

Color Spaces

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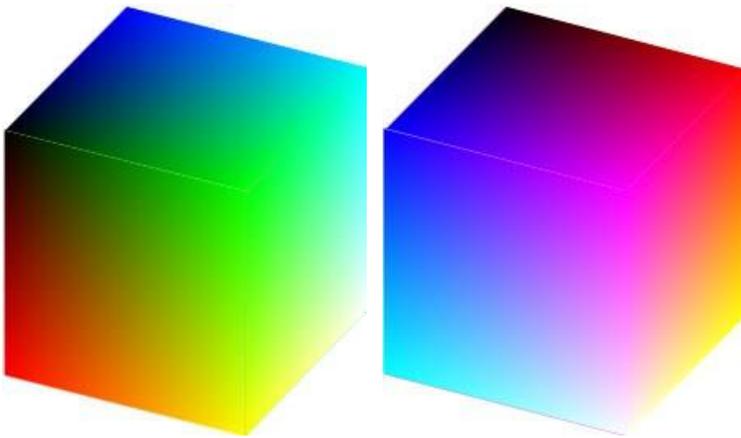
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Color Spaces

A color space is a system for representing colors. It takes three numbers to uniquely determine a color. Many different color spaces have been created over the years to categorize colors according to different characteristics. Picture Window primarily uses three different color spaces:

RGB

Most digital cameras, scanners and displays work by specifying colors according to their red, green, and blue components. These three values define a 3-dimensional color space called the RGB color space. The RGB color space can be visualized as a cube with red varying along one axis, green varying along the second, and blue varying along the third. Every color that can be created by mixing red, green, and blue light is located somewhere within the cube. The following images show the outside of the RGB cube viewed from two different directions:

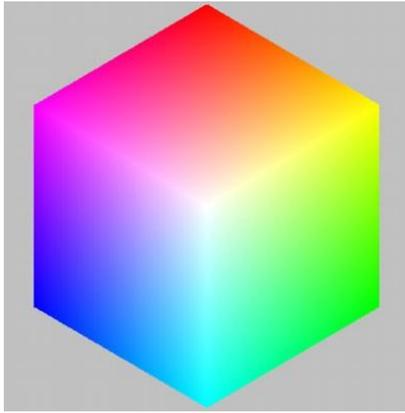


The eight corners of the cube correspond to the three primary colors (Red, Green, Blue), the three secondary colors (Cyan, Magenta, Yellow) and black and white. Neutral grays are located on the diagonal of the cube that connects the black and the white corners. While RGB may be the underlying color space in which all the work gets done, it does not correspond to the way humans conceptualize color.

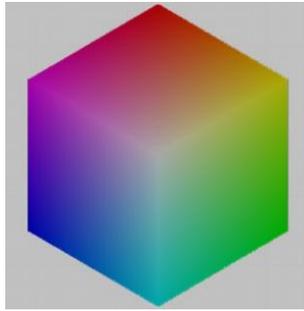
HSV (Hue Saturation Value)

The HSV color space characterizes colors according to their hue, saturation, and value (brightness). This color space is based on a hex-cone model which can be visualized as a prism with a hexagon on one end tapering down to a point at the other. The hexagonal face of the prism is derived by looking at the RGB cube centered on its white corner. The cube, when viewed from this angle, looks like a hexagon with white in the center and the primary and secondary colors making up the six vertices of the hexagon. This color hexagon is the one Picture Window uses in its color picker to display the brightest possible versions of all possible colors based on their hue and saturation.

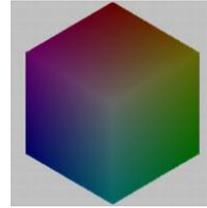
Successive cross sections of the HSV hex-cone as it narrows to its vertex are illustrated below, showing how the colors get darker and darker, eventually reaching black.



V = 100%



V = 75%



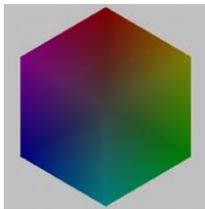
V = 50%



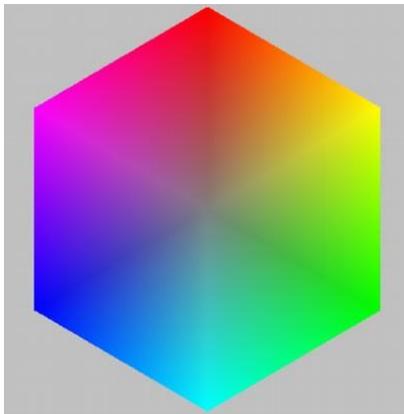
V = 25%

HSL (Hue Saturation Lightness)

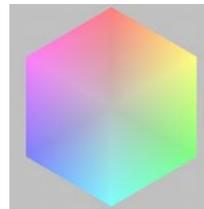
The HSL color space (also sometimes called HSB) characterizes colors according to their hue, saturation, and lightness (brightness). This color space is based on a double hex-cone model which consists of a hexagon in the middle that converges down to a point at either end. Like the HSV color space, the HSL space goes to black at one end, but unlike HSV, it tends toward white at the opposite end. The most saturated colors appear in the middle. Note that unlike the HSV color space, the central cross section has 50% gray in the center and not pure white which is only found at L = 100%.



L = 25%



L = 50%



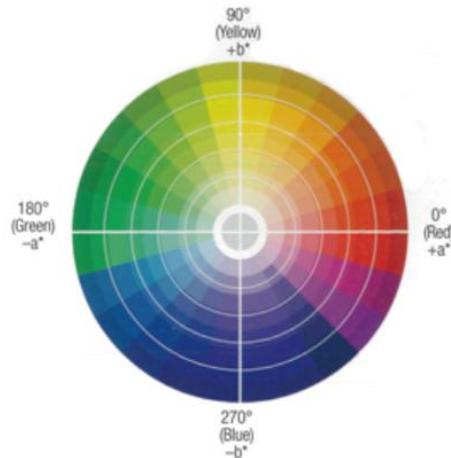
L = 75%

Luminance

Luminance is a measure of the perceived brightness of a color. The human eye is more sensitive to some colors than others, so luminance is computed as a weighted average of the red, green and blue channels. The green channel has the largest weight and blue the smallest, since the eye is much more sensitive to green light than to blue light of the same intensity. This makes luminance a reasonable default choice for converting color images to black and white.

Lab

Although Picture Window does not let you edit images using the Lab (also called CIELab) color space, its readout tool can display pixel values in Lab. The Lab space effectively separates black and white (luminance) information from color (chrominance). The **L** component runs from 0 for black to 100 for white and corresponds closely to luminance, or perceived lightness. The **a** and **b** components encode the color (hue and saturation) information with **a** corresponding roughly to the green/red axis and **b** corresponding roughly to the yellow/blue axis (see below). Like the HSL color space all colors converge to black as **L** approaches 0 and to white when **L** approaches 100. All neutral grays have **a = b = 0**.



Unlike HSV and HSL, in Lab, the brightest, most saturated colors are not located at a particular **L** value. For example, the **L** value for pure blue is only 30 while the **L** value for pure yellow is 98.

Lab is a poor choice for interactive image editing because it is very easy to get out-of-gamut colors. Because of the complicated limits on **L** based on **a** and **b**, this makes it hard to adjust the channels independently.

Lab also differs from the other color spaces in that it is device independent. Consequently, if you change the color profile associated with an image, its Lab values also change, since the profile defines the RGB primary colors, the white point and the gamma, all of which affect Lab.