python-colormath Documentation

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Contents

python-colormath is a simple Python module that spares the user from directly dealing with color math. Some features include:

- Support for a wide range of color spaces. A good chunk of the CIE spaces, RGB, HSL/HSV, CMY/CMYK, and many more.
- *Conversions* between the various color spaces. For example, XYZ to sRGB, Spectral to XYZ, CIE Lab to Adobe RGB.
- Calculation of *color difference*. All CIE Delta E functions, plus CMC.
- Chromatic adaptations (changing illuminants).
- RGB to hex and vice-versa.
- 16-bit RGB support.
- Runs on Python 2.7 and Python 3.3+.

CHAPTER 1

Assorted Info

- Issue tracker - Report bugs, ask questions, and share ideas here.
- GitHub project - Source code and issue tracking.
- @gctaylor Twitter - Tweets from the maintainer.
- Greg Taylor's blog - Occasional posts about color math and software development.

CHAPTER 2

Topics

2.1 Installation

python-colormath currently requires Python 2.7 or Python 3.3+. There are no plans to add support for earlier versions of Python 2 or 3. The only other requirements are NumPy and networkx.

For those on Linux/Unix Mac OS, the easiest route will be **`pip`** or **`easy_install`**:

```
pip install colormath
```

If you are on Windows, you'll need to visit NumPy, download their binary distribution, then install colormath.

2.2 Color Objects

python-colormath has support for many of the commonly used color spaces. These are represented by Color objects.

2.2.1 SpectralColor

class colormath.color_objects.**SpectralColor**(*spec_340nm=0.0*, *spec_350nm=0.0*, *spec_360nm=0.0*, *spec_370nm=0.0*, *spec_380nm=0.0*, *spec_390nm=0.0*, *spec_400nm=0.0*, *spec_410nm=0.0*, *spec_420nm=0.0*, *spec_430nm=0.0*, *spec_440nm=0.0*, *spec_450nm=0.0*, *spec_460nm=0.0*, *spec_470nm=0.0*, *spec_480nm=0.0*, *spec_490nm=0.0*, *spec_500nm=0.0*, *spec_510nm=0.0*, *spec_520nm=0.0*, *spec_530nm=0.0*, *spec_540nm=0.0*, *spec_550nm=0.0*, *spec_560nm=0.0*, *spec_570nm=0.0*, *spec_580nm=0.0*, *spec_590nm=0.0*, *spec_600nm=0.0*, *spec_610nm=0.0*, *spec_620nm=0.0*, *spec_630nm=0.0*, *spec_640nm=0.0*, *spec_650nm=0.0*, *spec_660nm=0.0*, *spec_670nm=0.0*, *spec_680nm=0.0*, *spec_690nm=0.0*, *spec_700nm=0.0*, *spec_710nm=0.0*, *spec_720nm=0.0*, *spec_730nm=0.0*, *spec_740nm=0.0*, *spec_750nm=0.0*, *spec_760nm=0.0*, *spec_770nm=0.0*, *spec_780nm=0.0*, *spec_790nm=0.0*, *spec_800nm=0.0*, *spec_810nm=0.0*, *spec_820nm=0.0*, *spec_830nm=0.0*, *observer='2'*, *illuminant='d50'*)

Bases: colormath.color_objects.IlluminantMixin, colormath.color_objects.ColorBase

A SpectralColor represents a spectral power distribution, as read by a spectrophotometer. Our current implementation has wavelength intervals of 10nm, starting at 340nm and ending at 830nm.

Spectral colors are the lowest level, most "raw" measurement of color. You may convert spectral colors to any other color space, but you can't convert any other color space back to spectral.

See Spectral power distribution on Wikipedia for some higher level details on how these work.

Parameters

- **observer** (*str*) – Observer angle. Either `'2'` or `'10'` degrees.
- **illuminant** (*str*) – See *Observers and Illuminants* for valid values.

calc_density(*density_standard=None*)

Calculates the density of the SpectralColor. By default, Status T density is used, and the correct density distribution (Red, Green, or Blue) is chosen by comparing the Red, Green, and Blue components of the spectral sample (the values being red in via "filters").

get_illuminant_xyz(*observer=None*, *illuminant=None*)

Parameters

- **observer** (*str*) – Get the XYZ values for another observer angle. Must be either '2' or '10'.
- **illuminant** (*str*) – Get the XYZ values for another illuminant.

Returns the color's illuminant's XYZ values.

get_numpy_array()
Dump this color into NumPy array.

get_value_tuple()
Returns a tuple of the color's values (in order). For example, an LabColor object will return (lab_l, lab_a, lab_b), where each member of the tuple is the float value for said variable.

set_illuminant(*illuminant*)
Validates and sets the color's illuminant.

Note: This only changes the illuminant. It does no conversion of the color's coordinates. For this, you'll want to refer to *XYZColor.apply_adaptation*.

Tip: Call this after setting your observer.

Parameters **illuminant** (*str*) – One of the various illuminants.

set_observer(*observer*)
Validates and sets the color's observer angle.

Note: This only changes the observer angle value. It does no conversion of the color's coordinates.

Parameters **observer** (*str*) – One of '2' or '10'.

illuminant = None
The color's illuminant. Set with *set_illuminant()*.

observer = None
The color's observer angle. Set with *set_observer()*.

2.2.2 LabColor

class colormath.color_objects.**LabColor**(*lab_l*, *lab_a*, *lab_b*, *observer='2'*, *illuminant='d50'*)
Bases: colormath.color_objects.IlluminantMixin, colormath.color_objects.ColorBase

Represents a CIE Lab color. For more information on CIE Lab, see Lab color space on Wikipedia.

Parameters

- **lab_l** (*float*) – L coordinate.
- **lab_a** (*float*) – a coordinate.
- **lab_b** (*float*) – b coordinate.
- **observer** (*str*) – Observer angle. Either '2' or '10' degrees.
- **illuminant** (*str*) – See *Observers and Illuminants* for valid values.

get_illuminant_xyz(*observer=None*, *illuminant=None*)

Parameters

- **observer** (*str*) – Get the XYZ values for another observer angle. Must be either '2' or '10'.
- **illuminant** (*str*) – Get the XYZ values for another illuminant.

Returns the color's illuminant's XYZ values.

get_value_tuple()
Returns a tuple of the color's values (in order). For example, an LabColor object will return (lab_l, lab_a, lab_b), where each member of the tuple is the float value for said variable.

set_illuminant(*illuminant*)
Validates and sets the color's illuminant.

Note: This only changes the illuminant. It does no conversion of the color's coordinates. For this, you'll want to refer to *XYZColor.apply_adaptation*.

Tip: Call this after setting your observer.

Parameters **illuminant** (*str*) – One of the various illuminants.

set_observer(*observer*)
Validates and sets the color's observer angle.

Note: This only changes the observer angle value. It does no conversion of the color's coordinates.

Parameters **observer** (*str*) – One of '2' or '10'.

illuminant = None
The color's illuminant. Set with *set_illuminant()*.

lab_a = None
a coordinate

lab_b = None
b coordinate

lab_l = None
L coordinate

observer = None
The color's observer angle. Set with *set_observer()*.

2.2.3 LCHabColor

class colormath.color_objects.**LCHabColor**(*lch_l*, *lch_c*, *lch_h*, *observer='2'*, *illuminant='d50'*)
Bases: colormath.color_objects.IlluminantMixin, colormath.color_objects.ColorBase

Represents an CIE LCH color that was converted to LCH by passing through CIE Lab. This differs from *LCHuvColor*, which was converted to LCH through CIE Luv.

See Introduction to Colour Spaces by Phil Cruse for an illustration of how CIE LCH differs from CIE Lab.

Parameters

- **lch_l** (*float*) – L coordinate.
- **lch_c** (*float*) – C coordinate.
- **lch_h** (*float*) – H coordinate.
- **observer** (*str*) – Observer angle. Either `'2'` or `'10'` degrees.
- **illuminant** (*str*) – See *Observers and Illuminants* for valid values.

get_illuminant_xyz(*observer=None*, *illuminant=None*)

Parameters

- **observer** (*str*) – Get the XYZ values for another observer angle. Must be either '2' or '10'.
- **illuminant** (*str*) – Get the XYZ values for another illuminant.

Returns the color's illuminant's XYZ values.

get_value_tuple()
Returns a tuple of the color's values (in order). For example, an LabColor object will return (lab_l, lab_a, lab_b), where each member of the tuple is the float value for said variable.

set_illuminant(*illuminant*)
Validates and sets the color's illuminant.

Note: This only changes the illuminant. It does no conversion of the color's coordinates. For this, you'll want to refer to *XYZColor.apply_adaptation*.

Tip: Call this after setting your observer.

Parameters **illuminant** (*str*) – One of the various illuminants.

set_observer(*observer*)
Validates and sets the color's observer angle.

Note: This only changes the observer angle value. It does no conversion of the color's coordinates.

Parameters **observer** (*str*) – One of '2' or '10'.

illuminant = None
The color's illuminant. Set with *set_illuminant()*.

lch_c = None
C coordinate

lch_h = None
H coordinate

lch_l = None
L coordinate

observer = None
The color's observer angle. Set with *set_observer()*.

2.2.4 LCHuvColor

class colormath.color_objects.**LCHuvColor**(*lch_l*, *lch_c*, *lch_h*, *observer='2'*, *illuminant='d50'*)

Bases: colormath.color_objects.IlluminantMixin, colormath.color_objects.ColorBase

Represents an CIE LCH color that was converted to LCH by passing through CIE Luv. This differs from *LCHabColor*, which was converted to LCH through CIE Lab.

See Introduction to Colour Spaces by Phil Cruse for an illustration of how CIE LCH differs from CIE Lab.

Parameters

- **lch_l** (*float*) – L coordinate.
- **lch_c** (*float*) – C coordinate.
- **lch_h** (*float*) – H coordinate.
- **observer** (*str*) – Observer angle. Either '2' or '10' degrees.
- **illuminant** (*str*) – See *Observers and Illuminants* for valid values.

get_illuminant_xyz(*observer=None*, *illuminant=None*)

Parameters

- **observer** (*str*) – Get the XYZ values for another observer angle. Must be either '2' or '10'.
- **illuminant** (*str*) – Get the XYZ values for another illuminant.

Returns the color's illuminant's XYZ values.

get_value_tuple()
Returns a tuple of the color's values (in order). For example, an LabColor object will return (lab_l, lab_a, lab_b), where each member of the tuple is the float value for said variable.

set_illuminant(*illuminant*)
Validates and sets the color's illuminant.

Note: This only changes the illuminant. It does no conversion of the color's coordinates. For this, you'll want to refer to *XYZColor.apply_adaptation*.

Tip: Call this after setting your observer.

Parameters **illuminant** (*str*) – One of the various illuminants.

set_observer(*observer*)
Validates and sets the color's observer angle.

Note: This only changes the observer angle value. It does no conversion of the color's coordinates.

Parameters **observer** (*str*) – One of '2' or '10'.

illuminant = None
The color's illuminant. Set with *set_illuminant()*.

lch_c = None
C coordinate

lch_h = None
H coordinate

lch_l = None
L coordinate

observer = None
The color's observer angle. Set with *set_observer()*.

2.2.5 LuvColor

class colormath.color_objects.**LuvColor**(*luv_l*, *luv_u*, *luv_v*, *observer='2'*, *illuminant='d50'*)
Bases: colormath.color_objects.IlluminantMixin, colormath.color_objects.ColorBase

Represents an Luv color.

Parameters

- **luv_l** (*float*) – L coordinate.
- **luv_u** (*float*) – u coordinate.
- **luv_v** (*float*) – v coordinate.
- **observer** (*str*) – Observer angle. Either '2' or '10' degrees.
- **illuminant** (*str*) – See *Observers and Illuminants* for valid values.

get_illuminant_xyz(*observer=None*, *illuminant=None*)

Parameters

- **observer** (*str*) – Get the XYZ values for another observer angle. Must be either '2' or '10'.
- **illuminant** (*str*) – Get the XYZ values for another illuminant.

Returns the color's illuminant's XYZ values.

get_value_tuple()
Returns a tuple of the color's values (in order). For example, an LabColor object will return (lab_l, lab_a, lab_b), where each member of the tuple is the float value for said variable.

set_illuminant(*illuminant*)
Validates and sets the color's illuminant.

Note: This only changes the illuminant. It does no conversion of the color's coordinates. For this, you'll want to refer to *XYZColor.apply_adaptation*.

Tip: Call this after setting your observer.

Parameters **illuminant** (*str*) – One of the various illuminants.

set_observer(*observer*)
Validates and sets the color's observer angle.

Note: This only changes the observer angle value. It does no conversion of the color's coordinates.

Parameters **observer** (*str*) – One of '2' or '10'.

illuminant = None
The color's illuminant. Set with *set_illuminant()*.

luv_l = None
L coordinate

luv_u = None
u coordinate

luv_v = None
v coordinate

observer = None
The color's observer angle. Set with *set_observer()*.

2.2.6 XYZColor

class colormath.color_objects.**XYZColor**(*xyz_x*, *xyz_y*, *xyz_z*, *observer='2'*, *illuminant='d50'*)

Bases: colormath.color_objects.IlluminantMixin, colormath.color_objects.ColorBase

Represents an XYZ color.

Parameters

- **xyz_x** (*float*) – X coordinate.
- **xyz_y** (*float*) – Y coordinate.
- **xyz_z** (*float*) – Z coordinate.
- **observer** (*str*) – Observer angle. Either '2' or '10' degrees.
- **illuminant** (*str*) – See *Observers and Illuminants* for valid values.

apply_adaptation(*target_illuminant*, *adaptation='bradford'*)
This applies an adaptation matrix to change the XYZ color's illuminant. You'll most likely only need this during RGB conversions.

get_illuminant_xyz(*observer=None*, *illuminant=None*)

Parameters

- **observer** (*str*) – Get the XYZ values for another observer angle. Must be either '2' or '10'.
- **illuminant** (*str*) – Get the XYZ values for another illuminant.

Returns the color's illuminant's XYZ values.

get_value_tuple()
Returns a tuple of the color's values (in order). For example, an LabColor object will return (lab_l, lab_a, lab_b), where each member of the tuple is the float value for said variable.

set_illuminant(*illuminant*)
Validates and sets the color's illuminant.

Note: This only changes the illuminant. It does no conversion of the color's coordinates. For this, you'll want to refer to *XYZColor.apply_adaptation*.

Tip: Call this after setting your observer.

Parameters **illuminant** (*str*) – One of the various illuminants.

set_observer(*observer*)
Validates and sets the color's observer angle.

Note: This only changes the observer angle value. It does no conversion of the color's coordinates.

Parameters **observer** (*str*) – One of '2' or '10'.

illuminant = None
The color's illuminant. Set with *set_illuminant()*.

observer = None
The color's observer angle. Set with *set_observer()*.

xyz_x = None
X coordinate

xyz_y = None
Y coordinate

xyz_z = None
Z coordinate

2.2.7 xyYColor

class colormath.color_objects.**xyYColor**(*xyy_x*, *xyy_y*, *xyy_Y*, *observer='2'*, *illuminant='d50'*)

Bases: colormath.color_objects.IlluminantMixin, colormath.color_objects.ColorBase

Represents an xyY color.

Parameters

- **xyy_x** (*float*) – x coordinate.
- **xyy_y** (*float*) – y coordinate.
- **xyy_Y** (*float*) – Y coordinate.
- **observer** (*str*) – Observer angle. Either '2' or '10' degrees.

- **illuminant** (*str*) – See *Observers and Illuminants* for valid values.

get_illuminant_xyz(*observer=None*, *illuminant=None*)

Parameters

- **observer** (*str*) – Get the XYZ values for another observer angle. Must be either '2' or '10'.
- **illuminant** (*str*) – Get the XYZ values for another illuminant.

Returns the color's illuminant's XYZ values.

get_value_tuple()
Returns a tuple of the color's values (in order). For example, an LabColor object will return (lab_l, lab_a, lab_b), where each member of the tuple is the float value for said variable.

set_illuminant(*illuminant*)
Validates and sets the color's illuminant.

Note: This only changes the illuminant. It does no conversion of the color's coordinates. For this, you'll want to refer to *XYZColor.apply_adaptation*.

Tip: Call this after setting your observer.

Parameters **illuminant** (*str*) – One of the various illuminants.

set_observer(*observer*)
Validates and sets the color's observer angle.

Note: This only changes the observer angle value. It does no conversion of the color's coordinates.

Parameters **observer** (*str*) – One of '2' or '10'.

illuminant = None
The color's illuminant. Set with *set_illuminant()*.

observer = None
The color's observer angle. Set with *set_observer()*.

xyy_Y = None
Y coordinate

xyy_x = None
x coordinate

xyy_y = None
y coordinate

2.2.8 sRGBColor

class colormath.color_objects.**sRGBColor**(*rgb_r*, *rgb_g*, *rgb_b*, *is_upscaled=False*)
Bases: colormath.color_objects.BaseRGBColor

Represents an sRGB color.

Note: If you pass in upscaled values, we automatically scale them down to 0.0-1.0. If you need the old upscaled values, you can retrieve them with *get_upscaled_value_tuple()*.

Variables

- **rgb_r** (*float*) – R coordinate
- **rgb_g** (*float*) – G coordinate
- **rgb_b** (*float*) – B coordinate
- **is_upscaled** (*bool*) – If True, RGB values are between 1-255. If False, 0.0-1.0.

Parameters

- **rgb_r** (*float*) – R coordinate. 0...1. 1-255 if is_upscaled=True.
- **rgb_g** (*float*) – G coordinate. 0...1. 1-255 if is_upscaled=True.
- **rgb_b** (*float*) – B coordinate. 0...1. 1-255 if is_upscaled=True.
- **is_upscaled** (*bool*) – If False, RGB coordinate values are beteween 0.0 and 1.0. If True, RGB values are between 1 and 255.

get_rgb_hex()
Converts the RGB value to a hex value in the form of: #RRGGBB

Return type str

get_upscaled_value_tuple()
Scales an RGB color object from decimal 0.0-1.0 to int 0-255.

get_value_tuple()
Returns a tuple of the color's values (in order). For example, an LabColor object will return (lab_l, lab_a, lab_b), where each member of the tuple is the float value for said variable.

classmethod new_from_rgb_hex(*hex_str*)
Converts an RGB hex string like #RRGGBB and assigns the values to this sRGBColor object.

Return type *sRGBColor*

clamped_rgb_b
The clamped (0.0-1.0) B value.

clamped_rgb_g
The clamped (0.0-1.0) G value.

clamped_rgb_r
The clamped (0.0-1.0) R value.

native_illuminant = 'd65'
The RGB space's native illuminant. Important when converting to XYZ.

rgb_gamma = 2.2
RGB space's gamma constant.

2.2.9 BT2020Color

class colormath.color_objects.**BT2020Color**(*rgb_r*, *rgb_g*, *rgb_b*, *is_upscaled=False*)
Bases: colormath.color_objects.BaseRGBColor

Represents a ITU-R BT.2020 color.

Note: If you pass in upscaled values, we automatically scale them down to 0.0-1.0. If you need the old upscaled values, you can retrieve them with *get_upscaled_value_tuple()*.

Variables

- **rgb_r** (*float*) – R coordinate
- **rgb_g** (*float*) – G coordinate
- **rgb_b** (*float*) – B coordinate
- **is_upscaled** (*bool*) – If True, RGB values are between 1-255. If False, 0.0-1.0.

Parameters

- **rgb_r** (*float*) – R coordinate. 0...1. 1-255 if is_upscaled=True.
- **rgb_g** (*float*) – G coordinate. 0...1. 1-255 if is_upscaled=True.
- **rgb_b** (*float*) – B coordinate. 0...1. 1-255 if is_upscaled=True.
- **is_upscaled** (*bool*) – If False, RGB coordinate values are beteween 0.0 and 1.0. If True, RGB values are between 1 and 255.

get_rgb_hex()
Converts the RGB value to a hex value in the form of: #RRGGBB

Return type str

get_upscaled_value_tuple()
Scales an RGB color object from decimal 0.0-1.0 to int 0-255.

get_value_tuple()
Returns a tuple of the color's values (in order). For example, an LabColor object will return (lab_l, lab_a, lab_b), where each member of the tuple is the float value for said variable.

classmethod new_from_rgb_hex(*hex_str*)
Converts an RGB hex string like #RRGGBB and assigns the values to this sRGBColor object.

Return type *sRGBColor*

clamped_rgb_b
The clamped (0.0-1.0) B value.

clamped_rgb_g
The clamped (0.0-1.0) G value.

clamped_rgb_r
The clamped (0.0-1.0) R value.

native_illuminant = 'd65'
The RGB space's native illuminant. Important when converting to XYZ.

rgb_gamma = 2.4
RGB space's gamma constant.

2.2.10 AdobeRGBColor

class colormath.color_objects.**AdobeRGBColor**(*rgb_r*, *rgb_g*, *rgb_b*, *is_upscaled=False*)
Bases: colormath.color_objects.BaseRGBColor

Represents an Adobe RGB color.

Note: If you pass in upscaled values, we automatically scale them down to 0.0-1.0. If you need the old upscaled values, you can retrieve them with *get_upscaled_value_tuple()*.

Variables

- **rgb_r** (*float*) – R coordinate
- **rgb_g** (*float*) – G coordinate
- **rgb_b** (*float*) – B coordinate
- **is_upscaled** (*bool*) – If True, RGB values are between 1-255. If False, 0.0-1.0.

Parameters

- **rgb_r** (*float*) – R coordinate. 0...1. 1-255 if is_upscaled=True.
- **rgb_g** (*float*) – G coordinate. 0...1. 1-255 if is_upscaled=True.
- **rgb_b** (*float*) – B coordinate. 0...1. 1-255 if is_upscaled=True.
- **is_upscaled** (*bool*) – If False, RGB coordinate values are beteween 0.0 and 1.0. If True, RGB values are between 1 and 255.

get_rgb_hex()
Converts the RGB value to a hex value in the form of: #RRGGBB

Return type str

get_upscaled_value_tuple()
Scales an RGB color object from decimal 0.0-1.0 to int 0-255.

get_value_tuple()
Returns a tuple of the color's values (in order). For example, an LabColor object will return (lab_l, lab_a, lab_b), where each member of the tuple is the float value for said variable.

classmethod new_from_rgb_hex(*hex_str*)
Converts an RGB hex string like #RRGGBB and assigns the values to this sRGBColor object.

Return type *sRGBColor*

clamped_rgb_b
The clamped (0.0-1.0) B value.

clamped_rgb_g
The clamped (0.0-1.0) G value.

clamped_rgb_r
The clamped (0.0-1.0) R value.

native_illuminant = 'd65'
The RGB space's native illuminant. Important when converting to XYZ.

rgb_gamma = 2.2
RGB space's gamma constant.

2.2.11 HSLColor

class colormath.color_objects.**HSLColor**(*hsl_h*, *hsl_s*, *hsl_l*)
Bases: colormath.color_objects.ColorBase

Represents an HSL color.

Parameters

- **hsl_h** (*float*) – H coordinate.
- **hsl_s** (*float*) – S coordinate.
- **hsl_l** (*float*) – L coordinate.

get_value_tuple()
Returns a tuple of the color's values (in order). For example, an LabColor object will return (lab_l, lab_a, lab_b), where each member of the tuple is the float value for said variable.

hsl_h = None
H coordinate

hsl_l = None
L coordinate

hsl_s = None
S coordinate

2.2.12 HSVColor

class colormath.color_objects.**HSVColor**(*hsv_h*, *hsv_s*, *hsv_v*)
Bases: colormath.color_objects.ColorBase

Represents an HSV color.

Parameters

- **hsv_h** (*float*) – H coordinate.
- **hsv_s** (*float*) – S coordinate.
- **hsv_v** (*float*) – V coordinate.

get_value_tuple()
Returns a tuple of the color's values (in order). For example, an LabColor object will return (lab_l, lab_a, lab_b), where each member of the tuple is the float value for said variable.

hsv_h = None
H coordinate

hsv_s = None
S coordinate

hsv_v = None
V coordinate

2.2.13 CMYColor

class colormath.color_objects.**CMYColor**(*cmy_c*, *cmy_m*, *cmy_y*)
Bases: colormath.color_objects.ColorBase

Represents a CMY color.

Parameters

- **cmy_c** (*float*) – C coordinate.
- **cmy_m** (*float*) – M coordinate.
- **cmy_y** (*float*) – Y coordinate.

get_value_tuple()
Returns a tuple of the color's values (in order). For example, an LabColor object will return (lab_l, lab_a, lab_b), where each member of the tuple is the float value for said variable.

cmy_c = None
C coordinate

cmy_m = None
M coordinate

cmy_y = None
Y coordinate

2.2.14 CMYKColor

class colormath.color_objects.**CMYKColor**(*cmyk_c*, *cmyk_m*, *cmyk_y*, *cmyk_k*)
Bases: colormath.color_objects.ColorBase

Represents a CMYK color.

Parameters

- **cmyk_c** (*float*) – C coordinate.
- **cmyk_m** (*float*) – M coordinate.
- **cmyk_y** (*float*) – Y coordinate.
- **cmyk_k** (*float*) – K coordinate.

get_value_tuple()
Returns a tuple of the color's values (in order). For example, an LabColor object will return (lab_l, lab_a, lab_b), where each member of the tuple is the float value for said variable.

cmyk_c = None
C coordinate

cmyk_k = None
K coordinate

cmyk_m = None
M coordinate

cmyk_y = None
Y coordinate

2.2.15 IPTColor

class colormath.color_objects.**IPTColor**(*ipt_i*, *ipt_p*, *ipt_t*)
Bases: colormath.color_objects.ColorBase

Represents an IPT color.

Reference: Fairchild, M. D. (2013). Color appearance models, 3rd Ed. (pp. 271-272). John Wiley & Sons.

Parameters

- **ipt_i** – I coordinate.
- **ipt_p** – P coordinate.
- **ipt_t** – T coordinate.

get_value_tuple()
Returns a tuple of the color's values (in order). For example, an LabColor object will return (lab_l, lab_a, lab_b), where each member of the tuple is the float value for said variable.

ipt_i = None
I coordinate

ipt_p = None
P coordinate

ipt_t = None
T coordinate

2.3 Observers and Illuminants

Illuminants and observer angles are used in all color spaces that use reflective (instead of transmissive) light. Here are a few brief overviews of what these are and what they do:

- Understanding Standard Illuminants in Color Measurement - Konica Minolta
- What is Meant by the Term "Observer Angle"? - XRite

To adjust the illuminants and/or observer angles on a color:

```
lab = LabColor(0.1, 0.2, 0.3, observer='10', illuminant='d65')
```

2.3.1 Two-degree observer angle

These illuminants can be used with `observer='2'`, for the color spaces that require illuminant/observer:

- `'a'`
- `'b'`
- `'c'`
- `'d50'`
- `'d55'`
- `'d65'`
- `'d75'`
- `'e'`
- `'f2'`
- `'f7'`
- `'f11'`

2.3.2 Ten-degree observer angle

These illuminants can be used with `observer='10'`, for the color spaces that require illuminant/observer:

- `'d50'`
- `'d55'`
- `'d65'`
- `'d75'`

2.4 Color Conversions

Converting between color spaces is very simple with python-colormath. To see a full list of supported color spaces, see *Color Objects*.

All conversions happen through the `convert_color` function shown below. The original Color instance is passed in as the first argument, and the desired Color class (not an instance) is passed in as the second argument. If the conversion can be made, a new Color instance will be returned.

`colormath.color_conversions.`**`convert_color`**(*color*, *target_cs*, *through_rgb_type=<class 'colormath.color_objects.sRGBColor'>*, *target_illuminant=None*, **args*, ***kwargs*)

Converts the color to the designated color space.

Parameters

- **`color`** – A Color instance to convert.
- **`target_cs`** – The Color class to convert to. Note that this is not an instance, but a class.
- **`through_rgb_type`** (*`BaseRGBColor`*) – If during your conversion between your original and target color spaces you have to pass through RGB, this determines which kind of RGB to use. For example, XYZ->HSL. You probably don't need to specify this unless you have a special usage case.
- **`target_illuminant`** (*`None or str`*) – If during conversion from RGB to a reflective color space you want to explicitly end up with a certain illuminant, pass this here. Otherwise the RGB space's native illuminant will be used.

Returns An instance of the type passed in as `target_cs`.

Raises `colormath.color_exceptions.UndefinedConversionError` if conversion between the two color spaces isn't possible.

2.4.1 Example

This is a simple example of a CIE Lab to CIE XYZ conversion. Refer to *Color Objects* for a full list of different color spaces that can be instantiated and converted between.

```
from colormath.color_objects import LabColor, XYZColor
from colormath.color_conversions import convert_color

lab = LabColor(0.903, 16.296, -2.22)
xyz = convert_color(lab, XYZColor)
```

Some color spaces require a trip through RGB during conversion. For example, to get from XYZ to HSL, we have to convert XYZ->RGB->HSL. The same could be said for XYZ to CMYK (XYZ->RGB->CMY->CMYK). Different RGB color spaces have different gamut sizes and capabilities, which can affect your converted color values.

sRGB is the default RGB color space due to its ubiquity. If you would like to use a different RGB space for a conversion, you can do something like this:

```
from colormath.color_objects import XYZColor, HSLColor, AdobeRGBColor
from colormath.color_conversions import convert_color

xyz = XYZColor(0.1, 0.2, 0.3)
hsl = convert_color(xyz, HSLColor, through_rgb_type=AdobeRGBColor)
# If you are going to convert back to XYZ, make sure you use the same
# RGB color space on the way back.
xyz2 = convert_color(hsl, XYZColor, through_rgb_type=AdobeRGBColor)
```

2.4.2 RGB conversions and native illuminants

When converting RGB colors to any of the CIE spaces, we have to pass through the XYZ color space. This serves as a crossroads for conversions to basically all of the reflective color spaces (CIE Lab, LCH, Luv, etc). The RGB spaces are reflective, where the illumination is provided. In the case of a reflective space like XYZ, the illuminant must be supplied by a light source.

Each RGB space has its own native illuminant, which can vary from space to space. To see some of these for yourself, check out Bruce Lindbloom's XYZ to RGB matrices.

To cite the most commonly used RGB color space as an example, sRGB has a native illuminant of D65. When we convert RGB to XYZ, that native illuminant carries over unless explicitly overridden. If you aren't expecting this behavior, you'll end up with variations in your converted color's numbers.

To explicitly request a specific illuminant, provide the `target_illuminant` keyword when using *colormath.color_conversions.convert_color()*.

```
from colormath.color_objects import XYZColor, sRGBColor
from colormath.color_conversions import convert_color

rgb = RGBColor(0.1, 0.2, 0.3)
xyz = convert_color(rgb, XYZColor, target_illuminant='d50')
```

2.4.3 RGB conversions and out-of-gamut coordinates

RGB spaces tend to have a smaller gamut than some of the CIE color spaces. When converting to RGB, this can cause some of the coordinates to end up being out of the acceptable range (0.0-1.0 or 1-255, depending on whether your RGB color is upscaled).

Rather than clamp these for you, we leave them as-is. This allows for more accurate conversions back to the CIE color spaces. If you require the clamped (0.0-1.0 or 1-255) values, use the following properties on any RGB color:

- `clamped_rgb_r`
- `clamped_rgb_g`
- `clamped_rgb_b`

2.5 Delta E Equations

Delta E equations are used to put a number on the visual difference between two *LabColor* instances. While different lighting conditions, substrates, and physical condition can all introduce unexpected variables, these equations are a good rough starting point for comparing colors.

Each of the following Delta E functions has different characteristics. Some may be more suitable for certain applications than others. While it's outside the scope of this module's documentation to go into much detail, we link to relevant material when possible.

2.5.1 Example

```
from colormath.color_objects import LabColor
from colormath.color_diff import delta_e_cie1976

# Reference color.
color1 = LabColor(lab_l=0.9, lab_a=16.3, lab_b=-2.22)
# Color to be compared to the reference.
color2 = LabColor(lab_l=0.7, lab_a=14.2, lab_b=-1.80)
# This is your delta E value as a float.
delta_e = delta_e_cie1976(color1, color2)
```

2.5.2 Delta E CIE 1976

colormath.color_diff.**delta_e_cie1976**(*color1*, *color2*)
Calculates the Delta E (CIE1976) of two colors.

2.5.3 Delta E CIE 1994

colormath.color_diff.**delta_e_cie1994**(*color1*, *color2*, *K_L=1*, *K_C=1*, *K_H=1*, *K_1=0.045*, *K_2=0.015*)
Calculates the Delta E (CIE1994) of two colors.

K_l: 0.045 graphic arts 0.048 textiles

K_2: 0.015 graphic arts 0.014 textiles

K_L: 1 default 2 textiles

2.5.4 Delta E CIE 2000

colormath.color_diff.**delta_e_cie2000**(*color1*, *color2*, *Kl=1*, *Kc=1*, *Kh=1*)
Calculates the Delta E (CIE2000) of two colors.

2.5.5 Delta E CMC

colormath.color_diff.**delta_e_cmc**(*color1*, *color2*, *pl=2*, *pc=1*)
Calculates the Delta E (CMC) of two colors.

CMC values Acceptability: pl=2, pc=1 Perceptability: pl=1, pc=1

2.6 ANSI and ISO Density

Density may be calculated from *LabColor* instances.

colormath.density.**auto_density**(*color*)
Given a SpectralColor, automatically choose the correct ANSI T filter. Returns a tuple with a string representation of the filter the calculated density.

Parameters **color** (SpectralColor) – The SpectralColor object to calculate density for.

Return type float

Returns The density value, with the filter selected automatically.

colormath.density.**ansi_density**(*color*, *density_standard*)
Calculates density for the given SpectralColor using the spectral weighting function provided. For example, ANSI_STATUS_T_RED. These may be found in colormath.density_standards.

Parameters

- **color** (SpectralColor) – The SpectralColor object to calculate density for.
- **density_standard** (*numpy.ndarray*) – NumPy array of filter of choice from colormath.density_standards.

Return type float

Returns The density value for the given color and density standard.

2.6.1 Example

```
from colormath.color_objects import SpectralColor
from colormath.density import auto_density, ansi_density
from colormath.density_standards import ANSI_STATUS_T_RED

# Omitted the full spectral kwargs for brevity.
color = SpectralColor(spec_340nm=0.08, ...)
# ANSI T Density for the spectral color.
density = auto_density(color)

# Or maybe we want to specify which filter to use.
red_density = ansi_density(color, ANSI_STATUS_T_RED)
```

2.6.2 Valid Density Constants

The following density constants within colormath.density_standards can be passed to *colormath.density.ansi_density()*:

- ANSI_STATUS_A_RED
- ANSI_STATUS_A_GREEN
- ANSI_STATUS_A_BLUE
- ANSI_STATUS_E_RED
- ANSI_STATUS_E_GREEN
- ANSI_STATUS_E_BLUE

- ANSI_STATUS_M_RED
- ANSI_STATUS_M_GREEN
- ANSI_STATUS_M_BLUE
- ANSI_STATUS_T_RED
- ANSI_STATUS_T_GREEN
- ANSI_STATUS_T_BLUE
- TYPE1
- TYPE2
- ISO_VISUAL

2.7 Color Appearance Models

Color appearance models allow the prediction of perceptual correlates (e.g., lightness, chroma or hue) of a given surface color under certain viewing conditions (e.g., a certain illuminant, surround or background). The complexity of color appearance models can range from very low, e.g., CIELAB can technically be considered a color appearance model, to very complex models that take into account a large number color appearance phenomena.

Each of the classes in this module represents a specific model and its computation, yielding the predicted perceptual correlates as instance attributes. Discussing the details of each model go beyond this documentation, but we provide references to the relevant literature for each model and would advice familiarising yourself with it, before using a given models.

2.7.1 Example

```
# Color stimulus
color = XYZColor(19.01, 20, 21.78)

# The two illuminants that will be compared.
illuminant_d65 = XYZColor(95.05, 100, 108.88)
illuminant_a = XYZColor(109.85, 100, 35.58)

# Background relative luminance
y_b = 20

# Adapting luminance
l_a = 328.31

# Surround condition assumed to be average (see CIECAM02 documentation for values)
c = 0.69
n_c = 1
f = 1

model = CIECAM02(color.xyz_x, color.xyz_y, color.xyz_z,
                 illuminant_d65.xyz_x, illuminant_d65.xyz_y, illuminant_d65.xyz_z,
                 y_b, l_a, c, n_c, f)
```

2.7.2 Nayatani95 et al. Model

class colormath.color_appearance_models.**Nayatani95**(*x*, *y*, *z*, *x_n*, *y_n*, *z_n*, *y_ob*, *e_o*, *e_or*, *n=1*)

Bases: object

References

- Fairchild, M. D. (2013). *Color appearance models*, 3rd Ed. John Wiley & Sons.
- Nayatani, Y., Sobagaki, H., & Yano, K. H. T. (1995). Lightness dependency of chroma scales of a nonlinear color-appearance model and its latest formulation. *Color Research & Application*, 20(3), 156-167.

Parameters

- **x** – X value of test sample X.
- **y** – Y value of test sample Y.
- **z** – Z value of test sample Z.
- **x_n** – X value of reference white X_n.
- **y_n** – Y value of reference white Y_n.
- **z_n** – Z value of reference white Z_n.
- **y_ob** – Luminance factor of achromatic background as percentage Y_o. Required to be larger than 0.18.
- **e_o** – Illuminance of the viewing field E_o in lux.
- **e_or** – Normalising illuminance $E_o r$ in lux.
- **n** – Noise term n.

brightness
Predicted brightness B_r.

chroma
Predicted chroma C.

colorfulness
Predicted colorfulness M.

hue_angle
Predicted hue angle θ.

saturation
Predicted saturation S.

2.7.3 Hunt Model

class colormath.color_appearance_models.**Hunt**(*x*, *y*, *z*, *x_b*, *y_b*, *z_b*, *x_w*, *y_w*, *z_w*, *l_a*, *n_c*, *n_b*, *l_as=None*, *cct_w=None*, *n_cb=None*, *n_bb=None*, *x_p=None*, *y_p=None*, *z_p=None*, *p=None*, *helson_judd=False*, *discount_illuminant=True*, *s=None*, *s_w=None*)

Bases: object

References

- Fairchild, M. D. (2013). *Color appearance models*, 3rd Ed. John Wiley & Sons.
- Hunt, R. W. G. (2005). *The reproduction of colour*. 5th Ed., John Wiley & Sons.

Parameters

- **x** – X value of test sample X.
- **y** – Y value of test sample Y.
- **z** – Z value of test sample Z.
- **x_b** – X value of background X_b.
- **y_b** – Y value of background Y_b.
- **z_b** – Z value of background Z_b.
- **x_w** – X value of reference white X_W.
- **y_w** – Y value of reference white Y_W.
- **z_w** – Z value of reference white Z_W.
- **l_a** – Adapting luminance L_A.
- **n_c** – Chromatic surround induction_factor N_c.
- **n_b** – Brightness surround induction factor N_b.
- **l_as** – Scotopic luminance of the illuminant L_{AS}. Will be approximated if not supplied.
- **cct_w** – Correlated color temperature of illuminant T. Will be used to approximate l_as if not supplied.
- **n_cb** – Chromatic background induction factor N_{cb}. Will be approximated using y_w and y_b if not supplied.
- **n_bb** – Brightness background induction factor N_{bb}. Will be approximated using y_w and y_b if not supplied.
- **x_p** – X value of proxima field X_p. If not supplied, will be assumed to equal background.
- **y_p** – Y value of proxima field Y_p. If not supplied, will be assumed to equal background.
- **z_p** – Z value of proxima field Z_p. If not supplied, will be assumed to equal background.
- **p** – Simultaneous contrast/assimilation parameter.
- **helson_judd** – Truth value indicating whether the Heslon-Judd effect should be accounted for. Default False.
- **discount_illuminant** – Truth value whether discount-the-illuminant should be applied. Default True.
- **s** – Scotopic response to the stimulus.
- **s_w** – Scotopic response for th reference white.

Raises **ValueError** – if illegal parameter combination is supplied.

brightness
Predicted brightness Q.

chroma
Predicted chroma C_{94}.

colorfulness
Predicted colorfulness M_{94}.

hue_angle
Predicted hue angle h_s.

lightness
Predicted colorfulness J.

saturation
Predicted saturation s.

2.7.4 RLAB Model

class colormath.color_appearance_models.**RLAB**(*x*, *y*, *z*, *x_n*, *y_n*, *z_n*, *y_n_abs*, *sigma*, *d*)
Bases: object

References

- Fairchild, M. D. (1996). Refinement of the RLAB color space. *Color Research & Application*, 21(5), 338-346.
- Fairchild, M. D. (2013). *Color appearance models*, 3rd Ed. John Wiley & Sons.

Parameters

- **x** – X value of test sample X.
- **y** – Y value of test sample Y.
- **z** – Z value of test sample Z.
- **x_n** – X value of reference white X_n.
- **y_n** – Y value of reference white Y_n.
- **z_n** – Z value of reference white Z_n.
- **y_n_abs** – Absolute luminance Y_n of a white object in cd/m^2.
- **sigma** – Relative luminance parameter σ. For average surround set $\sigma = 1/2.3$, for dim surround $\sigma = 1/2.9$ and for dark surround $\sigma = 1/3.5$.
- **d** – Degree of adaptation D.

a
Predicted red-green chromatic response a^R.

b
Predicted yellow-blue chromatic response b^R.

chroma
Predicted chroma C^R.

hue_angle
Predicted hue angle h^R.

lightness
Predicted colorfulness L^R.

saturation
Predicted saturation s^R.

2.7.5 ATD95 Model

class colormath.color_appearance_models.**ATD95**(*x*, *y*, *z*, *x_0*, *y_0*, *z_0*, *y_0_abs*, *k_1*, *k_2*, *sigma=300*)

Bases: object

References

- Fairchild, M. D. (2013). *Color appearance models*, 3rd Ed. John Wiley & Sons.
- Guth, S. L. (1995, April). Further applications of the ATD model for color vision. In *IS&T/SPIE's Symposium on Electronic Imaging: Science & Technology* (pp. 12-26). International Society for Optics and Photonics.

Parameters

- **x** – X value of test sample X.
- **y** – Y value of test sample Y.
- **z** – Z value of test sample Z.
- **x_0** – X value of reference white X_0.
- **y_0** – Y value of reference white Y_0.
- **z_0** – Z value of reference white Z_0.
- **y_0_abs** – Absolute adapting luminance Y_0 in cd/m^2.
- **k_1** – k_1
- **k_2** – k_2
- **sigma** – σ

brightness
Predicted brightness Br.

hue
Predicted hue H.

saturation
Predicted saturation C.

2.7.6 LLAB Model

class colormath.color_appearance_models.**LLAB**(*x*, *y*, *z*, *x_0*, *y_0*, *z_0*, *y_b*, *f_s*, *f_l*, *f_c*, *l*, *d=1*)

Bases: object

References

- Fairchild, M. D. (2013). *Color appearance models*, 3rd Ed. John Wiley & Sons.
- Luo, M. R., & Morovic, J. (1996, September). Two unsolved issues in colour management-colour appearance and gamut mapping. In *5th International Conference on High Technology* (pp. 136-147).
- Luo, M. R., Lo, M. C., & Kuo, W. G. (1996). The LLAB (l: c) colour model. *Color Research & Application*, 21(6), 412-429.

Parameters

- **x** – X value of test sample X.
- **y** – Y value of test sample Y.
- **z** – Z value of test sample Z.
- **x_0** – X value of reference white X_0.
- **y_0** – Y value of reference white Y_0.
- **z_0** – Z value of reference white Z_0.
- **y_b** – Luminance factor of the background Y_b in cd/m^2.
- **f_s** – Surround induction factor F_S.
- **f_l** – Lightness induction factor F_L.
- **f_c** – Chroma induction factor F_C.
- **l** – Absolute luminance of reference white L in cd/m^2.
- **d** – Discounting-the-Illuminant factor D.

a_l
Predicted red-green chromatic response A_L.

b_l
Predicted yellow-blue chromatic response B_L.

chroma
Predicted chroma Ch_L.

hue_angle
Predicted hue angle h_L.

lightness
Predicted colorfulness L_L.

saturation
Predicted saturation s_L.

2.7.7 CIECAM02 Model

class colormath.color_appearance_models.**CIECAM02**(*x*, *y*, *z*, *x_w*, *y_w*, *z_w*, *y_b*, *l_a*, *c*, *n_c*, *f*, *d=False*)

Bases: object

References

- CIE TC 8-01 (2004). A Color appearance model for color management systems. Publication 159. Vienna: CIE Central Bureau. ISBN 3-901906-29-0.
- Fairchild, M. D. (2013). *Color appearance models*, 3rd Ed. John Wiley & Sons.

Parameters

- **x** – X value of test sample X.
- **y** – Y value of test sample Y.
- **z** – Z value of test sample Z.
- **x_w** – X value of reference white X_W.

- **y_w** – Y value of reference white Y_W.
- **z_w** – Z value of reference white Z_W.
- **y_b** – Background relative luminance Y_b.
- **l_a** – Adapting luminance L_A in cd/m^2.
- **c** – Exponential nonlinearity c. (Average/Dim/Dark) (0.69/0.59/0.525).
- **n_c** – Chromatic induction factor N_c. (Average/Dim/Dark) (1.0,0.9,0.8).
- **f** – Maximum degree of adaptation F. (Average/Dim/Dark) (1.0/0.9/0.8).
- **d** – Discount-the-Illuminant factor D.

a
Predicted red-green chromatic response a.

b
Predicted yellow-blue chromatic response b.

brightness
Predicted colorfulness Q.

chroma
Predicted chroma C.

colorfulness
Predicted colorfulness M.

hue_angle
Predicted hue angle h.

lightness
Predicted colorfulness J.

saturation
Predicted saturation s_L.

2.7.8 CIECAM02-m1 Model

class colormath.color_appearance_models.**CIECAM02m1**(*x*, *y*, *z*, *x_w*, *y_w*, *z_w*, *x_b*, *y_b*, *z_b*, *l_a*, *c*, *n_c*, *f*, *p*, *d=False*)

Bases: *colormath.color_appearance_models.CIECAM02*

References

- Wu, R. C., & Wardman, R. H. (2007). Proposed modification to the CIECAM02 colour appearance model to include the simultaneous contrast effects. *Color Research & Application*, 32(2), 121-129.

Parameters

- **x** – X value of test sample X.
- **y** – Y value of test sample Y.
- **z** – Z value of test sample Z.
- **x_w** – X value of reference white X_W.
- **y_w** – Y value of reference white Y_W.
- **z_w** – Z value of reference white Z_W.

- **x_b** – X value of background X_b.
- **y_b** – Y value of background Y_b.
- **z_b** – Z value of background Z_b.
- **l_a** – Adapting luminance L_A in cd/m^2.
- **c** – Exponential nonlinearity c. (Average/Dim/Dark) (0.69/0.59/5.25).
- **n_c** – Chromatic induction factor N_c. (Average/Dim/Dark) (1.0,0.9,0.8).
- **f** – Maximum degree of adaptation F. (Average/Dim/Dark) (1.0/0.9/0.8).
- **p** – Simultaneous contrast/assimilation parameter.
- **d** – Discount-the-Illuminant factor D.

a
Predicted red-green chromatic response a.

b
Predicted yellow-blue chromatic response b.

brightness
Predicted colorfulness Q.

chroma
Predicted chroma C.

colorfulness
Predicted colorfulness M.

hue_angle
Predicted hue angle h.

lightness
Predicted colorfulness J.

saturation
Predicted saturation s_L.

2.8 Release Notes

2.8.1 3.0.0

Features

- Python 3.5 and 3.6 are now supported.

Backwards-Incompatible Changes

- Python 3.3 and 3.4 are no longer supported.
- networkx>=2.0 is now required.

Bug Fixes

- Add NodeNotFound to GraphConversionManager.get_conversion_path().

2.8.2 2.2.0

Features

- AppleRGBColor added. (jan-warchol)
- Added compatibility with NetworkX 2.0. (Erotemic)

Bug Fixes

- *IPT_to_XYZ* docstring corrected. (mumbleskates)

2.8.3 2.1.1

Bug Fixes

- Add `network` to install_requires. (Ed-von-Schleck)

2.8.4 2.1.0

Features

- Added new NetworkX graph-based resolution of conversions between color spaces. Reduces boilerplate and makes it much easier to add additional color spaces going forward. (MichaelMauderer)
- Added the IPT color space. (MichaelMauderer)
- Added Color Appearance Models. Natayani95, Hunt, RLAB, ATD95, LLAB, CIECAM02, CIECAM02-m1. (MichaelMauderer)

Bug Fixes

- xyY conversions now correctly avoid division by zero. (dwbullok)
- Un-transposed adaptation matrices. Has no effect on conversions, but if you use these directly you may see different numbers. (JasonTam)
- During XYZ->RGB, linear channel values are now clamped in order to avoid domain errors. Output should now always be between 0 and 1.

Backwards Incompatible changes

- If any of your code directly referenced the color adaptation matrices that were un-inverted, you'll need to adjust your math.

2.8.5 2.0.2

Bug Fixes

- Apparently I didn't add the function body for the clamped RGB properties. Yikes.

2.8.6 2.0.1

Features

- Lots of documentation improvements.
- `convert_color()` now has an explicitly defined/documented `target_illuminant` kwarg, instead of letting this fall through to its **kwargs. This should make IDE auto-complete better and provide more clarity.
- Added `clamped_rgb_r`, `clamped_rgb_g`, and `clamped_rgb_b` to RGB color spaces. Use these if you have to have in-gamut, potentially compressed coordinates.

Bug Fixes

- Direct conversions to non-sRGB colorspaces returned sRGBColor objects. Reported by Cezary Wagner.

2.8.7 2.0.0

Backwards Incompatible changes

- Minimum Python version is now 2.7.
- ColorBase.convert_to() is no more. Use colormath.color_conversions.convert_color() instead. API isn't as spiffy looking, but it's a lot less magical now.
- Completely re-worked RGB handling. Each RGB space now has its own class, inheriting from BaseRGBColor. Consequently, RGBColor is no more. In most cases, you can substitute RGBColor with sRGBColor during your upgrade.
- RGB channels are now [0..1] instead of [1..255]. Can use BaseRGBColor.get_upscaled_value_tuple() to get the upscaled values.
- BaseRGBColor.set_from_rgb_hex() was replaced with a BaseRGBColor.new_from_rgb_hex(), which returns a properly formed sRGBColor object.
- BaseRGBColor no longer accepts observer or illuminant kwargs.
- HSL no longer accepts observer, illuminant or rgb_type kwargs.
- HSV no longer accepts observer, illuminant or rgb_type kwargs.
- CMY no longer accepts observer, illuminant or rgb_type kwargs.
- CMYK no longer accepts observer, illuminant or rgb_type kwargs.
- Removed 'debug' kwargs in favor of Python's logging.
- Completely re-worked exception list. Eliminated some redundant exceptions, re-named basically everything else.

Features

- Python 3.3 support added.
- Added tox.ini with supported environments.
- Removed the old custom test runner in favor of nose.
- Replacing simplified RGB->XYZ conversions with Bruce Lindbloom's.
- A round of PEP8 work.
- Added a BaseColorConversionTest test class with some greatly improved color comparison. Much more useful in tracking down breakages.
- Eliminated non-matrix delta E computations in favor of the matrix equivalents. No need to maintain duplicate code, and the matrix stuff is faster for bulk operations.

Bug Fixes

- Corrected delta_e CMC example error. Should now run correctly.
- color_diff_matrix.delta_e_cie2000 had an edge case where certain angles would result in an incorrect delta E.
- Un-hardcoded XYZColor.apply_adaptation()'s adaptation and observer angles.

2.8.8 1.0.9

Features

- Added an optional vectorized deltaE function. This uses NumPy array/matrix math for a very large speed boost. (Eddie Bell)
- Added this changelog.

Bug Fixes

- Un-hardcode the observer angle in adaptation matrix. (Bastien Dejean)

2.8.9 1.0.8

- Initial GitHub release.

CHAPTER 3

Useful color math resources

- Bruce Lindbloom - Lots of formulas, calculators, and standards.
- John the Math Guy - Useful tutorials and explanations of color theory.

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