Lecture Five
Multimedia Systems

Color Systems

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Converting 24-bit color to 8-bit color:

How to apply Lookup Table for the block below?
<u>Hint:</u> (For R and G → 3 bits , and for B → 2 bits).

We need to convert a 24-bit colour block (with R, G, B components shown to the right) into an 8-bit colour block.

R

205	10
196	55

G

150	200
11	36

B

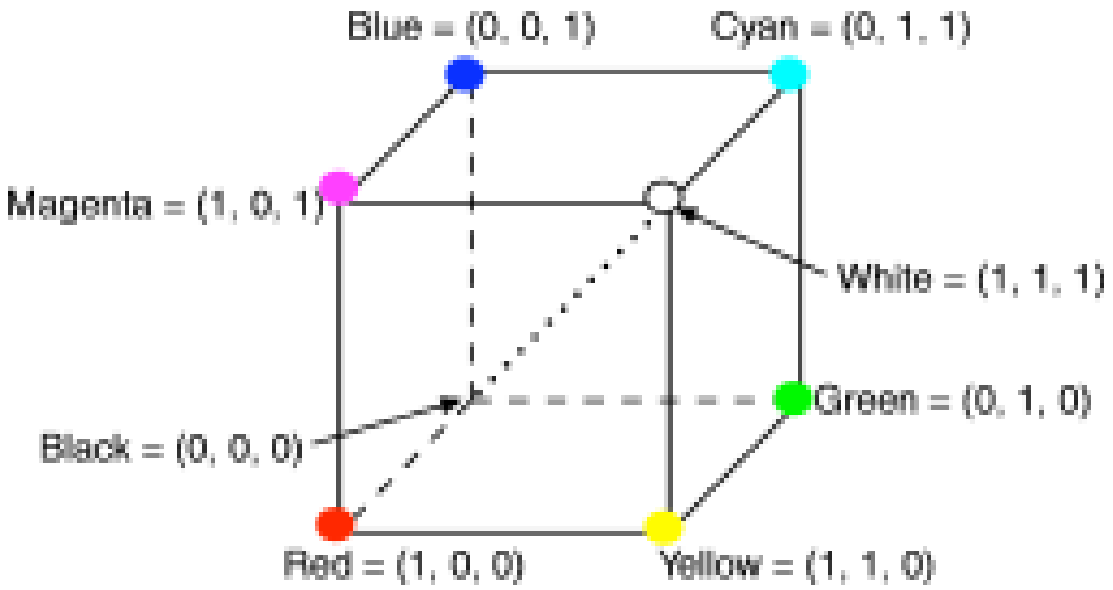
10	203
66	103

What is color space??

When colors need to be used in digital media like cameras and laptops, colors need to be presented in numbers. because digital media can only understand numbers. Therefore color space is a set of rules that allows describing colors with numbers.

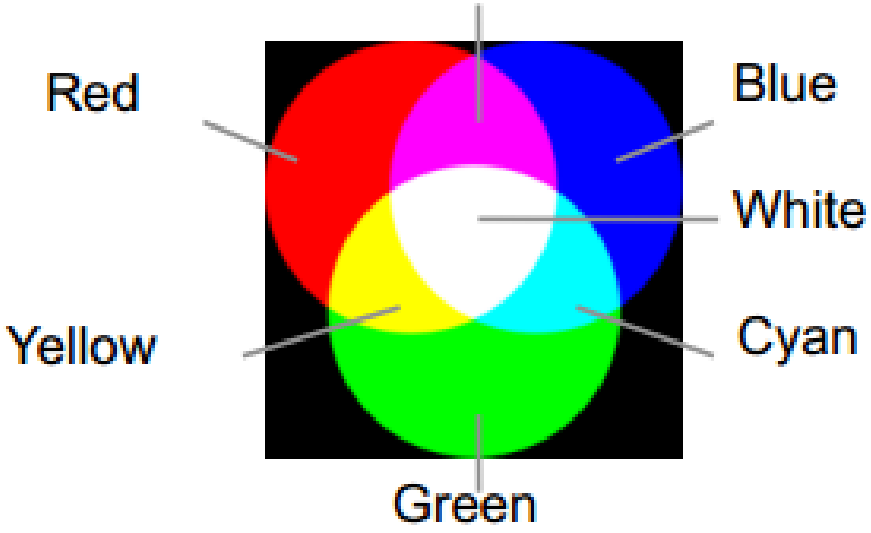
RGB color space:

- It is used with color CRT monitors.
- The RGB color model is an additive color model in which red, green and blue light are added together in various ways to reproduce a broad array of colors.
- The name of the model comes from the initials of the three additive primary colors, red, green, and blue.



Exercise:

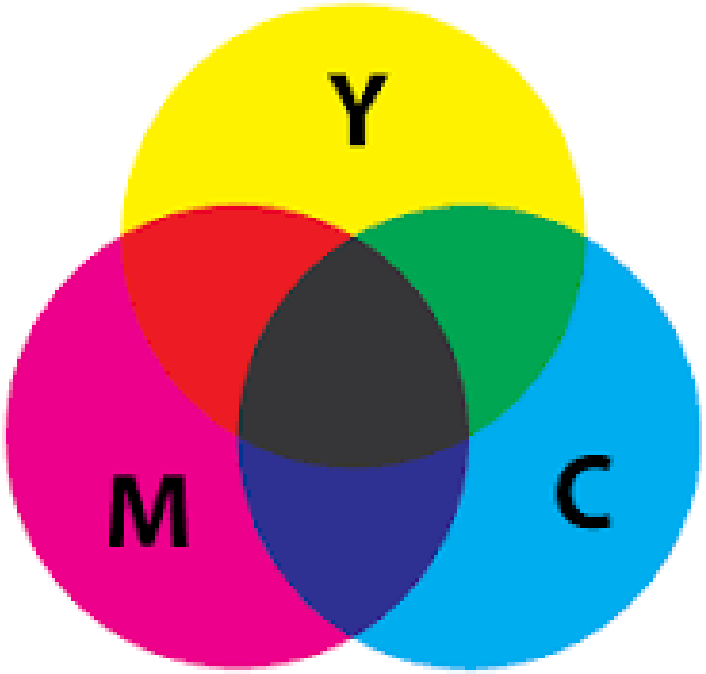
1. Read the image (‘peppers.png’) ?
2. Extract each component (Red) , (Green) and (Blue) ?
3. Show the three matrices on one figure?
4. Delete the green matrix then merge the photo again and display it?



CMY color space:

It is used in electrostatic/ink-jet plotters.

CMY Color Model. CRTs produce color by emission and uses the RGB model. Printers produce color by reflective light so it is a subtractive process and uses a model based on the colors: Cyan, Magenta, Yellow.



Converting from RGB to CMY:

Equations:

Cyan = Green + Blue.

Magenta = Red + Blue.

Yellow = Red + Green.

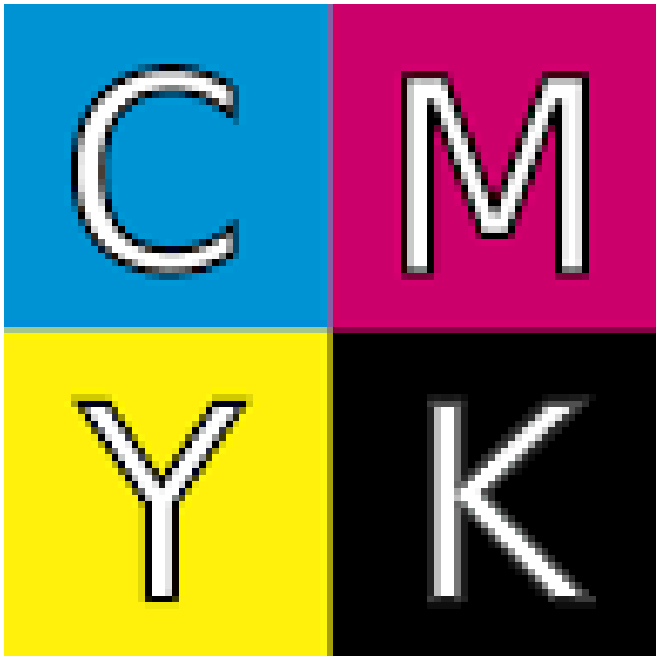
$$\begin{bmatrix} C \\ M \\ Y \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} - \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

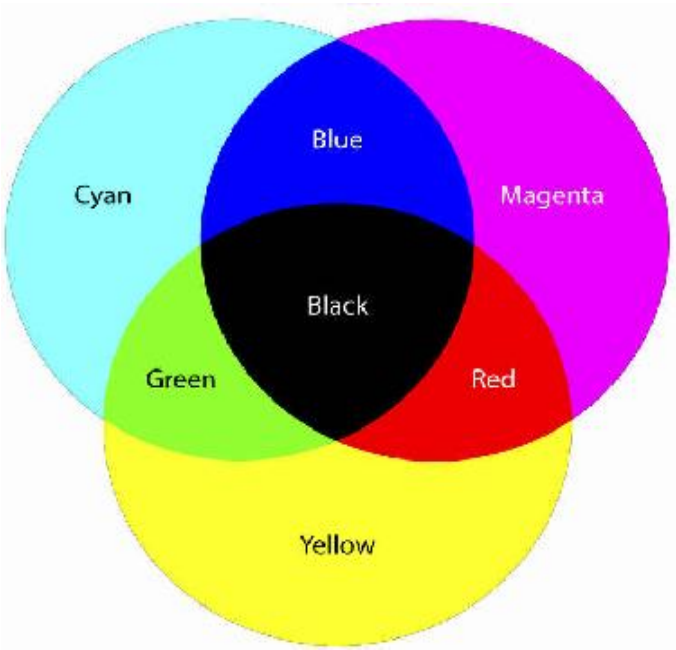
Exercise:

1. Read the image (‘peppers.png’) ?
2. Convert RGB color image into CMY color image?
3. Show each component (Cyan), (Magenta) and (Yellow) on a figure?
4. Show the converted image?

CMYK color space:

Color printing presses, some color printers use CMYK (K=black).





Converting CMY to CMYK:

Equations:

$K = \min(C, M, Y)$.

$C' = C - K$.

$M' = M - K$.

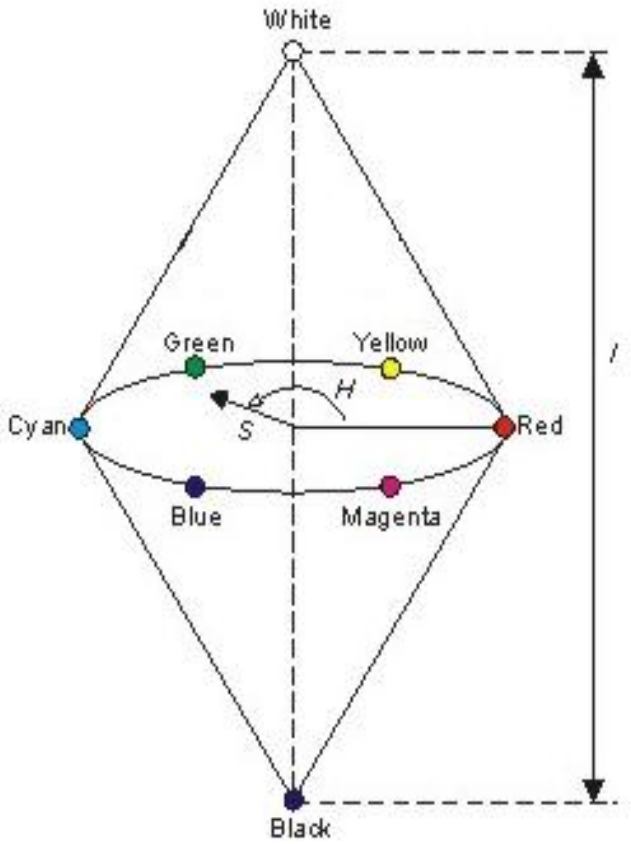
$Y' = Y - K$.

Exercise:

1. Read the image (‘peppers.png’) ?
2. Convert RGB color image into CMYK color image?
3. Show the converted image?

HSI color space:

- The HSI color space is very important and attractive color model for image processing applications because it represents colors similarly how the human eye senses colors.
- The HSI color model represents every color with three components: hue (H), saturation (S), intensity (I).
- The **Hue** component describes the color itself in the form of an angle between [0,360] degrees. 0 degree mean red, 120 means green 240 means blue. 60 degrees is yellow, 300 degrees is magenta.
- The **Saturation** component signals how much the color is polluted with white color. The range of the S component is [0,1].
- The **Intensity** range is between [0,1] and 0 means black, 1 means white.



Converting RGB to HSI:

Steps:

1. Read the **RGB** image.
2. Represent the image in domain [0,1].
3. Apply the following equations:

$$\theta = \cos^{-1}\left[\frac{\frac{1}{2}[(R-G)+(R-B)]}{[(R-G)^2+(R-B).(G-B)^{\frac{1}{2}}}\right]$$

$$H = \begin{cases} \theta; B <= G \\ 360-\theta; B > G \end{cases}$$

$$S = 1-(3/(R+G+B)).(\min(R,G,B)).$$

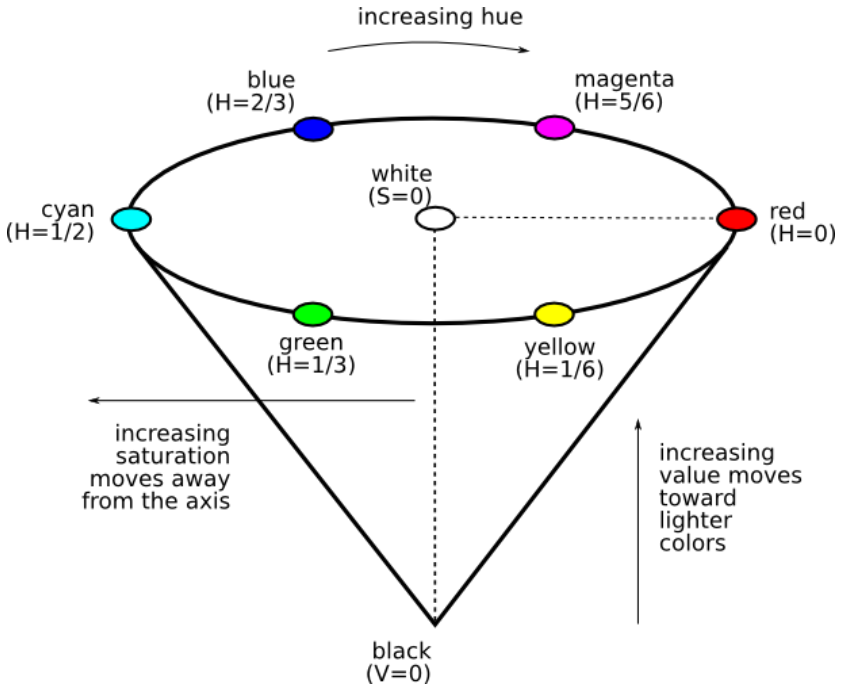
$$I = 1/3.(R+G+B).$$

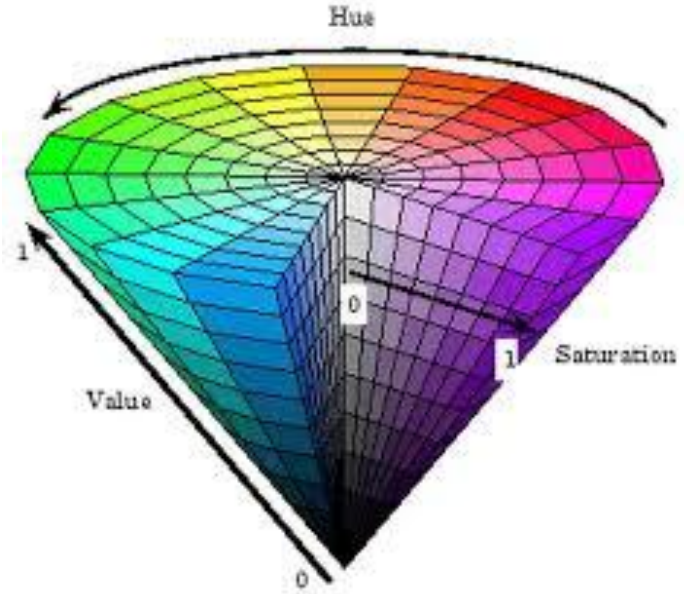
Exercise:

1. Read the image (‘peppers.png’) ?
2. Convert RGB color image into HSI color image?
3. Show the converted image?

HSV color space:

The Hue-Saturation-Value model is oriented towards the user/artist. Value is given by the height, saturation is coded in the distance from the axes and hue by the position on the boundary.





Converting RGB to HSV:

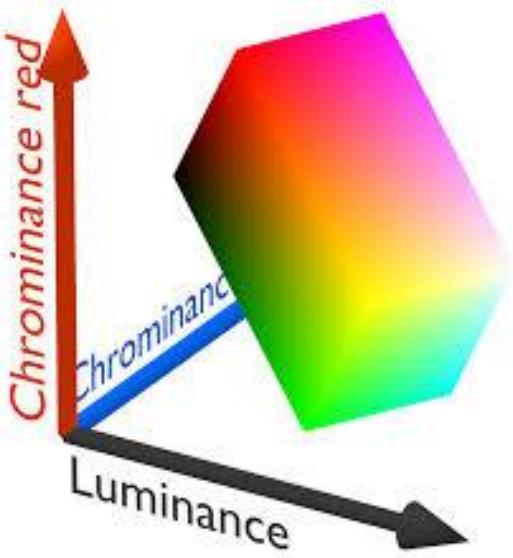
Steps:

1. Read the **RGB** image.
2. Use the function **rgb2hsv**.
3. Show the converted Image.

Exercise:

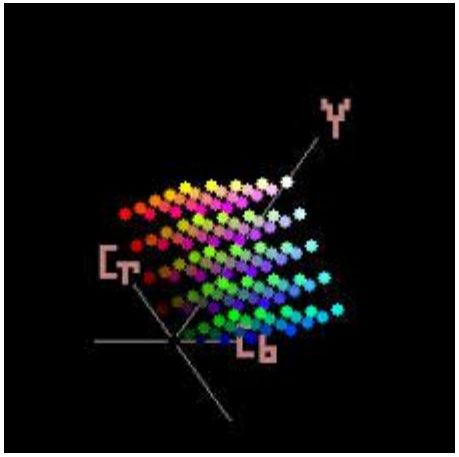
1. Read the image (‘peppers.png’) ?
2. Convert RGB color image into HSV color image?
3. Show the converted image?

YCbCr color space:



Y is the luma component of the color. Luma component is the brightness of the color. That means the light intensity of the color. The human eye is more sensitive to this component.

Cb and Cr is the blue component and red component related to the chroma component. That means “Cb is the blue component. Cr is the red component.”n These components are less sensitive to the human eyes.



Converting RGB to YCbCr:

Steps:

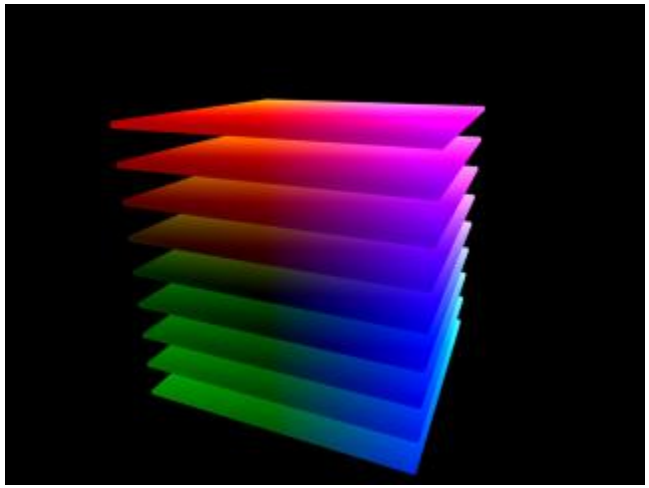
1. Read the **RGB** image.
2. Use the function **rgb2ycbcr**.
3. Show the converted Image.

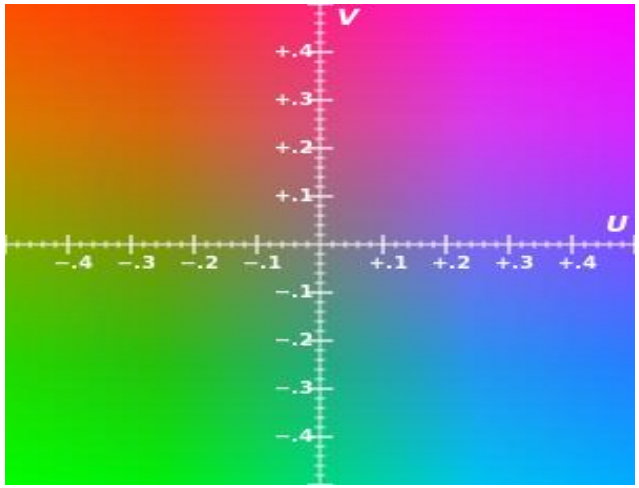
Exercise:

1. Read the image (‘peppers.png’) ?
2. Convert RGB image into YCbCr color image?
3. Show the converted image?

YUV color space:

YUV color space is a bit unusual. The Y component determines the brightness of the color (referred to as luminance or luma), while the U and V components determine the color itself (the chroma). Y ranges from 0 to 1 (or 0 to 255 in digital formats), while U and V range from -0.5 to 0.5 (or -128 to 127 in signed digital form, or 0 to 255 in unsigned form).





Converting from RGB to YUV:

Steps:

1. Read the **RGB** image.
2. Extract each component (Red), (Green) and (Blue).
3. Use these equations below:

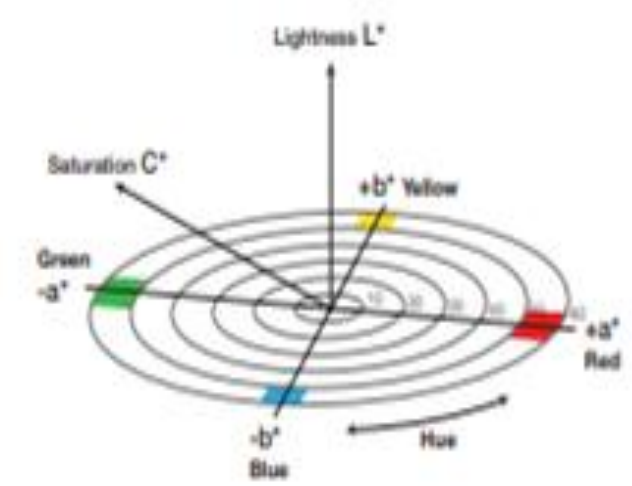
$$\begin{bmatrix} Y \\ U \\ V \end{bmatrix} = \begin{bmatrix} 0{,}299 & 0.587 & 0.114 \\ -0.14713 & -0.28886 & 0.436 \\ 0.615 & -0.51499 & -0.10001 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

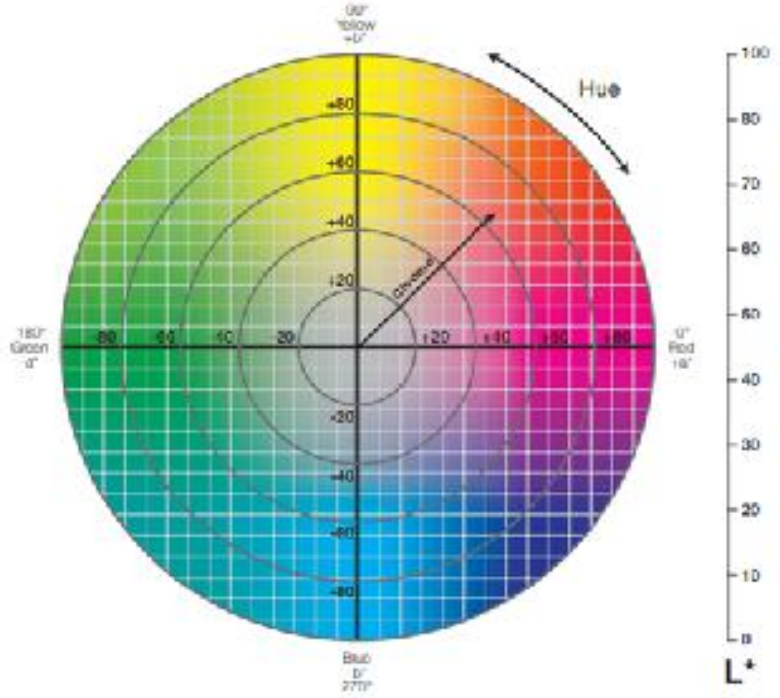
Exercise:

1. Read the image (‘peppers.png’) ?
2. Convert RGB image into YUV color image?
3. Show the converted image?

L*a*b color space:

L*, a*, and b*stand for:
L*: Lightness
a*: Red/Green Value
b*: Blue/Yellow Value





Converting from RGB to L*a*b:

Steps:

1. Read the **RGB** image.
2. Use **makecform** function like:

```
colorTransform = makecform('srgb2lab');
lab = applycform(rgbImage, colorTransform);
```

Exercise:

1. Read the image (‘peppers.png’) ?
2. Convert RGB image into L*a*b color image?
3. Show the converted image?