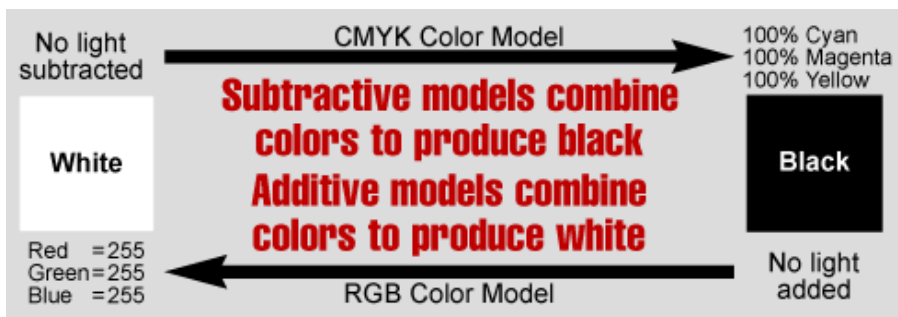# Additive Color Model

- ❖ For computer and TV displays
- ❖ Uses light to display color
- ❖ Colors result from transmitted light
- ❖ Red + Green + Blue = White
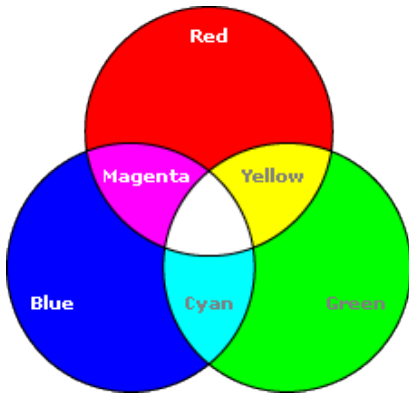- ❖ Known as the RGB color model

Subtractive Color Model

❖ For printers

❖ Uses ink to display color

❖ Colors result from reflected light

❖ Cyan + Magenta + Yellow = Black

❖ Known as the CMYK color model

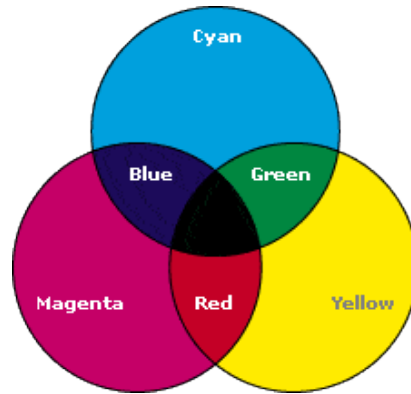# RGB vs. CMYK

No light subtracted	CMYK Color Model →	100% Cyan 100% Magenta 100% Yellow
White	**Subtractive models combine colors to produce black** **Additive models combine colors to produce white**	**Black**
Red = 255 Green = 255 Blue = 255	← RGB Color Model	No light added

Additive Model RGB

Subtractive Model CMYK

Color Formats

Popular color formats used for image and video processing

- ➢ RGB
- ➢ CMY(K)
- ➢ HSL
- ➢ YUV
- ➢ YCbCr
- ➢ YPbPr

Raster Graphics (Bitmap Images)

Image mapped out by a grid (raster) of pixels.

Raster Graphics
Image Scaling

Raster graphics are not scalable. Changing image size requires adding or removing pixels.

600 x 600
3 new pixels created for each original pixel

300 x 300
Original

100 x 100
8/9 of original pixels discarded

Raster Graphics
Bit Depth

Each pixel is represented by 1 to 64 bits, depending on color mode.

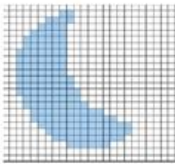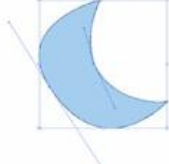| 1-Bit map	Grayscale	RGB	CMYK
1 bit	8 bits	24 bits	32 bits
2^1 = 2 values	2^8 = 256 values	2^{24} = 16,777,216	2^{32} = 4,294,967,296
0 = black	0 = Black	8 bits for each channel (R,G & B)	8 bits for each channel (C,M,Y & K)
1 = white	255= white	This is 255, 153, 0	This is 0,44,95,0
	This gray is 119		

Raster Graphics
Image Size

- Image size (bits) = pixel dimension X bit depth

- Divide by (8 X 2^{10}) to get Kilobytes

- Increasing the number of pixels increases the image size geometrically

- 500 x 500 pixels for 24 bit image ~ 732KB

- 1000 x 1000 pixels for 24 bit image ~ 2.9MB

- 2000 x 2000 pixels for 24 bit image ~ 11.4MB

Raster Graphics
File size

- File size does not usually equal image size.
- Many file formats, such as JPEG and GIF, employ compression that shrinks the file size below the image size.
- Example:
  - A 1024 X 768 red box is 2.25MB
  - Saved as medium quality JPEG the file shrinks to 4.8KB
  - Saved as GIF it needs only 1.5KB

Raster Graphics vs Vector Graphics

Raster	Vector
Made up of a *grid* of pixels	Geometric shapes and lines that are defined *mathematically*
Resolution dependent	Resolution *independent*
When scaled, visual quality and sharpness is degraded	When scaled, visual quality and sharpness is *unaffected*
File size is relatively *large*	File size is relatively *small*
File Formats: *GIF, TIF, BMP, PSD*	File Formats: *EPS, WMF, AI*
Pixel-oriented	*Object* -oriented

Raster Graphics Main Types

- ***Indexed color images:*** Use a *color lookup table* (***palette***) with a limited amount of colors
  - ➢ Each pixel uses an index to an RGB color in the palette

- ***True color images:*** Every pixel has *it's own (RGB) color-value* without using a color lookup table

Color Palettes (CLUTs)

- *Palettes* or *color lookup tables* (CLUT) are mathematical tables that define the color of a pixel displayed on the screen

- Paint programs provide palette tools for displaying available colors – not uniform across programs or platforms

- The most common palettes are 1, 4, 8, 16, and 24-bit deep

- Color graphics adaptors work with 256 shades of each color producing over 16 million colors (256 × 256 × 256)

Dithering

- Dithering is a process where the color value of each pixel is changed to the closest matching color value in the target palette, using a mathematical algorithm

- It "averages" the color over an area and is usually close to the original color

- Dithering software is usually built into image editing and multimedia programs

What is resolution?

- It depends on whether you are talking about:
  - an image's specification,
  - a printer's print quality,
  - a scanner's hardware,
  - a monitor's pixel dimension, or
  - a digital camera's image quality.

Device Resolution

- For printers, it specifies the number of ink spots that can be printed per unit area

- For scanners, it specifies the physical spacing of optical sensors

- For monitors, it specifies the total number of displayed pixels

- For digital cameras it specifies the total number of light-receptive cells in its sensor

Image Resolution

- Image size has no physical reality; it just specifies the total number of pixels which have no inherent size.

- When an image is displayed or printed, it takes on a physical size.

- Image resolution controls the conversion between the image size and the physical display size.

Resolution

- Resolution refers to the number of pixels in an image, and is a measurement of the output quality of an image.

- Usually measured in terms of samples, pixels, dots, or lines per inch.

- Images are displayed on your computer screen at display (or screen) resolution 72 or 96 pixels per inch (ppi).

- A printer needs much more image data than a monitor.

- In order to print a clean image, the typical desktop printer needs 150-300 dots per inch (dpi).

Display/Monitor Resolution

- The **dpi** resolution specified in image files has no impact when they are displayed on computer monitors or data projectors.

- Monitors can only display at their set resolution.

- Each pixel in the image file is mapped to a pixel on the monitor.