Lecture 5: Visual Encoding Principles

Information Visualization

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Required Readings

Chapter 3: Visual Encoding Principles
(two times: first 25 pages, Sec 3.1-3.4)
(next time: last 11 pages, Sec 3.5)


Further Reading


Relative vs Absolute Perception: Length

Weber's Law: relative judgements

\[
\frac{\Delta I}{I} = K
\]

filled rectangles vs white rectangles

Relative vs Absolute Perception: Lightness


Relative vs Absolute Perception: Color

[Purves. http://www.purveslab.net/seeforyourself/]

Image Theory

Visual Encoding

Visual Channel Types and Rankings

Further Reading

Stone. Color In Information Display. IEEE Visualization 2006

Course Notes. http://www.stonesc.com/Vis06


Tufte, Envisioning Information. Chapter 5: Color and Information

Ware, Information Visualization: Perception for Design

Ch 3: Lightness, Brightness, Contrast, and Constancy

Ch 4: Color

Ch 5: Visual Attention and Information That Pops Out

Ch 6: Static and Moving Patterns

Ch 8: Space Perception and the Display of Data in Space
Visual Channel Types and Rankings

Only Planar Position Works For All!

Ranking Differs For All Other Channels

Grouping Channels

Expressiveness and Effectiveness
- Expressiveness principle
  - pick visual channel to express all of and only information in dataset
- Effectiveness principle
  - ranking of channel should match importance of attribute
- What criteria determine channel ranks?
  - Accuracy, discriminability, separability, popout
  - Grouping precedence

Accuracy

Discriminability
- Limits on available dynamic range

Separability vs. Integrality

Separability vs. Integrality
- 2 groups each
  - 2 groups each

Visual Popout
Popout: Most channels
- parallel processing on most channels
  - sufficiently different item noticed immediately, popout: serial search required

Healey. Perception in Visualization
http://www.csc.ncsu.edu/faculty/healey/PP/

Discriminability: Categorical Color
- noncontiguous small regions: 6-12 bins


Popout Limits
- combination searches are serial
  - exception: a few pairs

Visual Channel Types and Rankings
- ordered: ordinal/quantitative
  - how much

Grouping: Precedence Not Effectiveness
- all channels effective; rank is order of precedence

Power of Planar Position
- speed depends on: which channel, difference from surroundings
  - 'sufficiently different' is context dependent

Color Vision Process
- rods
  - B/W info in low-light conditions
  - not discussed further
- 3 cone types
- sensors: RGB
- 3 opponent color channels
  - one luminance: black/white
  - two "color": red/green, blue/yellow
  - color deficiency
    - one hue channel collapsed
    - sex-linked mutation: 8% of men, .5% of women

Luminance, Saturation, Hue
- luminance: how much
- saturation: how much
- hue: what

Color As Three Numbers
- Stone Representing Color As Three Numbers, CG&A 25(4):78-85

Trichromacy
- different cone responses area function of wavelength
- for a given spectrum
  - multiply by response curve
  - integrate to get response

Stone, Representing Color As Three Numbers, CG&A 25(4):78-85
**Color Spaces**

- **RGB**: convenient for machines
  - these three channels are separable
  - perceptually based
- **CIE XYZ**: from color matching functions
- **L*a*b***: from XYZ + reference whitepoint
- **perceptually linear, safe to interpolate**
- **HLS**: simple transformation of RGB
  - good: separates out lightness, hue, saturation channels
  - bad: lightness not true luminance
  - careful: only pseudo-perceptual!

**Lightness vs Luminance**

- **L* values**
- **L from HLS All the same**

**Spectral Sensitivity**

- **Corners of the RGB color cube**
- **Luminance values**

**Metamerism**

- brain sees only cone response
- different spectra appear the same

**Metamerism Demo**


**Color Matching Experiments**


**Color Matching Functions**