Week 3: Color, Spatial Data

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http://www.cs.ubc.ca/~tmm/courses/journ15

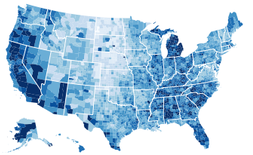
VAD Chap 8: Arrange spatial data

- 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)*
      - *Flow Glyphs (local)*
      - *Geometric (sparse seeds)*
      - *Textures (dense seeds)*
      - *Features (globally derived)*



Idiom: **choropleth map**

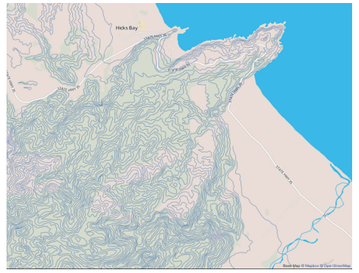
- ***use*** given spatial data
  - when central task is understanding spatial relationships
- data
  - geographic geometry
  - table with 1 quant attribute per region
- encoding
  - use given geometry for area mark boundaries
  - sequential segmented colormap



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

Idiom: **topographic map**

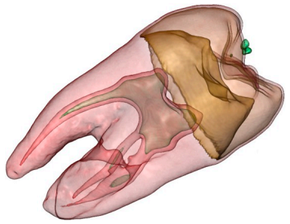
- data
  - geographic geometry
  - scalar spatial field
    - 1 quant attribute per grid cell
- derived data
  - isoline geometry
    - isocontours computed for specific levels of scalar values



Land Information New Zealand Data Service

Idiom: **isosurfaces**

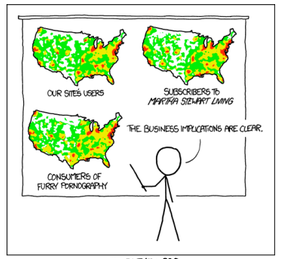
- data
  - scalar spatial field
    - 1 quant attribute per grid cell
- derived data
  - isosurface geometry
    - isocontours computed for specific levels of scalar values
- task
  - spatial relationships



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

Population maps trickiness

- beware!



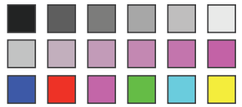
PET PEEVE #208:
GEOGRAPHIC PROFILE MAPS WHICH ARE BASICALLY JUST POPULATION MAPS

[https://xkcd.com/1138]

VAD Chap 10: Color

- 3 channels
  - identity for categorical
    - hue
  - magnitude for ordered
    - luminance
    - saturation
- transparency
  - useful for creating visual layers
    - but cannot combine with luminance or saturation

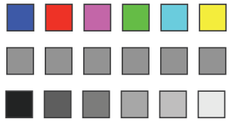
Luminance
Saturation
Hue



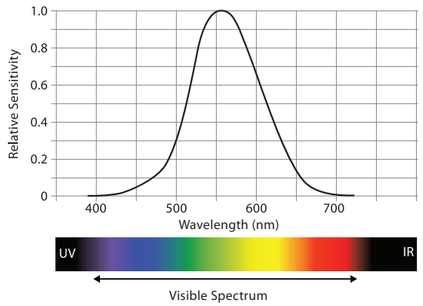
Other color spaces

- RGB: poor choice for visual encoding
- HSL: better, but beware
  - lightness ≠ luminance

Corners of the RGB color cube
L from HLS
All the same
Luminance values

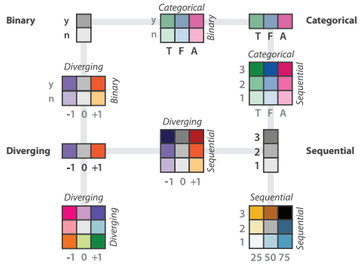


Spectral sensitivity



Colormaps

- Categorical
- Ordered
  - Sequential
  - Diverging
- Bivariate

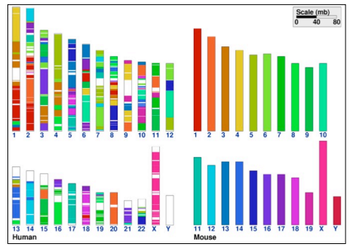


- categorical limits: noncontiguous
  - 6-12 bins hue/color
    - far fewer if colorblind
  - 3-4 bins luminance, saturation
  - size heavily affects salience
    - use high saturation for small regions, low saturation for large

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

Categorical color: Discriminability constraints

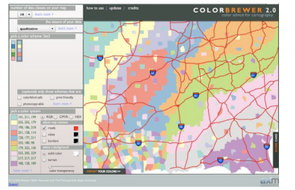
- noncontiguous small regions of color: only 6-12 bins

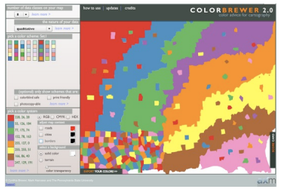


[Cinteny: flexible analysis and visualization of synteny and genome rearrangements in multiple organisms. Sinha and Meller. BMC Bioinformatics, 8:82, 2007.]

ColorBrewer

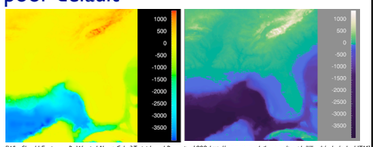
- http://www.colorbrewer2.org
- saturation and area example



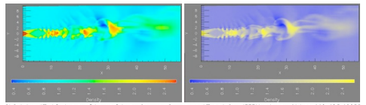


Ordered color: Rainbow is poor default

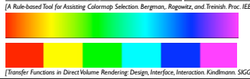
- problems
  - perceptually unordered
  - perceptually nonlinear
- benefits
  - fine-grained structure visible and nameable
- alternatives
  - fewer hues for large-scale structure
  - multiple hues with monotonically increasing luminance for fine-grained
  - segmented rainbows good for categorical, ok for binned



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



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



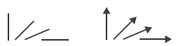
[Transfer Functions in Direct Volume Rendering: Design, Interface, Interaction. Kindlmann. SIGGRAPH 2002 Course Notes]

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

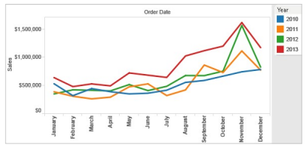
Diverging ordered arrow glyph

Cyclic ordered arrow glyph

Maureen Stone

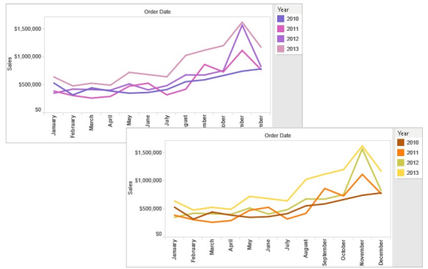
- Tableau Research
  - designer of Tableau color defaults
  - also author of A Field Guide to Digital Color
  - credits: following color slides excerpted from Seriously Colorful: Advanced Color Principles & Practices
    - Tableau Customer Conference 2014 talk

Different colorings tell different stories

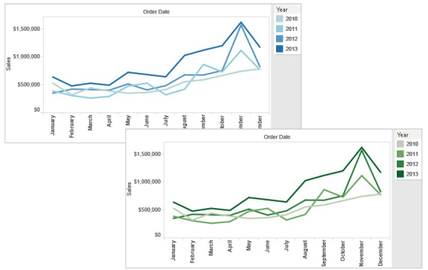


Four distinct categories

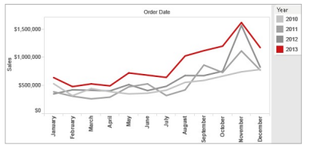
Similar, but still distinctly different



Ordered colors for ordered relationships

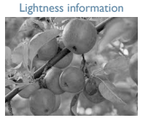


Contrasting color for emphasis



Perceived lightness: Fundamental to vision

Lightness information

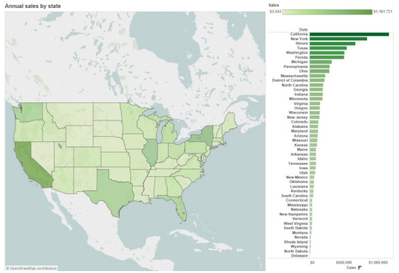


Color information

"Get it right in black and white"

Maps courtesy of the National Park Service (www.nps.gov)

Lightness encodes values



How do we define "lightness"?

Generated lightness: RGB, HSV, HLS

Perceived lightness: Luminance, L* (from CIELAB)

Same generated lightness: B or V, from HSB, HSV
Different perceived lightness: L*, from CIELAB

B = 100
L* = 98

B = 100
L* = 30

Tools for perceived lightness

CIELAB, L*a*b*, Lab, etc.

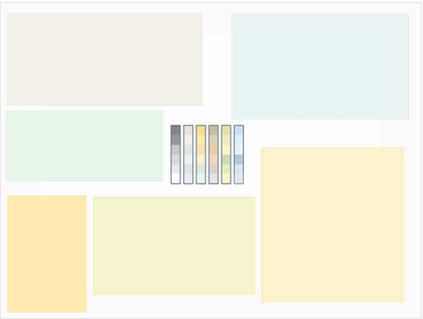
Adobe Creative Suite (gray, Lab)

Gpick (www.gpick.org) Opensource, PC, Unix

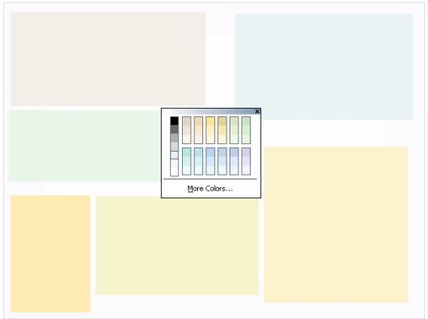
DigitalColor Meter (L*a*b*) Apple desktop utility

By default: Tableau 10 and 20

Size matters



Size matters



OK large, Not so OK small

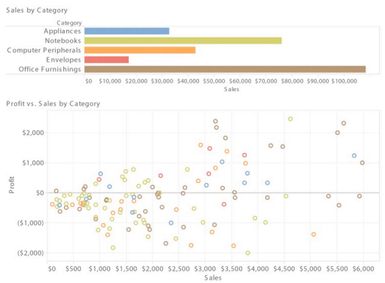
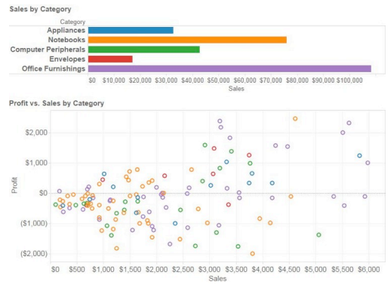
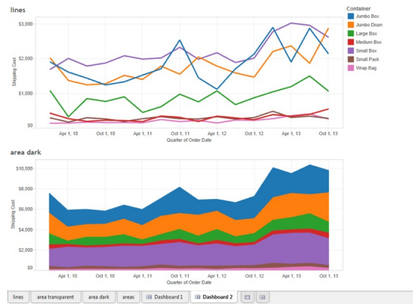


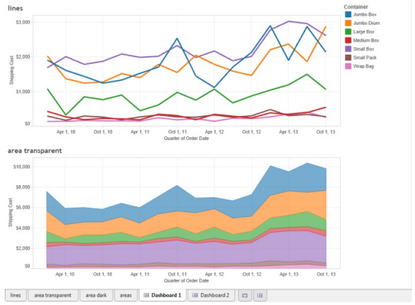
Tableau default



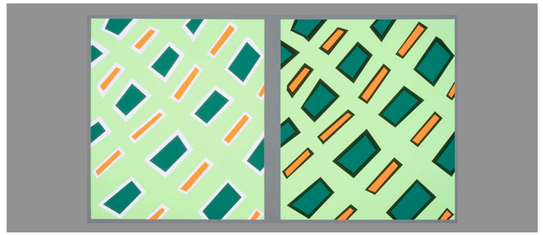
Large area color: Too bright

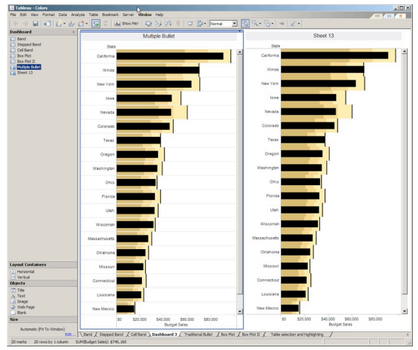


Use transparency to make less bold



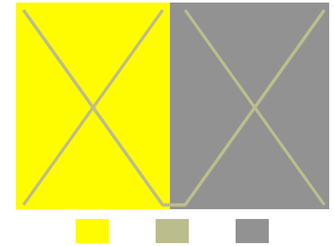
Bezold Effect: Outlines matter





"Color is the most relative medium in art."

—Josef Albers, Interaction of Color



Summary: Understanding color

- Hue, chroma, lightness
- Generated vs. perceived
- Contrast and analogy: Tell your story
- Size, outlines, background all matter

Color vision deficiency (CVD)

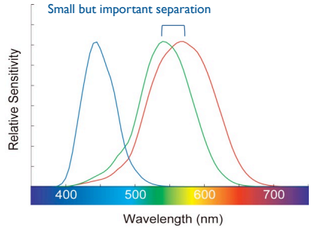
"normal"

Affects 8-10% of men

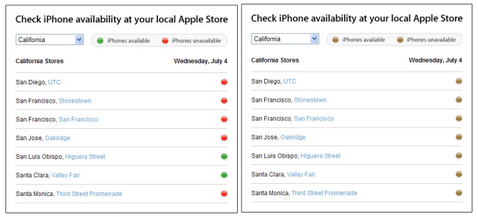
"weak red-green"

Simulation from Coblinder

Most CVD involves problems with red-green



When CVD is a problem



Red-green availability icons

As seen by a deuteranope

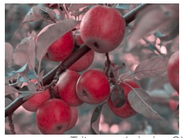
www.iloveux.com

Extreme CVD (Vischeck simulation)

Normal

Protanope (missing L)

Deuteranope (missing M)



Tritanope (missing S)

Reduces color to 2 dimensions

Normal

Protanope

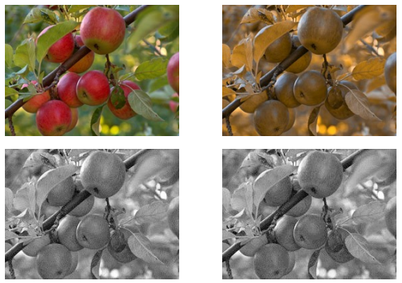
Deuteranope

Tritanope

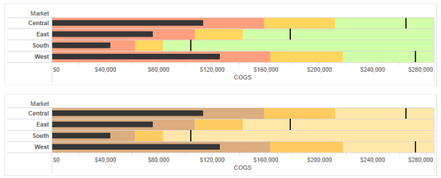
Named colors and CVD

Red-green not the only problem

Similar perception of lightness

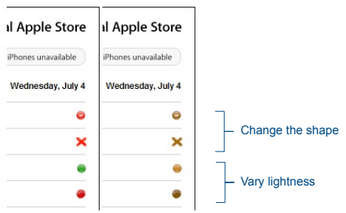


Encode with lightness



Deuteranope simulation

Avoid encoding by color alone



Problem: Genes in Vischeck

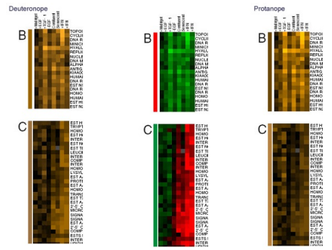


Tableau 10 and CVD

Normal

Mild

Severe

Blue-Orange is “safe”

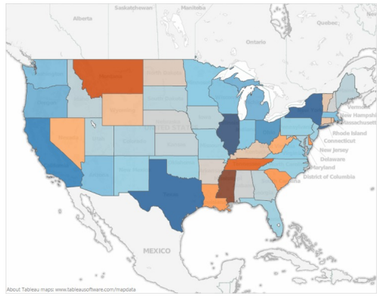


Tableau and CVD: Colorblind palette

Making “traffic light” colors work

Deuteranope simulation

Summary: Designing for CVD

- Blue-orange-gray “safe”
- Encode with lightness
- Double-encode where it really matters

CVD Simulation

- Built into some Adobe tools
- Coblis: http://www.color-blindness.com/coblis-color-blindness-simulator/

Tableau color design principles

Focus on data, not color design

Defaults encode best practices

Support multiple views, multiple mark types

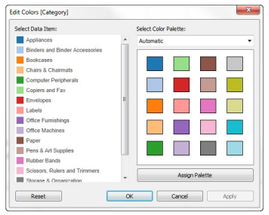
Encourage best practices, allow personal expression

Overview

Discrete palettes and continuous ramps
- Design of defaults and UX
- Design alternative choices
- Customized within the UX

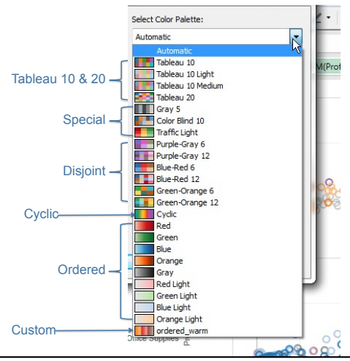
Create your own with XML (preferences.tps)

Discrete data: Palettes

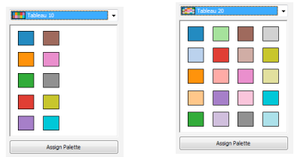


Assign colors to items in categories

Discrete Palettes

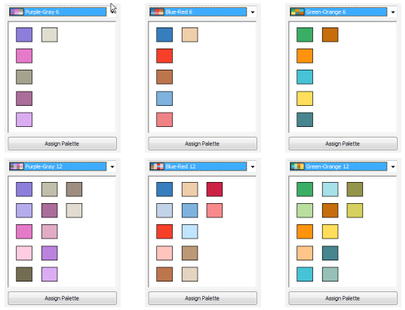


Default: Tableau 10 and 20



Automatic based on cardinality
Order is top-to-bottom, left-to-right

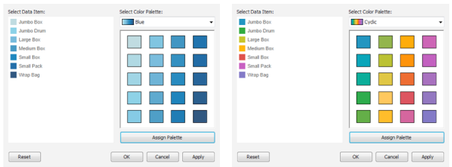
Disjoint Palettes Partition color space



Specials

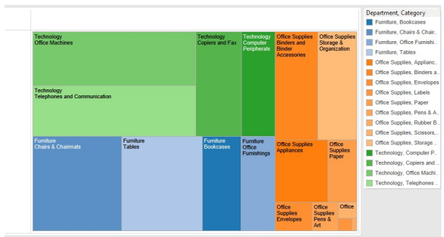
Colorblind Gray 5 Traffic Light

Ordered



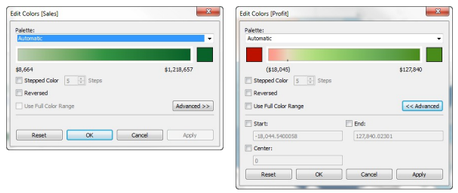
Discrete ramps, distribute across domain

Multiple fields on color



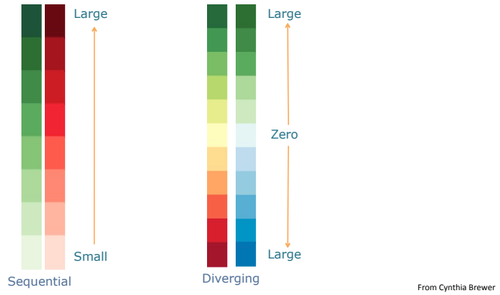
DEMO: CATEGORICAL COLOR

Continuous data: Ramps



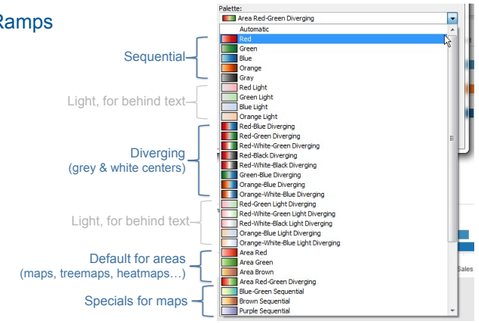
Assign colors to sequences of numeric values

Learn from Cartographers

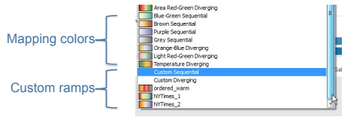


From Cynthia Brewer

Color Ramps



Color Ramps (continued)



DEMO: QUANTITATIVE COLOR

Preferences.tps

XML file

<color-palette > tag with name and type

```
<color-palette name='flame' type= 'ordered-sequential'>
    <color>#FFEF3A</color>
    <color>#FED724</color>
    <color>#FEAC0A</color>
    <color>#ED6211</color>
    <color>#E03D1A</color>
    <color>#CC0629</color>
 </color-palette>
```

regular
ordered-diverging
ordered-sequential

Summary

Color vision and design principles

Tableau principles

- Focus on the data
- Design your color "story"
- Consider size, legibility

Don't forget those with CVD

mstone@tableausoftware.com

Further reading

- Visualization Analysis and Design. Tamara Munzner. CRC Press, 2014.
  - *Chap 10: Map Color and Other Channels*
  - *Chap 8: Arrange Spatial Data*
- A Field Guide to Digital Color. Maureen Stone. AK Peters 2003.

Now

- Break (15 min)
- Demo (30 min)
  - Continue with color, add Tableau walkthroughs
- Lab 3 (45 min)

Lab/Assignment 3

- Work through two Stevens tutorials
- Work through two Stone color demos
- Apply color principles to three datasets from previous two labs
- submit next week
  - by 9am Tue, email tmm@cs.ubc.ca with subject JOURN Week 3