

Lecture 6: Color Information Visualization

CPS3: 533C, Fall 2007

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26 September 2007

News

- email has been going out with lect 2-5 quest grades
- is everybody receiving it?

Papers Covered

Representing Colors as Three Numbers, Maureen Stone, IEEE CG&A 25(4):78-85, Jul 2005.
<http://www.stonesc.com/pubs/Stone%20CGA%2007-2005.pdf>

Ware, Chapter 3: Lightness, Brightness, Contrast, and Constancy

Ware, Chapter 4: Color

Tufte, Chapter 5: Color and Information

How Not to Lie with Visualization, Bernice E. Rogowitz and Lloyd A. Treisman, Computers in Physics 10(3) May/June 1996, pp. 268-273.
<http://www.research.ibm.com/tx/proceedings/pravda/truvis.htm>

Further Reading

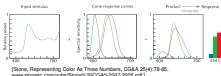
A Field Guide To Digital Color, Maureen Stone, AK Peters 2003.

Face-based Luminance Matching for Perceptual Colormap Generation, Gordon Kindmann, Erik Reinhard, Sarah Creem, IEEE Visualization 2002.
<http://www.cs.utah.edu/~gk/papers/vs02>

Color use guidelines for data representation, C. Brewer, 1999.
<http://www.personal.psu.edu/faculty/c/a/ca38/ColorSch/ASApaper.html>

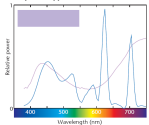
Trichromacy

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

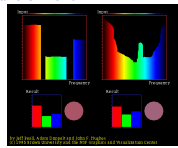


Metamerism

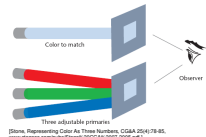
- brain sees only cone response
- different spectra appear the same



Metamerism Demo

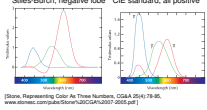


Color Matching Experiments

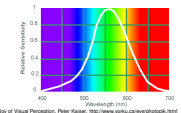


Color Matching Functions

- Stiles-Burch, negative lobe
- CIE standard, all positive



Spectral Sensitivity



Color Constancy

- relative judgements



Color Constancy

- relative judgements



Color Constancy

- relative judgements



Color Constancy

- relative judgements



Color Constancy

- relative judgements



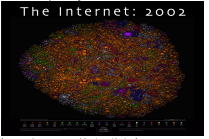
Color Constancy

- relative judgements



Coloring Categorical Data

22 colors, but only 8 distinguishable



Coloring Categorical Data

- discrete small patches separated in space
- limited distinguishability: around 8-14
 - channel dynamic range: low
 - choose bins explicitly for maximum mileage
- maximally discriminable colors from Ware
 - maximal saturation for small areas



[Calle Ware, Information Visualization: Perception for Design, Morgan Kaufmann 1999, Figure 4.21]

Minimal Saturation For Large Areas

- avoid saturated color in large areas "excessively exuberant"



[Edward Tufte, Envisioning Information, p.82][Calle Ware, Information Visualization: Perception for Design, Morgan Kaufmann 1999, Figure 4.21]

Minimal Saturation For Large Areas

- large continuous areas in pastel
 - diverging colormap (bathymetric/hypsometric)

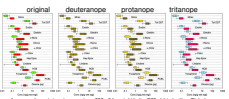


[Tufte, Envisioning Information, p. 91]

Color Deficiency

- deutanope
 - has red/green deficit
 - 10% of males!
- protanope
 - has yellow/blue deficit
- tritanope
 - has yellow/blue deficit
- http://www.vischeck.com/vischeck
 - test your images
 - use this with your final projects!

Color Deficiency Examples: vischeck



[www.scribd.com/document/28232014/egm-01img/03241.html, citing Global Assessment of Organic Contaminants in Farmed Salmon, Hase et al., Science 2004 303:226-229.]

Designing Around Deficiencies

- red/green could have domain meaning
 - then distinguish by more than hue alone
 - redundantly encode with saturation, brightness

	original	deutanope	protanope	tritanope
1	100	100	100	100
2	100	100	100	100
3	100	100	100	100
4	100	100	100	100
5	100	100	100	100
6	100	100	100	100
7	100	100	100	100
8	100	100	100	100
9	100	100	100	100
10	100	100	100	100
11	100	100	100	100
12	100	100	100	100
13	100	100	100	100
14	100	100	100	100
15	100	100	100	100
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99	100	100	100	100
100	100	100	100	100

[Courtesy of Brad Poley]

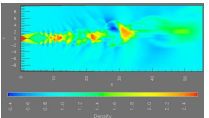
Coloring Ordered Data

- innate visual order
 - greyscale/luminance
 - saturation
 - brightness
- unclear visual order
 - hue



Rainbow Colormap Advantages

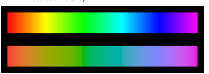
- low-frequency segmentation
 - the red part, the orange part, the green part, ...



[Rogowitz and Treish, Why Should Engineers and Scientists Be Worried About Color? http://www.research.ibm.com/people/rtreish/colorcolormap.htm]

Rainbow Colormap Disadvantages

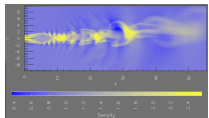
- segmentation artifacts
 - popular interpolation perceptually nonlinear!
- one solution: create perceptually linear colormap
 - but lose vibrancy



[Kindermann, Reinhard, and Coen, Face based Luminance Matching for Perceptual Colormap Generation, Proc. Vis 02 www.csb.utd.edu/glu/Face]

Non-Rainbow Colormap Advantages

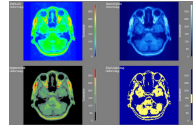
- high-frequency continuity
 - interpolating between just two hues



[Rogowitz and Treish, How NOT to Lie with Visualization, www.research.ibm.com/doc/proceedings/pravda/treish.htm]

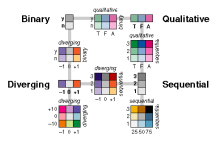
Segmenting Colormaps

- explicit rather than implicit segmentation



[Rogowitz and Treish, How NOT to Lie with Visualization, www.research.ibm.com/doc/proceedings/pravda/treish.htm]

Cartographic Color Advice, Brewer



[Brewer, www.personal.psu.edu/faculty/c1a/cab00/ColorSch/CSchEng.htm]