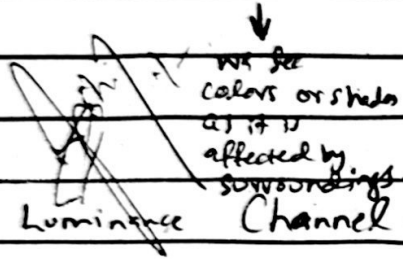


low light. \leftarrow Rods: - 120 million
Cones: - 5-6 million
 \nwarrow
bright light

③ Colors:

- - Luminance \rightarrow refers to amount of light that comes to eye.
- - Lightness Constancy \rightarrow Ability of visual system to perceive the true reflect of an object, regardless of changes in light.

- - Simultaneous Contrast \rightarrow Phenomena which says



perception of color and shade is not absolute but relative to surrounding context.

- - Luminance Channel \rightarrow Controlling luminance is primary rule of design

- No edges without lightness difference
- No shading without lightness variation
- Has higher spatial sensitivity (eye notices brightness change earlier than change in color)

- - Purpose of color \rightarrow To (label, measure, decorate, represent)

- - Function of color \rightarrow identify, group, layer, highlight.

- - trichromacy \rightarrow possessing three independent channels for color information

- - Opponent-Process Model \rightarrow our perception of color is controlled by activity of two types of opponent systems.

opposite colors are not perceived together.

achromatic / chromatic

\downarrow
no hue
(black, white, gray)

\downarrow
have hue

① How human perceive colors.

② How we see colors using opposite pairs.

• Color deficiencies (color Blindness)

• Protanope = faulty red cones

• Deuteranope = faulty green cones

• Tritanope = faulty blue cones

• What can be produced on monitor / printer
(RGB) (CMYK)

→ Gamut of my monitor != gamut of someone else != gamut of printer.
Specific range or subset of colors that particular device can display.

(5) Color Gamut & Models → Color model is a way to represent & define colors within that space.

• Primary Colors (Red, Blue, Yellow) can be mixed to create all other colors.

• Secondary Colors (Purple, Green, Orange) created by primaries.
 $R+B$ $B+Y$ $Y+R$

• Color Space → Range of colors that can be represented in a specific system (e.g. CIE LAB) (entire range of colors humans can see) like RGB.

• Color Cube → Color cube is a 3-dimensional representation of a color model.

• Relation of color cube and space → Color cube is visual representation within specific color space like RGB.
not all color spaces are cubes.

Computer Programs we see a color wheel (not a cube)

• Redefining Colors Spaces (w.r.t human eye)

• Represent all spectral colors perceivable by human eye / Seen by human eye.

• Strange Shape to represent all colors that human eye can see is because it corresponds to CIE Chromaticity Diagram / Perceptual uniformity.

• Color Model (representation of color using some basis)

• HSB (Hue-Saturation-Brightness) → Captures pure color.

(color pickers are often circular)

• Saturation captures amount of white mixed with the color

• Brightness captures amount of black mixed with a color.

• HSV (Hue-Saturation-Value) →

Same but focus on

brightness instead of lightness.

• Similar to HSB but replaces lightness with value (brightness)

• Rainbow Color Map

- Color Map is poor choice →
- No perceptual ordering (don't follow order) (Confusion)
- No Luminance Variation (Brightness of color doesn't change evenly)
- Misleading Perception of transitions (Sudden change in color might make people think there's sudden change in data, even when data is smooth).

• Color map → Specifies mapping between colors & data values

↓
Follow expressiveness principle.

Types:-

- Binary (Y/N)
- Categorical
- Diverging (Highlights variations)
- Sequential

• Categorical vs Ordered

↓
Hue is used as it has no natural order

↓
Saturation & luminance are better for ordered / continuous data.
(e.g. Varkitay)

Categorical	Sequential	Diverging
• For categorical or nominal data	Best for ordered data. (from low to high)	Best for meaningful midpoint or diverging point.

• Bivariate → displays 2 variables combination of two sequential color schemes.

→ combines 2 sequential color maps.

VAN DYKE

Weber's Law:
difference \propto background intensity

$$\frac{\Delta I}{I} = \text{constant} \approx 1$$

ΔI → background intensity

- Categorical Colormap guidelines

- Don't use too many colors
- Background has a color too
- Be aware of luminance
- Nameable colors help

- Ordered Colormaps (used for ordinal or quantitative attributes)

(Till slide 43)

- Color design Rules:

- ① R₁ → Vivid (bright & saturated) colors + attention
- ② R₂ → Too many vivid colors are not good, use less.
- ③ R₃ → Make foreground vivid and background dull for good contrast
- ④ R₄ → To make colors easier to tell, which is spiky, use different HSL
- ⑤ R₅ → • Small lightness differences are easier to notice at dark end.
• Larger differences are needed at bright end (Weber's Law)
- ⑥ R₆ → Small objects are harder to distinguish by color
- ⑦ R₇ → Complementary colors (blue & orange) contrast the most but mix into neutral grey
- ⑧ R₈ → Some colors (yellow) look more saturated naturally
- ⑨ R₉ → • brighter lights are in yellow range
• blue & red appear dimmer
- ⑩ R₁₀ → For labeling, stick to 6-7 simple, recognizable colors.
- ⑪ R₁₁ → • Warm colors (red, yellow) create excitement
• Cool colors (blue, green) create calm.
- ⑫ R₁₂ → • Changing lightness or saturation does not affect perceived hue.
- ⑬ R₁₃ → objects of similar hue are seen as part of same group.