. <https://bottosson.github.io/posts/oklab/>, 2020.
- [Poi80] Michael R. Pointer. Pointer's Gamut Data. 1980.
- [Rak17] Herilalaina Rakotoarison. Bunch. March 2017.
- [SCKL17] Muhammad Safdar, Guihua Cui, Youn Jin Kim, and Ming Ronnier Luo. Perceptually uniform color space for image signals including high dynamic range and wide gamut. *Optics Express*, 25(13):15131, June 2017. doi:10.1364/OE.25.015131.

- [SHKL18] Muhammad Safdar, Jon Y. Hardeberg, Youn Jin Kim, and Ming Ronnier Luo. A Colour Appearance Model based on J z a z b z Colour Space. *Color and Imaging Conference*, 2018(1):96–101, November 2018. doi:10.2352/ISSN.2169-2629.2018.26.96.
- [SHRL21] Muhammad Safdar, Jon Yngve Hardeberg, and Ming Ronnier Luo. ZCAM, a colour appearance model based on a high dynamic range uniform colour space. *Optics Express*, 29(4):6036, February 2021. doi:10.1364/OE.413659.
- [SM05] Madenda Sarifuddin and Rokia Missaoui. A New Perceptually Uniform Color Space with Associated Color Similarity Measure for ContentBased Image and Video Retrieval. 2005.
- [SWD05] Gaurav Sharma, Wencheng Wu, and Edul N. Dalal. The CIEDE2000 color-difference formula: Implementation notes, supplementary test data, and mathematical observations. *Color Research & Application*, 30(1):21–30, February 2005. doi:10.1002/col.20070.
- [SH15] Peter Shirley and David Hart. The prismatic color space for rgb computations. 2015.
- [Sir18] Daniele Siragusano. Private Discussion with Shaw, Nick. 2018.
- [Smi78] Alvy Ray Smith. Color gamut transform pairs. In *Proceedings of the 5th Annual Conference on Computer Graphics and Interactive Techniques - SIGGRAPH '78*, 12–19. New York, New York, USA, 1978. ACM Press. doi:10.1145/800248.807361.
- [Smi99] Brian Smits. An RGB-to-Spectrum Conversion for Reflectances. *Journal of Graphics Tools*, 4(4):11–22, January 1999. doi:10.1080/10867651.1999.10487511.
- [SWG00] K E Spaulding, G J Woolfe, and E J Giorgianni. Reference Input/Output Medium Metric RGB Color Encodings (RIMM/ROMM RGB). 2000.
- [Spi15] Nick Spiker. Private Discussion with Mansencal, T. 2015.
- [SS88] E. I. Stearns and R. E. Stearns. An example of a method for correcting radiance data for Bandpass error. *Color Research & Application*, 13(4):257–259, August 1988. doi:10.1002/col.5080130410.
- [SS00] Andrew Stockman and Lindsay T. Sharpe. Cone Fundamentals. <http://www.cvrl.org/cones.htm>, 2000.
- [SBS99] Sabine Susstrunk, Robert Buckley, and Steve Swen. Standard RGB Color Spaces. 1999.
- [SHF00] Sabine E. Susstrunk, Jack M. Holm, and Graham D. Finlayson. Chromatic adaptation performance of different RGB sensors. In Reiner Eschbach and Gabriel G. Marcu, editors, *Photonics West 2001 - Electronic Imaging*, volume 4300, 172–183. December 2000. doi:10.1117/12.410788.
- [Tho12] Larry Thorpe. CANON-LOG TRANSFER CHARACTERISTIC. 2012.
- [Tri15] Tashi Trieu. Private Discussion with Mansencal, T. 2015.
- [War16] Greg Ward. Private Discussion with Mansencal, T. 2016.
- [WEydelbergVileshin02] Greg Ward and Elena Eydelberg-Vileshin. Picture Perfect RGB Rendering Using Spectral Prefiltering and Sharp Color Primaries. *Eurographics workshop on Rendering*, pages 117–124, 2002. doi:10.2312/EGWR/EGWR02/117-124.
- [WY12] Andrew B. Watson and John I. Yellott. A unified formula for light-adapted pupil size. *Journal of Vision*, 12(10):12, September 2012. doi:10.1167/12.10.12.
- [WR04] Stephen Westland and Caterina Ripamonti. Table 8.2. In *Computational Colour Science Using MATLAB*, pages 137. John Wiley & Sons, Ltd, Chichester, UK, first edition, March 2004. doi:10.1002/0470020326.
- [WRC12a] Stephen Westland, Caterina Ripamonti, and Vien Cheung. Correction for Spectral Bandpass. In *Computational Colour Science Using MATLAB*, pages 38. second edition, 2012.
- [WRC12b] Stephen Westland, Caterina Ripamonti, and Vien Cheung. Extrapolation Methods. In *Computational Colour Science Using MATLAB*, pages 38. second edition, 2012.

- [WRC12c] Stephen Westland, Caterina Ripamonti, and Vien Cheung. Interpolation Methods. In *Computational Colour Science Using MATLAB*, pages 29–37. second edition, 2012.
- [WRC12d] Stephen Westland, Caterina Ripamonti, and Vien Cheung. CMCCAT2000. In *Computational Colour Science Using MATLAB*, pages 83–86. second edition, 2012.
- [WRC12e] Stephen Westland, Caterina Ripamonti, and Vien Cheung. CMCCAT97. In *Computational Colour Science Using MATLAB*, pages 80. second edition, 2012.
- [Wys63] Günter Wyszecki. Proposal for a New Color-Difference Formula. *Journal of the Optical Society of America*, 53(11):1318, November 1963. doi:10.1364/JOSA.53.001318.
- [WS00a] Günther Wyszecki and W S Stiles. Equation I(1.2.1). In *Color Science: Concepts and Methods, Quantitative Data and Formulae*, pages 8. Wiley, 2000.
- [WS00b] Günther Wyszecki and W S Stiles. Table 2(5.4.1) MacAdam Ellipses (Observer PGN) Observed and Calculated on the Basis of a Normal Distribution of Color Matches about a Color Center (Silberstein and MacAdam, 1945). In *Color Science: Concepts and Methods, Quantitative Data and Formulae*, pages 309. Wiley, 2000.
- [WS00c] Günther Wyszecki and W. S. Stiles. Integration Replaced by Summation. In *Color Science: Concepts and Methods, Quantitative Data and Formulae*, pages 158–163. Wiley, 2000.
- [WS00d] Günther Wyszecki and W. S. Stiles. Standard Photometric Observers. In *Color Science: Concepts and Methods, Quantitative Data and Formulae*, pages 256–259,395. Wiley, 2000.
- [WS00e] Günther Wyszecki and W. S. Stiles. Table 1(3.11) Isotemperature Lines. In *Color Science: Concepts and Methods, Quantitative Data and Formulae*, pages 228. Wiley, 2000.
- [WS00f] Günther Wyszecki and W. S. Stiles. Table 1(3.3.3). In *Color Science: Concepts and Methods, Quantitative Data and Formulae*, pages 138–139. Wiley, 2000.
- [WS00g] Günther Wyszecki and W. S. Stiles. Table II(3.7). In *Color Science: Concepts and Methods, Quantitative Data and Formulae*, pages 778–779. Wiley, 2000.
- [WS00h] Günther Wyszecki and W. S. Stiles. Table I(3.7). In *Color Science: Concepts and Methods, Quantitative Data and Formulae*, pages 776–777. Wiley, 2000.
- [WS00i] Günther Wyszecki and W. S. Stiles. Table I(6.5.3) Whiteness Formulae (Whiteness Measure Denoted by W). In *Color Science: Concepts and Methods, Quantitative Data and Formulae*, pages 837–839. Wiley, 2000.
- [WS00j] Günther Wyszecki and W. S. Stiles. The CIE 1964 Standard Observer. In *Color Science: Concepts and Methods, Quantitative Data and Formulae*, pages 141. Wiley, 2000.
- [WS00k] Günther Wyszecki and W. S. Stiles. CIE Method of Calculating D-Illuminants. In *Color Science: Concepts and Methods, Quantitative Data and Formulae*, pages 145–146. Wiley, 2000.
- [WS00l] Günther Wyszecki and W. S. Stiles. CIE 1976 ($L^*u^*v^*$)-Space and Color-Difference Formula. In *Color Science: Concepts and Methods, Quantitative Data and Formulae*, pages 167. Wiley, 2000.
- [WS00m] Günther Wyszecki and W. S. Stiles. DISTRIBUTION TEMPERATURE, COLOR TEMPERATURE, AND CORRELATED COLOR TEMPERATURE. In *Color Science: Concepts and Methods, Quantitative Data and Formulae*, pages 224–229. Wiley, 2000.
- [Yor14] Rory Yorke. Python: Change format of np.array or allow tolerance in in1d function. <http://stackoverflow.com/a/23521245/931625>, 2014.
- [ZL18] Qiyan Zhai and Ming R. Luo. Study of chromatic adaptation via neutral white matches on different viewing media. *Optics Express*, 26(6):7724, March 2018. doi:10.1364/OE.26.007724.
- [AdobeSystems05] Adobe Systems. Adobe RGB (1998) Color Image Encoding. 2005.
- [AdobeSystems13a] Adobe Systems. Adobe DNG Software Development Kit (SDK) - 1.3.0.0 - dng_sdk_1_3/dng_sdk/source/dng_temperature.cpp::dng_temperature::xy_coord. 2013.

- [AdobeSystems13b] Adobe Systems. Adobe DNG Software Development Kit (SDK) - 1.3.0.0 - dng_sdk_1_3/dng_sdk/source/dng_temperature.cpp::dng_temperature::Set_xy_coord. 2013.
- [AdobeSystems13c] Adobe Systems. Cube LUT Specification. 2013.
- [ANSI03] ANSI. Specification of ROMM RGB. 2003.
- [ANSIIESCommittee18] ANSI and IES Color Committee. *ANSI/IES TM-30-18 - IES Method for Evaluating Light Source Color Rendition*. ANSI/IES, 2018. ISBN 978-0-87995-379-9.
- [AppleInc19] Apple Inc. displayP3. <https://developer.apple.com/documentation/coregraphics/cgcolorspace/1408916-displayp3>, 2019.
- [ARRI12] ARRI. ALEXA - Log C Curve - Usage in VFX. 2012.
- [AssociationoRIaBusinesses15] Association of Radio Industries and Businesses. Essential Parameter Values for the Extended Image Dynamic Range Television (EIDRTV) System for Programme Production. 2015.
- [ASTMInternational89] ASTM International. ASTM D1535-89 - Standard Practice for Specifying Color by the Munsell System. 1989.
- [ASTMInternational07] ASTM International. ASTM D2244-07 - Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates. 2007. doi:10.1520/D2244-16.
- [ASTMInternational08] ASTM International. ASTM D1535-08e1 - Standard Practice for Specifying Color by the Munsell System. 2008. doi:10.1520/D1535-08E01.
- [ASTMInternational11] ASTM International. ASTM E2022-11 - Standard Practice for Calculation of Weighting Factors for Tristimulus Integration. 2011. doi:10.1520/E2022-11.
- [ASTMInternational15a] ASTM International. ASTM E308-15 - Standard Practice for Computing the Colors of Objects by Using the CIE System. 2015. doi:10.1520/E0308-15.
- [ASTMInternational15b] ASTM International. ASTM E313-15e1 - Standard Practice for Calculating Yellowness and Whiteness Indices from Instrumentally Measured Color Coordinates. 2015. doi:10.1520/E0313-20.
- [BabelColor12a] BabelColor. The ColorChecker (since 1976!). http://www.babelcolor.com/main_level/ColorChecker.htm. 2012.
- [BabelColor12b] BabelColor. ColorChecker RGB and spectra. 2012.
- [BlackmagicDesign20a] Blackmagic Design. Wide Gamut Intermediate DaVinci Resolve. 2020.
- [BlackmagicDesign20b] Blackmagic Design. DaVinci Wide Gamut - DaVinci Resolve Studio 17 Public Beta 1. November 2020.
- [BlackmagicDesign21] Blackmagic Design. Blackmagic Generation 5 Color Science. 2021.
- [Canon14] Canon. EOS C500 Firmware Update. <https://www.usa.canon.com/internet/portal/us/home/explore/products/showcases/cameras-and-lenses/cinema-eos-firmware/c500>, 2014.
- [Canon16] Canon. EOS C300 Mark II - EOS C300 Mark II Input Transform Version 2.0 (for Cinema Gamut / BT.2020). <https://www.usa.canon.com/internet/portal/us/home/support/details/cameras/cinema-eos/eos-c300-mark-ii>, 2016.
- [CIED1CIED822] CIE Division 1 and CIE Division 8. *CIE 248:2022 The CIE 2016 Colour Appearance Model for Colour Management Systems: CIECAM16*. Commission Internationale de l'Eclairage, 2022. ISBN 978-3-902842-94-7.
- [CIET13294] CIE TC 1-32. *CIE 109-1994 A Method of Predicting Corresponding Colours under Different Chromatic and Illuminance Adaptations*. Commission Internationale de l'Eclairage, 1994. ISBN 978-3-900734-51-0.

- [CIET13606] CIE TC 1-36. *CIE 170-1:2006 Fundamental Chromaticity Diagram with Physiological Axes - Part 1*. Commission Internationale de l'Eclairage, 2006. ISBN 978-3-901906-46-6.
- [CIET13805a] CIE TC 1-38. 9. INTERPOLATION. In *CIE 167:2005 Recommended Practice for Tabulating Spectral Data for Use in Colour Computations*, pages 14–19. 2005.
- [CIET13805b] CIE TC 1-38. 9.2.4 Method of interpolation for uniformly spaced independent variable. In *CIE 167:2005 Recommended Practice for Tabulating Spectral Data for Use in Colour Computations*, pages 1–27. 2005.
- [CIET13805c] CIE TC 1-38. Table V. Values of the c-coefficients of Equ.s 6 and 7. In *CIE 167:2005 Recommended Practice for Tabulating Spectral Data for Use in Colour Computations*, pages 19. 2005.
- [CIET13805d] CIE TC 1-38. EXTRAPOLATION. In *CIE 167:2005 Recommended Practice for Tabulating Spectral Data for Use in Colour Computations*, pages 19–20. 2005.
- [CIET14804a] CIE TC 1-48. 3.1 Recommendations concerning standard physical data of illuminants. In *CIE 015:2004 Colorimetry, 3rd Edition*, pages 12–13. 2004.
- [CIET14804b] CIE TC 1-48. 9.1 Dominant wavelength and purity. In *CIE 015:2004 Colorimetry, 3rd Edition*, pages 32–33. 2004.
- [CIET14804c] CIE TC 1-48. Extrapolation. In *CIE 015:2004 Colorimetry, 3rd Edition*, pages 24. 2004.
- [CIET14804d] CIE TC 1-48. The evaluation of whiteness. In *CIE 015:2004 Colorimetry, 3rd Edition*, pages 24. 2004.
- [CIET14804e] CIE TC 1-48. APPENDIX E. INFORMATION ON THE USE OF PLANCK'S EQUATION FOR STANDARD AIR. In *CIE 015:2004 Colorimetry, 3rd Edition*, pages 77–82. 2004.
- [CIET14804f] CIE TC 1-48. *CIE 015:2004 Colorimetry, 3rd Edition*. Commission Internationale de l'Eclairage, 2004. ISBN 978-3-901906-33-6.
- [CIET14804g] CIE TC 1-48. CIE 1976 uniform chromaticity scale diagram (UCS diagram). In *CIE 015:2004 Colorimetry, 3rd Edition*, pages 24. 2004.
- [CIET14804h] CIE TC 1-48. CIE 1976 uniform colour spaces. In *CIE 015:2004 Colorimetry, 3rd Edition*, pages 24. 2004.
- [CIET14804i] CIE TC 1-48. EXPLANATORY COMMENTS - 5. In *CIE 015:2004 Colorimetry, 3rd Edition*, pages 68–68. 2004.
- [CIET19017] CIE TC 1-90. *CIE 2017 colour fidelity index for accurate scientific use*. Number 224 in Technical report / CIE. CIE Central Bureau, Vienna, 2017. ISBN 978-3-902842-61-9.
- [CIE] CIE. CIE Spectral Data.
- [CIE04] CIE. CIE 15:2004 Tables Data. 2004.
- [Colblindora] Colblindor. Deuteranopia - Red-Green Color Blindness. <http://www.color-blindness.com/deuteranopia-red-green-color-blindness/>.
- [Colblindorb] Colblindor. Protanopia - Red-Green Color Blindness. <http://www.color-blindness.com/protanopia-red-green-color-blindness/>.
- [Colblindorc] Colblindor. Tritanopia - Blue-Yellow Color Blindness. <http://www.color-blindness.com/tritanopia-blue-yellow-color-blindness/>.
- [CVRLa] CVRL. Luminous efficiency. <http://www.cvrl.org/lumindex.htm>.
- [CVRLb] CVRL. New CIE XYZ functions transformed from the CIE (2006) LMS functions. <http://cvrl.ioo.ucl.ac.uk/ciexyzpr.htm>.
- [CVRLc] CVRL. Older CIE Standards. <http://cvrl.ioo.ucl.ac.uk/cie.htm>.
- [CVRLd] CVRL. Stiles & Burch individual 10-deg colour matching data. http://www.cvrl.org/stilesburch10_ind.htm.

- [CVRLe] CVRL. Stiles & Burch individual 2-deg colour matching data. http://www.cvrl.org/stilesburch2_ind.htm.
- [CVRLf] CVRL. CIE (2012) 10-deg XYZ "physiologically-relevant" colour matching functions. <http://www.cvrl.org/database/text/cienewxyz/cie2012xyz10.htm>.
- [CVRLg] CVRL. CIE (2012) 2-deg XYZ "physiologically-relevant" colour matching functions. <http://www.cvrl.org/database/text/cienewxyz/cie2012xyz2.htm>.
- [DigitalCInitiatives07] Digital Cinema Initiatives. Digital Cinema System Specification - Version 1.1. 2007.
- [DjangoSFoundation22] Django Software Foundation. Slugify. 2022.
- [Dji17] Dji. White Paper on D-Log and D-Gamut of DJI Cinema Color System. 2017.
- [Dolby16] Dolby. WHAT IS ICTCP? - INTRODUCTION. 2016.
- [EasyRGBa] EasyRGB. CMYK \rightarrow CMY. <http://www.easyrgb.com/index.php?X=MATH&H=14#text14>.
- [EasyRGBb] EasyRGB. CMY \rightarrow CMYK. <http://www.easyrgb.com/index.php?X=MATH&H=13#text13>.
- [EasyRGBc] EasyRGB. CMY \rightarrow RGB. <http://www.easyrgb.com/index.php?X=MATH&H=12#text12>.
- [EasyRGBd] EasyRGB. HSL \rightarrow RGB. <http://www.easyrgb.com/index.php?X=MATH&H=19#text19>.
- [EasyRGBe] EasyRGB. HSV \rightarrow RGB. <http://www.easyrgb.com/index.php?X=MATH&H=21#text21>.
- [EasyRGBf] EasyRGB. RGB \rightarrow CMY. <http://www.easyrgb.com/index.php?X=MATH&H=11#text11>.
- [EasyRGBg] EasyRGB. RGB \rightarrow HSL. <http://www.easyrgb.com/index.php?X=MATH&H=18#text18>.
- [EasyRGBh] EasyRGB. RGB \rightarrow HSV. <http://www.easyrgb.com/index.php?X=MATH&H=20#text20>.
- [EuropeanBUnion75] European Broadcasting Union. EBU Tech 3213 - EBU Standard for Chromaticity Tolerances for Studio Monitors. August 1975.
- [EuropeanCInitiative02] European Color Initiative. ECI RGB v2. 2002.
- [FFmpegDevelopers22a] FFmpeg Developers. FFmpeg::AVColorPrimaries. August 2022.
- [FFmpegDevelopers22b] FFmpeg Developers. FFmpeg::AVColorSpace. August 2022.
- [FFmpegDevelopers22c] FFmpeg Developers. FFmpeg::AVColorTransferCharacteristic. August 2022.
- [FiLMiCInc17] FiLMiC Inc. FiLMiC Pro - User Manual v6 - Revision 1. 2017.
- [Fujifilm16] Fujifilm. F-Log Data Sheet Ver.1.0. 2016.
- [GoProDM16] GoPro, Haarm-Pieter Duiker, and Thomas Mansencal. Gopro.py. https://github.com/hpd/OpenColorIO-Configs/blob/master/aces_1.0.3/python/aces_ocio/colorspaces/gopro2016.
- [HernandezAndresLR99] Javier Hernández-Andrés, Raymond L. Lee, and Javier Romero. Calculating correlated color temperatures across the entire gamut of daylight and skylight chromaticities. *Applied Optics*, 38(27):5703, September 1999. doi:10.1364/AO.38.005703.
- [HewlettPDCompany09] Hewlett-Packard Development Company. Understanding the HP DreamColor LP2480zx DCI-P3 Emulation Color Space. 2009.
- [HunterLab08a] HunterLab. Hunter L,a,b Color Scale. 2008.
- [HunterLab08b] HunterLab. Illuminant Factors in Universal Software and EasyMatch Coatings. 2008.
- [HunterLab12] HunterLab. Hunter Rd,a,b Color Scale - History and Application. 2012.
- [HutchColora] HutchColor. BestRGB (4 K).
- [HutchColorb] HutchColor. DonRGB4 (4 K).
- [HutchColorc] HutchColor. MaxRGB (4 K).
- [HutchColord] HutchColor. XtremeRGB (4 K).

- [IESCommitteeTM2714WGroup14] IES Computer Committee and TM-27-14 Working Group. *IES Standard Format for the Electronic Transfer of Spectral Data Electronic Transfer of Spectral Data*. Illuminating Engineering Society, 2014. ISBN 978-0-87995-295-2.
- [InternationalCConsortium10] International Color Consortium. Specification ICC.1:2010 (Profile version 4.3.0.0). 2010.
- [InternationalECommission99] International Electrotechnical Commission. IEC 61966-2-1:1999 - Multimedia systems and equipment - Colour measurement and management - Part 2-1: Colour management - Default RGB colour space - sRGB. 1999.
- [InternationalOfStandardization02] International Organization for Standardization. INTERNATIONAL STANDARD ISO 7589-2002 - Photography - Illuminants for sensitometry - Specifications for daylight, incandescent tungsten and printer. 2002.
- [InternationalOfStandardization12] International Organization for Standardization. INTERNATIONAL STANDARD ISO 17321-1 - Graphic technology and photography - Colour characterisation of digital still cameras (DSCs) - Part 1: Stimuli, metrology and test procedures. 2012.
- [InternationalOfStandardization13] International Organization for Standardization. INTERNATIONAL STANDARD ISO/IEC 23001-8 - Information technology - MPEG systems technologies - Part 8: Coding-independent code points. 2013.
- [InternationalOfStandardization20] International Organization for Standardization. INTERNATIONAL STANDARD ISO/IEC 14496-10 - Information technology - Coding of audio-visual objects - Part 10: Advanced video coding. 2020.
- [InternationalOfStandardization21] International Organization for Standardization. INTERNATIONAL STANDARD ISO/IEC 23091-2 - Information technology - Coding- independent code points - Part 2: Video. 2021.
- [InternationalTUnion98a] International Telecommunication Union. Recommendation ITU-R BT.1361 - Worldwide unified colorimetry and related characteristics of future television and imaging systems. 1998.
- [InternationalTUnion98b] International Telecommunication Union. Recommendation ITU-R BT.470-6 - CONVENTIONAL TELEVISION SYSTEMS. 1998.
- [InternationalTUnion11a] International Telecommunication Union. Recommendation ITU-R BT.1886 - Reference electro-optical transfer function for flat panel displays used in HDTV studio production BT Series Broadcasting service. 2011.
- [InternationalTUnion11b] International Telecommunication Union. Recommendation ITU-R BT.601-7 - Studio encoding parameters of digital television for standard 4:3 and wide-screen 16:9 aspect ratios. 2011.
- [InternationalTUnion11c] International Telecommunication Union. Recommendation ITU-T T.871 - Information technology - Digital compression and coding of continuous-tone still images: JPEG File Interchange Format (JFIF). 2011.
- [InternationalTUnion15a] International Telecommunication Union. Recommendation ITU-R BT.2020 - Parameter values for ultra-high definition television systems for production and international programme exchange. 2015.
- [InternationalTUnion15b] International Telecommunication Union. Recommendation ITU-R BT.709-6 - Parameter values for the HDTV standards for production and international programme exchange BT Series Broadcasting service. 2015.
- [InternationalTUnion15c] International Telecommunication Union. Report ITU-R BT.2246-4 - The present state of ultra-high definition television BT Series Broadcasting service. 2015.
- [InternationalTUnion17] International Telecommunication Union. Recommendation ITU-R BT.2100-1 - Image parameter values for high dynamic range television for use in production and international programme exchange. 2017.

- [InternationalTUnion18] International Telecommunication Union. Recommendation ITU-R BT.2100-2 - Image parameter values for high dynamic range television for use in production and international programme exchange. 2018.
- [InternationalTUnion19] International Telecommunication Union. Recommendation ITU-R BT.2124-0 - Objective metric for the assessment of the potential visibility of colour differences in television. 2019.
- [InternationalTUnion21] International Telecommunication Union. Recommendation ITU-T H.273 - Coding-independent code points for video signal type identification. 2021.
- [Laurent12] Laurent. Reproducibility of python pseudo-random numbers across systems and versions? <http://stackoverflow.com/questions/8786084/reproducibility-of-python-pseudo-random-numbers-across-systems-and-versions>, 2012.
- [LeicaCAG22] Leica Camera AG. Leica L-Log Reference Manual. 2022.
- [MartinezVerduPC+07] Francisco Martínez-Verdú, Esther Perales, Elisabet Chorro, Dolores de Fez, Valentín Viqueira, and Eduardo Gilabert. Computation and visualization of the MacAdam limits for any lightness, hue angle, and light source. *Journal of the Optical Society of America A*, 24(6):1501, June 2007. doi:10.1364/JOSAA.24.001501.
- [MunsellCSsciencea] Munsell Color Science. Macbeth Colorchecker.
- [MunsellCSscienceb] Munsell Color Science. Munsell Colours Data. <http://www.cis.rit.edu/research/mcsl2/online/munsell.php>.
- [NationalEMAAssociation04] National Electrical Manufacturers Association. Digital Imaging and Communications in Medicine (DICOM) Part 14: Grayscale Standard Display Function. 2004.
- [Nikon18] Nikon. N-Log Specification Document - Version 1.0.0. 2018.
- [Panasonic14] Panasonic. VARICAM V-Log/V-Gamut. 2014.
- [REDDCinema17] RED Digital Cinema. White Paper on REDWideGamutRGB and Log3G10. 2017.
- [RenewableRDCenter03] Renewable Resource Data Center. Reference Solar Spectral Irradiance: ASTM G-173. <http://rredc.nrel.gov/solar/spectra/am1.5/ASTMG173/ASTMG173.html>, 2003.
- [RisingSRResearch] Rising Sun Research. cineSpace LUT Library. <https://sourceforge.net/projects/cinespacelutlib/>.
- [Saeedn] Saeedn. Extend a line segment a specific distance. <http://stackoverflow.com/questions/7740507/extend-a-line-segment-a-specific-distance>.
- [sastanin] sastanin. How to make scipy.interpolate give an extrapolated result beyond the input range? <http://stackoverflow.com/a/2745496/931625>.
- [SocietyoMPaTEngineers93] Society of Motion Picture and Television Engineers. *RP 177:1993 - Derivation of Basic Television Color Equations*. Volume RP 177:199. The Society of Motion Picture and Television Engineers, January 1993. ISBN 978-1-61482-191-5. doi:10.5594/S9781614821915.
- [SocietyoMPaTEngineers99] Society of Motion Picture and Television Engineers. ANSI/SMPTE 240M-1995 - Signal Parameters - 1125-Line High-Definition Production Systems. 1999.
- [SocietyoMPaTEngineers04] Society of Motion Picture and Television Engineers. *RP 145:2004: SMPTE C Color Monitor Colorimetry*. Volume RP 145:200. The Society of Motion Picture and Television Engineers, January 2004. ISBN 978-1-61482-164-9. doi:10.5594/S9781614821649.
- [SocietyoMPaTEngineers14] Society of Motion Picture and Television Engineers. SMPTE ST 2084:2014 - Dynamic Range Electro-Optical Transfer Function of Mastering Reference Displays. 2014. doi:10.5594/SMPTE.ST2084.2014.
- [SocietyoMPaTEngineers19] Society of Motion Picture and Television Engineers. ST 428-1:2019 - D-Cinema Distribution Master — Image Characteristic. 2019. doi:10.5594/SMPTE.ST428-1.2019.
- [SonyCorporationa] Sony Corporation. S-Gamut3_S-Gamut3Cine_Matrix.xlsx.

- [SonyCorporationb] Sony Corporation. S-Log Whitepaper.
- [SonyCorporationc] Sony Corporation. Technical Summary for S-Gamut3.Cine/S-Log3 and S-Gamut3/S-Log3.
- [SonyCorporation12] Sony Corporation. S-Log2 Technical Paper. 2012.
- [SonyECorporation20a] Sony Electronics Corporation. IDT.Sony.Venice_SLog3_SGamut3Cine.cctl. 2020.
- [SonyECorporation20b] Sony Electronics Corporation. IDT.Sony.Venice_SLog3_SGamut3.cctl. 2020.
- [SonyImageworks12] Sony Imageworks. Make.py. <https://github.com/imageworks/OpenColorIO-Configs/blob/master/nuke-default/make.py>, 2012.
- [TheAoMPAaSciences19] The Academy of Motion Picture Arts and Sciences. Academy Spectral Similarity Index (SSI): Overview. 2019.
- [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommitteea] The Academy of Motion Picture Arts and Sciences, Science and Technology Council, and Academy Color Encoding System (ACES) Project Subcommittee. Academy Color Encoding System. <http://www.oscars.org/science-technology/council/projects/aces.html>.
- [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommitteeb] The Academy of Motion Picture Arts and Sciences, Science and Technology Council, and Academy Color Encoding System (ACES) Project Subcommittee. ACESutil.Lin_to_Log2_param.cctl. https://github.com/ampas/aces-dev/blob/518c27f577e99cdecfd2ebcf5a53444b1f9343/transforms/cctl/utilities/ACESutil.Lin_to_Log2_param.cctl
- [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommitteec] The Academy of Motion Picture Arts and Sciences, Science and Technology Council, and Academy Color Encoding System (ACES) Project Subcommittee. ACESutil.Log2_to_Lin_param.cctl. https://github.com/ampas/aces-dev/blob/518c27f577e99cdecfd2ebcf5a53444b1f9343/transforms/cctl/utilities/ACESutil.Log2_to_Lin_param.cctl
- [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee13] The Academy of Motion Picture Arts and Sciences, Science and Technology Council, and Academy Color Encoding System (ACES) Project Subcommittee. Specification S-2013-001 - ACESproxy, an Integer Log Encoding of ACES Image Data. 2013.
- [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14a] The Academy of Motion Picture Arts and Sciences, Science and Technology Council, and Academy Color Encoding System (ACES) Project Subcommittee. Specification S-2014-003 - ACEScc, A Logarithmic Encoding of ACES Data for use within Color Grading Systems. 2014.
- [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14b] The Academy of Motion Picture Arts and Sciences, Science and Technology Council, and Academy Color Encoding System (ACES) Project Subcommittee. Technical Bulletin TB-2014-004 - Informative Notes on SMPTE ST 2065-1 - Academy Color Encoding Specification (ACES). 2014.
- [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14c] The Academy of Motion Picture Arts and Sciences, Science and Technology Council, and Academy Color Encoding System (ACES) Project Subcommittee. Technical Bulletin TB-2014-012 - Academy Color Encoding System Version 1.0 Component Names. 2014.
- [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee15] The Academy of Motion Picture Arts and Sciences, Science and Technology Council, and Academy Color Encoding System (ACES) Project Subcommittee. Procedure P-2013-001 - Recommended Procedures for the Creation and Use of Digital Camera System Input Device Transforms (IDTs). 2015.
- [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee20] The Academy of Motion Picture Arts and Sciences, Science and Technology Council, and Academy Color Encoding System (ACES) Project Subcommittee. Specification S-2014-006 - Common LUT Format (CLF) - A Common File Format for Look-Up Tables. 2020.
- [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESProject16] The Academy of Motion Picture Arts and Sciences, Science and Technology Council, and Academy Color Encoding Sys-

- tem (ACES) Project. Specification S-2016-001 - ACEScct, A Quasi-Logarithmic Encoding of ACES Data for use within Color Grading Systems. <http://j.mp/S-2016-001>, 2016.
- [TheAoMPAaSciencesScienceandTCouncilAcademyCESACESPSSubcommittee15] The Academy of Motion Picture Arts and Sciences, Science and Technology Council, and Academy Color Encoding System (ACES) Project Subcommittee. Specification S-2014-004 - ACEScg - A Working Space for CGI Render and Compositing. 2015.
- [Wikipedia] Wikipedia. Ellipse. <https://en.wikipedia.org/wiki/Ellipse>.
- [Wikipedia01a] Wikipedia. Approximation. http://en.wikipedia.org/wiki/Color_temperature#Approximation, 2001.
- [Wikipedia01b] Wikipedia. Color temperature. http://en.wikipedia.org/wiki/Color_temperature, 2001.
- [Wikipedia01c] Wikipedia. Luminance. <https://en.wikipedia.org/wiki/Luminance>, 2001.
- [Wikipedia01d] Wikipedia. Rayleigh scattering. http://en.wikipedia.org/wiki/Rayleigh_scattering, 2001.
- [Wikipedia03a] Wikipedia. Lagrange polynomial - Definition. https://en.wikipedia.org/wiki/Lagrange_polynomial#Definition, 2003.
- [Wikipedia03b] Wikipedia. Luminosity function. https://en.wikipedia.org/wiki/Luminosity_function#Details, 2003.
- [Wikipedia03c] Wikipedia. Mean squared error. https://en.wikipedia.org/wiki/Mean_squared_error, 2003.
- [Wikipedia03d] Wikipedia. Michaelis-Menten kinetics. https://en.wikipedia.org/wiki/Michaelis%E2%80%93Menten_kinetics, 2003.
- [Wikipedia03e] Wikipedia. Rayleigh–Jeans law. https://en.wikipedia.org/wiki/Rayleigh–Jeans_law, 2003.
- [Wikipedia03f] Wikipedia. Vandermonde matrix. https://en.wikipedia.org/wiki/Vandermonde_matrix, 2003.
- [Wikipedia03g] Wikipedia. HSL and HSV. http://en.wikipedia.org/wiki/HSL_and_HSV, 2003.
- [Wikipedia04a] Wikipedia. Peak signal-to-noise ratio. https://en.wikipedia.org/wiki/Peak_signal-to-noise_ratio, 2004.
- [Wikipedia04b] Wikipedia. Surfaces. <http://en.wikipedia.org/wiki/Gamut#Surfaces>, 2004.
- [Wikipedia04c] Wikipedia. Whiteness. <http://en.wikipedia.org/wiki/Whiteness>, 2004.
- [Wikipedia04d] Wikipedia. Wide-gamut RGB color space. http://en.wikipedia.org/wiki/Wide-gamut_RGB_color_space, 2004.
- [Wikipedia04e] Wikipedia. YCbCr. <https://en.wikipedia.org/wiki/YCbCr>, 2004.
- [Wikipedia05a] Wikipedia. Lanczos resampling. https://en.wikipedia.org/wiki/Lanczos_resampling, 2005.
- [Wikipedia05b] Wikipedia. Luminous Efficacy. https://en.wikipedia.org/wiki/Luminous_efficiency, 2005.
- [Wikipedia05c] Wikipedia. Mesopic weighting function. http://en.wikipedia.org/wiki/Mesopic_vision#Mesopic_weighting_function, 2005.
- [Wikipedia05d] Wikipedia. CIE 1931 color space. http://en.wikipedia.org/wiki/CIE_1931_color_space, 2005.
- [Wikipedia05e] Wikipedia. ISO 31-11. https://en.wikipedia.org/wiki/ISO_31-11, 2005.
- [Wikipedia06a] Wikipedia. List of common coordinate transformations. http://en.wikipedia.org/wiki/List_of_common_coordinate_transformations, 2006.
- [Wikipedia06b] Wikipedia. White points of standard illuminants. http://en.wikipedia.org/wiki/Standard_illuminant#White_points, 2006.

- [Wikipedia07a] Wikipedia. Lightness. <http://en.wikipedia.org/wiki/Lightness>, 2007.
- [Wikipedia07b] Wikipedia. The reverse transformation. http://en.wikipedia.org/wiki/CIELUV#The_reverse_transformation, 2007.
- [Wikipedia07c] Wikipedia. CAT02. <http://en.wikipedia.org/wiki/CIECAM02#CAT02>, 2007.
- [Wikipedia07d] Wikipedia. CIECAM02. <http://en.wikipedia.org/wiki/CIECAM02>, 2007.
- [Wikipedia07e] Wikipedia. CIELUV. <http://en.wikipedia.org/wiki/CIELUV>, 2007.
- [Wikipedia08a] Wikipedia. Color difference. http://en.wikipedia.org/wiki/Color_difference, 2008.
- [Wikipedia08b] Wikipedia. Relation to CIE XYZ. http://en.wikipedia.org/wiki/CIE_1960_color_space#Relation_to_CIE XYZ, 2008.
- [Wikipedia08c] Wikipedia. CIE 1960 color space. http://en.wikipedia.org/wiki/CIE_1960_color_space, 2008.
- [Wikipedia08d] Wikipedia. CIE 1964 color space. http://en.wikipedia.org/wiki/CIE_1964_color_space, 2008.
- [Wikipedia15] Wikipedia. HCL color space. https://en.wikipedia.org/wiki/HCL_color_space, 2015.
- [XRite16] X-Rite. New color specifications for ColorChecker SG and Classic Charts. http://xritephoto.com/ph_product_overview.aspx?ID=938&Action=Support&SupportID=5884#, 2016.
- [XRitePantone12] X-Rite and Pantone. Color iQC and Color iMatch Color Calculations Guide. 2012.

Symbols

- `__add__()` (*colour.continuous.AbstractContinuousFunction* method), 432
- `__add__()` (*colour.utilities.MixinDataclassArithmetic* method), 1152
- `__array__()` (*colour.utilities.MixinDataclassArray* method), 1151
- `__call__()` (*colour.Extrapolator* method), 127
- `__call__()` (*colour.KernelInterpolator* method), 130
- `__call__()` (*colour.LinearInterpolator* method), 132
- `__call__()` (*colour.NullInterpolator* method), 135
- `__call__()` (*colour.SpragueInterpolator* method), 138
- `__contains__()` (*colour.SpectralShape* method), 269
- `__contains__()` (*colour.continuous.AbstractContinuousFunction* method), 431
- `__contains__()` (*colour.continuous.MultiSignals* method), 459
- `__contains__()` (*colour.continuous.Signal* method), 442
- `__contains__()` (*colour.utilities.CanonicalMapping* method), 1187
- `__delattr__()` (*colour.utilities.Structure* method), 1197
- `__delitem__()` (*colour.LUTSequence* method), 573
- `__delitem__()` (*colour.utilities.CanonicalMapping* method), 1186
- `__dir__()` (*colour.utilities.Structure* method), 1197
- `__div__()` (*colour.continuous.AbstractContinuousFunction* method), 433
- `__div__()` (*colour.utilities.MixinDataclassArithmetic* method), 1153
- `__eq__()` (*colour.LUTOperatorMatrix* method), 570
- `__eq__()` (*colour.LUTSequence* method), 574
- `__eq__()` (*colour.SpectralShape* method), 269
- `__eq__()` (*colour.continuous.AbstractContinuousFunction* method), 431
- `__eq__()` (*colour.continuous.MultiSignals* method), 459
- `__eq__()` (*colour.continuous.Signal* method), 443
- `__eq__()` (*colour.utilities.CanonicalMapping* method), 1187
- `__getattr__()` (*colour.utilities.Structure* method), 1197
- `__getitem__()` (*colour.LUTSequence* method), 573
- `__getitem__()` (*colour.continuous.AbstractContinuousFunction* method), 431
- `__getitem__()` (*colour.continuous.MultiSignals* method), 456
- `__getitem__()` (*colour.continuous.Signal* method), 441
- `__getitem__()` (*colour.utilities.CanonicalMapping* method), 1186
- `__getitem__()` (*colour.utilities.LazyCanonicalMapping* method), 1189
- `__hash__` (*colour.LUTOperatorMatrix* attribute), 569
- `__hash__` (*colour.LUTSequence* attribute), 574
- `__hash__` (*colour.utilities.CanonicalMapping* attribute), 1189
- `__hash__()` (*colour.SpectralShape* method), 268
- `__hash__()` (*colour.continuous.AbstractContinuousFunction* method), 430
- `__hash__()` (*colour.continuous.MultiSignals* method), 456
- `__hash__()` (*colour.continuous.Signal* method), 441
- `__iadd__()` (*colour.continuous.AbstractContinuousFunction* method), 432
- `__iadd__()` (*colour.utilities.MixinDataclassArithmetic* method), 1152
- `__idiv__()` (*colour.continuous.AbstractContinuousFunction* method), 433
- `__idiv__()` (*colour.utilities.MixinDataclassArithmetic* method), 1153
- `__imul__()` (*colour.continuous.AbstractContinuousFunction* method), 433
- `__imul__()` (*colour.utilities.MixinDataclassArithmetic* method), 1153
- `__init__()` (*colour.CAM_Specification_ATD95* method), 165
- `__init__()` (*colour.CAM_Specification_CAM16* method), 182
- `__init__()` (*colour.CAM_Specification_CIECAM02* method), 170
- `__init__()` (*colour.CAM_Specification_CIECAM16* method), 176
- `__init__()` (*colour.CAM_Specification_Hellwig2022* method), 188
- `__init__()` (*colour.CAM_Specification_Hunt* method), 193
- `__init__()` (*colour.CAM_Specification_Kim2009* method), 193

method), 198

`__init__()` (`colour.CAM_Specification_LLAB` method), 204

`__init__()` (`colour.CAM_Specification_Nayatani95` method), 208

`__init__()` (`colour.CAM_Specification_RLAB` method), 211

`__init__()` (`colour.CAM_Specification_ZCAM` method), 219

`__init__()` (`colour.CorrespondingChromaticitiesPrediction` method), 470

`__init__()` (`colour.CorrespondingColourDataset` method), 469

`__init__()` (`colour.Extrapolator` method), 126

`__init__()` (`colour.KernelInterpolator` method), 129

`__init__()` (`colour.LUT1D` method), 549

`__init__()` (`colour.LUT3D` method), 561

`__init__()` (`colour.LUT3x1D` method), 554

`__init__()` (`colour.LUTOperatorMatrix` method), 569

`__init__()` (`colour.LUTSequence` method), 573

`__init__()` (`colour.LinearInterpolator` method), 132

`__init__()` (`colour.MultiSpectralDistributions` method), 288

`__init__()` (`colour.NearestNeighbourInterpolator` method), 131

`__init__()` (`colour.NullInterpolator` method), 134

`__init__()` (`colour.PchipInterpolator` method), 136

`__init__()` (`colour.RGB_Colourspace` method), 710

`__init__()` (`colour.SpectralDistribution` method), 273

`__init__()` (`colour.SpectralDistribution_IESTM2714` method), 596

`__init__()` (`colour.SpectralDistribution_Sekonic` method), 611

`__init__()` (`colour.SpectralDistribution_UPRTek` method), 606

`__init__()` (`colour.SpectralShape` method), 267

`__init__()` (`colour.SpragueInterpolator` method), 137

`__init__()` (`colour.adaptation.InductionFactors_CMCCAT2000` method), 92

`__init__()` (`colour.algebra.sdiv_mode` method), 152

`__init__()` (`colour.algebra.spow_enable` method), 155

`__init__()` (`colour.appearance.InductionFactors_CAM16` method), 184

`__init__()` (`colour.appearance.InductionFactors_CIECAM02` method), 172

`__init__()` (`colour.appearance.InductionFactors_CIECAM16` method), 178

`__init__()` (`colour.appearance.InductionFactors_Hellwig2002` method), 190

`__init__()` (`colour.appearance.InductionFactors_Kim2009` method), 200

`__init__()` (`colour.appearance.InductionFactors_LLAB` method), 206

`__init__()` (`colour.appearance.InductionFactors_ZCAM` method), 221

`__init__()` (`colour.appearance.MediaParameters_Kim2009` method), 201

`__init__()` (`colour.characterisation.ColourChecker` method), 261

`__init__()` (`colour.characterisation.RGB_CameraSensitivities` method), 262

`__init__()` (`colour.characterisation.RGB_DisplayPrimaries` method), 264

`__init__()` (`colour.colorimetry.LMS_ConeFundamentals` method), 358

`__init__()` (`colour.colorimetry.RGB_ColourMatchingFunctions` method), 359

`__init__()` (`colour.colorimetry.XYZ_ColourMatchingFunctions` method), 360

`__init__()` (`colour.continuous.AbstractContinuousFunction` method), 428

`__init__()` (`colour.continuous.MultiSignals` method), 452

`__init__()` (`colour.continuous.Signal` method), 438

`__init__()` (`colour.domain_range_scale` method), 1131

`__init__()` (`colour.geometry.LineSegmentsIntersections_Specification` method), 502

`__init__()` (`colour.hints.Any` method), 522

`__init__()` (`colour.hints.NestedSequence` method), 531

`__init__()` (`colour.hints.SupportsIndex` method), 525

`__init__()` (`colour.hints.TextIO` method), 525

`__init__()` (`colour.hints.TypeExtrapolator` method), 535

`__init__()` (`colour.hints.TypeInterpolator` method), 534

`__init__()` (`colour.hints.TypeLUTSequenceItem` method), 536

`__init__()` (`colour.hints.TypeVar` method), 528

`__init__()` (`colour.io.AbstractLUTSequenceOperator` method), 579

`__init__()` (`colour.io.ImageAttribute_Specification` method), 540

`__init__()` (`colour.plotting.common.KwargArtist` method), 937

`__init__()` (`colour.plotting.common.KwargCamera` method), 938

`__init__()` (`colour.plotting.common.KwargRender` method), 940

`__init__()` (`colour.quality.ColourQuality_Specification_ANSIESTM3` method), 1067

`__init__()` (`colour.quality.ColourRendering_Specification_CIE2017` method), 1064

`__init__()` (`colour.quality.ColourRendering_Specification_CQS` method), 1072

`__init__()` (`colour.quality.ColourRendering_Specification_CRI` method), 1070

`__init__()` (`colour.recovery.Dataset_Otsu2018` method), 1102

`__init__()` (*colour.recovery.LUT3D_Jakob2019 method*), 1086
`__init__()` (*colour.recovery.Tree_Otsu2018 method*), 1105
`__init__()` (*colour.utilities.CacheRegistry method*), 1133
`__init__()` (*colour.utilities.CanonicalMapping method*), 1185
`__init__()` (*colour.utilities.Node method*), 1192
`__init__()` (*colour.utilities.Structure method*), 1196
`__init__()` (*colour.utilities.disable_multiprocessing method*), 1139
`__ipow__()` (*colour.continuous.AbstractContinuousFunction method*), 434
`__ipow__()` (*colour.utilities.MixinDataclassArithmetic method*), 1154
`__isub__()` (*colour.continuous.AbstractContinuousFunction method*), 432
`__isub__()` (*colour.utilities.MixinDataclassArithmetic method*), 1152
`__iter__()` (*colour.SpectralShape method*), 268
`__iter__()` (*colour.utilities.CanonicalMapping method*), 1187
`__iter__()` (*colour.utilities.MixinDataclassIterable method*), 1150
`__itruediv__()` (*colour.continuous.AbstractContinuousFunction method*), 433
`__itruediv__()` (*colour.utilities.MixinDataclassArithmetic method*), 1153
`__len__()` (*colour.LUTSequence method*), 573
`__len__()` (*colour.SpectralShape method*), 269
`__len__()` (*colour.continuous.AbstractContinuousFunction method*), 431
`__len__()` (*colour.utilities.CanonicalMapping method*), 1187
`__len__()` (*colour.utilities.Node method*), 1194
`__mul__()` (*colour.continuous.AbstractContinuousFunction method*), 432
`__mul__()` (*colour.utilities.MixinDataclassArithmetic method*), 1152
`__ne__()` (*colour.LUTOperatorMatrix method*), 570
`__ne__()` (*colour.LUTSequence method*), 574
`__ne__()` (*colour.SpectralShape method*), 270
`__ne__()` (*colour.continuous.AbstractContinuousFunction method*), 431
`__ne__()` (*colour.continuous.MultiSignals method*), 459
`__ne__()` (*colour.continuous.Signal method*), 443
`__ne__()` (*colour.utilities.CanonicalMapping method*), 1187
`__new__()` (*colour.utilities.Node static method*), 1192
`__pow__()` (*colour.continuous.AbstractContinuousFunction method*), 434
`__pow__()` (*colour.utilities.MixinDataclassArithmetic method*), 1154
`__repr__()` (*colour.LUTOperatorMatrix method*), 570
`__repr__()` (*colour.LUTSequence method*), 574
`__repr__()` (*colour.RGB_Colourspace method*), 714
`__repr__()` (*colour.SpectralDistribution_IESTM2714 method*), 600
`__repr__()` (*colour.SpectralShape method*), 268
`__repr__()` (*colour.continuous.AbstractContinuousFunction method*), 430
`__repr__()` (*colour.continuous.MultiSignals method*), 455
`__repr__()` (*colour.continuous.Signal method*), 440
`__repr__()` (*colour.utilities.CanonicalMapping method*), 1186
`__setattr__()` (*colour.utilities.Structure method*), 1197
`__setitem__()` (*colour.LUTSequence method*), 573
`__setitem__()` (*colour.continuous.AbstractContinuousFunction method*), 431
`__setitem__()` (*colour.continuous.MultiSignals method*), 457
`__setitem__()` (*colour.continuous.Signal method*), 441
`__setitem__()` (*colour.utilities.CanonicalMapping method*), 1186
`__setstate__()` (*colour.utilities.Structure method*), 1197
`__str__()` (*colour.LUTOperatorMatrix method*), 569
`__str__()` (*colour.LUTSequence method*), 573
`__str__()` (*colour.RGB_Colourspace method*), 713
`__str__()` (*colour.SpectralDistribution_IESTM2714 method*), 598
`__str__()` (*colour.SpectralDistribution_Sekonic method*), 612
`__str__()` (*colour.SpectralDistribution_UPRTek method*), 606
`__str__()` (*colour.SpectralShape method*), 268
`__str__()` (*colour.continuous.AbstractContinuousFunction method*), 430
`__str__()` (*colour.continuous.MultiSignals method*), 455
`__str__()` (*colour.continuous.Signal method*), 440
`__str__()` (*colour.utilities.CacheRegistry method*), 1133
`__str__()` (*colour.utilities.Node method*), 1194
`__sub__()` (*colour.continuous.AbstractContinuousFunction method*), 432
`__sub__()` (*colour.utilities.MixinDataclassArithmetic method*), 1152
`__truediv__()` (*colour.continuous.AbstractContinuousFunction method*), 433
`__truediv__()` (*colour.utilities.MixinDataclassArithmetic method*), 1153
`__weakref__` (*colour.Extrapolator attribute*), 126
`__weakref__` (*colour.KernelInterpolator attribute*), 130
`__weakref__` (*colour.LUTSequence attribute*), 574
`__weakref__` (*colour.LinearInterpolator attribute*),

133
 __weakref__ (colour.NullInterpolator attribute),
 134
 __weakref__ (colour.RGB_Colourspace attribute),
 712
 __weakref__ (colour.SpectralShape attribute), 270
 __weakref__ (colour.SpragueInterpolator attribute),
 138
 __weakref__ (colour.continuous.AbstractContinuousFunction
 attribute), 433
 __weakref__ (colour.io.AbstractLUTSequenceOperator
 attribute), 580
 __weakref__ (colour.utilities.CacheRegistry at-
 tribute), 1135
 __weakref__ (colour.utilities.CanonicalMapping at-
 tribute), 1189
 __weakref__ (colour.utilities.ColourRuntimeWarning
 attribute), 1207
 __weakref__ (colour.utilities.ColourUsageWarning
 attribute), 1207
 __weakref__ (colour.utilities.ColourWarning at-
 tribute), 1207
 __weakref__ (colour.utilities.Lookup attribute),
 1191
 __weakref__ (colour.utilities.MixinDataclassFields
 attribute), 1149
 __weakref__ (colour.utilities.Node attribute), 1193
 __weakref__ (colour.utilities.Structure attribute),
 1197

A

absolute_tolerance (colour.NullInterpolator prop-
 erty), 135
 AbstractContinuousFunction (class in
 colour.continuous), 427
 AbstractLUTSequenceOperator (class in colour.io),
 579
 adjust_tristimulus_weighting_factors_ASTME308()
 (in module colour.colorimetry), 344
 align() (colour.MultiSpectralDistributions method),
 295
 align() (colour.SpectralDistribution method), 281
 Any (class in colour.hints), 522
 apply() (colour.io.AbstractLUTSequenceOperator
 method), 579
 apply() (colour.LUT1D method), 551
 apply() (colour.LUT3D method), 565
 apply() (colour.LUT3x1D method), 557
 apply() (colour.LUTOperatorMatrix method), 571
 apply() (colour.LUTSequence method), 574
 arithmetical_operation()
 (colour.continuous.AbstractContinuousFunction
 method), 434
 arithmetical_operation()
 (colour.continuous.MultiSignals method),
 460
 arithmetical_operation()
 (colour.continuous.Signal method), 444

arithmetical_operation()
 (colour.utilities.MixinDataclassArithmetic
 method), 1154
 ArrayLike (in module colour.hints), 532
 artist() (in module colour.plotting), 929
 as_3_channels_image() (in module colour.io), 545
 as_array() (in module colour.utilities), 1156
 as_float() (in module colour.utilities), 1157
 as_float_array() (in module colour.utilities), 1158
 as_float_scalar() (in module colour.utilities),
 1159
 as_int() (in module colour.utilities), 1156
 as_int_array() (in module colour.utilities), 1157
 as_int_scalar() (in module colour.utilities), 1158
 attest() (in module colour.utilities), 1138

B

bandpass_correction() (in module colour), 354
 BANDPASS_CORRECTION_METHODS (in module colour),
 355
 bandpass_correction_Stearns1988() (in module
 colour.colorimetry), 356
 bandwidth_corrected
 (colour.SpectralDistribution_IESTM2714
 property), 598
 bandwidth_FWHM (colour.SpectralDistribution_IESTM2714
 property), 598
 batch() (in module colour.utilities), 1139
 best_illuminant() (in module
 colour.characterisation), 246
 blackbody_spectral_radiance() (in module
 colour.colorimetry), 320
 Boolean (in module colour.hints), 530
 BooleanOrArrayLike (in module colour.hints), 532
 BooleanOrNDArray (in module colour.hints), 534
 boundaries (colour.SpectralShape property), 267
 BRENNEMAN_EXPERIMENT_PRIMARIES_CHROMATICITIES
 (in module colour), 473
 BRENNEMAN_EXPERIMENTS (in module colour), 471
 BT2100_HLG_EOTF_INVERSE_METHODS (in module
 colour.models), 792
 BT2100_HLG_EOTF_METHODS (in module
 colour.models), 791
 BT2100_HLG_OOTF_INVERSE_METHODS (in module
 colour.models), 805
 BT2100_HLG_OOTF_METHODS (in module
 colour.models), 804

C

CACHE_REGISTRY (in module colour.utilities), 1136
 CacheRegistry (class in colour.utilities), 1132
 Callable (in module colour.hints), 523
 CAM02LCD_to_JMh_CIECAM02() (in module colour),
 654
 CAM02LCD_to_XYZ() (in module colour), 659
 CAM02SCD_to_JMh_CIECAM02() (in module colour),
 655
 CAM02SCD_to_XYZ() (in module colour), 661

- CAM02UCS_to_JMh_CIECAM02() (in module colour), 657
- CAM02UCS_to_XYZ() (in module colour), 663
- CAM16_to_XYZ() (in module colour), 180
- CAM16LCD_to_JMh_CAM16() (in module colour), 665
- CAM16LCD_to_XYZ() (in module colour), 670
- CAM16SCD_to_JMh_CAM16() (in module colour), 667
- CAM16SCD_to_XYZ() (in module colour), 672
- CAM16UCS_to_JMh_CAM16() (in module colour), 668
- CAM16UCS_to_XYZ() (in module colour), 674
- CAM_KWARGS_CIECAM02_sRGB (in module colour:appearance), 172
- CAM_Specification_ATD95 (class in colour), 165
- CAM_Specification_CAM16 (class in colour), 181
- CAM_Specification_CIECAM02 (class in colour), 170
- CAM_Specification_CIECAM16 (class in colour), 176
- CAM_Specification_Hellwig2022 (class in colour), 188
- CAM_Specification_Hunt (class in colour), 193
- CAM_Specification_Kim2009 (class in colour), 198
- CAM_Specification_LLAB (class in colour), 203
- CAM_Specification_Nayatani95 (class in colour), 208
- CAM_Specification_RLAB (class in colour), 211
- CAM_Specification_ZCAM (class in colour), 217
- camera() (in module colour:plotting), 929
- camera_RGB_to_ACES2065_1() (in module colour), 240
- canonical_items() (colour.utilities.CanonicalMapping method), 1189
- canonical_keys() (colour.utilities.CanonicalMapping method), 1188
- CanonicalMapping (class in colour.utilities), 1184
- cartesian_to_cylindrical() (in module colour:algebra), 148
- cartesian_to_polar() (in module colour:algebra), 147
- cartesian_to_spherical() (in module colour:algebra), 146
- cast() (in module colour:hints), 536
- CAT_BIANCO2010 (in module colour:adaptation), 97
- CAT_BRADFORD (in module colour:adaptation), 94
- CAT_CAT02 (in module colour:adaptation), 103
- CAT_CAT02_BRILL2008 (in module colour:adaptation), 101
- CAT_CAT16 (in module colour:adaptation), 105
- CAT_CMCCAT2000 (in module colour:adaptation), 107
- CAT_CMCCAT97 (in module colour:adaptation), 110
- CAT_FAIRCHILD (in module colour:adaptation), 112
- CAT_PC_BIANCO2010 (in module colour:adaptation), 99
- CAT_SHARP (in module colour:adaptation), 114
- CAT_VON_KRIES (in module colour:adaptation), 116
- CAT_XYZ_SCALING (in module colour:adaptation), 118
- CCS_COLOURCHECKERS (in module colour), 260
- CCS_ILLUMINANT_POINTER_GAMUT (in module colour:models), 898
- CCS_ILLUMINANTS (in module colour), 366
- CCS_LIGHT_SOURCES (in module colour), 368
- CCS_POINTER_GAMUT_BOUNDARY (in module colour:models), 902
- CCT_to_uv() (in module colour), 1115
- CCT_to_uv_Krystek1985() (in module colour:temperature), 1120
- CCT_TO_UV_METHODS (in module colour), 1115
- CCT_to_uv_Ohno2013() (in module colour:temperature), 1122
- CCT_to_uv_Planck1900() (in module colour:temperature), 1124
- CCT_to_uv_Robertson1968() (in module colour:temperature), 1118
- CCT_to_xy() (in module colour), 1117
- CCT_to_xy_CIE_D() (in module colour:temperature), 1129
- CCT_to_xy_Hernandez1999() (in module colour:temperature), 1126
- CCT_to_xy_Kang2002() (in module colour:temperature), 1128
- CCT_to_xy_McCamy1992() (in module colour:temperature), 1125
- CCT_TO_XY_METHODS (in module colour), 1117
- cctf_decoding (colour.RGB_Colourspace property), 712
- cctf_decoding() (in module colour), 744
- cctf_decoding_ProPhotoRGB() (in module colour:models), 752
- cctf_decoding_RIMMRGB() (in module colour:models), 750
- cctf_decoding_ROMMRGB() (in module colour:models), 748
- CCTF_DECODINGS (in module colour), 745
- cctf_encoding (colour.RGB_Colourspace property), 712
- cctf_encoding() (in module colour), 742
- cctf_encoding_ProPhotoRGB() (in module colour:models), 751
- cctf_encoding_RIMMRGB() (in module colour:models), 749
- cctf_encoding_ROMMRGB() (in module colour:models), 747
- CCTF_ENCODINGS (in module colour), 743
- centroid() (in module colour:utilities), 1178
- children (colour.utilities.Node property), 1193
- chromatic_adaptation() (in module colour), 81
- chromatic_adaptation_CIE1994() (in module colour:adaptation), 86
- chromatic_adaptation_CMCCAT2000() (in module colour:adaptation), 87
- chromatic_adaptation_Fairchild1990() (in module colour:adaptation), 85
- chromatic_adaptation_forward_CMCCAT2000() (in module colour:adaptation), 89
- chromatic_adaptation_inverse_CMCCAT2000() (in module colour:adaptation), 90
- CHROMATIC_ADAPTATION_METHODS (in module

- colour*), 84
- CHROMATIC_ADAPTATION_TRANSFORMS (in module *colour*), 84
- CHROMATIC_ADAPTATION_TRANSFORMS (in module *colour.adaptation*), 94
- chromatic_adaptation_VonKries() (in module *colour.adaptation*), 92
- chromatic_adaptation_Zhai2018() (in module *colour.adaptation*), 122
- chromatically_adapt() (*colour.RGB_Colourspace* method), 715
- chromatically_adapted_primaries() (in module *colour*), 705
- CIECAM02_to_XYZ() (in module *colour*), 168
- CIECAM16_to_XYZ() (in module *colour*), 174
- clear_all_caches() (*colour.utilities.CacheRegistry* method), 1134
- clear_cache() (*colour.utilities.CacheRegistry* method), 1134
- closest() (in module *colour.utilities*), 1171
- closest_indexes() (in module *colour.utilities*), 1171
- CMY_to_CMYK() (in module *colour*), 887
- CMY_to_RGB() (in module *colour*), 887
- CMYK_to_CMY() (in module *colour*), 888
- coefficient_K_Br_Nayatani1997() (in module *colour.appearance*), 224
- coefficient_q_Nayatani1997() (in module *colour.appearance*), 224
- colorimetric_purity() (in module *colour*), 373
- colour_correction() (in module *colour*), 251
- colour_correction_Cheung2004() (in module *colour.characterisation*), 257
- colour_correction_Finlayson2015() (in module *colour.characterisation*), 258
- COLOUR_CORRECTION_METHODS (in module *colour*), 251
- colour_correction_Vandermonde() (in module *colour.characterisation*), 259
- colour_cycle() (in module *colour.plotting*), 928
- colour_fidelity_index() (in module *colour*), 1063
- colour_fidelity_index_ANSIESTM3018() (in module *colour.quality*), 1068
- colour_fidelity_index_CIE2017() (in module *colour.quality*), 1065
- COLOUR_FIDELITY_INDEX_METHODS (in module *colour*), 1063
- COLOUR_PRIMARIES_ITUTH273 (in module *colour*), 891
- colour_quality_scale() (in module *colour*), 1071
- COLOUR_QUALITY_SCALE_METHODS (in module *colour*), 1071
- colour_rendering_index() (in module *colour*), 1069
- colour_style() (in module *colour.plotting*), 928
- ColourChecker (class in *colour.characterisation*), 261
- ColourQuality_Specification_ANSIESTM3018 (class in *colour.quality*), 1066
- ColourRendering_Specification_CIE2017 (class in *colour.quality*), 1064
- ColourRendering_Specification_CQS (class in *colour.quality*), 1072
- ColourRendering_Specification_CRI (class in *colour.quality*), 1070
- ColourRuntimeWarning (class in *colour.utilities*), 1207
- colourspace_model_axis_reorder() (in module *colour.plotting.models*), 1009
- COLOURSPACE_MODELS (in module *colour*), 621
- ColourUsageWarning (class in *colour.utilities*), 1207
- ColourWarning (class in *colour.utilities*), 1207
- comments (*colour.io.AbstractLUTSequenceOperator* property), 579
- complementary_wavelength() (in module *colour*), 371
- Complex (in module *colour.hints*), 530
- ComplexOrArrayLike (in module *colour.hints*), 532
- ComplexOrNDArray (in module *colour.hints*), 534
- CONSTANT_AVOGADRO (in module *colour.constants*), 416
- CONSTANT_BOLTZMANN (in module *colour.constants*), 416
- CONSTANT_K_M (in module *colour.constants*), 415
- CONSTANT_KP_M (in module *colour.constants*), 416
- CONSTANT_LIGHT_SPEED (in module *colour.constants*), 416
- CONSTANT_PLANCK (in module *colour.constants*), 417
- contrast_sensitivity_function() (in module *colour*), 418
- contrast_sensitivity_function_Barten1999() (in module *colour.contrast*), 420
- CONTRAST_SENSITIVITY_METHODS (in module *colour*), 419
- convert() (*colour.LUT1D* method), 552
- convert() (*colour.LUT3D* method), 566
- convert() (*colour.LUT3x1D* method), 558
- convert() (in module *colour*), 516
- convert_bit_depth() (in module *colour.io*), 540
- copy() (*colour.continuous.AbstractContinuousFunction* method), 435
- copy() (*colour.LUTSequence* method), 575
- copy() (*colour.RGB_Colourspace* method), 716
- copy() (*colour.utilities.CanonicalMapping* method), 1188
- copy_definition() (in module *colour.utilities*), 1147
- corresponding_chromaticities_prediction() (in module *colour*), 467
- corresponding_chromaticities_prediction_CIE1994() (in module *colour.corresponding*), 475
- corresponding_chromaticities_prediction_CMCCAT2000() (in module *colour.corresponding*), 476
- corresponding_chromaticities_prediction_Fairchild1990() (in module *colour.corresponding*), 474

CORRESPONDING_CHROMATICITIES_PREDICTION_MODELS `describe_video_signal_matrix_coefficients()` (in module `colour`), 468

`corresponding_chromaticities_prediction_VonKries()` (in module `colour.corresponding`), 477

`CorrespondingChromaticitiesPrediction` (class in `colour`), 470

`CorrespondingColourDataset` (class in `colour`), 469

`CV_range()` (in module `colour`), 870

`CVD_MATRICES_MACHADO2010` (in module `colour`), 234

`cylindrical_to_cartesian()` (in module `colour.algebra`), 148

D

`D_FACTOR_RLAB` (in module `colour.appearance`), 213

`data` (`colour.utilities.CanonicalMapping` property), 1186

`data` (`colour.utilities.Node` property), 1193

`DATA_POINTER_GAMUT_VOLUME` (in module `colour.models`), 900

`Dataclass` (in module `colour.hints`), 531

`Dataset_Otsu2018` (class in `colour.recovery`), 1101

`daylight_locus_function()` (in module `colour.colorimetry`), 323

`default` (`colour.NullInterpolator` property), 135

`DEFAULT_FLOAT_DTYPE` (in module `colour.constants`), 417

`DEFAULT_INT_DTYPE` (in module `colour.constants`), 417

`delta_E()` (in module `colour`), 478

`delta_E_CAM02LCD()` (in module `colour.difference`), 486

`delta_E_CAM02SCD()` (in module `colour.difference`), 487

`delta_E_CAM02UCS()` (in module `colour.difference`), 488

`delta_E_CAM16LCD()` (in module `colour.difference`), 489

`delta_E_CAM16SCD()` (in module `colour.difference`), 490

`delta_E_CAM16UCS()` (in module `colour.difference`), 491

`delta_E_CIE1976()` (in module `colour.difference`), 481

`delta_E_CIE1994()` (in module `colour.difference`), 482

`delta_E_CIE2000()` (in module `colour.difference`), 483

`delta_E_CMC()` (in module `colour.difference`), 484

`delta_E_DIN99()` (in module `colour.difference`), 492

`delta_E_ITP()` (in module `colour.difference`), 485

`DELTA_E_METHODS` (in module `colour`), 479

`describe_conversion_path()` (in module `colour`), 520

`describe_environment()` (in module `colour.utilities`), 1202

`describe_video_signal_colour_primaries()` (in module `colour.models`), 893

`describe_video_signal_matrix_coefficients()` (in module `colour.models`), 896

`describe_video_signal_transfer_characteristics()` (in module `colour.models`), 895

`Dict` (in module `colour.hints`), 523

`DIN99_to_Lab()` (in module `colour`), 649

`DIN99_to_XYZ()` (in module `colour`), 651

`disable_multiprocessing` (class in `colour.utilities`), 1139

`display_labels` (`colour.MultiSpectralDistributions` property), 289

`display_name` (`colour.MultiSpectralDistributions` property), 289

`display_name` (`colour.SpectralDistribution` property), 273

`domain` (`colour.continuous.AbstractContinuousFunction` property), 429

`domain` (`colour.continuous.MultiSignals` property), 453

`domain` (`colour.continuous.Signal` property), 438

`domain_distance()` (`colour.continuous.AbstractContinuousFunction` method), 435

`domain_range_scale` (class in `colour`), 1130

`dominant_wavelength()` (in module `colour`), 370

`dtype` (`colour.continuous.AbstractContinuousFunction` property), 429

`dtype` (`colour.continuous.MultiSignals` property), 452

`dtype` (`colour.continuous.Signal` property), 438

`DType` (in module `colour.hints`), 530

`DTypeBoolean` (in module `colour.hints`), 529

`DTypeComplex` (in module `colour.hints`), 530

`DTypeFloating` (in module `colour.hints`), 529

`DTypeInteger` (in module `colour.hints`), 529

`DTypeNumber` (in module `colour.hints`), 529

E

`eigen_decomposition()` (in module `colour.algebra`), 162

`ellipse_coefficients_canonical_form()` (in module `colour.geometry`), 496

`ellipse_coefficients_general_form()` (in module `colour.geometry`), 496

`ellipse_fitting()` (in module `colour.geometry`), 498

`ellipse_fitting_Halir1998()` (in module `colour.geometry`), 499

`ELLIPSE_FITTING_METHODS` (in module `colour.geometry`), 497

`end` (`colour.SpectralShape` property), 267

`eotf()` (in module `colour`), 782

`eotf_BT1886()` (in module `colour.models`), 790

`eotf_BT2100_HLG()` (in module `colour.models`), 791

`eotf_BT2100_PQ()` (in module `colour.models`), 794

`eotf_DCDM()` (in module `colour.models`), 786

`eotf_DICOMGSDF()` (in module `colour.models`), 788

`eotf_H273_ST428_1()` (in module `colour.models`), 795

- eotf_inverse() (in module colour), 783
 - eotf_inverse_BT1886() (in module colour.models), 790
 - eotf_inverse_BT2100_HLG() (in module colour.models), 793
 - eotf_inverse_BT2100_PQ() (in module colour.models), 795
 - eotf_inverse_DCDM() (in module colour.models), 787
 - eotf_inverse_DICOMSGDF() (in module colour.models), 789
 - eotf_inverse_H273_ST428_1() (in module colour.models), 796
 - eotf_inverse_sRGB() (in module colour.models), 801
 - eotf_inverse_ST2084() (in module colour.models), 799
 - EOTF_INVERSES (in module colour), 784
 - eotf_SMPTE240M() (in module colour.models), 797
 - eotf_sRGB() (in module colour.models), 800
 - eotf_ST2084() (in module colour.models), 798
 - EOTFS (in module colour), 783
 - EPSILON (in module colour.constants), 417
 - euclidean_distance() (in module colour.algebra), 158
 - excitation_purity() (in module colour), 372
 - exponent_function_basic() (in module colour.models), 753
 - exponent_function_monitor_curve() (in module colour.models), 755
 - extend_line_segment() (in module colour.geometry), 500
 - extrapolate() (colour.MultiSpectralDistributions method), 294
 - extrapolate() (colour.SpectralDistribution method), 280
 - Extrapolator (class in colour), 124
 - extrapolator (colour.continuous.AbstractContinuousFunction property), 430
 - extrapolator (colour.continuous.MultiSignals property), 454
 - extrapolator (colour.continuous.Signal property), 439
 - extrapolator_kwargs (colour.continuous.AbstractContinuousFunction property), 430
 - extrapolator_kwargs (colour.continuous.MultiSignals property), 454
 - extrapolator_kwargs (colour.continuous.Signal property), 439
- ## F
- fields (colour.utilities.MixinDataclassFields property), 1149
 - fill_nan() (colour.continuous.AbstractContinuousFunction method), 434
 - fill_nan() (colour.continuous.MultiSignals method), 466
 - fill_nan() (colour.continuous.Signal method), 446
 - fill_nan() (in module colour.utilities), 1178
 - filter_cmfs() (in module colour.plotting.common), 943
 - filter_colour_checkers() (in module colour.plotting.common), 944
 - filter_illuminants() (in module colour.plotting.common), 944
 - filter_kwargs() (in module colour.utilities), 1145
 - filter_mapping() (in module colour.utilities), 1146
 - filter_passthrough() (in module colour.plotting.common), 941
 - filter_RGB_colourspaces() (in module colour.plotting.common), 943
 - filter_warnings() (in module colour.utilities), 1200
 - find_coefficients_Jakob2019() (in module colour.recovery), 1087
 - first_item() (in module colour.utilities), 1146
 - first_key_from_value() (colour.utilities.Lookup method), 1190
 - Floating (in module colour.hints), 530
 - FLOATING_POINT_NUMBER_PATTERN (in module colour.constants), 418
 - FloatingOrArrayLike (in module colour.hints), 532
 - FloatingOrNDArray (in module colour.hints), 534
 - from_range_1() (in module colour.utilities), 1166
 - from_range_10() (in module colour.utilities), 1167
 - from_range_100() (in module colour.utilities), 1168
 - from_range_degrees() (in module colour.utilities), 1169
 - from_range_int() (in module colour.utilities), 1170
 - full() (in module colour.utilities), 1180
 - full_to_legal() (in module colour), 868
 - function (colour.continuous.AbstractContinuousFunction property), 430
 - function (colour.continuous.MultiSignals property), 454
 - function (colour.continuous.Signal property), 440
- ## G
- gamma_function() (in module colour), 746
 - generate_illuminants_rawtoaces_v1() (in module colour.characterisation), 242
 - generate_pulse_waves() (in module colour.volume), 1216
 - Generator (in module colour.hints), 523
 - get_domain_range_scale() (in module colour), 1131
 - get_sdiv_mode() (in module colour.algebra), 151
- ## H
- handle_numpy_errors() (in module colour.utilities), 1137
 - handle_spectral_arguments() (in module colour.colorimetry), 336

- [has_only_nan\(\)](#) (in module `colour.utilities`), 1173
[HCL_to_RGB\(\)](#) (in module `colour`), 885
[HDR_CIELAB_METHODS](#) (in module `colour`), 685
[hdr_CIELab_to_XYZ\(\)](#) (in module `colour`), 684
[HDR_IPT_METHODS](#) (in module `colour`), 687
[hdr_IPT_to_XYZ\(\)](#) (in module `colour`), 686
[header](#) (`colour.SpectralDistribution_IESTM2714` property), 597
[Hellwig2022_to_XYZ\(\)](#) (in module `colour`), 186
[HelmholtzKohlrusch_effect_luminous_Nayatani1997\(\)](#) (in module `colour`), 223
[HelmholtzKohlrusch_effect_object_Nayatani1997\(\)](#) (in module `colour`), 222
[HEX_to_RGB\(\)](#) (in module `colour.notation`), 915
[HKE_NAYATANI1997_METHODS](#) (in module `colour`), 222
[HSL_to_RGB\(\)](#) (in module `colour`), 883
[HSV_to_RGB\(\)](#) (in module `colour`), 881
[hull_section\(\)](#) (in module `colour.geometry`), 515
[Hunter_Lab_to_XYZ\(\)](#) (in module `colour`), 644
[Hunter_Rdab_to_XYZ\(\)](#) (in module `colour`), 646
- I**
- [Iab_to_XYZ\(\)](#) (in module `colour.models`), 624
[ICaCb_to_XYZ\(\)](#) (in module `colour`), 676
[ICtCp_to_RGB\(\)](#) (in module `colour`), 873
[ICtCp_to_XYZ\(\)](#) (in module `colour`), 877
[id](#) (`colour.utilities.Node` property), 1193
[ignore_numpy_errors\(\)](#) (in module `colour.utilities`), 1137
[ignore_python_warnings\(\)](#) (in module `colour.utilities`), 1138
[IgPgTg_to_XYZ\(\)](#) (in module `colour`), 678
[IHLS_to_RGB\(\)](#) (in module `colour`), 890
[ImageAttribute_Specification](#) (class in `colour.io`), 540
[in_array\(\)](#) (in module `colour.utilities`), 1174
[index_along_last_axis\(\)](#) (in module `colour.utilities`), 1181
[index_stress\(\)](#) (in module `colour`), 493
[index_stress_Garcia2007\(\)](#) (in module `colour.difference`), 494
[INDEX_STRESS_METHODS](#) (in module `colour`), 493
[InductionFactors_CAM16](#) (class in `colour.appearance`), 184
[InductionFactors_CIECAM02](#) (class in `colour.appearance`), 172
[InductionFactors_CIECAM16](#) (class in `colour.appearance`), 178
[InductionFactors_CMCCAT2000](#) (class in `colour.adaptation`), 92
[InductionFactors_Hellwig2022](#) (class in `colour.appearance`), 190
[InductionFactors_Kim2009](#) (class in `colour.appearance`), 200
[InductionFactors_LLAB](#) (class in `colour.appearance`), 206
[InductionFactors_ZCAM](#) (class in `colour.appearance`), 221
[insert\(\)](#) (`colour.LUTSequence` method), 574
[Integer](#) (in module `colour.hints`), 530
[INTEGER_THRESHOLD](#) (in module `colour.constants`), 418
[IntegerOrArrayLike](#) (in module `colour.hints`), 532
[IntegerOrNDArray](#) (in module `colour.hints`), 533
[intermediate_lightness_function_CIE1976\(\)](#) (in module `colour.colorimetry`), 391
[intermediate_luminance_function_CIE1976\(\)](#) (in module `colour.colorimetry`), 398
[interpolate\(\)](#) (`colour.MultiSpectralDistributions` method), 290
[interpolate\(\)](#) (`colour.SpectralDistribution` method), 274
[interpolator](#) (`colour.continuous.AbstractContinuousFunction` property), 429
[interpolator](#) (`colour.continuous.MultiSignals` property), 453
[interpolator](#) (`colour.continuous.Signal` property), 439
[interpolator](#) (`colour.Extrapolator` property), 126
[interpolator_kwargs](#) (`colour.continuous.AbstractContinuousFunction` property), 429
[interpolator_kwargs](#) (`colour.continuous.MultiSignals` property), 453
[interpolator_kwargs](#) (`colour.continuous.Signal` property), 439
[intersect_line_segments\(\)](#) (in module `colour.geometry`), 500
[interval](#) (`colour.SpectralShape` property), 267
[interval\(\)](#) (in module `colour.utilities`), 1172
[invert\(\)](#) (`colour.LUT1D` method), 550
[invert\(\)](#) (`colour.LUT3D` method), 564
[invert\(\)](#) (`colour.LUT3x1D` method), 556
[IPT_hue_angle\(\)](#) (in module `colour`), 680
[IPT_Munish2021_to_XYZ\(\)](#) (in module `colour`), 682
[IPT_to_XYZ\(\)](#) (in module `colour`), 679
[is_ctlrender_installed\(\)](#) (in module `colour.utilities`), 1140
[is_domain_explicit\(\)](#) (`colour.LUT1D` method), 549
[is_domain_explicit\(\)](#) (`colour.LUT3D` method), 561
[is_domain_explicit\(\)](#) (`colour.LUT3x1D` method), 554
[is_graphviz_installed\(\)](#) (in module `colour.utilities`), 1140
[is_identity\(\)](#) (in module `colour.algebra`), 162
[is_inner\(\)](#) (`colour.utilities.Node` method), 1194
[is_integer\(\)](#) (in module `colour.utilities`), 1144
[is_iterable\(\)](#) (in module `colour.utilities`), 1143
[is_leaf\(\)](#) (`colour.utilities.Node` method), 1194
[is_matplotlib_installed\(\)](#) (in module `colour.utilities`), 1140

[is_networkx_installed\(\)](#) (in module [colour.utilities](#)), 1141
[is_numeric\(\)](#) (in module [colour.utilities](#)), 1144
[is_opencolorio_installed\(\)](#) (in module [colour.utilities](#)), 1141
[is_openimageio_installed\(\)](#) (in module [colour.utilities](#)), 1141
[is_pandas_installed\(\)](#) (in module [colour.utilities](#)), 1142
[is_root\(\)](#) ([colour.utilities.Node](#) method), 1194
[is_sibling\(\)](#) (in module [colour.utilities](#)), 1145
[is_spow_enabled\(\)](#) (in module [colour.algebra](#)), 154
[is_string\(\)](#) (in module [colour.utilities](#)), 1143
[is_tqdm_installed\(\)](#) (in module [colour.utilities](#)), 1142
[is_trimesh_installed\(\)](#) (in module [colour.utilities](#)), 1142
[is_uniform\(\)](#) ([colour.continuous.AbstractContinuousFunction](#) method), 435
[is_uniform\(\)](#) (in module [colour.utilities](#)), 1173
[is_within_macadam_limits\(\)](#) (in module [colour](#)), 1207
[is_within_mesh_volume\(\)](#) (in module [colour](#)), 1208
[is_within_pointer_gamut\(\)](#) (in module [colour](#)), 1209
[is_within_visible_spectrum\(\)](#) (in module [colour](#)), 1215
[items](#) ([colour.utilities.MixinDataclassIterable](#) property), 1150
[Iterable](#) (in module [colour.hints](#)), 523
[Iterator](#) (in module [colour.hints](#)), 523
[IZABZ_METHODS](#) (in module [colour.models](#)), 695
[Izazbz_to_XYZ\(\)](#) (in module [colour.models](#)), 696

J

[Jab_to_JCh\(\)](#) (in module [colour.models](#)), 622
[JCh_to_Jab\(\)](#) (in module [colour.models](#)), 622
[JmH_CAM16_to_CAM16LCD\(\)](#) (in module [colour](#)), 665
[JmH_CAM16_to_CAM16SCD\(\)](#) (in module [colour](#)), 666
[JmH_CAM16_to_CAM16UCS\(\)](#) (in module [colour](#)), 667
[JmH_CIECAM02_to_CAM02LCD\(\)](#) (in module [colour](#)), 653
[JmH_CIECAM02_to_CAM02SCD\(\)](#) (in module [colour](#)), 654
[JmH_CIECAM02_to_CAM02UCS\(\)](#) (in module [colour](#)), 656
[JND_CIE1976](#) (in module [colour.difference](#)), 480
[Jzazbz_to_XYZ\(\)](#) (in module [colour](#)), 694

K

[kernel](#) ([colour.KernelInterpolator](#) property), 129
[kernel_cardinal_spline\(\)](#) (in module [colour](#)), 142
[kernel_kwarg](#) ([colour.KernelInterpolator](#) property), 130
[kernel_lanczos\(\)](#) (in module [colour](#)), 142
[kernel_linear\(\)](#) (in module [colour](#)), 141
[kernel_nearest_neighbour\(\)](#) (in module [colour](#)), 140
[kernel_sinc\(\)](#) (in module [colour](#)), 141
[KernelInterpolator](#) (class in [colour](#)), 127
[keys](#) ([colour.utilities.MixinDataclassIterable](#) property), 1150
[keys_from_value\(\)](#) ([colour.utilities.Lookup](#) method), 1190
[Kim2009_to_XYZ\(\)](#) (in module [colour](#)), 196
[KwargArtist](#) (class in [colour.plotting.common](#)), 937
[KwargCamera](#) (class in [colour.plotting.common](#)), 938
[KwargRender](#) (class in [colour.plotting.common](#)), 939

L

[Lab_to_DIN99\(\)](#) (in module [colour](#)), 648
[Lab_to_LChab\(\)](#) (in module [colour](#)), 628
[Lab_to_XYZ\(\)](#) (in module [colour](#)), 627
[label_rectangles\(\)](#) (in module [colour.plotting](#)), 930
[labels](#) ([colour.continuous.MultiSignals](#) property), 454
[lagrange_coefficients\(\)](#) (in module [colour](#)), 138
[lagrange_coefficients_ASTME2022\(\)](#) (in module [colour.colorimetry](#)), 345
[LazyCanonicalMapping](#) (class in [colour.utilities](#)), 1189
[LChab_to_Lab\(\)](#) (in module [colour](#)), 629
[LCHuv_to_Luv\(\)](#) (in module [colour](#)), 633
[least_square_mapping_MoorePenrose\(\)](#) (in module [colour.algebra](#)), 150
[leaves](#) ([colour.utilities.Node](#) property), 1193
[left](#) ([colour.Extrapolator](#) property), 126
[legal_to_full\(\)](#) (in module [colour](#)), 869
[lerp\(\)](#) (in module [colour.algebra](#)), 160
[lightness\(\)](#) (in module [colour](#)), 387
[lightness_Abebe2017\(\)](#) (in module [colour.colorimetry](#)), 394
[lightness_CIE1976\(\)](#) (in module [colour.colorimetry](#)), 390
[lightness_Fairchild2010\(\)](#) (in module [colour.colorimetry](#)), 392
[lightness_Fairchild2011\(\)](#) (in module [colour.colorimetry](#)), 393
[lightness_Glasser1958\(\)](#) (in module [colour.colorimetry](#)), 388
[LIGHTNESS_METHODS](#) (in module [colour](#)), 388
[lightness_Wyszecki1963\(\)](#) (in module [colour.colorimetry](#)), 389
[linear_conversion\(\)](#) (in module [colour.algebra](#)), 159
[linear_function\(\)](#) (in module [colour](#)), 747
[linear_table\(\)](#) ([colour.LUT1D](#) static method), 550
[linear_table\(\)](#) ([colour.LUT3D](#) static method), 562
[linear_table\(\)](#) ([colour.LUT3x1D](#) static method), 555

- LinearInterpolator (*class in colour*), 131
- LineSegmentsIntersections_Specification (*class in colour.geometry*), 502
- linstep_function() (*in module colour.algebra*), 160
- List (*in module colour.hints*), 524
- Literal (*in module colour.hints*), 530
- LiteralWarning (*in module colour.hints*), 536
- LMS_10_degree_cmfs_to_XYZ_10_degree_cmfs() (*in module colour.colorimetry*), 365
- LMS_2_degree_cmfs_to_XYZ_2_degree_cmfs() (*in module colour.colorimetry*), 365
- LMS_ConeFundamentals (*class in colour.colorimetry*), 357
- LOG3G10_DECODING_METHODS (*in module colour.models*), 836
- LOG3G10_ENCODING_METHODS (*in module colour.models*), 834
- log_decoding() (*in module colour*), 809
- log_decoding_ACEScc() (*in module colour.models*), 813
- log_decoding_ACEScct() (*in module colour.models*), 815
- log_decoding_ACESproxy() (*in module colour.models*), 817
- log_decoding_ARRILogC3() (*in module colour.models*), 819
- log_decoding_CanonLog() (*in module colour.models*), 824
- log_decoding_CanonLog2() (*in module colour.models*), 820
- log_decoding_CanonLog3() (*in module colour.models*), 822
- log_decoding_Cineon() (*in module colour.models*), 826
- log_decoding_ERIMMRGB() (*in module colour.models*), 828
- log_decoding_FLog() (*in module colour.models*), 830
- log_decoding_LLog() (*in module colour.models*), 832
- log_decoding_Log2() (*in module colour.models*), 833
- log_decoding_Log3G10() (*in module colour.models*), 836
- log_decoding_Log3G12() (*in module colour.models*), 837
- log_decoding_NLog() (*in module colour.models*), 839
- log_decoding_Panalog() (*in module colour.models*), 841
- log_decoding_PivotedLog() (*in module colour.models*), 843
- log_decoding_Protune() (*in module colour.models*), 844
- log_decoding_REDLog() (*in module colour.models*), 846
- log_decoding_REDLogFilm() (*in module colour.models*), 847
- log_decoding_SLog() (*in module colour.models*), 849
- log_decoding_SLog2() (*in module colour.models*), 851
- log_decoding_SLog3() (*in module colour.models*), 853
- log_decoding_ViperLog() (*in module colour.models*), 857
- log_decoding_VLog() (*in module colour.models*), 855
- LOG_DECODINGS (*in module colour*), 810
- log_encoding() (*in module colour*), 808
- log_encoding_ACEScc() (*in module colour.models*), 812
- log_encoding_ACEScct() (*in module colour.models*), 814
- log_encoding_ACESproxy() (*in module colour.models*), 816
- log_encoding_ARRILogC3() (*in module colour.models*), 818
- log_encoding_CanonLog() (*in module colour.models*), 823
- log_encoding_CanonLog2() (*in module colour.models*), 820
- log_encoding_CanonLog3() (*in module colour.models*), 821
- log_encoding_Cineon() (*in module colour.models*), 825
- log_encoding_ERIMMRGB() (*in module colour.models*), 827
- log_encoding_FLog() (*in module colour.models*), 829
- log_encoding_LLog() (*in module colour.models*), 831
- log_encoding_Log2() (*in module colour.models*), 833
- log_encoding_Log3G10() (*in module colour.models*), 834
- log_encoding_Log3G12() (*in module colour.models*), 837
- log_encoding_NLog() (*in module colour.models*), 838
- log_encoding_Panalog() (*in module colour.models*), 840
- log_encoding_PivotedLog() (*in module colour.models*), 842
- log_encoding_Protune() (*in module colour.models*), 843
- log_encoding_REDLog() (*in module colour.models*), 845
- log_encoding_REDLogFilm() (*in module colour.models*), 846
- log_encoding_SLog() (*in module colour.models*), 848
- log_encoding_SLog2() (*in module colour.models*), 850
- log_encoding_SLog3() (*in module colour.models*), 851

- 852
- `log_encoding_ViperLog()` (in module `colour.models`), 856
- `log_encoding_VLog()` (in module `colour.models`), 854
- `LOG_ENCODINGS` (in module `colour`), 809
- `logarithmic_function_basic()` (in module `colour.models`), 756
- `logarithmic_function_camera()` (in module `colour.models`), 758
- `logarithmic_function_quasilog()` (in module `colour.models`), 757
- `Lookup` (class in `colour.utilities`), 1190
- `lower_items()` (`colour.utilities.CanonicalMapping` method), 1188
- `lower_keys()` (`colour.utilities.CanonicalMapping` method), 1188
- `luminance()` (in module `colour`), 395
- `luminance_ASTMD1535()` (in module `colour.colorimetry`), 399
- `luminance_CIE1976()` (in module `colour.colorimetry`), 398
- `luminance_Fairchild2010()` (in module `colour.colorimetry`), 400
- `luminance_Fairchild2011()` (in module `colour.colorimetry`), 401
- `LUMINANCE_METHODS` (in module `colour`), 396
- `luminance_Newhall1943()` (in module `colour.colorimetry`), 397
- `luminous_efficacy()` (in module `colour`), 374
- `luminous_efficiency()` (in module `colour`), 374
- `luminous_flux()` (in module `colour`), 375
- `LUT1D` (class in `colour`), 548
- `LUT3D` (class in `colour`), 560
- `LUT3D_Jakob2019` (class in `colour.recovery`), 1084
- `LUT3x1D` (class in `colour`), 553
- `LUT_to_LUT()` (in module `colour.io`), 580
- `LUTOperatorMatrix` (class in `colour`), 567
- `LUTSequence` (class in `colour`), 571
- `Luv_to_LCHuv()` (in module `colour`), 632
- `Luv_to_uv()` (in module `colour`), 633
- `Luv_to_XYZ()` (in module `colour`), 631
- `Luv_uv_to_xy()` (in module `colour`), 635
- M**
- `manhattan_distance()` (in module `colour.algebra`), 159
- `mapping` (`colour.SpectralDistribution_IESTM2714` property), 596
- `Mapping` (in module `colour.hints`), 524
- `MAPPING_PLANE_TO_AXIS` (in module `colour.geometry`), 506
- `matrix` (`colour.LUTOperatorMatrix` property), 569
- `matrix_anomalous_trichromacy_Machado2009()` (in module `colour`), 232
- `matrix_augmented_Cheung2004()` (in module `colour.characterisation`), 254
- `matrix_chromatic_adaptation_VonKries()` (in module `colour.adaptation`), 121
- `MATRIX_COEFFICIENTS_ITUTH273` (in module `colour`), 892
- `matrix_colour_correction()` (in module `colour`), 249
- `matrix_colour_correction_Cheung2004()` (in module `colour.characterisation`), 255
- `matrix_colour_correction_Finlayson2015()` (in module `colour.characterisation`), 256
- `MATRIX_COLOUR_CORRECTION_METHODS` (in module `colour`), 249
- `matrix_colour_correction_Vandermonde()` (in module `colour.characterisation`), 257
- `matrix_cvd_Machado2009()` (in module `colour`), 233
- `matrix_dot()` (in module `colour.algebra`), 157
- `matrix_idt()` (in module `colour`), 238
- `matrix_RGB_to_RGB()` (in module `colour`), 701
- `matrix_RGB_to_XYZ` (`colour.RGB_Colourspace` property), 711
- `matrix_XYZ_to_RGB` (`colour.RGB_Colourspace` property), 712
- `matrix_YCbCr()` (in module `colour`), 860
- `maximum_angular_size_Barten1999()` (in module `colour.contrast`), 426
- `MEDIA_PARAMETERS_KIM2009` (in module `colour`), 199
- `MediaParameters_Kim2009` (class in `colour.appearance`), 201
- `message_box()` (in module `colour.utilities`), 1198
- `metadata` (`colour.SpectralDistribution_UPRTek` property), 606
- `method` (`colour.Extrapolator` property), 126
- `metric_mse()` (in module `colour.utilities`), 1183
- `metric_psnr()` (in module `colour.utilities`), 1183
- `MixinDataclassArithmetic` (class in `colour.utilities`), 1151
- `MixinDataclassArray` (class in `colour.utilities`), 1151
- `MixinDataclassFields` (class in `colour.utilities`), 1149
- `MixinDataclassIterable` (class in `colour.utilities`), 1150
- `ModuleType` (in module `colour.hints`), 524
- `MSDS_ACES_RICD` (in module `colour.characterisation`), 237
- `MSDS_BASIS_FUNCTIONS_sRGB_MALLET2019` (in module `colour.recovery`), 1091
- `MSDS_CAMERA_SENSITIVITIES` (in module `colour`), 263
- `MSDS_CMFS` (in module `colour`), 361
- `msds_cmfs_anomalous_trichromacy_Machado2009()` (in module `colour`), 231
- `MSDS_CMFS_LMS` (in module `colour.colorimetry`), 361
- `MSDS_CMFS_RGB` (in module `colour.colorimetry`), 361
- `MSDS_CMFS_STANDARD_OBSERVER` (in module `colour.colorimetry`), 362

- `msds_constant()` (in module `colour`), 314
`MSDS_DISPLAY_PRIMARIES` (in module `colour`), 265
`msds_ones()` (in module `colour`), 314
`msds_to_XYZ()` (in module `colour`), 330
`msds_to_XYZ_ASTME308()` (in module `colour.colorimetry`), 339
`msds_to_XYZ_integration()` (in module `colour.colorimetry`), 350
`MSDS_TO_XYZ_METHODS` (in module `colour`), 334
`msds_zeros()` (in module `colour`), 315
`multi_signals_unpack_data()` (`colour.continuous.MultiSignals` static method), 462
`multiline_repr()` (in module `colour.utilities`), 1206
`multiline_str()` (in module `colour.utilities`), 1204
`multiprocessing_pool()` (in module `colour.utilities`), 1139
`MultiSignals` (class in `colour.continuous`), 448
`MultiSpectralDistributions` (class in `colour`), 285
`munsell_colour_to_xyY()` (in module `colour`), 904
`MUNSELL_COLOURS` (in module `colour`), 906
`munsell_value()` (in module `colour`), 907
`munsell_value_ASTMD1535()` (in module `colour.notation`), 914
`munsell_value_Ladd1955()` (in module `colour.notation`), 912
`munsell_value_McCamy1987()` (in module `colour.notation`), 913
`MUNSELL_VALUE_METHODS` (in module `colour`), 908
`munsell_value_Moon1943()` (in module `colour.notation`), 910
`munsell_value_Munsell1933()` (in module `colour.notation`), 909
`munsell_value_Priest1920()` (in module `colour.notation`), 909
`munsell_value_Saunderson1944()` (in module `colour.notation`), 911
- ## N
- `name` (`colour.continuous.AbstractContinuousFunction` property), 428
`name` (`colour.io.AbstractLUTSequenceOperator` property), 579
`name` (`colour.RGB_Colourspace` property), 711
`name` (`colour.utilities.Node` property), 1192
`NDArray` (in module `colour.hints`), 533
`ndarray_write()` (in module `colour.utilities`), 1179
`NearestNeighbourInterpolator` (class in `colour`), 130
`NestedSequence` (class in `colour.hints`), 531
`Node` (class in `colour.utilities`), 1191
`normalise()` (`colour.MultiSpectralDistributions` method), 299
`normalise()` (`colour.SpectralDistribution` method), 285
`normalise_illuminant()` (in module `colour.characterisation`), 243
`normalise_maximum()` (in module `colour.algebra`), 156
`normalise_vector()` (in module `colour.algebra`), 156
`normalised_primary_matrix()` (in module `colour`), 704
`NullInterpolator` (class in `colour`), 133
`Number` (in module `colour.hints`), 530
`NumberOrArrayLike` (in module `colour.hints`), 532
`NumberOrNDArray` (in module `colour.hints`), 534
`numpy_print_options()` (in module `colour.utilities`), 1202
- ## O
- `oetf()` (in module `colour`), 759
`oetf_ARIBSTDB67()` (in module `colour.models`), 763
`oetf_BlackmagicFilmGeneration5()` (in module `colour.models`), 764
`oetf_BT2020()` (in module `colour.models`), 768
`oetf_BT2100_HLG()` (in module `colour.models`), 769
`oetf_BT2100_PQ()` (in module `colour.models`), 771
`oetf_BT601()` (in module `colour.models`), 772
`oetf_BT709()` (in module `colour.models`), 774
`oetf_DaVinciIntermediate()` (in module `colour.models`), 766
`oetf_H273_IEC61966_2()` (in module `colour.models`), 779
`oetf_H273_Log()` (in module `colour.models`), 775
`oetf_H273_LogSqrt()` (in module `colour.models`), 777
`oetf_inverse()` (in module `colour`), 760
`oetf_inverse_ARIBSTDB67()` (in module `colour.models`), 763
`oetf_inverse_BlackmagicFilmGeneration5()` (in module `colour.models`), 765
`oetf_inverse_BT2020()` (in module `colour.models`), 768
`oetf_inverse_BT2100_HLG()` (in module `colour.models`), 770
`oetf_inverse_BT2100_PQ()` (in module `colour.models`), 772
`oetf_inverse_BT601()` (in module `colour.models`), 773
`oetf_inverse_BT709()` (in module `colour.models`), 775
`oetf_inverse_DaVinciIntermediate()` (in module `colour.models`), 767
`oetf_inverse_H273_IEC61966_2()` (in module `colour.models`), 780
`oetf_inverse_H273_Log()` (in module `colour.models`), 776
`oetf_inverse_H273_LogSqrt()` (in module `colour.models`), 778
`OETF_INVERSES` (in module `colour`), 761
`oetf_SMPTE240M()` (in module `colour.models`), 781
`OETF` (in module `colour`), 760
`offset` (`colour.LUTOperatorMatrix` property), 569
`offset_YCbCr()` (in module `colour`), 861

[Oklab_to_XYZ\(\)](#) (in module *colour*), 688
[ones\(\)](#) (in module *colour.utilities*), 1180
[ootf\(\)](#) (in module *colour*), 802
[ootf_BT2100_HLG\(\)](#) (in module *colour.models*), 804
[ootf_BT2100_PQ\(\)](#) (in module *colour.models*), 806
[ootf_inverse\(\)](#) (in module *colour*), 802
[ootf_inverse_BT2100_HLG\(\)](#) (in module *colour.models*), 805
[ootf_inverse_BT2100_PQ\(\)](#) (in module *colour.models*), 807
[OOTF_INVERSES](#) (in module *colour*), 803
[OOTFS](#) (in module *colour*), 802
[optical_MTF_Barten1999\(\)](#) (in module *colour.contrast*), 423
[OPTIMAL_COLOUR_STIMULI_ILLUMINANTS](#) (in module *colour*), 1208
[optimisation_factory_Jzazbz\(\)](#) (in module *colour.characterisation*), 247
[optimisation_factory_rawtoaces_v1\(\)](#) (in module *colour.characterisation*), 246
[Optional](#) (in module *colour.hints*), 524
[optional\(\)](#) (in module *colour.utilities*), 1148
[orient\(\)](#) (in module *colour.utilities*), 1177
[OSA_UCS_to_XYZ\(\)](#) (in module *colour*), 690

P

[padding_kwargs](#) (*colour.KernelInterpolator* property), 130
[parent](#) (*colour.utilities.Node* property), 1192
[path](#) (*colour.SpectralDistribution_IESTM2714* property), 597
[PCA_Jiang2013\(\)](#) (in module *colour.recovery*), 1112
[PchipInterpolator](#) (class in *colour*), 135
[planck_law\(\)](#) (in module *colour.colorimetry*), 321
[plot_automatic_colour_conversion_graph\(\)](#) (in module *colour.plotting*), 1061
[plot_blackbody_colours\(\)](#) (in module *colour.plotting*), 958
[plot_blackbody_spectral_radiance\(\)](#) (in module *colour.plotting*), 957
[plot_chromaticity_diagram\(\)](#) (in module *colour.plotting.diagrams*), 980
[plot_chromaticity_diagram_CIE1931\(\)](#) (in module *colour.plotting*), 965
[plot_chromaticity_diagram_CIE1960UCS\(\)](#) (in module *colour.plotting*), 966
[plot_chromaticity_diagram_CIE1976UCS\(\)](#) (in module *colour.plotting*), 968
[plot_chromaticity_diagram_colours\(\)](#) (in module *colour.plotting.diagrams*), 978
[plot_colour_qualityBars\(\)](#) (in module *colour.plotting.quality*), 1029
[plot_constant_hue_loci\(\)](#) (in module *colour.plotting*), 1005
[plot_corresponding_chromaticities_prediction\(\)](#) (in module *colour.plotting*), 963
[plot_cvd_simulation_Machado2009\(\)](#) (in module *colour.plotting*), 959

[plot_ellipses_MacAdam1942_in_chromaticity_diagram\(\)](#) (in module *colour.plotting.models*), 1016
[plot_ellipses_MacAdam1942_in_chromaticity_diagram_CIE1931\(\)](#) (in module *colour.plotting*), 997
[plot_ellipses_MacAdam1942_in_chromaticity_diagram_CIE1960UCS\(\)](#) (in module *colour.plotting*), 999
[plot_ellipses_MacAdam1942_in_chromaticity_diagram_CIE1976UCS\(\)](#) (in module *colour.plotting*), 1001
[plot_hull_section_colours\(\)](#) (in module *colour.plotting.section*), 1035
[plot_hull_section_contour\(\)](#) (in module *colour.plotting.section*), 1037
[plot_image\(\)](#) (in module *colour.plotting*), 935
[plot_multi_cctfs\(\)](#) (in module *colour.plotting*), 1004
[plot_multi_cmfs\(\)](#) (in module *colour.plotting*), 949
[plot_multi_colour_checkers\(\)](#) (in module *colour.plotting*), 962
[plot_multi_colour_swatches\(\)](#) (in module *colour.plotting*), 932
[plot_multi_functions\(\)](#) (in module *colour.plotting*), 934
[plot_multi_illuminant_sds\(\)](#) (in module *colour.plotting*), 951
[plot_multi_lightness_functions\(\)](#) (in module *colour.plotting*), 954
[plot_multi_luminance_functions\(\)](#) (in module *colour.plotting*), 956
[plot_multi_munsell_value_functions\(\)](#) (in module *colour.plotting*), 1019
[plot_multi_sds\(\)](#) (in module *colour.plotting*), 946
[plot_multi_sds_colour_quality_scales_bars\(\)](#) (in module *colour.plotting*), 1027
[plot_multi_sds_colour_rendering_indexes_bars\(\)](#) (in module *colour.plotting*), 1024
[plot_planckian_locus\(\)](#) (in module *colour.plotting.temperature*), 1043
[plot_planckian_locus_in_chromaticity_diagram\(\)](#) (in module *colour.plotting.temperature*), 1044
[plot_planckian_locus_in_chromaticity_diagram_CIE1931\(\)](#) (in module *colour.plotting*), 1039
[plot_planckian_locus_in_chromaticity_diagram_CIE1960UCS\(\)](#) (in module *colour.plotting*), 1040
[plot_pointer_gamut\(\)](#) (in module *colour.plotting.models*), 1010
[plot_RGB_chromaticities_in_chromaticity_diagram\(\)](#) (in module *colour.plotting.models*), 1014
[plot_RGB_chromaticities_in_chromaticity_diagram_CIE1931\(\)](#) (in module *colour.plotting*), 992
[plot_RGB_chromaticities_in_chromaticity_diagram_CIE1960UCS\(\)](#) (in module *colour.plotting*), 993
[plot_RGB_chromaticities_in_chromaticity_diagram_CIE1976UCS\(\)](#) (in module *colour.plotting*), 995
[plot_RGB_colourspace_section\(\)](#) (in module *colour.plotting*), 1033
[plot_RGB_colourspace_gamuts\(\)](#) (in module *colour.plotting*), 1047

plot_RGB_colourspace_in_chromaticity_diagram() *colour.plotting*), 1031
 (in module *colour.plotting.models*), 1011
 plot_RGB_colourspace_in_chromaticity_diagram_CIE1931() *colour.geometry*), 497
 (in module *colour.plotting*), 985
 plot_RGB_colourspace_in_chromaticity_diagram_CIE1960UCS() *colour.plotting*), 987
 (in module *colour.plotting*), 990
 plot_RGB_scatter() (in module *colour.plotting*), 1048
 plot_sds_in_chromaticity_diagram() (in module *colour.plotting.diagrams*), 982
 plot_sds_in_chromaticity_diagram_CIE1931() (in module *colour.plotting*), 969
 plot_sds_in_chromaticity_diagram_CIE1960UCS() (in module *colour.plotting*), 972
 plot_sds_in_chromaticity_diagram_CIE1976UCS() (in module *colour.plotting*), 974
 plot_single_cctf() (in module *colour.plotting*), 1003
 plot_single_cmfs() (in module *colour.plotting*), 948
 plot_single_colour_checker() (in module *colour.plotting*), 961
 plot_single_colour_swatch() (in module *colour.plotting*), 931
 plot_single_function() (in module *colour.plotting*), 933
 plot_single_illuminant_sd() (in module *colour.plotting*), 950
 plot_single_lightness_function() (in module *colour.plotting*), 953
 plot_single_luminance_function() (in module *colour.plotting*), 955
 plot_single_munsell_value_function() (in module *colour.plotting*), 1018
 plot_single_sd() (in module *colour.plotting*), 945
 plot_single_sd_colour_quality_scaleBars() (in module *colour.plotting*), 1026
 plot_single_sd_colour_rendering_indexBars() (in module *colour.plotting*), 1023
 plot_single_sd_colour_rendition_report() (in module *colour.plotting*), 1050
 plot_single_sd_colour_rendition_report_full() (in module *colour.plotting.tm3018*), 1055
 plot_single_sd_colour_rendition_report_intermediate() (in module *colour.plotting.tm3018*), 1058
 plot_single_sd_colour_rendition_report_simple() (in module *colour.plotting.tm3018*), 1059
 plot_single_sd_rayleigh_scattering() (in module *colour.plotting*), 1020
 plot_spectral_locus() (in module *colour.plotting.diagrams*), 977
 plot_the_blue_sky() (in module *colour.plotting*), 1022
 plot_visible_spectrum() (in module *colour.plotting*), 952
 plot_visible_spectrum_section() (in module *colour.plotting*), 1031
 point_at_angle_on_ellipse() (in module *colour.geometry*), 497
 polar_to_cartesian() (in module *colour.algebra*), 196
 polynomial_expansion() (in module *colour*), 248
 polynomial_expansion_Finlayson2015() (in module *colour.characterisation*), 254
 POLYNOMIAL_EXPANSION_METHODS (in module *colour*), 248
 polynomial_expansion_Vandermonde() (in module *colour.characterisation*), 255
 power_function_Huang2015() (in module *colour.difference*), 495
 primaries (*colour.RGB_Colourspace* property), 711
 primaries_whitepoint() (in module *colour*), 706
 primitive() (in module *colour*), 503
 primitive_cube() (in module *colour.geometry*), 507
 primitive_grid() (in module *colour.geometry*), 506
 PRIMITIVE_METHODS (in module *colour*), 503
 primitive_vertices() (in module *colour*), 509
 primitive_vertices_cube_mpl() (in module *colour.geometry*), 513
 primitive_vertices_grid_mpl() (in module *colour.geometry*), 512
 PRIMITIVE_VERTICES_METHODS (in module *colour*), 509
 primitive_vertices_quad_mpl() (in module *colour.geometry*), 511
 primitive_vertices_sphere() (in module *colour.geometry*), 514
 print_numpy_errors() (in module *colour.utilities*), 1138
 Prismatic_to_RGB() (in module *colour*), 879
 process_image_OpenColorIO() (in module *colour.io*), 546
 ProLab_to_XYZ() (in module *colour*), 692
 pupil_diameter_Barten1999() (in module *colour.contrast*), 424

R

raise_numpy_errors() (in module *colour.utilities*), 1137
 random_triplet_generator() (in module *colour.algebra*), 149
 range (*colour.continuous.AbstractContinuousFunction* property), 429
 range (*colour.continuous.MultiSignals* property), 453
 range (*colour.continuous.Signal* property), 439
 range() (*colour.SpectralShape* method), 270
 rayleigh_jeans_law() (in module *colour.colorimetry*), 322
 rayleigh_optical_depth() (in module *colour.phenomena*), 927
 rayleigh_scattering() (in module *colour*), 916

reaction_rate_MichaelisMenten() (in module *colour.biochemistry*), 226
 reaction_rate_MichaelisMenten_Abebe2017() (in module *colour.biochemistry*), 229
 REACTION_RATE_MICHAELISMEN_TEN_METHODS (in module *colour.biochemistry*), 226
 reaction_rate_MichaelisMenten_Michaelis1913() (in module *colour.biochemistry*), 228
 read() (*colour.SpectralDistribution_IESTM2714* method), 603
 read() (*colour.SpectralDistribution_Sekonic* method), 613
 read() (*colour.SpectralDistribution_UPRTek* method), 608
 read_image() (in module *colour*), 537
 read_image_Imageio() (in module *colour.io*), 543
 READ_IMAGE_METHODS (in module *colour*), 536
 read_image_OpenImageIO() (in module *colour.io*), 541
 read_LUT() (in module *colour*), 575
 read_LUT_Cinespace() (in module *colour.io*), 581
 read_LUT_IridasCube() (in module *colour.io*), 583
 read_LUT_SonySPI1D() (in module *colour.io*), 586
 read_LUT_SonySPI3D() (in module *colour.io*), 588
 read_sds_from_csv_file() (in module *colour*), 590
 read_sds_from_xrite_file() (in module *colour*), 615
 read_spectral_data_from_csv_file() (in module *colour*), 592
 read_training_data_rawtoaces_v1() (in module *colour.characterisation*), 241
 reflection_geometry (*colour.SpectralDistribution_IESTM2714* property), 597
 RegexFlag (in module *colour.hints*), 529
 register_cache() (*colour.utilities.CacheRegistry* method), 1133
 registry (*colour.utilities.CacheRegistry* property), 1133
 relative_tolerance (*colour.NullInterpolator* property), 134
 render() (*colour.utilities.Node* method), 1195
 render() (in module *colour.plotting*), 929
 required() (in module *colour.utilities*), 1143
 reshape_msds() (in module *colour.colorimetry*), 302
 reshape_sd() (in module *colour.colorimetry*), 301
 retinal_illuminance_Barten1999() (in module *colour.contrast*), 425
 RGB_10_degree_cmfs_to_LMS_10_degree_cmfs() (in module *colour.colorimetry*), 364
 RGB_10_degree_cmfs_to_XYZ_10_degree_cmfs() (in module *colour.colorimetry*), 363
 RGB_2_degree_cmfs_to_XYZ_2_degree_cmfs() (in module *colour.colorimetry*), 363
 RGB_CameraSensitivities (class in *colour.characterisation*), 262
 RGB_ColourMatchingFunctions (class in *colour.colorimetry*), 358
 RGB_Colourspace (class in *colour*), 707
 RGB_COLOURSPACE_ACES2065_1 (in module *colour.models*), 718
 RGB_COLOURSPACE_ACESCC (in module *colour.models*), 718
 RGB_COLOURSPACE_ACESCCT (in module *colour.models*), 719
 RGB_COLOURSPACE_ACESCG (in module *colour.models*), 720
 RGB_COLOURSPACE_ACESPROXY (in module *colour.models*), 719
 RGB_COLOURSPACE_ADOBE_RGB1998 (in module *colour.models*), 720
 RGB_COLOURSPACE_ADOBE_WIDE_GAMUT_RGB (in module *colour.models*), 720
 RGB_COLOURSPACE_APPLE_RGB (in module *colour.models*), 721
 RGB_COLOURSPACE_ARRI_WIDE_GAMUT_3 (in module *colour.models*), 721
 RGB_COLOURSPACE_ARRI_WIDE_GAMUT_4 (in module *colour.models*), 721
 RGB_COLOURSPACE_BEST_RGB (in module *colour.models*), 722
 RGB_COLOURSPACE_BETA_RGB (in module *colour.models*), 722
 RGB_COLOURSPACE_BLACKMAGIC_WIDE_GAMUT (in module *colour.models*), 722
 RGB_COLOURSPACE_BT2020 (in module *colour.models*), 724
 RGB_COLOURSPACE_BT470_525 (in module *colour.models*), 723
 RGB_COLOURSPACE_BT470_625 (in module *colour.models*), 723
 RGB_COLOURSPACE_BT709 (in module *colour.models*), 723
 RGB_COLOURSPACE_CIE_RGB (in module *colour.models*), 724
 RGB_COLOURSPACE_CINEMA_GAMUT (in module *colour.models*), 724
 RGB_COLOURSPACE_COLOR_MATCH_RGB (in module *colour.models*), 725
 RGB_COLOURSPACE_DAVINCI_WIDE_GAMUT (in module *colour.models*), 725
 RGB_COLOURSPACE_DCDM_XYZ (in module *colour.models*), 725
 RGB_COLOURSPACE_DCI_P3 (in module *colour.models*), 726
 RGB_COLOURSPACE_DCI_P3_P (in module *colour.models*), 726
 RGB_COLOURSPACE_DISPLAY_P3 (in module *colour.models*), 726
 RGB_COLOURSPACE_DON_RGB_4 (in module *colour.models*), 727
 RGB_COLOURSPACE_DRAGON_COLOR (in module *colour.models*), 733
 RGB_COLOURSPACE_DRAGON_COLOR_2 (in module

colour.models), 733

RGB_COLOURSPACE_EBU_3213_E (in module *colour.models*), 727

RGB_COLOURSPACE_ECI_RGB_V2 (in module *colour.models*), 727

RGB_COLOURSPACE_EKTA_SPACE_PS_5 (in module *colour.models*), 728

RGB_COLOURSPACE_ERIMM_RGB (in module *colour.models*), 734

RGB_COLOURSPACE_F_GAMUT (in module *colour.models*), 728

RGB_COLOURSPACE_H273_22_UNSPECIFIED (in module *colour.models*), 729

RGB_COLOURSPACE_H273_GENERIC_FILM (in module *colour.models*), 728

RGB_colourspace_limits() (in module *colour*), 1210

RGB_COLOURSPACE_MAX_RGB (in module *colour.models*), 729

RGB_COLOURSPACE_NTSC1953 (in module *colour.models*), 730

RGB_COLOURSPACE_NTSC1987 (in module *colour.models*), 730

RGB_COLOURSPACE_P3_D65 (in module *colour.models*), 730

RGB_COLOURSPACE_PAL_SECAM (in module *colour.models*), 731

RGB_colourspace_pointer_gamut_coverage_MonteCarlo() (in module *colour*), 1211

RGB_COLOURSPACE_PROPHOTO_RGB (in module *colour.models*), 734

RGB_COLOURSPACE_PROTUNE_NATIVE (in module *colour.models*), 729

RGB_COLOURSPACE_RED_COLOR (in module *colour.models*), 731

RGB_COLOURSPACE_RED_COLOR_2 (in module *colour.models*), 731

RGB_COLOURSPACE_RED_COLOR_3 (in module *colour.models*), 732

RGB_COLOURSPACE_RED_COLOR_4 (in module *colour.models*), 732

RGB_COLOURSPACE_RED_WIDE_GAMUT_RGB (in module *colour.models*), 732

RGB_COLOURSPACE_RIMM_RGB (in module *colour.models*), 734

RGB_COLOURSPACE_ROMM_RGB (in module *colour.models*), 733

RGB_COLOURSPACE_RUSSELL_RGB (in module *colour.models*), 735

RGB_COLOURSPACE_S_GAMUT (in module *colour.models*), 738

RGB_COLOURSPACE_S_GAMUT3 (in module *colour.models*), 739

RGB_COLOURSPACE_S_GAMUT3_CINE (in module *colour.models*), 739

RGB_COLOURSPACE_SMPTE_240M (in module *colour.models*), 735

RGB_COLOURSPACE_SMPTE_C (in module *colour.models*), 735

RGB_COLOURSPACE_sRGB (in module *colour.models*), 740

RGB_COLOURSPACE_V_GAMUT (in module *colour.models*), 740

RGB_COLOURSPACE_VENICE_S_GAMUT3 (in module *colour.models*), 739

RGB_COLOURSPACE_VENICE_S_GAMUT3_CINE (in module *colour.models*), 740

RGB_colourspace_visible_spectrum_coverage_MonteCarlo() (in module *colour*), 1212

RGB_colourspace_volume_coverage_MonteCarlo() (in module *colour*), 1214

RGB_colourspace_volume_MonteCarlo() (in module *colour*), 1212

RGB_COLOURSPACE_XTREME_RGB (in module *colour.models*), 741

RGB_COLOURSPACES (in module *colour*), 716

RGB_DisplayPrimaries (class in *colour.characterisation*), 263

RGB_luminance() (in module *colour*), 706

RGB_luminance_equation() (in module *colour*), 707

RGB_to_CMY() (in module *colour*), 886

RGB_to_HCL() (in module *colour*), 884

RGB_to_HEX() (in module *colour.notation*), 915

RGB_to_HSL() (in module *colour*), 882

RGB_to_HSV() (in module *colour*), 880

RGB_to_IcTcP() (in module *colour*), 872

RGB_to_IHLS() (in module *colour*), 889

RGB_to_msds_camera_sensitivities_Jiang2013() (in module *colour.recovery*), 1110

RGB_to_Prismatic() (in module *colour*), 879

RGB_to_RGB() (in module *colour*), 700

RGB_to_sd_camera_sensitivity_Jiang2013() (in module *colour.recovery*), 1108

RGB_to_sd_Mallett2019() (in module *colour.recovery*), 1088

RGB_to_sd_Smits1999() (in module *colour.recovery*), 1107

RGB_to_XYZ() (in module *colour*), 699

RGB_to_YCbCr() (in module *colour*), 861

RGB_to_YcCbCrc() (in module *colour*), 865

RGB_to_YCoCg() (in module *colour*), 871

right (*colour.Extrapolator* property), 126

root (*colour.utilities.Node* property), 1193

row_as_diagonal() (in module *colour.utilities*), 1176

S

ScalarType (in module *colour.hints*), 533

scattering_cross_section() (in module *colour*), 926

sd_blackbody() (in module *colour*), 310

sd_CIE_illuminant_D_series() (in module *colour*), 307

sd_CIE_standard_illuminant_A() (in module *colour*), 306

- `sd_constant()` (in module *colour*), 312
- `sd_gaussian()` (in module *colour*), 316
- `sd_gaussian_fwhm()` (in module *colour.colorimetry*), 324
- `SD_GAUSSIAN_METHODS` (in module *colour*), 316
- `sd_gaussian_normal()` (in module *colour.colorimetry*), 323
- `sd_Jakob2019()` (in module *colour.recovery*), 1086
- `sd_mesopic_luminous_efficiency_function()` (in module *colour*), 376
- `sd_multi_leds()` (in module *colour*), 318
- `SD_MULTI_LEDS_METHODS` (in module *colour*), 318
- `sd_multi_leds_Ohno2005()` (in module *colour.colorimetry*), 326
- `sd_ones()` (in module *colour*), 312
- `sd_rayleigh_jeans()` (in module *colour*), 311
- `sd_rayleigh_scattering()` (in module *colour*), 917
- `sd_single_led()` (in module *colour*), 317
- `SD_SINGLE_LED_METHODS` (in module *colour*), 317
- `sd_single_led_Ohno2005()` (in module *colour.colorimetry*), 325
- `sd_to_ACES2065_1()` (in module *colour*), 236
- `sd_to_aces_relative_exposure_values()` (in module *colour*), 235
- `sd_to_XYZ()` (in module *colour*), 327
- `sd_to_XYZ_ASTME308()` (in module *colour.colorimetry*), 337
- `sd_to_XYZ_integration()` (in module *colour.colorimetry*), 348
- `SD_TO_XYZ_METHODS` (in module *colour*), 330
- `sd_to_XYZ_tristimulus_weighting_factors_ASTME308()` (in module *colour.colorimetry*), 342
- `sd_zeros()` (in module *colour*), 313
- `sdiv()` (in module *colour.algebra*), 153
- `sdiv_mode` (class in *colour.algebra*), 152
- `sds_and_msds_to_msds()` (in module *colour.colorimetry*), 303
- `sds_and_msds_to_sds()` (in module *colour.colorimetry*), 302
- `SDS_BASIS_FUNCTIONS_CIE_ILLUMINANT_D_SERIES` (in module *colour.colorimetry*), 369
- `SDS_COLOURCHECKERS` (in module *colour*), 260
- `SDS_FILTERS` (in module *colour*), 265
- `SDS_ILLUMINANTS` (in module *colour*), 367
- `SDS_LEFS` (in module *colour*), 384
- `SDS_LEFS_PHOTOPIC` (in module *colour.colorimetry*), 384
- `SDS_LEFS_SCOTOPIC` (in module *colour.colorimetry*), 385
- `SDS_LENSSES` (in module *colour*), 265
- `SDS_LIGHT_SOURCES` (in module *colour*), 368
- `SDS_SMITS1999` (in module *colour.recovery*), 1108
- `sequence` (*colour.LUTSequence* property), 573
- `Sequence` (in module *colour.hints*), 525
- `set_default_float_dtype()` (in module *colour.utilities*), 1160
- `set_default_int_dtype()` (in module *colour.utilities*), 1159
- `set_domain_range_scale()` (in module *colour*), 1132
- `set_sdiv_mode()` (in module *colour.algebra*), 152
- `set_spow_enable()` (in module *colour.algebra*), 155
- `shape` (*colour.MultiSpectralDistributions* property), 289
- `shape` (*colour.SpectralDistribution* property), 274
- `show_warning()` (in module *colour.utilities*), 1199
- `siblings` (*colour.utilities.Node* property), 1193
- `sigma_Barten1999()` (in module *colour.contrast*), 425
- `Signal` (class in *colour.continuous*), 435
- `signal_type` (*colour.continuous.MultiSignals* property), 454
- `signal_unpack_data()` (*colour.continuous.Signal* static method), 445
- `signals` (*colour.continuous.MultiSignals* property), 454
- `slugified_items()` (*colour.utilities.CanonicalMapping* method), 1188
- `slugified_keys()` (*colour.utilities.CanonicalMapping* method), 1188
- `slugify()` (in module *colour.utilities*), 1148
- `smooth()` (in module *colour.algebra*), 161
- `smoothstep_function()` (in module *colour.algebra*), 161
- `solid_RoschMacAdam()` (in module *colour.volume*), 1220
- `spectral_primary_decomposition_Mallett2019()` (in module *colour.recovery*), 1094
- `spectral_quantity` (*colour.SpectralDistribution_IESTM2714* property), 597
- `SPECTRAL_SHAPE_ASTME308` (in module *colour*), 301
- `SPECTRAL_SHAPE_DEFAULT` (in module *colour*), 301
- `SPECTRAL_SHAPE_sRGB_MALLETT2019` (in module *colour.recovery*), 1094
- `spectral_similarity_index()` (in module *colour*), 1073
- `spectral_uniformity()` (in module *colour*), 385
- `SpectralDistribution` (class in *colour*), 271
- `SpectralDistribution_IESTM2714` (class in *colour*), 594
- `SpectralDistribution_Sekonic` (class in *colour*), 610
- `SpectralDistribution_UPRTek` (class in *colour*), 604
- `SpectralShape` (class in *colour*), 266
- `spherical_to_cartesian()` (in module *colour.algebra*), 146
- `spow()` (in module *colour.algebra*), 155
- `spow_enable` (class in *colour.algebra*), 155
- `SPRAGUE_C_COEFFICIENTS` (*colour.SpragueInterpolator* attribute), 137
- `SpragueInterpolator` (class in *colour*), 136
- `sRGB_to_XYZ()` (in module *colour*), 703
- `start` (*colour.SpectralShape* property), 267

- [StrOrArrayLike \(in module colour.hints\)](#), 533
[StrOrNDArray \(in module colour.hints\)](#), 534
[Structure \(class in colour.utilities\)](#), 1196
[substrate_concentration_MichaelisMenten\(\) \(in module colour.biochemistry\)](#), 227
[substrate_concentration_MichaelisMenten_Abebe2017\(\) \(in module colour.biochemistry\)](#), 230
[SUBSTRATE_CONCENTRATION_MICHAELISMEN_TEN_METHODS \(in module colour.biochemistry\)](#), 227
[substrate_concentration_MichaelisMenten_Michaelis1913\(\) \(in module colour.biochemistry\)](#), 229
[SupportsIndex \(class in colour.hints\)](#), 525
[suppress_warnings\(\) \(in module colour.utilities\)](#), 1201
- ## T
- [table_interpolation\(\) \(in module colour\)](#), 139
[TABLE_INTERPOLATION_METHODS \(in module colour\)](#), 139
[table_interpolation_tetrahedral\(\) \(in module colour.algebra\)](#), 144
[table_interpolation_trilinear\(\) \(in module colour.algebra\)](#), 143
[TextIO \(class in colour.hints\)](#), 525
[to_dataframe\(\) \(colour.continuous.MultiSignals method\)](#), 466
[to_domain_1\(\) \(in module colour.utilities\)](#), 1161
[to_domain_10\(\) \(in module colour.utilities\)](#), 1162
[to_domain_100\(\) \(in module colour.utilities\)](#), 1163
[to_domain_degrees\(\) \(in module colour.utilities\)](#), 1164
[to_domain_int\(\) \(in module colour.utilities\)](#), 1165
[to_sds\(\) \(colour.MultiSpectralDistributions method\)](#), 299
[to_series\(\) \(colour.continuous.Signal method\)](#), 447
[training_data_sds_to_RGB\(\) \(in module colour.characterisation\)](#), 244
[training_data_sds_to_XYZ\(\) \(in module colour.characterisation\)](#), 245
[TRANSFER_CHARACTERISTICS_ITUTH273 \(in module colour\)](#), 892
[transmission_geometry \(colour.SpectralDistribution_IESTM2714 property\)](#), 597
[Tree_Otsu2018 \(class in colour.recovery\)](#), 1103
[trim\(\) \(colour.MultiSpectralDistributions method\)](#), 297
[trim\(\) \(colour.SpectralDistribution method\)](#), 283
[tristimulus_weighting_factors_ASTME2022\(\) \(in module colour.colorimetry\)](#), 346
[tsplit\(\) \(in module colour.utilities\)](#), 1175
[tstack\(\) \(in module colour.utilities\)](#), 1174
[Tuple \(in module colour.hints\)](#), 527
[TVS_ILLUMINANTS \(in module colour\)](#), 369
[TVS_ILLUMINANTS_HUNTERLAB \(in module colour\)](#), 369
[Type \(in module colour.hints\)](#), 527
[TypedDict\(\) \(in module colour.hints\)](#), 527
[TypeExtrapolator \(class in colour.hints\)](#), 535
[TypeInterpolator \(class in colour.hints\)](#), 534
[TypeLUTSequenceItem \(class in colour.hints\)](#), 536
[TypeVar \(class in colour.hints\)](#), 528
- ## U
- [UCS_to_uv\(\) \(in module colour\)](#), 638
[UCS_to_XYZ\(\) \(in module colour\)](#), 637
[uv_to_xy\(\) \(in module colour\)](#), 639
[uniform_axes3d\(\) \(in module colour.plotting\)](#), 930
[Union \(in module colour.hints\)](#), 524
[unregister_cache\(\) \(colour.utilities.CacheRegistry method\)](#), 1134
[use_derived_matrix_RGB_to_XYZ \(colour.RGB_Colourspace property\)](#), 712
[use_derived_matrix_XYZ_to_RGB \(colour.RGB_Colourspace property\)](#), 713
[use_derived_transformation_matrices\(\) \(colour.RGB_Colourspace method\)](#), 715
[uv_to_CCT\(\) \(in module colour\)](#), 1113
[uv_to_CCT_Krystek1985\(\) \(in module colour.temperature\)](#), 1119
[UV_TO_CCT_METHODS \(in module colour\)](#), 1114
[uv_to_CCT_Ohno2013\(\) \(in module colour.temperature\)](#), 1121
[uv_to_CCT_Planck1900\(\) \(in module colour.temperature\)](#), 1123
[uv_to_CCT_Robertson1968\(\) \(in module colour.temperature\)](#), 1118
[uv_to_Luv\(\) \(in module colour\)](#), 634
[uv_to_UCS\(\) \(in module colour\)](#), 639
[UVW_to_XYZ\(\) \(in module colour\)](#), 641
- ## V
- [validate_method\(\) \(in module colour.utilities\)](#), 1147
[values \(colour.MultiSpectralDistributions property\)](#), 289
[values \(colour.SpectralDistribution property\)](#), 274
[values \(colour.utilities.MixinDataclassIterable property\)](#), 1150
[vector_dot\(\) \(in module colour.algebra\)](#), 157
[VIEWING_CONDITIONS_CAM16 \(in module colour\)](#), 183
[VIEWING_CONDITIONS_CIECAM02 \(in module colour\)](#), 171
[VIEWING_CONDITIONS_CIECAM16 \(in module colour\)](#), 177
[VIEWING_CONDITIONS_CMCCAT2000 \(in module colour\)](#), 84
[VIEWING_CONDITIONS_CMCCAT2000 \(in module colour.adaptation\)](#), 89
[VIEWING_CONDITIONS_HELLWIG2022 \(in module colour\)](#), 190
[VIEWING_CONDITIONS_HUNT \(in module colour\)](#), 194

VIEWING_CONDITIONS_KIM2009 (in module colour), 200
VIEWING_CONDITIONS_LLAB (in module colour), 205
VIEWING_CONDITIONS_RLAB (in module colour), 212
VIEWING_CONDITIONS_ZCAM (in module colour), 220

W

walk() (colour.utilities.Node method), 1195
warn_numpy_errors() (in module colour.utilities), 1138
warning() (in module colour.utilities), 1199
wavelength_to_XYZ() (in module colour), 335
wavelengths (colour.MultiSpectralDistributions property), 289
wavelengths (colour.SpectralDistribution property), 273
wavelengths (colour.SpectralShape property), 268
WEIGHTS_YCBCR (in module colour), 858
white_balance_multipliers() (in module colour.characterisation), 242
whiteness() (in module colour), 402
whiteness_ASTME313() (in module colour.colorimetry), 407
whiteness_Berger1959() (in module colour.colorimetry), 404
whiteness_CIE2004() (in module colour.colorimetry), 409
whiteness_Ganz1979() (in module colour.colorimetry), 408
WHITENESS_METHODS (in module colour), 403
whiteness_Stensby1968() (in module colour.colorimetry), 406
whiteness-Taube1960() (in module colour.colorimetry), 405
whitepoint (colour.RGB_Colourspace property), 711
whitepoint_name (colour.RGB_Colourspace property), 711
window (colour.KernelInterpolator property), 129
write() (colour.SpectralDistribution_IESTM2714 method), 603
write_image() (in module colour), 538
write_image_Imageio() (in module colour.io), 544
WRITE_IMAGE_METHODS (in module colour), 538
write_image_OpenImageIO() (in module colour.io), 542
write_LUT() (in module colour), 577
write_LUT_Cinespace() (in module colour.io), 582
write_LUT_IridasCube() (in module colour.io), 585
write_LUT_SonySPI1D() (in module colour.io), 587
write_LUT_SonySPI3D() (in module colour.io), 589
write_sds_to_csv_file() (in module colour), 593

X

x (colour.KernelInterpolator property), 129
x (colour.LinearInterpolator property), 132
x (colour.NullInterpolator property), 134
x (colour.SpragueInterpolator property), 138

xy_to_CCT() (in module colour), 1116
xy_to_CCT_CIE_D() (in module colour.temperature), 1129
xy_to_CCT_Hernandez1999() (in module colour.temperature), 1126
xy_to_CCT_Kang2002() (in module colour.temperature), 1127
xy_to_CCT_McCamy1992() (in module colour.temperature), 1124
XYZ_TO_CCT_METHODS (in module colour), 1116
xy_to_Luv_uv() (in module colour), 636
xy_to_UCS_uv() (in module colour), 640
xy_to_xyY() (in module colour), 620
xy_to_XYZ() (in module colour), 618
xyY_to_munsell_colour() (in module colour), 905
xyY_to_xy() (in module colour), 619
xyY_to_XYZ() (in module colour), 617
XYZ_ColourMatchingFunctions (class in module colour.colorimetry), 359
XYZ_outer_surface() (in module colour.volume), 1218
XYZ_to_ATD95() (in module colour), 163
XYZ_to_CAM02LCD() (in module colour), 658
XYZ_to_CAM02SCD() (in module colour), 660
XYZ_to_CAM02UCS() (in module colour), 662
XYZ_to_CAM16() (in module colour), 179
XYZ_to_CAM16LCD() (in module colour), 669
XYZ_to_CAM16SCD() (in module colour), 671
XYZ_to_CAM16UCS() (in module colour), 673
XYZ_to_CIECAM02() (in module colour), 167
XYZ_to_CIECAM16() (in module colour), 173
XYZ_to_DIN99() (in module colour), 650
XYZ_to_hdr_CIELab() (in module colour), 683
XYZ_to_hdr_IPT() (in module colour), 685
XYZ_to_Hellwig2022() (in module colour), 185
XYZ_to_Hunt() (in module colour), 191
XYZ_to_Hunter_Lab() (in module colour), 643
XYZ_to_Hunter_Rdab() (in module colour), 645
XYZ_to_Iab() (in module colour.models), 623
XYZ_to_ICaCb() (in module colour), 675
XYZ_to_IcTcP() (in module colour), 875
XYZ_to_IgPgTg() (in module colour), 677
XYZ_to_IPT() (in module colour), 679
XYZ_to_IPT_Munish2021() (in module colour), 681
XYZ_to_Izazbz() (in module colour.models), 695
XYZ_to_Jzazbz() (in module colour), 693
XYZ_to_K_ab_HunterLab1966() (in module colour), 645
XYZ_to_Kim2009() (in module colour), 195
XYZ_to_Lab() (in module colour), 626
XYZ_to_LLAB() (in module colour), 202
XYZ_to_Luv() (in module colour), 630
XYZ_to_Nayatani95() (in module colour), 207
XYZ_to_Oklab() (in module colour), 688
XYZ_to_OSA_UCS() (in module colour), 689
XYZ_to_ProLab() (in module colour), 691
XYZ_to_RGB() (in module colour), 697
XYZ_to_RLAB() (in module colour), 210

[XYZ_to_sd\(\) \(in module colour\), 1074](#)
[XYZ_to_sd_Jakob2019\(\) \(in module colour.recovery\), 1082](#)
[XYZ_to_sd_Meng2015\(\) \(in module colour.recovery\), 1096](#)
[XYZ_TO_SD_METHODS \(in module colour\), 1081](#)
[XYZ_to_sd_Otsu2018\(\) \(in module colour.recovery\), 1098](#)
[XYZ_to_sRGB\(\) \(in module colour\), 702](#)
[XYZ_to_UCS\(\) \(in module colour\), 637](#)
[XYZ_to_UVW\(\) \(in module colour\), 641](#)
[XYZ_to_xy\(\) \(in module colour\), 618](#)
[XYZ_to_xyY\(\) \(in module colour\), 616](#)
[XYZ_to_ZCAM\(\) \(in module colour\), 213](#)

Y

[y \(colour.KernelInterpolator property\), 129](#)
[y \(colour.LinearInterpolator property\), 132](#)
[y \(colour.NullInterpolator property\), 134](#)
[y \(colour.PchipInterpolator property\), 136](#)
[y \(colour.SpragueInterpolator property\), 138](#)
[YCbCr_to_RGB\(\) \(in module colour\), 864](#)
[YcCbCrCrc_to_RGB\(\) \(in module colour\), 866](#)
[YCoCg_to_RGB\(\) \(in module colour\), 871](#)
[yellowness\(\) \(in module colour\), 410](#)
[yellowness_ASTMD1925\(\) \(in module colour.colorimetry\), 412](#)
[yellowness_ASTME313\(\) \(in module colour.colorimetry\), 414](#)
[yellowness_ASTME313_alternative\(\) \(in module colour.colorimetry\), 413](#)
[YELLOWNESS_COEFFICIENTS_ASTME313 \(in module colour.colorimetry\), 414](#)
[YELLOWNESS_METHODS \(in module colour\), 411](#)

Z

[ZCAM_to_XYZ\(\) \(in module colour\), 215](#)
[zeros\(\) \(in module colour.utilities\), 1179](#)