UNDERSTANDING COLOUR IN DATA VISUALIZATION

SC PARKS WILDER.

IAA 2021

November 2021

Christopher G. Healey

Department of Computer Science
North Carolina State University

healey@ncsu.edu

http://www.csc.ncsu.edu/faculty/healey

NC STATE UNIVERSITY

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Spot Photometer

http://www.sequipment.net/Cooke/CalSpot401.html

Newton Colour Wheel

http://mistcraftman.com/artistry/design-basics/design-basics-color.html

Thomas Young Wave Theory

1773-1829

Maxwell Colour Photograph

1831-1879

COLOUR HISTORY

- Sir Issac Newton, 1666
  - Newton colour circle, complementary and additive colours
- Thomas Young, 1801
  - wave theory, different types of colour receptors
- James Clerk Maxwel, 1860
  - three additive primaries idea of hue, saturation, and brightness
- Commission International de l'Éclairage, 1931
  - standardized colour sysem

CIE 1Z 1976

http://commons.wikimedia.org/wiki/

CIE L*a*b* sRGB Gamut

http://www.pelm/k31.com/

CIE 1960 Black Body Path

http://en.wikipedia.org/wiki/CIE_1960_color_space

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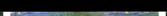
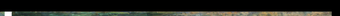
Pantel-Lite Scale

http://en.wikipedia.org/wiki/Pantone_scale

The Japanese Footbridge and the Water Lily Pool, Giverny (1899)
http://commons.wikimedia.org/



Water Lilies (1905)
http://nuyest.com/2012/10/10/about-art-monets-water-lilies-a-lie-accentuated-cause-tech-bites/



Reflections of Clouds on the Water-Lily Pond (1920)
http://commons.wikimedia.org/

COLOUR INTRODUCTION

- Ubiquitous
  - everyone "understands" some aspect of colour
- Aesthetic
  - colour studied as an artistic medium
- Perceptual
  - human ability to "interpret" colour
- Informational
  - popular feature for visualy encoding information

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http://www.amazon.com/Pantone-GG4000-Cliffs-Bridge-Supplement-Uncoated/dp/B00BCW2SU

http://20.bradu.br/Bucke.org/Bucke/beginning-psychology/ch08-01-seeing.html

http://en.wikipedia.org/wiki/Light

COLOUR REPRESENTATIONS

- Colour is a complex phenomena
- Human eye
  - 120 million rods in periphery of retina
  - 6 million cones in fovea
- Physical
  - wavelength, excitation prity, luminance
- Perceptual
  - hue, saturation, brightness

http://en.wikipedia.org/wiki/Color_temperature

http://digitalcontent.com/blog/color-saturation/

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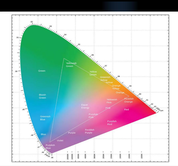
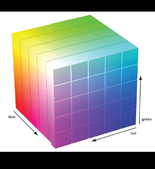


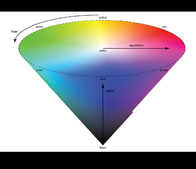
http://shop.nordstrom.com/c/petite-pagell-long-sleeve-lace-sheath-dress-regular-petite?dim=5575774

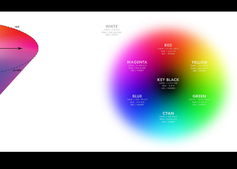
Basic Color Terms: Their Universality and Evolution. Berlin & Kay

COLOUR MODELS

- Colour names:
  - imprecise, ambiguous
    - *conveys emotional affect*
- Device-dependent colour models
  - RGB, HSV, YIQ
  - does not include all visible colours
- Device-independent colour models
  - CIE XYZ, CIE LUV, Munsell
  - theoretical colours thatmay not be displayable
    - *includes all visible colours*







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NASA AMES Color Tool

Interactive Color Tool - Beta Version
Color Scale
Number of Colors
Reverse Colors
Interpolation Method
Interpolation Colors
Interpolation Space
Interpolation Gamma
Interpolation Preview
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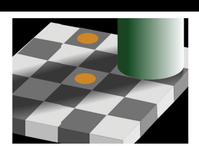
COLOUR PERCEPTION

- Simultaneous contrast
  - colours of different objects affect one another
- Colour surround
  - surrounding colour influences perceived interior colour
  - particularly noticeable or neutral greys
- Colour constancy
  - perceived colour remains constant under varying illumination



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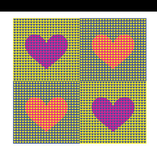

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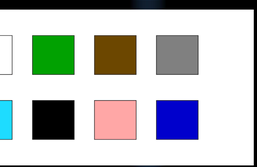

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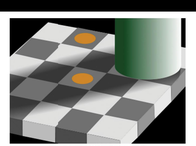
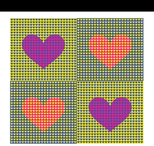


http://en.wikipedia.org/wiki/File:Checkershadowillusion.png

http://www.wikihow.com/Solve-a-Rubik%27s-Cube



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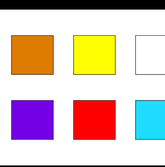

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http://www.ecomodernism.org/wp-content/uploads/2013/12/rubiks-cube.jpg

http://www.pcs.mums.ac.ir/~nikoofard/image_processing/index.htm

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http://ma.ahk.no/ansatte/andreas/illusjoner/illusjoner_skjerm.html

http://www.ecs.soton.ac.uk/people/gilbert/illusions/rubiks.jpg

http://www.ecs.soton.ac.uk/~mbm/illusions/ch4.html

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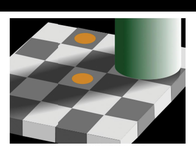

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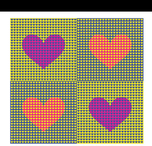

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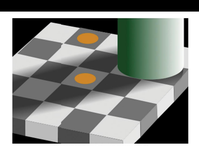

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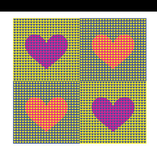

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http://ma.ahk.edu.lv/en/courses/webinars/2020/Webinars_Autumn/2nd/

http://www.indiedb.com/features/colour-illusions

http://www.ysu.edu/~ysu_art/~wenzel/work/2005/

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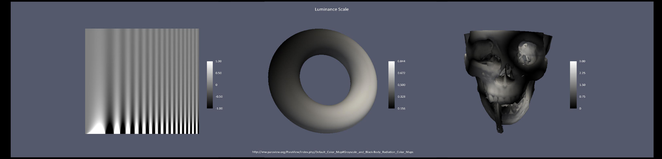
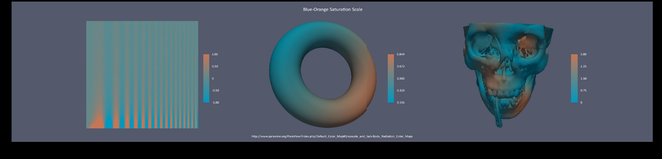


COLOUR GUIDELINES

- Luminance
  - best choice for high spatial frequency data, ordered data
  - good choice for colour-blind viewers
  - dominates hue and saturation
- Saturation
  - good choice for low spatial frequency data
  - good choice for divergent data
- Hue
  - good choice for categories
  - may be required for context



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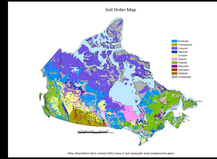

Collider Ensemble Visualization

http://www.ncsa.illinois.edu/~fkeller/

Super Bowl 2015 Play-by-Play Visualization

http://www.ccp.ncsa.illinois.edu/Faculty/Hanna/NFL

PRACTICAL EXAMPLES

- NFL play-by-play visualization
  - one bar per play, colour epresents team
  - textured X's for passes, diagonal stripes for rushes
- Tweet sentiment visualization
  - sentiment: "attitude based on feeling or emotion"
  - blue tweets for unpleasant, green tweets for pleasant
- Ensemble visualizaton
  - comparisons of particlecollision simulations
  - colour represents temprature during collision

Recent Tweet Visualizer

http://www.ccp.ncsa.illinois.edu/Faculty/Hanna/tweet_viz/index.php#

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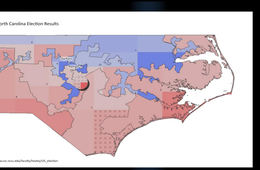
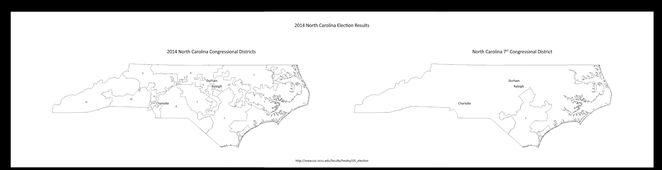
Particle-8





ELECTION VISUALIZATIONS

- Compare different elections
  - by type, by candidate, bytime
- Colour for candidate party
  - red: Republican, blue: Democrat, green: Independent
  - stronger saturation for larger margin of victory
- Texture for incumbents
  - textured X's in districts ost by incumbents
- Height for state influence
  - taller states have more Electoral College votes

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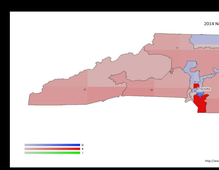

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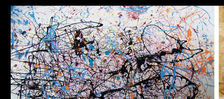


Untitled (Jackson Pollock)

http://www.kimkomando.com/image/2009/08/Pollock-is-in-the-but-wrong-of-the-behinder/

Guitar Player (Pablo Picasso)

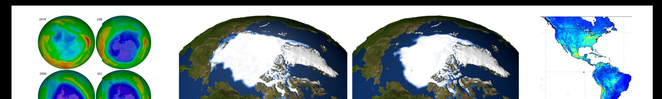
http://vigoscrossing.blogspot.com/2011/09/picasso-and-pablo-picasso.html

Wheatfield with Crows (Vincent van Gogh)

http://en.wikipedia.org/wiki/File:Wheatfield_with_Crows

SUMMARY

- Understanding coloor matters
  - *most common method fr visualizing data*
- Colour is powerful
  - aesthetic, cultural, contextual, conveys information
- Colour is complex
  - made up of *complimenary* parts
  - influenced by environment
  - many ways to "model" and "choose" colours



http://earthobservatory.nasa.gov/IOTD/view.php?id=5394

http://www.nasa.gov/centers/goddard/news/topstory/2005/aerosol_decline.html

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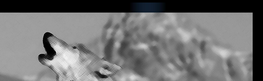

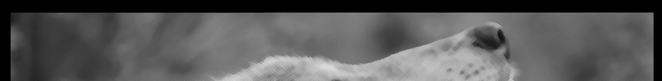

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University of British Columbia

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University of North Carolina at Chapel Hill

Dr. Pierre Poulin
Professor, Département d'informatique et de recherche opérationnelle
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ACKNOWLEDGEMENTS

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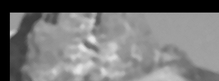
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