Color

Today: Color Theory (a little bit~)

Electromagnetic Spectrum
Electromagnetic Spectrum

Typical Reflectance Signatures

http://www.geog.ucsb.edu
Basics on Color Theory:

• Three basic properties of Color
  – **Hue** (the color)
  – **Saturation** (the intensity of the color)
  – **Brightness** (the Value of the color)

• This scale is referred to as the HSV color space

• Most color tool windows use:
  – The X axis to represent Hue
  – The Y axis to represent Saturation, and
  – The Z axis to represent brightness value

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HSV and Hue

• Hue is a main property of color

• **Red**, **Yellow**, and **Blue** are the primary hues

• When the primary hues are combined in equal amounts, they create secondary hues (**Orange**, **green**, and **violet**)

• Combine primaries and secondaries and you get tertiary
HSV and Saturation

- Saturation is often referred to as ‘intensity’ of a color.
- When you mix colors (or add black to a color), saturation/intensity decreases.
- When you ‘add white’ to a color, the color becomes lighter, but not necessarily more intense.

HSV and Value (Brightness)

- ‘Lightness’ and ‘darkness’ of a color is represented by ‘value’.
- Adding black or white to a color affects value.
- **Tints** of colors are made by adding white.
- **Shades** of colors are made by adding black.
Colors and Computers:

- Most computer hardware displays colors using the RGB color model *(Red, Green, Blue)*
  - RGB is a device dependent color space, meaning representation can be different depending on type of device, or even variation of manufacturer of similar devices
  - Therefore, an RGB value does not define the same color across devices without some kind of *color management*

- Most color management tools in Windows uses:
  - The X axis to represent Hue
  - The Y axis to represent Saturation, and
  - The Z axis to represent brightness value

Contrast Ratio

- Contrast ratio measures the ratio of luminance of the brightest color to that of the darkest color in any given display device
  - For example, contrast ratios for the following:
    - CRT computer monitor: \(450:1\)
    - Dell flat panel computer monitor: \(3,000:1\)
    - Samsung LCD HDTV display: \(150,000:1\)
    - Samsung LED HDTV display \(7,000,000:1\)

- In cartography, contrast leads to perceptual differentiation
  - the ability of the eye to discern differences

- Fundamental in developing figure/ground relationships and a visual hierarchy
Basic example of contrast ratio and establishment of visual hierarchy

Color Abstractions

Additive Primaries
Red, Green, Blue (RGB)
[i.e., absorption of light by the eye]

Subtractive Primaries
Cyan, Magenta, Yellow, Black (CMYK)
[i.e., absorption of light by materials]

Additive primaries and color mixing:
- Red = Green = Yellow
- Red + Blue = Magenta
- Green + Blue = Cyan
- Red + Blue + Green = White
- None = Black

Subtractive primaries and color mixing:
- Magenta + Yellow = Red
- Magenta + Cyan = Blue
- Cyan + Yellow = Green
- Magenta + Yellow + Cyan = Black
- None = White

http://mapmaker.rutgers.edu
Numeric Representations of RGB Color

• A color in the RGB color model/color space is represented by how much of each hue is included

• The numbers of color representations possible is also device dependent

• The color is represented by an RGB color triplet \((r,g,b)\)
  – Each component of the triplet can range form zero to a defined maximum value – in most computers the range is 0 – 255

• The 24-bit RGB computer representation is specified using three 8-bit integers (0-255) representing the intensities of Red, Green, and Blue
  – This is what is called Truecolor
  – Commonly used for image file formats like JPEG and TIFF

Common RGB color triplets

• Black 0,0,0
• White 255,255,255
• Red 255,0,0
• Green 0,255,0
• Blue 0,0,255
• Yellow 255,255,0
• Cyan 0,255,255
• Magenta 255,0,255
RGB Color Chart

Hexadecimal Color Code Chart

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CMYK Color Code Chart

Colorbrewer 2.0

• http://colorbrewer2.org/