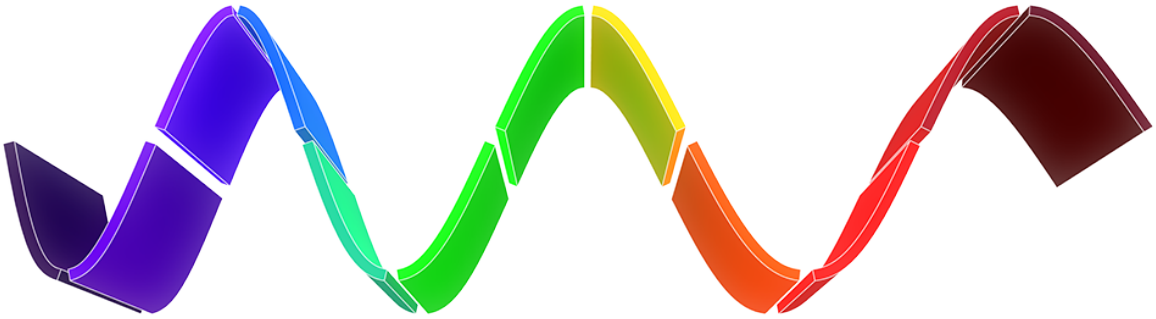
Colour Documentation

Release 0.3.12

Colour Developers

Mar 24, 2019

Contents



Colour is a Python colour science package implementing a comprehensive number of colour theory transformations and algorithms.

It is open source and freely available under the New BSD License terms.

CHAPTER 1

Draft Release Notes

The draft release notes from the develop branch are available at this url.

CHAPTER 2

Features

Colour features a rich dataset and collection of objects, please see the features page for more information.

CHAPTER 3

Installation

Anaconda from *Continuum Analytics* is the Python distribution we use to develop **Colour**: it ships all the scientific dependencies we require and is easily deployed cross-platform:

```
$ conda create -y -n python-colour
$ source activate python-colour
$ conda install -y -c conda-forge colour-science
```

Colour can be easily installed from the Python Package Index by issuing this command in a shell:

```
$ pip install colour-science
```

The detailed installation procedure is described in the Installation Guide.

CHAPTER 4

Usage

The two main references for Colour usage are the Colour Manual and the Jupyter Notebooks with detailed historical and theoretical context and images.

4.1 Colour Manual

4.1.1 Tutorial

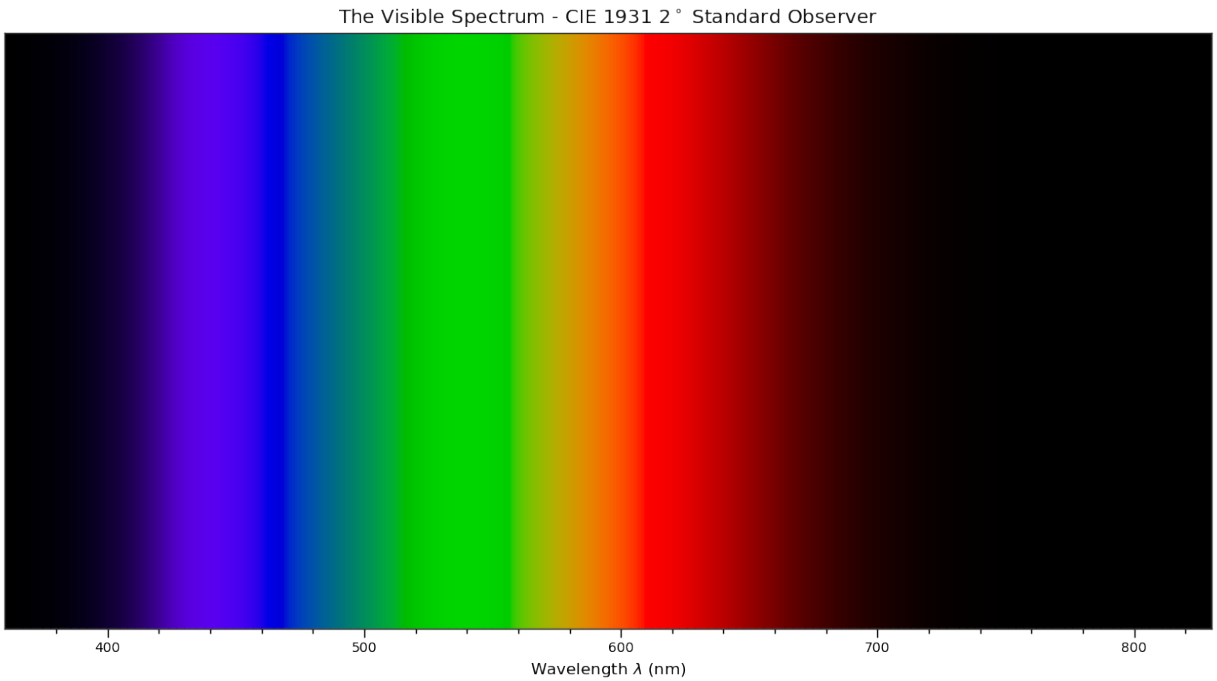
Colour spreads over various domains of Colour Science, from colour models to optical phenomena, this tutorial does not give a complete overview of the API but is a good introduction to the main concepts.

Note: A directory with examples is available at this path in Colour installation: *colour/examples*. It can be explored directly on Github: https://github.com/colour-science/colour/tree/master/colour/examples

```
from colour.plotting import *

colour_style()

plot_visible_spectrum()
```



4.1.1.1 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.
- *continuous*: Base objects for continuous data representation.
- *contrast*: Objects for contrast sensitivity computation.
- *characterisation*: Colour fitting and camera characterisation.
- *colorimetry*: Core objects for colour computations.
- *constants*: *CIE* and *CODATA* constants.
- *corresponding*: Corresponding colour chromaticities computations.
- *difference*: Colour difference computations.
- *examples*: Examples for the sub-packages.
- *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

import colour.plotting

for sub_package in ('adaptation', 'algebra', 'appearance', 'biochemistry',
                    'blindness', 'characterisation', 'colorimetry',
                    'constants', 'continuous', 'contrast', 'corresponding',
                    'difference', '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',
 'XYZ_SCALING_CAT',
 'VON_KRIES_CAT',
 'BRADFORD_CAT',
 'SHARP_CAT',
 '...']


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


Appearance
['Hunt_InductionFactors',
 'HUNT_VIEWING_CONDITIONS',
 'Hunt_Specification',
 'XYZ_to_Hunt',
 'ATD95_Specification',
```

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```
 '...']


Biochemistry
['reaction_rate_MichealisMenten',
 'substrate_concentration_MichealisMenten',
 '...']


Blindness
['CVD_MATRICES_MACHADO2010',
 'anomalous_trichromacy_cmfs_Machado2009',
 'anomalous_trichromacy_matrix_Machado2009',
 'cvd_matrix_Machado2009',
 '...']


Characterisation
['RGB_SpectralSensitivities',
 'RGB_DisplayPrimaries',
 'CAMERAS_RGB_SPECTRAL_SENSITIVITIES',
 'COLOURCHECKERS',
 'ColourChecker',
 '...']


Colorimetry
['SpectralShape',
 'DEFAULT_SPECTRAL_SHAPE',
 'SpectralDistribution',
 'MultiSpectralDistribution',
 'sd_blackbody',
 '...']


Constants
['K_M', 'KP_M', 'AVOGADRO_CONSTANT', 'BOLTZMANN_CONSTANT', 'LIGHT_SPEED', '...']


Continuous
['AbstractContinuousFunction', 'Signal', 'MultiSignal', '...']


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


Corresponding
['BRENEMAN_EXPERIMENTS',
 'BRENEMAN_EXPERIMENTS_PRIMARIES_CHROMATICITIES',
 'corresponding_chromaticities_prediction_CIE1994',
```

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```
 'corresponding_chromaticities_prediction_CMCCAT2000',
 'corresponding_chromaticities_prediction_Fairchild1990',
 '...']


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


Io
['SpectralDistribution_IESTM2714',
 'AbstractLUTSequenceOperator',
 'LUT1D',
 'LUT3x1D',
 'LUT3D',
 '...']


Models
['JMh_CIECAM02_to_CAM02LCD',
 'CAM02LCD_to_JMh_CIECAM02',
 'JMh_CIECAM02_to_CAM02SCD',
 'CAM02SCD_to_JMh_CIECAM02',
 'JMh_CIECAM02_to_CAM02UCS',
 '...']


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
['ASTM_G_173_ETR',
 'ASTM_G_173_GLOBAL_TILT',
 'ASTM_G_173_DIRECT_CIRCUMSOLAR',
 'COLOUR_STYLE_CONSTANTS',
 'COLOUR_ARROW_STYLE',
 '...']
```

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```
Quality
['TCS_SDS',
 'VS_SDS',
 'CRI_Specification',
 'colour_rendering_index',
 'CQS_Specification',
 '...']


Recovery
['SMITS_1999_SDS',
 'XYZ_to_sd_Meng2015',
 'RGB_to_sd_Smits1999',
 'XYZ_TO_SD_METHODS',
 'XYZ_to_sd',
 '...']


Temperature
['CCT_TO_UV_METHODS',
 'UV_TO_CCT_METHODS',
 'CCT_to_uv',
 'CCT_to_uv_Ohno2013',
 'CCT_to_uv_Robertson1968',
 '...']


Utilities
['Lookup',
 'Structure',
 'CaseInsensitiveMapping',
 'handle_numpy_errors',
 'ignore_numpy_errors',
 '...']


Volume
['ILLUMINANTS_OPTIMAL_COLOUR_STIMULI',
 '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__)
```

```
Returns 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
----------
```

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```
CCT : numeric
    Correlated colour temperature :math:`T_{cp}`.
D_uv : numeric, optional
    :math:`\Delta_{uv}`.
cmfs : XYZ_ColourMatchingFunctions, optional
    Standard observer colour matching functions.

Returns
-------
ndarray
    *CIE UCS* colourspace *uv* chromaticity coordinates.

References
----------
:cite:`Ohno2014a`

Examples
--------
>>> from colour import STANDARD_OBSERVERS_CMFS
>>> cmfs = STANDARD_OBSERVERS_CMFS['CIE 1931 2 Degree Standard Observer']
>>> CCT = 6507.4342201047066
>>> D_uv = 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:

```
import colour.colorimetry as colorimetry

pprint(colorimetry.__all__)
```

```
['SpectralShape',
 'DEFAULT_SPECTRAL_SHAPE',
 'SpectralDistribution',
 'MultiSpectralDistribution',
 'sd_blackbody',
 'blackbody_spectral_radiance',
 'planck_law',
 'LMS_ConeFundamentals',
 'RGB_ColourMatchingFunctions',
 'XYZ_ColourMatchingFunctions',
 'CMFS',
 'LMS_CMFS',
 'RGB_CMFS',
 'STANDARD_OBSERVERS_CMFS',
 'ILLUMINANTS',
 'D_ILLUMINANTS_S_SDS',
 'HUNTERLAB_ILLUMINANTS',
 'ILLUMINANTS_SDS',
 'LIGHT_SOURCES',
 'LIGHT_SOURCES_SDS',
 'LEFS',
 'PHOTOPIC_LEFS',
 'SCOTOPIC_LEFS',
 'sd_constant',
```

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```
'sd_zeros',
'sd_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',
'MULTI_SD_TO_XYZ_METHODS',
'sd_to_XYZ',
'multi_sds_to_XYZ',
'ASTME30815_PRACTISE_SHAPE',
'lagrange_coefficients_ASTME202211',
'tristimulus_weighting_factors_ASTME202211',
'adjust_tristimulus_weighting_factors_ASTME30815',
'sd_to_XYZ_integration',
'sd_to_XYZ_tristimulus_weighting_factors_ASTME30815',
'sd_to_XYZ_ASTME30815',
'multi_sds_to_XYZ_integration',
'wavelength_to_XYZ',
'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',
'intermediate_lightness_function_CIE1976',
'LUMINANCE_METHODS',
'luminance',
'luminance_Newhall1943',
'luminance_ASTMD153508',
'luminance_CIE1976',
'luminance_Fairchild2010',
'luminance_Fairchild2011',
'intermediate_luminance_function_CIE1976',
'dominant_wavelength',
'complementary_wavelength',
'excitation_purity',
'colorimetric_purity',
'luminous_flux',
'luminous_efficiency',
'luminous_efficacy',
```

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```
 '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']
```

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

```
import colour.colorimetry.dataset as dataset

pprint(dataset.__all__)
```

```
['CMFS',
 'LMS_CMFS',
 'RGB_CMFS',
 'STANDARD_OBSERVERS_CMFS',
 'ILLUMINANTS',
 'D_ILLUMINANTS_S_SDS',
 'HUNTERLAB_ILLUMINANTS',
 'ILLUMINANTS_SDS',
 'LIGHT_SOURCES',
 'LIGHT_SOURCES_SDS',
 'LEFS',
 'PHOTOPIC_LEFS',
 'SCOTOPIC_LEFS']
```

4.1.1.2 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.
sample_sd_data = {
    380: 0.048,
    385: 0.051,
    390: 0.055,
    395: 0.060,
    400: 0.065,
    405: 0.068,
    410: 0.068,
    415: 0.067,
```

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```
    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,
    680: 0.242,
    685: 0.251,
    690: 0.261,
    695: 0.271,
```

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```
    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(sample_sd_data, 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],
                      [  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],
```

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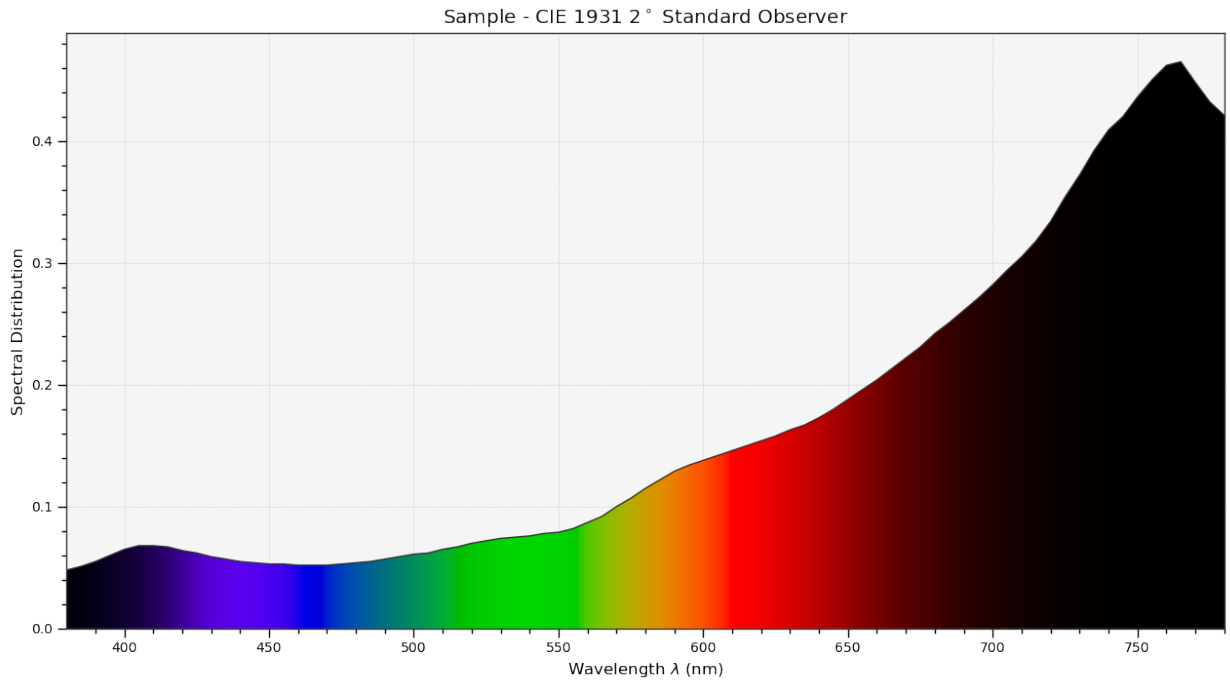
```
                        [  5.55000000e+02,   8.20000000e-02],
                        [  5.60000000e+02,   8.70000000e-02],
                        [  5.65000000e+02,   9.20000000e-02],
                        [  5.70000000e+02,   1.00000000e-01],
                        [  5.75000000e+02,   1.07000000e-01],
                        [  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)'
```

`colour.SpectralShape` 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.range* method is providing the complete range of values.
shape = colour.SpectralShape(0, 10, 0.5)
shape.range()
```

```
0.0
1.0
2.0
3.0
4.0
5.0
6.0
```

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```
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.DEFAULT_SPECTRAL_SHAPE` attribute and based on *ASTM E308-15* practise shape.

```
print(repr(colour.DEFAULT_SPECTRAL_SHAPE))
```

```
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*

```
spd1 = colour.sd_ones()
print('"Ones Filled Spectral Distribution"')
print(spd1[400])

print('\n"x2 Constant Multiplied"')
print((spd1 * 2)[400])

print('\n"+ Spectral Distribution"')
print((spd1 + 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()
```

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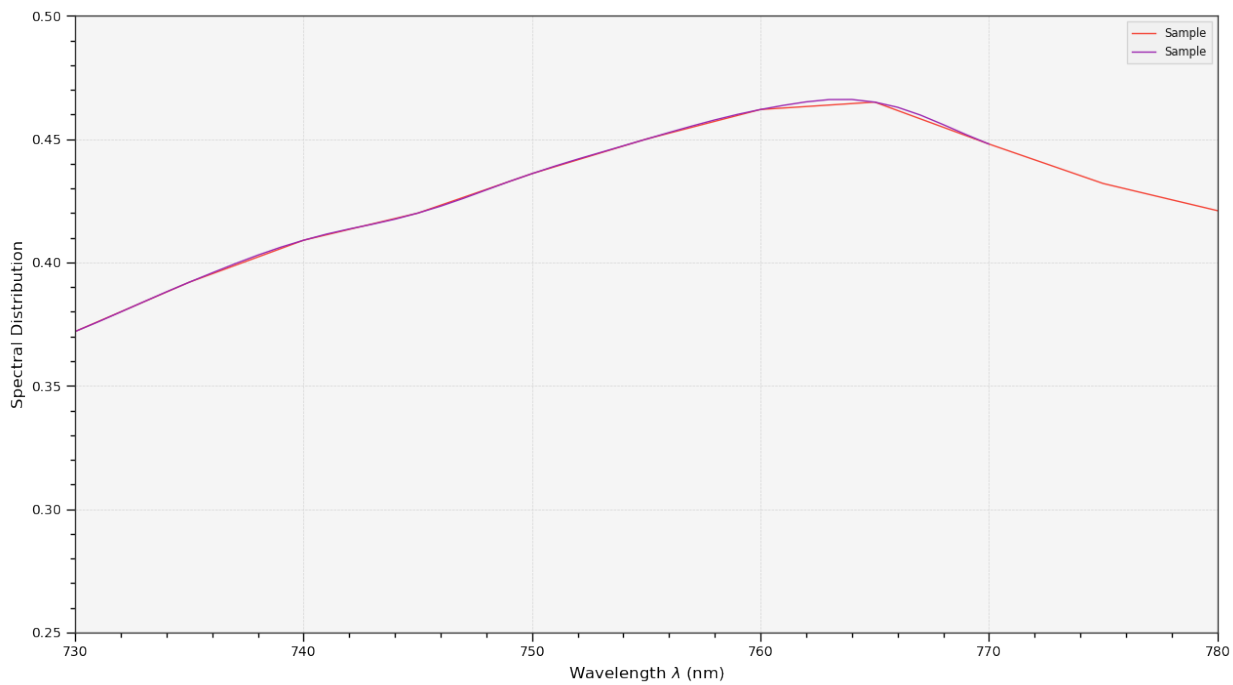
```
# Interpolating the copied sample spectral distribution.
sd_copy.interpolate(colour.SpectralShape(400, 770, 1))
sd_copy[401]
```

```
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 [CIET14804d]:

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

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```
 u'CubicSplineInterpolator',
 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),
    extrapolator_args={'method': 'Linear',
                       'right': 0})
sd_copy[340], sd_copy[830]
```

```
(0.046999999999999348, 0.0)
```

Aligning a spectral distribution is a convenient way to first interpolates 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))
sd_copy.align(colour.SpectralShape(340, 830, 5))
sd_copy[340], sd_copy[830]
```

```
(0.065000000000000002, 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.]
```

A 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_args={},
       extrapolator=Extrapolator,
       extrapolator_args={u'right': nan, u'method': u'Constant', u'left': nan})
```

```
# Returning the corresponding range *y* 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])
```

4.1.1.3 Convert to Tristimulus Values

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

```
sd = colour.SpectralDistribution(sample_sd_data)
cmfs = colour.STANDARD_OBSERVERS_CMFS['CIE 1931 2 Degree Standard Observer']
illuminant = colour.ILLUMINANTS_SDS['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]
```

4.1.1.4 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([name for name in colour.__all__ if name.startswith('XYZ_to')])
```

```
['XYZ_to_ATD95',
 'XYZ_to_CAM16',
```

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```
 'XYZ_to_CIECAM02',
 'XYZ_to_Hunt',
 'XYZ_to_LLAB',
 'XYZ_to_Nayatani95',
 'XYZ_to_RLAB',
 'XYZ_to_Hunter_Lab',
 'XYZ_to_Hunter_Rdab',
 'XYZ_to_IPT',
 'XYZ_to_JzAzBz',
 'XYZ_to_K_ab_HunterLab1966',
 'XYZ_to_Lab',
 'XYZ_to_Luv',
 'XYZ_to_OSA_UCS',
 'XYZ_to_RGB',
 'XYZ_to_UCS',
 'XYZ_to_UVW',
 'XYZ_to_hdr_CIELab',
 'XYZ_to_hdr_IPT',
 'XYZ_to_sRGB',
 'XYZ_to_xy',
 'XYZ_to_xyY',
 'XYZ_to_sd']
```

4.1.1.5 Convert to Screen 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('Sample', RGB),
    text_parameters={'size': 'x-large'})
```

4.1.1.6 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.COLOURCHECKERS.keys()))

# Colour rendition charts spectral distributions.
print(sorted(colour.characterisation.COLOURCHECKERS_SDS.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.COLOURCHECKERS_SDS['ColorChecker N Ohta'][patch_name]
XYZ = colour.sd_to_XYZ(patch_sd, cmfs, illuminant)
RGB = colour.XYZ_to_sRGB(XYZ / 100)
```

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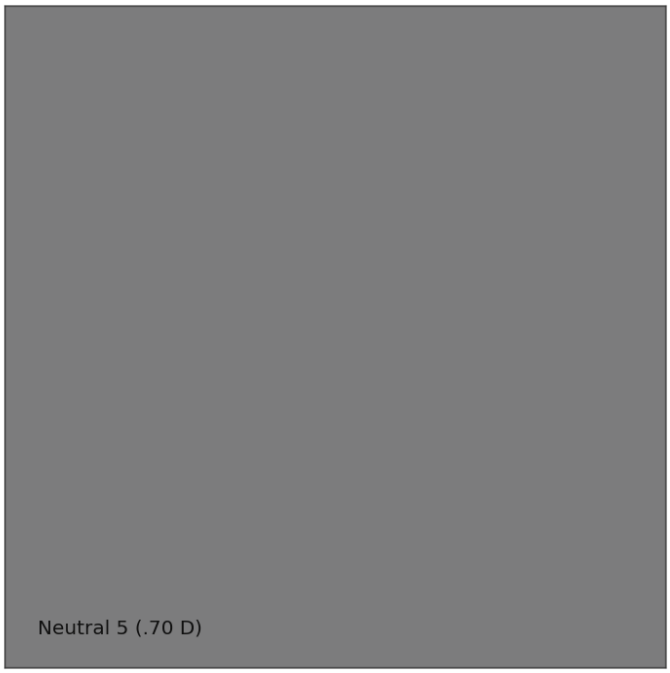
```
plot_single_colour_swatch(
    ColourSwatch(patch_name.title(), RGB),
    text_parameters={'size': 'x-large'})
```



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

```
plot_single_colour_checker(colour_checker='ColorChecker 2005', text_parameters={'visible': False})
```

4.1.1.7 Convert to Chromaticity Coordinates

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

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

```
[ 0.31259787  0.32870029]
```

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

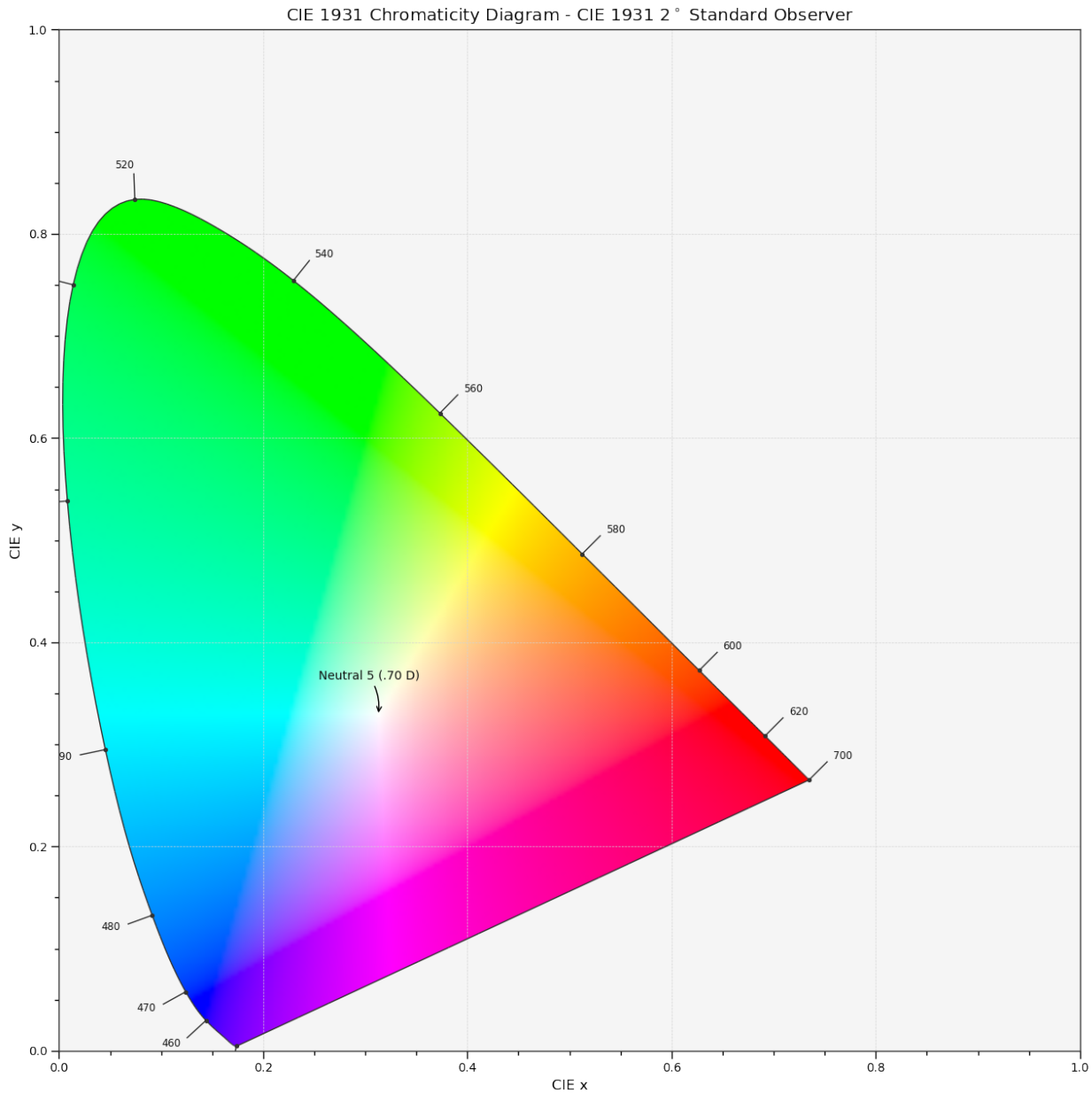
```
import matplotlib.pyplot as plt

# 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 *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)
```



4.1.1.8 And More…

With the hope that this small introduction was useful and gave envy to see more, a good place to explore the API further more is the Jupyter Notebooks page.

4.1.2 Basics

4.1.2.1 N-Dimensional Arrays Support

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

While it is recommended to use ndarrays 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:

```
import colour.plotting

RGB = colour.read_image('_static/Logo_Small_001.png')
RGB = RGB[..., 0:3]  # Discarding alpha channel.
```

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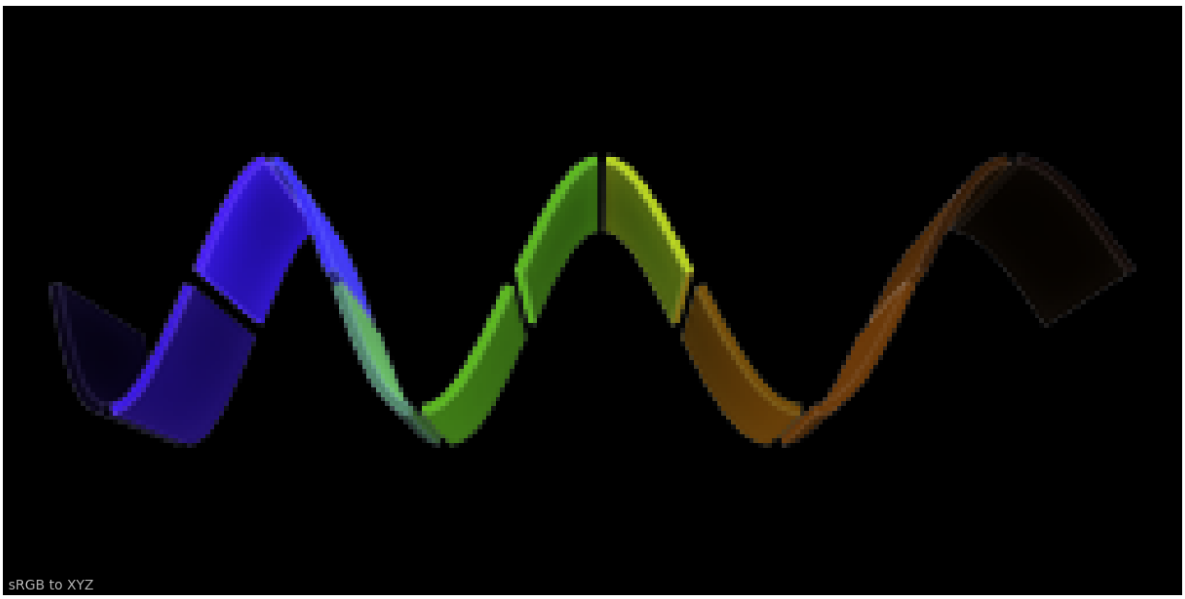
```
XYZ = colour.sRGB_to_XYZ(RGB)
colour.plotting.plot_image(XYZ, text_parameters={'text': 'sRGB to XYZ'})
```



4.1.2.2 Domain-Range Scales

Note: This section has 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 *100*.
- *Integers* in domain-range *[0, 2**n -1]* where *n* is the bit depth are scaled by *2**n -1*.

Warning: The conversion to **'1'** domain-range scale is a *soft* normalisation and similarly to the **'Reference'** domain-range scale it is normal that you encounter values exceeding *1*, e.g. High Dynamic Range Imagery (HDRI) or negative values, e.g. out-of-gamut RGB colourspace values.

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, XYZ_1 and Y_o are converted from domain *[0, 1]* to domain *[0, 100]* by colour.utilities.to_domain_100() definition and conversely return value XYZ_2 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]
```

4.1.3 Reference

4.1.3.1 Colour

Chromatic Adaptation

- *Chromatic Adaptation*
- *Fairchild (1990)*
- *CIE 1994*
- *CMCCAT2000*
- *Von Kries*

Chromatic Adaptation

colour

chromatic_adaptation(XYZ, XYZ_w, XYZ_wr[, ...])	Adapts given stimulus from test viewing conditions to reference viewing conditions.
CHROMATIC_ADAPTATION_METHODS	Supported chromatic adaptation methods.
CMCCAT2000_VIEWING_CONDITIONS	Reference *CMCCAT2000* chromatic adaptation model viewing conditions.

colour.chromatic_adaptation

colour.**chromatic_adaptation**(*XYZ*, *XYZ_w*, *XYZ_wr*, *method='Von Kries'*, ***kwargs*)

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

Parameters

- **XYZ** (array_like) – *CIE XYZ* tristimulus values of stimulus to adapt.
- **XYZ_w** (array_like) – Test viewing condition *CIE XYZ* tristimulus values of the whitepoint.
- **XYZ_wr** (array_like) – Reference viewing condition *CIE XYZ* tristimulus values of the whitepoint.
- **method** (unicode, optional) – **{'Von Kries', 'CIE 1994', 'CMCCAT2000', 'Fairchild 1990'}**, Computation method.

Other Parameters

- **E_o1** (*numeric*) – {colour.adaptation.chromatic_adaptation_CIE1994()}, Test illuminance E_{o1} in cd/m^2.

- **E_o2** (*numeric*) – {colour.adaptation.chromatic_adaptation_CIE1994()}, Reference illuminance E_{o2} in cd/m^2.
- **L_A1** (*numeric or array_like*) – {colour.adaptation.chromatic_adaptation_CMCCAT2000()}, Luminance of test adapting field L_{A1} in cd/m^2.
- **L_A2** (*numeric or array_like*) – {colour.adaptation.chromatic_adaptation_CMCCAT2000()}, Luminance of reference adapting field L_{A2} in cd/m^2.
- **Y_n** (*numeric or array_like*) – {colour.adaptation.chromatic_adaptation_Fairchild1990()}, Luminance Y_n of test adapting stimulus in cd/m^2.
- **Y_o** (*numeric*) – {colour.adaptation.chromatic_adaptation_CIE1994()}, Luminance factor Y_o of achromatic background normalised to domain [0.18, 1] in **'Reference'** domain-range scale.
- **direction** (*unicode, optional*) – {colour.adaptation.chromatic_adaptation_CMCCAT2000()}, **{'Forward', 'Reverse'}**, Chromatic adaptation direction.
- **discount_illuminant** (*bool, optional*) – {colour.adaptation.chromatic_adaptation_Fairchild1990()}, Truth value indicating if the illuminant should be discounted.
- **n** (*numeric, optional*) – {colour.adaptation.chromatic_adaptation_CIE1994()}, Noise component in fundamental primary system.
- **surround** (*CMCCAT2000_InductionFactors, optional*) – {colour.adaptation.chromatic_adaptation_CMCCAT2000()}, Surround viewing conditions induction factors.
- **transform** (*unicode, optional*) – {colour.adaptation.chromatic_adaptation_VonKries()}, **{'CAT02', 'XYZ Scaling', 'Von Kries', 'Bradford', 'Sharp', 'Fairchild', 'CMCCAT97', 'CMCCAT2000', 'CAT02_BRILL_CAT', 'Bianco', 'Bianco PC'}**, Chromatic adaptation transform.

Returns *CIE XYZ_c* tristimulus values of the stimulus corresponding colour.

Return type ndarray

Notes

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

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

References

[CIET13294], [Fai91], [Fai13c], [Fai13b], [LLRH02], [WRC12a]

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)
... # doctest: +ELLIPSIS
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)
... # doctest: +ELLIPSIS
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)
... # doctest: +ELLIPSIS
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)
... # doctest: +ELLIPSIS
array([ 0.2332526...,  0.2332455...,  0.7611593...])
```

colour.CHROMATIC_ADAPTATION_METHODS

colour.**CHROMATIC_ADAPTATION_METHODS = CaseInsensitiveMapping({'CIE 1994': ..., 'CMCCAT2000': ..., 'Fairchil**

Supported chromatic adaptation methods.

References

[CIET13294], [Fai91], [Fai13c], [Fai13b], [LLRH02], [WRC12a]

CHROMATIC_ADAPTATION_METHODS [CaseInsensitiveMapping] **{'CIE 1994', 'CMCCAT2000', 'Fairchild 1990', 'Von Kries'}**

colour.CMCCAT2000_VIEWING_CONDITIONS

colour.**CMCCAT2000_VIEWING_CONDITIONS = CaseInsensitiveMapping({'Average': ..., 'Dim': ..., 'Dark': ...})**

Reference *CMCCAT2000* chromatic adaptation model viewing conditions.

References

[LLRH02], [WRC12a]

CMCCAT2000_VIEWING_CONDITIONS [CaseInsensitiveMapping] ('Average', 'Dim', 'Dark')

Dataset

colour

CHROMATIC_ADAPTATION_TRANSFORMS	Supported chromatic adaptation transforms.

colour.CHROMATIC_ADAPTATION_TRANSFORMS

colour.**CHROMATIC_ADAPTATION_TRANSFORMS = CaseInsensitiveMapping({'XYZ Scaling': ..., 'Von Kries': ..., 'Bra**

Supported chromatic adaptation transforms.

References

[BS10], [BS08], [Fai], [LPLMv07], [Lin09a], [WRC12b], [WRC12a], [Wik07a]

CHROMATIC_ADAPTATION_TRANSFORMS [CaseInsensitiveMapping] **{'CAT02', 'XYZ Scaling', 'Von Kries', 'Bradford', 'Sharp', 'Fairchild, 'CMCCAT97', 'CMCCAT2000', 'CAT02_BRILL_CAT', 'Bianco', 'Bianco PC'}**

Fairchild (1990)

colour.adaptation

chromatic_adaptation_Fairchild1990(XYZ_1, ...)	Adapts given stimulus *CIE XYZ_1* tristimulus values from test viewing conditions to reference viewing conditions using *Fairchild (1990)* chromatic adaptation model.

colour.adaptation.chromatic_adaptation_Fairchild1990

`colour.adaptation.`**`chromatic_adaptation_Fairchild1990`**(*XYZ_1*, *XYZ_n*, *XYZ_r*, *Y_n*, *discount_illuminant=False*)

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

Parameters

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

Returns Adapted *CIE XYZ_2* tristimulus values of stimulus.

Return type 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], [Fai13c]

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)
... # doctest: +ELLIPSIS
array([ 23.3252634...,  23.3245581...,  76.1159375...])
```

CIE 1994

colour.adaptation

chromatic_adaptation_CIE1994(XYZ_1, xy_o1, ...)	Adapts given stimulus *CIE XYZ_1* tristimulus values from test viewing conditions to reference viewing conditions using *CIE 1994* chromatic adaptation model.

colour.adaptation.chromatic_adaptation_CIE1994

colour.adaptation.**chromatic_adaptation_CIE1994**(*XYZ_1*, *xy_o1*, *xy_o2*, *Y_o*, *E_o1*, *E_o2*, *n=1*)

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

Parameters

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

Returns Adapted *CIE XYZ_2* tristimulus values of test stimulus.

Return type 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)
... # doctest: +ELLIPSIS
array([ 24.0337952...,  21.1562121...,  17.6430119...])
```

CMCCAT2000

colour.adaptation

chromatic_adaptation_CMCCAT2000(XYZ, XYZ_w, ...)	Adapts given stimulus *CIE XYZ* tristimulus values using given viewing conditions.
CMCCAT2000_VIEWING_CONDITIONS	Reference *CMCCAT2000* chromatic adaptation model viewing conditions.

colour.adaptation.chromatic_adaptation_CMCCAT2000

colour.adaptation.**chromatic_adaptation_CMCCAT2000**(*XYZ*, *XYZ_w*, *XYZ_wr*, *L_A1*, *L_A2*, *surround=CMCCAT2000_InductionFactors(F=1)*, *direction='Forward'*)

Adapts 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_reverse_CMCCAT2000().

Parameters

- **XYZ** (array_like) – *CIE XYZ* tristimulus values of the stimulus to adapt.
- **XYZ_w** (array_like) – Source viewing condition *CIE XYZ* tristimulus values of the whitepoint.
- **XYZ_wr** (array_like) – Target viewing condition *CIE XYZ* tristimulus values of the whitepoint.
- **L_A1** (numeric or array_like) – Luminance of test adapting field L_{A1} in cd/m^2.
- **L_A2** (numeric or array_like) – Luminance of reference adapting field L_{A2} in cd/m^2.
- **surround** (CMCCAT2000_InductionFactors, optional) – Surround viewing conditions induction factors.
- **direction** (unicode, optional) – **{'Forward', 'Reverse'}**, Chromatic adaptation direction.

Returns Adapted stimulus *CIE XYZ* tristimulus values.

Return type 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], [WRC12a]

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')
... # doctest: +ELLIPSIS
array([ 19.5269832...,  23.0683396...,  24.9717522...])
```

Using the *CMCCAT2000* reverse 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='Reverse')
... # doctest: +ELLIPSIS
array([ 22.48,  22.74,   8.54])
```

colour.adaptation.CMCCAT2000_VIEWING_CONDITIONS

colour.adaptation.**CMCCAT2000_VIEWING_CONDITIONS = CaseInsensitiveMapping({'Average': ..., 'Dim': ..., 'Dark**

Reference *CMCCAT2000* chromatic adaptation model viewing conditions.

References

[LLRH02], [WRC12a]

CMCCAT2000_VIEWING_CONDITIONS [CaseInsensitiveMapping] ('Average', 'Dim', 'Dark')

Ancillary Objects

colour.adaptation

chromatic_adaptation_forward_CMCCAT2000(XYZ, ...)	Adapts given stimulus *CIE XYZ* tristimulus values from test viewing conditions to reference viewing conditions using *CMCCAT2000* forward chromatic adaptation model.
chromatic_adaptation_reverse_CMCCAT2000(...)	Adapts given stimulus corresponding colour *CIE XYZ* tristimulus values from reference viewing conditions to test viewing conditions using *CMCCAT2000* reverse chromatic adaptation model.
CMCCAT2000_InductionFactors	*CMCCAT2000* chromatic adaptation model induction factors.

colour.adaptation.chromatic_adaptation_forward_CMCCAT2000

colour.adaptation.**chromatic_adaptation_forward_CMCCAT2000**(*XYZ*, *XYZ_w*, *XYZ_wr*, *L_A1*, *L_A2*, *surround=CMCCAT2000_InductionFactors(F=1)*)

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

Parameters

- **XYZ** (array_like) – *CIE XYZ* tristimulus values of the stimulus to adapt.
- **XYZ_w** (array_like) – Test viewing condition *CIE XYZ* tristimulus values of the whitepoint.
- **XYZ_wr** (array_like) – Reference viewing condition *CIE XYZ* tristimulus values of the whitepoint.
- **L_A1** (numeric or array_like) – Luminance of test adapting field L_{A1} in cd/m^2.
- **L_A2** (numeric or array_like) – Luminance of reference adapting field L_{A2} in cd/m^2.
- **surround** (CMCCAT2000_InductionFactors, optional) – Surround viewing conditions induction factors.

Returns *CIE XYZ_c* tristimulus values of the stimulus corresponding colour.

Return type 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], [WRC12a]

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)
... # doctest: +ELLIPSIS
array([ 19.5269832...,  23.0683396...,  24.9717522...])
```

colour.adaptation.chromatic_adaptation_reverse_CMCCAT2000

colour.adaptation.**chromatic_adaptation_reverse_CMCCAT2000**(*XYZ_c*, *XYZ_w*, *XYZ_wr*, *L_A1*, *L_A2*, *surround=CMCCAT2000_InductionFactors(F=1)*)

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

Parameters

- **XYZ_c** (array_like) – *CIE XYZ* tristimulus values of the stimulus to adapt.
- **XYZ_w** (array_like) – Test viewing condition *CIE XYZ* tristimulus values of the whitepoint.
- **XYZ_wr** (array_like) – Reference viewing condition *CIE XYZ* tristimulus values of the whitepoint.
- **L_A1** (numeric or array_like) – Luminance of test adapting field L_{A1} in cd/m^2.
- **L_A2** (numeric or array_like) – Luminance of reference adapting field L_{A2} in cd/m^2.
- **surround** (CMCCAT2000_InductionFactors, optional) – Surround viewing conditions induction factors.

Returns *CIE XYZ_c* tristimulus values of the adapted stimulus.

Return type 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], [WRC12a]

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_reverse_CMCCAT2000(XYZ_c, XYZ_w, XYZ_wr, L_A1,
...                                         L_A2)
... # doctest: +ELLIPSIS
array([ 22.4839876...,  22.7419485...,   8.5393392...])
```

colour.adaptation.CMCCAT2000_InductionFactors

class colour.adaptation.**CMCCAT2000_InductionFactors**

CMCCAT2000 chromatic adaptation model induction factors.

Parameters **F** (numeric or array_like) – F surround condition.

References

[LLRH02], [WRC12a]

Create new instance of CMCCAT2000_InductionFactors(F,)

__init__()

Initialize self. See help(type(self)) for accurate signature.

Methods

count	Return number of occurrences of value.
index	Return first index of value.

Attributes

F	Alias for field number 0

Von Kries

colour.adaptation

chromatic_adaptation_VonKries(XYZ, XYZ_w, XYZ_wr)	Adapts given stimulus from test viewing conditions to reference viewing conditions.
CHROMATIC_ADAPTATION_TRANSFORMS	Supported chromatic adaptation transforms.

colour.adaptation.chromatic_adaptation_VonKries

`colour.adaptation.`**`chromatic_adaptation_VonKries`**(*XYZ*, *XYZ_w*, *XYZ_wr*, *transform='CAT02'*)

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

Parameters

- **XYZ** (array_like) – *CIE XYZ* tristimulus values of stimulus to adapt.
- **XYZ_w** (array_like) – Test viewing condition *CIE XYZ* tristimulus values of whitepoint.
- **XYZ_wr** (array_like) – Reference viewing condition *CIE XYZ* tristimulus values of whitepoint.
- **transform** (unicode, optional) – **{'CAT02', 'XYZ Scaling', 'Von Kries', 'Bradford', 'Sharp', 'Fairchild', 'CMCCAT97', 'CMCCAT2000', 'CAT02_BRILL_CAT', 'Bianco', 'Bianco PC'}**, Chromatic adaptation transform.

Returns *CIE XYZ_c* tristimulus values of the stimulus corresponding colour.

Return type 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

[Fai13b]

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)  # doctest: +ELLIPSIS
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)
... # doctest: +ELLIPSIS
array([ 0.2166600...,  0.1260477...,  0.0385506...])
```

colour.adaptation.CHROMATIC_ADAPTATION_TRANSFORMS

colour.adaptation.**CHROMATIC_ADAPTATION_TRANSFORMS = CaseInsensitiveMapping({'XYZ Scaling': ..., 'Von Kries':**

Supported chromatic adaptation transforms.

References

[BS10], [BS08], [Fai], [LPLMv07], [Lin09a], [WRC12b], [WRC12a], [Wik07a]

CHROMATIC_ADAPTATION_TRANSFORMS [CaseInsensitiveMapping] **{'CAT02', 'XYZ Scaling', 'Von Kries', 'Bradford', 'Sharp', 'Fairchild, 'CMCCAT97', 'CMCCAT2000', 'CAT02_BRILL_CAT', 'Bianco', 'Bianco PC'}**

Dataset

colour.adaptation

BRADFORD_CAT
BS_CAT
BS_PC_CAT
CAT02_BRILL_CAT
CAT02_CAT
CMCCAT2000_CAT
CMCCAT97_CAT
FAIRCHILD_CAT
SHARP_CAT
VON_KRIES_CAT
XYZ_SCALING_CAT

colour.adaptation.BRADFORD_CAT

colour.adaptation.**BRADFORD_CAT = array([[0.8951, 0.2664, -0.1614], [-0.7502, 1.7135, 0.0367], [0.0389, -0.0**

colour.adaptation.BS_CAT

colour.adaptation.**BS_CAT = array([[0.8752, 0.2787, -0.1539], [-0.8904, 1.8709, 0.0195], [-0.0061, 0.0162, 0.**

colour.adaptation.BS_PC_CAT

colour.adaptation.**BS_PC_CAT = array([[0.6489, 0.3915, -0.0404], [-0.3775, 1.3055, 0.072], [-0.0271, 0.0888,**

colour.adaptation.CAT02_BRILL_CAT

colour.adaptation.**CAT02_BRILL_CAT = array([[0.7328, 0.4296, -0.1624], [-0.7036, 1.6975, 0.0061], [0. , 0. ,**

colour.adaptation.CAT02_CAT

colour.adaptation.**CAT02_CAT = array([[0.7328, 0.4296, -0.1624], [-0.7036, 1.6975, 0.0061], [0.003 , 0.0136,**

colour.adaptation.CMCCAT2000_CAT

```
colour.adaptation.CMCCAT2000_CAT = array([[ 7.98200000e-01, 3.38900000e-01, -1.37100000e-01], [ -5.91800000e-
```

colour.adaptation.CMCCAT97_CAT

```
colour.adaptation.CMCCAT97_CAT = array([[ 0.8951, -0.7502, 0.0389], [ 0.2664, 1.7135, 0.0685], [-0.1614, 0.03
```

colour.adaptation.FAIRCHILD_CAT

```
colour.adaptation.FAIRCHILD_CAT = array([[ 0.8562, 0.3372, -0.1934], [-0.836 , 1.8327, 0.0033], [ 0.0357, -0.
```

colour.adaptation.SHARP_CAT

```
colour.adaptation.SHARP_CAT = array([[ 1.2694, -0.0988, -0.1706], [-0.8364, 1.8006, 0.0357], [ 0.0297, -0.031
```

colour.adaptation.VON_KRIES_CAT

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

colour.adaptation.XYZ_SCALING_CAT

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

Ancillary Objects

colour.adaptation

chromatic_adaptation_matrix_VonKries(XYZ_w, ...)	Computes the *chromatic adaptation* matrix from test viewing conditions to reference viewing conditions.

colour.adaptation.chromatic_adaptation_matrix_VonKries

colour.adaptation.**chromatic_adaptation_matrix_VonKries**(*XYZ_w*, *XYZ_wr*, *transform='CAT02'*)

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

Parameters

- **XYZ_w** (array_like) – Test viewing condition *CIE XYZ* tristimulus values of whitepoint.
- **XYZ_wr** (array_like) – Reference viewing condition *CIE XYZ* tristimulus values of whitepoint.
- **transform** (unicode, optional) – **{'CAT02', 'XYZ Scaling', 'Von Kries', 'Bradford', 'Sharp', 'Fairchild', 'CMCCAT97', 'CMCCAT2000', 'CAT02_BRILL_CAT', 'Bianco', 'Bianco PC'}**, Chromatic adaptation transform.

Returns Chromatic adaptation matrix M_{cat}.

Return type ndarray

Raises `KeyError` – If chromatic adaptation method is not defined.

Notes

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

References

[Fai13b]

Examples

```
>>> XYZ_w = np.array([0.95045593, 1.00000000, 1.08905775])
>>> XYZ_wr = np.array([0.96429568, 1.00000000, 0.82510460])
>>> chromatic_adaptation_matrix_VonKries(XYZ_w, XYZ_wr)
... # doctest: +ELLIPSIS
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'
>>> chromatic_adaptation_matrix_VonKries(XYZ_w, XYZ_wr, method)
... # doctest: +ELLIPSIS
array([[ 1.0479297...,  0.0229468..., -0.0501922...],
       [ 0.0296278...,  0.9904344..., -0.0170738...],
       [-0.0092430...,  0.0150551...,  0.7518742...]])
```

Algebra

- *Extrapolation*
- *Interpolation*
- *Coordinates*
- *Geometry*
- *Matrix*
- *Random*
- *Regression*

- *Common*

Extrapolation

colour

Extrapolator([interpolator, method, left, ...])	Extrapolates the 1-D function of given interpolator.

colour.Extrapolator

class colour.**Extrapolator**(*interpolator=None*, *method='Linear'*, *left=None*, *right=None*, *dtype=<class 'numpy.float64'>*)

Extrapolates 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** (object) – Interpolator object.
- **method** (unicode, optional) – **{'Linear', 'Constant'}**, Extrapolation method.
- **left** (numeric, optional) – Value to return for x < xi[0].
- **right** (numeric, optional) – Value to return for x > xi[-1].
- **dtype** (type) – Data type used for internal conversions.

__class__()

Notes

- The interpolator must define *x* and *y* attributes.

References

[Sas], [WRC12d]

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 *array_like* 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=None*, *method='Linear'*, *left=None*, *right=None*, *dtype=<class 'numpy.float64'>*)

Initialize self. See help(type(self)) for accurate signature.

Methods

`__init__`([interpolator, method, left, ...])	Initialize self.

Attributes

`interpolator`	Getter and setter property for the *Colour* or *scipy* interpolator class instance.
`left`	Getter and setter property for left value to return for x < xi[0].
`method`	Getter and setter property for the extrapolation method.
`right`	Getter and setter property for right value to return for x > xi[-1].

Interpolation

`colour`

KernelInterpolator(x, y[, window, kernel, ...])	Kernel based interpolation of a 1-D function.
NearestNeighbourInterpolator(*args, **kwargs)	A nearest-neighbour interpolator.
LinearInterpolator(x, y[, dtype])	Linearly interpolates a 1-D function.
NullInterpolator(x, y[, absolute_tolerance, ...])	Performs 1-D function null interpolation, i.e.
PchipInterpolator(x, y, *args, **kwargs)	Interpolates a 1-D function using Piecewise Cubic Hermite Interpolating Polynomial interpolation.
SpragueInterpolator(x, y[, dtype])	Constructs a fifth-order polynomial that passes through y dependent variable.
lagrange_coefficients(r[, n])	Computes the *Lagrange Coefficients* at given point r for degree n.
TABLE_INTERPOLATION_METHODS	Supported table interpolation methods.
table_interpolation(V_xyz, table[, method])	Performs interpolation of given V_{xyz} values using given interpolation table.

colour.KernelInterpolator

class colour.**KernelInterpolator**(*x, y, window=3, kernel=<function kernel_lanczos>, kernel_args=None, padding_args=None, dtype=<class 'numpy.float64'>*)

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** (array_like) – Independent x variable values corresponding with y variable.
- **y** (array_like) – Dependent and already known y variable values to interpolate.
- **window** (int, optional) – Width of the window in samples on each side.
- **kernel** (callable, optional) – Kernel to use for interpolation.
- **kernel_args** (dict, optional) – Arguments to use when calling the kernel.
- **padding_args** (dict, optional) – Arguments to use when padding y variable values with the np.pad() definition.
- **dtype** (type) – Data type used for internal conversions.

x

y

window

kernel

kernel_args

padding_args

__call__()

References

[BB09], [Wik05c]

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)  # doctest: +ELLIPSIS
6.9411400...
```

Interpolating an *array_like* variable:

```
>>> f([0.25, 0.75])  # doctest: +ELLIPSIS
array([ 6.1806208...,  8.0823848...])
```

Using a different *lanczos* kernel:

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

Using a different window size:

```
>>> f = KernelInterpolator(
...     x,
...     y,
...     window=16,
...     kernel=kernel_lanczos,
...     kernel_args={'a': 16})
>>> f([0.25, 0.75])  # doctest: +ELLIPSIS
array([ 5.3961792...,  5.6521093...])
```

__init__(*x*, *y*, *window=3*, *kernel=<function kernel_lanczos>*, *kernel_args=None*, *padding_args=None*, *dtype=<class 'numpy.float64'>*)

Initialize self. See help(type(self)) for accurate signature.

Methods

`__init__`(x, y[, window, kernel, ...])	Initialize self.

Attributes

`kernel`	Getter and setter property for the kernel callable.
`kernel_args`	Getter and setter property for the kernel call time arguments.
`padding_args`	Getter and setter property for the kernel call time arguments.

Continued on next page

Table 17 – continued from previous page

window	Getter and setter property for the window.
x	Getter and setter property for the independent x variable.
y	Getter and setter property for the dependent and already known y variable.

colour.NearestNeighbourInterpolator

class colour.**NearestNeighbourInterpolator**(**args*, ***kwargs*)

A nearest-neighbour interpolator.

Other Parameters

- **x** (*array_like*) – Independent x variable values corresponding with y variable.
- **y** (*array_like*) – Dependent and already known y variable values to interpolate.
- **window** (*int, optional*) – Width of the window in samples on each side.
- **padding_args** (*dict, optional*) – Arguments to use when padding y variable values with the `np.pad()` definition.
- **dtype** (*type*) – Data type used for internal conversions.

__init__(**args*, ***kwargs*)

Initialize self. See help(type(self)) for accurate signature.

Methods

__init__(*args, **kwargs)	Initialize self.

Attributes

kernel	Getter and setter property for the kernel callable.
kernel_args	Getter and setter property for the kernel call time arguments.
padding_args	Getter and setter property for the kernel call time arguments.
window	Getter and setter property for the window.
x	Getter and setter property for the independent x variable.
y	Getter and setter property for the dependent and already known y variable.

colour.LinearInterpolator

class colour.**LinearInterpolator**(*x*, *y*, *dtype=<class 'numpy.float64'>*)

Linearly interpolates a 1-D function.

Parameters

- **x** (`array_like`) – Independent x variable values corresponding with y variable.
- **y** (`array_like`) – Dependent and already known y variable values to interpolate.

- **dtype** (type) – Data type used for internal conversions.

x

y

__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)
>>> # Doctests ellipsis for Python 2.x compatibility.
>>> f(0.5)  # doctest: +ELLIPSIS
7.64...
```

Interpolating an *array_like* variable:

```
>>> f([0.25, 0.75])
array([ 6.7825,  8.5075])
```

__init__(*x*, *y*, *dtype=<class 'numpy.float64'>*)
Initialize self. See help(type(self)) for accurate signature.

Methods

__init__(x, y[, dtype])	Initialize self.

Attributes

x	Getter and setter property for the independent x variable.
y	Getter and setter property for the dependent and already known y variable.

colour.NullInterpolator

class colour.**NullInterpolator**(*x*, *y*, *absolute_tolerance=1e-06*, *relative_tolerance=1e-06*, *default=nan*, *dtype=<class 'numpy.float64'>*)

Performs 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** (ndarray) – Independent x variable values corresponding with y variable.

- **y** (ndarray) – Dependent and already known y variable values to interpolate.
- **absolute_tolerance** (numeric, optional) – Absolute tolerance.
- **relative_tolerance** (numeric, optional) – Relative tolerance.
- **default** (numeric, optional) – Default value for interpolation outside tolerances.
- **dtype** (type) – Data type used for internal conversions.

x

y

relative_tolerance

absolute_tolerance

default

__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)  # doctest: +ELLIPSIS
9.3699999...
>>> f = NullInterpolator(x, y, absolute_tolerance=0.01)
>>> f(1.01)  # doctest: +ELLIPSIS
9.3699999...
```

__init__(*x*, *y*, *absolute_tolerance=1e-06*, *relative_tolerance=1e-06*, *default=nan*, *dtype=<class 'numpy.float64'>*)

Initialize self. See help(type(self)) for accurate signature.

Methods

__init__(x, y[, absolute_tolerance, ...])	Initialize self.

Attributes

absolute_tolerance	Getter and setter property for the absolute tolerance.
default	Getter and setter property for the default value for call outside tolerances.
relative_tolerance	Getter and setter property for the relative tolerance.
x	Getter and setter property for the independent x variable.

Continued on next page

Table 23 – continued from previous page

y	Getter and setter property for the dependent and already known y variable.

colour.PchipInterpolator

class colour.**PchipInterpolator**(*x*, *y*, **args*, ***kwargs*)

Interpolates a 1-D function using Piecewise Cubic Hermite Interpolating Polynomial interpolation.

y

Notes

- This class is a wrapper around *scipy.interpolate.PchipInterpolator* class.

__init__(*x*, *y*, **args*, ***kwargs*)

Initialize self. See help(type(self)) for accurate signature.

Methods

__init__(x, y, *args, **kwargs)	Initialize self.
antiderivative([nu])	Construct a new piecewise polynomial representing the antiderivative.
construct_fast(c, x[, extrapolate, axis])	Construct the piecewise polynomial without making checks.
derivative([nu])	Construct a new piecewise polynomial representing the derivative.
extend(c, x[, right])	Add additional breakpoints and coefficients to the polynomial.
from_derivatives(xi, yi[, orders, extrapolate])	Construct a piecewise polynomial in the Bernstein basis, compatible with the specified values and derivatives at breakpoints.
from_power_basis(pp[, extrapolate])	Construct a piecewise polynomial in Bernstein basis from a power basis polynomial.
integrate(a, b[, extrapolate])	Compute a definite integral over a piecewise polynomial.
roots()	Return the roots of the interpolated function.

Attributes

axis	
c	
extrapolate	
x	
y	Getter and setter property for the dependent and already known y variable.

colour.SpragueInterpolator

class colour.**SpragueInterpolator**(*x*, *y*, *dtype=<class 'numpy.float64'>*)

Constructs 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** (array_like) – Independent x variable values corresponding with y variable.
- **y** (array_like) – Dependent and already known y variable values to interpolate.
- **dtype** (type) – Data type used for internal conversions.

x

y

__call__()

Notes

- The minimum number k of data points required along the interpolation axis is $k = 6$.

References

[CIET13805b], [WRC12e]

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)  # doctest: +ELLIPSIS
7.2185025...
```

Interpolating an *array_like* variable:

```
>>> f([0.25, 0.75])  # doctest: +ELLIPSIS
array([ 6.7295161...,  7.8140625...])
```

__init__(*x*, *y*, *dtype=<class 'numpy.float64'>*)

Initialize self. See help(type(self)) for accurate signature.

Methods

__init__(x, y[, dtype])	Initialize self.

Attributes

SPRAGUE_C_COEFFICIENTS	Defines the coefficients used to generate extra points for boundaries interpolation.
x	Getter and setter property for the independent x variable.
y	Getter and setter property for the dependent and already known y variable.

colour.lagrange_coefficients

colour.**lagrange_coefficients**(*r*, *n=4*)

Computes the *Lagrange Coefficients* at given point r for degree n.

Parameters

- **r** (numeric) – Point to get the *Lagrange Coefficients* at.
- **n** (int, optional) – Degree of the *Lagrange Coefficients* being calculated.

Returns

Return type ndarray

References

[Fai85], [Wik03b]

Examples

```
>>> lagrange_coefficients(0.1)
array([ 0.8265,  0.2755, -0.1305,  0.0285])
```

colour.TABLE_INTERPOLATION_METHODS

colour.**TABLE_INTERPOLATION_METHODS = CaseInsensitiveMapping({'Trilinear': ..., 'Tetrahedral': ...})**

Supported table interpolation methods.

References

[Boub], [Kir06]

TABLE_INTERPOLATION_METHODS [CaseInsensitiveMapping] **{'Trilinear', 'Tetrahedral'}**

colour.table_interpolation

colour.**table_interpolation**(*V_xyz*, *table*, *method='Trilinear'*)

Performs interpolation of given V_{xyz} values using given interpolation table.

Parameters

- **V_xyz** (array_like) – V_{xyz} values to interpolate.

- **table** (array_like) – 4-Dimensional (NxNxNx3) interpolation table.
- **method** (unicode, optional) – **{'Trilinear', 'Tetrahedral'}**, Interpolation method.

Returns Interpolated V_{xyz} values.

Return type ndarray

References

[Boub], [Kir06]

Examples

```
>>> import os
>>> import colour
>>> path = os.path.join(
...     os.path.dirname(__file__),'..', 'io', 'luts', 'tests', 'resources',
...     'iridas_cube', 'ColourCorrect.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)  # doctest: +ELLIPSIS
[[ 0.9670298...  0.7148159...  0.9762744...]
 [ 0.5472322...  0.6977288...  0.0062302...]
 [ 0.9726843...  0.2160895...  0.2529823...]]
>>> table_interpolation(V_xyz, table)  # doctest: +ELLIPSIS
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')
... # doctest: +ELLIPSIS
array([[ 1.0196197...,  0.7674062...,  1.0311751...],
       [ 0.5105603...,  0.6466722...,  0.1077296...],
       [ 1.1178206...,  0.1762039...,  0.2209534...]])
```

Interpolation Kernels

colour

kernel_nearest_neighbour(x)	Returns the *nearest-neighbour* kernel evaluated at given samples.
kernel_linear(x)	Returns the *linear* kernel evaluated at given samples.
kernel_sinc(x[, a])	Returns the *sinc* kernel evaluated at given samples.
kernel_lanczos(x[, a])	Returns the *lanczos* kernel evaluated at given samples.
kernel_cardinal_spline(x[, a, b])	Returns the *cardinal spline* kernel evaluated at given samples.

colour.kernel_nearest_neighbour

colour.**kernel_nearest_neighbour**(*x*)

Returns the *nearest-neighbour* kernel evaluated at given samples.

Parameters **x** (array_like) – Samples at which to evaluate the *nearest-neighbour* kernel.

Returns The *nearest-neighbour* kernel evaluated at given samples.

Return type 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*)

Returns the *linear* kernel evaluated at given samples.

Parameters **x** (array_like) – Samples at which to evaluate the *linear* kernel.

Returns The *linear* kernel evaluated at given samples.

Return type ndarray

References

[BB09]

Examples

```
>>> kernel_linear(np.linspace(0, 1, 10))  # doctest: +ELLIPSIS
array([ 1.        ,  0.8888888...,  0.7777777...,  0.6666666...,  0.5555555...,
        0.4444444...,  0.3333333...,  0.2222222...,  0.1111111...,  0.        ])
```

colour.kernel_sinc

colour.**kernel_sinc**(*x*, *a=3*)

Returns the *sinc* kernel evaluated at given samples.

Parameters

- **x** (array_like) – Samples at which to evaluate the *sinc* kernel.
- **a** (int, optional) – Size of the *sinc* kernel.

Returns The *sinc* kernel evaluated at given samples.

Return type ndarray

References

[BB09]

Examples

```
>>> kernel_sinc(np.linspace(0, 1, 10))  # doctest: +ELLIPSIS
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*, *a=3*)

Returns the *lanczos* kernel evaluated at given samples.

Parameters

- **x** (`array_like`) – Samples at which to evaluate the *lanczos* kernel.
- **a** (`int, optional`) – Size of the *lanczos* kernel.

Returns The *lanczos* kernel evaluated at given samples.

Return type ndarray

References

[Wik05c]

Examples

```
>>> kernel_lanczos(np.linspace(0, 1, 10))  # doctest: +ELLIPSIS
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*, *a=0.5*, *b=0.0*)

Returns 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** (array_like) – Samples at which to evaluate the *cardinal spline* kernel.
- **a** (int, optional) – a control parameter.
- **b** (int, optional) – b control parameter.

Returns The *cardinal spline* kernel evaluated at given samples.

Return type ndarray

References

[BB09]

Examples

```
>>> kernel_cardinal_spline(np.linspace(0, 1, 10))  # doctest: +ELLIPSIS
array([ 1.        ,  0.9711934...,  0.8930041...,  0.7777777...,  0.6378600...,
        0.4855967...,  0.3333333...,  0.1934156...,  0.0781893...,  0.        ])
```

Ancillary Objects

colour.algebra

table_interpolation_trilinear(V_xyz, table)	Performs trilinear interpolation of given V_{xyz} values using given interpolation table.
table_interpolation_tetrahedral(V_xyz, table)	Performs tetrahedral interpolation of given V_{xyz} values using given interpolation table.

colour.algebra.table_interpolation_trilinear

colour.algebra.**table_interpolation_trilinear**(*V_xyz*, *table*)

Performs trilinear interpolation of given V_{xyz} values using given interpolation table.

Parameters

- **V_xyz** (array_like) – V_{xyz} values to interpolate.
- **table** (array_like) – 4-Dimensional (NxNxNx3) interpolation table.

Returns Interpolated V_{xyz} values.

Return type ndarray

References

[Boub]

Examples

```
>>> import os
>>> import colour
>>> path = os.path.join(
...     os.path.dirname(__file__),'..', 'io', 'luts', 'tests', 'resources',
...     'iridas_cube', 'ColourCorrect.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)  # doctest: +ELLIPSIS
[[ 0.9670298...  0.7148159...  0.9762744...]
 [ 0.5472322...  0.6977288...  0.0062302...]
 [ 0.9726843...  0.2160895...  0.2529823...]]
>>> table_interpolation_trilinear(V_xyz, table)  # doctest: +ELLIPSIS
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*, *table*)

Performs tetrahedral interpolation of given V_{xyz} values using given interpolation table.

Parameters

- **V_xyz** (array_like) – V_{xyz} values to interpolate.
- **table** (array_like) – 4-Dimensional (NxNxNx3) interpolation table.

Returns Interpolated V_{xyz} values.

Return type ndarray

References

[Kir06]

Examples

```
>>> import os
>>> import colour
>>> path = os.path.join(
...     os.path.dirname(__file__),'..', 'io', 'luts', 'tests', 'resources',
...     'iridas_cube', 'ColourCorrect.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)  # doctest: +ELLIPSIS
[[ 0.9670298...  0.7148159...  0.9762744...]
 [ 0.5472322...  0.6977288...  0.0062302...]
 [ 0.9726843...  0.2160895...  0.2529823...]]
>>> table_interpolation_tetrahedral(V_xyz, table)  # doctest: +ELLIPSIS
```

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```
array([[ 1.0196197...,  0.7674062...,  1.0311751...],
       [ 0.5105603...,  0.6466722...,  0.1077296...],
       [ 1.1178206...,  0.1762039...,  0.2209534...]])
```

Coordinates

colour.algebra

cartesian_to_spherical(a)	Transforms given Cartesian coordinates array xyz to Spherical coordinates array $\rho\theta\phi$ (radial distance, inclination or elevation and azimuth).
spherical_to_cartesian(a)	Transforms given Spherical coordinates array $\rho\theta\phi$ (radial distance, inclination or elevation and azimuth) to Cartesian coordinates array xyz.
cartesian_to_polar(a)	Transforms given Cartesian coordinates array xy to Polar coordinates array $\rho\phi$ (radial coordinate, angular coordinate).
polar_to_cartesian(a)	Transforms given Polar coordinates array $\rho\phi$ (radial coordinate, angular coordinate) to Cartesian coordinates array xy.
cartesian_to_cylindrical(a)	Transforms given Cartesian coordinates array xyz to Cylindrical coordinates array $\rho\phi z$ (azimuth, radial distance and height).
cylindrical_to_cartesian(a)	Transforms given Cylindrical coordinates array $\rho\phi z$ (azimuth, radial distance and height) to Cartesian coordinates array xyz.

colour.algebra.cartesian_to_spherical

colour.algebra.**cartesian_to_spherical**(a)

Transforms given Cartesian coordinates array xyz to Spherical coordinates array $\rho\theta\phi$ (radial distance, inclination or elevation and azimuth).

Parameters **a** (array_like) – Cartesian coordinates array xyz to transform.

Returns Spherical coordinates array $\rho\theta\phi$.

Return type ndarray

References

[Wik06a], [Wik05b]

Examples

```
>>> a = np.array([3, 1, 6])
>>> cartesian_to_spherical(a)  # doctest: +ELLIPSIS
array([ 6.7823299...,  1.0857465...,  0.3217505...])
```

colour.algebra.spherical_to_cartesian

colour.algebra.**spherical_to_cartesian**(a)

Transforms given Spherical coordinates array $\rho\theta\phi$ (radial distance, inclination or elevation and azimuth) to Cartesian coordinates array xyz.

Parameters **a** (array_like) – Spherical coordinates array $\rho\theta\phi$ to transform.

Returns Cartesian coordinates array xyz.

Return type ndarray

References

[Wik06a], [Wik05b]

Examples

```
>>> a = np.array([6.78232998, 1.08574654, 0.32175055])
>>> spherical_to_cartesian(a)  # doctest: +ELLIPSIS
array([ 3.        ,  0.9999999...,  6.        ])
```

colour.algebra.cartesian_to_polar

colour.algebra.**cartesian_to_polar**(a)

Transforms given Cartesian coordinates array xy to Polar coordinates array $\rho\phi$ (radial coordinate, angular coordinate).

Parameters **a** (array_like) – Cartesian coordinates array xy to transform.

Returns Polar coordinates array $\rho\phi$.

Return type ndarray

References

[Wik06a], [Wik05b]

Examples

```
>>> a = np.array([3, 1])
>>> cartesian_to_polar(a)  # doctest: +ELLIPSIS
array([ 3.1622776...,  0.3217505...])
```

colour.algebra.polar_to_cartesian

colour.algebra.**polar_to_cartesian**(a)

Transforms given Polar coordinates array $\rho\phi$ (radial coordinate, angular coordinate) to Cartesian coordinates array xy.

Parameters **a** (array_like) – Polar coordinates array $\rho\phi$ to transform.

Returns Cartesian coordinates array xy.

Return type ndarray

References

[Wik06a], [Wik05b]

Examples

```
>>> a = np.array([3.16227766, 0.32175055])
>>> polar_to_cartesian(a)  # doctest: +ELLIPSIS
array([ 3.        ,  0.9999999...])
```

colour.algebra.cartesian_to_cylindrical

colour.algebra.**cartesian_to_cylindrical**(a)

Transforms given Cartesian coordinates array xyz to Cylindrical coordinates array $\rho\phi z$ (azimuth, radial distance and height).

Parameters **a** (array_like) – Cartesian coordinates array xyz to transform.

Returns Cylindrical coordinates array $\rho\phi z$.

Return type ndarray

References

[Wik06a], [Wik05b]

Examples

```
>>> a = np.array([3, 1, 6])
>>> cartesian_to_cylindrical(a)  # doctest: +ELLIPSIS
array([ 3.1622776...,  0.3217505...,  6.        ])
```

colour.algebra.cylindrical_to_cartesian

colour.algebra.**cylindrical_to_cartesian**(a)

Transforms given Cylindrical coordinates array $\rho\phi z$ (azimuth, radial distance and height) to Cartesian coordinates array xyz.

Parameters **a** (array_like) – Cylindrical coordinates array $\rho\phi z$ to transform.

Returns Cartesian coordinates array xyz.

Return type ndarray

References

[Wik06a], [Wik05b]

Examples

```
>>> a = np.array([3.16227766, 0.32175055, 6.00000000])
>>> cylindrical_to_cartesian(a)  # doctest: +ELLIPSIS
array([ 3.        ,  0.9999999...,  6.        ])
```

Geometry

colour.algebra

normalise_vector(a)	Normalises given vector a.
euclidean_distance(a, b)	Returns the euclidean distance between point arrays a and b.
extend_line_segment(a, b[, distance])	Extends the line segment defined by point arrays a and b by given distance and return the new end point.
intersect_line_segments(l_1, l_2)	Computes l_1 line segments intersections with l_2 line segments.
ellipse_coefficients_general_form(coefficients)	Returns the general form ellipse coefficients from given canonical form ellipse coefficients.
ellipse_coefficients_canonical_form(coefficients)	Returns the canonical form ellipse coefficients from given general form ellipse coefficients.
point_at_angle_on_ellipse(phi, coefficients)	Returns the coordinates of the point at angle ϕ in degrees on the ellipse with given canonical form coefficients.
ELLIPSE_FITTING_METHODS	Supported ellipse fitting methods.
ellipse_fitting(a[, method])	Returns the coefficients of the implicit second-order polynomial/quadratic curve that fits given point array a using given method.

colour.algebra.normalise_vector

colour.algebra.**normalise_vector**(a)

Normalises given vector a.

Parameters **a** (array_like) – Vector a to normalise.

Returns Normalised vector a.

Return type ndarray

Examples

```
>>> a = np.array([0.20654008, 0.12197225, 0.05136952])
>>> normalise_vector(a)  # doctest: +ELLIPSIS
array([ 0.8419703...,  0.4972256...,  0.2094102...])
```

colour.algebra.euclidean_distance

colour.algebra.**euclidean_distance**(*a*, *b*)

Returns the euclidean distance between point arrays a and b.

Parameters

- **a** (array_like) – Point array a.
- **b** (array_like) – Point array b.

Returns Euclidean distance.

Return type numeric or ndarray

Examples

```
>>> a = np.array([100.00000000, 21.57210357, 272.22819350])
>>> b = np.array([100.00000000, 426.67945353, 72.39590835])
>>> euclidean_distance(a, b)  # doctest: +ELLIPSIS
451.7133019...
```

colour.algebra.extend_line_segment

colour.algebra.**extend_line_segment**(*a*, *b*, *distance=1*)

Extends the line segment defined by point arrays a and b by given distance and return the new end point.

Parameters

- **a** (array_like) – Point array a.
- **b** (array_like) – Point array b.
- **distance** (numeric, optional) – Distance to extend the line segment.

Returns New end point.

Return type ndarray

References

[Sae]

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)  # doctest: +ELLIPSIS
array([-0.5367248...,  1.1776534...])
```

colour.algebra.intersect_line_segments

colour.algebra.**intersect_line_segments**(*l_1*, *l_2*)

Computes l_1 line segments intersections with l_2 line segments.

Parameters

- **l_1** (array_like) – 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** (array_like) – 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 *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  # doctest: +ELLIPSIS
array([[[        nan,         nan],
        [ 0.2279184...,  0.6006430...],
        [        nan,         nan]],
<BLANKLINE>
       [[ 0.4281451...,  0.5055568...],
        [ 0.3056055...,  0.6279838...],
        [ 0.7578749...,  0.1761301...]]])
>>> s.intersect
array([[False,  True, False],
       [ True,  True,  True]], dtype=bool)
```

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```
>>> s.parallel
array([[False, False, False],
       [False, False, False]], dtype=bool)
>>> s.coincident
array([[False, False, False],
       [False, False, False]], dtype=bool)
```

colour.algebra.ellipse_coefficients_general_form

colour.algebra.**ellipse_coefficients_general_form**(*coefficients*)

Returns 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** (array_like) – Canonical form ellipse coefficients.

Returns General form ellipse coefficients.

Return type ndarray

References

[Wik]

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.algebra.ellipse_coefficients_canonical_form

colour.algebra.**ellipse_coefficients_canonical_form**(*coefficients*)

Returns 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** (array_like) – General form ellipse coefficients.

Returns Canonical form ellipse coefficients.

Return type ndarray

References

[Wik]

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.algebra.point_at_angle_on_ellipse

colour.algebra.**point_at_angle_on_ellipse**(*phi*, *coefficients*)

Returns the coordinates of the point at angle ϕ in degrees on the ellipse with given canonical form coefficients.

Parameters

- **phi** (array_like) – Point at angle ϕ in degrees to retrieve the coordinates of.
- **coefficients** (array_like) – 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 ndarray

Examples

```
>>> coefficients = np.array([0.5, 0.5, 2, 1, 45])
>>> point_at_angle_on_ellipse(45, coefficients)  # doctest: +ELLIPSIS
array([ 1.,  2.])
```

colour.algebra.ELLIPSE_FITTING_METHODS

colour.algebra.**ELLIPSE_FITTING_METHODS = CaseInsensitiveMapping({'Halir 1998': ...})**

Supported ellipse fitting methods.

References

[HF98]

ELLIPSE_FITTING_METHODS [CaseInsensitiveMapping] **{'Halir 1998'}**

colour.algebra.ellipse_fitting

colour.algebra.**ellipse_fitting**(*a*, *method='Halir 1998'*)

Returns 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:

```
:math:`F\left(x, y\right)` = 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** (array_like) – Point array a to be fitted.
- **method** (unicode, optional) – **{'Halir 1998'}**, Computation method.

Returns Coefficients of the implicit second-order polynomial/quadratic curve that fits given point array a.

Return type ndarray

References

[HF98]

Examples

```
>>> a = np.array([[2, 0], [0, 1], [-2, 0], [0, -1]])
>>> ellipse_fitting(a)  # doctest: +ELLIPSIS
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.algebra

LineSegmentsIntersections_Specification	Defines the specification for intersection of line segments l_1 and l_2 returned by colour.algebra.intersect_line_segments() definition.
ellipse_fitting_Halir1998(a)	Returns the coefficients of the implicit second-order polynomial/quadratic curve that fits given point array a using *Halir and Flusser (1998)* method.

colour.algebra.LineSegmentsIntersections_Specification

class colour.algebra.**LineSegmentsIntersections_Specification**

Defines the specification for intersection of line segments l_1 and l_2 returned by colour.algebra.intersect_line_segments() definition.

Parameters

- **xy** (array_like) – Array of l_1 and l_2 line segments intersections coordinates. Non existing segments intersections coordinates are set with *np.nan*.
- **intersect** (array_like) – Array of *bool* indicating if line segments l_1 and l_2 intersect.
- **parallel** (array_like) – Array of *bool* indicating if line segments l_1 and l_2 are parallel.
- **coincident** (array_like) – Array of *bool* indicating if line segments l_1 and l_2 are coincident.

Create new instance of LineSegmentsIntersections_Specification(xy, intersect, parallel, coincident)

__init__()

Initialize self. See help(type(self)) for accurate signature.

Methods

count	Return number of occurrences of value.
index	Return first index of value.

Attributes

coincident	Alias for field number 3
intersect	Alias for field number 1
parallel	Alias for field number 2
xy	Alias for field number 0

colour.algebra.ellipse_fitting_Halir1998

colour.algebra.**ellipse_fitting_Halir1998**(a)

Returns 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:

```
:math:`F\left(x, y\right)` = 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** (array_like) – Point array a to be fitted.

Returns Coefficients of the implicit second-order polynomial/quadratic curve that fits given point array a.

Return type ndarray

References

[HF98]

Examples

```
>>> a = np.array([[2, 0], [0, 1], [-2, 0], [0, -1]])
>>> ellipse_fitting_Halir1998(a)  # doctest: +ELLIPSIS
array([ 0.2425356...,  0.        ,  0.9701425...,  0.        ,  0.        ,
       -0.9701425...])
>>> ellipse_coefficients_canonical_form(ellipse_fitting_Halir1998(a))
array([-0., -0.,  2.,  1.,  0.])
```

Matrix

colour.algebra

is_identity(a[, n])	Returns if a array is an identity matrix.

colour.algebra.is_identity

colour.algebra.**is_identity**(*a*, *n=3*)

Returns if a array is an identity matrix.

Parameters

- **a** (array_like, (N)) – Variable a to test.
- **n** (int, optional) – Matrix dimension.

Returns Is 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
```

Random

colour.algebra

random_triplet_generator(size[, limits, ...])	Returns a generator yielding random triplets.

colour.algebra.random_triplet_generator

colour.algebra.**random_triplet_generator**(*size, limits=array([[0, 1], [0, 1], [0, 1]]), random_state=<mtrand.RandomState object>*)

Returns a generator yielding random triplets.

Parameters

- **size** (int) – Generator size.
- **limits** (array_like, (3, 2)) – Random values limits on each triplet axis.
- **random_state** (RandomState) – Mersenne Twister pseudo-random number generator.

Returns Random triplets generator.

Return type generator

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 [Lau12].

Examples

```
>>> from pprint import pprint
>>> prng = np.random.RandomState(4)
>>> random_triplet_generator(10, random_state=prng)
... # doctest: +ELLIPSIS
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...],
       [ 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`

`least_square_mapping_MoorePenrose`(y, x)	Computes the *least-squares* mapping from dependent variable y to independent variable x using *Moore-Penrose* inverse.

colour.algebra.least_square_mapping_MoorePenrose

`colour.algebra.`**`least_square_mapping_MoorePenrose`**(y, x)

Computes the *least-squares* mapping from dependent variable y to independent variable x using *Moore-Penrose* inverse.

Parameters

- **y** (`array_like`) – Dependent and already known y variable.
- **x** (`array_like, optional`) – Independent x variable(s) values corresponding with y variable.

Returns *Least-squares* mapping.

Return type 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)  # doctest: +ELLIPSIS
array([[ 1.0526376...,  0.1378078..., -0.2276339...],
       [ 0.0739584...,  1.0293994..., -0.1060115...],
       [ 0.0572550..., -0.2052633...,  1.1015194...]])
```

Common

colour.algebra

is_spow_enabled()	Returns whether *Colour* safe / symmetrical power function is enabled.
set_spow_enable(enable)	Sets *Colour* safe / symmetrical power function enabled state.
spow_enable(enable)	A context manager and decorator temporarily setting *Colour* safe / symmetrical power function enabled state.
spow(a, p)	Raises given array a to the power p as follows: $sign(a) * \lvert a \rvert^p$.

colour.algebra.is_spow_enabled

colour.algebra.**is_spow_enabled**()

Returns 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*)

Sets *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*)

A context manager and decorator temporarily setting *Colour* safe / symmetrical power function enabled state.

Parameters **enable** (bool) – Whether to enable or disable *Colour* safe / symmetrical power function.

__init__(*enable*)

Initialize self. See help(type(self)) for accurate signature.

Methods

__init__(enable)	Initialize self.

colour.algebra.spow

colour.algebra.**spow**(a, p)

Raises given array a to the power p as follows: $sign(a) * |a|^p$.

This avoids NaNs generation when array a is negative and the power p is fractional.

Parameters

- **a** (numeric or array_like) – Array a.
- **p** (numeric or array_like) – Power p.

Returns Array a safely raised to the power p.

Return type numeric or ndarray

Examples

```
>>> np.power(-2, 0.15)
nan
>>> spow(-2, 0.15)  # doctest: +ELLIPSIS
-1.1095694...
>>> spow(0, 0)
0.0
```

Colour Appearance Models

- *ATD (1995)*
- *CIECAM02*
- *CAM16*
- *Hunt*
- $LLAB(l:c)$
- *Nayatani (1995)*
- *RLAB*

ATD (1995)

`colour`

`XYZ_to_ATD95`(XYZ, XYZ_0, Y_0, k_1, k_2[, sigma])	Computes the *ATD (1995)* colour vision model correlates.
`ATD95_Specification`	Defines the *ATD (1995)* colour vision model specification.

colour.XYZ_to_ATD95

`colour.`**`XYZ_to_ATD95`**(*XYZ*, *XYZ_0*, *Y_0*, *k_1*, *k_2*, *sigma=300*)

Computes the *ATD (1995)* colour vision model correlates.

Parameters

- **`XYZ`** (`array_like`) – *CIE XYZ* tristimulus values of test sample / stimulus.
- **`XYZ_0`** (`array_like`) – *CIE XYZ* tristimulus values of reference white.
- **`Y_0`** (`numeric or array_like`) – Absolute adapting field luminance in cd/m^2.
- **`k_1`** (`numeric or array_like`) – Application specific weight k_1.
- **`k_2`** (`numeric or array_like`) – Application specific weight k_2.
- **`sigma`** (`numeric or array_like, optional`) – Constant σ varied to predict different types of data.

Returns *ATD (1995)* colour vision model specification.

Return type *ATD95_Specification*

Notes

Domain	Scale - Reference	Scale - 1
`XYZ`	[0, 100]	[0, 1]
`XYZ_0`	[0, 100]	[0, 1]

Range	Scale - Reference	Scale - 1
ATD95_Specification.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

[Fai13a], [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)  # doctest: +ELLIPSIS
ATD95_Specification(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.ATD95_Specification

class colour.**ATD95_Specification**

Defines 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** (numeric or array_like) – *Hue* angle H in degrees.
- **C** (numeric or array_like) – 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** (numeric or array_like) – Correlate of *brightness* Br.
- **A_1** (numeric or array_like) – First stage A_1 response.
- **T_1** (numeric or array_like) – First stage T_1 response.
- **D_1** (numeric or array_like) – First stage D_1 response.
- **A_2** (numeric or array_like) – Second stage A_2 response.
- **T_2** (numeric or array_like) – Second stage A_2 response.
- **D_2** (numeric or array_like) – Second stage D_2 response.

Notes

- This specification is the one used in the current model implementation.

References

[Fai13a], [Gut95]

Create new instance of ATD95_Specification(h, C, Q, A_1, T_1, D_1, A_2, T_2, D_2)

__init__()
Initialize self. See help(type(self)) for accurate signature.

Methods

count	Return number of occurrences of value.
index	Return first index of value.

Attributes

A_1	Alias for field number 3
A_2	Alias for field number 6
C	Alias for field number 1
D_1	Alias for field number 5
D_2	Alias for field number 8
Q	Alias for field number 2
T_1	Alias for field number 4
T_2	Alias for field number 7
h	Alias for field number 0

CIECAM02

colour

XYZ_to_CIECAM02(XYZ, XYZ_w, L_A, Y_b[, ...])	Computes the *CIECAM02* colour appearance model correlates from given *CIE XYZ* tristimulus values.
CIECAM02_to_XYZ(CIECAM02_specification, ...)	Converts *CIECAM02* specification to *CIE XYZ* tristimulus values.
CIECAM02_Specification	Defines the *CIECAM02* colour appearance model specification.
CIECAM02_VIEWING_CONDITIONS	Reference *CIECAM02* colour appearance model viewing conditions.

colour.XYZ_to_CIECAM02

colour.**XYZ_to_CIECAM02**(*XYZ, XYZ_w, L_A, Y_b, surround=CIECAM02_InductionFactors(F=1, c=0.69, N_c=1), discount_illuminant=False*)
Computes the *CIECAM02* colour appearance model correlates from given *CIE XYZ* tristimulus values.

This is the *forward* implementation.

Parameters

- **XYZ** (array_like) – *CIE XYZ* tristimulus values of test sample / stimulus.
- **XYZ_w** (array_like) – *CIE XYZ* tristimulus values of reference white.
- **L_A** (numeric or array_like) – 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** (numeric or array_like) – Relative luminance of background Y_b in cd/m^2.
- **surround** (CIECAM02_InductionFactors, optional) – Surround viewing conditions induction factors.
- **discount_illuminant** (bool, optional) – Truth value indicating if the illuminant should be discounted.

Returns *CIECAM02* colour appearance model specification.

Return type *CIECAM02_Specification*

Notes

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

Range	Scale - Reference	Scale - 1
CIECAM02_specification.h	[0, 360]	[0, 1]
CIECAM02_specification.H	[0, 360]	[0, 1]

References

[Fai04], [LL13], [MFH+02], [Wik07b]

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 = CIECAM02_VIEWING_CONDITIONS['Average']
>>> XYZ_to_CIECAM02(XYZ, XYZ_w, L_A, Y_b, surround)  # doctest: +ELLIPSIS
CIECAM02_Specification(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**(*CIECAM02_specification, XYZ_w, L_A, Y_b, surround=CIECAM02_InductionFactors(F=1, c=0.69, N_c=1), discount_illuminant=False*)

Converts *CIECAM02* specification to *CIE XYZ* tristimulus values.

This is the *reverse* implementation.

Parameters

- **CIECAM02_specification** (CIECAM02_Specification) – *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** (array_like) – *CIE XYZ* tristimulus values of reference white.
- **L_A** (numeric or array_like) – 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** (numeric or array_like) – Relative luminance of background Y_b in cd/m^2.
- **surround** (CIECAM02_InductionFactors, optional) – Surround viewing conditions.
- **discount_illuminant** (bool, optional) – Discount the illuminant.

Returns **XYZ** – *CIE XYZ* tristimulus values.

Return type ndarray

Raises ValueError – If neither *C* or *M* correlates have been defined in the CIECAM02_specification argument.

Warning: The output range of that definition is non standard!

Notes

Domain	Scale - Reference	Scale - 1
CIECAM02_specification.h	[0, 360]	[0, 1]
CIECAM02_specification.H	[0, 360]	[0, 1]
XYZ_w	[0, 100]	[0, 1]

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

- CIECAM02_specification can also be passed as a compatible argument to colour.utilities.as_namedtuple() definition.

References

[Fai04], [LL13], [MFH+02], [Wik07b]

Examples

```
>>> specification = CIECAM02_Specification(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
```

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```
>>> CIECAM02_to_XYZ(specification, XYZ_w, L_A, Y_b)  # doctest: +ELLIPSIS
array([ 19.01...,  20...  ,  21.78...])
```

colour.CIECAM02_Specification

class colour.**CIECAM02_Specification**

Defines the *CIECAM02* colour appearance model specification.

Parameters

- **J** (numeric or array_like) – Correlate of *Lightness* J.
- **C** (numeric or array_like) – Correlate of *chroma* C.
- **h** (numeric or array_like) – *Hue* angle h in degrees.
- **s** (numeric or array_like) – Correlate of *saturation* s.
- **Q** (numeric or array_like) – Correlate of *brightness* Q.
- **M** (numeric or array_like) – Correlate of *colourfulness* M.
- **H** (numeric or array_like) – *Hue* h quadrature H.
- **HC** (numeric or array_like) – *Hue* h composition H^C.

References

[Fai04], [LL13], [MFH+02], [Wik07b]

Returns a new instance of the `colour.CIECAM02_Specification` class.

__init__()

Initialize self. See help(type(self)) for accurate signature.

Methods

count	Return number of occurrences of value.
index	Return first index of value.

Attributes

C	Alias for field number 1
H	Alias for field number 6
HC	Alias for field number 7
J	Alias for field number 0
M	Alias for field number 5
Q	Alias for field number 4
h	Alias for field number 2
s	Alias for field number 3

colour.CIECAM02_VIEWING_CONDITIONS

`colour.CIECAM02_VIEWING_CONDITIONS = CaseInsensitiveMapping({'Average': ..., 'Dim': ..., 'Dark': ...})`

Reference *CIECAM02* colour appearance model viewing conditions.

References

[Fai04], [LL13], [MFH+02], [Wik07b]

CIECAM02_VIEWING_CONDITIONS [CaseInsensitiveMapping] **{'Average', 'Dim', 'Dark'}**

Ancillary Objects

`colour.appearance`

`CIECAM02_InductionFactors`	*CIECAM02* colour appearance model induction factors.

colour.appearance.CIECAM02_InductionFactors

class `colour.appearance.CIECAM02_InductionFactors`

CIECAM02 colour appearance model induction factors.

Parameters

- **F** (`numeric or array_like`) – Maximum degree of adaptation F.
- **c** (`numeric or array_like`) – Exponential non linearity c.
- **N_c** (`numeric or array_like`) – Chromatic induction factor N_c.

References

[Fai04], [LL13], [MFH+02], [Wik07b]

Create new instance of CIECAM02_InductionFactors(F, c, N_c)

__init__()

Initialize self. See help(type(self)) for accurate signature.

Methods

`count`	Return number of occurrences of value.
`index`	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

CAM16

colour

XYZ_to_CAM16(XYZ, XYZ_w, L_A, Y_b[, ...])	Computes the *CAM16* colour appearance model correlates from given *CIE XYZ* tristimulus values.
CAM16_to_XYZ(CAM16_specification, XYZ_w, ...)	Converts *CAM16* specification to *CIE XYZ* tristimulus values.
CAM16_Specification	Defines the *CAM16* colour appearance model specification.
CAM16_VIEWING_CONDITIONS	Reference *CAM16* colour appearance model viewing conditions.

colour.XYZ_to_CAM16

colour.**XYZ_to_CAM16**(*XYZ*, *XYZ_w*, *L_A*, *Y_b*, *surround=CIECAM02_InductionFactors(F=1, c=0.69, N_c=1)*, *discount_illuminant=False*)

Computes the *CAM16* colour appearance model correlates from given *CIE XYZ* tristimulus values.

This is the *forward* implementation.

Parameters

- **XYZ** (array_like) – *CIE XYZ* tristimulus values of test sample / stimulus.
- **XYZ_w** (array_like) – *CIE XYZ* tristimulus values of reference white.
- **L_A** (numeric or array_like) – 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** (numeric or array_like) – Relative luminance of background Y_b in cd/m^2.
- **surround** (CAM16_InductionFactors, optional) – Surround viewing conditions induction factors.
- **discount_illuminant** (bool, optional) – Truth value indicating if the illuminant should be discounted.

Returns *CAM16* colour appearance model specification.

Return type *CAM16_Specification*

Notes

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

Range	Scale - Reference	Scale - 1
CAM16_Specification.h	[0, 360]	[0, 1]
CAM16_Specification.H	[0, 360]	[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 = CAM16_VIEWING_CONDITIONS['Average']
>>> XYZ_to_CAM16(XYZ, XYZ_w, L_A, Y_b, surround)  # doctest: +ELLIPSIS
CAM16_Specification(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**(*CAM16_specification*, *XYZ_w*, *L_A*, *Y_b*, *surround=CIECAM02_InductionFactors(F=1, c=0.69, N_c=1)*, *discount_illuminant=False*)

Converts *CAM16* specification to *CIE XYZ* tristimulus values.

This is the *reverse* implementation.

Parameters

- **CAM16_specification** (CAM16_Specification) – *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** (array_like) – *CIE XYZ* tristimulus values of reference white.
- **L_A** (numeric or array_like) – 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** (numeric or array_like) – Relative luminance of background Y_b in cd/m^2.
- **surround** (CAM16_InductionFactors, optional) – Surround viewing conditions.
- **discount_illuminant** (bool, optional) – Discount the illuminant.

Returns **XYZ** – *CIE XYZ* tristimulus values.

Return type ndarray

Raises ValueError – If neither *C* or *M* correlates have been defined in the CAM16_specification argument.

Notes

Domain	Scale - Reference	Scale - 1
CAM16_specification.h	[0, 360]	[0, 1]
CAM16_specification.H	[0, 360]	[0, 1]
XYZ_w	[0, 100]	[0, 1]

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

- CAM16_specification can also be passed as a compatible argument to colour.utilities.as_namedtuple() definition.

References

[LLW+17]

Examples

```
>>> specification = CAM16_Specification(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)  # doctest: +ELLIPSIS
array([ 19.01...,  20...  ,  21.78...])
```

colour.CAM16_Specification

class colour.**CAM16_Specification**

Defines the *CAM16* colour appearance model specification.

Parameters

- **J** (numeric or array_like) – Correlate of *Lightness* J.
- **C** (numeric or array_like) – Correlate of *chroma* C.
- **h** (numeric or array_like) – *Hue* angle h in degrees.
- **s** (numeric or array_like) – Correlate of *saturation* s.
- **Q** (numeric or array_like) – Correlate of *brightness* Q.
- **M** (numeric or array_like) – Correlate of *colourfulness* M.
- **H** (numeric or array_like) – *Hue* h quadrature H.
- **HC** (numeric or array_like) – *Hue* h composition H^C.

References

[LLW+17]

Returns a new instance of the colour.CAM16_Specification class.

__init__()

Initialize self. See help(type(self)) for accurate signature.

Methods

count	Return number of occurrences of value.
index	Return first index of value.

Attributes

C	Alias for field number 1
H	Alias for field number 6
HC	Alias for field number 7
J	Alias for field number 0
M	Alias for field number 5
Q	Alias for field number 4
h	Alias for field number 2
s	Alias for field number 3

colour.CAM16_VIEWING_CONDITIONS

colour.**CAM16_VIEWING_CONDITIONS = CaseInsensitiveMapping({'Average': ..., 'Dim': ..., 'Dark': ...})**

Reference *CAM16* colour appearance model viewing conditions.

References

[LLW+17]

CAM16_VIEWING_CONDITIONS [CaseInsensitiveMapping] **{'Average', 'Dim', 'Dark'}**

Ancillary Objects

colour.appearance

CAM16_InductionFactors	*CAM16* colour appearance model induction factors.

colour.appearance.CAM16_InductionFactors

class colour.appearance.**CAM16_InductionFactors**

CAM16 colour appearance model induction factors.

Parameters

- **F** (numeric or array_like) – Maximum degree of adaptation F.
- **c** (numeric or array_like) – Exponential non linearity c.
- **N_c** (numeric or array_like) – Chromatic induction factor N_c.

References

[LLW+17]

Create new instance of CAM16_InductionFactors(F, c, N_c)

__init__()
Initialize self. See help(type(self)) for accurate signature.

Methods

count	Return number of occurrences of value.
index	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

XYZ_to_Hunt(XYZ, XYZ_w, XYZ_b, L_A[, ...])	Computes the *Hunt* colour appearance model correlates.
Hunt_Specification	Defines the *Hunt* colour appearance model specification.
HUNT_VIEWING_CONDITIONS	Reference *Hunt* colour appearance model viewing conditions.

colour.XYZ_to_Hunt

colour.**XYZ_to_Hunt**(*XYZ, XYZ_w, XYZ_b, L_A, surround=Hunt_InductionFactors(N_c=1, N_b=75, N_cb=None, N_bb=None), L_AS=None, CCT_w=None, XYZ_p=None, p=None, S=None, S_w=None, helson_judd_effect=False, discount_illuminant=True*)

Computes the *Hunt* colour appearance model correlates.

Parameters

- **XYZ** (array_like) – *CIE XYZ* tristimulus values of test sample / stimulus.
- **XYZ_w** (array_like) – *CIE XYZ* tristimulus values of reference white.
- **XYZ_b** (array_like) – *CIE XYZ* tristimulus values of background.
- **L_A** (numeric or array_like) – Adapting field *luminance* L_A in cd/m^2.
- **surround** (Hunt_InductionFactors, optional) – Surround viewing conditions induction factors.
- **L_AS** (numeric or array_like, optional) – Scotopic luminance L_{AS} of the illuminant, approximated if not specified.
- **CCT_w** (numeric or array_like, optional) – Correlated color temperature T_{cp}: of the illuminant, needed to approximate L_{AS}.
- **XYZ_p** (array_like, optional) – *CIE XYZ* tristimulus values of proximal field, assumed to be equal to background if not specified.

- **p** (numeric or array_like, optional) – 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** (numeric or array_like, optional) – Scotopic response S to the stimulus, approximated using tristimulus values Y of the stimulus if not specified.
- **S_w** (numeric or array_like, optional) – 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, optional) – Truth value indicating whether the *Helson-Judd* effect should be accounted for.
- **discount_illuminant** (bool, optional) – Truth value indicating if the illuminant should be discounted.

Returns *Hunt* colour appearance model specification.

Return type *Hunt_Specification*

Raises ValueError – If an illegal arguments 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
Hunt_Specification.h	[0, 360]	[0, 1]

References

[Fai13f], [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 = HUNT_VIEWING_CONDITIONS['Normal Scenes']
>>> CCT_w = 6504.0
>>> XYZ_to_Hunt(XYZ, XYZ_w, XYZ_b, L_A, surround, CCT_w=CCT_w)
... # doctest: +ELLIPSIS
Hunt_Specification(J=30.0462678..., C=0.1210508..., h=269.2737594..., s=0.0199093..., Q=22.
↪2097654..., M=0.1238964..., H=None, HC=None)
```

colour.Hunt_Specification

class colour.**Hunt_Specification**

Defines 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** (numeric or array_like) – Correlate of *Lightness* J.
- **C** (numeric or array_like) – Correlate of *chroma* C_94.
- **h** (numeric or array_like) – *Hue* angle h_S in degrees.
- **s** (numeric or array_like) – Correlate of *saturation* s.
- **Q** (numeric or array_like) – Correlate of *brightness* Q.
- **M** (numeric or array_like) – Correlate of *colourfulness* M_94.
- **H** (numeric or array_like) – *Hue* h quadrature H.
- **HC** (numeric or array_like) – *Hue* h composition H_C.

Notes

- This specification is the one used in the current model implementation.

References

[Fai13f], [Hun04]

Create new instance of Hunt_Specification(J, C, h, s, Q, M, H, HC)

__init__()

Initialize self. See help(type(self)) for accurate signature.

Methods

count	Return number of occurrences of value.
index	Return first index of value.

Attributes

C	Alias for field number 1
H	Alias for field number 6
HC	Alias for field number 7
J	Alias for field number 0
M	Alias for field number 5
Q	Alias for field number 4
h	Alias for field number 2
s	Alias for field number 3

colour.HUNT_VIEWING_CONDITIONS

`colour.HUNT_VIEWING_CONDITIONS = CaseInsensitiveMapping({'Small Areas, Uniform Background & Surrounds': ...,`

Reference *Hunt* colour appearance model viewing conditions.

References

[Fai13f], [Hun04]

HUNT_VIEWING_CONDITIONS [CaseInsensitiveMapping] **{'Small Areas, Uniform Background & Surrounds', 'Normal Scenes', 'Television & CRT, Dim Surrounds', 'Large Transparencies On Light Boxes', 'Projected Transparencies, Dark Surrounds'}**

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'

$LLAB(l:c)$

`colour`

`XYZ_to_LLAB`(XYZ, XYZ_0, Y_b, L[, surround, ...])	Computes the *:math:'LLAB(l:c)'* colour appearance model correlates.
`LLAB_Specification`	Defines the *:math:'LLAB(l:c)'* colour appearance model specification.
`LLAB_VIEWING_CONDITIONS`	Reference $LLAB(l:c)$ colour appearance model viewing conditions.

colour.XYZ_to_LLAB

`colour.XYZ_to_LLAB(XYZ, XYZ_0, Y_b, L, surround=LLAB_InductionFactors(D=1, F_S=3, F_L=1, F_C=1))`

Computes the *:math:'LLAB(l:c)'* colour appearance model correlates.

Parameters

- **XYZ** (`array_like`) – *CIE XYZ* tristimulus values of test sample / stimulus.
- **XYZ_0** (`array_like`) – *CIE XYZ* tristimulus values of reference white.
- **Y_b** (`numeric or array_like`) – Luminance factor of the background in cd/m^2.
- **L** (`numeric or array_like`) – Absolute luminance L of reference white in cd/m^2.
- **surround** (`LLAB_InductionFactors, optional`) – Surround viewing conditions induction factors.

Returns *:math:'LLAB(l:c)'* colour appearance model specification.

Return type *LLAB_Specification*

Notes

Domain	Scale - Reference	Scale - 1
XYZ	[0, 100]	[0, 1]
XYZ_0	[0, 100]	[0, 1]

Range	Scale - Reference	Scale - 1
LLAB_Specification.h	[0, 360]	[0, 1]

References

[Fai13e], [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 = LLAB_VIEWING_CONDITIONS['ref_average_4_minus']
>>> XYZ_to_LLAB(XYZ, XYZ_0, Y_b, L, surround)  # doctest: +ELLIPSIS
LLAB_Specification(J=37.3668650..., C=0.0089496..., h=270..., s=0.0002395..., M=0.0190185...,␣
↪HC=None, a=..., b=-0.0190185...)
```

colour.LLAB_Specification

class colour.**LLAB_Specification**

Defines 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** (numeric or array_like) – Correlate of *Lightness* L_L.
- **C** (numeric or array_like) – Correlate of *chroma* Ch_L.
- **h** (numeric or array_like) – *Hue* angle h_L in degrees.
- **s** (numeric or array_like) – Correlate of *saturation* s_L.
- **M** (numeric or array_like) – Correlate of *colourfulness* C_L.
- **HC** (numeric or array_like) – *Hue* h composition H^C.
- **a** (numeric or array_like) – Opponent signal A_L.
- **b** (numeric or array_like) – Opponent signal B_L.

Notes

- This specification is the one used in the current model implementation.

References

[Fai13e], [LLK96], [LM96]

Create new instance of LLAB_Specification(J, C, h, s, M, HC, a, b)

__init__()
Initialize self. See help(type(self)) for accurate signature.

Methods

count	Return number of occurrences of value.
index	Return first index of value.

Attributes

C	Alias for field number 1
HC	Alias for field number 5
J	Alias for field number 0
M	Alias for field number 4
a	Alias for field number 6
b	Alias for field number 7
h	Alias for field number 2
s	Alias for field number 3

colour.LLAB_VIEWING_CONDITIONS

colour.**LLAB_VIEWING_CONDITIONS = CaseInsensitiveMapping({'Reference Samples & Images, Average Surround, Subte**
Reference $LLAB(l : c)$ colour appearance model viewing conditions.

References

[Fai13e], [LLK96], [LM96]

LLAB_VIEWING_CONDITIONS [CaseInsensitiveMapping] **{'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'}**

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

LLAB_InductionFactors	*:math:'LLAB(l:c)'* colour appearance model induction factors.

colour.appearance.LLAB_InductionFactors

class colour.appearance.**LLAB_InductionFactors**

:math:'LLAB(l:c)' colour appearance model induction factors.

Parameters

- **D** (numeric or array_like) – *Discounting-the-Illuminant* factor D.
- **F_S** (numeric or array_like) – Surround induction factor F_S.
- **F_L** (numeric or array_like) – *Lightness* induction factor F_L.
- **F_C** (numeric or array_like) – *Chroma* induction factor F_C.

References

[Fai13e], [LLK96], [LM96]

Create new instance of LLAB_InductionFactors(D, F_S, F_L, F_C)

__init__()

Initialize self. See help(type(self)) for accurate signature.

Methods

count	Return number of occurrences of value.
index	Return first index of value.

Attributes

D	Alias for field number 0
F_C	Alias for field number 3
F_L	Alias for field number 2
F_S	Alias for field number 1

Nayatani (1995)

colour

XYZ_to_Nayatani95(XYZ, XYZ_n, Y_o, E_o, E_or)	Computes the *Nayatani (1995)* colour appearance model correlates.
Nayatani95_Specification	Defines the *Nayatani (1995)* colour appearance model specification.

colour.XYZ_to_Nayatani95

`colour.XYZ_to_Nayatani95(XYZ, XYZ_n, Y_o, E_o, E_or, n=1)`

Computes the *Nayatani (1995)* colour appearance model correlates.

Parameters

- **XYZ** (array_like) – *CIE XYZ* tristimulus values of test sample / stimulus.
- **XYZ_n** (array_like) – *CIE XYZ* tristimulus values of reference white.
- **Y_o** (numeric or array_like) – Luminance factor Y_o of achromatic background as percentage normalised to domain [0.18, 1.0] in **'Reference'** domain-range scale.
- **E_o** (numeric or array_like) – Illuminance E_o of the viewing field in lux.
- **E_or** (numeric or array_like) – Normalising illuminance E_{or} in lux usually normalised to domain [1000, 3000].
- **n** (numeric or array_like, optional) – Noise term used in the non linear chromatic adaptation model.

Returns *Nayatani (1995)* colour appearance model specification.

Return type *Nayatani95_Specification*

Notes

Domain	Scale - Reference	Scale - 1
XYZ	[0, 100]	[0, 1]
XYZ_n	[0, 100]	[0, 1]

Range	Scale - Reference	Scale - 1
Nayatani95_Specification.h	[0, 360]	[0, 1]

References

[Fai13g], [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)  # doctest: +ELLIPSIS
Nayatani95_Specification(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.Nayatani95_Specification

class colour.**Nayatani95_Specification**

Defines 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** (numeric or array_like) – Correlate of *achromatic Lightness* $L_p^\star$.
- **C** (numeric or array_like) – Correlate of *chroma* C.
- **h** (numeric or array_like) – *Hue* angle θ in degrees.
- **s** (numeric or array_like) – Correlate of *saturation* S.
- **Q** (numeric or array_like) – Correlate of *brightness* B_r.
- **M** (numeric or array_like) – Correlate of *colourfulness* M.
- **H** (numeric or array_like) – *Hue* h quadrature H.
- **HC** (numeric or array_like) – *Hue* h composition H_C.
- **L_star_N** (numeric or array_like) – Correlate of *normalised achromatic Lightness* $L_n^\star$.

Notes

- This specification is the one used in the current model implementation.

References

[Fai13g], [NSY95]

Create new instance of Nayatani95_Specification(L_star_P, C, h, s, Q, M, H, HC, L_star_N)

__init__()

Initialize self. See help(type(self)) for accurate signature.

Methods

count	Return number of occurrences of value.
index	Return first index of value.

Attributes

C	Alias for field number 1
H	Alias for field number 6
HC	Alias for field number 7
L_star_N	Alias for field number 8
L_star_P	Alias for field number 0
M	Alias for field number 5

Continued on next page

Table 66 – continued from previous page

Q	Alias for field number 4
h	Alias for field number 2
s	Alias for field number 3

RLAB

colour

XYZ_to_RLAB(XYZ, XYZ_n, Y_n[, sigma, D])	Computes the *RLAB* model color appearance correlates.
RLAB_D_FACTOR	*RLAB* colour appearance model *Discounting-the-Illuminant* factor values.
RLAB_Specification	Defines the *RLAB* colour appearance model specification.
RLAB_VIEWING_CONDITIONS	Reference *RLAB* colour appearance model viewing conditions.

colour.XYZ_to_RLAB

colour.**XYZ_to_RLAB**(*XYZ*, *XYZ_n*, *Y_n*, *sigma=0.4347826086956522*, *D=1*)

Computes the *RLAB* model color appearance correlates.

Parameters

- **XYZ** (array_like) – *CIE XYZ* tristimulus values of test sample / stimulus.
- **XYZ_n** (array_like) – *CIE XYZ* tristimulus values of reference white.
- **Y_n** (numeric or array_like) – Absolute adapting luminance in cd/m^2.
- **sigma** (numeric or array_like, optional) – Relative luminance of the surround, see colour.RLAB_VIEWING_CONDITIONS for reference.
- **D** (numeric or array_like, optional) – *Discounting-the-Illuminant* factor normalised to domain [0, 1].

Returns *RLAB* colour appearance model specification.

Return type *RLAB_Specification*

Notes

Domain	Scale - Reference	Scale - 1
XYZ	[0, 100]	[0, 1]
XYZ_n	[0, 100]	[0, 1]

Range	Scale - Reference	Scale - 1
RLAB_Specification.h	[0, 360]	[0, 1]

References

[Fai96], [Fai13h]

Examples

```
>>> XYZ = np.array([19.01, 20.00, 21.78])
>>> XYZ_n = np.array([109.85, 100, 35.58])
>>> Y_n = 31.83
>>> sigma = RLAB_VIEWING_CONDITIONS['Average']
>>> D = RLAB_D_FACTOR['Hard Copy Images']
>>> XYZ_to_RLAB(XYZ, XYZ_n, Y_n, sigma, D)  # doctest: +ELLIPSIS
RLAB_Specification(J=49.8347069..., C=54.8700585..., h=286.4860208..., s=1.1010410..., HC=None,␣
↪a=15.5711021..., b=-52.6142956...)
```

colour.RLAB_D_FACTOR

`colour.RLAB_D_FACTOR = CaseInsensitiveMapping({'Hard Copy Images': ..., 'Soft Copy Images': ..., 'Projected`

RLAB colour appearance model *Discounting-the-Illuminant* factor values.

References

[Fai96], [Fai13h]

RLAB_D_FACTOR [CaseInsensitiveMapping] **{'Hard Copy Images', 'Soft Copy Images', 'Projected Transparencies, Dark Room'}**

Aliases:

- 'hard_cp_img': 'Hard Copy Images'
- 'soft_cp_img': 'Soft Copy Images'
- 'projected_dark': 'Projected Transparencies, Dark Room'

colour.RLAB_Specification

class `colour.RLAB_Specification`

Defines 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** (numeric or array_like) – Correlate of *Lightness* L^R.
- **C** (numeric or array_like) – Correlate of *achromatic chroma* C^R.
- **h** (numeric or array_like) – *Hue* angle h^R in degrees.
- **s** (numeric or array_like) – Correlate of *saturation* s^R.
- **HC** (numeric or array_like) – *Hue* h composition H^C.
- **a** (numeric or array_like) – Red-green chromatic response a^R.

- **b** (numeric or array_like) – Yellow-blue chromatic response b^R.

Notes

- This specification is the one used in the current model implementation.

References

[Fai96], [Fai13h]

Create new instance of RLAB_Specification(J, C, h, s, HC, a, b)

__init__()
Initialize self. See help(type(self)) for accurate signature.

Methods

count	Return number of occurrences of value.
index	Return first index of value.

Attributes

C	Alias for field number 1
HC	Alias for field number 4
J	Alias for field number 0
a	Alias for field number 5
b	Alias for field number 6
h	Alias for field number 2
s	Alias for field number 3

colour.RLAB_VIEWING_CONDITIONS

colour.**RLAB_VIEWING_CONDITIONS = CaseInsensitiveMapping({'Average': ..., 'Dim': ..., 'Dark': ...})**
Reference *RLAB* colour appearance model viewing conditions.

References

[Fai96], [Fai13h]

RLAB_VIEWING_CONDITIONS [CaseInsensitiveMapping] **{'Average', 'Dim', 'Dark'}**

Biochemistry

- *Michaelis–Menten Kinetics*

Michaelis–Menten Kinetics

colour.biochemistry

reaction_rate_MichealisMenten(S, V_max, K_m)	Describes the rate of enzymatic reactions, by relating reaction rate v to concentration of a substrate S.
substrate_concentration_MichealisMenten(v, ...)	Describes the rate of enzymatic reactions, by relating concentration of a substrate S to reaction rate v.

colour.biochemistry.reaction_rate_MichealisMenten

colour.biochemistry.**reaction_rate_MichealisMenten**(*S*, *V_max*, *K_m*)

Describes the rate of enzymatic reactions, by relating reaction rate v to concentration of a substrate S.

Parameters

- **S** (array_like) – Concentration of a substrate S.
- **V_max** (array_like) – Maximum rate V_{max} achieved by the system, at saturating substrate concentration.
- **K_m** (array_like) – Substrate concentration V_{max} at which the reaction rate is half of V_{max}.

Returns Reaction rate v.

Return type array_like

References

[Wik03e]

Examples

```
>>> reaction_rate_MichealisMenten(0.5, 2.5, 0.8)  # doctest: +ELLIPSIS
0.9615384...
```

colour.biochemistry.substrate_concentration_MichealisMenten

colour.biochemistry.**substrate_concentration_MichealisMenten**(*v*, *V_max*, *K_m*)

Describes the rate of enzymatic reactions, by relating concentration of a substrate S to reaction rate v.

Parameters

- **v** (array_like) – Reaction rate v.
- **V_max** (array_like) – Maximum rate V_{max} achieved by the system, at saturating substrate concentration.
- **K_m** (array_like) – Substrate concentration V_{max} at which the reaction rate is half of V_{max}.

Returns Concentration of a substrate S.

Return type array_like

References

[Wik03e]

Examples

```
>>> substrate_concentration_MichealisMenten(0.961538461538461, 2.5, 0.8)
... # doctest: +ELLIPSIS
0.4999999...
```

Colour Vision Deficiency

- *Machado, Oliveira and Fernandes (2009)*

Machado, Oliveira and Fernandes (2009)

colour

anomalous_trichromacy_cmfs_Machado2009(cmfs, ...)	Shifts 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..
anomalous_trichromacy_matrix_Machado2009(...)	Computes *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..
cvd_matrix_Machado2009(deficiency, severity)	Computes *Machado et al.(2009) CVD* matrix for given deficiency and severity using the pre-computed matrices dataset..

colour.anomalous_trichromacy_cmfs_Machado2009

colour.**anomalous_trichromacy_cmfs_Machado2009**(*cmfs*, *d_LMS*)

Shifts 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** (array_like) – Δ_{LMS} shift amount in nanometers.

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 *LMS_ConeFundamentals*

> **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

[Colb], [Cola], [Colc], [MOF09]

Examples

```
>>> from colour import LMS_CMFS
>>> cmfs = LMS_CMFS['Stockman & Sharpe 2 Degree Cone Fundamentals']
>>> cmfs[450]
array([ 0.0498639,  0.0870524,  0.955393 ])
>>> anomalous_trichromacy_cmfs_Machado2009(cmfs, np.array([15, 0, 0]))[450]
... # doctest: +ELLIPSIS
array([ 0.0891288...,  0.0870524 ,  0.955393  ])
```

colour.anomalous_trichromacy_matrix_Machado2009

colour.**anomalous_trichromacy_matrix_Machado2009**(*cmfs*, *primaries*, *d_LMS*)

Computes *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** (array_like) – Δ_{LMS} shift amount in nanometers.

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 ndarray

References

[Colb], [Cola], [Colc], [MOF09]

Examples

```
>>> from colour import DISPLAYS_RGB_PRIMARIES, LMS_CMFS
>>> cmfs = LMS_CMFS['Stockman & Sharpe 2 Degree Cone Fundamentals']
>>> d_LMS = np.array([15, 0, 0])
>>> primaries = DISPLAYS_RGB_PRIMARIES['Apple Studio Display']
>>> anomalous_trichromacy_matrix_Machado2009(cmfs, primaries, d_LMS)
... # doctest: +ELLIPSIS
array([[-0.2777465...,  2.6515008..., -1.3737543...],
       [ 0.2718936...,  0.2004786...,  0.5276276...],
       [ 0.0064404...,  0.2592157...,  0.7343437...]])
```

colour.cvd_matrix_Machado2009

colour.**cvd_matrix_Machado2009**(*deficiency*, *severity*)

Computes *Machado et al. (2009) CVD* matrix for given deficiency and severity using the pre-computed matrices dataset.

Parameters

- **deficiency** (unicode) – {'Protanomaly', 'Deuteranomaly', 'Tritanomaly'} 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** (numeric) – Severity of the colour vision deficiency in domain [0, 1].

Returns *CVD* matrix.

Return type ndarray

References

[Colb], [Cola], [Colc], [MOF09]

Examples

```
>>> cvd_matrix_Machado2009('Protanomaly', 0.15)  # doctest: +ELLIPSIS
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 = CaseInsensitiveMapping({'Protanomaly': ..., 'Deuteranomaly': ..., 'Tritan**

Machado (2010) Simulation matrices Φ_{CVD}.

CVD_MATRICES_MACHADO2010 [CaseInsensitiveMapping] {'Protanomaly', 'Deuteranomaly', 'Tritanomaly'}

Colour Characterisation

- *Colour Fitting*
- *Colour Rendition Charts*
- *Cameras*
- *Displays*

Colour Fitting

colour

POLYNOMIAL_EXPANSION_METHODS	Supported polynomial expansion methods.
polynomial_expansion(a[, method])	Performs polynomial expansion of given a array.
COLOUR_CORRECTION_MATRIX_METHODS	Supported colour correction matrix methods.
colour_correction_matrix(M_T, M_R[, method])	Computes 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])	Performs colour correction of given *RGB* 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 = CaseInsensitiveMapping({'Cheung 2004': ..., 'Finlayson 2015': ..., 'V**

Supported polynomial expansion methods.

References

[CWCR04], [FMH15], [WR04], [Wik03f]

POLYNOMIAL_EXPANSION_METHODS [CaseInsensitiveMapping] **{'Cheung 2004', 'Finlayson 2015', 'Vandermonde'}**

colour.polynomial_expansion

colour.**polynomial_expansion**(*a*, *method='Cheung 2004'*, ***kwargs*)

Performs polynomial expansion of given a array.

Parameters

- **a** (array_like, (3, n)) – a array to expand.
- **method** (unicode, optional) – **{'Cheung 2004', 'Finlayson 2015', 'Vandermonde'}**, Computation method.

Other Parameters

- **degree** (*int*) – {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.
- **terms** (*int*) – {colour.characterisation.augmented_matrix_Cheung2004()}, Number of terms of the expanded polynomial, must be one of *[3, 5, 7, 8, 10, 11, 14, 16, 17, 19, 20, 22]*.
- **root_polynomial_expansion** (*bool*) – {colour.characterisation.polynomial_expansion_Finlayson2015()}, Whether to use the root-polynomials set for the expansion.

Returns Expanded a array.

Return type ndarray, (3, n)

References

[CWCR04], [FMH15], [WR04], [Wik03f]

Examples

```
>>> RGB = np.array([0.17224810, 0.09170660, 0.06416938])
>>> polynomial_expansion(RGB)  # doctest: +ELLIPSIS
array([ 0.1722481...,  0.0917066...,  0.0641693...])
>>> polynomial_expansion(RGB, 'Cheung 2004', terms=5)  # doctest: +ELLIPSIS
array([ 0.1722481...,  0.0917066...,  0.0641693...,  0.0010136...,  1...])
```

colour.COLOUR_CORRECTION_MATRIX_METHODS

colour.**COLOUR_CORRECTION_MATRIX_METHODS = CaseInsensitiveMapping({'Cheung 2004': ..., 'Finlayson 2015': ...**

Supported colour correction matrix methods.

References

[CWCR04], [FMH15], [WR04], [Wik03f]

POLYNOMIAL_EXPANSION_METHODS [CaseInsensitiveMapping] **{'Cheung 2004', 'Finlayson 2015', 'Vandermonde'}**

colour.colour_correction_matrix

colour.**colour_correction_matrix**(*M_T*, *M_R*, *method='Cheung 2004'*, ***kwargs*)

Computes 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** (array_like, (3, n)) – Test array M_T to fit onto array M_R.
- **M_R** (array_like, (3, n)) – Reference array the array M_T will be colour fitted against.
- **method** (unicode, optional) – **{'Cheung 2004', 'Finlayson 2015', 'Vandermonde'}**, Computation method.

Other Parameters

- **degree** (*int*) – {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.
- **terms** (*int*) – {colour.characterisation.augmented_matrix_Cheung2004()}, Number of terms of the expanded polynomial, must be one of *[3, 5, 7, 8, 10, 11, 14, 16, 17, 19, 20, 22]*.
- **root_polynomial_expansion** (*bool*) – {colour.characterisation.polynomial_expansion_Finlayson2015()}, Whether to use the root-polynomials set for the expansion.

Returns Colour correction matrix.

Return type ndarray, (3, n)

References

[CWCR04], [FMH15], [WR04], [Wik03f]

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],
```

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```
...      [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],
...      [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_matrix(M_T, M_R)  # doctest: +ELLIPSIS
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 = CaseInsensitiveMapping({'Cheung 2004': ..., 'Finlayson 2015': ..., 'Vand**

Supported colour correction methods.

References

[CWCR04], [FMH15], [WR04], [Wik03f]

COLOUR_CORRECTION_METHODS [CaseInsensitiveMapping] **{'Cheung 2004', 'Finlayson 2015', 'Vandermonde'}**

colour.colour_correction

colour.**colour_correction**(*RGB*, *M_T*, *M_R*, *method='Cheung 2004'*, ***kwargs*)

Performs 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** (array_like, (3, n)) – *RGB* colourspace array to colour correct.
- **M_T** (array_like, (3, n)) – Test array M_T to fit onto array M_R.
- **M_R** (array_like, (3, n)) – Reference array the array M_T will be colour fitted against.
- **method** (unicode, optional) – **{'Cheung 2004', 'Finlayson 2015', 'Vandermonde'}**, Computation method.

Other Parameters

- **degree** (*int*) – {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.
- **terms** (*int*) – {colour.characterisation.augmented_matrix_Cheung2004()}, Number of terms of the expanded polynomial, must be one of *[3, 5, 7, 8, 10, 11, 14, 16, 17, 19, 20, 22]*.
- **root_polynomial_expansion** (*bool*) – {colour.characterisation.polynomial_expansion_Finlayson2015()}, Whether to use the root-polynomials set for the expansion.

Returns Colour corrected *RGB* colourspace array.

Return type ndarray

References

[CWCR04], [FMH15], [WR04], [Wik03f]

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],
```

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```
...      [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],
...      [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)  # doctest: +ELLIPSIS
array([ 0.1334872...,  0.0843921...,  0.0599014...])
```

Ancillary Objects

`colour.characterisation`

augmented_matrix_Cheung2004(RGB[, terms])	Performs polynomial expansion of given *RGB* colourspace array using *Cheung et al.(2004)* method..
polynomial_expansion_Finlayson2015(RGB[, ...])	Performs polynomial expansion of given *RGB* colourspace array using *Finlayson et al.(2015)* method..
polynomial_expansion_Vandermonde(a[, degree])	Performs polynomial expansion of given a array using *Vandermonde* method.
colour_correction_matrix_Cheung2004(M_T, M_R)	Computes a colour correction from given M_T colour array to M_R colour array using *Cheung et al.(2004)* method..
colour_correction_matrix_Finlayson2015(M_T, M_R)	Computes a colour correction matrix from given M_T colour array to M_R colour array using *Finlayson et al.(2015)* method..
colour_correction_matrix_Vandermonde(M_T, M_R)	Computes a colour correction matrix from given M_T colour array to M_R colour array using *Vandermonde* method.
colour_correction_Cheung2004(RGB, M_T, M_R)	Performs 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..
colour_correction_Finlayson2015(RGB, M_T, M_R)	Performs 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..
colour_correction_Vandermonde(RGB, M_T, M_R)	Performs 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.

colour.characterisation.augmented_matrix_Cheung2004

colour.characterisation.**augmented_matrix_Cheung2004**(*RGB*, *terms=3*)

Performs polynomial expansion of given *RGB* colourspace array using *Cheung et al. (2004)* method.

Parameters

- **RGB** (array_like) – *RGB* colourspace array to expand.
- **terms** (int, optional) – Number of terms of the expanded polynomial, must be one of *[3, 5, 7, 8, 10, 11, 14, 16, 17, 19, 20, 22]*.

Returns Expanded *RGB* colourspace array.

Return type 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])
>>> augmented_matrix_Cheung2004(RGB, terms=5)  # doctest: +ELLIPSIS
array([ 0.1722481...,  0.0917066...,  0.0641693...,  0.0010136...,  1...])
```

colour.characterisation.polynomial_expansion_Finlayson2015

`colour.characterisation.`**`polynomial_expansion_Finlayson2015`**(*RGB*, *degree=1*, *root_polynomial_expansion=True*)

Performs polynomial expansion of given *RGB* colourspace array using *Finlayson et al. (2015)* method.

Parameters

- **RGB** (array_like) – *RGB* colourspace array to expand.
- **degree** (int, optional) – Expanded polynomial degree.
- **root_polynomial_expansion** (bool) – Whether to use the root-polynomials set for the expansion.

Returns Expanded *RGB* colourspace array.

Return type ndarray

References

[FMH15]

Examples

```
>>> RGB = np.array([0.17224810, 0.09170660, 0.06416938])
>>> polynomial_expansion_Finlayson2015(RGB, degree=2)  # doctest: +ELLIPSIS
array([ 0.1722481...,  0.0917066...,  0.06416938...,  0.0078981...,  0.0029423...,
        0.0055265...])
```

colour.characterisation.polynomial_expansion_Vandermonde

`colour.characterisation.`**`polynomial_expansion_Vandermonde`**(a, *degree=1*)

Performs polynomial expansion of given a array using *Vandermonde* method.

Parameters

- **a** (array_like) – a array to expand.
- **degree** (int, optional) – Expanded polynomial degree.

Returns Expanded a array.

Return type ndarray

References

[Wik03f]

Examples

```
>>> RGB = np.array([0.17224810, 0.09170660, 0.06416938])
>>> polynomial_expansion_Vandermonde(RGB)  # doctest: +ELLIPSIS
array([ 0.1722481 ,  0.0917066 ,  0.06416938,  1.        ])
```

colour.characterisation.colour_correction_matrix_Cheung2004

`colour.characterisation.`**`colour_correction_matrix_Cheung2004`**(*M_T*, *M_R*, *terms=3*)

Computes a colour correction from given M_T colour array to M_R colour array using *Cheung et al. (2004)* method.

Parameters

- **M_T** (array_like, (3, n)) – Test array M_T to fit onto array M_R.
- **M_R** (array_like, (3, n)) – Reference array the array M_T will be colour fitted against.
- **terms** (int, optional) – Number of terms of the expanded polynomial, must be one of *[3, 5, 7, 8, 10, 11, 14, 16, 17, 19, 20, 22]*.

Returns Colour correction matrix.

Return type ndarray, (3, n)

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
>>> colour_correction_matrix(M_T, M_R)  # doctest: +ELLIPSIS
array([[ 1.0526376...,  0.1378078..., -0.2276339...],
       [ 0.0739584...,  1.0293994..., -0.1060115...],
       [ 0.0572550..., -0.2052633...,  1.1015194...]])
```

colour.characterisation.colour_correction_matrix_Finlayson2015

`colour.characterisation.`**`colour_correction_matrix_Finlayson2015`**(*M_T*, *M_R*, *degree=1*, *root_polynomial_expansion=True*)

Computes a colour correction matrix from given M_T colour array to M_R colour array using *Finlayson et al. (2015)* method.

Parameters

- **M_T** (array_like, (3, n)) – Test array M_T to fit onto array M_R.
- **M_R** (array_like, (3, n)) – Reference array the array M_T will be colour fitted against.
- **degree** (int, optional) – Expanded polynomial degree.

- **root_polynomial_expansion** (bool) – Whether to use the root-polynomials set for the expansion.

Returns Colour correction matrix.

Return type ndarray, (3, n)

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
>>> colour_correction_matrix(M_T, M_R)  # doctest: +ELLIPSIS
array([[ 1.0526376...,  0.1378078..., -0.2276339...],
       [ 0.0739584...,  1.0293994..., -0.1060115...],
       [ 0.0572550..., -0.2052633...,  1.1015194...]])
```

colour.characterisation.colour_correction_matrix_Vandermonde

colour.characterisation.**colour_correction_matrix_Vandermonde**(*M_T*, *M_R*, *degree=1*)

Computes a colour correction matrix from given M_T colour array to M_R colour array using *Vandermonde* method.

Parameters

- **M_T** (array_like, (3, n)) – Test array M_T to fit onto array M_R.
- **M_R** (array_like, (3, n)) – Reference array the array M_T will be colour fitted against.
- **degree** (int, optional) – Expanded polynomial degree.

Returns Colour correction matrix.

Return type ndarray, (3, n)

References

[Wik03f]

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
>>> colour_correction_matrix(M_T, M_R)  # doctest: +ELLIPSIS
array([[ 1.0526376...,  0.1378078..., -0.2276339...],
       [ 0.0739584...,  1.0293994..., -0.1060115...],
       [ 0.0572550..., -0.2052633...,  1.1015194...]])
```

colour.characterisation.colour_correction_Cheung2004

colour.characterisation.**colour_correction_Cheung2004**(*RGB*, *M_T*, *M_R*, *terms=3*)

Performs 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** (array_like, (3, n)) – *RGB* colourspace array to colour correct.
- **M_T** (array_like, (3, n)) – Test array M_T to fit onto array M_R.
- **M_R** (array_like, (3, n)) – Reference array the array M_T will be colour fitted against.
- **terms** (int, optional) – Number of terms of the expanded polynomial, must be one of *[3, 5, 7, 8, 10, 11, 14, 16, 17, 19, 20, 22]*.

Returns Colour corrected *RGB* colourspace array.

Return type ndarray

References

[CWCR04], [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)  # doctest: +ELLIPSIS
array([ 0.1793456...,  0.1003392...,  0.0617218...])
```

colour.characterisation.colour_correction_Finlayson2015

colour.characterisation.**colour_correction_Finlayson2015**(*RGB*, *M_T*, *M_R*, *degree=1*, *root_polynomial_expansion=True*)

Performs 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** (array_like, (3, n)) – *RGB* colourspace array to colour correct.
- **M_T** (array_like, (3, n)) – Test array M_T to fit onto array M_R.
- **M_R** (array_like, (3, n)) – Reference array the array M_T will be colour fitted against.
- **degree** (int, optional) – 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 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)  # doctest: +ELLIPSIS
array([ 0.1793456...,  0.1003392...,  0.0617218...])
```

colour.characterisation.colour_correction_Vandermonde

`colour.characterisation.`**`colour_correction_Vandermonde`**(*RGB*, *M_T*, *M_R*, *degree=1*)

Performs 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** (array_like, (3, n)) – *RGB* colourspace array to colour correct.
- **M_T** (array_like, (3, n)) – Test array M_T to fit onto array M_R.
- **M_R** (array_like, (3, n)) – Reference array the array M_T will be colour fitted against.
- **degree** (int, optional) – Expanded polynomial degree.

Returns Colour corrected *RGB* colourspace array.

Return type ndarray

References

[Wik03f]

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)  # doctest: +ELLIPSIS
array([ 0.2128689...,  0.1106242...,  0.036213 ...])
```

Colour Rendition Charts

Dataset

colour

COLOURCHECKERS	Aggregated *ColourCheckers* chromaticity coordinates.
COLOURCHECKERS_SDS	Aggregated *ColourCheckers* spectral distributions.

colour.COLOURCHECKERS

colour.**COLOURCHECKERS = CaseInsensitiveMapping({'ColorChecker 1976': ..., 'ColorChecker 2005': ..., 'BabelC**

Aggregated *ColourCheckers* chromaticity coordinates.

References

[Bab12b], [Bab12a], [XR15]

COLOURCHECKERS [CaseInsensitiveMapping] **{'ColorChecker 1976', 'ColorChecker 2005', 'BabelColor Average', 'ColorChecker24 - Before November 2014', 'ColorChecker24 - After November 2014'}**

Aliases:

- 'babel_average': 'BabelColor Average'
- 'cc2005': 'ColorChecker 2005'
- 'ccb2014': 'ColorChecker24 - Before November 2014'
- 'cca2014': 'ColorChecker24 - After November 2014'

colour.COLOURCHECKERS_SDS

colour.**COLOURCHECKERS_SDS = CaseInsensitiveMapping({'BabelColor Average': ..., 'ColorChecker N Ohta': ...,**

Aggregated *ColourCheckers* spectral distributions.

References

[Oht97], [Bab12b], [Bab12a], [MunsellCSciencea]

COLOURCHECKERS [CaseInsensitiveMapping] **{'BabelColor Average', 'ColorChecker N Ohta'}**

Aliases:

- 'babel_average': 'BabelColor Average'
- 'cc_ohta': 'ColorChecker N Ohta'

Ancillary Objects

colour.characterisation

ColourChecker	*ColourChecker* data.

colour.characterisation.ColourChecker

class colour.characterisation.**ColourChecker**

ColourChecker data.

Parameters

- **name** (unicode) – *ColourChecker* name.
- **data** (OrderedDict) – chromaticity coordinates in *CIE xyY* colourspace.
- **illuminant** (array_like) – *ColourChecker* illuminant chromaticity coordinates.

Create new instance of ColourChecker(name, data, illuminant)

__init__()
Initialize self. See help(type(self)) for accurate signature.

Methods

count	Return number of occurrences of value.
index	Return first index of value.

Attributes

data	Alias for field number 1
illuminant	Alias for field number 2
name	Alias for field number 0

Cameras

colour.characterisation

RGB_SpectralSensitivities([data, domain, labels])	Implements support for a camera *RGB* spectral sensitivities.

colour.characterisation.RGB_SpectralSensitivities

class colour.characterisation.**RGB_SpectralSensitivities**(*data=None, domain=None, labels=None, **kwargs*)

Implements support for a camera *RGB* spectral sensitivities.

Parameters

- **data** (Series or Dataframe or Signal or MultiSignal or MultiSpectralDistribution or array_like or dict_like, optional) – Data to be stored in the multi-spectral distribution.
- **domain** (array_like, optional) – 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 attribute.
- **labels** (array_like, optional) – Names to use for the colour.SpectralDistribution class instances.

Other Parameters

- **name** (*unicode, optional*) – Multi-spectral distribution name.

- **interpolator** (*object, optional*) – Interpolator class type to use as interpolating function for the `colour.SpectralDistribution` class instances.
- **interpolator_args** (*dict_like, optional*) – Arguments to use when instantiating the interpolating function of the `colour.SpectralDistribution` class instances.
- **extrapolator** (*object, optional*) – Extrapolator class type to use as extrapolating function for the `colour.SpectralDistribution` class instances.
- **extrapolator_args** (*dict_like, optional*) – Arguments to use when instantiating the extrapolating function of the `colour.SpectralDistribution` class instances.
- **strict_labels** (*array_like, optional*) – Multi-spectral distribution labels for figures, default to `colour.characterisation.RGB_SpectralSensitivities.labels` attribute value.

`__init__`(*data=None, domain=None, labels=None, **kwargs*)

Initialize self. See help(type(self)) for accurate signature.

Methods

`__init__`([data, domain, labels])	Initialize self.
`align`(shape[, interpolator, ...])	Aligns the multi-spectral distribution in-place to given spectral shape: Interpolates first then extrapolates to fit the given range.
`arithmetical_operation`(a, operation[, in_place])	Performs given arithmetical operation with a operand, the operation can be either performed on a copy or in-place.
`clone`()	
`copy`()	Returns a copy of the sub-class instance.
`domain_distance`(a)	Returns the euclidean distance between given array and independent domain x closest element.
`extrapolate`(shape[, extrapolator, ...])	Extrapolates the multi-spectral distribution in-place according to *CIE 15:2004* and *CIE 167:2005* recommendations or given extrapolation arguments.
`fill_nan`([method, default])	Fill NaNs in independent domain x variable and corresponding range y variable using given method.
`get`()	
`interpolate`(shape[, interpolator, ...])	Interpolates the multi-spectral distribution in-place according to *CIE 167:2005* recommendation or given interpolation arguments.
`is_uniform`()	Returns if independent domain x variable is uniform.
`multi_signal_unpack_data`([data, domain, ...])	Unpack given data for multi-continuous signal instantiation.
`normalise`([factor])	Normalises the multi-spectral distribution with given normalization factor.
`to_dataframe`()	Converts the continuous signal to a *Pandas* `DataFrame` class instance.

Continued on next page

Table 80 – continued from previous page

to_sds()	Converts the multi-spectral distributions to a list of spectral distributions and update their name and strict name using the labels and strict labels.
trim(shape)	Trims the multi-spectral distribution wavelengths to given shape.
trim_wavelengths(shape)	
zeros()	

Attributes

data	
domain	Getter and setter property for the colour.continuous.Signal sub-class instances independent domain x variable.
dtype	Getter and setter property for the continuous signal dtype.
extrapolator	Getter and setter property for the colour.continuous.Signal sub-class instances extrapolator type.
extrapolator_args	Getter and setter property for the colour.continuous.Signal sub-class instances extrapolator instantiation time arguments.
function	Getter and setter property for the colour.continuous.Signal sub-class instances callable.
interpolator	Getter and setter property for the colour.continuous.Signal sub-class instances interpolator type.
interpolator_args	Getter and setter property for the colour.continuous.Signal sub-class instances interpolator instantiation time arguments.
items	
labels	Getter and setter property for the colour.continuous.Signal sub-class instances name.
mapping	
name	Getter and setter property for the abstract continuous function name.
range	Getter and setter property for the colour.continuous.Signal sub-class instances corresponding range y variable.
shape	Getter and setter property for the multi-spectral distribution shape.
signal_type	Getter and setter property for the colour.continuous.Signal sub-class instances type.
signals	Getter and setter property for the colour.continuous.Signal sub-class instances.
strict_labels	Getter and setter property for the multi-spectral distribution strict labels.
strict_name	Getter and setter property for the multi-spectral distribution strict name.
title	

Continued on next page

Table 81 – continued from previous page

values	Getter and setter property for the multi-spectral distribution values.
wavelengths	Getter and setter property for the multi-spectral distribution wavelengths λ_n.
x	
y	
z	

Dataset

colour

CAMERAS_RGB_SPECTRAL_SENSITIVITIES	Cameras *RGB* spectral sensitivities.

colour.CAMERAS_RGB_SPECTRAL_SENSITIVITIES

colour.**CAMERAS_RGB_SPECTRAL_SENSITIVITIES = CaseInsensitiveMapping({'Nikon 5100 (NPL)': ..., 'Sigma SDMerill**

Cameras *RGB* spectral sensitivities.

References

[DFGM15]

CAMERAS_RGB_SPECTRAL_SENSITIVITIES [CaseInsensitiveMapping] **{Nikon 5100 (NPL), Sigma SDMerill (NPL)}**

Displays

colour.characterisation

RGB_DisplayPrimaries([data, domain, labels])	Implements 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=None*, *domain=None*, *labels=None*, ***kwargs*)

Implements support for a *RGB* display (such as a *CRT* or *LCD*) primaries multi-spectral distributions.

Parameters

- **data** (Series or Dataframe or Signal or MultiSignal or MultiSpectralDistribution or array_like or dict_like, optional) – Data to be stored in the multi-spectral distribution.
- **domain** (array_like, optional) – 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 attribute.
- **labels** (array_like, optional) – Names to use for the colour.

SpectralDistribution class instances.

Other Parameters

- **name** (*unicode, optional*) – Multi-spectral distribution name.
- **interpolator** (*object, optional*) – Interpolator class type to use as interpolating function for the colour.SpectralDistribution class instances.
- **interpolator_args** (*dict_like, optional*) – Arguments to use when instantiating the interpolating function of the colour.SpectralDistribution class instances.
- **extrapolator** (*object, optional*) – Extrapolator class type to use as extrapolating function for the colour.SpectralDistribution class instances.
- **extrapolator_args** (*dict_like, optional*) – Arguments to use when instantiating the extrapolating function of the colour.SpectralDistribution class instances.
- **strict_labels** (*array_like, optional*) – Multi-spectral distribution labels for figures, default to colour.characterisation.RGB_DisplayPrimaries.labels attribute value.

__init__(*data=None, domain=None, labels=None, **kwargs*)
Initialize self. See help(type(self)) for accurate signature.

Methods

__init__([data, domain, labels])	Initialize self.
align(shape[, interpolator, ...])	Aligns the multi-spectral distribution in-place to given spectral shape: Interpolates first then extrapolates to fit the given range.
arithmetical_operation(a, operation[, in_place])	Performs given arithmetical operation with a operand, the operation can be either performed on a copy or in-place.
clone()	
copy()	Returns a copy of the sub-class instance.
domain_distance(a)	Returns the euclidean distance between given array and independent domain x closest element.
extrapolate(shape[, extrapolator, ...])	Extrapolates the multi-spectral distribution in-place according to *CIE 15:2004* and *CIE 167:2005* recommendations or given extrapolation arguments.
fill_nan([method, default])	Fill NaNs in independent domain x variable and corresponding range y variable using given method.
get()	
interpolate(shape[, interpolator, ...])	Interpolates the multi-spectral distribution in-place according to *CIE 167:2005* recommendation or given interpolation arguments.
is_uniform()	Returns if independent domain x variable is uniform.
multi_signal_unpack_data([data, domain, ...])	Unpack given data for multi-continuous signal instantiation.
normalise([factor])	Normalises the multi-spectral distribution with given normalization factor.

Continued on next page

Table 84 – continued from previous page

to_dataframe()	Converts the continuous signal to a *Pandas* DataFrame class instance.
to_sds()	Converts the multi-spectral distributions to a list of spectral distributions and update their name and strict name using the labels and strict labels.
trim(shape)	Trims the multi-spectral distribution wavelengths to given shape.
trim_wavelengths(shape)	
zeros()	

Attributes

data	
domain	Getter and setter property for the colour.continuous.Signal sub-class instances independent domain x variable.
dtype	Getter and setter property for the continuous signal dtype.
extrapolator	Getter and setter property for the colour.continuous.Signal sub-class instances extrapolator type.
extrapolator_args	Getter and setter property for the colour.continuous.Signal sub-class instances extrapolator instantiation time arguments.
function	Getter and setter property for the colour.continuous.Signal sub-class instances callable.
interpolator	Getter and setter property for the colour.continuous.Signal sub-class instances interpolator type.
interpolator_args	Getter and setter property for the colour.continuous.Signal sub-class instances interpolator instantiation time arguments.
items	
labels	Getter and setter property for the colour.continuous.Signal sub-class instances name.
mapping	
name	Getter and setter property for the abstract continuous function name.
range	Getter and setter property for the colour.continuous.Signal sub-class instances corresponding range y variable.
shape	Getter and setter property for the multi-spectral distribution shape.
signal_type	Getter and setter property for the colour.continuous.Signal sub-class instances type.
signals	Getter and setter property for the colour.continuous.Signal sub-class instances.
strict_labels	Getter and setter property for the multi-spectral distribution strict labels.

Continued on next page

Table 85 – continued from previous page

strict_name	Getter and setter property for the multi-spectral distribution strict name.
title	
values	Getter and setter property for the multi-spectral distribution values.
wavelengths	Getter and setter property for the multi-spectral distribution wavelengths λ_n.
x	
y	
z	

Dataset

colour

DISPLAYS_RGB_PRIMARIES	Displays *RGB* primaries multi-spectral distributions.

colour.DISPLAYS_RGB_PRIMARIES

colour.**DISPLAYS_RGB_PRIMARIES = CaseInsensitiveMapping({'Typical CRT Brainard 1997': ..., 'Apple Studio Disp**

Displays *RGB* primaries multi-spectral distributions.

References

[FW98], [Mac10]

DISPLAYS_RGB_PRIMARIES [CaseInsensitiveMapping] **{Apple Studio Display, Typical CRT Brainard 1997}**

Colorimetry

- *Spectral Data Structure*
- *Spectral Data Generation*
- *Conversion to Tristimulus Values*
  - *ASTM E308-15*
  - *Integration*
- *Spectral Bandpass Dependence Correction*
  - *Stearns and Stearns (1988)*
- *Colour Matching Functions*
- *Colour Matching Functions Transformations*
- *Illuminants and Light Sources*
- *Dominant Wavelength and Purity*
- *Luminous Efficiency Functions*

- *Lightness Computation*
  - *Glasser, Mckinney, Reilly and Schnelle (1958)*
  - *Wyszecki (1963)*
  - *CIE 1976*
  - *Fairchild and Wyble (2010)*
  - *Fairchild and Chen (2011)*
- *Luminance Computation*
  - *Newhall, Nickerson and Judd (1943)*
  - *CIE 1976*
  - *ASTM D1535-08e1*
  - *Fairchild and Wyble (2010)*
  - *Fairchild and Chen (2011)*
- *Whiteness Computation*
  - *Berger (1959)*
  - *Taube (1960)*
  - *Stensby (1968)*
  - *ASTM E313*
  - *Ganz and Griesser (1979)*
  - *CIE 2004*
- *Yellowness Computation*
  - *ASTM D1925*
  - *ASTM E313*

Spectral Data Structure

`colour`

`SpectralShape`([start, end, interval])	Defines the base object for spectral distribution shape.
`SpectralDistribution`([data, domain])	Defines the spectral distribution: the base object for spectral computations.
`MultiSpectralDistribution`([data, domain, labels])	Defines multi-spectral distribution: the base object for multi spectral computations.
`DEFAULT_SPECTRAL_SHAPE`	(360, 780, 1).
`ASTME30815_PRACTISE_SHAPE`	(360, 780, 1).

colour.SpectralShape

class `colour.`**`SpectralShape`**(*start=None*, *end=None*, *interval=None*)

Defines the base object for spectral distribution shape.

Parameters

- **start** (numeric, optional) – Wavelength λ_i range start in nm.
- **end** (numeric, optional) – Wavelength λ_i range end in nm.
- **interval** (numeric, optional) – Wavelength λ_i range interval.

start

end

interval

boundaries

__str__()

__repr__()

__iter__()

__contains__()

__len__()

__eq__()

__ne__()

range()

Examples

```
>>> SpectralShape(360, 830, 1)
SpectralShape(360, 830, 1)
```

__init__(*start=None*, *end=None*, *interval=None*)

Initialize self. See help(type(self)) for accurate signature.

Methods

__init__([start, end, interval])	Initialize self.
range([dtype])	Returns an iterable range for the spectral shape.

Attributes

boundaries	Getter and setter property for the spectral shape boundaries.
end	Getter and setter property for the spectral shape end.
interval	Getter and setter property for the spectral shape interval.
start	Getter and setter property for the spectral shape start.

colour.SpectralDistribution

class colour.**SpectralDistribution**(*data=None*, *domain=None*, ***kwargs*)

Defines 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.

Parameters

- **data** (Series or Signal, SpectralDistribution or array_like or dict_like, optional) – Data to be stored in the spectral distribution.
- **domain** (array_like, optional) – Values to initialise the colour.SpectralDistribution.wavelength attribute with. If both data and domain arguments are defined, the latter will be used to initialise the colour.SpectralDistribution.wavelength attribute.

Other Parameters

- **name** (*unicode, optional*) – Spectral distribution name.
- **interpolator** (*object, optional*) – Interpolator class type to use as interpolating function.
- **interpolator_args** (*dict_like, optional*) – Arguments to use when instantiating the interpolating function.
- **extrapolator** (*object, optional*) – Extrapolator class type to use as extrapolating function.
- **extrapolator_args** (*dict_like, optional*) – Arguments to use when instantiating the extrapolating function.
- **strict_name** (*unicode, optional*) – Spectral distribution name for figures, default to colour.SpectralDistribution.name attribute value.

strict_name

wavelengths

values

shape

__init__()

extrapolate()

interpolate()

align()

trim()

normalise()

References

[CIET13805a], [CIET13805c], [CIET14804h]

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)  # doctest: +ELLIPSIS
SpectralDistribution([[ 500.    ,    0.0651],
                      [ 520.    ,    0.0705],
                      [ 540.    ,    0.0772],
                      [ 560.    ,    0.087 ],
                      [ 580.    ,    0.1128],
                      [ 600.    ,    0.136 ]],
                     interpolator=SpragueInterpolator,
                     interpolator_args={},
                     extrapolator=Extrapolator,
                     extrapolator_args={...})
```

Instantiating a spectral distribution with a non-uniformly spaced independent variable:

```
>>> data[510] = 0.31416
>>> with numpy_print_options(suppress=True):
...     SpectralDistribution(data)  # doctest: +ELLIPSIS
SpectralDistribution([[ 500.     ,    0.0651 ],
                      [ 510.     ,    0.31416],
                      [ 520.     ,    0.0705 ],
                      [ 540.     ,    0.0772 ],
                      [ 560.     ,    0.087  ],
                      [ 580.     ,    0.1128 ],
                      [ 600.     ,    0.136  ]],
                     interpolator=CubicSplineInterpolator,
                     interpolator_args={},
                     extrapolator=Extrapolator,
                     extrapolator_args={...})
```

__init__(*data=None*, *domain=None*, ***kwargs*)

Initialize self. See help(type(self)) for accurate signature.

Methods

`__init__`([data, domain])	Initialize self.
`align`(shape[, interpolator, ...])	Aligns the spectral distribution in-place to given spectral shape: Interpolates first then extrapolates to fit the given range.
`arithmetical_operation`(a, operation[, in_place])	Performs given arithmetical operation with a operand, the operation can be either performed on a copy or in-place.

Continued on next page

Table 90 – continued from previous page

clone()	
copy()	Returns a copy of the sub-class instance.
domain_distance(a)	Returns the euclidean distance between given array and independent domain x closest element.
extrapolate(shape[, extrapolator, ...])	Extrapolates the spectral distribution in-place according to *CIE 15:2004* and *CIE 167:2005* recommendations or given extrapolation arguments.
fill_nan([method, default])	Fill NaNs in independent domain x variable and corresponding range y variable using given method.
get()	
interpolate(shape[, interpolator, ...])	Interpolates the spectral distribution in-place according to *CIE 167:2005* recommendation or given interpolation arguments.
is_uniform()	Returns if independent domain x variable is uniform.
normalise([factor])	Normalises the spectral distribution using given normalization factor.
signal_unpack_data([data, domain, dtype])	Unpack given data for continuous signal instantiation.
to_series()	Converts the continuous signal to a *Pandas* Series class instance.
trim(shape)	Trims the spectral distribution wavelengths to given spectral shape.
trim_wavelengths(shape)	
zeros()	

Attributes

data	
domain	Getter and setter property for the continuous signal independent domain x variable.
dtype	Getter and setter property for the continuous signal dtype.
extrapolator	Getter and setter property for the continuous signal extrapolator type.
extrapolator_args	Getter and setter property for the continuous signal extrapolator instantiation time arguments.
function	Getter and setter property for the continuous signal callable.
interpolator	Getter and setter property for the continuous signal interpolator type.
interpolator_args	Getter and setter property for the continuous signal interpolator instantiation time arguments.
items	
name	Getter and setter property for the abstract continuous function name.

Continued on next page

Table 91 – continued from previous page

range	Getter and setter property for the continuous signal corresponding range y variable.
shape	Getter and setter property for the spectral distribution shape.
strict_name	Getter and setter property for the spectral distribution strict name.
title	
values	Getter and setter property for the spectral distribution values.
wavelengths	Getter and setter property for the spectral distribution wavelengths λ_n.

colour.MultiSpectralDistribution

class colour.**MultiSpectralDistribution**(*data=None*, *domain=None*, *labels=None*, ***kwargs*)

Defines multi-spectral distribution: the base object for multi spectral computations. It is used to model colour matching functions, display primaries, camera sensitivities, etc...

The multi-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.

Parameters

- **data** (Series or Dataframe or Signal or MultiSignal or MultiSpectralDistribution or array_like or dict_like, optional) – Data to be stored in the multi-spectral distribution.
- **domain** (array_like, optional) – 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 attribute.
- **labels** (array_like, optional) – Names to use for the colour.SpectralDistribution class instances.

Other Parameters

- **name** (*unicode, optional*) – Multi-spectral distribution name.
- **interpolator** (*object, optional*) – Interpolator class type to use as interpolating function for the colour.SpectralDistribution class instances.
- **interpolator_args** (*dict_like, optional*) – Arguments to use when instantiating the interpolating function of the colour.SpectralDistribution class instances.
- **extrapolator** (*object, optional*) – Extrapolator class type to use as extrapolating function for the colour.SpectralDistribution class instances.
- **extrapolator_args** (*dict_like, optional*) – Arguments to use when instantiating the extrapolating function of the colour.SpectralDistribution class instances.
- **strict_labels** (*array_like, optional*) – Multi-spectral distribution labels for figures, default to colour.MultiSpectralDistribution.labels attribute value.

strict_name

strict_labels

wavelengths

values

shape

extrapolate()

interpolate()

align()

trim()

normalise()

to_sds()

References

[CIET13805a], [CIET13805c], [CIET14804h]

Examples

Instantiating a multi-spectral distribution 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):
...     MultiSpectralDistribution(data, labels=labels)
... # doctest: +ELLIPSIS
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 ]],
             ... labels=[...'x_bar', ...'y_bar', ...'z_bar'],
             ... interpolator=SpragueInterpolator,
             ... interpolator_args={},
             ... extrapolator=Extrapolator,
             ... extrapolator_args={...})
```

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):
...     MultiSpectralDistribution(data, labels=labels)
... # doctest: +ELLIPSIS
```

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(continued from previous page)

```
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 ]],
             ... labels=[...'x_bar', ...'y_bar', ...'z_bar'],
             ... interpolator=CubicSplineInterpolator,
             ... interpolator_args={},
             ... extrapolator=Extrapolator,
             ... extrapolator_args={...})
```

__init__(*data=None*, *domain=None*, *labels=None*, ***kwargs*)

Initialize self. See help(type(self)) for accurate signature.

Methods

`__init__`([data, domain, labels])	Initialize self.
`align`(shape[, interpolator, ...])	Aligns the multi-spectral distribution in-place to given spectral shape: Interpolates first then extrapolates to fit the given range.
`arithmetical_operation`(a, operation[, in_place])	Performs given arithmetical operation with a operand, the operation can be either performed on a copy or in-place.
`clone`()	
`copy`()	Returns a copy of the sub-class instance.
`domain_distance`(a)	Returns the euclidean distance between given array and independent domain x closest element.
`extrapolate`(shape[, extrapolator, ...])	Extrapolates the multi-spectral distribution in-place according to *CIE 15:2004* and *CIE 167:2005* recommendations or given extrapolation arguments.
`fill_nan`([method, default])	Fill NaNs in independent domain x variable and corresponding range y variable using given method.
`get`()	
`interpolate`(shape[, interpolator, ...])	Interpolates the multi-spectral distribution in-place according to *CIE 167:2005* recommendation or given interpolation arguments.
`is_uniform`()	Returns if independent domain x variable is uniform.
`multi_signal_unpack_data`([data, domain, ...])	Unpack given data for multi-continuous signal instantiation.
`normalise`([factor])	Normalises the multi-spectral distribution with given normalization factor.
`to_dataframe`()	Converts the continuous signal to a *Pandas* `DataFrame` class instance.

Continued on next page

Table 92 – continued from previous page

to_sds()	Converts the multi-spectral distributions to a list of spectral distributions and update their name and strict name using the labels and strict labels.
trim(shape)	Trims the multi-spectral distribution wavelengths to given shape.
trim_wavelengths(shape)	
zeros()	

Attributes

data	
domain	Getter and setter property for the colour.continuous.Signal sub-class instances independent domain x variable.
dtype	Getter and setter property for the continuous signal dtype.
extrapolator	Getter and setter property for the colour.continuous.Signal sub-class instances extrapolator type.
extrapolator_args	Getter and setter property for the colour.continuous.Signal sub-class instances extrapolator instantiation time arguments.
function	Getter and setter property for the colour.continuous.Signal sub-class instances callable.
interpolator	Getter and setter property for the colour.continuous.Signal sub-class instances interpolator type.
interpolator_args	Getter and setter property for the colour.continuous.Signal sub-class instances interpolator instantiation time arguments.
items	
labels	Getter and setter property for the colour.continuous.Signal sub-class instances name.
mapping	
name	Getter and setter property for the abstract continuous function name.
range	Getter and setter property for the colour.continuous.Signal sub-class instances corresponding range y variable.
shape	Getter and setter property for the multi-spectral distribution shape.
signal_type	Getter and setter property for the colour.continuous.Signal sub-class instances type.
signals	Getter and setter property for the colour.continuous.Signal sub-class instances.
strict_labels	Getter and setter property for the multi-spectral distribution strict labels.
strict_name	Getter and setter property for the multi-spectral distribution strict name.
title	

Continued on next page

Table 93 – continued from previous page

values	Getter and setter property for the multi-spectral distribution values.
wavelengths	Getter and setter property for the multi-spectral distribution wavelengths λ_n.
x	
y	
z	

colour.DEFAULT_SPECTRAL_SHAPE

colour.**DEFAULT_SPECTRAL_SHAPE = SpectralShape(360, 780, 1)**

(360, 780, 1).

References

[ASTMInternational15]

ASTME30815_PRACTISE_SHAPE : SpectralShape

Type Shape for *ASTM E308-15* practise

colour.ASTME30815_PRACTISE_SHAPE

colour.**ASTME30815_PRACTISE_SHAPE = SpectralShape(360, 780, 1)**

(360, 780, 1).

References

[ASTMInternational15]

ASTME30815_PRACTISE_SHAPE : SpectralShape

Type Shape for *ASTM E308-15* practise

Spectral Data Generation

colour

sd_CIE_standard_illuminant_A([shape])	*CIE Standard Illuminant A* is intended to represent typical, domestic, tungsten-filament lighting.
sd_CIE_illuminant_D_series(xy[, M1_M2_rounding])	Returns the spectral distribution of given *CIE Illuminant D Series* using given *xy* chromaticity coordinates.
sd_blackbody(temperature[, shape, c1, c2, n])	Returns the spectral distribution of the planckian radiator for given temperature $T[K]$.
sd_constant(k[, shape, dtype])	Returns a spectral distribution of given spectral shape filled with constant k values.
sd_ones([shape])	Returns a spectral distribution of given spectral shape filled with ones.

Continued on next page

Table 94 – continued from previous page

sd_zeros([shape])	Returns a spectral distribution of given spectral shape filled with zeros.
SD_GAUSSIAN_METHODS	Supported gaussian spectral distribution computation methods.
sd_gaussian(mu_peak_wavelength, sigma_fwhm)	Returns a gaussian spectral distribution of given spectral shape using given method.
SD_SINGLE_LED_METHODS	Supported single *LED* spectral distribution computation methods.
sd_single_led(peak_wavelength, fwhm[, ...])	Returns a single *LED* spectral distribution of given spectral shape at given peak wavelength and full width at half maximum according to given method.
SD_MULTI_LEDS_METHODS	Supported multi *LED* spectral distribution computation methods.
sd_multi_leds(peak_wavelengths, fwhm[, ...])	Returns a multi *LED* 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(360, 780, 1)*)

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, optional) – Spectral shape used to create the spectral distribution of the *CIE Standard Illuminant A*.

Returns *CIE Standard Illuminant A*. spectral distribution.

Return type *SpectralDistribution*

References

[CIET14804a]

Examples

```
>>> from colour import SpectralShape
>>> sd_CIE_standard_illuminant_A(SpectralShape(400, 700, 10))
... # doctest: +ELLIPSIS
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...],
```

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```
                     [ 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...],
                     [ 680.        ,  185.4292591...],
                     [ 690.        ,  191.9309499...],
                     [ 700.        ,  198.2612232...]],
                    interpolator=SpragueInterpolator,
                    interpolator_args={},
                    extrapolator=Extrapolator,
                    extrapolator_args={...})
```

colour.sd_CIE_illuminant_D_series

`colour.`**`sd_CIE_illuminant_D_series`**(*xy*, *M1_M2_rounding=True*)

Returns the spectral distribution of given *CIE Illuminant D Series* using given *xy* chromaticity coordinates.

Parameters

- **xy** (`array_like`) – *xy* chromaticity coordinates.
- **M1_M2_rounding** (`bool, optional`) – 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 *SpectralDistribution*

Notes

- The nominal *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

[CIET14804g], [WS00d]

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)  # doctest: +ELLIPSIS
SpectralDistribution([[ 300.     ,    0.0341...],
                      [ 305.     ,    1.6643...],
                      [ 310.     ,    3.2945...],
                      [ 315.     ,   11.7652...],
                      [ 320.     ,   20.236 ...],
                      [ 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...],
```

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```
                    [ 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...],
                    [ 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...],
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                    [ 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...],
```

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```
                      [ 800.     ,   59.4519...],
                      [ 805.     ,   55.7054...],
                      [ 810.     ,   51.959 ...],
                      [ 815.     ,   54.6998...],
                      [ 820.     ,   57.4406...],
                      [ 825.     ,   58.8765...],
                      [ 830.     ,   60.3125...]],
                     interpolator=SpragueInterpolator,
                     interpolator_args={},
                     extrapolator=Extrapolator,
                     extrapolator_args={...})
```

colour.sd_blackbody

colour.**sd_blackbody**(*temperature, shape=SpectralShape(360, 780, 1), c1=3.741771e-16, c2=0.014388, n=1*)

Returns the spectral distribution of the planckian radiator for given temperature $T[K]$.

Parameters

- **temperature** (numeric) – Temperature $T[K]$ in kelvin degrees.
- **shape** (SpectralShape, optional) – Spectral shape used to create the spectral distribution of the planckian radiator.
- **c1** (numeric, optional) – The official value of $c1$ is provided by the Committee on Data for Science and Technology (CODATA) and is $c1 = 3,741771x10.16\ W/m_2$ *(Mohr and Taylor, 2000)*.
- **c2** (numeric, optional) – Since T is measured on the International Temperature Scale, the value of $c2$ used in colorimetry should follow that adopted in the current International Temperature Scale (ITS-90) *(Preston-Thomas, 1990; Mielenz et aI., 1991)*, namely $c2 = 1,4388x10.2\ m/K$.
- **n** (numeric, optional) – 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.

Return type *SpectralDistribution*

Examples

```
>>> from colour import STANDARD_OBSERVERS_CMFS
>>> from colour.utilities import numpy_print_options
>>> cmfs = STANDARD_OBSERVERS_CMFS['CIE 1931 2 Degree Standard Observer']
>>> with numpy_print_options(suppress=True):
...     sd_blackbody(5000, cmfs.shape)  # doctest: +ELLIPSIS
SpectralDistribution([[  3.60000000e+02,   6.65427827e+12],
                      [  3.61000000e+02,   6.70960528e+12],
                      [  3.62000000e+02,   6.76482512e+12],
                      [  3.63000000e+02,   6.81993308e+12],
                      [  3.64000000e+02,   6.87492449e+12],
                      [  3.65000000e+02,   6.92979475e+12],
```

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                    [  3.67000000e+02,   7.03915372e+12],
                    [  3.68000000e+02,   7.09363351e+12],
                    [  3.69000000e+02,   7.14797433e+12],
                    [  3.70000000e+02,   7.20217187e+12],
                    [  3.71000000e+02,   7.25622190e+12],
                    [  3.72000000e+02,   7.31012021e+12],
                    [  3.73000000e+02,   7.36386268e+12],
                    [  3.74000000e+02,   7.41744525e+12],
                    [  3.75000000e+02,   7.47086391e+12],
                    [  3.76000000e+02,   7.52411471e+12],
                    [  3.77000000e+02,   7.57719377e+12],
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                    [  3.79000000e+02,   7.68282141e+12],
                    [  3.80000000e+02,   7.73536252e+12],
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                    [  3.84000000e+02,   7.94362458e+12],
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                    [  3.86000000e+02,   8.04656547e+12],
                    [  3.87000000e+02,   8.09772662e+12],
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                    [  3.89000000e+02,   8.19941421e+12],
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                    [  3.91000000e+02,   8.30023471e+12],
                    [  3.92000000e+02,   8.35031222e+12],
                    [  3.93000000e+02,   8.40016398e+12],
                    [  3.94000000e+02,   8.44978711e+12],
                    [  3.95000000e+02,   8.49917881e+12],
                    [  3.96000000e+02,   8.54833632e+12],
                    [  3.97000000e+02,   8.59725693e+12],
                    [  3.98000000e+02,   8.64593802e+12],
                    [  3.99000000e+02,   8.69437700e+12],
                    [  4.00000000e+02,   8.74257133e+12],
                    [  4.01000000e+02,   8.79051856e+12],
                    [  4.02000000e+02,   8.83821626e+12],
                    [  4.03000000e+02,   8.88566209e+12],
                    [  4.04000000e+02,   8.93285373e+12],
                    [  4.05000000e+02,   8.97978893e+12],
                    [  4.06000000e+02,   9.02646551e+12],
                    [  4.07000000e+02,   9.07288133e+12],
                    [  4.08000000e+02,   9.11903431e+12],
                    [  4.09000000e+02,   9.16492240e+12],
                    [  4.10000000e+02,   9.21054364e+12],
                    [  4.11000000e+02,   9.25589609e+12],
                    [  4.12000000e+02,   9.30097789e+12],
                    [  4.13000000e+02,   9.34578722e+12],
                    [  4.14000000e+02,   9.39032230e+12],
                    [  4.15000000e+02,   9.43458143e+12],
                    [  4.16000000e+02,   9.47856292e+12],
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```

colour.sd_constant

`colour.`**`sd_constant`**(*k*, *shape=SpectralShape(360, 780, 1)*, *dtype=<class 'numpy.float64'>*)

Returns a spectral distribution of given spectral shape filled with constant k values.

Parameters

- **k** (numeric) – Constant k to fill the spectral distribution with.
- **shape** (SpectralShape, optional) – Spectral shape used to create the spectral distribution.
- **dtype** (type) – Data type used for the spectral distribution.

Returns Constant k to filled spectral distribution.

Return type *SpectralDistribution*

Notes

- By default, the spectral distribution will use the shape given by `colour.DEFAULT_SPECTRAL_SHAPE` 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(360, 780, 1))`

Returns a spectral distribution of given spectral shape filled with ones.

Parameters **shape** (`SpectralShape`, `optional`) – Spectral shape used to create the spectral distribution.

Returns Ones filled spectral distribution.

Return type *SpectralDistribution*

Notes

- By default, the spectral distribution will use the shape given by `colour.DEFAULT_SPECTRAL_SHAPE` 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(360, 780, 1))`

Returns a spectral distribution of given spectral shape filled with zeros.

Parameters **shape** (`SpectralShape`, `optional`) – Spectral shape used to create the spectral distribution.

Returns Zeros filled spectral distribution.

Return type *SpectralDistribution*

Notes

- By default, the spectral distribution will use the shape given by `colour.DEFAULT_SPECTRAL_SHAPE` attribute.

Examples

```
>>> sd = sd_zeros()
>>> sd.shape
SpectralShape(360.0, 780.0, 1.0)
>>> sd[400]
0.0
```

colour.SD_GAUSSIAN_METHODS

colour.**SD_GAUSSIAN_METHODS = CaseInsensitiveMapping({'Normal': ..., 'FWHM': ...})**

Supported gaussian spectral distribution computation methods.

SD_GAUSSIAN_METHODS [CaseInsensitiveMapping] **{'Normal', 'FWHM'}**

colour.sd_gaussian

colour.**sd_gaussian**(*mu_peak_wavelength*, *sigma_fwhm*, *shape=SpectralShape(360, 780, 1)*, *method='Normal'*)

Returns a gaussian spectral distribution of given spectral shape using given method.

Parameters

- **mu_peak_wavelength** (numeric) – Mean wavelength μ the gaussian spectral distribution will peak at.
- **sigma_fwhm** (numeric) – 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, optional) – Spectral shape used to create the spectral distribution.
- **method** (unicode, optional) – **{'Normal', 'FWHM'}**, Computation method.

Returns Gaussian spectral distribution.

Return type *SpectralDistribution*

Notes

- By default, the spectral distribution will use the shape given by colour.DEFAULT_SPECTRAL_SHAPE attribute.

Examples

```
>>> sd = sd_gaussian(555, 25)
>>> sd.shape
SpectralShape(360.0, 780.0, 1.0)
>>> sd[555]  # doctest: +ELLIPSIS
1.0000000...
>>> sd[530]  # doctest: +ELLIPSIS
0.6065306...
>>> sd = sd_gaussian(555, 25, method='FWHM')
>>> sd.shape
SpectralShape(360.0, 780.0, 1.0)
>>> sd[555]
1.0
>>> sd[530]  # doctest: +ELLIPSIS
0.3678794...
```

colour.SD_SINGLE_LED_METHODS

colour.**SD_SINGLE_LED_METHODS = CaseInsensitiveMapping({'Ohno 2005': ...})**

Supported single *LED* spectral distribution computation methods.

SD_SINGLE_LED_METHODS [CaseInsensitiveMapping] **{'Ohno 2005'}**

colour.sd_single_led

colour.**sd_single_led**(*peak_wavelength, fwhm, shape=SpectralShape(360, 780, 1), method='Ohno 2005'*)

Returns 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** (numeric) – Wavelength the single *LED* spectral distribution will peak at.
- **fwhm** (numeric) – 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, optional) – Spectral shape used to create the spectral distribution.
- **method** (unicode, optional) – **{'Ohno 2005'}**, Computation method.

Returns Single *LED* spectral distribution.

Return type *SpectralDistribution*

Notes

- By default, the spectral distribution will use the shape given by colour.DEFAULT_SPECTRAL_SHAPE attribute.

References

[Ohn05], [OD08]

Examples

```
>>> sd = sd_single_led(555, 25)
>>> sd.shape
SpectralShape(360.0, 780.0, 1.0)
>>> sd[555]  # doctest: +ELLIPSIS
1.0000000...
```

colour.SD_MULTI_LEDS_METHODS

colour.**SD_MULTI_LEDS_METHODS = CaseInsensitiveMapping({'Ohno 2005': ...})**

Supported multi *LED* spectral distribution computation methods.

SD_MULTI_LEDS_METHODS [CaseInsensitiveMapping] **{'Ohno 2005'}**

colour.sd_multi_leds

colour.**sd_multi_leds**(*peak_wavelengths*, *fwhm*, *peak_power_ratios=None*, *shape=SpectralShape(360, 780, 1)*, *method='Ohno 2005'*)

Returns 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** (array_like) – Wavelengths the multi *LED* spectral distribution will peak at, i.e. the peaks for each generated single *LED* spectral distributions.
- **fwhm** (array_like) – 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** (array_like, optional) – Peak power ratios for each generated single *LED* spectral distributions.
- **shape** (SpectralShape, optional) – Spectral shape used to create the spectral distribution.
- **method** (unicode, optional) – **{'Ohno 2005'}**, Computation method.

Returns Multi *LED* spectral distribution.

Return type *SpectralDistribution*

Notes

- By default, the spectral distribution will use the shape given by colour.DEFAULT_SPECTRAL_SHAPE 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]  # doctest: +ELLIPSIS
0.1295132...
```

colour.colorimetry

blackbody_spectral_radiance(wavelength, ...)	Returns the spectral radiance of a blackbody at thermodynamic temperature $T[K]$ in a medium having index of refraction n.
daylight_locus_function(x_D)	Returns the daylight locus as *xy* chromaticity coordinates.
planck_law(wavelength, temperature[, c1, c2, n])	Returns the spectral radiance of a blackbody at thermodynamic temperature $T[K]$ in a medium having index of refraction n.
sd_gaussian_normal(mu, sigma[, shape])	Returns a gaussian spectral distribution of given spectral shape at given mean wavelength μ and standard deviation $sigma$.
sd_gaussian_fwhm(peak_wavelength, fwhm[, shape])	Returns a gaussian spectral distribution of given spectral shape at given peak wavelength and full width at half maximum.
sd_single_led_Ohno2005(peak_wavelength, fwhm)	Returns a single *LED* spectral distribution of given spectral shape at given peak wavelength and full width at half maximum according to *Ohno (2005)* method.
sd_multi_leds_Ohno2005(peak_wavelengths, fwhm)	Returns a multi *LED* spectral distribution of given spectral shape at given peak wavelengths and full widths at half maximum according to *Ohno (2005)* method.

colour.colorimetry.blackbody_spectral_radiance

colour.colorimetry.**blackbody_spectral_radiance**(*wavelength*, *temperature*, *c1=3.741771e-16*, *c2=0.014388*, *n=1*)

Returns the spectral radiance of a blackbody at thermodynamic temperature $T[K]$ in a medium having index of refraction n.

Parameters

- **wavelength** (numeric or array_like) – Wavelength in meters.
- **temperature** (numeric or array_like) – Temperature $T[K]$ in kelvin degrees.
- **c1** (numeric or array_like, optional) – The official value of $c1$ is provided by the Committee on Data for Science and Technology (CODATA) and is $c1 = 3,741771x10.16\ W/m_2$ *(Mohr and Taylor, 2000)*.
- **c2** (numeric or array_like, optional) – Since T is measured on the International Temperature Scale, the value of $c2$ used in colorimetry should follow that adopted in the current International Temperature Scale (ITS-90) *(Preston-Thomas, 1990; Mielenz et aI., 1991)*, namely $c2 = 1,4388x10.2\ m/K$.
- **n** (numeric or array_like, optional) – 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*.

Return type numeric or ndarray

Notes

- The following form implementation is expressed in term of wavelength.
- The SI unit of radiance is *watts per steradian per square metre*.

References

[CIET14804c]

Examples

```
>>> # Doctests ellipsis for Python 2.x compatibility.
>>> planck_law(500 * 1e-9, 5500)  # doctest: +ELLIPSIS
20472701909806.5...
```

colour.colorimetry.daylight_locus_function

`colour.colorimetry.`**`daylight_locus_function`**(*x_D*)

Returns the daylight locus as *xy* chromaticity coordinates.

Parameters **x_D** (numeric or array_like) – *x* chromaticity coordinates

Returns Daylight locus as *xy* chromaticity coordinates.

Return type numeric or array_like

References

[WS00a]

Examples

```
>>> daylight_locus_function(0.31270)  # doctest: +ELLIPSIS
0.3291051...
```

colour.colorimetry.planck_law

`colour.colorimetry.`**`planck_law`**(*wavelength*, *temperature*, *c1=3.741771e-16*, *c2=0.014388*, *n=1*)

Returns the spectral radiance of a blackbody at thermodynamic temperature $T[K]$ in a medium having index of refraction n.

Parameters

- **wavelength** (numeric or array_like) – Wavelength in meters.
- **temperature** (numeric or array_like) – Temperature $T[K]$ in kelvin degrees.
- **c1** (numeric or array_like, optional) – The official value of $c1$ is provided by the Committee on Data for Science and Technology (CODATA) and is $c1 = 3,741771x10.16\ W/m_2$ *(Mohr and Taylor, 2000)*.

- **c2** (numeric or array_like, optional) – Since T is measured on the International Temperature Scale, the value of $c2$ used in colorimetry should follow that adopted in the current International Temperature Scale (ITS-90) *(Preston-Thomas, 1990; Mielenz et aI., 1991)*, namely $c2 = 1,4388x10.2\ m/K$.
- **n** (numeric or array_like, optional) – 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*.

Return type numeric or ndarray

Notes

- The following form implementation is expressed in term of wavelength.
- The SI unit of radiance is *watts per steradian per square metre*.

References

[CIET14804c]

Examples

```
>>> # Doctests ellipsis for Python 2.x compatibility.
>>> planck_law(500 * 1e-9, 5500)  # doctest: +ELLIPSIS
20472701909806.5...
```

colour.colorimetry.sd_gaussian_normal

`colour.colorimetry.`**`sd_gaussian_normal`**(*mu*, *sigma*, *shape=SpectralShape(360, 780, 1)*)

Returns a gaussian spectral distribution of given spectral shape at given mean wavelength μ and standard deviation $sigma$.

Parameters

- **mu** (numeric) – Mean wavelength μ the gaussian spectral distribution will peak at.
- **sigma** (numeric) – Standard deviation $sigma$ of the gaussian spectral distribution.
- **shape** (SpectralShape, optional) – Spectral shape used to create the spectral distribution.

Returns Gaussian spectral distribution.

Return type *SpectralDistribution*

Notes

- By default, the spectral distribution will use the shape given by `colour.DEFAULT_SPECTRAL_SHAPE` attribute.

Examples

```
>>> sd = sd_gaussian_normal(555, 25)
>>> sd.shape
SpectralShape(360.0, 780.0, 1.0)
>>> sd[555]  # doctest: +ELLIPSIS
1.0000000...
>>> sd[530]  # doctest: +ELLIPSIS
0.6065306...
```

colour.colorimetry.sd_gaussian_fwhm

`colour.colorimetry.`**`sd_gaussian_fwhm`**(*peak_wavelength*, *fwhm*, *shape=SpectralShape(360, 780, 1)*)

Returns a gaussian spectral distribution of given spectral shape at given peak wavelength and full width at half maximum.

Parameters

- **peak_wavelength** (numeric) – Wavelength the gaussian spectral distribution will peak at.
- **fwhm** (numeric) – 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, optional) – Spectral shape used to create the spectral distribution.

Returns Gaussian spectral distribution.

Return type *SpectralDistribution*

Notes

- By default, the spectral distribution will use the shape given by `colour.DEFAULT_SPECTRAL_SHAPE` attribute.

Examples

```
>>> sd = sd_gaussian_fwhm(555, 25)
>>> sd.shape
SpectralShape(360.0, 780.0, 1.0)
>>> sd[555]
1.0
>>> sd[530]  # doctest: +ELLIPSIS
0.3678794...
```

colour.colorimetry.sd_single_led_Ohno2005

`colour.colorimetry.`**`sd_single_led_Ohno2005`**(*peak_wavelength*, *fwhm*, *shape=SpectralShape(360, 780, 1)*)

Returns 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** (numeric) – Wavelength the single *LED* spectral distribution will peak at.
- **fwhm** (numeric) – 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, optional) – Spectral shape used to create the spectral distribution.

Returns Single *LED* spectral distribution.

Return type *SpectralDistribution*

Notes

- By default, the spectral distribution will use the shape given by colour.DEFAULT_SPECTRAL_SHAPE attribute.

References

[Ohn05], [OD08]

Examples

```
>>> sd = sd_single_led_Ohno2005(555, 25)
>>> sd.shape
SpectralShape(360.0, 780.0, 1.0)
>>> sd[555]  # doctest: +ELLIPSIS
1.0000000...
```

colour.colorimetry.sd_multi_leds_Ohno2005

colour.colorimetry.**sd_multi_leds_Ohno2005**(*peak_wavelengths*, *fwhm*, *peak_power_ratios=None*, *shape=SpectralShape(360, 780, 1)*)

Returns 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** (array_like) – Wavelengths the multi *LED* spectral distribution will peak at, i.e. the peaks for each generated single *LED* spectral distributions.
- **fwhm** (array_like) – 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** (array_like, optional) – Peak power ratios for each generated single *LED* spectral distributions.

- **shape** (SpectralShape, optional) – Spectral shape used to create the spectral distribution.

Returns Multi *LED* spectral distribution.

Return type *SpectralDistribution*

Notes

- By default, the spectral distribution will use the shape given by colour.DEFAULT_SPECTRAL_SHAPE 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]  # doctest: +ELLIPSIS
0.1295132...
```

Conversion to Tristimulus Values

colour

sd_to_XYZ(sd[, cmfs, illuminant, k, method])	Converts given spectral distribution to *CIE XYZ* tristimulus values using given colour matching functions, illuminant and method.
SD_TO_XYZ_METHODS	Supported spectral distribution to *CIE XYZ* tristimulus values conversion methods.
multi_sds_to_XYZ(msd[, shape, cmfs, ...])	Converts given multi-spectral distribution array msd with given spectral shape to *CIE XYZ* tristimulus values using given colour matching functions and illuminant.
MULTI_SD_TO_XYZ_METHODS	Supported multi-spectral array to *CIE XYZ* tristimulus values conversion methods.
wavelength_to_XYZ(wavelength[, cmfs])	Converts given wavelength λ to *CIE XYZ* tristimulus values using given colour matching functions.

colour.sd_to_XYZ

colour.**sd_to_XYZ**(*sd*, *cmfs=XYZ_ColourMatchingFunctions(name='CIE 1931 2 Degree Standard Observer', ...)*, *illuminant=SpectralDistribution(name='1 Constant', ...)*, *k=None*, *method='ASTM E308-15'*, ***kwargs*)

Converts given spectral distribution to *CIE XYZ* tristimulus values using given colour matching functions, illuminant and method.

Parameters

- **sd** (SpectralDistribution) – Spectral distribution.
- **cmfs** (XYZ_ColourMatchingFunctions) – Standard observer colour matching functions.
- **illuminant** (SpectralDistribution, optional) – Illuminant spectral distribution.
- **k** (numeric, optional) – 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 $lm \cdot W^{-1}$) and $\Phi_\lambda(\lambda)$ must be the spectral concentration of the radiometric quantity corresponding to the photometric quantity required.
- **method** (unicode, optional) – **{'ASTM E308-15', 'Integration'}**, Computation method.

Other Parameters

- **mi_5nm_omission_method** (*bool, optional*) – {colour.colorimetry.sd_to_XYZ_ASTME30815()}, 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, optional*) – {colour.colorimetry.sd_to_XYZ_ASTME30815()}, 20 nm measurement intervals spectral distribution conversion to tristimulus values will use a dedicated interpolation method instead of a table of tristimulus weighting factors.
- **use_practice_range** (*bool, optional*) – {colour.colorimetry.sd_to_XYZ_ASTME30815()}, Practise *ASTM E308-15* working wavelengths range is [360, 780], if *True* this argument will trim the colour matching functions appropriately.

Returns *CIE XYZ* tristimulus values.

Return type ndarray, (3,)

Notes

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

References

[ASTMInternational11], [ASTMInternational15], [WS00f]

Examples

```
>>> from colour import (
...     CMFS, ILLUMINANTS_SDS, SpectralDistribution)
>>> cmfs = CMFS['CIE 1931 2 Degree Standard Observer']
>>> data = {
...     400: 0.0641,
...     420: 0.0645,
...     440: 0.0562,
...     460: 0.0537,
...     480: 0.0559,
...     500: 0.0651,
...     520: 0.0705,
...     540: 0.0772,
...     560: 0.0870,
...     580: 0.1128,
...     600: 0.1360,
...     620: 0.1511,
...     640: 0.1688,
...     660: 0.1996,
...     680: 0.2397,
...     700: 0.2852
... }
>>> sd = SpectralDistribution(data)
>>> illuminant = ILLUMINANTS_SDS['D65']
>>> sd_to_XYZ(sd, cmfs, illuminant)
... # doctest: +ELLIPSIS
array([ 10.8399031...,   9.6840375...,   6.2164159...])
>>> sd_to_XYZ(sd, cmfs, illuminant, use_practice_range=False)
... # doctest: +ELLIPSIS
array([ 10.8399852...,   9.6840602...,   6.2164085...])
>>> sd_to_XYZ(sd, cmfs, illuminant, method='Integration')
... # doctest: +ELLIPSIS
array([ 10.8401846...,   9.6837311...,   6.2120912...])
```

colour.SD_TO_XYZ_METHODS

colour.**SD_TO_XYZ_METHODS = CaseInsensitiveMapping({'ASTM E308-15': ..., 'Integration': ..., 'astm2015': ...**

Supported spectral distribution to *CIE XYZ* tristimulus values conversion methods.

References

[ASTMInternational11], [ASTMInternational15], [WS00f]

SD_TO_XYZ_METHODS [CaseInsensitiveMapping] **{'ASTM E308-15', 'Integration'}**

Aliases:

- 'astm2015': 'ASTM E308-15'

colour.multi_sds_to_XYZ

colour.**multi_sds_to_XYZ**(*msd*, *shape=SpectralShape(360, 780, 1)*, *cmfs=XYZ_ColourMatchingFunctions(name='CIE 1931 2 Degree Standard Observer', ...)*, *illuminant=SpectralDistribution(name='1 Constant', ...)*, *method='Integration'*, ***kwargs*)

Converts given multi-spectral distribution array msd with given spectral shape to *CIE XYZ* tristimulus values using given colour matching functions and illuminant.

Parameters

- **msa** (array_like) – Multi-spectral distribution array msd, the wavelengths are expected to be in the last axis, e.g. for a 512x384 multi-spectral image with 77 bins, msd shape should be (384, 512, 77).
- **shape** (SpectralShape, optional) – Spectral shape of the multi-spectral distribution array msd, cmfs and illuminant will be aligned with it.
- **cmfs** (XYZ_ColourMatchingFunctions) – Standard observer colour matching functions.
- **illuminant** (SpectralDistribution, optional) – Illuminant spectral distribution.
- **method** (unicode, optional) – **{'Integration'}**, Computation method.

Other Parameters **k** (*numeric, optional*) – {colour.colorimetry.multi_sds_to_XYZ_integration()}, 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 $lm \cdot W^{-1}$) and $\Phi_\lambda(\lambda)$ must be the spectral concentration of the radiometric quantity corresponding to the photometric quantity required.

Returns *CIE XYZ* tristimulus values, for a 512x384 multi-spectral image with 77 bins, the output shape will be (384, 512, 3).

Return type array_like

Notes

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

References

[WS00f]

Examples

```
>>> msd = np.array([
...     [
...         [0.0137, 0.0913, 0.0152, 0.0281, 0.1918, 0.0430],
...         [0.0159, 0.3145, 0.0842, 0.0907, 0.7103, 0.0437],
...         [0.0096, 0.2582, 0.4139, 0.2228, 0.0041, 0.3744],
...         [0.0111, 0.0709, 0.0220, 0.1249, 0.1817, 0.0020],
...         [0.0179, 0.2971, 0.5630, 0.2375, 0.0024, 0.5819],
...         [0.1057, 0.4620, 0.1918, 0.5625, 0.4209, 0.0027],
...     ],
...     [
...         [0.0433, 0.2683, 0.2373, 0.0518, 0.0118, 0.0823],
...         [0.0258, 0.0831, 0.0430, 0.3230, 0.2302, 0.0081],
...         [0.0248, 0.1203, 0.0054, 0.0065, 0.1860, 0.3625],
...         [0.0186, 0.1292, 0.0079, 0.4006, 0.9404, 0.3213],
...         [0.0310, 0.1682, 0.3719, 0.0861, 0.0041, 0.7849],
...         [0.0473, 0.3221, 0.2268, 0.3161, 0.1124, 0.0024],
...     ],
... ])
>>> multi_sds_to_XYZ(msd, SpectralShape(400, 700, 60))
... # doctest: +ELLIPSIS
array([[[  7.6862675...,   4.0925470...,   8.4950412...],
        [ 27.4119366...,  15.5014764...,  29.2825122...],
        [ 17.1283666...,  27.7798651...,  25.5232032...],
        [ 11.9824544...,   8.8127109...,   6.6518695...],
        [ 19.1030682...,  34.4597818...,  29.7653804...],
        [ 46.8243374...,  39.9551652...,  43.6541858...]],
<BLANKLINE>
       [[  8.0978189...,  12.7544378...,  25.8004512...],
        [ 23.4360673...,  19.6127966...,   7.9342408...],
        [  7.0933208...,   2.7894394...,  11.1527704...],
        [ 45.6313772...,  29.0068105...,  11.9934522...],
        [  8.9327884...,  19.4008147...,  17.1534186...],
        [ 24.6610235...,  26.1093760...,  30.7298791...]]])
```

colour.MULTI_SD_TO_XYZ_METHODS

colour.**MULTI_SD_TO_XYZ_METHODS = CaseInsensitiveMapping({'Integration': ...})**

Supported multi-spectral array to *CIE XYZ* tristimulus values conversion methods.

References

[WS00f]

MULTI_SD_TO_XYZ_METHODS [CaseInsensitiveMapping] **{'Integration'}**

colour.wavelength_to_XYZ

colour.**wavelength_to_XYZ**(*wavelength*, *cmfs=XYZ_ColourMatchingFunctions(name='CIE 1931 2 Degree Standard Observer', ...)*)

Converts 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** (numeric or array_like) – Wavelength λ in nm.
- **cmfs** (XYZ_ColourMatchingFunctions, optional) – Standard observer colour matching functions.

Returns *CIE XYZ* tristimulus values.

Return type 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 CMFS
>>> cmfs = CMFS['CIE 1931 2 Degree Standard Observer']
>>> wavelength_to_XYZ(480, cmfs)  # doctest: +ELLIPSIS
array([ 0.09564  ,  0.13902  ,  0.8129501...])
>>> wavelength_to_XYZ(480.5, cmfs)  # doctest: +ELLIPSIS
array([ 0.0914287...,  0.1418350...,  0.7915726...])
```

ASTM E308-15

colour.colorimetry

sd_to_XYZ_ASTME30815(sd[, cmfs, illuminant, ...])	Converts given spectral distribution to *CIE XYZ* tristimulus values using given colour matching functions and illuminant according to practise *ASTM E308-15* method.

colour.colorimetry.sd_to_XYZ_ASTME30815

colour.colorimetry.**sd_to_XYZ_ASTME30815**(*sd, cmfs=XYZ_ColourMatchingFunctions(name='CIE 1931 2 Degree Standard Observer', ...), illuminant=SpectralDistribution(name='1 Constant', ...), use_practice_range=True, mi_5nm_omission_method=True, mi_20nm_interpolation_method=True, k=None*)

Converts 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** (XYZ_ColourMatchingFunctions) – Standard observer colour matching functions.
- **illuminant** (SpectralDistribution, optional) – Illuminant spectral distribution.
- **use_practice_range** (bool, optional) – 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, optional) – 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, optional) – 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** (numeric, optional) – 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 $lm \cdot W^{-1}$) 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 ndarray, (3,)

Warning:

- The tables of tristimulus weighting factors are cached in colour.colorimetry.tristimulus._TRISTIMULUS_WEIGHTING_FACTORS_CACHE attribute. Their identifier key is defined by the colour matching functions and illuminant names along the current shape such as: *CIE 1964 10 Degree Standard Observer, A, (360.0, 830.0, 10.0)* Considering the above, one should be mindful that using similar colour matching functions and illuminant names but with different spectral data will lead to unexpected behaviour.

Notes

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

References

[ASTMInternational15]

Examples

```
>>> from colour import (
...     CMFS, ILLUMINANTS_SDS, SpectralDistribution)
>>> cmfs = CMFS['CIE 1931 2 Degree Standard Observer']
>>> data = {
...     400: 0.0641,
...     420: 0.0645,
...     440: 0.0562,
...     460: 0.0537,
...     480: 0.0559,
...     500: 0.0651,
...     520: 0.0705,
...     540: 0.0772,
...     560: 0.0870,
...     580: 0.1128,
...     600: 0.1360,
...     620: 0.1511,
...     640: 0.1688,
...     660: 0.1996,
...     680: 0.2397,
...     700: 0.2852
... }
>>> sd = SpectralDistribution(data)
>>> illuminant = ILLUMINANTS_SDS['D65']
>>> sd_to_XYZ_ASTME30815(sd, cmfs, illuminant)
... # doctest: +ELLIPSIS
array([ 10.8399031...,   9.6840375...,   6.2164159...])
```

Ancillary Objects

`colour.colorimetry`

`sd_to_XYZ_tristimulus_weighting_factors_ASTME30815(...)`	Converts given spectral distribution to *CIE XYZ* tristimulus values using given colour matching functions and illuminant using a table of tristimulus weighting factors according to practise *ASTM E308-15* method.
`adjust_tristimulus_weighting_factors_ASTME30815(W, ...)`	Adjusts 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.
`lagrange_coefficients_ASTME202211([...])`	Computes the *Lagrange Coefficients* for given interval size using practise *ASTM E2022-11* method.
`tristimulus_weighting_factors_ASTME202211(...)`	Returns a table of tristimulus weighting factors for given colour matching functions and illuminant using practise *ASTM E2022-11* method.

colour.colorimetry.sd_to_XYZ_tristimulus_weighting_factors_ASTME30815

colour.colorimetry.**sd_to_XYZ_tristimulus_weighting_factors_ASTME30815**(*sd*, *cmfs=XYZ_ColourMatchingFunctions(name='1931 2 Degree Standard Observer', ...)*, *illuminant=SpectralDistribution(name='1 Constant', ...)*, *k=None*)

Converts given spectral distribution to *CIE XYZ* tristimulus values using given colour matching functions and illuminant using a table of tristimulus weighting factors according to practise *ASTM E308-15* method.

Parameters

- **sd** (SpectralDistribution) – Spectral distribution.
- **cmfs** (XYZ_ColourMatchingFunctions) – Standard observer colour matching functions.
- **illuminant** (SpectralDistribution, optional) – Illuminant spectral distribution.
- **k** (numeric, optional) – 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 $lm \cdot W^{-1}$) 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 ndarray, (3,)

Notes

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

References

[ASTMInternational15]

Examples

```
>>> from colour import (
...     CMFS, ILLUMINANTS_SDS, SpectralDistribution)
>>> cmfs = CMFS['CIE 1931 2 Degree Standard Observer']
>>> data = {
```

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```
...     400: 0.0641,
...     420: 0.0645,
...     440: 0.0562,
...     460: 0.0537,
...     480: 0.0559,
...     500: 0.0651,
...     520: 0.0705,
...     540: 0.0772,
...     560: 0.0870,
...     580: 0.1128,
...     600: 0.1360,
...     620: 0.1511,
...     640: 0.1688,
...     660: 0.1996,
...     680: 0.2397,
...     700: 0.2852
... }
>>> sd = SpectralDistribution(data)
>>> illuminant = ILLUMINANTS_SDS['D65']
>>> sd_to_XYZ_tristimulus_weighting_factors_ASTME30815(
...     sd, cmfs, illuminant)  # doctest: +ELLIPSIS
array([ 10.8402899...,   9.6843539...,   6.2160858...])
```

colour.colorimetry.adjust_tristimulus_weighting_factors_ASTME30815

colour.colorimetry.**adjust_tristimulus_weighting_factors_ASTME30815**(*W*, *shape_r*, *shape_t*)

Adjusts 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** (array_like) – Tristimulus weighting factors table.
- **shape_r** (SpectralShape) – Reference spectral shape.
- **shape_t** (SpectralShape) – Test spectral shape.

Returns Adjusted tristimulus weighting factors.

Return type ndarray

References

[ASTMInternational15]

Examples

```
>>> from colour import (CMFS, sd_CIE_standard_illuminant_A,
...     SpectralDistribution, SpectralShape)
>>> from colour.utilities import numpy_print_options
>>> cmfs = CMFS['CIE 1964 10 Degree Standard Observer']
>>> A = sd_CIE_standard_illuminant_A(cmfs.shape)
```

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```
>>> W = tristimulus_weighting_factors_ASTME202211(
...     cmfs, A, SpectralShape(360, 830, 20))
>>> with numpy_print_options(suppress=True):
...     adjust_tristimulus_weighting_factors_ASTME30815(
...         W,  SpectralShape(360, 830, 20), SpectralShape(400, 700, 20))
... # doctest: +ELLIPSIS
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_ASTME202211

colour.colorimetry.**lagrange_coefficients_ASTME202211**(*interval=10*, *interval_type='inner'*)

Computes the *Lagrange Coefficients* for given interval size using practise *ASTM E2022-11* method.

Parameters

- **interval** (int) – Interval size in nm.
- **interval_type** (unicode, optional) – **{'inner', 'boundary'}**, 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 ndarray

References

[ASTMInternational11]

Examples

```
>>> lagrange_coefficients_ASTME202211(10, 'inner')
... # doctest: +ELLIPSIS
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...],
```

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```
       [-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_ASTME202211(10, 'boundary')
... # doctest: +ELLIPSIS
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_ASTME202211

`colour.colorimetry.`**`tristimulus_weighting_factors_ASTME202211`**(*cmfs*, *illuminant*, *shape*, *k=None*)

Returns 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** (`XYZ_ColourMatchingFunctions`) – Standard observer colour matching functions.
- **illuminant** (`SpectralDistribution`) – Illuminant spectral distribution.
- **shape** (`SpectralShape`) – Shape used to build the table, only the interval is needed.
- **k** (`numeric, optional`) – 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 $lm \cdot W^{-1}$) 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 ndarray

Raises `ValueError` – If the colour matching functions or illuminant intervals are not equal to 1 nm.

Warning:

- The tables of tristimulus weighting factors are cached in `colour.colorimetry.tristimulus._TRISTIMULUS_WEIGHTING_FACTORS_CACHE` attribute. Their identifier key is defined by the

colour matching functions and illuminant names along the current shape such as: *CIE 1964 10 Degree Standard Observer, A, (360.0, 830.0, 10.0)* Considering the above, one should be mindful that using similar colour matching functions and illuminant names but with different spectral data will lead to unexpected behaviour.

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 (CMFS, sd_CIE_standard_illuminant_A,
...     SpectralDistribution, SpectralShape)
>>> from colour.utilities import numpy_print_options
>>> cmfs = CMFS['CIE 1964 10 Degree Standard Observer']
>>> A = sd_CIE_standard_illuminant_A(cmfs.shape)
>>> with numpy_print_options(suppress=True):
...     tristimulus_weighting_factors_ASTME202211(
...         cmfs, A, SpectralShape(360, 830, 20))
... # doctest: +ELLIPSIS
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...],
       [  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

sd_to_XYZ_integration(sd[, cmfs, illuminant, k])	Converts given spectral distribution to *CIE XYZ* tristimulus values using given colour matching functions and illuminant according to classical integration method.
multi_sds_to_XYZ_integration(msd, shape[, ...])	Converts given multi-spectral distribution array msd with given spectral shape to *CIE XYZ* tristimulus values using given colour matching functions and illuminant.

colour.colorimetry.sd_to_XYZ_integration

colour.colorimetry.**sd_to_XYZ_integration**(*sd, cmfs=XYZ_ColourMatchingFunctions(name='CIE 1931 2 Degree Standard Observer', ...), illuminant=SpectralDistribution(name='1 Constant', ...), k=None*)

Converts given spectral distribution to *CIE XYZ* tristimulus values using given colour matching functions and illuminant according to classical integration method.

Parameters

- **sd** (SpectralDistribution) – Spectral distribution.
- **cmfs** (XYZ_ColourMatchingFunctions) – Standard observer colour matching functions.
- **illuminant** (SpectralDistribution, optional) – Illuminant spectral distribution.
- **k** (numeric, optional) – 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 $lm \cdot W^{-1}$) 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 ndarray, (3,)

Notes

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

References

[WS00f]

Examples

```
>>> from colour import (
...     CMFS, ILLUMINANTS_SDS, SpectralDistribution)
>>> cmfs = CMFS['CIE 1931 2 Degree Standard Observer']
>>> data = {
...     400: 0.0641,
...     420: 0.0645,
...     440: 0.0562,
...     460: 0.0537,
...     480: 0.0559,
...     500: 0.0651,
...     520: 0.0705,
...     540: 0.0772,
...     560: 0.0870,
...     580: 0.1128,
...     600: 0.1360,
...     620: 0.1511,
...     640: 0.1688,
...     660: 0.1996,
...     680: 0.2397,
...     700: 0.2852
... }
>>> sd = SpectralDistribution(data)
>>> illuminant = ILLUMINANTS_SDS['D65']
>>> sd_to_XYZ_integration(sd, cmfs, illuminant)
... # doctest: +ELLIPSIS
array([ 10.8401846...,   9.6837311...,   6.2120912...])
```

colour.colorimetry.multi_sds_to_XYZ_integration

colour.colorimetry.**multi_sds_to_XYZ_integration**(*msd*, *shape*, *cmfs=XYZ_ColourMatchingFunctions(name='CIE 1931 2 Degree Standard Observer', ...)*, *illuminant=SpectralDistribution(name='1 Constant', ...)*, *k=None*)

Converts given multi-spectral distribution array msd with given spectral shape to *CIE XYZ* tristimulus values using given colour matching functions and illuminant.

Parameters

- **msa** (array_like) – Multi-spectral distribution array msd, the wavelengths are expected to be in the last axis, e.g. for a 512x384 multi-spectral image with 77 bins, msd shape should be (384, 512, 77).
- **shape** (SpectralShape, optional) – Spectral shape of the multi-spectral distribution array msd, cmfs and illuminant will be aligned with it.
- **cmfs** (XYZ_ColourMatchingFunctions) – Standard observer colour matching functions.
- **illuminant** (SpectralDistribution, optional) – Illuminant spectral distribution.

- **k** (numeric, optional) – 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 $lm \cdot W^{-1}$) and $\Phi_\lambda(\lambda)$ must be the spectral concentration of the radiometric quantity corresponding to the photometric quantity required.

Returns *CIE XYZ* tristimulus values, for a 512x384 multi-spectral image with 77 bins, the output shape will be (384, 512, 3).

Return type array_like

Notes

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

References

[WS00f]

Examples

```
>>> from colour import ILLUMINANTS_SDS
>>> msd = np.array([
...     [
...         [0.0137, 0.0913, 0.0152, 0.0281, 0.1918, 0.0430],
...         [0.0159, 0.3145, 0.0842, 0.0907, 0.7103, 0.0437],
...         [0.0096, 0.2582, 0.4139, 0.2228, 0.0041, 0.3744],
...         [0.0111, 0.0709, 0.0220, 0.1249, 0.1817, 0.0020],
...         [0.0179, 0.2971, 0.5630, 0.2375, 0.0024, 0.5819],
...         [0.1057, 0.4620, 0.1918, 0.5625, 0.4209, 0.0027],
...     ],
...     [
...         [0.0433, 0.2683, 0.2373, 0.0518, 0.0118, 0.0823],
...         [0.0258, 0.0831, 0.0430, 0.3230, 0.2302, 0.0081],
...         [0.0248, 0.1203, 0.0054, 0.0065, 0.1860, 0.3625],
...         [0.0186, 0.1292, 0.0079, 0.4006, 0.9404, 0.3213],
...         [0.0310, 0.1682, 0.3719, 0.0861, 0.0041, 0.7849],
...         [0.0473, 0.3221, 0.2268, 0.3161, 0.1124, 0.0024],
...     ],
... ])
>>> D65 = ILLUMINANTS_SDS['D65']
>>> multi_sds_to_XYZ(
... msd, SpectralShape(400, 700, 60), illuminant=D65)
... # doctest: +ELLIPSIS
array([[[  7.1958378...,   3.8605390...,  10.1016398...],
        [ 25.5738615...,  14.7200581...,  34.8440007...],
        [ 17.5854414...,  28.5668344...,  30.1806687...],
```

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```
        [ 11.3271912...,   8.4598177...,   7.9015758...],
        [ 19.6581831...,  35.5918480...,  35.1430220...],
        [ 45.8212491...,  39.2600939...,  51.7907710...]],
<BLANKLINE>
       [[  8.8287837...,  13.3870357...,  30.5702050...],
        [ 22.3324362...,  18.9560919...,   9.3952305...],
        [  6.6887212...,   2.5728891...,  13.2618778...],
        [ 41.8166227...,  27.1191979...,  14.2627944...],
        [  9.2414098...,  20.2056200...,  20.1992502...],
        [ 24.7830551...,  26.2221584...,  36.4430633...]]])
```

Spectral Bandpass Dependence Correction

colour

bandpass_correction(sd[, method])	Implements spectral bandpass dependence correction on given spectral distribution using given method.
BANDPASS_CORRECTION_METHODS	Supported spectral bandpass dependence correction methods.

colour.bandpass_correction

colour.**bandpass_correction**(*sd*, *method='Stearns 1988'*)

Implements spectral bandpass dependence correction on given spectral distribution using given method.

Parameters

- **sd** (SpectralDistribution) – Spectral distribution.
- **method** (unicode, optional) – ('Stearns 1988',) Correction method.

Returns Spectral bandpass dependence corrected spectral distribution.

Return type *SpectralDistribution*

colour.BANDPASS_CORRECTION_METHODS

colour.**BANDPASS_CORRECTION_METHODS = CaseInsensitiveMapping({'Stearns 1988': ...})**

Supported spectral bandpass dependence correction methods.

BANDPASS_CORRECTION_METHODS [CaseInsensitiveMapping] **{'Stearns 1988', }**

Stearns and Stearns (1988)

colour.colorimetry

bandpass_correction_Stearns1988(sd)	Implements 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*)

Implements 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 *SpectralDistribution*

References

[SS88], [WRC12c]

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))
... # doctest: +ELLIPSIS
SpectralDistribution([[ 500.        ,    0.0646518...],
                      [ 520.        ,    0.0704293...],
                      [ 540.        ,    0.0769485...],
                      [ 560.        ,    0.0856928...],
                      [ 580.        ,    0.1129644...],
                      [ 600.        ,    0.1379256...]],
                     interpolator=SpragueInterpolator,
                     interpolator_args={},
                     extrapolator=Extrapolator,
                     extrapolator_args={...})
```

Colour Matching Functions

colour.colorimetry

LMS_ConeFundamentals([data, domain, labels])	Implements support for the Stockman and Sharpe *LMS* cone fundamentals colour matching functions.
RGB_ColourMatchingFunctions([data, domain, ...])	Implements support for the *CIE RGB* colour matching functions.
XYZ_ColourMatchingFunctions([data, domain, ...])	Implements support for the *CIE* Standard Observers *XYZ* colour matching functions.

colour.colorimetry.LMS_ConeFundamentals

class colour.colorimetry.**LMS_ConeFundamentals**(*data=None*, *domain=None*, *labels=None*, ***kwargs*)

Implements support for the Stockman and Sharpe *LMS* cone fundamentals colour matching functions.

Parameters

- **data** (Series or Dataframe or Signal or MultiSignal or MultiSpectralDistribution or array_like or dict_like, optional) – Data to be stored in the multi-spectral distribution.
- **domain** (array_like, optional) – class instances colour.continuous.Signal.wavelengths attribute with. If both data and domain arguments are defined, the latter will be used to initialise the Values to initialise the multiple colour.SpectralDistribution colour.continuous.Signal.wavelengths attribute.
- **labels** (array_like, optional) – Names to use for the colour.SpectralDistribution class instances.

Other Parameters

- **name** (*unicode, optional*) – Multi-spectral distribution name.
- **interpolator** (*object, optional*) – Interpolator class type to use as interpolating function for the colour.SpectralDistribution class instances.
- **interpolator_args** (*dict_like, optional*) – Arguments to use when instantiating the interpolating function of the colour.SpectralDistribution class instances.
- **extrapolator** (*object, optional*) – Extrapolator class type to use as extrapolating function for the colour.SpectralDistribution class instances.
- **extrapolator_args** (*dict_like, optional*) – Arguments to use when instantiating the extrapolating function of the colour.SpectralDistribution class instances.
- **strict_labels** (*array_like, optional*) – Multi-spectral distribution labels for figures, default to colour.colorimetry.LMS_ConeFundamentals.labels attribute value.

__init__(*data=None*, *domain=None*, *labels=None*, ***kwargs*)

Initialize self. See help(type(self)) for accurate signature.

Methods

__init__([data, domain, labels])	Initialize self.
align(shape[, interpolator, ...])	Aligns the multi-spectral distribution in-place to given spectral shape: Interpolates first then extrapolates to fit the given range.

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Table 103 – continued from previous page

arithmetical_operation(a, operation[, in_place])	Performs given arithmetical operation with a operand, the operation can be either performed on a copy or in-place.
clone()	
copy()	Returns a copy of the sub-class instance.
domain_distance(a)	Returns the euclidean distance between given array and independent domain x closest element.
extrapolate(shape[, extrapolator, ...])	Extrapolates the multi-spectral distribution in-place according to *CIE 15:2004* and *CIE 167:2005* recommendations or given extrapolation arguments.
fill_nan([method, default])	Fill NaNs in independent domain x variable and corresponding range y variable using given method.
get()	
interpolate(shape[, interpolator, ...])	Interpolates the multi-spectral distribution in-place according to *CIE 167:2005* recommendation or given interpolation arguments.
is_uniform()	Returns if independent domain x variable is uniform.
multi_signal_unpack_data([data, domain, ...])	Unpack given data for multi-continuous signal instantiation.
normalise([factor])	Normalises the multi-spectral distribution with given normalization factor.
to_dataframe()	Converts the continuous signal to a *Pandas* DataFrame class instance.
to_sds()	Converts the multi-spectral distributions to a list of spectral distributions and update their name and strict name using the labels and strict labels.
trim(shape)	Trims the multi-spectral distribution wavelengths to given shape.
trim_wavelengths(shape)	
zeros()	

Attributes

data	
domain	Getter and setter property for the colour.continuous.Signal sub-class instances independent domain x variable.
dtype	Getter and setter property for the continuous signal dtype.
extrapolator	Getter and setter property for the colour.continuous.Signal sub-class instances extrapolator type.
extrapolator_args	Getter and setter property for the colour.continuous.Signal sub-class instances extrapolator instantiation time arguments.

Continued on next page

Table 104 – continued from previous page

function	Getter and setter property for the colour.continuous.Signal sub-class instances callable.
interpolator	Getter and setter property for the colour.continuous.Signal sub-class instances interpolator type.
interpolator_args	Getter and setter property for the colour.continuous.Signal sub-class instances interpolator instantiation time arguments.
items	
labels	Getter and setter property for the colour.continuous.Signal sub-class instances name.
mapping	
name	Getter and setter property for the abstract continuous function name.
range	Getter and setter property for the colour.continuous.Signal sub-class instances corresponding range y variable.
shape	Getter and setter property for the multi-spectral distribution shape.
signal_type	Getter and setter property for the colour.continuous.Signal sub-class instances type.
signals	Getter and setter property for the colour.continuous.Signal sub-class instances.
strict_labels	Getter and setter property for the multi-spectral distribution strict labels.
strict_name	Getter and setter property for the multi-spectral distribution strict name.
title	
values	Getter and setter property for the multi-spectral distribution values.
wavelengths	Getter and setter property for the multi-spectral distribution wavelengths λ_n.
x	
y	
z	

colour.colorimetry.RGB_ColourMatchingFunctions

class colour.colorimetry.**RGB_ColourMatchingFunctions**(*data=None*, *domain=None*, *labels=None*, ***kwargs*)

Implements support for the *CIE RGB* colour matching functions.

Parameters

- **data** (Series or Dataframe or Signal or MultiSignal or MultiSpectralDistribution or array_like or dict_like, optional) – Data to be stored in the multi-spectral distribution.
- **domain** (array_like, optional) – 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 attribute.
- **labels** (array_like, optional) – Names to use for the colour.

SpectralDistribution class instances.

Other Parameters

- **name** (*unicode, optional*) – Multi-spectral distribution name.
- **interpolator** (*object, optional*) – Interpolator class type to use as interpolating function for the colour.SpectralDistribution class instances.
- **interpolator_args** (*dict_like, optional*) – Arguments to use when instantiating the interpolating function of the colour.SpectralDistribution class instances.
- **extrapolator** (*object, optional*) – Extrapolator class type to use as extrapolating function for the colour.SpectralDistribution class instances.
- **extrapolator_args** (*dict_like, optional*) – Arguments to use when instantiating the extrapolating function of the colour.SpectralDistribution class instances.
- **strict_labels** (*array_like, optional*) – Multi-spectral distribution labels for figures, default to colour.colorimetry.RGB_ColourMatchingFunctions.labels attribute value.

__init__(*data=None, domain=None, labels=None, **kwargs*)

Initialize self. See help(type(self)) for accurate signature.

Methods

__init__([data, domain, labels])	Initialize self.
align(shape[, interpolator, ...])	Aligns the multi-spectral distribution in-place to given spectral shape: Interpolates first then extrapolates to fit the given range.
arithmetical_operation(a, operation[, in_place])	Performs given arithmetical operation with a operand, the operation can be either performed on a copy or in-place.
clone()	
copy()	Returns a copy of the sub-class instance.
domain_distance(a)	Returns the euclidean distance between given array and independent domain x closest element.
extrapolate(shape[, extrapolator, ...])	Extrapolates the multi-spectral distribution in-place according to *CIE 15:2004* and *CIE 167:2005* recommendations or given extrapolation arguments.
fill_nan([method, default])	Fill NaNs in independent domain x variable and corresponding range y variable using given method.
get()	
interpolate(shape[, interpolator, ...])	Interpolates the multi-spectral distribution in-place according to *CIE 167:2005* recommendation or given interpolation arguments.
is_uniform()	Returns if independent domain x variable is uniform.
multi_signal_unpack_data([data, domain, ...])	Unpack given data for multi-continuous signal instantiation.

Continued on next page

Table 105 – continued from previous page

normalise([factor])	Normalises the multi-spectral distribution with given normalization factor.
to_dataframe()	Converts the continuous signal to a *Pandas* DataFrame class instance.
to_sds()	Converts the multi-spectral distributions to a list of spectral distributions and update their name and strict name using the labels and strict labels.
trim(shape)	Trims the multi-spectral distribution wavelengths to given shape.
trim_wavelengths(shape)	
zeros()	

Attributes

data	
domain	Getter and setter property for the colour.continuous.Signal sub-class instances independent domain x variable.
dtype	Getter and setter property for the continuous signal dtype.
extrapolator	Getter and setter property for the colour.continuous.Signal sub-class instances extrapolator type.
extrapolator_args	Getter and setter property for the colour.continuous.Signal sub-class instances extrapolator instantiation time arguments.
function	Getter and setter property for the colour.continuous.Signal sub-class instances callable.
interpolator	Getter and setter property for the colour.continuous.Signal sub-class instances interpolator type.
interpolator_args	Getter and setter property for the colour.continuous.Signal sub-class instances interpolator instantiation time arguments.
items	
labels	Getter and setter property for the colour.continuous.Signal sub-class instances name.
mapping	
name	Getter and setter property for the abstract continuous function name.
range	Getter and setter property for the colour.continuous.Signal sub-class instances corresponding range y variable.
shape	Getter and setter property for the multi-spectral distribution shape.
signal_type	Getter and setter property for the colour.continuous.Signal sub-class instances type.
signals	Getter and setter property for the colour.continuous.Signal sub-class instances.

Continued on next page

Table 106 – continued from previous page

strict_labels	Getter and setter property for the multi-spectral distribution strict labels.
strict_name	Getter and setter property for the multi-spectral distribution strict name.
title	
values	Getter and setter property for the multi-spectral distribution values.
wavelengths	Getter and setter property for the multi-spectral distribution wavelengths λ_n.
x	
y	
z	

colour.colorimetry.XYZ_ColourMatchingFunctions

class colour.colorimetry.**XYZ_ColourMatchingFunctions**(*data=None, domain=None, labels=None, **kwargs*)

Implements support for the *CIE* Standard Observers *XYZ* colour matching functions.

Parameters

- **data** (Series or Dataframe or Signal or MultiSignal or MultiSpectralDistribution or array_like or dict_like, optional) – Data to be stored in the multi-spectral distribution.
- **domain** (array_like, optional) – 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 attribute.
- **labels** (array_like, optional) – Names to use for the colour.SpectralDistribution class instances.

Other Parameters

- **name** (*unicode, optional*) – Multi-spectral distribution name.
- **interpolator** (*object, optional*) – Interpolator class type to use as interpolating function for the colour.SpectralDistribution class instances.
- **interpolator_args** (*dict_like, optional*) – Arguments to use when instantiating the interpolating function of the colour.SpectralDistribution class instances.
- **extrapolator** (*object, optional*) – Extrapolator class type to use as extrapolating function for the colour.SpectralDistribution class instances.
- **extrapolator_args** (*dict_like, optional*) – Arguments to use when instantiating the extrapolating function of the colour.SpectralDistribution class instances.
- **strict_labels** (*array_like, optional*) – Multi-spectral distribution labels for figures, default to colour.colorimetry.XYZ_ColourMatchingFunctions.labels attribute value.

__init__(*data=None, domain=None, labels=None, **kwargs*)

Initialize self. See help(type(self)) for accurate signature.

Methods

`__init__`([data, domain, labels])	Initialize self.
`align`(shape[, interpolator, ...])	Aligns the multi-spectral distribution in-place to given spectral shape: Interpolates first then extrapolates to fit the given range.
`arithmetical_operation`(a, operation[, in_place])	Performs given arithmetical operation with a operand, the operation can be either performed on a copy or in-place.
`clone`()	
`copy`()	Returns a copy of the sub-class instance.
`domain_distance`(a)	Returns the euclidean distance between given array and independent domain x closest element.
`extrapolate`(shape[, extrapolator, ...])	Extrapolates the multi-spectral distribution in-place according to *CIE 15:2004* and *CIE 167:2005* recommendations or given extrapolation arguments.
`fill_nan`([method, default])	Fill NaNs in independent domain x variable and corresponding range y variable using given method.
`get`()	
`interpolate`(shape[, interpolator, ...])	Interpolates the multi-spectral distribution in-place according to *CIE 167:2005* recommendation or given interpolation arguments.
`is_uniform`()	Returns if independent domain x variable is uniform.
`multi_signal_unpack_data`([data, domain, ...])	Unpack given data for multi-continuous signal instantiation.
`normalise`([factor])	Normalises the multi-spectral distribution with given normalization factor.
`to_dataframe`()	Converts the continuous signal to a *Pandas* `DataFrame` class instance.
`to_sds`()	Converts the multi-spectral distributions to a list of spectral distributions and update their name and strict name using the labels and strict labels.
`trim`(shape)	Trims the multi-spectral distribution wavelengths to given shape.
`trim_wavelengths`(shape)	
`zeros`()	

Attributes

`data`	
`domain`	Getter and setter property for the `colour.continuous.Signal` sub-class instances independent domain x variable.
`dtype`	Getter and setter property for the continuous signal dtype.

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Table 108 – continued from previous page

extrapolator	Getter and setter property for the colour.continuous.Signal sub-class instances extrapolator type.
extrapolator_args	Getter and setter property for the colour.continuous.Signal sub-class instances extrapolator instantiation time arguments.
function	Getter and setter property for the colour.continuous.Signal sub-class instances callable.
interpolator	Getter and setter property for the colour.continuous.Signal sub-class instances interpolator type.
interpolator_args	Getter and setter property for the colour.continuous.Signal sub-class instances interpolator instantiation time arguments.
items	
labels	Getter and setter property for the colour.continuous.Signal sub-class instances name.
mapping	
name	Getter and setter property for the abstract continuous function name.
range	Getter and setter property for the colour.continuous.Signal sub-class instances corresponding range y variable.
shape	Getter and setter property for the multi-spectral distribution shape.
signal_type	Getter and setter property for the colour.continuous.Signal sub-class instances type.
signals	Getter and setter property for the colour.continuous.Signal sub-class instances.
strict_labels	Getter and setter property for the multi-spectral distribution strict labels.
strict_name	Getter and setter property for the multi-spectral distribution strict name.
title	
values	Getter and setter property for the multi-spectral distribution values.
wavelengths	Getter and setter property for the multi-spectral distribution wavelengths λ_n.
x	
y	
z	

Dataset

colour

CMFS	Aggregated colour matching functions.
LMS_CMFS	*LMS* colour matching functions.
RGB_CMFS	*CIE RGB* colour matching functions.
STANDARD_OBSERVERS_CMFS	*CIE* Standard Observers *XYZ* colour matching functions.

colour.CMFS

`colour.CMFS = CaseInsensitiveMapping({'Stockman & Sharpe 2 Degree Cone Fundamentals': ..., 'Stockman & Sharp`

Aggregated colour matching functions.

References

[Bro09], [CVRd], [CVRe], [CVRf], [SS00], [CVRg], [Mac10]

CMFS [CaseInsensitiveMapping] **{'Stockman & Sharpe 10 Degree Cone Fundamentals', 'Stockman & Sharpe 2 Degree Cone Fundamentals', '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 2012 2 Degree Standard Observer', 'CIE 2012 10 Degree Standard Observer'}**

colour.LMS_CMFS

`colour.LMS_CMFS = CaseInsensitiveMapping({'Stockman & Sharpe 2 Degree Cone Fundamentals': ..., 'Stockman & S`

LMS colour matching functions.

References

[SS00], [Mac10]

LMS_CMFS [CaseInsensitiveMapping] {'Stockman & Sharpe 2 Degree Cone Fundamentals', 'Stockman & Sharpe 10 Degree Cone Fundamentals', 'Smith & Pokorny 1975 Normal Trichromats'}

colour.RGB_CMFS

`colour.RGB_CMFS = CaseInsensitiveMapping({'Wright & Guild 1931 2 Degree RGB CMFs': ..., 'Stiles & Burch 1955`

CIE RGB colour matching functions.

References

[Bro09], [CVRf], [CVRg]

RGB_CMFS [CaseInsensitiveMapping] **{'Wright & Guild 1931 2 Degree RGB CMFs', 'Stiles & Burch 1955 2 Degree RGB CMFs', 'Stiles & Burch 1959 10 Degree RGB CMFs'}**

colour.STANDARD_OBSERVERS_CMFS

`colour.STANDARD_OBSERVERS_CMFS = CaseInsensitiveMapping({'CIE 1931 2 Degree Standard Observer': ..., 'CIE 19`

CIE Standard Observers *XYZ* colour matching functions.

References

[CVRd], [CVRe]

STANDARD_OBSERVERS_CMFS [CaseInsensitiveMapping] **{'CIE 1931 2 Degree Standard Observer', 'CIE 1964 10 Degree Standard Observer', 'CIE 2012 2 Degree Standard Observer', 'CIE 2012 10 Degree Standard Observer'}**

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`

`RGB_2_degree_cmfs_to_XYZ_2_degree_cmfs(...)`	Converts *Wright & Guild 1931 2 Degree RGB CMFs* colour matching functions into the *CIE 1931 2 Degree Standard Observer* colour matching functions.
`RGB_10_degree_cmfs_to_XYZ_10_degree_cmfs(...)`	Converts *Stiles & Burch 1959 10 Degree RGB CMFs* colour matching functions into the *CIE 1964 10 Degree Standard Observer* colour matching functions.
`RGB_10_degree_cmfs_to_LMS_10_degree_cmfs(...)`	Converts *Stiles & Burch 1959 10 Degree RGB CMFs* colour matching functions into the *Stockman & Sharpe 10 Degree Cone Fundamentals* spectral sensitivity functions.
`LMS_2_degree_cmfs_to_XYZ_2_degree_cmfs(...)`	Converts *Stockman & Sharpe 2 Degree Cone Fundamentals* colour matching functions into the *CIE 2012 2 Degree Standard Observer* colour matching functions.
`LMS_10_degree_cmfs_to_XYZ_10_degree_cmfs(...)`	Converts *Stockman & Sharpe 10 Degree Cone Fundamentals* colour matching functions into the *CIE 2012 10 Degree Standard Observer* 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*)

Converts *Wright & Guild 1931 2 Degree RGB CMFs* colour matching functions into the *CIE 1931 2 Degree Standard Observer* colour matching functions.

Parameters **wavelength** (`numeric or array_like`) – Wavelength λ in nm.

Returns *CIE 1931 2 Degree Standard Observer* spectral tristimulus values.

Return type ndarray

Notes

- Data for the *CIE 1931 2 Degree Standard Observer* already exists, this definition is intended for educational purpose.

References

[WS00i]

Examples

```
>>> from colour.utilities import numpy_print_options
>>> with numpy_print_options(suppress=True):
...     RGB_2_degree_cmfs_to_XYZ_2_degree_cmfs(700)  # doctest: +ELLIPSIS
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*)

Converts *Stiles & Burch 1959 10 Degree RGB CMFs* colour matching functions into the *CIE 1964 10 Degree Standard Observer* colour matching functions.

Parameters **wavelength** (numeric or array_like) – Wavelength λ in nm.

Returns *CIE 1964 10 Degree Standard Observer* spectral tristimulus values.

Return type ndarray

Notes

- Data for the *CIE 1964 10 Degree Standard Observer* already exists, this definition is intended for educational purpose.

References

[WS00m]

Examples

```
>>> from colour.utilities import numpy_print_options
>>> with numpy_print_options(suppress=True):
...     RGB_10_degree_cmfs_to_XYZ_10_degree_cmfs(700)  # doctest: +ELLIPSIS
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*)

Converts *Stiles & Burch 1959 10 Degree RGB CMFs* colour matching functions into the *Stockman & Sharpe 10 Degree Cone Fundamentals* spectral sensitivity functions.

Parameters **wavelength** (numeric or array_like) – Wavelength λ in nm.

Returns *Stockman & Sharpe 10 Degree Cone Fundamentals* spectral tristimulus values.

Return type 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)  # doctest: +ELLIPSIS
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*)

Converts *Stockman & Sharpe 2 Degree Cone Fundamentals* colour matching functions into the *CIE 2012 2 Degree Standard Observer* colour matching functions.

Parameters **wavelength** (numeric or array_like) – Wavelength λ in nm.

Returns *CIE 2012 2 Degree Standard Observer* spectral tristimulus values.

Return type ndarray

Notes

- Data for the *CIE 2012 2 Degree Standard Observer* already exists, this definition is intended for educational purpose.

References

[CVRb]

Examples

```
>>> from colour.utilities import numpy_print_options
>>> with numpy_print_options(suppress=True):
...     LMS_2_degree_cmfs_to_XYZ_2_degree_cmfs(700)  # doctest: +ELLIPSIS
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*)

Converts *Stockman & Sharpe 10 Degree Cone Fundamentals* colour matching functions into the *CIE 2012 10 Degree Standard Observer* colour matching functions.

Parameters **wavelength** (numeric or array_like) – Wavelength λ in nm.

Returns *CIE 2012 10 Degree Standard Observer* spectral tristimulus values.

Return type ndarray

Notes

- Data for the *CIE 2012 10 Degree Standard Observer* already exists, this definition is intended for educational purpose.

References

[CVRa]

Examples

```
>>> from colour.utilities import numpy_print_options
>>> with numpy_print_options(suppress=True):
...     LMS_10_degree_cmfs_to_XYZ_10_degree_cmfs(700)  # doctest: +ELLIPSIS
array([ 0.0098162...,  0.0037761...,  0.        ])
```

Illuminants and Light Sources

Dataset

colour

ILLUMINANTS	Aggregated *CIE* illuminants chromaticity coordinates.
ILLUMINANTS_SDS	*CIE* illuminants spectral distributions.
HUNTERLAB_ILLUMINANTS	Aggregated *Hunter L,a,b* illuminant dataset.
LIGHT_SOURCES	Aggregated light sources chromaticity coordinates.
LIGHT_SOURCES_SDS	Aggregated light sources spectral distributions.

colour.ILLUMINANTS

colour.**ILLUMINANTS = CaseInsensitiveMapping({'CIE 1931 2 Degree Standard Observer': ..., 'CIE 1964 10 Degree**

Aggregated *CIE* illuminants chromaticity coordinates.

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)
sd.interpolator = colour.LinearInterpolator
```

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```
colour.XYZ_to_xy(
    colour.sd_to_XYZ(
        sd, colour.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 litterature. Their chromaticity coordinates as given in [CIET14804d] are (0.34567, 0.35851) and (0.31272, 0.32903) respectively.

References

[CIET14804d], [DigitalCInitiatives07], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14c], [Wik06b]

ILLUMINANTS [CaseInsensitiveMapping] **{'CIE 1931 2 Degree Standard Observer', 'CIE 1964 10 Degree Standard Observer'}**

Aliases:

- 'cie_2_1931': 'CIE 1931 2 Degree Standard Observer'
- 'cie_10_1964': 'CIE 1964 10 Degree Standard Observer'

colour.ILLUMINANTS_SDS

colour.**ILLUMINANTS_SDS = CaseInsensitiveMapping({'A': ..., 'B': ..., 'C': ..., 'D50': ..., 'D55': ..., 'D60**

CIE illuminants spectral distributions.

Notes

CIE Illuminant D Series D60 illuminant spectral distribution was 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)
```

References

[CIE04], [CIE]

ILLUMINANTS_SDS : CaseInsensitiveMapping

colour.HUNTERLAB_ILLUMINANTS

colour.**HUNTERLAB_ILLUMINANTS = CaseInsensitiveMapping({'CIE 1931 2 Degree Standard Observer': ..., 'CIE 1964**

Aggregated *Hunter L,a,b* illuminant dataset.

References

[Hun08a], [Hun08b]

HUNTERLAB_ILLUMINANTS [CaseInsensitiveMapping] **{'CIE 1931 2 Degree Standard Observer', 'CIE 1964 10 Degree Standard Observer'}**

Aliases:

- 'cie_2_1931': 'CIE 1931 2 Degree Standard Observer'
- 'cie_10_1964': 'CIE 1964 10 Degree Standard Observer'

colour.LIGHT_SOURCES

`colour.LIGHT_SOURCES = CaseInsensitiveMapping({'CIE 1931 2 Degree Standard Observer': ..., 'CIE 1964 10 Degr`

Aggregated light sources chromaticity coordinates.

LIGHT_SOURCES [CaseInsensitiveMapping] **{'CIE 1931 2 Degree Standard Observer', 'CIE 1964 10 Degree Standard Observer'}**

Aliases:

- 'cie_2_1931': 'CIE 1931 2 Degree Standard Observer'
- 'cie_10_1964': 'CIE 1964 10 Degree Standard Observer'

colour.LIGHT_SOURCES_SDS

`colour.LIGHT_SOURCES_SDS = CaseInsensitiveMapping({'Natural': ..., 'Philips TL-84': ..., 'SA': ..., 'SC': .`

Aggregated light sources spectral distributions.

LIGHT_SOURCES_SDS : CaseInsensitiveMapping

Dominant Wavelength and Purity

`colour`

`dominant_wavelength`(xy, xy_n[, cmfs, reverse])	Returns 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.
`complementary_wavelength`(xy, xy_n[, cmfs])	Returns 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.
`excitation_purity`(xy, xy_n[, cmfs])	Returns the *excitation purity* P_e for given colour stimulus xy.
`colorimetric_purity`(xy, xy_n[, cmfs])	Returns the *colorimetric purity* P_c for given colour stimulus xy.

colour.dominant_wavelength

colour.**dominant_wavelength**(*xy*, *xy_n*, *cmfs=XYZ_ColourMatchingFunctions(name='CIE 1931 2 Degree Standard Observer', ...)*, *reverse=False*)

Returns 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 than xy_wl first intersection coordinates will be set to the *complementary dominant wavelength* intersection coordinates with the spectral locus.

Parameters

- **xy** (array_like) – Colour stimulus *xy* chromaticity coordinates.
- **xy_n** (array_like) – Achromatic stimulus *xy* chromaticity coordinates.
- **cmfs** (XYZ_ColourMatchingFunctions, optional) – Standard observer colour matching functions.
- **reverse** (bool, optional) – Reverse the computation direction to retrieve the *complementary wavelength*.

Returns *Dominant wavelength*, first intersection point *xy* chromaticity coordinates, second intersection point *xy* chromaticity coordinates.

Return type tuple

References

[CIET14804b], [Erdb]

Examples

Dominant wavelength computation:

```
>>> from pprint import pprint
>>> xy = np.array([0.54369557, 0.32107944])
>>> xy_n = np.array([0.31270000, 0.32900000])
>>> cmfs = CMFS['CIE 1931 2 Degree Standard Observer']
>>> pprint(dominant_wavelength(xy, xy_n, cmfs))  # doctest: +ELLIPSIS
(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, cmfs))  # doctest: +ELLIPSIS
(array(-509.0),
 array([ 0.4572314...,  0.1362814...]),
 array([ 0.0104096...,  0.7320745...]))
```

colour.complementary_wavelength

colour.**complementary_wavelength**(*xy*, *xy_n*, *cmfs=XYZ_ColourMatchingFunctions(name='CIE 1931 2 Degree Standard Observer', ...)*)

Returns 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** (array_like) – Colour stimulus *xy* chromaticity coordinates.
- **xy_n** (array_like) – Achromatic stimulus *xy* chromaticity coordinates.
- **cmfs** (XYZ_ColourMatchingFunctions, optional) – Standard observer colour matching functions.

Returns *Complementary wavelength*, first intersection point *xy* chromaticity coordinates, second intersection point *xy* chromaticity coordinates.

Return type tuple

References

[CIET14804b], [Erdb]

Examples

Complementary wavelength computation:

```
>>> from pprint import pprint
>>> xy = np.array([0.37605506, 0.24452225])
>>> xy_n = np.array([0.31270000, 0.32900000])
>>> cmfs = CMFS['CIE 1931 2 Degree Standard Observer']
>>> pprint(complementary_wavelength(xy, xy_n, cmfs))  # doctest: +ELLIPSIS
(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, cmfs))  # doctest: +ELLIPSIS
(array(492.0),
 array([ 0.0364795 ,  0.3384712...]),
 array([ 0.0364795 ,  0.3384712...]))
```

colour.excitation_purity

colour.**excitation_purity**(*xy*, *xy_n*, *cmfs=XYZ_ColourMatchingFunctions(name='CIE 1931 2 Degree Standard Observer', ...)*)

Returns the *excitation purity* P_e for given colour stimulus xy.

Parameters

- **xy** (array_like) – Colour stimulus *xy* chromaticity coordinates.
- **xy_n** (array_like) – Achromatic stimulus *xy* chromaticity coordinates.
- **cmfs** (XYZ_ColourMatchingFunctions, optional) – Standard observer colour matching functions.

Returns *Excitation purity* P_e.

Return type numeric or array_like

References

[CIET14804b], [Erdb]

Examples

```
>>> xy = np.array([0.54369557, 0.32107944])
>>> xy_n = np.array([0.31270000, 0.32900000])
>>> cmfs = CMFS['CIE 1931 2 Degree Standard Observer']
>>> excitation_purity(xy, xy_n, cmfs)  # doctest: +ELLIPSIS
0.6228856...
```

colour.colorimetric_purity

colour.**colorimetric_purity**(*xy*, *xy_n*, *cmfs=XYZ_ColourMatchingFunctions(name='CIE 1931 2 Degree Standard Observer', ...)*)

Returns the *colorimetric purity* P_c for given colour stimulus xy.

Parameters

- **xy** (array_like) – Colour stimulus *xy* chromaticity coordinates.
- **xy_n** (array_like) – Achromatic stimulus *xy* chromaticity coordinates.
- **cmfs** (XYZ_ColourMatchingFunctions, optional) – Standard observer colour matching functions.

Returns *Colorimetric purity* P_c.

Return type numeric or array_like

References

[CIET14804b], [Erdb]

Examples

```
>>> xy = np.array([0.54369557, 0.32107944])
>>> xy_n = np.array([0.31270000, 0.32900000])
>>> cmfs = CMFS['CIE 1931 2 Degree Standard Observer']
>>> colorimetric_purity(xy, xy_n, cmfs)  # doctest: +ELLIPSIS
0.6135828...
```

Luminous Efficiency Functions

colour

luminous_efficacy(sd[, lef])	Returns the *luminous efficacy* in $lm \cdot W^{-1}$ of given spectral distribution using given luminous efficiency function.
luminous_efficiency(sd[, lef])	Returns the *luminous efficiency* of given spectral distribution using given luminous efficiency function.
luminous_flux(sd[, lef, K_m])	Returns the *luminous flux* for given spectral distribution using given luminous efficiency function.
sd_mesopic_luminous_efficiency_function(Lp)	Returns the mesopic luminous efficiency function $V_m(\lambda)$ for given photopic luminance L_p.

colour.luminous_efficacy

colour.**luminous_efficacy**(*sd*, *lef=SpectralDistribution(name='CIE 1924 Photopic Standard Observer', ...)*)

Returns 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, optional) – $V(\lambda)$ luminous efficiency function.

Returns Luminous efficacy in $lm \cdot W^{-1}$.

Return type numeric

References

[Wik05d]

Examples

```
>>> from colour import LIGHT_SOURCES_SDS
>>> sd = LIGHT_SOURCES_SDS['Neodimium Incandescent']
>>> luminous_efficacy(sd)  # doctest: +ELLIPSIS
136.2170803...
```

colour.luminous_efficiency

colour.**luminous_efficiency**(*sd*, *lef=SpectralDistribution(name='CIE 1924 Photopic Standard Observer', ...)*)

Returns the *luminous efficiency* of given spectral distribution using given luminous efficiency function.

Parameters

- **sd** (SpectralDistribution) – test spectral distribution
- **lef** (SpectralDistribution, optional) – $V(\lambda)$ luminous efficiency function.

Returns Luminous efficiency.

Return type numeric

References

[Wik03c]

Examples

```
>>> from colour import LIGHT_SOURCES_SDS
>>> sd = LIGHT_SOURCES_SDS['Neodimium Incandescent']
>>> luminous_efficiency(sd)  # doctest: +ELLIPSIS
0.1994393...
```

colour.luminous_flux

colour.**luminous_flux**(*sd*, *lef=SpectralDistribution(name='CIE 1924 Photopic Standard Observer', ...)*, *K_m=683.0*)

Returns the *luminous flux* for given spectral distribution using given luminous efficiency function.

Parameters

- **sd** (SpectralDistribution) – test spectral distribution
- **lef** (SpectralDistribution, optional) – $V(\lambda)$ luminous efficiency function.
- **K_m** (numeric, optional) – $lm \cdot W^{-1}$ maximum photopic luminous efficiency

Returns Luminous flux.

Return type numeric

References

[Wik03c]

Examples

```
>>> from colour import LIGHT_SOURCES_SDS
>>> sd = LIGHT_SOURCES_SDS['Neodimium Incandescent']
>>> luminous_flux(sd)  # doctest: +ELLIPSIS
23807.6555273...
```

colour.sd_mesopic_luminous_efficiency_function

colour.**sd_mesopic_luminous_efficiency_function**(*Lp, source='Blue Heavy', method='MOVE', photopic_lef=SpectralDistribution(name='CIE 1924 Photopic Standard Observer', ...), scotopic_lef=SpectralDistribution(name='CIE 1951 Scotopic Standard Observer', ...)*)

Returns the mesopic luminous efficiency function $V_m(\lambda)$ for given photopic luminance L_p.

Parameters

- **Lp** (numeric) – Photopic luminance L_p.
- **source** (unicode, optional) – **{'Blue Heavy', 'Red Heavy'}**, Light source colour temperature.
- **method** (unicode, optional) – **{'MOVE', 'LRC'}**, Method to calculate the weighting factor.
- **photopic_lef** (SpectralDistribution, optional) – $V(\lambda)$ photopic luminous efficiency function.
- **scotopic_lef** (SpectralDistribution, optional) – $V'(\lambda)$ scotopic luminous efficiency function.

Returns Mesopic luminous efficiency function $V_m(\lambda)$.

Return type *SpectralDistribution*

References

[Wik05e]

Examples

```
>>> from colour.utilities import numpy_print_options
>>> with numpy_print_options(suppress=True):
...     sd_mesopic_luminous_efficiency_function(0.2)  # doctest: +ELLIPSIS
SpectralDistribution([[ 380.        ,    0.000424 ...],
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                      [ 385.        ,    0.0007929...],
                      [ 386.        ,    0.000907 ...],
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                        [ 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...]],
                       interpolator=SpragueInterpolator,
                       interpolator_args={},
                       extrapolator=Extrapolator,
                       extrapolator_args={...})
```

Dataset

`colour`

LEFS	Aggregated luminous efficiency functions.

Continued on next page

Table 114 – continued from previous page

PHOTOPIC_LEFS	Photopic luminous efficiency functions.
SCOTOPIC_LEFS	Scotopic luminous efficiency functions.

colour.LEFS

colour.**LEFS = CaseInsensitiveMapping({'CIE 1924 Photopic Standard Observer': ..., 'Judd Modified CIE 1951 Ph**

Aggregated luminous efficiency functions.

References

[CVRc], [CVRe], [Wik05e]

LEFS [CaseInsensitiveMapping] **{'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 1951 Scotopic Standard Observer'}**

colour.PHOTOPIC_LEFS

colour.**PHOTOPIC_LEFS = CaseInsensitiveMapping({'CIE 1924 Photopic Standard Observer': ..., 'Judd Modified CI**

Photopic luminous efficiency functions.

References

[CVRc], [CVRe]

PHOTOPIC_LEFS [CaseInsensitiveMapping] **{'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'}**

Aliases:

- 'cie_2_1924': 'CIE 1931 2 Degree Standard Observer'
- 'cie_10_1964': 'CIE 1964 Photopic 10 Degree Standard Observer'

colour.SCOTOPIC_LEFS

colour.**SCOTOPIC_LEFS = CaseInsensitiveMapping({'CIE 1951 Scotopic Standard Observer': ..., 'cie_1951': ...}**

Scotopic luminous efficiency functions.

References

[CVRe]

SCOTOPIC_LEFS [CaseInsensitiveMapping] **{'CIE 1951 Scotopic Standard Observer', }**

Aliases:

- 'cie_1951': 'CIE 1951 Scotopic Standard Observer'

Lightness Computation

colour

lightness(Y[, method])	Returns the *Lightness* L of given *luminance* Y using given method.
LIGHTNESS_METHODS	Supported *Lightness* computations methods.

colour.lightness

colour.**lightness**(*Y*, *method='CIE 1976'*, ***kwargs*)

Returns the *Lightness* L of given *luminance* Y using given method.

Parameters

- **Y** (numeric or array_like) – *luminance* Y.
- **method** (unicode, optional) – **{'CIE 1976', 'Glasser 1958', 'Wyszecki 1963', 'Fairchild 2010', 'Fairchild 2011'}**, Computation method.

Other Parameters

- **Y_n** (*numeric or array_like, optional*) – {colour.colorimetry.lightness_CIE1976()}, White reference *luminance* Y_n.
- **epsilon** (*numeric or array_like, optional*) – {colour.colorimetry.lightness_Fairchild2010(), colour.colorimetry.lightness_Fairchild2011()}, ϵ exponent.

Returns *Lightness* L.

Return type numeric or array_like

Notes

Domain	Scale - Reference	Scale - 1
Y	[0, 100]	[0, 1]

Range	Scale - Reference	Scale - 1
L	[0, 100]	[0, 1]

References

[CIET14804f], [FW10], [FC11], [GMRS58], [Wik07d], [Wys63], [WS00c]

Examples

```
>>> lightness(12.19722535)  # doctest: +ELLIPSIS
41.5278758...
>>> lightness(12.19722535, Y_n=100)  # doctest: +ELLIPSIS
41.5278758...
```

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```
>>> lightness(12.19722535, Y_n=95)  # doctest: +ELLIPSIS
42.5199307...
>>> lightness(12.19722535, method='Glasser 1958')  # doctest: +ELLIPSIS
39.8351264...
>>> lightness(12.19722535, method='Wyszecki 1963')  # doctest: +ELLIPSIS
40.5475745...
>>> lightness(12.19722535, epsilon=0.710, method='Fairchild 2011')
... # doctest: +ELLIPSIS
29.8295108...
```

colour.LIGHTNESS_METHODS

colour.**LIGHTNESS_METHODS = CaseInsensitiveMapping({'Glasser 1958': ..., 'Wyszecki 1963': ..., 'CIE 1976': .**

Supported *Lightness* computations methods.

References

[CIET14804f], [FW10], [FC11], [GMRS58], [Wys63], [WS00c]

LIGHTNESS_METHODS [CaseInsensitiveMapping] **{'Glasser 1958', 'Wyszecki 1963', 'CIE 1976', 'Fairchild 2010', 'Fairchild 2011'}**

Aliases:

- 'Lstar1976': 'CIE 1976'

Glasser, Mckinney, Reilly and Schnelle (1958)

colour.colorimetry

lightness_Glasser1958(Y)	Returns the *Lightness* L of given *luminance* Y using *Glasser et al.(1958)* method..

colour.colorimetry.lightness_Glasser1958

colour.colorimetry.**lightness_Glasser1958**(Y)

Returns the *Lightness* L of given *luminance* Y using *Glasser et al. (1958)* method.

Parameters **Y** (numeric or array_like) – *luminance* Y.

Returns *Lightness* L.

Return type numeric or array_like

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)  # doctest: +ELLIPSIS
39.8351264...
```

Wyszecki (1963)

colour.colorimetry

lightness_Wyszecki1963(Y)	Returns the *Lightness* W of given *luminance* Y using *Wyszecki (1963)* method.

colour.colorimetry.lightness_Wyszecki1963

colour.colorimetry.**lightness_Wyszecki1963**(Y)

Returns the *Lightness* W of given *luminance* Y using *Wyszecki (1963)* method.

Parameters **Y** (numeric or array_like) – *luminance* Y.

Returns *Lightness* W.

Return type numeric or array_like

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)  # doctest: +ELLIPSIS
40.5475745...
```

CIE 1976

colour.colorimetry

lightness_CIE1976(Y[, Y_n])	Returns the *Lightness* L^* of given *luminance* Y using given reference white *luminance* Y_n as per *CIE 1976* recommendation.
intermediate_lightness_function_CIE1976(Y[, Y_n])	Returns the intermediate value $f(Y/Yn)$ in the *Lightness* L^* computation for given *luminance* Y using given reference white *luminance* Y_n as per *CIE 1976* recommendation.

colour.colorimetry.lightness_CIE1976

colour.colorimetry.**lightness_CIE1976**(*Y*, *Y_n=100*)

Returns the *Lightness* L^* of given *luminance* Y using given reference white *luminance* Y_n as per *CIE 1976* recommendation.

Parameters

- **Y** (numeric or array_like) – *luminance* Y.
- **Y_n** (numeric or array_like, optional) – White reference *luminance* Y_n.

Returns *Lightness* L^*.

Return type numeric or array_like

Notes

Domain	Scale - Reference	Scale - 1
Y	[0, 100]	[0, 1]

Range	Scale - Reference	Scale - 1
L_star	[0, 100]	[0, 1]

References

[CIET14804f], [WS00c]

Examples

```
>>> lightness_CIE1976(12.19722535)  # doctest: +ELLIPSIS
41.5278758...
```

colour.colorimetry.intermediate_lightness_function_CIE1976

`colour.colorimetry.`**`intermediate_lightness_function_CIE1976`**(*Y*, *Y_n=100*)

Returns the intermediate value $f(Y/Yn)$ in the *Lightness* L^* computation for given *luminance* Y using given reference white *luminance* Y_n as per *CIE 1976* recommendation.

Parameters

- **Y** (numeric or array_like) – *luminance* Y.
- **Y_n** (numeric or array_like, optional) – White reference *luminance* Y_n.

Returns Intermediate value $f(Y/Yn)$.

Return type numeric or array_like

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

[CIET14804f], [WS00c]

Examples

```
>>> intermediate_lightness_function_CIE1976(12.19722535)
... # doctest: +ELLIPSIS
0.4959299...
>>> intermediate_lightness_function_CIE1976(12.19722535, 95)
... # doctest: +ELLIPSIS
0.5044821...
```

Fairchild and Wyble (2010)

`colour.colorimetry`

`lightness_Fairchild2010`(Y[, epsilon])	Computes *Lightness* L_{hdr} of given *luminance* Y using *Fairchild and Wyble (2010)* method according to *Michealis-Menten* kinetics.

colour.colorimetry.lightness_Fairchild2010

`colour.colorimetry.`**`lightness_Fairchild2010`**(*Y*, *epsilon=1.836*)

Computes *Lightness* L_{hdr} of given *luminance* Y using *Fairchild and Wyble (2010)* method according to

Michealis-Menten kinetics.

Parameters

- **Y** (array_like) – *luminance* Y.
- **epsilon** (numeric or array_like, optional) – ϵ exponent.

Returns *Lightness* L_{hdr}.

Return type array_like

Warning: The input domain of that definition is non standard!

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)  # doctest: +ELLIPSIS
31.9963902...
```

Fairchild and Chen (2011)

colour.colorimetry

lightness_Fairchild2011(Y[, epsilon, method])	Computes *Lightness* L_{hdr} of given *luminance* Y using *Fairchild and Chen (2011)* method according to *Michealis-Menten* kinetics.

colour.colorimetry.lightness_Fairchild2011

colour.colorimetry.**lightness_Fairchild2011**(*Y*, *epsilon=0.474*, *method='hdr-CIELAB'*)

Computes *Lightness* L_{hdr} of given *luminance* Y using *Fairchild and Chen (2011)* method according to *Michealis-Menten* kinetics.

Parameters

- **Y** (array_like) – *luminance* Y.

- **epsilon** (numeric or array_like, optional) – ϵ exponent.
- **method** (unicode, optional) – **{'hdr-CIELAB', 'hdr-IPT'}**, *Lightness* L_{hdr} computation method.

Returns *Lightness* L_{hdr}.

Return type array_like

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)  # doctest: +ELLIPSIS
51.8529584...
>>> lightness_Fairchild2011(12.19722535 / 100, method='hdr-IPT')
... # doctest: +ELLIPSIS
51.6431084...
```

Luminance Computation

colour

luminance(LV[, method])	Returns the *luminance* Y of given *Lightness* L^* or given *Munsell* value V.
LUMINANCE_METHODS	Supported *luminance* computations methods.

colour.luminance

colour.**luminance**(*LV*, *method='CIE 1976'*, ***kwargs*)

Returns the *luminance* Y of given *Lightness* L^* or given *Munsell* value V.

Parameters

- **LV** (numeric or array_like) – *Lightness* L^* or *Munsell* value V.
- **method** (unicode, optional) – **{'CIE 1976', 'Newhall 1943', 'ASTM D1535-08', 'Fairchild 2010', 'Fairchild 2011'}**, Computation method.

Other Parameters

- **Y_n** (*numeric or array_like, optional*) – {colour.colorimetry.luminance_CIE1976()}, White reference *luminance* Y_n.
- **epsilon** (*numeric or array_like, optional*) – {colour.colorimetry.lightness_Fairchild2010(), colour.colorimetry.lightness_Fairchild2011()}, ϵ exponent.

Returns *luminance* Y.

Return type numeric or array_like

Notes

Domain	Scale - Reference	Scale - 1
LV	[0, 100]	[0, 1]

Range	Scale - Reference	Scale - 1
Y	[0, 100]	[0, 1]

References

[ASTMInternational08], [CIET14804f], [FW10], [FC11], [NNJ43], [Wik01c], [WS00c]

Examples

```
>>> luminance(41.527875844653451)  # doctest: +ELLIPSIS
12.1972253...
>>> luminance(41.527875844653451, Y_n=100)  # doctest: +ELLIPSIS
12.1972253...
>>> luminance(42.51993072812094, Y_n=95)  # doctest: +ELLIPSIS
12.1972253...
>>> luminance(4.08244375 * 10, method='Newhall 1943')
... # doctest: +ELLIPSIS
12.5500788...
>>> luminance(4.08244375 * 10, method='ASTM D1535-08')
... # doctest: +ELLIPSIS
12.2363426...
>>> luminance(29.829510892279330, epsilon=0.710, method='Fairchild 2011')
... # doctest: +ELLIPSIS
12.1972253...
```

colour.LUMINANCE_METHODS

colour.**LUMINANCE_METHODS = CaseInsensitiveMapping({'Newhall 1943': ..., 'ASTM D1535-08': ..., 'CIE 1976': .**

Supported *luminance* computations methods.

References

[ASTMInternational08], [CIET14804f], [FW10], [FC11], [NNJ43], [WS00c]

LUMINANCE_METHODS [CaseInsensitiveMapping] **{'Newhall 1943', 'ASTM D1535-08', 'CIE 1976', 'Fairchild 2010'}**

Aliases:

- 'astm2008': 'ASTM D1535-08'
- 'cie1976': 'CIE 1976'

Newhall, Nickerson and Judd (1943)

colour.colorimetry

`luminance_Newhall1943`(V)	Returns the *luminance* R_Y of given *Munsell* value V using *Newhall et al.(1943)* method..

colour.colorimetry.luminance_Newhall1943

colour.colorimetry.**luminance_Newhall1943**(V)

Returns the *luminance* R_Y of given *Munsell* value V using *Newhall et al. (1943)* method.

Parameters **V** (numeric or array_like) – *Munsell* value V.

Returns *luminance* R_Y.

Return type numeric or array_like

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)  # doctest: +ELLIPSIS
12.5500788...
```

CIE 1976

colour.colorimetry

`luminance_CIE1976`(L_star[, Y_n])	Returns the *luminance* Y of given *Lightness* L^* with given reference white *luminance* Y_n.
`intermediate_luminance_function_CIE1976`(f_Y_Y_n)	Returns the *luminance* Y in the *luminance* Y computation for given intermediate value $f(Y/Yn)$ using given reference white *luminance* Y_n as per *CIE 1976* recommendation.

colour.colorimetry.luminance_CIE1976

`colour.colorimetry.`**`luminance_CIE1976`**(*L_star*, *Y_n=100*)

Returns the *luminance* Y of given *Lightness* L^* with given reference white *luminance* Y_n.

Parameters

- **L_star** (numeric or array_like) – *Lightness* L^*
- **Y_n** (numeric or array_like) – White reference *luminance* Y_n.

Returns *luminance* Y.

Return type numeric or array_like

Notes

Domain	Scale - Reference	Scale - 1
L_star	[0, 100]	[0, 1]

Range	Scale - Reference	Scale - 1
Y	[0, 100]	[0, 1]

References

[CIET14804f], [WS00c]

Examples

```
>>> luminance_CIE1976(41.527875844653451)  # doctest: +ELLIPSIS
12.1972253...
>>> luminance_CIE1976(41.527875844653451, 95)  # doctest: +ELLIPSIS
11.5873640...
```

colour.colorimetry.intermediate_luminance_function_CIE1976

`colour.colorimetry.`**`intermediate_luminance_function_CIE1976`**(*f_Y_Y_n*, *Y_n=100*)

Returns the *luminance* Y in the *luminance* Y computation for given intermediate value $f(Y/Yn)$ using given reference white *luminance* Y_n as per *CIE 1976* recommendation.

Parameters

- **f_Y_Y_n** (numeric or array_like) – Intermediate value $f(Y/Yn)$.

- **Y_n** (numeric or array_like) – White reference *luminance* Y_n.

Returns *luminance* Y.

Return type numeric or array_like

Notes

Domain	Scale - Reference	Scale - 1
f_Y_Y_n	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
Y	[0, 100]	[0, 100]

References

[CIET14804f], [WS00c]

Examples

```
>>> intermediate_luminance_function_CIE1976(0.495929964178047)
... # doctest: +ELLIPSIS
12.1972253...
>>> intermediate_luminance_function_CIE1976(0.504482161449319, 95)
... # doctest: +ELLIPSIS
12.1972253...
```

ASTM D1535-08e1

colour.colorimetry

luminance_ASTMD153508(V)	Returns the *luminance* Y of given *Munsell* value V using *ASTM D1535-08e1* method.

colour.colorimetry.luminance_ASTMD153508

colour.colorimetry.**luminance_ASTMD153508**(V)

Returns the *luminance* Y of given *Munsell* value V using *ASTM D1535-08e1* method.

Parameters **V** (numeric or array_like) – *Munsell* value V.

Returns *luminance* Y.

Return type numeric or array_like

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_ASTMD153508(4.08244375)  # doctest: +ELLIPSIS
12.2363426...
```

Fairchild and Wyble (2010)

colour.colorimetry

luminance_Fairchild2010(L_hdr[, epsilon])	Computes *luminance* Y of given *Lightness* L_{hdr} using *Fairchild and Wyble (2010)* method according to *Michealis-Menten* kinetics.

colour.colorimetry.luminance_Fairchild2010

colour.colorimetry.**luminance_Fairchild2010**(*L_hdr*, *epsilon=1.836*)

Computes *luminance* Y of given *Lightness* L_{hdr} using *Fairchild and Wyble (2010)* method according to *Michealis-Menten* kinetics.

Parameters

- **L_hdr** (array_like) – *Lightness* L_{hdr}.
- **epsilon** (numeric or array_like, optional) – ϵ exponent.

Returns *luminance* Y.

Return type array_like

> **Warning:** The output range of that definition is non standard!

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)
... # doctest: +ELLIPSIS
0.1219722...
```

Fairchild and Chen (2011)

colour.colorimetry

luminance_Fairchild2011(L_hdr[, epsilon, method])	Computes *luminance* Y of given *Lightness* L_{hdr} using *Fairchild and Chen (2011)* method according to *Michealis-Menten* kinetics.

colour.colorimetry.luminance_Fairchild2011

colour.colorimetry.**luminance_Fairchild2011**(*L_hdr*, *epsilon=0.474*, *method='hdr-CIELAB'*)

Computes *luminance* Y of given *Lightness* L_{hdr} using *Fairchild and Chen (2011)* method according to *Michealis-Menten* kinetics.

Parameters

- **L_hdr** (array_like) – *Lightness* L_{hdr}.
- **epsilon** (numeric or array_like, optional) – ϵ exponent.
- **method** (unicode, optional) – **{'hdr-CIELAB', 'hdr-IPT'}**, *Lightness* L_{hdr} computation method.

Returns *luminance* Y.

Return type array_like

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)  # doctest: +ELLIPSIS
0.1219722...
>>> luminance_Fairchild2011(51.643108411718522, method='hdr-IPT')
... # doctest: +ELLIPSIS
0.1219722...
```

Whiteness Computation

colour

whiteness([method])	Returns the *whiteness* W using given method.
WHITENESS_METHODS	Supported *whiteness* computations methods.

colour.whiteness

colour.**whiteness**(*method='CIE 2004', **kwargs*)

Returns the *whiteness* W using given method.

Parameters **method** (unicode, optional) – **{'CIE 2004', 'Berger 1959', 'Taube 1960', 'Stensby 1968', 'ASTM E313', 'Ganz 1979'}**, Computation method.

Other Parameters

- **XYZ** (*array_like*) – {colour.colorimetry.whiteness_Berger1959(), colour.colorimetry.whiteness_Taube1960(), colour.colorimetry.whiteness_ASTME313()}, *CIE XYZ* tristimulus values of sample.
- **XYZ_0** (*array_like*) – {colour.colorimetry.whiteness_Berger1959(), colour.colorimetry.whiteness_Taube1960()}, *CIE XYZ* tristimulus values of reference white.
- **Lab** (*array_like*) – {colour.colorimetry.whiteness_Stensby1968()}, *CIE L*a*b** colourspace array of sample.
- **xy** (*array_like*) – {colour.colorimetry.whiteness_Ganz1979(), colour.colorimetry.whiteness_CIE2004()}, Chromaticity coordinates *xy* of sample.
- **Y** (*numeric or array_like*) – {colour.colorimetry.whiteness_Ganz1979(), colour.colorimetry.whiteness_CIE2004()}, Tristimulus Y value of sample.
- **xy_n** (*array_like*) – {colour.colorimetry.whiteness_CIE2004()}, Chromaticity coordinates *xy_n* of perfect diffuser.

- **observer** (*unicode, optional*) – {colour.colorimetry.whiteness_CIE2004()}, **{'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.

Return type numeric or 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]
XYZ	[0, 100]	[0, 1]
XYZ_0	[0, 100]	[0, 1]
Y	[0, 100]	[0, 1]

Range	Scale - Reference	Scale - 1
W	[0, 100]	[0, 1]

References

[CIET14804i], [WS00k], [XRP12], [Wik04c]

Examples

```
>>> import numpy as np
>>> xy = np.array([0.3167, 0.3334])
>>> Y = 100
>>> xy_n = np.array([0.3139, 0.3311])
>>> whiteness(xy=xy, Y=Y, xy_n=xy_n)  # doctest: +ELLIPSIS
array([ 93.85...,  -1.305...])
>>> XYZ = np.array([95.00000000, 100.00000000, 105.00000000])
>>> XYZ_0 = np.array([94.80966767, 100.00000000, 107.30513595])
>>> method = 'Taube 1960'
>>> whiteness(XYZ=XYZ, XYZ_0=XYZ_0, method=method)  # doctest: +ELLIPSIS
91.4071738...
```

colour.WHITENESS_METHODS

colour.**WHITENESS_METHODS = CaseInsensitiveMapping({'Berger 1959': ..., 'Taube 1960': ..., 'Stensby 1968': .**

Supported *whiteness* computations methods.

References

[CIET14804i], [XRP12]

WHITENESS_METHODS [CaseInsensitiveMapping] **{'CIE 2004', 'Berger 1959', 'Taube 1960', 'Stensby 1968', 'ASTM E313', 'Ganz 1979', 'CIE 2004'}**

Aliases:

- 'cie2004': 'CIE 2004'

Berger (1959)

colour.colorimetry

whiteness_Berger1959(XYZ, XYZ_0)	Returns the *whiteness* index WI of given sample *CIE XYZ* tristimulus values using *Berger (1959)* method.

colour.colorimetry.whiteness_Berger1959

colour.colorimetry.**whiteness_Berger1959**(*XYZ*, *XYZ_0*)

Returns the *whiteness* index WI of given sample *CIE XYZ* tristimulus values using *Berger (1959)* method.

Parameters

- **XYZ** (array_like) – *CIE XYZ* tristimulus values of sample.
- **XYZ_0** (array_like) – *CIE XYZ* tristimulus values of reference white.

Returns *Whiteness* WI.

Return type numeric or 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

[XRP12]

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)  # doctest: +ELLIPSIS
30.3638017...
```

Taube (1960)

colour.colorimetry

whiteness_Taube1960(XYZ, XYZ_0)	Returns the *whiteness* index WI of given sample *CIE XYZ* tristimulus values using *Taube (1960)* method.

colour.colorimetry.whiteness_Taube1960

colour.colorimetry.**whiteness_Taube1960**(*XYZ*, *XYZ_0*)

Returns the *whiteness* index WI of given sample *CIE XYZ* tristimulus values using *Taube (1960)* method.

Parameters

- **XYZ** (array_like) – *CIE XYZ* tristimulus values of sample.
- **XYZ_0** (array_like) – *CIE XYZ* tristimulus values of reference white.

Returns *Whiteness* WI.

Return type numeric or 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

[XRP12]

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)  # doctest: +ELLIPSIS
91.4071738...
```

Stensby (1968)

colour.colorimetry

whiteness_Stensby1968(Lab)	Returns 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*)

Returns the *whiteness* index WI of given sample *CIE L*a*b** colourspace array using *Stensby (1968)* method.

Parameters **Lab** (array_like) – *CIE L*a*b** colourspace array of sample.

Returns *Whiteness* WI.

Return type numeric or 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
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

[XRP12]

Examples

```
>>> import numpy as np
>>> Lab = np.array([100.00000000, -2.46875131, -16.72486654])
>>> whiteness_Stensby1968(Lab)  # doctest: +ELLIPSIS
142.7683456...
```

ASTM E313

colour.colorimetry

whiteness_ASTME313(XYZ)	Returns the *whiteness* index WI of given sample *CIE XYZ* tristimulus values using *ASTM E313* method.

colour.colorimetry.whiteness_ASTME313

colour.colorimetry.**whiteness_ASTME313**(*XYZ*)

Returns the *whiteness* index WI of given sample *CIE XYZ* tristimulus values using *ASTM E313* method.

Parameters **XYZ** (array_like) – *CIE XYZ* tristimulus values of sample.

Returns *Whiteness* WI.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
XYZ	[0, 100]	[0, 1]

Range	Scale - Reference	Scale - 1
WI	[0, 100]	[0, 1]

References

[XRP12]

Examples

```
>>> import numpy as np
>>> XYZ = np.array([95.00000000, 100.00000000, 105.00000000])
>>> whiteness_ASTME313(XYZ)  # doctest: +ELLIPSIS
55.7400000...
```

Ganz and Griesser (1979)

colour.colorimetry

whiteness_Ganz1979(xy, Y)	Returns the *whiteness* index W and *tint* T of given sample *xy* chromaticity coordinates using *Ganz and Griesser (1979)* method.

colour.colorimetry.whiteness_Ganz1979

colour.colorimetry.**whiteness_Ganz1979**(*xy*, *Y*)

Returns the *whiteness* index W and *tint* T of given sample *xy* chromaticity coordinates using *Ganz and Griesser (1979)* method.

Parameters

- **xy** (array_like) – Chromaticity coordinates *xy* of sample.
- **Y** (numeric or array_like) – Tristimulus Y value of sample.

Returns *Whiteness* W and *tint* T.

Return type 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

[XRP12]

Examples

```
>>> import numpy as np
>>> xy = np.array([0.3167, 0.3334])
>>> whiteness_Ganz1979(xy, 100)  # doctest: +ELLIPSIS
array([ 85.6003766...,   0.6789003...])
```

CIE 2004

colour.colorimetry

whiteness_CIE2004(xy, Y, xy_n[, observer])	Returns the *whiteness* W or W_{10} and *tint* T or T_{10} of given sample *xy* chromaticity coordinates using *CIE 2004* method.

colour.colorimetry.whiteness_CIE2004

colour.colorimetry.**whiteness_CIE2004**(*xy*, *Y*, *xy_n*, *observer='CIE 1931 2 Degree Standard Observer'*)

Returns the *whiteness* W or W_{10} and *tint* T or T_{10} of given sample *xy* chromaticity coordinates using *CIE 2004* method.

Parameters

- **xy** (array_like) – Chromaticity coordinates *xy* of sample.
- **Y** (numeric or array_like) – Tristimulus Y value of sample.
- **xy_n** (array_like) – Chromaticity coordinates *xy_n* of perfect diffuser.
- **observer** (unicode, optional) – **{'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 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

[CIET14804i]

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)  # doctest: +ELLIPSIS
array([ 93.85...,  -1.305...])
```

Yellowness Computation

colour

yellowness(XYZ[, method])	Returns the *yellowness* W using given method.
YELLOWNESS_METHODS	Supported *yellowness* computations methods.

colour.yellowness

colour.**yellowness**(*XYZ*, *method='ASTM E313'*)

Returns the *yellowness* W using given method.

Parameters

- **XYZ** (array_like) – *CIE XYZ* tristimulus values of sample.
- **method** (unicode, optional) – **{'ASTM E313', 'ASTM D1925'}**, Computation method.

Returns *yellowness* Y.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
XYZ	[0, 100]	[0, 1]

Range	Scale - Reference	Scale - 1
YI	[0, 100]	[0, 1]

References

[XRP12]

Examples

```
>>> import numpy as np
>>> XYZ = np.array([95.00000000, 100.00000000, 105.00000000])
>>> yellowness(XYZ)  # doctest: +ELLIPSIS
```

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```
11.0650000...
>>> method = 'ASTM D1925'
>>> yellowness(XYZ, method=method)  # doctest: +ELLIPSIS
10.2999999...
```

colour.YELLOWNESS_METHODS

`colour.YELLOWNESS_METHODS = CaseInsensitiveMapping({'ASTM D1925': ..., 'ASTM E313': ...})`

Supported *yellowness* computations methods.

References

[XRP12]

YELLOWNESS_METHODS [CaseInsensitiveMapping] **{'ASTM E313', 'ASTM D1925'}**

ASTM D1925

`colour.colorimetry`

`yellowness_ASTMD1925`(XYZ)	Returns the *yellowness* index YI of given sample *CIE XYZ* tristimulus values using *ASTM D1925* method.

colour.colorimetry.yellowness_ASTMD1925

`colour.colorimetry.yellowness_ASTMD1925`(*XYZ*)

Returns 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** (array_like) – *CIE XYZ* tristimulus values of sample.

Returns *Whiteness* YI.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
XYZ	[0, 100]	[0, 1]

Range	Scale - Reference	Scale - 1
YI	[0, 100]	[0, 1]

References

[XRP12]

Examples

```
>>> import numpy as np
>>> XYZ = np.array([95.00000000, 100.00000000, 105.00000000])
>>> yellowness_ASTMD1925(XYZ)  # doctest: +ELLIPSIS
10.2999999...
```

ASTM E313

colour.colorimetry

yellowness_ASTME313(XYZ)	Returns the *yellowness* index YI of given sample *CIE XYZ* tristimulus values using *ASTM E313* method.

colour.colorimetry.yellowness_ASTME313

colour.colorimetry.**yellowness_ASTME313**(*XYZ*)

Returns 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** (array_like) – *CIE XYZ* tristimulus values of sample.

Returns *Whiteness* YI.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
XYZ	[0, 100]	[0, 1]

Range	Scale - Reference	Scale - 1
YI	[0, 100]	[0, 1]

References

[XRP12]

Examples

```
>>> import numpy as np
>>> XYZ = np.array([95.00000000, 100.00000000, 105.00000000])
>>> yellowness_ASTME313(XYZ)  # doctest: +ELLIPSIS
11.0650000...
```

Constants

- *CIE*
- *CODATA*
- *Common*

CIE

colour.constants

K_M	Rounded maximum photopic luminous efficiency K_m value in $lm \cdot W^{-1}$.
KP_M	Rounded maximum scotopic luminous efficiency K'_m value in $lm \cdot W^{-1}$.

colour.constants.K_M

colour.constants.**K_M = 683.0**

Rounded maximum photopic luminous efficiency K_m value in $lm \cdot W^{-1}$.

K_M : numeric

Notes

- To be adequate for all practical applications the K_m value has been rounded from the original 683.002 value.

References

[WS00g]

colour.constants.KP_M

colour.constants.**KP_M = 1700.0**

Rounded maximum scotopic luminous efficiency K'_m value in $lm \cdot W^{-1}$.

KP_M : numeric

Notes

- To be adequate for all practical applications the K'_m value has been rounded from the original 1700.06 value.

References

[WS00g]

CODATA

colour.constants

AVOGADRO_CONSTANT	Avogadro constant.
BOLTZMANN_CONSTANT	Boltzmann constant.
LIGHT_SPEED	Speed of light in vacuum.
PLANCK_CONSTANT	Planck constant.

colour.constants.AVOGADRO_CONSTANT

colour.constants.**AVOGADRO_CONSTANT = 6.02214179e+23**

Avogadro constant.

AVOGADRO_CONSTANT : numeric

colour.constants.BOLTZMANN_CONSTANT

colour.constants.**BOLTZMANN_CONSTANT = 1.38065e-23**

Boltzmann constant.

BOLTZMANN_CONSTANT : numeric

colour.constants.LIGHT_SPEED

colour.constants.**LIGHT_SPEED = 299792458.0**

Speed of light in vacuum.

LIGHT_SPEED : numeric

colour.constants.PLANCK_CONSTANT

colour.constants.**PLANCK_CONSTANT = 6.62607e-34**

Planck constant.

PLANCK_CONSTANT : numeric

Common

colour.constants

DEFAULT_FLOAT_DTYPE	alias of numpy.float64
EPSILON	
FLOATING_POINT_NUMBER_PATTERN	str(object='') -> str str(bytes_or_buffer[, encoding[, errors]]) -> str
INTEGER_THRESHOLD	Integer threshold value.

colour.constants.DEFAULT_FLOAT_DTYPE

colour.constants.**DEFAULT_FLOAT_DTYPE**
alias of numpy.float64

colour.constants.EPSILON

colour.constants.**EPSILON = 2.2204460492503131e-16**

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.

INTEGER_THRESHOLD : numeric

Contrast Sensitivity

- *Contrast Sensitivity*
- *Barten (1999) Contrast Sensitivity Function*

Contrast Sensitivity

colour

contrast_sensitivity_function([method])	Returns the contrast sensitivity S of the human eye according to the contrast sensitivity function (CSF) described by given method.
CONTRAST_SENSITIVITY_METHODS	Supported contrast sensitivity methods.

colour.contrast_sensitivity_function

colour.**contrast_sensitivity_function**(*method='Barten 1999', **kwargs*)

Returns the contrast sensitivity S of the human eye according to the contrast sensitivity function (CSF) described by given method.

Parameters **method** (unicode, optional) – **{'Barten 1999'}**, Computation method.

Other Parameters

- **E** (*numeric or array_like, optional*) – {colour.contrast.contrast_sensitivity_function_Barten1999()}, Retinal illuminance E in Trolands.
- **N_max** (*numeric or array_like, optional*) – {colour.contrast.contrast_sensitivity_function_Barten1999()}, Maximum number of cycles N_{max} over which the eye can integrate the information.
- **T** (*numeric or array_like, optional*) – {colour.contrast.contrast_sensitivity_function_Barten1999()}, Integration time T in seconds of the eye.
- **X_0** (*numeric or array_like, optional*) – {colour.contrast.contrast_sensitivity_function_Barten1999()}, Angular size X_0 in degrees of the object in the x direction.
- **Y_0** (*numeric or array_like, optional*) – {colour.contrast.contrast_sensitivity_function_Barten1999()}, Angular size Y_0 in degrees of the object in the y direction.
- **X_max** (*numeric or array_like, optional*) – {colour.contrast.contrast_sensitivity_function_Barten1999()}, Maximum angular size X_{max} in degrees of the integration area in the x direction.
- **Y_max** (*numeric or array_like, optional*) – {colour.contrast.contrast_sensitivity_function_Barten1999()}, Maximum angular size Y_{max} in degrees of the integration area in the y direction.
- **k** (*numeric or array_like, optional*) – {colour.contrast.contrast_sensitivity_function_Barten1999()}, Signal-to-noise (SNR) ratio k.
- **n** (*numeric or array_like, optional*) – {colour.contrast.contrast_sensitivity_function_Barten1999()}, Quantum efficiency of the eye n.
- **p** (*numeric or array_like, optional*) – {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** (*numeric or array_like, optional*) – {colour.contrast.contrast_sensitivity_function_Barten1999()}, Spectral density ϕ_0 in $secondsdegrees^2$ of the neural noise.

- **sigma** (*numeric or array_like, optional*) – {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.
- **u** (*numeric*) – {colour.contrast.contrast_sensitivity_function_Barten1999()}, Spatial frequency u, the cycles per degree.
- **u_0** (*numeric or array_like, optional*) – {colour.contrast.contrast_sensitivity_function_Barten1999()}, Spatial frequency u_0 in $cycles \div degrees$ above which the lateral inhibition ceases.

Returns Contrast sensitivity S.

Return type ndarray

References

[Bar99], [Bar03], [CKM+04], [InternationalTUnion15c],

Examples

```
>>> contrast_sensitivity_function(u=4)  # doctest: +ELLIPSIS
360.8691122...
>>> contrast_sensitivity_function('Barten 1999', u=4)  # doctest: +ELLIPSIS
360.8691122...
```

colour.CONTRAST_SENSITIVITY_METHODS

colour.**CONTRAST_SENSITIVITY_METHODS = CaseInsensitiveMapping({'Barten 1999': ...})**

Supported contrast sensitivity methods.

References

[Bar99], [Bar03], [CKM+04], [InternationalTUnion15c],

CONTRAST_SENSITIVITY_METHODS [CaseInsensitiveMapping] **{'Barten 1999'}**

Barten (1999) Contrast Sensitivity Function

colour.contrast

contrast_sensitivity_function_Barten1999(u)	Returns the contrast sensitivity S of the human eye according to the contrast sensitivity function (CSF) described by *Barten (1999)*.

colour.contrast.contrast_sensitivity_function_Barten1999

colour.contrast.**contrast_sensitivity_function_Barten1999**(*u*, *sigma=0.0087911571732306338*, *k=3.0*, *T=0.1*, *X_0=60*, *Y_0=None*, *X_max=12*, *Y_max=None*, *N_max=15*, *n=0.03*, *p=1227400.0*, *E=66.082316060529919*, *phi_0=3.0000000000000004e-08*, *u_0=7*)

Returns 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** (numeric) – Spatial frequency u, the cycles per degree.
- **sigma** (numeric or array_like, optional) – Standard deviation σ of the line-spread function resulting from the convolution of the different elements of the convolution process.
- **k** (numeric or array_like, optional) – Signal-to-noise (SNR) ratio k.
- **T** (numeric or array_like, optional) – Integration time T in seconds of the eye.
- **X_0** (numeric or array_like, optional) – Angular size X_0 in degrees of the object in the x direction.
- **Y_0** (numeric or array_like, optional) – Angular size Y_0 in degrees of the object in the y direction.
- **X_max** (numeric or array_like, optional) – Maximum angular size X_{max} in degrees of the integration area in the x direction.
- **Y_max** (numeric or array_like, optional) – Maximum angular size Y_{max} in degrees of the integration area in the y direction.
- **N_max** (numeric or array_like, optional) – Maximum number of cycles N_{max} over which the eye can integrate the information.
- **n** (numeric or array_like, optional) – Quantum efficiency of the eye n.
- **p** (numeric or array_like, optional) – Photon conversion factor p in $photons \div seconds \div degrees^2 \div Trolands$ that depends on the light source.
- **E** (numeric or array_like, optional) – Retinal illuminance E in Trolands.
- **phi_0** (numeric or array_like, optional) – Spectral density ϕ_0 in $secondsdegrees^2$ of the neural noise.
- **u_0** (numeric or array_like, optional) – Spatial frequency u_0 in $cycles \div degrees$ above which the lateral inhibition ceases.

Returns Contrast sensitivity S.

Return type 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], [CKM+04], [InternationalTUnion15c],

Examples

```
>>> contrast_sensitivity_function_Barten1999(4)  # doctest: +ELLIPSIS
360.8691122...
```

Reproducing *Figure 31* in [InternationalTUnion15c] 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)
```

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```
...         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)
>>> (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))
... # doctest: +ELLIPSIS
array([ 0.0207396...,  0.0134885...,  0.0096063...,  0.0077299...,  0.0068983...,
        0.0065057...,  0.0062712...,  0.0061198...,  0.0060365...,  0.0059984...])
```

Ancillary Objects

`colour.contrast`

`optical_MTF_Barten1999`(u[, sigma])	Returns the optical modulation transfer function (MTF) M_{opt} of the eye using *Barten (1999)* method.
`pupil_diameter_Barten1999`(L[, X_0, Y_0])	Returns the pupil diameter for given luminance and object or stimulus angular size using *Barten (1999)* method.
`sigma_Barten1999`([sigma_0, C_ab, d])	Returns 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.
`retinal_illuminance_Barten1999`(L[, d, ...])	Returns the retinal illuminance E in Trolands for given average luminance L and pupil diameter d using *Barten (1999)* method.
`maximum_angular_size_Barten1999`(u[, X_0, ...])	Returns the maximum angular size X of the object considered using *Barten (1999)* method.

colour.contrast.optical_MTF_Barten1999

`colour.contrast.`**`optical_MTF_Barten1999`**(*u*, *sigma=0.01*)

Returns the optical modulation transfer function (MTF) M_{opt} of the eye using *Barten (1999)* method.

Parameters

- **u** (`numeric or array_like`) – Spatial frequency u, the cycles per degree.
- **sigma** (`numeric or array_like, optional`) – 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 numeric or array_like

References

[Bar99], [Bar03], [CKM+04], [InternationalTUnion15c],

Examples

```
>>> optical_MTF_Barten1999(4, 0.01)  # doctest: +ELLIPSIS
0.9689107...
```

colour.contrast.pupil_diameter_Barten1999

colour.contrast.**pupil_diameter_Barten1999**(*L*, *X_0=60*, *Y_0=None*)

Returns the pupil diameter for given luminance and object or stimulus angular size using *Barten (1999)* method.

Parameters

- **L** (numeric or array_like) – Average luminance L in cd/m^2.
- **X_0** (numeric or array_like, optional) – Angular size of the object X_0 in degrees in the x direction.
- **Y_0** (numeric or array_like, optional) – Angular size of the object X_0 in degrees in the y direction.

References

[Bar99], [Bar03], [CKM+04], [InternationalTUnion15c],

Examples

```
>>> pupil_diameter_Barten1999(100, 60, 60)  # doctest: +ELLIPSIS
2.0777571...
```

colour.contrast.sigma_Barten1999

colour.contrast.**sigma_Barten1999**(*sigma_0=0.008333333333333333*, *C_ab=0.0013333333333333333*, *d=2.1*)

Returns 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** (numeric or array_like, optional) – Constant σ_0 in degrees.
- **C_ab** (numeric or array_like, optional) – Spherical aberration of the eye C_{ab} in $degrees \div mm$.
- **d** (numeric or array_like, optional) – 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 ndarray

> **Warning:** This definition expects σ_0 and C_{ab} 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.

References

[Bar99], [Bar03], [CKM+04], [InternationalTUnion15c],

Examples

```
>>> sigma_Barten1999(0.5 / 60, 0.08 / 60, 2.1)  # doctest: +ELLIPSIS
0.0087911...
```

colour.contrast.retinal_illuminance_Barten1999

colour.contrast.**retinal_illuminance_Barten1999**(*L*, *d=2.1*, *apply_stiles_crawford_effect_correction=True*)

Returns the retinal illuminance E in Trolands for given average luminance L and pupil diameter d using *Barten (1999)* method.

Parameters

- **L** (numeric or array_like) – Average luminance L in cd/m^2.
- **d** (numeric or array_like, optional) – Pupil diameter d in millimeters.
- **apply_stiles_crawford_effect_correction** (bool, optional) – Whether to apply the correction for *Stiles-Crawford* effect.

Returns Retinal illuminance E in Trolands.

Return type 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], [CKM+04], [InternationalTUnion15c],

Examples

```
>>> retinal_illuminance_Barten1999(100, 2.1)  # doctest: +ELLIPSIS
330.4115803...
>>> retinal_illuminance_Barten1999(100, 2.1, False)  # doctest: +ELLIPSIS
346.3605900...
```

colour.contrast.maximum_angular_size_Barten1999

`colour.contrast.`**`maximum_angular_size_Barten1999`**(*u*, *X_0=60*, *X_max=12*, *N_max=15*)

Returns the maximum angular size X of the object considered using *Barten (1999)* method.

Parameters

- **u** (numeric) – Spatial frequency u, the cycles per degree.
- **X_0** (numeric or array_like, optional) – Angular size X_0 in degrees of the object in the x direction.
- **X_max** (numeric or array_like, optional) – Maximum angular size X_{max} in degrees of the integration area in the x direction.
- **N_max** (numeric or array_like, optional) – 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 numeric or ndarray

References

[Bar99], [Bar03], [CKM+04], [InternationalTUnion15c],

Examples

```
>>> maximum_angular_size_Barten1999(4)  # doctest: +ELLIPSIS
3.5729480...
```

Continuous Signal

- *Continuous Signal*

Continuous Signal

colour.continuous

AbstractContinuousFunction([name])	Defines the base class for abstract continuous function.
Signal([data, domain])	Defines the base class for continuous signal.
MultiSignal([data, domain, labels])	Defines the base class for multi-continuous signal, a container for multiple colour.continuous.Signal sub-class instances.

colour.continuous.AbstractContinuousFunction

class colour.continuous.**AbstractContinuousFunction**(*name=None*)

Defines 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 $x \in \mathbb{R}$ variable returns a corresponding range $y \in \mathbb{R}$ variable. 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 attribute.

Parameters **name** (unicode, optional) – Continuous function name.

name

domain

range

interpolator

interpolator_args

extrapolator

extrapolator_args

function

__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=None*)

Initialize self. See help(type(self)) for accurate signature.

Methods

`__init__`([name])	Initialize self.
`arithmetical_operation`(a, operation[, in_place])	Performs given arithmetical operation with a operand, the operation can be either performed on a copy or in-place, must be reimplemented by sub-classes.
`copy`()	Returns a copy of the sub-class instance.
`domain_distance`(a)	Returns the euclidean distance between given array and independent domain x closest element.
`fill_nan`([method, default])	Fill NaNs in independent domain x variable and corresponding range y variable using given method, must be reimplemented by sub-classes.
`is_uniform`()	Returns if independent domain x variable is uniform.

Attributes

`domain`	Getter and setter property for the abstract continuous function independent domain x variable, must be reimplemented by sub-classes.
`extrapolator`	Getter and setter property for the abstract continuous function extrapolator type, must be reimplemented by sub-classes.

Continued on next page

Table 145 – continued from previous page

extrapolator_args	Getter and setter property for the abstract continuous function extrapolator instantiation time arguments, must be reimplemented by sub-classes.
function	Getter and setter property for the abstract continuous function callable, must be reimplemented by sub-classes.
interpolator	Getter and setter property for the abstract continuous function interpolator type, must be reimplemented by sub-classes.
interpolator_args	Getter and setter property for the abstract continuous function interpolator instantiation time arguments, must be reimplemented by sub-classes.
name	Getter and setter property for the abstract continuous function name.
range	Getter and setter property for the abstract continuous function corresponding range y variable, must be reimplemented by sub-classes.

colour.continuous.Signal

class colour.continuous.**Signal**(*data=None*, *domain=None*, ***kwargs*)

Defines the base class for continuous signal.

The 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.

Parameters

- **data** (Series or Signal or array_like or dict_like, optional) – Data to be stored in the continuous signal.
- **domain** (array_like, optional) – Values to initialise the colour.continuous.Signal.domain attribute with. If both data and domain arguments are defined, the latter with be used to initialise the colour.continuous.Signal.domain attribute.

Other Parameters

- **name** (*unicode, optional*) – Continuous signal name.
- **dtype** (*type, optional*) – **{np.float16, np.float32, np.float64, np.float128}**, Floating point data type.
- **interpolator** (*object, optional*) – Interpolator class type to use as interpolating function.
- **interpolator_args** (*dict_like, optional*) – Arguments to use when instantiating the interpolating function.
- **extrapolator** (*object, optional*) – Extrapolator class type to use as extrapolating function.
- **extrapolator_args** (*dict_like, optional*) – Arguments to use when instantiating the extrapolating function.

dtype

domain

range

interpolator

interpolator_args

extrapolator

extrapolator_args

function

__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.]
```

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```
 [  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 Series*:

```
>>> if is_pandas_installed():
...     from pandas import Series
...     print(Signal(  # doctest: +SKIP
...         Series(dict(zip(domain, range_)))))
[[  100.    10.]
 [  200.    20.]
 [  300.    30.]
 [  400.    40.]
 [  500.    50.]
 [  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]  # doctest: +ELLIPSIS
0.0359701...
>>> x = np.linspace(100, 1000, 3)
>>> Signal(range_, domain)[x]  # doctest: +ELLIPSIS
array([  ...,   4.7669395...e-01,   8.4147098...e-01])
```

Using an alternative interpolating function:

```
>>> x = 150
>>> from colour.algebra import CubicSplineInterpolator
>>> Signal(
...     range_,
...     domain,
```

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```
...     interpolator=CubicSplineInterpolator)[x]  # doctest: +ELLIPSIS
0.0555274...
>>> x = np.linspace(100, 1000, 3)
>>> Signal(
...     range_,
...     domain,
...     interpolator=CubicSplineInterpolator)[x]  # doctest: +ELLIPSIS
array([ 0.        ,  0.4794253...,  0.8414709...])
```

__init__(*data=None*, *domain=None*, ***kwargs*)

Initialize self. See help(type(self)) for accurate signature.

Methods

`__init__`([data, domain])	Initialize self.
`arithmetical_operation`(a, operation[, in_place])	Performs given arithmetical operation with a operand, the operation can be either performed on a copy or in-place.
`copy`()	Returns a copy of the sub-class instance.
`domain_distance`(a)	Returns the euclidean distance between given array and independent domain x closest element.
`fill_nan`([method, default])	Fill NaNs in independent domain x variable and corresponding range y variable using given method.
`is_uniform`()	Returns if independent domain x variable is uniform.
`signal_unpack_data`([data, domain, dtype])	Unpack given data for continuous signal instantiation.
`to_series`()	Converts the continuous signal to a *Pandas* `Series` class instance.

Attributes

`domain`	Getter and setter property for the continuous signal independent domain x variable.
`dtype`	Getter and setter property for the continuous signal dtype.
`extrapolator`	Getter and setter property for the continuous signal extrapolator type.
`extrapolator_args`	Getter and setter property for the continuous signal extrapolator instantiation time arguments.
`function`	Getter and setter property for the continuous signal callable.
`interpolator`	Getter and setter property for the continuous signal interpolator type.
`interpolator_args`	Getter and setter property for the continuous signal interpolator instantiation time arguments.

Continued on next page

Table 147 – continued from previous page

name	Getter and setter property for the abstract continuous function name.
range	Getter and setter property for the continuous signal corresponding range y variable.

colour.continuous.MultiSignal

class colour.continuous.**MultiSignal**(*data=None*, *domain=None*, *labels=None*, ***kwargs*)

Defines the base class for multi-continuous signal, a container for multiple colour.continuous.Signal sub-class instances.

Parameters

- **data** (Series or Dataframe or Signal or MultiSignal or array_like or dict_like, optional) – Data to be stored in the multi-continuous signal.
- **domain** (array_like, optional) – 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** (array_like, optional) – Names to use for the colour.continuous.Signal sub-class instances.

Other Parameters

- **name** (*unicode, optional*) – Multi-continuous signal name.
- **dtype** (*type, optional*) – **{np.float16, np.float32, np.float64, np.float128}**, Floating point data type.
- **interpolator** (*object, optional*) – Interpolator class type to use as interpolating function for the colour.continuous.Signal sub-class instances.
- **interpolator_args** (*dict_like, optional*) – Arguments to use when instantiating the interpolating function of the colour.continuous.Signal sub-class instances.
- **extrapolator** (*object, optional*) – Extrapolator class type to use as extrapolating function for the colour.continuous.Signal sub-class instances.
- **extrapolator_args** (*dict_like, optional*) – Arguments to use when instantiating the extrapolating function of the colour.continuous.Signal sub-class instances.
- **signal_type** (*type, optional*) – The colour.continuous.Signal sub-class type used for instances.

dtype

domain

range

interpolator

interpolator_args

extrapolator

extrapolator_args

function

signals

labels

signal_type

__str__()

__repr__()

__hash__()

__getitem__()

__setitem__()

__contains__()

__eq__()

__ne__()

arithmetical_operation()

multi_signal_unpack_data()

fill_nan()

to_dataframe()

Examples

Instantiation with implicit *domain* and a single signal:

```
>>> range_ = np.linspace(10, 100, 10)
>>> print(MultiSignal(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(MultiSignal(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(MultiSignal(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(MultiSignal(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.]
 [  800.    80.    90.   100.]
 [  900.    90.   100.   110.]
 [ 1000.   100.   110.   120.]]
```

Instantiation using a *Signal* sub-class:

```
>>> class NotSignal(Signal):
...     pass
```

```
>>> multi_signal = MultiSignal(range_, domain, signal_type=NotSignal)
>>> print(multi_signal)
[[  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_signal.signals[0])  # doctest: +SKIP
 <class 'multi_signal.NotSignal'>
```

Instantiation with a *Pandas Series*:

```
>>> if is_pandas_installed():
...     from pandas import Series
...     print(MultiSignal(  # doctest: +SKIP
...         Series(dict(zip(domain, np.linspace(10, 100, 10))))))
[[  100.    10.]
 [  200.    20.]
 [  300.    30.]
```

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```
 [  400.    40.]
 [  500.    50.]
 [  600.    60.]
 [  700.    70.]
 [  800.    80.]
 [  900.    90.]
 [ 1000.   100.]]
```

Instantiation with a *Pandas Dataframe*:

```
>>> if is_pandas_installed():
...     from pandas import DataFrame
...     data = dict(zip(['a', 'b', 'c'], tsplit(range_)))
...     print(MultiSignal(  # doctest: +SKIP
...         DataFrame(data, 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.]]
```

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])
>>> MultiSignal(range_, domain)[x]  # doctest: +ELLIPSIS
array([ 0.0359701...,  0.2845447...,  0.5331193...])
>>> x = np.linspace(100, 1000, 3)
>>> MultiSignal(range_, domain)[x]  # doctest: +ELLIPSIS
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
>>> MultiSignal(
...     range_,
...     domain,
...     interpolator=CubicSplineInterpolator)[x]  # doctest: +ELLIPSIS
array([ 0.0555274...,  0.3055274...,  0.5555274...])
>>> x = np.linspace(100, 1000, 3)
>>> MultiSignal(
...     range_,
...     domain,
...     interpolator=CubicSplineInterpolator)[x]  # doctest: +ELLIPSIS
array([[ 0.        ...,  0.25      ...,  0.5       ...],
       [ 0.4794253...,  0.7294253...,  0.9794253...],
       [ 0.8414709...,  1.0914709...,  1.3414709...]])
```

__init__(*data=None*, *domain=None*, *labels=None*, ***kwargs*)
Initialize self. See help(type(self)) for accurate signature.

Methods

`__init__`([data, domain, labels])	Initialize self.
`arithmetical_operation`(a, operation[, in_place])	Performs given arithmetical operation with a operand, the operation can be either performed on a copy or in-place.
`copy`()	Returns a copy of the sub-class instance.
`domain_distance`(a)	Returns the euclidean distance between given array and independent domain x closest element.
`fill_nan`([method, default])	Fill NaNs in independent domain x variable and corresponding range y variable using given method.
`is_uniform`()	Returns if independent domain x variable is uniform.
`multi_signal_unpack_data`([data, domain, ...])	Unpack given data for multi-continuous signal instantiation.
`to_dataframe`()	Converts the continuous signal to a *Pandas* `DataFrame` class instance.

Attributes

`domain`	Getter and setter property for the `colour.continuous.Signal` sub-class instances independent domain x variable.
`dtype`	Getter and setter property for the continuous signal dtype.
`extrapolator`	Getter and setter property for the `colour.continuous.Signal` sub-class instances extrapolator type.
`extrapolator_args`	Getter and setter property for the `colour.continuous.Signal` sub-class instances extrapolator instantiation time arguments.
`function`	Getter and setter property for the `colour.continuous.Signal` sub-class instances callable.
`interpolator`	Getter and setter property for the `colour.continuous.Signal` sub-class instances interpolator type.
`interpolator_args`	Getter and setter property for the `colour.continuous.Signal` sub-class instances interpolator instantiation time arguments.
`labels`	Getter and setter property for the `colour.continuous.Signal` sub-class instances name.
`name`	Getter and setter property for the abstract continuous function name.

Continued on next page

Table 149 – continued from previous page

range	Getter and setter property for the colour.continuous.Signal sub-class instances corresponding range y variable.
signal_type	Getter and setter property for the colour.continuous.Signal sub-class instances type.
signals	Getter and setter property for the colour.continuous.Signal sub-class instances.

Corresponding Chromaticities

- *Prediction*
  - *Fairchild (1990)*
  - *CIE 1994*
  - *CMCCAT2000*
  - *Von Kries*

Prediction

colour

corresponding_chromaticities_prediction([...])	Returns the corresponding chromaticities prediction for given chromatic adaptation model.
CORRESPONDING_CHROMATICITIES_PREDICTION_MODELS	Aggregated corresponding chromaticities prediction models.

colour.corresponding_chromaticities_prediction

colour.**corresponding_chromaticities_prediction**(*experiment=1*, *model='Von Kries'*, ***kwargs*)

Returns the corresponding chromaticities prediction for given chromatic adaptation model.

Parameters

- **experiment** (integer, optional) – {1, 2, 3, 4, 6, 8, 9, 11, 12} *Breneman (1987)* experiment number.
- **model** (unicode, optional) – **{'Von Kries', 'CIE 1994', 'CMCCAT2000', 'Fairchild 1990'}**, Chromatic adaptation model.

Other Parameters **transform** (*unicode, optional*) – {colour.corresponding.corresponding_chromaticities_prediction_VonKries()}, **{'CAT02', 'XYZ Scaling', 'Von Kries', 'Bradford', 'Sharp', 'Fairchild', 'CMCCAT97', 'CMCCAT2000', 'CAT02_BRILL_CAT', 'Bianco', 'Bianco PC'}**, Chromatic adaptation transform.

Returns Corresponding chromaticities prediction.

Return type tuple

References

[Bre87], [CIET13294], [Fai91], [Fai13c], [Fai13b], [LLRH02], [WRC12a]

Examples

```
>>> from pprint import pprint
>>> pr = corresponding_chromaticities_prediction(2, 'CMCCAT2000')
>>> pr = [(p.uvp_m, p.uvp_p) for p in pr]
>>> pprint(pr)  # doctest: +SKIP
[((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 = CaseInsensitiveMapping({'CIE 1994': ..., 'CMCCAT2000**

Aggregated corresponding chromaticities prediction models.

References

[Bre87], [CIET13294], [Fai91], [Fai13c], [Fai13b], [LLRH02], [WRC12a]

CORRESPONDING_CHROMATICITIES_PREDICTION_MODELS [CaseInsensitiveMapping] **{'CIE 1994', 'CMCCAT2000', 'Fairchild 1990', 'Von Kries'}**

Aliases:

- 'vonkries': 'Von Kries'

Dataset

colour

BRENEMAN_EXPERIMENTS	*Breneman (1987)* experiments.
BRENEMAN_EXPERIMENTS_PRIMARIES_CHROMATICITIES	*Breneman (1987)* experiments primaries chromaticities.

colour.BRENEMAN_EXPERIMENTS

colour.**BRENEMAN_EXPERIMENTS = {1: (BrenemanExperimentResult(name='Illuminant', uvp_t=array([0.259, 0.526]),**

References

[Bre87]

BRENEMAN_EXPERIMENTS : dict

colour.BRENEMAN_EXPERIMENTS_PRIMARIES_CHROMATICITIES

colour.**BRENEMAN_EXPERIMENTS_PRIMARIES_CHROMATICITIES = {1: PrimariesChromaticityCoordinates(experiment=1, il**

Breneman (1987) experiments primaries chromaticities.

References

[Bre87]

BRENEMAN_EXPERIMENTS_PRIMARIES_CHROMATICITIES : dict

Fairchild (1990)

colour.corresponding

corresponding_chromaticities_prediction_Fairchild1990([the])	Returns the corresponding chromaticities prediction for *Fairchild (1990)* chromatic adaptation model.

colour.corresponding.corresponding_chromaticities_prediction_Fairchild1990

colour.corresponding.**corresponding_chromaticities_prediction_Fairchild1990**(*experiment=1*)

Returns the corresponding chromaticities prediction for *Fairchild (1990)* chromatic adaptation model.

Parameters **experiment** (integer, optional) – {1, 2, 3, 4, 6, 8, 9, 11, 12} *Breneman (1987)* experiment number.

Returns Corresponding chromaticities prediction.

Return type tuple

References

[Bre87], [Fai91], [Fai13c]

Examples

```
>>> from pprint import pprint
>>> pr = corresponding_chromaticities_prediction_Fairchild1990(2)
>>> pr = [(p.uvp_m, p.uvp_p) for p in pr]
>>> pprint(pr)  # doctest: +SKIP
[((0.207, 0.486), (0.2089528..., 0.4724034...)),
 ((0.449, 0.511), (0.4375652..., 0.5121030...)),
 ((0.263, 0.505), (0.2621362..., 0.4972538...)),
```

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(continued from previous page)

```
 ((0.322, 0.545), (0.3235312..., 0.5475665...)),
 ((0.316, 0.537), (0.3151390..., 0.5398333...)),
 ((0.265, 0.553), (0.2634745..., 0.5544335...)),
 ((0.221, 0.538), (0.2211595..., 0.5324470...)),
 ((0.135, 0.532), (0.1396949..., 0.5207234...)),
 ((0.145, 0.472), (0.1512288..., 0.4533041...)),
 ((0.163, 0.331), (0.1715691..., 0.3026264...)),
 ((0.176, 0.431), (0.1825792..., 0.4077892...)),
 ((0.244, 0.349), (0.2418904..., 0.3413401...))]
```

CIE 1994

colour.corresponding

corresponding_chromaticities_prediction_CIE1994(...)	Returns the corresponding chromaticities prediction for *CIE 1994* chromatic adaptation model.

colour.corresponding.corresponding_chromaticities_prediction_CIE1994

colour.corresponding.**corresponding_chromaticities_prediction_CIE1994**(*experiment=1*)

Returns the corresponding chromaticities prediction for *CIE 1994* chromatic adaptation model.

Parameters **experiment** (integer, optional) – {1, 2, 3, 4, 6, 8, 9, 11, 12} *Breneman (1987)* experiment number.

Returns Corresponding chromaticities prediction.

Return type tuple

References

[Bre87], [CIET13294]

Examples

```
>>> from pprint import pprint
>>> pr = corresponding_chromaticities_prediction_CIE1994(2)
>>> pr = [(p.uvp_m, p.uvp_p) for p in pr]
>>> pprint(pr)  # doctest: +SKIP
[((0.207, 0.486), (0.2133909..., 0.4939794...)),
 ((0.449, 0.511), (0.4450345..., 0.5120939...)),
 ((0.263, 0.505), (0.2693262..., 0.5083212...)),
 ((0.322, 0.545), (0.3308593..., 0.5443940...)),
 ((0.316, 0.537), (0.3225195..., 0.5377826...)),
 ((0.265, 0.553), (0.2709737..., 0.5513666...)),
 ((0.221, 0.538), (0.2280786..., 0.5351592...)),
 ((0.135, 0.532), (0.1439436..., 0.5303576...)),
 ((0.145, 0.472), (0.1500743..., 0.4842895...)),
 ((0.163, 0.331), (0.1559955..., 0.3772379...)),
 ((0.176, 0.431), (0.1806318..., 0.4518475...)),
 ((0.244, 0.349), (0.2454445..., 0.4018004...))]
```

CMCCAT2000

colour.corresponding

corresponding_chromaticities_prediction_CMCCAT2000(*[...]*)	Returns the corresponding chromaticities prediction for *CMCCAT2000* chromatic adaptation model.

colour.corresponding.corresponding_chromaticities_prediction_CMCCAT2000

colour.corresponding.**corresponding_chromaticities_prediction_CMCCAT2000**(*experiment=1*)

Returns the corresponding chromaticities prediction for *CMCCAT2000* chromatic adaptation model.

Parameters **experiment** (integer, optional) – {1, 2, 3, 4, 6, 8, 9, 11, 12} *Breneman (1987)* experiment number.

Returns Corresponding chromaticities prediction.

Return type tuple

References

[Bre87], [LLRH02], [WRC12a]

Examples

```
>>> from pprint import pprint
>>> pr = corresponding_chromaticities_prediction_CMCCAT2000(2)
>>> pr = [(p.uvp_m, p.uvp_p) for p in pr]
>>> pprint(pr)  # doctest: +SKIP
[((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...))]
```

Von Kries

colour.corresponding

corresponding_chromaticities_prediction_VonKries(*[...]*)	Returns the corresponding chromaticities prediction for *Von Kries* chromatic adaptation model using given transform.

colour.corresponding.corresponding_chromaticities_prediction_VonKries

`colour.corresponding.`**`corresponding_chromaticities_prediction_VonKries`**(*experiment=1*, *transform='CAT02'*)

Returns the corresponding chromaticities prediction for *Von Kries* chromatic adaptation model using given transform.

Parameters

- **experiment** (integer, optional) – {1, 2, 3, 4, 6, 8, 9, 11, 12} *Breneman (1987)* experiment number.
- **transform** (unicode, optional) – **{'CAT02', 'XYZ Scaling', 'Von Kries', 'Bradford', 'Sharp', 'Fairchild', 'CMCCAT97', 'CMCCAT2000', 'CAT02_BRILL_CAT', 'Bianco', 'Bianco PC'}**, Chromatic adaptation transform.

Returns Corresponding chromaticities prediction.

Return type tuple

References

[Bre87], [Fai13b]

Examples

```
>>> from pprint import pprint
>>> pr = corresponding_chromaticities_prediction_VonKries(2, 'Bradford')
>>> pr = [(p.uvp_m, p.uvp_p) for p in pr]
>>> pprint(pr)  # doctest: +SKIP
[((0.207, 0.486), (0.2082014..., 0.4722922...)),
 ((0.449, 0.511), (0.4489102..., 0.5071602...)),
 ((0.263, 0.505), (0.2643545..., 0.4959631...)),
 ((0.322, 0.545), (0.3348730..., 0.5471220...)),
 ((0.316, 0.537), (0.3248758..., 0.5390589...)),
 ((0.265, 0.553), (0.2733105..., 0.5555028...)),
 ((0.221, 0.538), (0.2271480..., 0.5331317...)),
 ((0.135, 0.532), (0.1442730..., 0.5226804...)),
 ((0.145, 0.472), (0.1498745..., 0.4550785...)),
 ((0.163, 0.331), (0.1564975..., 0.3148795...)),
 ((0.176, 0.431), (0.1760593..., 0.4103772...)),
 ((0.244, 0.349), (0.2259805..., 0.3465291...))]
```

Colour Difference

- *Delta E*
- *CIE 1976*
- *CIE 1994*
- *CIE 2000*
- *CMC*

- *Luo, Cui and Li (2006)*
- *Li, Li, Wang, Zu, Luo, Cui, Melgosa, Brill and Pointer (2017)*
- *DIN99*

Delta E

colour

delta_E(a, b[, method])	Returns the difference ΔE_{ab} between two given *CIE L*a*b** or $J'a'b'$ colourspace arrays using given method.
DELTA_E_METHODS	Supported ΔE_{ab} computations methods.

colour.delta_E

colour.**delta_E**(*a*, *b*, *method='CIE 2000'*, ***kwargs*)

Returns the difference ΔE_{ab} between two given *CIE L*a*b** or $J'a'b'$ colourspace arrays using given method.

Parameters

- **a** (array_like) – *CIE L*a*b** or $J'a'b'$ colourspace array a.
- **b** (array_like) – *CIE L*a*b** or $J'a'b'$ colourspace array b.
- **method** (unicode, optional) – **{'CIE 2000', 'CIE 1976', 'CIE 1994', 'CMC', 'CAM02-LCD', 'CAM02-SCD', 'CAM02-UCS', 'CAM16-LCD', 'CAM16-SCD', 'CAM16-UCS', 'DIN99'}** Computation method.

Other Parameters

- **textiles** (*bool, optional*) – {colour.difference.delta_E_CIE1994(), colour.difference.delta_E_CIE2000(), colour.difference.delta_E_DIN99()}, Textiles application specific parametric factors $k_L = 2,\ k_C = k_H = 1,\ k_1 = 0.048,\ k_2 = 0.014,\ k_E = 2,\ k_CH = 0.5$ weights are used instead of $k_L = k_C = k_H = 1,\ k_1 = 0.045,\ k_2 = 0.015,\ k_E = k_CH = 1.0$.
- **l** (*numeric, optional*) – {colour.difference.delta_E_CIE2000()}, Lightness weighting factor.
- **c** (*numeric, optional*) – {colour.difference.delta_E_CIE2000()}, Chroma weighting factor.

Returns Colour difference ΔE_{ab}.

Return type numeric or ndarray

References

[ASTMInternational07], [LLW+17], [Lin03a], [Lin11], [Lin09b], [Lin09c], [LCL06], [Mel13], [Wik08c]

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)  # doctest: +ELLIPSIS
94.0356490...
>>> delta_E(a, b, method='CIE 2000')  # doctest: +ELLIPSIS
94.0356490...
>>> delta_E(a, b, method='CIE 1976')  # doctest: +ELLIPSIS
451.7133019...
>>> delta_E(a, b, method='CIE 1994')  # doctest: +ELLIPSIS
83.7792255...
>>> delta_E(a, b, method='CIE 1994', textiles=False)
... # doctest: +ELLIPSIS
83.7792255...
>>> delta_E(a, b, method='DIN99')  # doctest: +ELLIPSIS
66.1119282...
>>> 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')  # doctest: +ELLIPSIS
0.0001034...
>>> delta_E(a, b, method='CAM16-LCD')  # doctest: +ELLIPSIS
0.0001034...
```

colour.DELTA_E_METHODS

colour.**DELTA_E_METHODS = CaseInsensitiveMapping({'CIE 1976': ..., 'CIE 1994': ..., 'CIE 2000': ..., 'CMC':**

Supported ΔE_{ab} computations methods.

References

[ASTMInternational07], [LLW+17], [Lin03a], [Lin11], [Lin09b], [Lin09c], [LCL06], [Mel13], [Wik08c]

DELTA_E_METHODS [CaseInsensitiveMapping] **{'CIE 1976', 'CIE 1994', 'CIE 2000', 'CMC', 'CAM02-LCD', 'CAM02-SCD', 'CAM02-UCS', 'CAM16-LCD', 'CAM16-SCD', 'CAM16-UCS', 'DIN99'}**

Aliases:

- 'cie1976': 'CIE 1976'
- 'cie1994': 'CIE 1994'
- 'cie2000': 'CIE 2000'

CIE 1976

colour.difference

`delta_E_CIE1976`(Lab_1, Lab_2)	Returns the difference ΔE_{76} between two given *CIE L*a*b** colourspace arrays using *CIE 1976* recommendation.

colour.difference.delta_E_CIE1976

`colour.difference.`**`delta_E_CIE1976`**(*Lab_1*, *Lab_2*)

Returns the difference ΔE_{76} between two given *CIE L*a*b** colourspace arrays using *CIE 1976* recommendation.

Parameters

- **Lab_1** (`array_like`) – *CIE L*a*b** colourspace array 1.
- **Lab_2** (`array_like`) – *CIE L*a*b** colourspace array 2.

Returns Colour difference ΔE_{76}.

Return type numeric or ndarray

Notes

Domain	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)  # doctest: +ELLIPSIS
451.7133019...
```

CIE 1994

`colour.difference`

`delta_E_CIE1994`(Lab_1, Lab_2[, textiles])	Returns 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*, *Lab_2*, *textiles=False*)

Returns the difference ΔE_{94} between two given *CIE L*a*b** colourspace arrays using *CIE 1994* recommendation.

Parameters

- **Lab_1** (`array_like`) – *CIE L*a*b** colourspace array 1.
- **Lab_2** (`array_like`) – *CIE L*a*b** colourspace array 2.
- **textiles** (`bool, optional`) – 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 numeric or ndarray

Notes

Domain	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]

- *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)  # doctest: +ELLIPSIS
83.7792255...
>>> delta_E_CIE1994(Lab_1, Lab_2, textiles=True)  # doctest: +ELLIPSIS
88.3355530...
```

CIE 2000

colour.difference

delta_E_CIE2000(Lab_1, Lab_2[, textiles])	Returns 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*, *Lab_2*, *textiles=False*)

Returns the difference ΔE_{00} between two given *CIE L*a*b** colourspace arrays using *CIE 2000* recommendation.

Parameters

- **Lab_1** (array_like) – *CIE L*a*b** colourspace array 1.
- **Lab_2** (array_like) – *CIE L*a*b** colourspace array 2.
- **textiles** (bool, optional) – 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 numeric or ndarray

Notes

Domain	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]

- *CIE 2000* 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.
- 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)  # doctest: +ELLIPSIS
94.0356490...
>>> Lab_2 = np.array([50.00000000, 426.67945353, 72.39590835])
>>> delta_E_CIE2000(Lab_1, Lab_2)  # doctest: +ELLIPSIS
100.8779470...
>>> delta_E_CIE2000(Lab_1, Lab_2, textiles=True)  # doctest: +ELLIPSIS
95.7920535...
```

CMC

`colour.difference`

`delta_E_CMC`(Lab_1, Lab_2[, l, c])	Returns 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*, *Lab_2*, *l=2*, *c=1*)

Returns 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** (`array_like`) – *CIE L*a*b** colourspace array 1.
- **Lab_2** (`array_like`) – *CIE L*a*b** colourspace array 2.
- **l** (`numeric, optional`) – Lightness weighting factor.
- **c** (`numeric, optional`) – Chroma weighting factor.

Returns Colour difference ΔE_{CMC}.

Return type numeric or ndarray

Notes

Domain	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)  # doctest: +ELLIPSIS
172.7047712...
```

Luo, Cui and Li (2006)

colour.difference

delta_E_CAM02LCD(Jpapbp_1, Jpapbp_2)	Returns the difference $\Delta E'$ between two given *Li et al.(2017) CAM16-LCD* colourspaces $J'a'b'$ arrays..
delta_E_CAM02SCD(Jpapbp_1, Jpapbp_2)	Returns the difference $\Delta E'$ between two given *Li et al.(2017) CAM16-SCD* colourspaces $J'a'b'$ arrays..
delta_E_CAM02UCS(Jpapbp_1, Jpapbp_2)	Returns the difference $\Delta E'$ between two given *Li et al.(2017) CAM16-UCS* colourspaces $J'a'b'$ arrays..

colour.difference.delta_E_CAM02LCD

colour.difference.**delta_E_CAM02LCD**(*Jpapbp_1*, *Jpapbp_2*)

Returns the difference $\Delta E'$ between two given *Li et al. (2017) CAM16-LCD* colourspaces $J'a'b'$ arrays.

Parameters

- **Jpapbp_1** (array_like) – Standard / reference *Li et al. (2017) CAM16-LCD* colourspaces $J'a'b'$ array.
- **Jpapbp_2** (array_like) – Sample / test *Li et al. (2017) CAM16-LCD* colourspaces $J'a'b'$ array.

Returns Colour difference $\Delta E'$.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
Jpapbp_1	Jp_1 : [0, 100] ap_1 : [-100, 100] bp_1 : [-100, 100]	Jp_1 : [0, 1] ap_1 : [-1, 1] bp_1 : [-1, 1]
Jpapbp_2	Jp_2 : [0, 100] ap_2 : [-100, 100] bp_2 : [-100, 100]	Jp_2 : [0, 1] ap_2 : [-1, 1] bp_2 : [-1, 1]

References

[LLW+17]

Notes

- This docstring is automatically generated, please refer to `colour.delta_E_CAM02LCD()` definition for an usage example.

colour.difference.delta_E_CAM02SCD

`colour.difference.`**`delta_E_CAM02SCD`**(*Jpapbp_1*, *Jpapbp_2*)

Returns the difference $\Delta E'$ between two given *Li et al. (2017) CAM16-SCD* colourspaces $J'a'b'$ arrays.

Parameters

- **Jpapbp_1** (array_like) – Standard / reference *Li et al. (2017) CAM16-SCD* colourspaces $J'a'b'$ array.
- **Jpapbp_2** (array_like) – Sample / test *Li et al. (2017) CAM16-SCD* colourspaces $J'a'b'$ array.

Returns Colour difference $\Delta E'$.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
Jpapbp_1	Jp_1 : [0, 100] ap_1 : [-100, 100] bp_1 : [-100, 100]	Jp_1 : [0, 1] ap_1 : [-1, 1] bp_1 : [-1, 1]
Jpapbp_2	Jp_2 : [0, 100] ap_2 : [-100, 100] bp_2 : [-100, 100]	Jp_2 : [0, 1] ap_2 : [-1, 1] bp_2 : [-1, 1]

References

[LLW+17]

Notes

- This docstring is automatically generated, please refer to `colour.delta_E_CAM02SCD()` definition for an usage example.

colour.difference.delta_E_CAM02UCS

`colour.difference.`**`delta_E_CAM02UCS`**(*Jpapbp_1*, *Jpapbp_2*)

Returns the difference $\Delta E'$ between two given *Li et al. (2017) CAM16-UCS* colourspaces $J'a'b'$ arrays.

Parameters

- **Jpapbp_1** (array_like) – Standard / reference *Li et al. (2017) CAM16-UCS* colourspaces $J'a'b'$ array.
- **Jpapbp_2** (array_like) – Sample / test *Li et al. (2017) CAM16-UCS* colourspaces $J'a'b'$ array.

Returns Colour difference $\Delta E'$.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
Jpapbp_1	Jp_1 : [0, 100] ap_1 : [-100, 100] bp_1 : [-100, 100]	Jp_1 : [0, 1] ap_1 : [-1, 1] bp_1 : [-1, 1]
Jpapbp_2	Jp_2 : [0, 100] ap_2 : [-100, 100] bp_2 : [-100, 100]	Jp_2 : [0, 1] ap_2 : [-1, 1] bp_2 : [-1, 1]

References

[LLW+17]

Notes

- This docstring is automatically generated, please refer to `colour.delta_E_CAM02UCS()` definition for an usage example.

Li, Li, Wang, Zu, Luo, Cui, Melgosa, Brill and Pointer (2017)

`colour.difference`

`delta_E_CAM16LCD`(Jpapbp_1, Jpapbp_2)	Returns the difference $\Delta E'$ between two given *Li et al.(2017) CAM16-LCD* colourspaces $J'a'b'$ arrays..
`delta_E_CAM16SCD`(Jpapbp_1, Jpapbp_2)	Returns the difference $\Delta E'$ between two given *Li et al.(2017) CAM16-SCD* colourspaces $J'a'b'$ arrays..

Continued on next page

Table 162 – continued from previous page

`delta_E_CAM16UCS`(Jpapbp_1, Jpapbp_2)	Returns the difference $\Delta E'$ between two given *Li et al.(2017) CAM16-UCS* colourspaces $J'a'b'$ arrays..

colour.difference.delta_E_CAM16LCD

`colour.difference.`**`delta_E_CAM16LCD`**(*Jpapbp_1*, *Jpapbp_2*)

Returns the difference $\Delta E'$ between two given *Li et al. (2017) CAM16-LCD* colourspaces $J'a'b'$ arrays.

Parameters

- **Jpapbp_1** (array_like) – Standard / reference *Li et al. (2017) CAM16-LCD* colourspaces $J'a'b'$ array.
- **Jpapbp_2** (array_like) – Sample / test *Li et al. (2017) CAM16-LCD* colourspaces $J'a'b'$ array.

Returns Colour difference $\Delta E'$.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
Jpapbp_1	Jp_1 : [0, 100] ap_1 : [-100, 100] bp_1 : [-100, 100]	Jp_1 : [0, 1] ap_1 : [-1, 1] bp_1 : [-1, 1]
Jpapbp_2	Jp_2 : [0, 100] ap_2 : [-100, 100] bp_2 : [-100, 100]	Jp_2 : [0, 1] ap_2 : [-1, 1] bp_2 : [-1, 1]

References

[LLW+17]

Notes

- This docstring is automatically generated, please refer to `colour.delta_E_CAM02LCD()` definition for an usage example.

colour.difference.delta_E_CAM16SCD

`colour.difference.`**`delta_E_CAM16SCD`**(*Jpapbp_1*, *Jpapbp_2*)

Returns the difference $\Delta E'$ between two given *Li et al. (2017) CAM16-SCD* colourspaces $J'a'b'$ arrays.

Parameters

- **Jpapbp_1** (array_like) – Standard / reference *Li et al. (2017) CAM16-SCD* colourspaces $J'a'b'$ array.
- **Jpapbp_2** (array_like) – Sample / test *Li et al. (2017) CAM16-SCD* colourspaces $J'a'b'$ array.

Returns Colour difference $\Delta E'$.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
Jpapbp_1	Jp_1 : [0, 100] ap_1 : [-100, 100] bp_1 : [-100, 100]	Jp_1 : [0, 1] ap_1 : [-1, 1] bp_1 : [-1, 1]
Jpapbp_2	Jp_2 : [0, 100] ap_2 : [-100, 100] bp_2 : [-100, 100]	Jp_2 : [0, 1] ap_2 : [-1, 1] bp_2 : [-1, 1]

References

[LLW+17]

Notes

- This docstring is automatically generated, please refer to `colour.delta_E_CAM02SCD()` definition for an usage example.

colour.difference.delta_E_CAM16UCS

`colour.difference.`**`delta_E_CAM16UCS`**(*Jpapbp_1*, *Jpapbp_2*)

Returns the difference $\Delta E'$ between two given *Li et al. (2017) CAM16-UCS* colourspaces $J'a'b'$ arrays.

Parameters

- **Jpapbp_1** (array_like) – Standard / reference *Li et al. (2017) CAM16-UCS* colourspaces $J'a'b'$ array.
- **Jpapbp_2** (array_like) – Sample / test *Li et al. (2017) CAM16-UCS* colourspaces $J'a'b'$ array.

Returns Colour difference $\Delta E'$.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
Jpapbp_1	Jp_1 : [0, 100] ap_1 : [-100, 100] bp_1 : [-100, 100]	Jp_1 : [0, 1] ap_1 : [-1, 1] bp_1 : [-1, 1]
Jpapbp_2	Jp_2 : [0, 100] ap_2 : [-100, 100] bp_2 : [-100, 100]	Jp_2 : [0, 1] ap_2 : [-1, 1] bp_2 : [-1, 1]

References

[LLW+17]

Notes

- This docstring is automatically generated, please refer to `colour.delta_E_CAM02UCS()` definition for an usage example.

DIN99

`colour.difference`

`delta_E_DIN99`(Lab_1, Lab_2[, textiles])	Returns the difference ΔE_{DIN99} between two given *CIE L*a*b** colourspace arrays using *DIN99* formula.

colour.difference.delta_E_DIN99

`colour.difference.`**`delta_E_DIN99`**(*Lab_1*, *Lab_2*, *textiles=False*)

Returns the difference ΔE_{DIN99} between two given *CIE L*a*b** colourspace arrays using *DIN99* formula.

Parameters

- **Lab_1** (`array_like`) – *CIE L*a*b** colourspace array 1.
- **Lab_2** (`array_like`) – *CIE L*a*b** colourspace array 2.

Returns Colour difference ΔE_{DIN99}.

Return type numeric or ndarray

Notes

Domain	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

[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)  # doctest: +ELLIPSIS
1.1772166...
```

Input and Output

- *Image Data*
- *Look Up Table (LUT) Data*
- *CSV Tabular Data*
- *IES TM-27-14 Data*
- *X-Rite Data*

Image Data

colour

read_image(path[, bit_depth, attributes])	Reads given image using *OpenImageIO*.
write_image(image, path[, bit_depth, attributes])	Writes given image using *OpenImageIO*.

colour.read_image

colour.**read_image**(*path*, *bit_depth='float32'*, *attributes=False*)

Reads given image using *OpenImageIO*.

Parameters

- **path** (unicode) – Image path.
- **bit_depth** (unicode, optional) – **{'float32', 'uint8', 'uint16', 'float16'}**, Image bit_depth.
- **attributes** (bool, optional) – Whether to return the image attributes.

Returns Image as a ndarray.

Return type ndarray

Notes

- For convenience, single channel images are squeezed to 2d arrays.

Examples

```
>>> import os
>>> path = os.path.join('tests', 'resources', 'CMSTestPattern.exr')
>>> image = read_image(path)  # doctest: +SKIP
```

colour.write_image

colour.**write_image**(*image*, *path*, *bit_depth='float32'*, *attributes=None*)

Writes given image using *OpenImageIO*.

Parameters

- **image** (array_like) – Image data.
- **path** (unicode) – Image path.
- **bit_depth** (unicode, optional) – **{'float32', 'uint8', 'uint16', 'float16'}**, Image bit_depth.
- **attributes** (array_like, optional) – An array of colour.io.ImageAttribute_Specification class instances used to set attributes of the image.

Returns Definition success.

Return type bool

Examples

Basic image writing:

```
>>> import os
>>> path = os.path.join('tests', 'resources', 'CMSTestPattern.exr')
>>> image = read_image(path)  # doctest: +SKIP
>>> path = os.path.join('tests', 'resources', 'CMSTestPattern.tif')
>>> write_image(image, path)  # doctest: +SKIP
True
```

Advanced image writing while setting attributes:

```
>>> compression = ImageAttribute_Specification('Compression', 'none')
>>> write_image(image, path, 'uint8', [compression])  # doctest: +SKIP
True
```

Ancillary Objects

colour.io

ImageAttribute_Specification	Defines the an image specification attribute.

colour.io.ImageAttribute_Specification

class colour.io.**ImageAttribute_Specification**

Defines the an image specification attribute.

Parameters

- **name** (unicode) – Attribute name.
- **value** (object) – Attribute value.
- **type** (TypeDesc, optional) – Attribute type as an *OpenImageIO* TypeDesc class instance.

Returns a new instance of the colour.ImageAttribute_Specification class.

__init__()
Initialize self. See help(type(self)) for accurate signature.

Methods

count	Return number of occurrences of value.
index	Return first index of value.

Attributes

name	Alias for field number 0
type_	Alias for field number 2
value	Alias for field number 1

Look Up Table (LUT) Data

colour

LUT1D([table, name, domain, size, comments])	Defines the base class for a 1D *LUT*.
LUT3x1D([table, name, domain, size, comments])	Defines the base class for a 3x1D *LUT*.
LUT3D([table, name, domain, size, comments])	Defines the base class for a 3D *LUT*.
LUTSequence(*args)	Defines the base class for a *LUT* sequence, i.e.
read_LUT(path[, method])	Reads given *LUT* file using given method.
write_LUT(LUT, path[, decimals, method])	Writes given *LUT* to given file using given method.

colour.LUT1D

class colour.**LUT1D**(*table=None, name=None, domain=None, size=10, comments=None*)
Defines the base class for a 1D *LUT*.

Parameters

- **table** (array_like, optional) – Underlying *LUT* table.
- **name** (unicode, optional) – *LUT* name.
- **domain** (unicode, optional) – *LUT* domain, also used to define the instantiation time default table domain.
- **size** (int, optional) – Size of the instantiation time default table.
- **comments** (array_like, optional) – Comments to add to the *LUT*.

is_domain_explicit()

linear_table()

apply()

as_LUT()

Examples

Instantiating a unity LUT with a table with 16 elements:

```
>>> print(LUT1D(size=16))
LUT1D - Unity 16
----------------
<BLANKLINE>
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)))  # doctest: +ELLIPSIS
LUT1D - ...
--------...
<BLANKLINE>
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
--------------
<BLANKLINE>
Dimensions : 1
Domain     : [-0.1  1.5]
Size       : (16,)
Comment 01 : A first comment.
Comment 02 : A second comment.
```

__init__(*table=None*, *name=None*, *domain=None*, *size=10*, *comments=None*)

Initialize self. See help(type(self)) for accurate signature.

Methods

`__init__`([table, name, domain, size, comments])	Initialize self.

Continued on next page

Table 169 – continued from previous page

apply(RGB[, interpolator, interpolator_args])	Applies the *LUT* to given *RGB* colourspace array using given method.
arithmetical_operation(a, operation[, in_place])	Performs given arithmetical operation with a operand, the operation can be either performed on a copy or in-place, must be reimplemented by sub-classes.
as_LUT(cls[, force_conversion])	Converts the *LUT* to given `cls` class instance.
copy()	Returns a copy of the sub-class instance.
is_domain_explicit()	Returns whether the *LUT* domain is explicit (or implicit).
linear_table([size, domain])	Returns a linear table, the number of output samples n is equal to `size`.

Attributes

comments	Getter and setter property for the *LUT* comments.
dimensions	Getter and setter property for the *LUT* dimensions.
domain	Getter and setter property for the *LUT* domain.
name	Getter and setter property for the *LUT* name.
size	Getter property for the *LUT* size.
table	Getter and setter property for the underlying *LUT* table.

colour.LUT3x1D

class colour.**LUT3x1D**(*table=None*, *name=None*, *domain=None*, *size=10*, *comments=None*)

Defines the base class for a 3x1D *LUT*.

Parameters

- **table** (array_like, optional) – Underlying *LUT* table.
- **name** (unicode, optional) – *LUT* name.
- **domain** (unicode, optional) – *LUT* domain, also used to define the instantiation time default table domain.
- **size** (int, optional) – Size of the instantiation time default table.
- **comments** (array_like, optional) – Comments to add to the *LUT*.

is_domain_explicit()

linear_table()

apply()

as_LUT()

Examples

Instantiating a unity LUT with a table with 16x3 elements:

```
>>> print(LUT3x1D(size=16))
LUT3x1D - Unity 16
------------------
<BLANKLINE>
Dimensions : 2
Domain     : [[ 0.  0.  0.]
              [ 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)))
... # doctest: +ELLIPSIS
LUT3x1D - ...
----------...
<BLANKLINE>
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
----------------
<BLANKLINE>
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=None*, *name=None*, *domain=None*, *size=10*, *comments=None*)

Initialize self. See help(type(self)) for accurate signature.

Methods

`__init__`([table, name, domain, size, comments])	Initialize self.
`apply`(RGB[, interpolator, interpolator_args])	Applies the *LUT* to given *RGB* colourspace array using given method.
`arithmetical_operation`(a, operation[, in_place])	Performs given arithmetical operation with a operand, the operation can be either performed on a copy or in-place, must be reimplemented by sub-classes.

Continued on next page

Table 171 – continued from previous page

as_LUT(cls[, force_conversion])	Converts the *LUT* to given cls class instance.
copy()	Returns a copy of the sub-class instance.
is_domain_explicit()	Returns whether the *LUT* domain is explicit (or implicit).
linear_table([size, domain])	Returns a linear table, the number of output samples n is equal to size * 3 or size[0] + size[1] + size[2].

Attributes

comments	Getter and setter property for the *LUT* comments.
dimensions	Getter and setter property for the *LUT* dimensions.
domain	Getter and setter property for the *LUT* domain.
name	Getter and setter property for the *LUT* name.
size	Getter property for the *LUT* size.
table	Getter and setter property for the underlying *LUT* table.

colour.LUT3D

class colour.**LUT3D**(*table=None*, *name=None*, *domain=None*, *size=33*, *comments=None*)

Defines the base class for a 3D *LUT*.

Parameters

- **table** (array_like, optional) – Underlying *LUT* table.
- **name** (unicode, optional) – *LUT* name.
- **domain** (unicode, optional) – *LUT* domain, also used to define the instantiation time default table domain.
- **size** (int, optional) – Size of the instantiation time default table.
- **comments** (array_like, optional) – Comments to add to the *LUT*.

is_domain_explicit()

linear_table()

apply()

as_LUT()

Examples

Instantiating a unity LUT with a table with 16x16x16x3 elements:

```
>>> print(LUT3D(size=16))
LUT3D - Unity 16
----------------
<BLANKLINE>
Dimensions : 3
```

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```
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)))  # doctest: +ELLIPSIS
LUT3D - ...
--------...
<BLANKLINE>
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
--------------
<BLANKLINE>
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=None*, *name=None*, *domain=None*, *size=33*, *comments=None*)

Initialize self. See help(type(self)) for accurate signature.

Methods

`__init__`([table, name, domain, size, comments])	Initialize self.
`apply`(RGB[, interpolator, interpolator_args])	Applies the *LUT* to given *RGB* colourspace array using given method.
`arithmetical_operation`(a, operation[, in_place])	Performs given arithmetical operation with a operand, the operation can be either performed on a copy or in-place, must be reimplemented by sub-classes.
`as_LUT`(cls[, force_conversion])	Converts the *LUT* to given `cls` class instance.
`copy`()	Returns a copy of the sub-class instance.
`is_domain_explicit`()	Returns whether the *LUT* domain is explicit (or implicit).

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Table 173 – continued from previous page

`linear_table`([size, domain])	Returns a linear table, the number of output samples n is equal to `size**3 * 3` or `size[0] * size[1] * size[2] * 3`.

Attributes

`comments`	Getter and setter property for the *LUT* comments.
`dimensions`	Getter and setter property for the *LUT* dimensions.
`domain`	Getter and setter property for the *LUT* domain.
`name`	Getter and setter property for the *LUT* name.
`size`	Getter property for the *LUT* size.
`table`	Getter and setter property for the underlying *LUT* table.

colour.LUTSequence

class colour.**LUTSequence**(**args*)

Defines the base class for a *LUT* sequence, i.e. a series of *LUTs*.

The *colour.LUTSequence* class can be used to model series of *LUTs* such as when a shaper *LUT* is combined with a 3D *LUT*.

Other Parameters ***args** (*list, optional*) – Sequence of *colour.LUT1D*, *colour.LUT3x1D*, *colour.LUT3D* or *colour.io.lut.l.AbstractLUTSequenceOperator* class instances.

sequence

__getitem__()

__setitem__()

__delitem__()

__len__()

__str__()

__repr__()

__eq__()

__ne__()

insert()

apply()

copy()

Examples

```
>>> LUT_1 = LUT1D()
>>> LUT_2 = LUT3D(size=3)
>>> LUT_3 = LUT3x1D()
>>> print(LUTSequence(LUT_1, LUT_2, LUT_3))
```

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```
LUT Sequence
------------
<BLANKLINE>
Overview
<BLANKLINE>
    LUT1D ---> LUT3D ---> LUT3x1D
<BLANKLINE>
Operations
<BLANKLINE>
    LUT1D - Unity 10
    ----------------
<BLANKLINE>
    Dimensions : 1
    Domain     : [ 0.  1.]
    Size       : (10,)
<BLANKLINE>
    LUT3D - Unity 3
    ---------------
<BLANKLINE>
    Dimensions : 3
    Domain     : [[ 0.  0.  0.]
                  [ 1.  1.  1.]]
    Size       : (3, 3, 3, 3)
<BLANKLINE>
    LUT3x1D - Unity 10
    ------------------
<BLANKLINE>
    Dimensions : 2
    Domain     : [[ 0.  0.  0.]
                  [ 1.  1.  1.]]
    Size       : (10, 3)
```

__init__(**args*)

Initialize self. See help(type(self)) for accurate signature.

Methods

`__init__`(*args)	Initialize self.
`append`(value)	S.append(value) – append value to the end of the sequence
`apply`(RGB[, interpolator_1D, ...])	Applies the *LUT* sequence sequentially to given *RGB* colourspace array.
`clear`()	
`copy`()	Returns a copy of the *LUT* sequence.
`count`(value)	
`extend`(values)	S.extend(iterable) – extend sequence by appending elements from the iterable
`index`(value, [start, [stop]])	Raises ValueError if the value is not present.
`insert`(index, LUT)	Inserts given *LUT* at given index into the *LUT* sequence.
`pop`([index])	Raise IndexError if list is empty or index is out of range.

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Table 175 – continued from previous page

remove(value)	S.remove(value) – remove first occurrence of value.
reverse()	S.reverse() – reverse *IN PLACE*

Attributes

sequence	Getter and setter property for the underlying *LUT* sequence.

colour.read_LUT

colour.**read_LUT**(*path*, *method=None*, ***kwargs*)

Reads given *LUT* file using given method.

Parameters

- **path** (unicode) – *LUT* path.
- **method** (unicode, optional) – **{None, 'Cinespace', 'Iridas Cube', 'Resolve Cube', 'Sony SPI1D', 'Sony SPI3D'}**, Reading method, if *None*, the method will be auto-detected according to extension.

Returns LUT1D, LUT3x1D or LUT3D class instance.

Return type *LUT1D* or *LUT3x1D* or *LUT3D*

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
-------------------------------
<BLANKLINE>
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',
...     'oetf_reverse_sRGB_1D.spi1d')
>>> print(read_LUT(path))
LUT1D - oetf reverse sRGB 1D
```

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```
----------------------------
<BLANKLINE>
Dimensions : 1
Domain     : [-0.1  1.5]
Size       : (16,)
Comment 01 : Generated by "Colour 0.3.11".
Comment 02 : "colour.models.oetf_reverse_sRGB".
```

Reading a 3D *Sony .spi3d LUT*:

```
>>> path = os.path.join(
...     os.path.dirname(__file__), 'tests', 'resources', 'sony_spi3d',
...     'ColourCorrect.spi3d')
>>> print(read_LUT(path))
LUT3D - ColourCorrect
---------------------
<BLANKLINE>
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.write_LUT

`colour.write_LUT(LUT, path, decimals=7, method=None, **kwargs)`

Writes given *LUT* to given file using given method.

Parameters

- **LUT** (`LUT1D` or `LUT3x1D` or `LUT3D`) – `LUT1D`, `LUT3x1D` or `LUT3D` class instance to write at given path.
- **path** (`unicode`) – *LUT* path.
- **decimals** (`int, optional`) – Formatting decimals.
- **method** (`unicode, optional`) – **{None, 'Cinespace', 'Iridas Cube', 'Resolve Cube', 'Sony SPI1D', 'Sony SPI3D'}**, Writing method, if *None*, the method will be auto-detected according to extension.

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')  # doctest: +SKIP
```

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')  # doctest: +SKIP
```

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')  # doctest: +SKIP
```

Ancillary Objects

`colour.io`

`AbstractLUTSequenceOperator`	Defines the base class for *LUT* sequence operators.
`LUT_to_LUT`(LUT, cls[, force_conversion])	Converts given *LUT* to given `cls` class instance.
`read_LUT_Cinespace`(path)	Reads given *Cinespace .csp LUT* file.
`write_LUT_Cinespace`(LUT, path[, decimals])	Writes given *LUT* to given *Cinespace .csp LUT* file.
`read_LUT_IridasCube`(path)	Reads given *Iridas .cube LUT* file.
`write_LUT_IridasCube`(LUT, path[, decimals])	Writes given *LUT* to given *Iridas .cube LUT* file.
`read_LUT_SonySPI1D`(path)	Reads given *Sony .spi1d LUT* file.
`write_LUT_SonySPI1D`(LUT, path[, decimals])	Writes given *LUT* to given *Sony .spi1d LUT* file.
`read_LUT_SonySPI3D`(path)	Reads given *Sony .spi3d LUT* file.
`write_LUT_SonySPI3D`(LUT, path[, decimals])	Writes given *LUT* to given *Sony .spi3d LUT* file.

colour.io.AbstractLUTSequenceOperator

class colour.io.**AbstractLUTSequenceOperator**

Defines the base class for *LUT* sequence operators.

This is an `ABCMeta` abstract class that must be inherited by sub-classes.

apply()

__init__()

Initialize self. See help(type(self)) for accurate signature.

Methods

`apply`(RGB, *args)	Applies the *LUT* sequence operator to given *RGB* colourspace array.

colour.io.LUT_to_LUT

`colour.io.`**`LUT_to_LUT`**(*LUT*, *cls*, *force_conversion=False*, ***kwargs*)

Converts given *LUT* to given `cls` class instance.

Parameters

- **cls** (`LUT1D` or `LUT3x1D` or `LUT3D`) – *LUT* class instance.
- **force_conversion** (`bool`, `optional`) – Whether to force the conversion as it might be destructive.

Other Parameters

- **interpolator** (*object, optional*) – Interpolator class type to use as interpolating function.
- **interpolator_args** (*dict_like, optional*) – Arguments to use when instantiating the interpolating function.
- **size** (*int, optional*) – Expected table size in case of an upcast to or a downcast from a `LUT3D` class instance.
- **channel_weights** (*array_like, optional*) – Channel weights in case of a downcast from a `LUT3x1D` or `LUT3D` class instance.

Returns Converted *LUT* class instance.

Return type *LUT1D* or *LUT3x1D* or *LUT3D*

> **Warning:** Some conversions are destructive and raise a `ValueError` exception by default.

Raises `ValueError` – If the conversion is destructive.

Examples

```
>>> print(LUT_to_LUT(LUT1D(), LUT3D, force_conversion=True))
LUT3D - Unity 10 - Converted 1D to 3D
-------------------------------------
<BLANKLINE>
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
---------------------------------------
<BLANKLINE>
Dimensions : 1
Domain     : [ 0.  1.]
```

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```
Size       : (10,)
>>> print(LUT_to_LUT(LUT3D(), LUT1D, force_conversion=True))
LUT1D - Unity 33 - Converted 3D to 1D
-------------------------------------
<BLANKLINE>
Dimensions : 1
Domain     : [ 0.  1.]
Size       : (10,)
```

colour.io.read_LUT_Cinespace

`colour.io.read_LUT_Cinespace(path)`

Reads given *Cinespace .csp LUT* file.

Parameters **path** (unicode) – *LUT* path.

Returns LUT3x1D or LUT3D or LUTSequence class instance.

Return type *LUT3x1D* or *LUT3D* or *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
-------------------------------
<BLANKLINE>
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',
...     'ColourCorrect.csp')
>>> print(read_LUT_Cinespace(path))
LUT3D - Generated by Foundry::LUT
---------------------------------
<BLANKLINE>
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*, *path*, *decimals=7*)

Writes given *LUT* to given *Cinespace .csp LUT* file.

Parameters

- **LUT** (LUT1D or LUT3x1D or LUT3D or LUTSequence) – LUT1D, LUT3x1D or LUT3D or LUTSequence class instance to write at given path.
- **path** (unicode) – *LUT* path.
- **decimals** (int, optional) – 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')  # doctest: +SKIP
```

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')  # doctest: +SKIP
```

colour.io.read_LUT_IridasCube

colour.io.**read_LUT_IridasCube**(*path*)

Reads given *Iridas .cube LUT* file.

Parameters **path** (unicode) – *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
-------------------------------
<BLANKLINE>
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',
...     'ColourCorrect.cube')
>>> print(read_LUT_IridasCube(path))
LUT3D - Generated by Foundry::LUT
---------------------------------
<BLANKLINE>
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
--------------
<BLANKLINE>
Dimensions : 2
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*, *path*, *decimals=7*)

Writes given *LUT* to given *Iridas .cube LUT* file.

Parameters

- **LUT** (LUT3x1D or LUT3d or LUTSequence) – LUT3x1D, LUT3D or LUTSequence class instance to write at given path.
- **path** (unicode) – *LUT* path.
- **decimals** (int, optional) – 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(LUT, 'My_LUT.cube')  # doctest: +SKIP
```

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',
...     np.array([[-0.1, -0.2, -0.4], [1.5, 3.0, 6.0]]),
...     comments=['A first comment.', 'A second comment.'])
>>> write_LUT_IridasCube(LUT, 'My_LUT.cube')  # doctest: +SKIP
```

colour.io.read_LUT_SonySPI1D

colour.io.**read_LUT_SonySPI1D**(*path*)

Reads given *Sony .spi1d LUT* file.

Parameters **path** (unicode) – *LUT* path.

Returns LUT1D or LUT3x1D class instance.

Return type *LUT1D* or *LUT3x1D*

Examples

Reading a 1D *Sony .spi1d LUT*:

```
>>> import os
>>> path = os.path.join(
...     os.path.dirname(__file__), 'tests', 'resources', 'sony_spi1d',
...     'oetf_reverse_sRGB_1D.spi1d')
>>> print(read_LUT_SonySPI1D(path))
LUT1D - oetf reverse sRGB 1D
----------------------------
<BLANKLINE>
Dimensions : 1
Domain     : [-0.1  1.5]
Size       : (16,)
Comment 01 : Generated by "Colour 0.3.11".
Comment 02 : "colour.models.oetf_reverse_sRGB".
```

Reading a 3x1D *Sony .spi1d LUT*:

```
>>> path = os.path.join(
...     os.path.dirname(__file__), 'tests', 'resources', 'sony_spi1d',
...     'oetf_reverse_sRGB_3x1D.spi1d')
>>> print(read_LUT_SonySPI1D(path))
LUT3x1D - oetf reverse sRGB 3x1D
--------------------------------
<BLANKLINE>
Dimensions : 2
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.oetf_reverse_sRGB".
```

colour.io.write_LUT_SonySPI1D

`colour.io.`**`write_LUT_SonySPI1D`**(*LUT*, *path*, *decimals=7*)

Writes given *LUT* to given *Sony .spi1d LUT* file.

Parameters

- **LUT** (`LUT1D or LUT2d`) – `LUT1D`, `LUT3x1D` or `LUTSequence` class instance to write at given path.
- **path** (`unicode`) – *LUT* path.
- **decimals** (`int, optional`) – 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')  # doctest: +SKIP
```

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')  # doctest: +SKIP
```

colour.io.read_LUT_SonySPI3D

colour.io.**read_LUT_SonySPI3D**(*path*)

Reads given *Sony .spi3d LUT* file.

Parameters **path** (unicode) – *LUT* path.

Returns LUT3D or LUT3x1D class instance.

Return type *LUT3D* or *LUT3x1D*

Examples

Reading a 3D *Sony .spi3d LUT*:

```
>>> import os
>>> path = os.path.join(
...     os.path.dirname(__file__), 'tests', 'resources', 'sony_spi3d',
...     'ColourCorrect.spi3d')
>>> print(read_LUT_SonySPI3D(path))
LUT3D - ColourCorrect
---------------------
<BLANKLINE>
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*, *path*, *decimals=7*)

Writes given *LUT* to given *Sony .spi3d LUT* file.

Parameters

- **LUT** (LUT3D) – LUT3D or LUTSequence class instance to write at given path.
- **path** (unicode) – *LUT* path.
- **decimals** (int, optional) – 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')  # doctest: +SKIP
```

CSV Tabular Data

colour

read_sds_from_csv_file(path[, delimiter, ...])	Reads the spectral data from given *CSV* file and return its content as an *OrderedDict* of colour.SpectralDistribution classes.
read_spectral_data_from_csv_file(path[, ...])	Reads the spectral data from given *CSV* file in the following form:
write_sds_to_csv_file(sds, path[, ...])	Writes the given spectral distributions to given *CSV* file.

colour.read_sds_from_csv_file

colour.**read_sds_from_csv_file**(*path*, *delimiter=', '*, *fields=None*, *default=0*)

Reads the spectral data from given *CSV* file and return its content as an *OrderedDict* of colour.SpectralDistribution classes.

Parameters

- **path** (unicode) – Absolute *CSV* file path.
- **delimiter** (unicode, optional) – *CSV* file content delimiter.
- **fields** (array_like, optional) – *CSV* file spectral data fields names. If no value is provided the first line of the file will be used for as spectral data fields names.
- **default** (numeric) – Default value for fields row with missing value.

Returns colour.SpectralDistribution classes of given *CSV* file.

Return type OrderedDict

Examples

```
>>> from colour.utilities import numpy_print_options
>>> import os
>>> csv_file = os.path.join(os.path.dirname(__file__), 'tests',
...                         'resources', 'colorchecker_n_ohta.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']  # doctest: +ELLIPSIS
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],
                      [ 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],
```

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```
                     [ 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],
                     [ 775.   ,    0.432],
                     [ 780.   ,    0.421]],
                    interpolator=SpragueInterpolator,
                    interpolator_args={},
                    extrapolator=Extrapolator,
                    extrapolator_args={...})
```

colour.read_spectral_data_from_csv_file

colour.**read_spectral_data_from_csv_file**(*path*, *delimiter=', '*, *fields=None*, *default=0*)

Reads 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 *OrderedDict* of *dict* as follows:

OrderedDict([('field', {'wavelength': 'value', ..., 'wavelength': 'value'}), ..., ('field', {'wavelength': 'value', ..., 'wavelength': 'value'})])

Parameters

- **path** (unicode) – Absolute *CSV* file path.
- **delimiter** (unicode, optional) – *CSV* file content delimiter.
- **fields** (array_like, optional) – *CSV* file spectral data fields names. If no value is provided the first line of the file will be used as spectral data fields names.
- **default** (numeric, optional) – Default value for fields row with missing value.

Returns *CSV* file content.

Return type OrderedDict

Raises RuntimeError – If the *CSV* spectral data file doesn't define the appropriate fields.

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.
- If no value is provided for the fields names, the first line of the file will be used as spectral data fields names.

Examples

```
>>> import os
>>> from pprint import pprint
>>> csv_file = os.path.join(os.path.dirname(__file__), 'tests',
...                         'resources', 'colorchecker_n_ohta.csv')
>>> sds_data = read_spectral_data_from_csv_file(csv_file)
>>> pprint(list(sds_data.keys()))
['1',
 '2',
 '3',
 '4',
 '5',
 '6',
 '7',
 '8',
 '9',
 '10',
 '11',
 '12',
 '13',
```

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```
'14',
'15',
'16',
'17',
'18',
'19',
'20',
'21',
'22',
'23',
'24']
```

colour.write_sds_to_csv_file

colour.**write_sds_to_csv_file**(*sds*, *path*, *delimiter=', '*, *fields=None*)

Writes the given spectral distributions to given *CSV* file.

Parameters

- **sds** (dict) – Spectral distributions to write.
- **path** (unicode) – Absolute *CSV* file path.
- **delimiter** (unicode, optional) – *CSV* file content delimiter.
- **fields** (array_like, optional) – *CSV* file spectral data fields names. If no value is provided the order of fields will be the one defined by the sorted spectral distributions *dict*.

Returns Definition success.

Return type bool

Raises RuntimeError – If the given spectral distributions have different shapes.

IES TM-27-14 Data

colour

SpectralDistribution_IESTM2714([path, ...])	Defines a *IES TM-27-14* spectral distribution.

colour.SpectralDistribution_IESTM2714

class colour.**SpectralDistribution_IESTM2714**(*path=None*, *header=None*, *spectral_quantity=None*, *reflection_geometry=None*, *transmission_geometry=None*, *bandwidth_FWHM=None*, *bandwidth_corrected=None*)

Defines a *IES TM-27-14* spectral distribution.

This class can read and write *IES TM-27-14* spectral data XML files.

Parameters

- **path** (unicode, optional) – Spectral data XML file path.

- **header** (IES_TM2714_Header, optional) – *IES TM-27-14* spectral distribution header.
- **spectral_quantity** (unicode, optional) – **{'flux', 'absorptance', 'transmittance', 'reflectance', 'intensity', 'irradiance', 'radiance', 'exitance', 'R-Factor', 'T-Factor', 'relative', 'other'}**, Quantity of measurement for each element of the spectral data.
- **reflection_geometry** (unicode, optional) – **{'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** (unicode, optional) – **{'0:0', 'di:0', 'de:0', '0:di', '0:de', 'd:d', 'other'}**, Spectral transmittance factors geometric conditions.
- **bandwidth_FWHM** (numeric, optional) – Spectroradiometer full-width half-maximum bandwidth in nanometers.
- **bandwidth_corrected** (bool, optional) – Specifies if bandwidth correction has been applied to the measured data.

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.

mapping

path

header

spectral_quantity

reflection_geometry

transmission_geometry

bandwidth_FWHM

bandwidth_corrected

read()

write()

References

[IESCCommitteeTM2714WGroup14]

Examples

```
>>> from os.path import dirname, join
>>> directory = join(dirname(__file__), 'tests', 'resources')
>>> sd = SpectralDistribution_IESTM2714(
...     join(directory, 'Fluorescent.spdx'))
>>> sd.read()
True
>>> sd.header.manufacturer
'Unknown'
>>> # Doctests ellipsis for Python 2.x compatibility.
>>> sd[501.7]  # doctest: +ELLIPSIS
0.0950000...
```

__init__(*path=None*, *header=None*, *spectral_quantity=None*, *reflection_geometry=None*, *transmission_geometry=None*, *bandwidth_FWHM=None*, *bandwidth_corrected=None*)

Initialize self. See help(type(self)) for accurate signature.

Methods

`__init__`([path, header, spectral_quantity, ...])	Initialize self.
`align`(shape[, interpolator, ...])	Aligns the spectral distribution in-place to given spectral shape: Interpolates first then extrapolates to fit the given range.
`arithmetical_operation`(a, operation[, in_place])	Performs given arithmetical operation with a operand, the operation can be either performed on a copy or in-place.
`clone`()	
`copy`()	Returns a copy of the sub-class instance.
`domain_distance`(a)	Returns the euclidean distance between given array and independent domain x closest element.

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extrapolate(shape[, extrapolator, ...])	Extrapolates the spectral distribution in-place according to *CIE 15:2004* and *CIE 167:2005* recommendations or given extrapolation arguments.
fill_nan([method, default])	Fill NaNs in independent domain x variable and corresponding range y variable using given method.
get()	
interpolate(shape[, interpolator, ...])	Interpolates the spectral distribution in-place according to *CIE 167:2005* recommendation or given interpolation arguments.
is_uniform()	Returns if independent domain x variable is uniform.
normalise([factor])	Normalises the spectral distribution using given normalization factor.
read()	Reads and parses the spectral data XML file path.
signal_unpack_data([data, domain, dtype])	Unpack given data for continuous signal instantiation.
to_series()	Converts the continuous signal to a *Pandas* Series class instance.
trim(shape)	Trims the spectral distribution wavelengths to given spectral shape.
trim_wavelengths(shape)	
write()	Write the spectral distribution spectral data to XML file path.
zeros()	

Attributes

bandwidth_FWHM	Getter and setter property for the full-width half-maximum bandwidth.
bandwidth_corrected	Getter and setter property for whether bandwidth correction has been applied to the measured data.
data	
domain	Getter and setter property for the continuous signal independent domain x variable.
dtype	Getter and setter property for the continuous signal dtype.
extrapolator	Getter and setter property for the continuous signal extrapolator type.
extrapolator_args	Getter and setter property for the continuous signal extrapolator instantiation time arguments.
function	Getter and setter property for the continuous signal callable.
header	Getter and setter property for the header.
interpolator	Getter and setter property for the continuous signal interpolator type.
interpolator_args	Getter and setter property for the continuous signal interpolator instantiation time arguments.

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items	
mapping	Getter and setter property for the mapping structure.
name	Getter and setter property for the abstract continuous function name.
path	Getter and setter property for the path.
range	Getter and setter property for the continuous signal corresponding range y variable.
reflection_geometry	Getter and setter property for the reflection geometry.
shape	Getter and setter property for the spectral distribution shape.
spectral_quantity	Getter and setter property for the spectral quantity.
strict_name	Getter and setter property for the spectral distribution strict name.
title	
transmission_geometry	Getter and setter property for the transmission geometry.
values	Getter and setter property for the spectral distribution values.
wavelengths	Getter and setter property for the spectral distribution wavelengths λ_n.

X-Rite Data

colour

read_sds_from_xrite_file(path)	Reads the spectral data from given *X-Rite* file and returns it as an *OrderedDict* of colour.SpectralDistribution classes.

colour.read_sds_from_xrite_file

colour.**read_sds_from_xrite_file**(*path*)

Reads the spectral data from given *X-Rite* file and returns it as an *OrderedDict* of colour.SpectralDistribution classes.

Parameters **path** (unicode) – Absolute *X-Rite* file path.

Returns colour.SpectralDistribution classes of given *X-Rite* file.

Return type OrderedDict

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',
...                           'xrite_digital_colour_checker.txt')
>>> sds_data = read_sds_from_xrite_file(xrite_file)
>>> pprint(list(sds_data.keys()))  # doctest: +SKIP
['X1', 'X2', 'X3', 'X4', 'X5', 'X6', 'X7', 'X8', 'X9', 'X10']
```

Colour Models

Tristimulus Values, CIE xyY Colourspace and Chromaticity Coordinates

`colour`

`XYZ_to_xyY`(XYZ[, illuminant])	Converts from *CIE XYZ* tristimulus values to *CIE xyY* colourspace and reference *illuminant*.
`xyY_to_XYZ`(xyY)	Converts from *CIE xyY* colourspace to *CIE XYZ* tristimulus values.
`XYZ_to_xy`(XYZ[, illuminant])	Returns the *xy* chromaticity coordinates from given *CIE XYZ* tristimulus values.
`xy_to_XYZ`(xy)	Returns the *CIE XYZ* tristimulus values from given *xy* chromaticity coordinates.
`xyY_to_xy`(xyY)	Converts from *CIE xyY* colourspace to *xy* chromaticity coordinates.
`xy_to_xyY`(xy[, Y])	Converts from *xy* chromaticity coordinates to *CIE xyY* colourspace by extending the array last dimension with Y Luminance.

colour.XYZ_to_xyY

`colour.`**`XYZ_to_xyY`**(*XYZ*, *illuminant=array([0.3127, 0.329])*)

Converts from *CIE XYZ* tristimulus values to *CIE xyY* colourspace and reference *illuminant*.

Parameters

- **XYZ** (`array_like`) – *CIE XYZ* tristimulus values.
- **illuminant** (`array_like, optional`) – Reference *illuminant* chromaticity coordinates.

Returns *CIE xyY* colourspace array.

Return type ndarray

Notes

Domain	Scale - Reference	Scale - 1
XYZ	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
xyY	[0, 1]	[0, 1]

References

[Lin03b], [Wik05a]

Examples

```
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> XYZ_to_xyY(XYZ)  # doctest: +ELLIPSIS
array([ 0.5436955...,  0.3210794...,  0.1219722...])
```

colour.xyY_to_XYZ

`colour.`**`xyY_to_XYZ`**(*xyY*)

Converts from *CIE xyY* colourspace to *CIE XYZ* tristimulus values.

Parameters **xyY** (array_like) – *CIE xyY* colourspace array.

Returns *CIE XYZ* tristimulus values.

Return type ndarray

Notes

Domain	Scale - Reference	Scale - 1
xyY	[0, 1]	[0, 1]

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

References

[Lin09d], [Wik05a]

Examples

```
>>> xyY = np.array([0.54369557, 0.32107944, 0.12197225])
>>> xyY_to_XYZ(xyY)  # doctest: +ELLIPSIS
array([ 0.2065400...,  0.1219722...,  0.0513695...])
```

colour.XYZ_to_xy

colour.**XYZ_to_xy**(*XYZ*, *illuminant=array([0.3127, 0.329])*)

Returns the *xy* chromaticity coordinates from given *CIE XYZ* tristimulus values.

Parameters

- **XYZ** (array_like) – *CIE XYZ* tristimulus values.
- **illuminant** (array_like, optional) – Reference *illuminant* chromaticity coordinates.

Returns *xy* chromaticity coordinates.

Return type ndarray

Notes

Domain	Scale - Reference	Scale - 1
XYZ	[0, 1]	[0, 1]

References

[Wik05a]

Examples

```
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> XYZ_to_xy(XYZ)  # doctest: +ELLIPSIS
array([ 0.5436955...,  0.3210794...])
```

colour.xy_to_XYZ

colour.**xy_to_XYZ**(*xy*)

Returns the *CIE XYZ* tristimulus values from given *xy* chromaticity coordinates.

Parameters **xy** (array_like) – *xy* chromaticity coordinates.

Returns *CIE XYZ* tristimulus values.

Return type ndarray

Notes

Domain	Scale - Reference	Scale - 1
xy	[0, 1]	[0, 1]

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

References

[Wik05a]

Examples

```
>>> xy = np.array([0.54369557, 0.32107944])
>>> xy_to_XYZ(xy)  # doctest: +ELLIPSIS
array([ 1.6933366...,  1.        ,  0.4211574...])
```

colour.xyY_to_xy

`colour.`**`xyY_to_xy`**(*xyY*)

Converts from *CIE xyY* colourspace to *xy* chromaticity coordinates.

`xyY` argument with last dimension being equal to 2 will be assumed to be a *xy* chromaticity coordinates argument and will be returned directly by the definition.

Parameters **xyY** (`array_like`) – *CIE xyY* colourspace array or *xy* chromaticity coordinates.

Returns *xy* chromaticity coordinates.

Return type ndarray

Notes

Domain	Scale - Reference	Scale - 1
xyY	[0, 1]	[0, 1]

References

[Wik05a]

Examples

```
>>> xyY = np.array([0.54369557, 0.32107944, 0.12197225])
>>> xyY_to_xy(xyY)  # doctest: +ELLIPSIS
array([ 0.54369557...,  0.32107944...])
>>> xy = np.array([0.54369557, 0.32107944])
>>> xyY_to_xy(xy)  # doctest: +ELLIPSIS
array([ 0.54369557...,  0.32107944...])
```

colour.xy_to_xyY

`colour.`**`xy_to_xyY`**(*xy*, *Y=1*)

Converts from *xy* chromaticity coordinates to *CIE xyY* colourspace by extending the array last dimension with *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** (array_like) – *xy* chromaticity coordinates or *CIE xyY* colourspace array.
- **Y** (numeric, optional) – Optional Y Luminance value used to construct the *CIE xyY* colourspace array, otherwise the Y Luminance will be set to 1.

Returns *CIE xyY* colourspace array.

Return type 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

[Wik05a]

Examples

```
>>> xy = np.array([0.54369557, 0.32107944])
>>> xy_to_xyY(xy)  # doctest: +ELLIPSIS
array([ 0.5436955...,  0.3210794...,  1.        ])
>>> xy = np.array([0.54369557, 0.32107944, 1.00000000])
>>> xy_to_xyY(xy)  # doctest: +ELLIPSIS
array([ 0.5436955...,  0.3210794...,  1.        ])
>>> xy = np.array([0.54369557, 0.32107944])
>>> xy_to_xyY(xy, 100)  # doctest: +ELLIPSIS
array([   0.5436955...,    0.3210794...,  100.        ])
```

CIE L*a*b* Colourspace

colour

XYZ_to_Lab(XYZ[, illuminant])	Converts from *CIE XYZ* tristimulus values to *CIE L*a*b** colourspace.
Lab_to_XYZ(Lab[, illuminant])	Converts from *CIE L*a*b** colourspace to *CIE XYZ* tristimulus values.
Lab_to_LCHab(Lab)	Converts from *CIE L*a*b** colourspace to *CIE L*C*Hab* colourspace.

Continued on next page

Table 185 – continued from previous page

LCHab_to_Lab(LCHab)	Converts from *CIE L*C*Hab* colourspace to *CIE L*a*b** colourspace.

colour.XYZ_to_Lab

colour.**XYZ_to_Lab**(*XYZ*, *illuminant=array([0.3127, 0.329])*)

Converts from *CIE XYZ* tristimulus values to *CIE L*a*b** colourspace.

Parameters

- **XYZ** (array_like) – *CIE XYZ* tristimulus values.
- **illuminant** (array_like, optional) – Reference *illuminant xy* chromaticity coordinates or *CIE xyY* colourspace array.

Returns *CIE L*a*b** colourspace array.

Return type 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] a : [-100, 100] b : [-100, 100]	L : [0, 1] a : [-1, 1] b : [-1, 1]

References

[CIET14804f]

Examples

```
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> XYZ_to_Lab(XYZ)  # doctest: +ELLIPSIS
array([ 41.5278752...,  52.6385830...,  26.9231792...])
```

colour.Lab_to_XYZ

colour.**Lab_to_XYZ**(*Lab*, *illuminant=array([0.3127, 0.329])*)

Converts from *CIE L*a*b** colourspace to *CIE XYZ* tristimulus values.

Parameters

- **Lab** (array_like) – *CIE L*a*b** colourspace array.

- **illuminant** (array_like, optional) – Reference *illuminant xy* chromaticity coordinates or *CIE xyY* colourspace array.

Returns *CIE XYZ* tristimulus values.

Return type 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]
illuminant	[0, 1]	[0, 1]

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

References

[CIET14804f]

Examples

```
>>> Lab = np.array([41.52787529, 52.63858304, 26.92317922])
>>> Lab_to_XYZ(Lab)  # doctest: +ELLIPSIS
array([ 0.2065400...,  0.1219722...,  0.0513695...])
```

colour.Lab_to_LCHab

colour.**Lab_to_LCHab**(*Lab*)

Converts from *CIE L*a*b** colourspace to *CIE L*C*Hab* colourspace.

Parameters **Lab** (array_like) – *CIE L*a*b** colourspace array.

Returns *CIE L*C*Hab* colourspace array.

Return type 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
LCHab	L : [0, 100] C : [0, 100] ab : [0, 360]	L : [0, 1] C : [0, 1] ab : [0, 1]

References

[CIET14804f]

Examples

```
>>> Lab = np.array([41.52787529, 52.63858304, 26.92317922])
>>> Lab_to_LCHab(Lab)  # doctest: +ELLIPSIS
array([ 41.5278752...,  59.1242590...,  27.0884878...])
```

colour.LCHab_to_Lab

colour.**LCHab_to_Lab**(*LCHab*)

Converts from *CIE L*C*Hab* colourspace to *CIE L*a*b** colourspace.

Parameters **LCHab** (array_like) – *CIE L*C*Hab* colourspace array.

Returns *CIE L*a*b** colourspace array.

Return type ndarray

Notes

Domain	Scale - Reference	Scale - 1
LCHab	L : [0, 100] C : [0, 100] ab : [0, 360]	L : [0, 1] C : [0, 1] ab : [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

[CIET14804f]

Examples

```
>>> LCHab = np.array([41.52787529, 59.12425901, 27.08848784])
>>> LCHab_to_Lab(LCHab)  # doctest: +ELLIPSIS
array([ 41.5278752...,  52.6385830...,  26.9231792...])
```

CIE L*u*v* Colourspace

colour

XYZ_to_Luv(XYZ[, illuminant])	Converts from *CIE XYZ* tristimulus values to *CIE L*u*v** colourspace.
Luv_to_XYZ(Luv[, illuminant])	Converts from *CIE L*u*v** colourspace to *CIE XYZ* tristimulus values.
Luv_to_LCHuv(Luv)	Converts from *CIE L*u*v** colourspace to *CIE L*C*Huv* colourspace.
LCHuv_to_Luv(LCHuv)	Converts from *CIE L*C*Huv* colourspace to *CIE L*u*v** colourspace.
Luv_to_uv(Luv[, illuminant])	Returns the uv^p chromaticity coordinates from given *CIE L*u*v** colourspace array.
Luv_uv_to_xy(uv)	Returns the *xy* chromaticity coordinates from given *CIE L*u*v** colourspace uv^p chromaticity coordinates.
xy_to_Luv_uv(xy)	Returns the *CIE L*u*v** colourspace uv^p chromaticity coordinates from given *xy* chromaticity coordinates.

colour.XYZ_to_Luv

colour.**XYZ_to_Luv**(*XYZ*, *illuminant=array([0.3127, 0.329])*)

Converts from *CIE XYZ* tristimulus values to *CIE L*u*v** colourspace.

Parameters

- **XYZ** (array_like) – *CIE XYZ* tristimulus values.
- **illuminant** (array_like, optional) – Reference *illuminant xy* chromaticity coordinates or *CIE xyY* colourspace array.

Returns *CIE L*u*v** colourspace array.

Return type 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] a : [-1, 1] b : [-1, 1]

References

[CIET14804f], [Wik07c]

Examples

```
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> XYZ_to_Luv(XYZ)  # doctest: +ELLIPSIS
array([ 41.5278752...,  96.8362605...,  17.7521014...])
```

colour.Luv_to_XYZ

`colour.`**`Luv_to_XYZ`**(*Luv*, *illuminant=array([0.3127, 0.329])*)

Converts from *CIE L*u*v** colourspace to *CIE XYZ* tristimulus values.

Parameters

- **Luv** (array_like) – *CIE L*u*v** colourspace array.
- **illuminant** (array_like, optional) – Reference *illuminant xy* chromaticity coordinates or *CIE xyY* colourspace array.

Returns *CIE XYZ* tristimulus values.

Return type ndarray

Notes

Domain	Scale - Reference	Scale - 1
Luv	L : [0, 100] u : [-100, 100] v : [-100, 100]	L : [0, 1] a : [-1, 1] b : [-1, 1]
illuminant	[0, 1]	[0, 1]

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

References

[CIET14804f], [Wik07c]

Examples

```
>>> Luv = np.array([41.52787529, 96.83626054, 17.75210149])
>>> Luv_to_XYZ(Luv)  # doctest: +ELLIPSIS
array([ 0.2065400...,  0.1219722...,  0.0513695...])
```

colour.Luv_to_LCHuv

`colour.`**`Luv_to_LCHuv`**(*Luv*)

Converts from *CIE L*u*v** colourspace to *CIE L*C*Huv* colourspace.

Parameters **Luv** (array_like) – *CIE L*u*v** colourspace array.

Returns *CIE L*C*Huv* colourspace array.

Return type ndarray

Notes

Domain	Scale - Reference	Scale - 1
Luv	L : [0, 100] u : [-100, 100] v : [-100, 100]	L : [0, 1] a : [-1, 1] b : [-1, 1]

Range	Scale - Reference	Scale - 1
LCHuv	L : [0, 100] C : [0, 100] uv : [0, 360]	L : [0, 1] C : [0, 1] uv : [0, 1]

References

[CIET14804f]

Examples

```
>>> Luv = np.array([41.52787529, 96.83626054, 17.75210149])
>>> Luv_to_LCHuv(Luv)  # doctest: +ELLIPSIS
array([ 41.5278752...,  98.4499795...,  10.3881634...])
```

colour.LCHuv_to_Luv

`colour.`**`LCHuv_to_Luv`**(*LCHuv*)

Converts from *CIE L*C*Huv* colourspace to *CIE L*u*v** colourspace.

Parameters **LCHuv** (array_like) – *CIE L*C*Huv* colourspace array.

Returns *CIE L*u*v** colourspace array.

Return type ndarray

Notes

Domain	Scale - Reference	Scale - 1
LCHuv	L : [0, 100] C : [0, 100] uv : [0, 360]	L : [0, 1] C : [0, 1] uv : [0, 1]

Range	Scale - Reference	Scale - 1
Luv	L : [0, 100] u : [-100, 100] v : [-100, 100]	L : [0, 1] a : [-1, 1] b : [-1, 1]

References

[CIET14804f]

Examples

```
>>> LCHuv = np.array([41.52787529, 98.44997950, 10.38816348])
>>> LCHuv_to_Luv(LCHuv)  # doctest: +ELLIPSIS
array([ 41.5278752...,  96.8362605...,  17.7521014...])
```

colour.Luv_to_uv

`colour.`**`Luv_to_uv`**(*Luv*, *illuminant=array([0.3127, 0.329])*)

Returns the uv^p chromaticity coordinates from given *CIE L*u*v** colourspace array.

Parameters

- **Luv** (array_like) – *CIE L*u*v** colourspace array.
- **illuminant** (array_like, optional) – Reference *illuminant xy* chromaticity coordinates or *CIE xyY* colourspace array.

Returns uv^p chromaticity coordinates.

Return type ndarray

Notes

Domain	Scale - Reference	Scale - 1
Luv	L : [0, 100] u : [-100, 100] v : [-100, 100]	L : [0, 1] a : [-1, 1] b : [-1, 1]
illuminant	[0, 1]	[0, 1]

References

[CIET14804e]

Examples

```
>>> Luv = np.array([41.52787529, 96.83626054, 17.75210149])
>>> Luv_to_uv(Luv)  # doctest: +ELLIPSIS
array([ 0.3772021...,  0.5012026...])
```

colour.Luv_uv_to_xy

`colour.`**`Luv_uv_to_xy`**(*uv*)

Returns the *xy* chromaticity coordinates from given *CIE L*u*v** colourspace uv^p chromaticity coordinates.

Parameters **uv** (array_like) – *CIE L*u*v* u"v"* chromaticity coordinates.

Returns *xy* chromaticity coordinates.

Return type ndarray

References

[Wik07e]

Examples

```
>>> uv = np.array([0.37720213, 0.50120264])
>>> Luv_uv_to_xy(uv)  # doctest: +ELLIPSIS
array([ 0.5436955...,  0.3210794...])
```

colour.xy_to_Luv_uv

colour.**xy_to_Luv_uv**(*xy*)

Returns the *CIE L*u*v** colourspace uv^p chromaticity coordinates from given *xy* chromaticity coordinates.

Parameters **xy** (array_like) – *xy* chromaticity coordinates.

Returns *CIE L*u*v* u"v"* chromaticity coordinates.

Return type ndarray

References

[Wik07c]

Examples

```
>>> xy = np.array([0.54369558, 0.32107944])
>>> xy_to_Luv_uv(xy)  # doctest: +ELLIPSIS
array([ 0.3772021...,  0.5012026...])
```

CIE 1960 UCS Colourspace

colour

XYZ_to_UCS(XYZ)	Converts from *CIE XYZ* tristimulus values to *CIE 1960 UCS* colourspace.
UCS_to_XYZ(UVW)	Converts from *CIE 1960 UCS* colourspace to *CIE XYZ* tristimulus values.
UCS_to_uv(UVW)	Returns the *uv* chromaticity coordinates from given *CIE 1960 UCS* colourspace array.

Continued on next page

Table 187 – continued from previous page

UCS_uv_to_xy(uv)	Returns the *xy* chromaticity coordinates from given *CIE 1960 UCS* colourspace *uv* chromaticity coordinates.
xy_to_UCS_uv(xy)	Returns the *CIE 1960 UCS* colourspace *uv* chromaticity coordinates from given *xy* chromaticity coordinates.

colour.XYZ_to_UCS

colour.**XYZ_to_UCS**(*XYZ*)

Converts from *CIE XYZ* tristimulus values to *CIE 1960 UCS* colourspace.

Parameters **XYZ** (array_like) – *CIE XYZ* tristimulus values.

Returns *CIE 1960 UCS* colourspace array.

Return type ndarray

Notes

Domain	Scale - Reference	Scale - 1
XYZ	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
UVW	[0, 1]	[0, 1]

References

[Wik08d], [Wik08a]

Examples

```
>>> import numpy as np
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> XYZ_to_UCS(XYZ)  # doctest: +ELLIPSIS
array([ 0.1376933...,  0.1219722...,  0.1053731...])
```

colour.UCS_to_XYZ

colour.**UCS_to_XYZ**(*UVW*)

Converts from *CIE 1960 UCS* colourspace to *CIE XYZ* tristimulus values.

Parameters **UVW** (array_like) – *CIE 1960 UCS* colourspace array.

Returns *CIE XYZ* tristimulus values.

Return type ndarray

Notes

Domain	Scale - Reference	Scale - 1
UVW	[0, 1]	[0, 1]

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

References

[Wik08d], [Wik08a]

Examples

```
>>> import numpy as np
>>> UVW = np.array([0.13769339, 0.12197225, 0.10537310])
>>> UCS_to_XYZ(UVW)  # doctest: +ELLIPSIS
array([ 0.2065400...,  0.1219722...,  0.0513695...])
```

colour.UCS_to_uv

`colour.`**`UCS_to_uv`**(*UVW*)

Returns the *uv* chromaticity coordinates from given *CIE 1960 UCS* colourspace array.

Parameters **UVW** (array_like) – *CIE 1960 UCS* colourspace array.

Returns *uv* chromaticity coordinates.

Return type ndarray

Notes

Domain	Scale - Reference	Scale - 1
UVW	[0, 1]	[0, 1]

References

[Wik08d]

Examples

```
>>> import numpy as np
>>> UVW = np.array([0.13769339, 0.12197225, 0.10537310])
>>> UCS_to_uv(UVW)  # doctest: +ELLIPSIS
array([ 0.3772021...,  0.3341350...])
```

colour.UCS_uv_to_xy

`colour.UCS_uv_to_xy(uv)`

Returns the *xy* chromaticity coordinates from given *CIE 1960 UCS* colourspace *uv* chromaticity coordinates.

Parameters **uv** (array_like) – *CIE UCS uv* chromaticity coordinates.

Returns *xy* chromaticity coordinates.

Return type ndarray

References

[Wik08d]

Examples

```
>>> import numpy as np
>>> uv = np.array([0.37720213, 0.33413508])
>>> UCS_uv_to_xy(uv)  # doctest: +ELLIPSIS
array([ 0.5436955...,  0.3210794...])
```

colour.xy_to_UCS_uv

`colour.xy_to_UCS_uv(xy)`

Returns the *CIE 1960 UCS* colourspace *uv* chromaticity coordinates from given *xy* chromaticity coordinates.

Parameters **xy** (array_like) – *xy* chromaticity coordinates.

Returns *CIE UCS uv* chromaticity coordinates.

Return type ndarray

References

[Wik08d]

Examples

```
>>> import numpy as np
>>> xy = np.array([0.54369555, 0.32107941])
>>> xy_to_UCS_uv(xy)  # doctest: +ELLIPSIS
array([ 0.3772021...,  0.3341350...])
```

CIE 1964 U*V*W* Colourspace

`colour`

XYZ_to_UVW(XYZ[, illuminant])	Converts from *CIE XYZ* tristimulus values to *CIE 1964 U*V*W** colourspace.
UVW_to_XYZ(UVW[, illuminant])	Converts *CIE 1964 U*V*W** colourspace to *CIE XYZ* tristimulus values.

colour.XYZ_to_UVW

colour.**XYZ_to_UVW**(*XYZ*, *illuminant=array([0.3127, 0.329])*)

Converts from *CIE XYZ* tristimulus values to *CIE 1964 U*V*W** colourspace.

Parameters

- **XYZ** (array_like) – *CIE XYZ* tristimulus values.
- **illuminant** (array_like, optional) – Reference *illuminant xy* chromaticity coordinates or *CIE xyY* colourspace array.

Returns *CIE 1964 U*V*W** colourspace array.

Return type ndarray

> **Warning:** The input domain and output range of that definition are non standard!

Notes

Domain	Scale - Reference	Scale - 1
XYZ	[0, 1]	[0, 1]
illuminant	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
UVW	U : [-100, 100] V : [-100, 100] W : [0, 100]	U : [-1, 1] V : [-1, 1] W : [0, 1]

References

[Wik08b]

Examples

```
>>> import numpy as np
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952]) * 100
>>> XYZ_to_UVW(XYZ)  # doctest: +ELLIPSIS
array([ 94.5503572...,  11.5553652...,  40.5475740...])
```

colour.UVW_to_XYZ

`colour.UVW_to_XYZ(UVW, illuminant=array([ 0.3127, 0.329 ]))`

Converts *CIE 1964 U*V*W** colourspace to *CIE XYZ* tristimulus values.

Parameters

- **UVW** (array_like) – *CIE 1964 U*V*W** colourspace array.
- **illuminant** (array_like, optional) – Reference *illuminant xy* chromaticity coordinates or *CIE xyY* colourspace array.

Returns *CIE XYZ* tristimulus values.

Return type ndarray

> **Warning:** The input domain and output range of that definition are non standard!

Notes

Domain	Scale - Reference	Scale - 1
UVW	U : [-100, 100] V : [-100, 100] W : [0, 100]	U : [-1, 1] V : [-1, 1] W : [0, 1]
illuminant	[0, 1]	[0, 1]

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

References

[Wik08b]

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

XYZ_to_Hunter_Lab(XYZ[, XYZ_n, K_ab])	Converts from *CIE XYZ* tristimulus values to *Hunter L,a,b* colour scale.
Hunter_Lab_to_XYZ(Lab[, XYZ_n, K_ab])	Converts from *Hunter L,a,b* colour scale to *CIE XYZ* tristimulus values.

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Table 189 – continued from previous page

XYZ_to_K_ab_HunterLab1966(XYZ)	Converts from *whitepoint CIE XYZ* tristimulus values to *Hunter L,a,b* K_a and K_b chromaticity coefficients.

colour.XYZ_to_Hunter_Lab

colour.**XYZ_to_Hunter_Lab**(*XYZ*, *XYZ_n=array([95.02, 100., 108.82])*, *K_ab=array([172.3, 67.2])*)

Converts from *CIE XYZ* tristimulus values to *Hunter L,a,b* colour scale.

Parameters

- **XYZ** (array_like) – *CIE XYZ* tristimulus values.
- **XYZ_n** (array_like, optional) – Reference *illuminant* tristimulus values.
- **K_ab** (array_like, optional) – 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 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

[Hun08a]

Examples

```
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952]) * 100
>>> D65 = HUNTERLAB_ILLUMINANTS[
...     'CIE 1931 2 Degree Standard Observer']['D65']
>>> XYZ_to_Hunter_Lab(XYZ, D65.XYZ_n, D65.K_ab)   # doctest: +ELLIPSIS
array([ 34.9245257...,  47.0618985...,  14.3861510...])
```

colour.Hunter_Lab_to_XYZ

colour.**Hunter_Lab_to_XYZ**(*Lab*, *XYZ_n=array([95.02, 100., 108.82])*, *K_ab=array([172.3, 67.2])*)

Converts from *Hunter L,a,b* colour scale to *CIE XYZ* tristimulus values.

Parameters

- **Lab** (array_like) – *Hunter L,a,b* colour scale array.
- **XYZ_n** (array_like, optional) – Reference *illuminant* tristimulus values.
- **K_ab** (array_like, optional) – 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 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]
XYZ_n	[0, 100]	[0, 1]

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

References

[Hun08a]

Examples

```
>>> Lab = np.array([34.92452577, 47.06189858, 14.38615107])
>>> D65 = HUNTERLAB_ILLUMINANTS[
...     '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*)

Converts from *whitepoint CIE XYZ* tristimulus values to *Hunter L,a,b* K_a and K_b chromaticity coefficients.

Parameters **XYZ** (array_like) – *Whitepoint CIE XYZ* tristimulus values.

Returns *Hunter L,a,b* K_a and K_b chromaticity coefficients.

Return type ndarray

References

[Hun08b]

Examples

```
>>> XYZ = np.array([109.850, 100.000, 35.585])
>>> XYZ_to_K_ab_HunterLab1966(XYZ)  # doctest: +ELLIPSIS
array([ 185.2378721...,   38.4219142...])
```

Hunter Rd,a,b Colour Scale

colour

XYZ_to_Hunter_Rdab(XYZ[, XYZ_n, K_ab])	Converts from *CIE XYZ* tristimulus values to *Hunter Rd,a,b* colour scale.
Hunter_Rdab_to_XYZ(R_d_ab[, XYZ_n, K_ab])	Converts from *Hunter Rd,a,b* colour scale to *CIE XYZ* tristimulus values.

colour.XYZ_to_Hunter_Rdab

colour.**XYZ_to_Hunter_Rdab**(*XYZ, XYZ_n=array([95.02, 100., 108.82]), K_ab=array([172.3, 67.2])*)

Converts from *CIE XYZ* tristimulus values to *Hunter Rd,a,b* colour scale.

Parameters

- **XYZ** (array_like) – *CIE XYZ* tristimulus values.
- **XYZ_n** (array_like, optional) – Reference *illuminant* tristimulus values.
- **K_ab** (array_like, optional) – 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 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] a_Rd : [-100, 100] b_Rd : [-100, 100]	R_d : [0, 1] a_Rd : [-1, 1] b_Rd : [-1, 1]

References

[Hun12]

Examples

```
>>> import numpy as np
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952]) * 100
>>> D65 = HUNTERLAB_ILLUMINANTS[
...     'CIE 1931 2 Degree Standard Observer']['D65']
>>> XYZ_to_Hunter_Rdab(XYZ, D65.XYZ_n, D65.K_ab)
... # doctest: +ELLIPSIS
array([ 12.197225 ...,  57.1253787...,  17.4624134...])
```

colour.Hunter_Rdab_to_XYZ

colour.**Hunter_Rdab_to_XYZ**(*R_d_ab*, *XYZ_n=array([95.02, 100., 108.82])*, *K_ab=array([172.3, 67.2])*)

Converts from *Hunter Rd,a,b* colour scale to *CIE XYZ* tristimulus values.

Parameters

- **R_d_ab** (array_like) – *Hunter Rd,a,b* colour scale array.
- **XYZ_n** (array_like, optional) – Reference *illuminant* tristimulus values.
- **K_ab** (array_like, optional) – 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 ndarray

Notes

Domain	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

[Hun12]

Examples

```
>>> import numpy as np
>>> R_d_ab = np.array([12.19722500, 57.12537874, 17.46241341])
>>> D65 = HUNTERLAB_ILLUMINANTS[
...     'CIE 1931 2 Degree Standard Observer']['D65']
```

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```
>>> Hunter_Rdab_to_XYZ(R_d_ab, D65.XYZ_n, D65.K_ab)
array([ 20.654008,  12.197225,   5.136952])
```

DIN99 Colourspace

colour

Lab_to_DIN99(Lab[, k_E, k_CH])	Converts from *CIE L*a*b** colourspace to *DIN99* colourspace.
DIN99_to_Lab(Lab_99[, k_E, k_CH])	Converts from *DIN99* colourspace to *CIE L*a*b** colourspace.

colour.Lab_to_DIN99

colour.**Lab_to_DIN99**(*Lab*, *k_E=1*, *k_CH=1*)

Converts from *CIE L*a*b** colourspace to *DIN99* colourspace.

Parameters

- **Lab** (array_like) – *CIE L*a*b** colourspace array.
- **k_E** (numeric, optional) – Parametric factor K_E used to compensate for texture and other specimen presentation effects.
- **k_CH** (numeric, optional) – Parametric factor K_{CH} used to compensate for texture and other specimen presentation effects.

Returns *DIN99* colourspace array.

Return type 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]

Examples

```
>>> import numpy as np
>>> Lab = np.array([41.52787529, 52.63858304, 26.92317922])
>>> Lab_to_DIN99(Lab)  # doctest: +ELLIPSIS
array([ 53.2282198...,  28.4163465...,   3.8983955...])
```

colour.DIN99_to_Lab

colour.**DIN99_to_Lab**(*Lab_99*, *k_E=1*, *k_CH=1*)

Converts from *DIN99* colourspace to *CIE L*a*b** colourspace.

Parameters

- **Lab_99** (array_like) – *DIN99* colourspace array.
- **k_E** (numeric, optional) – Parametric factor K_E used to compensate for texture and other specimen presentation effects.
- **k_CH** (numeric, optional) – Parametric factor K_{CH} used to compensate for texture and other specimen presentation effects.

Returns *CIE L*a*b** colourspace array.

Return type ndarray

Notes

Domain	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]

Examples

```
>>> import numpy as np
>>> Lab_99 = np.array([53.22821988, 28.41634656, 3.89839552])
>>> DIN99_to_Lab(Lab_99)  # doctest: +ELLIPSIS
array([ 41.5278752...,  52.6385830...,  26.9231792...])
```

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

colour

JMh_CIECAM02_to_CAM02LCD(JMh)	Converts from *CIECAM02* JMh correlates array to *Luo et al.(2006) CAM02-LCD* colourspace $J'a'b'$ array..
CAM02LCD_to_JMh_CIECAM02(Jpapbp)	Converts from *Luo et al.(2006) CAM02-LCD* colourspace $J'a'b'$ array to *CIECAM02* JMh correlates array..
JMh_CIECAM02_to_CAM02SCD(JMh)	Converts from *CIECAM02* JMh correlates array to *Luo et al.(2006) CAM02-SCD* colourspace $J'a'b'$ array..
CAM02SCD_to_JMh_CIECAM02(Jpapbp)	Converts from *Luo et al.(2006) CAM02-SCD* colourspace $J'a'b'$ array to *CIECAM02* JMh correlates array..
JMh_CIECAM02_to_CAM02UCS(JMh)	Converts from *CIECAM02* JMh correlates array to *Luo et al.(2006) CAM02-UCS* colourspace $J'a'b'$ array..
CAM02UCS_to_JMh_CIECAM02(Jpapbp)	Converts from *Luo et al.(2006) CAM02-UCS* colourspace $J'a'b'$ array to *CIECAM02* JMh correlates array..

colour.JMh_CIECAM02_to_CAM02LCD

colour.**JMh_CIECAM02_to_CAM02LCD**(*JMh*)

Converts from *CIECAM02* JMh correlates array to *Luo et al. (2006) CAM02-LCD* colourspace $J'a'b'$ array.

Parameters **JMh** (array_like) – *CIECAM02* correlates array JMh.

Returns *Luo et al. (2006) CAM02-LCD* colourspace $J'a'b'$ array.

Return type ndarray

Notes

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_1 : [0, 100] ap_1 : [-100, 100] bp_1 : [-100, 100]	Jp_1 : [0, 1] ap_1 : [-1, 1] bp_1 : [-1, 1]

References

[LCL06]

Examples

```
>>> from colour.appearance import (
...     CIECAM02_VIEWING_CONDITIONS,
...     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 = CIECAM02_VIEWING_CONDITIONS['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)  # doctest: +ELLIPSIS
array([ 54.9043313...,  -0.0845039...,  -0.0685483...])
```

colour.CAM02LCD_to_JMh_CIECAM02

colour.**CAM02LCD_to_JMh_CIECAM02**(*Jpapbp*)

Converts from *Luo et al. (2006) CAM02-LCD* colourspace $J'a'b'$ array to *CIECAM02* JMh correlates array.

Parameters **Jpapbp** (array_like) – *Luo et al. (2006) CAM02-LCD* colourspace $J'a'b'$ array.

Returns *CIECAM02* correlates array JMh.

Return type ndarray

Notes

Domain	Scale - Reference	Scale - 1
Jpapbp	Jp_1 : [0, 100] ap_1 : [-100, 100] bp_1 : [-100, 100]	Jp_1 : [0, 1] ap_1 : [-1, 1] bp_1 : [-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)  # doctest: +ELLIPSIS
array([  4.1731091...e+01,   1.0884217...e-01,   2.1904843...e+02])
```

colour.JMh_CIECAM02_to_CAM02SCD

colour.**JMh_CIECAM02_to_CAM02SCD**(*JMh*)

Converts from *CIECAM02* JMh correlates array to *Luo et al. (2006) CAM02-SCD* colourspace $J'a'b'$ array.

Parameters **JMh** (array_like) – *CIECAM02* correlates array JMh.

Returns *Luo et al. (2006) CAM02-SCD* colourspace $J'a'b'$ array.

Return type ndarray

Notes

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_1 : [0, 100] ap_1 : [-100, 100] bp_1 : [-100, 100]	Jp_1 : [0, 1] ap_1 : [-1, 1] bp_1 : [-1, 1]

References

[LCL06]

Examples

```
>>> from colour.appearance import (
...     CIECAM02_VIEWING_CONDITIONS,
...     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 = CIECAM02_VIEWING_CONDITIONS['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)  # doctest: +ELLIPSIS
array([ 54.9043313...,  -0.0843617...,  -0.0684329...])
```

colour.CAM02SCD_to_JMh_CIECAM02

colour.**CAM02SCD_to_JMh_CIECAM02**(*Jpapbp*)

Converts from *Luo et al. (2006) CAM02-SCD* colourspace $J'a'b'$ array to *CIECAM02* JMh correlates array.

Parameters **Jpapbp** (array_like) – *Luo et al. (2006) CAM02-SCD* colourspace $J'a'b'$ array.

Returns *CIECAM02* correlates array JMh.

Return type ndarray

Notes

Domain	Scale - Reference	Scale - 1
Jpapbp	Jp_1 : [0, 100] ap_1 : [-100, 100] bp_1 : [-100, 100]	Jp_1 : [0, 1] ap_1 : [-1, 1] bp_1 : [-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)  # doctest: +ELLIPSIS
array([  4.1731091...e+01,   1.0884217...e-01,   2.1904843...e+02])
```

colour.JMh_CIECAM02_to_CAM02UCS

`colour.`**`JMh_CIECAM02_to_CAM02UCS`**(*JMh*)

Converts from *CIECAM02* JMh correlates array to *Luo et al. (2006) CAM02-UCS* colourspace $J'a'b'$ array.

Parameters **JMh** (array_like) – *CIECAM02* correlates array JMh.

Returns *Luo et al. (2006) CAM02-UCS* colourspace $J'a'b'$ array.

Return type ndarray

Notes

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_1 : [0, 100] ap_1 : [-100, 100] bp_1 : [-100, 100]	Jp_1 : [0, 1] ap_1 : [-1, 1] bp_1 : [-1, 1]

References

[LCL06]

Examples

```
>>> from colour.appearance import (
...     CIECAM02_VIEWING_CONDITIONS,
...     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 = CIECAM02_VIEWING_CONDITIONS['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)  # doctest: +ELLIPSIS
array([ 54.9043313...,  -0.0844236...,  -0.0684831...])
```

colour.CAM02UCS_to_JMh_CIECAM02

`colour.`**`CAM02UCS_to_JMh_CIECAM02`**(*Jpapbp*)

Converts from *Luo et al. (2006) CAM02-UCS* colourspace $J'a'b'$ array to *CIECAM02* JMh correlates array.

Parameters **Jpapbp** (array_like) – *Luo et al. (2006) CAM02-UCS* colourspace $J'a'b'$ array.

Returns *CIECAM02* correlates array JMh.

Return type ndarray

Notes

Domain	Scale - Reference	Scale - 1
Jpapbp	Jp_1 : [0, 100] ap_1 : [-100, 100] bp_1 : [-100, 100]	Jp_1 : [0, 1] ap_1 : [-1, 1] bp_1 : [-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, -0.08442362, -0.06848314])
>>> CAM02UCS_to_JMh_CIECAM02(Jpapbp)  # doctest: +ELLIPSIS
array([  4.1731091...e+01,   1.0884217...e-01,   2.1904843...e+02])
```

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

colour

JMh_CAM16_to_CAM16LCD(JMh, *[, ...])	Converts from *CAM16* JMh correlates array to *Li et al.(2017) CAM16-LCD* colourspace $J'a'b'$ array..
CAM16LCD_to_JMh_CAM16(Jpapbp, *[, ...])	Converts from *Li et al.(2017) CAM16-LCD* colourspace $J'a'b'$ array to *CAM16* JMh correlates array..
JMh_CAM16_to_CAM16SCD(JMh, *[, ...])	Converts from *CAM16* JMh correlates array to *Li et al.(2017) CAM16-SCD* colourspace $J'a'b'$ array..
CAM16SCD_to_JMh_CAM16(Jpapbp, *[, ...])	Converts from *Li et al.(2017) CAM16-SCD* colourspace $J'a'b'$ array to *CAM16* JMh correlates array..
JMh_CAM16_to_CAM16UCS(JMh, *[, ...])	Converts from *CAM16* JMh correlates array to *Li et al.(2017) CAM16-UCS* colourspace $J'a'b'$ array..
CAM16UCS_to_JMh_CAM16(Jpapbp, *[, ...])	Converts from *Li et al.(2017) CAM16-UCS* colourspace $J'a'b'$ array to *CAM16* JMh correlates array..

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)*)

Converts from *CAM16* JMh correlates array to *Li et al. (2017) CAM16-LCD* colourspace $J'a'b'$ array.

Parameters **JMh** (array_like) – *CAM16* correlates array JMh.

Returns *Li et al. (2017) CAM16-LCD* colourspace $J'a'b'$ array.

Return type ndarray

Notes

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_1 : [0, 100] ap_1 : [-100, 100] bp_1 : [-100, 100]	Jp_1 : [0, 1] ap_1 : [-1, 1] bp_1 : [-1, 1]

References

[LLW+17]

Notes

- This docstring is automatically generated, please refer to `colour.JMh_CIECAM02_to_CAM02LCD()` definition for an usage example.

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)*)

Converts from *Li et al. (2017) CAM16-LCD* colourspace $J'a'b'$ array to *CAM16* JMh correlates array.

Parameters **Jpapbp** (array_like) – *Li et al. (2017) CAM16-LCD* colourspace $J'a'b'$ array.

Returns *CAM16* correlates array JMh.

Return type ndarray

Notes

Domain	Scale - Reference	Scale - 1
Jpapbp	Jp_1 : [0, 100] ap_1 : [-100, 100] bp_1 : [-100, 100]	Jp_1 : [0, 1] ap_1 : [-1, 1] bp_1 : [-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]

Notes

- This docstring is automatically generated, please refer to `colour.CAM02LCD_to_JMh_CIECAM02()` definition for an usage example.

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))`

Converts from *CAM16* JMh correlates array to *Li et al. (2017) CAM16-SCD* colourspace $J'a'b'$ array.

Parameters **JMh** (array_like) – *CAM16* correlates array JMh.

Returns *Li et al. (2017) CAM16-SCD* colourspace $J'a'b'$ array.

Return type ndarray

Notes

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_1 : [0, 100] ap_1 : [-100, 100] bp_1 : [-100, 100]	Jp_1 : [0, 1] ap_1 : [-1, 1] bp_1 : [-1, 1]

References

[LLW+17]

Notes

- This docstring is automatically generated, please refer to `colour.JMh_CIECAM02_to_CAM02SCD()` definition for an usage example.

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))`

Converts from *Li et al. (2017) CAM16-SCD* colourspace $J'a'b'$ array to *CAM16* JMh correlates array.

Parameters **Jpapbp** (array_like) – *Li et al. (2017) CAM16-SCD* colourspace $J'a'b'$ array.

Returns *CAM16* correlates array JMh.

Return type ndarray

Notes

Domain	Scale - Reference	Scale - 1
Jpapbp	Jp_1 : [0, 100] ap_1 : [-100, 100] bp_1 : [-100, 100]	Jp_1 : [0, 1] ap_1 : [-1, 1] bp_1 : [-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]

Notes

- This docstring is automatically generated, please refer to `colour.CAM02SCD_to_JMh_CIECAM02()` definition for an usage example.

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)*)

Converts from *CAM16* JMh correlates array to *Li et al. (2017) CAM16-UCS* colourspace $J'a'b'$ array.

Parameters **JMh** (array_like) – *CAM16* correlates array JMh.

Returns *Li et al. (2017) CAM16-UCS* colourspace $J'a'b'$ array.

Return type ndarray

Notes

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_1 : [0, 100] ap_1 : [-100, 100] bp_1 : [-100, 100]	Jp_1 : [0, 1] ap_1 : [-1, 1] bp_1 : [-1, 1]

References

[LLW+17]

Notes

- This docstring is automatically generated, please refer to `colour.JMh_CIECAM02_to_CAM02UCS()` definition for an usage example.

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)*)

Converts from *Li et al. (2017) CAM16-UCS* colourspace $J'a'b'$ array to *CAM16* JMh correlates array.

Parameters **Jpapbp** (array_like) – *Li et al. (2017) CAM16-UCS* colourspace $J'a'b'$ array.

Returns *CAM16* correlates array JMh.

Return type ndarray

Notes

Domain	Scale - Reference	Scale - 1
Jpapbp	Jp_1 : [0, 100] ap_1 : [-100, 100] bp_1 : [-100, 100]	Jp_1 : [0, 1] ap_1 : [-1, 1] bp_1 : [-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]

Notes

- This docstring is automatically generated, please refer to `colour.CAM02UCS_to_JMh_CIECAM02()` definition for an usage example.

IPT Colourspace

`colour`

XYZ_to_IPT(XYZ)	Converts from *CIE XYZ* tristimulus values to *IPT* colourspace.
IPT_to_XYZ(IPT)	Converts from *IPT* colourspace to *CIE XYZ* tristimulus values.
IPT_hue_angle(IPT)	Computes the hue angle in degrees from *IPT* colourspace.

colour.XYZ_to_IPT

colour.**XYZ_to_IPT**(*XYZ*)

Converts from *CIE XYZ* tristimulus values to *IPT* colourspace.

Parameters **XYZ** (array_like) – *CIE XYZ* tristimulus values.

Returns *IPT* colourspace array.

Return type ndarray

Notes

Domain	Scale - Reference	Scale - 1
XYZ	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
IPT	I : [0, 1] P : [-1, 1] T : [-1, 1]	I : [0, 1] P : [-1, 1] T : [-1, 1]

- Input *CIE XYZ* tristimulus values needs to be adapted for *CIE Standard Illuminant D Series D65*.

References

[Fai13d]

Examples

```
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> XYZ_to_IPT(XYZ)  # doctest: +ELLIPSIS
array([ 0.3842619...,  0.3848730...,  0.1888683...])
```

colour.IPT_to_XYZ

colour.**IPT_to_XYZ**(*IPT*)

Converts from *IPT* colourspace to *CIE XYZ* tristimulus values.

Parameters **IPT** (array_like) – *IPT* colourspace array.

Returns *CIE XYZ* tristimulus values.

Return type ndarray

Notes

Domain	Scale - Reference	Scale - 1
IPT	I : [0, 1] P : [-1, 1] T : [-1, 1]	I : [0, 1] P : [-1, 1] T : [-1, 1]

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

References

[Fai13d]

Examples

```
>>> IPT = np.array([0.38426191, 0.38487306, 0.18886838])
>>> IPT_to_XYZ(IPT)  # doctest: +ELLIPSIS
array([ 0.2065400...,  0.1219722...,  0.0513695...])
```

colour.IPT_hue_angle

`colour.`**`IPT_hue_angle`**(*IPT*)

Computes the hue angle in degrees from *IPT* colourspace.

Parameters **IPT** (array_like) – *IPT* colourspace array.

Returns Hue angle in degrees.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
IPT	I : [0, 1] P : [-1, 1] T : [-1, 1]	I : [0, 1] P : [-1, 1] T : [-1, 1]

Range	Scale - Reference	Scale - 1
hue	[0, 360]	[0, 1]

References

[Fai13d]

Examples

```
>>> IPT = np.array([0.96907232, 1, 1.12179215])
>>> IPT_hue_angle(IPT)  # doctest: +ELLIPSIS
48.2852074...
```

hdr-CIELAB Colourspace

colour

XYZ_to_hdr_CIELab(XYZ[, illuminant, Y_s, ...])	Converts from *CIE XYZ* tristimulus values to *hdr-CIELAB* colourspace.
hdr_CIELab_to_XYZ(Lab_hdr[, illuminant, ...])	Converts from *hdr-CIELAB* colourspace to *CIE XYZ* tristimulus values.
HDR_CIELAB_METHODS	Supported *hdr-CIELAB* colourspace computation methods.

colour.XYZ_to_hdr_CIELab

colour.**XYZ_to_hdr_CIELab**(*XYZ, illuminant=array([0.3127, 0.329]), Y_s=0.2, Y_abs=100, method='Fairchild 2011'*)

Converts from *CIE XYZ* tristimulus values to *hdr-CIELAB* colourspace.

Parameters

- **XYZ** (array_like) – *CIE XYZ* tristimulus values.
- **illuminant** (array_like, optional) – Reference *illuminant xy* chromaticity coordinates or *CIE xyY* colourspace array.
- **Y_s** (numeric or array_like) – Relative luminance Y_s of the surround.
- **Y_abs** (numeric or array_like) – Absolute luminance Y_{abs} of the scene diffuse white in cd/m^2.
- **method** (unicode, optional) – **{'Fairchild 2011', 'Fairchild 2010'}**, Computation method.

Returns *hdr-CIELAB* colourspace array.

Return type 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)  # doctest: +ELLIPSIS
array([ 51.8700206...,  60.4763385...,  32.1455191...])
>>> XYZ_to_hdr_CIELab(XYZ, method='Fairchild 2010')  # doctest: +ELLIPSIS
array([  31.9962111...,  128.0076303...,   48.7695230...])
```

colour.hdr_CIELab_to_XYZ

`colour.`**`hdr_CIELab_to_XYZ`**(*Lab_hdr, illuminant=array([0.3127, 0.329]), Y_s=0.2, Y_abs=100, method='Fairchild 2011'*)

Converts from *hdr-CIELAB* colourspace to *CIE XYZ* tristimulus values.

Parameters

- **Lab_hdr** (array_like) – *hdr-CIELAB* colourspace array.
- **illuminant** (array_like, optional) – Reference *illuminant xy* chromaticity coordinates or *CIE xyY* colourspace array.
- **Y_s** (numeric or array_like) – Relative luminance Y_s of the surround.
- **Y_abs** (numeric or array_like) – Absolute luminance Y_{abs} of the scene diffuse white in cd/m^2.
- **method** (unicode, optional) – **{'Fairchild 2011', 'Fairchild 2010'}**, Computation method.

Returns *CIE XYZ* tristimulus values.

Return type ndarray

Notes

Domain	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]
illuminant	[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)  # doctest: +ELLIPSIS
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')
... # doctest: +ELLIPSIS
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_CIELAB_METHODS [tuple] **{'Fairchild 2011', 'Fairchild 2010'}**

hdr-IPT Colourspace

colour

XYZ_to_hdr_IPT(XYZ[, Y_s, Y_abs, method])	Converts from *CIE XYZ* tristimulus values to *hdr-IPT* colourspace.
hdr_IPT_to_XYZ(IPT_hdr[, Y_s, Y_abs, method])	Converts from *hdr-IPT* colourspace to *CIE XYZ* tristimulus values.
HDR_IPT_METHODS	Supported *hdr-IPT* colourspace computation methods.

colour.XYZ_to_hdr_IPT

colour.**XYZ_to_hdr_IPT**(*XYZ*, *Y_s=0.2*, *Y_abs=100*, *method='Fairchild 2011'*)

Converts from *CIE XYZ* tristimulus values to *hdr-IPT* colourspace.

Parameters

- **XYZ** (array_like) – *CIE XYZ* tristimulus values.
- **Y_s** (numeric or array_like) – Relative luminance Y_s of the surround.
- **Y_abs** (numeric or array_like) – Absolute luminance Y_{abs} of the scene diffuse white in cd/m^2.
- **method** (unicode, optional) – **{'Fairchild 2011', 'Fairchild 2010'}**, Computation method.

Returns *hdr-IPT* colourspace array.

Return type 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] P_hdr : [-100, 100] T_hdr : [-100, 100]	I_hdr : [0, 1] P_hdr : [-1, 1] T_hdr : [-1, 1]

- Input *CIE XYZ* tristimulus values needs to be adapted for *CIE Standard Illuminant D Series D65*.

References

[FW10], [FC11]

Examples

```
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> XYZ_to_hdr_IPT(XYZ)  # doctest: +ELLIPSIS
array([ 48.3937634...,  42.4499020...,  22.0195403...])
>>> XYZ_to_hdr_IPT(XYZ, method='Fairchild 2010')  # doctest: +ELLIPSIS
array([ 30.0287314...,  83.9384506...,  34.9028738...])
```

colour.hdr_IPT_to_XYZ

colour.**hdr_IPT_to_XYZ**(*IPT_hdr*, *Y_s=0.2*, *Y_abs=100*, *method='Fairchild 2011'*)

Converts from *hdr-IPT* colourspace to *CIE XYZ* tristimulus values.

Parameters

- **IPT_hdr** (array_like) – *hdr-IPT* colourspace array.
- **Y_s** (numeric or array_like) – Relative luminance Y_s of the surround.
- **Y_abs** (numeric or array_like) – Absolute luminance Y_{abs} of the scene diffuse white in cd/m^2.
- **method** (unicode, optional) – **{'Fairchild 2011', 'Fairchild 2010'}**, Computation method.

Returns *CIE XYZ* tristimulus values.

Return type ndarray

Notes

Domain	Scale - Reference	Scale - 1
IPT_hdr	I_hdr : [0, 100] P_hdr : [-100, 100] T_hdr : [-100, 100]	I_hdr : [0, 1] P_hdr : [-1, 1] 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)  # doctest: +ELLIPSIS
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')
... # doctest: +ELLIPSIS
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]

HDR_IPT_METHODS [tuple] **{'Fairchild 2011', 'Fairchild 2010'}**

OSA UCS Colourspace

colour

XYZ_to_OSA_UCS(XYZ)	Converts from *CIE XYZ* tristimulus values under the *CIE 1964 10 Degree Standard Observer* to *OSA UCS* colourspace.
OSA_UCS_to_XYZ(Ljg[, optimisation_parameters])	Converts from *OSA UCS* colourspace to *CIE XYZ* tristimulus values under the *CIE 1964 10 Degree Standard Observer*.

colour.XYZ_to_OSA_UCS

colour.**XYZ_to_OSA_UCS**(*XYZ*)

Converts 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** (array_like) – *CIE XYZ* tristimulus values under the *CIE 1964 10 Degree Standard Observer*.

Returns *OSA UCS* Ljg lightness, jaune (yellowness), and greenness.

Return type 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)  # doctest: +ELLIPSIS
array([-3.0049979...,  2.9971369..., -9.6678423...])
```

colour.OSA_UCS_to_XYZ

`colour.OSA_UCS_to_XYZ(Ljg, optimisation_parameters=None)`

Converts from *OSA UCS* colourspace to *CIE XYZ* tristimulus values under the *CIE 1964 10 Degree Standard Observer*.

Parameters

- **Ljg** (array_like) – *OSA UCS* Ljg lightness, jaune (yellowness), and greenness.
- **optimisation_parameters** (dict_like, optional) – Parameters for `scipy.optimize.fmin()` definition.

Returns *CIE XYZ* tristimulus values under the *CIE 1964 10 Degree Standard Observer*.

Return type ndarray

> **Warning:** There is no analytical reverse 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)  # doctest: +ELLIPSIS
array([ 20.6540240...,  12.1972369...,   5.1369372...])
```

$JzAzBz$ Colourspace

colour

XYZ_to_JzAzBz(XYZ_D65[, constants])	Converts from *CIE XYZ* tristimulus values to $J_zA_zB_z$ colourspace.
JzAzBz_to_XYZ(JzAzBz[, constants])	Converts from $J_zA_zB_z$ colourspace to *CIE XYZ* tristimulus values.

colour.XYZ_to_JzAzBz

colour.**XYZ_to_JzAzBz**(*XYZ_D65*, *constants={'b': 1.15, 'c_1': 0.8359375, 'c_2': 18.8515625, 'c_3': 18.6875, 'd': -0.56, 'd_0': 1.6295499532821565e-11, 'g': 0.66, 'm_1': 0.1593017578125, 'm_2': 134.03437499999998}*)

Converts from *CIE XYZ* tristimulus values to $J_zA_zB_z$ colourspace.

Parameters

- **XYZ_D65** (array_like) – *CIE XYZ* tristimulus values under *CIE Standard Illuminant D Series D65*.
- **constants** (Structure, optional) – $J_zA_zB_z$ colourspace constants.

Returns $J_zA_zB_z$ colourspace array where J_z is Lightness, A_z is redness-greenness and B_z is yellowness-blueness.

Return type ndarray

Notes

Domain	Scale - Reference	Scale - 1
XYZ	[0, 1]	[0, 1]

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)  # doctest: +ELLIPSIS
array([ 0.0053504...,  0.0092430...,  0.0052600...])
```

colour.JzAzBz_to_XYZ

colour.**JzAzBz_to_XYZ**(*JzAzBz*, *constants={'b': 1.15, 'c_1': 0.8359375, 'c_2': 18.8515625, 'c_3': 18.6875, 'd': -0.56, 'd_0': 1.6295499532821565e-11, 'g': 0.66, 'm_1': 0.1593017578125, 'm_2': 134.03437499999998}*)

Converts from $J_zA_zB_z$ colourspace to *CIE XYZ* tristimulus values.

Parameters

- **JzAzBz** (array_like) – $J_zA_zB_z$ colourspace array where J_z is Lightness, A_z is redness-greenness and B_z is yellowness-blueness.
- **constants** (Structure, optional) – $J_zA_zB_z$ colourspace constants.

Returns *CIE XYZ* tristimulus values under *CIE Standard Illuminant D Series D65*.

Return type ndarray

Notes

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	[0, 1]	[0, 1]

References

[SCKL17]

Examples

```
>>> JzAzBz = np.array([0.00535048, 0.00924302, 0.00526007])
>>> JzAzBz_to_XYZ(JzAzBz)  # doctest: +ELLIPSIS
array([ 0.2065402...,  0.1219723...,  0.0513696...])
```

RGB Colourspace and Transformations

colour

XYZ_to_RGB(XYZ, illuminant_XYZ, ... [, ...])	Converts from *CIE XYZ* tristimulus values to *RGB* colourspace array.
RGB_to_XYZ(RGB, illuminant_RGB, ... [, ...])	Converts given *RGB* colourspace array to *CIE XYZ* tristimulus values.
RGB_to_RGB(RGB, input_colourspace, ... [, ...])	Converts given *RGB* colourspace array from given input *RGB* colourspace to output *RGB* colourspace using given *chromatic adaptation* method.

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Table 199 – continued from previous page

RGB_to_RGB_matrix(input_colourspace, ... [, ...])	Computes the matrix M converting from given input *RGB* colourspace to output *RGB* colourspace using given *chromatic adaptation* method.

colour.XYZ_to_RGB

colour.**XYZ_to_RGB**(*XYZ*, *illuminant_XYZ*, *illuminant_RGB*, *XYZ_to_RGB_matrix*, *chromatic_adaptation_transform='CAT02'*, *encoding_cctf=None*)

Converts from *CIE XYZ* tristimulus values to *RGB* colourspace array.

Parameters

- **XYZ** (array_like) – *CIE XYZ* tristimulus values.
- **illuminant_XYZ** (array_like) – *CIE XYZ* tristimulus values *illuminant xy* chromaticity coordinates or *CIE xyY* colourspace array.
- **illuminant_RGB** (array_like) – *RGB* colourspace *illuminant xy* chromaticity coordinates or *CIE xyY* colourspace array.
- **XYZ_to_RGB_matrix** (array_like) – *Normalised primary matrix*.
- **chromatic_adaptation_transform** (unicode, optional) – **{'CAT02', 'XYZ Scaling', 'Von Kries', 'Bradford', 'Sharp', 'Fairchild', 'CMCCAT97', 'CMCCAT2000', 'CAT02_BRILL_CAT', 'Bianco', 'Bianco PC', None}**, *Chromatic adaptation* transform, if *None* no chromatic adaptation is performed.
- **encoding_cctf** (object, optional) – Encoding colour component transfer function (Encoding CCTF) or opto-electronic transfer function (OETF / OECF).

Returns *RGB* colourspace array.

Return type 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'
>>> XYZ_to_RGB_matrix = np.array(
...     [[3.24062548, -1.53720797, -0.49862860],
```

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```
...      [-0.96893071, 1.87575606, 0.04151752],
...      [0.05571012, -0.20402105, 1.05699594]]
... )
>>> XYZ_to_RGB(XYZ, illuminant_XYZ, illuminant_RGB, XYZ_to_RGB_matrix,
...            chromatic_adaptation_transform)  # doctest: +ELLIPSIS
array([ 0.4559557...,  0.0303970...,  0.0408724...])
```

colour.RGB_to_XYZ

colour.**RGB_to_XYZ**(*RGB*, *illuminant_RGB*, *illuminant_XYZ*, *RGB_to_XYZ_matrix*, *chromatic_adaptation_transform='CAT02'*, *decoding_cctf=None*)

Converts given *RGB* colourspace array to *CIE XYZ* tristimulus values.

Parameters

- **RGB** (array_like) – *RGB* colourspace array.
- **illuminant_RGB** (array_like) – *RGB* colourspace *illuminant* chromaticity coordinates or *CIE xyY* colourspace array.
- **illuminant_XYZ** (array_like) – *CIE XYZ* tristimulus values *illuminant* chromaticity coordinates or *CIE xyY* colourspace array.
- **RGB_to_XYZ_matrix** (array_like) – *Normalised primary matrix*.
- **chromatic_adaptation_transform** (unicode, optional) – **{'CAT02', 'XYZ Scaling', 'Von Kries', 'Bradford', 'Sharp', 'Fairchild', 'CMCCAT97', 'CMCCAT2000', 'CAT02_BRILL_CAT', 'Bianco', 'Bianco PC', None}**, *Chromatic adaptation* transform, if *None* no chromatic adaptation is performed.
- **decoding_cctf** (object, optional) – Decoding colour component transfer function (Decoding CCTF) or electro-optical transfer function (EOTF / EOCF).

Returns *CIE XYZ* tristimulus values.

Return type 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])
```

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```
>>> chromatic_adaptation_transform = 'Bradford'
>>> RGB_to_XYZ_matrix = 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, RGB_to_XYZ_matrix,
...            chromatic_adaptation_transform)  # doctest: +ELLIPSIS
array([ 0.2163881...,  0.1257    ,  0.0384749...])
```

colour.RGB_to_RGB

`colour.RGB_to_RGB(RGB, input_colourspace, output_colourspace, chromatic_adaptation_transform='CAT02', apply_decoding_cctf=False, apply_encoding_cctf=False)`

Converts given *RGB* colourspace array from given input *RGB* colourspace to output *RGB* colourspace using given *chromatic adaptation* method.

Parameters

- **RGB** (array_like) – *RGB* colourspace array.
- **input_colourspace** (RGB_Colourspace) – *RGB* input colourspace.
- **output_colourspace** (RGB_Colourspace) – *RGB* output colourspace.
- **chromatic_adaptation_transform** (unicode, optional) – **{'CAT02', 'XYZ Scaling', 'Von Kries', 'Bradford', 'Sharp', 'Fairchild', 'CMCCAT97', 'CMCCAT2000', 'CAT02_BRILL_CAT', 'Bianco', 'Bianco PC', None}**, *Chromatic adaptation* transform, if *None* no chromatic adaptation is performed.
- **apply_decoding_cctf** (bool, optional) – Apply input colourspace decoding colour component transfer function / electro-optical transfer function.
- **apply_encoding_cctf** (bool, optional) – Apply output colourspace encoding colour component transfer function / opto-electronic transfer function.

Returns *RGB* colourspace array.

Return type 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 sRGB_COLOURSPACE, PROPHOTO_RGB_COLOURSPACE
>>> RGB = np.array([0.45595571, 0.03039702, 0.04087245])
>>> RGB_to_RGB(RGB, sRGB_COLOURSPACE, PROPHOTO_RGB_COLOURSPACE)
... # doctest: +ELLIPSIS
array([ 0.2568891...,  0.0721446...,  0.0465553...])
```

colour.RGB_to_RGB_matrix

colour.**RGB_to_RGB_matrix**(*input_colourspace*, *output_colourspace*, *chromatic_adaptation_transform='CAT02'*)

Computes 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** (unicode, optional) – **{'CAT02', 'XYZ Scaling', 'Von Kries', 'Bradford', 'Sharp', 'Fairchild', 'CMCCAT97', 'CMCCAT2000', 'CAT02_BRILL_CAT', 'Bianco', 'Bianco PC', None}**, *Chromatic adaptation* transform, if *None* no chromatic adaptation is performed.

Returns Conversion matrix M.

Return type ndarray

Examples

```
>>> from colour.models import sRGB_COLOURSPACE, PROPHOTO_RGB_COLOURSPACE
>>> RGB_to_RGB_matrix(sRGB_COLOURSPACE, PROPHOTO_RGB_COLOURSPACE)
... # doctest: +ELLIPSIS
array([[ 0.5288241...,  0.3340609...,  0.1373616...],
       [ 0.0975294...,  0.8790074...,  0.0233981...],
       [ 0.0163599...,  0.1066124...,  0.8772485...]])
```

Ancillary Objects

colour

XYZ_to_sRGB(XYZ[, illuminant, ...])	Converts from *CIE XYZ* tristimulus values to *sRGB* colourspace.
sRGB_to_XYZ(RGB[, illuminant, ...])	Converts from *sRGB* colourspace to *CIE XYZ* tristimulus values.

colour.XYZ_to_sRGB

colour.**XYZ_to_sRGB**(*XYZ*, *illuminant=array([0.3127, 0.329])*, *chromatic_adaptation_transform='CAT02'*, *apply_encoding_cctf=True*)

Converts from *CIE XYZ* tristimulus values to *sRGB* colourspace.

Parameters

- **XYZ** (array_like) – *CIE XYZ* tristimulus values.

- **illuminant** (array_like, optional) – Source illuminant chromaticity coordinates.
- **chromatic_adaptation_transform** (unicode, optional) – **{'CAT02', 'XYZ Scaling', 'Von Kries', 'Bradford', 'Sharp', 'Fairchild', 'CMCCAT97', 'CMCCAT2000', 'CAT02_BRILL_CAT', 'Bianco', 'Bianco PC'}**, *Chromatic adaptation* transform.
- **apply_encoding_cctf** (bool, optional) – Apply *sRGB* encoding colour component transfer function / opto-electronic transfer function.

Returns *sRGB* colour array.

Return type 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)  # doctest: +ELLIPSIS
array([ 0.7057393...,  0.1924826...,  0.2235416...])
```

colour.sRGB_to_XYZ

colour.**sRGB_to_XYZ**(*RGB*, *illuminant=array([0.3127, 0.329])*, *chromatic_adaptation_method='CAT02'*, *apply_decoding_cctf=True*)

Converts from *sRGB* colourspace to *CIE XYZ* tristimulus values.

Parameters

- **RGB** (array_like) – *sRGB* colourspace array.
- **illuminant** (array_like, optional) – Source illuminant chromaticity coordinates.
- **chromatic_adaptation_method** (unicode, optional) – **{'CAT02', 'XYZ Scaling', 'Von Kries', 'Bradford', 'Sharp', 'Fairchild', 'CMCCAT97', 'CMCCAT2000', 'CAT02_BRILL_CAT', 'Bianco', 'Bianco PC'}**, *Chromatic adaptation* method.
- **apply_decoding_cctf** (bool, optional) – Apply *sRGB* decoding colour component transfer function / electro-optical transfer function.

Returns *CIE XYZ* tristimulus values.

Return type 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)  # doctest: +ELLIPSIS
array([ 0.2065429...,  0.1219794...,  0.0513714...])
```

RGB Colourspace Derivation

colour

normalised_primary_matrix(primaries, whitepoint)	Returns the *normalised primary matrix* using given *primaries* and *whitepoint* xy chromaticity coordinates.
chromatically_adapted_primaries(primaries, ...)	Chromatically adapts given *primaries* xy chromaticity coordinates from test `whitepoint_t` to reference `whitepoint_r`.
primaries_whitepoint(npm)	Returns the *primaries* and *whitepoint* xy chromaticity coordinates using given *normalised primary matrix*.
RGB_luminance(RGB, primaries, whitepoint)	Returns the *luminance* Y of given *RGB* components from given *primaries* and *whitepoint*.
RGB_luminance_equation(primaries, whitepoint)	Returns the *luminance equation* from given *primaries* and *whitepoint*.

colour.normalised_primary_matrix

colour.**normalised_primary_matrix**(*primaries*, *whitepoint*)

Returns the *normalised primary matrix* using given *primaries* and *whitepoint* xy chromaticity coordinates.

Parameters

- **primaries** (array_like, (3, 2)) – Primaries xy chromaticity coordinates.
- **whitepoint** (array_like) – Illuminant / whitepoint xy chromaticity coordinates.

Returns *Normalised primary matrix*.

Return type ndarray, (3, 3)

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)  # doctest: +ELLIPSIS
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*, *whitepoint_t*, *whitepoint_r*, *chromatic_adaptation_transform='CAT02'*)

Chromatically adapts given *primaries* xy chromaticity coordinates from test `whitepoint_t` to reference `whitepoint_r`.

Parameters

- **primaries** (`array_like, (3, 2)`) – Primaries xy chromaticity coordinates.
- **whitepoint_t** (`array_like`) – Test illuminant / whitepoint xy chromaticity coordinates.
- **whitepoint_r** (`array_like`) – Reference illuminant / whitepoint xy chromaticity coordinates.
- **chromatic_adaptation_transform** (`unicode, optional`) – **{'CAT02', 'XYZ Scaling', 'Von Kries', 'Bradford', 'Sharp', 'Fairchild', 'CMCCAT97', 'CMCCAT2000', 'CAT02_BRILL_CAT', 'Bianco', 'Bianco PC'}**, *Chromatic adaptation* transform.

Returns Chromatically adapted primaries xy chromaticity coordinates.

Return type 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)
... # doctest: +ELLIPSIS
array([[ 0.6484414...,  0.3308533...],
       [ 0.3211951...,  0.5978443...],
       [ 0.1558932...,  0.0660492...]])
```

colour.primaries_whitepoint

colour.**primaries_whitepoint**(*npm*)

Returns the *primaries* and *whitepoint* xy chromaticity coordinates using given *normalised primary matrix*.

Parameters **npm** (array_like, (3, 3)) – *Normalised primary matrix*.

Returns *Primaries* and *whitepoint* xy chromaticity coordinates.

Return type tuple

References

[Tri15]

Examples

```
>>> npm = np.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]])
>>> p, w = primaries_whitepoint(npm)
>>> p  # doctest: +ELLIPSIS
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 # doctest: +ELLIPSIS
array([ 0.32168,  0.33767])
```

colour.RGB_luminance

colour.**RGB_luminance**(*RGB*, *primaries*, *whitepoint*)

Returns the *luminance* Y of given *RGB* components from given *primaries* and *whitepoint*.

Parameters

- **RGB** (array_like) – *RGB* chromaticity coordinate matrix.
- **primaries** (array_like, (3, 2)) – Primaries chromaticity coordinate matrix.
- **whitepoint** (array_like) – Illuminant / whitepoint chromaticity coordinates.

Returns *Luminance* Y.

Return type numeric or 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)  # doctest: +ELLIPSIS
0.1230145...
```

colour.RGB_luminance_equation

colour.**RGB_luminance_equation**(*primaries*, *whitepoint*)

Returns the *luminance equation* from given *primaries* and *whitepoint*.

Parameters

- **primaries** (array_like, (3, 2)) – Primaries chromaticity coordinates.
- **whitepoint** (array_like) – Illuminant / whitepoint chromaticity coordinates.

Returns *Luminance* equation.

Return type unicode

Examples

```
>>> p = np.array([0.73470, 0.26530, 0.00000, 1.00000, 0.00010, -0.07700])
>>> whitepoint = np.array([0.32168, 0.33767])
>>> # Doctests skip for Python 2.x compatibility.
>>> RGB_luminance_equation(p, whitepoint)  # doctest: +SKIP
'Y = 0.3439664...(R) + 0.7281660...(G) + -0.0721325...(B)'
```

RGB Colourspaces

colour

RGB_Colourspace(name, primaries, whitepoint)	Implements support for the *RGB* colourspaces dataset from colour.models.dataset.aces_rgb, etc....
RGB_COLOURSPACES	Aggregated *RGB* colourspaces.

colour.RGB_Colourspace

class colour.**RGB_Colourspace**(*name*, *primaries*, *whitepoint*, *whitepoint_name=None*, *RGB_to_XYZ_matrix=None*, *XYZ_to_RGB_matrix=None*, *encoding_cctf=None*, *decoding_cctf=None*, *use_derived_RGB_to_XYZ_matrix=False*, *use_derived_XYZ_to_RGB_matrix=False*)

Implements support for the *RGB* colourspaces dataset from colour.models.dataset.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 `RGB_to_XYZ_matrix` and `XYZ_to_RGB_matrix` 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_RGB_to_XYZ_matrix` and `colour.RGB_Colourspace.use_derived_XYZ_to_RGB_matrix` attributes values.

Parameters

- **name** (`unicode`) – *RGB* colourspace name.
- **primaries** (`array_like`) – *RGB* colourspace primaries.
- **whitepoint** (`array_like`) – *RGB* colourspace whitepoint.
- **whitepoint_name** (`unicode, optional`) – *RGB* colourspace whitepoint name.
- **RGB_to_XYZ_matrix** (`array_like, optional`) – Transformation matrix from colourspace to *CIE XYZ* tristimulus values.
- **XYZ_to_RGB_matrix** (`array_like, optional`) – Transformation matrix from *CIE XYZ* tristimulus values to colourspace.
- **encoding_cctf** (`object, optional`) – Encoding colour component transfer function (Encoding CCTF) / opto-electronic transfer function (OETF / OECF) that maps estimated tristimulus values in a scene to $R'G'B'$ video component signal value.
- **decoding_cctf** (`object, optional`) – Decoding colour component transfer function (Decoding CCTF) / electro-optical transfer function (EOTF / EOCF) that maps an $R'G'B'$ video component signal value to tristimulus values at the display.
- **use_derived_RGB_to_XYZ_matrix** (`bool, optional`) – Whether to use the instantiation time normalised primary matrix or to use a computed derived normalised primary matrix.
- **use_derived_XYZ_to_RGB_matrix** (`bool, optional`) – Whether to use the instantiation time inverse normalised primary matrix or to use a computed derived inverse normalised primary matrix.

name

primaries

whitepoint

whitepoint_name

RGB_to_XYZ_matrix

XYZ_to_RGB_matrix

encoding_cctf

decoding_cctf

use_derived_RGB_to_XYZ_matrix

use_derived_XYZ_to_RGB_matrix

__str__()

__repr__()

use_derived_transformation_matrices()

chromatically_adapt()

copy()

Notes

- The normalised primary matrix defined by `colour.RGB_Colourspace.RGB_to_XYZ_matrix` attribute 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], [Pan14]

Examples

```
>>> p = np.array([0.73470, 0.26530, 0.00000, 1.00000, 0.00010, -0.07700])
>>> whitepoint = np.array([0.32168, 0.33767])
>>> RGB_to_XYZ_matrix = np.identity(3)
>>> XYZ_to_RGB_matrix = np.identity(3)
>>> colourspace = RGB_Colourspace('RGB Colourspace', p, whitepoint, 'ACES',
...                               RGB_to_XYZ_matrix, XYZ_to_RGB_matrix)
>>> colourspace.RGB_to_XYZ_matrix
array([[ 1.,  0.,  0.],
       [ 0.,  1.,  0.],
       [ 0.,  0.,  1.]])
>>> colourspace.XYZ_to_RGB_matrix
array([[ 1.,  0.,  0.],
       [ 0.,  1.,  0.],
       [ 0.,  0.,  1.]])
>>> colourspace.use_derived_transformation_matrices(True)
True
>>> colourspace.RGB_to_XYZ_matrix  # doctest: +ELLIPSIS
array([[  9.5255239...e-01,   0.0000000...e+00,   9.3678631...e-05],
```

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```
       [  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.XYZ_to_RGB_matrix  # doctest: +ELLIPSIS
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_RGB_to_XYZ_matrix = False
>>> colourspace.RGB_to_XYZ_matrix
array([[ 1.,  0.,  0.],
       [ 0.,  1.,  0.],
       [ 0.,  0.,  1.]])
>>> colourspace.use_derived_XYZ_to_RGB_matrix = False
>>> colourspace.XYZ_to_RGB_matrix
array([[ 1.,  0.,  0.],
       [ 0.,  1.,  0.],
       [ 0.,  0.,  1.]])
```

__init__(*name*, *primaries*, *whitepoint*, *whitepoint_name=None*, *RGB_to_XYZ_matrix=None*, *XYZ_to_RGB_matrix=None*, *encoding_cctf=None*, *decoding_cctf=None*, *use_derived_RGB_to_XYZ_matrix=False*, *use_derived_XYZ_to_RGB_matrix=False*)

Initialize self. See help(type(self)) for accurate signature.

Methods

`__init__`(name, primaries, whitepoint[, ...])	Initialize self.
`chromatically_adapt`(whitepoint[, ...])	Chromatically adapts the *RGB* colourspace *primaries* xy chromaticity coordinates from *RGB* colourspace whitepoint to reference `whitepoint`.
`copy`()	Returns a copy of the *RGB* colourspace.
`use_derived_transformation_matrices`([usage])	Enables or disables usage of both derived transformations matrices, the normalised primary matrix and its inverse in subsequent computations.

Attributes

`RGB_to_XYZ_matrix`	Getter and setter property for the transformation matrix from colourspace to *CIE XYZ* tristimulus values.
`XYZ_to_RGB_matrix`	Getter and setter property for the transformation matrix from *CIE XYZ* tristimulus values to colourspace.
`decoding_cctf`	Getter and setter property for the decoding colour component transfer function (Decoding CCTF) / electro-optical transfer function (EOTF / EOCF).
`encoding_cctf`	Getter and setter property for the encoding colour component transfer function (Encoding CCTF) / opto-electronic transfer function (OETF / OECF).

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illuminant	
name	Getter and setter property for the name.
primaries	Getter and setter property for the primaries.
use_derived_RGB_to_XYZ_matrix	Getter and setter property for whether to use the instantiation time normalised primary matrix or to use a computed derived normalised primary matrix.
use_derived_XYZ_to_RGB_matrix	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.
whitepoint	Getter and setter property for the whitepoint.
whitepoint_name	Getter and setter property for the whitepoint_name.

colour.RGB_COLOURSPACES

colour.**RGB_COLOURSPACES = CaseInsensitiveMapping({'ACES2065-1': ..., 'ACEScc': ..., 'ACEScct': ..., 'ACESpr**

Aggregated *RGB* colourspaces.

RGB_COLOURSPACES : CaseInsensitiveMapping

Aliases:

- 'aces': ACES_2065_1_COLOURSPACE.name
- 'adobe1998': ADOBE_RGB_1998_COLOURSPACE.name
- 'prophoto': PROPHOTO_RGB_COLOURSPACE.name

colour.models

ACES_2065_1_COLOURSPACE	*ACES2065-1* colourspace, base encoding, used for exchange of full fidelity images and archiving.
ACES_CC_COLOURSPACE	*ACEScc* colourspace, a working space for color correctors, target for ASC-CDL values created on-set.
ACES_CCT_COLOURSPACE	*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.
ACES_PROXY_COLOURSPACE	*ACESproxy* colourspace, a lightweight encoding for transmission over HD-SDI (or other production transmission schemes), onset look management.
ACES_CG_COLOURSPACE	*ACEScg* colourspace, a working space for paint/compositor applications that don't support ACES2065-1 or ACEScc.
ADOBE_RGB_1998_COLOURSPACE	*Adobe RGB (1998)* colourspace.
ADOBE_WIDE_GAMUT_RGB_COLOURSPACE	*Adobe Wide Gamut RGB* colourspace.
ALEXA_WIDE_GAMUT_COLOURSPACE	*ALEXA Wide Gamut* colourspace.
APPLE_RGB_COLOURSPACE	*Apple RGB* colourspace.
BEST_RGB_COLOURSPACE	*Best RGB* colourspace.
BETA_RGB_COLOURSPACE	*Beta RGB* colourspace.
BT470_525_COLOURSPACE	*ITU-R BT.470 - 525* colourspace.

Continued on next page

Table 205 – continued from previous page

BT470_625_COLOURSPACE	*ITU-R BT.470 - 625* colourspace.
BT709_COLOURSPACE	*ITU-R BT.709* colourspace.
BT2020_COLOURSPACE	*ITU-R BT.2020* colourspace.
CIE_RGB_COLOURSPACE	*CIE RGB* colourspace.
CINEMA_GAMUT_COLOURSPACE	*Cinema Gamut* colourspace.
COLOR_MATCH_RGB_COLOURSPACE	*ColorMatch RGB* colourspace.
DCDM_XYZ_COLOURSPACE	*DCDM XYZ* colourspace.
DCI_P3_COLOURSPACE	*DCI-P3* colourspace.
DCI_P3_P_COLOURSPACE	*DCI-P3+* colourspace.
DON_RGB_4_COLOURSPACE	*Don RGB 4* colourspace.
ECI_RGB_V2_COLOURSPACE	*ECI RGB v2* colourspace.
EKTA_SPACE_PS_5_COLOURSPACE	*Ekta Space PS 5* colourspace.
PROTUNE_NATIVE_COLOURSPACE	*Protune Native* colourspace.
MAX_RGB_COLOURSPACE	*Max RGB* colourspace.
NTSC_COLOURSPACE	*NTSC* colourspace.
P3_D65_COLOURSPACE	*P3-D65* colourspace.
PAL_SECAM_COLOURSPACE	*Pal/Secam* colourspace.
RED_COLOR_COLOURSPACE	*REDcolor* colourspace.
RED_COLOR_2_COLOURSPACE	*REDcolor2* colourspace.
RED_COLOR_3_COLOURSPACE	*REDcolor3* colourspace.
RED_COLOR_4_COLOURSPACE	*REDcolor4* colourspace.
RED_WIDE_GAMUT_RGB_COLOURSPACE	*REDWideGamutRGB* colourspace.
DRAGON_COLOR_COLOURSPACE	*DRAGONcolor* colourspace.
DRAGON_COLOR_2_COLOURSPACE	*DRAGONcolor2* colourspace.
ROMM_RGB_COLOURSPACE	*ROMM RGB* colourspace.
RIMM_RGB_COLOURSPACE	*RIMM RGB* colourspace.
ERIMM_RGB_COLOURSPACE	*ERIMM RGB* colourspace.
PROPHOTO_RGB_COLOURSPACE	*ProPhoto RGB* colourspace, an alias colourspace for *ROMM RGB*.
RUSSELL_RGB_COLOURSPACE	*Russell RGB* colourspace.
SMPTE_240M_COLOURSPACE	*SMPTE 240M* colourspace.
S_GAMUT_COLOURSPACE	*S-Gamut* colourspace.
S_GAMUT3_COLOURSPACE	*S-Gamut3* colourspace.
S_GAMUT3_CINE_COLOURSPACE	*S-Gamut3.Cine* colourspace.
sRGB_COLOURSPACE	*sRGB* colourspace.
V_GAMUT_COLOURSPACE	*V-Gamut* colourspace.
XTREME_RGB_COLOURSPACE	*Xtreme RGB* colourspace.

colour.models.ACES_2065_1_COLOURSPACE

colour.models.**ACES_2065_1_COLOURSPACE = RGB_Colourspace(ACES2065-1, [[7.34700000e-01, 2.65300000e-01], [0.0**

ACES2065-1 colourspace, base encoding, used for exchange of full fidelity images and archiving.

References

[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14c], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14d], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee]

ACES_2065_1_COLOURSPACE : RGB_Colourspace

colour.models.ACES_CC_COLOURSPACE

colour.models.**ACES_CC_COLOURSPACE = RGB_Colourspace(ACEScc, [[0.713, 0.293], [0.165, 0.83], [0.128, 0.044**

ACEScc colourspace, a working space for color correctors, target for ASC-CDL values created on-set.

References

[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14c],
[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14d],
[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14b],
[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee]

ACES_CC_COLOURSPACE : RGB_Colourspace

colour.models.ACES_CCT_COLOURSPACE

colour.models.**ACES_CCT_COLOURSPACE = RGB_Colourspace(ACEScct, [[0.713, 0.293], [0.165, 0.83], [0.128, 0.0**

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

[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14c],
[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14d],
[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESProject16], [TheAoMPAaSciencesScienceaTCouncilAcademyC

ACES_CCT_COLOURSPACE : RGB_Colourspace

colour.models.ACES_PROXY_COLOURSPACE

colour.models.**ACES_PROXY_COLOURSPACE = RGB_Colourspace(ACESproxy, [[0.713, 0.293], [0.165, 0.83], [0.128,**

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

[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14c],
[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14d],
[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14a],
[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee]

ACES_PROXY_COLOURSPACE : RGB_Colourspace

colour.models.ACES_CG_COLOURSPACE

colour.models.**ACES_CG_COLOURSPACE = RGB_Colourspace(ACEScg, [[0.713, 0.293], [0.165, 0.83], [0.128, 0.044**

ACEScg colourspace, a working space for paint/compositor applications that don't support ACES2065-1 or ACEScc.

References

[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14c], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14d], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee15], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee]

ACES_CG_COLOURSPACE : RGB_Colourspace

colour.models.ADOBE_RGB_1998_COLOURSPACE

colour.models.**ADOBE_RGB_1998_COLOURSPACE = RGB_Colourspace(Adobe RGB (1998), [[0.64, 0.33], [0.21, 0.71], [**

Adobe RGB (1998) colourspace.

References

[AdobeSystems05]

ADOBE_RGB_1998_COLOURSPACE : RGB_Colourspace

colour.models.ADOBE_WIDE_GAMUT_RGB_COLOURSPACE

colour.models.**ADOBE_WIDE_GAMUT_RGB_COLOURSPACE = RGB_Colourspace(Adobe Wide Gamut RGB, [[0.7347, 0.2653], [**

Adobe Wide Gamut RGB colourspace.

References

[Wik04d]

ADOBE_WIDE_GAMUT_RGB_COLOURSPACE : RGB_Colourspace

colour.models.ALEXA_WIDE_GAMUT_COLOURSPACE

colour.models.**ALEXA_WIDE_GAMUT_COLOURSPACE = RGB_Colourspace(ALEXA Wide Gamut, [[0.684 , 0.313], [0.221 ,**

ALEXA Wide Gamut colourspace.

References

[ARR12]

ALEXA_WIDE_GAMUT_COLOURSPACE : RGB_Colourspace

colour.models.APPLE_RGB_COLOURSPACE

colour.models.**APPLE_RGB_COLOURSPACE = RGB_Colourspace(Apple RGB, [[0.625, 0.34], [0.28 , 0.595], [0.155,**

Apple RGB colourspace.

References

[SBS99]

APPLE_RGB_COLOURSPACE : RGB_Colourspace

colour.models.BEST_RGB_COLOURSPACE

colour.models.**BEST_RGB_COLOURSPACE = RGB_Colourspace(Best RGB, [[0.73519164, 0.26480836], [0.21533613, 0.77**

Best RGB colourspace.

References

[Huta]

BEST_RGB_COLOURSPACE : RGB_Colourspace

colour.models.BETA_RGB_COLOURSPACE

colour.models.**BETA_RGB_COLOURSPACE = RGB_Colourspace(Beta RGB, [[0.6888, 0.3112], [0.1986, 0.7551], [0.126**

Beta RGB colourspace.

References

[Lin14]

BETA_RGB_COLOURSPACE : RGB_Colourspace

colour.models.BT470_525_COLOURSPACE

colour.models.**BT470_525_COLOURSPACE = RGB_Colourspace(ITU-R BT.470 - 525, [[0.67, 0.33], [0.21, 0.71], [0.**

ITU-R BT.470 - 525 colourspace.

References

[InternationalTUnion98]

BT470_525_COLOURSPACE : RGB_Colourspace

colour.models.BT470_625_COLOURSPACE

colour.models.**BT470_625_COLOURSPACE = RGB_Colourspace(ITU-R BT.470 - 625, [[0.64, 0.33], [0.29, 0.6], [0.**

ITU-R BT.470 - 625 colourspace.

References

[InternationalTUnion98]

BT470_625_COLOURSPACE : RGB_Colourspace

colour.models.BT709_COLOURSPACE

colour.models.**BT709_COLOURSPACE = RGB_Colourspace(ITU-R BT.709, [[0.64, 0.33], [0.3 , 0.6], [0.15, 0.06]]**

ITU-R BT.709 colourspace.

References

[InternationalTUnion15b]

BT709_COLOURSPACE : RGB_Colourspace

colour.models.BT2020_COLOURSPACE

colour.models.**BT2020_COLOURSPACE = RGB_Colourspace(ITU-R BT.2020, [[0.708, 0.292], [0.17 , 0.797], [0.131,**

ITU-R BT.2020 colourspace.

References

[InternationalTUnion15a]

BT2020_COLOURSPACE : RGB_Colourspace

colour.models.CIE_RGB_COLOURSPACE

colour.models.**CIE_RGB_COLOURSPACE = RGB_Colourspace(CIE RGB, [[0.73474284, 0.26525716], [0.27377903, 0.7174**

CIE RGB colourspace.

References

[FBH97]

CIE_RGB_COLOURSPACE : RGB_Colourspace

colour.models.CINEMA_GAMUT_COLOURSPACE

colour.models.**CINEMA_GAMUT_COLOURSPACE = RGB_Colourspace(Cinema Gamut, [[0.74, 0.27], [0.17, 1.14], [0.08,**

Cinema Gamut colourspace.

References

[Can14]

CINEMA_GAMUT_COLOURSPACE : RGB_Colourspace

colour.models.COLOR_MATCH_RGB_COLOURSPACE

colour.models.**COLOR_MATCH_RGB_COLOURSPACE = RGB_Colourspace(ColorMatch RGB, [[0.63 , 0.34], [0.295, 0.605]**

ColorMatch RGB colourspace.

References

[Lin14]

COLOR_MATCH_RGB_COLOURSPACE : RGB_Colourspace

colour.models.DCDM_XYZ_COLOURSPACE

colour.models.**DCDM_XYZ_COLOURSPACE = RGB_Colourspace(DCDM XYZ, [[1., 0.], [0., 1.], [0., 0.]], [0.3333333**

DCDM XYZ colourspace.

References

[DigitalCInitiatives07]

DCDM_XYZ_COLOURSPACE : RGB_Colourspace

colour.models.DCI_P3_COLOURSPACE

colour.models.**DCI_P3_COLOURSPACE = RGB_Colourspace(DCI-P3, [[0.68 , 0.32], [0.265, 0.69], [0.15 , 0.06]**

DCI-P3 colourspace.

References

[DigitalCInitiatives07], [HewlettPDCompany09]

DCI_P3_COLOURSPACE : RGB_Colourspace

colour.models.DCI_P3_P_COLOURSPACE

colour.models.**DCI_P3_P_COLOURSPACE = RGB_Colourspace(DCI-P3+, [[0.74, 0.27], [0.22, 0.78], [0.09, -0.09]],**

DCI-P3+ colourspace.

References

[Can14]

DCI_P3_P_COLOURSPACE : RGB_Colourspace

colour.models.DON_RGB_4_COLOURSPACE

colour.models.**DON_RGB_4_COLOURSPACE = RGB_Colourspace(Don RGB 4, [[0.69612069, 0.29956897], [0.21468298, 0.**

Don RGB 4 colourspace.

References

[Hutb]

DON_RGB_4_COLOURSPACE : RGB_Colourspace

colour.models.ECI_RGB_V2_COLOURSPACE

colour.models.**ECI_RGB_V2_COLOURSPACE = RGB_Colourspace(ECI RGB v2, [[0.67010309, 0.32989691], [0.20990566,**

ECI RGB v2 colourspace.

References

[EuropeanCInitiative02]

ECI_RGB_V2_COLOURSPACE : RGB_Colourspace

colour.models.EKTA_SPACE_PS_5_COLOURSPACE

colour.models.**EKTA_SPACE_PS_5_COLOURSPACE = RGB_Colourspace(Ekta Space PS 5, [[0.69473684, 0.30526316], [0.**

Ekta Space PS 5 colourspace.

References

[Hol]

EKTA_SPACE_PS_5_COLOURSPACE : RGB_Colourspace

colour.models.PROTUNE_NATIVE_COLOURSPACE

colour.models.**PROTUNE_NATIVE_COLOURSPACE = RGB_Colourspace(Protune Native, [[0.69848046, 0.19302645], [0.32**

Protune Native colourspace.

References

[GDM16], [Man15]

PROTUNE_NATIVE_COLOURSPACE : RGB_Colourspace

colour.models.MAX_RGB_COLOURSPACE

colour.models.**MAX_RGB_COLOURSPACE = RGB_Colourspace(Max RGB, [[0.73413379, 0.26586621], [0.10039113, 0.8996**

Max RGB colourspace.

References

[Hutc]

MAX_RGB_COLOURSPACE : RGB_Colourspace

colour.models.NTSC_COLOURSPACE

colour.models.**NTSC_COLOURSPACE = RGB_Colourspace(NTSC, [[0.67, 0.33], [0.21, 0.71], [0.14, 0.08]], [0.310**

NTSC colourspace.

References

[InternationalTUnion98]

NTSC_COLOURSPACE : RGB_Colourspace

colour.models.P3_D65_COLOURSPACE

colour.models.**P3_D65_COLOURSPACE = RGB_Colourspace(P3-D65, [[0.68 , 0.32], [0.265, 0.69], [0.15 , 0.06]**

P3-D65 colourspace.

P3_D65_COLOURSPACE : RGB_Colourspace

colour.models.PAL_SECAM_COLOURSPACE

colour.models.**PAL_SECAM_COLOURSPACE = RGB_Colourspace(Pal/Secam, [[0.64, 0.33], [0.29, 0.6], [0.15, 0.06]**

Pal/Secam colourspace.

References

[InternationalTUnion98]

PAL_SECAM_COLOURSPACE : RGB_Colourspace

colour.models.RED_COLOR_COLOURSPACE

colour.models.**RED_COLOR_COLOURSPACE = RGB_Colourspace(REDcolor, [[0.70105856, 0.33018098], [0.29881132, 0.6**

REDcolor colourspace.

References

[Man15], [SonyImageworks12]

RED_COLOR_COLOURSPACE : RGB_Colourspace

colour.models.RED_COLOR_2_COLOURSPACE

colour.models.**RED_COLOR_2_COLOURSPACE = RGB_Colourspace(REDcolor2, [[0.89740722, 0.33077623], [0.29602209,**

REDcolor2 colourspace.

References

[Man15], [SonyImageworks12]

RED_COLOR_2_COLOURSPACE : RGB_Colourspace

colour.models.RED_COLOR_3_COLOURSPACE

colour.models.**RED_COLOR_3_COLOURSPACE = RGB_Colourspace(REDcolor3, [[0.70259866, 0.33018559], [0.29578224,**

REDcolor3 colourspace.

References

[Man15], [SonyImageworks12]

RED_COLOR_3_COLOURSPACE : RGB_Colourspace

colour.models.RED_COLOR_4_COLOURSPACE

colour.models.**RED_COLOR_4_COLOURSPACE = RGB_Colourspace(REDcolor4, [[0.70259815, 0.3301851], [0.29578233,**
REDcolor4 colourspace.

References

[Man15], [SonyImageworks12]

RED_COLOR_4_COLOURSPACE : RGB_Colourspace

colour.models.RED_WIDE_GAMUT_RGB_COLOURSPACE

colour.models.**RED_WIDE_GAMUT_RGB_COLOURSPACE = RGB_Colourspace(REDWideGamutRGB, [[0.780308, 0.304253], [0.1**
REDWideGamutRGB colourspace.

References

[Man15], [Nat16], [SonyImageworks12]

RED_WIDE_GAMUT_RGB_COLOURSPACE : RGB_Colourspace

colour.models.DRAGON_COLOR_COLOURSPACE

colour.models.**DRAGON_COLOR_COLOURSPACE = RGB_Colourspace(DRAGONcolor, [[0.75865589, 0.33035535], [0.2949236**
DRAGONcolor colourspace.

References

[Man15], [SonyImageworks12]

DRAGON_COLOR_COLOURSPACE : RGB_Colourspace

colour.models.DRAGON_COLOR_2_COLOURSPACE

colour.models.**DRAGON_COLOR_2_COLOURSPACE = RGB_Colourspace(DRAGONcolor2, [[0.75865621, 0.33035584], [0.2949**
DRAGONcolor2 colourspace.

References

[Man15], [SonyImageworks12]

DRAGON_COLOR_2_COLOURSPACE : RGB_Colourspace

colour.models.ROMM_RGB_COLOURSPACE

colour.models.**ROMM_RGB_COLOURSPACE = RGB_Colourspace(ROMM RGB, [[7.34700000e-01, 2.65300000e-01], [1.596000**

ROMM RGB colourspace.

References

[ANS03], [SWG00]

ROMM_RGB_COLOURSPACE : RGB_Colourspace

colour.models.RIMM_RGB_COLOURSPACE

colour.models.**RIMM_RGB_COLOURSPACE = RGB_Colourspace(RIMM RGB, [[7.34700000e-01, 2.65300000e-01], [1.596000**

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]

RIMM_RGB_COLOURSPACE : RGB_Colourspace

colour.models.ERIMM_RGB_COLOURSPACE

colour.models.**ERIMM_RGB_COLOURSPACE = RGB_Colourspace(ERIMM RGB, [[7.34700000e-01, 2.65300000e-01], [1.5960**

ERIMM RGB colourspace.

References

[SWG00]

ERIMM_RGB_COLOURSPACE : RGB_Colourspace

colour.models.PROPHOTO_RGB_COLOURSPACE

colour.models.**PROPHOTO_RGB_COLOURSPACE = RGB_Colourspace(ProPhoto RGB, [[7.34700000e-01, 2.65300000e-01], [**

ProPhoto RGB colourspace, an alias colourspace for *ROMM RGB*.

References

[ANS03], [SWG00]

PROPHOTO_RGB_COLOURSPACE : RGB_Colourspace

colour.models.RUSSELL_RGB_COLOURSPACE

colour.models.**RUSSELL_RGB_COLOURSPACE = RGB_Colourspace(Russell RGB, [[0.69, 0.31], [0.18, 0.77], [0.1 , 0**

Russell RGB colourspace.

References

[Cot]

RUSSELL_RGB_COLOURSPACE : RGB_Colourspace

colour.models.SMPTE_240M_COLOURSPACE

colour.models.**SMPTE_240M_COLOURSPACE = RGB_Colourspace(SMPTE 240M, [[0.63 , 0.34], [0.31 , 0.595], [0.155**

SMPTE 240M colourspace.

References

[SocietyoMPaTEngineers99], [SocietyoMPaTEngineers04]

SMPTE_240M_COLOURSPACE : RGB_Colourspace

colour.models.S_GAMUT_COLOURSPACE

colour.models.**S_GAMUT_COLOURSPACE = RGB_Colourspace(S-Gamut, [[0.73 , 0.28], [0.14 , 0.855], [0.1 , -0.05**

S-Gamut colourspace.

References

[GDY+], [SonyCorporationb]

S_GAMUT_COLOURSPACE : RGB_Colourspace

colour.models.S_GAMUT3_COLOURSPACE

colour.models.**S_GAMUT3_COLOURSPACE = RGB_Colourspace(S-Gamut3, [[0.73 , 0.28], [0.14 , 0.855], [0.1 , -0.**

S-Gamut3 colourspace.

References

[SonyCorporationc]

S_GAMUT3_COLOURSPACE : RGB_Colourspace

colour.models.S_GAMUT3_CINE_COLOURSPACE

colour.models.**S_GAMUT3_CINE_COLOURSPACE = RGB_Colourspace(S-Gamut3.Cine, [[0.766, 0.275], [0.225, 0.8], [**

S-Gamut3.Cine colourspace.

References

[SonyCorporationa]

S_GAMUT3_CINE_COLOURSPACE : RGB_Colourspace

colour.models.sRGB_COLOURSPACE

colour.models.**sRGB_COLOURSPACE = RGB_Colourspace(sRGB, [[0.64, 0.33], [0.3 , 0.6], [0.15, 0.06]], [0.312**

sRGB colourspace.

References

[InternationalECommission99], [InternationalTUnion15b]

sRGB_COLOURSPACE : RGB_Colourspace

colour.models.V_GAMUT_COLOURSPACE

colour.models.**V_GAMUT_COLOURSPACE = RGB_Colourspace(V-Gamut, [[0.73 , 0.28], [0.165, 0.84], [0.1 , -0.03**

V-Gamut colourspace.

References

[Pan14]

V_GAMUT_COLOURSPACE : RGB_Colourspace

colour.models.XTREME_RGB_COLOURSPACE

colour.models.**XTREME_RGB_COLOURSPACE = RGB_Colourspace(Xtreme RGB, [[1., 0.], [0., 1.], [0., 0.]], [0.345**

Xtreme RGB colourspace.

References

[Hutd]

XTREME_RGB_COLOURSPACE : RGB_Colourspace

Colour Component Transfer Functions

colour

encoding_cctf(value[, function])	Encodes linear RGB values to non linear $R'G'B'$ values using given encoding colour component transfer function (Encoding CCTF).
ENCODING_CCTFS	Supported encoding colour component transfer functions (Encoding CCTFs), a collection of the functions defined by colour.LOG_ENCODING_CURVES, colour.OETFS, colour.EOTFS_REVERSE attributes and 3 gamma encoding functions (1 / 2.2, 1 / 2.4, 1 / 2.6).
decoding_cctf(value[, function])	Decodes non-linear $R'G'B'$ values to linear RGB values using given decoding colour component transfer function (Decoding CCTF).

Continued on next page

Table 206 – continued from previous page

DECODING_CCTFS	Supported decoding colour component transfer functions (Decoding CCTFs), a collection of the functions defined by colour.LOG_DECODING_CURVES, colour.EOTFS, colour.OETFS_REVERSE attributes and 3 gamma decoding functions (2.2, 2.4, 2.6).

colour.encoding_cctf

colour.**encoding_cctf**(*value*, *function='sRGB'*, ***kwargs*)

Encodes linear RGB values to non linear $R'G'B'$ values using given encoding colour component transfer function (Encoding CCTF).

Parameters

- **value** (numeric or array_like) – Linear RGB values.
- **function** (unicode, optional) – {colour.ENCODING_CCTFS}, Computation function.

Other Parameters ****kwargs** (*dict, optional*) – Keywords arguments for the relevant encoding CCTF of the colour.ENCODING_CCTFS attribute collection.

> **Warning:** For *ITU-R BT.2100*, only the reverse electro-optical transfer functions (EOTFs / EOCFs) are exposed by this definition, please refer to the colour.oetf() definition for the opto-electronic transfer functions (OETF / OECF).

Returns Non linear $R'G'B'$ values.

Return type numeric or ndarray

Examples

```
>>> encoding_cctf(0.18, function='PLog', log_reference=400)
... # doctest: +ELLIPSIS
0.3910068...
>>> encoding_cctf(0.18, function='ST 2084', L_p=1000)
... # doctest: +ELLIPSIS
0.1820115...
>>> encoding_cctf(  # doctest: +ELLIPSIS
...     0.11699185725296059, function='ITU-R BT.1886')
0.4090077...
```

colour.ENCODING_CCTFS

colour.**ENCODING_CCTFS = CaseInsensitiveMapping({'ACEScc': ..., 'ACEScct': ..., 'ACESproxy': ..., 'ALEXA Log**

Supported encoding colour component transfer functions (Encoding CCTFs), a collection of the functions defined by colour.LOG_ENCODING_CURVES, colour.OETFS, colour.EOTFS_REVERSE attributes and 3 gamma encoding functions (1 / 2.2, 1 / 2.4, 1 / 2.6).

Warning: For *ITU-R BT.2100*, only the reverse electro-optical transfer functions (EOTFs / EOCFs) are exposed by this attribute, please refer to the `colour.OETFS` attribute for the opto-electronic transfer functions (OETF / OECF).

ENCODING_CCTFS [CaseInsensitiveMapping] {`colour.LOG_ENCODING_CURVES`, `colour.OETFS`, `colour.EOTFS_REVERSE`}

colour.decoding_cctf

`colour.`**`decoding_cctf`**(*value*, *function='Cineon'*, ***kwargs*)

Decodes non-linear $R'G'B'$ values to linear RGB values using given decoding colour component transfer function (Decoding CCTF).

Parameters

- **value** (`numeric or array_like`) – Non-linear $R'G'B'$ values.
- **function** (`unicode, optional`) – {`colour.DECODING_CCTFS`}, Computation function.

Other Parameters ****kwargs** (*dict, optional*) – Keywords arguments for the relevant decoding CCTF of the `colour.DECODING_CCTFS` attribute collection.

Warning: For *ITU-R BT.2100*, only the electro-optical transfer functions (EOTFs / EOCFs) are exposed by this definition, please refer to the `colour.oetf_reverse()` definition for the reverse opto-electronic transfer functions (OETF / OECF).

Returns Linear RGB values.

Return type numeric or ndarray

Examples

```
>>> decoding_cctf(0.391006842619746, function='PLog', log_reference=400)
... # doctest: +ELLIPSIS
0.1...
>>> decoding_cctf(0.182011532850008, function='ST 2084', L_p=1000)
... # doctest: +ELLIPSIS
0.1...
>>> decoding_cctf(  # doctest: +ELLIPSIS
...     0.461356129500442, function='ITU-R BT.1886')
0.1...
```

colour.DECODING_CCTFS

`colour.`**`DECODING_CCTFS = CaseInsensitiveMapping({'ACEScc': ..., 'ACEScct': ..., 'ACESproxy': ..., 'ALEXA Log`**

Supported decoding colour component transfer functions (Decoding CCTFs), a collection of the functions defined by `colour.LOG_DECODING_CURVES`, `colour.EOTFS`, `colour.OETFS_REVERSE` attributes 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, please refer to the `colour.OETFS_REVERSE` attribute for the reverse opto-electronic transfer functions (OETF / OECF).

Notes

- The order by which this attribute is defined and updated is critically important to ensure that *ITU-R BT.2100* definitions are reciprocal.

DECODING_CCTFS [CaseInsensitiveMapping] {`colour.LOG_DECODING_CURVES`, `colour.EOTFS`, `colour.OETFS_REVERSE`}

Opto-Electronic Transfer Functions

`colour`

`oetf`(value[, function])	Encodes estimated tristimulus values in a scene to $R'G'B'$ video component signal value using given opto-electronic transfer function (OETF / OECF).
`OETFS`	Supported opto-electrical transfer functions (OETFs / OECFs).
`oetf_reverse`(value[, function])	Decodes $R'G'B'$ video component signal value to tristimulus values at the display using given reverse opto-electronic transfer function (OETF / OECF).
`OETFS_REVERSE`	Supported reverse opto-electrical transfer functions (OETFs / OECFs).

colour.oetf

`colour.`**`oetf`**(*value*, *function='sRGB'*, ***kwargs*)

Encodes estimated tristimulus values in a scene to $R'G'B'$ video component signal value using given opto-electronic transfer function (OETF / OECF).

Parameters

- **value** (`numeric or array_like`) – Value.
- **function** (`unicode, optional`) – **{'sRGB', 'ARIB STD-B67', 'DICOM GSDF', 'ITU-R BT.2020', 'ITU-R BT.2100 HLG', 'ITU-R BT.2100 PQ', 'ITU-R BT.601', 'ITU-R BT.709', 'ProPhoto RGB', 'RIMM RGB', 'ROMM RGB', 'SMPTE 240M', 'ST 2084'}**, Opto-electronic transfer function (OETF / OECF).

Other Parameters

- **E_clip** (*numeric, optional*) – {`colour.models.oetf_RIMMRGB()`}, Maximum exposure level.
- **I_max** (*numeric, optional*) – {`colour.models.oetf_ROMMRGB()`, `colour.models.oetf_RIMMRGB()`}, Maximum code value: 255, 4095 and 650535 for respectively 8-bit, 12-bit and 16-bit per channel.

- **L_p** (*numeric, optional*) – {colour.models.oetf_ST2084()}, Display peak luminance cd/m^2.
- **is_12_bits_system** (*bool*) – {colour.models.oetf_BT2020()}, *ITU-R BT.2020 alpha* and *beta* constants are used if system is not 12-bit.
- **r** (*numeric, optional*) – {colour.models.oetf_ARIBSTDB67()}, Video level corresponding to reference white level.

Returns $R'G'B'$ video component signal value.

Return type numeric or ndarray

Examples

```
>>> oetf(0.18)  # doctest: +ELLIPSIS
0.4613561...
>>> oetf(0.18, function='ITU-R BT.2020')  # doctest: +ELLIPSIS
0.4090077...
>>> oetf(0.18, function='ST 2084', L_p=1000)
... # doctest: +ELLIPSIS
0.1820115...
```

colour.OETFS

colour.**OETFS = CaseInsensitiveMapping({'ARIB STD-B67': ..., 'DICOM GSDF': ..., 'ITU-R BT.2020': ..., 'ITU-R**

Supported opto-electrical transfer functions (OETFs / OECFs).

OETFS [CaseInsensitiveMapping] **{'sRGB', 'ARIB STD-B67', 'DICOM GSDF', 'ITU-R BT.2020', 'ITU-R BT.2100 HLG', 'ITU-R BT.2100 PQ', 'ITU-R BT.601', 'ITU-R BT.709', 'ProPhoto RGB', 'RIMM RGB', 'ROMM RGB', 'SMPTE 240M', 'ST 2084'}**

colour.oetf_reverse

colour.**oetf_reverse**(*value, function='sRGB', **kwargs*)

Decodes $R'G'B'$ video component signal value to tristimulus values at the display using given reverse opto-electronic transfer function (OETF / OECF).

Parameters

- **value** (numeric or array_like) – Value.
- **function** (unicode, optional) – **{'sRGB', 'ARIB STD-B67', 'ITU-R BT.2100 HLD', 'ITU-R BT.2100 PQ', 'ITU-R BT.601', 'ITU-R BT.709'}**, Reverse opto-electronic transfer function (OETF / OECF).

Other Parameters **r** (*numeric, optional*) – {colour.models.oetf_ARIBSTDB67()}, Video level corresponding to reference white level.

Returns Tristimulus values at the display.

Return type numeric or ndarray

Examples

```
>>> oetf_reverse(0.461356129500442)  # doctest: +ELLIPSIS
0.1...
>>> oetf_reverse(  # doctest: +ELLIPSIS
...     0.409007728864150, function='ITU-R BT.601')
0.1...
```

colour.OETFS_REVERSE

colour.**OETFS_REVERSE = CaseInsensitiveMapping({'ARIB STD-B67': ..., 'ITU-R BT.2100 HLD': ..., 'ITU-R BT.2100**

Supported reverse opto-electrical transfer functions (OETFs / OECFs).

OETFS_REVERSE [CaseInsensitiveMapping] **{'sRGB', 'ARIB STD-B67', 'ITU-R BT.2100 HLD', 'ITU-R BT.2100 PQ', 'ITU-R BT.601', 'ITU-R BT.709'}**

colour.models

oetf_ARIBSTDB67(E[, r, constants])	Defines *ARIB STD-B67 (Hybrid Log-Gamma)* opto-electrical transfer function (OETF / OECF).
oetf_reverse_ARIBSTDB67(E_p[, r, constants])	Defines *ARIB STD-B67 (Hybrid Log-Gamma)* reverse opto-electrical transfer function (OETF / OECF).
oetf_DICOMGSDF(L[, out_int])	Defines the *DICOM - Grayscale Standard Display Function* opto-electronic transfer function (OETF / OECF).
oetf_BT2020(E[, is_12_bits_system, constants])	Defines *Recommendation ITU-R BT.2020* opto-electrical transfer function (OETF / OECF).
oetf_BT2100_HLG(E)	Defines *Recommendation ITU-R BT.2100 Reference HLG* opto-electrical transfer function (OETF / OECF).
oetf_reverse_BT2100_HLG(E)	Defines *Recommendation ITU-R BT.2100 Reference HLG* reverse opto-electrical transfer function (OETF / OECF).
oetf_BT2100_PQ(E)	Defines *Recommendation ITU-R BT.2100 Reference PQ* opto-electrical transfer function (OETF / OECF).
oetf_reverse_BT2100_PQ(E_p)	Defines *Recommendation ITU-R BT.2100 Reference PQ* reverse opto-electrical transfer function (OETF / OECF).
oetf_BT601(L)	Defines *Recommendation ITU-R BT.601-7* opto-electronic transfer function (OETF / OECF).
oetf_reverse_BT601(E)	Defines *Recommendation ITU-R BT.601-7* reverse opto-electronic transfer function (OETF / OECF).
oetf_BT709(L)	Defines *Recommendation ITU-R BT.709-6* opto-electronic transfer function (OETF / OECF).
oetf_reverse_BT709(V)	Defines *Recommendation ITU-R BT.709-6* reverse opto-electronic transfer function (OETF / OECF).
oetf_ProPhotoRGB(X[, bit_depth, out_int])	Defines the *ROMM RGB* encoding opto-electronic transfer function (OETF / OECF).
oetf_RIMMRGB(X[, bit_depth, out_int, E_clip])	Defines the *RIMM RGB* encoding opto-electronic transfer function (OETF / OECF).

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oetf_ROMMRGB(X[, bit_depth, out_int])	Defines the *ROMM RGB* encoding opto-electronic transfer function (OETF / OECF).
oetf_SMPTE240M(L_c)	Defines *SMPTE 240M* opto-electrical transfer function (OETF / OECF).
oetf_ST2084(C[, L_p, constants])	Defines *SMPTE ST 2084:2014* optimised perceptual opto-electronic transfer function (OETF / OECF).
oetf_sRGB(L)	Defines the *sRGB* colourspace opto-electronic transfer function (OETF / OECF).
oetf_reverse_sRGB(V)	Defines the *sRGB* colourspace reverse opto-electronic transfer function (OETF / OECF).

colour.models.oetf_ARIBSTDB67

colour.models.**oetf_ARIBSTDB67**(*E*, *r=0.5*, *constants={'a': 0.17883277, 'b': 0.28466892, 'c': 0.55991073}*)

Defines *ARIB STD-B67 (Hybrid Log-Gamma)* opto-electrical transfer function (OETF / OECF).

Parameters

- **E** (numeric or array_like) – 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** (numeric, optional) – Video level corresponding to reference white level.
- **constants** (Structure, optional) – *ARIB STD-B67 (Hybrid Log-Gamma)* constants.

Returns Resulting non-linear signal E'.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
E	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
E_p	[0, 1]	[0, 1]

References

[AssociationoRIaBusinesses15]

Examples

```
>>> oetf_ARIBSTDB67(0.18)  # doctest: +ELLIPSIS
0.2121320...
```

colour.models.oetf_reverse_ARIBSTDB67

colour.models.**oetf_reverse_ARIBSTDB67**(*E_p*, *r=0.5*, *constants={'a': 0.17883277, 'b': 0.28466892, 'c': 0.55991073}*)

Defines *ARIB STD-B67 (Hybrid Log-Gamma)* reverse opto-electrical transfer function (OETF / OECF).

Parameters

- **E_p** (numeric or array_like) – Non-linear signal E'.
- **r** (numeric, optional) – Video level corresponding to reference white level.
- **constants** (Structure, optional) – *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 numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
E_p	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
E	[0, 1]	[0, 1]

References

[AssociationoRIaBusinesses15]

Examples

```
>>> oetf_reverse_ARIBSTDB67(0.212132034355964)  # doctest: +ELLIPSIS
0.1799999...
```

colour.models.oetf_DICOMGSDF

colour.models.**oetf_DICOMGSDF**(*L*, *out_int=False*)

Defines the *DICOM - Grayscale Standard Display Function* opto-electronic transfer function (OETF / OECF).

Parameters

- **L** (numeric or array_like) – *Luminance* L.
- **out_int** (bool, optional) – Whether to return value as integer code value or float equivalent of a code value at a given bit depth.

Returns Just-Noticeable Difference (JND) Index, j.

Return type numeric or 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

```
>>> oetf_DICOMGSDF(130.0662)  # doctest: +ELLIPSIS
0.5004862...
>>> oetf_DICOMGSDF(130.0662, out_int=True)
512
```

colour.models.oetf_BT2020

`colour.models.`**`oetf_BT2020`**(*E*, *is_12_bits_system=False*, *constants={'alpha': <function <lambda>>, 'beta': <function <lambda>>}*)

Defines *Recommendation ITU-R BT.2020* opto-electrical transfer function (OETF / OECF).

Parameters

- **E** (numeric or array_like) – 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, optional) – *Recommendation ITU-R BT.2020* constants.

Returns Resulting non-linear signal E'.

Return type numeric or 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)  # doctest: +ELLIPSIS
0.4090077...
```

colour.models.oetf_BT2100_HLG

colour.models.**oetf_BT2100_HLG**(E)

Defines *Recommendation ITU-R BT.2100 Reference HLG* opto-electrical transfer function (OETF / OECF).

The OETF maps relative scene linear light into the non-linear *HLG* signal value.

Parameters **E** (numeric or array_like) – E is the signal for each colour component R_S, G_S, B_S proportional to scene linear light and scaled by camera exposure.

Returns E' is the resulting non-linear signal R', G', B'.

Return type numeric or 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], [InternationalTUnion16]

Examples

```
>>> oetf_BT2100_HLG(0.18 / 12)  # doctest: +ELLIPSIS
0.2121320...
```

colour.models.oetf_reverse_BT2100_HLG

colour.models.**oetf_reverse_BT2100_HLG**(E)

Defines *Recommendation ITU-R BT.2100 Reference HLG* reverse opto-electrical transfer function (OETF / OECF).

Parameters **E_p** (numeric or array_like) – E' is the resulting non-linear signal R', G', B'.

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 numeric or 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], [InternationalTUnion16]

Examples

```
>>> oetf_reverse_BT2100_HLG(0.212132034355964)  # doctest: +ELLIPSIS
0.0149999...
```

colour.models.oetf_BT2100_PQ

`colour.models.`**`oetf_BT2100_PQ`**(E)

Defines *Recommendation ITU-R BT.2100 Reference PQ* opto-electrical transfer function (OETF / OECF).

The OETF maps relative scene linear light into the non-linear *PQ* signal value.

Parameters **E** (numeric or array_like) – $E = R_S, G_S, B_S; Y_S; or I_S$ 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 numeric or 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], [InternationalTUnion16]

Examples

```
>>> oetf_BT2100_PQ(0.1)  # doctest: +ELLIPSIS
0.7247698...
```

colour.models.oetf_reverse_BT2100_PQ

colour.models.**oetf_reverse_BT2100_PQ**(*E_p*)

Defines *Recommendation ITU-R BT.2100 Reference PQ* reverse opto-electrical transfer function (OETF / OECF).

Parameters **E_p** (numeric or array_like) – 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 numeric or 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], [InternationalTUnion16]

Examples

```
>>> oetf_reverse_BT2100_PQ(0.724769816665726)  # doctest: +ELLIPSIS
0.0999999...
```

colour.models.oetf_BT601

colour.models.**oetf_BT601**(*L*)

Defines *Recommendation ITU-R BT.601-7* opto-electronic transfer function (OETF / OECF).

Parameters **L** (numeric or array_like) – *Luminance* L of the image.

Returns Corresponding electrical signal E.

Return type numeric or 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)  # doctest: +ELLIPSIS
0.4090077...
```

colour.models.oetf_reverse_BT601

`colour.models.`**`oetf_reverse_BT601`**`(E)`

Defines *Recommendation ITU-R BT.601-7* reverse opto-electronic transfer function (OETF / OECF).

Parameters **E** (numeric or array_like) – Electrical signal E.

Returns Corresponding *luminance* L of the image.

Return type numeric or 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_reverse_BT601(0.409007728864150)  # doctest: +ELLIPSIS
0.1...
```

colour.models.oetf_BT709

`colour.models.`**`oetf_BT709`**(*L*)

Defines *Recommendation ITU-R BT.709-6* opto-electronic transfer function (OETF / OECF).

Parameters **L** (numeric or array_like) – *Luminance* L of the image.

Returns Corresponding electrical signal V.

Return type numeric or 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)  # doctest: +ELLIPSIS
0.4090077...
```

colour.models.oetf_reverse_BT709

`colour.models.`**`oetf_reverse_BT709`**(*V*)

Defines *Recommendation ITU-R BT.709-6* reverse opto-electronic transfer function (OETF / OECF).

Parameters **V** (numeric or array_like) – Electrical signal V.

Returns Corresponding *luminance* L of the image.

Return type numeric or 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_reverse_BT709(0.409007728864150)  # doctest: +ELLIPSIS
0.1...
```

colour.models.oetf_ProPhotoRGB

`colour.models.oetf_ProPhotoRGB`(*X*, *bit_depth=8*, *out_int=False*)

Defines the *ROMM RGB* encoding opto-electronic transfer function (OETF / OECF).

Parameters

- **X** (numeric or array_like) – Linear data X_{ROMM}.
- **bit_depth** (int, optional) – Bit depth used for conversion.
- **out_int** (bool, optional) – 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 numeric or 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

[ANS03], [SWG00]

Examples

```
>>> oetf_ROMMRGB(0.18)  # doctest: +ELLIPSIS
0.3857114...
>>> oetf_ROMMRGB(0.18, out_int=True)
98
```

colour.models.oetf_RIMMRGB

`colour.models.`**`oetf_RIMMRGB`**(*X*, *bit_depth=8*, *out_int=False*, *E_clip=2.0*)

Defines the *RIMM RGB* encoding opto-electronic transfer function (OETF / OECF).

RIMM RGB encoding non-linearity is based on that specified by *Recommendation ITU-R BT.709-6*.

Parameters

- **X** (numeric or array_like) – Linear data X_{RIMM}.
- **bit_depth** (int, optional) – Bit depth used for conversion.
- **out_int** (bool, optional) – Whether to return value as integer code value or float equivalent of a code value at a given bit depth.
- **E_clip** (numeric, optional) – Maximum exposure level.

Returns Non-linear data X'_{RIMM}.

Return type numeric or 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

```
>>> oetf_RIMMRGB(0.18)  # doctest: +ELLIPSIS
0.2916737...
>>> oetf_RIMMRGB(0.18, out_int=True)
74
```

colour.models.oetf_ROMMRGB

`colour.models.`**`oetf_ROMMRGB`**(*X*, *bit_depth=8*, *out_int=False*)

Defines the *ROMM RGB* encoding opto-electronic transfer function (OETF / OECF).

Parameters

- **X** (numeric or array_like) – Linear data X_{ROMM}.

- **bit_depth** (int, optional) – Bit depth used for conversion.
- **out_int** (bool, optional) – 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 numeric or 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

[ANS03], [SWG00]

Examples

```
>>> oetf_ROMMRGB(0.18)  # doctest: +ELLIPSIS
0.3857114...
>>> oetf_ROMMRGB(0.18, out_int=True)
98
```

colour.models.oetf_SMPTE240M

colour.models.**oetf_SMPTE240M**(L_c)

Defines *SMPTE 240M* opto-electrical transfer function (OETF / OECF).

Parameters **L_c** (numeric or array_like) – 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 numeric or 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)  # doctest: +ELLIPSIS
0.4022857...
```

colour.models.oetf_ST2084

colour.models.**oetf_ST2084**(*C*, *L_p=10000*, *constants={'c_1': 0.8359375, 'c_2': 18.8515625, 'c_3': 18.6875, 'm_1': 0.1593017578125, 'm_2': 78.84375}*)

Defines *SMPTE ST 2084:2014* optimised perceptual opto-electronic transfer function (OETF / OECF).

Parameters

- **C** (numeric or array_like) – Target optical output C in cd/m^2 of the ideal reference display.
- **L_p** (numeric, optional) – 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, optional) – *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 numeric or ndarray

> **Warning:** *SMPTE ST 2084:2014* is an absolute transfer function.

Notes

Domain	Scale - Reference	Scale - 1
C	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
N	[0, 1]	[0, 1]

- *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.

References

[Mil14], [SocietyoMPaTEngineers14]

Examples

```
>>> oetf_ST2084(100)  # doctest: +ELLIPSIS
0.5080784...
```

colour.models.oetf_sRGB

colour.models.**oetf_sRGB**(*L*)

Defines the *sRGB* colourspace opto-electronic transfer function (OETF / OECF).

Parameters **L** (numeric or array_like) – *Luminance* L of the image.

Returns Corresponding electrical signal V.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
L	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
V	[0, 1]	[0, 1]

References

[InternationalECommission99], [InternationalTUnion15b]

Examples

```
>>> oetf_sRGB(0.18)  # doctest: +ELLIPSIS
0.4613561...
```

colour.models.oetf_reverse_sRGB

colour.models.**oetf_reverse_sRGB**(*V*)

Defines the *sRGB* colourspace reverse opto-electronic transfer function (OETF / OECF).

Parameters **V** (numeric or array_like) – Electrical signal V.

Returns Corresponding *luminance* L of the image.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
V	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
L	[0, 1]	[0, 1]

References

[InternationalECommission99], [InternationalTUnion15b]

Examples

```
>>> oetf_reverse_sRGB(0.461356129500442)  # doctest: +ELLIPSIS
0.1...
```

Ancillary Objects

colour

gamma_function(a[, exponent, ...])	Defines a typical gamma encoding / decoding function.
linear_function(a)	Defines a typical linear encoding / decoding function, essentially a pass-through function.

colour.gamma_function

colour.**gamma_function**(*a*, *exponent=1*, *negative_number_handling='Indeterminate'*)

Defines a typical gamma encoding / decoding function.

Parameters

- **a** (numeric or array_like) – Array to encode / decode.
- **exponent** (numeric or array_like, optional) – Encoding / decoding exponent.
- **negative_number_handling** (unicode, optional) – **{'Indeterminate', 'Mirror', 'Preserve', 'Clamp'}**, 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 numeric or ndarray

Raises `ValueError` – If the negative number handling method is not defined.

Examples

```
>>> gamma_function(0.18, 2.2)  # doctest: +ELLIPSIS
0.0229932...
>>> gamma_function(-0.18, 2.0)  # doctest: +ELLIPSIS
0.0323999...
>>> gamma_function(-0.18, 2.2)
nan
>>> gamma_function(-0.18, 2.2, 'Mirror')  # doctest: +ELLIPSIS
-0.0229932...
>>> gamma_function(-0.18, 2.2, 'Preserve')  # doctest: +ELLIPSIS
-0.1...
>>> gamma_function(-0.18, 2.2, 'Clamp')  # doctest: +ELLIPSIS
0.0
```

colour.linear_function

`colour.`**`linear_function`**(*a*)

Defines a typical linear encoding / decoding function, essentially a pass-through function.

Parameters **a** (`numeric or array_like`) – Array to encode / decode.

Returns Encoded / decoded array.

Return type numeric or ndarray

Examples

```
>>> linear_function(0.18)
0.18
```

Electro-Optical Transfer Functions

`colour`

`eotf`(value[, function])	Decodes $R'G'B'$ video component signal value to tristimulus values at the display using given electro-optical transfer function (EOTF / EOCF).
`EOTFS`	Supported electro-optical transfer functions (EOTFs / EOCFs).
`eotf_reverse`(value[, function])	Encodes estimated tristimulus values in a scene to $R'G'B'$ video component signal value using given reverse electro-optical transfer function (EOTF / EOCF).
`EOTFS_REVERSE`	Supported reverse electro-optical transfer functions (EOTFs / EOCFs).

colour.eotf

colour.**eotf**(*value*, *function='ITU-R BT.1886'*, ***kwargs*)

Decodes $R'G'B'$ video component signal value to tristimulus values at the display using given electro-optical transfer function (EOTF / EOCF).

Parameters

- **value** (numeric or array_like) – Value.
- **function** (unicode, optional) – **{'ITU-R BT.1886', 'DCDM', 'DICOM GSDF', 'ITU-R BT.2020', 'ITU-R BT.2100 HLG', 'ITU-R BT.2100 PQ', 'ProPhoto RGB', 'RIMM RGB', 'ROMM RGB', 'SMPTE 240M', 'ST 2084'}**, Electro-optical transfer function (EOTF / EOCF).

Other Parameters

- **E_clip** (*numeric, optional*) – {colour.models.eotf_RIMMRGB()}, Maximum exposure level.
- **I_max** (*numeric, optional*) – {colour.models.eotf_ROMMRGB(), colour.models.eotf_RIMMRGB()}, Maximum code value: 255, 4095 and 650535 for respectively 8-bit, 12-bit and 16-bit per channel.
- **L_B** (*numeric, optional*) – {colour.models.eotf_BT1886(), colour.models.eotf_BT2100_HLG()}, Screen luminance for black.
- **L_W** (*numeric, optional*) – {colour.models.eotf_BT1886(), colour.models.eotf_BT2100_HLG()}, Screen luminance for white.
- **L_p** (*numeric, optional*) – {colour.models.eotf_ST2084()}, Display peak luminance cd/m^2.
- **gamma** (*numeric, optional*) – {colour.models.eotf_BT2100_HLG()}, System gamma value, 1.2 at the nominal display peak luminance of $1000cd/m^2$.
- **is_12_bits_system** (*bool*) – {colour.models.eotf_BT2020()}, *ITU-R BT.2020 alpha* and *beta* constants are used if system is not 12-bit.

Returns Tristimulus values at the display.

Return type numeric or ndarray

Examples

```
>>> eotf(0.461356129500442)  # doctest: +ELLIPSIS
0.1...
>>> eotf(0.409007728864150, function='ITU-R BT.2020')
... # doctest: +ELLIPSIS
0.1...
>>> eotf(0.182011532850008, function='ST 2084', L_p=1000)
... # doctest: +ELLIPSIS
0.1...
```

colour.EOTFS

colour.**EOTFS = CaseInsensitiveMapping({'DCDM': ..., 'DICOM GSDF': ..., 'ITU-R BT.1886': ..., 'ITU-R BT.2020'**

Supported electro-optical transfer functions (EOTFs / EOCFs).

EOTFS [CaseInsensitiveMapping] **{'DCDM', 'DICOM GSDF', 'ITU-R BT.1886', 'ITU-R BT.2020', 'ITU-R BT.2100 HLG', 'ITU-R BT.2100 PQ', 'ProPhoto RGB', 'RIMM RGB', 'ROMM RGB', 'SMPTE 240M', 'ST 2084'}**

colour.eotf_reverse

`colour.`**`eotf_reverse`**(*value, function='ITU-R BT.1886', **kwargs*)

Encodes estimated tristimulus values in a scene to $R'G'B'$ video component signal value using given reverse electro-optical transfer function (EOTF / EOCF).

Parameters

- **value** (numeric or array_like) – Value.
- **function** (unicode, optional) – **{'ITU-R BT.1886', 'DCDM', 'ITU-R BT.2100 HLG', 'ITU-R BT.2100 PQ'}**, Reverse electro-optical transfer function (EOTF / EOCF).

Other Parameters

- **L_B** (*numeric, optional*) – {colour.models.eotf_reverse_BT1886(), colour.models.eotf_reverse_BT2100_HLG()}, Screen luminance for black.
- **L_W** (*numeric, optional*) – {colour.models.eotf_reverse_BT1886(), colour.models.eotf_reverse_BT2100_HLG()}, Screen luminance for white.
- **gamma** (*numeric, optional*) – {colour.models.eotf_BT2100_HLG()}, System gamma value, 1.2 at the nominal display peak luminance of $1000cd/m^2$.
- **out_int** (*bool, optional*) – {colour.models.eotf_reverse_DCDM()}, Whether to return value as integer code value or float equivalent of a code value at a given bit depth.

Returns $R'G'B'$ video component signal value.

Return type numeric or ndarray

Examples

```
>>> eotf_reverse(0.11699185725296059)  # doctest: +ELLIPSIS
0.4090077...
>>> eotf_reverse(  # doctest: +ELLIPSIS
...     0.11699185725296059, function='ITU-R BT.1886')
0.4090077...
```

colour.EOTFS_REVERSE

`colour.`**`EOTFS_REVERSE = CaseInsensitiveMapping({'DCDM': ..., 'ITU-R BT.1886': ..., 'ITU-R BT.2100 HLG': ...,`**

Supported reverse electro-optical transfer functions (EOTFs / EOCFs).

EOTFS_REVERSE [CaseInsensitiveMapping] **{'DCDM', 'ITU-R BT.1886', 'ITU-R BT.2100 HLG', 'ITU-R BT.2100 PQ'}**

`colour.models`

eotf_DCDM(XYZ_p[, in_int])	Defines the *DCDM* electro-optical transfer function (EOTF / EOCF).
eotf_reverse_DCDM(XYZ[, out_int])	Defines the *DCDM* reverse electro-optical transfer function (EOTF / EOCF).
eotf_DICOMGSDF(J[, in_int])	Defines the *DICOM - Grayscale Standard Display Function* electro-optical transfer function (EOTF / EOCF).
eotf_BT1886(V[, L_B, L_W])	Defines *Recommendation ITU-R BT.1886* electro-optical transfer function (EOTF / EOCF).
eotf_reverse_BT1886(L[, L_B, L_W])	Defines *Recommendation ITU-R BT.1886* reverse electro-optical transfer function (EOTF / EOCF).
eotf_BT2020(E_p[, is_12_bits_system, constants])	Defines *Recommendation ITU-R BT.2020* electro-optical transfer function (EOTF / EOCF).
eotf_BT2100_HLG(E_p[, L_B, L_W, gamma])	Defines *Recommendation ITU-R BT.2100 Reference HLG* electro-optical transfer function (EOTF / EOCF).
eotf_reverse_BT2100_HLG(F_D[, L_B, L_W, gamma])	Defines *Recommendation ITU-R BT.2100 Reference HLG* reverse electro-optical transfer function (EOTF / EOCF).
eotf_BT2100_PQ(E_p)	Defines *Recommendation ITU-R BT.2100 Reference PQ* electro-optical transfer function (EOTF / EOCF).
eotf_reverse_BT2100_PQ(F_D)	Defines *Recommendation ITU-R BT.2100 Reference PQ* reverse electro-optical transfer function (EOTF / EOCF).
eotf_ProPhotoRGB(X_p[, bit_depth, in_int])	Defines the *ROMM RGB* encoding electro-optical transfer function (EOTF / EOCF).
eotf_RIMMRGB(X_p[, bit_depth, in_int, E_clip])	Defines the *RIMM RGB* encoding electro-optical transfer function (EOTF / EOCF).
eotf_ROMMRGB(X_p[, bit_depth, in_int])	Defines the *ROMM RGB* encoding electro-optical transfer function (EOTF / EOCF).
eotf_SMPTE240M(V_r)	Defines *SMPTE 240M* electro-optical transfer function (EOTF / EOCF).
eotf_ST2084(N[, L_p, constants])	Defines *SMPTE ST 2084:2014* optimised perceptual electro-optical transfer function (EOTF / EOCF).

colour.models.eotf_DCDM

colour.models.**eotf_DCDM**(*XYZ_p*, *in_int=False*)

Defines the *DCDM* electro-optical transfer function (EOTF / EOCF).

Parameters

- **XYZ_p** (numeric or array_like) – Non-linear *CIE XYZ*' tristimulus values.
- **in_int** (bool, optional) – 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 numeric or ndarray

Notes

Domain *	Scale - Reference	Scale - 1
XYZ_p	[0, 1]	[0, 1]

Range *	Scale - Reference	Scale - 1
XYZ	[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

[DigitalCInitiatives07]

Examples

```
>>> eotf_DCDM(0.11281860951766724)  # doctest: +ELLIPSIS
0.18...
>>> eotf_DCDM(462, in_int=True)  # doctest: +ELLIPSIS
0.18...
```

colour.models.eotf_reverse_DCDM

`colour.models.`**`eotf_reverse_DCDM`**(*XYZ*, *out_int=False*)

Defines the *DCDM* reverse electro-optical transfer function (EOTF / EOCF).

Parameters

- **XYZ** (numeric or array_like) – *CIE XYZ* tristimulus values.
- **out_int** (bool, optional) – 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 numeric or ndarray

Notes

Domain *	Scale - Reference	Scale - 1
XYZ	[0, 1]	[0, 1]

Range *	Scale - Reference	Scale - 1
XYZ_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

[DigitalCInitiatives07]

Examples

```
>>> eotf_reverse_DCDM(0.18)  # doctest: +ELLIPSIS
0.1128186...
>>> eotf_reverse_DCDM(0.18, out_int=True)
462
```

colour.models.eotf_DICOMGSDF

`colour.models.eotf_DICOMGSDF(J, in_int=False)`

Defines the *DICOM - Grayscale Standard Display Function* electro-optical transfer function (EOTF / EOCF).

Parameters

- **J** (numeric or array_like) – Just-Noticeable Difference (JND) Index, j.
- **in_int** (bool, optional) – Whether to treat the input value as integer code value or float equivalent of a code value at a given bit depth.

Returns Corresponding *luminance* L.

Return type numeric or 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)  # doctest: +ELLIPSIS
130.0628647...
>>> eotf_DICOMGSDF(512, in_int=True)  # doctest: +ELLIPSIS
130.0652840...
```

colour.models.eotf_BT1886

`colour.models.`**`eotf_BT1886`**(*V*, *L_B=0*, *L_W=1*)

Defines *Recommendation ITU-R BT.1886* electro-optical transfer function (EOTF / EOCF).

Parameters

- **V** (`numeric or array_like`) – 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** (`numeric, optional`) – Screen luminance for black.
- **L_W** (`numeric, optional`) – Screen luminance for white.

Returns Screen luminance in cd/m^2.

Return type numeric or 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)  # doctest: +ELLIPSIS
0.1169918...
```

colour.models.eotf_reverse_BT1886

`colour.models.`**`eotf_reverse_BT1886`**(*L*, *L_B=0*, *L_W=1*)

Defines *Recommendation ITU-R BT.1886* reverse electro-optical transfer function (EOTF / EOCF).

Parameters

- **L** (`numeric or array_like`) – Screen luminance in cd/m^2.
- **L_B** (`numeric, optional`) – Screen luminance for black.
- **L_W** (`numeric, optional`) – Screen luminance for white.

Returns Input video signal level (normalised, black at $V = 0$, to white at $V = 1$.

Return type numeric or 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_reverse_BT1886(0.11699185725296059)  # doctest: +ELLIPSIS
0.4090077...
```

colour.models.eotf_BT2020

`colour.models.`**`eotf_BT2020`**(*E_p*, *is_12_bits_system=False*, *constants={'alpha': <function <lambda>>, 'beta': <function <lambda>>}*)

Defines *Recommendation ITU-R BT.2020* electro-optical transfer function (EOTF / EOCF).

Parameters

- **E_p** (numeric or array_like) – 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, optional) – *Recommendation ITU-R BT.2020* constants.

Returns Resulting voltage E.

Return type numeric or 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

```
>>> eotf_BT2020(0.705515089922121)  # doctest: +ELLIPSIS
0.4999999...
```

colour.models.eotf_BT2100_HLG

colour.models.**eotf_BT2100_HLG**(*E_p*, *L_B=0*, *L_W=1000*, *gamma=None*)

Defines *Recommendation ITU-R BT.2100 Reference HLG* electro-optical transfer function (EOTF / EOCF).

The EOTF maps the non-linear *HLG* signal into display light.

Parameters

- **E_p** (numeric or array_like) – E' denotes a non-linear colour value R', G', B' or L', M', S' in *HLG* space.
- **L_B** (numeric, optional) – L_B is the display luminance for black in cd/m^2.
- **L_W** (numeric, optional) – L_W is nominal peak luminance of the display in cd/m^2 for achromatic pixels.
- **gamma** (numeric, optional) – System gamma value, 1.2 at the nominal display peak luminance of $1000cd/m^2$.

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 numeric or 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], [InternationalTUnion16]

Examples

```
>>> eotf_BT2100_HLG(0.212132034355964)  # doctest: +ELLIPSIS
6.4760398...
```

colour.models.eotf_reverse_BT2100_HLG

colour.models.**eotf_reverse_BT2100_HLG**(*F_D*, *L_B=0*, *L_W=1000*, *gamma=None*)

Defines *Recommendation ITU-R BT.2100 Reference HLG* reverse electro-optical transfer function (EOTF / EOCF).

Parameters

- **F_D** (numeric or array_like) – 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** (numeric, optional) – L_B is the display luminance for black in cd/m^2.
- **L_W** (numeric, optional) – L_W is nominal peak luminance of the display in cd/m^2 for achromatic pixels.
- **gamma** (numeric, optional) – System gamma value, 1.2 at the nominal display peak luminance of $1000cd/m^2$.

Returns E' denotes a non-linear colour value R', G', B' or L', M', S' in *HLG* space.

Return type numeric or 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], [InternationalTUnion16]

Examples

```
>>> eotf_reverse_BT2100_HLG(6.476039825649814)  # doctest: +ELLIPSIS
0.2121320...
```

colour.models.eotf_BT2100_PQ

colour.models.**eotf_BT2100_PQ**(*E_p*)

Defines *Recommendation ITU-R BT.2100 Reference PQ* electro-optical transfer function (EOTF / EOCF).

The EOTF maps the non-linear *PQ* signal into display light.

Parameters **E_p** (numeric or array_like) – 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 numeric or 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], [InternationalTUnion16]

Examples

```
>>> eotf_BT2100_PQ(0.724769816665726)  # doctest: +ELLIPSIS
779.9883608...
```

colour.models.eotf_reverse_BT2100_PQ

colour.models.**eotf_reverse_BT2100_PQ**(*F_D*)

Defines *Recommendation ITU-R BT.2100 Reference PQ* reverse electro-optical transfer function (EOTF / EOCF).

Parameters **F_D** (numeric or array_like) – 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 numeric or 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], [InternationalTUnion16]

Examples

```
>>> eotf_reverse_BT2100_PQ(779.988360834085370)  # doctest: +ELLIPSIS
0.7247698...
```

colour.models.eotf_ProPhotoRGB

`colour.models.`**`eotf_ProPhotoRGB`**(*X_p*, *bit_depth=8*, *in_int=False*)

Defines the *ROMM RGB* encoding electro-optical transfer function (EOTF / EOCF).

Parameters

- **X_p** (numeric or array_like) – Non-linear data X'_{ROMM}.
- **bit_depth** (int, optional) – Bit depth used for conversion.
- **in_int** (bool, optional) – 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 numeric or 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

[ANS03], [SWG00]

Examples

```
>>> eotf_ROMMRGB(0.385711424751138) # doctest: +ELLIPSIS
0.1...
>>> eotf_ROMMRGB(98, in_int=True) # doctest: +ELLIPSIS
0.1...
```

colour.models.eotf_RIMMRGB

`colour.models.`**`eotf_RIMMRGB`**(*X_p*, *bit_depth=8*, *in_int=False*, *E_clip=2.0*)

Defines the *RIMM RGB* encoding electro-optical transfer function (EOTF / EOCF).

Parameters

- **X_p** (numeric or array_like) – Non-linear data X'_{RIMM}.
- **bit_depth** (int, optional) – Bit depth used for conversion.
- **in_int** (bool, optional) – Whether to treat the input value as integer code value or float equivalent of a code value at a given bit depth.

- **E_clip** (numeric, optional) – Maximum exposure level.

Returns Linear data X_{RIMM}.

Return type numeric or 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

```
>>> eotf_RIMMRGB(0.291673732475746)  # doctest: +ELLIPSIS
0.1...
>>> eotf_RIMMRGB(74, in_int=True)  # doctest: +ELLIPSIS
0.1...
```

colour.models.eotf_ROMMRGB

colour.models.**eotf_ROMMRGB**(*X_p*, *bit_depth=8*, *in_int=False*)

Defines the *ROMM RGB* encoding electro-optical transfer function (EOTF / EOCF).

Parameters

- **X_p** (numeric or array_like) – Non-linear data X'_{ROMM}.
- **bit_depth** (int, optional) – Bit depth used for conversion.
- **in_int** (bool, optional) – 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 numeric or 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

[ANS03], [SWG00]

Examples

```
>>> eotf_ROMMRGB(0.385711424751138) # doctest: +ELLIPSIS
0.1...
>>> eotf_ROMMRGB(98, in_int=True) # doctest: +ELLIPSIS
0.1...
```

colour.models.eotf_SMPTE240M

colour.models.**eotf_SMPTE240M**(V_r)

Defines *SMPTE 240M* electro-optical transfer function (EOTF / EOCF).

Parameters **V_r** (numeric or array_like) – 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 numeric or 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)  # doctest: +ELLIPSIS
0.1...
```

colour.models.eotf_ST2084

colour.models.**eotf_ST2084**(*N*, *L_p=10000*, *constants={'c_1': 0.8359375, 'c_2': 18.8515625, 'c_3': 18.6875, 'm_1': 0.1593017578125, 'm_2': 78.84375}*)

Defines *SMPTE ST 2084:2014* optimised perceptual electro-optical transfer function (EOTF / EOCF).

This perceptual quantizer (PQ) has been modeled by Dolby Laboratories using *Barten (1999)* contrast sensitivity function.

Parameters

- **N** (numeric or array_like) – 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** (numeric, optional) – 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, optional) – *SMPTE ST 2084:2014* constants.

Returns Target optical output C in cd/m^2 of the ideal reference display.

Return type numeric or ndarray

> **Warning:** *SMPTE ST 2084:2014* is an absolute transfer function.

Notes

Domain	Scale - Reference	Scale - 1
N	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
C	[0, 1]	[0, 1]

- *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.

References

[Mil14], [SocietyoMPaTEngineers14]

Examples

```
>>> eotf_ST2084(0.508078421517399)  # doctest: +ELLIPSIS
100.0000000...
```

Opto-Optical Transfer Functions

colour

ootf(value[, function])	Maps relative scene linear light to display linear light using given opto-optical transfer function (OOTF / OOCF).
OOTFS	Supported opto-optical transfer functions (OOTFs / OOCFs).
ootf_reverse(value[, function])	Maps relative display linear light to scene linear light using given reverse opto-optical transfer function (OOTF / OOCF).
OOTFS_REVERSE	Supported reverse opto-optical transfer functions (OOTFs / OOCFs).

colour.ootf

colour.**ootf**(*value*, *function='ITU-R BT.2100 PQ'*, ***kwargs*)

Maps relative scene linear light to display linear light using given opto-optical transfer function (OOTF / OOCF).

Parameters

- **value** (numeric or array_like) – Value.
- **function** (unicode, optional) – **{'ITU-R BT.2100 HLG', 'ITU-R BT.2100 PQ'}** Opto-optical transfer function (OOTF / OOCF).

Returns Luminance of a displayed linear component.

Return type numeric or ndarray

Examples

```
>>> ootf(0.1)  # doctest: +ELLIPSIS
779.9883608...
>>> ootf(0.1, function='ITU-R BT.2100 HLG')  # doctest: +ELLIPSIS
63.0957344...
```

colour.OOTFS

colour.**OOTFS = CaseInsensitiveMapping({'ITU-R BT.2100 HLG': ..., 'ITU-R BT.2100 PQ': ...})**

Supported opto-optical transfer functions (OOTFs / OOCFs).

OOTFS [CaseInsensitiveMapping] **{'ITU-R BT.2100 HLG', 'ITU-R BT.2100 PQ'}**

colour.ootf_reverse

colour.**ootf_reverse**(*value*, *function='ITU-R BT.2100 PQ'*, ***kwargs*)

Maps relative display linear light to scene linear light using given reverse opto-optical transfer function (OOTF / OOCF).

Parameters

- **value** (numeric or array_like) – Value.
- **function** (unicode, optional) – **{'ITU-R BT.2100 HLG', 'ITU-R BT.2100 PQ'}** Reverse opto-optical transfer function (OOTF / OOCF).

Other Parameters

- **L_B** (*numeric, optional*) – {colour.models.ootf_reverse_BT2100_HLG()}, L_B is the display luminance for black in cd/m^2.
- **L_W** (*numeric, optional*) – {colour.models.ootf_reverse_BT2100_HLG()}, L_W is nominal peak luminance of the display in cd/m^2 for achromatic pixels.
- **gamma** (*numeric, optional*) – {colour.models.ootf_reverse_BT2100_HLG()}, System gamma value, 1.2 at the nominal display peak luminance of $1000cd/m^2$.

Returns Luminance of scene linear light.

Return type numeric or ndarray

Examples

```
>>> ootf_reverse(779.988360834115840)  # doctest: +ELLIPSIS
0.1000000...
>>> ootf_reverse(  # doctest: +ELLIPSIS
...     63.095734448019336, function='ITU-R BT.2100 HLG')
0.1000000...
```

colour.OOTFS_REVERSE

colour.**OOTFS_REVERSE = CaseInsensitiveMapping({'ITU-R BT.2100 HLG': ..., 'ITU-R BT.2100 PQ': ...})**

Supported reverse opto-optical transfer functions (OOTFs / OOCFs).

OOTFS_REVERSE [CaseInsensitiveMapping] **{'ITU-R BT.2100 HLG', 'ITU-R BT.2100 PQ'}**

colour.models

ootf_BT2100_HLG(E[, L_B, L_W, gamma])	Defines *Recommendation ITU-R BT.2100 Reference HLG* opto-optical transfer function (OOTF / OOCF).
ootf_reverse_BT2100_HLG(F_D[, L_B, L_W, gamma])	Defines *Recommendation ITU-R BT.2100 Reference HLG* reverse opto-optical transfer function (OOTF / OOCF).
ootf_BT2100_PQ(E)	Defines *Recommendation ITU-R BT.2100 Reference PQ* opto-optical transfer function (OOTF / OOCF).
ootf_reverse_BT2100_PQ(F_D)	Defines *Recommendation ITU-R BT.2100 Reference PQ* reverse opto-optical transfer function (OOTF / OOCF).

colour.models.ootf_BT2100_HLG

colour.models.**ootf_BT2100_HLG**(*E, L_B=0, L_W=1000, gamma=None*)

Defines *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** (numeric or array_like) – 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** (numeric, optional) – L_B is the display luminance for black in cd/m^2.
- **L_W** (numeric, optional) – L_W is nominal peak luminance of the display in cd/m^2 for achromatic pixels.
- **gamma** (numeric, optional) – System gamma value, 1.2 at the nominal display peak luminance of $1000cd/m^2$.

Returns F_D is the luminance of a displayed linear component $R_D, G_D, or B_D$, in cd/m^2.

Return type numeric or 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], [InternationalTUnion16]

Examples

```
>>> ootf_BT2100_HLG(0.1)  # doctest: +ELLIPSIS
63.0957344...
```

colour.models.ootf_reverse_BT2100_HLG

colour.models.**ootf_reverse_BT2100_HLG**(*F_D*, *L_B=0*, *L_W=1000*, *gamma=None*)

Defines *Recommendation ITU-R BT.2100 Reference HLG* reverse opto-optical transfer function (OOTF / OOCF).

Parameters

- **F_D** (numeric or array_like) – F_D is the luminance of a displayed linear component $R_D, G_D, or B_D$, in cd/m^2.
- **L_B** (numeric, optional) – L_B is the display luminance for black in cd/m^2.
- **L_W** (numeric, optional) – L_W is nominal peak luminance of the display in cd/m^2 for achromatic pixels.
- **gamma** (numeric, optional) – System gamma value, 1.2 at the nominal display peak luminance of $1000cd/m^2$.

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 numeric or 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], [InternationalTUnion16]

Examples

```
>>> ootf_reverse_BT2100_HLG(63.095734448019336)  # doctest: +ELLIPSIS
0.1000000...
```

colour.models.ootf_BT2100_PQ

`colour.models.`**`ootf_BT2100_PQ`**(E)

Defines *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** (numeric or array_like) – $E = R_S, G_S, B_S; Y_S; or I_S$ 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; or I_D).

Return type numeric or 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], [InternationalTUnion16]

Examples

```
>>> ootf_BT2100_PQ(0.1)  # doctest: +ELLIPSIS
779.9883608...
```

colour.models.ootf_reverse_BT2100_PQ

colour.models.**ootf_reverse_BT2100_PQ**(*F_D*)

Defines *Recommendation ITU-R BT.2100 Reference PQ* reverse opto-optical transfer function (OOTF / OOCF).

Parameters **F_D** (numeric or array_like) – 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 numeric or 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], [InternationalTUnion16]

Examples

```
>>> ootf_reverse_BT2100_PQ(779.988360834115840)  # doctest: +ELLIPSIS
0.1000000...
```

Log Encoding and Decoding Curves

colour

log_encoding_curve(value[, curve])	Encodes linear-light values to $R'G'B'$ video component signal value using given *log* curve.
LOG_ENCODING_CURVES	Supported *log* encoding curves.
log_decoding_curve(value[, curve])	Decodes $R'G'B'$ video component signal value to linear-light values using given *log* curve.
LOG_DECODING_CURVES	Supported *log* decoding curves.

colour.log_encoding_curve

colour.**log_encoding_curve**(*value*, *curve='Cineon'*, ***kwargs*)

Encodes linear-light values to $R'G'B'$ video component signal value using given *log* curve.

Parameters

- **value** (numeric or array_like) – Value.
- **curve** (unicode, optional) – **{'ACEScc', 'ACEScct', 'ACESproxy', 'ALEXA Log C', 'Canon Log 2', 'Canon Log 3', 'Canon Log', 'Cineon', 'D-Log', 'ERIMM RGB', 'Filmic Pro 6', 'Log3G10', 'Log3G12', 'Panalog', 'PLog', 'Protune', 'REDLog', 'REDLogFilm', 'S-Log', 'S-Log2', 'S-Log3', 'T-Log', 'V-Log', 'ViperLog'}**, Computation curve.

Other Parameters

- **EI** (*int, optional*) – {colour.models.log_encoding_ALEXALogC()}, Ei.
- **E_clip** (*numeric, optional*) – {colour.models.log_encoding_ERIMMRGB()}, Maximum exposure limit.
- **E_min** (*numeric, optional*) – {colour.models.log_encoding_ERIMMRGB()}, Minimum exposure limit.
- **I_max** (*numeric, optional*) – {colour.models.log_encoding_ERIMMRGB()}, Maximum code value: 255, 4095 and 650535 for respectively 8-bit, 12-bit and 16-bit per channel.
- **bit_depth** (*unicode, optional*) – {colour.models.log_encoding_ACESproxy(), colour.models.log_encoding_SLog(), colour.models.log_encoding_SLog2()}, **{8, 10, 12}**, Bit depth used for conversion, *ACESproxy* uses **{10, 12}**.
- **black_offset** (*numeric or array_like*) – {colour.models.log_encoding_Cineon(), colour.models.log_encoding_Panalog(), colour.models.log_encoding_REDLog(), colour.models.log_encoding_REDLogFilm()}, Black offset.
- **density_per_code_value** (*numeric or array_like*) – {colour.models.log_encoding_PivotedLog()}, Density per code value.
- **firmware** (*unicode, optional*) – {colour.models.log_encoding_ALEXALogC()}, **{'SUP 3.x', 'SUP 2.x'}**, Alexa firmware version.
- **in_reflection** (*bool, optional*) – {colour.models.log_encoding_SLog(), colour.models.log_encoding_SLog2()}, Whether the light level x to a camera is reflection.
- **linear_reference** (*numeric or array_like*) – {colour.models.log_encoding_PivotedLog()}, Linear reference.
- **log_reference** (*numeric or array_like*) – {colour.models.log_encoding_PivotedLog()}, Log reference.
- **out_legal** (*bool, optional*) – {colour.models.log_encoding_SLog(), colour.models.log_encoding_SLog2(), colour.models.log_encoding_SLog3()}, Whether the non-linear *Sony S-Log*, *Sony S-Log2* or *Sony S-Log3* data y is encoded in legal range.
- **negative_gamma** (*numeric or array_like*) – {colour.models.log_encoding_PivotedLog()}, Negative gamma.
- **method** (*unicode, optional*) – {colour.models.log_encoding_ALEXALogC()}, **{'Linear Scene Exposure Factor', 'Normalised Sensor Signal'}**, Conversion method.

Returns *Log* value.

Return type numeric or ndarray

Examples

```
>>> log_encoding_curve(0.18)  # doctest: +ELLIPSIS
0.4573196...
>>> log_encoding_curve(0.18, curve='ACEScc')  # doctest: +ELLIPSIS
0.4135884...
>>> log_encoding_curve(0.18, curve='PLog', log_reference=400)
... # doctest: +ELLIPSIS
0.3910068...
>>> log_encoding_curve(0.18, curve='S-Log')  # doctest: +ELLIPSIS
0.3849708...
```

colour.LOG_ENCODING_CURVES

colour.**LOG_ENCODING_CURVES = CaseInsensitiveMapping({'ACEScc': ..., 'ACEScct': ..., 'ACESproxy': ..., 'ALE**

Supported *log* encoding curves.

LOG_ENCODING_CURVES [CaseInsensitiveMapping] **{'ACEScc', 'ACEScct', 'ACESproxy', 'ALEXA Log C', 'Canon Log 2', 'Canon Log 3', 'Canon Log', 'Cineon', 'D-Log', 'ERIMM RGB', 'Filmic Pro 6', 'Log3G10', 'Log3G12', 'Panalog', 'PLog', 'Protune', 'REDLog', 'REDLogFilm', 'S-Log', 'S-Log2', 'S-Log3', 'T-Log', 'V-Log', 'ViperLog'}**

colour.log_decoding_curve

colour.**log_decoding_curve**(*value*, *curve='Cineon'*, ***kwargs*)

Decodes $R'G'B'$ video component signal value to linear-light values using given *log* curve.

Parameters

- **value** (numeric or array_like) – Value.
- **curve** (unicode, optional) – **{'ACEScc', 'ACEScct', 'ACESproxy', 'ALEXA Log C', 'Canon Log 2', 'Canon Log 3', 'Canon Log', 'Cineon', 'D-Log', 'ERIMM RGB', 'Filmic Pro 6', 'Log3G10', 'Log3G12', 'Panalog', 'PLog', 'Protune', 'REDLog', 'REDLogFilm', 'S-Log', 'S-Log2', 'S-Log3', 'T-Log', 'V-Log', 'ViperLog'}**, Computation curve.

Other Parameters

- **EI** (*int, optional*) – {colour.models.log_decoding_ALEXALogC()}, Ei.
- **E_clip** (*numeric, optional*) – {colour.models.log_decoding_ERIMMRGB()}, Maximum exposure limit.
- **E_min** (*numeric, optional*) – {colour.models.log_decoding_ERIMMRGB()}, Minimum exposure limit.
- **I_max** (*numeric, optional*) – {colour.models.log_decoding_ERIMMRGB()}, Maximum code value: 255, 4095 and 650535 for respectively 8-bit, 12-bit and 16-bit per channel.
- **bit_depth** (*int, optional*) – {colour.models.log_decoding_ACESproxy(), colour.models.log_decoding_SLog(), colour.models.log_decoding_SLog2()}, **{8, 10, 12}**, Bit depth used for conversion, *ACESproxy* uses **{10, 12}**.

- **black_offset** (*numeric or array_like*) – {colour.models.log_decoding_Cineon(), colour.models.log_decoding_Panalog(), colour.models.log_decoding_REDLog(), colour.models.log_decoding_REDLogFilm()}, Black offset.
- **density_per_code_value** (*numeric or array_like*) – {colour.models.log_decoding_PivotedLog()}, Density per code value.
- **firmware** (*unicode, optional*) – {colour.models.log_decoding_ALEXALogC()}, **{'SUP 3.x', 'SUP 2.x'}**, Alexa firmware version.
- **in_legal** (*bool, optional*) – {colour.models.log_decoding_SLog(), colour.models.log_decoding_SLog2(), colour.models.log_decoding_SLog3()}, Whether the non-linear *Sony S-Log*, *Sony S-Log2* or *Sony S-Log3* data y is encoded in legal range.
- **linear_reference** (*numeric or array_like*) – {colour.models.log_decoding_PivotedLog()}, Linear reference.
- **log_reference** (*numeric or array_like*) – {colour.models.log_decoding_PivotedLog()}, Log reference.
- **negative_gamma** (*numeric or array_like*) – {colour.models.log_decoding_PivotedLog()}, Negative gamma.
- **out_reflection** (*bool, optional*) – {colour.models.log_decoding_SLog(), colour.models.log_decoding_SLog2()}, Whether the light level x to a camera is reflection.
- **method** (*unicode, optional*) – {colour.models.log_decoding_ALEXALogC()}, **{'Linear Scene Exposure Factor', 'Normalised Sensor Signal'}**, Conversion method.

Returns *Log* value.

Return type numeric or ndarray

Examples

```
>>> log_decoding_curve(0.457319613085418)  # doctest: +ELLIPSIS
0.1...
>>> log_decoding_curve(0.413588402492442, curve='ACEScc')
... # doctest: +ELLIPSIS
0.1...
>>> log_decoding_curve(0.391006842619746, curve='PLog', log_reference=400)
... # doctest: +ELLIPSIS
0.1...
>>> log_decoding_curve(0.376512722254600, curve='S-Log')
... # doctest: +ELLIPSIS
0.1...
```

colour.LOG_DECODING_CURVES

colour.**LOG_DECODING_CURVES = CaseInsensitiveMapping({'ACEScc': ..., 'ACEScct': ..., 'ACESproxy': ..., 'ALEX**

Supported *log* decoding curves.

LOG_DECODING_CURVES [CaseInsensitiveMapping] **{'ACEScc', 'ACEScct', 'ACESproxy', 'ALEXA Log C', 'Canon Log 2', 'Canon Log 3', 'Canon Log', 'Cineon', 'D-Log', 'ERIMM RGB', 'Filmic Pro 6', 'Log3G10', 'Log3G12', 'Panalog', 'PLog', 'Protune', 'REDLog', 'REDLogFilm', 'S-Log', 'S-Log2', 'S-Log3', 'T-Log', 'V-Log', 'ViperLog'}**

colour.models

log_encoding_ACEScc(lin_AP1)	Defines the *ACEScc* colourspace log encoding / opto-electronic transfer function.
log_decoding_ACEScc(ACEScc)	Defines the *ACEScc* colourspace log decoding / electro-optical transfer function.
log_encoding_ACEScct(lin_AP1[, constants])	Defines the *ACEScct* colourspace log encoding / opto-electronic transfer function.
log_decoding_ACEScct(ACEScct[, constants])	Defines the *ACEScct* colourspace log decoding / electro-optical transfer function.
log_encoding_ACESproxy(lin_AP1[, bit_depth, ...])	Defines the *ACESproxy* colourspace log encoding curve / opto-electronic transfer function.
log_decoding_ACESproxy(ACESproxy[, ...])	Defines the *ACESproxy* colourspace log decoding curve / electro-optical transfer function.
log_encoding_ALEXALogC(x[, firmware, method, EI])	Defines the *ALEXA Log C* log encoding curve / opto-electronic transfer function.
log_decoding_ALEXALogC(t[, firmware, method, EI])	Defines the *ALEXA Log C* log decoding curve / electro-optical transfer function.
log_encoding_CanonLog2(x[, bit_depth, ...])	Defines the *Canon Log 2* log encoding curve / opto-electronic transfer function.
log_decoding_CanonLog2(clog2[, bit_depth, ...])	Defines the *Canon Log 2* log decoding curve / electro-optical transfer function.
log_encoding_CanonLog3(x[, bit_depth, ...])	Defines the *Canon Log 3* log encoding curve / opto-electronic transfer function.
log_decoding_CanonLog3(clog3[, bit_depth, ...])	Defines the *Canon Log 3* log decoding curve / electro-optical transfer function.
log_encoding_CanonLog(x[, bit_depth, ...])	Defines the *Canon Log* log encoding curve / opto-electronic transfer function.
log_decoding_CanonLog(clog[, bit_depth, ...])	Defines the *Canon Log* log decoding curve / electro-optical transfer function.
log_encoding_Cineon(x[, black_offset])	Defines the *Cineon* log encoding curve / opto-electronic transfer function.
log_decoding_Cineon(y[, black_offset])	Defines the *Cineon* log decoding curve / electro-optical transfer function.
log_encoding_ERIMMRGB(X[, bit_depth, ...])	Defines the *ERIMM RGB* log encoding curve / opto-electronic transfer function (OETF / OECF).
log_decoding_ERIMMRGB(X_p[, bit_depth, ...])	Defines the *ERIMM RGB* log decoding curve / electro-optical transfer function (EOTF / EOCF).
log_encoding_Log3G10(x[, legacy_curve])	Defines the *Log3G10* log encoding curve / opto-electronic transfer function.
log_decoding_Log3G10(y[, legacy_curve])	Defines the *Log3G10* log decoding curve / electro-optical transfer function.
log_encoding_Log3G12(x)	Defines the *Log3G12* log encoding curve / opto-electronic transfer function.
log_decoding_Log3G12(y)	Defines the *Log3G12* log decoding curve / electro-optical transfer function.
log_encoding_Panalog(x[, black_offset])	Defines the *Panalog* log encoding curve / opto-electronic transfer function.
log_decoding_Panalog(y[, black_offset])	Defines the *Panalog* log decoding curve / electro-optical transfer function.
log_encoding_PivotedLog(x[, log_reference, ...])	Defines the *Josh Pines* style *Pivoted Log* log encoding curve / opto-electronic transfer function.

Continued on next page

Table 215 – continued from previous page

log_decoding_PivotedLog(y[, log_reference, ...])	Defines the *Josh Pines* style *Pivoted Log* log decoding curve / electro-optical transfer function.
log_encoding_Protune(x)	Defines the *Protune* log encoding curve / opto-electronic transfer function.
log_decoding_Protune(y)	Defines the *Protune* log decoding curve / electro-optical transfer function.
log_encoding_REDLog(x[, black_offset])	Defines the *REDLog* log encoding curve / opto-electronic transfer function.
log_decoding_REDLog(y[, black_offset])	Defines the *REDLog* log decoding curve / electro-optical transfer function.
log_encoding_REDLogFilm(x[, black_offset])	Defines the *REDLogFilm* log encoding curve / opto-electronic transfer function.
log_decoding_REDLogFilm(y[, black_offset])	Defines the *REDLogFilm* log decoding curve / electro-optical transfer function.
log_encoding_SLog(x[, bit_depth, out_legal, ...])	Defines the *Sony S-Log* log encoding curve / opto-electronic transfer function.
log_decoding_SLog(y[, bit_depth, in_legal, ...])	Defines the *Sony S-Log* log decoding curve / electro-optical transfer function.
log_encoding_SLog2(x[, bit_depth, ...])	Defines the *Sony S-Log2* log encoding curve / opto-electronic transfer function.
log_decoding_SLog2(y[, bit_depth, in_legal, ...])	Defines the *Sony S-Log2* log decoding curve / electro-optical transfer function.
log_encoding_SLog3(x[, bit_depth, ...])	Defines the *Sony S-Log3* log encoding curve / opto-electronic transfer function.
log_decoding_SLog3(y[, bit_depth, in_legal, ...])	Defines the *Sony S-Log3* log decoding curve / electro-optical transfer function.
log_encoding_VLog(L_in[, bit_depth, ...])	Defines the *Panasonic V-Log* log encoding curve / opto-electronic transfer function.
log_decoding_VLog(V_out[, bit_depth, ...])	Defines the *Panasonic V-Log* log decoding curve / electro-optical transfer function.
log_encoding_ViperLog(x)	Defines the *Viper Log* log encoding curve / opto-electronic transfer function.
log_decoding_ViperLog(y)	Defines the *Viper Log* log decoding curve / electro-optical transfer function.

colour.models.log_encoding_ACEScc

colour.models.**log_encoding_ACEScc**(*lin_AP1*)

Defines the *ACEScc* colourspace log encoding / opto-electronic transfer function.

Parameters **lin_AP1** (numeric or array_like) – *lin_AP1* value.

Returns *ACEScc* non-linear value.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
lin_AP1	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
ACEScc	[0, 1]	[0, 1]

References

[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14c],
[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14d],
[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14b],
[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee]

Examples

```
>>> log_encoding_ACEScc(0.18)  # doctest: +ELLIPSIS
0.4135884...
```

colour.models.log_decoding_ACEScc

colour.models.**log_decoding_ACEScc**(*ACEScc*)

Defines the *ACEScc* colourspace log decoding / electro-optical transfer function.

Parameters **ACEScc** (numeric or array_like) – *ACEScc* non-linear value.

Returns *lin_AP1* value.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
ACEScc	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
lin_AP1	[0, 1]	[0, 1]

References

[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14c],
[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14d],
[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14b],
[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee]

Examples

```
>>> log_decoding_ACEScc(0.413588402492442)  # doctest: +ELLIPSIS
0.1799999...
```

colour.models.log_encoding_ACEScct

`colour.models.log_encoding_ACEScct(lin_AP1, constants={'A': 10.5402377416545, 'B': 0.0729055341958355, 'X_BRK': 0.0078125, 'Y_BRK': 0.155251141552511})`

Defines the *ACEScct* colourspace log encoding / opto-electronic transfer function.

Parameters

- **lin_AP1** (numeric or array_like) – *lin_AP1* value.
- **constants** (Structure, optional) – *ACEScct* constants.

Returns *ACEScct* non-linear value.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
lin_AP1	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
ACEScct	[0, 1]	[0, 1]

References

[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14c], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14d], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESProject16], [TheAoMPAaSciencesScienceaTCouncilAcademyC

Examples

```
>>> log_encoding_ACEScct(0.18)  # doctest: +ELLIPSIS
0.4135884...
```

colour.models.log_decoding_ACEScct

`colour.models.log_decoding_ACEScct(ACEScct, constants={'A': 10.5402377416545, 'B': 0.0729055341958355, 'X_BRK': 0.0078125, 'Y_BRK': 0.155251141552511})`

Defines the *ACEScct* colourspace log decoding / electro-optical transfer function.

Parameters

- **ACEScct** (numeric or array_like) – *ACEScct* non-linear value.
- **constants** (Structure, optional) – *ACEScct* constants.

Returns *lin_AP1* value.

Return type numeric or ndarray

References

[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14c], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14d], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESProject16], [TheAoMPAaSciencesScienceaTCouncilAcademyC

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)  # doctest: +ELLIPSIS
0.1799999...
```

colour.models.log_encoding_ACESproxy

colour.models.**log_encoding_ACESproxy**(*lin_AP1*, *bit_depth=10*, *out_int=False*, *constants={10: {'CV_max': 940, 'CV_min': 64, 'mid_CV_offset': 425, 'mid_log_offset': 2.5, 'steps_per_stop': 50}, 12: {'CV_max': 3760, 'CV_min': 256, 'mid_CV_offset': 1700, 'mid_log_offset': 2.5, 'steps_per_stop': 200}}*)

Defines the *ACESproxy* colourspace log encoding curve / opto-electronic transfer function.

Parameters

- **lin_AP1** (numeric or array_like) – *lin_AP1* value.
- **bit_depth** (int, optional) – **{10, 12}**, *ACESproxy* bit depth.
- **out_int** (bool, optional) – Whether to return value as integer code value or float equivalent of a code value at a given bit depth.
- **constants** (Structure, optional) – *ACESproxy* constants.

Returns *ACESproxy* non-linear value.

Return type numeric or 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

[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14c],
[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14d],
[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14a],
[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee]

Examples

```
>>> log_encoding_ACESproxy(0.18)  # doctest: +ELLIPSIS
0.4164222...
>>> log_encoding_ACESproxy(0.18, out_int=True)
426
```

colour.models.log_decoding_ACESproxy

`colour.models.log_decoding_ACESproxy(ACESproxy, bit_depth=10, in_int=False, constants={10: {'CV_max': 940, 'CV_min': 64, 'mid_CV_offset': 425, 'mid_log_offset': 2.5, 'steps_per_stop': 50}, 12: {'CV_max': 3760, 'CV_min': 256, 'mid_CV_offset': 1700, 'mid_log_offset': 2.5, 'steps_per_stop': 200}})`

Defines the *ACESproxy* colourspace log decoding curve / electro-optical transfer function.

Parameters

- **ACESproxy** (numeric or array_like) – *ACESproxy* non-linear value.
- **bit_depth** (int, optional) – **{10, 12}**, *ACESproxy* bit depth.
- **in_int** (bool, optional) – Whether to treat the input value as integer code value or float equivalent of a code value at a given bit depth.
- **constants** (Structure, optional) – *ACESproxy* constants.

Returns *lin_AP1* value.

Return type numeric or 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

[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14c],
[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14d],
[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14a],
[TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee]

Examples

```
>>> log_decoding_ACESproxy(0.416422287390029)  # doctest: +ELLIPSIS
0.1...
>>> log_decoding_ACESproxy(426, in_int=True)  # doctest: +ELLIPSIS
0.1...
```

colour.models.log_encoding_ALEXALogC

`colour.models.`**`log_encoding_ALEXALogC`**(*x*, *firmware='SUP 3.x'*, *method='Linear Scene Exposure Factor'*, *EI=800*)

Defines the *ALEXA Log C* log encoding curve / opto-electronic transfer function.

Parameters

- **x** (numeric or array_like) – Linear data x.
- **firmware** (unicode, optional) – **{'SUP 3.x', 'SUP 2.x'}**, Alexa firmware version.
- **method** (unicode, optional) – **{'Linear Scene Exposure Factor', 'Normalised Sensor Signal'}**, Conversion method.
- **EI** (int, optional) – Ei.

Returns *ALEXA Log C* encoded data t.

Return type numeric or ndarray

References

[ARR12]

Notes

Domain	Scale - Reference	Scale - 1
x	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
t	[0, 1]	[0, 1]

Examples

```
>>> log_encoding_ALEXALogC(0.18)  # doctest: +ELLIPSIS
0.3910068...
```

colour.models.log_decoding_ALEXALogC

colour.models.**log_decoding_ALEXALogC**(*t*, *firmware='SUP 3.x'*, *method='Linear Scene Exposure Factor'*, *EI=800*)

Defines the *ALEXA Log C* log decoding curve / electro-optical transfer function.

Parameters

- **t** (numeric or array_like) – *ALEXA Log C* encoded data t.
- **firmware** (unicode, optional) – **{'SUP 3.x', 'SUP 2.x'}**, Alexa firmware version.
- **method** (unicode, optional) – **{'Linear Scene Exposure Factor', 'Normalised Sensor Signal'}**, Conversion method.
- **EI** (int, optional) – Ei.

Returns Linear data x.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
t	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
x	[0, 1]	[0, 1]

References

[ARR12]

Examples

```
>>> log_decoding_ALEXALogC(0.391006832034084)  # doctest: +ELLIPSIS
0.18...
```

colour.models.log_encoding_CanonLog2

colour.models.**log_encoding_CanonLog2**(*x*, *bit_depth=10*, *out_legal=True*, *in_reflection=True*)

Defines the *Canon Log 2* log encoding curve / opto-electronic transfer function.

Parameters

- **x** (numeric or array_like) – Linear data x.
- **bit_depth** (int, optional) – Bit depth used for conversion.
- **out_legal** (bool, optional) – Whether the *Canon Log 2* non-linear data is encoded in legal range.
- **in_reflection** (bool, optional) – Whether the light level x to a camera is reflection.

Returns *Canon Log 2* non-linear data.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
x	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
clog2	[0, 1]	[0, 1]

References

[Can16]

Examples

```
>>> log_encoding_CanonLog2(0.18) * 100  # doctest: +ELLIPSIS
39.8254694...
```

colour.models.log_decoding_CanonLog2

`colour.models.`**`log_decoding_CanonLog2`**(*clog2*, *bit_depth=10*, *in_legal=True*, *out_reflection=True*)

Defines the *Canon Log 2* log decoding curve / electro-optical transfer function.

Parameters

- **clog2** (numeric or array_like) – *Canon Log 2* non-linear data.
- **bit_depth** (int, optional) – Bit depth used for conversion.
- **in_legal** (bool, optional) – Whether the *Canon Log 2* non-linear data is encoded in legal range.
- **out_reflection** (bool, optional) – Whether the light level x to a camera is reflection.

Returns Linear data x.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
clog2	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
x	[0, 1]	[0, 1]

References

[Can16]

Examples

```
>>> log_decoding_CanonLog2(39.825469498316735 / 100)  # doctest: +ELLIPSIS
0.1799999...
```

colour.models.log_encoding_CanonLog3

`colour.models.log_encoding_CanonLog3`(*x*, *bit_depth=10*, *out_legal=True*, *in_reflection=True*)

Defines the *Canon Log 3* log encoding curve / opto-electronic transfer function.

Parameters

- **x** (numeric or array_like) – Linear data x.
- **bit_depth** (int, optional) – Bit depth used for conversion.
- **out_legal** (bool, optional) – Whether the *Canon Log 3* non-linear data is encoded in legal range.
- **in_reflection** (bool, optional) – Whether the light level x to a camera is reflection.

Returns *Canon Log 3* non-linear data.

Return type numeric or 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 later 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
```

Notes

Domain	Scale - Reference	Scale - 1
x	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
clog3	[0, 1]	[0, 1]

References

[Can16]

Examples

```
>>> log_encoding_CanonLog3(0.18) * 100  # doctest: +ELLIPSIS
34.3389369...
```

colour.models.log_decoding_CanonLog3

`colour.models.log_decoding_CanonLog3(clog3, bit_depth=10, in_legal=True, out_reflection=True)`

Defines the *Canon Log 3* log decoding curve / electro-optical transfer function.

Parameters

- **clog3** (numeric or array_like) – *Canon Log 3* non-linear data.
- **bit_depth** (int, optional) – Bit depth used for conversion.
- **in_legal** (bool, optional) – Whether the *Canon Log 3* non-linear data is encoded in legal range.
- **out_reflection** (bool, optional) – Whether the light level x to a camera is reflection.

Returns Linear data x.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
clog3	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
x	[0, 1]	[0, 1]

References

[Can16]

Examples

```
>>> log_decoding_CanonLog3(34.338936938868677 / 100)  # doctest: +ELLIPSIS
0.1800000...
```

colour.models.log_encoding_CanonLog

`colour.models.log_encoding_CanonLog(x, bit_depth=10, out_legal=True, in_reflection=True)`

Defines the *Canon Log* log encoding curve / opto-electronic transfer function.

Parameters

- **x** (numeric or array_like) – Linear data x.
- **bit_depth** (int, optional) – Bit depth used for conversion.
- **out_legal** (bool, optional) – Whether the *Canon Log* non-linear data is encoded in legal range.
- **in_reflection** (bool, optional) – Whether the light level x to a camera is reflection.

Returns *Canon Log* non-linear data.

Return type numeric or 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  # doctest: +ELLIPSIS
34.3389651...
```

colour.models.log_decoding_CanonLog

`colour.models.log_decoding_CanonLog(clog, bit_depth=10, in_legal=True, out_reflection=True)`

Defines the *Canon Log* log decoding curve / electro-optical transfer function.

Parameters

- **clog** (numeric or array_like) – *Canon Log* non-linear data.
- **bit_depth** (int, optional) – Bit depth used for conversion.
- **in_legal** (bool, optional) – Whether the *Canon Log* non-linear data is encoded in legal range.
- **out_reflection** (bool, optional) – Whether the light level x to a camera is reflection.

Returns Linear data x.

Return type numeric or 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)  # doctest: +ELLIPSIS
0.17999999...
```

colour.models.log_encoding_Cineon

`colour.models.`**`log_encoding_Cineon`**(*x*, *black_offset=0.0107977516232771*)

Defines the *Cineon* log encoding curve / opto-electronic transfer function.

Parameters

- **x** (numeric or array_like) – Linear data x.
- **black_offset** (numeric or array_like) – Black offset.

Returns Non-linear data y.

Return type numeric or 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)  # doctest: +ELLIPSIS
0.4573196...
```

colour.models.log_decoding_Cineon

`colour.models.log_decoding_Cineon`(*y*, *black_offset=0.0107977516232771*)

Defines the *Cineon* log decoding curve / electro-optical transfer function.

Parameters

- **y** (numeric or array_like) – Non-linear data y.
- **black_offset** (numeric or array_like) – Black offset.

Returns Linear data x.

Return type numeric or 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)  # doctest: +ELLIPSIS
0.1799999...
```

colour.models.log_encoding_ERIMMRGB

`colour.models.log_encoding_ERIMMRGB`(*X*, *bit_depth=8*, *out_int=False*, *E_min=0.001*, *E_clip=316.2*)

Defines the *ERIMM RGB* log encoding curve / opto-electronic transfer function (OETF / OECF).

Parameters

- **X** (numeric or array_like) – Linear data X_{ERIMM}.
- **bit_depth** (int, optional) – Bit depth used for conversion.
- **out_int** (bool, optional) – Whether to return value as integer code value or float equivalent of a code value at a given bit depth.

- **E_min** (numeric, optional) – Minimum exposure limit.
- **E_clip** (numeric, optional) – Maximum exposure limit.

Returns Non-linear data X'_{ERIMM}.

Return type numeric or 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)  # doctest: +ELLIPSIS
0.4100523...
>>> log_encoding_ERIMMRGB(0.18, out_int=True)
105
```

colour.models.log_decoding_ERIMMRGB

colour.models.**log_decoding_ERIMMRGB**(*X_p*, *bit_depth=8*, *in_int=False*, *E_min=0.001*, *E_clip=316.2*)

Defines the *ERIMM RGB* log decoding curve / electro-optical transfer function (EOTF / EOCF).

Parameters

- **X_p** (numeric or array_like) – Non-linear data X'_{ERIMM}.
- **bit_depth** (int, optional) – Bit depth used for conversion.
- **in_int** (bool, optional) – Whether to treat the input value as integer code value or float equivalent of a code value at a given bit depth.
- **E_min** (numeric, optional) – Minimum exposure limit.
- **E_clip** (numeric, optional) – Maximum exposure limit.

Returns Linear data X_{ERIMM}.

Return type numeric or 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) # doctest: +ELLIPSIS
0.1...
>>> log_decoding_ERIMMRGB(105, in_int=True) # doctest: +ELLIPSIS
0.1...
```

colour.models.log_encoding_Log3G10

`colour.models.log_encoding_Log3G10`(*x*, *legacy_curve=False*)

Defines the *Log3G10* log encoding curve / opto-electronic transfer function.

Parameters

- **x** (numeric or array_like) – Linear data x.
- **legacy_curve** (bool, optional) – Whether to use the v1 *Log3G10* log encoding curve. Default is *False*.

Returns Non-linear data y.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
x	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
y	[0, 1]	[0, 1]

- The v1 *Log3G10* 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 v2 *Log3G10* log encoding curve in the release version of the *RED SDK*. Use the *legacy_curve=True* argument to switch to the v1 curve for compatibility with the current (as of September 21, 2016) *RED SDK*.
- The intent of the v1 *Log3G10* 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]

Examples

```
>>> log_encoding_Log3G10(0.18, legacy_curve=True)  # doctest: +ELLIPSIS
0.3333336...
>>> log_encoding_Log3G10(0.0)  # doctest: +ELLIPSIS
0.0915514...
```

colour.models.log_decoding_Log3G10

`colour.models.`**`log_decoding_Log3G10`**(*y*, *legacy_curve=False*)

Defines the *Log3G10* log decoding curve / electro-optical transfer function.

Parameters

- **y** (numeric or array_like) – Non-linear data y.
- **legacy_curve** (bool, optional) – Whether to use the v1 *Log3G10* log encoding curve. Default is *False*.

Returns Linear data x.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
y	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
x	[0, 1]	[0, 1]

References

[Nat16]

Examples

```
>>> log_decoding_Log3G10(1.0 / 3, legacy_curve=True)  # doctest: +ELLIPSIS
0.1799994...
>>> log_decoding_Log3G10(1.0)  # doctest: +ELLIPSIS
184.3223476...
```

colour.models.log_encoding_Log3G12

`colour.models.`**`log_encoding_Log3G12`**(x)

Defines the *Log3G12* log encoding curve / opto-electronic transfer function.

Parameters **x** (`numeric or array_like`) – Linear data x.

Returns Non-linear data y.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
x	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
y	[0, 1]	[0, 1]

References

[Nat16]

Examples

```
>>> log_encoding_Log3G12(0.18)  # doctest: +ELLIPSIS
0.3333326...
```

colour.models.log_decoding_Log3G12

`colour.models.`**`log_decoding_Log3G12`**(*y*)

Defines the *Log3G12* log decoding curve / electro-optical transfer function.

Parameters **y** (`numeric or array_like`) – Non-linear data y.

Returns Linear data x.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
y	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
x	[0, 1]	[0, 1]

References

[Nat16]

Examples

```
>>> log_decoding_Log3G12(1.0 / 3)  # doctest: +ELLIPSIS
0.1800015...
```

colour.models.log_encoding_Panalog

`colour.models.`**`log_encoding_Panalog`**(*x*, *black_offset=0.04077184461038074*)

Defines the *Panalog* log encoding curve / opto-electronic transfer function.

Parameters

- **x** (`numeric or array_like`) – Linear data x.
- **black_offset** (`numeric or array_like`) – Black offset.

Returns Non-linear data y.

Return type numeric or 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)  # doctest: +ELLIPSIS
0.3745767...
```

colour.models.log_decoding_Panalog

`colour.models.`**`log_decoding_Panalog`**(*y*, *black_offset=0.04077184461038074*)

Defines the *Panalog* log decoding curve / electro-optical transfer function.

Parameters

- **y** (`numeric or array_like`) – Non-linear data y.
- **black_offset** (`numeric or array_like`) – Black offset.

Returns Linear data x.

Return type numeric or 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)  # doctest: +ELLIPSIS
0.1...
```

colour.models.log_encoding_PivotedLog

`colour.models.log_encoding_PivotedLog(x, log_reference=445, linear_reference=0.18, negative_gamma=0.6, density_per_code_value=0.002)`

Defines the *Josh Pines* style *Pivoted Log* log encoding curve / opto-electronic transfer function.

Parameters

- **x** (numeric or array_like) – Linear data x.
- **log_reference** (numeric or array_like) – Log reference.
- **linear_reference** (numeric or array_like) – Linear reference.
- **negative_gamma** (numeric or array_like) – Negative gamma.
- **density_per_code_value** (numeric or array_like) – Density per code value.

Returns Non-linear data y.

Return type numeric or 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)  # doctest: +ELLIPSIS
0.4349951...
```

colour.models.log_decoding_PivotedLog

`colour.models.log_decoding_PivotedLog(y, log_reference=445, linear_reference=0.18, negative_gamma=0.6, density_per_code_value=0.002)`

Defines the *Josh Pines* style *Pivoted Log* log decoding curve / electro-optical transfer function.

Parameters

- **y** (numeric or array_like) – Non-linear data y.
- **log_reference** (numeric or array_like) – Log reference.
- **linear_reference** (numeric or array_like) – Linear reference.
- **negative_gamma** (numeric or array_like) – Negative gamma.
- **density_per_code_value** (numeric or array_like) – Density per code value.

Returns Linear data x.

Return type numeric or 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_PivotedLog(0.434995112414467)  # doctest: +ELLIPSIS
0.1...
```

colour.models.log_encoding_Protune

colour.models.**log_encoding_Protune**(x)

Defines the *Protune* log encoding curve / opto-electronic transfer function.

Parameters **x** (numeric or array_like) – Linear data x.

Returns Non-linear data y.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
x	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
y	[0, 1]	[0, 1]

References

[GDM16]

Examples

```
>>> log_encoding_Protune(0.18)  # doctest: +ELLIPSIS
0.6456234...
```

colour.models.log_decoding_Protune

colour.models.**log_decoding_Protune**(y)

Defines the *Protune* log decoding curve / electro-optical transfer function.

Parameters **y** (numeric or array_like) – Non-linear data y.

Returns Linear data x.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
y	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
x	[0, 1]	[0, 1]

References

[GDM16]

Examples

```
>>> log_decoding_Protune(0.645623486803636)  # doctest: +ELLIPSIS
0.1...
```

colour.models.log_encoding_REDLog

colour.models.**log_encoding_REDLog**(x, *black_offset=0.009955040995908344*)

Defines the *REDLog* log encoding curve / opto-electronic transfer function.

Parameters

- **x** (numeric or array_like) – Linear data x.
- **black_offset** (numeric or array_like) – Black offset.

Returns Non-linear data y.

Return type numeric or 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)  # doctest: +ELLIPSIS
0.6376218...
```

colour.models.log_decoding_REDLog

`colour.models.`**`log_decoding_REDLog`**(*y*, *black_offset=0.009955040995908344*)

Defines the *REDLog* log decoding curve / electro-optical transfer function.

Parameters

- **y** (`numeric or array_like`) – Non-linear data y.
- **black_offset** (`numeric or array_like`) – Black offset.

Returns Linear data x.

Return type numeric or 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)  # doctest: +ELLIPSIS
0.1...
```

colour.models.log_encoding_REDLogFilm

`colour.models.log_encoding_REDLogFilm`(*x*, *black_offset=0.0107977516232771*)

Defines the *REDLogFilm* log encoding curve / opto-electronic transfer function.

Parameters

- **x** (numeric or array_like) – Linear data x.
- **black_offset** (numeric or array_like) – Black offset.

Returns Non-linear data y.

Return type numeric or 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)  # doctest: +ELLIPSIS
0.4573196...
```

colour.models.log_decoding_REDLogFilm

`colour.models.log_decoding_REDLogFilm`(*y*, *black_offset=0.0107977516232771*)

Defines the *REDLogFilm* log decoding curve / electro-optical transfer function.

Parameters

- **y** (numeric or array_like) – Non-linear data y.
- **black_offset** (numeric or array_like) – Black offset.

Returns Linear data x.

Return type numeric or 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)  # doctest: +ELLIPSIS
0.1799999...
```

colour.models.log_encoding_SLog

`colour.models.log_encoding_SLog`(*x*, *bit_depth=10*, *out_legal=True*, *in_reflection=True*)

Defines the *Sony S-Log* log encoding curve / opto-electronic transfer function.

Parameters

- **x** (numeric or array_like) – Reflection or $IRE/100$ input light level x to a camera.
- **bit_depth** (int, optional) – Bit depth used for conversion.
- **out_legal** (bool, optional) – Whether the non-linear *Sony S-Log* data y is encoded in legal range.
- **in_reflection** (bool, optional) – Whether the light level x to a camera is reflection.

Returns Non-linear *Sony S-Log* data y.

Return type numeric or 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)  # doctest: +ELLIPSIS
0.3849708...
>>> log_encoding_SLog(0.18, out_legal=False)  # doctest: +ELLIPSIS
0.3765127...
>>> log_encoding_SLog(0.18, in_reflection=False)  # doctest: +ELLIPSIS
0.3708204...
```

colour.models.log_decoding_SLog

colour.models.**log_decoding_SLog**(*y*, *bit_depth=10*, *in_legal=True*, *out_reflection=True*)

Defines the *Sony S-Log* log decoding curve / electro-optical transfer function.

Parameters

- **y** (numeric or array_like) – Non-linear *Sony S-Log* data y.
- **bit_depth** (int, optional) – Bit depth used for conversion.
- **in_legal** (bool, optional) – Whether the non-linear *Sony S-Log* data y is encoded in legal range.
- **out_reflection** (bool, optional) – Whether the light level x to a camera is reflection.

Returns Reflection or $IRE/100$ input light level x to a camera.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
y	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
x	[0, 1]	[0, 1]

References

[SonyCorporation12]

Examples

```
>>> log_decoding_SLog(0.384970815928670)  # doctest: +ELLIPSIS
0.1...
>>> log_decoding_SLog(0.376512722254600, in_legal=False)
... # doctest: +ELLIPSIS
0.1...
>>> log_decoding_SLog(0.370820482371268, out_reflection=False)
... # doctest: +ELLIPSIS
0.1...
```

colour.models.log_encoding_SLog2

`colour.models.log_encoding_SLog2(x, bit_depth=10, out_legal=True, in_reflection=True)`

Defines the *Sony S-Log2* log encoding curve / opto-electronic transfer function.

Parameters

- **x** (numeric or array_like) – Reflection or $IRE/100$ input light level x to a camera.
- **bit_depth** (int, optional) – Bit depth used for conversion.
- **out_legal** (bool, optional) – Whether the non-linear *Sony S-Log2* data y is encoded in legal range.
- **in_reflection** (bool, optional) – Whether the light level x to a camera is reflection.

Returns Non-linear *Sony S-Log2* data y.

Return type numeric or 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)  # doctest: +ELLIPSIS
0.3395325...
>>> log_encoding_SLog2(0.18, out_legal=False)  # doctest: +ELLIPSIS
0.3234495...
>>> log_encoding_SLog2(0.18, in_reflection=False)  # doctest: +ELLIPSIS
0.3262865...
```

colour.models.log_decoding_SLog2

`colour.models.log_decoding_SLog2(y, bit_depth=10, in_legal=True, out_reflection=True)`

Defines the *Sony S-Log2* log decoding curve / electro-optical transfer function.

Parameters

- **y** (numeric or array_like) – Non-linear *Sony S-Log2* data y.
- **bit_depth** (int, optional) – Bit depth used for conversion.

- **in_legal** (bool, optional) – Whether the non-linear *Sony S-Log2* data y is encoded in legal range.
- **out_reflection** (bool, optional) – Whether the light level x to a camera is reflection.

Returns Reflection or $IRE/100$ input light level x to a camera.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
y	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
x	[0, 1]	[0, 1]

References

[SonyCorporation12]

Examples

```
>>> log_decoding_SLog2(0.339532524633774)  # doctest: +ELLIPSIS
0.1...
>>> log_decoding_SLog2(0.323449512215013, in_legal=False)
... # doctest: +ELLIPSIS
0.1...
>>> log_decoding_SLog2(0.326286538946799, out_reflection=False)
... # doctest: +ELLIPSIS
0.1...
```

colour.models.log_encoding_SLog3

colour.models.**log_encoding_SLog3**(*x*, *bit_depth=10*, *out_legal=True*, *in_reflection=True*)

Defines the *Sony S-Log3* log encoding curve / opto-electronic transfer function.

Parameters

- **x** (numeric or array_like) – Reflection or $IRE/100$ input light level x to a camera.
- **bit_depth** (int, optional) – Bit depth used for conversion.
- **out_legal** (bool, optional) – Whether the non-linear *Sony S-Log3* data y is encoded in legal range.
- **in_reflection** (bool, optional) – Whether the light level x to a camera is reflection.

Returns Non-linear *Sony S-Log3* data y.

Return type numeric or 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)  # doctest: +ELLIPSIS
0.4105571...
>>> log_encoding_SLog3(0.18, out_legal=False)  # doctest: +ELLIPSIS
0.4063926...
>>> log_encoding_SLog3(0.18, in_reflection=False)  # doctest: +ELLIPSIS
0.3995079...
```

colour.models.log_decoding_SLog3

`colour.models.`**`log_decoding_SLog3`**(*y*, *bit_depth=10*, *in_legal=True*, *out_reflection=True*)

Defines the *Sony S-Log3* log decoding curve / electro-optical transfer function.

Parameters

- **y** (numeric or array_like) – Non-linear *Sony S-Log3* data y.
- **bit_depth** (int, optional) – Bit depth used for conversion.
- **in_legal** (bool, optional) – Whether the non-linear *Sony S-Log3* data y is encoded in legal range.
- **out_reflection** (bool, optional) – Whether the light level x to a camera is reflection.

Returns Reflection or $IRE/100$ input light level x to a camera.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
y	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
x	[0, 1]	[0, 1]

References

[SonyCorporationc]

Examples

```
>>> log_decoding_SLog3(0.410557184750733)  # doctest: +ELLIPSIS
0.1...
>>> log_decoding_SLog3(0.406392694063927, in_legal=False)
... # doctest: +ELLIPSIS
0.1...
>>> log_decoding_SLog3(0.399507939606216, out_reflection=False)
... # doctest: +ELLIPSIS
0.1...
```

colour.models.log_encoding_VLog

`colour.models.log_encoding_VLog(L_in, bit_depth=10, out_legal=True, in_reflection=True, constants={'b': 0.00873, 'c': 0.241514, 'cut1': 0.01, 'cut2': 0.181, 'd': 0.598206})`

Defines the *Panasonic V-Log* log encoding curve / opto-electronic transfer function.

Parameters

- **L_in** (numeric or array_like) – Linear reflection data :math‘L_{in}‘.
- **bit_depth** (int, optional) – Bit depth used for conversion.
- **out_legal** (bool, optional) – Whether the non-linear *Panasonic V-Log* data V_{out} is encoded in legal range.
- **in_reflection** (bool, optional) – Whether the light level :math‘L_{in}‘ to a camera is reflection.
- **constants** (Structure, optional) – *Panasonic V-Log* constants.

Returns Non-linear data V_{out}.

Return type numeric or 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

[Pan14]

Examples

```
>>> log_encoding_VLog(0.18)  # doctest: +ELLIPSIS
0.4233114...
```

colour.models.log_decoding_VLog

`colour.models.log_decoding_VLog(V_out, bit_depth=10, in_legal=True, out_reflection=True, constants={'b': 0.00873, 'c': 0.241514, 'cut1': 0.01, 'cut2': 0.181, 'd': 0.598206})`

Defines the *Panasonic V-Log* log decoding curve / electro-optical transfer function.

Parameters

- **V_out** (numeric or array_like) – Non-linear data V_{out}.
- **bit_depth** (int, optional) – Bit depth used for conversion.
- **in_legal** (bool, optional) – Whether the non-linear *Panasonic V-Log* data V_{out} is encoded in legal range.
- **out_reflection** (bool, optional) – Whether the light level :math‘L_{in}‘ to a camera is reflection.
- **constants** (Structure, optional) – *Panasonic V-Log* constants.

Returns Linear reflection data :math‘L_{in}‘.

Return type numeric or 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

[Pan14]

Examples

```
>>> log_decoding_VLog(0.423311448760136)  # doctest: +ELLIPSIS
0.1799999...
```

colour.models.log_encoding_ViperLog

`colour.models.log_encoding_ViperLog(x)`

Defines the *Viper Log* log encoding curve / opto-electronic transfer function.

Parameters **x** (numeric or array_like) – Linear data x.

Returns Non-linear data y.

Return type numeric or 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)  # doctest: +ELLIPSIS
0.6360080...
```

colour.models.log_decoding_ViperLog

`colour.models.log_decoding_ViperLog(y)`

Defines the *Viper Log* log decoding curve / electro-optical transfer function.

Parameters **y** (numeric or array_like) – Non-linear data y.

Returns Linear data x.

Return type numeric or 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_ViperLog(0.636008067010413)  # doctest: +ELLIPSIS
0.1799999...
```

ACES Spectral Conversion

colour

sd_to_aces_relative_exposure_values(sd[, ...])	Converts given spectral distribution to *ACES2065-1* colourspace relative exposure values.

colour.sd_to_aces_relative_exposure_values

colour.**sd_to_aces_relative_exposure_values**(*sd*, *illuminant=SpectralDistribution(name='D65', ...)*, *apply_chromatic_adaptation=False*, *chromatic_adaptation_transform='CAT02'*)

Converts given spectral distribution to *ACES2065-1* colourspace relative exposure values.

Parameters

- **sd** (SpectralDistribution) – Spectral distribution.
- **illuminant** (SpectralDistribution, optional) – *Illuminant* spectral distribution.
- **apply_chromatic_adaptation** (bool, optional) – Whether to apply chromatic adaptation using given transform.
- **chromatic_adaptation_transform** (unicode, optional) – **{'CAT02', 'XYZ Scaling', 'Von Kries', 'Bradford', 'Sharp', 'Fairchild', 'CMCCAT97', 'CMCCAT2000', 'CAT02_BRILL_CAT', 'Bianco', 'Bianco PC'}**, *Chromatic adaptation* transform.

Returns *ACES2065-1* colourspace relative exposure values array.

Return type ndarray, (3,)

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], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14c], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee14d], [TheAoMPAaSciencesScienceaTCouncilAcademyCESACESPSubcommittee]

Examples

```
>>> from colour import COLOURCHECKERS_SDS
>>> sd = COLOURCHECKERS_SDS['ColorChecker N Ohta']['dark skin']
>>> sd_to_aces_relative_exposure_values(sd)  # doctest: +ELLIPSIS
array([ 0.1171785...,  0.0866347...,  0.0589707...])
>>> sd_to_aces_relative_exposure_values(sd,
...     apply_chromatic_adaptation=True)  # doctest: +ELLIPSIS
array([ 0.1180766...,  0.0869023...,  0.0589104...])
```

Ancillary Objects

colour.models

ACES_RICD	Implements support for the *CIE RGB* colour matching functions.

colour.models.ACES_RICD

colour.models.**ACES_RICD = RGB_ColourMatchingFunctions(name='ACES RICD', ...)**

Implements support for the *CIE RGB* colour matching functions.

Parameters

- **data** (Series or Dataframe or Signal or MultiSignal or MultiSpectralDistribution or array_like or dict_like, optional) – Data to be stored in the multi-spectral distribution.
- **domain** (array_like, optional) – 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 attribute.
- **labels** (array_like, optional) – Names to use for the colour.SpectralDistribution class instances.

Other Parameters

- **name** (*unicode, optional*) – Multi-spectral distribution name.
- **interpolator** (*object, optional*) – Interpolator class type to use as interpolating function for the colour.SpectralDistribution class instances.
- **interpolator_args** (*dict_like, optional*) – Arguments to use when instantiating the interpolating function of the colour.SpectralDistribution class instances.
- **extrapolator** (*object, optional*) – Extrapolator class type to use as extrapolating function for the colour.SpectralDistribution class instances.
- **extrapolator_args** (*dict_like, optional*) – Arguments to use when instantiating the extrapolating function of the colour.SpectralDistribution class instances.

- **strict_labels** (*array_like, optional*) – Multi-spectral distribution labels for figures, default to `colour.colorimetry.RGB_ColourMatchingFunctions.labels` attribute value.

Colour Encodings

Y'CbCr Colour Encoding

`colour`

`RGB_to_YCbCr`(RGB[, K, in_bits, in_legal, ...])	Converts an array of *R'G'B'* values to the corresponding *Y'CbCr* colour encoding values array.
`YCbCr_to_RGB`(YCbCr[, K, in_bits, in_legal, ...])	Converts an array of *Y'CbCr* colour encoding values to the corresponding *R'G'B'* values array.
`YCBCR_WEIGHTS`	Implements a case-insensitive mutable mapping / *dict* object.
`RGB_to_YcCbcCrc`(RGB[, out_bits, out_legal, ...])	Converts an array of *RGB* linear values to the corresponding *Yc'Cbc'Crc'* colour encoding values array.
`YcCbcCrc_to_RGB`(YcCbcCrc[, in_bits, ...])	Converts an array of *Yc'Cbc'Crc'* colour encoding values to the corresponding *RGB* array of linear values.

colour.RGB_to_YCbCr

`colour.`**`RGB_to_YCbCr`**(*RGB, K=array([0.2126, 0.0722]), in_bits=10, in_legal=False, in_int=False, out_bits=8, out_legal=True, out_int=False, **kwargs*)

Converts an array of *R'G'B'* values to the corresponding *Y'CbCr* colour encoding values array.

Parameters

- **RGB** (`array_like`) – Input *R'G'B'* array of floats or integer values.
- **K** (`array_like, optional`) – Luma weighting coefficients of red and blue. See `colour.YCBCR_WEIGHTS` for presets. Default is *(0.2126, 0.0722)*, the weightings for *ITU-R BT.709*.
- **in_bits** (`int, optional`) – 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, optional`) – Whether to treat the input values as legal range. Default is *False*.
- **in_int** (`bool, optional`) – Whether to treat the input values as `in_bits` integer code values. Default is *False*.
- **out_bits** (`int, optional`) – 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, optional`) – Whether to return legal range values. Default is *True*.
- **out_int** (`bool, optional`) – Whether to return values as `out_bits` integer code values. Default is *False*.

Other Parameters

- **in_range** (*array_like, optional*) – 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_like, optional*) – 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.YCbCr_ranges()` definition.

Returns *Y’CbCr* colour encoding array of integer or float values.

Return type 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_YcCbcCrc()` 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 *Y’CbCr* 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], [Wik04e]

Examples

```
>>> RGB = np.array([1.0, 1.0, 1.0])
>>> RGB_to_YCbCr(RGB)  # doctest: +ELLIPSIS
array([ 0.9215686...,  0.5019607...,  0.5019607...])
```

Matching 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))
... # doctest: +ELLIPSIS
array([ 0.9215686...,  0.5       ,  0.5       ])
```

Matching float output of The Foundry Nuke's Colorspace node set to YPbPr:

```
>>> RGB_to_YCbCr(RGB, out_legal=False, out_int=False)
... # doctest: +ELLIPSIS
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 ITU-T T.871 [InternationalTUnion11c]:

```
>>> RGB = np.array([102, 0, 51])
>>> RGB_to_YCbCr(RGB, K=YCBCR_WEIGHTS['ITU-R BT.601'], in_range=(0, 255),
...               out_range=(0, 255, 0, 256), out_int=True)
array([ 36, 136, 175])
```

Note the use of 256 for the max *Cb / Cr* value, 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.

These JFIF JPEG ranges are also obtained as follows:

```
>>> RGB_to_YCbCr(RGB, K=YCBCR_WEIGHTS['ITU-R BT.601'], in_bits=8,
...               in_int=True, out_legal=False, out_int=True)
array([ 36, 136, 175])
```

colour.YCbCr_to_RGB

`colour.`**`YCbCr_to_RGB`**(*YCbCr, K=array([0.2126, 0.0722]), in_bits=8, in_legal=True, in_int=False, out_bits=10, out_legal=False, out_int=False, **kwargs*)

Converts an array of *Y'CbCr* colour encoding values to the corresponding *R'G'B'* values array.

Parameters

- **YCbCr** (array_like) – Input *Y'CbCr* colour encoding array of integer or float values.
- **K** (array_like, optional) – Luma weighting coefficients of red and blue. See colour.YCBCR_WEIGHTS for presets. Default is *(0.2126, 0.0722)*, the weightings for *ITU-R BT.709*.
- **in_bits** (int, optional) – 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, optional) – Whether to treat the input values as legal range. Default is *False*.
- **in_int** (bool, optional) – Whether to treat the input values as in_bits integer code values. Default is *False*.

- **out_bits** (int, optional) – 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, optional) – Whether to return legal range values. Default is *True*.
- **out_int** (bool, optional) – Whether to return values as out_bits integer code values. Default is *False*.

Other Parameters

- **in_range** (*array_like, optional*) – 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.YCbCr_ranges() definition.
- **out_range** (*array_like, optional*) – 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.

Returns *R'G'B'* array of integer or float values.

Return type 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.YcCbcCrc_to_RGB() definition should be used for the constant luminance case as per [InternationalTUnion15a].

References

[InternationalTUnion11c], [InternationalTUnion15b], [SocietyoMPaTEngineers99], [Wik04e]

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.YCBCR_WEIGHTS

colour.**YCBCR_WEIGHTS = CaseInsensitiveMapping({'ITU-R BT.601': ..., 'ITU-R BT.709': ..., 'ITU-R BT.2020': .**

Implements a case-insensitive mutable mapping / *dict* object.

Allows values retrieving from keys while ignoring the key case. The keys are expected to be unicode or string-like objects supporting the `str.lower()` method.

Parameters **data** (`dict`) – *dict* of data to store into the mapping at initialisation.

Other Parameters ****kwargs** (*dict, optional*) – Key / Value pairs to store into the mapping at initialisation.

colour.**__setitem__**()

colour.**__getitem__**()

colour.**__delitem__**()

colour.**__contains__**()

colour.**__iter__**()

colour.**__len__**()

colour.**__eq__**()

colour.**__ne__**()

colour.**__repr__**()

colour.**copy**()

colour.**lower_items**()

> **Warning:** The keys are expected to be unicode or string-like objects.

References

[Rei]

Examples

```
>>> methods = CaseInsensitiveMapping({'McCamy': 1, 'Hernandez': 2})
>>> methods['mccamy']
1
```

colour.RGB_to_YcCbcCrc

colour.**RGB_to_YcCbcCrc**(*RGB, out_bits=10, out_legal=True, out_int=False, is_12_bits_system=False, **kwargs*)

Converts an array of *RGB* linear values to the corresponding *Yc'Cbc'Crc'* colour encoding values array.

Parameters

- **RGB** (`array_like`) – Input *RGB* array of linear float values.

- **out_bits** (int, optional) – 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, optional) – Whether to return legal range values. Default is *True*.
- **out_int** (bool, optional) – Whether to return values as out_bits integer code values. Default is *False*.
- **is_12_bits_system** (bool, optional) – *Recommendation ITU-R BT.2020* OETF (OECF) adopts different parameters for 10 and 12 bit systems. Default is *False*.

Other Parameters **out_range** (*array_like, optional*) – 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.YCbCr_ranges() definition.

Returns *Yc'Cbc'Crc'* colour encoding array of integer or float values.

Return type ndarray

Notes

Domain *	Scale - Reference	Scale - 1
RGB	[0, 1]	[0, 1]

Range *	Scale - Reference	Scale - 1
YcCbcCrc	[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], [Wik04e]

Examples

```
>>> RGB = np.array([0.18, 0.18, 0.18])
>>> RGB_to_YcCbcCrc(RGB, out_legal=True, out_bits=10, out_int=True,
...                 is_12_bits_system=False)
array([422, 512, 512])
```

colour.YcCbcCrc_to_RGB

`colour.YcCbcCrc_to_RGB(YcCbcCrc, in_bits=10, in_legal=True, in_int=False, is_12_bits_system=False, **kwargs)`

Converts an array of *Yc'Cbc'Crc'* colour encoding values to the corresponding *RGB* array of linear values.

Parameters

- **YcCbcCrc** (array_like) – Input *Yc'Cbc'Crc'* colour encoding array of linear float values.
- **in_bits** (int, optional) – 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, optional) – Whether to treat the input values as legal range. Default is *False*.
- **in_int** (bool, optional) – Whether to treat the input values as in_bits integer code values. Default is *False*.
- **is_12_bits_system** (bool, optional) – *Recommendation ITU-R BT.2020* EOTF (EOCF) adopts different parameters for 10 and 12 bit systems. Default is *False*.

Other Parameters **in_range** (*array_like, optional*) – 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.YCbCr_ranges() definition.

Returns *RGB* array of linear float values.

Return type ndarray

Notes

Domain *	Scale - Reference	Scale - 1
YcCbcCrc	[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], [Wik04e]

Examples

```
>>> YcCbcCrc = np.array([1689, 2048, 2048])
>>> YcCbcCrc_to_RGB(YcCbcCrc, in_legal=True, in_bits=12, in_int=True,
...                 is_12_bits_system=True)
... # doctest: +ELLIPSIS
array([ 0.1800903...,  0.1800903...,  0.1800903...])
```

Ancillary Objects

colour

full_to_legal(CV[, bit_depth, in_int, out_int])	Converts 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).
legal_to_full(CV[, bit_depth, in_int, out_int])	Converts 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).
CV_range([bit_depth, is_legal, is_int])	Returns the code value CV range for given bit depth, range legality and representation.

colour.full_to_legal

colour.**full_to_legal**(*CV*, *bit_depth=10*, *in_int=False*, *out_int=False*)

Converts 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** (array_like) – Full range code value CV or float equivalent of a code value at a given bit depth.
- **bit_depth** (int, optional) – Bit depth used for conversion.
- **in_int** (bool, optional) – 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, optional) – 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 ndarray

Examples

```
>>> full_to_legal(0.0)  # doctest: +ELLIPSIS
0.0625610...
>>> full_to_legal(1.0)  # doctest: +ELLIPSIS
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)  # doctest: +ELLIPSIS
```

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```
0.0625610...
>>> full_to_legal(1023, in_int=True)  # doctest: +ELLIPSIS
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*, *bit_depth=10*, *in_int=False*, *out_int=False*)

Converts 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** (array_like) – Legal range code value CV or float equivalent of a code value at a given bit depth.
- **bit_depth** (int, optional) – Bit depth used for conversion.
- **in_int** (bool, optional) – 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, optional) – 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 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
>>> 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=10*, *is_legal=False*, *is_int=False*)

Returns the code value CV range for given bit depth, range legality and representation.

Parameters

- **bit_depth** (int, optional) – Bit depth of the code value CV range.
- **is_legal** (bool, optional) – Whether the code value CV range is legal.
- **is_int** (bool, optional) – Whether the code value CV range represents integer code values.

Returns Code value CV range.

Return type ndarray

Examples

```
>>> CV_range(8, True, True)
array([ 16, 235])
>>> CV_range(8, True, False)  # doctest: +ELLIPSIS
array([ 0.0627451...,  0.9215686...])
>>> CV_range(10, False, False)
array([ 0.,  1.])
```

YCoCg Colour Encoding

colour

RGB_to_YCoCg(RGB)	Converts an array of *R'G'B'* values to the corresponding *YCoCg* colour encoding values array.
YCoCg_to_RGB(YCoCg)	Converts an array of *YCoCg* colour encoding values to the corresponding *R'G'B'* values array.

colour.RGB_to_YCoCg

colour.**RGB_to_YCoCg**(*RGB*)

Converts an array of *R'G'B'* values to the corresponding *YCoCg* colour encoding values array.

Parameters **RGB** (array_like) – Input *R'G'B'* array.

Returns *YCoCg* colour encoding array.

Return type 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)`

Converts an array of *YCoCg* colour encoding values to the corresponding *R'G'B'* values array.

Parameters **YCoCg** (array_like) – *YCoCg* colour encoding array.

Returns Output *R'G'B'* array.

Return type 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

RGB_to_ICTCP(RGB[, L_p])	Converts from *ITU-R BT.2020* colourspace to IC_TC_P colour encoding.
ICTCP_to_RGB(ICTCP[, L_p])	Converts from IC_TC_P colour encoding to *ITU-R BT.2020* colourspace.

colour.RGB_to_ICTCP

`colour.RGB_to_ICTCP(RGB, L_p=10000)`

Converts from *ITU-R BT.2020* colourspace to IC_TC_P colour encoding.

Parameters

- **RGB** (array_like) – *ITU-R BT.2020* colourspace array.
- **L_p** (numeric, optional) – Display peak luminance cd/m^2 for *SMPTE ST 2084:2014* non-linear encoding.

Returns IC_TC_P colour encoding array.

Return type ndarray

Notes

Domain	Scale - Reference	Scale - 1
RGB	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
ICTCP	I : [0, 1] CT : [-1, 1] CP : [-1, 1]	I : [0, 1] CT : [-1, 1] CP : [-1, 1]

References

[Dol16], [LPY+16]

Examples

```
>>> RGB = np.array([0.45620519, 0.03081071, 0.04091952])
>>> RGB_to_ICTCP(RGB)  # doctest: +ELLIPSIS
array([ 0.0735136...,  0.0047525...,  0.0935159...])
```

colour.ICTCP_to_RGB

colour.**ICTCP_to_RGB**(*ICTCP*, *L_p=10000*)

Converts from IC_TC_P colour encoding to *ITU-R BT.2020* colourspace.

Parameters

- **ICTCP** (array_like) – IC_TC_P colour encoding array.
- **L_p** (numeric, optional) – Display peak luminance cd/m^2 for *SMPTE ST 2084:2014* non-linear encoding.

Returns *ITU-R BT.2020* colourspace array.

Return type ndarray

Notes

Domain	Scale - Reference	Scale - 1
ICTCP	I : [0, 1] CT : [-1, 1] CP : [-1, 1]	I : [0, 1] CT : [-1, 1] CP : [-1, 1]

Range	Scale - Reference	Scale - 1
RGB	[0, 1]	[0, 1]

References

[Dol16], [LPY+16]

Examples

```
>>> ICTCP = np.array([0.07351364, 0.00475253, 0.09351596])
>>> ICTCP_to_RGB(ICTCP)  # doctest: +ELLIPSIS
array([ 0.4562052...,  0.0308107...,  0.0409195...])
```

RGB Representations

Prismatic Colourspace

colour

RGB_to_Prismatic(RGB)	Converts from *RGB* colourspace to *Prismatic* $L\rho\gamma\beta$ colourspace array.
Prismatic_to_RGB(Lrgb)	Converts from *Prismatic* $L\rho\gamma\beta$ colourspace array to *RGB* colourspace.

colour.RGB_to_Prismatic

colour.**RGB_to_Prismatic**(*RGB*)

Converts from *RGB* colourspace to *Prismatic* $L\rho\gamma\beta$ colourspace array.

Parameters **RGB** (array_like) – *RGB* colourspace array.

Returns *Prismatic* $L\rho\gamma\beta$ colourspace array.

Return type 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)  # doctest: +ELLIPSIS
array([ 0.75...   ,  0.1666666...,  0.3333333...,  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*)

Converts from *Prismatic* $L\rho\gamma\beta$ colourspace array to *RGB* colourspace.

Parameters **Lrgb** (array_like) – *Prismatic* $L\rho\gamma\beta$ colourspace array.

Returns *RGB* colourspace array.

Return type 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)  # doctest: +ELLIPSIS
array([ 0.25...   ,  0.4999999...,  0.75...  ])
```

HSV Colourspace

colour

RGB_to_HSV(RGB)	Converts from *RGB* colourspace to *HSV* colourspace.
HSV_to_RGB(HSV)	Converts from *HSV* colourspace to *RGB* colourspace.

colour.RGB_to_HSV

`colour.`**`RGB_to_HSV`**(*RGB*)

Converts from *RGB* colourspace to *HSV* colourspace.

Parameters **RGB** (array_like) – *RGB* colourspace array.

Returns *HSV* array.

Return type ndarray

Notes

Domain	Scale - Reference	Scale - 1
RGB	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
HSV	[0, 1]	[0, 1]

References

[Eash], [Smi78], [Wik03a]

Examples

```
>>> RGB = np.array([0.45620519, 0.03081071, 0.04091952])
>>> RGB_to_HSV(RGB)  # doctest: +ELLIPSIS
array([ 0.9960394...,  0.9324630...,  0.4562051...])
```

colour.HSV_to_RGB

colour.**HSV_to_RGB**(*HSV*)

Converts from *HSV* colourspace to *RGB* colourspace.

Parameters **HSV** (array_like) – *HSV* colourspace array.

Returns *RGB* colourspace array.

Return type ndarray

Notes

Domain	Scale - Reference	Scale - 1
HSV	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
RGB	[0, 1]	[0, 1]

References

[Ease], [Smi78], [Wik03a]

Examples

```
>>> HSV = np.array([0.99603944, 0.93246304, 0.45620519])
>>> HSV_to_RGB(HSV)  # doctest: +ELLIPSIS
array([ 0.4562051...,  0.0308107...,  0.0409195...])
```

HSL Colourspace

colour

RGB_to_HSL(RGB)	Converts from *RGB* colourspace to *HSL* colourspace.
HSL_to_RGB(HSL)	Converts from *HSL* colourspace to *RGB* colourspace.

colour.RGB_to_HSL

colour.**RGB_to_HSL**(*RGB*)

Converts from *RGB* colourspace to *HSL* colourspace.

Parameters **RGB** (array_like) – *RGB* colourspace array.

Returns *HSL* array.

Return type ndarray

Notes

Domain	Scale - Reference	Scale - 1
RGB	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
HSL	[0, 1]	[0, 1]

References

[Easg], [Smi78], [Wik03a]

Examples

```
>>> RGB = np.array([0.45620519, 0.03081071, 0.04091952])
>>> RGB_to_HSL(RGB)  # doctest: +ELLIPSIS
array([ 0.9960394...,  0.8734714...,  0.2435079...])
```

colour.HSL_to_RGB

colour.**HSL_to_RGB**(*HSL*)

Converts from *HSL* colourspace to *RGB* colourspace.

Parameters **HSL** (array_like) – *HSL* colourspace array.

Returns *RGB* colourspace array.

Return type ndarray

Notes

Domain	Scale - Reference	Scale - 1
HSL	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
RGB	[0, 1]	[0, 1]

References

[Easd], [Smi78], [Wik03a]

Examples

```
>>> HSL = np.array([0.99603944, 0.87347144, 0.24350795])
>>> HSL_to_RGB(HSL)  # doctest: +ELLIPSIS
array([ 0.4562051...,  0.0308107...,  0.0409195...])
```

CMY Colourspace

colour

RGB_to_CMY(RGB)	Converts from *RGB* colourspace to *CMY* colourspace.
CMY_to_RGB(CMY)	Converts from *CMY* colourspace to *CMY* colourspace.
CMY_to_CMYK(CMY)	Converts from *CMY* colourspace to *CMYK* colourspace.
CMYK_to_CMY(CMYK)	Converts from *CMYK* colourspace to *CMY* colourspace.

colour.RGB_to_CMY

colour.**RGB_to_CMY**(*RGB*)

Converts from *RGB* colourspace to *CMY* colourspace.

Parameters **RGB** (array_like) – *RGB* colourspace array.

Returns *CMY* array.

Return type ndarray

Notes

Domain	Scale - Reference	Scale - 1
RGB	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
CMY	[0, 1]	[0, 1]

References

[Easf]

Examples

```
>>> RGB = np.array([0.45620519, 0.03081071, 0.04091952])
>>> RGB_to_CMY(RGB)  # doctest: +ELLIPSIS
array([ 0.5437948...,  0.9691892...,  0.9590804...])
```

colour.CMY_to_RGB

`colour.`**`CMY_to_RGB`**(*CMY*)

Converts from *CMY* colourspace to *CMY* colourspace.

Parameters **CMY** (array_like) – *CMY* colourspace array.

Returns *RGB* colourspace array.

Return type ndarray

Notes

Domain	Scale - Reference	Scale - 1
CMY	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
RGB	[0, 1]	[0, 1]

References

[Easb]

Examples

```
>>> CMY = np.array([0.54379481, 0.96918929, 0.95908048])
>>> CMY_to_RGB(CMY)  # doctest: +ELLIPSIS
array([ 0.4562051...,  0.0308107...,  0.0409195...])
```

colour.CMY_to_CMYK

`colour.`**`CMY_to_CMYK`**(*CMY*)

Converts from *CMY* colourspace to *CMYK* colourspace.

Parameters **CMY** (array_like) – *CMY* colourspace array.

Returns *CMYK* array.

Return type ndarray

Notes

Domain	Scale - Reference	Scale - 1
CMY	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
CMYK	[0, 1]	[0, 1]

References

[Easa]

Examples

```
>>> CMY = np.array([0.54379481, 0.96918929, 0.95908048])
>>> CMY_to_CMYK(CMY)  # doctest: +ELLIPSIS
array([ 0.        ,  0.9324630...,  0.9103045...,  0.5437948...])
```

colour.CMYK_to_CMY

`colour.`**`CMYK_to_CMY`**(*CMYK*)

Converts from *CMYK* colourspace to *CMY* colourspace.

Parameters **CMYK** (array_like) – *CMYK* colourspace array.

Returns *CMY* array.

Return type ndarray

Notes

Domain	Scale - Reference	Scale - 1
CMYK	[0, 1]	[0, 1]

Range	Scale - Reference	Scale - 1
CMY	[0, 1]	[0, 1]

References

[Easc]

Examples

```
>>> CMYK = np.array([0.50000000, 0.00000000, 0.74400000, 0.01960784])
>>> CMYK_to_CMY(CMYK)  # doctest: +ELLIPSIS
array([ 0.5098039...,  0.0196078...,  0.7490196...])
```

Pointer's Gamut

colour

POINTER_GAMUT_BOUNDARIES
POINTER_GAMUT_DATA
POINTER_GAMUT_ILLUMINANT

colour.POINTER_GAMUT_BOUNDARIES

colour.**POINTER_GAMUT_BOUNDARIES = array([[0.659, 0.316], [0.634, 0.351], [0.594, 0.391], [0.557, 0.427],**

colour.POINTER_GAMUT_DATA

colour.**POINTER_GAMUT_DATA = array([[15, 10, 0], [15, 15, 10], [15, 14, 20], ..., [90, 9, 330], [90, 4, 3**

colour.POINTER_GAMUT_ILLUMINANT

colour.**POINTER_GAMUT_ILLUMINANT = array([0.31005673, 0.3161457])**

Colour Notation Systems

- *Munsell Renotation System*

- *Munsell Value*
  - *Priest, Gibson and MacNicholas (1920)*
  - *Munsell, Sloan and Godlove (1933)*
  - *Moon and Spencer (1943)*
  - *Saunderson and Milner (1944)*
  - *Ladd and Pinney (1955)*
  - *McCamy (1987)*
  - *ASTM D1535-08e1*
- *Hexadecimal Triplet Notation*

Munsell Renotation System

`colour`

`munsell_colour_to_xyY`(munsell_colour)	Converts given *Munsell* colour to *CIE xyY* colourspace.
`xyY_to_munsell_colour`(xyY[, hue_decimals, . . .])	Converts from *CIE xyY* colourspace to *Munsell* colour.

colour.munsell_colour_to_xyY

`colour.`**`munsell_colour_to_xyY`**(*munsell_colour*)

Converts given *Munsell* colour to *CIE xyY* colourspace.

Parameters **`munsell_colour`** (`unicode`) – *Munsell* colour.

Returns *CIE xyY* colourspace array.

Return type ndarray, (3,)

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')  # doctest: +ELLIPSIS
array([ 0.3873694...,  0.3575165...,  0.59362   ])
```

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```
>>> munsell_colour_to_xyY('N8.9')  # doctest: +ELLIPSIS
array([ 0.31006  ,  0.31616  ,  0.7461345...])
```

colour.xyY_to_munsell_colour

`colour.`**`xyY_to_munsell_colour`**(*xyY*, *hue_decimals=1*, *value_decimals=1*, *chroma_decimals=1*)

Converts from *CIE xyY* colourspace to *Munsell* colour.

Parameters

- **xyY** (array_like, (3,)) – *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 unicode

Notes

Domain	Scale - Reference	Scale - 1
xyY	[0, 1]	[0, 1]

References

[Cen], [Cen12]

Examples

```
>>> xyY = np.array([0.38736945, 0.35751656, 0.59362000])
>>> # Doctests skip for Python 2.x compatibility.
>>> xyY_to_munsell_colour(xyY)  # doctest: +SKIP
'4.2YR 8.1/5.3'
```

Dataset

colour

MUNSELL_COLOURS	Aggregated *Munsell* colours.

colour.MUNSELL_COLOURS

`colour.`**`MUNSELL_COLOURS = CaseInsensitiveMapping({'Munsell Colours All': ..., 'Munsell Colours 1929': ..., '`**

Aggregated *Munsell* colours.

MUNSELL_COLOURS : CaseInsensitiveMapping

Aliases:

- 'all': 'Munsell Colours All'
- '1929': 'Munsell Colours 1929'
- 'real': 'Munsell Colours Real'

Munsell Value

colour

munsell_value(Y[, method])	Returns the *Munsell* value V of given *luminance* Y using given method.
MUNSELL_VALUE_METHODS	Supported *Munsell* value computations methods.

colour.munsell_value

colour.**munsell_value**(*Y*, *method='ASTM D1535-08'*)

Returns the *Munsell* value V of given *luminance* Y using given method.

Parameters

- **Y** (numeric or array_like) – *luminance* Y.
- **method** (unicode, optional) – **{'ASTM D1535-08', 'Priest 1920', 'Munsell 1933', 'Moon 1943', 'Saunderson 1944', 'Ladd 1955', 'McCamy 1987'}**, Computation method.

Returns *Munsell* value V.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
Y	[0, 100]	[0, 1]

Range	Scale - Reference	Scale - 1
V	[0, 10]	[0, 1]

References

[ASTMInternational89], [Wik07d]

Examples

```
>>> munsell_value(12.23634268)  # doctest: +ELLIPSIS
4.0824437...
>>> munsell_value(12.23634268, method='Priest 1920') # doctest: +ELLIPSIS
3.4980484...
>>> munsell_value(12.23634268, method='Munsell 1933') # doctest: +ELLIPSIS
```

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```
4.1627702...
>>> munsell_value(12.23634268, method='Moon 1943') # doctest: +ELLIPSIS
4.0688120...
>>> munsell_value(12.23634268, method='Saunderson 1944')
... # doctest: +ELLIPSIS
4.0444736...
>>> munsell_value(12.23634268, method='Ladd 1955') # doctest: +ELLIPSIS
4.0511633...
>>> munsell_value(12.23634268, method='McCamy 1987') # doctest: +ELLIPSIS
array(4.0814348...)
```

colour.MUNSELL_VALUE_METHODS

colour.**MUNSELL_VALUE_METHODS = CaseInsensitiveMapping({'Priest 1920': ..., 'Munsell 1933': ..., 'Moon 1943'**

Supported *Munsell* value computations methods.

References

[ASTMInternational89], [Wik07d]

MUNSELL_VALUE_METHODS [CaseInsensitiveMapping] **{'Priest 1920', 'Munsell 1933', 'Moon 1943', 'Saunderson 1944', 'Ladd 1955', 'McCamy 1987', 'ASTM D1535-08'}**

Aliases:

- 'astm2008': 'ASTM D1535-08'

Priest, Gibson and MacNicholas (1920)

colour.notation

munsell_value_Priest1920(Y)	Returns the *Munsell* value V of given *luminance* Y using *Priest et al.(1920)* method..

colour.notation.munsell_value_Priest1920

colour.notation.**munsell_value_Priest1920**(Y)

Returns the *Munsell* value V of given *luminance* Y using *Priest et al. (1920)* method.

Parameters **Y** (numeric or array_like) – *luminance* Y.

Returns *Munsell* value V.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
Y	[0, 100]	[0, 1]

Range	Scale - Reference	Scale - 1
V	[0, 10]	[0, 1]

References

[Wik07d]

Examples

```
>>> munsell_value_Priest1920(12.23634268)  # doctest: +ELLIPSIS
3.4980484...
```

Munsell, Sloan and Godlove (1933)

`colour.notation`

`munsell_value_Munsell1933`(Y)	Returns the *Munsell* value V of given *luminance* Y using *Munsell et al.(1933)* method..

colour.notation.munsell_value_Munsell1933

`colour.notation.`**`munsell_value_Munsell1933`**(Y)

Returns the *Munsell* value V of given *luminance* Y using *Munsell et al. (1933)* method.

Parameters **Y** (numeric or array_like) – *luminance* Y.

Returns *Munsell* value V.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
Y	[0, 100]	[0, 1]

Range	Scale - Reference	Scale - 1
V	[0, 10]	[0, 1]

References

[Wik07d]

Examples

```
>>> munsell_value_Munsell1933(12.23634268)  # doctest: +ELLIPSIS
4.1627702...
```

Moon and Spencer (1943)

colour.notation

munsell_value_Moon1943(Y)	Returns the *Munsell* value V of given *luminance* Y using *Moon and Spencer (1943)* method.

colour.notation.munsell_value_Moon1943

colour.notation.**munsell_value_Moon1943**(Y)

Returns the *Munsell* value V of given *luminance* Y using *Moon and Spencer (1943)* method.

Parameters **Y** (numeric or array_like) – *luminance* Y.

Returns *Munsell* value V.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
Y	[0, 100]	[0, 1]

Range	Scale - Reference	Scale - 1
V	[0, 10]	[0, 1]

References

[Wik07d]

Examples

```
>>> munsell_value_Moon1943(12.23634268)  # doctest: +ELLIPSIS
4.0688120...
```

Saunderson and Milner (1944)

colour.notation

munsell_value_Saunderson1944(Y)	Returns the *Munsell* value V of given *luminance* Y using *Saunderson and Milner (1944)* method.

colour.notation.munsell_value_Saunderson1944

colour.notation.**munsell_value_Saunderson1944**(Y)

Returns the *Munsell* value V of given *luminance* Y using *Saunderson and Milner (1944)* method.

Parameters **Y** (numeric) – *luminance* Y.

Returns *Munsell* value V.

Return type numeric

Notes

Domain	Scale - Reference	Scale - 1
Y	[0, 100]	[0, 1]

Range	Scale - Reference	Scale - 1
V	[0, 10]	[0, 1]

References

[Wik07d]

Examples

```
>>> munsell_value_Saunderson1944(12.23634268)  # doctest: +ELLIPSIS
4.0444736...
```

Ladd and Pinney (1955)

colour.notation

munsell_value_Ladd1955(Y)	Returns the *Munsell* value V of given *luminance* Y using *Ladd and Pinney (1955)* method.

colour.notation.munsell_value_Ladd1955

colour.notation.**munsell_value_Ladd1955**(Y)

Returns the *Munsell* value V of given *luminance* Y using *Ladd and Pinney (1955)* method.

Parameters **Y** (numeric or array_like) – *luminance* Y.

Returns *Munsell* value V.

Return type numeric or ndarray

Notes

Domain	Scale - Reference	Scale - 1
Y	[0, 100]	[0, 1]

Range	Scale - Reference	Scale - 1
V	[0, 10]	[0, 1]

References

[Wik07d]

Examples

```
>>> munsell_value_Ladd1955(12.23634268)  # doctest: +ELLIPSIS
4.0511633...
```

McCamy (1987)

`colour.notation`

`munsell_value_McCamy1987`(Y)	Returns the *Munsell* value V of given *luminance* Y using *McCamy (1987)* method.

colour.notation.munsell_value_McCamy1987

`colour.notation.`**`munsell_value_McCamy1987`**(Y)

Returns the *Munsell* value V of given *luminance* Y using *McCamy (1987)* method.

Parameters **Y** (numeric or array_like) – *luminance* Y.

Returns *Munsell* value V.

Return type numeric or 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)  # doctest: +ELLIPSIS
array(4.0814348...)
```

ASTM D1535-08e1

`colour.notation`

`munsell_value_ASTMD153508`(Y)	Returns the *Munsell* value V of given *luminance* Y using a reverse lookup table from *ASTM D1535-08e1* method.

colour.notation.munsell_value_ASTMD153508

`colour.notation.`**`munsell_value_ASTMD153508`**(Y)

Returns the *Munsell* value V of given *luminance* Y using a reverse lookup table from *ASTM D1535-08e1* method.

Parameters **Y** (numeric or array_like) – *luminance* Y

Returns *Munsell* value V.

Return type numeric or 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_ASTMD153508(12.23634268)  # doctest: +ELLIPSIS
4.0824437...
```

Hexadecimal Triplet Notation

colour.notation

RGB_to_HEX(RGB)	Converts from *RGB* colourspace to hexadecimal triplet representation.
HEX_to_RGB(HEX)	Converts from hexadecimal triplet representation to *RGB* colourspace.

colour.notation.RGB_to_HEX

colour.notation.**RGB_to_HEX**(*RGB*)

Converts from *RGB* colourspace to hexadecimal triplet representation.

Parameters **RGB** (array_like) – *RGB* colourspace array.

Returns Hexadecimal triplet representation.

Return type unicode

Notes

Domain	Scale - Reference	Scale - 1
RGB	[0, 1]	[0, 1]

Examples

```
>>> RGB = np.array([0.66666667, 0.86666667, 1.00000000])
>>> # Doctests skip for Python 2.x compatibility.
>>> RGB_to_HEX(RGB)  # doctest: +SKIP
'#aaddff'
```

colour.notation.HEX_to_RGB

colour.notation.**HEX_to_RGB**(*HEX*)

Converts from hexadecimal triplet representation to *RGB* colourspace.

Parameters **HEX** (unicode or array_like) – Hexadecimal triplet representation.

Returns *RGB* colourspace array.

Return type ndarray

Notes

Notes

Range	Scale - Reference	Scale - 1
RGB	[0, 1]	[0, 1]

Examples

```
>>> HEX = '#aaddff'
>>> HEX_to_RGB(HEX)  # doctest: +ELLIPSIS
array([ 0.6666666...,  0.8666666...,  1.        ])
```

Optical Phenomena

- *Rayleigh Scattering*

Rayleigh Scattering

colour

rayleigh_scattering(wavelength[, ...])	Returns the *Rayleigh* optical depth $T_r(\lambda)$ as function of wavelength λ in centimeters (cm).
sd_rayleigh_scattering([shape, ...])	Returns the *Rayleigh* spectral distribution for given spectral shape.
scattering_cross_section(wavelength[, ...])	Returns 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.

colour.rayleigh_scattering

colour.**rayleigh_scattering**(*wavelength*, *CO2_concentration=300*, *temperature=288.15*, *pressure=101325*, *latitude=0*, *altitude=0*, *avogadro_constant=6.02214179e+23*, *n_s=<function air_refraction_index_Bodhaine1999>*, *F_air=<function F_air_Bodhaine1999>*)

Returns the *Rayleigh* optical depth $T_r(\lambda)$ as function of wavelength λ in centimeters (cm).

Parameters

- **wavelength** (numeric or array_like) – Wavelength λ in centimeters (cm).
- **CO2_concentration** (numeric or array_like, optional) – CO_2 concentration in parts per million (ppm).

- **temperature** (numeric or array_like, optional) – Air temperature $T[K]$ in kelvin degrees.
- **pressure** (numeric or array_like) – Surface pressure P of the measurement site.
- **latitude** (numeric or array_like, optional) – Latitude of the site in degrees.
- **altitude** (numeric or array_like, optional) – Altitude of the site in meters.
- **avogadro_constant** (numeric or array_like, optional) – *Avogadro*'s number (molecules mol^{-1}).
- **n_s** (object) – Air refraction index n_s computation method.
- **F_air** (object) – $(6 + 3_p)/(6 - 7_p)$, the depolarisation term $F(air)$ or *King Factor* computation method.

Returns *Rayleigh* optical depth $T_r(\lambda)$.

Return type numeric or 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], [Wik01d]

Examples

```
>>> rayleigh_optical_depth(555 * 10e-8)  # doctest: +ELLIPSIS
0.1004070...
```

colour.sd_rayleigh_scattering

colour.**sd_rayleigh_scattering**(*shape=SpectralShape(360, 780, 1), CO2_concentration=300, temperature=288.15, pressure=101325, latitude=0, altitude=0, avogadro_constant=6.02214179e+23, n_s=<function air_refraction_index_Bodhaine1999>, F_air=<function F_air_Bodhaine1999>*)

Returns the *Rayleigh* spectral distribution for given spectral shape.

Parameters

- **shape** (SpectralShape, optional) – Spectral shape used to create the *Rayleigh* scattering spectral distribution.
- **CO2_concentration** (numeric or array_like, optional) – CO_2 concentration in parts per million (ppm).
- **temperature** (numeric or array_like, optional) – Air temperature $T[K]$ in kelvin degrees.
- **pressure** (numeric or array_like) – Surface pressure P of the measurement site.
- **latitude** (numeric or array_like, optional) – Latitude of the site in degrees.

- **altitude** (numeric or array_like, optional) – Altitude of the site in meters.
- **avogadro_constant** (numeric or array_like, optional) – *Avogadro*'s number (molecules mol^{-1}).
- **n_s** (object) – Air refraction index n_s computation method.
- **F_air** (object) – $(6 + 3_p)/(6 - 7_p)$, the depolarisation term $F(air)$ or *King Factor* computation method.

Returns *Rayleigh* optical depth spectral distribution.

Return type *SpectralDistribution*

References

[BWDS99], [Wik01d]

Examples

```
>>> from colour.utilities import numpy_print_options
>>> with numpy_print_options(suppress=True):
...     sd_rayleigh_scattering()  # doctest: +ELLIPSIS
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...],
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```

colour.scattering_cross_section

colour.**scattering_cross_section**(*wavelength*, *CO2_concentration=300*, *temperature=288.15*, *avogadro_constant=6.02214179e+23*, *n_s=<function air_refraction_index_Bodhaine1999>*, *F_air=<function F_air_Bodhaine1999>*)

Returns 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** (numeric or array_like) – Wavelength λ in centimeters (cm).
- **CO2_concentration** (numeric or array_like, optional) – CO_2 concentration in parts per million (ppm).
- **temperature** (numeric or array_like, optional) – Air temperature $T[K]$ in kelvin degrees.
- **avogadro_constant** (numeric or array_like, optional) – *Avogadro*'s number (molecules mol^{-1}).
- **n_s** (object) – Air refraction index n_s computation method.
- **F_air** (object) – $(6 + 3_p)/(6 - 7_p)$, the depolarisation term $F(air)$ or *King Factor* computation method.

Returns Scattering cross section per molecule σ of dry air.

Return type numeric or 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], [Wik01d]

Examples

```
>>> scattering_cross_section(555 * 10e-8)  # doctest: +ELLIPSIS
4.6613309...e-27
```

colour.phenomena

rayleigh_optical_depth(wavelength[, ...])	Returns the *Rayleigh* optical depth $T_r(\lambda)$ as function of wavelength λ in centimeters (cm).

colour.phenomena.rayleigh_optical_depth

colour.phenomena.**rayleigh_optical_depth**(*wavelength*, *CO2_concentration=300*, *temperature=288.15*, *pressure=101325*, *latitude=0*, *altitude=0*, *avogadro_constant=6.02214179e+23*, *n_s=<function air_refraction_index_Bodhaine1999>*, *F_air=<function F_air_Bodhaine1999>*)

Returns the *Rayleigh* optical depth $T_r(\lambda)$ as function of wavelength λ in centimeters (cm).

Parameters

- **wavelength** (numeric or array_like) – Wavelength λ in centimeters (cm).
- **CO2_concentration** (numeric or array_like, optional) – CO_2 concentration in parts per million (ppm).
- **temperature** (numeric or array_like, optional) – Air temperature $T[K]$ in kelvin degrees.
- **pressure** (numeric or array_like) – Surface pressure P of the measurement site.
- **latitude** (numeric or array_like, optional) – Latitude of the site in degrees.
- **altitude** (numeric or array_like, optional) – Altitude of the site in meters.
- **avogadro_constant** (numeric or array_like, optional) – *Avogadro*'s number (molecules mol^{-1}).
- **n_s** (object) – Air refraction index n_s computation method.
- **F_air** (object) – $(6 + 3_p)/(6 - 7_p)$, the depolarisation term $F(air)$ or *King Factor* computation method.

Returns *Rayleigh* optical depth $T_r(\lambda)$.

Return type numeric or 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], [Wik01d]

Examples

```
>>> rayleigh_optical_depth(555 * 10e-8)  # doctest: +ELLIPSIS
0.1004070...
```

Plotting

- *Common*

- *Colorimetry*
- *Colour Vision Deficiency*
- *Colour Characterisation*
- *Corresponding Chromaticities*
- *CIE Chromaticity Diagrams*
- *Colour Models*
- *Colour Notation Systems*
- *Optical Phenomena*
- *Colour Quality*
- *Colour Temperature & Correlated Colour Temperature*
- *Colour Models Volume*
- *Geometry Plotting Utilities*

Common

`colour.plotting`

`colour_style`([use_style])	Returns *Colour* plotting style.
`colour_cycle`(**kwargs)	Returns a colour cycle iterator using given colour map.
`artist`(**kwargs)	Returns the current figure and its axes or creates a new one.
`camera`(**kwargs)	Sets the camera settings.
`render`(**kwargs)	Renders the current figure while adjusting various settings such as the bounding box, the title or background transparency.
`label_rectangles`(labels, rectangles[, ...])	Add labels above given rectangles.
`uniform_axes3d`(axes)	Sets equal aspect ratio to given 3d axes.
`plot_single_colour_swatch`(colour_swatch, ...)	Plots given colour swatch.
`plot_multi_colour_swatches`(colour_swatches)	Plots given colours swatches.
`plot_single_function`(function[, samples, ...])	Plots given function.
`plot_multi_functions`(functions[, samples, ...])	Plots given functions.
`plot_image`(image[, text_parameters, ...])	Plots given image.

colour.plotting.colour_style

`colour.plotting.`**`colour_style`**(*use_style=True*)

Returns *Colour* plotting style.

Parameters **use_style** (`bool`, `optional`) – 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*`)`

Returns a colour cycle iterator using given colour map.

Other Parameters

- **colour_cycle_map** (*unicode or LinearSegmentedColormap, optional*) – Matplotlib colourmap name.
- **colour_cycle_count** (*int, optional*) – Colours count to pick in the colourmap.

Returns Colour cycle iterator.

Return type cycle

colour.plotting.artist

`colour.plotting.`**`artist`**`(`***kwargs*`)`

Returns the current figure and its axes or creates a new one.

Other Parameters

- **axes** (*Axes, optional*) – Axes that will be passed through without creating a new figure.
- **uniform** (*unicode, optional*) – Whether to create the figure with an equal aspect ratio.

Returns Figure, axes.

Return type tuple

colour.plotting.camera

`colour.plotting.`**`camera`**`(`***kwargs*`)`

Sets the camera settings.

Other Parameters

- **azimuth** (*numeric, optional*) – Camera azimuth.
- **camera_aspect** (*unicode, optional*) – Matplotlib axes aspect. Default is *equal*.
- **elevation** (*numeric, optional*) – Camera elevation.

Returns Current axes.

Return type Axes

colour.plotting.render

`colour.plotting.`**`render`**`(`***kwargs*`)`

Renders the current figure while adjusting various settings such as the bounding box, the title or background transparency.

Other Parameters

- **figure** (*Figure, optional*) – Figure to apply the render elements onto.

- **axes** (*Axes, optional*) – Axes to apply the render elements onto.
- **filename** (*unicode, optional*) – Figure will be saved using given `filename` argument.
- **standalone** (*bool, optional*) – Whether to show the figure and call `plt.show()` definition.
- **aspect** (*unicode, optional*) – Matplotlib axes aspect.
- **axes_visible** (*bool, optional*) – Whether the axes are visible. Default is *True*.
- **bounding_box** (*array_like, optional*) – Array defining current axes limits such *bounding_box = (x min, x max, y min, y max)*.
- **tight_layout** (*bool, optional*) – Whether to invoke the `plt.tight_layout()` definition.
- **legend** (*bool, optional*) – Whether to display the legend. Default is *False*.
- **legend_columns** (*int, optional*) – Number of columns in the legend. Default is *1*.
- **transparent_background** (*bool, optional*) – Whether to turn off the background patch. Default is *False*.
- **title** (*unicode, optional*) – Figure title.
- **wrap_title** (*unicode, optional*) – Whether to wrap the figure title, the default is to wrap at a number of characters equal to the width of the figure multiplied by 10.
- **x_label** (*unicode, optional*) – *X* axis label.
- **y_label** (*unicode, optional*) – *Y* axis label.
- **x_ticker** (*bool, optional*) – Whether to display the *X* axis ticker. Default is *True*.
- **y_ticker** (*bool, optional*) – Whether to display the *Y* axis ticker. Default is *True*.

Returns Current figure and axes.

Return type tuple

colour.plotting.label_rectangles

`colour.plotting.`**`label_rectangles`**(*labels*, *rectangles*, *rotation='vertical'*, *text_size=10*, *offset=None*, ***kwargs*)

Add labels above given rectangles.

Parameters

- **`labels`** (`array_like`) – Labels to display.
- **`rectangles`** (`object`) – Rectangles to used to set the labels value and position.
- **`rotation`** (`unicode, optional`) – **{'horizontal', 'vertical'}**, Labels orientation.
- **`text_size`** (`numeric, optional`) – Labels text size.
- **`offset`** (`array_like, optional`) – Labels offset as percentages of the largest rectangle dimensions.

Other Parameters **axes** (*Axes, optional*) – Axes to use for plotting.

Returns Definition success.

Return type bool

colour.plotting.uniform_axes3d

`colour.plotting.`**`uniform_axes3d`**(*axes*)

Sets equal aspect ratio to given 3d axes.

Parameters **axes** (`object`) – Axis to set the equal aspect ratio.

Returns Definition success.

Return type bool

colour.plotting.plot_single_colour_swatch

`colour.plotting.`**`plot_single_colour_swatch`**(*colour_swatch*, ***kwargs*)

Plots given colour swatch.

Parameters **colour_swatch** (`ColourSwatch`) – ColourSwatch.

Other Parameters

- ****kwargs** (*dict, optional*) – {`colour.plotting.artist()`, `colour.plotting.plot_multi_colour_swatches()`, `colour.plotting.render()`}, Please refer to the documentation of the previously listed definitions.
- **width** (*numeric, optional*) – {`colour.plotting.plot_multi_colour_swatches()`}, Colour swatch width.
- **height** (*numeric, optional*) – {`colour.plotting.plot_multi_colour_swatches()`}, Colour swatch height.
- **spacing** (*numeric, optional*) – {`colour.plotting.plot_multi_colour_swatches()`}, Colour swatches spacing.
- **columns** (*int, optional*) – {`colour.plotting.plot_multi_colour_swatches()`}, Colour swatches columns count.
- **text_parameters** (*dict, optional*) – {`colour.plotting.plot_multi_colour_swatches()`}, Parameters for the `plt.text()` definition, `offset` can be set to define the text offset.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> RGB = ColourSwatch(RGB=(0.45620519, 0.03081071, 0.04091952))
>>> plot_single_colour_swatch(RGB)  # doctest: +SKIP
```

colour.plotting.plot_multi_colour_swatches

`colour.plotting.`**`plot_multi_colour_swatches`**(*colour_swatches, width=1, height=1, spacing=0, columns=None, text_parameters=None, background_colour=(1.0, 1.0, 1.0), compare_swatches=None, **kwargs*)

Plots given colours swatches.

Parameters

- **colour_swatches** (`list`) – Colour swatch sequence.
- **width** (`numeric, optional`) – Colour swatch width.
- **height** (`numeric, optional`) – Colour swatch height.
- **spacing** (`numeric, optional`) – Colour swatches spacing.
- **columns** (`int, optional`) – Colour swatches columns count, defaults to the colour swatch count or half of it if comparing.
- **text_parameters** (`dict, optional`) – Parameters for the `plt.text()` definition, `visible` can be set to make the text visible,"offset" can be set to define the text offset.
- **background_colour** (`array_like or unicode, optional`) – Background colour.
- **compare_swatches** (`unicode, optional`) – **{None, 'Stacked', 'Diagonal'}**, 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.

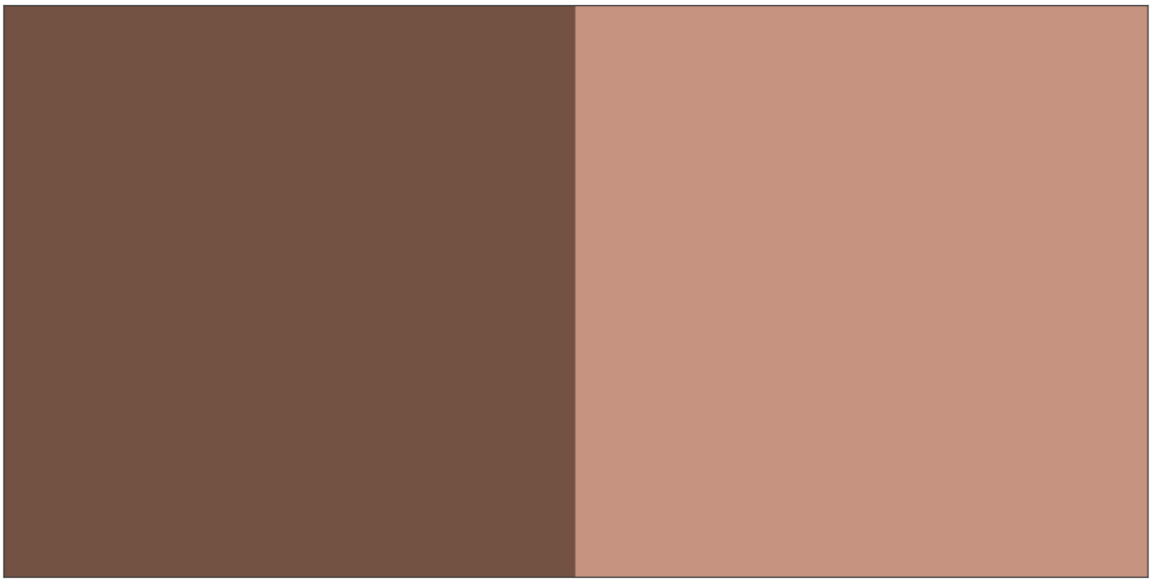
Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> RGB_1 = ColourSwatch(RGB=(0.45293517, 0.31732158, 0.26414773))
>>> RGB_2 = ColourSwatch(RGB=(0.77875824, 0.57726450, 0.50453169))
>>> plot_multi_colour_swatches([RGB_1, RGB_2])  # doctest: +SKIP
```



colour.plotting.plot_single_function

colour.plotting.**plot_single_function**(*function, samples=None, log_x=None, log_y=None, **kwargs*)

Plots given function.

Parameters

- **function** (callable, optional) – Function to plot.
- **samples** (array_like, optional,) – Samples to evaluate the functions with.
- **log_x** (int, optional) – Log base to use for the *x* axis scale, if *None*, the *x* axis scale will be linear.
- **log_y** (int, optional) – Log base to use for the *y* axis scale, if *None*, the *y* axis scale will be linear.

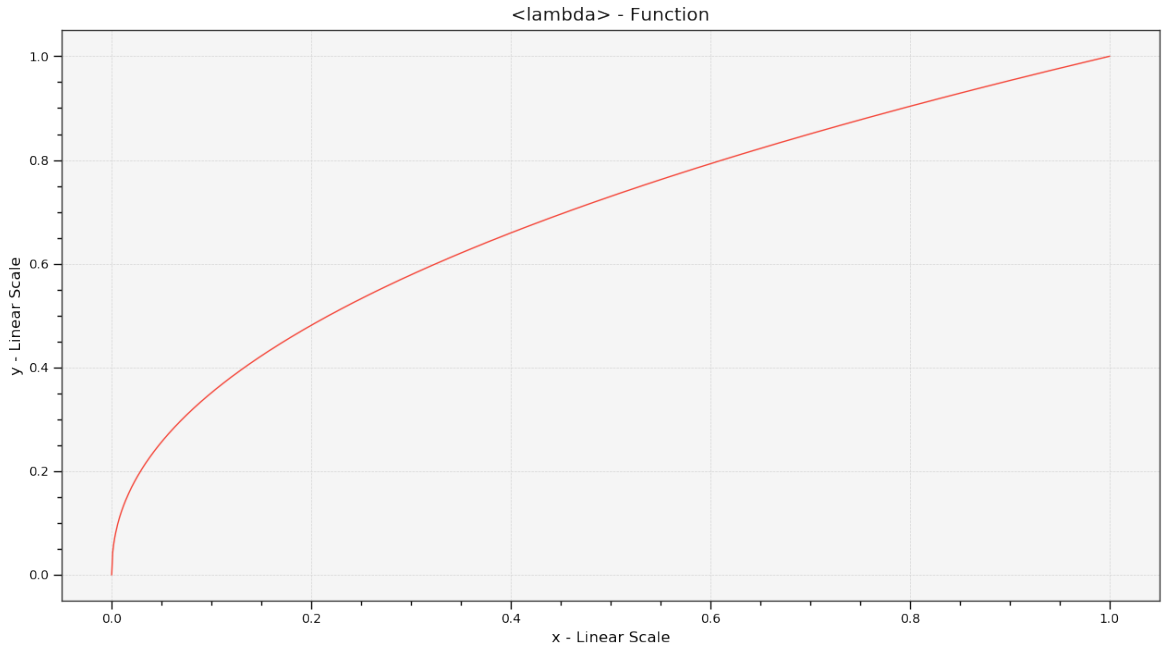
Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.plot_multi_functions(), colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_single_function(partial(gamma_function, exponent=1 / 2.2))
... # doctest: +SKIP
```



colour.plotting.plot_multi_functions

`colour.plotting.`**`plot_multi_functions`**(*functions*, *samples=None*, *log_x=None*, *log_y=None*, ***kwargs*)

Plots given functions.

Parameters

- **functions** (dict) – Functions to plot.
- **samples** (array_like, optional,) – Samples to evaluate the functions with.
- **log_x** (int, optional) – Log base to use for the *x* axis scale, if *None*, the *x* axis scale will be linear.
- **log_y** (int, optional) – Log base to use for the *y* axis scale, if *None*, the *y* axis scale will be linear.

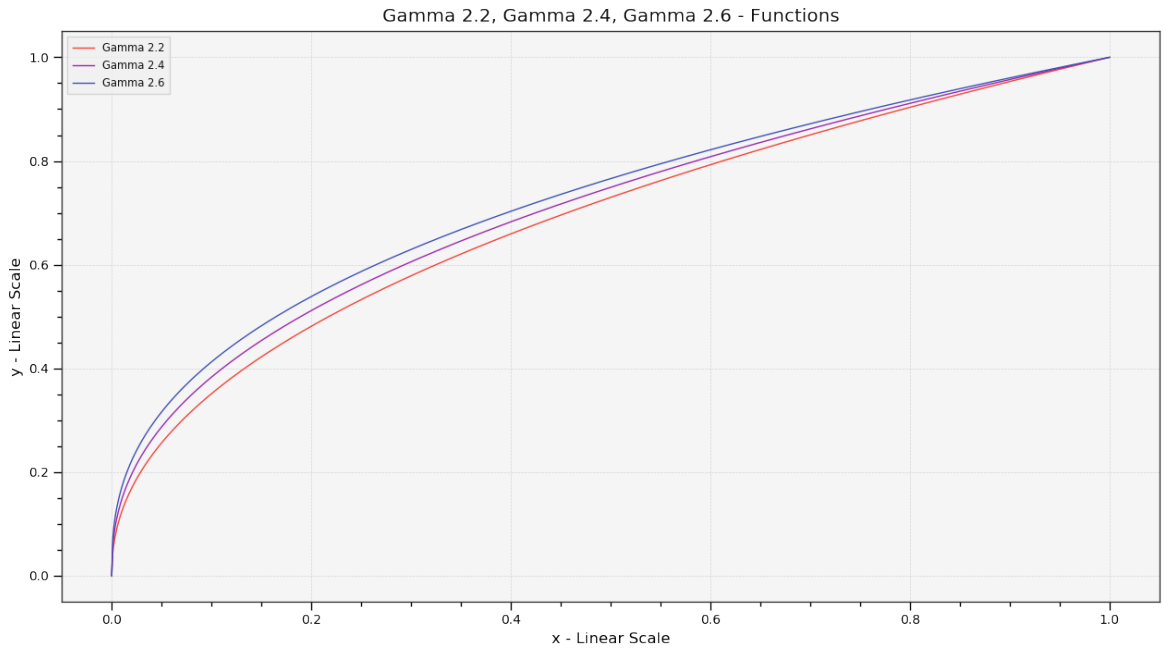
Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.

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)
... # doctest: +SKIP
```



colour.plotting.plot_image

colour.plotting.**plot_image**(*image*, *text_parameters=None*, *interpolation='nearest'*, *colour_map=<matplotlib.colors.LinearSegmentedColormap object>*, ***kwargs*)

Plots given image.

Parameters

- **image** (array_like) – Image to plot.
- **text_parameters** (dict, optional) – Parameters for the plt.text() definition, offset can be set to define the text offset.
- **interpolation** (unicode, optional) – **{'nearest', None, 'none', 'bilinear', 'bicubic', 'spline16', 'spline36', 'hanning', 'hamming', 'hermite', 'kaiser', 'quadric', 'catrom', 'gaussian', 'bessel', 'mitchell', 'sinc', 'lanczos'}** Image display interpolation.
- **colour_map** (unicode, optional) – Colour map used to display single channel images.

Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.render()}, Please refer to the documentation of the previously listed defi-

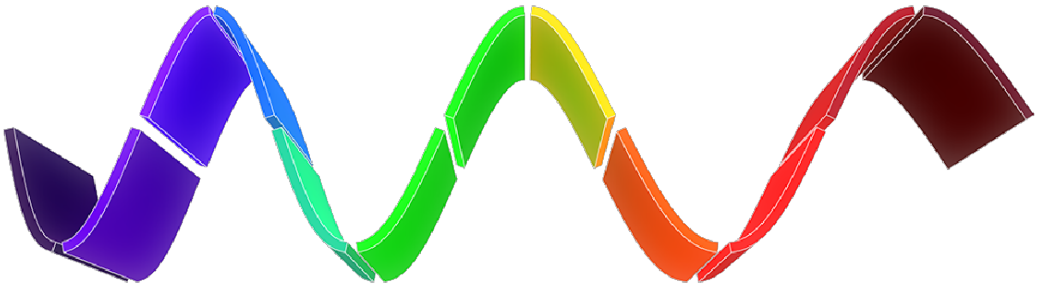
nitions.

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], '..', 'docs', '_static', 'Logo_Medium_001.png')
>>> plot_image(read_image(path))  # doctest: +SKIP
```



Colorimetry

`colour.plotting`

plot_single_sd(sd[, cmfs, out_of_gamut_clipping])	Plots given spectral distribution.
plot_multi_sds(sds[, cmfs, use_sds_colours, ...])	Plots given spectral distributions.
plot_single_cmfs([cmfs])	Plots given colour matching functions.
plot_multi_cmfs([cmfs])	Plots given colour matching functions.
plot_single_illuminant_sd([illuminant, cmfs])	Plots given single illuminant spectral distribution.
plot_multi_illuminant_sds([illuminants])	Plots given illuminants spectral distributions.
plot_visible_spectrum([cmfs, ...])	Plots the visible colours spectrum using given standard observer *CIE XYZ* colour matching functions.
plot_single_lightness_function([function])	Plots given *Lightness* function.
plot_multi_lightness_functions([functions])	Plots given *Lightness* functions.

Continued on next page

Table 241 – continued from previous page

plot_single_luminance_function([function])	Plots given *Luminance* function.
plot_multi_luminance_functions([functions])	Plots given *Luminance* functions.
plot_blackbody_spectral_radiance([...])	Plots given blackbody spectral radiance.
plot_blackbody_colours([shape, cmfs])	Plots blackbody colours.

colour.plotting.plot_single_sd

colour.plotting.**plot_single_sd**(*sd*, *cmfs='CIE 1931 2 Degree Standard Observer'*, *out_of_gamut_clipping=True*, ***kwargs*)

Plots given spectral distribution.

Parameters

- **sd** (SpectralDistribution) – Spectral distribution to plot.
- **out_of_gamut_clipping** (bool, optional) – 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.
- **cmfs** (unicode) – Standard observer colour matching functions used for spectrum creation.

Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

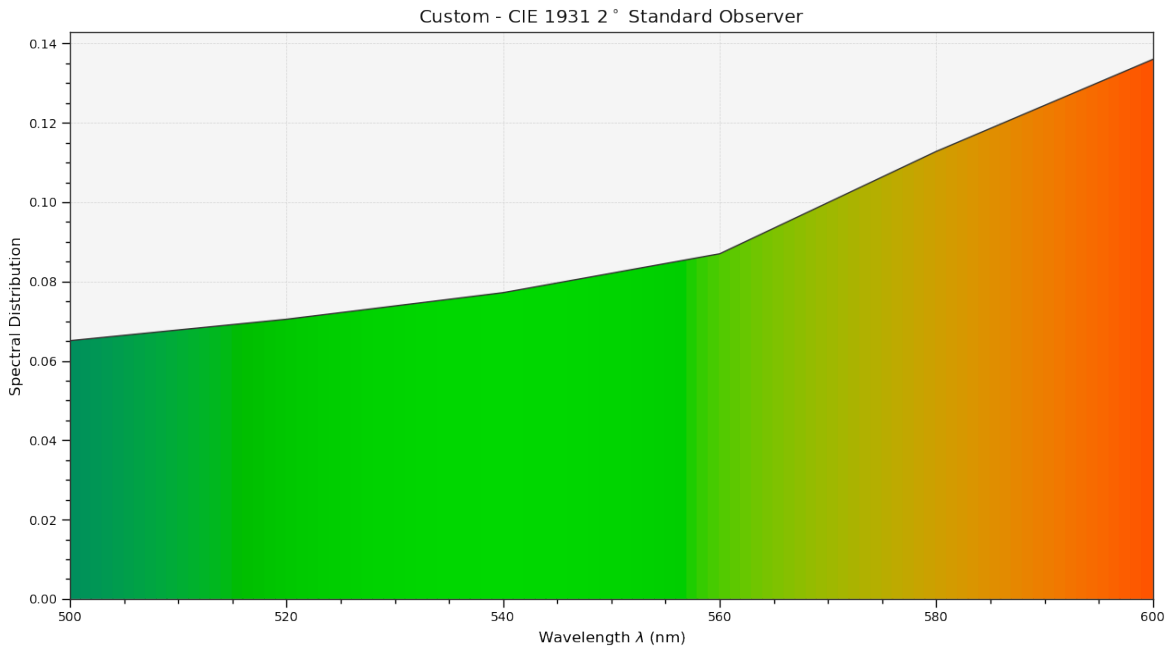
Return type tuple

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)  # doctest: +SKIP
```



colour.plotting.plot_multi_sds

`colour.plotting.`**`plot_multi_sds`**(*sds*, *cmfs='CIE 1931 2 Degree Standard Observer'*, *use_sds_colours=False*, *normalise_sds_colours=False*, ***kwargs*)

Plots given spectral distributions.

Parameters

- **sds** (array_like or MultiSpectralDistribution) – Spectral distributions or multi-spectral distributions to plot. *sds* can be a single colour.MultiSpectralDistribution class instance, a list of colour.MultiSpectralDistribution class instances or a list of colour.SpectralDistribution class instances.
- **cmfs** (unicode, optional) – Standard observer colour matching functions used for spectrum creation.
- **use_sds_colours** (bool, optional) – Whether to use spectral distributions colours.
- **normalise_sds_colours** (bool) – Whether to normalise spectral distributions colours.

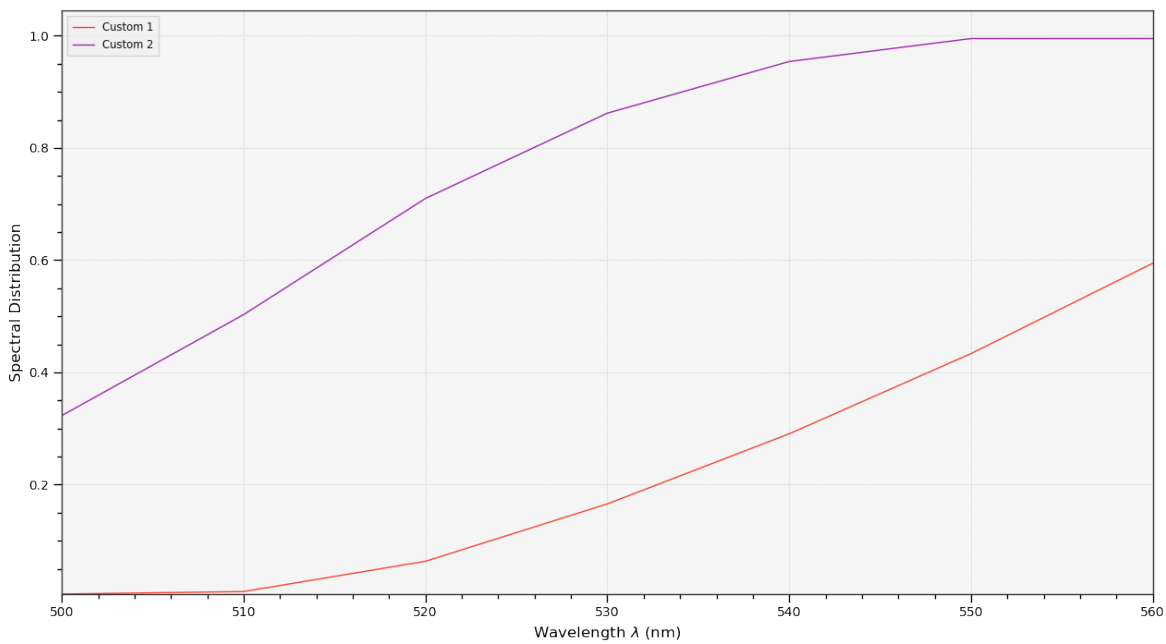
Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.

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
... }
>>> spd1 = SpectralDistribution(data_1, name='Custom 1')
>>> spd2 = SpectralDistribution(data_2, name='Custom 2')
>>> plot_multi_sds([spd1, spd2])  # doctest: +SKIP
```



colour.plotting.plot_single_cmfs

`colour.plotting.`**`plot_single_cmfs`**(*cmfs='CIE 1931 2 Degree Standard Observer', **kwargs*)

Plots given colour matching functions.

Parameters **cmfs** (`unicode`, `optional`) – Colour matching functions to plot.

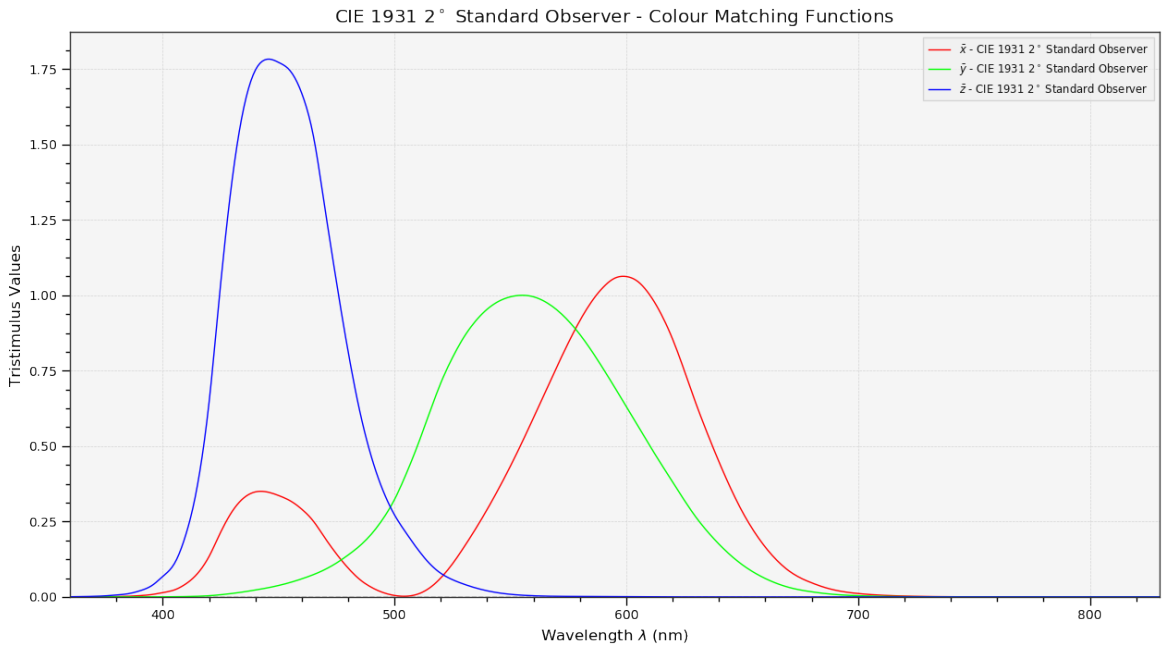
Other Parameters ****kwargs** (*dict, optional*) – {`colour.plotting.artist()`, `colour.plotting.plot_multi_cmfs()`, `colour.plotting.render()`}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_single_cmfs('CIE 1931 2 Degree Standard Observer')
... # doctest: +SKIP
```



colour.plotting.plot_multi_cmfs

`colour.plotting.`**`plot_multi_cmfs`**(*cmfs=None*, ***kwargs*)

Plots given colour matching functions.

Parameters **cmfs** (`array_like, optional`) – Colour matching functions to plot.

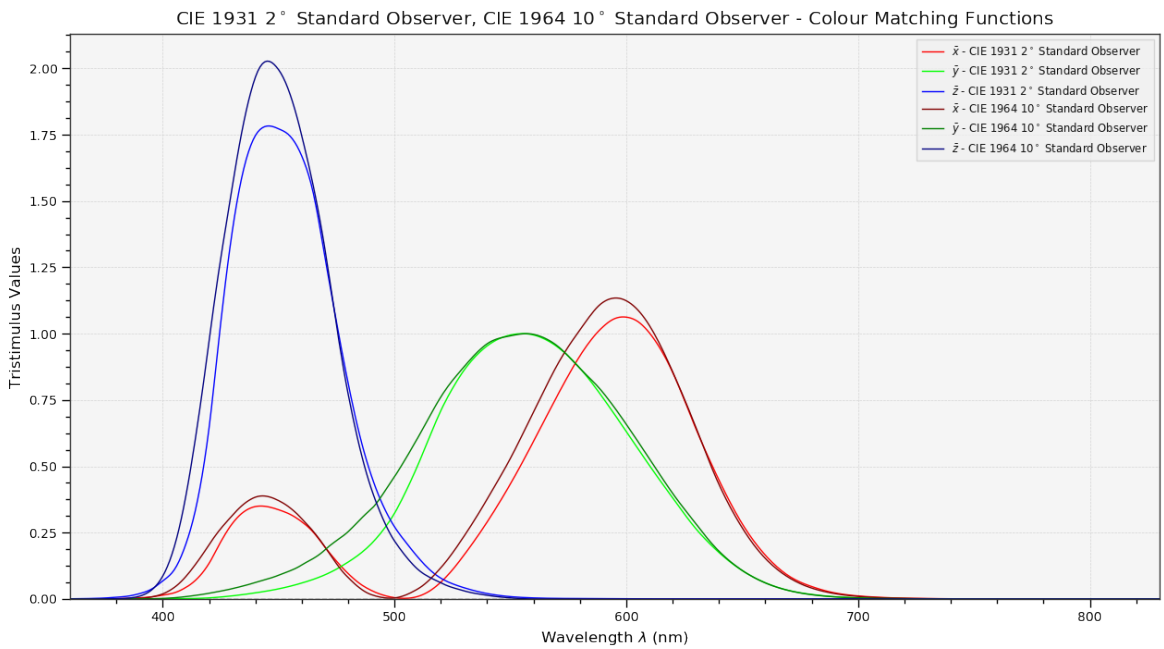
Other Parameters ****kwargs** (*dict, optional*) – {`colour.plotting.artist()`, `colour.plotting.render()`}, Please refer to the documentation of the previously listed definitions.

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)  # doctest: +SKIP
```



colour.plotting.plot_single_illuminant_sd

`colour.plotting.`**`plot_single_illuminant_sd`**(*illuminant='A', cmfs='CIE 1931 2 Degree Standard Observer', **kwargs*)

Plots given single illuminant spectral distribution.

Parameters

- **illuminant** (`unicode, optional`) – Factory illuminant to plot.
- **cmfs** (`unicode, optional`) – Standard observer colour matching functions to plot.

Other Parameters

- ****kwargs** (*dict, optional*) – {`colour.plotting.artist()`, `colour.plotting.plot_single_sd()`, `colour.plotting.render()`}, Please refer to the documentation of the previously listed definitions.
- **out_of_gamut_clipping** (*bool, optional*) – {`colour.plotting.plot_single_sd()`}, 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.

Returns Current figure and axes.

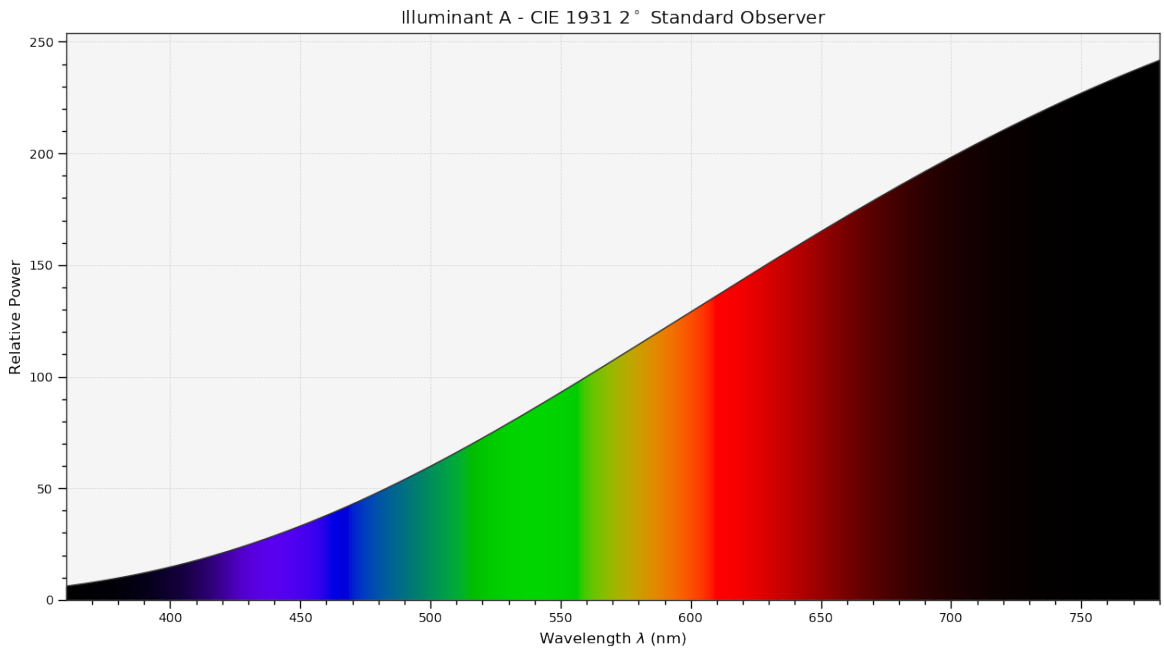
Return type tuple

References

[Spi15]

Examples

```
>>> plot_single_illuminant_sd('A')  # doctest: +SKIP
```



colour.plotting.plot_multi_illuminant_sds

`colour.plotting.`**`plot_multi_illuminant_sds`**(*illuminants=None*, ***kwargs*)

Plots given illuminants spectral distributions.

Parameters **illuminants** (`array_like, optional`) – Factory illuminants to plot.

Other Parameters

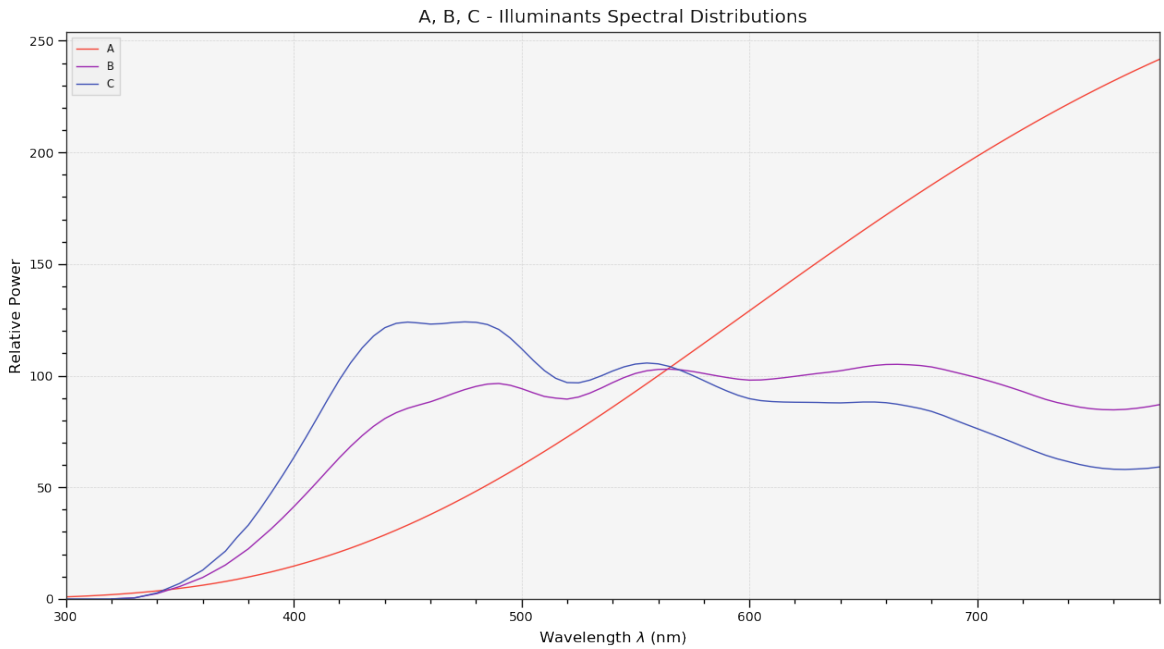
- ****kwargs** (*dict, optional*) – {`colour.plotting.artist()`, `colour.plotting.plot_multi_sds()`, `colour.plotting.render()`}, Please refer to the documentation of the previously listed definitions.
- **use_sds_colours** (*bool, optional*) – {`colour.plotting.plot_multi_sds()`} Whether to use spectral distributions colours.
- **normalise_sds_colours** (*bool*) – {`colour.plotting.plot_multi_sds()`} Whether to normalise spectral distributions colours.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_multi_illuminant_sds(['A', 'B', 'C'])  # doctest: +SKIP
```



colour.plotting.plot_visible_spectrum

`colour.plotting.`**`plot_visible_spectrum`**(*cmfs='CIE 1931 2 Degree Standard Observer', out_of_gamut_clipping=True, **kwargs*)

Plots the visible colours spectrum using given standard observer *CIE XYZ* colour matching functions.

Parameters

- **cmfs** (unicode, optional) – Standard observer colour matching functions used for spectrum creation.
- **out_of_gamut_clipping** (bool, optional) – 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.

Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.plot_single_sd(), colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

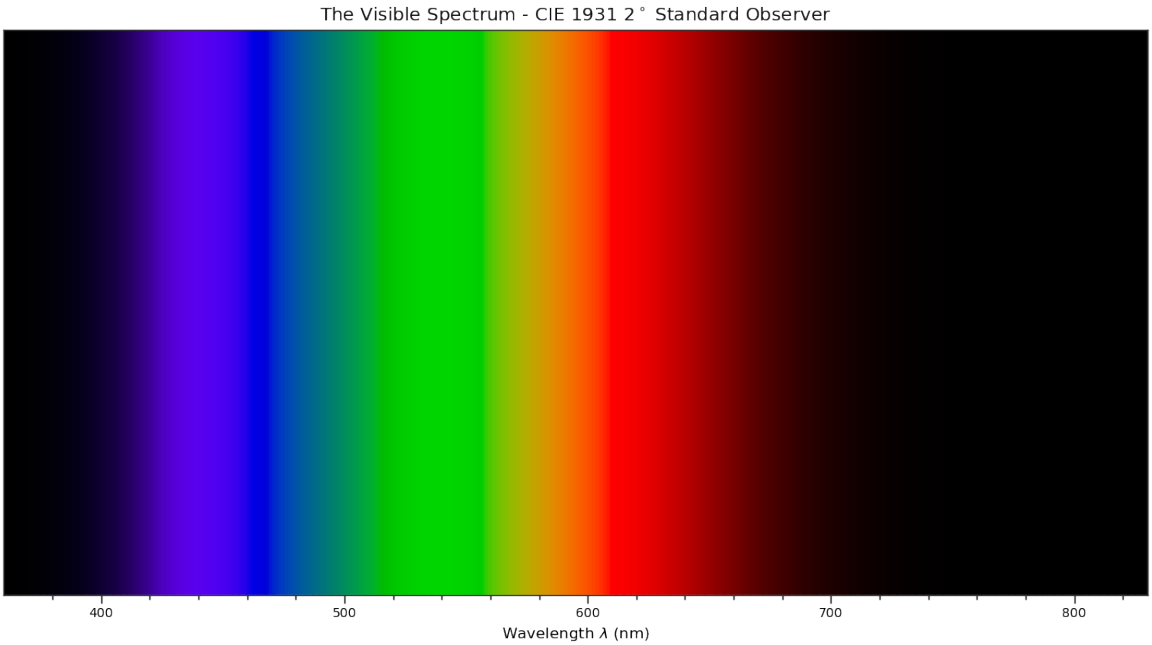
Return type tuple

References

[Spi15]

Examples

```
>>> plot_visible_spectrum()  # doctest: +SKIP
```



colour.plotting.plot_single_lightness_function

`colour.plotting.`**`plot_single_lightness_function`**(*function='CIE 1976', **kwargs*)

Plots given *Lightness* function.

Parameters **`function`** (`unicode, optional`) – *Lightness* function to plot.

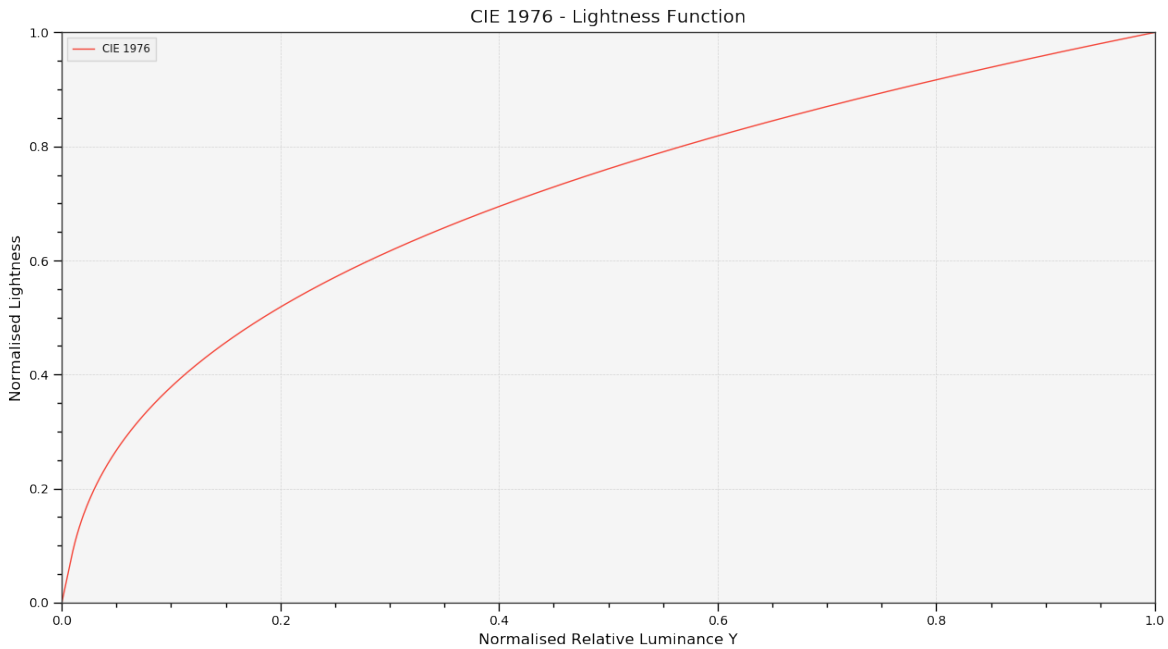
Other Parameters ****kwargs** (*dict, optional*) – {`colour.plotting.artist()`, `colour.plotting.plot_multi_functions()`, `colour.plotting.render()`}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_single_lightness_function('CIE 1976')  # doctest: +SKIP
```



colour.plotting.plot_multi_lightness_functions

`colour.plotting.`**`plot_multi_lightness_functions`**(*functions=None*, ***kwargs*)

Plots given *Lightness* functions.

Parameters **functions** (`array_like, optional`) – *Lightness* functions to plot.

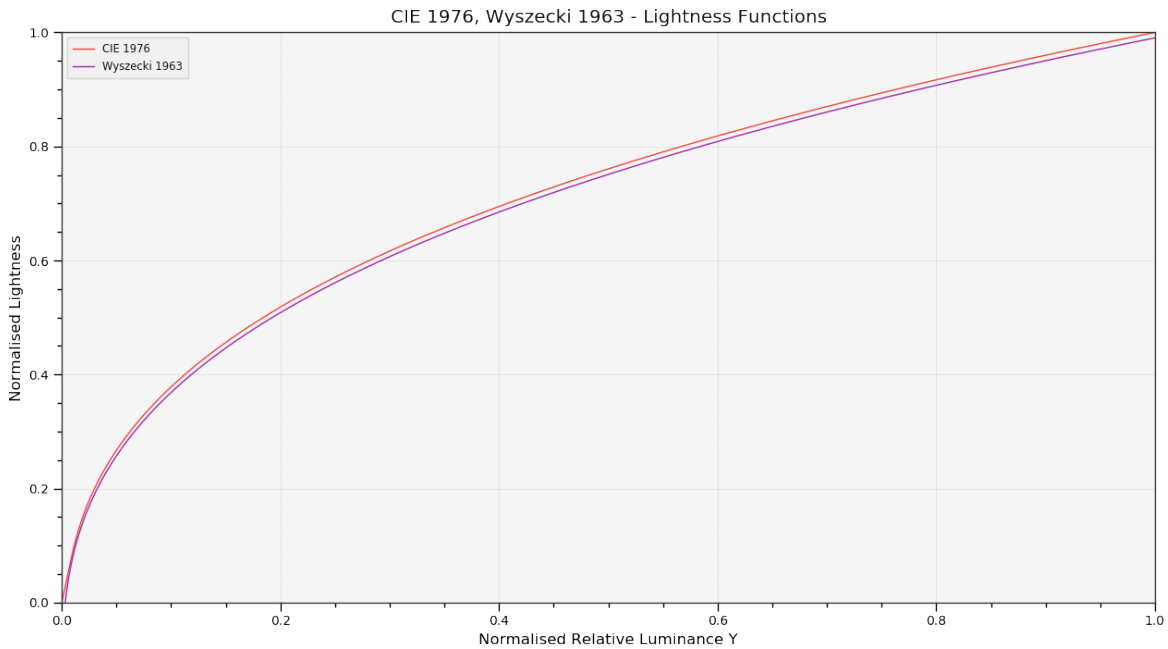
Other Parameters ****kwargs** (*dict, optional*) – {`colour.plotting.artist()`, `colour.plotting.plot_multi_functions()`, `colour.plotting.render()`}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_multi_lightness_functions(['CIE 1976', 'Wyszecki 1963'])
... # doctest: +SKIP
```



colour.plotting.plot_single_luminance_function

`colour.plotting.`**`plot_single_luminance_function`**(*function='CIE 1976', **kwargs*)

Plots given *Luminance* function.

Parameters **function** (unicode, optional) – *Luminance* function to plot.

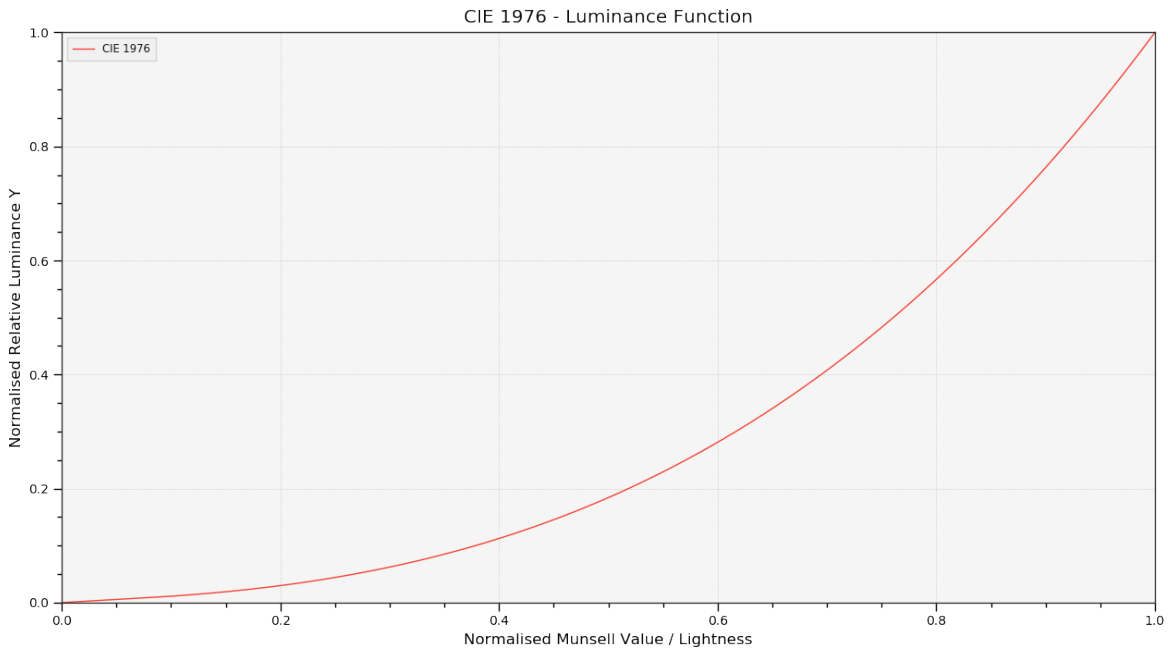
Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.plot_multi_functions(), colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_single_luminance_function('CIE 1976')  # doctest: +SKIP
```



colour.plotting.plot_multi_luminance_functions

`colour.plotting.`**`plot_multi_luminance_functions`**(*functions=None*, ***kwargs*)

Plots given *Luminance* functions.

Parameters **functions** (`array_like, optional`) – *Luminance* functions to plot.

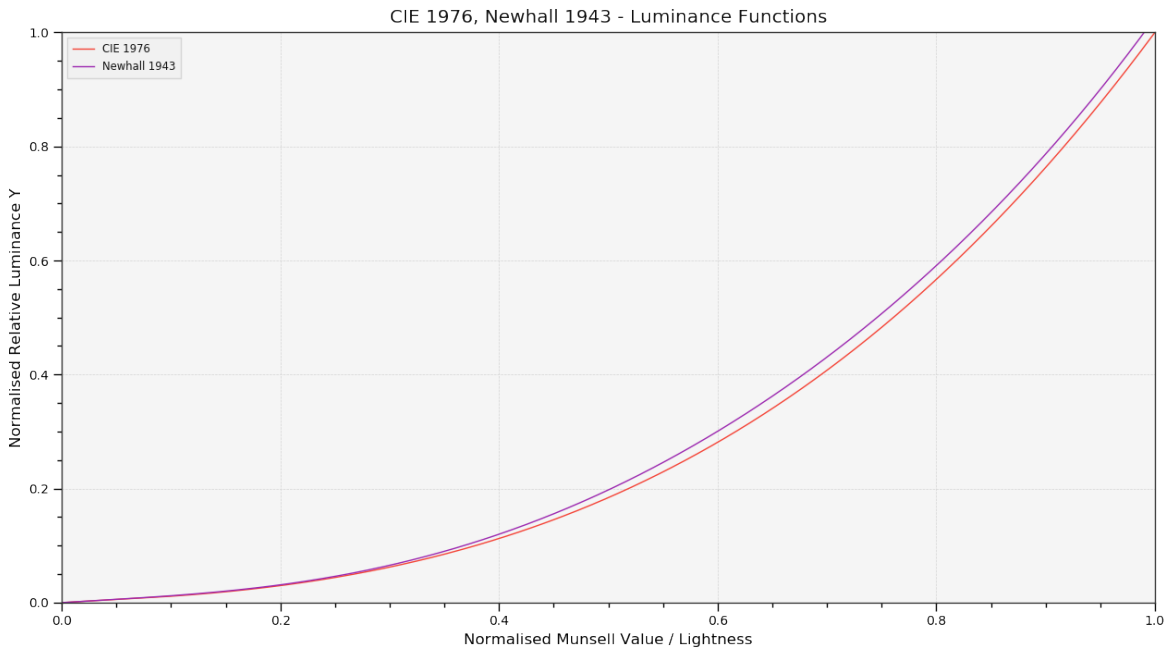
Other Parameters ****kwargs** (*dict, optional*) – {`colour.plotting.artist()`, `colour.plotting.plot_multi_functions()`, `colour.plotting.render()`}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_multi_luminance_functions(['CIE 1976', 'Newhall 1943'])
... # doctest: +SKIP
```



colour.plotting.plot_blackbody_spectral_radiance

`colour.plotting.`**`plot_blackbody_spectral_radiance`**(*temperature=3500, cmfs='CIE 1931 2 Degree Standard Observer', blackbody='VY Canis Major', **kwargs*)

Plots given blackbody spectral radiance.

Parameters

- **`temperature`** (`numeric, optional`) – Blackbody temperature.
- **`cmfs`** (`unicode, optional`) – Standard observer colour matching functions.
- **`blackbody`** (`unicode, optional`) – Blackbody name.

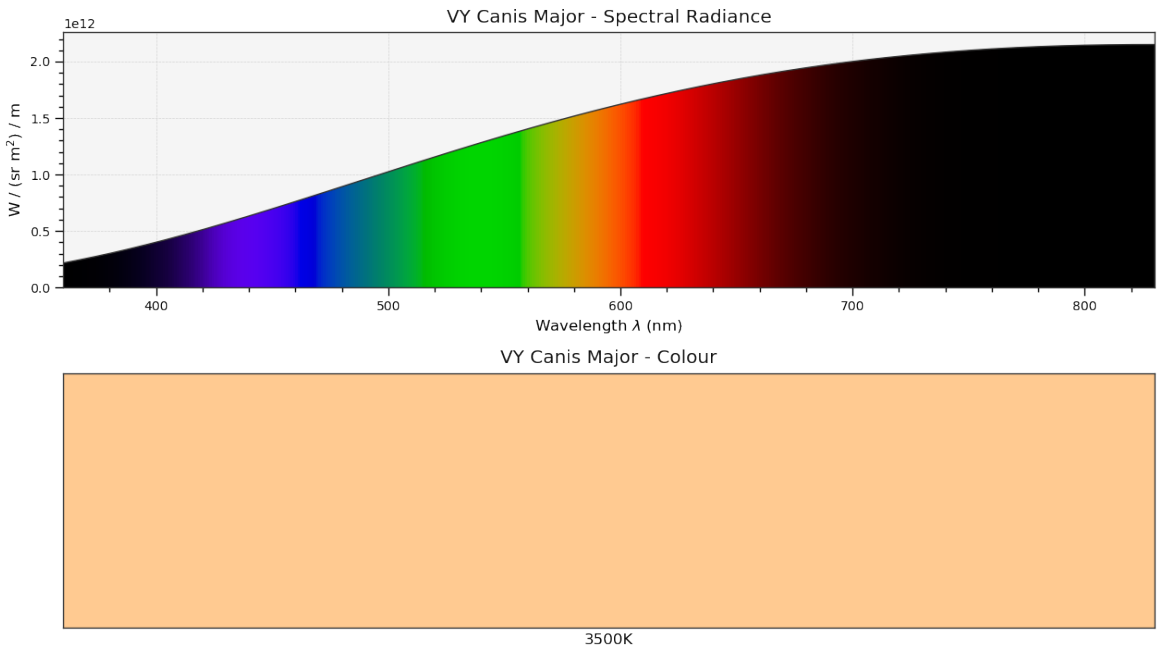
Other Parameters ****kwargs** (*dict, optional*) – {`colour.plotting.artist()`, `colour.plotting.plot_single_sd()`, `colour.plotting.render()`}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_blackbody_spectral_radiance(3500, blackbody='VY Canis Major')
... # doctest: +SKIP
```



colour.plotting.plot_blackbody_colours

`colour.plotting.`**`plot_blackbody_colours`**(*shape=SpectralShape(150, 12500, 50), cmfs='CIE 1931 2 Degree Standard Observer', **kwargs*)

Plots blackbody colours.

Parameters

- **shape** (`SpectralShape`, `optional`) – Spectral shape to use as plot boundaries.
- **cmfs** (`unicode`, `optional`) – Standard observer colour matching functions.

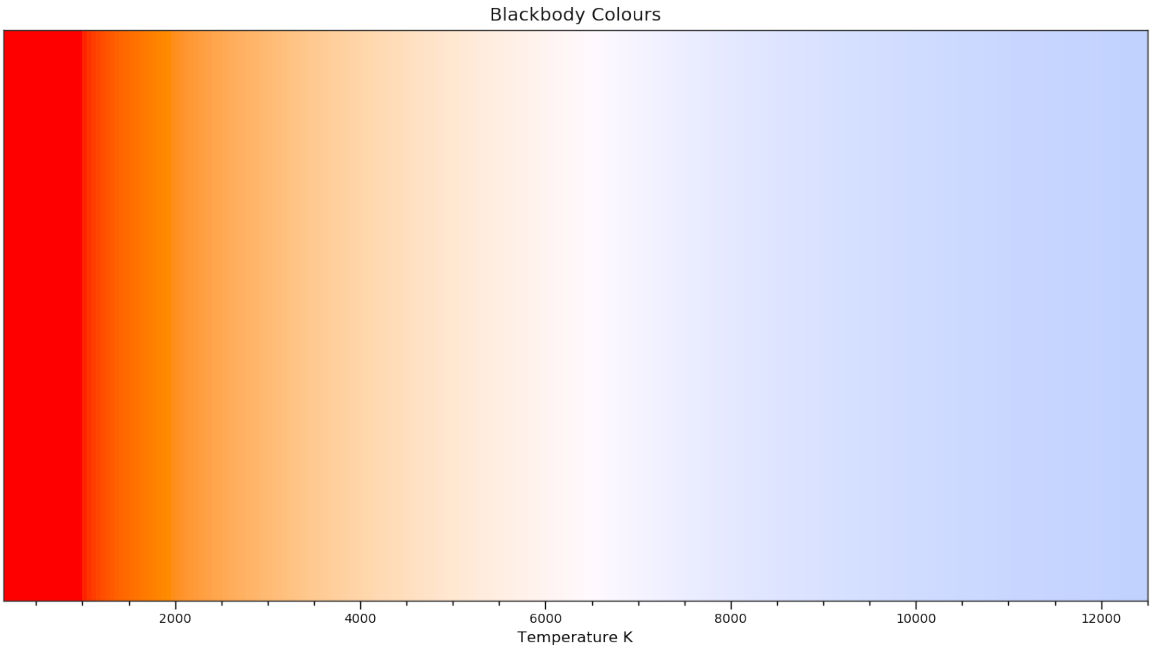
Other Parameters ****kwargs** (*dict, optional*) – {`colour.plotting.artist()`, `colour.plotting.render()`}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_blackbody_colours(SpectralShape(150, 12500, 50))  # doctest: +SKIP
```



Colour Vision Deficiency

`colour.plotting`

`plot_cvd_simulation_Machado2009`(RGB[, ...])	Performs colour vision deficiency simulation on given *RGB* colourspace array using *Machado et al.(2009)* model..

colour.plotting.plot_cvd_simulation_Machado2009

`colour.plotting.`**`plot_cvd_simulation_Machado2009`**(*RGB*, *deficiency='Protanomaly'*, *severity=0.5*, *M_a=None*, ***kwargs*)

Performs colour vision deficiency simulation on given *RGB* colourspace array using *Machado et al. (2009)* model.

Parameters

- **RGB** (`array_like`) – *RGB* colourspace array.
- **deficiency** (`unicode, optional`) – {'Protanomaly', 'Deuteranomaly', 'Tritanomaly'} Colour blindness / vision deficiency type.
- **severity** (`numeric, optional`) – Severity of the colour vision deficiency in domain [0, 1].
- **M_a** (`array_like, optional`) – Anomalous trichromacy matrix to use instead of Machado (2010) pre-computed matrix.

Other Parameters ****kwargs** (*dict, optional*) – {`colour.plotting.artist()`, `colour.plotting.plot_image()`, `colour.plotting.render()`}, Please refer to the documentation of the previously listed definitions.

Notes

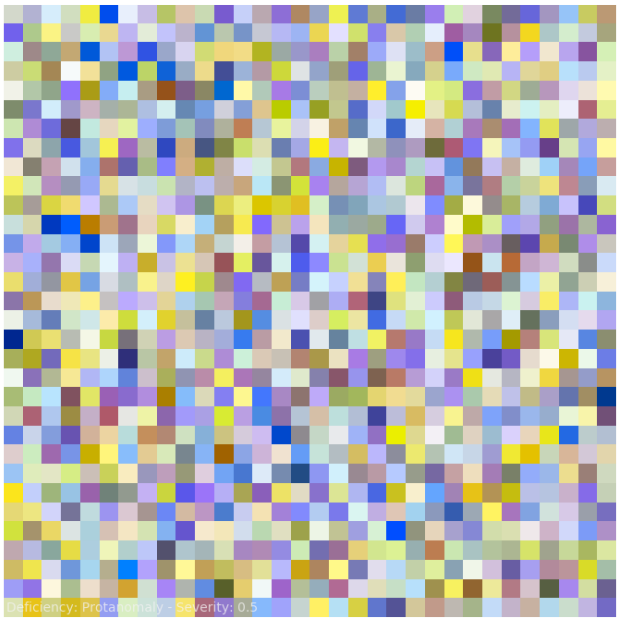
- Input *RGB* array is expected to be linearly encoded.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> import numpy as np
>>> RGB = np.random.rand(32, 32, 3)
>>> plot_cvd_simulation_Machado2009(RGB)  # doctest: +SKIP
```



Colour Characterisation

`colour.plotting`

`plot_single_colour_checker`([colour_checker])	Plots given colour checker.
`plot_multi_colour_checkers`([colour_checkers])	Plots and compares given colour checkers.

colour.plotting.plot_single_colour_checker

`colour.plotting.`**`plot_single_colour_checker`**(*colour_checker='ColorChecker 2005', **kwargs*)

Plots given colour checker.

Parameters **colour_checker** (unicode, optional) – Color checker name.

Other Parameters ***kwargs** (*dict, optional*) – {`colour.plotting.artist()`, `colour.plotting.plot_multi_colour_swatches()`, `colour.plotting.render()`}, Please refer to

the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_single_colour_checker('ColorChecker 2005')  # doctest: +SKIP
```

colour.plotting.plot_multi_colour_checkers

`colour.plotting.`**`plot_multi_colour_checkers`**(*colour_checkers=None, **kwargs*)

Plots and compares given colour checkers.

Parameters **colour_checkers** (`array_like, optional`) – Color checker names, must be less than or equal to 2 names.

Other Parameters ****kwargs** (*dict, optional*) – {`colour.plotting.artist()`, `colour.plotting.plot_multi_colour_swatches()`, `colour.plotting.render()`}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_multi_colour_checkers(['ColorChecker 1976', 'ColorChecker 2005'])
... # doctest: +SKIP
```

Corresponding Chromaticities

`colour.plotting`

`plot_corresponding_chromaticities_prediction`([...])	Plots given chromatic adaptation model corresponding chromaticities prediction.

colour.plotting.plot_corresponding_chromaticities_prediction

`colour.plotting.`**`plot_corresponding_chromaticities_prediction`**(*experiment=1*, *model='Von Kries'*, *transform='CAT02'*, ***kwargs*)

Plots given chromatic adaptation model corresponding chromaticities prediction.

Parameters

- **`experiment`** (`int`, `optional`) – Corresponding chromaticities prediction experiment number.
- **`model`** (`unicode`, `optional`) – Corresponding chromaticities prediction model name.
- **`transform`** (`unicode`, `optional`) – Transformation to use with *Von Kries* chromatic adaptation model.

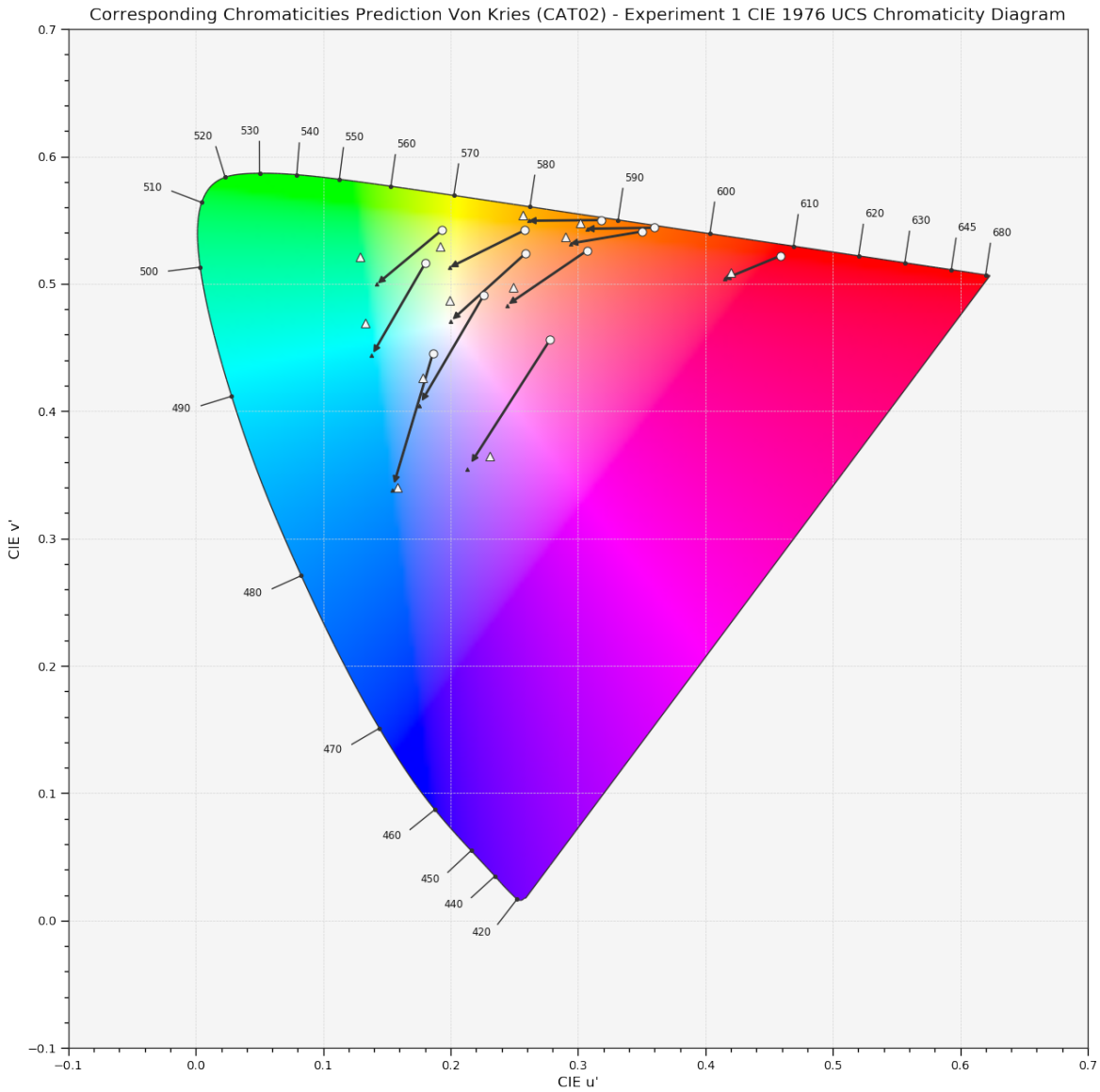
Other Parameters ****kwargs** (*dict, optional*) – {`colour.plotting.artist()`, `colour.plotting.diagrams.plot_chromaticity_diagram()`, `colour.plotting.render()`}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_corresponding_chromaticities_prediction(1, 'Von Kries', 'CAT02')
... # doctest: +SKIP
```



CIE Chromaticity Diagrams

colour.plotting

plot_chromaticity_diagram_CIE1931([cmfs, ...])	Plots the *CIE 1931 Chromaticity Diagram*.
plot_chromaticity_diagram_CIE1960UCS([cmfs, ...])	Plots the *CIE 1960 UCS Chromaticity Diagram*.

Continued on next page

Table 245 – continued from previous page

plot_chromaticity_diagram_CIE1976UCS([cmfs, ...])	Plots the *CIE 1976 UCS Chromaticity Diagram*.
plot_sds_in_chromaticity_diagram_CIE1931(sds)	Plots given spectral distribution chromaticity coordinates into the *CIE 1931 Chromaticity Diagram*.
plot_sds_in_chromaticity_diagram_CIE1960UCS(sds)	Plots given spectral distribution chromaticity coordinates into the *CIE 1960 UCS Chromaticity Diagram*.
plot_sds_in_chromaticity_diagram_CIE1976UCS(sds)	Plots given spectral distribution chromaticity coordinates into the *CIE 1976 UCS Chromaticity Diagram*.

colour.plotting.plot_chromaticity_diagram_CIE1931

colour.plotting.**plot_chromaticity_diagram_CIE1931**(*cmfs='CIE 1931 2 Degree Standard Observer', show_diagram_colours=True, show_spectral_locus=True, **kwargs*)

Plots the *CIE 1931 Chromaticity Diagram*.

Parameters

- **cmfs** (unicode, optional) – Standard observer colour matching functions used for *Chromaticity Diagram* bounds.
- **show_diagram_colours** (bool, optional) – Whether to display the *Chromaticity Diagram* background colours.
- **show_spectral_locus** (bool, optional) – Whether to display the *Spectral Locus*.

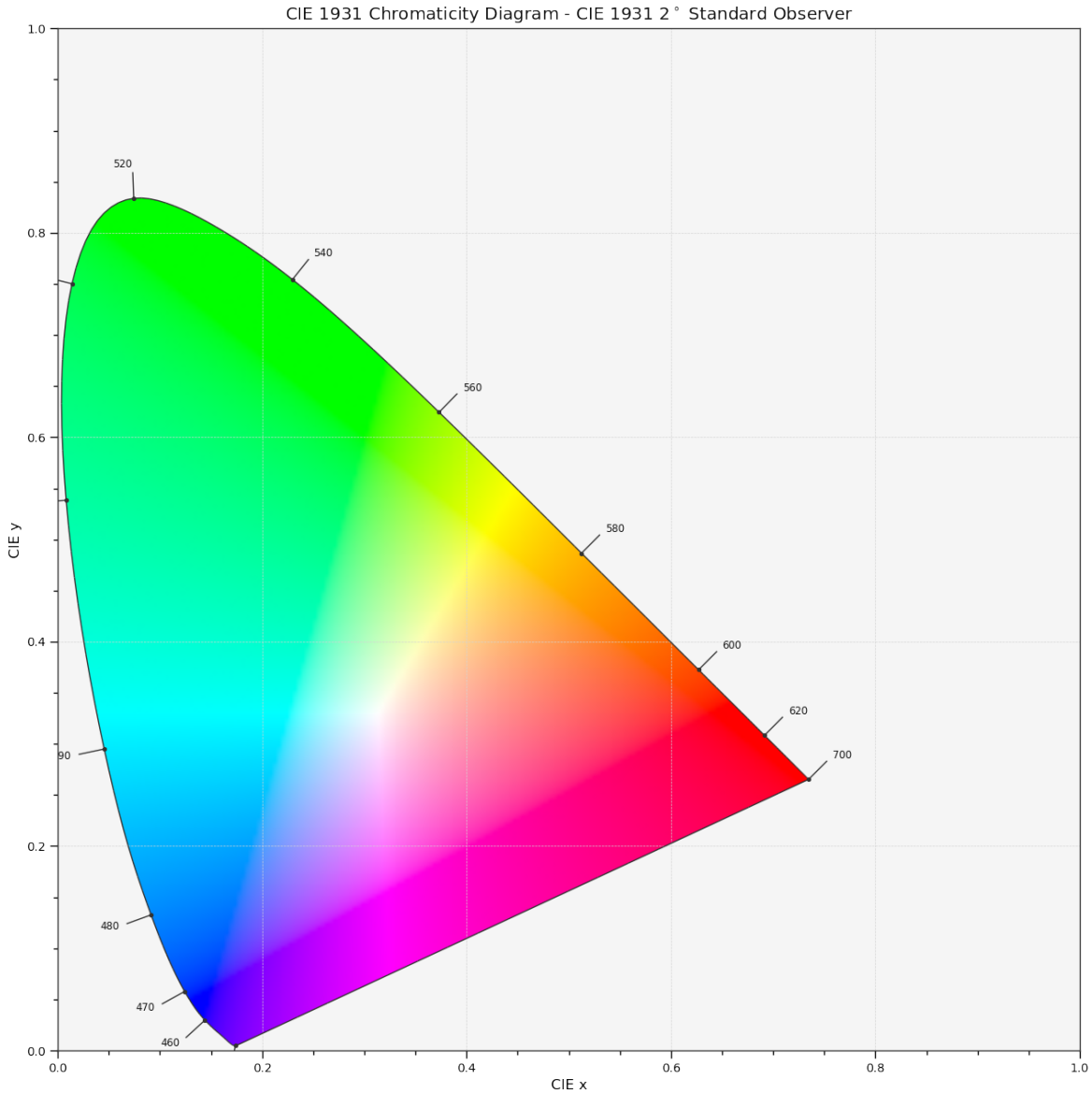
Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.diagrams.plot_chromaticity_diagram(), colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_chromaticity_diagram_CIE1931()  # doctest: +SKIP
```



colour.plotting.plot_chromaticity_diagram_CIE1960UCS

`colour.plotting.`**`plot_chromaticity_diagram_CIE1960UCS`**(*cmfs='CIE 1931 2 Degree Standard Observer', show_diagram_colours=True, show_spectral_locus=True, **kwargs*)

Plots the *CIE 1960 UCS Chromaticity Diagram*.

Parameters

- **cmfs** (unicode, optional) – Standard observer colour matching functions used for *Chromaticity Diagram* bounds.
- **show_diagram_colours** (bool, optional) – Whether to display the *Chromaticity Diagram* background colours.
- **show_spectral_locus** (bool, optional) – Whether to display the *Spectral Locus*.

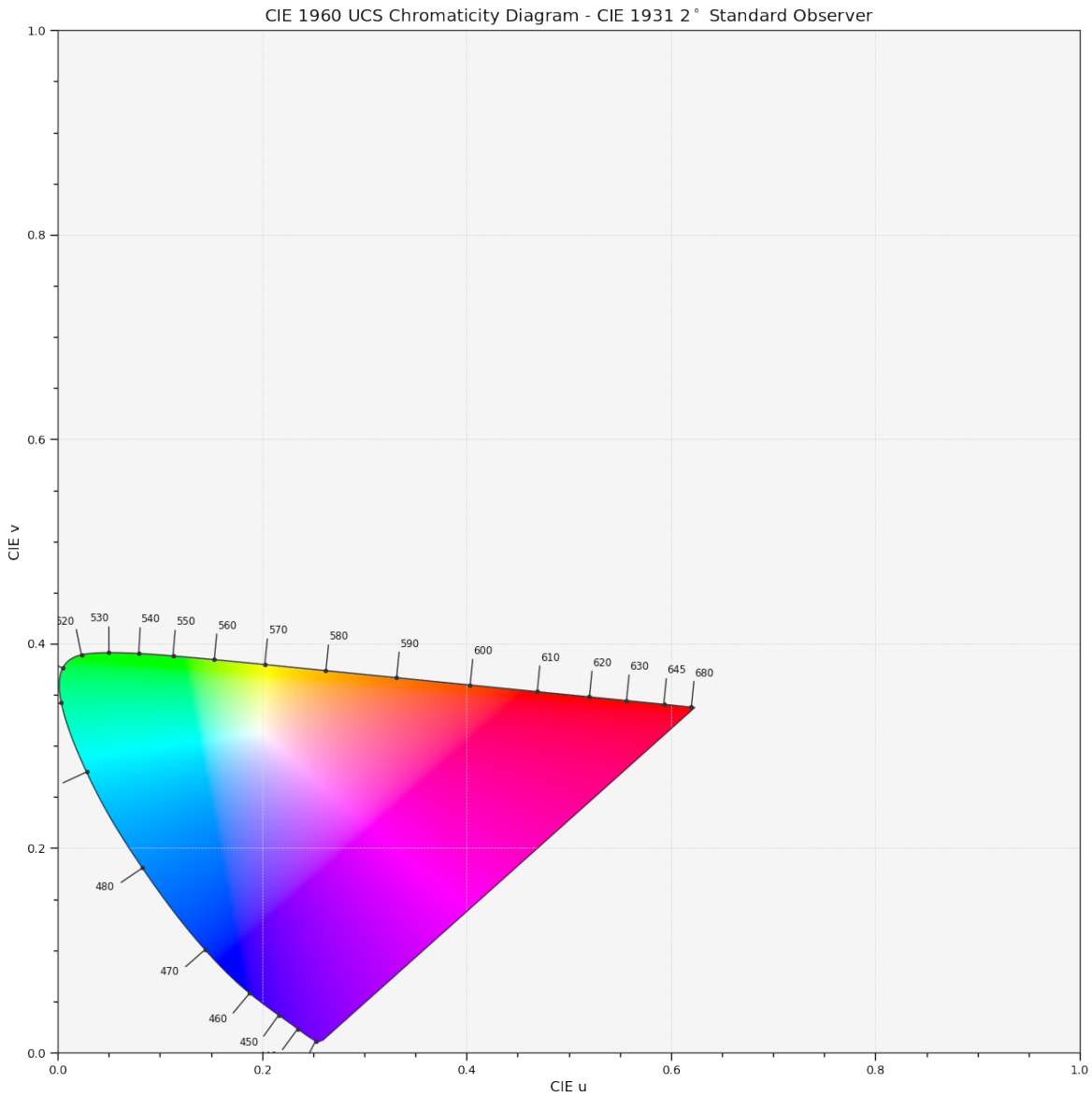
Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.diagrams.plot_chromaticity_diagram(), colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_chromaticity_diagram_CIE1960UCS()  # doctest: +SKIP
```



colour.plotting.plot_chromaticity_diagram_CIE1976UCS

colour.plotting.**plot_chromaticity_diagram_CIE1976UCS**(*cmfs='CIE 1931 2 Degree Standard Observer', show_diagram_colours=True, show_spectral_locus=True, **kwargs*)

Plots the *CIE 1976 UCS Chromaticity Diagram*.

Parameters

- **cmfs** (unicode, optional) – Standard observer colour matching functions used for *Chromaticity Diagram* bounds.
- **show_diagram_colours** (bool, optional) – Whether to display the *Chromaticity Diagram* background colours.
- **show_spectral_locus** (bool, optional) – Whether to display the *Spectral Locus*.

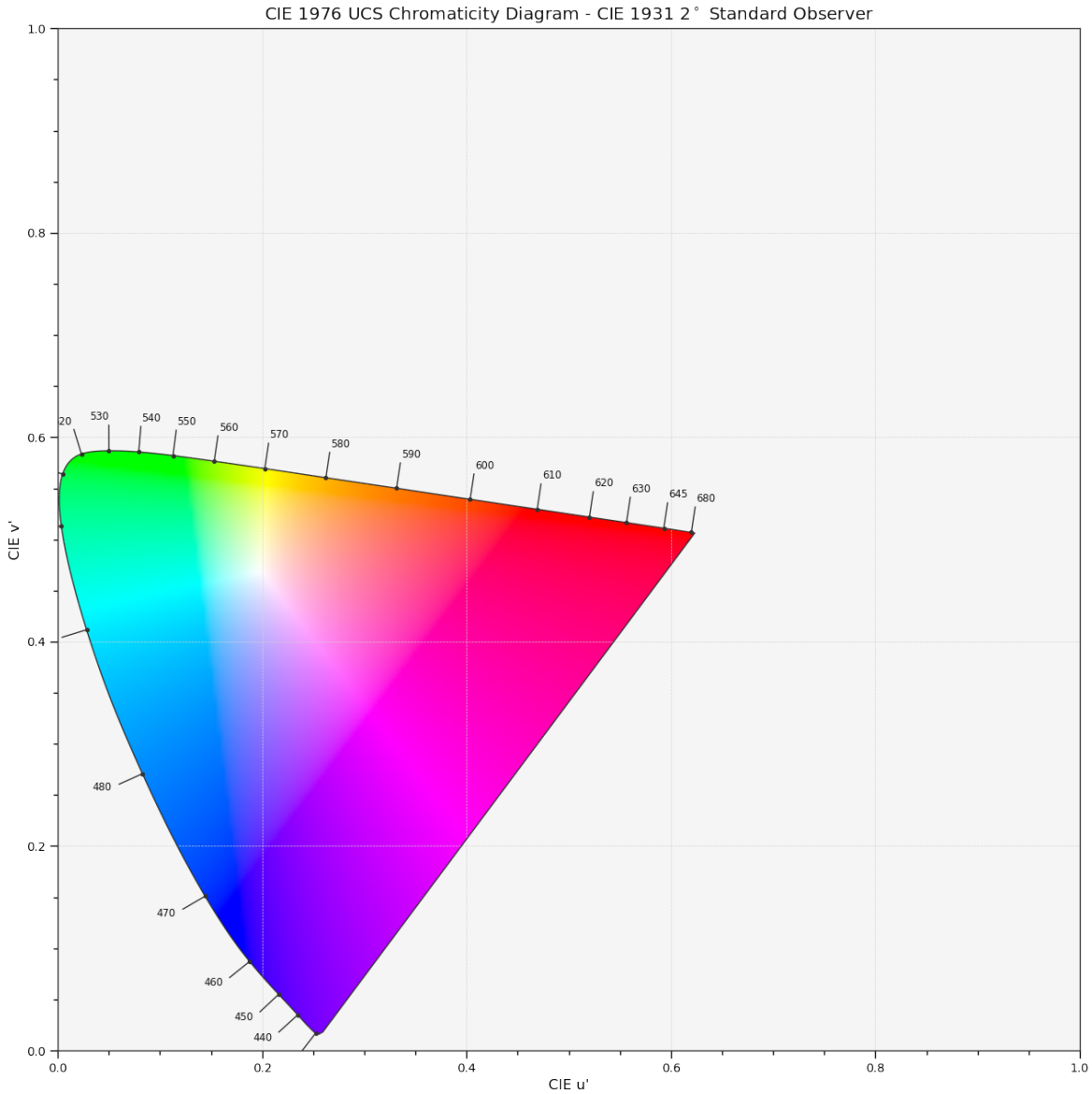
Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.diagrams.plot_chromaticity_diagram(), colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_chromaticity_diagram_CIE1976UCS()  # doctest: +SKIP
```



colour.plotting.plot_sds_in_chromaticity_diagram_CIE1931

colour.plotting.**plot_sds_in_chromaticity_diagram_CIE1931**(*sds*, *cmfs='CIE 1931 2 Degree Standard Observer'*, *annotate_parameters=None*, *chromaticity_diagram_callable_CIE1931=<function plot_chromaticity_diagram_CIE1931>*, ***kwargs*)

Plots given spectral distribution chromaticity coordinates into the *CIE 1931 Chromaticity Diagram*.

Parameters

- **sds** (array_like, optional) – Spectral distributions to plot.
- **cmfs** (unicode, optional) – Standard observer colour matching functions used for *Chromaticity Diagram* bounds.

- **annotate_parameters** (dict or array_like, optional) – Parameters for the plt.annotate() definition, used to annotate the resulting chromaticity coordinates with their respective spectral distribution names if annotate is set to *True*. annotate_parameters 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.
- **chromaticity_diagram_callable_CIE1931** (callable, optional) – Callable responsible for drawing the *CIE 1931 Chromaticity Diagram*.

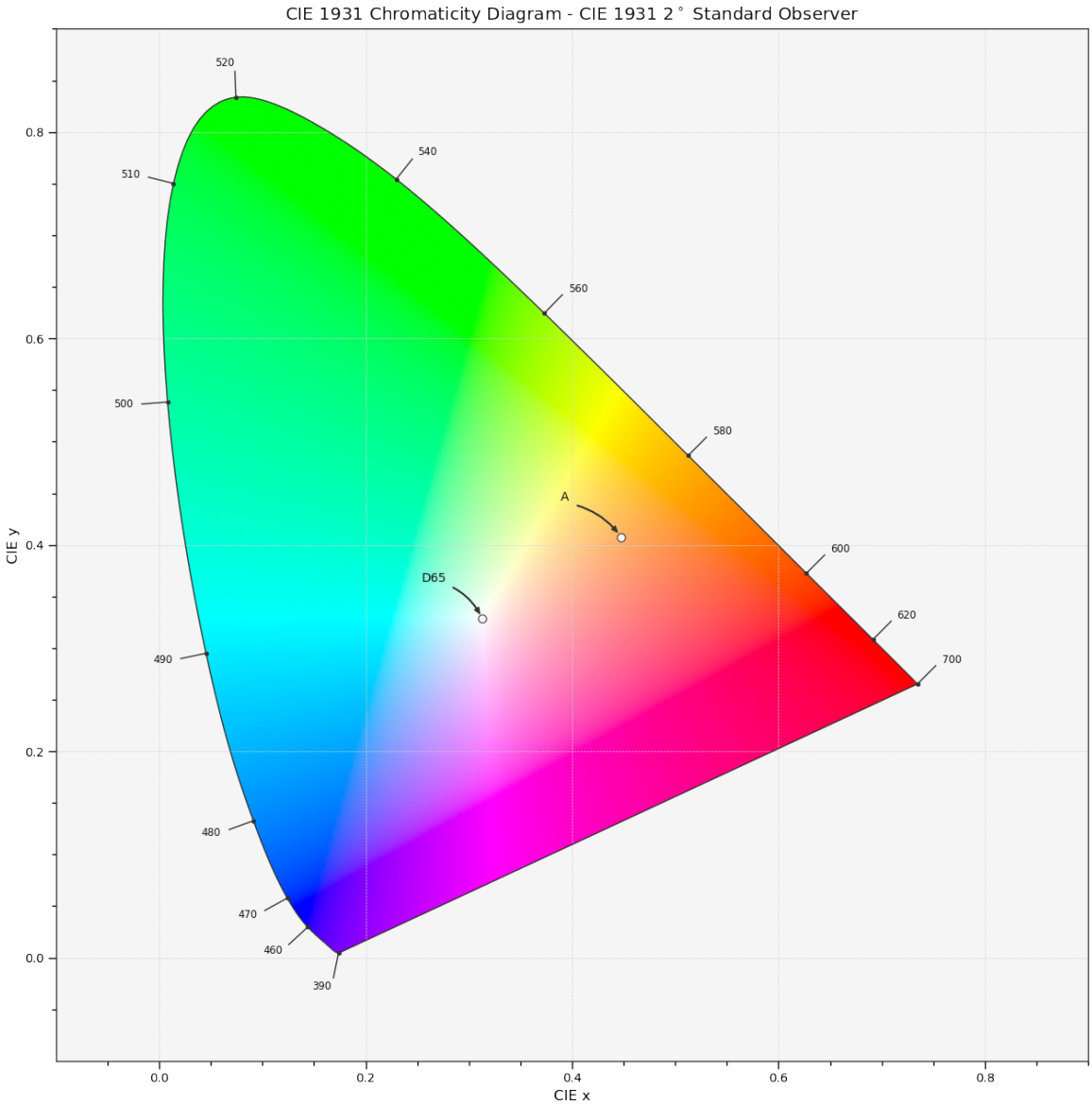
Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.diagrams.plot_chromaticity_diagram(), colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> from colour import ILLUMINANTS_SDS
>>> A = ILLUMINANTS_SDS['A']
>>> D65 = ILLUMINANTS_SDS['D65']
>>> plot_sds_in_chromaticity_diagram_CIE1931([A, D65])  # doctest: +SKIP
```



colour.plotting.plot_sds_in_chromaticity_diagram_CIE1960UCS

`colour.plotting.`**`plot_sds_in_chromaticity_diagram_CIE1960UCS`**(*sds*, *cmfs='CIE 1931 2 Degree Standard Observer'*, *annotate_parameters=None*, *chromaticity_diagram_callable_CIE1960UCS=<function plot_chromaticity_diagram_CIE1960UCS>*, ***kwargs*)

Plots given spectral distribution chromaticity coordinates into the *CIE 1960 UCS Chromaticity Diagram*.

Parameters

- **sds** (`array_like, optional`) – Spectral distributions to plot.
- **cmfs** (`unicode, optional`) – Standard observer colour matching functions used for

Chromaticity Diagram bounds.

- **annotate_parameters** (dict or array_like, optional) – Parameters for the plt.annotate() definition, used to annotate the resulting chromaticity coordinates with their respective spectral distribution names if annotate is set to *True*. annotate_parameters 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.
- **chromaticity_diagram_callable_CIE1960UCS** (callable, optional) – Callable responsible for drawing the *CIE 1960 UCS Chromaticity Diagram*.

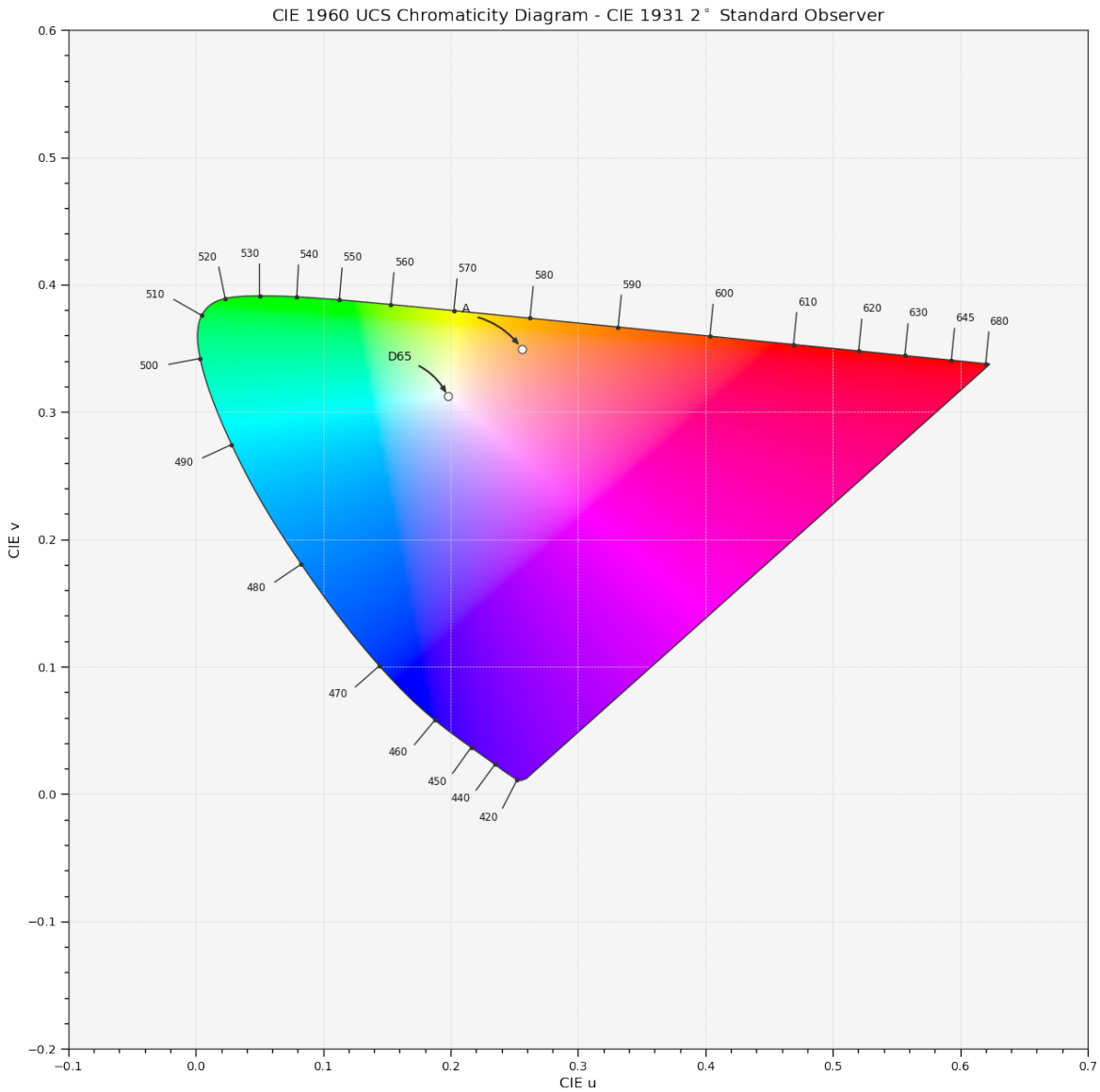
Other Parameters **kwargs (*dict, optional*) – {colour.plotting.artist(), colour.plotting.diagrams.plot_chromaticity_diagram(), colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> from colour import ILLUMINANTS_SDS
>>> A = ILLUMINANTS_SDS['A']
>>> D65 = ILLUMINANTS_SDS['D65']
>>> plot_sds_in_chromaticity_diagram_CIE1960UCS([A, D65])
... # doctest: +SKIP
```



colour.plotting.plot_sds_in_chromaticity_diagram_CIE1976UCS

`colour.plotting.`**`plot_sds_in_chromaticity_diagram_CIE1976UCS`**(*sds, cmfs='CIE 1931 2 Degree Standard Observer', annotate_parameters=None, chromaticity_diagram_callable_CIE1976UCS=<function plot_chromaticity_diagram_CIE1976UCS>, **kwargs*)

Plots given spectral distribution chromaticity coordinates into the *CIE 1976 UCS Chromaticity Diagram*.

Parameters

- **sds** (`array_like, optional`) – Spectral distributions to plot.
- **cmfs** (`unicode, optional`) – Standard observer colour matching functions used for

Chromaticity Diagram bounds.

- **annotate_parameters** (dict or array_like, optional) – Parameters for the plt.annotate() definition, used to annotate the resulting chromaticity coordinates with their respective spectral distribution names if annotate is set to *True*. annotate_parameters 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.
- **chromaticity_diagram_callable_CIE1976UCS** (callable, optional) – Callable responsible for drawing the *CIE 1976 UCS Chromaticity Diagram*.

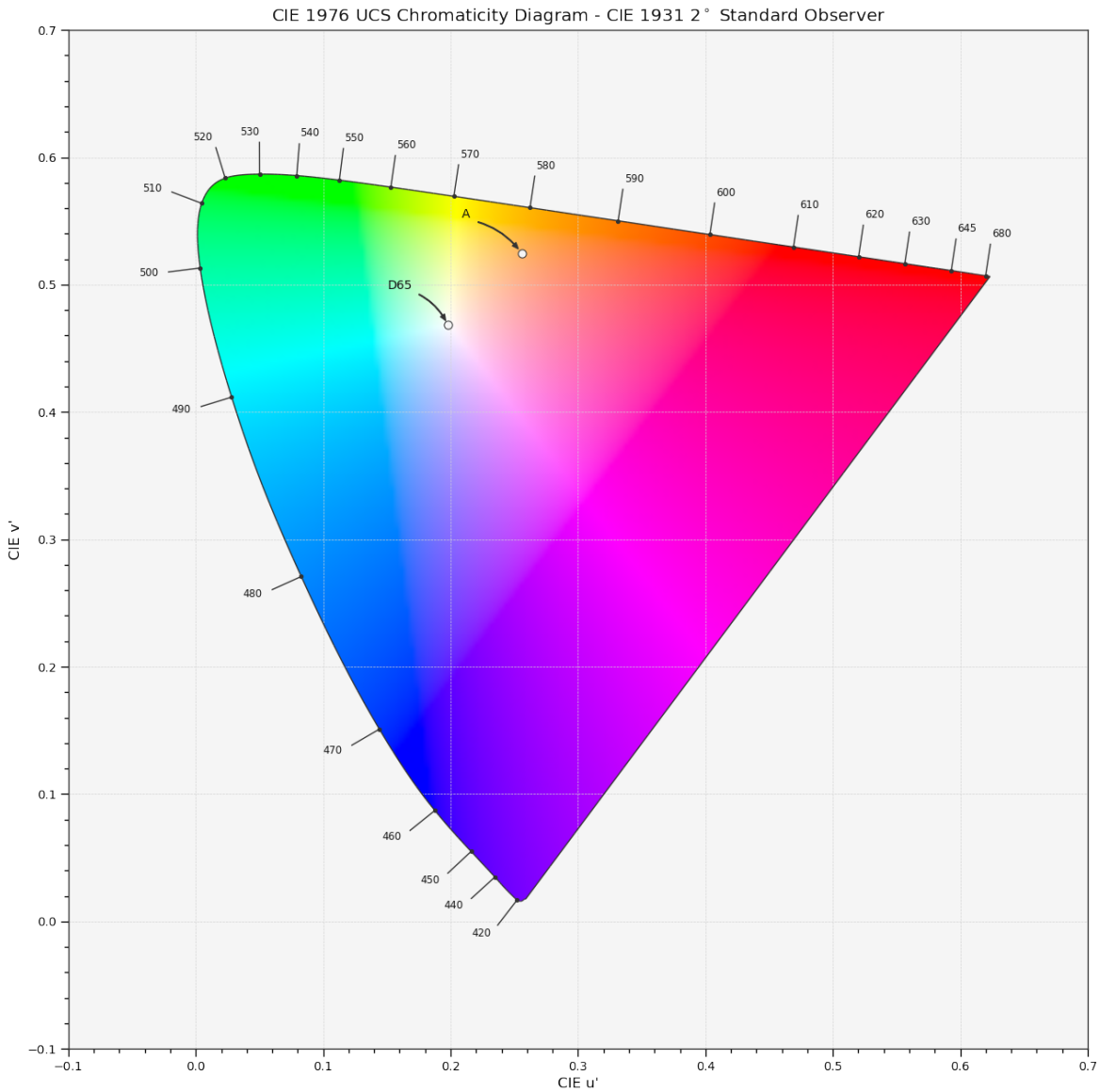
Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.diagrams.plot_chromaticity_diagram(), colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> from colour import ILLUMINANTS_SDS
>>> A = ILLUMINANTS_SDS['A']
>>> D65 = ILLUMINANTS_SDS['D65']
>>> plot_sds_in_chromaticity_diagram_CIE1976UCS([A, D65])
... # doctest: +SKIP
```



Ancillary Objects

`colour.plotting.diagrams`

`plot_spectral_locus`([cmfs, ...])	Plots the *Spectral Locus* according to given method.
`plot_chromaticity_diagram_colours`([samples, ...])	Plots the *Chromaticity Diagram* colours according to given method.
`plot_chromaticity_diagram`([cmfs, ...])	Plots the *Chromaticity Diagram* according to given method.
`plot_sds_in_chromaticity_diagram`(sds[, ...])	Plots given spectral distribution chromaticity coordinates into the *Chromaticity Diagram* using given method.

colour.plotting.diagrams.plot_spectral_locus

`colour.plotting.diagrams.`**`plot_spectral_locus`**(*cmfs='CIE 1931 2 Degree Standard Observer', spectral_locus_colours=None, spectral_locus_labels=None, method='CIE 1931', **kwargs*)

Plots the *Spectral Locus* according to given method.

Parameters

- **cmfs** (unicode, optional) – Standard observer colour matching functions defining the *Spectral Locus*.
- **spectral_locus_colours** (array_like or unicode, optional) – *Spectral Locus* colours, if spectral_locus_colours is set to *RGB*, the colours will be computed according to the corresponding chromaticity coordinates.
- **spectral_locus_labels** (array_like, optional) – 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** (unicode, optional) – **{'CIE 1931', 'CIE 1960 UCS', 'CIE 1976 UCS'}**, *Chromaticity Diagram* method.

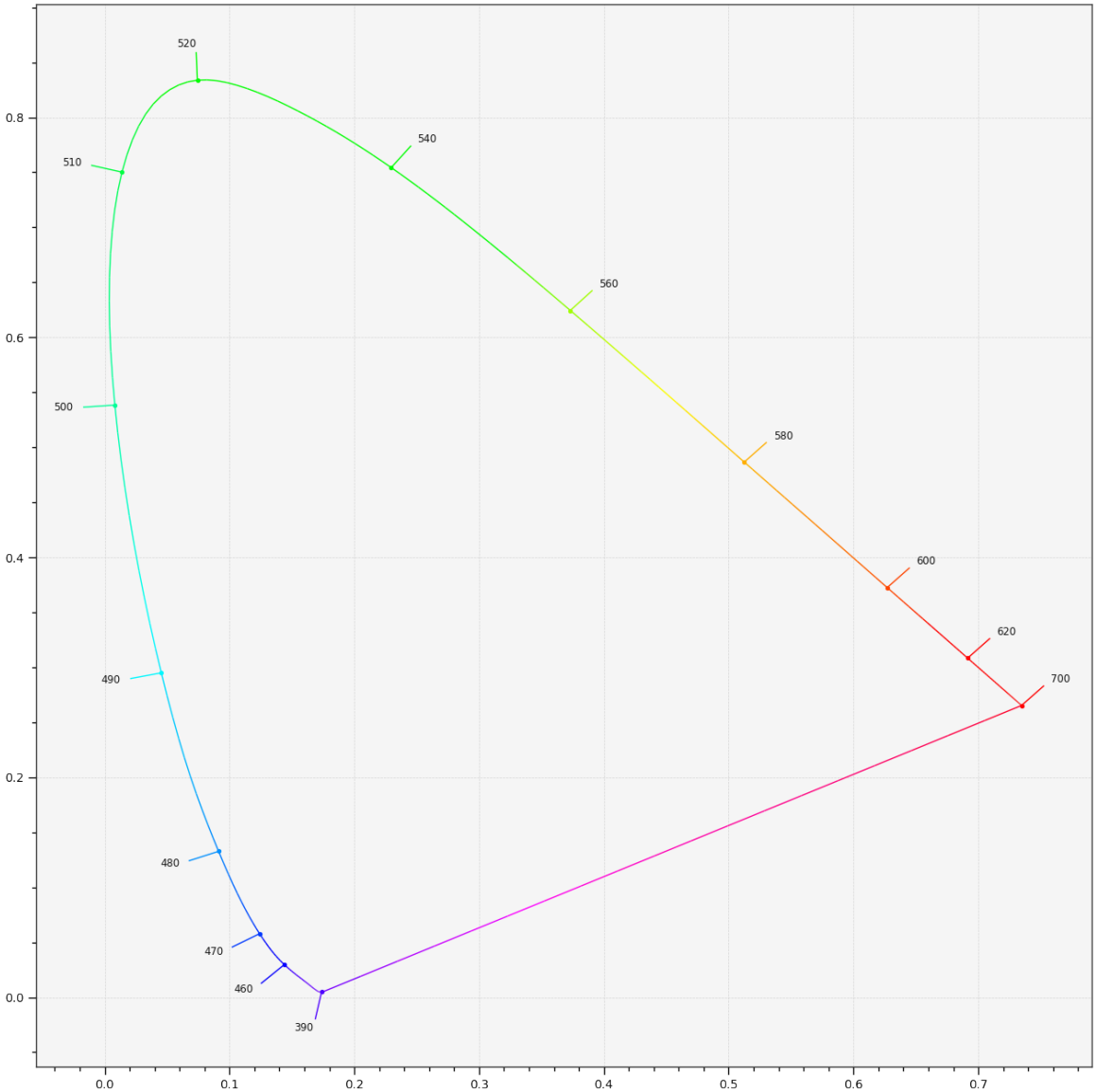
Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_spectral_locus(spectral_locus_colours='RGB')  # doctest: +SKIP
```



colour.plotting.diagrams.plot_chromaticity_diagram_colours

`colour.plotting.diagrams.`**`plot_chromaticity_diagram_colours`**(*samples=256, diagram_opacity=1.0, diagram_clipping_path=None, cmfs='CIE 1931 2 Degree Standard Observer', method='CIE 1931', **kwargs*)

Plots the *Chromaticity Diagram* colours according to given method.

Parameters

- **samples** (numeric, optional) – Samples count on one axis.
- **diagram_opacity** (numeric, optional) – Opacity of the *Chromaticity Diagram* colours.

- **diagram_clipping_path** (array_like, optional) – Path of points used to clip the *Chromaticity Diagram* colours.
- **cmfs** (unicode, optional) – Standard observer colour matching functions used for *Chromaticity Diagram* bounds.
- **method** (unicode, optional) – **{'CIE 1931', 'CIE 1960 UCS', 'CIE 1976 UCS'}**, *Chromaticity Diagram* method.

Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_chromaticity_diagram_colours()  # doctest: +SKIP
```

colour.plotting.diagrams.plot_chromaticity_diagram

`colour.plotting.diagrams.`**`plot_chromaticity_diagram`**(*cmfs='CIE 1931 2 Degree Standard Observer', show_diagram_colours=True, show_spectral_locus=True, method='CIE 1931', **kwargs*)

Plots the *Chromaticity Diagram* according to given method.

Parameters

- **cmfs** (unicode, optional) – Standard observer colour matching functions used for *Chromaticity Diagram* bounds.
- **show_diagram_colours** (bool, optional) – Whether to display the *Chromaticity Diagram* background colours.
- **show_spectral_locus** (bool, optional) – Whether to display the *Spectral Locus*.

- **method** (unicode, optional) – **{'CIE 1931', 'CIE 1960 UCS', 'CIE 1976 UCS'}**, *Chromaticity Diagram* method.

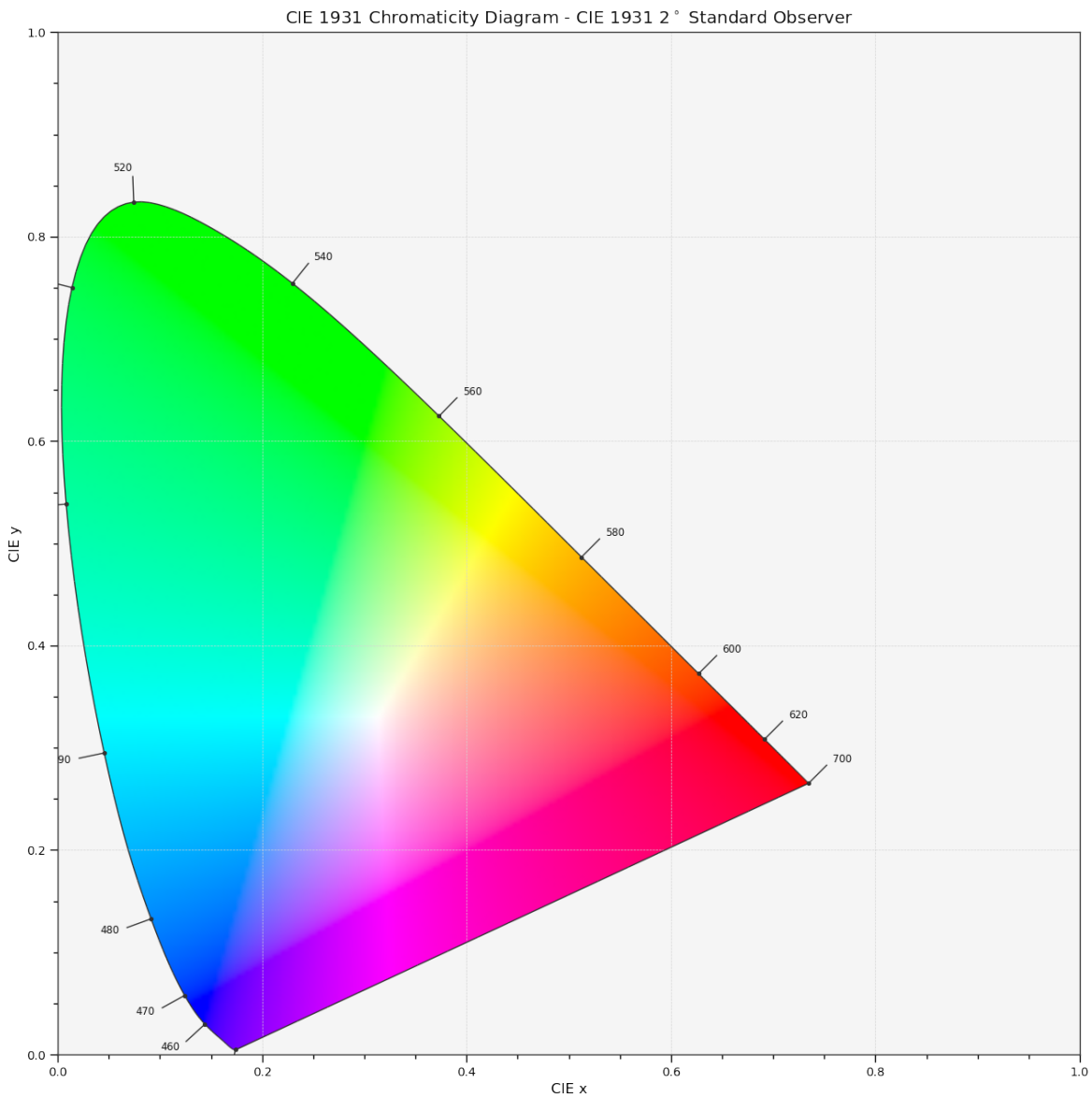
Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.diagrams.plot_spectral_locus(), colour.plotting.diagrams.plot_chromaticity_diagram_colours(), colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_chromaticity_diagram()  # doctest: +SKIP
```



colour.plotting.diagrams.plot_sds_in_chromaticity_diagram

colour.plotting.diagrams.**plot_sds_in_chromaticity_diagram**(*sds, cmfs='CIE 1931 2 Degree Standard Observer', annotate_parameters=None, chromaticity_diagram_callable=<function plot_chromaticity_diagram>, method='CIE 1931', **kwargs*)

Plots given spectral distribution chromaticity coordinates into the *Chromaticity Diagram* using given method.

Parameters

- **sds** (array_like, optional) – Spectral distributions to plot.
- **cmfs** (unicode, optional) – Standard observer colour matching functions used for *Chromaticity Diagram* bounds.
- **annotate_parameters** (dict or array_like, optional) – Parameters for the plt.annotate() definition, used to annotate the resulting chromaticity coordinates with their respective spectral distribution names if annotate is set to *True*. annotate_parameters 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.
- **chromaticity_diagram_callable** (callable, optional) – Callable responsible for drawing the *Chromaticity Diagram*.
- **method** (unicode, optional) – **{'CIE 1931', 'CIE 1960 UCS', 'CIE 1976 UCS'}**, *Chromaticity Diagram* method.

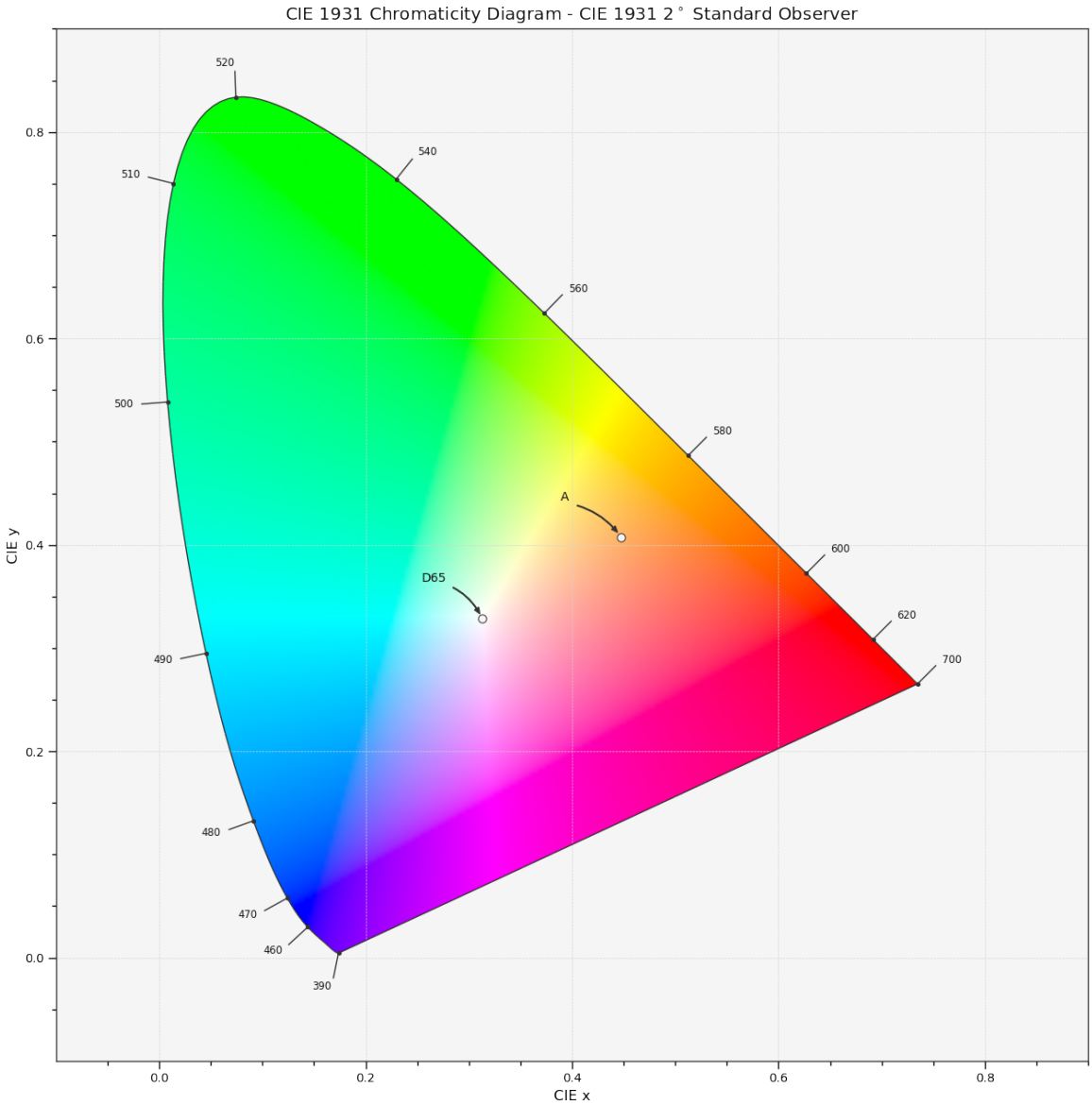
Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.diagrams.plot_chromaticity_diagram(), colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> from colour import ILLUMINANTS_SDS
>>> A = ILLUMINANTS_SDS['A']
>>> D65 = ILLUMINANTS_SDS['D65']
>>> plot_sds_in_chromaticity_diagram([A, D65])  # doctest: +SKIP
```



Colour Models

`colour.plotting`

`plot_RGB_colourspaces_in_chromaticity_diagram_CIE1931(...)`	Plots given *RGB* colourspaces in the *CIE 1931 Chromaticity Diagram*.
`plot_RGB_colourspaces_in_chromaticity_diagram_CIE1960UCS(...)`	Plots given *RGB* colourspaces in the *CIE 1960 UCS Chromaticity Diagram*.
`plot_RGB_colourspaces_in_chromaticity_diagram_CIE1976UCS(...)`	Plots given *RGB* colourspaces in the *CIE 1976 UCS Chromaticity Diagram*.
`plot_RGB_chromaticities_in_chromaticity_diagram_CIE1931(...)`	Plots given *RGB* colourspace array in the *CIE 1931 Chromaticity Diagram*.

Continued on next page

Table 247 – continued from previous page

plot_RGB_chromaticities_in_chromaticity_diagram_CIE1960UCS(RGB)	Plots given *RGB* colourspace array in the *CIE 1960 UCS Chromaticity Diagram*.
plot_RGB_chromaticities_in_chromaticity_diagram_CIE1976UCS(RGB)	Plots given *RGB* colourspace array in the *CIE 1976 UCS Chromaticity Diagram*.
plot_ellipses_MacAdam1942_in_chromaticity_diagram_CIE1931([...])	Plots *MacAdam (1942) Ellipses (Observer PGN)* in the *CIE 1931 Chromaticity Diagram*.
plot_ellipses_MacAdam1942_in_chromaticity_diagram_CIE1960UCS([...])	Plots *MacAdam (1942) Ellipses (Observer PGN)* in the *CIE 1960 UCS Chromaticity Diagram*.
plot_ellipses_MacAdam1942_in_chromaticity_diagram_CIE1976UCS([...])	Plots *MacAdam (1942) Ellipses (Observer PGN)* in the *CIE 1976 UCS Chromaticity Diagram*.
plot_single_cctf([cctf, decoding_cctf])	Plots given colourspace colour component transfer function.
plot_multi_cctfs([cctfs, decoding_cctf])	Plots given colour component transfer functions.

colour.plotting.plot_RGB_colourspaces_in_chromaticity_diagram_CIE1931

colour.plotting.**plot_RGB_colourspaces_in_chromaticity_diagram_CIE1931**(*colourspaces=None, cmfs='CIE 1931 2 Degree Standard Observer', chromaticity_diagram_callable_CIE1931=<function plot_chromaticity_diagram_CIE1931>, **kwargs*)

Plots given *RGB* colourspaces in the *CIE 1931 Chromaticity Diagram*.

Parameters

- **colourspaces** (array_like, optional) – *RGB* colourspaces to plot.
- **cmfs** (unicode, optional) – Standard observer colour matching functions used for *Chromaticity Diagram* bounds.
- **chromaticity_diagram_callable_CIE1931** (callable, optional) – Callable responsible for drawing the *CIE 1931 Chromaticity Diagram*.

Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.diagrams.plot_chromaticity_diagram(), colour.plotting.render()}, Please refer to 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'])
... # doctest: +SKIP
```

colour.plotting.plot_RGB_colourspaces_in_chromaticity_diagram_CIE1960UCS

`colour.plotting.`**`plot_RGB_colourspaces_in_chromaticity_diagram_CIE1960UCS`**(*colourspaces=None, cmfs='CIE 1931 2 Degree Standard Observer', chromaticity_diagram_callable_CIE1960UCS=<fun plot_chromaticity_diagram_CIE1960UCS> **kwargs*)

Plots given *RGB* colourspaces in the *CIE 1960 UCS Chromaticity Diagram*.

Parameters

- **colourspaces** (`array_like, optional`) – *RGB* colourspaces to plot.

- **cmfs** (unicode, optional) – Standard observer colour matching functions used for *Chromaticity Diagram* bounds.
- **chromaticity_diagram_callable_CIE1960UCS** (callable, optional) – Callable responsible for drawing the *CIE 1960 UCS Chromaticity Diagram*.

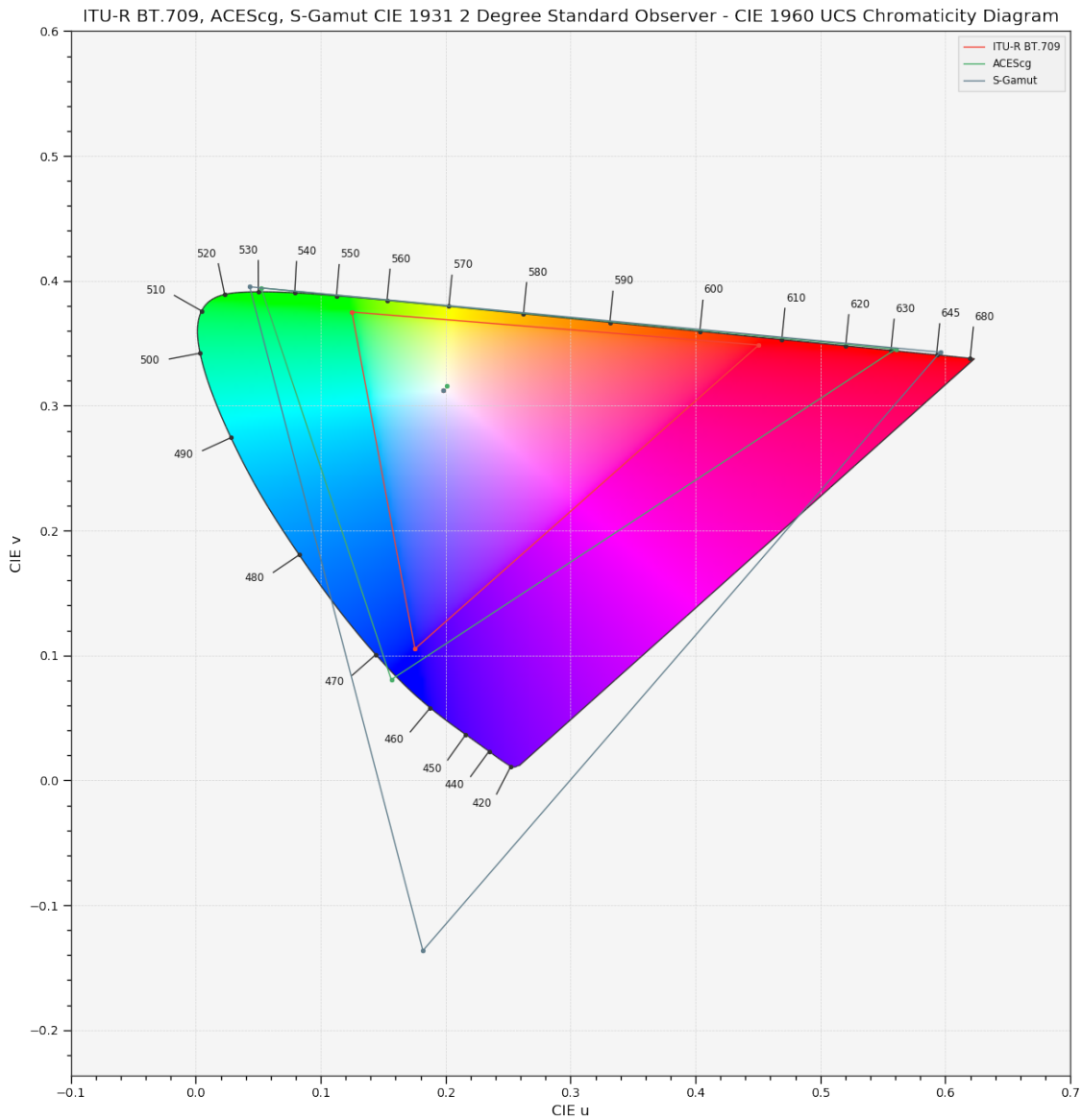
Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.diagrams.plot_chromaticity_diagram(), colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_RGB_colourspaces_in_chromaticity_diagram_CIE1960UCS((
...     ['ITU-R BT.709', 'ACEScg', 'S-Gamut'])
... # doctest: +SKIP
```



colour.plotting.plot_RGB_colourspaces_in_chromaticity_diagram_CIE1976UCS

colour.plotting.**plot_RGB_colourspaces_in_chromaticity_diagram_CIE1976UCS**(*colourspaces=None, cmfs='CIE 1931 2 Degree Standard Observer', chromaticity_diagram_callable_CIE1976UCS=<fun plot_chromaticity_diagram_CIE1976UCS **kwargs*)

Plots given *RGB* colourspaces in the *CIE 1976 UCS Chromaticity Diagram*.

Parameters

- **colourspaces** (array_like, optional) – *RGB* colourspaces to plot.

- **cmfs** (unicode, optional) – Standard observer colour matching functions used for *Chromaticity Diagram* bounds.
- **chromaticity_diagram_callable_CIE1976UCS** (callable, optional) – Callable responsible for drawing the *CIE 1976 UCS Chromaticity Diagram*.

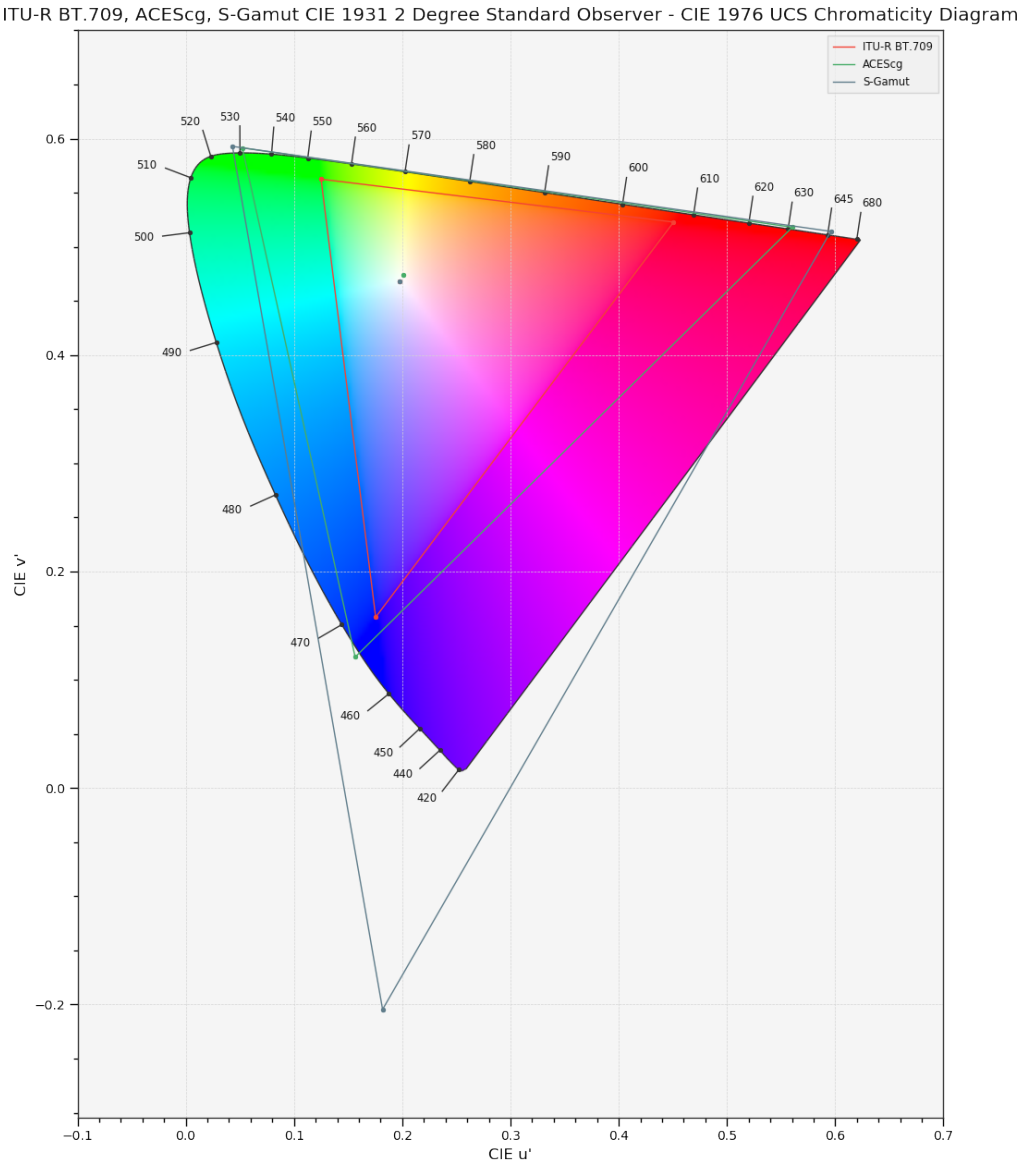
Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.diagrams.plot_chromaticity_diagram(), colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_RGB_colourspaces_in_chromaticity_diagram_CIE1976UCS((
...     ['ITU-R BT.709', 'ACEScg', 'S-Gamut'])
... # doctest: +SKIP
```



colour.plotting.plot_RGB_chromaticities_in_chromaticity_diagram_CIE1931

`colour.plotting.`**`plot_RGB_chromaticities_in_chromaticity_diagram_CIE1931`**(*RGB*, *colourspace='sRGB'*, *chromaticity_diagram_callable_CIE1931=<function plot_RGB_colourspaces_in_chromaticity_di*, *scatter_parameters=None*, ***kwargs*)

Plots given *RGB* colourspace array in the *CIE 1931 Chromaticity Diagram*.

Parameters

- **RGB** (`array_like`) – *RGB* colourspace array.

- **colourspace** (optional, unicode) – *RGB* colourspace of the *RGB* array.
- **chromaticity_diagram_callable_CIE1931** (callable, optional) – Callable responsible for drawing the *CIE 1931 Chromaticity Diagram*.
- **scatter_parameters** (dict, optional) – Parameters for the plt.scatter() definition, if c is set to *RGB*, the scatter will use given RGB colours.

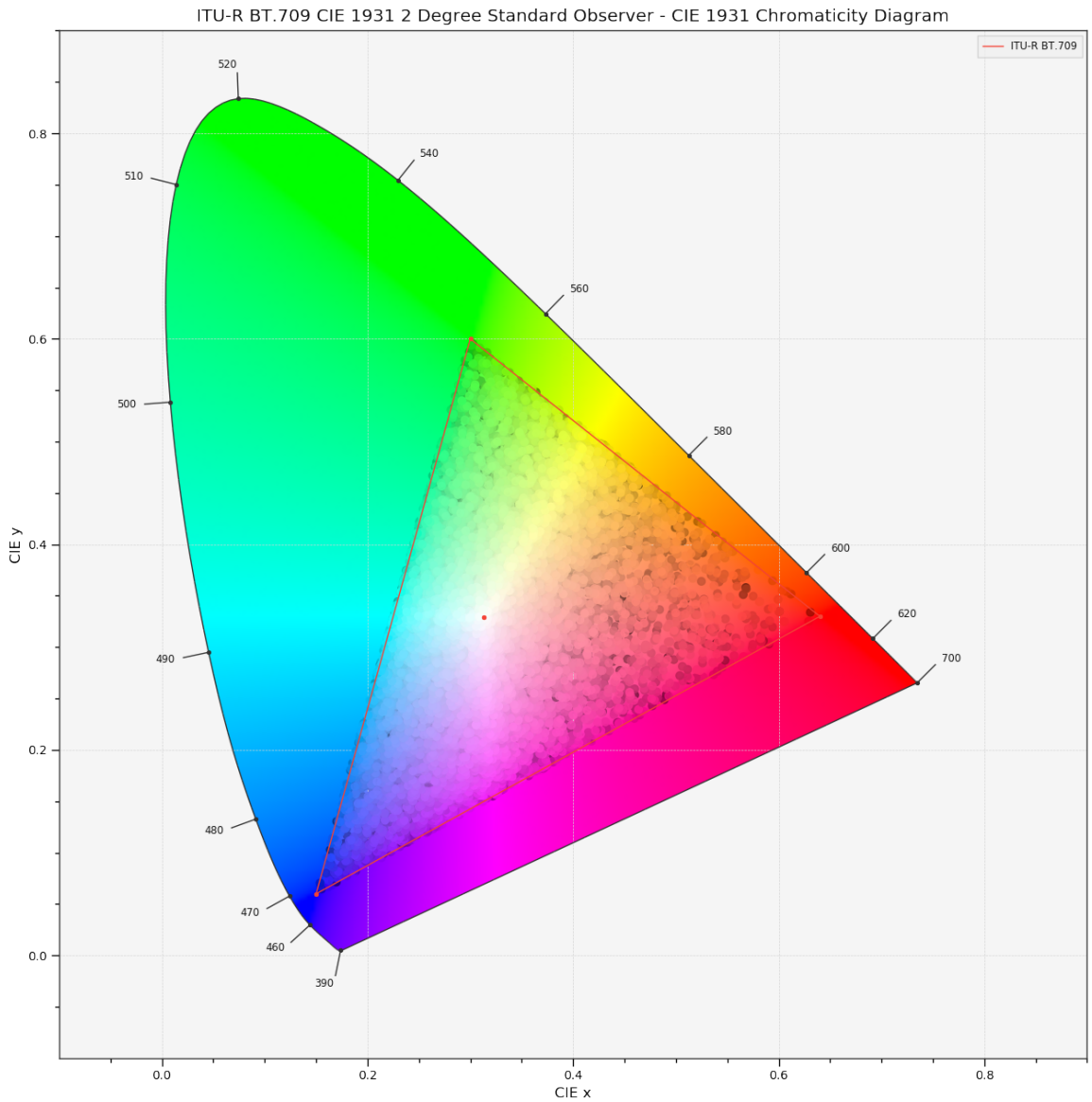
Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.diagrams.plot_chromaticity_diagram(), colour.plotting.diagrams.plot_RGB_colourspaces_in_chromaticity_diagram(), colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.

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')
... # doctest: +SKIP
```



colour.plotting.plot_RGB_chromaticities_in_chromaticity_diagram_CIE1960UCS

`colour.plotting.`**`plot_RGB_chromaticities_in_chromaticity_diagram_CIE1960UCS`**(*RGB*, *colourspace='sRGB'*, *chromaticity_diagram_callable_CIE1960UCS=<f plot_RGB_colourspaces_in_chromaticity scatter_parameters=None*, ***kwargs*)

Plots given *RGB* colourspace array in the *CIE 1960 UCS Chromaticity Diagram*.

Parameters

- **RGB** (`array_like`) – *RGB* colourspace array.

- **colourspace** (optional, unicode) – *RGB* colourspace of the *RGB* array.
- **chromaticity_diagram_callable_CIE1960UCS** (callable, optional) – Callable responsible for drawing the *CIE 1960 UCS Chromaticity Diagram*.
- **scatter_parameters** (dict, optional) – Parameters for the plt.scatter() definition, if c is set to *RGB*, the scatter will use given RGB colours.

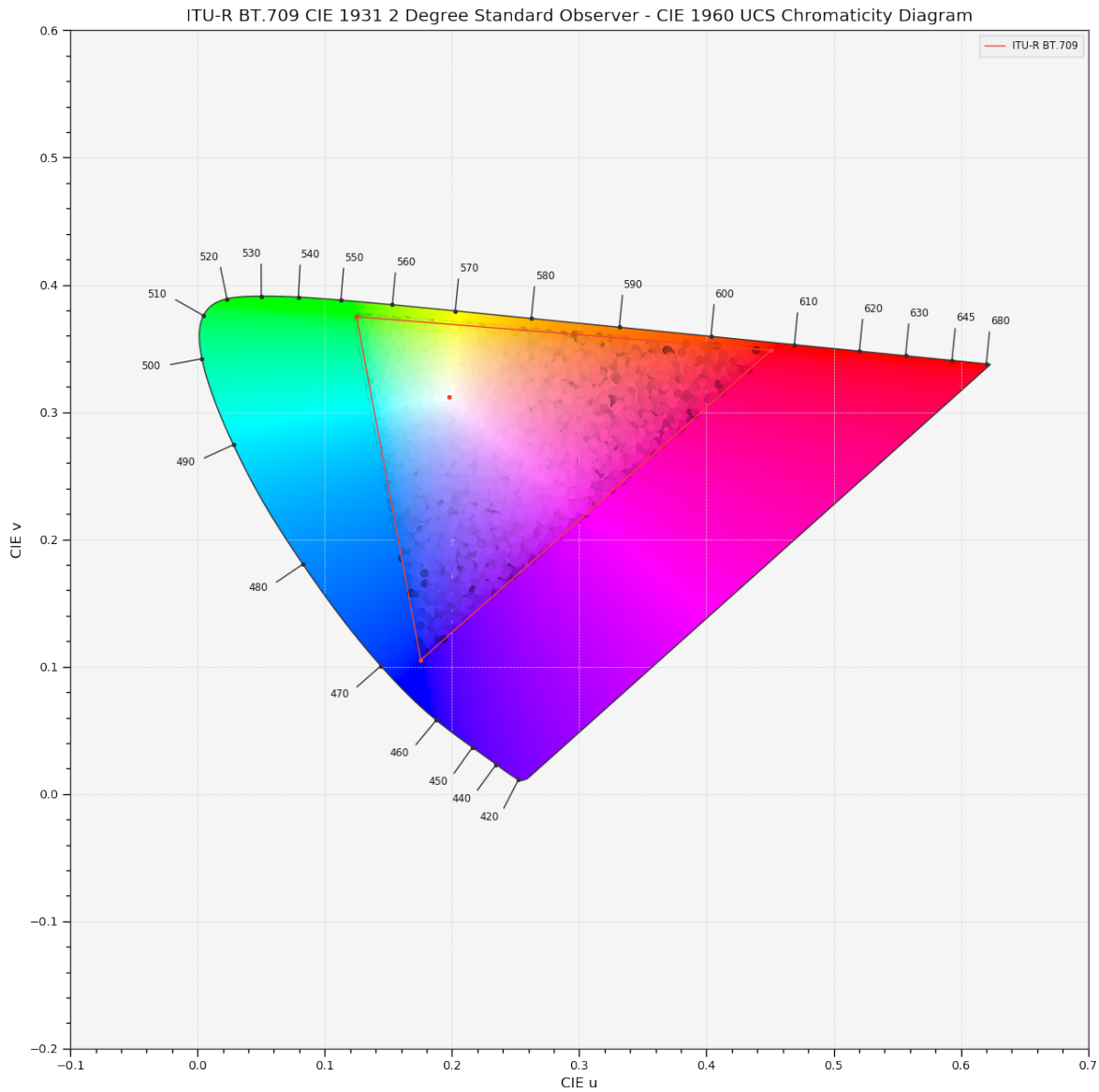
Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.diagrams.plot_chromaticity_diagram(), colour.plotting.diagrams.plot_RGB_colourspaces_in_chromaticity_diagram(), colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.

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')
... # doctest: +SKIP
```



colour.plotting.plot_RGB_chromaticities_in_chromaticity_diagram_CIE1976UCS

`colour.plotting.`**`plot_RGB_chromaticities_in_chromaticity_diagram_CIE1976UCS`**(*RGB*, *colourspace='sRGB'*, *chromaticity_diagram_callable_CIE1976UCS=<f*, *plot_RGB_colourspaces_in_chromaticity*, *scatter_parameters=None*, ***kwargs*)

Plots given *RGB* colourspace array in the *CIE 1976 UCS Chromaticity Diagram*.

Parameters

- **RGB** (`array_like`) – *RGB* colourspace array.

- **colourspace** (optional, unicode) – *RGB* colourspace of the *RGB* array.
- **chromaticity_diagram_callable_CIE1976UCS** (callable, optional) – Callable responsible for drawing the *CIE 1976 UCS Chromaticity Diagram*.
- **scatter_parameters** (dict, optional) – Parameters for the plt.scatter() definition, if c is set to *RGB*, the scatter will use given RGB colours.

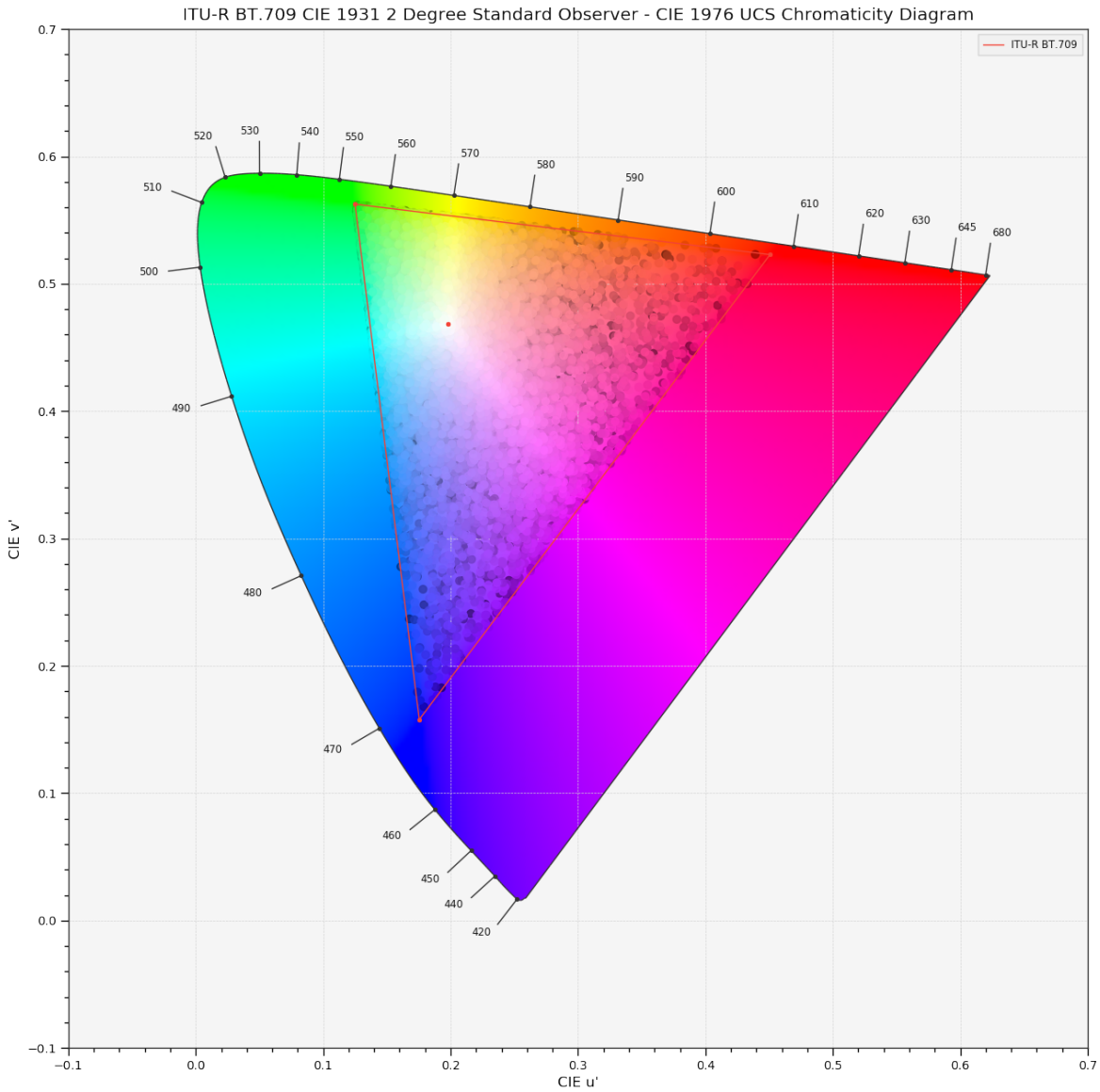
Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.diagrams.plot_chromaticity_diagram(), colour.plotting.diagrams.plot_RGB_colourspaces_in_chromaticity_diagram(), colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.

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')
... # doctest: +SKIP
```



colour.plotting.plot_ellipses_MacAdam1942_in_chromaticity_diagram_CIE1931

`colour.plotting.`**`plot_ellipses_MacAdam1942_in_chromaticity_diagram_CIE1931`**(*chromaticity_diagram_callable_CIE1931 plot_chromaticity_diagram_CIE1931>, chromaticity_diagram_clipping=False, ellipse_parameters=None, **kwargs*)

Plots *MacAdam (1942) Ellipses (Observer PGN)* in the *CIE 1931 Chromaticity Diagram*.

Parameters

- **`chromaticity_diagram_callable_CIE1931`** (`callable, optional`) – Callable responsible for drawing the *CIE 1931 Chromaticity Diagram*.

- **chromaticity_diagram_clipping** (bool, optional,) – Whether to clip the *CIE 1931 Chromaticity Diagram* colours with the ellipses.
- **ellipse_parameters** (dict or array_like, optional) – Parameters for the Ellipse class, ellipse_parameters 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.

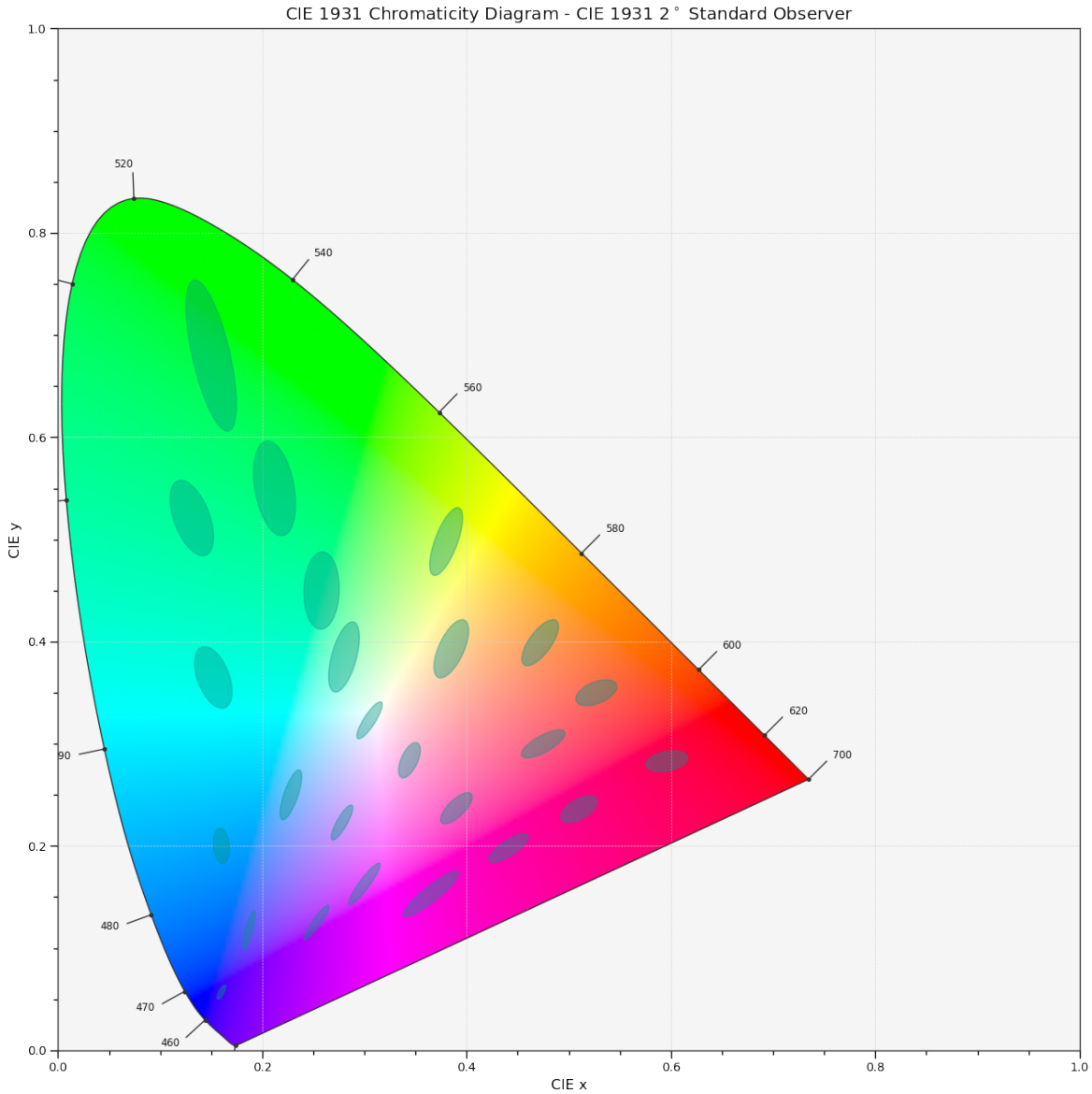
Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.diagrams.plot_chromaticity_diagram(), colour.plotting.models.plot_ellipses_MacAdam1942_in_chromaticity_diagram()}, colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_ellipses_MacAdam1942_in_chromaticity_diagram_CIE1931()
... # doctest: +SKIP
```



colour.plotting.plot_ellipses_MacAdam1942_in_chromaticity_diagram_CIE1960UCS

`colour.plotting.`**`plot_ellipses_MacAdam1942_in_chromaticity_diagram_CIE1960UCS`**(*chromaticity_diagram_callable_CIE19 plot_chromaticity_diagram_CIE1960 chromaticity_diagram_clipping=False, ellipse_parameters=None, **kwargs*)

Plots *MacAdam (1942) Ellipses (Observer PGN)* in the *CIE 1960 UCS Chromaticity Diagram*.

Parameters

- **`chromaticity_diagram_callable_CIE1960UCS`** (`callable, optional`) – Callable responsible for drawing the *CIE 1960 UCS Chromaticity Diagram*.

- **chromaticity_diagram_clipping** (bool, optional,) – Whether to clip the *CIE 1960 UCS Chromaticity Diagram* colours with the ellipses.
- **ellipse_parameters** (dict or array_like, optional) – Parameters for the Ellipse class, ellipse_parameters 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.

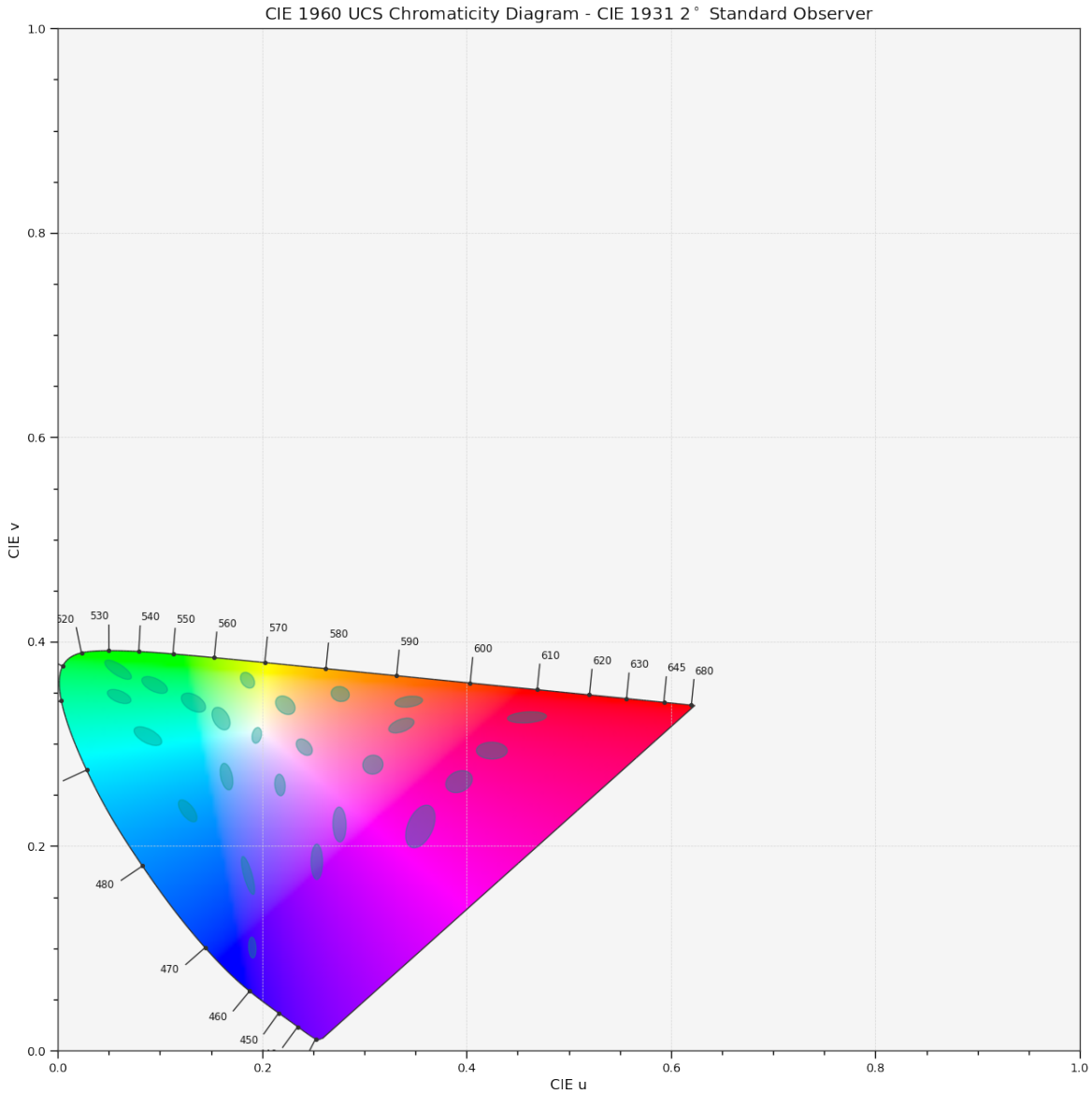
Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.diagrams.plot_chromaticity_diagram(), colour.plotting.models.plot_ellipses_MacAdam1942_in_chromaticity_diagram()}, colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_ellipses_MacAdam1942_in_chromaticity_diagram_CIE1960UCS()
... # doctest: +SKIP
```



colour.plotting.plot_ellipses_MacAdam1942_in_chromaticity_diagram_CIE1976UCS

`colour.plotting.`**`plot_ellipses_MacAdam1942_in_chromaticity_diagram_CIE1976UCS`**(*chromaticity_diagram_callable_CIE19 plot_chromaticity_diagram_CIE1976 chromaticity_diagram_clipping=False, ellipse_parameters=None, **kwargs*)

Plots *MacAdam (1942) Ellipses (Observer PGN)* in the *CIE 1976 UCS Chromaticity Diagram*.

Parameters

- **`chromaticity_diagram_callable_CIE1976UCS`** (`callable, optional`) – Callable responsible for drawing the *CIE 1976 UCS Chromaticity Diagram*.

- **chromaticity_diagram_clipping** (bool, optional,) – Whether to clip the *CIE 1976 UCS Chromaticity Diagram* colours with the ellipses.
- **ellipse_parameters** (dict or array_like, optional) – Parameters for the Ellipse class, ellipse_parameters 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.

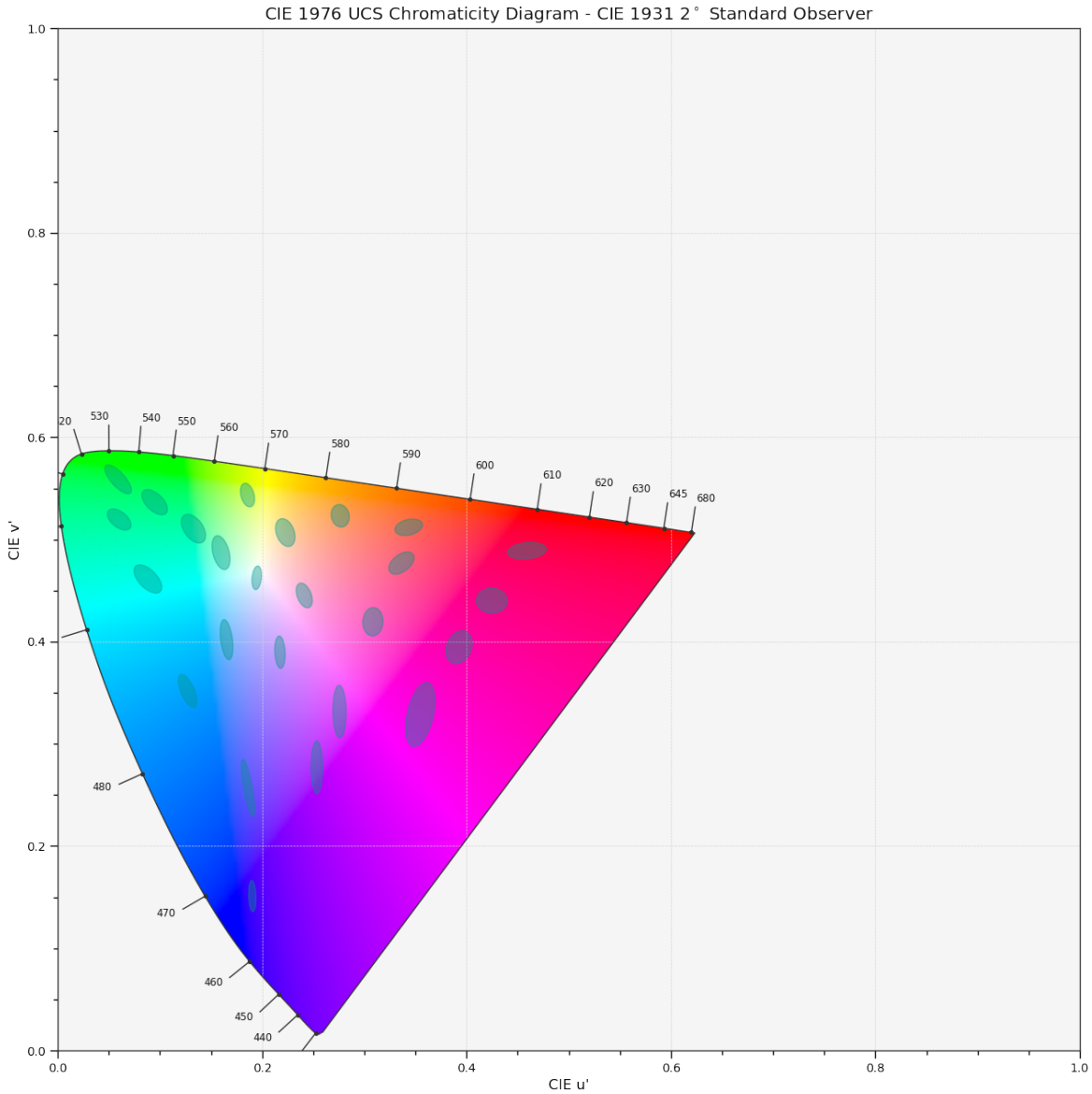
Other Parameters **kwargs (*dict, optional*) – {colour.plotting.artist(), colour.plotting.diagrams.plot_chromaticity_diagram(), colour.plotting.models.plot_ellipses_MacAdam1942_in_chromaticity_diagram()}, colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_ellipses_MacAdam1942_in_chromaticity_diagram_CIE1976UCS()
... # doctest: +SKIP
```



colour.plotting.plot_single_cctf

`colour.plotting.`**`plot_single_cctf`**(*cctf='ITU-R BT.709'*, *decoding_cctf=False*, ***kwargs*)

Plots given colourspace colour component transfer function.

Parameters

- **cctf** (`unicode, optional`) – Colour component transfer function to plot.
- **decoding_cctf** (`bool`) – Plot the decoding colour component transfer function instead.

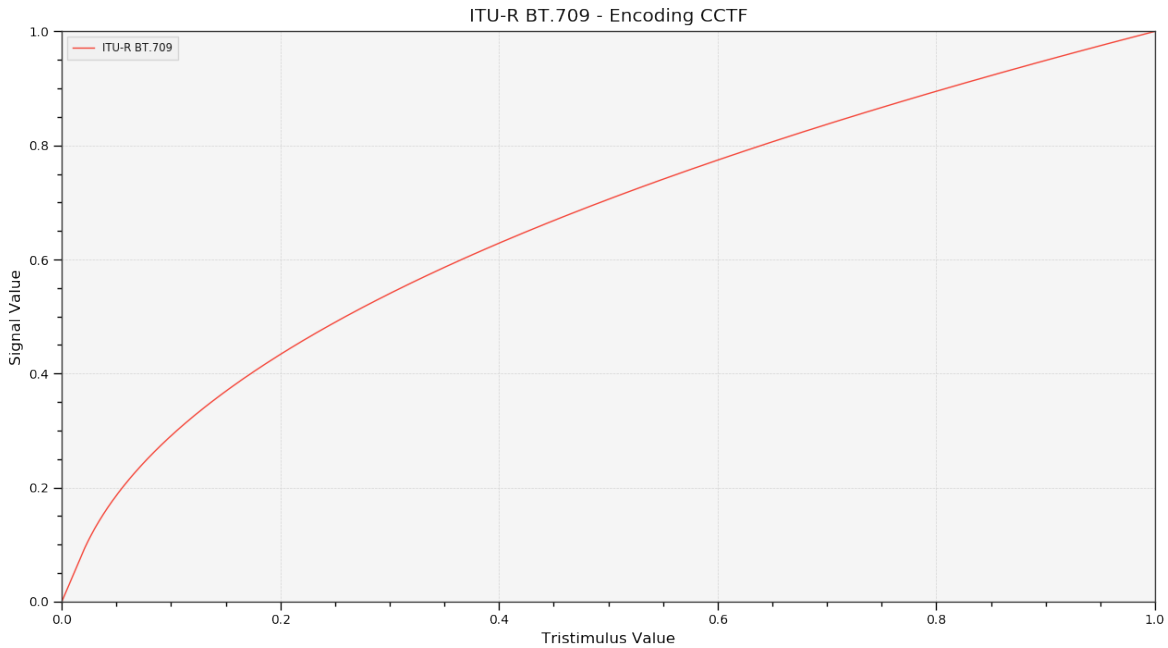
Other Parameters ****kwargs** (*dict, optional*) – {`colour.plotting.artist()`, `colour.plotting.plot_multi_functions()`, `colour.plotting.render()`}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_single_cctf('ITU-R BT.709')  # doctest: +SKIP
```



colour.plotting.plot_multi_cctfs

`colour.plotting.`**`plot_multi_cctfs`**(*cctfs=None*, *decoding_cctf=False*, ***kwargs*)

Plots given colour component transfer functions.

Parameters

- **cctfs** (`array_like, optional`) – Colour component transfer function to plot.
- **decoding_cctf** (`bool`) – Plot the decoding colour component transfer function instead.

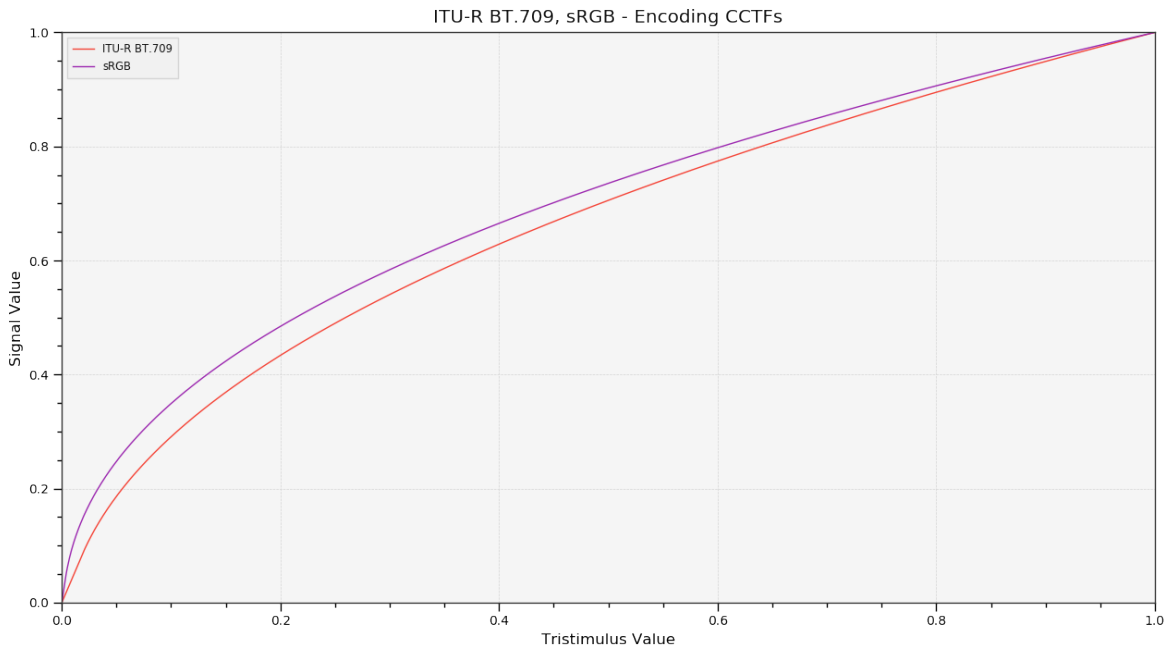
Other Parameters ****kwargs** (*dict, optional*) – {`colour.plotting.artist()`, `colour.plotting.plot_multi_functions()`, `colour.plotting.render()`}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_multi_cctfs(['ITU-R BT.709', 'sRGB'])  # doctest: +SKIP
```



Ancillary Objects

`colour.plotting.models`

`plot_pointer_gamut`([method])	Plots *Pointer's Gamut* according to given method.
`plot_RGB_colourspaces_in_chromaticity_diagram`([...]	Plots given *RGB* colourspaces in the *Chromaticity Diagram* according to given method.
`plot_RGB_chromaticities_in_chromaticity_diagram`(RGB, ...)	Plots given *RGB* colourspace array in the *Chromaticity Diagram* according to given method.

colour.plotting.models.plot_pointer_gamut

`colour.plotting.models.`**`plot_pointer_gamut`**(*method='CIE 1931', **kwargs*)

Plots *Pointer's Gamut* according to given method.

Parameters **`method`** (`unicode, optional`) – **{'CIE 1931', 'CIE 1960 UCS', 'CIE 1976 UCS'}**, Plotting method.

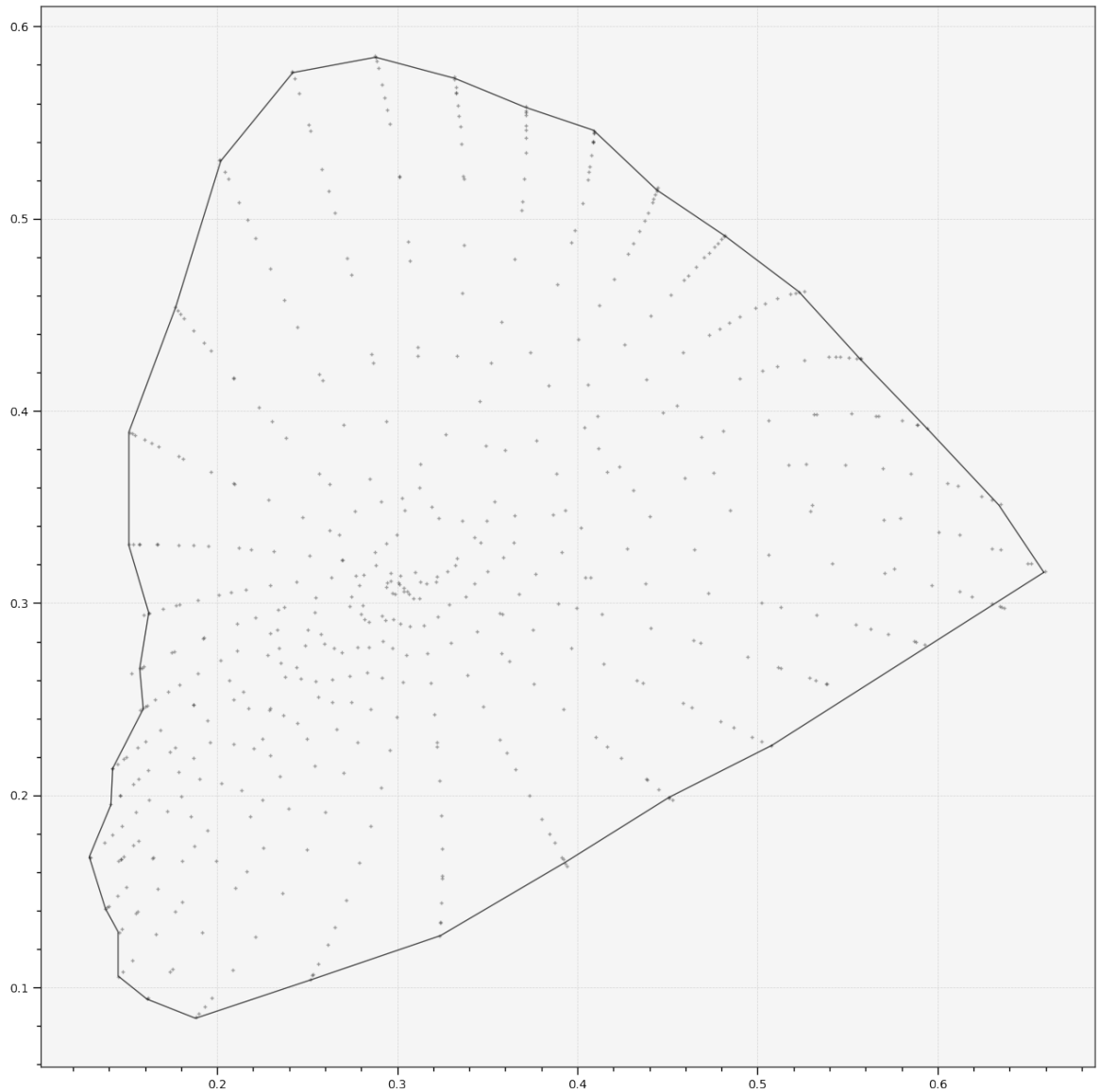
Other Parameters ****kwargs** (*dict, optional*) – {`colour.plotting.artist()`, `colour.plotting.render()`}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_pointer_gamut()  # doctest: +SKIP
```



colour.plotting.models.plot_RGB_colourspaces_in_chromaticity_diagram

`colour.plotting.models.`**`plot_RGB_colourspaces_in_chromaticity_diagram`**(*colourspaces=None, cmfs='CIE 1931 2 Degree Standard Observer', chromaticity_diagram_callable=<function plot_chromaticity_diagram>, method='CIE 1931', show_whitepoints=True, show_pointer_gamut=False, **kwargs*)

Plots given *RGB* colourspaces in the *Chromaticity Diagram* according to given method.

Parameters

- **colourspaces** (array_like, optional) – *RGB* colourspaces to plot.
- **cmfs** (unicode, optional) – Standard observer colour matching functions used for *Chromaticity Diagram* bounds.
- **chromaticity_diagram_callable** (callable, optional) – Callable responsible for drawing the *Chromaticity Diagram*.
- **method** (unicode, optional) – **{'CIE 1931', 'CIE 1960 UCS', 'CIE 1976 UCS'}**, *Chromaticity Diagram* method.
- **show_whitepoints** (bool, optional) – Whether to display the *RGB* colourspaces whitepoints.
- **show_pointer_gamut** (bool, optional) – Whether to display the *Pointer's Gamut*.

Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.diagrams.plot_chromaticity_diagram(), colour.plotting.plot_pointer_gamut(), colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_RGB_colourspaces_in_chromaticity_diagram(
...     ['ITU-R BT.709', 'ACEScg', 'S-Gamut'])
... # doctest: +SKIP
```

colour.plotting.models.plot_RGB_chromaticities_in_chromaticity_diagram

`colour.plotting.models.`**`plot_RGB_chromaticities_in_chromaticity_diagram`**(*RGB*, *colourspace='sRGB'*, *chromaticity_diagram_callable=<function plot_RGB_colourspaces_in_chromaticity_dia*, *method='CIE 1931'*, *scatter_parameters=None*, ***kwargs*)

Plots given *RGB* colourspace array in the *Chromaticity Diagram* according to given method.

Parameters

- **RGB** (`array_like`) – *RGB* colourspace array.

- **colourspace** (optional, unicode) – *RGB* colourspace of the *RGB* array.
- **chromaticity_diagram_callable** (callable, optional) – Callable responsible for drawing the *Chromaticity Diagram*.
- **method** (unicode, optional) – **{'CIE 1931', 'CIE 1960 UCS', 'CIE 1976 UCS'}**, *Chromaticity Diagram* method.
- **scatter_parameters** (dict, optional) – Parameters for the plt.scatter() definition, if c is set to *RGB*, the scatter will use given RGB colours.

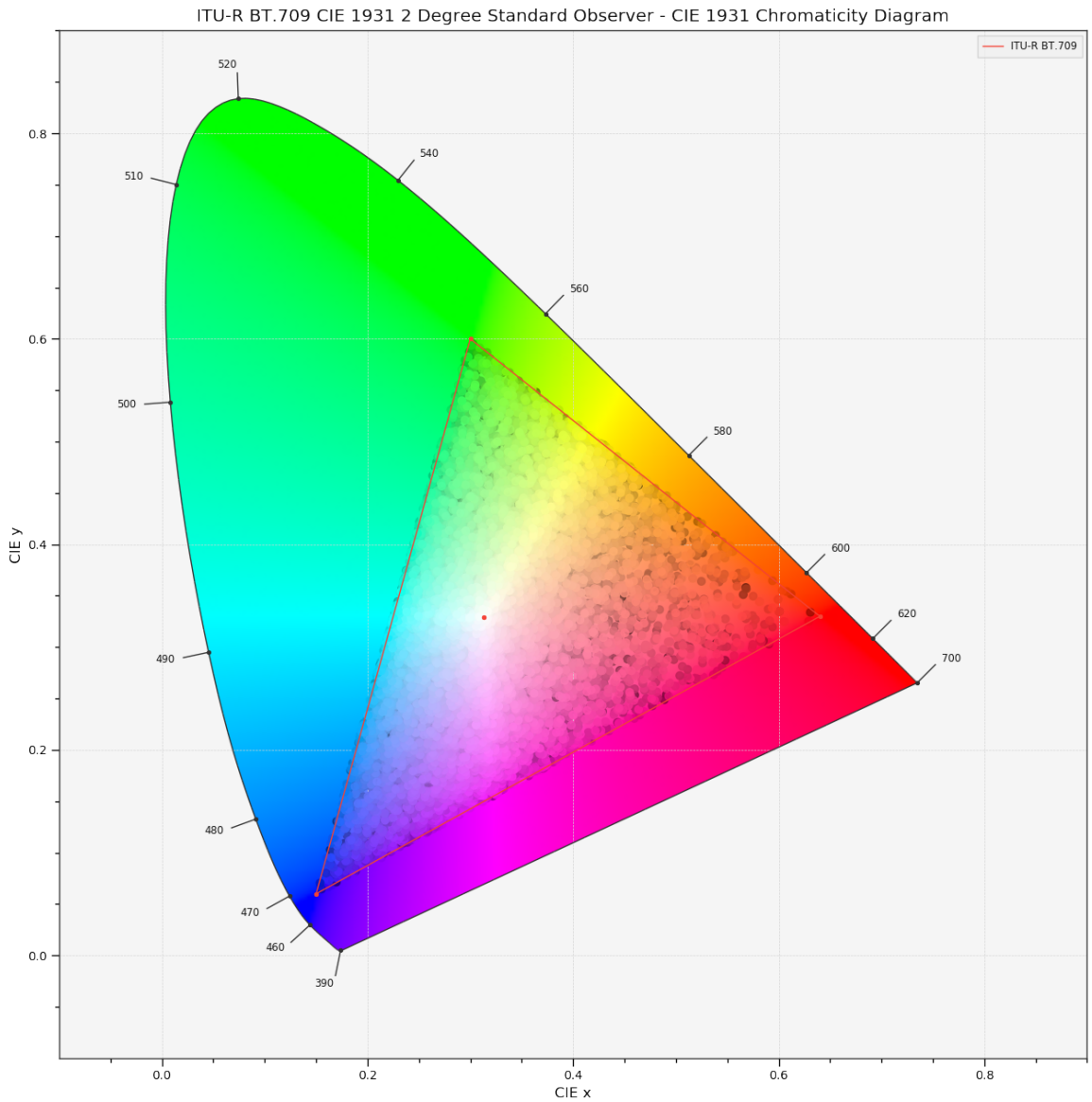
Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.diagrams.plot_chromaticity_diagram(), colour.plotting.diagrams.plot_RGB_colourspaces_in_chromaticity_diagram(), colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.

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')
... # doctest: +SKIP
```



Colour Notation Systems

`colour.plotting`

`plot_single_munsell_value_function`([function])	Plots given *Lightness* function.
`plot_multi_munsell_value_functions`([functions])	Plots given *Munsell* value functions.

colour.plotting.plot_single_munsell_value_function

`colour.plotting.`**`plot_single_munsell_value_function`**(*function='ASTM D1535-08', **kwargs*)

Plots given *Lightness* function.

Parameters **`function`** (`unicode, optional`) – *Munsell* value function to plot.

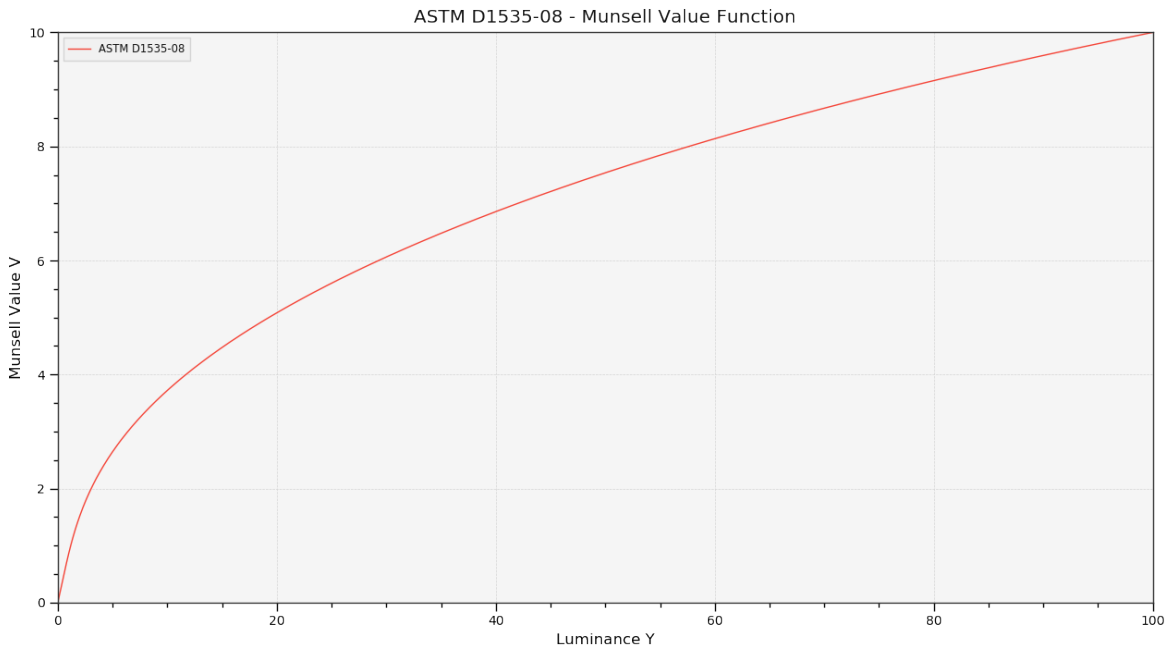
Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.plot_multi_functions(), colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_single_munsell_value_function('ASTM D1535-08')  # doctest: +SKIP
```



colour.plotting.plot_multi_munsell_value_functions

colour.plotting.**plot_multi_munsell_value_functions**(*functions=None*, ***kwargs*)

Plots given *Munsell* value functions.

Parameters **functions** (array_like, optional) – *Munsell* value functions to plot.

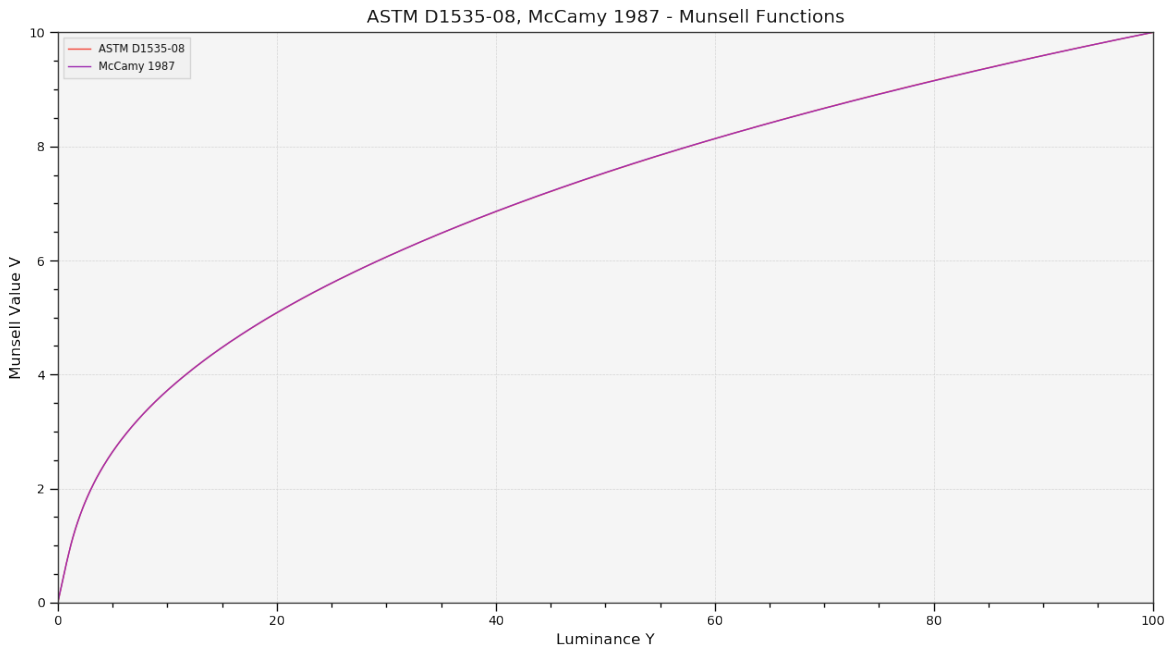
Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.plot_multi_functions(), colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_multi_munsell_value_functions(['ASTM D1535-08', 'McCamy 1987'])
... # doctest: +SKIP
```



Optical Phenomena

`colour.plotting`

`plot_single_sd_rayleigh_scattering`([...])	Plots a single *Rayleigh* scattering spectral distribution.
`plot_the_blue_sky`([cmfs])	Plots the blue sky.

colour.plotting.plot_single_sd_rayleigh_scattering

`colour.plotting.`**`plot_single_sd_rayleigh_scattering`**(*CO2_concentration=300, temperature=288.15, pressure=101325, latitude=0, altitude=0, cmfs='CIE 1931 2 Degree Standard Observer', **kwargs*)

Plots a single *Rayleigh* scattering spectral distribution.

Parameters

- **`CO2_concentration`** (`numeric, optional`) – CO_2 concentration in parts per million (ppm).
- **`temperature`** (`numeric, optional`) – Air temperature $T[K]$ in kelvin degrees.
- **`pressure`** (`numeric`) – Surface pressure P of the measurement site.
- **`latitude`** (`numeric, optional`) – Latitude of the site in degrees.
- **`altitude`** (`numeric, optional`) – Altitude of the site in meters.
- **`cmfs`** (`unicode, optional`) – Standard observer colour matching functions.

Other Parameters

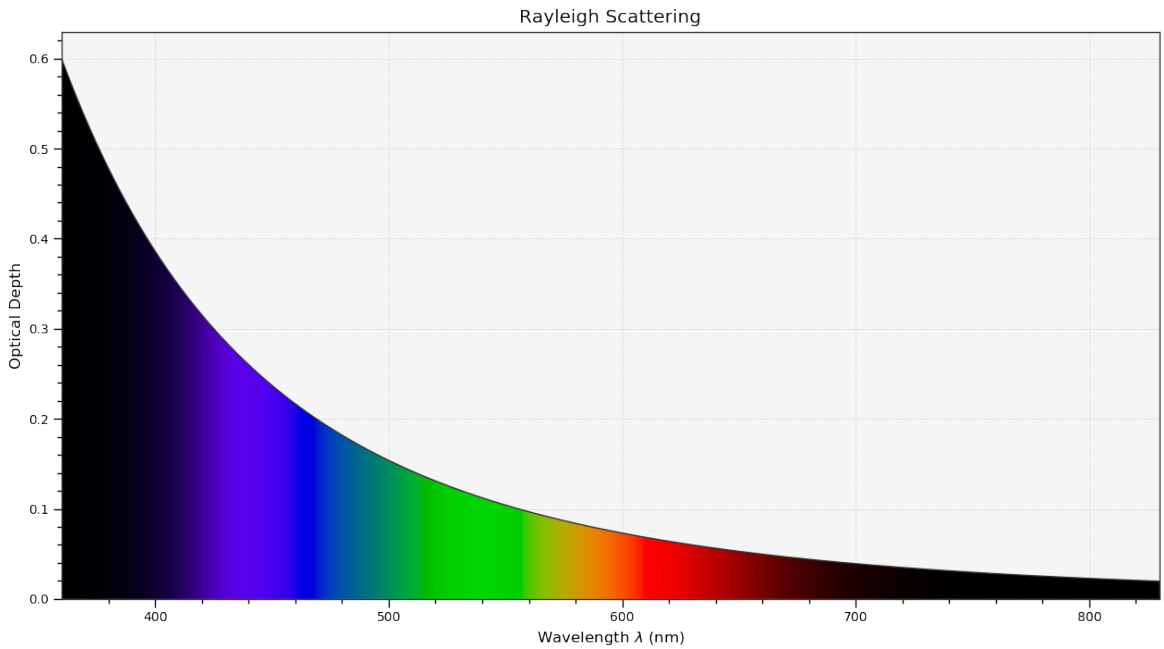
- ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.plot_single_sd(), colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.
- **out_of_gamut_clipping** (*bool, optional*) – {colour.plotting.plot_single_sd()}, Whether to clip out 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.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_single_sd_rayleigh_scattering()  # doctest: +SKIP
```



colour.plotting.plot_the_blue_sky

colour.plotting.**plot_the_blue_sky**(*cmfs='CIE 1931 2 Degree Standard Observer', **kwargs*)

Plots the blue sky.

Parameters **cmfs** (unicode, optional) – Standard observer colour matching functions.

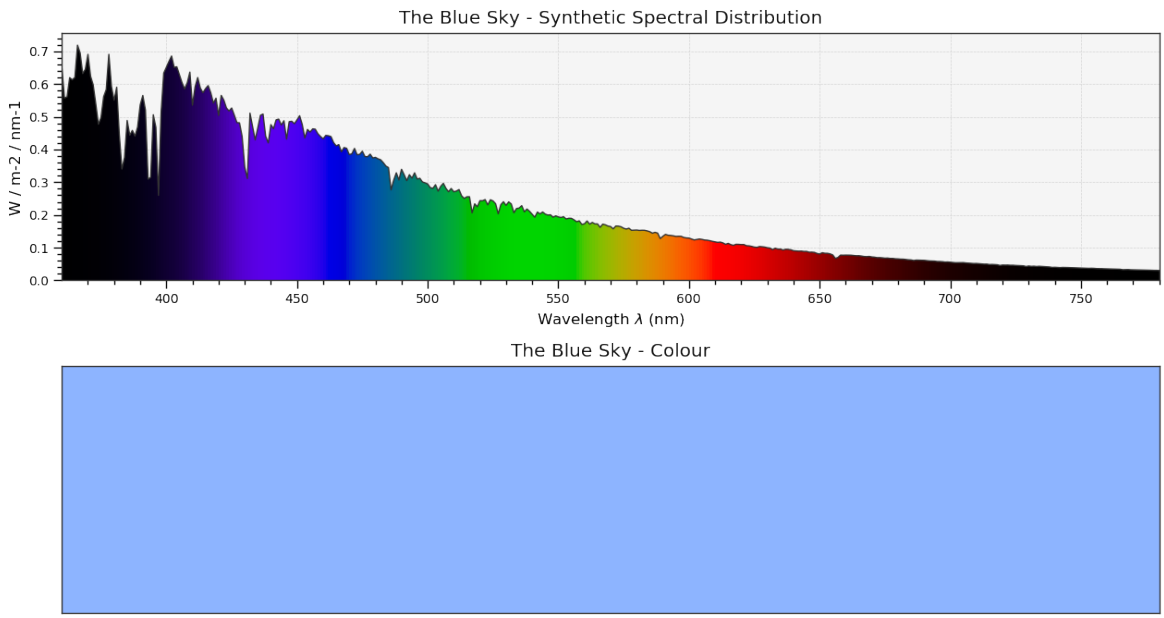
Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.plot_single_sd(), colour.plotting.plot_multi_colour_swatches(), colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_the_blue_sky()  # doctest: +SKIP
```



Colour Quality

`colour.plotting`

`plot_single_sd_colour_rendering_index_bars`(sd, ...)	Plots the *Colour Rendering Index* (CRI) of given illuminant or light source spectral distribution.
`plot_multi_sds_colour_rendering_indexes_bars`(...)	Plots the *Colour Rendering Index* (CRI) of given illuminants or light sources spectral distributions.
`plot_single_sd_colour_quality_scale_bars`(sd, ...)	Plots the *Colour Quality Scale* (CQS) of given illuminant or light source spectral distribution.
`plot_multi_sds_colour_quality_scales_bars`(...)	Plots the *Colour Quality Scale* (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*, ***kwargs*)

Plots 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).

Other Parameters

- ****kwargs** (*dict, optional*) – {`colour.plotting.artist()`, `colour.plotting.quality.plot_colour_quality_bars()`, `colour.plotting.render()`}, Please refer to the documentation of the previously listed definitions.

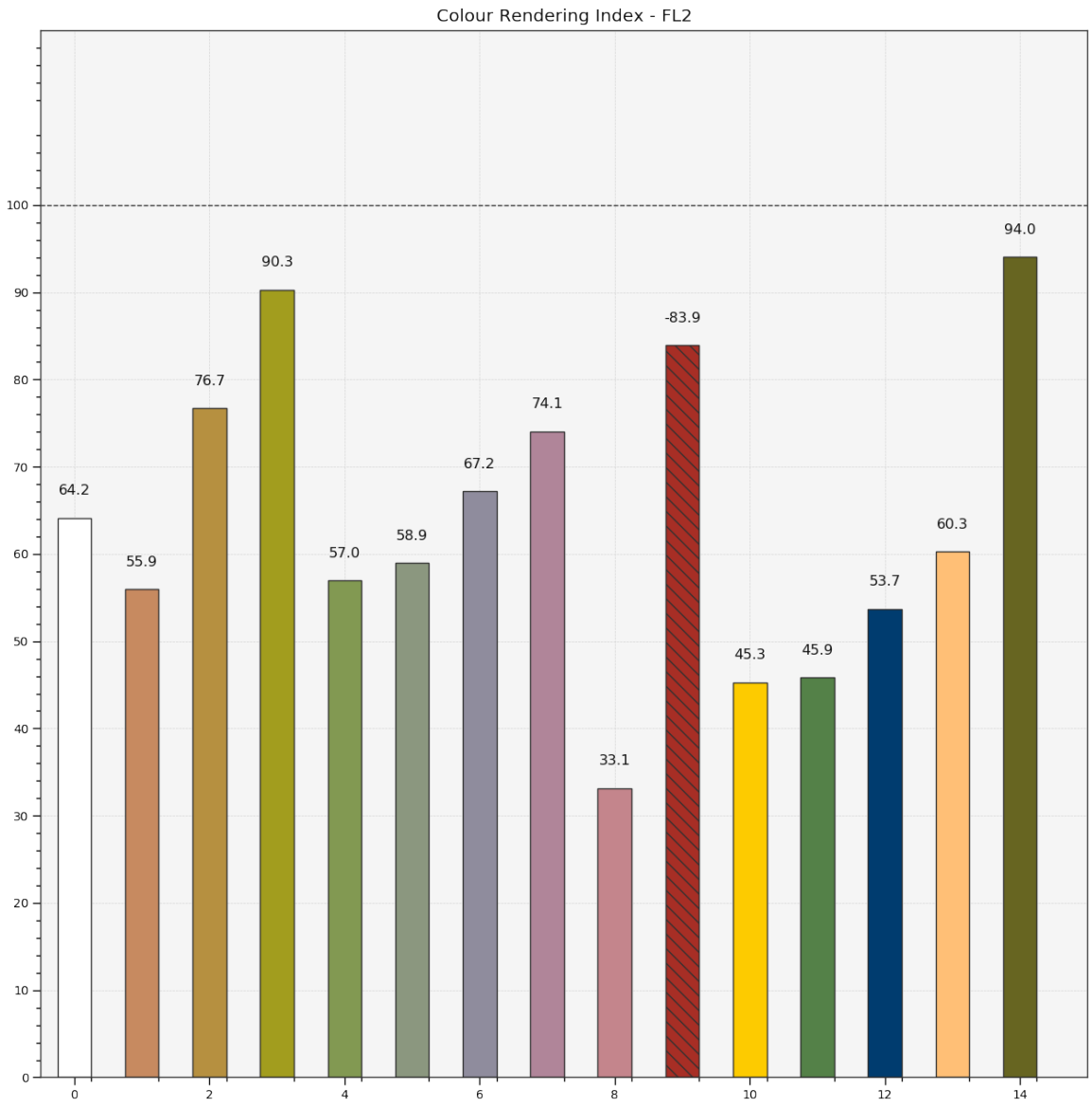
- **labels** (*bool, optional*) – {colour.plotting.quality.plot_colour_quality_bars()}, Add labels above bars.
- **hatching** (*bool or None, optional*) – {colour.plotting.quality.plot_colour_quality_bars()}, Use hatching for the bars.
- **hatching_repeat** (*int, optional*) – {colour.plotting.quality.plot_colour_quality_bars()}, Hatching pattern repeat.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> from colour import ILLUMINANTS_SDS
>>> illuminant = ILLUMINANTS_SDS['FL2']
>>> plot_single_sd_colour_rendering_index_bars(illuminant)
... # doctest: +SKIP
```



colour.plotting.plot_multi_sds_colour_rendering_indexes_bars

`colour.plotting.`**`plot_multi_sds_colour_rendering_indexes_bars`**(*sds*, ***kwargs*)

Plots the *Colour Rendering Index* (CRI) of given illuminants or light sources spectral distributions.

Parameters **sds** (`array_like`) – Array of illuminants or light sources spectral distributions to plot the *Colour Rendering Index* (CRI).

Other Parameters

- ****kwargs** (*dict, optional*) – {`colour.plotting.artist()`, `colour.plotting.quality.plot_colour_quality_bars()`, `colour.plotting.render()`}, Please refer to the documentation of the previously listed definitions.
- **labels** (*bool, optional*) – {`colour.plotting.quality.plot_colour_quality_bars()`}, Add labels above bars.

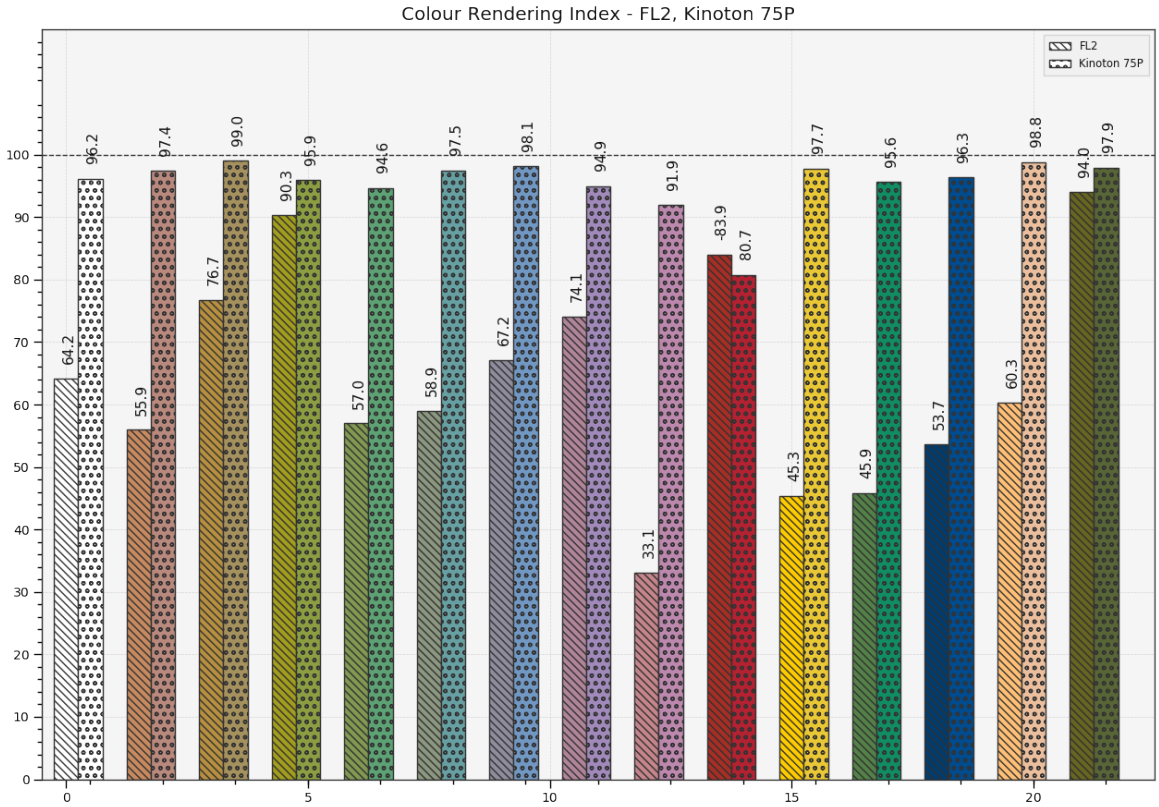
- **hatching** (*bool or None, optional*) – {colour.plotting.quality.plot_colour_quality_bars()}, Use hatching for the bars.
- **hatching_repeat** (*int, optional*) – {colour.plotting.quality.plot_colour_quality_bars()}, Hatching pattern repeat.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> from colour import (ILLUMINANTS_SDS,
...                     LIGHT_SOURCES_SDS)
>>> illuminant = ILLUMINANTS_SDS['FL2']
>>> light_source = LIGHT_SOURCES_SDS['Kinoton 75P']
>>> plot_multi_sds_colour_rendering_indexes_bars(
...     [illuminant, light_source])  # doctest: +SKIP
```



colour.plotting.plot_single_sd_colour_quality_scale_bars

`colour.plotting.`**`plot_single_sd_colour_quality_scale_bars`**(*sd*, ***kwargs*)

Plots 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).

Other Parameters

- ****kwargs** (*dict, optional*) – {`colour.plotting.artist()`, `colour.plotting.quality.plot_colour_quality_bars()`, `colour.plotting.render()`}, Please refer to the documentation of the previously listed definitions.
- **labels** (*bool, optional*) – {`colour.plotting.quality.plot_colour_quality_bars()`}, Add labels above bars.

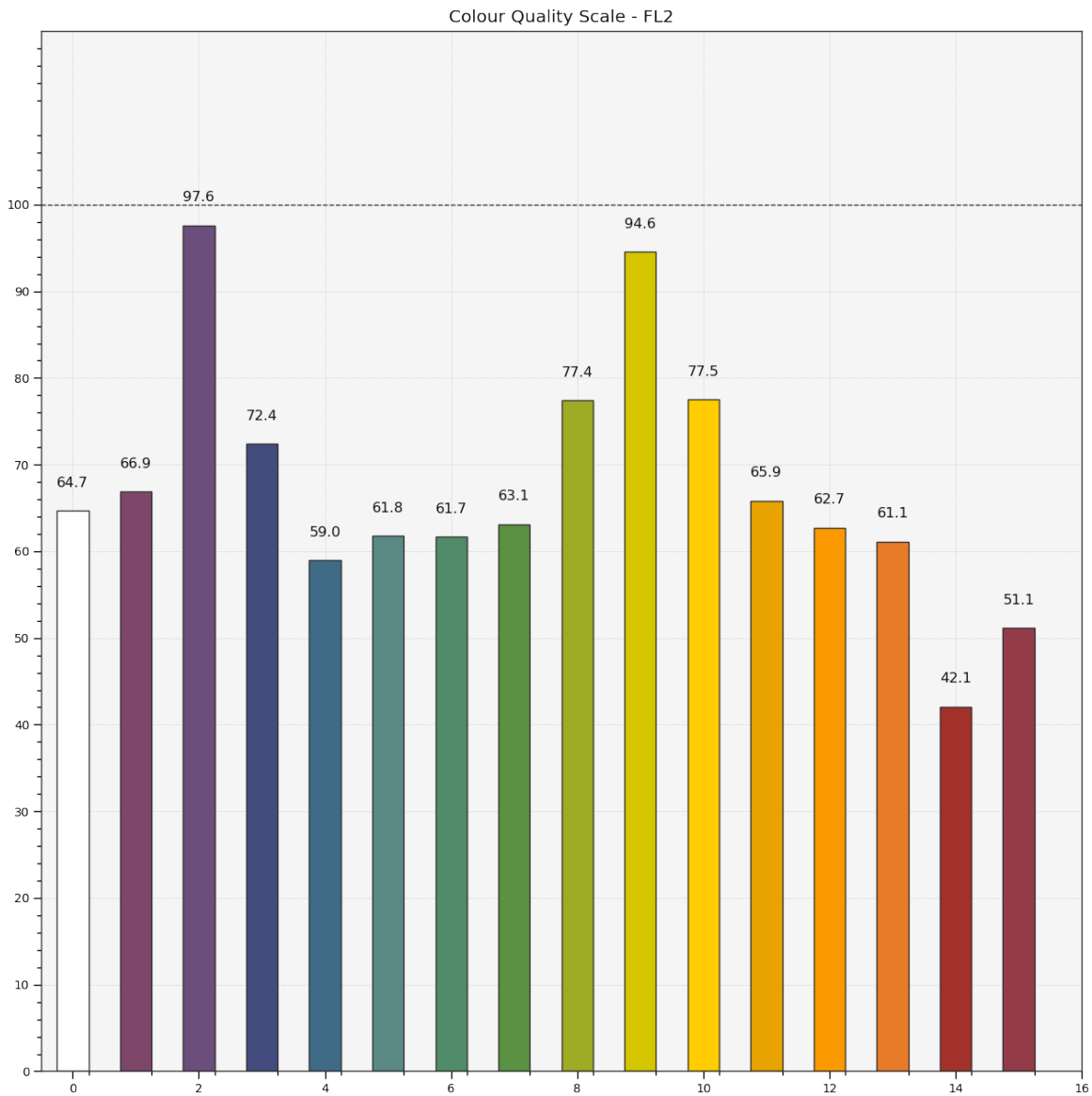
- **hatching** (*bool or None, optional*) – {`colour.plotting.quality.plot_colour_quality_bars()`}, Use hatching for the bars.
- **hatching_repeat** (*int, optional*) – {`colour.plotting.quality.plot_colour_quality_bars()`}, Hatching pattern repeat.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> from colour import ILLUMINANTS_SDS
>>> illuminant = ILLUMINANTS_SDS['FL2']
>>> plot_single_sd_colour_quality_scale_bars(illuminant)
... # doctest: +SKIP
```



colour.plotting.plot_multi_sds_colour_quality_scales_bars

colour.plotting.**plot_multi_sds_colour_quality_scales_bars**(*sds*, ***kwargs*)

Plots the *Colour Quality Scale* (CQS) of given illuminants or light sources spectral distributions.

Parameters **sds** (array_like) – Array of illuminants or light sources spectral distributions to plot the *Colour Quality Scale* (CQS).

Other Parameters

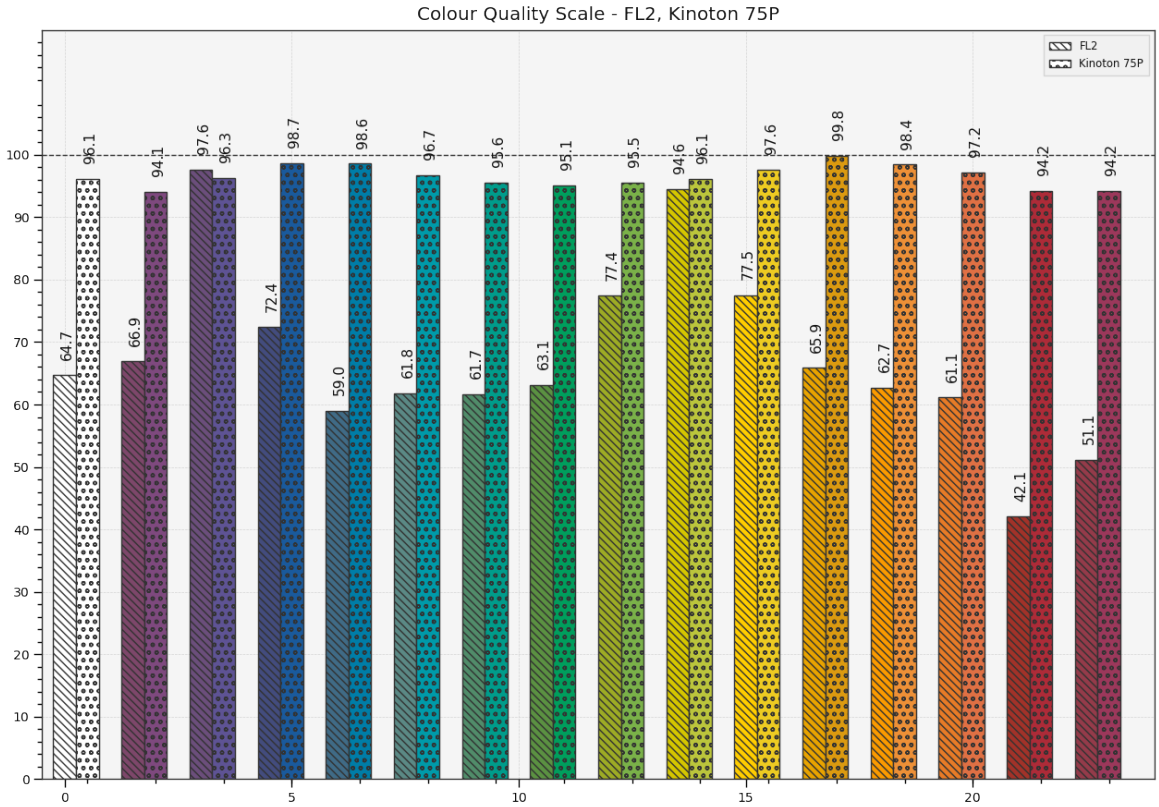
- ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.quality.plot_colour_quality_bars(), colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.
- **labels** (*bool, optional*) – {colour.plotting.quality.plot_colour_quality_bars()}, Add labels above bars.
- **hatching** (*bool or None, optional*) – {colour.plotting.quality.plot_colour_quality_bars()}, Use hatching for the bars.
- **hatching_repeat** (*int, optional*) – {colour.plotting.quality.plot_colour_quality_bars()}, Hatching pattern repeat.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> from colour import (ILLUMINANTS_SDS,
...                     LIGHT_SOURCES_SDS)
>>> illuminant = ILLUMINANTS_SDS['FL2']
>>> light_source = LIGHT_SOURCES_SDS['Kinoton 75P']
>>> plot_multi_sds_colour_quality_scales_bars([illuminant, light_source])
... # doctest: +SKIP
```



Ancillary Objects

`colour.plotting.quality`

`plot_colour_quality_bars`(specifications[, ...])	Plots the colour quality data of given illuminants or light sources colour quality specifications.

colour.plotting.quality.plot_colour_quality_bars

`colour.plotting.quality.`**`plot_colour_quality_bars`**(*specifications*, *labels=True*, *hatching=None*, *hatching_repeat=2*, ***kwargs*)

Plots the colour quality data of given illuminants or light sources colour quality specifications.

Parameters

- **`specifications`** (`array_like`) – Array of illuminants or light sources colour quality

specifications.

- **labels** (bool, optional) – Add labels above bars.
- **hatching** (bool or None, optional) – Use hatching for the bars.
- **hatching_repeat** (int, optional) – Hatching pattern repeat.

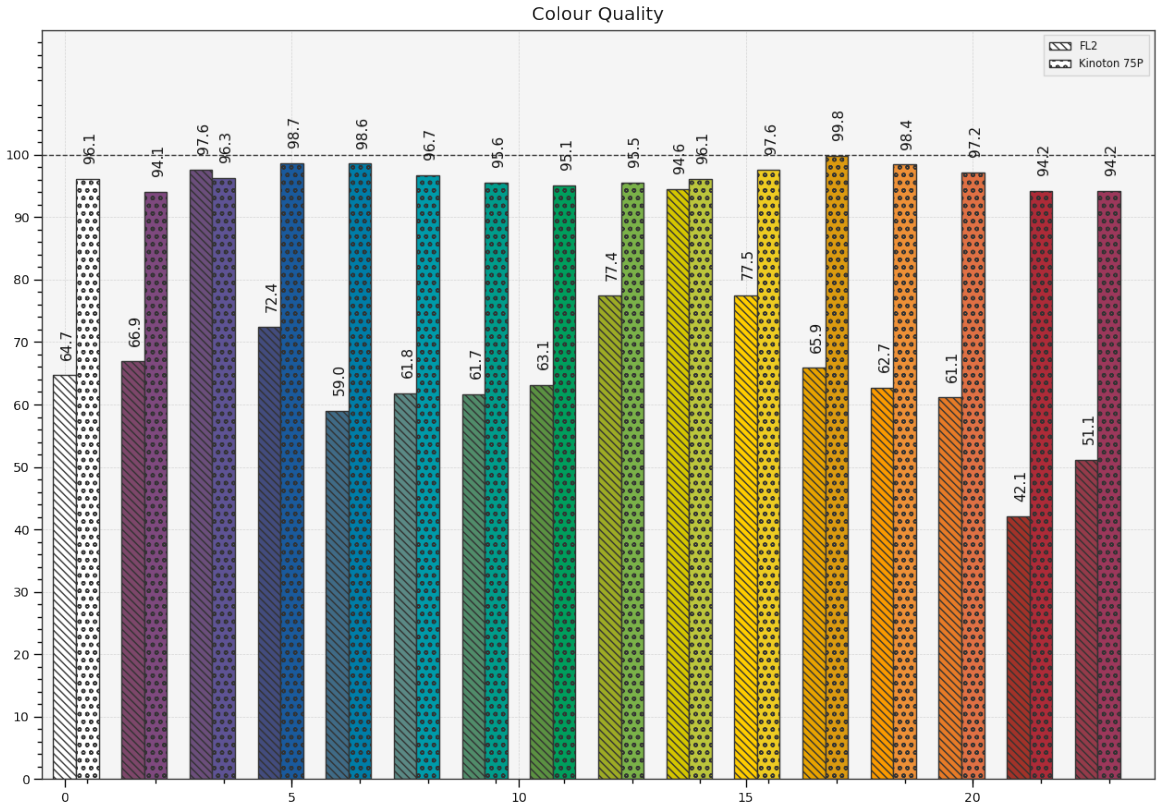
Other Parameters **kwargs (*dict, optional*) – {colour.plotting.artist(), colour.plotting.quality.plot_colour_quality_bars(), colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> from colour import (ILLUMINANTS_SDS,
...                     LIGHT_SOURCES_SDS, SpectralShape)
>>> illuminant = ILLUMINANTS_SDS['FL2']
>>> light_source = LIGHT_SOURCES_SDS['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_quality_bars([cqs_i, cqs_l])  # doctest: +SKIP
```



Colour Temperature & Correlated Colour Temperature

`colour.plotting`

`plot_planckian_locus_in_chromaticity_diagram_CIE_1931(...)`	Plots the *Planckian Locus* and given illuminants in *CIE 1931 Chromaticity Diagram*.
`plot_planckian_locus_in_chromaticity_diagram_CIE_1960_UCS(...)`	Plots the *Planckian Locus* and given illuminants in *CIE 1960 UCS Chromaticity Diagram*.

colour.plotting.plot_planckian_locus_in_chromaticity_diagram_CIE1931

colour.plotting.**plot_planckian_locus_in_chromaticity_diagram_CIE1931**(*illuminants=None, annotate_parameters=None, chromaticity_diagram_callable_CIE1931=<function plot_chromaticity_diagram_CIE1931>, **kwargs*)

Plots the *Planckian Locus* and given illuminants in *CIE 1931 Chromaticity Diagram*.

Parameters

- **illuminants** (array_like, optional) – Factory illuminants to plot.
- **annotate_parameters** (dict or array_like, optional) – Parameters for the plt.annotate() definition, used to annotate the resulting chromaticity coordinates with their respective illuminant names if annotate is set to *True*. annotate_parameters can be either a single dictionary applied to all the arrows with same settings or a sequence of dictionaries with different settings for each illuminant.
- **chromaticity_diagram_callable_CIE1931** (callable, optional) – Callable responsible for drawing the *CIE 1931 Chromaticity Diagram*.

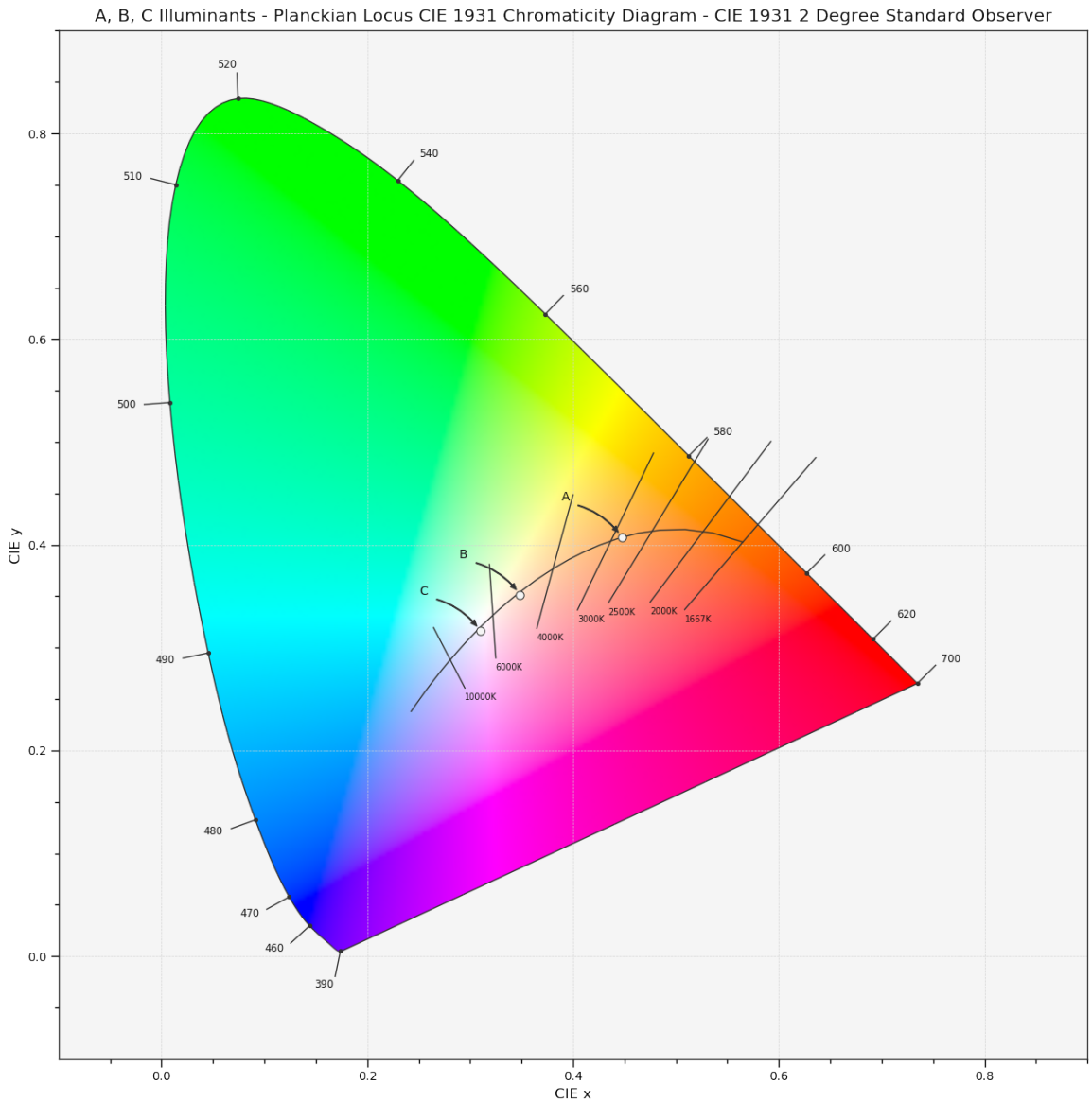
Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.diagrams.plot_chromaticity_diagram(), colour.plotting.temperature.plot_planckian_locus(), colour.plotting.temperature.plot_planckian_locus_in_chromaticity_diagram(), colour.plotting.render()}, Please refer to 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'])
... # doctest: +SKIP
```



colour.plotting.plot_planckian_locus_in_chromaticity_diagram_CIE1960UCS

`colour.plotting.`**`plot_planckian_locus_in_chromaticity_diagram_CIE1960UCS`**(*illuminants=None, annotate_parameters=None, chromaticity_diagram_callable_CIE1960UCS=<func plot_chromaticity_diagram_CIE1960UCS> **kwargs*)

Plots the *Planckian Locus* and given illuminants in *CIE 1960 UCS Chromaticity Diagram*.

Parameters

- **illuminants** (`array_like, optional`) – Factory illuminants to plot.
- **annotate_parameters** (`dict or array_like, optional`) – Parameters for the `plt`.

annotate() definition, used to annotate the resulting chromaticity coordinates with their respective illuminant names if annotate is set to *True*. annotate_parameters can be either a single dictionary applied to all the arrows with same settings or a sequence of dictionaries with different settings for each illuminant.

- **chromaticity_diagram_callable_CIE1960UCS** (callable, optional) – Callable responsible for drawing the *CIE 1960 UCS Chromaticity Diagram*.

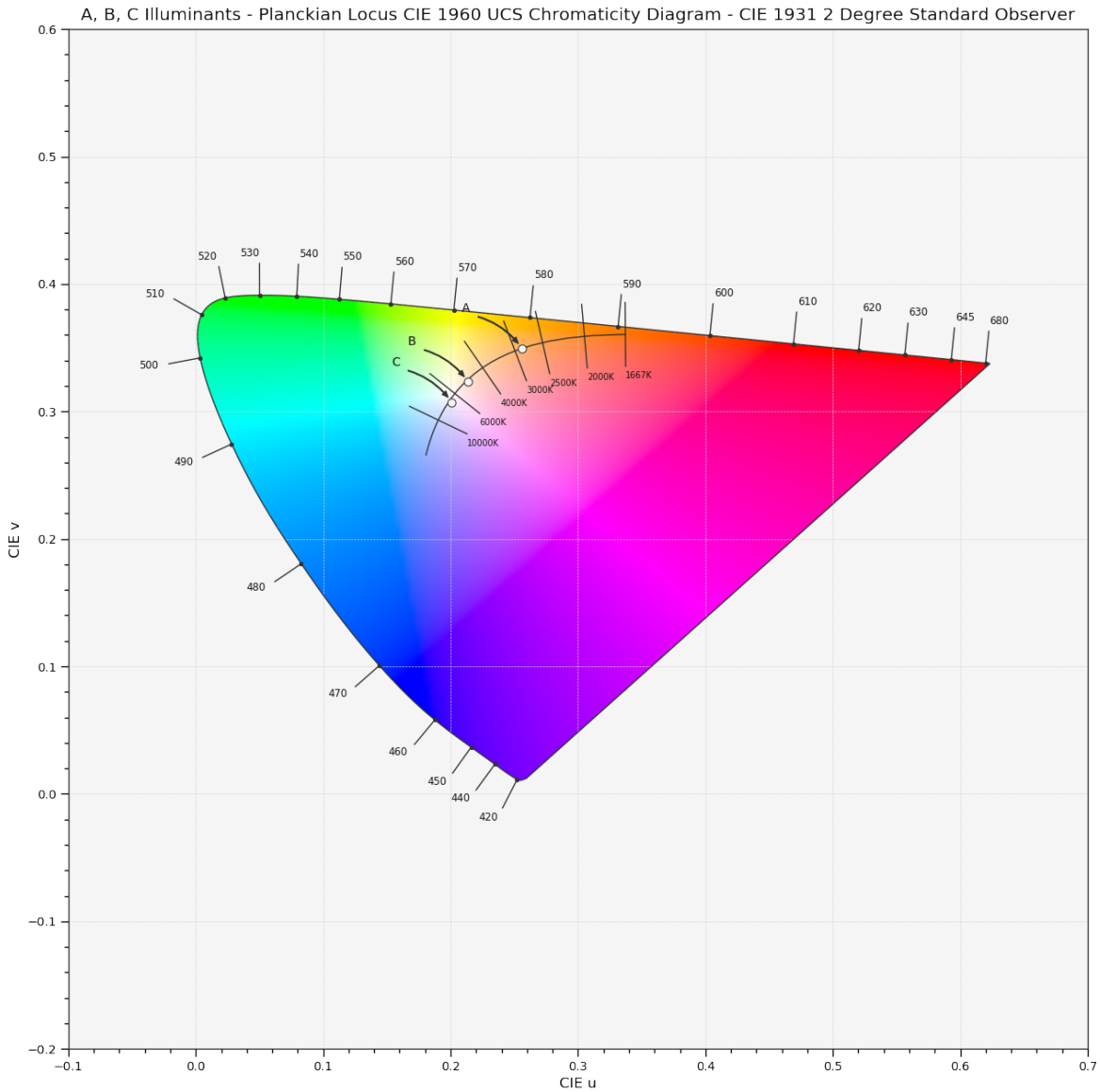
Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.diagrams.plot_chromaticity_diagram(), colour.plotting.temperature.plot_planckian_locus(), colour.plotting.temperature.plot_planckian_locus_in_chromaticity_diagram(), colour.plotting.render()}, Please refer to 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'])  # doctest: +SKIP
```



Ancillary Objects

`colour.plotting.temperature`

`plot_planckian_locus([...])`	Plots the *Planckian Locus* according to given method.
`plot_planckian_locus_in_chromaticity_diagram([...])`	Plots 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=None*, *method='CIE 1931'*, ***kwargs*)

Plots the *Planckian Locus* according to given method.

Parameters

- **planckian_locus_colours** (array_like or unicode, optional) – *Planckian Locus* colours.
- **method** (unicode, optional) – **{'CIE 1931', 'CIE 1960 UCS', 'CIE 1976 UCS'}**, *Chromaticity Diagram* method.

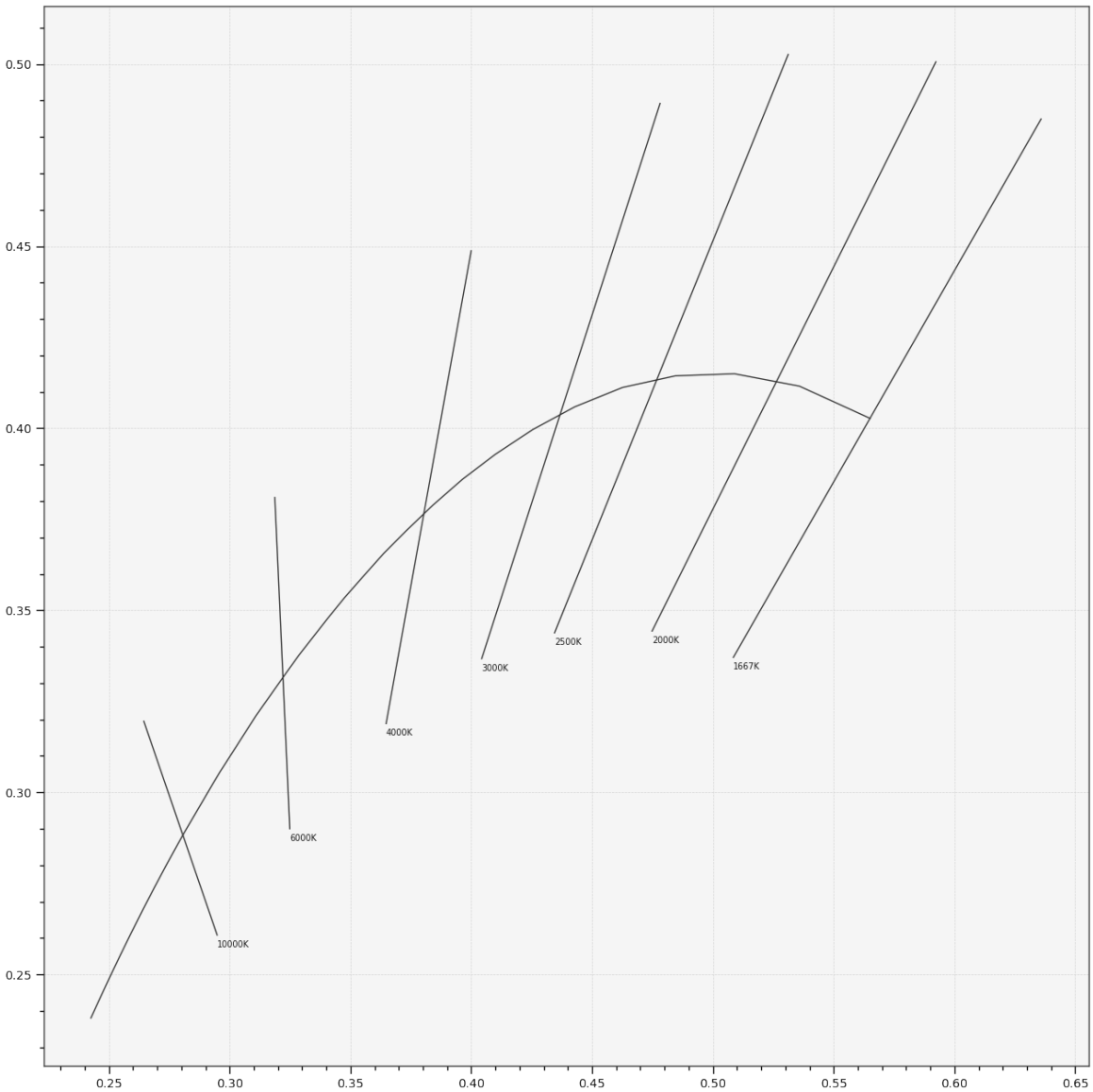
Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_planckian_locus()  # doctest: +SKIP
```



colour.plotting.temperature.plot_planckian_locus_in_chromaticity_diagram

`colour.plotting.temperature.`**`plot_planckian_locus_in_chromaticity_diagram`**(*illuminants=None, annotate_parameters=None, chromaticity_diagram_callable=<function plot_chromaticity_diagram>, method='CIE 1931', **kwargs*)

Plots the *Planckian Locus* and given illuminants in the *Chromaticity Diagram* according to given method.

Parameters

- **illuminants** (`array_like, optional`) – Factory illuminants to plot.

- **annotate_parameters** (dict or array_like, optional) – Parameters for the plt.annotate() definition, used to annotate the resulting chromaticity coordinates with their respective illuminant names if annotate is set to *True*. annotate_parameters can be either a single dictionary applied to all the arrows with same settings or a sequence of dictionaries with different settings for each illuminant.
- **chromaticity_diagram_callable** (callable, optional) – Callable responsible for drawing the *Chromaticity Diagram*.
- **method** (unicode, optional) – **{'CIE 1931', 'CIE 1960 UCS', 'CIE 1976 UCS'}**, *Chromaticity Diagram* method.

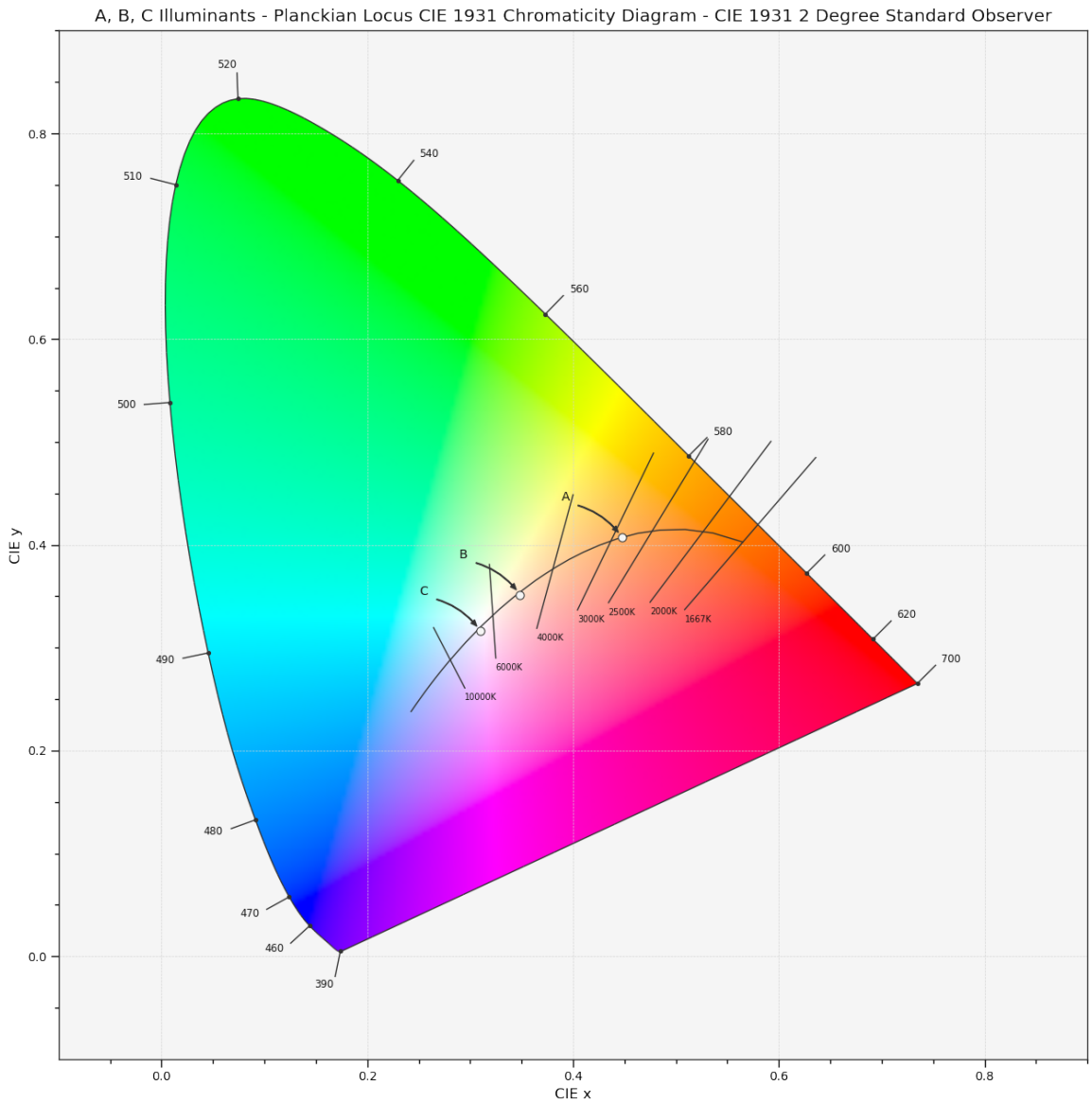
Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.diagrams.plot_chromaticity_diagram(), colour.plotting.temperature.plot_planckian_locus(), colour.plotting.render()}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_planckian_locus_in_chromaticity_diagram(['A', 'B', 'C'])
... # doctest: +SKIP
```



Colour Models Volume

`colour.plotting`

`plot_RGB_colourspaces_gamuts`([colourspaces, ...])	Plots given *RGB* colourspaces gamuts in given reference colourspace.
`plot_RGB_scatter`(RGB, colourspace[, ...])	Plots given *RGB* colourspace array in a scatter plot.

colour.plotting.plot_RGB_colourspaces_gamuts

`colour.plotting.`**`plot_RGB_colourspaces_gamuts`**(*coloursp aces=None, reference_colourspace='CIE xyY', segments=8, show_grid=True, grid_segments=10, show_spectral_locus=False, spectral_locus_colour=None, cmfs='CIE 1931 2 Degree Standard Observer', **kwargs*)

Plots given *RGB* colourspaces gamuts in given reference colourspace.

Parameters

- **colourspaces** (array_like, optional) – *RGB* colourspaces to plot the gamuts.
- **reference_colourspace** (unicode, optional) – **{'CIE XYZ', 'CIE xyY', 'CIE xy', 'CIE Lab', 'CIE LCHab', 'CIE Luv', 'CIE Luv uv', 'CIE LCHuv', 'CIE UCS', 'CIE UCS uv', 'CIE UVW', 'DIN 99', 'Hunter Lab', 'Hunter Rdab', 'IPT', 'JzAzBz', 'OSA UCS', 'hdr-CIELAB', 'hdr-IPT'}**, Reference colourspace to plot the gamuts into.
- **segments** (int, optional) – Edge segments count for each *RGB* colourspace cubes.
- **show_grid** (bool, optional) – Whether to show a grid at the bottom of the *RGB* colourspace cubes.
- **grid_segments** (bool, optional) – Edge segments count for the grid.
- **show_spectral_locus** (bool, optional) – Whether to show the spectral locus.
- **spectral_locus_colour** (array_like, optional) – Spectral locus colour.
- **cmfs** (unicode, optional) – Standard observer colour matching functions used for spectral locus.

Other Parameters

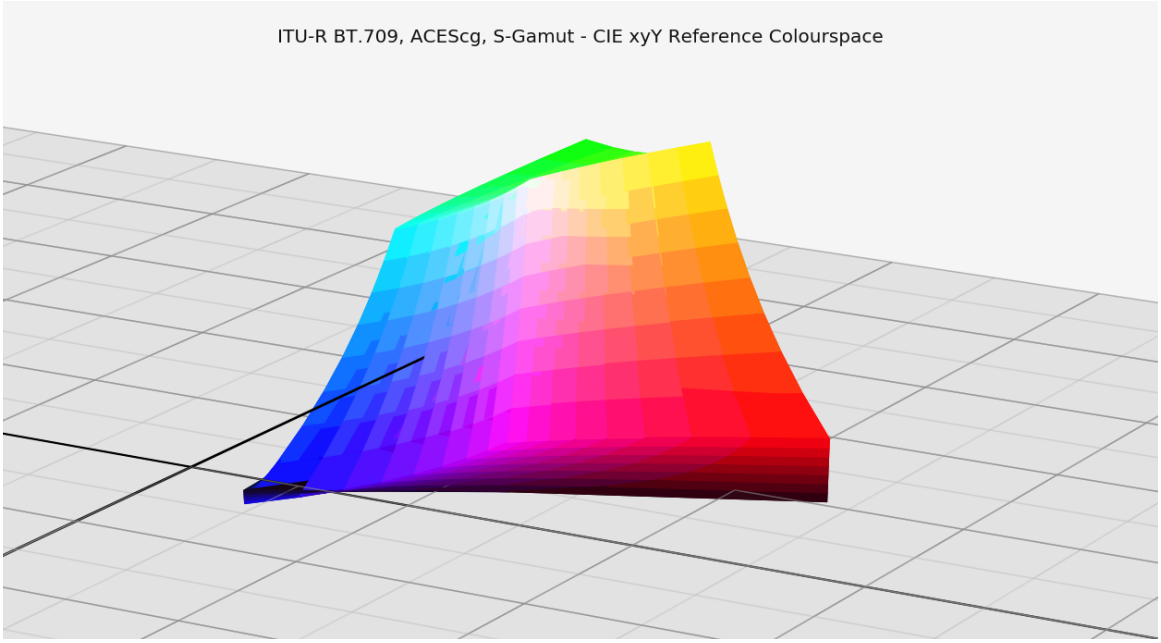
- ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.volume.nadir_grid()}, Please refer to the documentation of the previously listed definitions.
- **face_colours** (*array_like, optional*) – Face colours array such as *face_colours = (None, (0.5, 0.5, 1.0))*.
- **edge_colours** (*array_like, optional*) – Edge colours array such as *edge_colours = (None, (0.5, 0.5, 1.0))*.
- **face_alpha** (*numeric, optional*) – Face opacity value such as *face_alpha = (0.5, 1.0)*.
- **edge_alpha** (*numeric, optional*) – Edge opacity value such as *edge_alpha = (0.0, 1.0)*.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> plot_RGB_colourspaces_gamuts(['ITU-R BT.709', 'ACEScg', 'S-Gamut'])
... # doctest: +SKIP
```



colour.plotting.plot_RGB_scatter

`colour.plotting.`**`plot_RGB_scatter`**(*RGB*, *colourspace*, *reference_colourspace='CIE xyY'*, *colourspaces=None*, *segments=8*, *show_grid=True*, *grid_segments=10*, *show_spectral_locus=False*, *spectral_locus_colour=None*, *points_size=12*, *cmfs='CIE 1931 2 Degree Standard Observer'*, ***kwargs*)

Plots given *RGB* colourspace array in a scatter plot.

Parameters

- **RGB** (array_like) – *RGB* colourspace array.
- **colourspace** (RGB_Colourspace) – *RGB* colourspace of the *RGB* array.
- **reference_colourspace** (unicode, optional) – **{'CIE XYZ', 'CIE xyY', 'CIE xy', 'CIE Lab', 'CIE LCHab', 'CIE Luv', 'CIE Luv uv', 'CIE LCHuv', 'CIE UCS', 'CIE UCS uv', 'CIE UVW', 'DIN 99', 'Hunter Lab', 'Hunter Rdab', 'IPT', 'JzAzBz', 'OSA UCS', 'hdr-CIELAB', 'hdr-IPT'}**, Reference colourspace for colour conversion.
- **colourspaces** (array_like, optional) – *RGB* colourspaces to plot the gamuts.
- **segments** (int, optional) – Edge segments count for each *RGB* colourspace cubes.
- **show_grid** (bool, optional) – Whether to show a grid at the bottom of the *RGB* colourspace cubes.
- **grid_segments** (bool, optional) – Edge segments count for the grid.
- **show_spectral_locus** (bool, optional) – Whether to show the spectral locus.
- **spectral_locus_colour** (array_like, optional) – Spectral locus colour.
- **points_size** (numeric, optional) – Scatter points size.
- **cmfs** (unicode, optional) – Standard observer colour matching functions used for spectral locus.

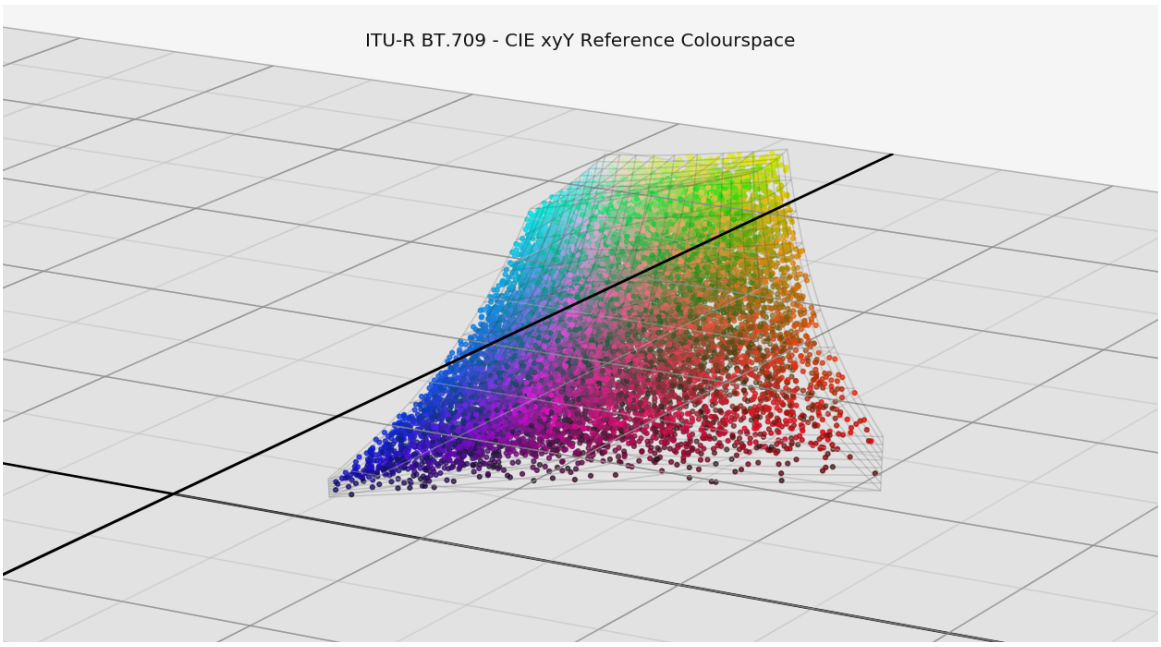
Other Parameters ****kwargs** (*dict, optional*) – {colour.plotting.artist(), colour.plotting.plot_RGB_colourspaces_gamuts()}, Please refer to the documentation of the previously listed definitions.

Returns Current figure and axes.

Return type tuple

Examples

```
>>> RGB = np.random.random((128, 128, 3))
>>> plot_RGB_scatter(RGB, 'ITU-R BT.709')  # doctest: +SKIP
```



Geometry Plotting Utilities

colour.plotting

quad([plane, origin, width, height, depth])	Returns the vertices of a quad geometric element in counter-clockwise order.
grid([plane, origin, width, height, depth, ...])	Returns the vertices of a grid made of quads.
cube([plane, origin, width, height, depth, ...])	Returns the vertices of a cube made of grids.

colour.plotting.quad

colour.plotting.**quad**(*plane='xy', origin=None, width=1, height=1, depth=0*)

Returns the vertices of a quad geometric element in counter-clockwise order.

Parameters

- **plane** (array_like, optional) – **{'xy', 'xz', 'yz'}**, Construction plane of the quad.

- **origin** (array_like, optional) – Quad origin on the construction plane.
- **width** (numeric, optional) – Quad width.
- **height** (numeric, optional) – Quad height.
- **depth** (numeric, optional) – Quad depth.

Returns Quad vertices.

Return type ndarray

Examples

```
>>> quad()
array([[0, 0, 0],
       [1, 0, 0],
       [1, 1, 0],
       [0, 1, 0]])
```

colour.plotting.grid

colour.plotting.**grid**(*plane='xy', origin=None, width=1, height=1, depth=0, width_segments=1, height_segments=1*)

Returns the vertices of a grid made of quads.

Parameters

- **plane** (array_like, optional) – **{'xy', 'xz', 'yz'}**, Construction plane of the grid.
- **origin** (array_like, optional) – Grid origin on the construction plane.
- **width** (numeric, optional) – Grid width.
- **height** (numeric, optional) – Grid height.
- **depth** (numeric, optional) – Grid depth.
- **width_segments** (int, optional) – Grid segments, quad counts along the width.
- **height_segments** (int, optional) – Grid segments, quad counts along the height.

Returns Grid vertices.

Return type ndarray

Examples

```
>>> grid(width_segments=2, height_segments=2)
array([[[ 0. ,  0. ,  0. ],
        [ 0.5,  0. ,  0. ],
        [ 0.5,  0.5,  0. ],
        [ 0. ,  0.5,  0. ]],
<BLANKLINE>
       [[ 0. ,  0.5,  0. ],
        [ 0.5,  0.5,  0. ],
        [ 0.5,  1. ,  0. ],
        [ 0. ,  1. ,  0. ]],
<BLANKLINE>
```

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```
       [[ 0.5,  0. ,  0. ],
        [ 1. ,  0. ,  0. ],
        [ 1. ,  0.5,  0. ],
        [ 0.5,  0.5,  0. ]],
<BLANKLINE>
       [[ 0.5,  0.5,  0. ],
        [ 1. ,  0.5,  0. ],
        [ 1. ,  1. ,  0. ],
        [ 0.5,  1. ,  0. ]]])
```

colour.plotting.cube

`colour.plotting.cube`(*plane=None*, *origin=None*, *width=1*, *height=1*, *depth=1*, *width_segments=1*, *height_segments=1*, *depth_segments=1*)

Returns the vertices of a cube made of grids.

Parameters

- **plane** (array_like, optional) – Any combination of **{'+x', '-x', '+y', '-y', '+z', '-z'}**, Included grids in the cube construction.
- **origin** (array_like, optional) – Cube origin.
- **width** (numeric, optional) – Cube width.
- **height** (numeric, optional) – Cube height.
- **depth** (numeric, optional) – Cube depth.
- **width_segments** (int, optional) – Cube segments, quad counts along the width.
- **height_segments** (int, optional) – Cube segments, quad counts along the height.
- **depth_segments** (int, optional) – Cube segments, quad counts along the depth.

Returns Cube vertices.

Return type ndarray

Examples

```
>>> cube()
array([[[ 0.,  0.,  0.],
        [ 1.,  0.,  0.],
        [ 1.,  1.,  0.],
        [ 0.,  1.,  0.]],
<BLANKLINE>
       [[ 0.,  0.,  1.],
        [ 1.,  0.,  1.],
        [ 1.,  1.,  1.],
        [ 0.,  1.,  1.]],
<BLANKLINE>
       [[ 0.,  0.,  0.],
        [ 1.,  0.,  0.],
        [ 1.,  0.,  1.],
        [ 0.,  0.,  1.]],
<BLANKLINE>
```

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```
       [[ 0.,  1.,  0.],
        [ 1.,  1.,  0.],
        [ 1.,  1.,  1.],
        [ 0.,  1.,  1.]],
<BLANKLINE>
       [[ 0.,  0.,  0.],
        [ 0.,  1.,  0.],
        [ 0.,  1.,  1.],
        [ 0.,  0.,  1.]],
<BLANKLINE>
       [[ 1.,  0.,  0.],
        [ 1.,  1.,  0.],
        [ 1.,  1.,  1.],
        [ 1.,  0.,  1.]]])
```

Colour Quality

- *Colour Rendering Index*
- *Colour Quality Scale*

Colour Rendering Index

colour

colour_rendering_index(sd_test[, ...])	Returns the *Colour Rendering Index* (CRI) Q_a of given spectral distribution.

colour.colour_rendering_index

colour.**colour_rendering_index**(*sd_test*, *additional_data=False*)

Returns the *Colour Rendering Index* (CRI) Q_a of given spectral distribution.

Parameters

- **sd_test** (SpectralDistribution) – Test spectral distribution.
- **additional_data** (bool, optional) – Whether to output additional data.

Returns *Colour Rendering Index* (CRI).

Return type numeric or *CRI_Specification*

References

[OD08]

Examples

```
>>> from colour import ILLUMINANTS_SDS
>>> sd = ILLUMINANTS_SDS['FL2']
>>> colour_rendering_index(sd)  # doctest: +ELLIPSIS
64.1515202...
```

colour.quality

CRI_Specification	Defines the *Colour Rendering Index* (CRI) colour quality specification.

colour.quality.CRI_Specification

class colour.quality.**CRI_Specification**

Defines the *Colour Rendering Index* (CRI) colour quality specification.

Parameters

- **name** (unicode) – Name of the test spectral distribution.
- **Q_a** (numeric) – *Colour Rendering Index* (CRI) Q_a.
- **Q_as** (dict) – Individual *colour rendering indexes* data for each sample.
- **colorimetry_data** (tuple) – Colorimetry data for the test and reference computations.

References

[OD08]

Create new instance of CRI_Specification(name, Q_a, Q_as, colorimetry_data)

__init__()

Initialize self. See help(type(self)) for accurate signature.

Methods

count	Return number of occurrences of value.
index	Return first index of value.

Attributes

Q_a	Alias for field number 1
Q_as	Alias for field number 2
colorimetry_data	Alias for field number 3
name	Alias for field number 0

Colour Quality Scale

colour

colour_quality_scale(sd_test[, additional_data])	Returns the *Colour Quality Scale* (CQS) of given spectral distribution.

colour.colour_quality_scale

colour.**colour_quality_scale**(*sd_test*, *additional_data=False*)

Returns the *Colour Quality Scale* (CQS) of given spectral distribution.

Parameters

- **sd_test** (SpectralDistribution) – Test spectral distribution.
- **additional_data** (bool, optional) – Whether to output additional data.

Returns Color quality scale.

Return type numeric or *CQS_Specification*

References

[DO10], [OD08]

Examples

```
>>> from colour import ILLUMINANTS_SDS
>>> sd = ILLUMINANTS_SDS['FL2']
>>> colour_quality_scale(sd)  # doctest: +ELLIPSIS
64.6863391...
```

colour.quality

CQS_Specification	Defines the *Colour Quality Scale* (CQS) colour quality specification.

colour.quality.CQS_Specification

class colour.quality.**CQS_Specification**

Defines the *Colour Quality Scale* (CQS) colour quality specification.

Parameters

- **name** (unicode) – Name of the test spectral distribution.
- **Q_a** (numeric) – Colour quality scale Q_a.
- **Q_f** (numeric) – 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** (numeric) – Colour preference scale Q_p similar to colour quality scale Q_a but placing additional weight on preference of object colour appearance. This metric is based on the notion that increases in chroma are generally preferred and should be rewarded.

- **Q_g** (numeric) – 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** (numeric) – Relative gamut area scale Q_d.
- **Q_as** (dict) – Individual *Colour Quality Scale* (CQS) data for each sample.
- **colorimetry_data** (tuple) – Colorimetry data for the test and reference computations.

References

[DO10], [OD08]

Create new instance of CQS_Specification(name, Q_a, Q_f, Q_p, Q_g, Q_d, Q_as, colorimetry_data)

__init__()
Initialize self. See help(type(self)) for accurate signature.

Methods

count	Return number of occurrences of value.
index	Return first index of value.

Attributes

Q_a	Alias for field number 1
Q_as	Alias for field number 6
Q_d	Alias for field number 5
Q_f	Alias for field number 2
Q_g	Alias for field number 4
Q_p	Alias for field number 3
colorimetry_data	Alias for field number 7
name	Alias for field number 0

Reflectance Recovery

- *CIE XYZ Colourspace to Spectral*
- *Smits (1999)*
- *Meng, Simon and Hanika (2015)*

CIE XYZ Colourspace to Spectral

colour

XYZ_to_sd(XYZ[, method])	Recovers the spectral distribution of given *CIE XYZ* tristimulus values using given method.
XYZ_TO_SD_METHODS	Supported spectral distribution recovery methods.

colour.XYZ_to_sd

colour.**XYZ_to_sd**(*XYZ*, *method='Meng 2015'*, ***kwargs*)

Recovers the spectral distribution of given *CIE XYZ* tristimulus values using given method.

Parameters

- **XYZ** (array_like) – *CIE XYZ* tristimulus values to recover the spectral distribution from.
- **method** (unicode, optional) – **{'Meng 2015', 'Smits 1999'}**, Computation method.

Other Parameters

- **cmfs** (*XYZ_ColourMatchingFunctions*) – {colour.recovery.XYZ_to_sd_Meng2015()}, Standard observer colour matching functions.
- **interval** (*numeric, optional*) – {colour.recovery.XYZ_to_sd_Meng2015()}, Wavelength λ_i range interval in nm. The smaller interval is, the longer the computations will be.
- **optimisation_parameters** (*dict_like, optional*) – {colour.recovery.XYZ_to_sd_Meng2015()}, Parameters for scipy.optimize.minimize() definition.

Returns Recovered spectral distribution.

Return type *SpectralDistribution*

Notes

Domain	Scale - Reference	Scale - 1
XYZ	[0, 1]	[0, 1]

- *Smits (1999)* method will internally convert given *CIE XYZ* tristimulus values to *RGB* colourspace array assuming equal energy illuminant *E*.

References

[MSHD15], [Smi99]

Examples

Meng (2015) reflectance recovery:

```
>>> import numpy as np
>>> from colour.utilities import numpy_print_options
>>> from colour.colorimetry import sd_to_XYZ_integration
>>> XYZ = np.array([0.21781186, 0.12541048, 0.04697113])
>>> sd = XYZ_to_sd(XYZ, interval=10)
```

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```
>>> with numpy_print_options(suppress=True):
...     # Doctests skip for Python 2.x compatibility.
...     sd  # doctest: +SKIP
SpectralDistribution([[ 360.        ,    0.0741540...],
                      [ 370.        ,    0.0741409...],
                      [ 380.        ,    0.0741287...],
                      [ 390.        ,    0.0740876...],
                      [ 400.        ,    0.0740215...],
                      [ 410.        ,    0.0738692...],
                      [ 420.        ,    0.0731412...],
                      [ 430.        ,    0.0705798...],
                      [ 440.        ,    0.0647359...],
                      [ 450.        ,    0.0551962...],
                      [ 460.        ,    0.0425597...],
                      [ 470.        ,    0.0283678...],
                      [ 480.        ,    0.0147370...],
                      [ 490.        ,    0.0044271...],
                      [ 500.        ,    0.0000302...],
                      [ 510.        ,    0.        ...],
                      [ 520.        ,    0.        ...],
                      [ 530.        ,    0.        ...],
                      [ 540.        ,    0.0051962...],
                      [ 550.        ,    0.0289516...],
                      [ 560.        ,    0.0687006...],
                      [ 570.        ,    0.1204130...],
                      [ 580.        ,    0.1789378...],
                      [ 590.        ,    0.2383451...],
                      [ 600.        ,    0.2930157...],
                      [ 610.        ,    0.3387433...],
                      [ 620.        ,    0.3734033...],
                      [ 630.        ,    0.3972820...],
                      [ 640.        ,    0.4125508...],
                      [ 650.        ,    0.4215782...],
                      [ 660.        ,    0.4265503...],
                      [ 670.        ,    0.4292647...],
                      [ 680.        ,    0.4307000...],
                      [ 690.        ,    0.4313993...],
                      [ 700.        ,    0.4316316...],
                      [ 710.        ,    0.4317109...],
                      [ 720.        ,    0.4317684...],
                      [ 730.        ,    0.4317864...],
                      [ 740.        ,    0.4317972...],
                      [ 750.        ,    0.4318385...],
                      [ 760.        ,    0.4318576...],
                      [ 770.        ,    0.4318455...],
                      [ 780.        ,    0.4317877...],
                      [ 790.        ,    0.4318119...],
                      [ 800.        ,    0.4318070...],
                      [ 810.        ,    0.4318089...],
                      [ 820.        ,    0.4317781...],
                      [ 830.        ,    0.4317733...]],
                     interpolator=SpragueInterpolator,
                     interpolator_args={},
                     extrapolator=Extrapolator,
                     extrapolator_args={...})
>>> sd_to_XYZ_integration(sd) / 100  # doctest: +ELLIPSIS
array([ 0.2178552...,  0.1254142...,  0.0470105...])
```

Smits (1999) reflectance recovery:

```
>>> sd = XYZ_to_sd(XYZ, method='Smits 1999')
>>> with numpy_print_options(suppress=True):
...     sd  # doctest: +ELLIPSIS
SpectralDistribution([[ 380.        ,    0.07691923],
                      [ 417.7778    ,    0.0587005 ],
                      [ 455.5556    ,    0.03943195],
                      [ 493.3333    ,    0.03024978],
                      [ 531.1111    ,    0.02750692],
                      [ 568.8889    ,    0.02808645],
                      [ 606.6667    ,    0.34298985],
                      [ 644.4444    ,    0.41185795],
                      [ 682.2222    ,    0.41185795],
                      [ 720.        ,    0.41180754]],
                     interpolator=LinearInterpolator,
                     interpolator_args={},
                     extrapolator=Extrapolator,
                     extrapolator_args={...})
>>> sd_to_XYZ_integration(sd) / 100  # doctest: +ELLIPSIS
array([ 0.2004540...,  0.1105632...,  0.0420963...])
```

colour.XYZ_TO_SD_METHODS

colour.**XYZ_TO_SD_METHODS = CaseInsensitiveMapping({'Meng 2015': ..., 'Smits 1999': ...})**

Supported spectral distribution recovery methods.

References

[MSHD15], [Smi99]

XYZ_TO_SD_METHODS [CaseInsensitiveMapping] **{'Meng 2015', 'Smits 1999'}**

Smits (1999)

colour.recovery

RGB_to_sd_Smits1999(RGB)	Recovers the spectral distribution of given *RGB* colourspace array using *Smits (1999)* method.
SMITS_1999_SDS	*Smits (1999)* spectral distributions.

colour.recovery.RGB_to_sd_Smits1999

colour.recovery.**RGB_to_sd_Smits1999**(*RGB*)

Recovers the spectral distribution of given *RGB* colourspace array using *Smits (1999)* method.

Parameters **RGB** (array_like, (3,)) – *RGB* colourspace array to recover the spectral distribution from.

Returns Recovered spectral distribution.

Return type *SpectralDistribution*

Notes

Domain	Scale - Reference	Scale - 1
RGB	[0, 1]	[0, 1]

References

[Smi99]

Examples

```
>>> from colour.utilities import numpy_print_options
>>> RGB = np.array([0.40639599, 0.02752894, 0.03982193])
>>> with numpy_print_options(suppress=True):
...     RGB_to_sd_Smits1999(RGB)  # doctest: +ELLIPSIS
SpectralDistribution([[ 380.        ,    0.0769192...],
                      [ 417.7778    ,    0.0587004...],
                      [ 455.5556    ,    0.0394319...],
                      [ 493.3333    ,    0.0302497...],
                      [ 531.1111    ,    0.0275069...],
                      [ 568.8889    ,    0.0280864...],
                      [ 606.6667    ,    0.3429898...],
                      [ 644.4444    ,    0.4118579...],
                      [ 682.2222    ,    0.4118579...],
                      [ 720.        ,    0.4118075...]],
                     interpolator=LinearInterpolator,
                     interpolator_args={},
                     extrapolator=Extrapolator,
                     extrapolator_args={...})
```

colour.recovery.SMITS_1999_SDS

`colour.recovery.SMITS_1999_SDS = CaseInsensitiveMapping({'white': ..., 'cyan': ..., 'magenta': ..., 'yellow`

Smits (1999) spectral distributions.

References

[Smi99]

SMITS_1999_SDS : CaseInsensitiveMapping

Meng, Simon and Hanika (2015)

`colour.recovery`

`XYZ_to_sd_Meng2015`(XYZ[, cmfs, interval, ...])	Recovers the spectral distribution of given *CIE XYZ* tristimulus values using *Meng et al.(2015)* method..

colour.recovery.XYZ_to_sd_Meng2015

`colour.recovery.XYZ_to_sd_Meng2015(XYZ, cmfs=XYZ_ColourMatchingFunctions(name='CIE 1931 2 Degree Standard Observer', ...), interval=5, optimisation_parameters=None)`

Recovers the spectral distribution of given *CIE XYZ* tristimulus values using *Meng et al. (2015)* method.

Parameters

- **XYZ** (array_like, (3,)) – *CIE XYZ* tristimulus values to recover the spectral distribution from.
- **cmfs** (XYZ_ColourMatchingFunctions) – Standard observer colour matching functions.
- **interval** (numeric, optional) – Wavelength λ_i range interval in nm. The smaller interval is, the longer the computations will be.
- **optimisation_parameters** (dict_like, optional) – Parameters for scipy.optimize.minimize() definition.

Returns Recovered spectral distribution.

Return type *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_ASTME30815() definition that handles only measurement interval of 1, 5, 10 or 20nm.

References

[MSHD15]

Examples

```
>>> from colour.utilities import numpy_print_options
>>> XYZ = np.array([0.20654008, 0.12197225, 0.05136952])
>>> sd = XYZ_to_sd_Meng2015(XYZ, interval=10)
>>> with numpy_print_options(suppress=True):
...     # Doctests skip for Python 2.x compatibility.
...     sd  # doctest: +SKIP
SpectralDistribution([[ 360.        ,    0.0780368...],
                      [ 370.        ,    0.0780387...],
                      [ 380.        ,    0.0780469...],
                      [ 390.        ,    0.0780894...],
                      [ 400.        ,    0.0780285...],
                      [ 410.        ,    0.0777034...],
                      [ 420.        ,    0.0769175...],
```

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```
                     [ 430.        ,    0.0746243...],
                     [ 440.        ,    0.0691410...],
                     [ 450.        ,    0.0599949...],
                     [ 460.        ,    0.04779  ...],
                     [ 470.        ,    0.0337270...],
                     [ 480.        ,    0.0196952...],
                     [ 490.        ,    0.0078056...],
                     [ 500.        ,    0.0004368...],
                     [ 510.        ,    0.0000065...],
                     [ 520.        ,    0.       ...],
                     [ 530.        ,    0.       ...],
                     [ 540.        ,    0.0124283...],
                     [ 550.        ,    0.0389186...],
                     [ 560.        ,    0.0774087...],
                     [ 570.        ,    0.1246716...],
                     [ 580.        ,    0.1765055...],
                     [ 590.        ,    0.2281652...],
                     [ 600.        ,    0.2751726...],
                     [ 610.        ,    0.3141208...],
                     [ 620.        ,    0.3434564...],
                     [ 630.        ,    0.3636521...],
                     [ 640.        ,    0.3765182...],
                     [ 650.        ,    0.3841561...],
                     [ 660.        ,    0.3884648...],
                     [ 670.        ,    0.3906975...],
                     [ 680.        ,    0.3918679...],
                     [ 690.        ,    0.3924590...],
                     [ 700.        ,    0.3927439...],
                     [ 710.        ,    0.3928570...],
                     [ 720.        ,    0.3928867...],
                     [ 730.        ,    0.3929099...],
                     [ 740.        ,    0.3928997...],
                     [ 750.        ,    0.3928827...],
                     [ 760.        ,    0.3928579...],
                     [ 770.        ,    0.3927857...],
                     [ 780.        ,    0.3927272...],
                     [ 790.        ,    0.3926867...],
                     [ 800.        ,    0.3926441...],
                     [ 810.        ,    0.3926385...],
                     [ 820.        ,    0.3926247...],
                     [ 830.        ,    0.3926105...]],
                    interpolator=SpragueInterpolator,
                    interpolator_args={},
                    extrapolator=Extrapolator,
                    extrapolator_args={...})
>>> sd_to_XYZ_integration(sd) / 100  # doctest: +ELLIPSIS
array([ 0.2065817...,  0.1219754...,  0.0514131...])
```

Colour Temperature

- *Correlated Colour Temperature*
  - *Robertson (1968)*

- *Krystek (1985)*
- *Ohno (2013)*
- *Hernandez-Andres, Lee and Romero (1999)*
- *Kang, Moon, Hong, Lee, Cho and Kim (2002)*
- *CIE Illuminant D Series*

Correlated Colour Temperature

colour

CCT_to_uv(CCT[, method])	Returns the *CIE UCS* colourspace *uv* chromaticity coordinates from given correlated colour temperature T_{cp} using given method.
CCT_TO_UV_METHODS	Supported correlated colour temperature T_{cp} to *CIE UCS* colourspace *uv* chromaticity coordinates computation methods.
uv_to_CCT(uv[, method])	Returns the correlated colour temperature T_{cp} and Δ_{uv} from given *CIE UCS* colourspace *uv* chromaticity coordinates using given method.
UV_TO_CCT_METHODS	Supported *CIE UCS* colourspace *uv* chromaticity coordinates to correlated colour temperature T_{cp} computation methods.
CCT_to_xy(CCT[, method])	Returns the *CIE XYZ* tristimulus values *xy* chromaticity coordinates from given correlated colour temperature T_{cp} using given method.
CCT_TO_XY_METHODS	Supported correlated colour temperature T_{cp} to *CIE XYZ* tristimulus values *xy* chromaticity coordinates computation methods.
xy_to_CCT(xy[, method])	Returns the correlated colour temperature T_{cp} from given *CIE XYZ* tristimulus values *xy* chromaticity coordinates using given method.
XY_TO_CCT_METHODS	Supported *CIE XYZ* tristimulus values *xy* chromaticity coordinates to correlated colour temperature T_{cp} computation methods.

colour.CCT_to_uv

colour.**CCT_to_uv**(*CCT*, *method='Ohno 2013'*, ***kwargs*)

Returns the *CIE UCS* colourspace *uv* chromaticity coordinates from given correlated colour temperature T_{cp} using given method.

Parameters

- **CCT** (numeric) – Correlated colour temperature T_{cp}.
- **method** (unicode, optional) – **{'Ohno 2013', 'Robertson 1968', 'Krystek 1985'}**, Computation method.

Other Parameters

- **D_uv** (*numeric*) – {`CCT_to_uv_Ohno2013, CCT_to_uv_Robertson1968()`}, Δ_{uv}.
- **cmfs** (*XYZ_ColourMatchingFunctions, optional*) – {`colour.temperature.CCT_to_uv_Ohno2013()`}, Standard observer colour matching functions.

Returns *CIE UCS* colourspace *uv* chromaticity coordinates.

Return type ndarray

References

[AdobeSystems13a], [AdobeSystems13b], [Kry85], [Ohn14], [WS00e]

Examples

```
>>> from colour import STANDARD_OBSERVERS_CMFS
>>> cmfs = STANDARD_OBSERVERS_CMFS['CIE 1931 2 Degree Standard Observer']
>>> CCT = 6507.47380460
>>> D_uv = 0.00322335
>>> CCT_to_uv(CCT, D_uv=D_uv, cmfs=cmfs)  # doctest: +ELLIPSIS
array([ 0.1977999...,  0.3121999...])
```

colour.CCT_TO_UV_METHODS

colour.**CCT_TO_UV_METHODS = CaseInsensitiveMapping({'Ohno 2013': ..., 'Robertson 1968': ..., 'Krystek 1985':**

Supported correlated colour temperature T_{cp} to *CIE UCS* colourspace *uv* chromaticity coordinates computation methods.

References

[AdobeSystems13a], [AdobeSystems13b], [Kry85], [Ohn14], [WS00e]

CCT_TO_UV_METHODS [CaseInsensitiveMapping] **{'Ohno 2013', 'Robertson 1968', 'Krystek 1985}**

Aliases:

- 'ohno2013': 'Ohno 2013'
- 'robertson1968': 'Robertson 1968'

colour.uv_to_CCT

colour.**uv_to_CCT**(*uv*, *method='Ohno 2013'*, ***kwargs*)

Returns the correlated colour temperature T_{cp} and Δ_{uv} from given *CIE UCS* colourspace *uv* chromaticity coordinates using given method.

Parameters

- **uv** (`array_like`) – *CIE UCS* colourspace *uv* chromaticity coordinates.
- **method** (`unicode, optional`) – **{'Ohno 2013', 'Robertson 1968'}**, Computation method.

Other Parameters

- **cmfs** (*XYZ_ColourMatchingFunctions, optional*) – {colour.temperature.uv_to_CCT_Ohno2013()}, Standard observer colour matching functions.
- **start** (*numeric, optional*) – {colour.temperature.uv_to_CCT_Ohno2013()}, Temperature range start in kelvins.
- **end** (*numeric, optional*) – {colour.temperature.uv_to_CCT_Ohno2013()}, Temperature range end in kelvins.
- **count** (*int, optional*) – {colour.temperature.uv_to_CCT_Ohno2013()}, Temperatures count in the planckian tables.
- **iterations** (*int, optional*) – {colour.temperature.uv_to_CCT_Ohno2013()}, Number of planckian tables to generate.

Returns Correlated colour temperature T_{cp}, Δ_{uv}.

Return type ndarray

References

[AdobeSystems13a], [AdobeSystems13b], [Ohn14], [WS00e]

Examples

```
>>> from colour import STANDARD_OBSERVERS_CMFS
>>> cmfs = STANDARD_OBSERVERS_CMFS['CIE 1931 2 Degree Standard Observer']
>>> uv = np.array([0.1978, 0.3122])
>>> uv_to_CCT(uv, cmfs=cmfs)  # doctest: +ELLIPSIS
array([  6.5074738...e+03,   3.2233461...e-03])
```

colour.UV_TO_CCT_METHODS

colour.**UV_TO_CCT_METHODS = CaseInsensitiveMapping({'Ohno 2013': ..., 'Robertson 1968': ..., 'ohno2013': ...**

Supported *CIE UCS* colourspace *uv* chromaticity coordinates to correlated colour temperature T_{cp} computation methods.

References

[AdobeSystems13a], [AdobeSystems13b], [Ohn14], [WS00e]

UV_TO_CCT_METHODS [CaseInsensitiveMapping] **{'Ohno 2013', 'Robertson 1968'}**

Aliases:

- 'ohno2013': 'Ohno 2013'
- 'robertson1968': 'Robertson 1968'

colour.CCT_to_xy

colour.**CCT_to_xy**(*CCT*, *method='Kang 2002'*)

Returns the *CIE XYZ* tristimulus values *xy* chromaticity coordinates from given correlated colour temperature T_{cp} using given method.

Parameters

- **CCT** (numeric or array_like) – Correlated colour temperature T_{cp}.
- **method** (unicode, optional) – **{'Kang 2002', 'CIE Illuminant D Series'}**, Computation method.

Returns *xy* chromaticity coordinates.

Return type ndarray

References

[KMH+02], [Wik01b], [WS00d]

colour.CCT_TO_XY_METHODS

colour.**CCT_TO_XY_METHODS = CaseInsensitiveMapping({'Kang 2002': ..., 'CIE Illuminant D Series': ..., 'kang2**

Supported correlated colour temperature T_{cp} to *CIE XYZ* tristimulus values *xy* chromaticity coordinates computation methods.

References

[KMH+02], [Wik01b], [WS00d]

CCT_TO_XY_METHODS [CaseInsensitiveMapping] **{'Kang 2002', 'CIE Illuminant D Series'}**

Aliases:

- 'kang2002': 'Kang 2002'
- 'cie_d': 'Hernandez 1999'

colour.xy_to_CCT

colour.**xy_to_CCT**(*xy*, *method='McCamy 1992'*)

Returns the correlated colour temperature T_{cp} from given *CIE XYZ* tristimulus values *xy* chromaticity coordinates using given method.

Parameters

- **xy** (array_like) – *xy* chromaticity coordinates.
- **method** (unicode, optional) – **{'McCamy 1992', 'Hernandez 1999'}**, Computation method.

Returns Correlated colour temperature T_{cp}.

Return type numeric or ndarray

References

[HernandezAndresLR99], [Wik01a], [Wik01b]

colour.XY_TO_CCT_METHODS

`colour.XY_TO_CCT_METHODS = CaseInsensitiveMapping({'McCamy 1992': ..., 'Hernandez 1999': ..., 'mccamy1992':`

Supported *CIE XYZ* tristimulus values *xy* chromaticity coordinates to correlated colour temperature T_{cp} computation methods.

References

[HernandezAndresLR99], [Wik01a], [Wik01b]

XY_TO_CCT_METHODS [CaseInsensitiveMapping] **{'McCamy 1992', 'Hernandez 1999'}**

Aliases:

- 'mccamy1992': 'McCamy 1992'
- 'hernandez1999': 'Hernandez 1999'

Robertson (1968)

`colour.temperature`

`CCT_to_uv_Robertson1968`(CCT[, D_uv])	Returns the *CIE UCS* colourspace *uv* chromaticity coordinates from given correlated colour temperature T_{cp} and Δ_{uv} using *Roberston (1968)* method.
`uv_to_CCT_Robertson1968`(uv)	Returns the correlated colour temperature T_{cp} and Δ_{uv} from given *CIE UCS* colourspace *uv* chromaticity coordinates using *Roberston (1968)* method.

colour.temperature.CCT_to_uv_Robertson1968

`colour.temperature.CCT_to_uv_Robertson1968`(*CCT*, *D_uv=0*)

Returns the *CIE UCS* colourspace *uv* chromaticity coordinates from given correlated colour temperature T_{cp} and Δ_{uv} using *Roberston (1968)* method.

Parameters

- **CCT** (numeric) – Correlated colour temperature T_{cp}.
- **D_uv** (numeric) – Δ_{uv}.

Returns *CIE UCS* colourspace *uv* chromaticity coordinates.

Return type ndarray

References

[AdobeSystems13b], [WS00e]

Examples

```
>>> CCT = 6500.0081378199056
>>> D_uv = 0.008333331244225
>>> CCT_to_uv_Robertson1968(CCT, D_uv)  # doctest: +ELLIPSIS
array([ 0.1937413...,  0.3152210...])
```

colour.temperature.uv_to_CCT_Robertson1968

`colour.temperature.`**`uv_to_CCT_Robertson1968`**(*uv*)

Returns the correlated colour temperature T_{cp} and Δ_{uv} from given *CIE UCS* colourspace *uv* chromaticity coordinates using *Roberston (1968)* method.

Parameters **uv** (array_like) – *CIE UCS* colourspace *uv* chromaticity coordinates.

Returns Correlated colour temperature T_{cp}, Δ_{uv}.

Return type ndarray

References

[AdobeSystems13a], [WS00e]

Examples

```
>>> uv = np.array([0.193741375998230, 0.315221043940594])
>>> uv_to_CCT_Robertson1968(uv)  # doctest: +ELLIPSIS
array([  6.5000162...e+03,   8.3333289...e-03])
```

Krystek (1985)

`colour.temperature`

CCT_to_uv_Krystek1985(CCT)	Returns the *CIE UCS* colourspace *uv* chromaticity coordinates from given correlated colour temperature T_{cp} using *Krystek (1985)* method.

colour.temperature.CCT_to_uv_Krystek1985

`colour.temperature.`**`CCT_to_uv_Krystek1985`**(*CCT*)

Returns the *CIE UCS* colourspace *uv* chromaticity coordinates from given correlated colour temperature T_{cp} using *Krystek (1985)* method.

Parameters **CCT** (numeric) – Correlated colour temperature T_{cp}.

Returns *CIE UCS* colourspace *uv* chromaticity coordinates.

Return type 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)  # doctest: +ELLIPSIS
array([ 0.1837669...,  0.3093443...])
```

Ohno (2013)

`colour.temperature`

`CCT_to_uv_Ohno2013`(CCT[, D_uv, cmfs])	Returns the *CIE UCS* colourspace *uv* chromaticity coordinates from given correlated colour temperature T_{cp}, Δ_{uv} and colour matching functions using *Ohno (2013)* method.
`uv_to_CCT_Ohno2013`(uv[, cmfs, start, end, ...])	Returns 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.

colour.temperature.CCT_to_uv_Ohno2013

`colour.temperature.`**`CCT_to_uv_Ohno2013`**(*CCT, D_uv=0, cmfs=XYZ_ColourMatchingFunctions(name='CIE 1931 2 Degree Standard Observer', ...)*)

Returns 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** (numeric) – Correlated colour temperature T_{cp}.
- **D_uv** (numeric, optional) – Δ_{uv}.
- **cmfs** (`XYZ_ColourMatchingFunctions`, optional) – Standard observer colour matching functions.

Returns *CIE UCS* colourspace *uv* chromaticity coordinates.

Return type ndarray

References

[Ohn14]

Examples

```
>>> from colour import STANDARD_OBSERVERS_CMFS
>>> cmfs = STANDARD_OBSERVERS_CMFS['CIE 1931 2 Degree Standard Observer']
>>> CCT = 6507.4342201047066
>>> D_uv = 0.003223690901513
>>> CCT_to_uv_Ohno2013(CCT, D_uv, cmfs)  # doctest: +ELLIPSIS
array([ 0.1977999...,  0.3122004...])
```

colour.temperature.uv_to_CCT_Ohno2013

`colour.temperature.`**`uv_to_CCT_Ohno2013`**(*uv*, *cmfs=XYZ_ColourMatchingFunctions(name='CIE 1931 2 Degree Standard Observer', ...)*, *start=1000*, *end=100000*, *count=10*, *iterations=6*)

Returns 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** (`array_like`) – *CIE UCS* colourspace *uv* chromaticity coordinates.
- **cmfs** (`XYZ_ColourMatchingFunctions`, `optional`) – Standard observer colour matching functions.
- **start** (`numeric`, `optional`) – Temperature range start in kelvins.
- **end** (`numeric`, `optional`) – Temperature range end in kelvins.
- **count** (`int`, `optional`) – Temperatures count in the planckian tables.
- **iterations** (`int`, `optional`) – Number of planckian tables to generate.

Returns Correlated colour temperature T_{cp}, Δ_{uv}.

Return type ndarray

References

[Ohn14]

Examples

```
>>> from colour import STANDARD_OBSERVERS_CMFS
>>> cmfs = STANDARD_OBSERVERS_CMFS['CIE 1931 2 Degree Standard Observer']
>>> uv = np.array([0.1978, 0.3122])
>>> uv_to_CCT_Ohno2013(uv, cmfs)  # doctest: +ELLIPSIS
array([  6.5074738...e+03,   3.2233461...e-03])
```

Hernandez-Andres, Lee and Romero (1999)

`colour.temperature`

xy_to_CCT_Hernandez1999(xy)	Returns the correlated colour temperature T_{cp} from given *CIE XYZ* tristimulus values *xy* chromaticity coordinates using *Hernandez-Andres et al.(1999)* method..

colour.temperature.xy_to_CCT_Hernandez1999

colour.temperature.**xy_to_CCT_Hernandez1999**(*xy*)

Returns the correlated colour temperature T_{cp} from given *CIE XYZ* tristimulus values *xy* chromaticity coordinates using *Hernandez-Andres et al. (1999)* method.

Parameters **xy** (array_like) – *xy* chromaticity coordinates.

Returns Correlated colour temperature T_{cp}.

Return type numeric

References

[HernandezAndresLR99]

Examples

```
>>> xy = np.array([0.31270, 0.32900])
>>> xy_to_CCT_Hernandez1999(xy)  # doctest: +ELLIPSIS
6500.7420431...
```

Kang, Moon, Hong, Lee, Cho and Kim (2002)

colour.temperature

CCT_to_xy_Kang2002(CCT)	Returns the *CIE XYZ* tristimulus values *xy* chromaticity coordinates from given correlated colour temperature T_{cp} using *Kang et al.(2002)* method..

colour.temperature.CCT_to_xy_Kang2002

colour.temperature.**CCT_to_xy_Kang2002**(*CCT*)

Returns the *CIE XYZ* tristimulus values *xy* chromaticity coordinates from given correlated colour temperature T_{cp} using *Kang et al. (2002)* method.

Parameters **CCT** (numeric or array_like) – Correlated colour temperature T_{cp}.

Returns *xy* chromaticity coordinates.

Return type ndarray

Raises ValueError – If the correlated colour temperature is not in appropriate domain.

References

[KMH+02]

Examples

```
>>> CCT_to_xy_Kang2002(6504.38938305)  # doctest: +ELLIPSIS
array([ 0.313426 ...,  0.3235959...])
```

CIE Illuminant D Series

colour.temperature

CCT_to_xy_CIE_D(CCT)	Converts from the correlated colour temperature T_{cp} of a *CIE Illuminant D Series* to the chromaticity of that *CIE Illuminant D Series* illuminant.

colour.temperature.CCT_to_xy_CIE_D

colour.temperature.**CCT_to_xy_CIE_D**(*CCT*)

Converts from the correlated colour temperature T_{cp} of a *CIE Illuminant D Series* to the chromaticity of that *CIE Illuminant D Series* illuminant.

Parameters **CCT** (numeric or array_like) – Correlated colour temperature T_{cp}.

Returns *xy* chromaticity coordinates.

Return type ndarray

Raises ValueError – If the correlated colour temperature is not in appropriate domain.

References

[WS00d]

Examples

```
>>> CCT_to_xy_CIE_D(6504.38938305)  # doctest: +ELLIPSIS
array([ 0.3127077...,  0.3291128...])
```

Utilities

- *Common*
- *Array*
- *Metrics*

- *Data Structures*
- *Verbose*

Common

colour

domain_range_scale(scale)	A context manager and decorator temporarily setting *Colour* domain-range scale.
get_domain_range_scale()	Returns the current *Colour* domain-range scale.
set_domain_range_scale([scale])	Sets the current *Colour* domain-range scale.

colour.domain_range_scale

class colour.**domain_range_scale**(*scale*)

A 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** (unicode) – **{'Reference', '1'}**, *Colour* domain-range scale to set.

__init__(*scale*)

Initialize self. See help(type(self)) for accurate signature.

Methods

__init__(scale)	Initialize self.

colour.get_domain_range_scale

colour.**get_domain_range_scale**()

Returns 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 unicode

colour.set_domain_range_scale

`colour.set_domain_range_scale(scale='Reference')`

Sets 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** (unicode or int) – **{'Reference', '1'}**, *Colour* domain-range scale to set.

`colour.utilities`

handle_numpy_errors(**kwargs)	Decorator for handling *Numpy* errors.
ignore_numpy_errors(function)	Wrapper for given function.
raise_numpy_errors(function)	Wrapper for given function.
print_numpy_errors(function)	Wrapper for given function.
warn_numpy_errors(function)	Wrapper for given function.
ignore_python_warnings(function)	Decorator for ignoring *Python* warnings.
batch(iterable[, k])	Returns a batch generator from given iterable.
is_openimageio_installed([raise_exception])	Returns if *OpenImageIO* is installed and available.
is_pandas_installed([raise_exception])	Returns if *Pandas* is installed and available.
is_iterable(a)	Returns if given a variable is iterable.
is_string(a)	Returns if given a variable is a *string* like variable.
is_numeric(a)	Returns if given a variable is a number.
is_integer(a)	Returns if given a variable is an integer under given threshold.
is_sibling(element, mapping)	Returns whether given element type is present in given mapping types.
filter_kwargs(function, **kwargs)	Filters keyword arguments incompatible with the given function signature.
filter_mapping(mapping, filterers[, ...])	Filters given mapping with given filterers.
first_item(a)	Return the first item of an iterable.
to_domain_1(a[, scale_factor, dtype])	Scales given array a to domain **'1'**.
to_domain_10(a[, scale_factor, dtype])	Scales given array a to domain **'10'**, used by *Munsell Renotation System*.
to_domain_100(a[, scale_factor, dtype])	Scales given array a to domain **'100'**.
to_domain_degrees(a[, scale_factor, dtype])	Scales given array a to degrees domain.
to_domain_int(a[, bit_depth, dtype])	Scales given array a to int domain.
from_range_1(a[, scale_factor])	Scales given array a from range **'1'**.
from_range_10(a[, scale_factor])	Scales given array a from range **'10'**, used by *Munsell Renotation System*.
from_range_100(a[, scale_factor])	Scales given array a from range **'100'**.
from_range_degrees(a[, scale_factor])	Scales given array a from degrees range.
from_range_int(a[, bit_depth, dtype])	Scales given array a from int range.

colour.utilities.handle_numpy_errors

colour.utilities.**handle_numpy_errors**(***kwargs*)

Decorator for handling *Numpy* errors.

Other Parameters ****kwargs** (*dict, optional*) – Keywords arguments.

Returns

Return type object

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*)

Wrapper for given function.

colour.utilities.raise_numpy_errors

colour.utilities.**raise_numpy_errors**(*function*)

Wrapper for given function.

colour.utilities.print_numpy_errors

colour.utilities.**print_numpy_errors**(*function*)

Wrapper for given function.

colour.utilities.warn_numpy_errors

colour.utilities.**warn_numpy_errors**(*function*)

Wrapper for given function.

colour.utilities.ignore_python_warnings

colour.utilities.**ignore_python_warnings**(*function*)

Decorator for ignoring *Python* warnings.

Parameters **function** (object) – Function to decorate.

Returns

Return type object

Examples

```
>>> @ignore_python_warnings
... def f():
...     warnings.warn('This is an ignored warning!')
>>> f()
```

colour.utilities.batch

colour.utilities.**batch**(*iterable*, *k=3*)

Returns a batch generator from given iterable.

Parameters

- **iterable** (iterable) – Iterable to create batches from.
- **k** (integer) – Batches size.

Returns Is *string_like* variable.

Return type bool

Examples

```
>>> batch(tuple(range(10)))  # doctest: +ELLIPSIS
<generator object batch at 0x...>
```

colour.utilities.is_openimageio_installed

colour.utilities.**is_openimageio_installed**(*raise_exception=False*)

Returns if *OpenImageIO* is installed and available.

Parameters **raise_exception** (bool) – Raise exception if *OpenImageIO* is unavailable.

Returns Is *OpenImageIO* installed.

Return type bool

Raises ImportError – If *OpenImageIO* is not installed.

colour.utilities.is_pandas_installed

colour.utilities.**is_pandas_installed**(*raise_exception=False*)

Returns if *Pandas* is installed and available.

Parameters **raise_exception** (bool) – Raise exception if *Pandas* is unavailable.

Returns Is *Pandas* installed.

Return type bool

Raises ImportError – If *Pandas* is not installed.

colour.utilities.is_iterable

colour.utilities.**is_iterable**(*a*)

Returns if given *a* variable is iterable.

Parameters **a** (object) – Variable to check the iterability.

Returns *a* variable iterability.

Return type bool

Examples

```
>>> is_iterable([1, 2, 3])
True
>>> is_iterable(1)
False
```

colour.utilities.is_string

colour.utilities.**is_string**(*a*)

Returns if given *a* variable is a *string* like variable.

Parameters **a** (object) – Data to test.

Returns Is *a* variable a *string* 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*)

Returns if given *a* variable is a number.

Parameters **a** (object) – Variable to check.

Returns Is *a* variable a number.

Return type bool

Examples

```
>>> is_numeric(1)
True
>>> is_numeric((1,))
False
```

colour.utilities.is_integer

`colour.utilities.`**`is_integer`**(*a*)

Returns if given *a* variable is an integer under given threshold.

Parameters **a** (object) – Variable to check.

Returns Is *a* variable an integer.

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*, *mapping*)

Returns whether given element type is present in given mapping types.

Parameters

- **element** (object) – Element to check if its type is present in the mapping types.
- **mapping** (dict) – Mapping.

Returns Whether given element type is present in given mapping types.

Return type bool

colour.utilities.filter_kwargs

`colour.utilities.`**`filter_kwargs`**(*function*, ***kwargs*)

Filters keyword arguments incompatible with the given function signature.

Parameters **function** (callable) – Callable to filter the incompatible keyword arguments.

Other Parameters ****kwargs** (*dict, optional*) – 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)
>>> fn_c(1, **filter_kwargs(fn_c, b=2, c=3))
(1, 2, 3)
```

colour.utilities.filter_mapping

colour.utilities.**filter_mapping**(*mapping*, *filterers*, *anchors=True*, *flags=<RegexFlag.IGNORECASE: 2>*)

Filters given mapping with given filterers.

Parameters

- **mapping** (dict_like) – Mapping to filter.
- **filterers** (unicode or object or array_like) – Filterer pattern for given mapping elements or a list of filterers.
- **anchors** (bool, optional) – Whether to use Regex line anchors, i.e. ^ and $ are added, surrounding the filterer pattern.
- **flags** (int, optional) – Regex flags.

Returns Filtered mapping elements.

Return type OrderedDict

Notes

- To honour the filterers ordering, the return value is an `OrderedDict` class instance.

Examples

```
>>> class Element(object):
...     pass
>>> mapping = {
...     'Element A': Element(),
...     'Element B': Element(),
...     'Element C': Element(),
...     'Not Element C': Element(),
... }
>>> # Doctests skip for Python 2.x compatibility.
>>> filter_mapping(mapping, '\w+\s+A')  # doctest: +SKIP
{u'Element A': <colour.utilities.common.Element object at 0x...>}
>>> # Doctests skip for Python 2.x compatibility.
>>> sorted(filter_mapping(mapping, 'Element.*'))  # doctest: +SKIP
[u'Element A', u'Element B', u'Element C']
```

colour.utilities.first_item

`colour.utilities.`**`first_item`**(*a*)

Return the first item of an iterable.

Parameters **a** (`object`) – Iterable to get the first item from.

Returns

Return type object

Raises `StopIteration` – If the iterable is empty.

Examples

```
>>> a = range(10)
>>> first_item(a)
0
```

colour.utilities.to_domain_1

`colour.utilities.`**`to_domain_1`**(*a*, *scale_factor=100*, *dtype=<class 'numpy.float64'>*)

Scales 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 just 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** (`array_like`) – a to scale to domain **'1'**.
- **scale_factor** (`numeric or array_like, optional`) – Scale factor, usually *numeric* but can be an *array_like* if some axis need different scaling to be brought to domain **'1'**.
- **dtype** (`object, optional`) – Data type used for the conversion to `np.ndarray`.

Returns a scaled to domain **'1'**.

Return type 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*, *scale_factor=10*, *dtype=<class 'numpy.float64'>*)

Scales 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 just 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** (`array_like`) – a to scale to domain **'10'**.
- **scale_factor** (`numeric or array_like, optional`) – Scale factor, usually *numeric* but can be an *array_like* if some axis need different scaling to be brought to domain **'10'**.
- **dtype** (`object, optional`) – Data type used for the conversion to `np.ndarray`.

Returns a scaled to domain **'10'**.

Return type 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*, *scale_factor=100*, *dtype=<class 'numpy.float64'>*)

Scales 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 just 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** (`array_like`) – a to scale to domain **'100'**.
- **scale_factor** (`numeric or array_like, optional`) – Scale factor, usually *numeric* but can be an *array_like* if some axis need different scaling to be brought to domain **'100'**.
- **dtype** (`object, optional`) – Data type used for the conversion to `np.ndarray`.

Returns a scaled to domain **'100'**.

Return type 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*, *scale_factor=360*, *dtype=<class 'numpy.float64'>*)

Scales 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 just 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** (array_like) – a to scale to degrees domain.
- **scale_factor** (numeric or array_like, optional) – Scale factor, usually *numeric* but can be an *array_like* if some axis need different scaling to be brought to degrees domain.
- **dtype** (object, optional) – Data type used for the conversion to np.ndarray.

Returns a scaled to degrees domain.

Return type 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*, *bit_depth=8*, *dtype=<class 'numpy.float64'>*)

Scales 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 just conveniently convert array a to np.ndarray.
- If *Colour* domain-range scale is **'1'**, array a is multiplied by $2^{bit\_depth} - 1$.
- If *Colour* domain-range scale is **'100'** (currently unsupported private value only used for unit tests), array a is multiplied by $2^{bit\_depth} - 1$.

Parameters

- **a** (array_like) – a to scale to int domain.
- **bit_depth** (numeric or array_like, optional) – Bit depth, usually *int* but can be an *array_like* if some axis need different scaling to be brought to int domain.
- **dtype** (object, optional) – Data type used for the conversion to np.ndarray.

Returns a scaled to int domain.

Return type ndarray

Notes

- To avoid precision issues and rounding, the scaling is performed on floating-point 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*, *scale_factor=100*)

Scales 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** (`array_like`) – a to scale from range **'1'**.
- **scale_factor** (`numeric or array_like, optional`) – Scale factor, usually *numeric* but can be an *array_like* if some axis need different scaling to be brought from range **'1'**.

Returns a scaled from range **'1'**.

Return type ndarray

Examples

With *Colour* domain-range scale set to **'Reference'**:

```
>>> with domain_range_scale('Reference'):
...     from_range_1(1)
1
```

With *Colour* domain-range scale set to **'1'**:

```
>>> with domain_range_scale('1'):
...     from_range_1(1)
1
```

With *Colour* domain-range scale set to **'100'** (unsupported):

```
>>> with domain_range_scale('100'):
...     from_range_1(1)
100
```

colour.utilities.from_range_10

`colour.utilities.`**`from_range_10`**(*a*, *scale_factor=10*)

Scales 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** (`array_like`) – a to scale from range **'10'**.
- **scale_factor** (`numeric or array_like, optional`) – Scale factor, usually *numeric* but can be an *array_like* if some axis need different scaling to be brought from range **'10'**.

Returns a scaled from range **'10'**.

Return type ndarray

Examples

With *Colour* domain-range scale set to **'Reference'**:

```
>>> with domain_range_scale('Reference'):
...     from_range_10(1)
1
```

With *Colour* domain-range scale set to **'1'**:

```
>>> with domain_range_scale('1'):
...     from_range_10(1)
0.1
```

With *Colour* domain-range scale set to **'100'** (unsupported):

```
>>> with domain_range_scale('100'):
...     from_range_10(1)
10
```

colour.utilities.from_range_100

`colour.utilities.`**`from_range_100`**(*a*, *scale_factor=100*)

Scales 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** (`array_like`) – a to scale from range **'100'**.
- **scale_factor** (`numeric or array_like, optional`) – Scale factor, usually *numeric* but can be an *array_like* if some axis need different scaling to be brought from range **'100'**.

Returns a scaled from range **'100'**.

Return type ndarray

Examples

With *Colour* domain-range scale set to **'Reference'**:

```
>>> with domain_range_scale('Reference'):
...     from_range_100(1)
1
```

With *Colour* domain-range scale set to **'1'**:

```
>>> with domain_range_scale('1'):
...     from_range_100(1)
0.01
```

With *Colour* domain-range scale set to **'100'** (unsupported):

```
>>> with domain_range_scale('100'):
...     from_range_100(1)
1
```

colour.utilities.from_range_degrees

`colour.utilities.`**`from_range_degrees`**(*a*, *scale_factor=360*)

Scales 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** (`array_like`) – a to scale from degrees range.

- **scale_factor** (numeric or array_like, optional) – Scale factor, usually *numeric* but can be an *array_like* if some axis need different scaling to be brought from degrees range.

Returns a scaled from degrees range.

Return type ndarray

Examples

With *Colour* domain-range scale set to **'Reference'**:

```
>>> with domain_range_scale('Reference'):
...     from_range_degrees(1)
1
```

With *Colour* domain-range scale set to **'1'**:

```
>>> with domain_range_scale('1'):
...     from_range_degrees(1)  # doctest: +ELLIPSIS
0.0027777...
```

With *Colour* domain-range scale set to **'100'** (unsupported):

```
>>> with domain_range_scale('100'):
...     from_range_degrees(1)  # doctest: +ELLIPSIS
0.2777777...
```

colour.utilities.from_range_int

colour.utilities.**from_range_int**(*a*, *bit_depth=8*, *dtype=<class 'numpy.float64'>*)

Scales 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** (array_like) – a to scale from int range.
- **bit_depth** (numeric or array_like, optional) – Bit depth, usually *int* but can be an *array_like* if some axis need different scaling to be brought from int range.
- **dtype** (object, optional) – Data type used for the conversion to np.ndarray.

Returns a scaled from int range.

Return type ndarray

Notes

- To avoid precision issues and rounding, the scaling is performed on floating-point numbers.

Examples

With *Colour* domain-range scale set to **'Reference'**:

```
>>> with domain_range_scale('Reference'):
...     from_range_int(1)
1
```

With *Colour* domain-range scale set to **'1'**:

```
>>> with domain_range_scale('1'):
...     from_range_int(1)  # doctest: +ELLIPSIS
array(0.0039215...)
```

With *Colour* domain-range scale set to **'100'** (unsupported):

```
>>> with domain_range_scale('100'):
...     from_range_int(1)  # doctest: +ELLIPSIS
array(0.3921568...)
```

Array

`colour.utilities`

`as_array`(a[, dtype])	Converts given a variable to *ndarray* with given type.
`as_int_array`(a)	Converts given a variable to *ndarray* using the type defined by `colour.constant.DEFAULT_INT_DTYPE` attribute.
`as_float_array`(a)	Converts given a variable to *ndarray* using the type defined by `colour.constant.DEFAULT_FLOAT_DTYPE` attribute.
`as_numeric`(a[, dtype])	Converts given a variable to *numeric*.
`as_int`(a)	Converts given a variable to *numeric* using the type defined by `colour.constant.DEFAULT_INT_DTYPE` attribute.
`as_float`(a)	Converts given a variable to *numeric* using the type defined by `colour.constant.DEFAULT_FLOAT_DTYPE` attribute.
`as_namedtuple`(a, named_tuple)	Converts given a variable to given *namedtuple* class instance.
`closest_indexes`(a, b)	Returns the a variable closest element indexes to reference b variable elements.
`closest`(a, b)	Returns the a variable closest elements to reference b variable elements.
`normalise_maximum`(a[, axis, factor, clip])	Normalises given *array_like* a variable values by a variable maximum value and optionally clip them between.
`interval`(distribution[, unique])	Returns the interval size of given distribution.
`is_uniform`(distribution)	Returns if given distribution is uniform.
`in_array`(a, b[, tolerance])	Tests whether each element of an array is also present in a second array within given tolerance.

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tstack(a[, dtype])	Stacks arrays in sequence along the last axis (tail).
tsplit(a[, dtype])	Splits arrays in sequence along the last axis (tail).
row_as_diagonal(a)	Returns the per row diagonal matrices of the given array.
dot_vector(m, v)	Convenient wrapper around `np.einsum()` with the following subscripts: '...*ij*,...*j*->...*i*'.
dot_matrix(a, b)	Convenient wrapper around `np.einsum()` with the following subscripts: '...*ij*,...*jk*->...*ik*'.
orient(a, orientation)	Orient given array according to given `orientation` value.
centroid(a)	Computes the centroid indexes of given a array.
linear_conversion(a, old_range, new_range)	Performs a simple linear conversion of given array between the old and new ranges.
lerp(a, b, c)	Performs a simple linear interpolation between given array a and array b using c value.
fill_nan(a[, method, default])	Fills given array NaNs according to given method.
ndarray_write(a)	A context manager setting given array writeable to perform an operation and then read-only.

colour.utilities.as_array

`colour.utilities.`**`as_array`**(*a*, *dtype=<class 'numpy.float64'>*)

Converts given a variable to *ndarray* with given type.

Parameters

- **a** (`object`) – Variable to convert.
- **dtype** (`object`) – Type to use for conversion.

Returns a variable converted to *ndarray*.

Return type ndarray

Examples

```
>>> as_array([1, 2, 3])
array([ 1.,  2.,  3.])
>>> as_array([1, 2, 3], dtype=DEFAULT_INT_DTYPE)
array([1, 2, 3])
```

colour.utilities.as_int_array

`colour.utilities.`**`as_int_array`**(*a*)

Converts given a variable to *ndarray* using the type defined by `colour.constant.DEFAULT_INT_DTYPE` attribute.

Parameters **a** (`object`) – Variable to convert.

Returns a variable converted to *ndarray*.

Return type 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*)

Converts given *a* variable to *ndarray* using the type defined by `colour.constant.DEFAULT_FLOAT_DTYPE` attribute.

Parameters **a** (`object`) – Variable to convert.

Returns *a* variable converted to *ndarray*.

Return type ndarray

Examples

```
>>> as_float_array([1, 2, 3])
array([ 1.,  2.,  3.])
```

colour.utilities.as_numeric

`colour.utilities.`**`as_numeric`**(*a*, *dtype=<class 'numpy.float64'>*)

Converts given *a* variable to *numeric*. In the event where *a* cannot be converted, it is passed as is.

Parameters

- **a** (`object`) – Variable to convert.
- **dtype** (`object`) – Type to use for conversion.

Returns *a* variable converted to *numeric*.

Return type ndarray

Examples

```
>>> as_numeric(np.array([1]))
1.0
>>> as_numeric(np.arange(10))
array([ 0.,  1.,  2.,  3.,  4.,  5.,  6.,  7.,  8.,  9.])
```

colour.utilities.as_int

`colour.utilities.`**`as_int`**(*a*)

Converts given *a* variable to *numeric* using the type defined by `colour.constant.DEFAULT_INT_DTYPE` attribute. In the event where *a* cannot be converted, it is converted to *ndarray* using the type defined by `colour.constant.DEFAULT_INT_DTYPE` attribute.

Parameters **a** (`object`) – Variable to convert.

Returns a variable converted to *numeric*.

Return type ndarray

> **Warning:** The behaviour of this definition is different than `colour.utilities.as_numeric()` definition when it comes to conversion failure: the former will forcibly convert a variable to *ndarray* using the type defined by `colour.constant.DEFAULT_INT_DTYPE` attribute while the later will pass the a variable as is.

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*)

Converts given a variable to *numeric* using the type defined by `colour.constant.DEFAULT_FLOAT_DTYPE` attribute. In the event where a cannot be converted, it is converted to *ndarray* using the type defined by `colour.constant.DEFAULT_FLOAT_DTYPE` attribute.

Parameters **a** (`object`) – Variable to convert.

Returns a variable converted to *numeric*.

Return type ndarray

> **Warning:** The behaviour of this definition is different than `colour.utilities.as_numeric()` definition when it comes to conversion failure: the former will forcibly convert a variable to *ndarray* using the type defined by `colour.constant.DEFAULT_FLOAT_DTYPE` attribute while the later will pass the a variable as is.

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_namedtuple

`colour.utilities.`**`as_namedtuple`**(*a*, *named_tuple*)

Converts given a variable to given *namedtuple* class instance.

a can be either a *Numpy* structured array, a *namedtuple*, a *mapping*, or an *array_like* object. The definition will attempt to convert it to given *namedtuple*.

Parameters

- **a** (object) – Variable to convert.
- **named_tuple** (namedtuple) – *namedtuple* class.

Returns math:*a* variable converted to *namedtuple*.

Return type namedtuple

Examples

```
>>> from collections import namedtuple
>>> a_a = 1
>>> a_b = 2
>>> a_c = 3
>>> NamedTuple = namedtuple('NamedTuple', 'a b c')
>>> as_namedtuple(NamedTuple(a=1, b=2, c=3), NamedTuple)
NamedTuple(a=1, b=2, c=3)
>>> as_namedtuple({'a': a_a, 'b': a_b, 'c': a_c}, NamedTuple)
NamedTuple(a=1, b=2, c=3)
>>> as_namedtuple([a_a, a_b, a_c], NamedTuple)
NamedTuple(a=1, b=2, c=3)
```

colour.utilities.closest_indexes

colour.utilities.**closest_indexes**(*a*, *b*)

Returns the a variable closest element indexes to reference b variable elements.

Parameters

- **a** (array_like) – Variable to search for the closest element indexes.
- **b** (numeric) – Reference variable.

Returns Closest a variable element indexes.

Return type numeric

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*, *b*)

Returns the a variable closest elements to reference b variable elements.

Parameters

- **a** (array_like) – Variable to search for the closest elements.
- **b** (numeric) – Reference variable.

Returns Closest a variable elements.

Return type numeric

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.normalise_maximum

`colour.utilities.`**`normalise_maximum`**(*a*, *axis=None*, *factor=1*, *clip=True*)

Normalises given *array_like* a variable values by a variable maximum value and optionally clip them between.

Parameters

- **a** (`array_like`) – a variable to normalise.
- **axis** (`numeric, optional`) – Normalization axis.
- **factor** (`numeric, optional`) – Normalization factor.
- **clip** (`bool, optional`) – Clip values to domain [0, 'factor'].

Returns Maximum normalised a variable.

Return type ndarray

Examples

```
>>> a = np.array([0.48222001, 0.31654775, 0.22070353])
>>> normalise_maximum(a)  # doctest: +ELLIPSIS
array([ 1.        ,  0.6564384...,  0.4576822...])
```

colour.utilities.interval

`colour.utilities.`**`interval`**(*distribution*, *unique=True*)

Returns the interval size of given distribution.

Parameters

- **distribution** (`array_like`) – Distribution to retrieve the interval.
- **unique** (`bool, optional`) – Whether to return unique intervals if the distribution is non-uniformly spaced or the complete intervals

Returns Distribution interval.

Return type 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*)

Returns if given distribution is uniform.

Parameters **`distribution`** (`array_like`) – Distribution to check for uniformity.

Returns Is 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.in_array

`colour.utilities.`**`in_array`**(*a*, *b*, *tolerance=2.2204460492503131e-16*)

Tests whether each element of an array is also present in a second array within given tolerance.

Parameters

- **`a`** (`array_like`) – Array to test the elements from.
- **`b`** (`array_like`) – The values against which to test each value of array *a*.
- **`tolerance`** (`numeric, optional`) – Tolerance value.

Returns A boolean array with *a* shape describing whether an element of *a* is present in *b* within given tolerance.

Return type 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*, *dtype=<class 'numpy.float64'>*)

Stacks arrays in sequence along the last axis (tail).

Rebuilds arrays divided by `colour.utilities.tsplit()`.

Parameters

- **a** (`array_like`) – Array to perform the stacking.
- **dtype** (`object`) – Type to use for initial conversion to *ndarray*.

Returns

Return type 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.],
```

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```
        [ 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*, *dtype=<class 'numpy.float64'>*)

Splits arrays in sequence along the last axis (tail).

Parameters

- **a** (`array_like`) – Array to perform the splitting.
- **dtype** (`object`) – Type to use for initial conversion to *ndarray*.

Returns

Return type 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.]],
<BLANKLINE>
       [[ 0.,  1.,  2.,  3.,  4.,  5.]],
```

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```
<BLANKLINE>
       [[ 0.,  1.,  2.,  3.,  4.,  5.]]])
```

colour.utilities.row_as_diagonal

colour.utilities.**row_as_diagonal**(*a*)

Returns the per row diagonal matrices of the given array.

Parameters **a** (array_like) – Array to perform the diagonal matrices computation.

Returns

Return type 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]],
<BLANKLINE>
       [[ 0.30851087,  0.        ,  0.        ],
        [ 0.        ,  0.37131459,  0.        ],
        [ 0.        ,  0.        ,  0.16274825]],
<BLANKLINE>
       [[ 0.71061831,  0.        ,  0.        ],
        [ 0.        ,  0.67718718,  0.        ],
        [ 0.        ,  0.        ,  0.09562581]],
<BLANKLINE>
       [[ 0.71588836,  0.        ,  0.        ],
        [ 0.        ,  0.76772047,  0.        ],
        [ 0.        ,  0.        ,  0.15476079]],
<BLANKLINE>
       [[ 0.92985142,  0.        ,  0.        ],
        [ 0.        ,  0.22263399,  0.        ],
        [ 0.        ,  0.        ,  0.88027331]]])
```

colour.utilities.dot_vector

colour.utilities.**dot_vector**(*m*, *v*)

Convenient wrapper around np.einsum() with the following subscripts: '...*ij*,...*j*->...*i*'.

It performs the dot product of two arrays where *m* parameter is expected to be an array of 3x3 matrices and parameter *v* an array of vectors.

Parameters

- **m** (array_like) – Array of 3x3 matrices.
- **v** (array_like) – Array of vectors.

Returns

Return type 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))
>>> dot_vector(m, v)  # doctest: +ELLIPSIS
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.utilities.dot_matrix

`colour.utilities.`**`dot_matrix`**(*a*, *b*)

Convenient wrapper around `np.einsum()` with the following subscripts: '...*ij*,...*jk*->...*ik*'.

It performs the dot product of two arrays where *a* parameter is expected to be an array of 3x3 matrices and parameter *b* another array of of 3x3 matrices.

Parameters

- **a** (array_like) – Array of 3x3 matrices.
- **b** (array_like) – Array of 3x3 matrices.

Returns

Return type 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))
```

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```
>>> b = a
>>> dot_matrix(a, b)  # doctest: +ELLIPSIS
array([[[ 0.2342420...,  1.0418482..., -0.2760903...],
        [-1.7099407...,  2.5793226...,  0.1306181...],
        [-0.0044203...,  0.0377490...,  0.9666713...]],
<BLANKLINE>
       [[ 0.2342420...,  1.0418482..., -0.2760903...],
        [-1.7099407...,  2.5793226...,  0.1306181...],
        [-0.0044203...,  0.0377490...,  0.9666713...]],
<BLANKLINE>
       [[ 0.2342420...,  1.0418482..., -0.2760903...],
        [-1.7099407...,  2.5793226...,  0.1306181...],
        [-0.0044203...,  0.0377490...,  0.9666713...]],
<BLANKLINE>
       [[ 0.2342420...,  1.0418482..., -0.2760903...],
        [-1.7099407...,  2.5793226...,  0.1306181...],
        [-0.0044203...,  0.0377490...,  0.9666713...]],
<BLANKLINE>
       [[ 0.2342420...,  1.0418482..., -0.2760903...],
        [-1.7099407...,  2.5793226...,  0.1306181...],
        [-0.0044203...,  0.0377490...,  0.9666713...]],
<BLANKLINE>
       [[ 0.2342420...,  1.0418482..., -0.2760903...],
        [-1.7099407...,  2.5793226...,  0.1306181...],
        [-0.0044203...,  0.0377490...,  0.9666713...]]])
```

colour.utilities.orient

`colour.utilities.`**`orient`**(*a*, *orientation*)

Orient given array according to given `orientation` value.

Parameters

- **a** (`array_like`) – Array to perform the orientation onto.
- **orientation** (`unicode, optional`) – **{'Flip', 'Flop', '90 CW', '90 CCW', '180'}** Orientation to perform.

Returns Oriented array.

Return type 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],
```

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```
       [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*)

Computes the centroid indexes of given *a* array.

Parameters **a** (array_like) – *a* array to compute the centroid indexes.

Returns *a* array centroid indexes.

Return type ndarray

Examples

```
>>> a = np.tile(np.arange(0, 5), (5, 1))
>>> centroid(a)
array([2, 3])
```

colour.utilities.linear_conversion

`colour.utilities.`**`linear_conversion`**(*a*, *old_range*, *new_range*)

Performs a simple linear conversion of given array between the old and new ranges.

Parameters

- **a** (array_like) – Array to perform the linear conversion onto.
- **old_range** (array_like) – Old range.
- **new_range** (array_like) – New range.

Returns Linear conversion result.

Return type 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.utilities.lerp

`colour.utilities.lerp(a, b, c)`

Performs a simple linear interpolation between given array a and array b using c value.

Parameters

- **a** (array_like) – Array a, the start of the range in which to interpolate.
- **b** (array_like) – Array b, the end of the range in which to interpolate.
- **c** (array_like) – Array c value to use to interpolate between array a and array b.

Returns Linear interpolation result.

Return type ndarray

Examples

```
>>> a = 0
>>> b = 2
>>> lerp(a, b, 0.5)
1.0
```

colour.utilities.fill_nan

`colour.utilities.fill_nan(a, method='Interpolation', default=0)`

Fills given array NaNs according to given method.

Parameters

- **a** (array_like) – Array to fill the NaNs of.
- **method** (unicode) – **{'Interpolation', 'Constant'}**, *Interpolation* method linearly interpolates through the NaNs, *Constant* method replaces NaNs with `default`.
- **default** (numeric) – Value to use with the *Constant* method.

Returns NaNs filled array.

Return type 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)`

A context manager setting given array writeable to perform an operation and then read-only.

Parameters **a** (array_like) – Array to perform an operation.

Returns Array.

Return type ndarray

Examples

```
>>> a = np.linspace(0, 1, 10)
>>> a.setflags(write=False)
>>> try:
...     a += 1
... except ValueError:
...     pass
>>> with ndarray_write(a):
...     a +=1
```

Metrics

colour.utilities

metric_mse(a, b)	Computes the mean squared error (MSE) or mean squared deviation (MSD) between given *array_like* a and b variables.
metric_psnr(a, b[, max_a])	Computes the peak signal-to-noise ratio (PSNR) between given *array_like* a and b variables.

colour.utilities.metric_mse

colour.utilities.**metric_mse**(a, b)

Computes the mean squared error (MSE) or mean squared deviation (MSD) between given *array_like* a and b variables.

Parameters

- **a** (array_like) – a variable.
- **b** (array_like) – b variable.

Returns Mean squared error (MSE).

Return type float

References

[Wik03d]

Examples

```
>>> a = np.array([0.48222001, 0.31654775, 0.22070353])
>>> b = a * 0.9
>>> metric_mse(a, b)  # doctest: +ELLIPSIS
0.0012714...
```

colour.utilities.metric_psnr

colour.utilities.**metric_psnr**(*a*, *b*, *max_a=1*)

Computes the peak signal-to-noise ratio (PSNR) between given *array_like* a and b variables.

Parameters

- **a** (array_like) – a variable.
- **b** (array_like) – b variable.
- **max_a** (numeric, optional) – Maximum possible pixel value of the a variable.

Returns Peak signal-to-noise ratio (PSNR).

Return type float

References

[Wik04a]

Examples

```
>>> a = np.array([0.48222001, 0.31654775, 0.22070353])
>>> b = a * 0.9
>>> metric_psnr(a, b)  # doctest: +ELLIPSIS
28.9568515...
```

Data Structures

colour.utilities

CaseInsensitiveMapping([data])	Implements a case-insensitive mutable mapping / *dict* object.
Lookup	Extends *dict* type to provide a lookup by value(s).
Structure(*args, **kwargs)	Defines an object similar to C/C++ structured type.

colour.utilities.CaseInsensitiveMapping

class colour.utilities.**CaseInsensitiveMapping**(*data=None*, ***kwargs*)

Implements a case-insensitive mutable mapping / *dict* object.

Allows values retrieving from keys while ignoring the key case. The keys are expected to be unicode or string-like objects supporting the str.lower() method.

Parameters **data** (dict) – *dict* of data to store into the mapping at initialisation.

Other Parameters ****kwargs** (*dict, optional*) – Key / Value pairs to store into the mapping at initialisation.

__setitem__()

__getitem__()

__delitem__()

__contains__()

__iter__()

__len__()

__eq__()

__ne__()

__repr__()

copy()

lower_items()

> **Warning:** The keys are expected to be unicode or string-like objects.

References

[Rei]

Examples

```
>>> methods = CaseInsensitiveMapping({'McCamy': 1, 'Hernandez': 2})
>>> methods['mccamy']
1
```

__init__(*data=None*, ***kwargs*)

Initialize self. See help(type(self)) for accurate signature.

Methods

__init__([data])	Initialize self.
clear()	
copy()	Returns a copy of the mapping.
get(k[,d])	
items()	
keys()	
lower_items()	Iterates over the lower items names.
pop(k[,d])	If key is not found, d is returned if given, otherwise KeyError is raised.
popitem()	as a 2-tuple; but raise KeyError if D is empty.
setdefault(k[,d])	
update([E,]**F)	If E present and has a .keys() method, does: for k in E: D[k] = E[k] If E present and lacks .keys() method, does: for (k, v) in E: D[k] = v In either case, this is followed by: for k, v in F.items(): D[k] = v
values()	

Attributes

data	Getter and setter property for the data.

colour.utilities.Lookup

class colour.utilities.**Lookup**

Extends *dict* type to provide a lookup by value(s).

keys_from_value()

first_key_from_value()

References

[Mana]

Examples

```
>>> person = Lookup(first_name='Doe', last_name='John', gender='male')
>>> person.first_key_from_value('Doe')
'first_name'
>>> persons = Lookup(John='Doe', Jane='Doe', Luke='Skywalker')
>>> sorted(persons.keys_from_value('Doe'))
['Jane', 'John']
```

__init__()

Initialize self. See help(type(self)) for accurate signature.

Methods

clear()	
copy()	
first_key_from_value(value)	Gets the first key with given value.
fromkeys	Create a new dictionary with keys from iterable and values set to value.
get	Return the value for key if key is in the dictionary, else default.
items()	
keys()	
keys_from_value(value)	Gets the keys with given value.
pop(k[,d])	If key is not found, d is returned if given, otherwise KeyError is raised
popitem()	2-tuple; but raise KeyError if D is empty.
setdefault	Insert key with a value of default if key is not in the dictionary.

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Table 283 – continued from previous page

update([E,]**F)	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]
values()	

colour.utilities.Structure

class colour.utilities.**Structure**(**args*, ***kwargs*)

Defines an object similar to C/C++ structured type.

Other Parameters

- ***args** (*list, optional*) – Arguments.
- ****kwargs** (*dict, optional*) – Key / Value pairs.

References

[Manb]

Examples

```
>>> person = Structure(first_name='Doe', last_name='John', gender='male')
>>> # Doctests skip for Python 2.x compatibility.
>>> person.first_name  # doctest: +SKIP
'Doe'
>>> sorted(person.keys())
['first_name', 'gender', 'last_name']
>>> # Doctests skip for Python 2.x compatibility.
>>> person['gender']  # doctest: +SKIP
'male'
```

__init__(**args*, ***kwargs*)

Initialize self. See help(type(self)) for accurate signature.

Methods

__init__(*args, **kwargs)	Initialize self.
clear()	
copy()	
fromkeys	Create a new dictionary with keys from iterable and values set to value.
get	Return the value for key if key is in the dictionary, else default.
items()	
keys()	
pop(k[,d])	If key is not found, d is returned if given, otherwise KeyError is raised

Continued on next page

Table 284 – continued from previous page

popitem()	2-tuple; but raise KeyError if D is empty.
setdefault	Insert key with a value of default if key is not in the dictionary.
update([E,]**F)	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]
values()	

Verbose

colour.utilities

message_box(message[, width, padding, ...])	Prints a message inside a box.
warning(*args, **kwargs)	Issues a warning.
filter_warnings([state, colour_warnings, ...])	Filters *Colour* and also optionally overall Python warnings.
suppress_warnings([colour_warnings, ...])	A context manager filtering *Colour* and also optionally overall Python warnings.
numpy_print_options(*args, **kwargs)	A context manager implementing context changes to *Numpy* print behaviour.
describe_environment([runtime_packages, ...])	Describes *Colour* running environment, i.e.

colour.utilities.message_box

colour.utilities.**message_box**(*message*, *width=79*, *padding=3*, *print_callable=<built-in function print>*)

Prints a message inside a box.

Parameters

- **message** (unicode) – Message to print.
- **width** (int, optional) – Message box width.
- **padding** (unicode, optional) – Padding on each sides of the message.
- **print_callable** (callable, optional) – Callable used to print the message box.

Returns Definition success.

Return type bool

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       *
```

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```
*   eiusmod tempor incididunt ut labore et dolore magna aliqua.          *
*                                                                        *
==========================================================================
True
>>> message_box(message, width=60)
============================================================
*                                                          *
*   Lorem ipsum dolor sit amet, consectetur adipiscing     *
*   elit, sed do eiusmod tempor incididunt ut labore et    *
*   dolore magna aliqua.                                   *
*                                                          *
============================================================
True
>>> message_box(message, width=75, padding=16)
===============================================================================
*                                                                             *
*                Lorem ipsum dolor sit amet, consectetur                      *
*                adipiscing elit, sed do eiusmod tempor                       *
*                incididunt ut labore et dolore magna                         *
*                aliqua.                                                      *
*                                                                             *
===============================================================================
True
```

colour.utilities.warning

`colour.utilities.`**`warning`**(**args*, ***kwargs*)

Issues a warning.

Other Parameters

- ***args** (*list, optional*) – Arguments.
- ****kwargs** (*dict, optional*) – Keywords arguments.

Returns Definition success.

Return type bool

Examples

```
>>> warning('This is a warning!')  # doctest: +SKIP
```

colour.utilities.filter_warnings

`colour.utilities.`**`filter_warnings`**(*state=True*, *colour_warnings=True*, *colour_runtime_warnings=False*, *colour_usage_warnings=False*, *python_warnings=False*)

Filters *Colour* and also optionally overall Python warnings.

Parameters

- **state** (bool, optional) – Warnings filter state.

- **colour_warnings** (bool, optional) – Whether to filter *Colour* warnings, this also filters *Colour* usage and runtime warnings.
- **colour_runtime_warnings** (bool, optional) – Whether to filter *Colour* runtime warnings.
- **colour_usage_warnings** (bool, optional) – Whether to filter *Colour* usage warnings.
- **python_warnings** (bool, optional) – Whether to filter *Python* warnings.

Returns Definition success.

Return type bool

Examples

Filtering *Colour* warnings: >>> filter_warnings() True

Filtering *Colour* runtime warnings: >>> filter_warnings(colour_warnings=False, colour_runtime_warnings=True) True

Filtering *Colour* usage warnings: >>> filter_warnings(colour_warnings=False, colour_usage_warnings=True) True

Filtering *Colour* and also Python warnings: >>> filter_warnings(python_warnings=True) True

colour.utilities.suppress_warnings

colour.utilities.**suppress_warnings**(*colour_warnings=True*, *colour_runtime_warnings=False*, *colour_usage_warnings=False*, *python_warnings=False*)

A context manager filtering *Colour* and also optionally overall Python warnings.

Parameters

- **colour_warnings** (bool, optional) – Whether to filter *Colour* warnings, this also filters *Colour* usage and runtime warnings.
- **colour_runtime_warnings** (bool, optional) – Whether to filter *Colour* runtime warnings.
- **colour_usage_warnings** (bool, optional) – Whether to filter *Colour* usage warnings.
- **python_warnings** (bool, optional) – Whether to filter *Python* warnings.

colour.utilities.numpy_print_options

colour.utilities.**numpy_print_options**(**args*, ***kwargs*)

A context manager implementing context changes to *Numpy* print behaviour.

Other Parameters

- ***args** (*list, optional*) – Arguments.
- ****kwargs** (*dict, optional*) – Keywords arguments.

Examples

```
>>> np.array([np.pi])  # doctest: +ELLIPSIS
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=True*, *development_packages=False*, *print_environment=True*, ***kwargs*)

Describes *Colour* running environment, i.e. interpreter, runtime and development packages.

Parameters

- **runtime_packages** (bool, optional) – Whether to return the runtime packages versions.
- **development_packages** (bool, optional) – Whether to return the development packages versions.
- **print_environment** (bool, optional) – Whether to print the environment.

Other Parameters

- **padding** (*unicode, optional*) – {colour.utilities.message_box()}, Padding on each sides of the message.
- **print_callable** (*callable, optional*) – {colour.utilities.message_box()}, Callable used to print the message box.
- **width** (*int, optional*) – {colour.utilities.message_box()}, Message box width.

Returns Environment.

Return type defaultdict

Examples

```
>>> environment = describe_environment(width=75)  # doctest: +SKIP
===============================================================================
*                                                                             *
*   Interpreter :                                                             *
*       python : 2.7.14 | packaged by conda-forge | (default, Dec 25          *
*   2017, 01:18:54)                                                           *
*               [GCC 4.2.1 Compatible Apple LLVM 6.1.0                        *
*   (clang-602.0.53)]                                                         *
*                                                                             *
*   colour-science.org :                                                      *
*       colour : v0.3.11-323-g380c1838                                        *
*                                                                             *
*   Runtime :                                                                 *
*       numpy : 1.14.3                                                        *
*       scipy : 1.0.0                                                         *
*       pandas : 0.22.0                                                       *
*       matplotlib : 2.2.2                                                    *
```

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```
*       notebook : 5.4.0                                                *
*       ipywidgets : 7.2.1                                              *
*                                                                       *
===========================================================================
>>> environment = describe_environment(True, True, width=75)
... # doctest: +SKIP
===========================================================================
*                                                                       *
*   Interpreter :                                                       *
*       python : 2.7.14 | packaged by conda-forge | (default, Dec 25    *
*   2017, 01:18:54)                                                     *
*               [GCC 4.2.1 Compatible Apple LLVM 6.1.0                  *
*   (clang-602.0.53)]                                                   *
*                                                                       *
*   colour-science.org :                                                *
*       colour : v0.3.11-323-g380c1838                                  *
*                                                                       *
*   Runtime :                                                           *
*       numpy : 1.14.3                                                  *
*       scipy : 1.0.0                                                   *
*       pandas : 0.22.0                                                 *
*       matplotlib : 2.2.2                                              *
*       notebook : 5.4.0                                                *
*       ipywidgets : 7.2.1                                              *
*                                                                       *
*   Development :                                                       *
*       coverage : 4.5.1                                                *
*       flake8 : 3.5.0                                                  *
*       invoke : 0.22.1                                                 *
*       mock : 2.0.0                                                    *
*       nose : 1.3.7                                                    *
*       restructuredtext_lint : 1.1.3                                   *
*       six : 1.11.0                                                    *
*       sphinx : 1.7.5                                                  *
*       sphinx_rtd_theme : 0.2.4                                        *
*       twine : 1.10.0                                                  *
*       yapf : 0.20.2                                                   *
*                                                                       *
===========================================================================
```

Ancillary Objects

`colour.utilities`

`ColourWarning`	This is the base class of *Colour* warnings.
`ColourUsageWarning`	This is the base class of *Colour* usage warnings.
`ColourRuntimeWarning`	This is the base class of *Colour* runtime warnings.

colour.utilities.ColourWarning

exception colour.utilities.**ColourWarning**

This is the base class of *Colour* warnings. It is a subclass of `Warning` class.

colour.utilities.ColourUsageWarning

exception colour.utilities.**ColourUsageWarning**

This is the base class of *Colour* usage warnings. It is a subclass of colour.utilities.ColourWarning class.

colour.utilities.ColourRuntimeWarning

exception colour.utilities.**ColourRuntimeWarning**

This is the base class of *Colour* runtime warnings. It is a subclass of colour.utilities.ColourWarning class.

Colour Volume

- *Optimal Colour Stimuli - MacAdam Limits*
- *Mesh Volume*
- *Pointer's Gamut*
- *RGB Volume*
- *Visible Spectrum*

Optimal Colour Stimuli - MacAdam Limits

colour

is_within_macadam_limits(xyY, illuminant[, ...])	Returns if given *CIE xyY* colourspace array is within MacAdam limits of given illuminant.
ILLUMINANTS_OPTIMAL_COLOUR_STIMULI	Illuminants *Optimal Colour Stimuli*.

colour.is_within_macadam_limits

colour.**is_within_macadam_limits**(*xyY*, *illuminant*, *tolerance=None*)

Returns if given *CIE xyY* colourspace array is within MacAdam limits of given illuminant.

Parameters

- **xyY** (array_like) – *CIE xyY* colourspace array.
- **illuminant** (unicode) – Illuminant.
- **tolerance** (numeric, optional) – Tolerance allowed in the inside-triangle check.

Returns Is within MacAdam limits.

Return type bool

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.ILLUMINANTS_OPTIMAL_COLOUR_STIMULI

colour.**ILLUMINANTS_OPTIMAL_COLOUR_STIMULI = CaseInsensitiveMapping({'A': ..., 'C': ..., 'D65': ...})**

Illuminants *Optimal Colour Stimuli*.

References

[Wik04b]

ILLUMINANTS_OPTIMAL_COLOUR_STIMULI [CaseInsensitiveMapping] **{'A', 'C', 'D65'}**

Mesh Volume

colour

is_within_mesh_volume(points, mesh[, tolerance])	Returns if given points are within given mesh volume using Delaunay triangulation.

colour.is_within_mesh_volume

colour.**is_within_mesh_volume**(*points*, *mesh*, *tolerance=None*)

Returns if given points are within given mesh volume using Delaunay triangulation.

Parameters

- **points** (array_like) – Points to check if they are within mesh volume.
- **mesh** (array_like) – Points of the volume used to generate the Delaunay triangulation.
- **tolerance** (numeric, optional) – Tolerance allowed in the inside-triangle check.

Returns Is within mesh volume.

Return type bool

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

`is_within_pointer_gamut`(XYZ[, tolerance])	Returns if given *CIE XYZ* tristimulus values are within Pointer's Gamut volume.

colour.is_within_pointer_gamut

colour.**is_within_pointer_gamut**(*XYZ*, *tolerance=None*)

Returns if given *CIE XYZ* tristimulus values are within Pointer's Gamut volume.

Parameters

- **XYZ** (array_like) – *CIE XYZ* tristimulus values.
- **tolerance** (numeric, optional) – Tolerance allowed in the inside-triangle check.

Returns Is within Pointer's Gamut.

Return type bool

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

RGB_colourspace_limits(colourspace[, illuminant])	Computes given *RGB* colourspace volume limits in *Lab* colourspace.
RGB_colourspace_pointer_gamut_coverage_MonteCarlo(...)	Returns given *RGB* colourspace percentage coverage of Pointer's Gamut volume using *Monte Carlo* method.
RGB_colourspace_visible_spectrum_coverage_MonteCarlo(...)	Returns given *RGB* colourspace percentage coverage of visible spectrum volume using *Monte Carlo* method.
RGB_colourspace_volume_MonteCarlo(colourspace)	Performs given *RGB* colourspace volume computation using *Monte Carlo* method and multiprocessing.
RGB_colourspace_volume_coverage_MonteCarlo(...)	Returns given *RGB* colourspace percentage coverage of an arbitrary volume.

colour.RGB_colourspace_limits

colour.**RGB_colourspace_limits**(*colourspace*, *illuminant=array([0.3127, 0.329])*)

Computes given *RGB* colourspace volume limits in *Lab* colourspace.

Parameters

- **colourspace** (RGB_Colourspace) – *RGB* colourspace to compute the volume of.
- **illuminant** (array_like, optional) – *Lab* colourspace *illuminant* chromaticity coordinates.

Returns *RGB* colourspace volume limits.

Return type ndarray

Examples

```
>>> from colour import sRGB_COLOURSPACE as sRGB
>>> RGB_colourspace_limits(sRGB)  # doctest: +ELLIPSIS
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*, *samples=10000000.0*, *random_generator=<function random_triplet_generator>*, *random_state=None*)

Returns 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** (numeric, optional) – Samples count.
- **random_generator** (generator, optional) – Random triplet generator providing the random samples.
- **random_state** (RandomState, optional) – Mersenne Twister pseudo-random number generator to use in the random number generator.

Returns Percentage coverage of *Pointer's Gamut* volume.

Return type float

Examples

```
>>> from colour import sRGB_COLOURSPACE as sRGB
>>> prng = np.random.RandomState(2)
>>> RGB_colourspace_pointer_gamut_coverage_MonteCarlo(
...     sRGB, 10e3, random_state=prng)  # doctest: +ELLIPSIS
81...
```

colour.RGB_colourspace_visible_spectrum_coverage_MonteCarlo

colour.**RGB_colourspace_visible_spectrum_coverage_MonteCarlo**(*colourspace*, *samples=10000000.0*, *random_generator=<function random_triplet_generator>*, *random_state=None*)

Returns 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** (numeric, optional) – Samples count.
- **random_generator** (generator, optional) – Random triplet generator providing the random samples.
- **random_state** (RandomState, optional) – Mersenne Twister pseudo-random number generator to use in the random number generator.

Returns Percentage coverage of visible spectrum volume.

Return type float

Examples

```
>>> from colour import sRGB_COLOURSPACE as sRGB
>>> prng = np.random.RandomState(2)
>>> RGB_colourspace_visible_spectrum_coverage_MonteCarlo(
...     sRGB, 10e3, random_state=prng)  # doctest: +ELLIPSIS
47...
```

colour.RGB_colourspace_volume_MonteCarlo

colour.**RGB_colourspace_volume_MonteCarlo**(*colourspace, samples=10000000.0, limits=array([[0., 100.], [-150., 150.], [-150., 150.]]), illuminant_Lab=array([0.3127, 0.329]), chromatic_adaptation_method='CAT02', random_generator=<function random_triplet_generator>, random_state=None, processes=None*)

Performs given *RGB* colourspace volume computation using *Monte Carlo* method and multiprocessing.

Parameters

- **colourspace** (RGB_Colourspace) – *RGB* colourspace to compute the volume of.
- **samples** (numeric, optional) – Samples count.
- **limits** (array_like, optional) – *Lab* colourspace volume.
- **illuminant_Lab** (array_like, optional) – *Lab* colourspace *illuminant* chromaticity coordinates.
- **chromatic_adaptation_method** (unicode, optional) – **{'CAT02', 'XYZ Scaling', 'Von Kries', 'Bradford', 'Sharp', 'Fairchild', 'CMCCAT97', 'CMCCAT2000', 'CAT02_BRILL_CAT', 'Bianco', 'Bianco PC'}**, *Chromatic adaptation* method.
- **random_generator** (generator, optional) – Random triplet generator providing the random samples within the *Lab* colourspace volume.
- **random_state** (RandomState, optional) – Mersenne Twister pseudo-random number generator to use in the random number generator.
- **processes** (integer, optional) – Processes count, default to multiprocessing.cpu_count() definition.

Returns *RGB* colourspace volume.

Return type float

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 import sRGB_COLOURSPACE as sRGB
>>> prng = np.random.RandomState(2)
>>> processes = 1
>>> RGB_colourspace_volume_MonteCarlo(sRGB, 10e3, random_state=prng,
...                                   processes=processes)
... # doctest: +ELLIPSIS
816...
```

colour.RGB_colourspace_volume_coverage_MonteCarlo

colour.**RGB_colourspace_volume_coverage_MonteCarlo**(*colourspace*, *coverage_sampler*, *samples=10000000.0*, *random_generator=<function random_triplet_generator>*, *random_state=None*)

Returns given *RGB* colourspace percentage coverage of an arbitrary volume.

Parameters

- **colourspace** (RGB_Colourspace) – *RGB* colourspace to compute the volume coverage percentage.
- **coverage_sampler** (object) – Python object responsible for checking the volume coverage.
- **samples** (numeric, optional) – Samples count.
- **random_generator** (generator, optional) – Random triplet generator providing the random samples.
- **random_state** (RandomState, optional) – Mersenne Twister pseudo-random number generator to use in the random number generator.

Returns Percentage coverage of volume.

Return type float

Examples

```
>>> from colour import sRGB_COLOURSPACE as sRGB
>>> prng = np.random.RandomState(2)
>>> RGB_colourspace_volume_coverage_MonteCarlo(
...     sRGB, is_within_pointer_gamut, 10e3, random_state=prng)
... # doctest: +ELLIPSIS
81...
```

Visible Spectrum

colour

is_within_visible_spectrum(XYZ[, interval, ...])	Returns if given *CIE XYZ* tristimulus values are within visible spectrum volume / given colour matching functions volume.

colour.is_within_visible_spectrum

colour.**is_within_visible_spectrum**(*XYZ*, *interval=10*, *cmfs=XYZ_ColourMatchingFunctions(name='CIE 1931 2 Degree Standard Observer', ...)*, *illuminant=SpectralDistribution(name='1 Constant', ...)*, *tolerance=None*)

Returns if given *CIE XYZ* tristimulus values are within visible spectrum volume / given colour matching functions volume.

Parameters

- **XYZ** (array_like) – *CIE XYZ* tristimulus values.
- **interval** (int, optional) – Wavelength λ_i range interval used to compute the pulse waves for the *CIE XYZ* colourspace outer surface.
- **cmfs** (XYZ_ColourMatchingFunctions, optional) – Standard observer colour matching functions.
- **illuminant** (SpectralDistribution, optional) – Illuminant spectral distribution.
- **tolerance** (numeric, optional) – Tolerance allowed in the inside-triangle check.

Returns Is within visible spectrum.

Return type bool

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

generate_pulse_waves(bins)	Generates the pulse waves of given number of bins necessary to totally stimulate the colour matching functions.
XYZ_outer_surface([interval, cmfs, illuminant])	Generates the *CIE XYZ* colourspace outer surface for given colour matching functions using multi-spectral conversion of pulse waves to *CIE XYZ* tristimulus values.

colour.volume.generate_pulse_waves

colour.volume.**generate_pulse_waves**(*bins*)

Generates the pulse waves of given number of bins necessary to totally stimulate the colour matching functions.

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.

Returns Pulse waves.

Return type ndarray

References

[Lin15], [Man18]

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.]])
```

colour.volume.XYZ_outer_surface

colour.volume.**XYZ_outer_surface**(*interval=10, cmfs=XYZ_ColourMatchingFunctions(name='CIE 1931 2 Degree Standard Observer', ...), illuminant=SpectralDistribution(name='1 Constant', ...)*)

Generates the *CIE XYZ* colourspace outer surface for given colour matching functions using multi-spectral conversion of pulse waves to *CIE XYZ* tristimulus values.

Parameters

- **interval** (int, optional) – Wavelength λ_i range interval used to compute the pulse waves.
- **cmfs** (XYZ_ColourMatchingFunctions, optional) – Standard observer colour matching functions.
- **illuminant** (SpectralDistribution, optional) – Illuminant spectral distribution.

Returns Outer surface *CIE XYZ* tristimulus values.

Return type ndarray

References

[Lin15], [Man18]

Examples

```
>>> XYZ_outer_surface(84)  # doctest: +ELLIPSIS
array([[  0.0000000...e+00,   0.0000000...e+00,   0.0000000...e+00],
       [  1.4766924...e-03,   4.1530347...e-05,   6.9884362...e-03],
       [  1.6281275...e-01,   3.7114387...e-02,   9.0151471...e-01],
       [  1.8650894...e-01,   5.6617464...e-01,   9.1355179...e-02],
       [  6.1555347...e-01,   3.8427775...e-01,   4.7422070...e-04],
       [  3.3622045...e-02,   1.2354556...e-02,   0.0000000...e+00],
       [  1.0279500...e-04,   3.7121158...e-05,   0.0000000...e+00],
       [  1.6428945...e-01,   3.7155917...e-02,   9.0850314...e-01],
       [  3.4932169...e-01,   6.0328903...e-01,   9.9286989...e-01],
       [  8.0206241...e-01,   9.5045240...e-01,   9.1829399...e-02],
       [  6.4917552...e-01,   3.9663231...e-01,   4.7422070...e-04],
       [  3.3724840...e-02,   1.2391678...e-02,   0.0000000...e+00],
       [  1.5794874...e-03,   7.8651505...e-05,   6.9884362...e-03],
       [  3.5079839...e-01,   6.0333056...e-01,   9.9985832...e-01],
       [  9.6487517...e-01,   9.8756679...e-01,   9.9334411...e-01],
       [  8.3568446...e-01,   9.6280696...e-01,   9.1829399...e-02],
       [  6.4927831...e-01,   3.9666943...e-01,   4.7422070...e-04],
       [  3.5201532...e-02,   1.2433208...e-02,   6.9884362...e-03],
       [  1.6439224...e-01,   3.7193038...e-02,   9.0850314...e-01],
       [  9.6635186...e-01,   9.8760832...e-01,   1.0003325...e+00],
       [  9.9849722...e-01,   9.9992134...e-01,   9.9334411...e-01],
       [  8.3578726...e-01,   9.6284408...e-01,   9.1829399...e-02],
       [  6.5075501...e-01,   3.9671096...e-01,   7.4626569...e-03],
       [  1.9801429...e-01,   4.9547595...e-02,   9.0850314...e-01],
       [  3.5090118...e-01,   6.0336768...e-01,   9.9985832...e-01],
       [  9.9997391...e-01,   9.9996287...e-01,   1.0003325...e+00],
       [  9.9860001...e-01,   9.9995847...e-01,   9.9334411...e-01],
       [  8.3726395...e-01,   9.6288561...e-01,   9.8817836...e-02],
```

(continues on next page)

(continued from previous page)

```
       [  8.1356776...e-01,   4.3382535...e-01,   9.0897737...e-01],
       [  3.8452323...e-01,   6.1572224...e-01,   9.9985832...e-01],
       [  9.6645466...e-01,   9.8764544...e-01,   1.0003325...e+00],
       [  1.0000767...e+00,   1.0000000...e+00,   1.0003325...e+00]])
```

4.1.3.2 Indices and tables

- genindex
- search

4.1.4 Bibliography

4.1.4.1 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]
- [CIET13805d]
- [Dji17]
- [FiLMiCInc17]
- [Hou15]
- [Lau12]
- [Mac35]
- [Mac42]
- [MunsellCScienceb]
- [Poi80]
- [RenewableRDCenter03]
- [SWD05]
- [Sir18]

- [SHF00]
- [WEV02]
- [War16]
- [WS00b]
- [WS00j]
- [WS00l]
- [WS00h]

4.2 Examples

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

```
>>> import colour
```

4.2.1 Chromatic Adaptation

```
>>> XYZ = [0.20654008, 0.12197225, 0.05136952]
>>> D65 = colour.ILLUMINANTS['CIE 1931 2 Degree Standard Observer']['D65']
>>> A = colour.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.keys())
['CIE 1994', 'CMCCAT2000', 'Fairchild 1990', 'Von Kries']
```

4.2.2 Algebra

4.2.2.1 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])
```

4.2.2.2 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])
```

4.2.3 Spectral Computations

```
>>> colour.sd_to_XYZ(colour.LIGHT_SOURCES_SDS['Neodimium Incandescent'])
array([ 36.94726204,  32.62076174,  13.0143849 ])
>>> sorted(colour.SPECTRAL_TO_XYZ_METHODS.keys())
['ASTM E308-15', 'Integration', 'astm2015']
```

4.2.4 Multi-Spectral Computations

```
>>> msd = 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, 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, 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.multi_sds_to_XYZ(msd, colour.SpectralShape(400, 700, 60),
...                              cmfs, illuminant))
[[[  9.73192501   5.02105851   3.22790699]
  [ 16.08032168  24.47303359  10.28681006]
  [ 17.73513774  29.61865582  12.10713449]]
 [[ 25.69298792  11.72611193   3.70187275]
  [ 18.51208526   8.03720984   9.30361825]
  [ 48.55945054  32.30885571   4.09223401]]
 [[  5.7743232   10.10692925  10.08461311]
  [  8.81306527   3.65394599   4.20783881]
  [  8.06007398  15.87077693   7.02551086]]
 [[ 90.88877129  81.82966846  29.86765971]
  [ 38.64801062  26.70860262  15.08396538]
  [  8.77151115  10.56330761   4.28940206]]]
>>> sorted(colour.MULTI_SPECTRAL_TO_XYZ_METHODS.keys())
['Integration']
```

4.2.5 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,
                     extrapolator_args={'right': None, 'method': 'Constant', 'left': None})
```

4.2.6 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]))
```

4.2.7 Lightness Computation

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

4.2.8 Luminance Computation

```
>>> colour.luminance(41.52787585)
12.197225353400775
>>> sorted(colour.LUMINANCE_METHODS.keys())
['ASTM D1535-08',
 'CIE 1976',
 'Fairchild 2010',
 'Fairchild 2011',
 'Newhall 1943',
 'astm2008',
 'cie1976']
```

4.2.9 Whiteness Computation

```
>>> colour.whiteness(xy=[0.3167, 0.3334], Y=100, xy_n=[0.3139, 0.3311])
array([ 93.85 ,  -1.305])
>>> sorted(colour.WHITENESS_METHODS.keys())
['ASTM E313',
 'Berger 1959',
 'CIE 2004',
 'Ganz 1979',
 'Stensby 1968',
 'Taube 1960',
 'cie2004']
```

4.2.10 Yellowness Computation

```
>>> XYZ = [95.00000000, 100.00000000, 105.00000000]
>>> colour.yellowness(XYZ)
11.065000000000003
>>> sorted(colour.YELLOWNESS_METHODS.keys())
['ASTM D1925', 'ASTM E313']
```

4.2.11 Luminous Flux, Efficiency & Efficacy Computation

4.2.11.1 Luminous Flux

```
>>> sd = colour.LIGHT_SOURCES_SDS['Neodimium Incandescent']
>>> colour.luminous_flux(sd)
23807.655527367202
```

4.2.11.2 Luminous Efficiency

```
>>> sd = colour.LIGHT_SOURCES_SDS['Neodimium Incandescent']
>>> colour.luminous_efficiency(sd)
0.19943935624521045
```

4.2.11.3 Luminous Efficacy

```
>>> sd = colour.LIGHT_SOURCES_SDS['Neodimium Incandescent']
>>> colour.luminous_efficacy(sd)
136.21708031547874
```

4.2.12 Colour Models

4.2.12.1 CIE xyY Colourspace

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

4.2.12.2 CIE L*a*b* Colourspace

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

4.2.12.3 CIE L*u*v* Colourspace

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

4.2.12.4 CIE 1960 UCS Colourspace

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

4.2.12.5 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])
```

4.2.12.6 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])
```

4.2.12.7 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])
```

4.2.12.8 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.CIECAM02_VIEWING_CONDITIONS['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 ])
```

4.2.12.9 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.CAM16_VIEWING_CONDITIONS['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]
```

4.2.12.10 IPT Colourspace

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

4.2.12.11 DIN99 Colourspace

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

4.2.12.12 hdr-CIELAB Colourspace

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

4.2.12.13 hdr-IPT Colourspace

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

4.2.12.14 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])
```

4.2.12.15 JzAzBz Colourspace

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

4.2.12.16 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'
>>> XYZ_to_RGB_matrix = [
        [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,
```

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```
         XYZ_to_RGB_matrix,
         chromatic_adaptation_transform)
array([ 0.45595571,  0.03039702,  0.04087245])
```

4.2.12.17 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]])
```

4.2.12.18 Y'CbCr Colour Encoding

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

4.2.12.19 YCoCg Colour Encoding

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

4.2.12.20 ICTCP Colour Encoding

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

4.2.12.21 HSV Colourspace

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

4.2.12.22 Prismatic Colourspace

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

4.2.13 RGB Colourspaces

```
>>> sorted(colour.RGB_COLOURSPACES.keys())
['ACES2065-1',
 'ACEScc',
 'ACEScct',
 'ACEScg',
 'ACESproxy',
 'ALEXA Wide Gamut',
 'Adobe RGB (1998)',
 'Adobe Wide Gamut RGB',
 'Apple RGB',
 'Best RGB',
 'Beta RGB',
 'CIE RGB',
 'Cinema Gamut',
 'ColorMatch RGB',
 'DCDM XYZ',
 'DCI-P3',
 'DCI-P3+',
 'DJI D-Gamut',
 'DRAGONcolor',
 'DRAGONcolor2',
 'Don RGB 4',
 'ECI RGB v2',
 'ERIMM RGB',
 'Ekta Space PS 5',
 'FilmLight E-Gamut',
 'ITU-R BT.2020',
 'ITU-R BT.470 - 525',
 'ITU-R BT.470 - 625',
 'ITU-R BT.709',
 'Max RGB',
 'NTSC',
 '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',
 'Sharp RGB',
 'V-Gamut',
 'Xtreme RGB',
 'aces',
 'adobe1998',
 'prophoto',
 'sRGB']
```

4.2.14 OETFs

```
>>> sorted(colour.OETFS.keys())
['ARIB STD-B67',
 'DICOM GSDF',
 'ITU-R BT.2020',
 'ITU-R BT.2100 HLG',
 'ITU-R BT.2100 PQ',
 'ITU-R BT.601',
 'ITU-R BT.709',
 'ProPhoto RGB',
 'RIMM RGB',
 'ROMM RGB',
 'SMPTE 240M',
 'ST 2084',
 'sRGB']
```

4.2.15 OETFs Reverse

```
>>> sorted(colour.OETFS_REVERSE.keys())
['ARIB STD-B67',
 'ITU-R BT.2100 HLD',
 'ITU-R BT.2100 PQ',
 'ITU-R BT.601',
 'ITU-R BT.709',
 'sRGB']
```

4.2.16 EOTFs

```
>>> sorted(colour.EOTFS.keys())
['DCDM',
 'DICOM GSDF',
 'ITU-R BT.1886',
 'ITU-R BT.2020',
 'ITU-R BT.2100 HLG',
 'ITU-R BT.2100 PQ',
 'ProPhoto RGB',
 'RIMM RGB',
 'ROMM RGB',
 'SMPTE 240M',
 'ST 2084']
```

4.2.17 EOTFs Reverse

```
>>> sorted(colour.EOTFS_REVERSE.keys())
['DCDM', 'ITU-R BT.1886', 'ITU-R BT.2100 HLG', 'ITU-R BT.2100 PQ']
```

4.2.18 OOTFs

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

4.2.19 OOTFs Reverse

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

4.2.20 Log Encoding / Decoding Curves

```
>>> sorted(colour.LOG_ENCODING_CURVES.keys())
['ACEScc',
 'ACEScct',
 'ACESproxy',
 'ALEXA Log C',
 'Canon Log',
 'Canon Log 2',
 'Canon Log 3',
 'Cineon',
 'D-Log',
 'ERIMM RGB',
 'Filmic Pro 6',
 'Log3G10',
 'Log3G12',
 'PLog',
 'Panalog',
 'Protune',
 'REDLog',
 'REDLogFilm',
 'S-Log',
 'S-Log2',
 'S-Log3',
 'T-Log',
 'V-Log',
 'ViperLog']
```

4.2.21 Chromatic Adaptation Models

```
>>> XYZ = [0.20654008, 0.12197225, 0.05136952]
>>> XYZ_w = [0.95045593, 1.00000000, 1.08905775]
>>> XYZ_wr = [1.09846607, 1.00000000, 0.35582280]
>>> colour.chromatic_adaptation_VonKries(XYZ, XYZ_w, XYZ_wr)
array([ 0.2533053 ,  0.13765138,  0.01543307])
>>> sorted(colour.CHROMATIC_ADAPTATION_METHODS.keys())
['CIE 1994', 'CMCCAT2000', 'Fairchild 1990', 'Von Kries']
```

4.2.22 Colour Appearance Models

```
>>> 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)
CIECAM02_Specification(J=34.434525727858997, C=67.365010921125915, h=22.279164147957076, s=62.
↪814855853327131, Q=177.47124941102123, M=70.024939419291385, H=2.689608534423904, HC=None)
```

4.2.23 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.keys())
['CAM02-LCD',
 'CAM02-SCD',
 'CAM02-UCS',
 'CAM16-LCD',
 'CAM16-SCD',
 'CAM16-UCS',
 'CIE 1976',
 'CIE 1994',
 'CIE 2000',
 'CMC',
 'DIN99',
 'cie1976',
 'cie1994',
 'cie2000']
```

4.2.24 Colour Correction

```
>>> 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([ 0.15205429,  0.08974029,  0.04141435])
>>> sorted(colour.COLOUR_CORRECTION_METHODS.keys())
['Cheung 2004', 'Finlayson 2015', 'Vandermonde']
```

4.2.25 Colour Notation Systems

4.2.25.1 Munsell Value

```
>>> colour.munsell_value(12.23634268)
4.0824437076525664
>>> sorted(colour.MUNSELL_VALUE_METHODS.keys())
['ASTM D1535-08',
```

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```
 'Ladd 1955',
 'McCamy 1987',
 'Moon 1943',
 'Munsell 1933',
 'Priest 1920',
 'Saunderson 1944',
 'astm2008']
```

4.2.25.2 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   ])
```

4.2.26 Colour Blindness

```
>>> import colour
>>> cmfs = colour.LMS_CMFS['Stockman & Sharpe 2 Degree Cone Fundamentals']
>>> colour.anomalous_trichromacy_cmfs_Machado2009(cmfs, np.array([15, 0, 0]))[450]
array([ 0.08912884,  0.0870524 ,  0.955393  ])
>>> primaries = colour.DISPLAYS_RGB_PRIMARIES['Apple Studio Display']
>>> d_LMS = (15, 0, 0)
>>> colour.anomalous_trichromacy_matrix_Machado2009(cmfs, primaries, d_LMS)
array([[-0.27774652,  2.65150084, -1.37375432],
       [ 0.27189369,  0.20047862,  0.52762768],
       [ 0.00644047,  0.25921579,  0.73434374]])
```

4.2.27 Optical 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})
```

4.2.28 Light Quality

4.2.28.1 Colour Rendering Index

```
>>> colour.colour_quality_scale(colour.ILLUMINANTS_SDS['FL2'])
64.686416902221609
```

4.2.28.2 Colour Quality Scale

```
>>> colour.colour_rendering_index(colour.ILLUMINANTS_SDS['FL2'])
64.151520202968015
```

4.2.29 Reflectance Recovery

```
>>> colour.XYZ_to_sd([0.20654008, 0.12197225, 0.05136952])
SpectralDistribution([[  3.60000000e+02,   7.73462151e-02],
                      [  3.65000000e+02,   7.73632975e-02],
                      [  3.70000000e+02,   7.74299705e-02],
                      ...
                      [  8.20000000e+02,   3.93126353e-01],
                      [  8.25000000e+02,   3.93158148e-01],
                      [  8.30000000e+02,   3.93163548e-01]],
                     interpolator=SpragueInterpolator,
                     interpolator_args={},
                     extrapolator=Extrapolator,
                     extrapolator_args={'right': None, 'method': 'Constant', 'left': None})

>>> sorted(colour.REFLECTANCE_RECOVERY_METHODS.keys())
['Meng 2015', 'Smits 1999']
```

4.2.30 Correlated Colour Temperature Computation Methods

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

4.2.31 Volume

```
>>> colour.RGB_colourspace_volume_MonteCarlo(colour.RGB_COLOURSPACE['sRGB'])
821958.30000000005
```

4.2.32 Contrast Sensitivity Function

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

4.2.33 IO

4.2.33.1 Images

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

4.2.33.2 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])
```

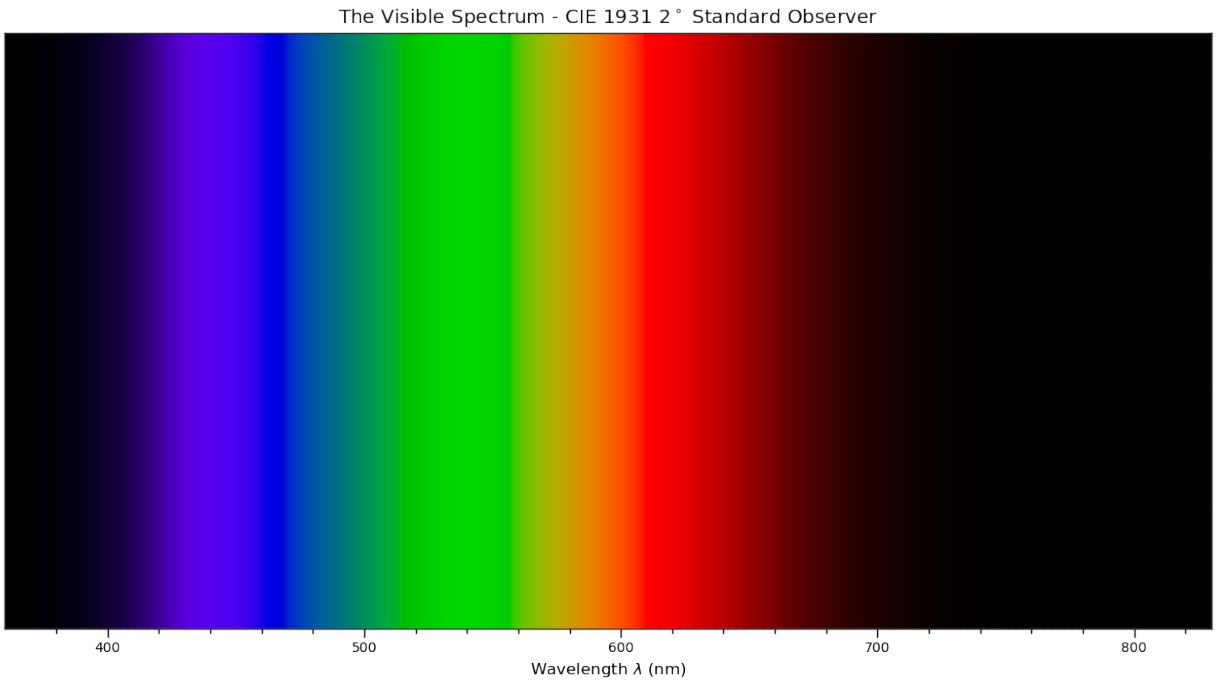
4.2.34 Plotting

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

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

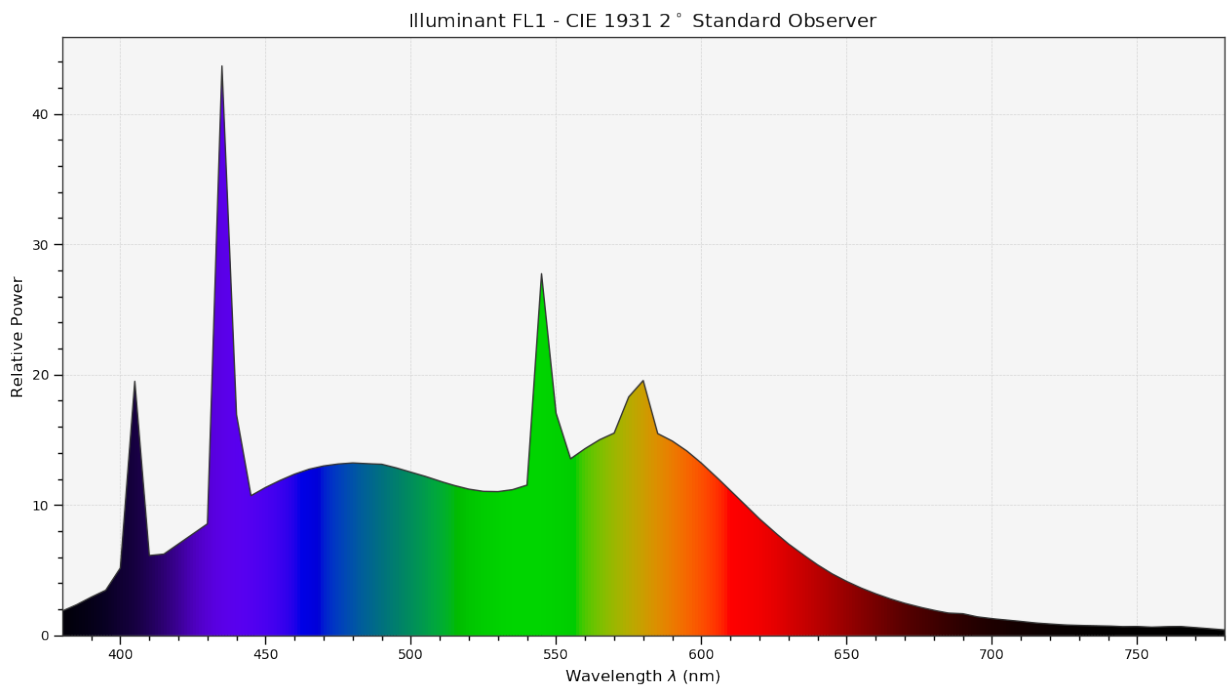
4.2.34.1 Visible Spectrum

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



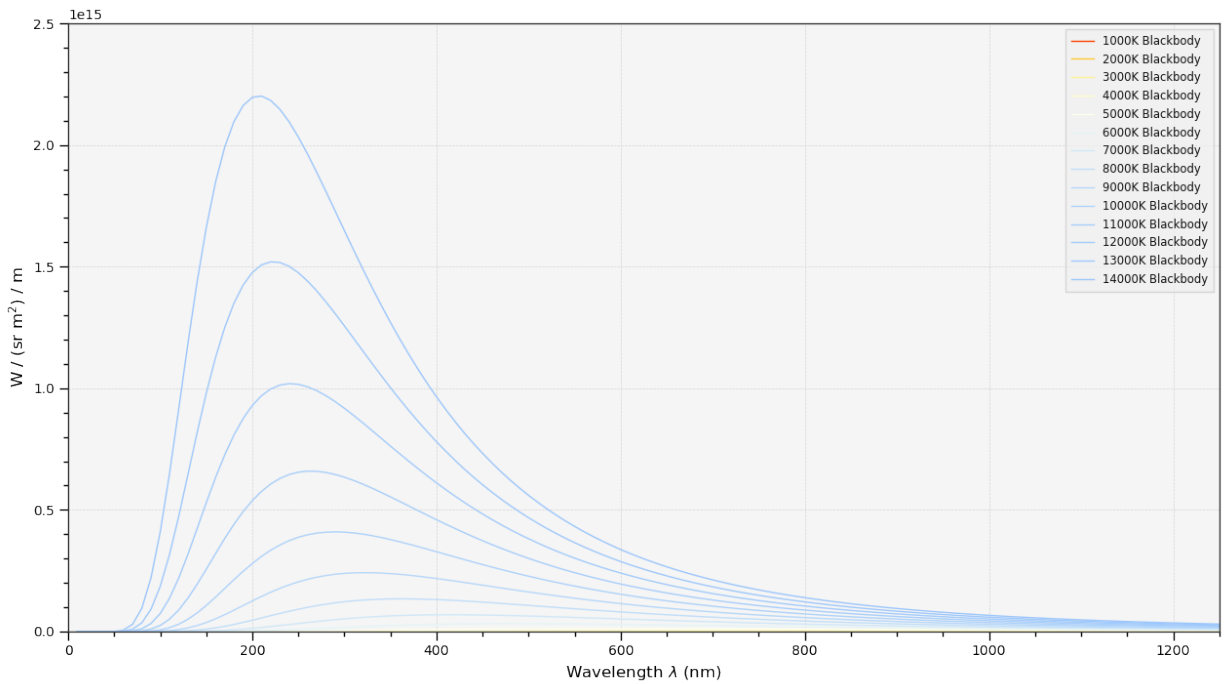
4.2.34.2 Spectral Distribution

```
>>> plot_single_illuminant_sd('FL1')
```



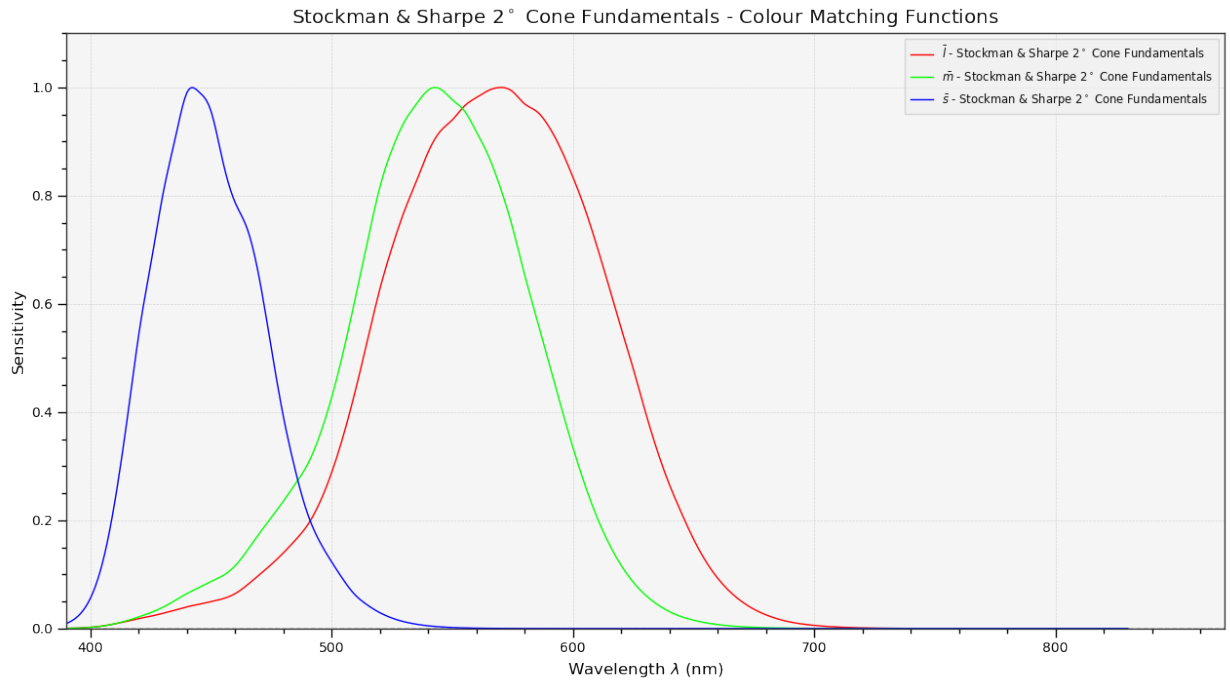
4.2.34.3 Blackbody

```
>>> 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',
...     use_sds_colours=True,
...     normalise_sds_colours=True,
...     legend_location='upper right',
...     bounding_box=(0, 1250, 0, 2.5e15))
```



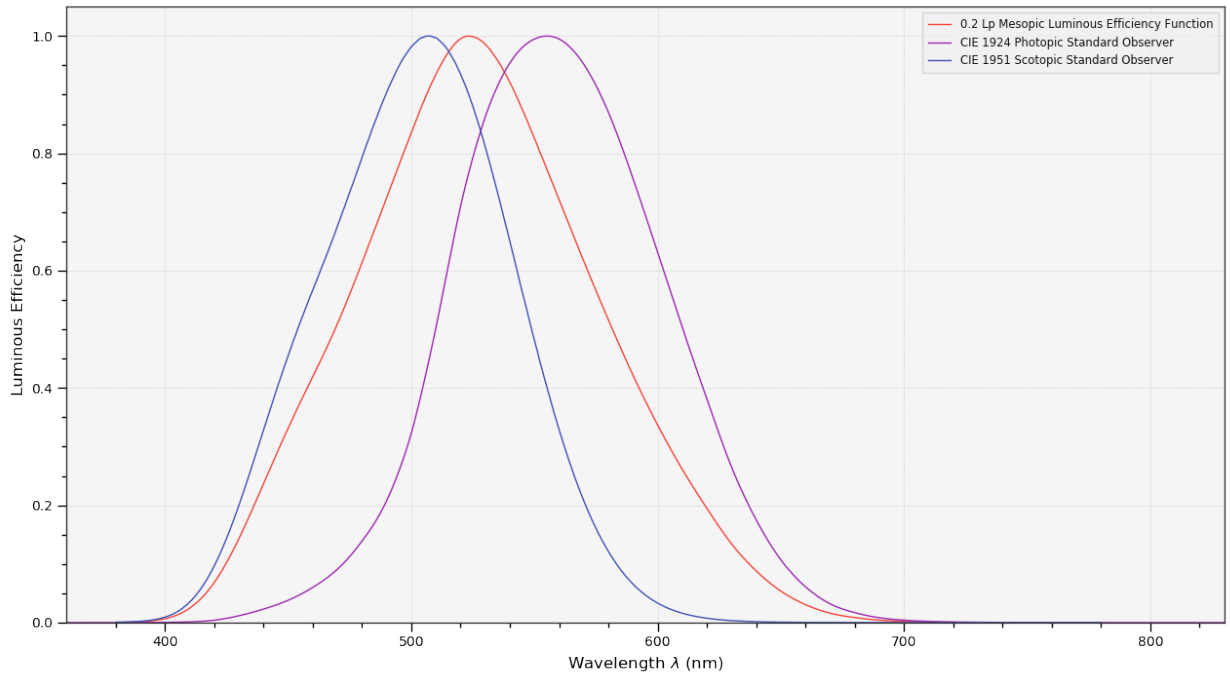
4.2.34.4 Colour Matching Functions

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



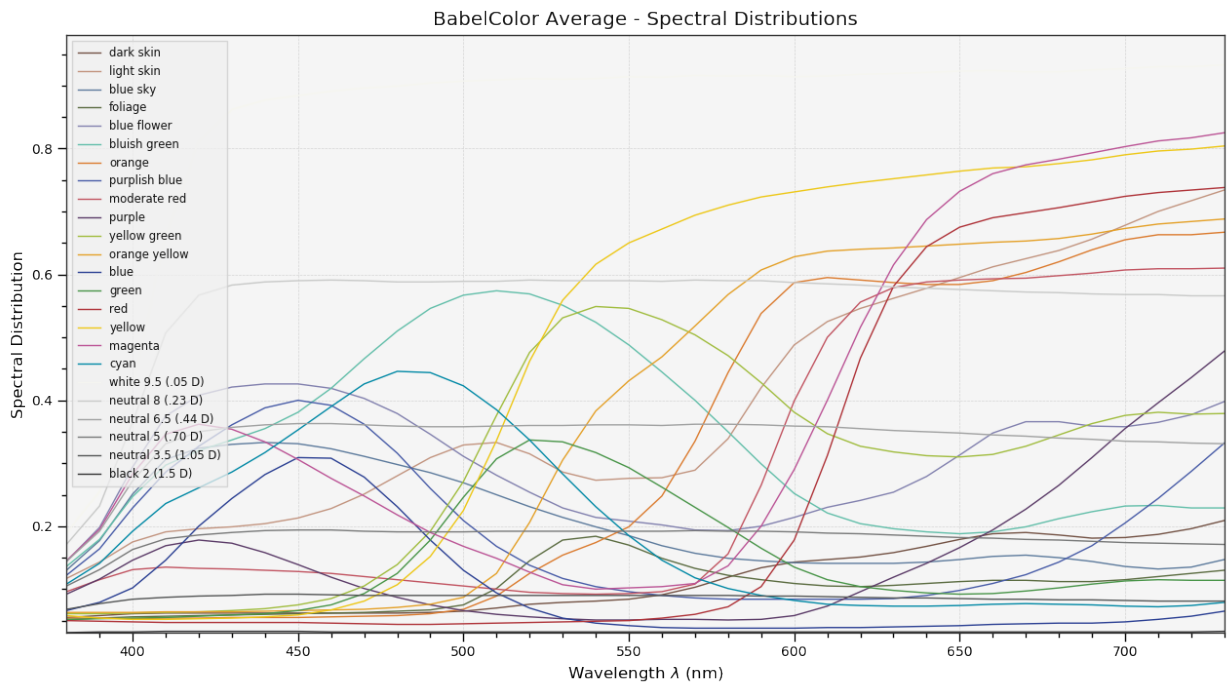
4.2.34.5 Luminous Efficiency

```
>>> 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, .1))
```



4.2.34.6 Colour Checker

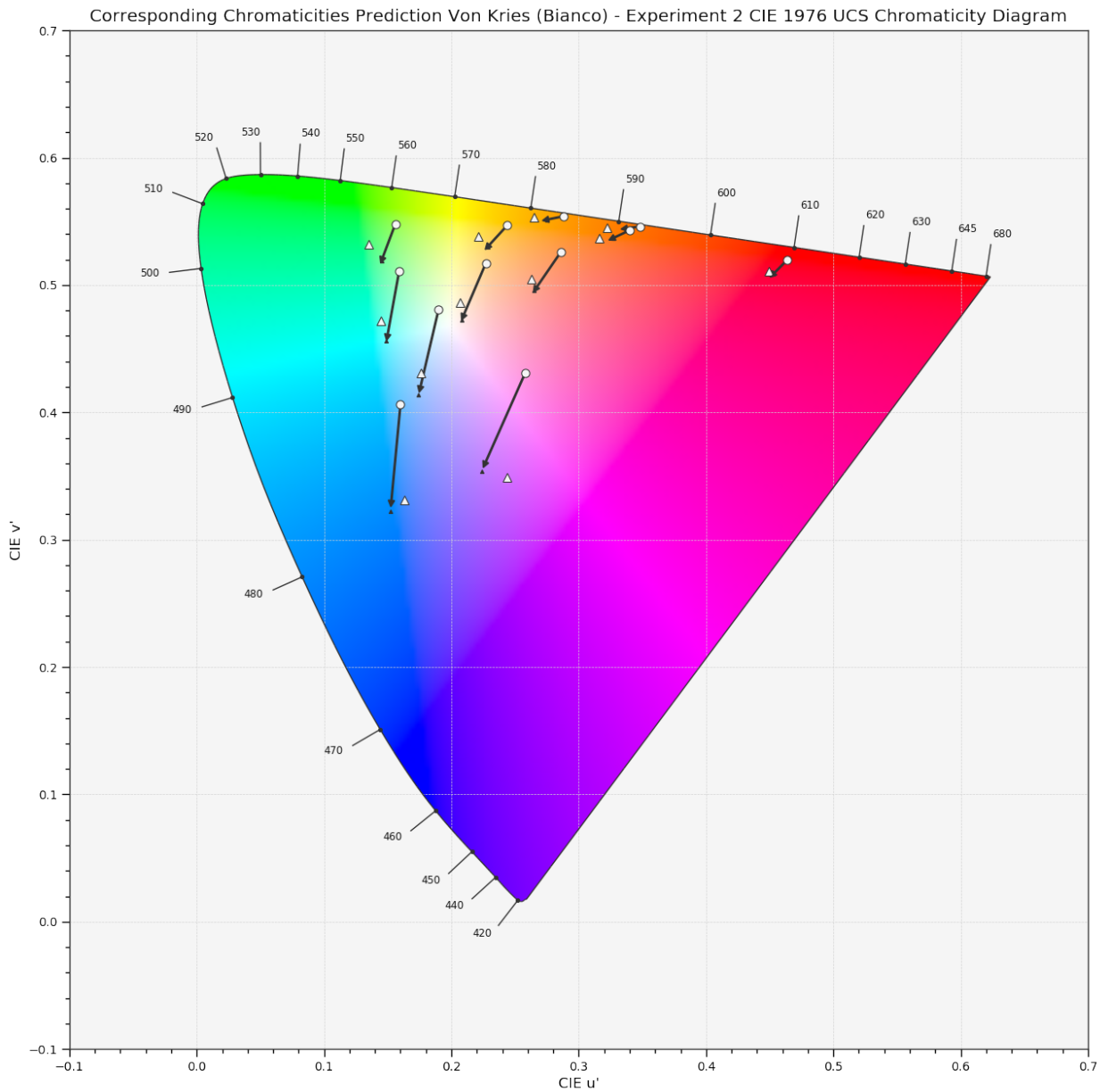
```
>>> from colour.characterisation.dataset.colour_checkers.sds import (
...     COLOURCHECKER_INDEXES_TO_NAMES_MAPPING)
>>> plot_multi_sds(
...     [
...         colour.COLOURCHECKERS_SDS['BabelColor Average'][value]
...         for key, value in sorted(
...             COLOURCHECKER_INDEXES_TO_NAMES_MAPPING.items())
...     ],
...     use_sds_colours=True,
...     title=('BabelColor Average - '
...            'Spectral Distributions'))
```




```
>>> plot_single_colour_checker('ColorChecker 2005', text_parameters={'visible': False})
```

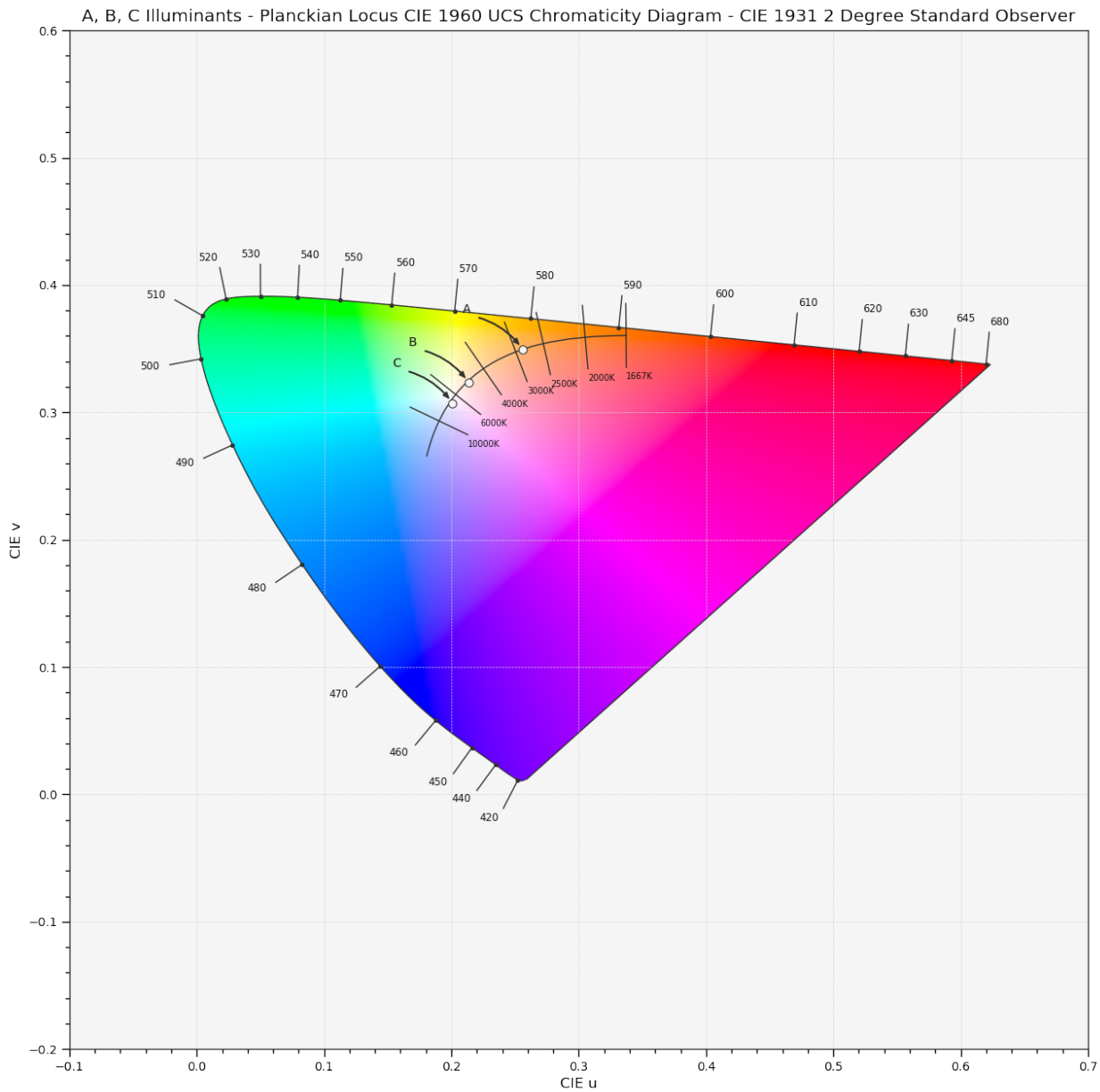
4.2.34.7 Chromaticities Prediction

```
>>> plot_corresponding_chromaticities_prediction(2, 'Von Kries', 'Bianco')
```



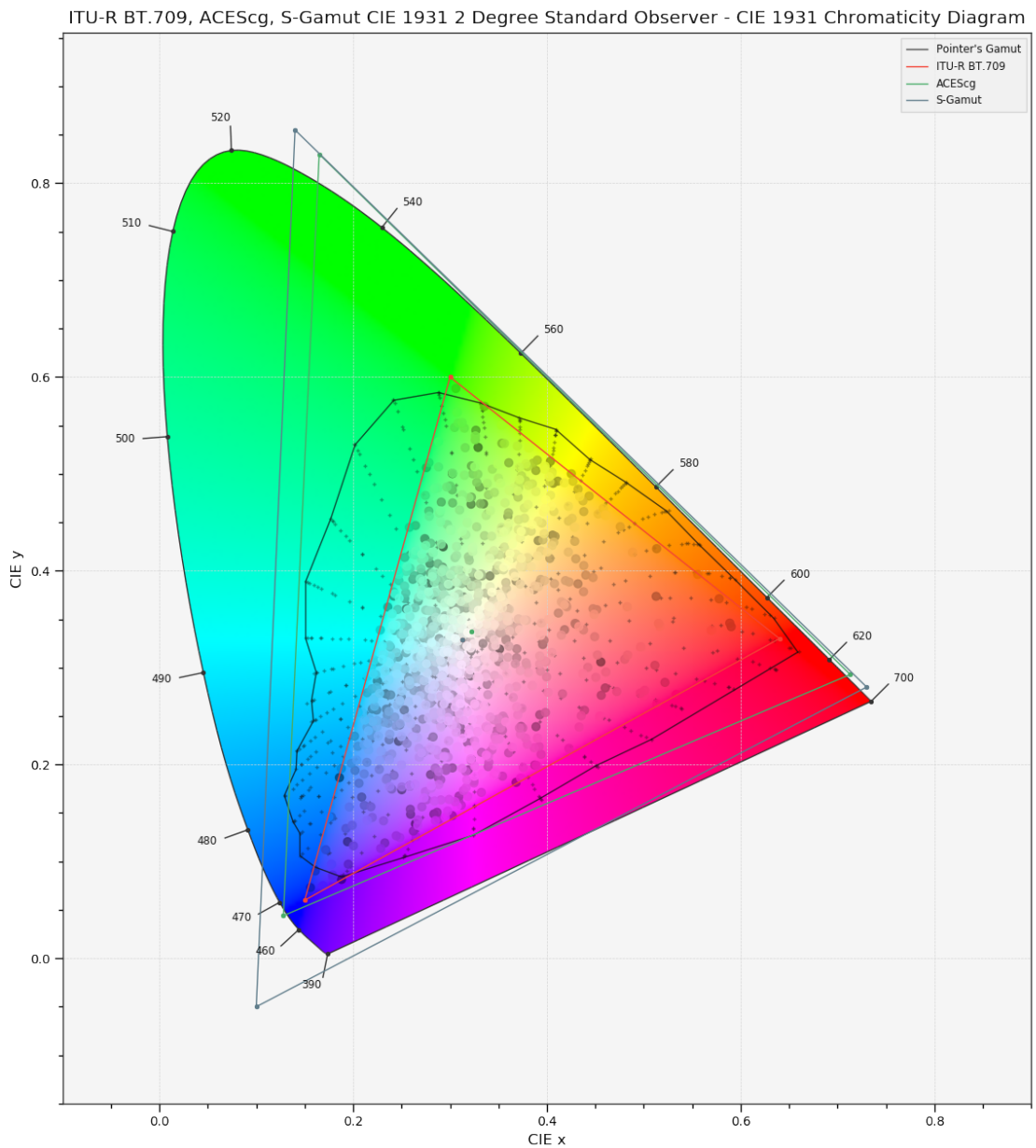
4.2.34.8 Colour Temperature

```
>>> plot_planckian_locus_in_chromaticity_diagram_CIE1960UCS(['A', 'B', 'C'])
```



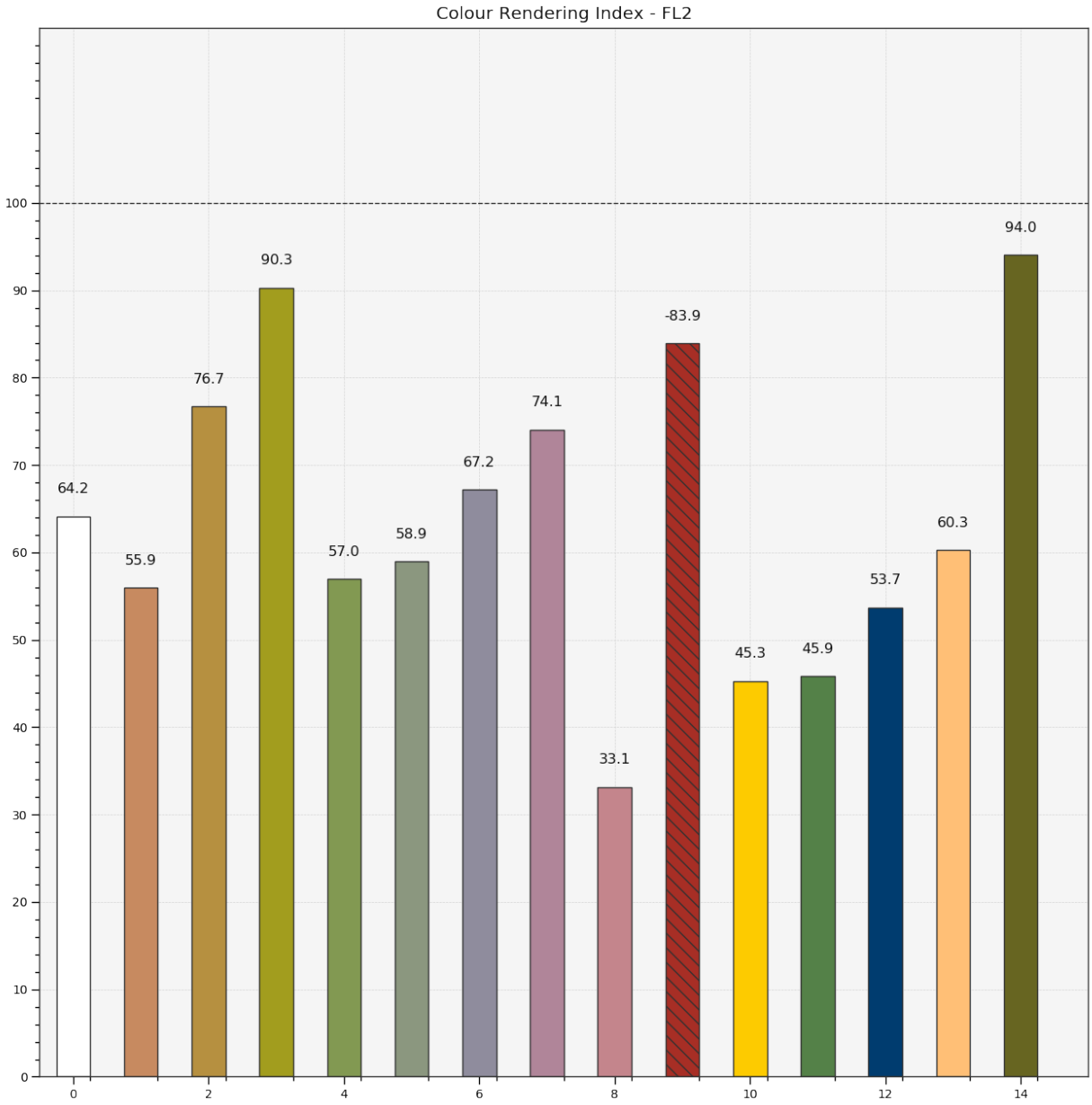
4.2.34.9 Chromaticities

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



4.2.34.10 Colour Rendering Index

```
>>> plot_single_sd_colour_rendering_index_bars(
...     colour.ILLUMINANTS_SDS['FL2'])
```


Colour Rendering Index - FL2
64.2
55.9
76.7
90.3
57.0
58.9
67.2
74.1
33.1
-83.9
45.3
45.9
53.7
60.3
94.0
0
10
20
30
40
50
60
70
80
90
100
0
2
4
6
8
10
12
14

CHAPTER 5

Contributing

If you would like to contribute to Colour, please refer to the following Contributing guide.

CHAPTER 6

Changes

The changes are viewable on the Releases page.

CHAPTER 7

Bibliography

The bibliography is available on the Bibliography page.

It is also viewable directly from the repository in BibTeX format.

CHAPTER 8

See Also

Here is a list of notable colour science packages sorted by languages:

Python

- ColorPy by Kness, M.
- Colorspacious by Smith, N. J., et al.
- python-colormath by Taylor, G., 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.

CHAPTER 9

About

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