Week 3:
Color, Spatial Data

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JRNL 520H, Special Topics in Contemporary Journalism: Data Visualization
Week 3: 27 September 2016

http://www.cs.ubc.ca/~tmm/courses/journ16

Whereabouts

- Caitlin on travel this week and next week
  - don't expect email answers until she returns; email Tamara instead!
- Tamara on travel Thu Sep 30 - Mon Oct 3
  - at Stanford Fri/Sat to give keynote at the Computation & Journalism symposium http://journalism.stanford.edu/cj2016/
  - will still be answering email
  - no office hours in Sing Tao this week
    - by appointment with Tamara in ICICS/CS bldg Room X661
      - email tmm@cs.ubc.ca to arrange (late afternoon today or Wed are only possible times)
- Tamara on travel Thu Oct 6 - Mon Oct 10
  - in Portland Fri/Sat to give another keynote, will still be answering email
  - short office hours in Sing Tao next week: 12:30-1:30pm

News

- Assign 1 marks sent out by email
  - max 97, min 73, avg 86
  - major sources of analysis problems:
    - absolute vs relative data: February has fewer days
    - missing data: final month (Aug) was incomplete
- Assign 2 updated Sat Sep 24
  - email went out in three rounds - did everybody receive it?
  - thanks to Curtis and Emi for reporting bug to us!
- Today's format
  - interleave foundations & demos
    - Tamara will walk through Tableau demos
    - you follow along step by step on your own laptop
    - Tamara will take breaks to rove the room to help out folks who get stuck

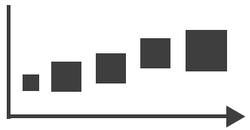
Last Time

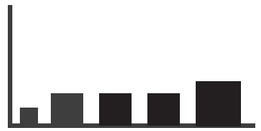
Arrange space: Visual encoding for tables

Encode

- **Arrange**
  - Express
  - Separate

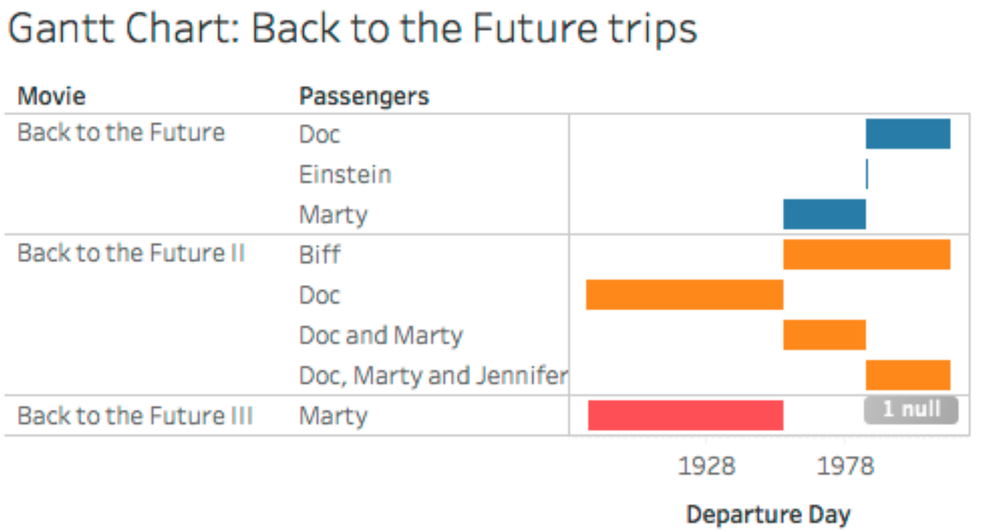
  - Order
  - Align





Demo 1: Back to the Future

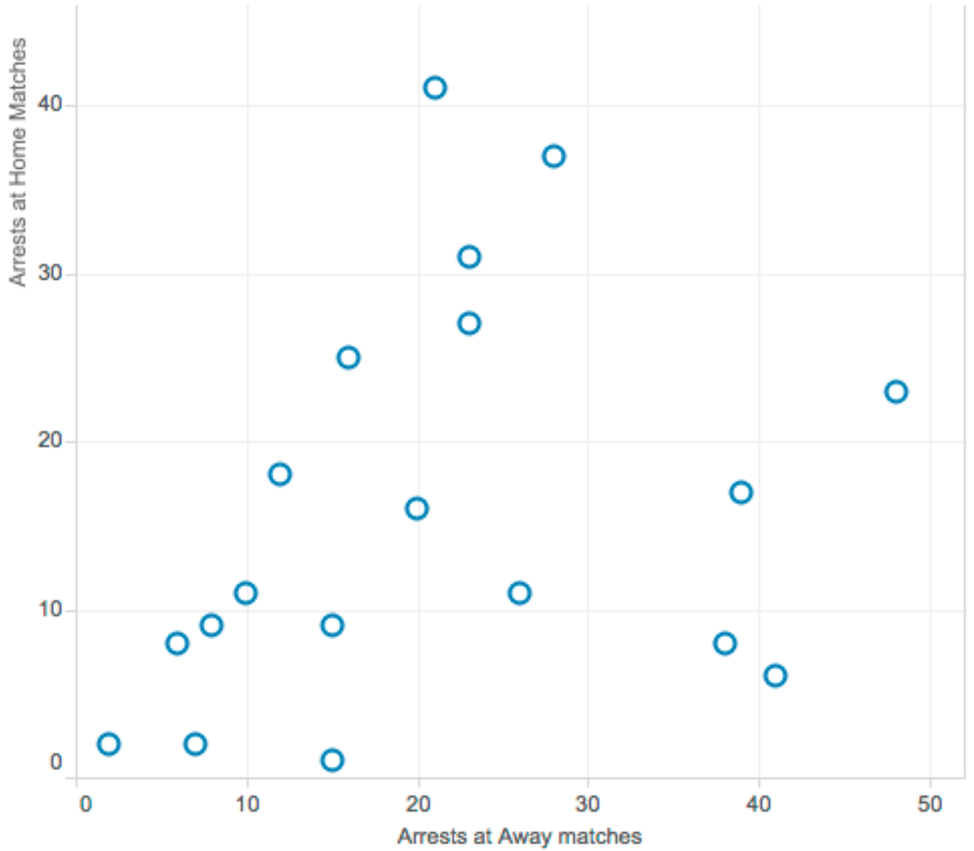
- Tableau Lessons
  - simple analytics: totals
  - more disaggregation practice
  - Show Me



- Big Ideas
  - beyond simple bars
  - challenges of missing data

Demo 2: Arrests Premiere League

- Tableau Lessons
  - visual encoding practice
  - more filters practice
  - dual axes
- Big Ideas
  - outlier removal for subsequent data analysis
- Life Lessons
  - don't be a jerk at sporting events!



Demo 3: Market Share

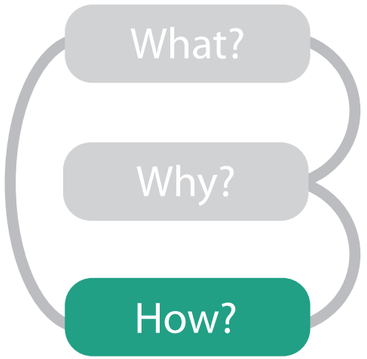
- work through this on your own if you want practice!
  - we didn't have time to do together in class
  - straw poll: how many of you did this already?

- Tableau Lessons
  - more practice with changing visual encodings
  - highlighting individual items

- Big Ideas
  - different patterns result in different insights

Color

Idiom design choices: Encode

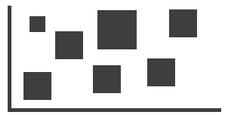


Encode

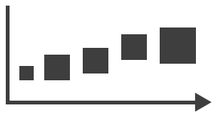
Arrange

- Express

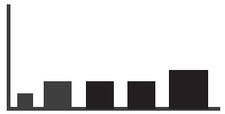
- Separate



- Order



- Align



- Use

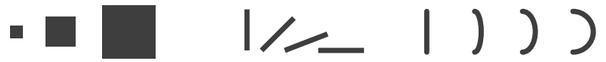
Map

from categorical and ordered attributes

- Color
  - *Hue*
  - *Saturation*
  - *Luminance*



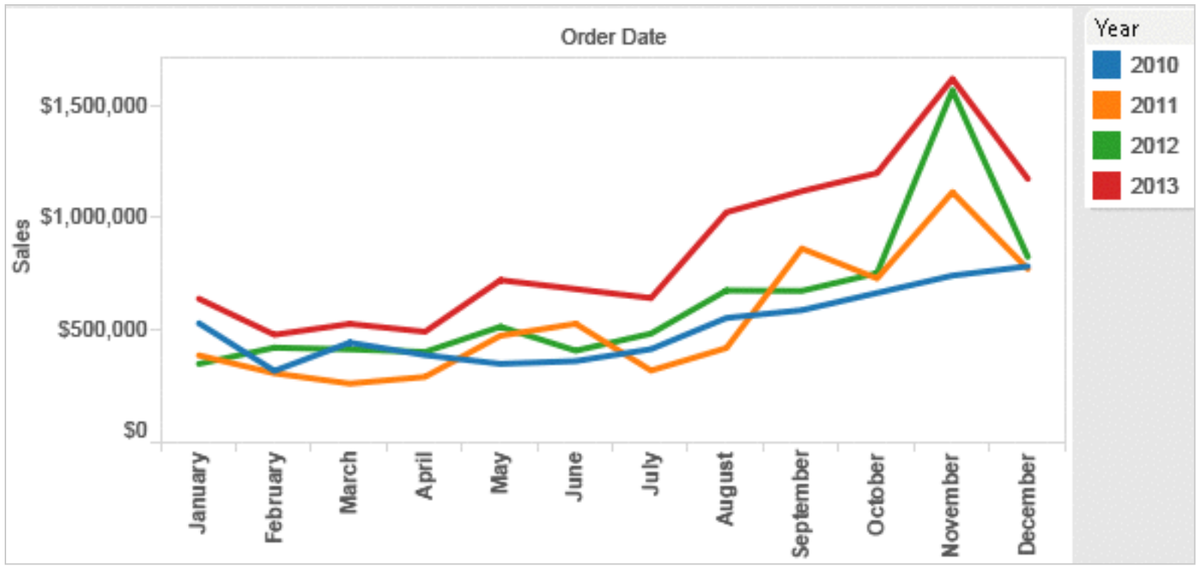
- Size, Angle, Curvature, ...

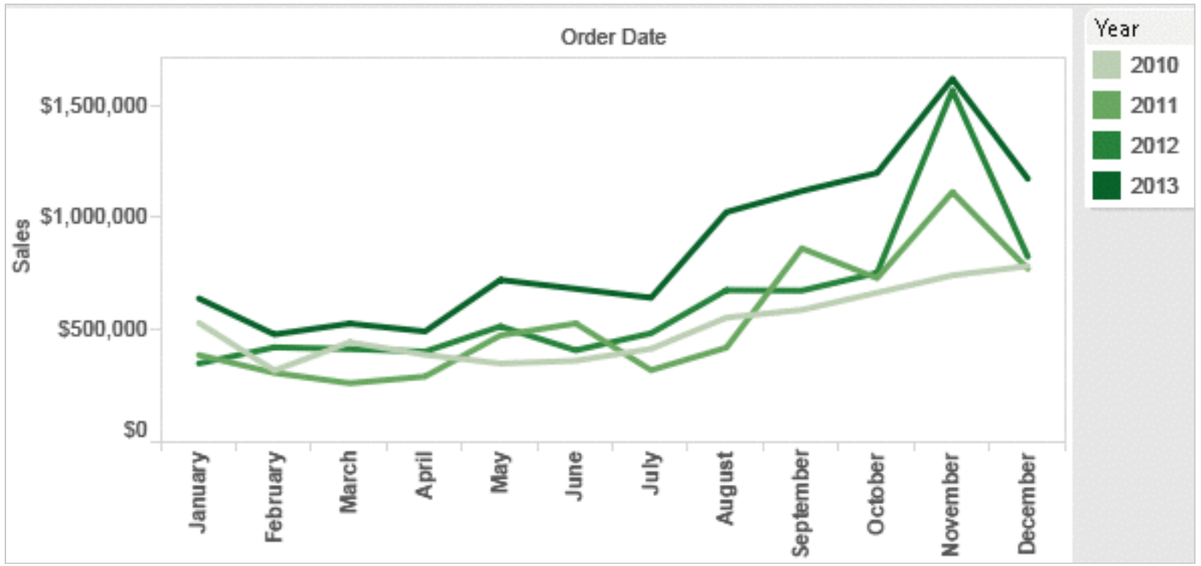


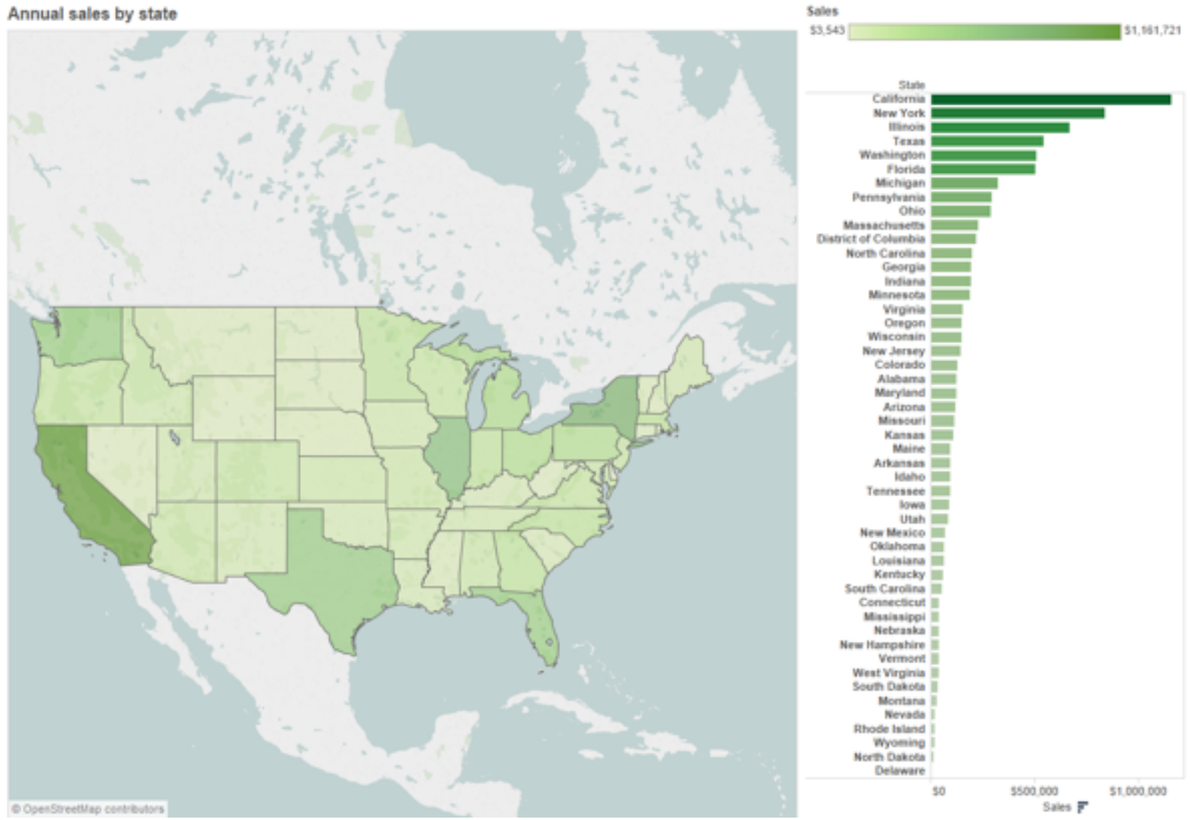
- Shape

- Motion
  Direction, Rate, Frequency, ...

Categorical vs ordered color







[Seriously Colorful: Advanced Color Principles & Practices. Stone.Tableau Customer Conference 2014.]

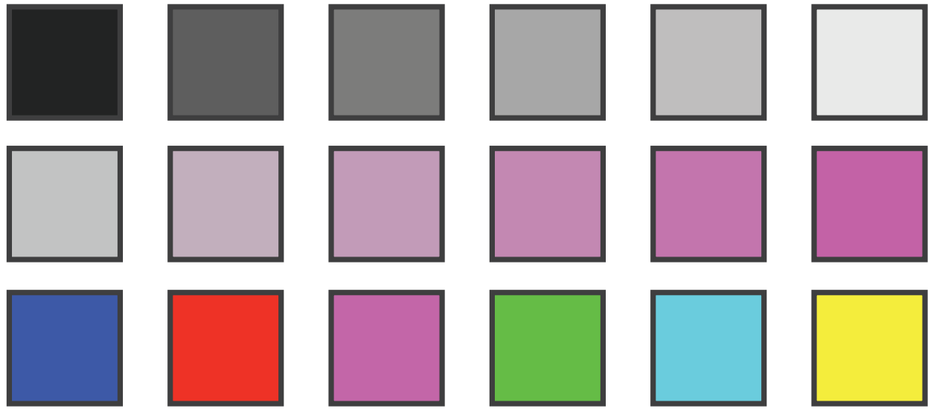
Color: Luminance, saturation, hue

- 3 channels
  - identity for categorical
    - hue
  - magnitude for ordered
    - luminance
    - saturation
- RGB: poor for encoding
- HSL: better, but beware
  - lightness ≠ luminance

Luminance

Saturation

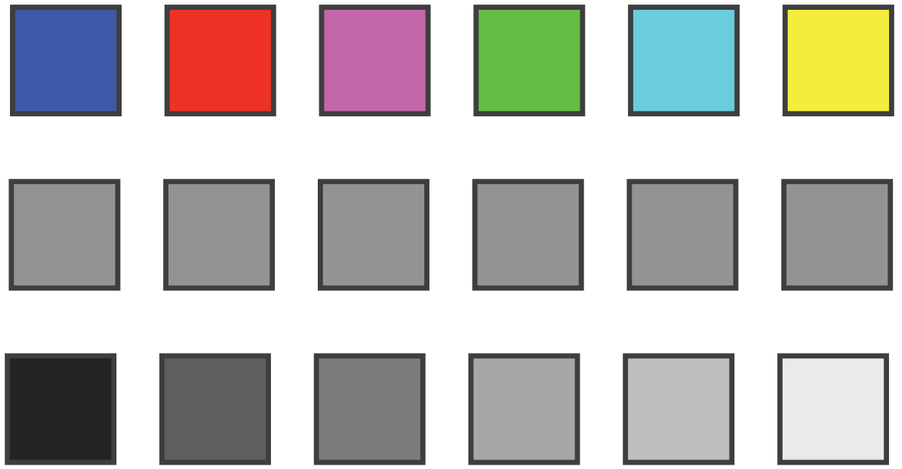
Hue



Corners of the RGB color cube

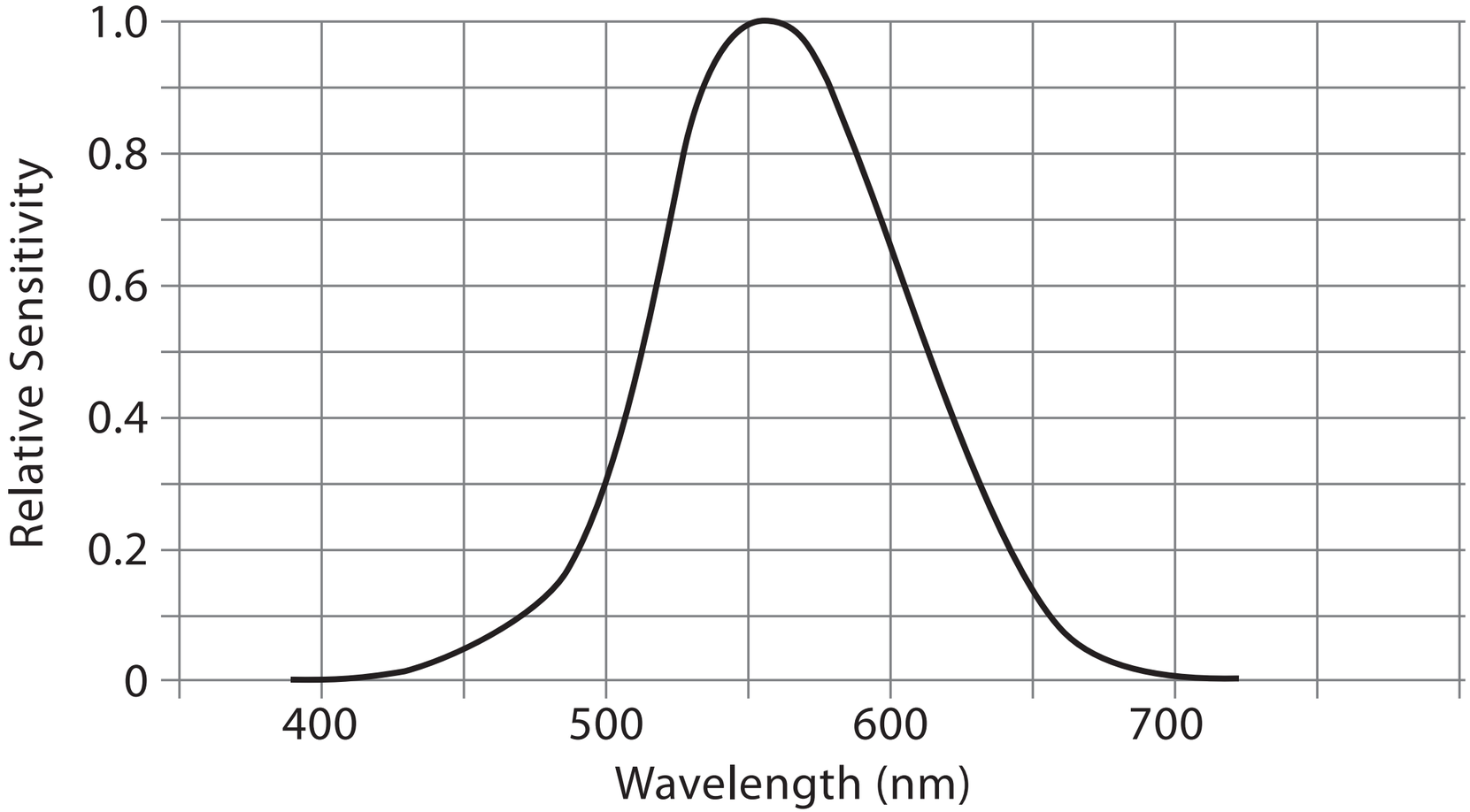
L from HLS
All the same

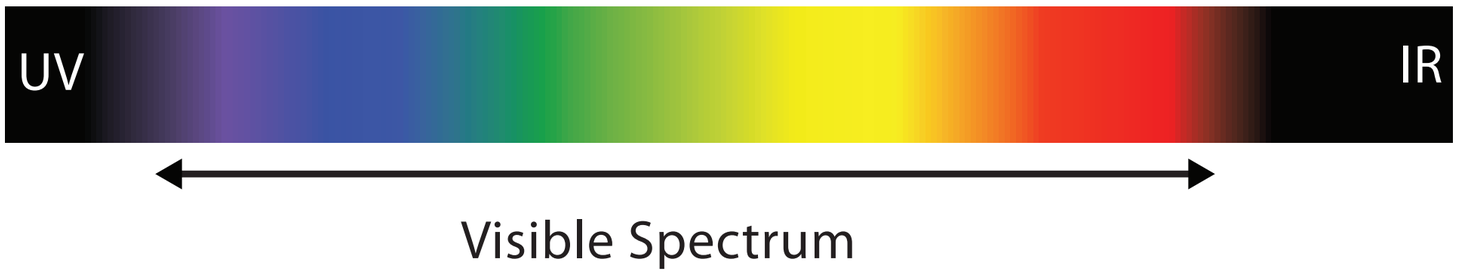
Luminance values



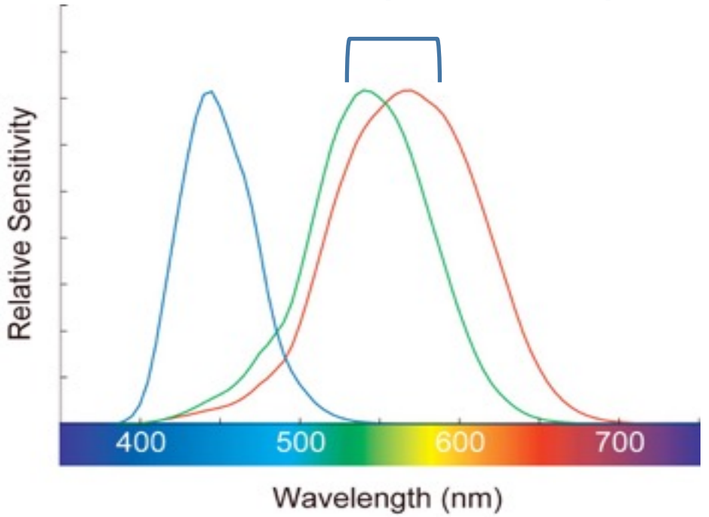
Spectral sensitivity

& three cone types



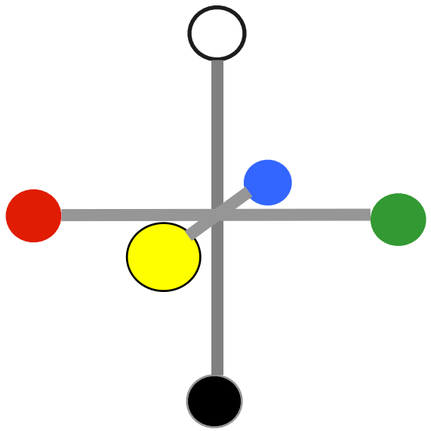


Small but important separation



Opponent color and color deficiency

- 3 cones processed before optic nerve
  - one achromatic luminance channel L
    - edge detection through luminance contrast
  - two chroma channels, R-G and Y-B axis
- "color blind" if one axis has degraded acuity
  - 8% of men are red/green color deficient
  - blue/yellow is rare

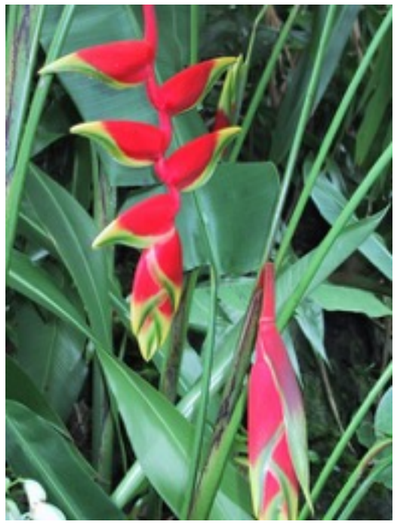


Lightness information

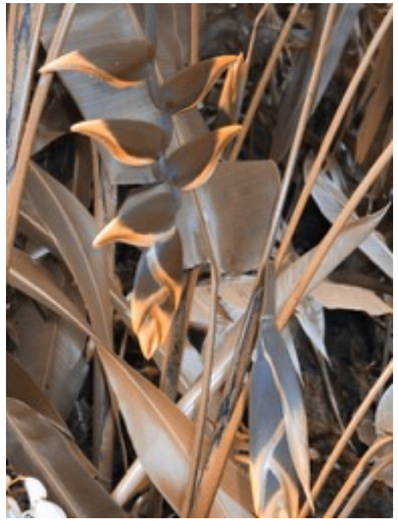
Color information

[Seriously Colorful: Advanced Color Principles & Practices. Stone.Tableau Customer Conference 2014.]

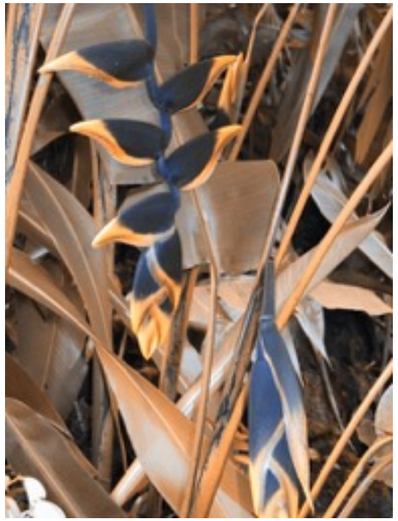
Designing for color deficiency: Check with simulator



Normal vision



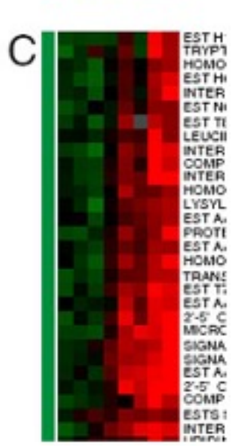
Deuteranope



Protanope

Tritanope

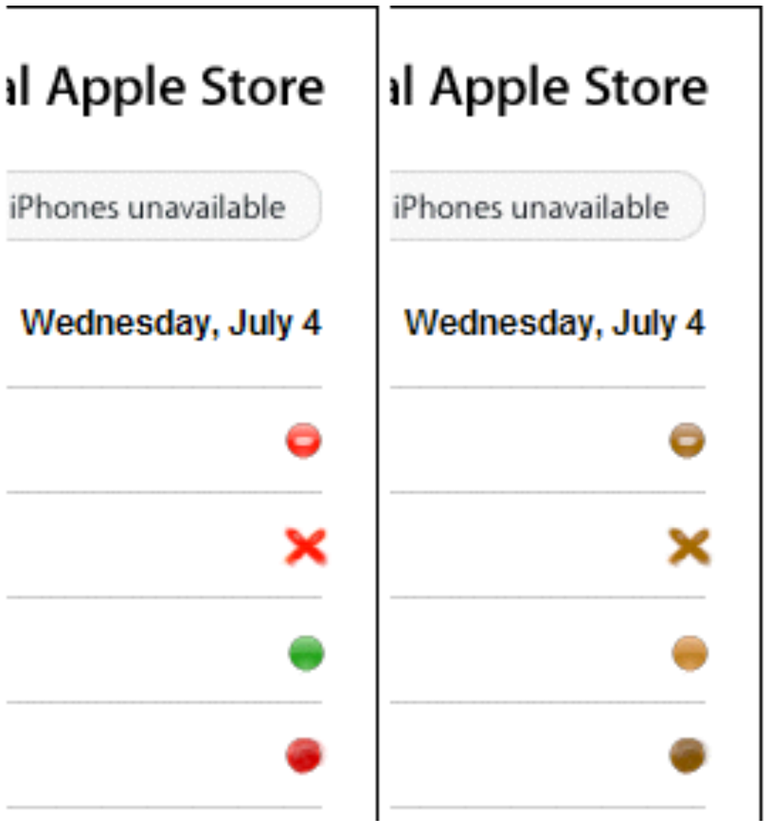
http://rehue.net

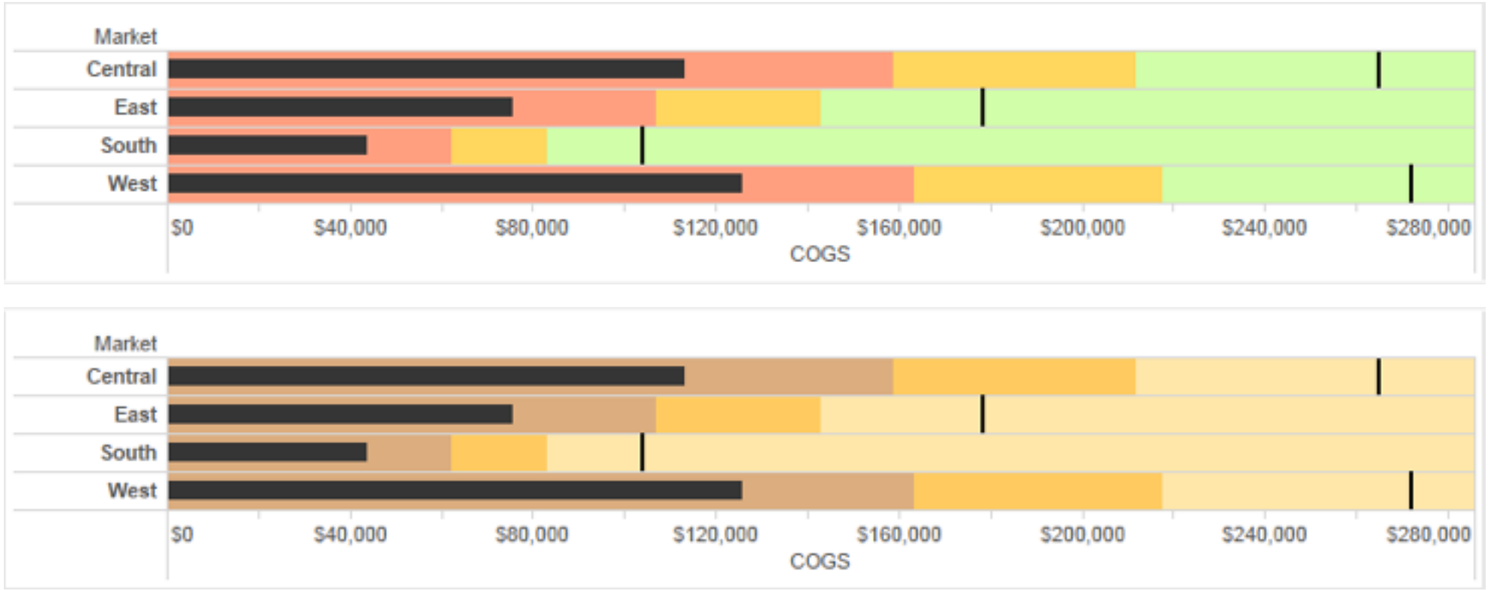


[Seriously Colorful: Advanced Color Principles & Practices. Stone. Tableau Customer Conference 2014.]

Designing for color deficiency: Avoid encoding by hue alone

- redundantly encode
  - vary luminance
  - change shape





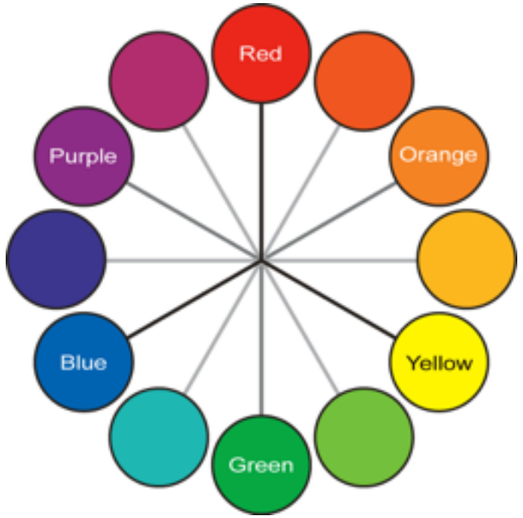
Deuteranope simulation

Change the shape

Vary luminance

[Seriously Colorful: Advanced Color Principles & Practices. Stone. Tableau Customer Conference 2014.]

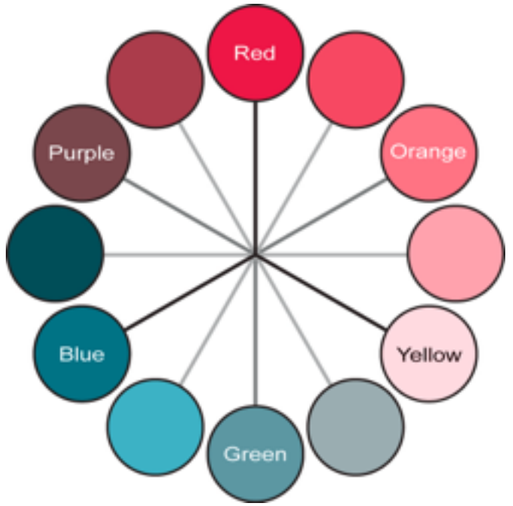
Color deficiency: Reduces color to 2 dimensions



Normal

Protanope

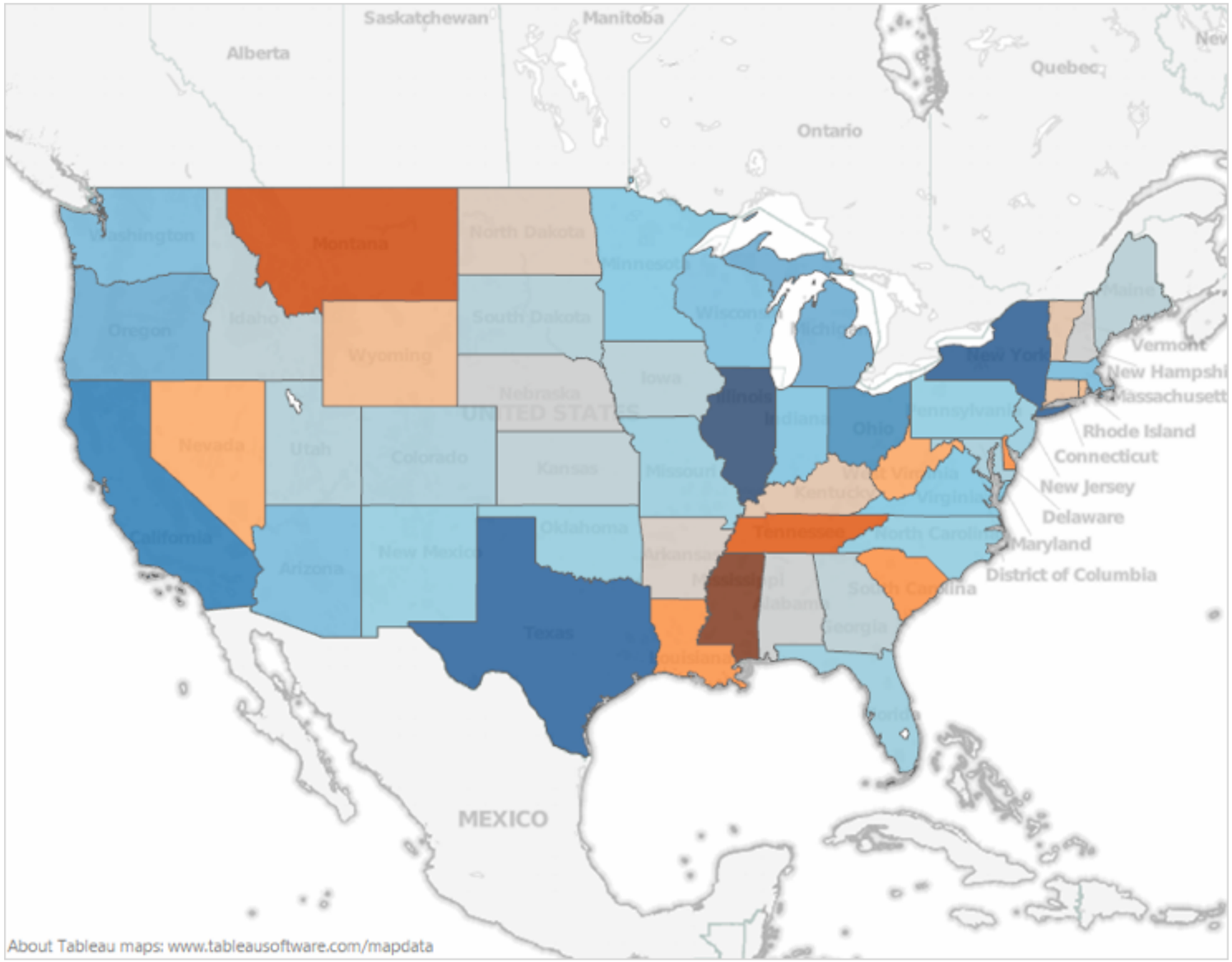
Deuteranope



Tritanope

[Seriously Colorful: Advanced Color Principles & Practices. Stone.Tableau Customer Conference 2014.]

Designing for color deficiency: Blue-Orange is safe



[Seriously Colorful: Advanced Color Principles & Practices. Stone.Tableau Customer Conference 2014.]

Color/Lightness constancy: Illumination conditions

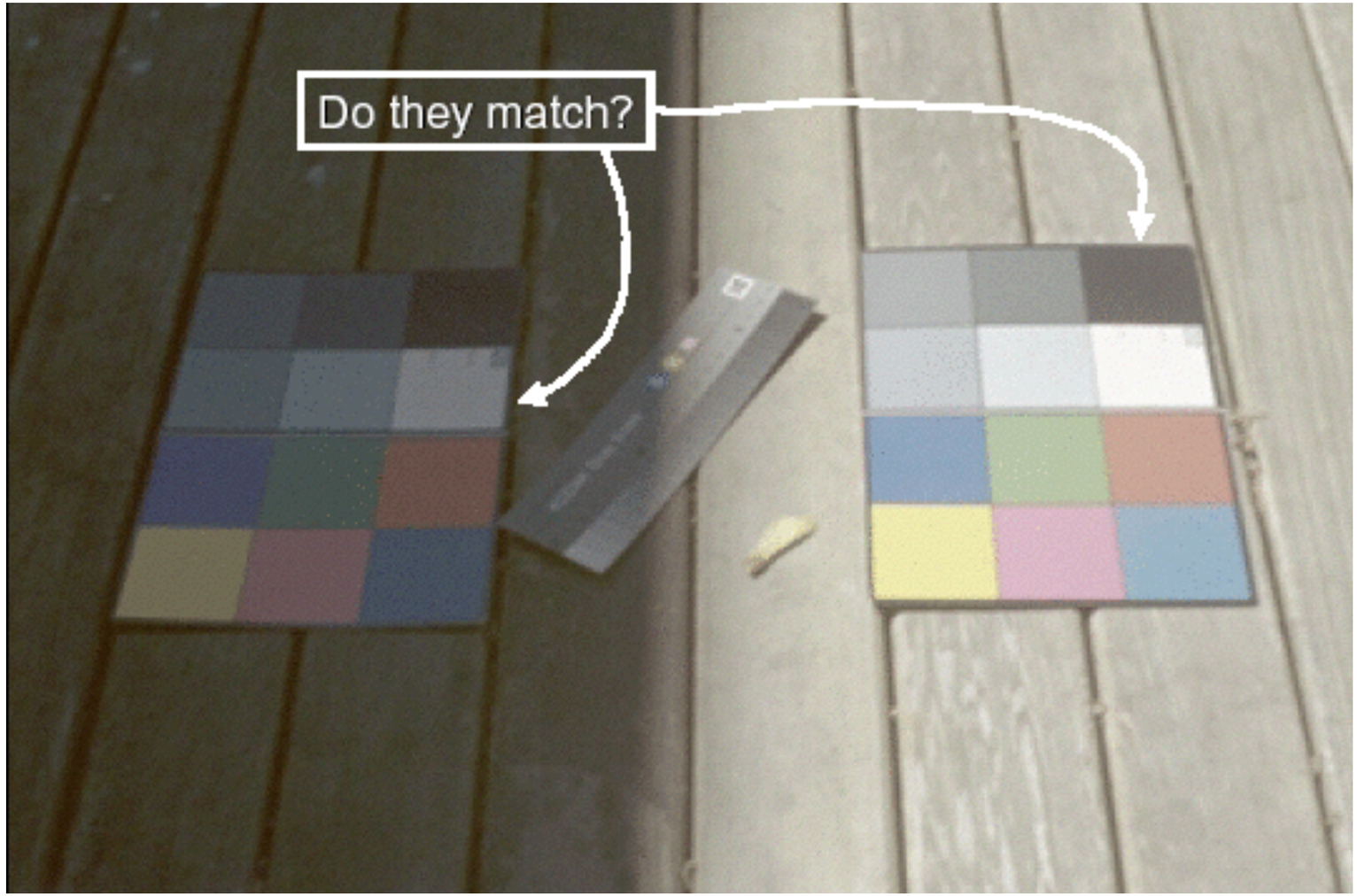


Image courtesy of John McCann

Color/Lightness constancy: Illumination conditions

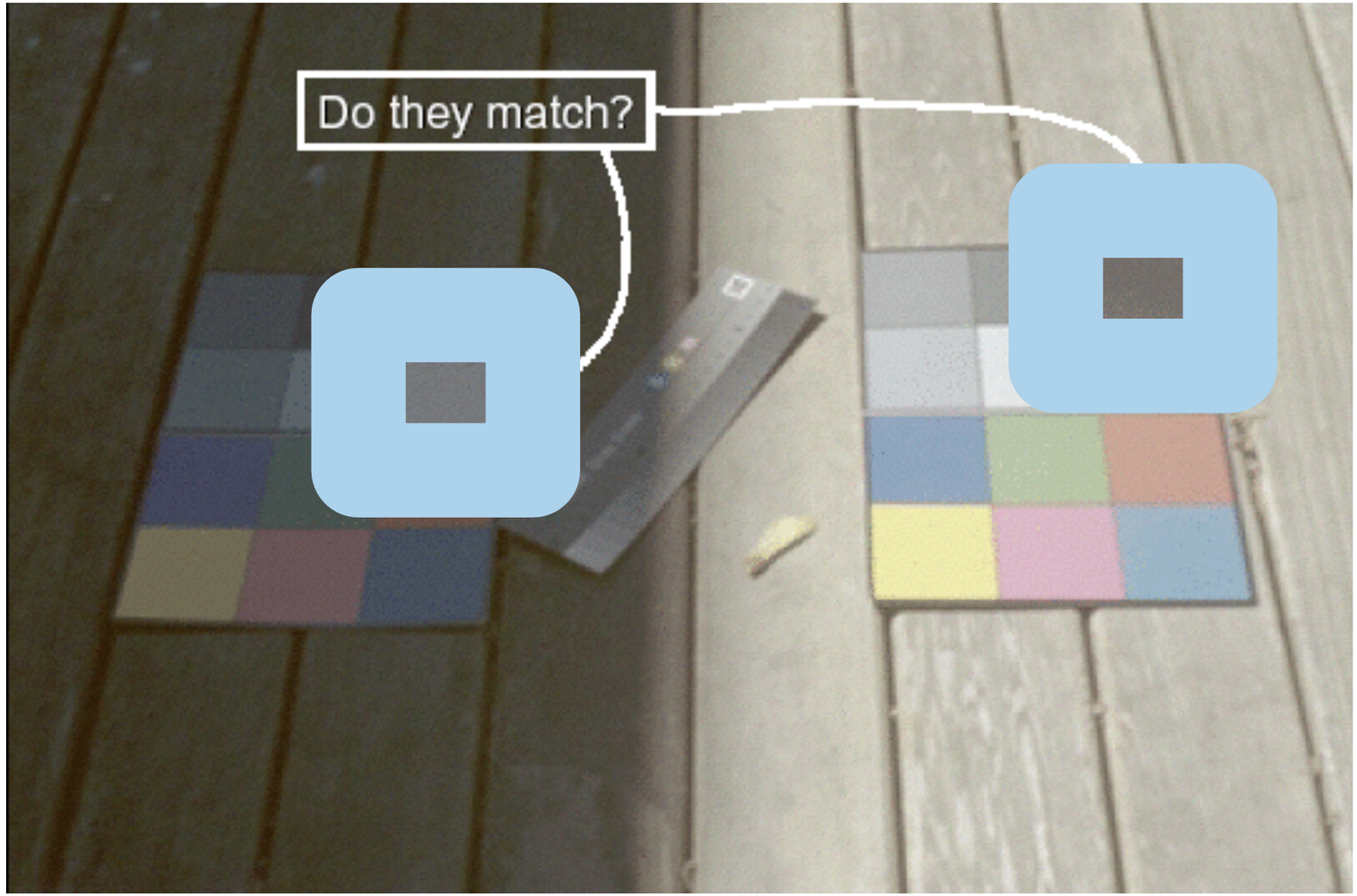
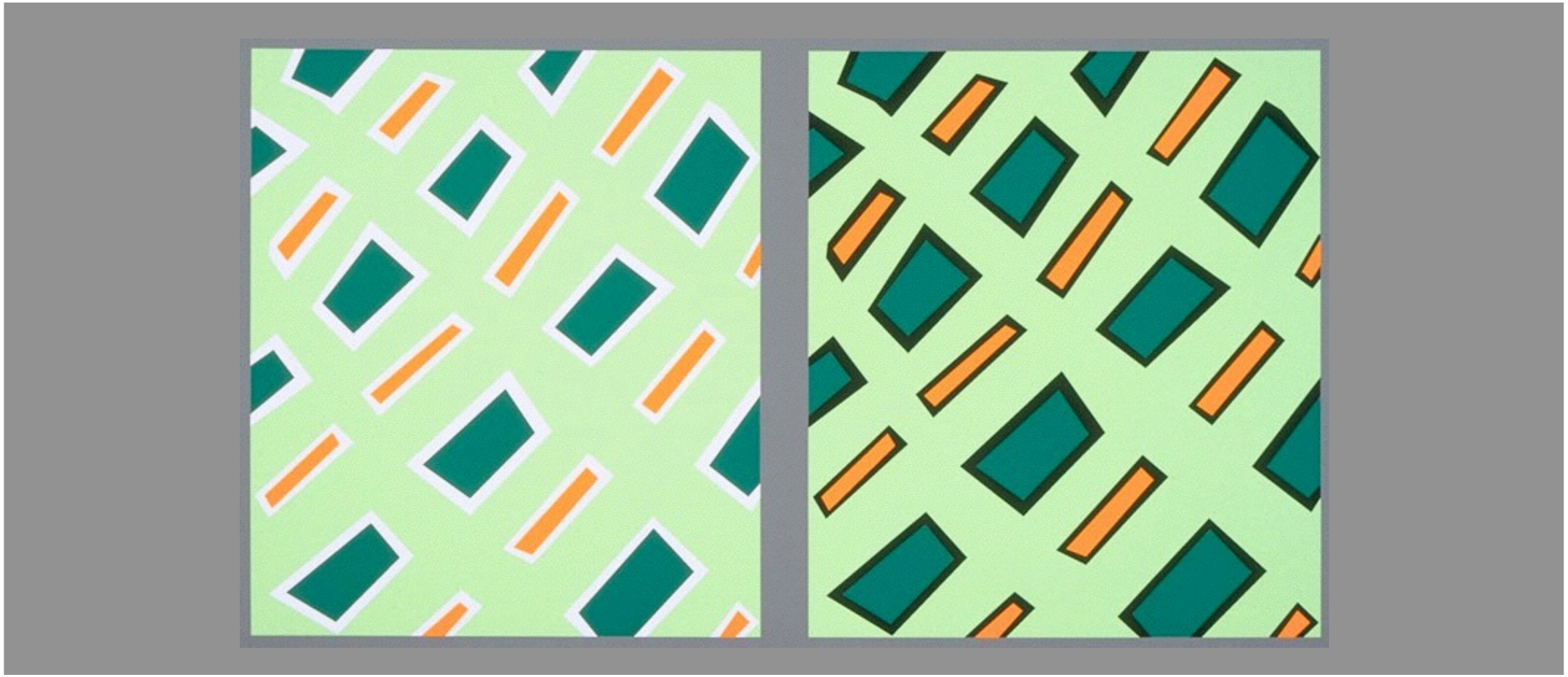


Image courtesy of John McCann

Bezold Effect: Outlines matter

- color constancy: simultaneous contrast effect



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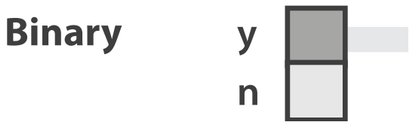
Colormaps

- Categorical

- Ordered
  - *Sequential*
  - *Diverging*



after [Color Use Guidelines for Mapping and Visualization. Brewer, 1994. http://www.personal.psu.edu/faculty/c/a/cab38/ColorSch/Schemes.html]

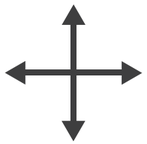
Colormaps

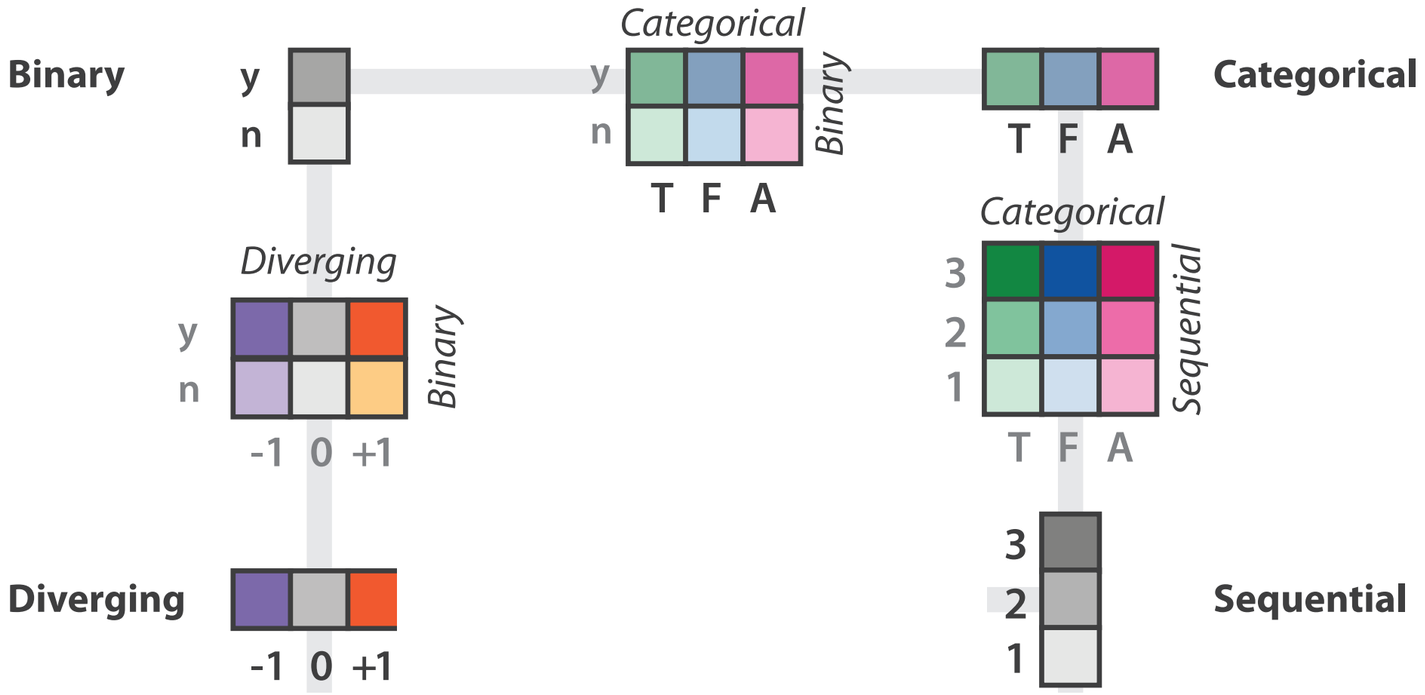
- Categorical

- Ordered
  - *Sequential*

  - *Diverging*

- Bivariate





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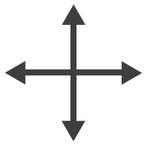
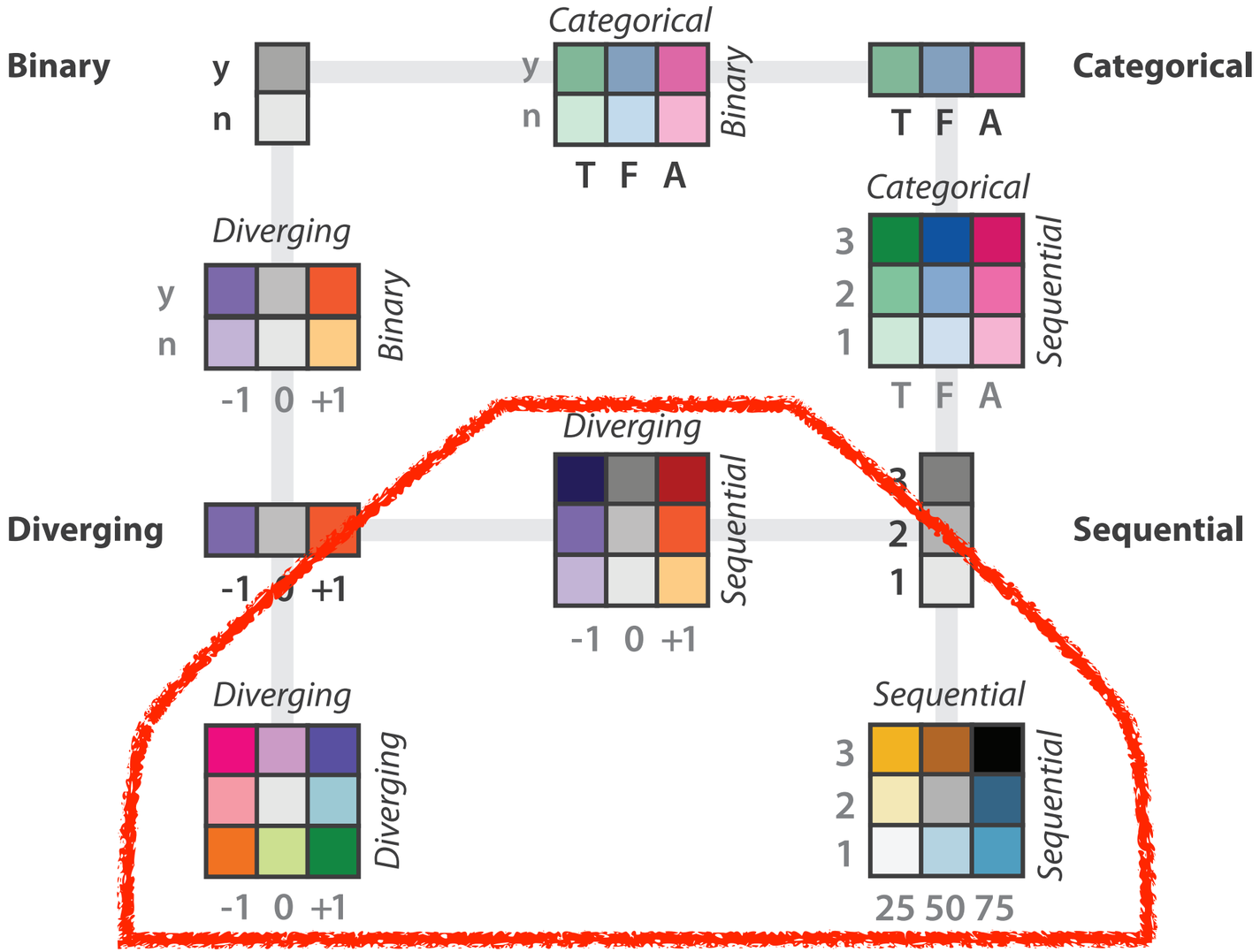


use with care!



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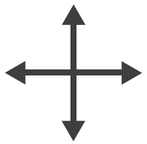
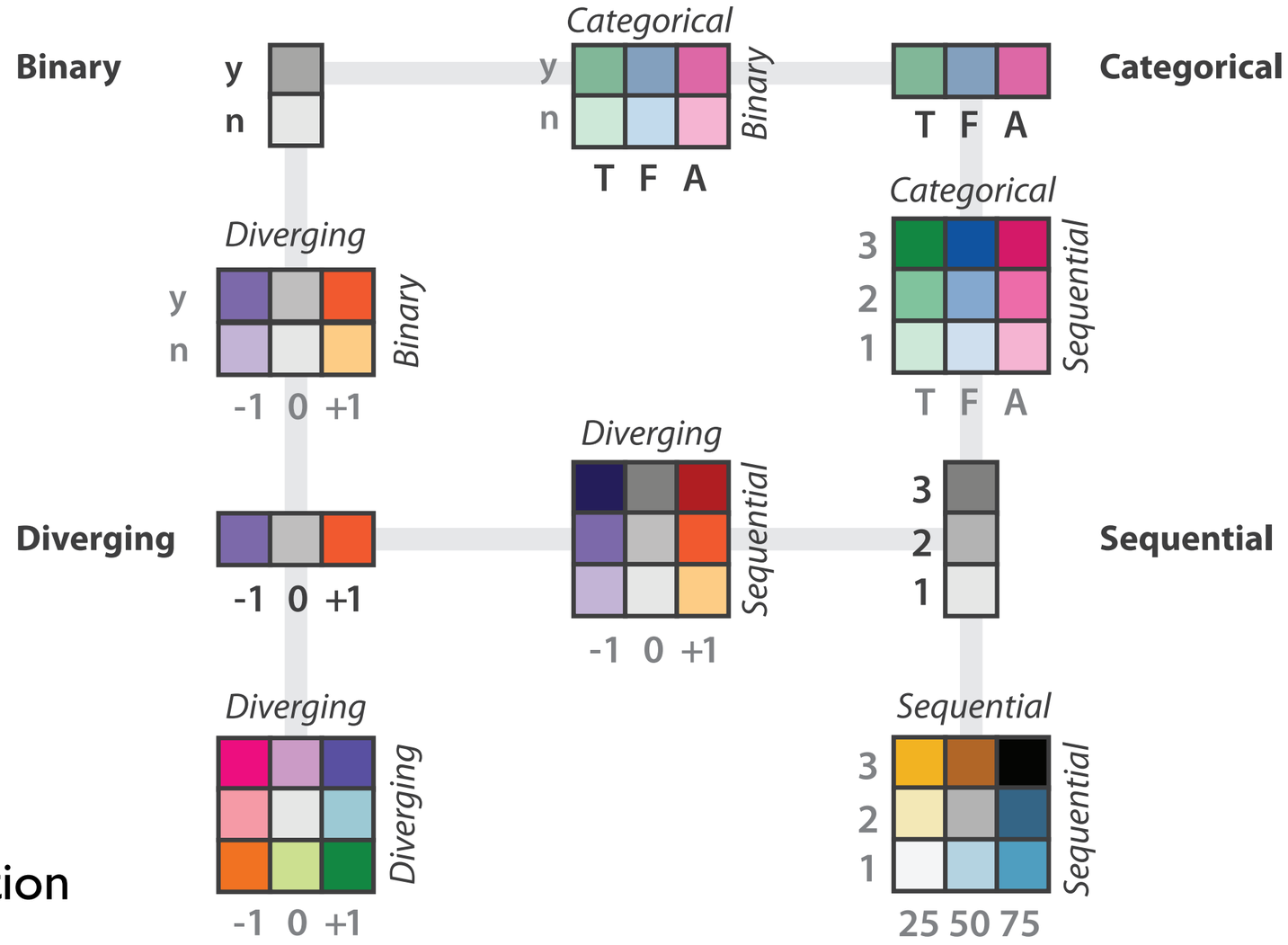


- color channel interactions
  - size heavily affects salience
    - small regions need high saturation
    - large need low saturation
  - saturation & luminance: 3-4 bins max
    - also not separable from transparency



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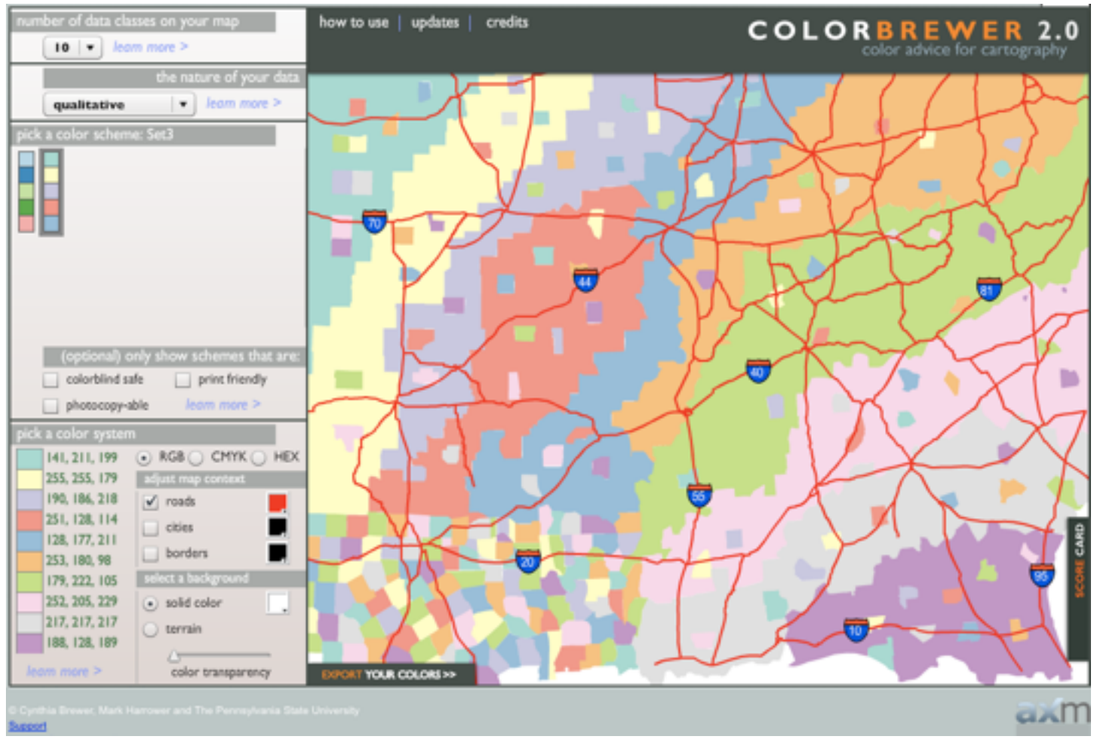
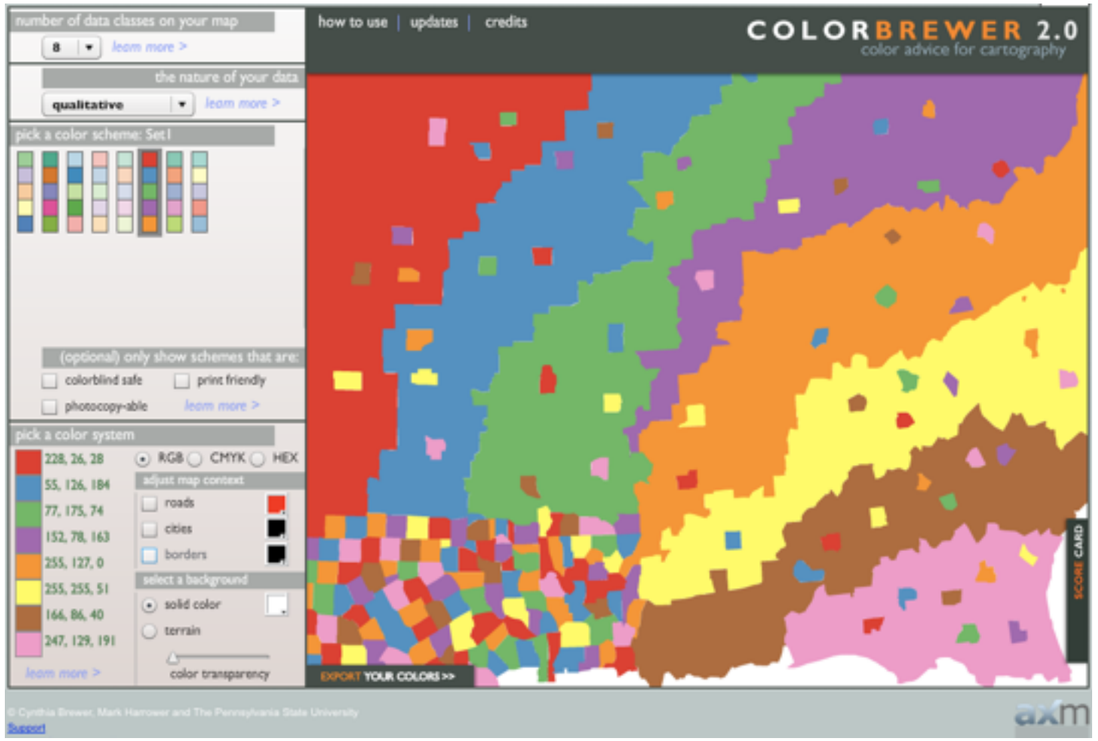
ColorBrewer

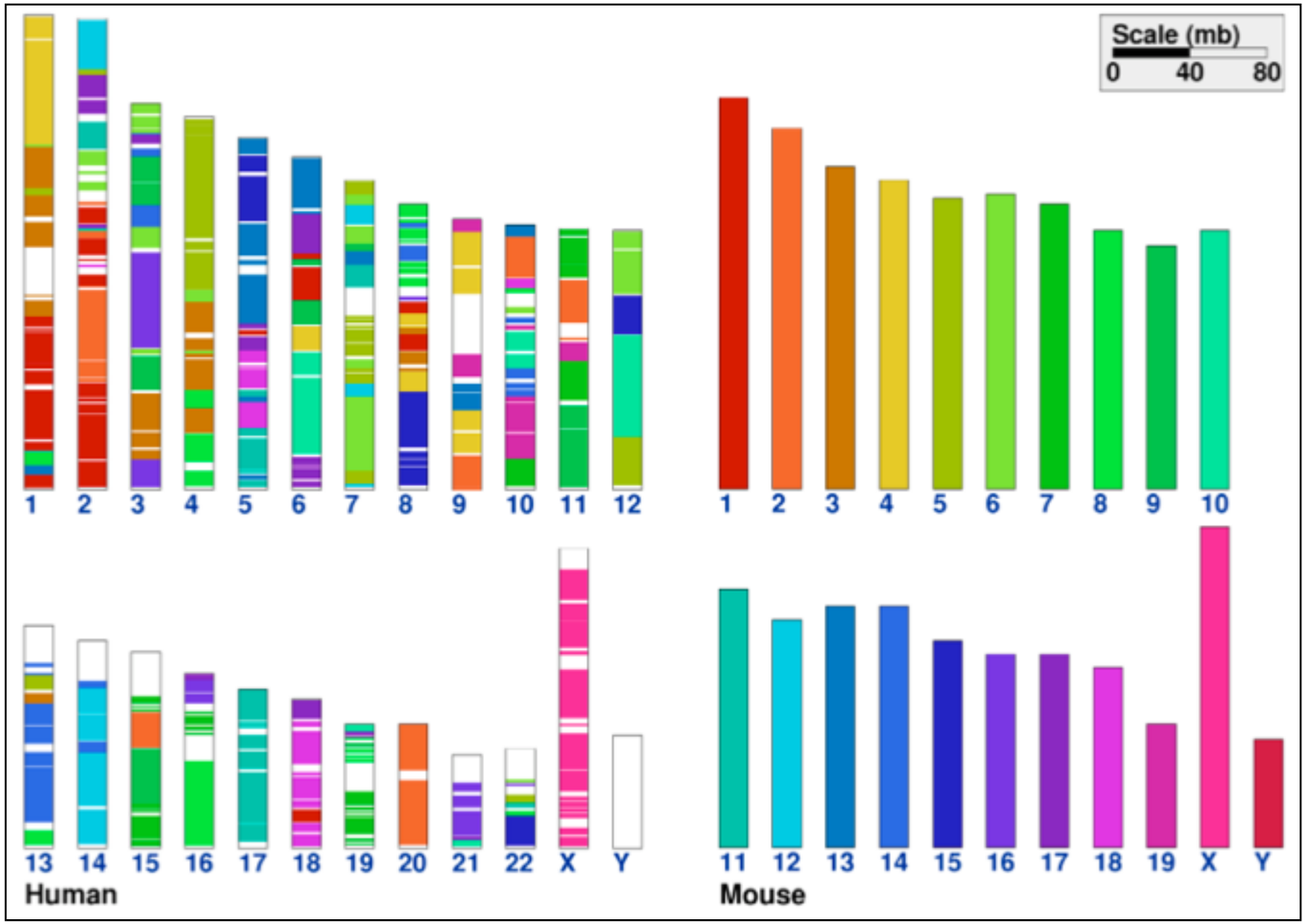
- http://www.colorbrewer2.org
- saturation and area example: size affects salience!





Categorical color: Discriminability constraints

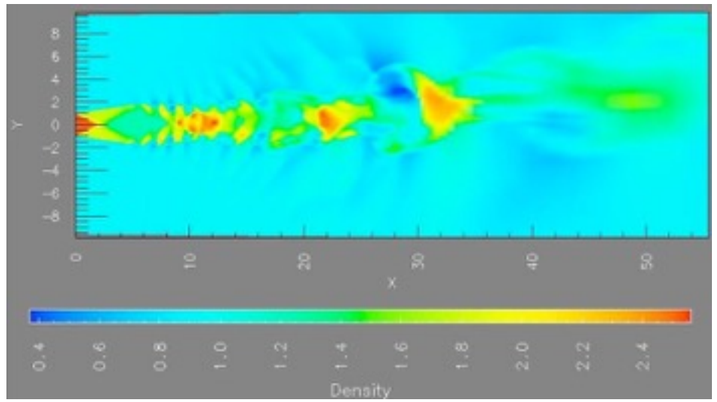
- noncontiguous small regions of color: only 6-12 bins



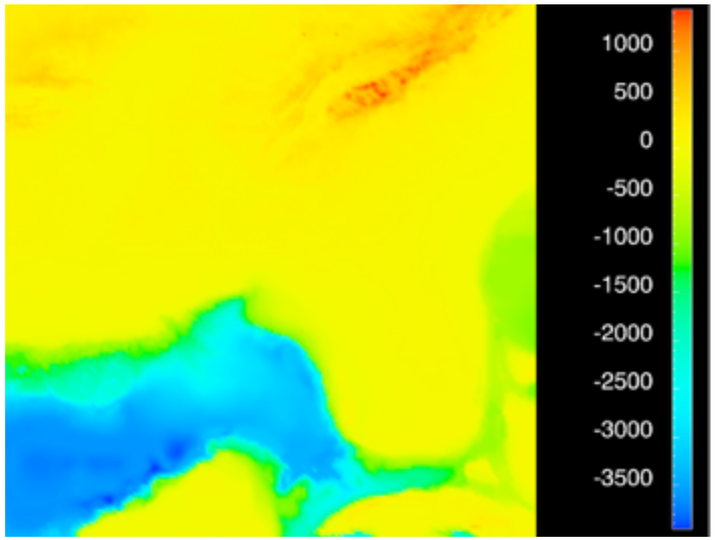
[Cinteny: flexible analysis and visualization of synteny and genome rearrangements in multiple organisms. Sinha and Meller. BMC Bioinformatics, 8:82, 2007.]

Ordered color: Rainbow is poor default

- problems
  - perceptually unordered
  - perceptually nonlinear
- benefits
  - fine-grained structure visible and nameable



[A Rule-based Tool for Assisting Colormap Selection. Bergman,. Rogowitz, and. Treinish. Proc. IEEE Visualization (Vis), pp. 118–125, 1995.]

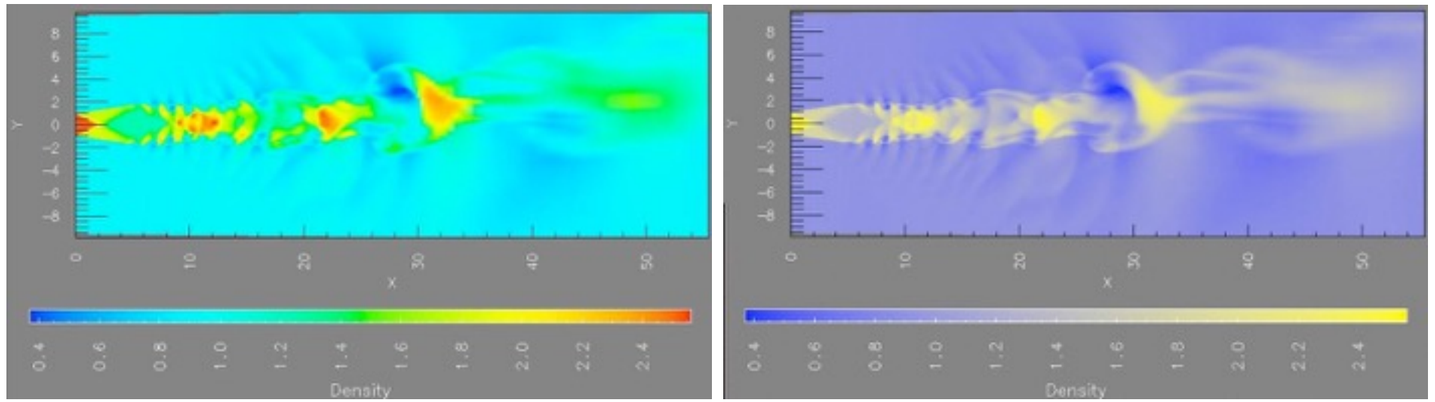


[Why Should Engineers Be Worried About Color? Treinish and Rogowitz 1998. http://www.research.ibm.com/people/l/lloydt/color/color.HTM]

[Transfer Functions in Direct Volume Rendering: Design, Interface, Interaction. Kindlmann. SIGGRAPH 2002 Course Notes]

Ordered color: Rainbow is poor default

- problems
  - perceptually unordered
  - perceptually nonlinear
- benefits
  - fine-grained structure visible and nameable
- alternatives
  - large-scale structure: fewer hues



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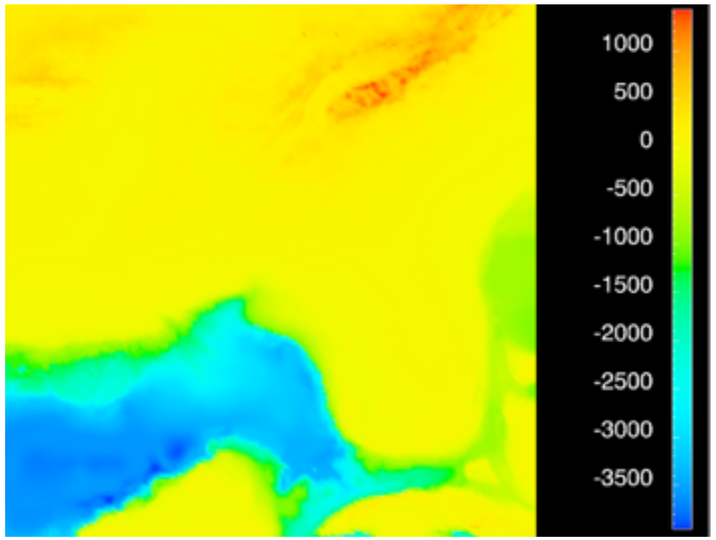

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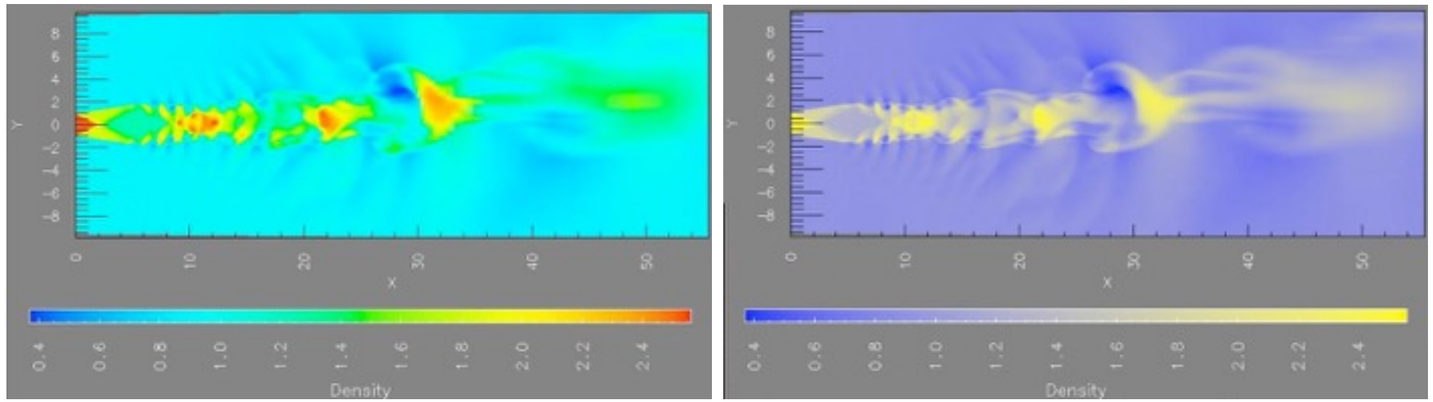
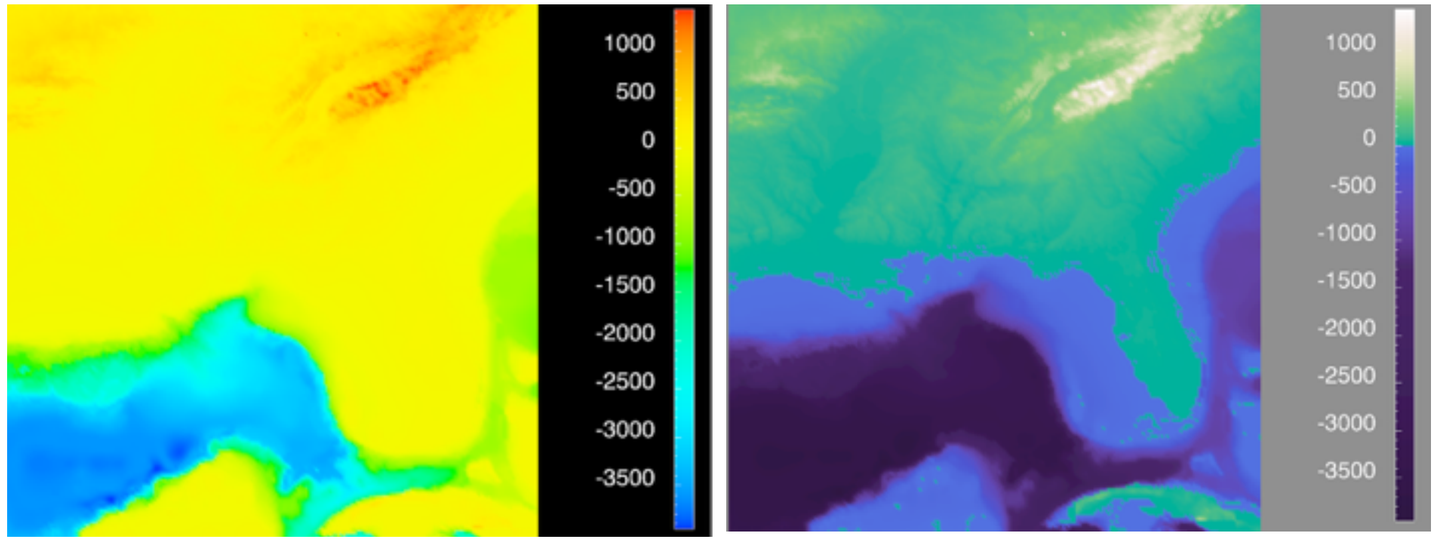
- problems
  - perceptually unordered
  - perceptually nonlinear
- benefits
  - fine-grained structure visible and nameable
- alternatives
  - large-scale structure: fewer hues
  - fine structure: multiple hues with monotonically increasing luminance [eg viridis R/python]



[A Rule-based Tool for Assisting Colormap Selection. Bergman,. Rogowitz, and. Treinish. Proc. IEEE Visualization (Vis), pp. 118–125, 1995.]

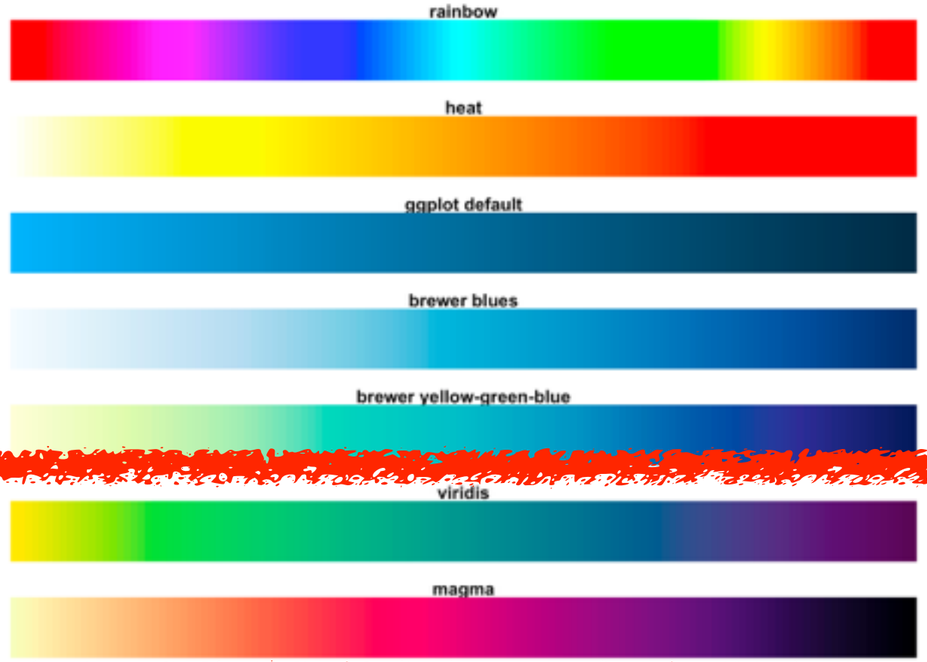


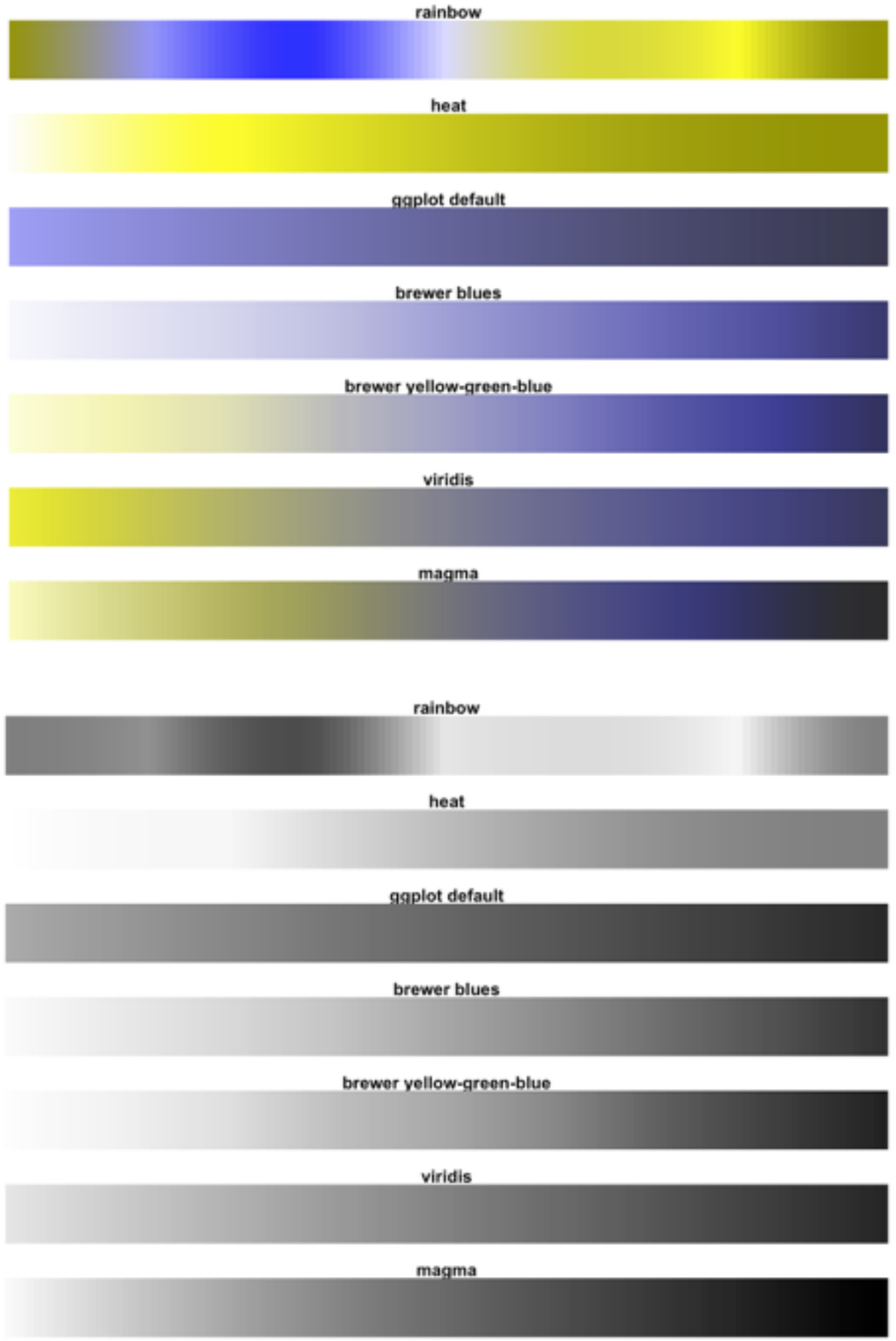
[Why Should Engineers Be Worried About Color? Treinish and Rogowitz 1998. http://www.research.ibm.com/people/l/lloydt/color/color.HTM]

[Transfer Functions in Direct Volume Rendering: Design, Interface, Interaction. Kindlmann. SIGGRAPH 2002 Course Notes]

Viridis

- colorful, perceptually uniform, colorblind-safe, monotonically increasing luminance

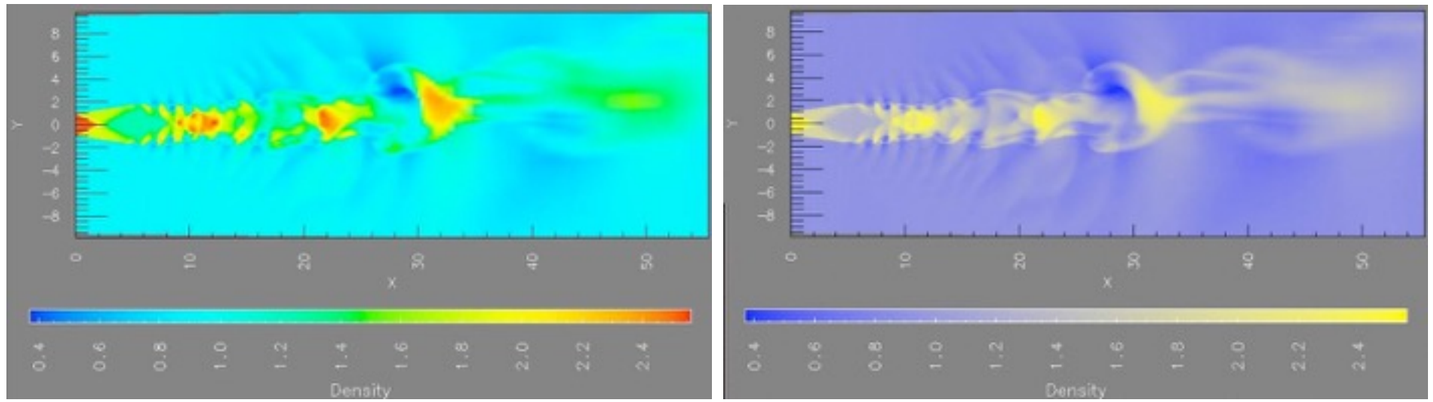




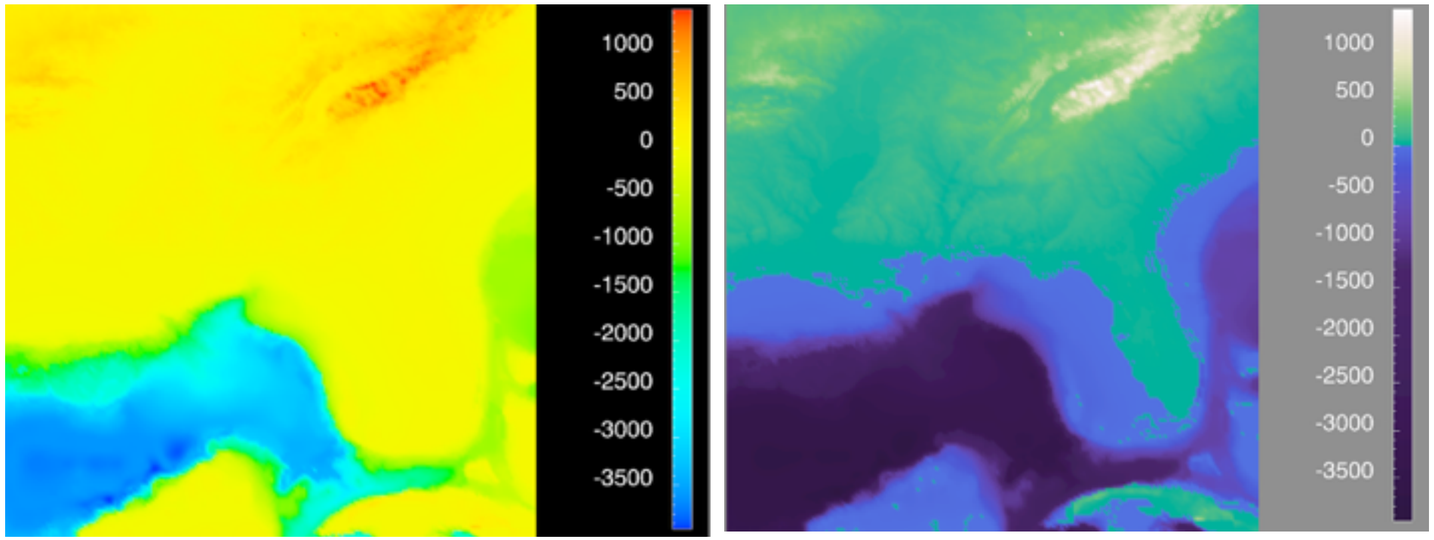
https://cran.r-project.org/web/packages/viridis/vignettes/intro-to-viridis.html

Ordered color: Rainbow is poor default

- problems
  - perceptually unordered
  - perceptually nonlinear
- benefits
  - fine-grained structure visible and nameable
- alternatives
  - large-scale structure: fewer hues
  - fine structure: multiple hues with monotonically increasing luminance [eg viridis R/python]
  - segmented rainbows for binned or categorical



[A Rule-based Tool for Assisting Colormap Selection. Bergman,. Rogowitz, and. Treinish. Proc. IEEE Visualization (Vis), pp. 118–125, 1995.]



[Why Should Engineers Be Worried About Color? Treinish and Rogowitz 1998. http://www.research.ibm.com/people/l/lloydt/color/color.HTM]

[Transfer Functions in Direct Volume Rendering: Design, Interface, Interaction. Kindlmann. SIGGRAPH 2002 Course Notes]

Map other channels

- size
  - length accurate, 2D area ok, 3D volume poor
- angle
  - nonlinear accuracy
    - horizontal, vertical, exact diagonal
- shape
  - complex combination of lower-level primitives
  - many bins
- motion
  - highly separable against static
    - binary: great for highlighting
  - use with care to avoid irritation

➔ **Size, Angle, Curvature, ...**

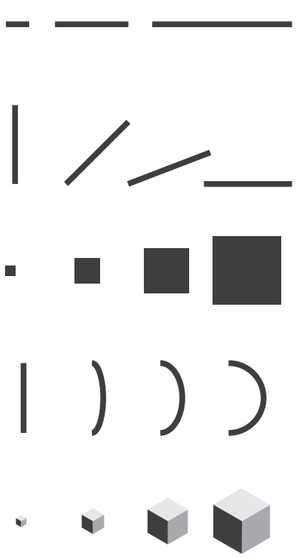
➔ Length

➔ Angle

➔ Area

➔ Curvature

➔ Volume



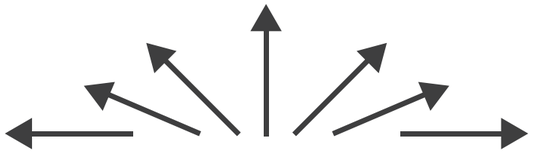
➔ **Shape**

➔ **Motion**

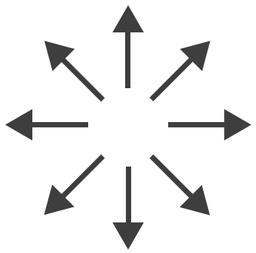
➔ Motion
Direction, Rate, Frequency, ...

Angle

Sequential ordered
line mark or arrow glyph



Diverging ordered
arrow glyph



Cyclic ordered
arrow glyph

Further reading

- Visualization Analysis and Design. Munzner. AK Peters Visualization Series, CRC Press, 2014
  - *Chap 10: Map Color and Other Channels*
- ColorBrewer, Brewer.
  - http://www.colorbrewer2.org
- *Color In Information Display*. Stone. IEEE Vis Course Notes, 2006.
  - http://www.stonesc.com/Vis06
- A Field Guide to Digital Color. Stone. AK Peters, 2003.
- *Rainbow Color Map (Still) Considered Harmful.* Borland and Taylor. IEEE Computer Graphics and Applications 27:2 (2007), 14–17.
- Visual Thinking for Design. Ware. Morgan Kaufmann, 2008.
- Information Visualization: Perception for Design, 3rd edition. Ware. Morgan Kaufmann / Academic Press, 2004.
- https://cran.r-project.org/web/packages/viridis/vignettes/intro-to-viridis.html

Maureen Stone

- Tableau Research
  - designer of Tableau color defaults
  - also author of A Field Guide to Digital Color
  - credits: following color slides excerpted from Seriously Colorful: Advanced Color Principles & Practices
    - Tableau Customer Conference 2014 talk

Demo 1: Stone Color Workbook

- Credit: Maureen Stone, Tableau Research
  - designer of Tableau color defaults, author of *A Field Guide to Digital Color*
  - workbook from Tableau Customer Conference 2014 talk
    Seriously Colorful: Advanced Color Principles & Practices

- Tableau Lessons
  - more visual encoding practice
  - color palettes, univariate & bivariate
  - discrete (categorical) vs continuous (quantitative)

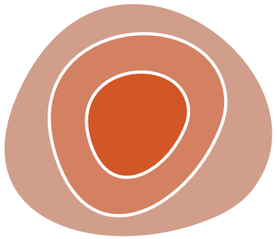
- Big Ideas
  - Tableau has many built-in features to get color right, but care still needed

Spatial Data

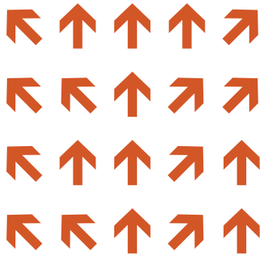
VAD Chap 8: Arrange spatial data

- **Use Given**
  - Geometry
    - *Geographic*
    - *Other Derived*

  - Spatial Fields
    - *Scalar Fields (one value per cell)*
      - *Isocontours*
      - *Direct Volume Rendering*

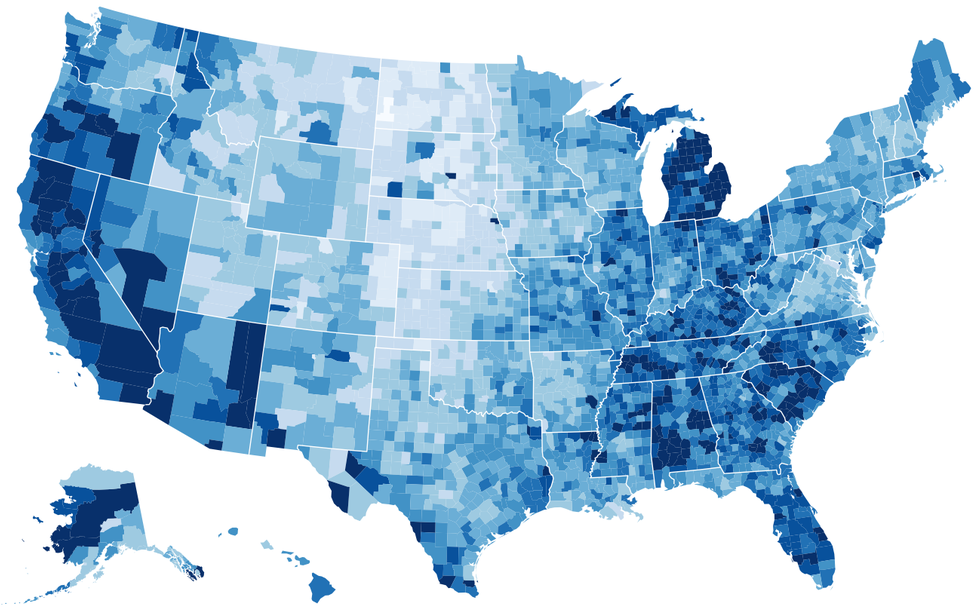


    - *Vector and Tensor Fields (many values per cell)*



Idiom: **choropleth map**

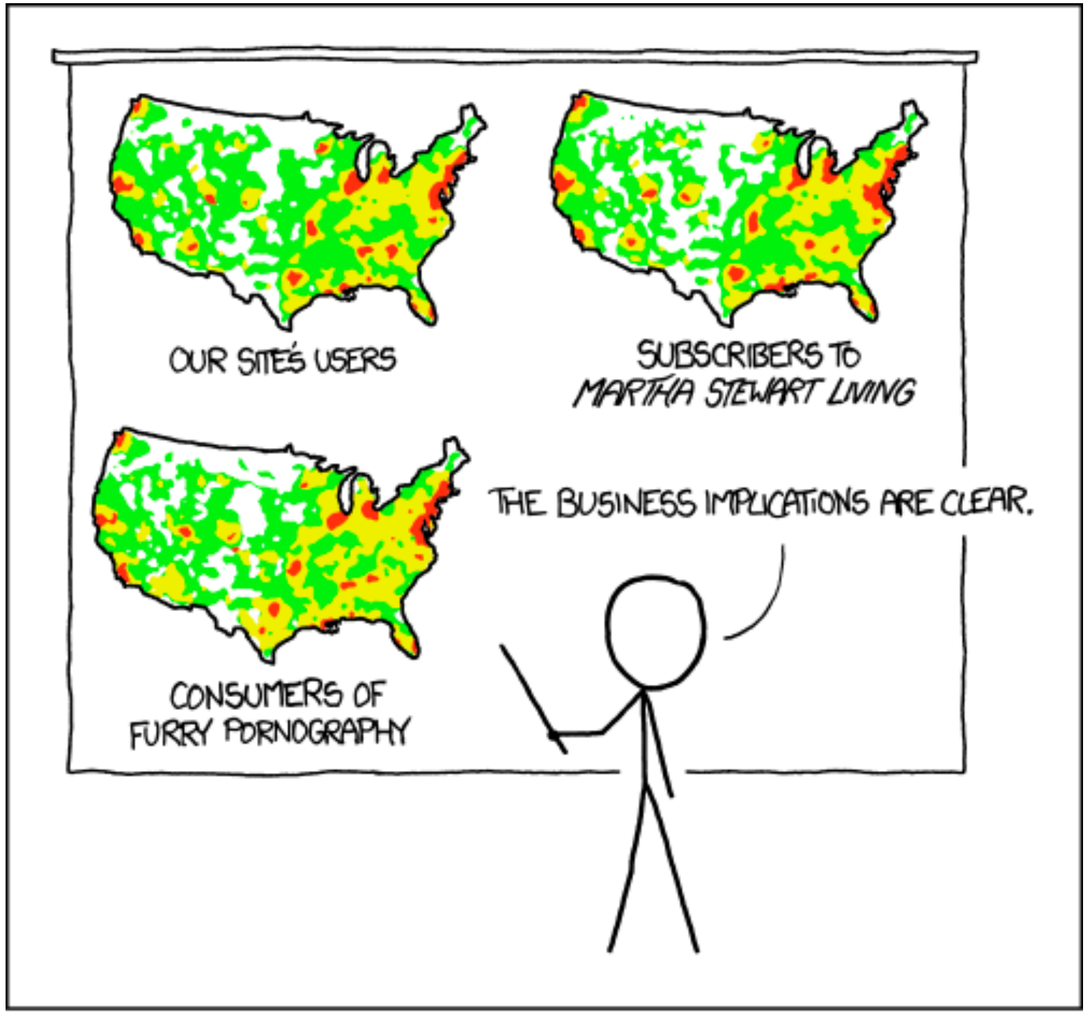
- *use* given spatial data
  - when central task is understanding spatial relationships
- data
  - geographic geometry
  - table with 1 quant attribute per region
- encoding
  - use given geometry for area mark boundaries
  - sequential segmented colormap
- trickiness
  - small regions are less visually salient



http://bl.ocks.org/mbostock/4060606

Population maps trickiness

- beware!
- absolute vs relative again
  - population density vs per capita
- investigate with Ben Jones Tableau Public demo
  - http://public.tableau.com/profile/ben.jones#!/vizhome/PopVsFin/PopVsFin
    Are Maps of Financial Variables just Population Maps?
    - yes, unless you look at per capita (relative) numbers

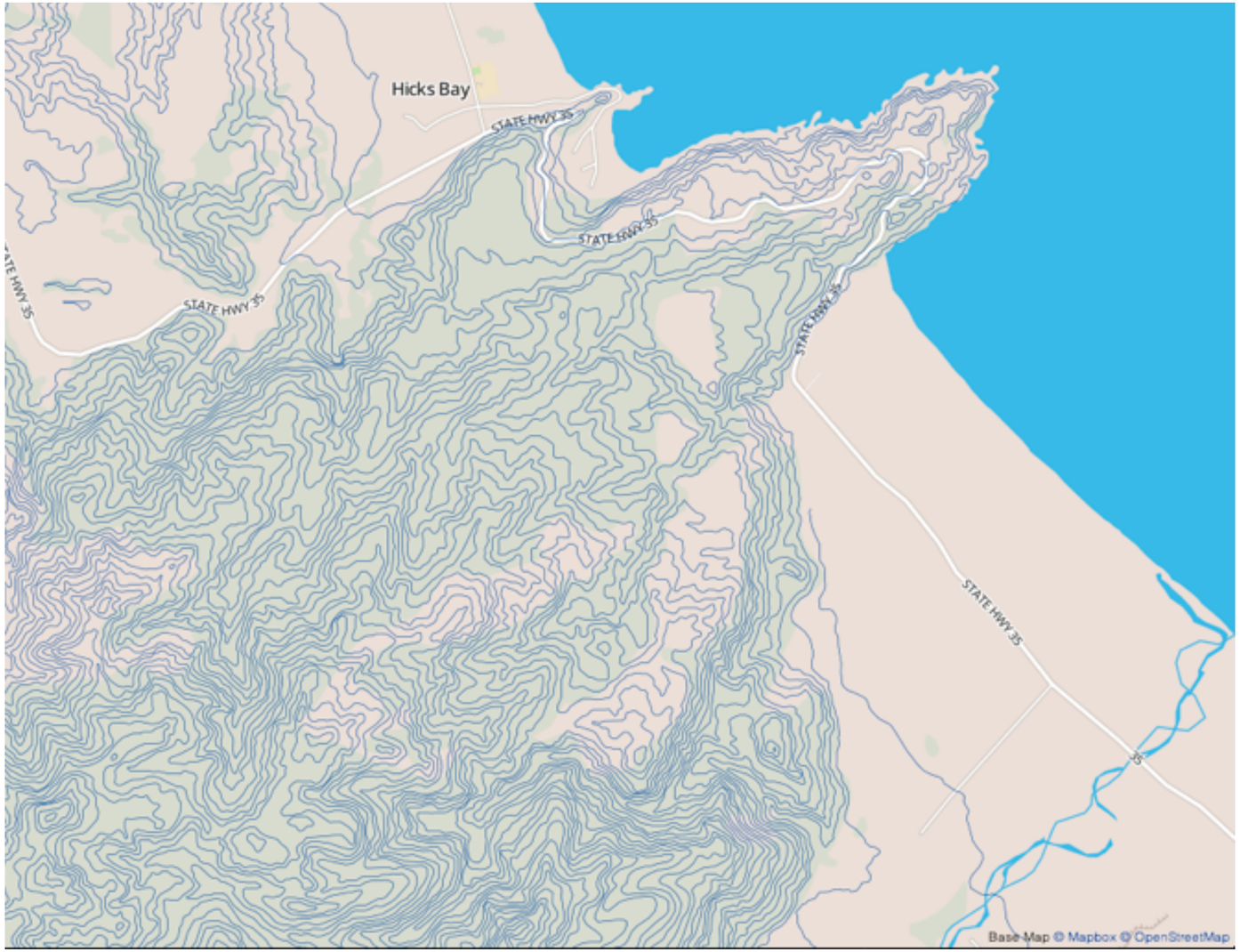


PET PEEVE #208:
GEOGRAPHIC PROFILE MAPS WHICH ARE BASICALLY JUST POPULATION MAPS

[https://xkcd.com/1138]

Idiom: **topographic map**

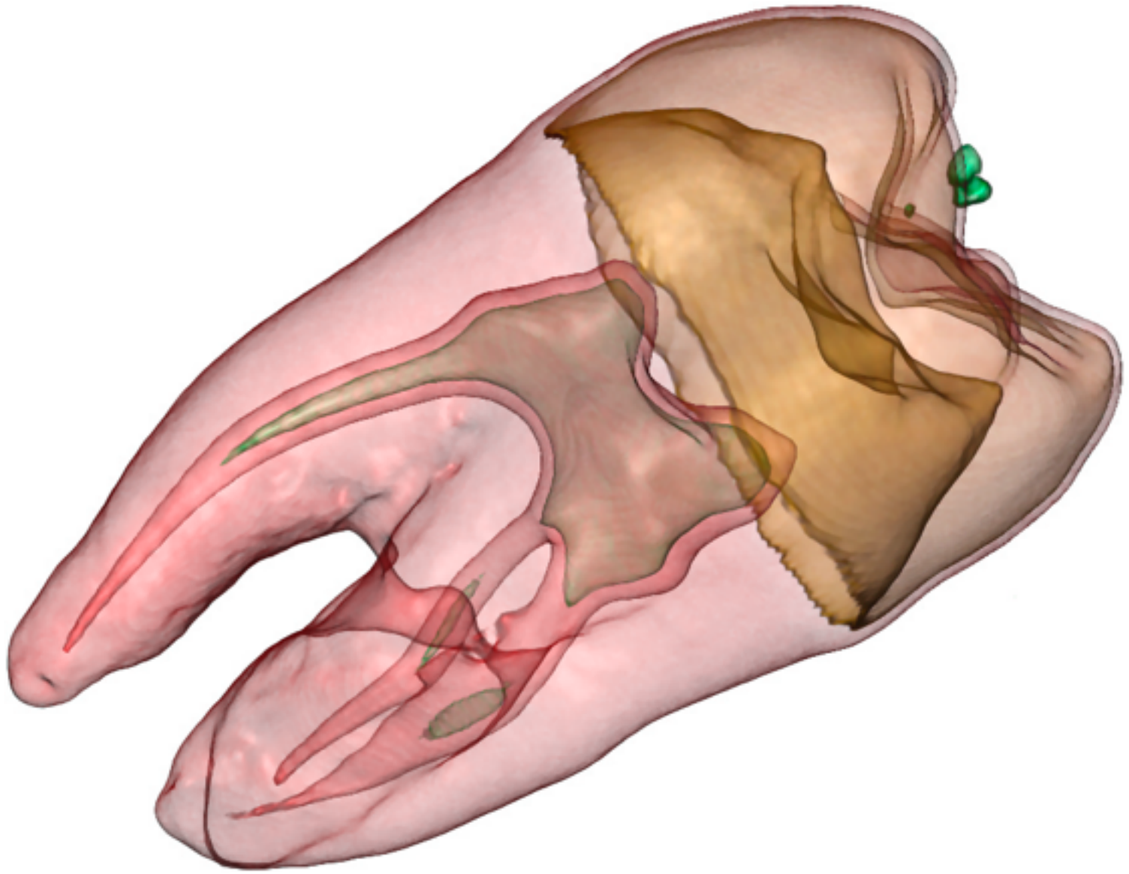
- data
  - geographic geometry
  - scalar spatial field
    - 1 quant attribute per grid cell
- derived data
  - isoline geometry
    - isocontours computed for specific levels of scalar values



Land Information New Zealand Data Service

Idiom: **isosurfaces**

- data
  - scalar spatial field
    - 1 quant attribute per grid cell
- derived data
  - isosurface geometry
    - isocontours computed for specific levels of scalar values
- task
  - spatial relationships



[Interactive Volume Rendering Techniques. Kniss. Master's thesis, University of Utah Computer Science, 2002.]

Demo 2: Intro to Maps

- Tableau Lessons
  - handling spatial data
  - multiple data sources
  - paths on maps
  - more on handling missing data: filtering

- Big Ideas
  - integrating visual encoding design choices with given spatial data

Assignment 3: Start in

- Drought and Deluge

- choose dataset to analyze and write about