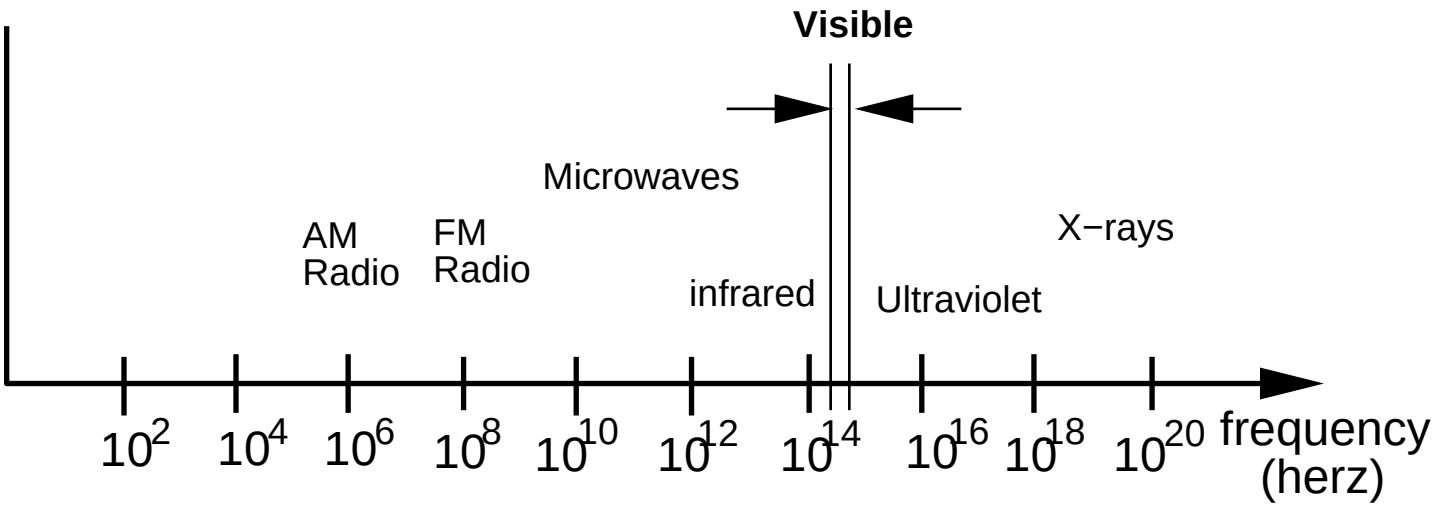
Light, Intensities and Color Models

1. Properties of light
2. Color models for raster graphics
3. Selecting Intensities
4. Display continuous tone and half−tone images

Properties of Light



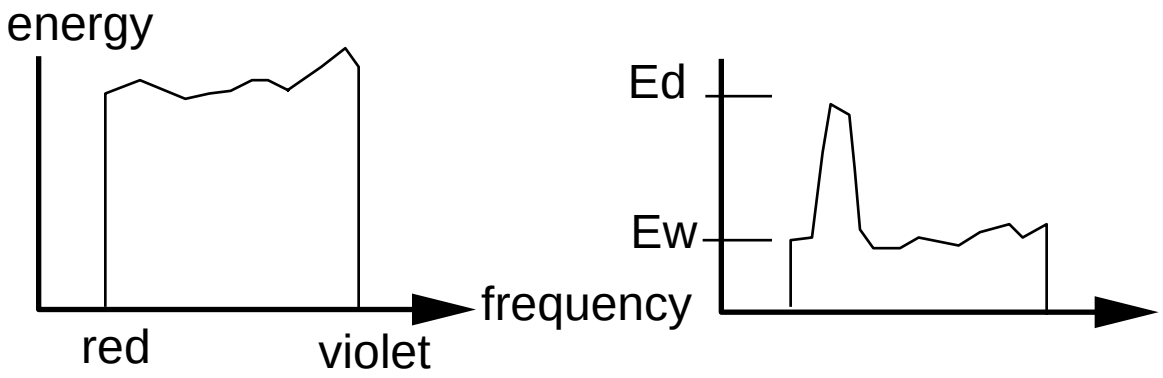
Electromagnetic Spectrum

- Each frequency value within the visible band corresponds to a distinct color
- $f = \frac{c}{\lambda}$
- Red (4.3×10^{14} herz or 700nm) −−Violet (7.5×10^{14} herz or 400nm)
- The combination of frequencies emitted by a light source determines the color
- Some frequencies get reflected and some get absorted!

Properties of Light (cont'd)

- 3 basic sensations

  Color/hue − dominant frequency
  Brightness − intensity of the light
  Saturation − purity of the color



Brightness = area under the curve

Purity = Ed − Ew

- Selected two or three colors (primary colors) can form a wide range of other colors (color gamut)

- If two color sources combine to produce white light they are referred to as complementary colors

Color Models

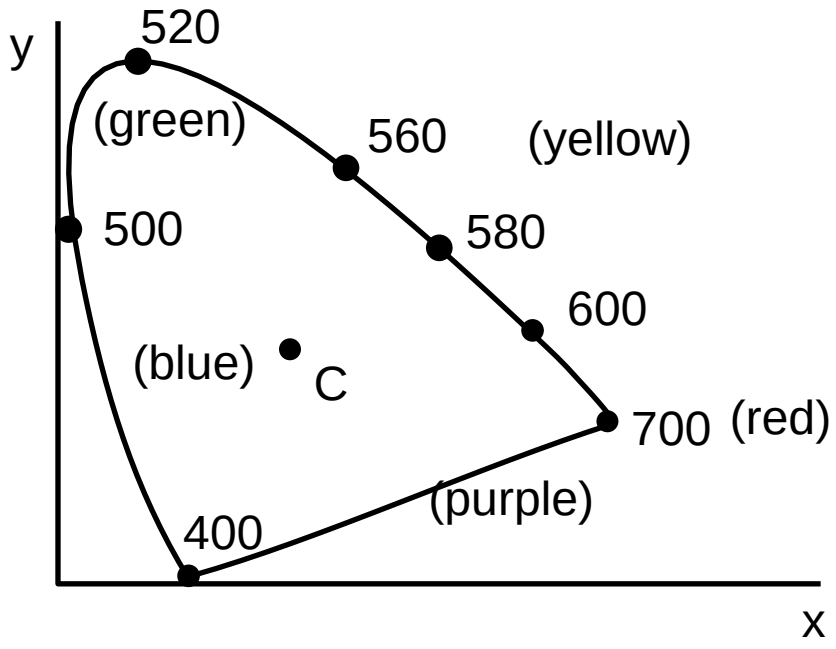
- A color model is a method for explaining the properties or behavior of color within some particular context
- three color theory

$$C = T_1X + T_2Y + T_3Z$$

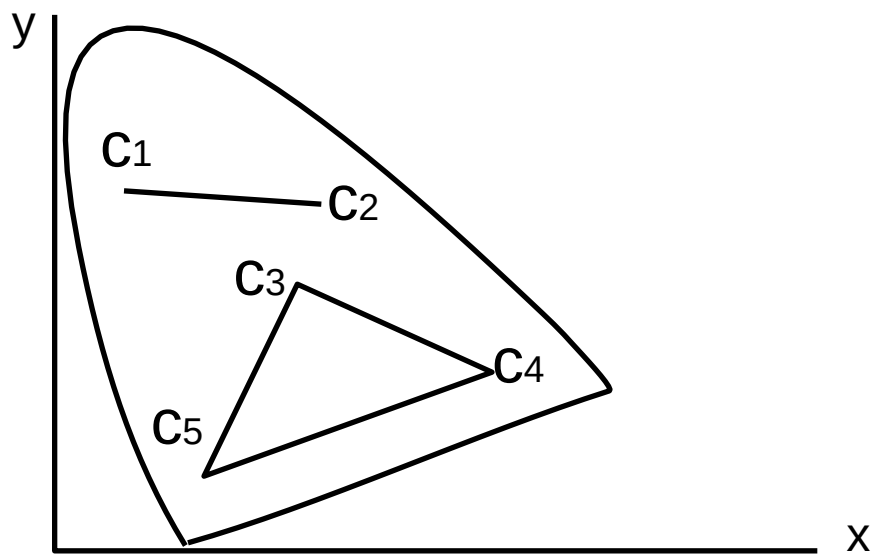
CIE (Commission Internationale de l'Éclairage)

- use three standard primaries defined to specify the amount of each primary needed to describe any spectral color

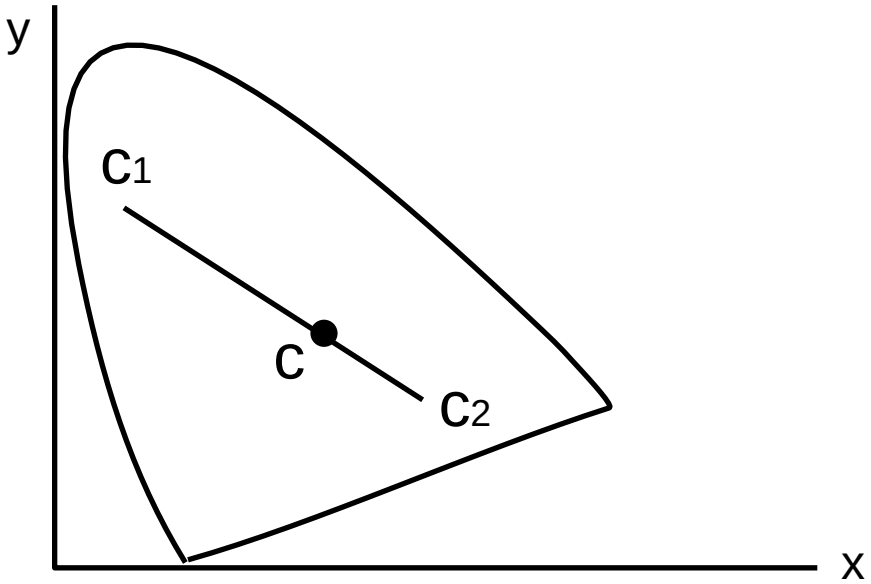
CIE Chromaticity diagram



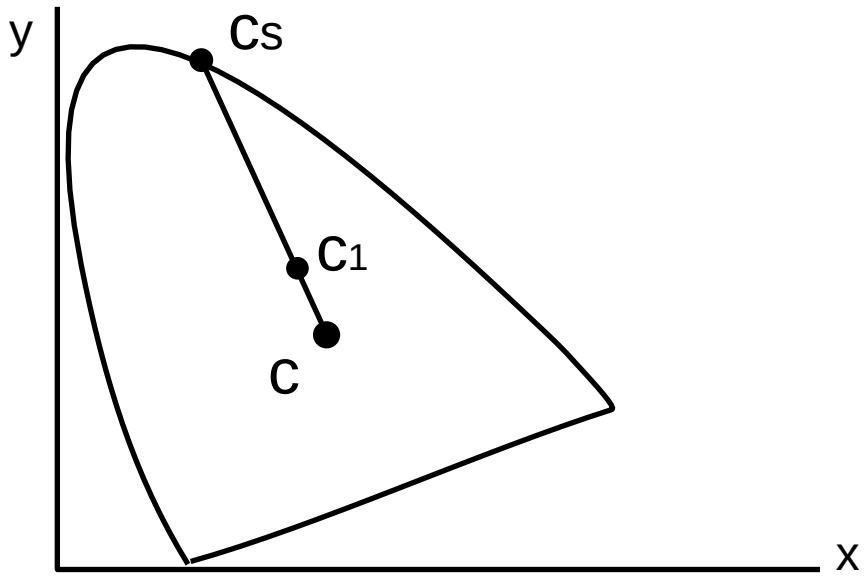
A two−color and three−color system



Representing complementary colors

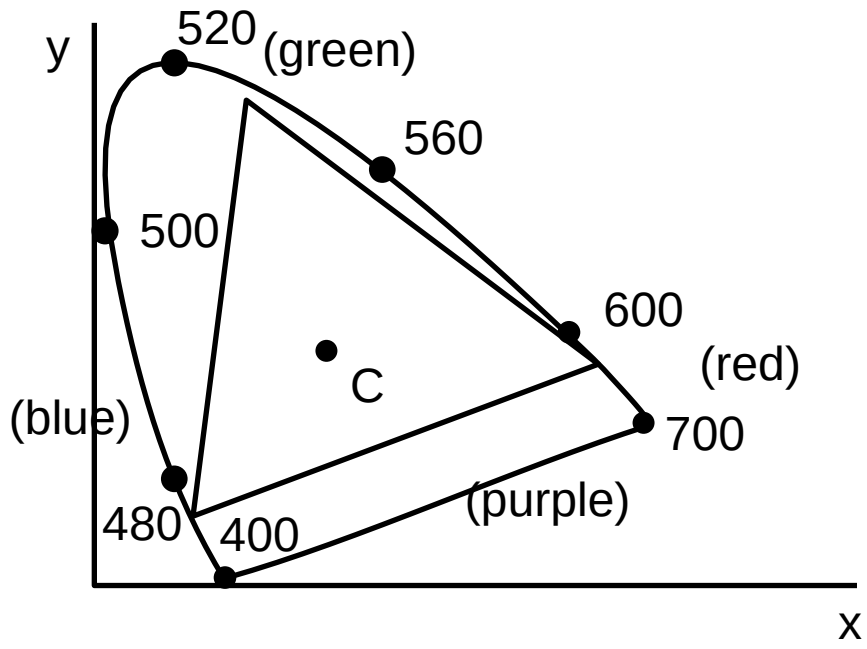


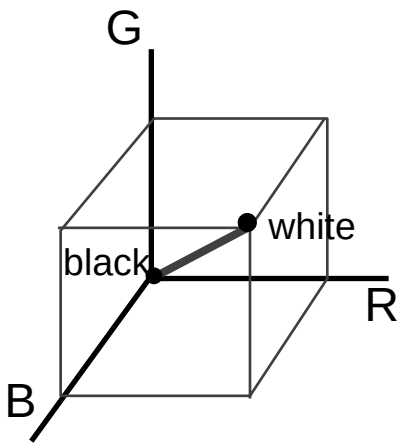
Computing purity



RGB Color Model

- based on theory of vision
- for video monitors



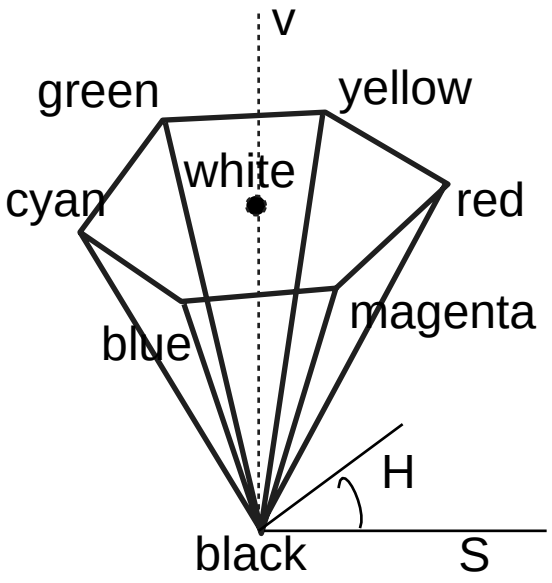


YIQ Color Model

- the NTSC color model for forming the composite video signal
- Y (brightness), I (orange−cyan hue), Q (green−magneta hue)

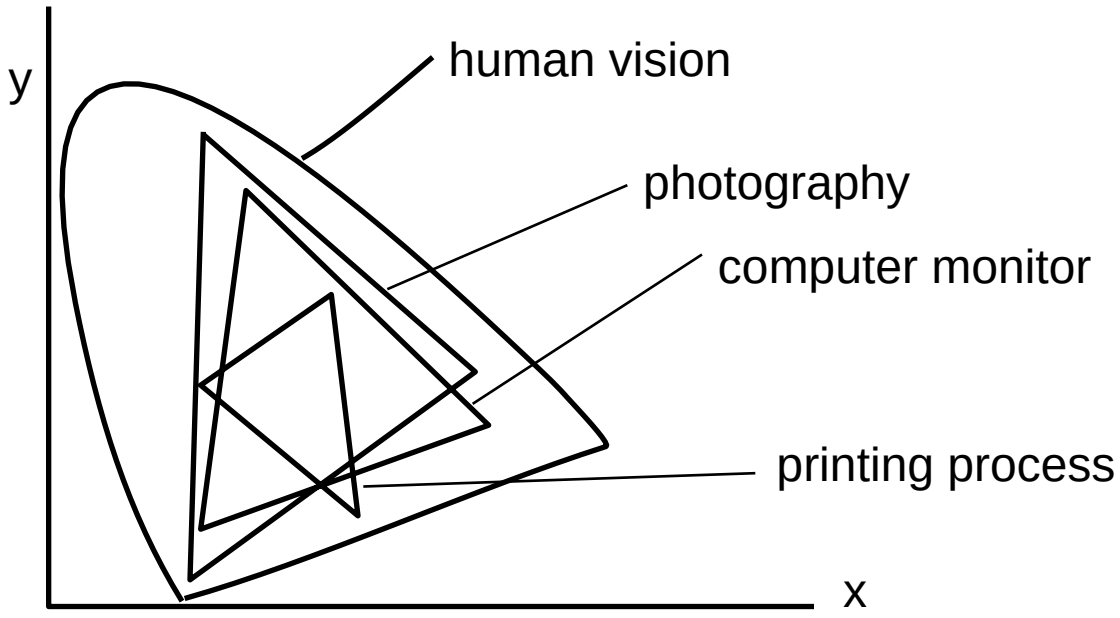
HSV Color Model

- Hue, Saturation and Value
- most intuitive



CMY Color Model

- Cyan, Magenta, Yellow, Black
- for printing



Color selection:

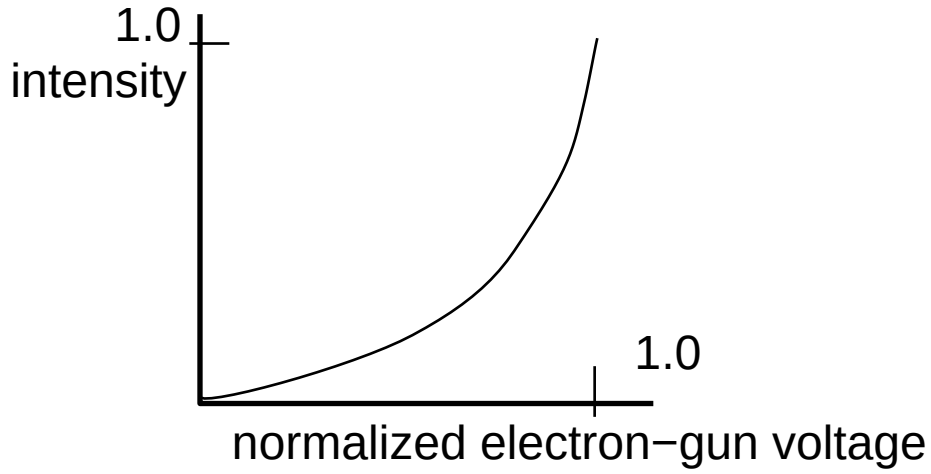
- use a smaller number of colors
- avoid displaying adjacent colors that differ widely in dominant frequency
- tints and shades blend better than pure hues
- for background, gray or the complement of one of the foreground colors is usually best

Selecting Intensities

- eye is sensitive to ratios of intensity rather than to absolute values of intensity
- the intensity levels on the monitor should be spaced so that the ratio of successive intensity is constant

Gamma Correction

- cope with the non−linearity of display devices



Monitor response curve

$I = a V^{\gamma}$ where I is the display intensity;
V input voltage;
a and γ depend on the characteristics of the monitor

the voltage vaue $V = \left(\frac{I}{a} \right)^{1/\gamma}$

Locate the nearest intensity I_k from the table and compute V as $\left(\frac{I_k}{a} \right)^{1/\gamma}$

Display Continuous−tone Images

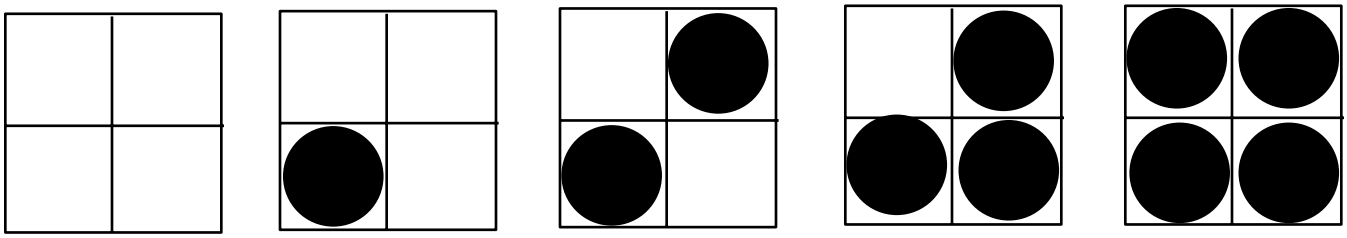
- acceptable displays can be obtained for many applications with fewer intensity levels
- reproductions of continuous−tone images using 32 intensity levels show only very subtle differences from the original

Halftone Approximations

- expand the range of available intensities using the spatial integration ability of our eyes for bilevel displays

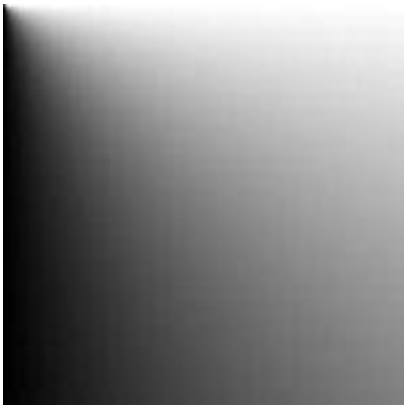
- trade spatial resolution in exchange for more gray levels

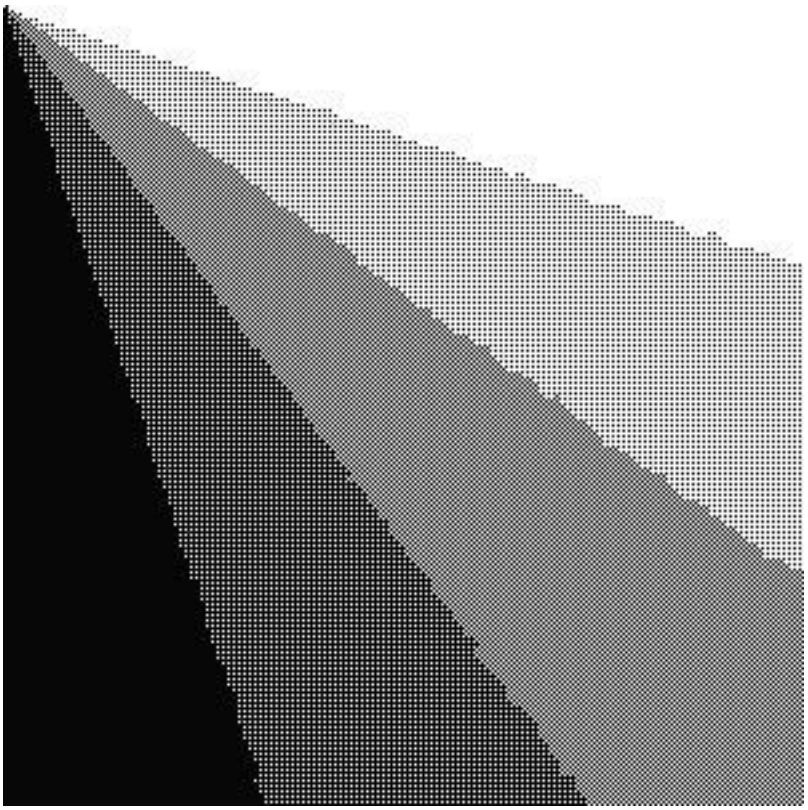
2x2 grid to display 5 intensity levels:



- for nxn grid, $n^2 + 1$ levels can be represented

- As increasing n, intensity levels increase but resolution of the image decreases!





Dithering Techniques

- approximate halftones without reducing resolution
- add random noise over an entire picture which tends to soften intensity boundaries
- halftoning = ordered or clustered dot dithering