Data Visualization
-
Visual Encoding

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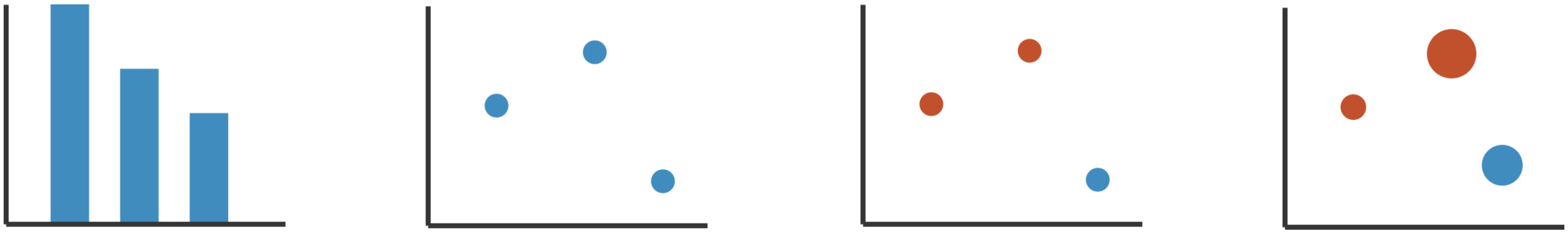
Visual encoding

- Data abstraction always uses a visual encoding

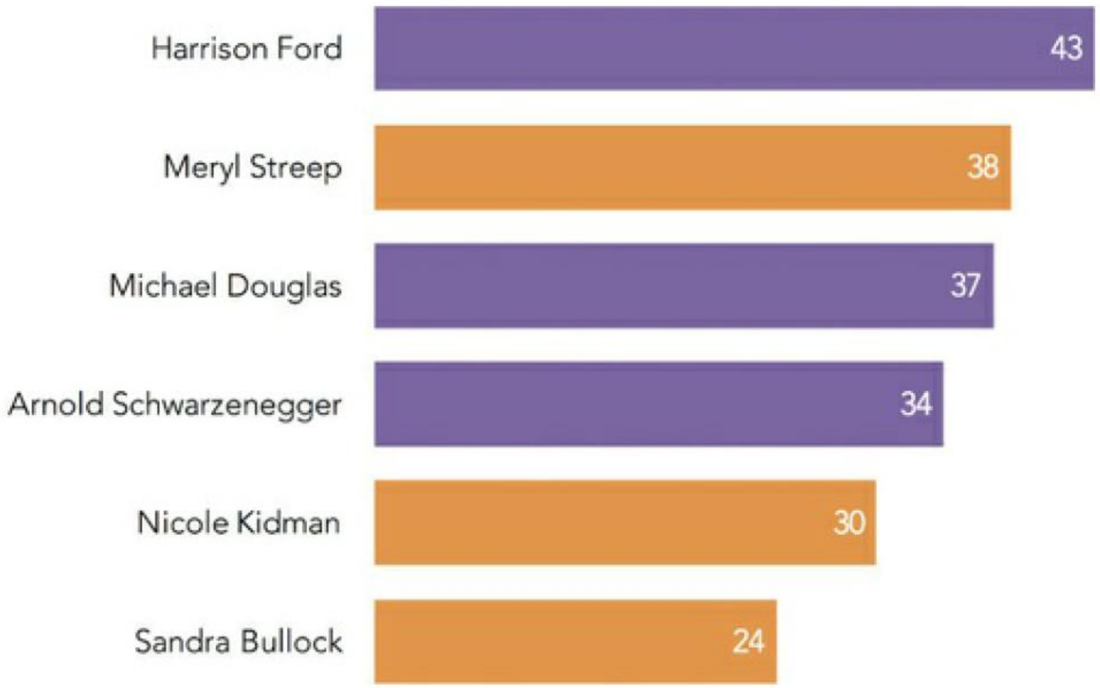


(a) Bar charts encode two attributes using
a line mark with the vertical spatial position channel for the quantitative attribute,
and the horizontal spatial position channel for the categorical attribute.
(b) Scat-terplots encode two quantitative attributes using point marks and both vertical and horizontal spatial position.
(c) A third categorical attribute is encoded by adding color to the scatterplot.
(d) Adding the visual channel of size encodes a fourth quantitative attribute as well.

Visual encoding - examples

Figure 6.1 Illustration of Visual Encoding

ACTOR	GENDER	YEARS SINCE FIRST MOVIE
Harrison Ford	Male	43
Meryl Streep	Female	38
Michael Douglas	Male	37
Arnold Schwarzenegger	Male	34
Nicole Kidman	Female	30
Sandra Bullock	Female	24



Andy Kirk, Data Visualisation A Handbook

Visual encoding - examples

Figure 1.4 Two graphical methods for showing the same set of relationships between entities.

How to systematically analyze idiom structure?

- Marks are basic geometric elements that depict items or links
- Channels control their appearance

The effectiveness of a channel for encoding data depends on its type

Marks

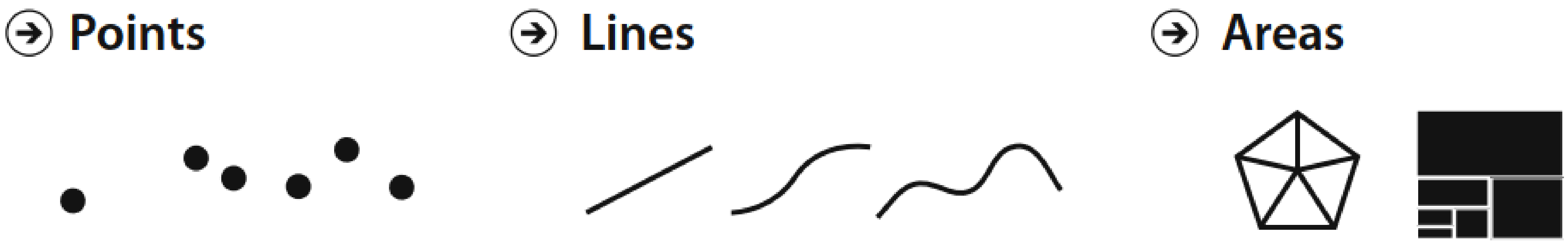
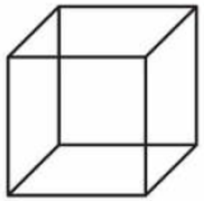


Figure 5.2. Marks are geometric primitives.

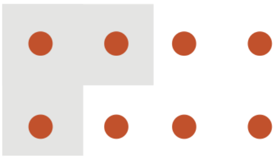
a zerodimensional (0D) mark is a point, a one-dimensional (1D) mark is a line, and a two-dimensional (2D) mark is an area. A threedimensional (3D) volume mark is possible, but they are not frequently used.

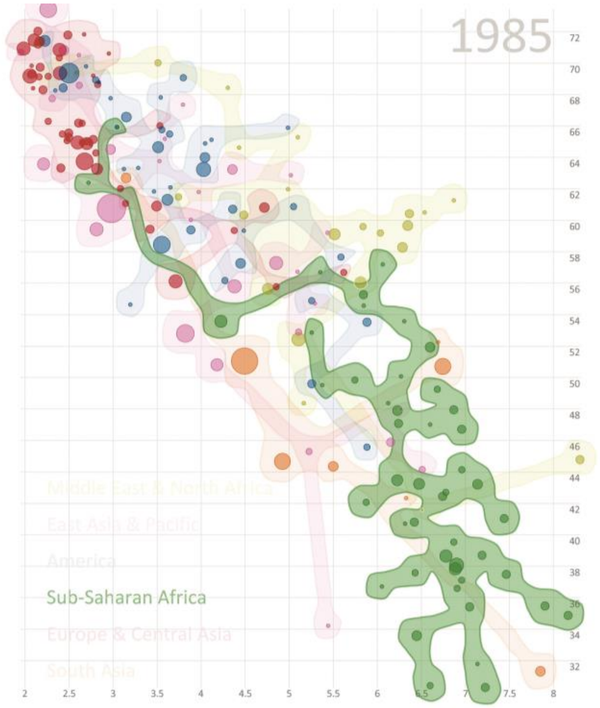
Marks

MARK	EXAMPLE	DESCRIPTION
Point		The *point* mark has no variation ('constant') in the spatial dimension. It is largely a placeholder commonly used to represent a quantity through position on a scale, forming the basis of, for example, scatter plots.
Line		The *line* mark has one ('linear') spatial dimension. It is commonly used to represent quantitative value through variation in size, forming the basis of, for example, the bar chart.
Area		The *area* mark has two ('quadratic') spatial dimensions. It is commonly used to represent quantitative values through variation in size and position, forming the basis of, for example, bubble plots.
Form		The *form* mark has three ('cubic') spatial dimensions. It might be used to represent quantitative values through variation in size (specifically, through volume), forming the basis of, for example, a 3D proportional shape chart.

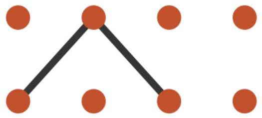
Marks

➔ Containment



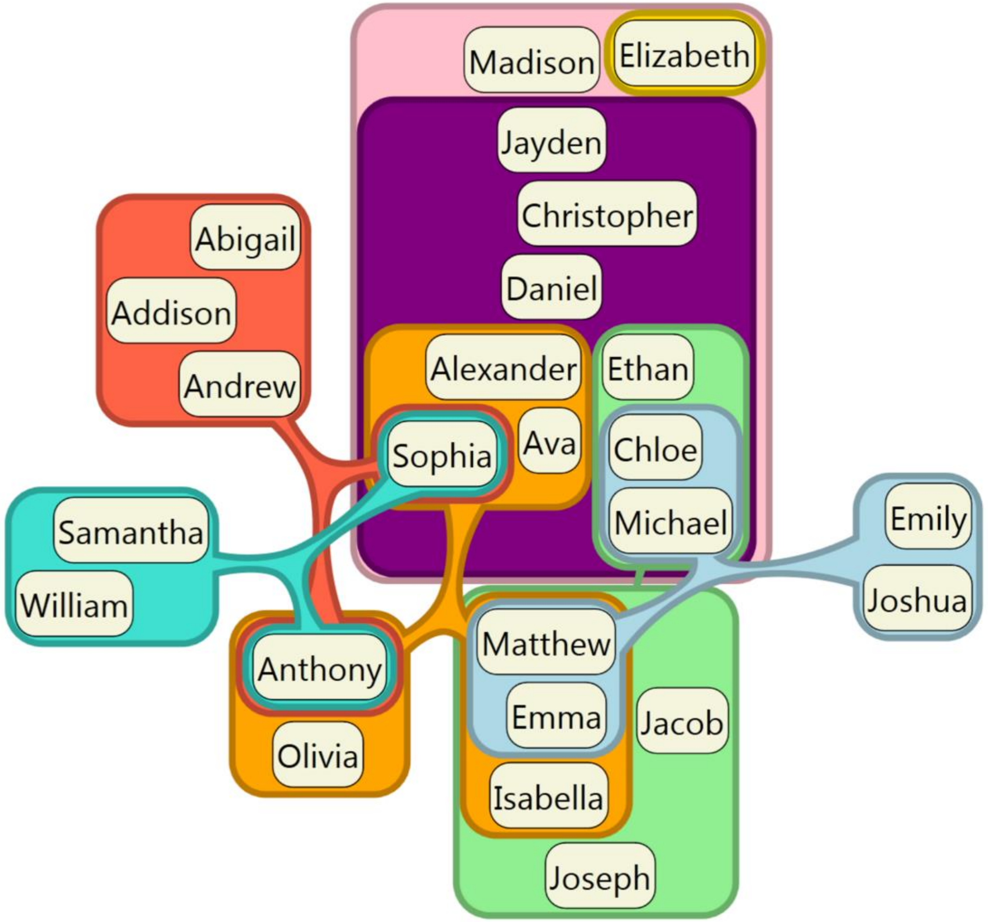


➔ Connection



Marks can represent individual items or the links in between

Containment can be nested



[Untangling Euler Diagrams, Riche and Dwyer, 2010]

Channel

- Many different words for a common concept

- channel, attribute, dimension, variable, feature, and carrier

Expressiveness

- The expressiveness principle dictates that the visual encoding should express all of, and only, the information in the dataset attributes.

- The identity channels are the correct match for the categorical attributes that have no intrinsic order.
- The magnitude channels are the correct match for the ordered attributes, both ordinal and quantitative.

Effectiveness

- The effectiveness principle dictates that the importance of the attribute should match the salience of the channel; that is, its noticeability.

- the most important attributes should be encoded with the most effective channels in order to be most noticeable
- decreasingly important attributes can be matched with less effective channels

Channels

- The term channel is independent of the dimensionality of the geometric primitive.

- channel properties differ by type and amount of information that can be conveyed to human perceptual system

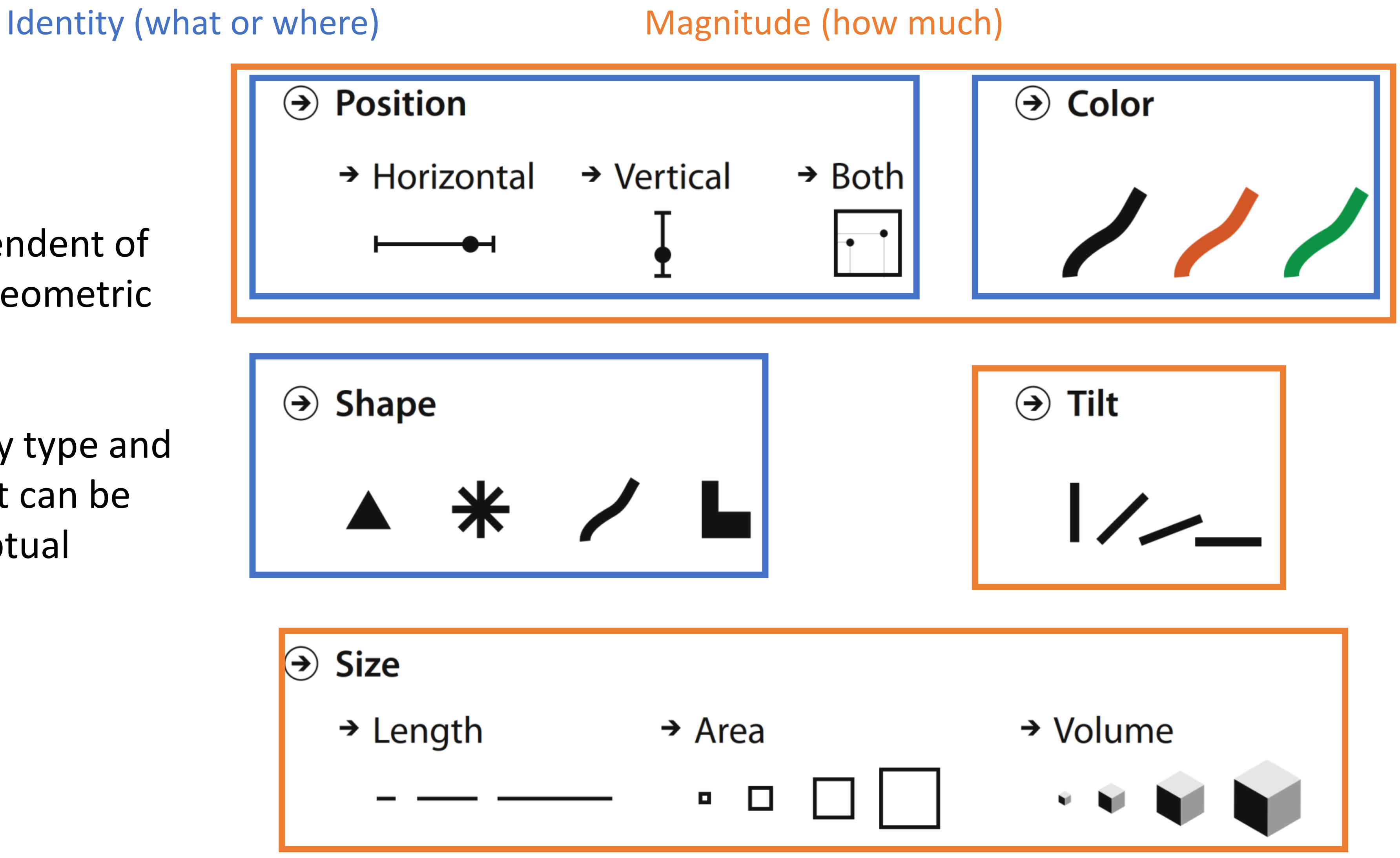
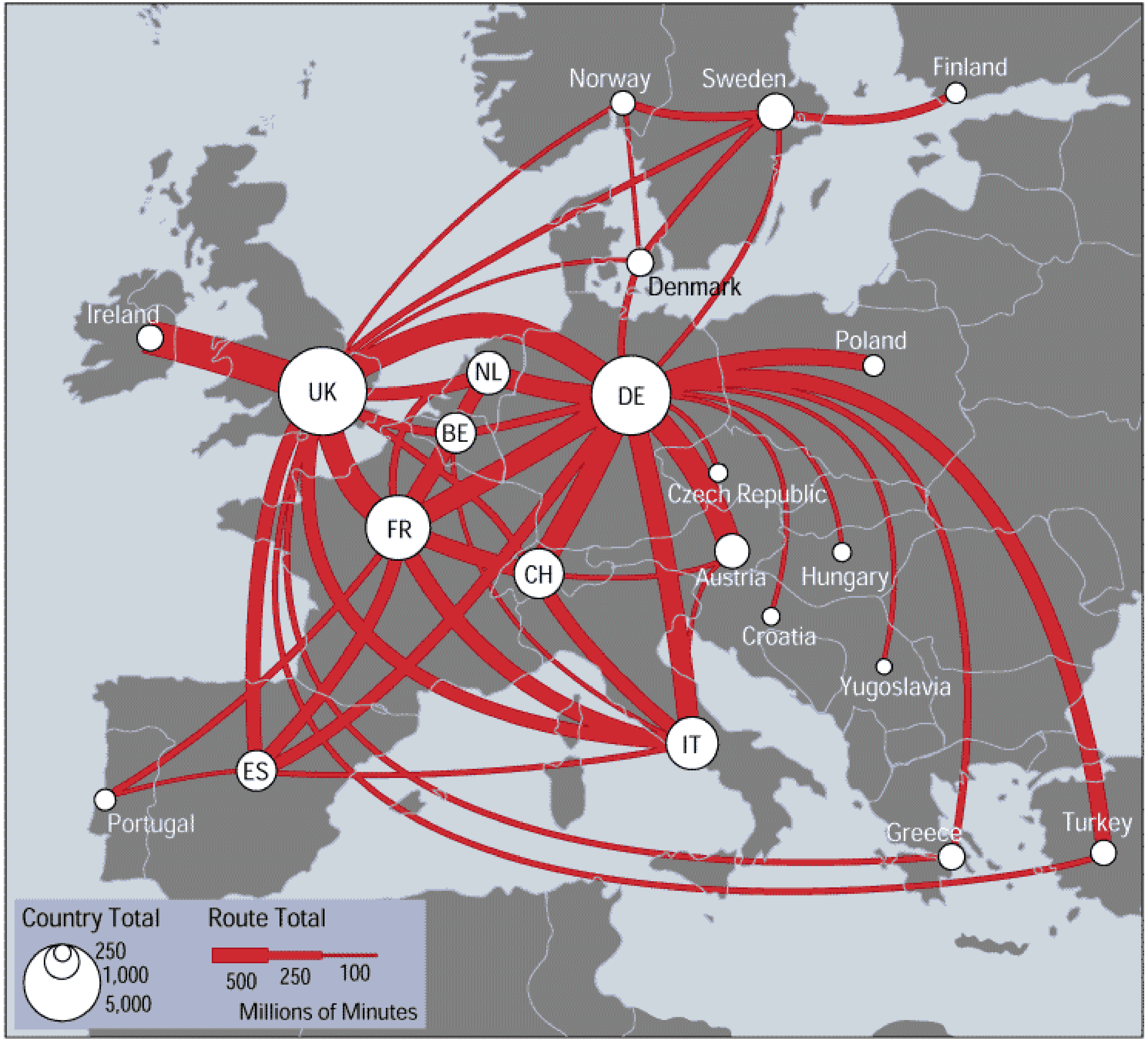
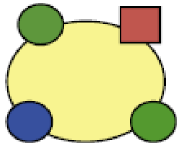
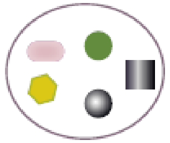
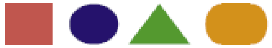


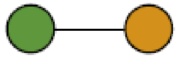
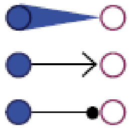
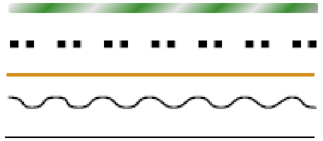
Figure 5.3. Visual channels control the appearance of marks.



Telecom network

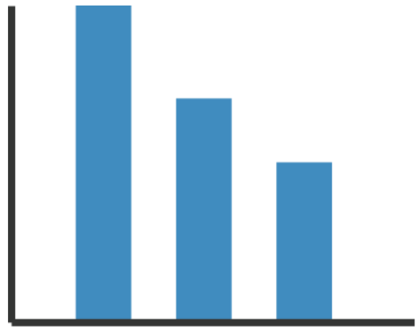
Visual grammar of relationship

Graphical code	Visual instantiation	Semantics
1. Partitioned region		Entity partitions
2. Attached shapes		Part-of relationships
3. Enclosed shapes		Contained entities Part-of relationships
4. Sequence of shapes		Sequence of entities

Graphical code	Visual instantiation	Semantics
5. Linking line		Relationship between entities
6. Asymmetrical connecting graphic		Asymmetrical relationship
7. Line style		Type of relationship
8. Line weight		Strength of relationship
9. Tab shapes with matching receptacles		A fit between components
10. Proximity groupings		Groups of components

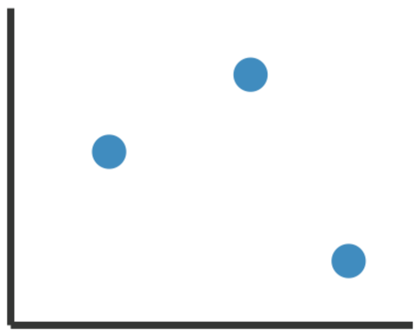
ure 6.62 The visual grammar of relationship representations.

Combination of mark and channels



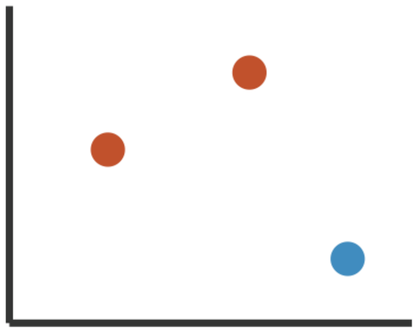
1:
vertical position

mark: line



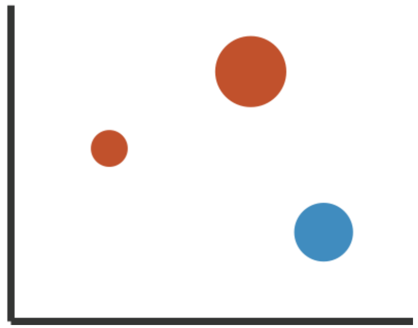
2:
vertical position
horizontal position

mark: point



3:
vertical position
horizontal position
color hue

mark: point



4:
vertical position
horizontal position
color hue
size (area)

mark: point

Charts

- marks and attributes are the **ingredients**
- a chart ‘type’ is the **recipe** offering a predefined template for displaying data
- Different chart types offer different ways of representing data
- unique combinations of marks and attributes onto which specific types of data can be mapped

Bertin, 1967

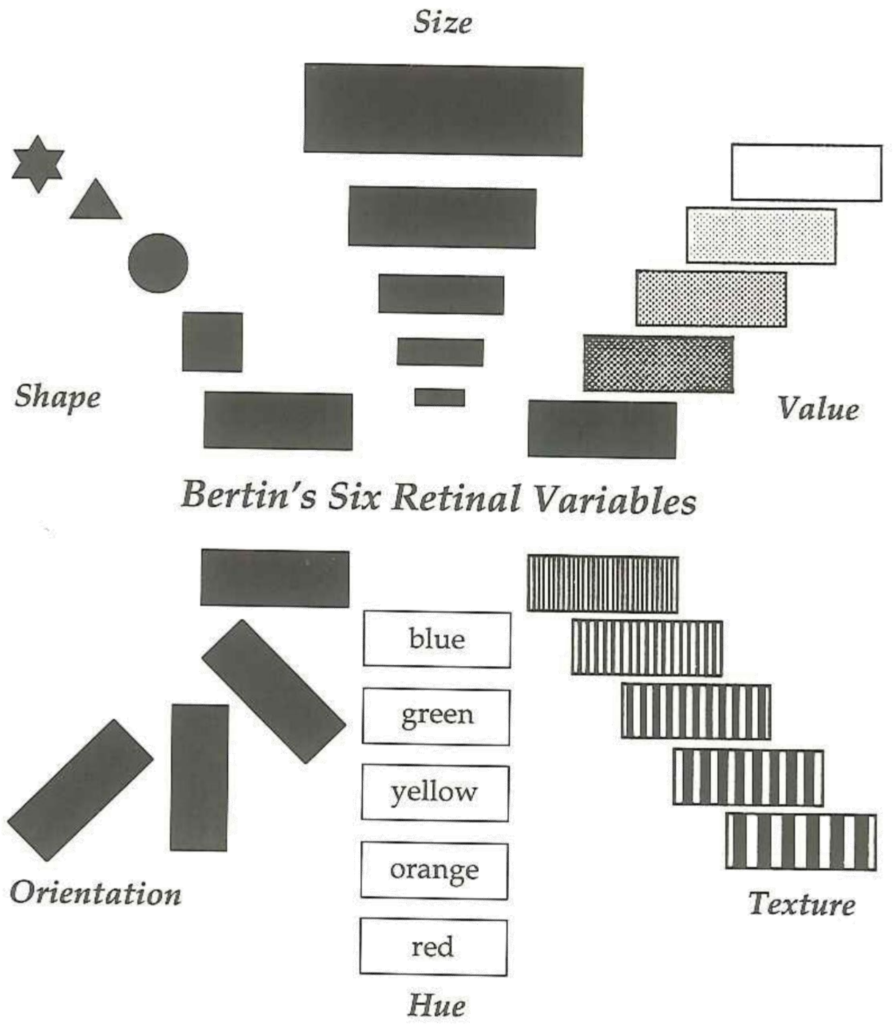
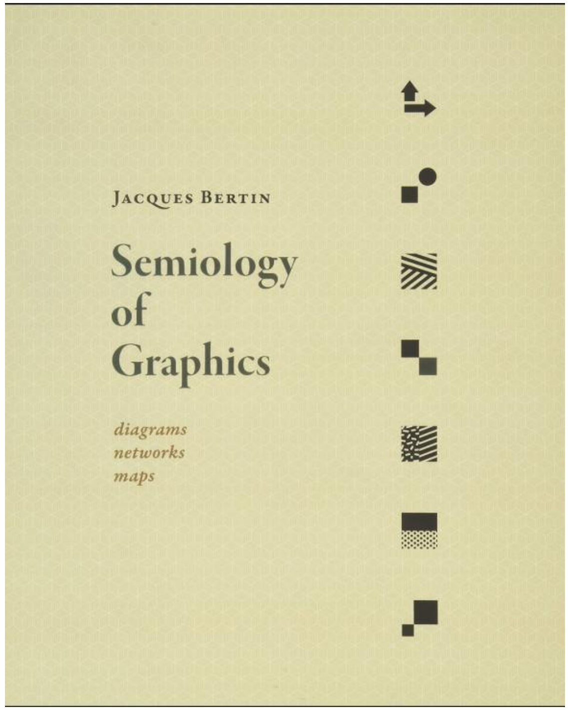
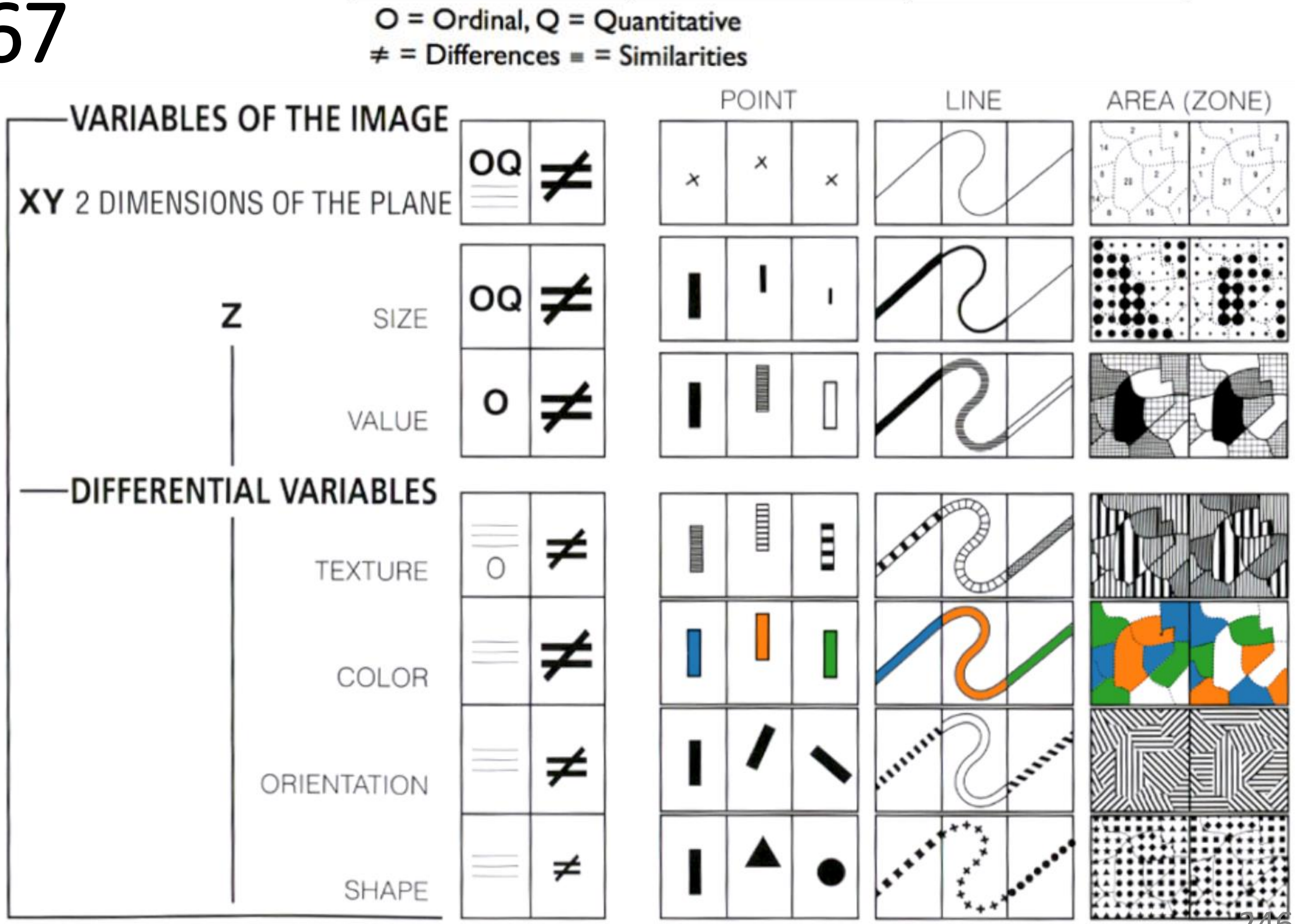


FIGURE 3.1. Bertin's six retinal variables.

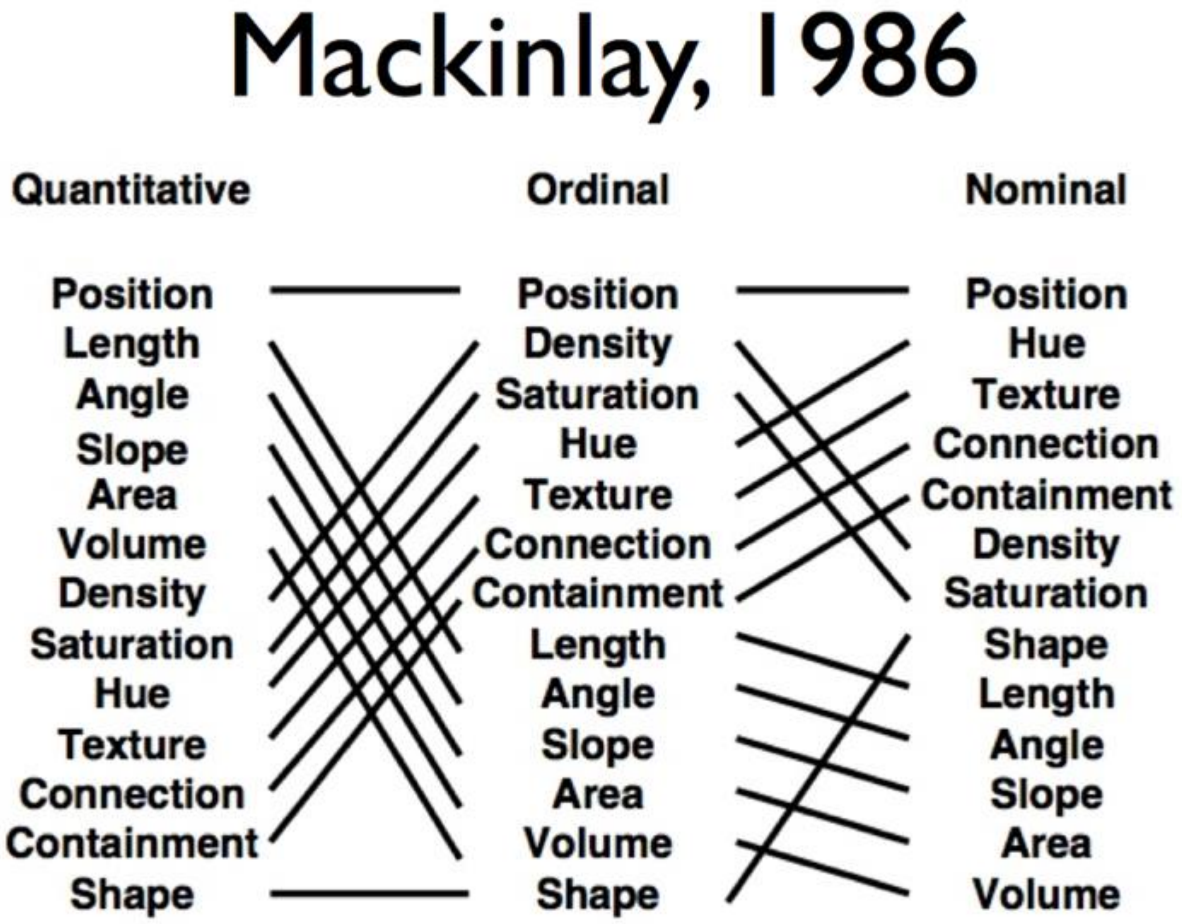


Bertin, 1967



O = Ordinal, Q = Quantitative
≠ = Differences ≡ = Similarities
VARIABLES OF THE IMAGE
XY 2 DIMENSIONS OF THE PLANE
Z
SIZE
VALUE
DIFFERENTIAL VARIABLES
TEXTURE
COLOR
ORIENTATION
SHAPE
POINT
LINE
AREA (ZONE)
OQ
≠
OQ
≠
O
≠
O
≠
≠
≠
≠

Mackinlay, 1986



[Mackinlay, Automating the Design of Graphical Presentations of Relational Information, ACM TOG 5:2, 1986]

Cleveland / McGill, 1984

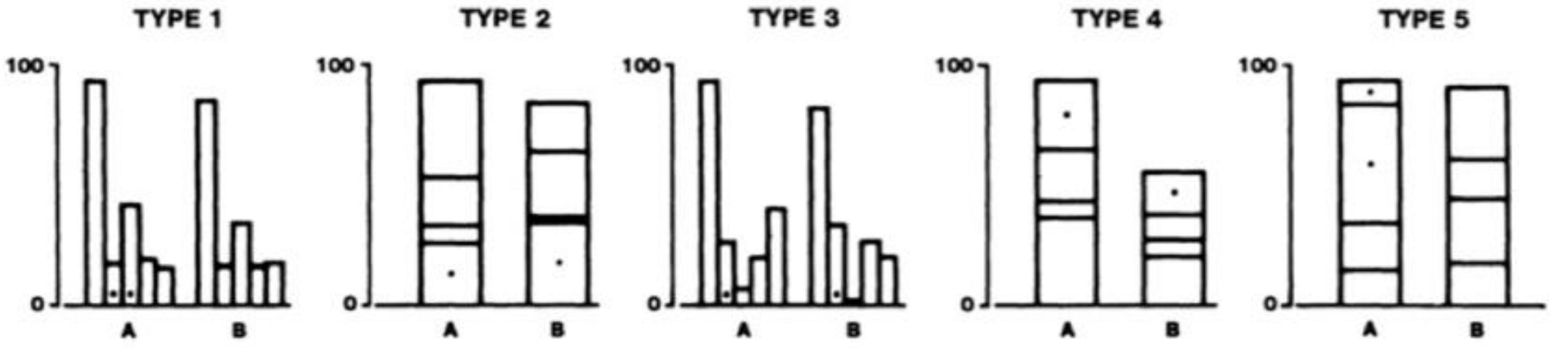


Figure 4. Graphs from position–length experiment.

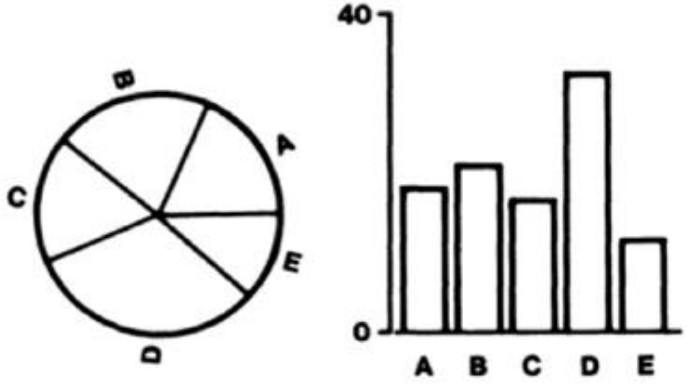


Figure 3. Graphs from position–angle experiment.

William S. Cleveland; Robert McGill , "Graphical Perception: Theory, Experimentation, and Application to the Development of Graphical Methods." 1984

Heer & Bostock, 2010

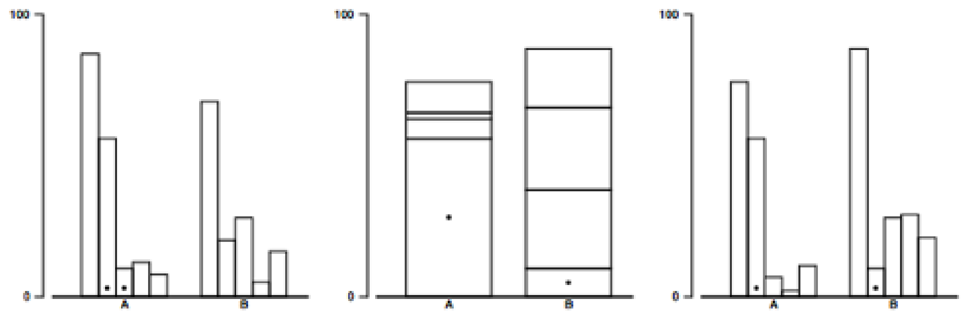


Figure 1: Stimuli for judgment tasks T1, T2 & T3. Subjects estimated percent differences between elements.

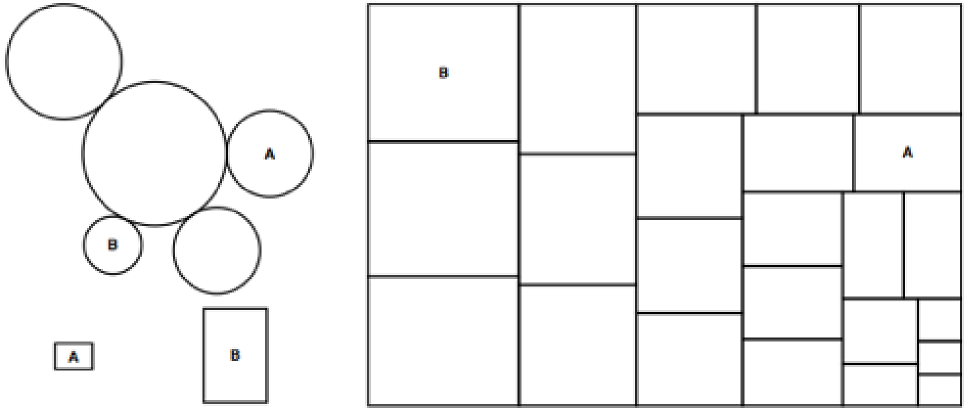


Figure 2: Area judgment stimuli. Top left: Bubble chart (T7), Bottom left: Center-aligned rectangles (T8), Right: Treemap (T9).

Accuracy of channels

- obvious way to quantify effectiveness is accuracy: how close is human perceptual judgement to some objective measurement of the stimulus?

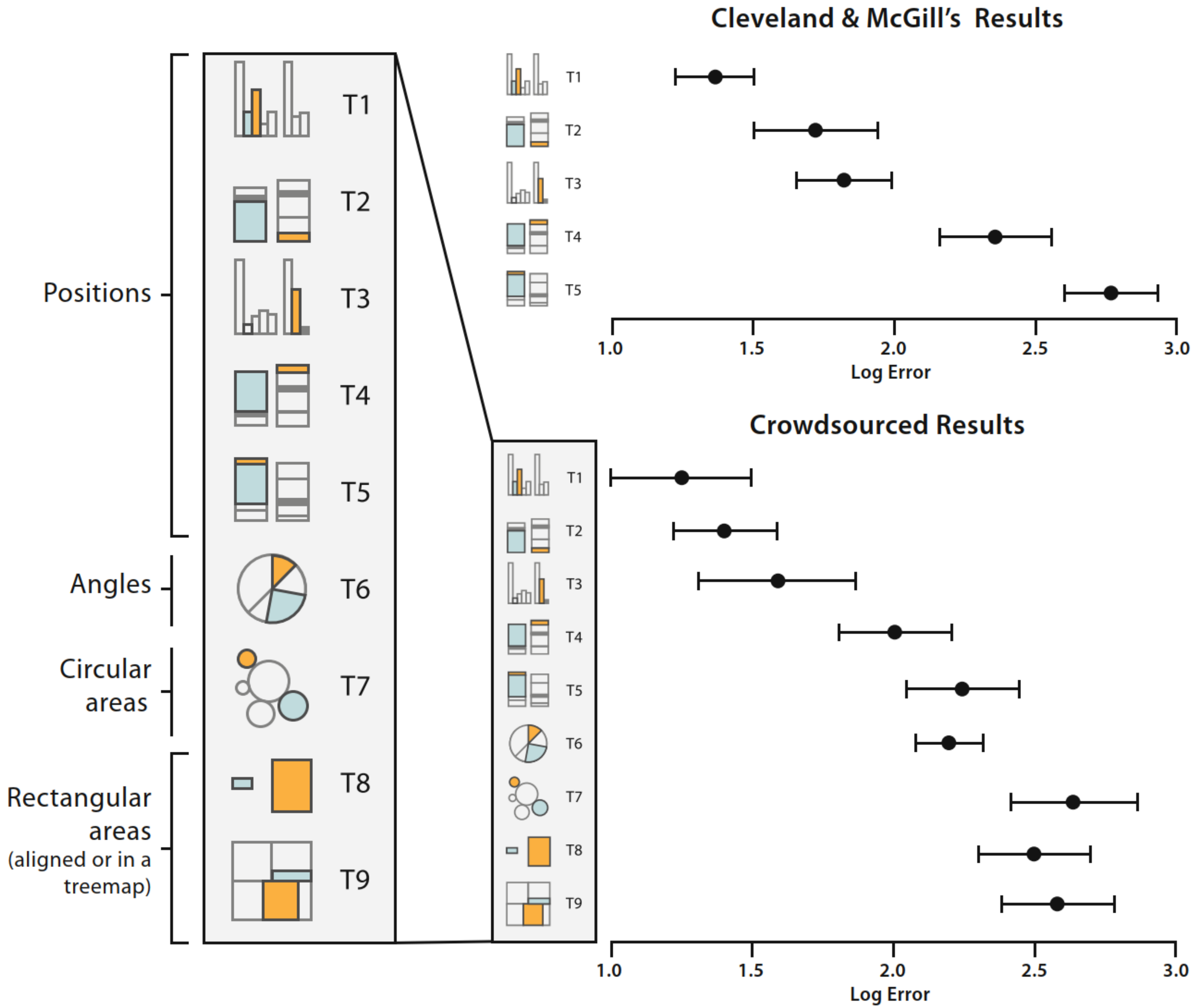


Figure 5.8. Error rates across visual channels, with recent crowdsourced results replicating and extending seminal work from Cleveland and McGill [Cleveland and McGill 84a]. After [Heer and Bostock 10, Figure 4].

Properties and Best Uses of Visual Encodings

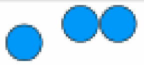
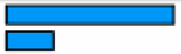
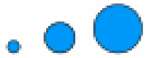
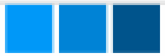
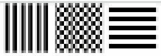
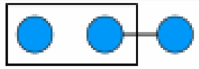
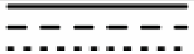
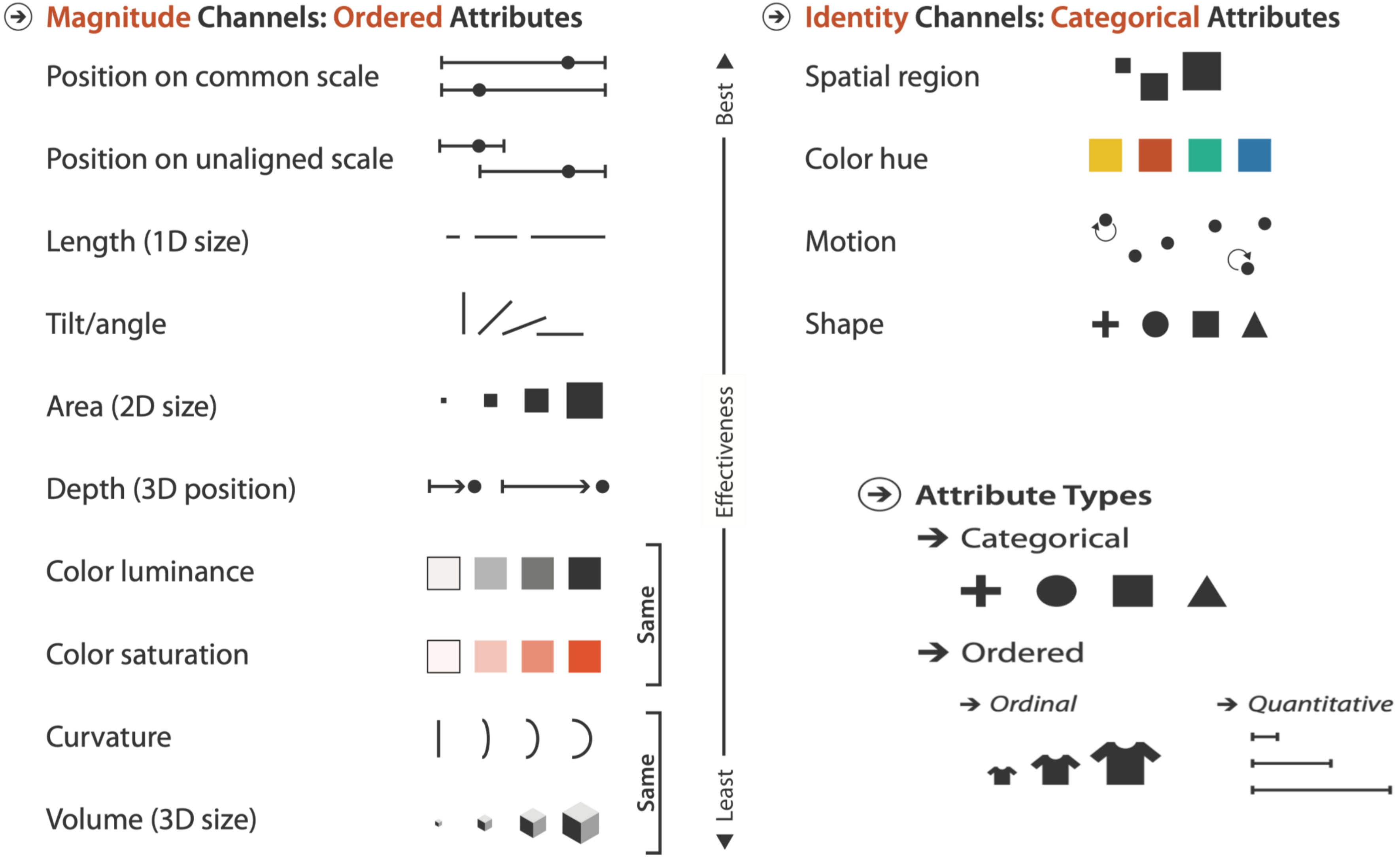
Example	Encoding	Ordered	Useful values	Quantitative	Ordinal	Categorical	Relational
	position, placement	**yes**	**infinite**	Good	Good	Good	Good
1, 2, 3; A, B, C	text labels	**optional** (alphabetical or numbered)	**infinite**	Good	Good	Good	Good
	length	**yes**	**many**	Good	Good		
	size, area	**yes**	**many**	Good	Good		
	angle	**yes**	medium/few	Good	Good		
	pattern density	**yes**	few	Good	Good		
	weight, boldness	**yes**	few		Good		
	saturation, brightness	**yes**	few		Good		
	color	no	few (< 20)			Good	
	shape, icon	no	medium			Good	
	pattern texture	no	medium			Good	
	enclosure, connection	no	**infinite**			Good	Good
	line pattern	no	few				Good
	line endings	no	few				Good
	line weight	**yes**	few		Good		

Table of Visual Attributes

Richard Brath
v. Sept 2013

		Information Visualization Researchers									Vision Rsch	Shape Rsch
		Bertin 1967	Cleveland 1985	MacKinlay 1986	MacEachren 1995	Wilkinson 1999	Ware 2000	Mazza 2009	Iliinsky 2012	Chen, Floridi 2013	Preattentive Perception	Brath 2009/2011
Trans-form	Position	X	X	X	X	X	X	X	X	X		
	Length		X	X			X	X	X	X	X	
	Size (Area)	X	X	X	X	X	X	X	X	X	X	
	Orientation	X		X	X	X	X	X	X	X	X	
	Volume		X	X			X					
Shape	Shape	X		X	X	X	X	X	X	X		X
	Angle		X	X						X		X
	Curvature										X	X
	Mark										X	X
	Line Ending							X	X	3	X	X
	Closure									X	X	X
	Local Warp											X
	Edge Type									1,2		X
	Corner Type									3		X
	Icon, glyph, etc									4		
Colour	Brightness	X		X	X	X	X	X	X	X	X	
	Hue	X	X	X	X	X	X	X	X	X	X	
	Saturation			X	X	X	X	X	X	X		
Texture	Granularity	X		X	X	X	X	X	X	X		
	Pattern					X	X	X	X			
	Orientation					X	X					
Relation	Connection			X				X	X	X		
	Containment			X				X	X			
Optics	Blur				X	X				X		
	Transparency				X	X				X		
	Stereo Depth										X	
	Concavity									X	X	
	Light Direction									X	X	
	Shadow									X		
	Partial occlusion									X		
Move-ment	Flicker						X			X	X	
	Speed						X			X	X	
	Direction									X	X	
Misc	Numerosity									X	X	
	Spatial Grouping									X	X	
	Arrangement				X							
	Resolution				X							
	Artistic Effects										X	
	Text Labels							X	X	X		

Effectiveness and expressiveness of channels



Perception intensity

- Weber's Law
- Not all perception/ senses are equal
- Exponents:

Loudness 0.6

Brightness 0.33

Smell 0.55 (Coffee) - 0.6 (Heptane)

Taste 0.6 (Saccharine) -1.3 (Salt)

Temperature 1.0 (Cold) – 1.6 (Warm)

Vibration 0.6 (250 Hz) – 0.95 (60 Hz)

Duration 1.1

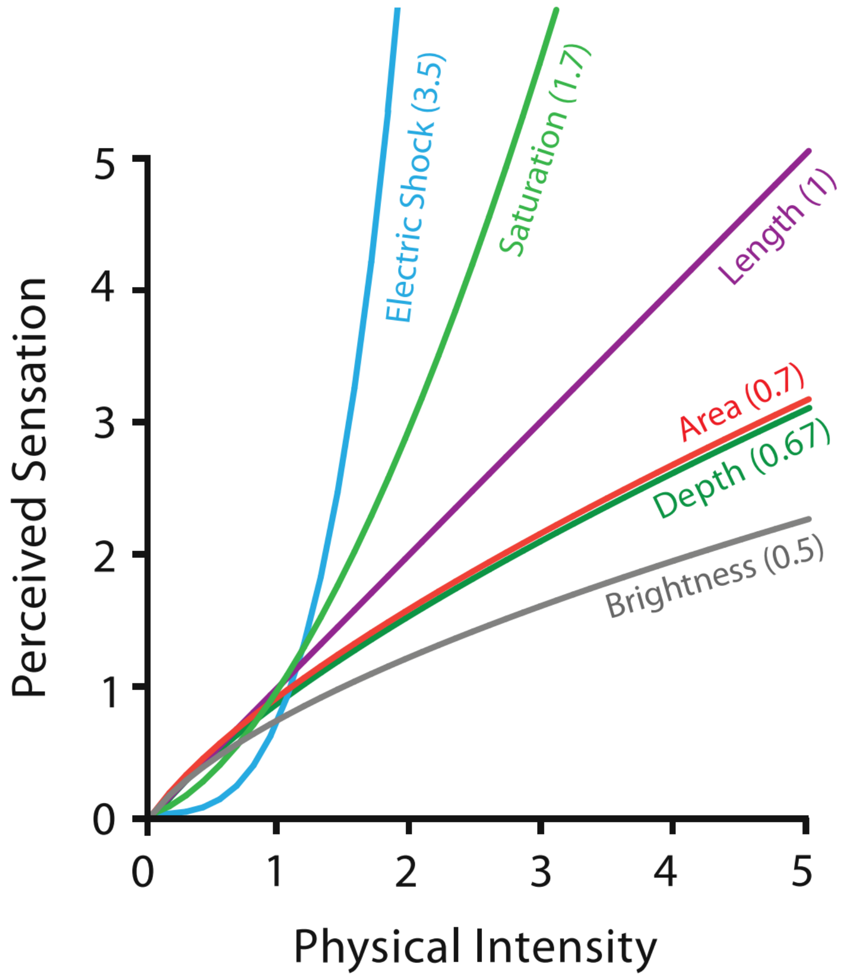
Pressure 1.1

Heaviness 1.45

Electic Shock 3.5

[Psychophysics of Sensory Function, Stevens 61]

Steven's Psychophysical Power Law: $S= I^N$



Absolute values

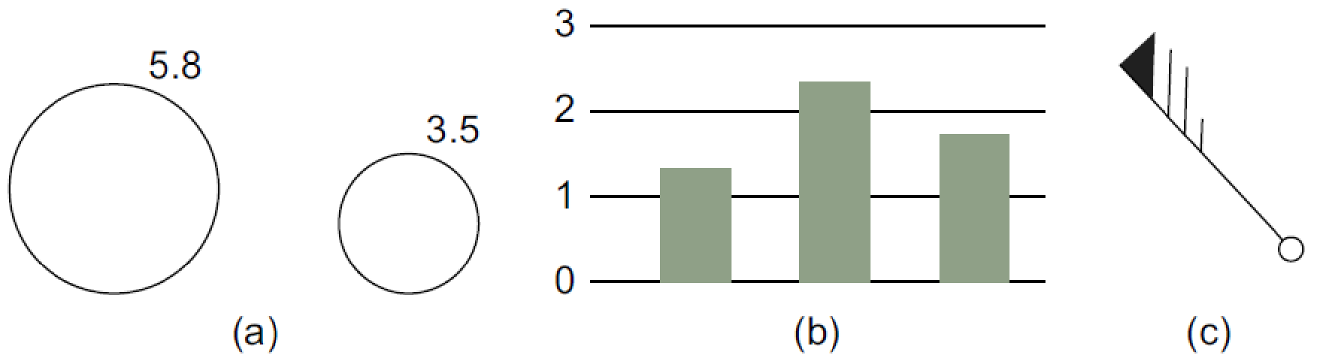


Figure 5.28 Three different ways that more exact numerical values can be read from a diagram. Bar and line graphs should be given faint horizontal lines extending the scale into the background of the chart.

Subitizing

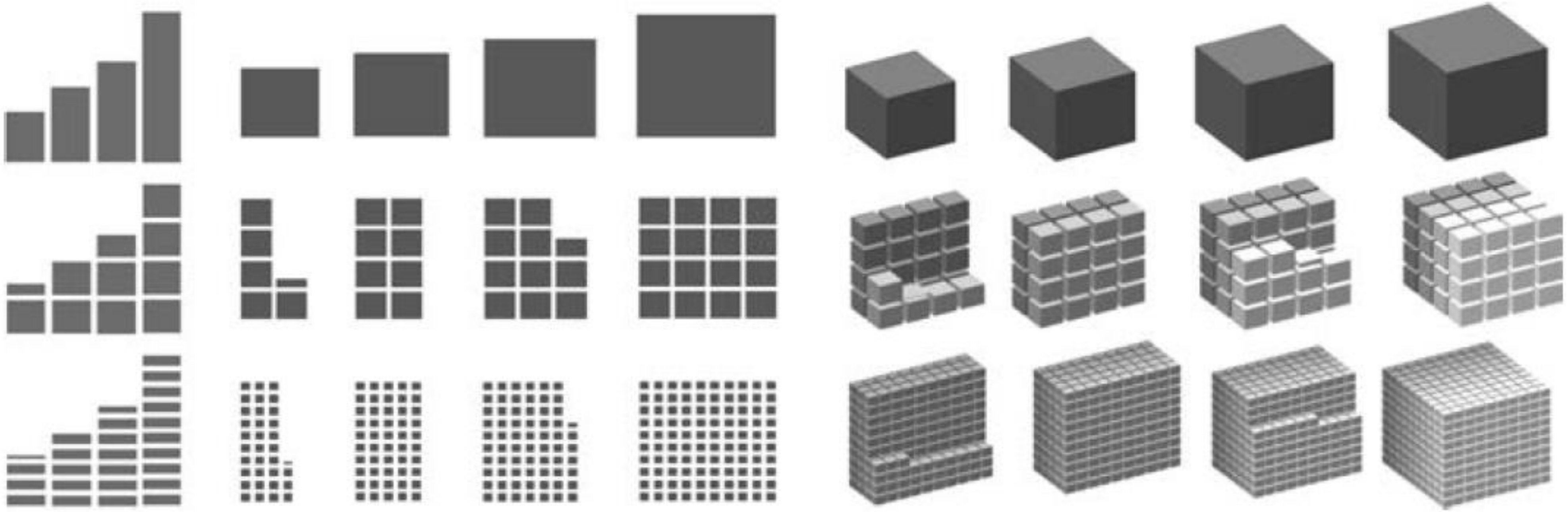
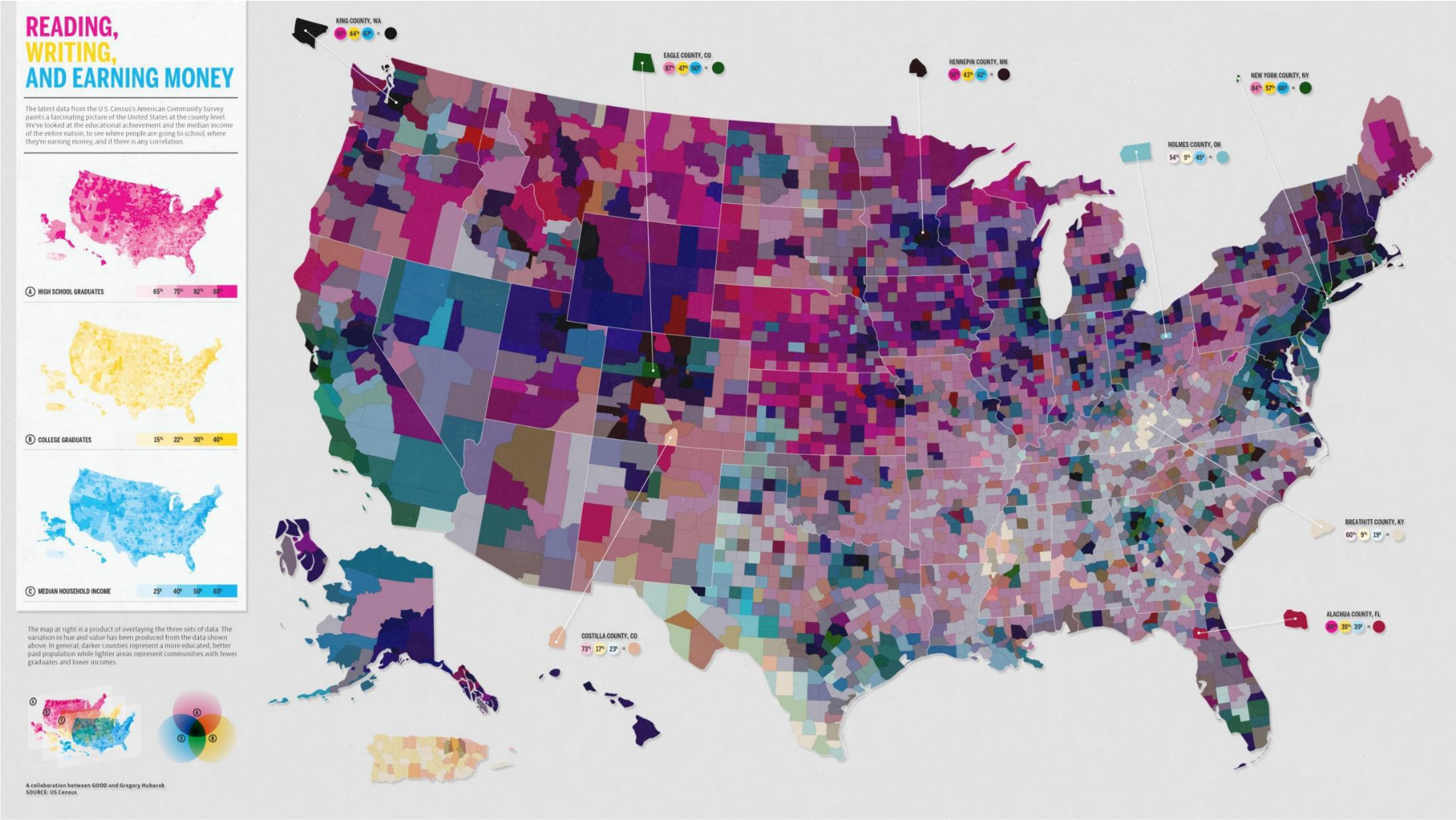


Figure 5.27 Greater accuracy can be obtained if area and volume glyphs are broken into discrete parts. However, if this is done, they cannot be made small.

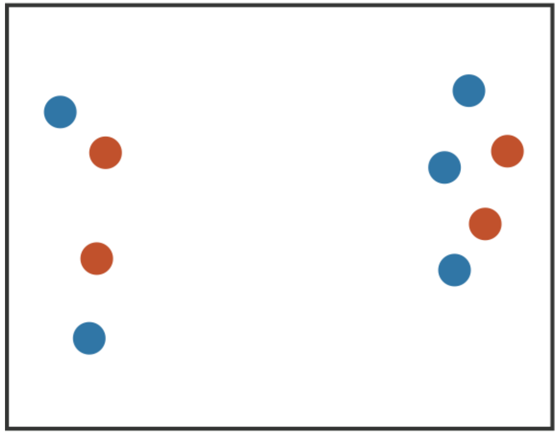
Separable vs. Integral



http://www.3go7od.is/post/america-s-richest-counties-and-best-educated-counties/ via Venkatesh Rajamanickam

Separability vs. Integrality

Position
+ Hue (Color)

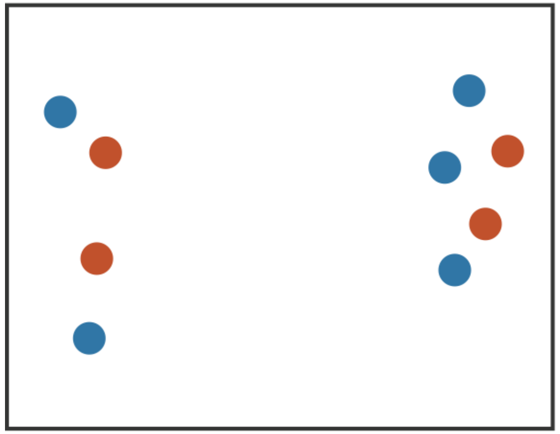


Fully separable

2 groups each

Separability vs. Integrality

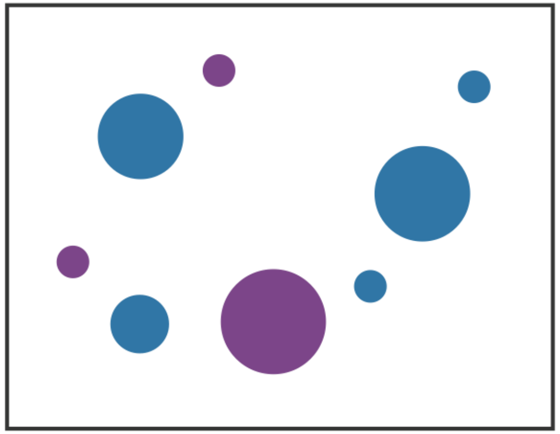
Position
+ Hue (Color)



Fully separable

2 groups each

Size
+ Hue (Color)

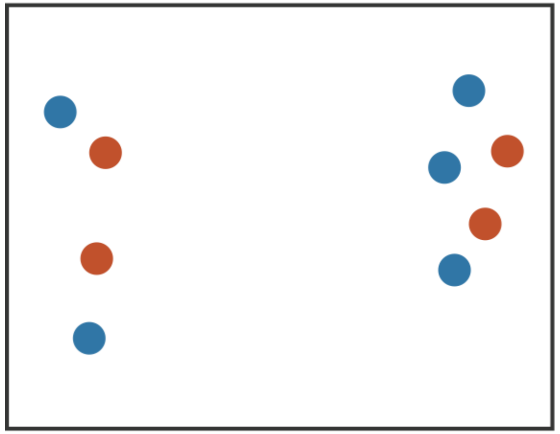


Some interference

2 groups each

Separability vs. Integrality

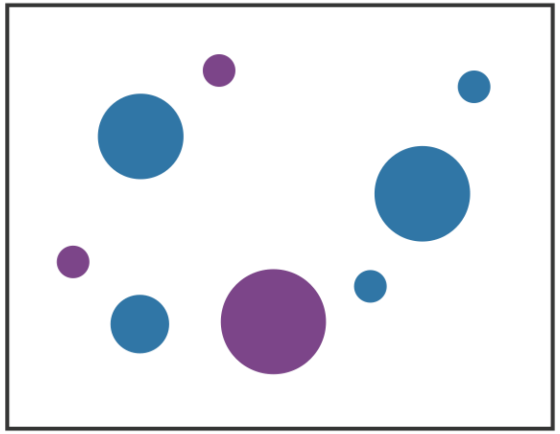
Position
+ Hue (Color)



Fully separable

2 groups each

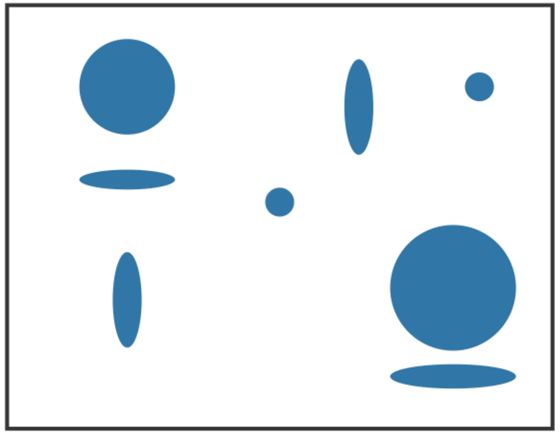
Size
+ Hue (Color)



Some interference

2 groups each

Width
+ Height

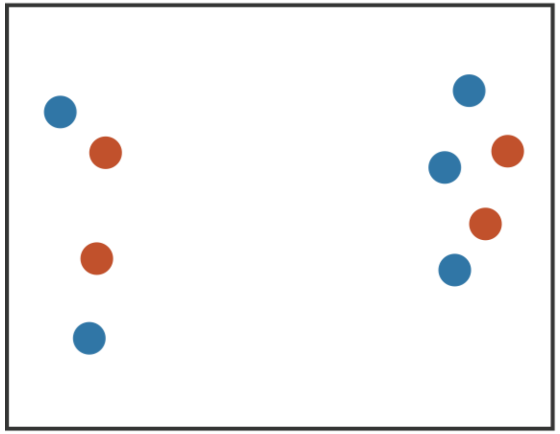


Some/significant interference

3 groups total: integral area

Separability vs. Integrality

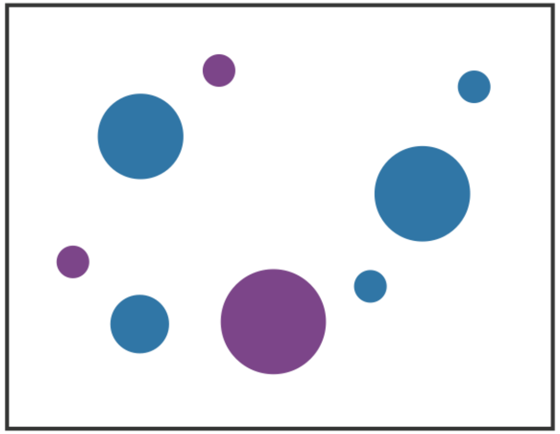
Position
+ Hue (Color)



Fully separable

2 groups each

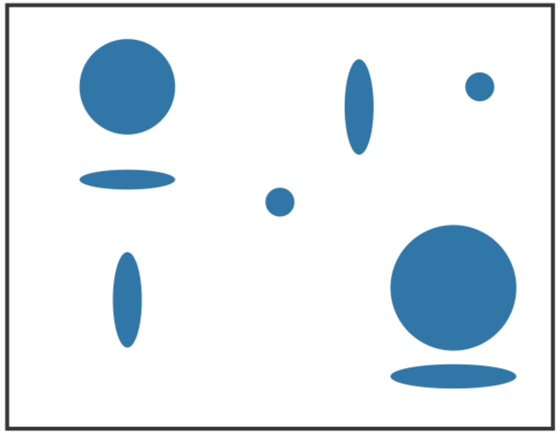
Size
+ Hue (Color)



Some interference

2 groups each

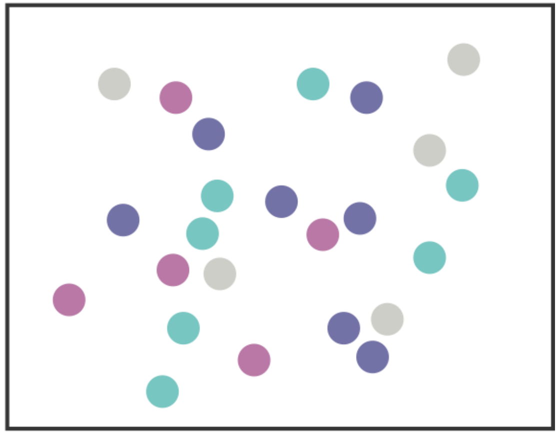
Width
+ Height



Some/significant interference

3 groups total: integral area

Red
+ Green



Major interference

4 groups total: integral hue

Separable or integral

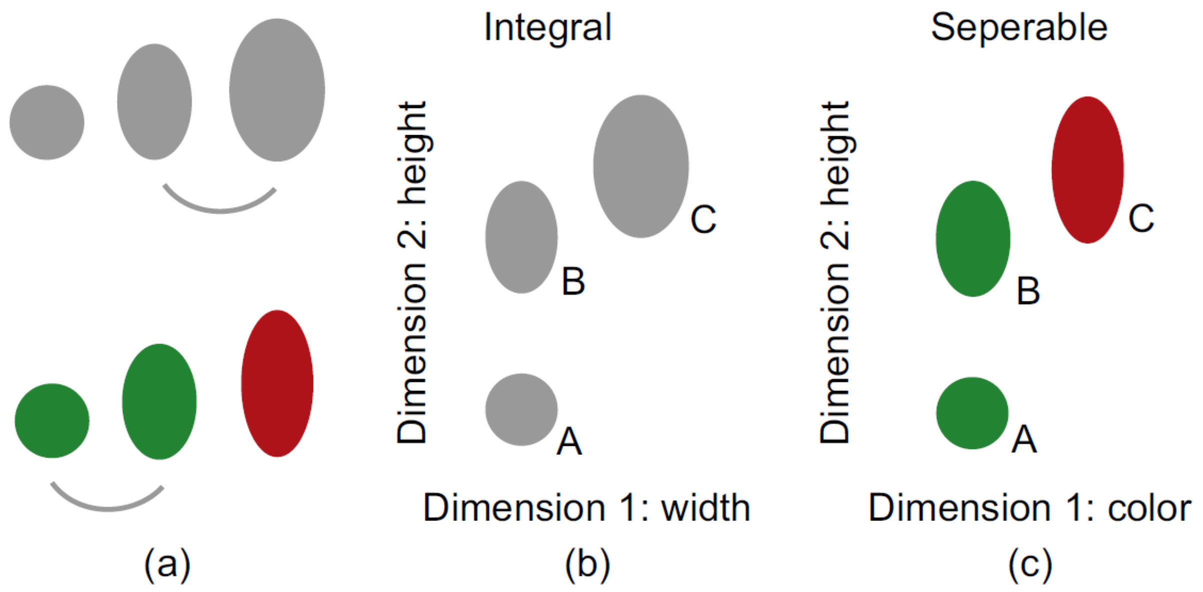


Figure 5.20 (a) The width and height of an ellipse are perceived integrally, so the ellipses are seen as more similar to each other (because they have the same shape) than the pair having the same width. The color and height of a shape are perceived separably, so the two green shapes are seen as most similar. (b, c) Space plots of the two examples.

Separable vs. integral

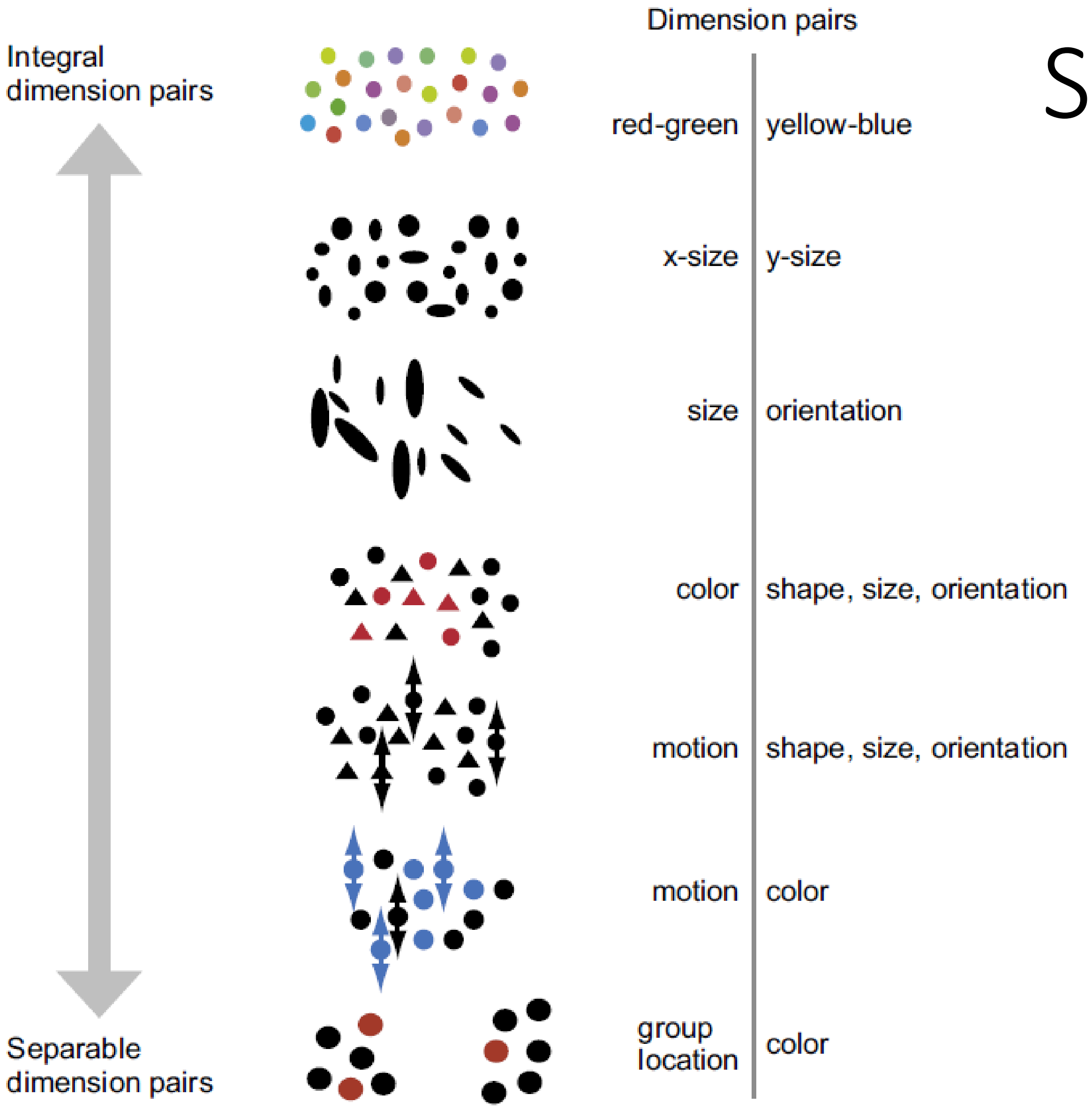
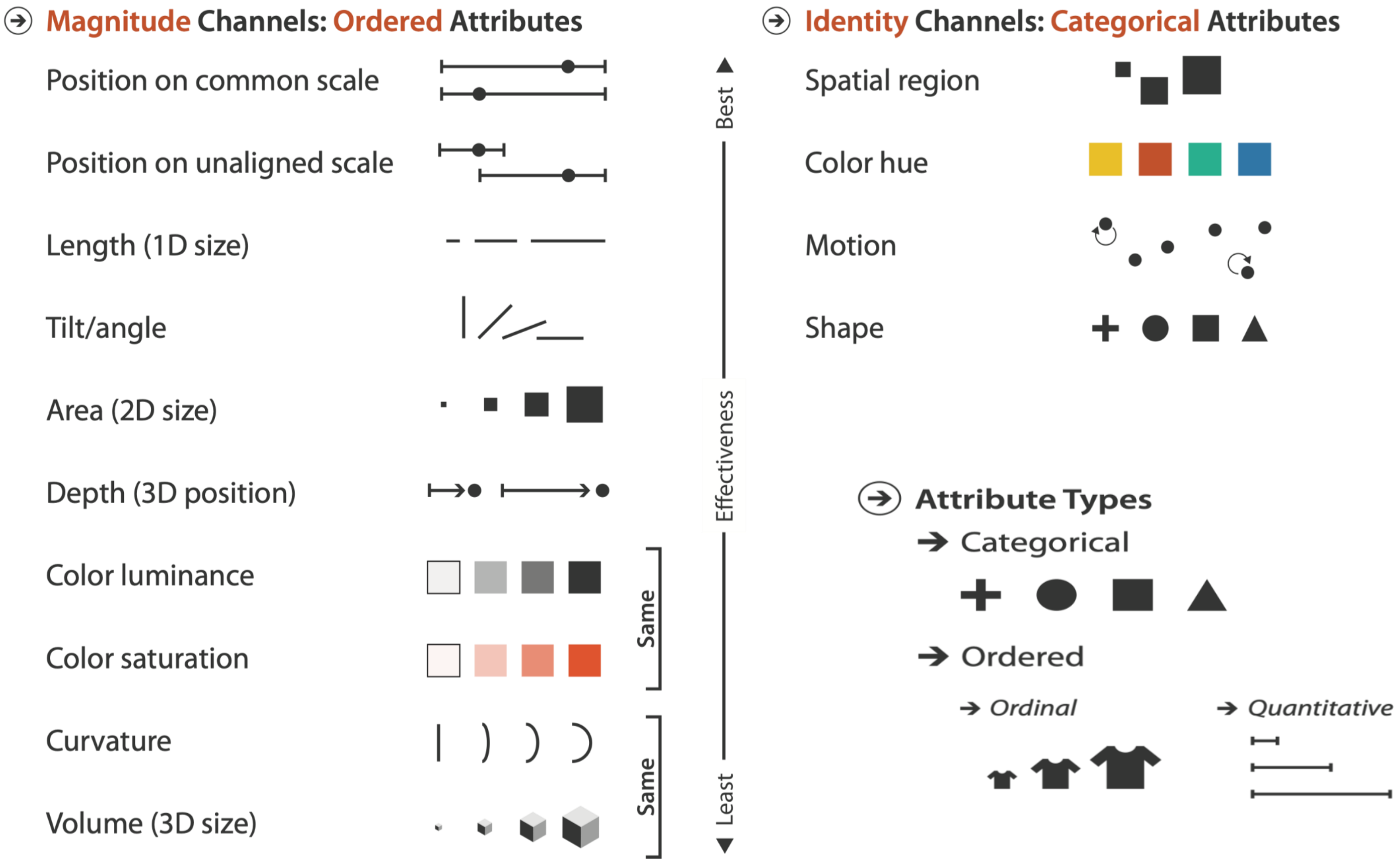


Figure 5.24 Examples of glyphs coded according to two display attributes. At the top are more integral coding pairs. At the bottom are more separable coding pairs.

Effectiveness and expressiveness of channels



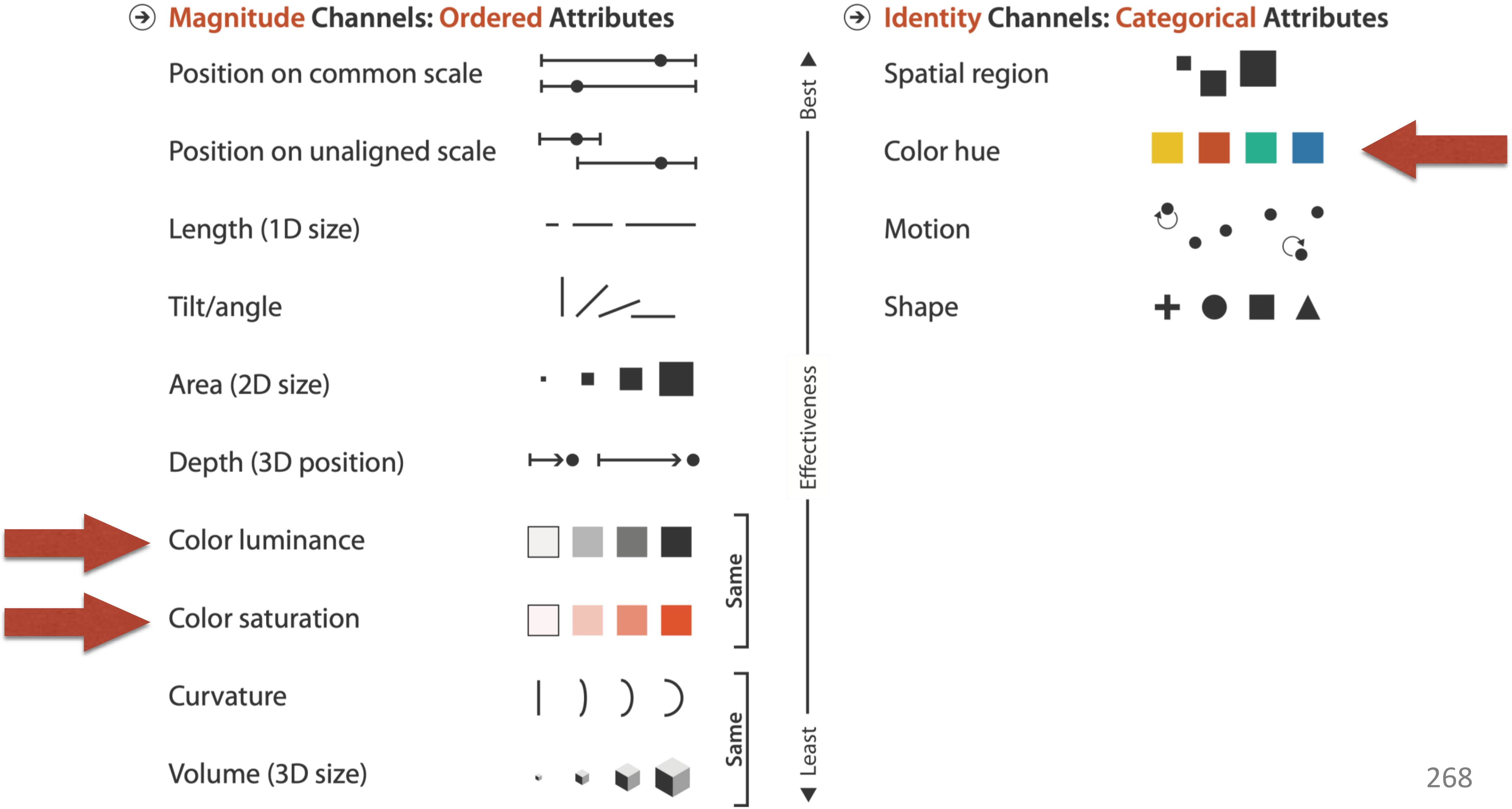
Data Visualization – Color

Dr. Claudius Zelenka

Kiel University

cze@informatik.uni-kiel.de

Channels: What's up with color?



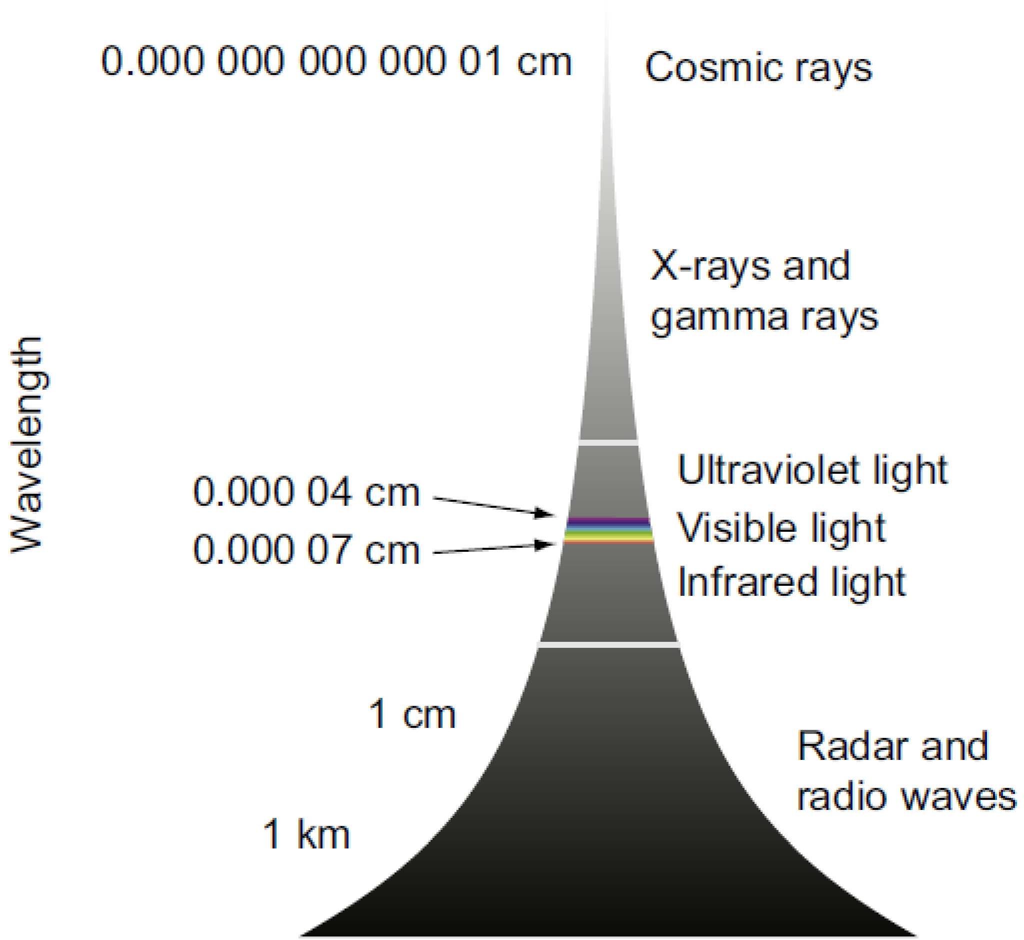
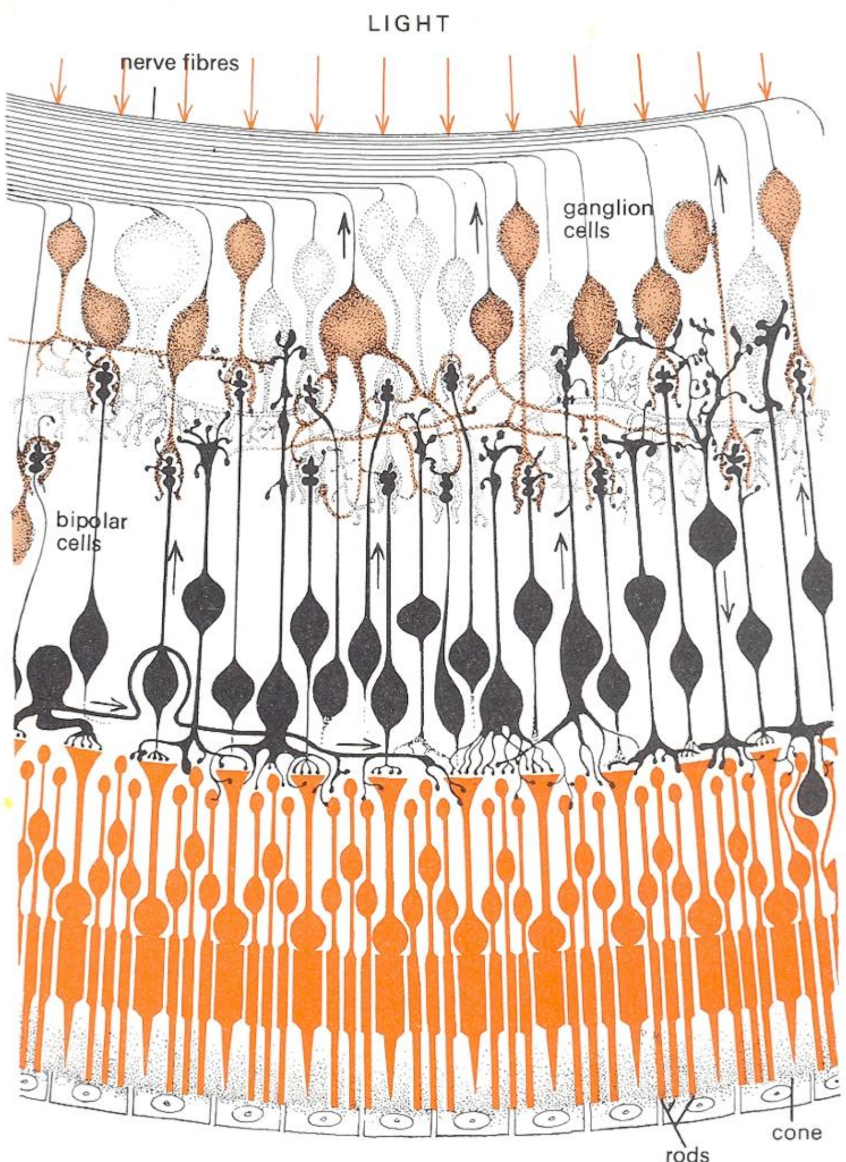


Figure 2.1 The visible light spectrum is a tiny part of a much larger spectrum of electromagnetic radiation.

Photoreceptors



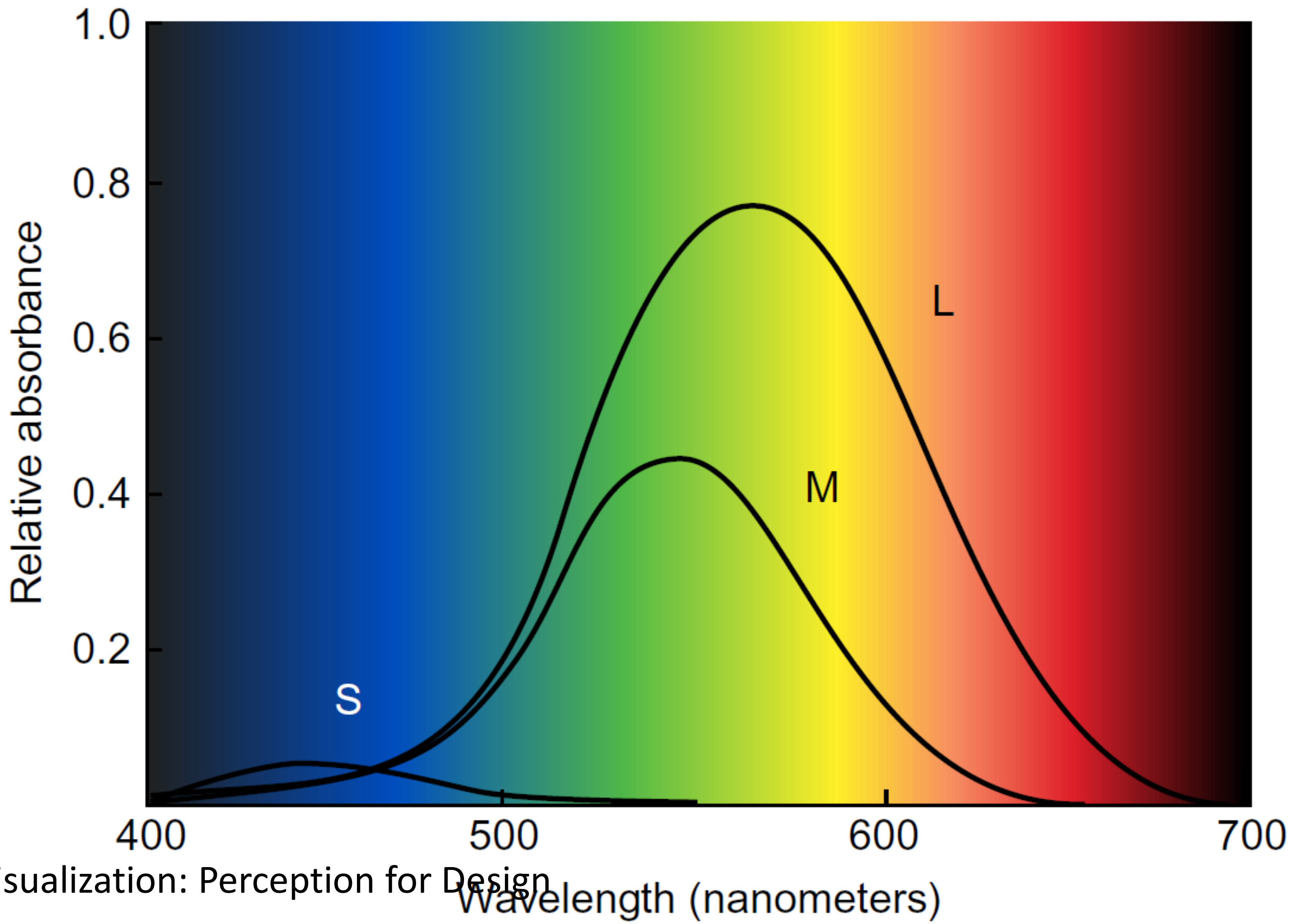
Rods
- Approximately 100-150 million rods.
- Non-uniform distribution across the retina
- Sensitive to low-light levels (scotopic vision)

Cones
- Approximately 6-7 million cones.
- Sensitive to daytime-light levels (photopic vision)
- Detect color by the use of 3 different kinds:
- Red (L cone) : 564-580nm wavelengths (65% of all cones)
- Green (M cone) : 534-545nm (30% of all cones)
- Blue (S cone) : 420-440nm (5% of all cones)

Colin Ware, Information Visualization: Perception for Design

Cones (SML)

(short, medium, long)



Colin Ware, Information Visualization: Perception for Design

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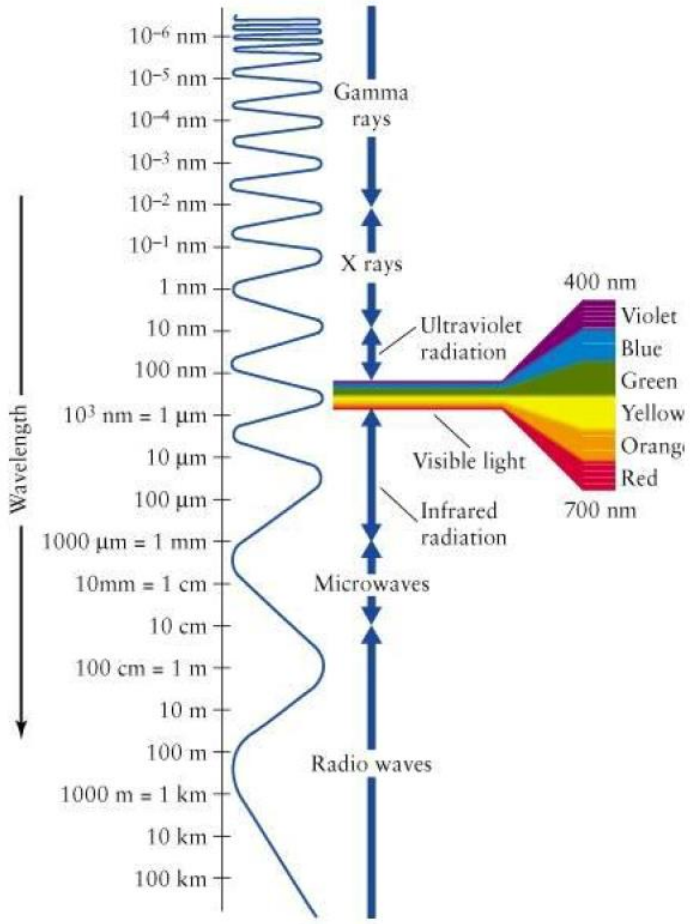
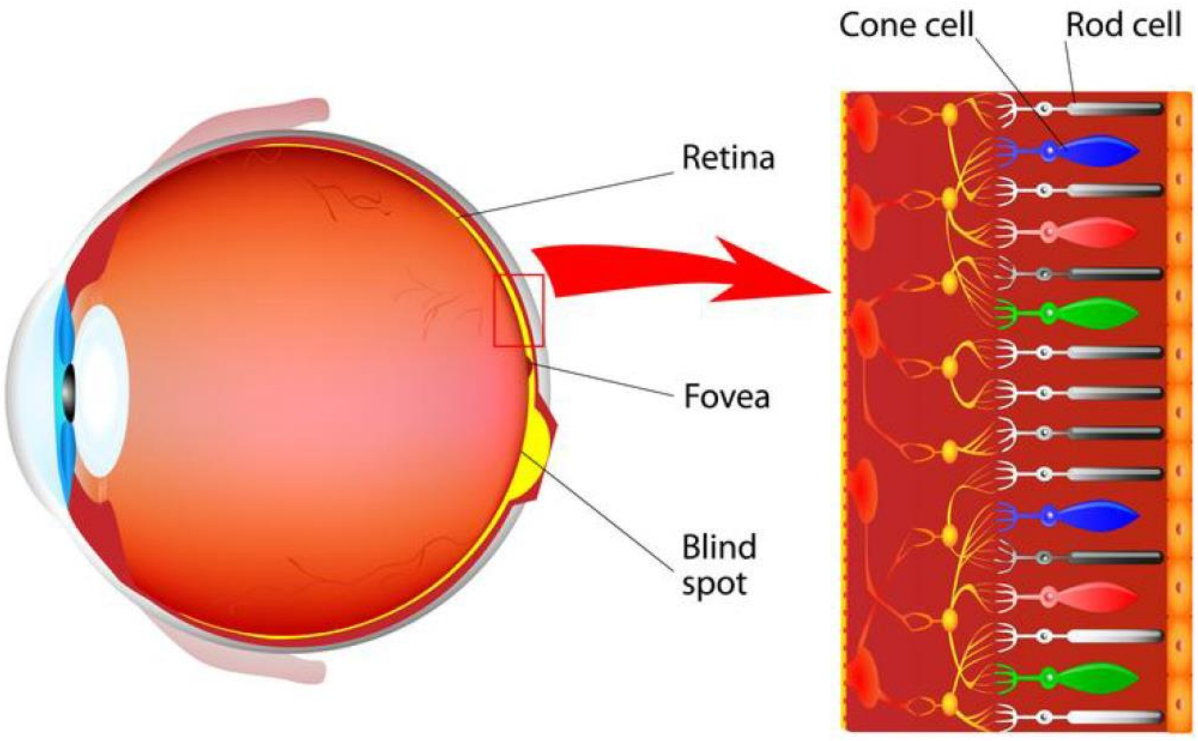


400–700nm

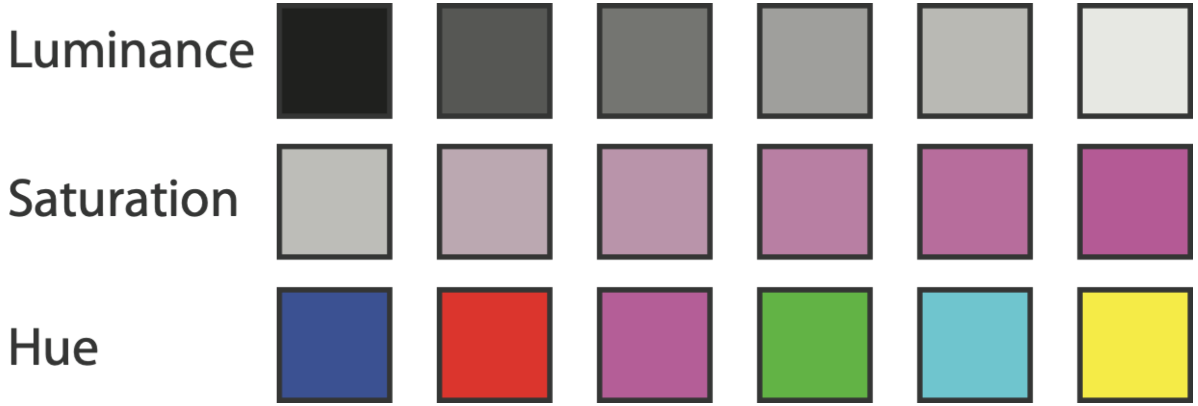
Photoreceptor cell



~120 million rods
~6 million cones

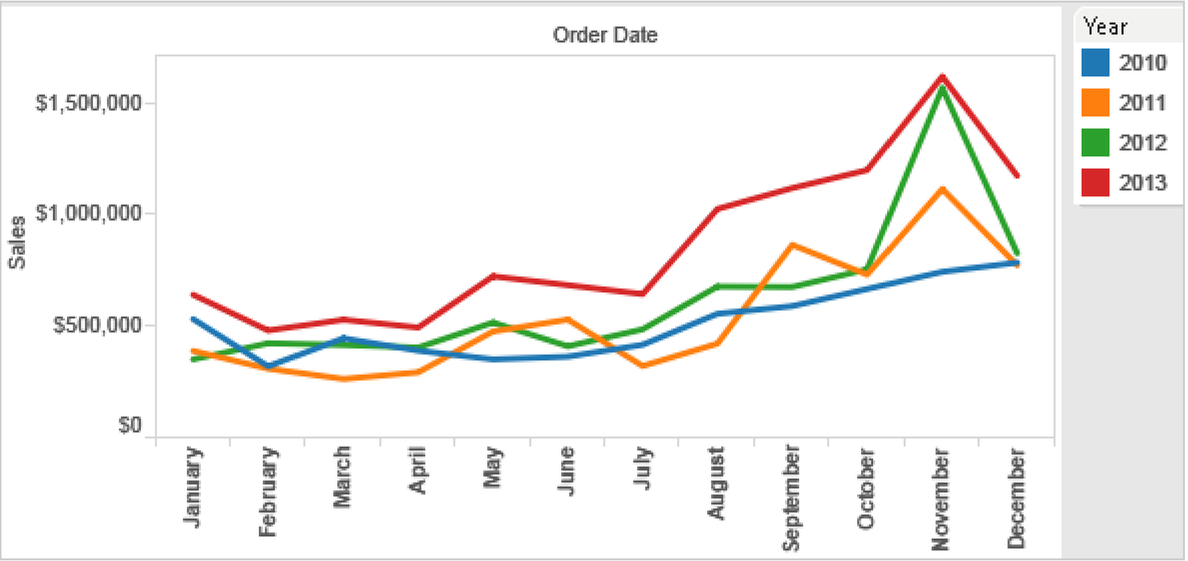
Decomposing color

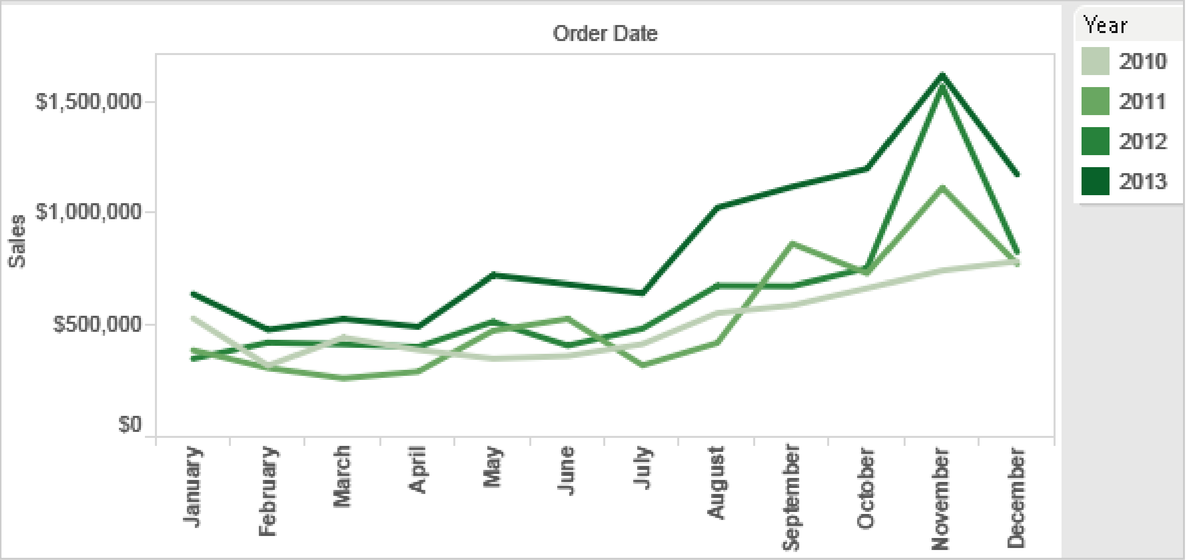
- first rule of color: do not (just) talk about color!
  - color is confusing if treated as monolithic
- decompose into three channels
  - ordered can show magnitude
    - **luminance**: how bright (B/W)
    - **saturation**: how colorful
  - categorical can show identity
    - **hue**: what color
- channels have different properties
  - what they convey directly to perceptual system
  - how much they can convey
    - how many discriminable bins can we use?

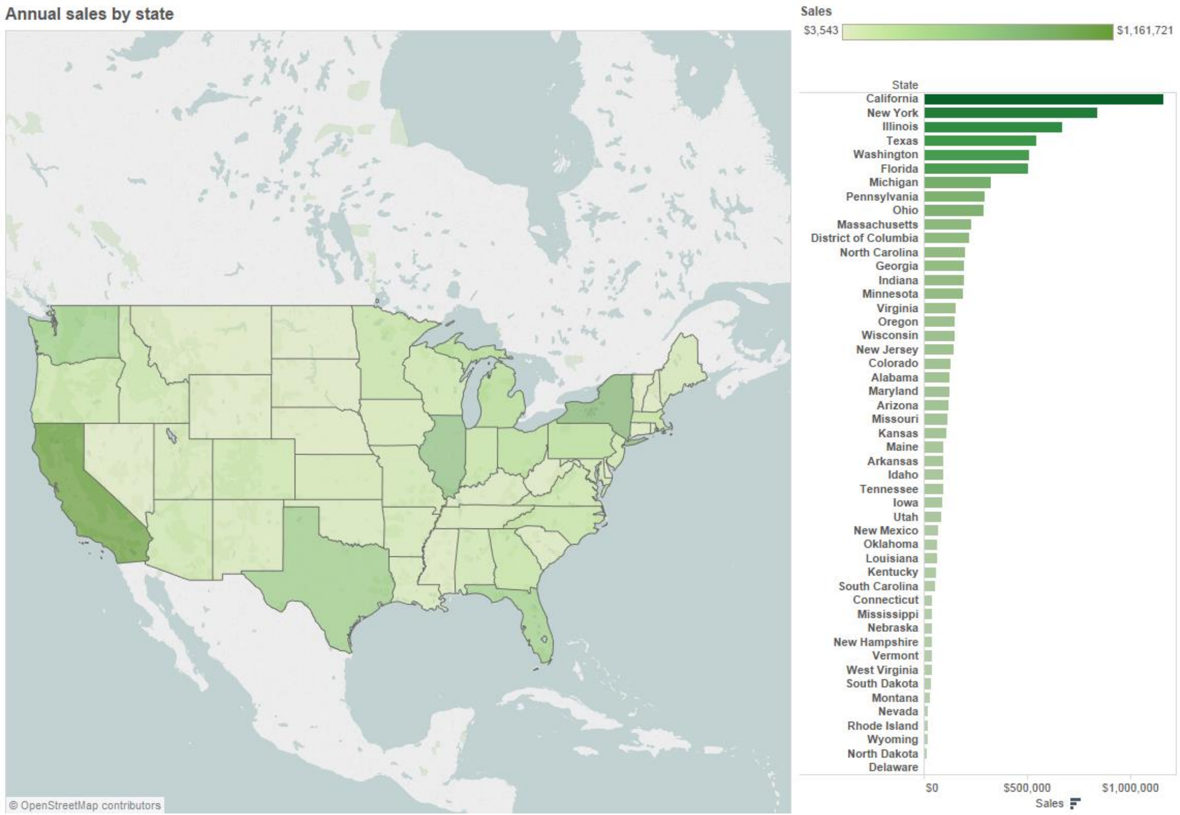


Color Channels in Visualization

Categorical vs ordered color



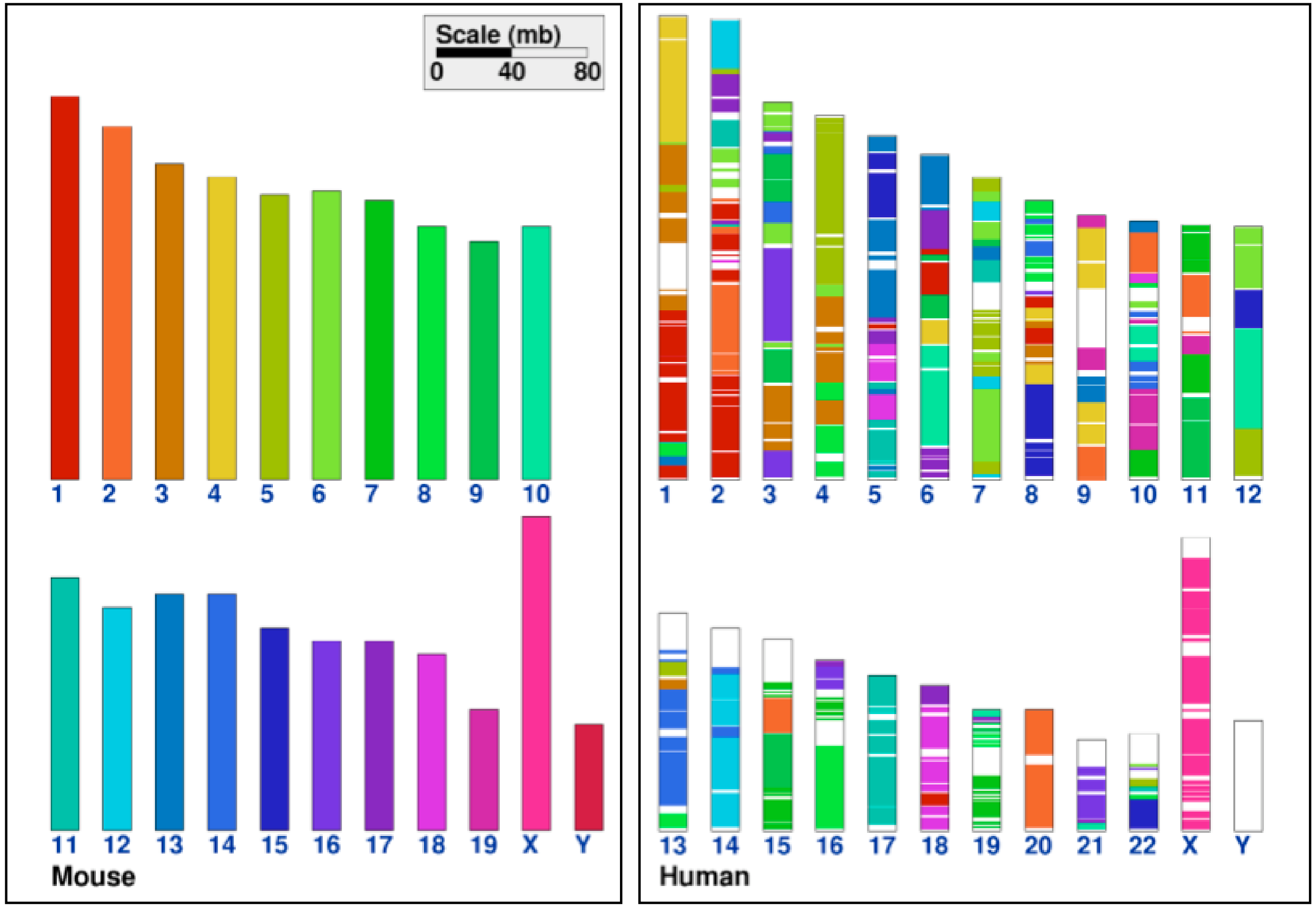




[Seriously Colorful: Advanced Color Principles & Practices. Stone.Tableau Customer Conference 2014.]

Categorical color: limited number of discriminable bins

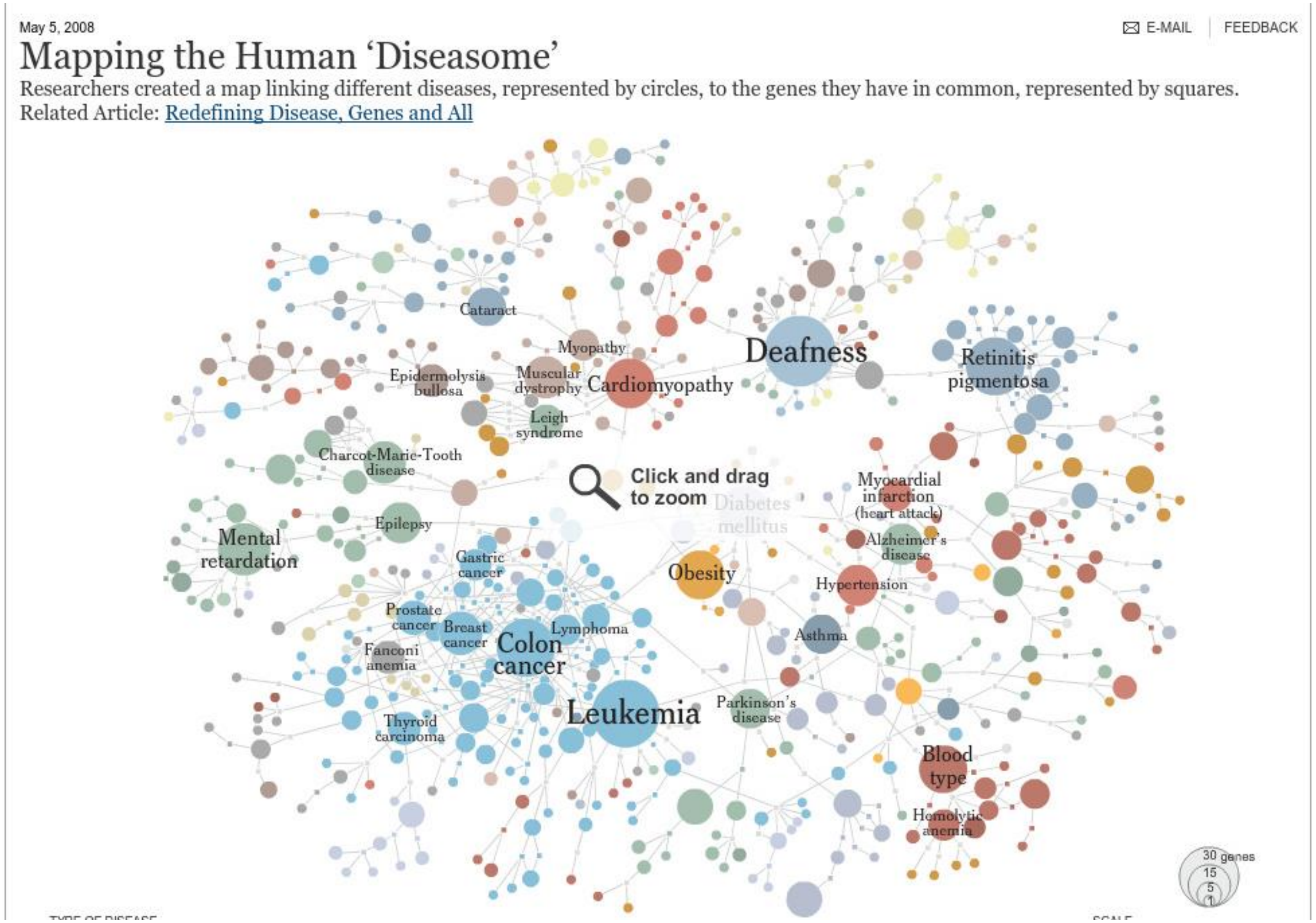
- human perception built on relative comparisons
  - great if color contiguous
  - surprisingly bad for absolute comparisons
- noncontiguous small regions of color
  - fewer bins than you want
  - rule of thumb: 6-12 bins, including background and highlights

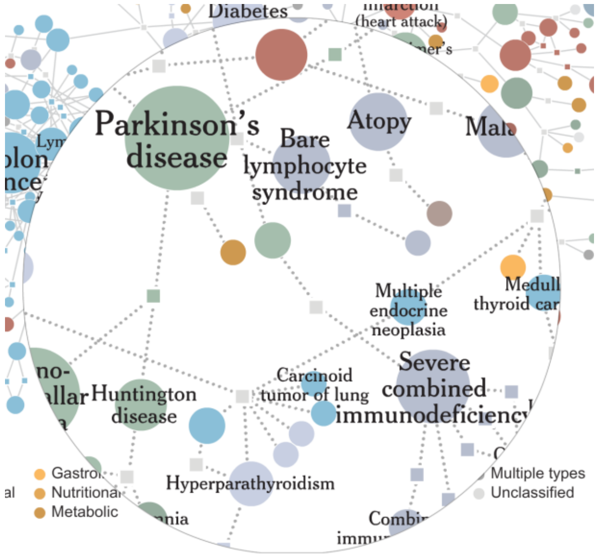


[Cinteny: flexible analysis and visualization of synteny and genome rearrangements in multiple organisms. Sinha and Meller. BMC Bioinformatics, 8:82, 2007.]

Categorical color: limited number of discriminable bins

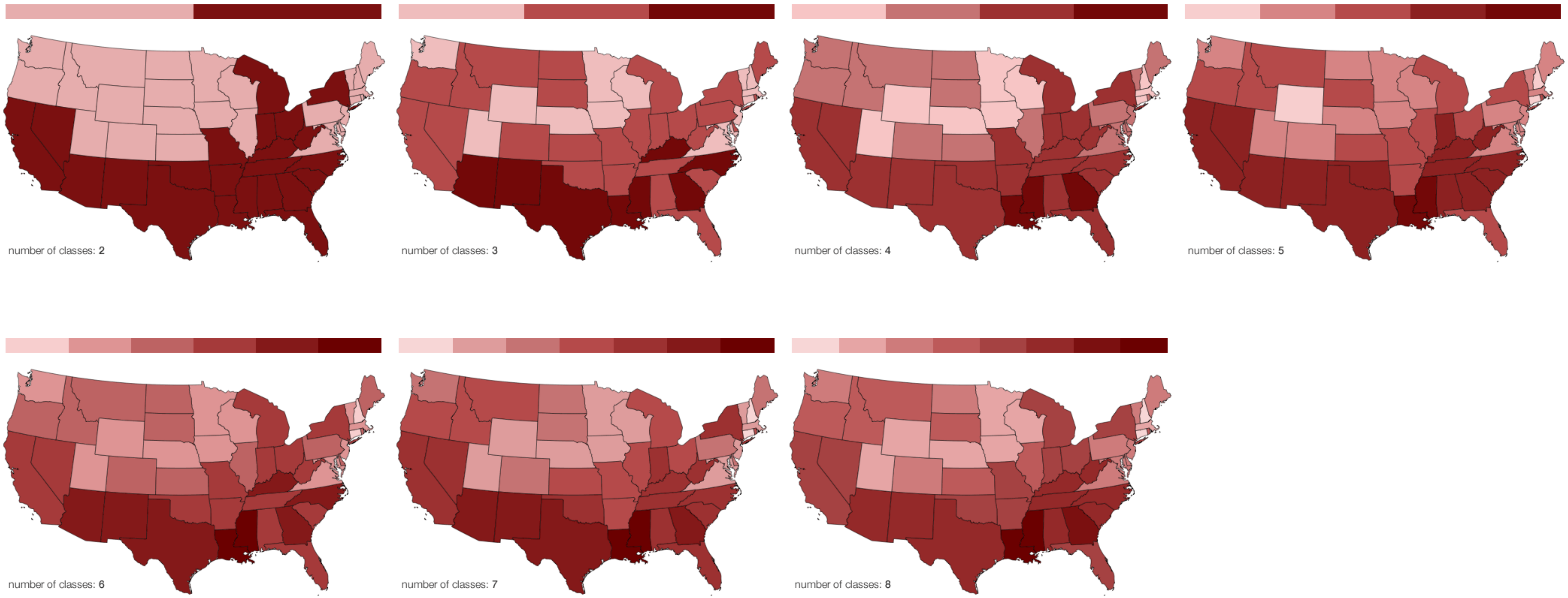
Cancer
Bone
Skeletal
Connective tissue
Muscular
Dermatological
Cardiovascular
Hematological
Renal
Endocrine
Immunological
Gastrointestinal
Nutritional
Metabolic
Ear, nose, throat
Ophthalmological
Respiratory
Developmental
Neurological
Psychiatric
Multiple types
Unclassified





https://archive.nytimes.com/www.nytimes.com/interactive/2008/05/05/science/20080506_DISEASE.html

Ordered color: limited number of discriminable bins

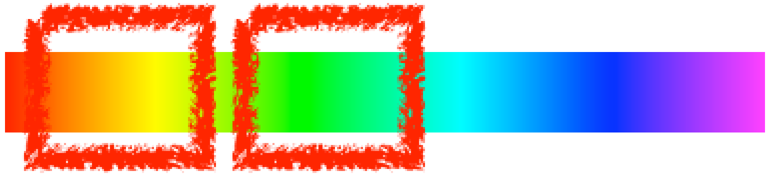


[Gregor Aisch, vis4.net/blog/posts/choropleth-maps/](vis4.net/blog/posts/choropleth-maps/)

Ordered color: Rainbow is poor default

- problems
  - perceptually unordered
  - perceptually nonlinear

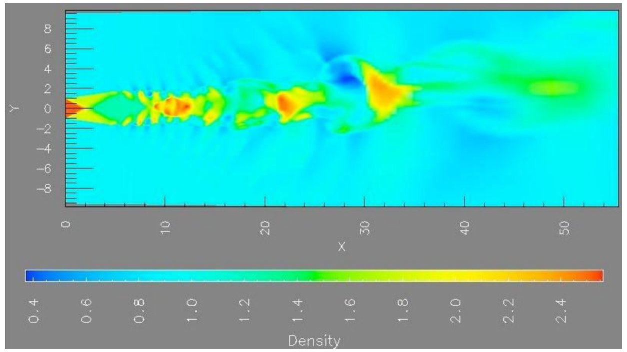
Ordered color: Rainbow is poor default



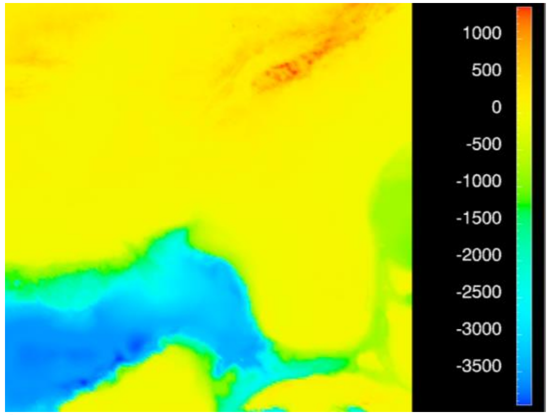
- problems
  - –perceptually unordered
  - –perceptually nonlinear

Ordered color: Rainbow is poor default

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



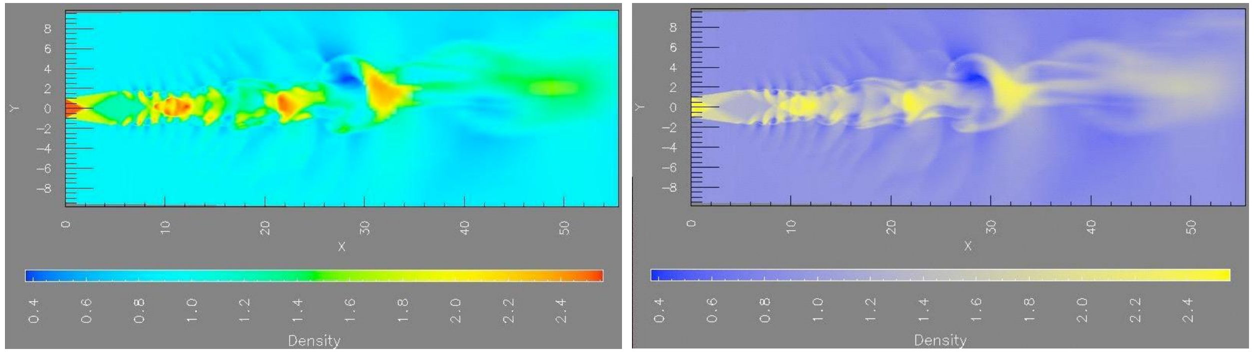
[A Rule-based Tool for Assisting Colormap Selection. Bergman,. Rogowitz, and. Treinish. Proc. IEEE Visualization (Vis), pp. 118–125, 1995.]



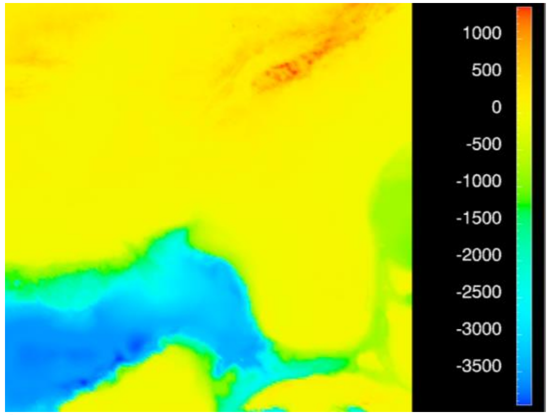
[Why Should Engineers Be Worried About Color? Treinish and Rogowitz 1998. http://www.research.ibm.com/people/l/lloydt/color/color.HTM]

Ordered color: Rainbow is poor default

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



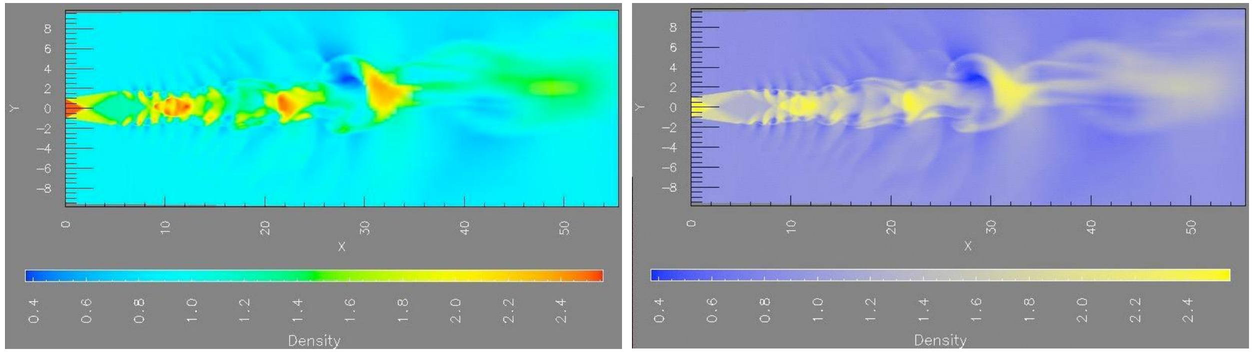
[A Rule-based Tool for Assisting Colormap Selection. Bergman,. Rogowitz, and. Treinish. Proc. IEEE Visualization (Vis), pp. 118–125, 1995.]



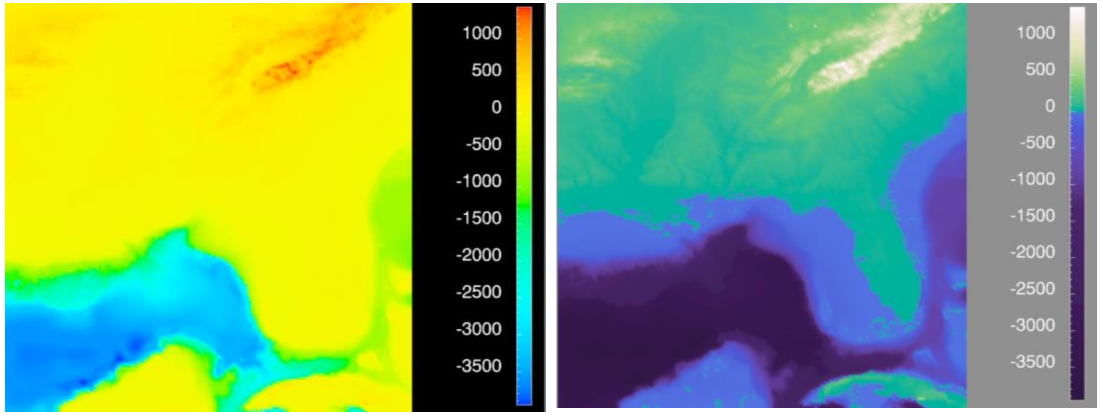
[Why Should Engineers Be Worried About Color? Treinish and Rogowitz 1998. http://www.research.ibm.com/people/l/lloydt/color/color.HTM]

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]



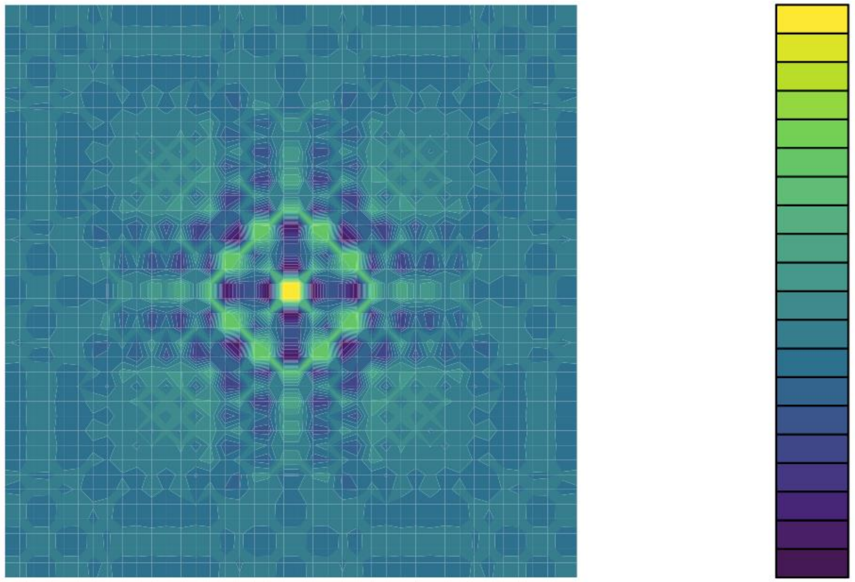
[A Rule-based Tool for Assisting Colormap Selection. Bergman,. Rogowitz, and. Treinish. Proc. IEEE Visualization (Vis), pp. 118–125, 1995.]

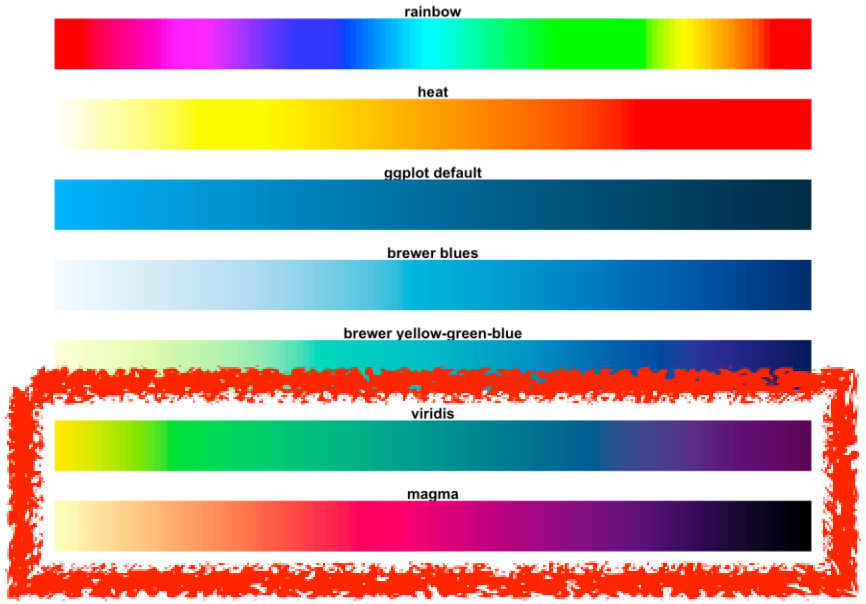


[Why Should Engineers Be Worried About Color? Treinish and Rogowitz 1998. http://www.research.ibm.com/people/l/lloydt/color/color.HTM]

Viridis / Magma: sequential colormaps

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

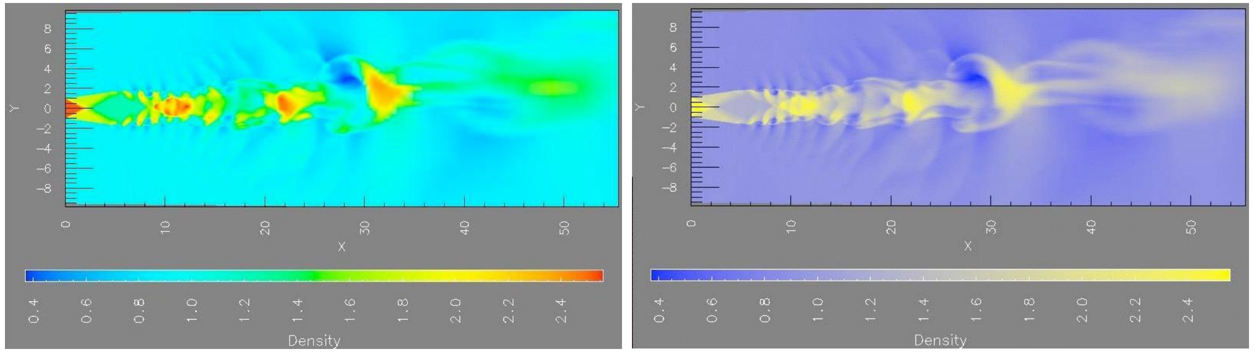




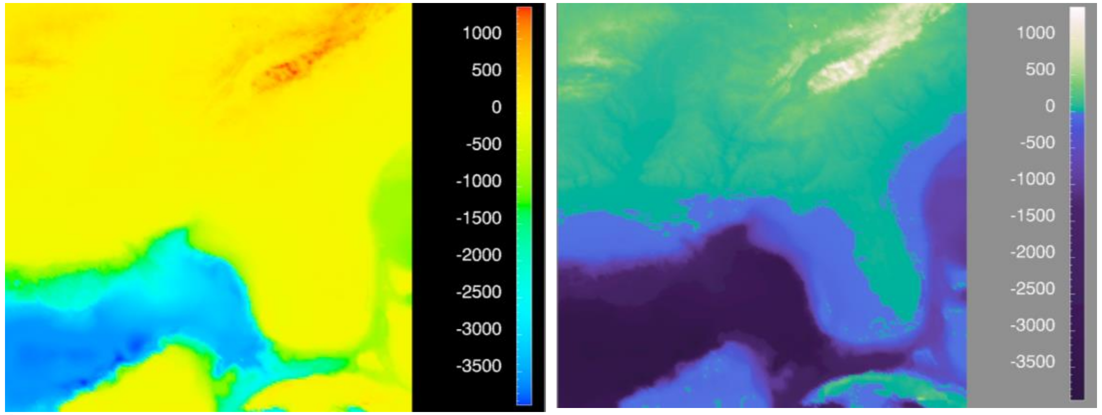
https://cran.r-project.org/web/packages/viridis/vignettes/intro-to-viridis.html

Ordered color: Rainbow is poor default

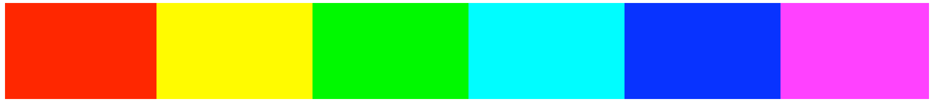
- problems
  - perceptually unordered
  - perceptually nonlinear
- benefits
  - fine-grained structure visible and nameable
- alternatives
  - large-scale structure: fewer hues
  - fine structure: multiple hues with monotonically increasing luminance [eg viridis]
- legit for categorical
  - segmented saturated rainbow is good!



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



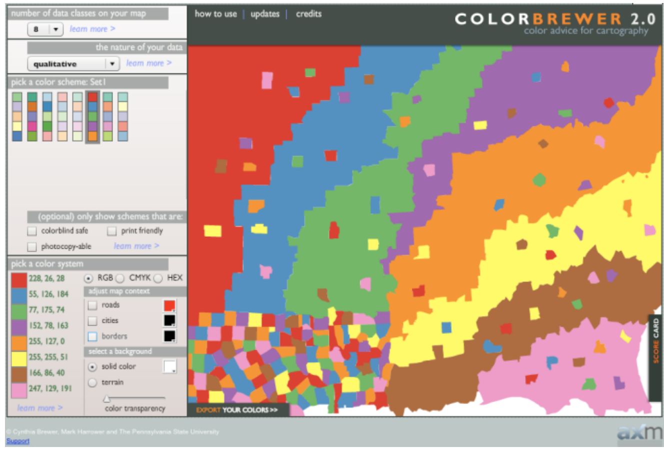
[Why Should Engineers Be Worried About Color? Treinish and Rogowitz 1998. http://www.research.ibm.com/people/l/lloydt/color/color.HTM]

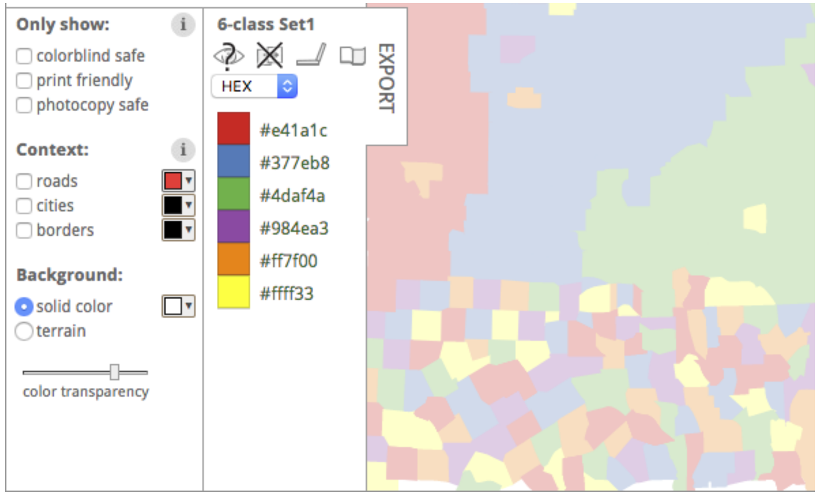


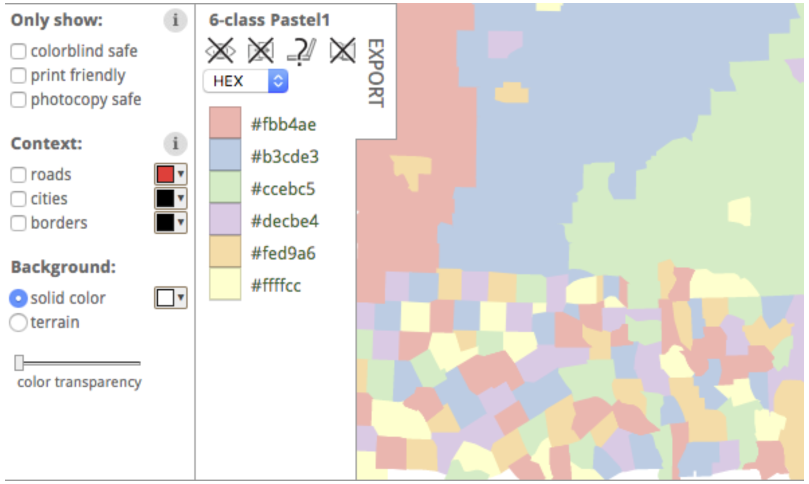
[Transfer Functions in Direct Volume Rendering: Design, Interface, Interaction. Kindlmann. SIGGRAPH 2002 Course Notes]

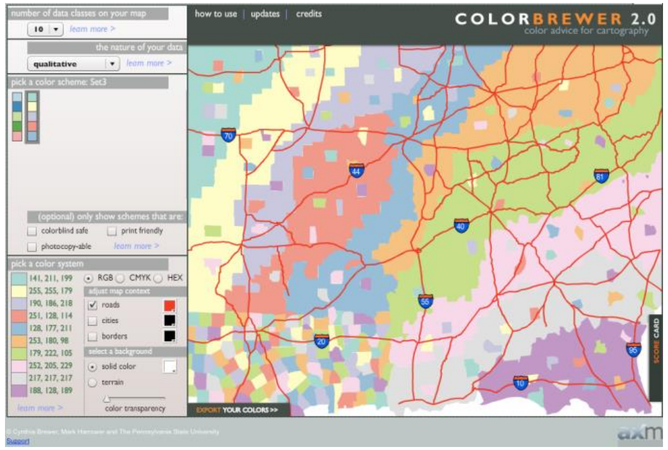
Interaction between channels: Not fully separable

- color channel interactions
  - size heavily affects salience
  - small regions need high saturation
  - large regions need low saturation
- saturation & luminance:
  - not separable from each other!
  - also not separable from transparency
  - small separated regions: 2 bins safest (use only one of these channels), 3-4 bins max
  - contiguous regions: many bins (use only one of these channels)





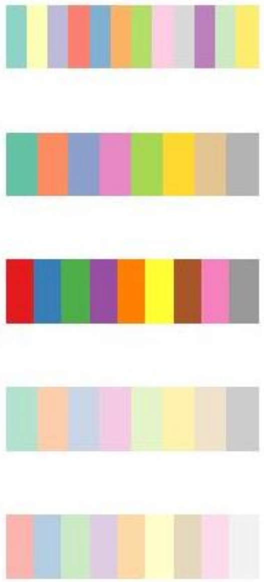




http://colorbrewer2.org/

Color Palettes

Color palettes: univariate



categorical

- categorical
  - aim for maximum distinguishability
  - aka *qualitative, nominal*

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

Color palettes: univariate

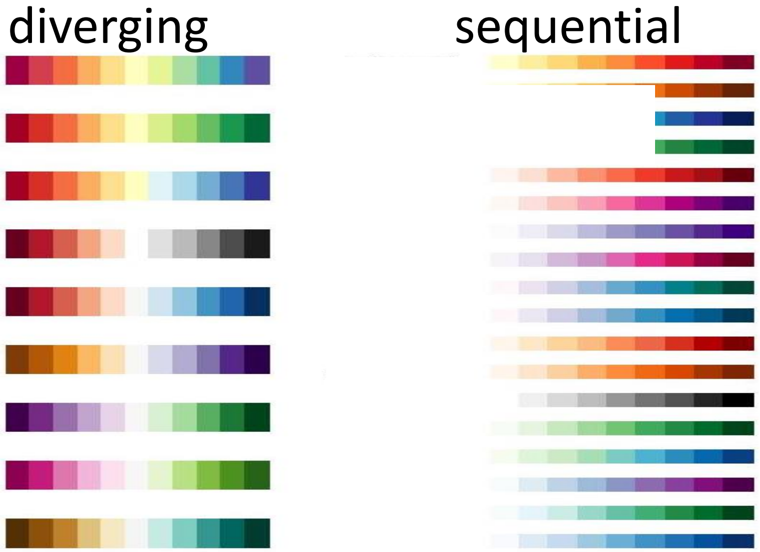
→ Categorical

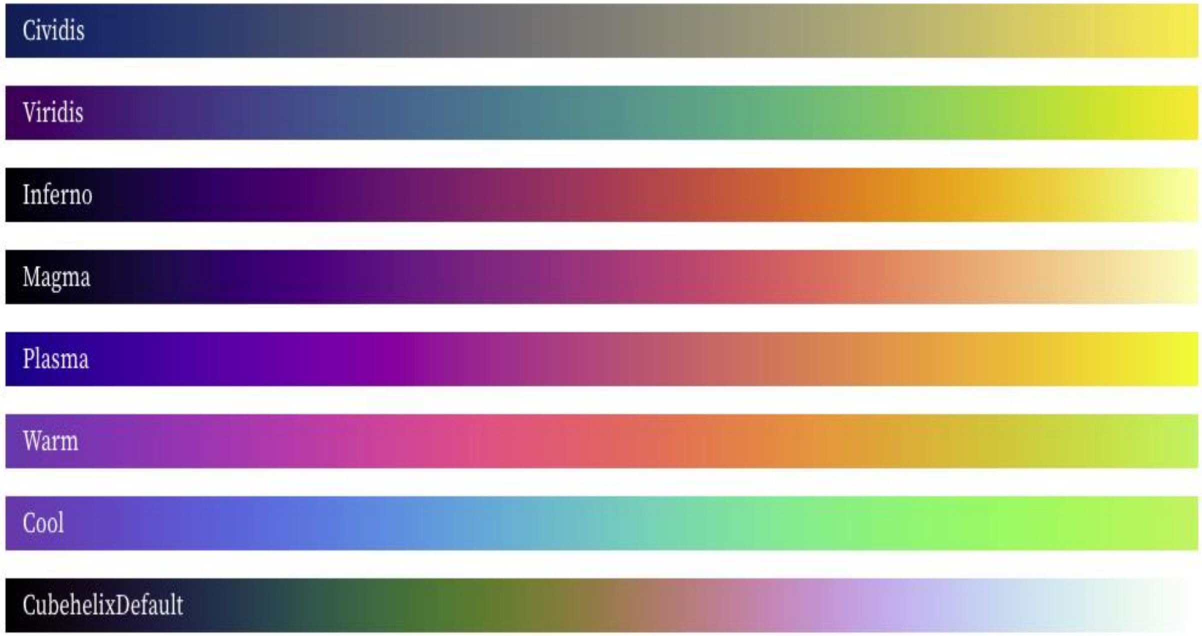
→ Ordered

→ *Sequential*

→ *Diverging*

- diverging
  - useful when data has meaningful "midpoint"
  - use neutral color for midpoint
    - white, yellow, grey
  - use saturated colors for endpoints
- sequential
  - ramp luminance or saturation
  - if multi-hue, good to order by luminance





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

Color palettes: univariate

- ➔ Categorical

- ➔ Ordered
  - ➔ *Sequential*

  - ➔ *Diverging*

  - ➔ Cyclic

cyclic multihue

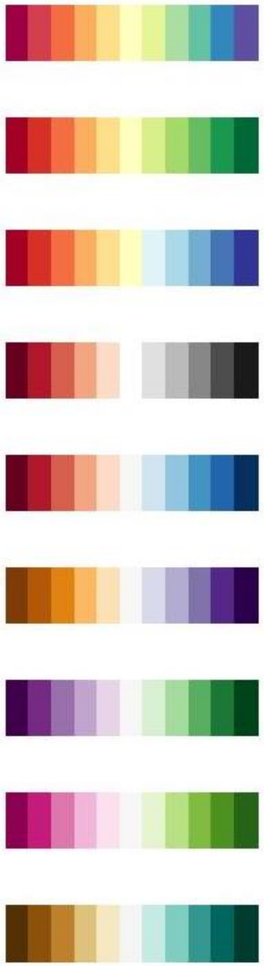
https://github.com/d3/d3-scale-chromatic

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

Color palette design considerations: univariate

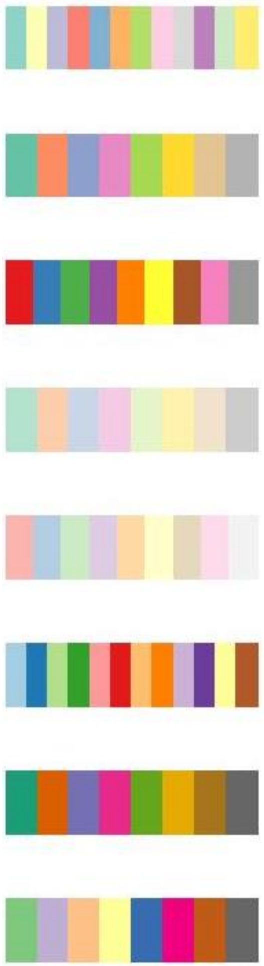
segmented

diverging



sequential

categorical



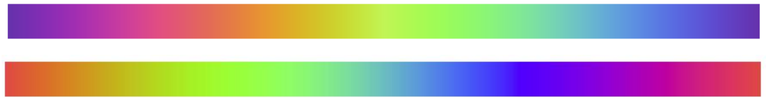
continuous

sequential single hue

diverging two hue

sequential multihue

cyclic multihue



- segmented or continuous?
- diverging or sequential or cyclic?
- single-hue or two-hue or multi-hue?
- perceptually linear?
- ordered by luminance?
- colorblind safe?

[A Study of Colormaps in Network Visualization. Karim et al. *Appl. Sci.* **2019**, *9*, 4228; doi:10.3390/app9204228]

https://github.com/d3/d3-scale-chromatic

Colormaps: bivariate

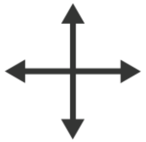
→ Categorical

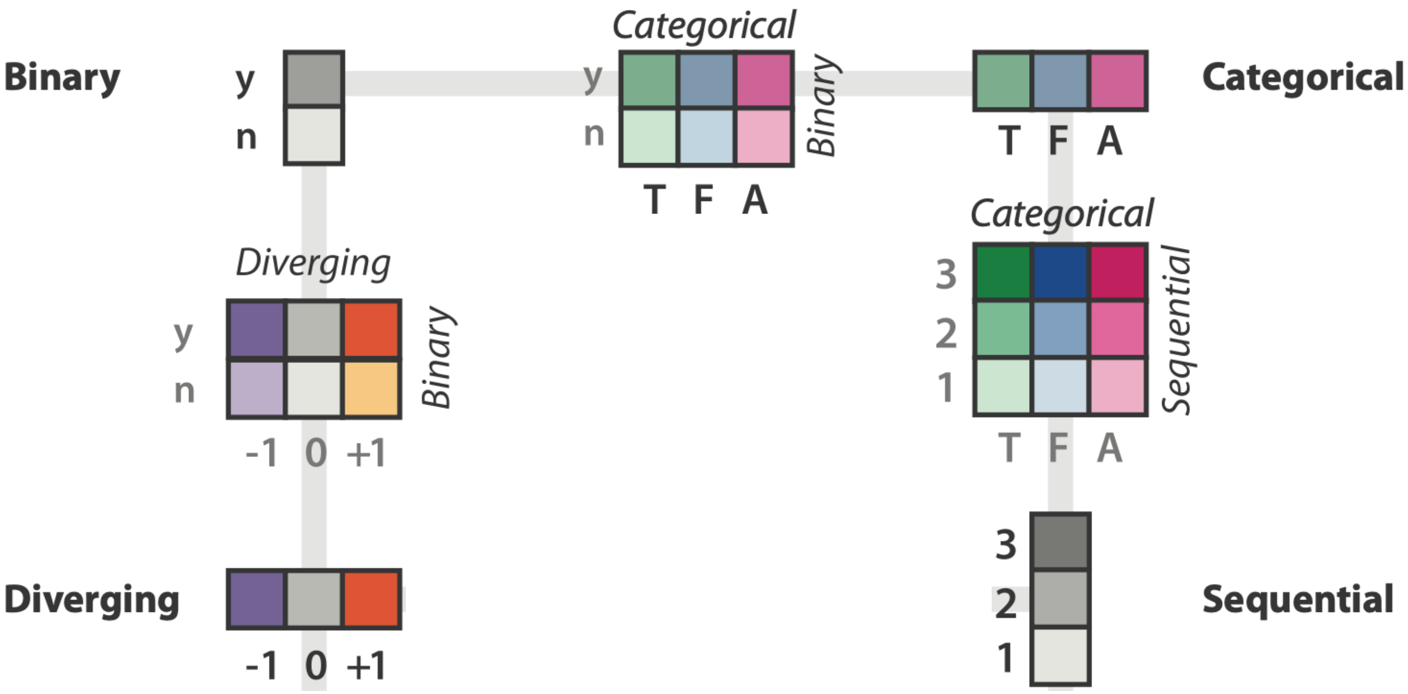
→ Ordered

→ *Sequential*

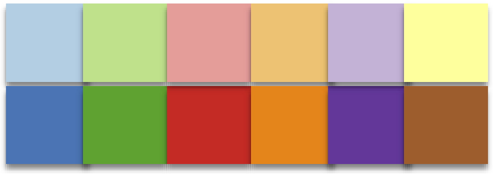
→ *Diverging*

→ Bivariate





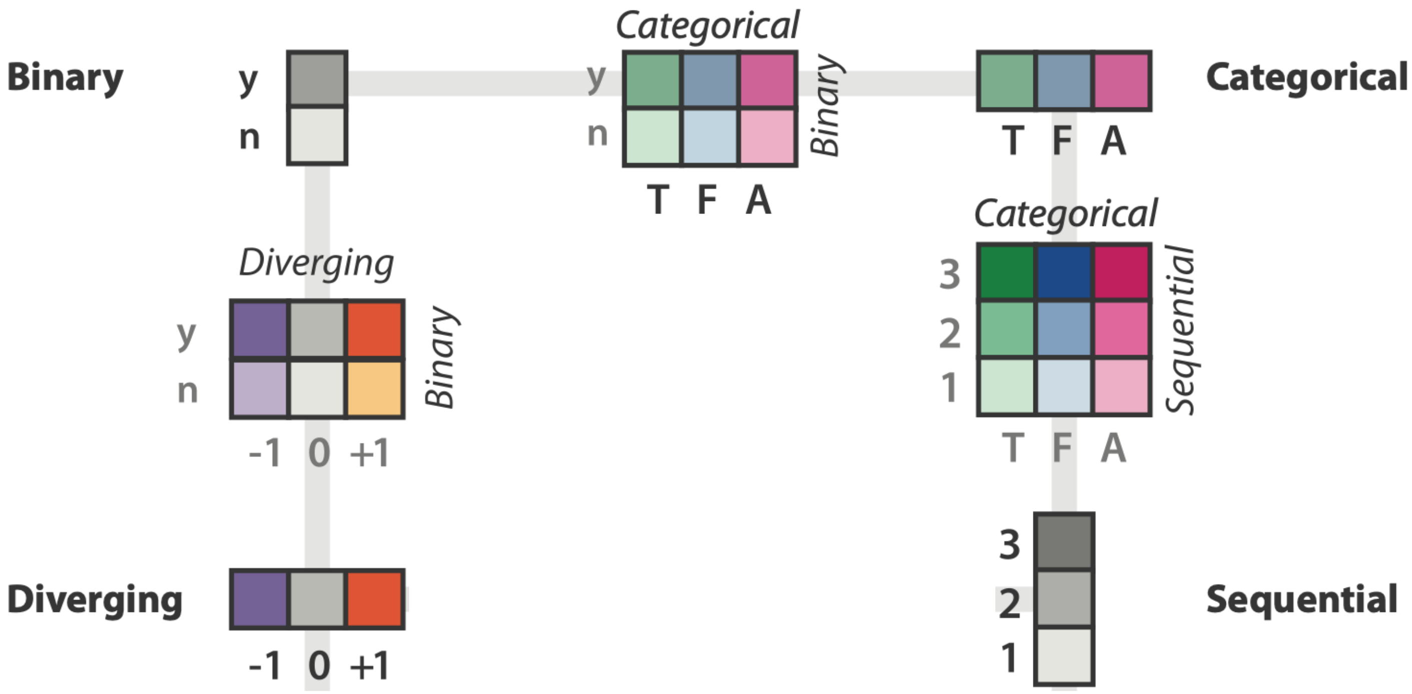
- bivariate best case
  - binary in one of the directions



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

Colormaps: bivariate

- Categorical
- Ordered
  - *Sequential*
  - *Diverging*
- Bivariate



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

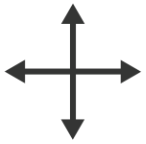
Colormaps

- ➔ Categorical

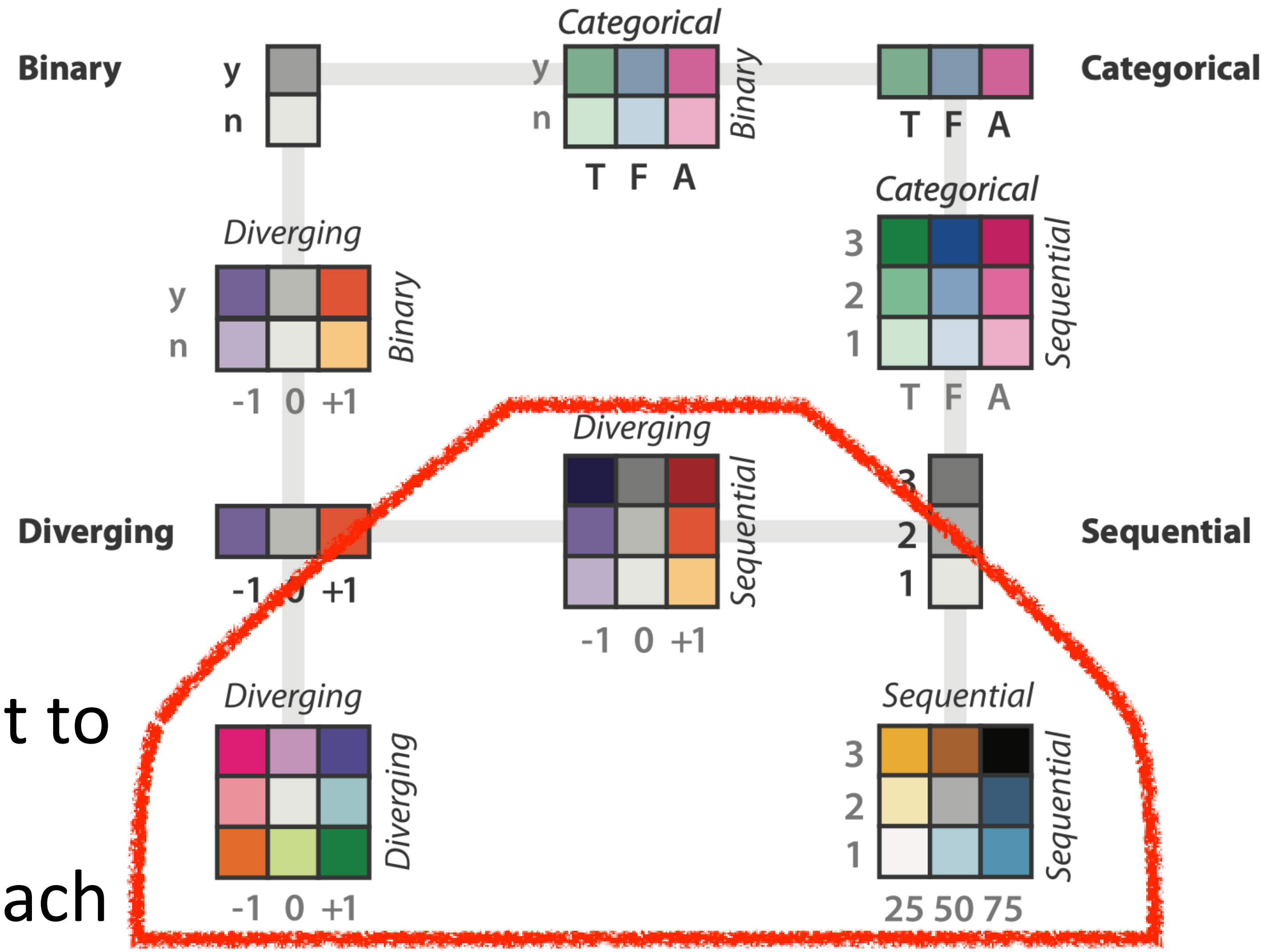
- ➔ Ordered
  - ➔ *Sequential*

  - ➔ *Diverging*

- ➔ Bivariate

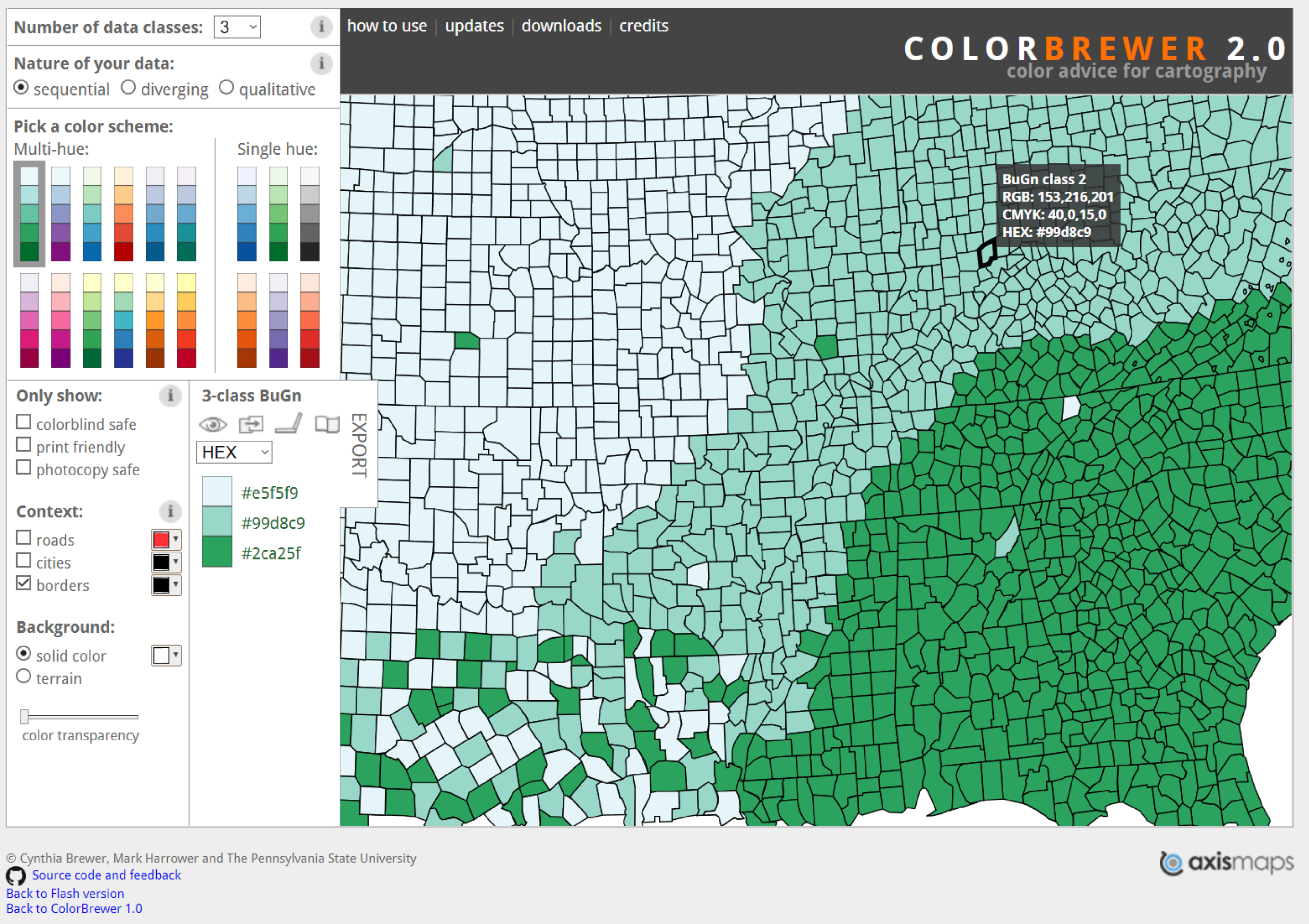


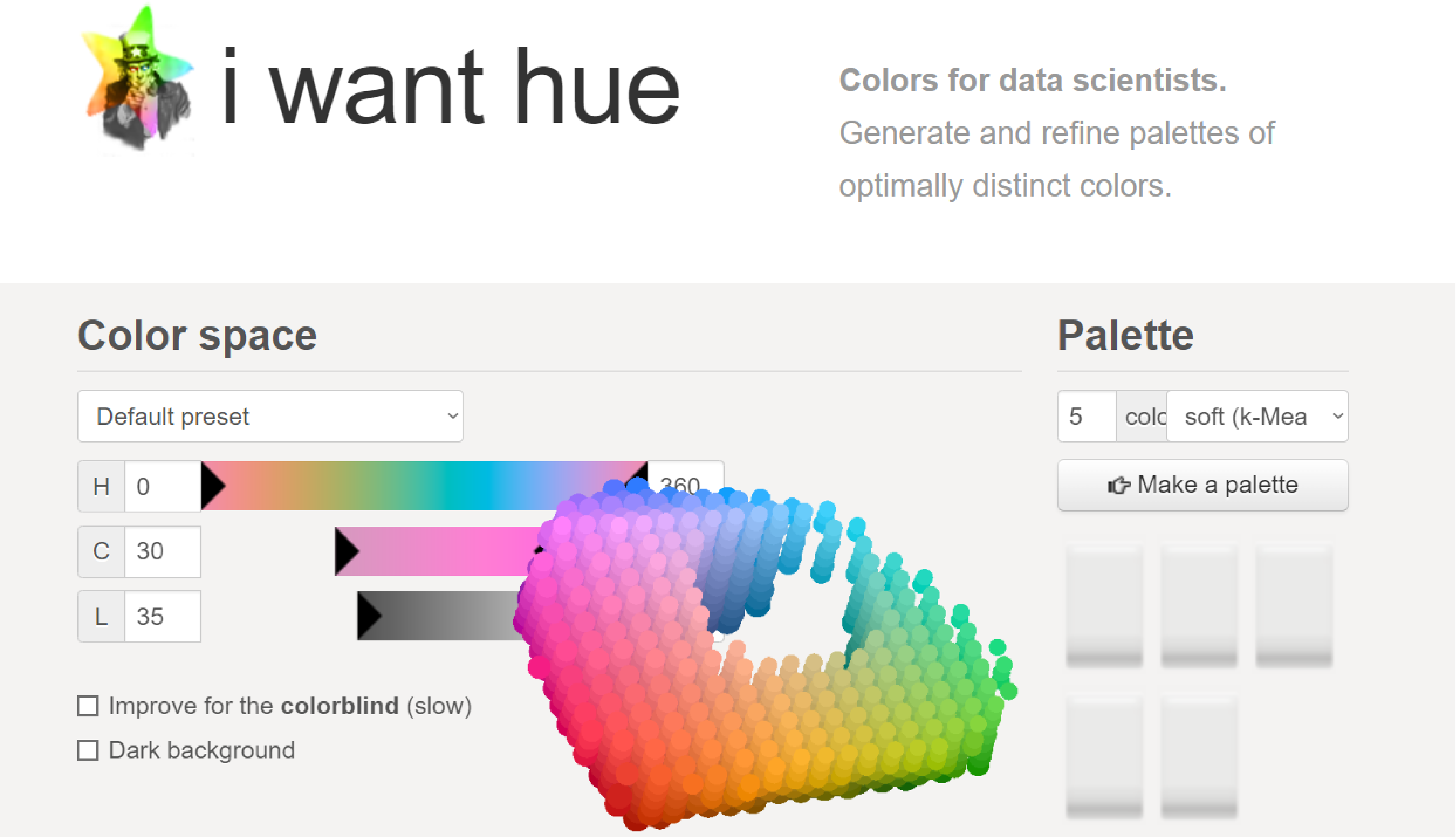
use with care!



- bivariate can be very difficult to interpret
  - when multiple levels in each direction

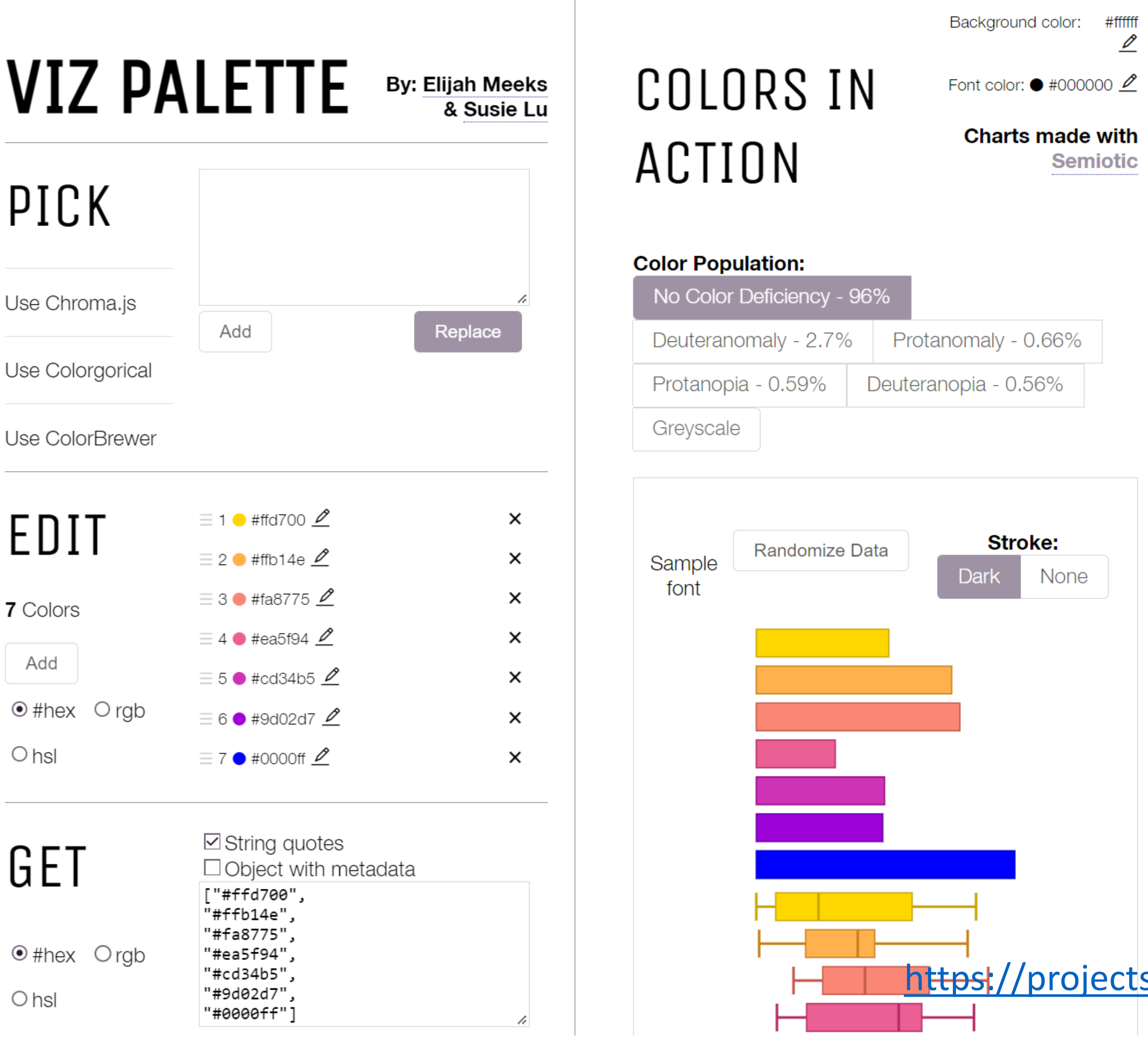
after [Color Use Guidelines for Mapping and Visualization. Brewer, 1994. http://www.personal.psu.edu/faculty/c/a/cab38/ColorSch/Schemes.html]


Number of data classes: 3
Nature of your data:
sequential
diverging
qualitative
Pick a color scheme:
Multi-hue:
Single hue:
Only show:
colorblind safe
print friendly
photocopy safe
Context:
roads
cities
borders
Background:
solid color
terrain
color transparency
3-class BuGn
HEX
EXPORT
#e5f5f9
#99d8c9
#2ca25f
how to use
updates
downloads
credits
COLORBREWER 2.0
color advice for cartography
BuGn class 2
RGB: 153,216,201
CMYK: 40,0,15,0
HEX: #99d8c9
© Cynthia Brewer, Mark Harrower and The Pennsylvania State University
Source code and feedback
Back to Flash version
Back to ColorBrewer 1.0
axismaps



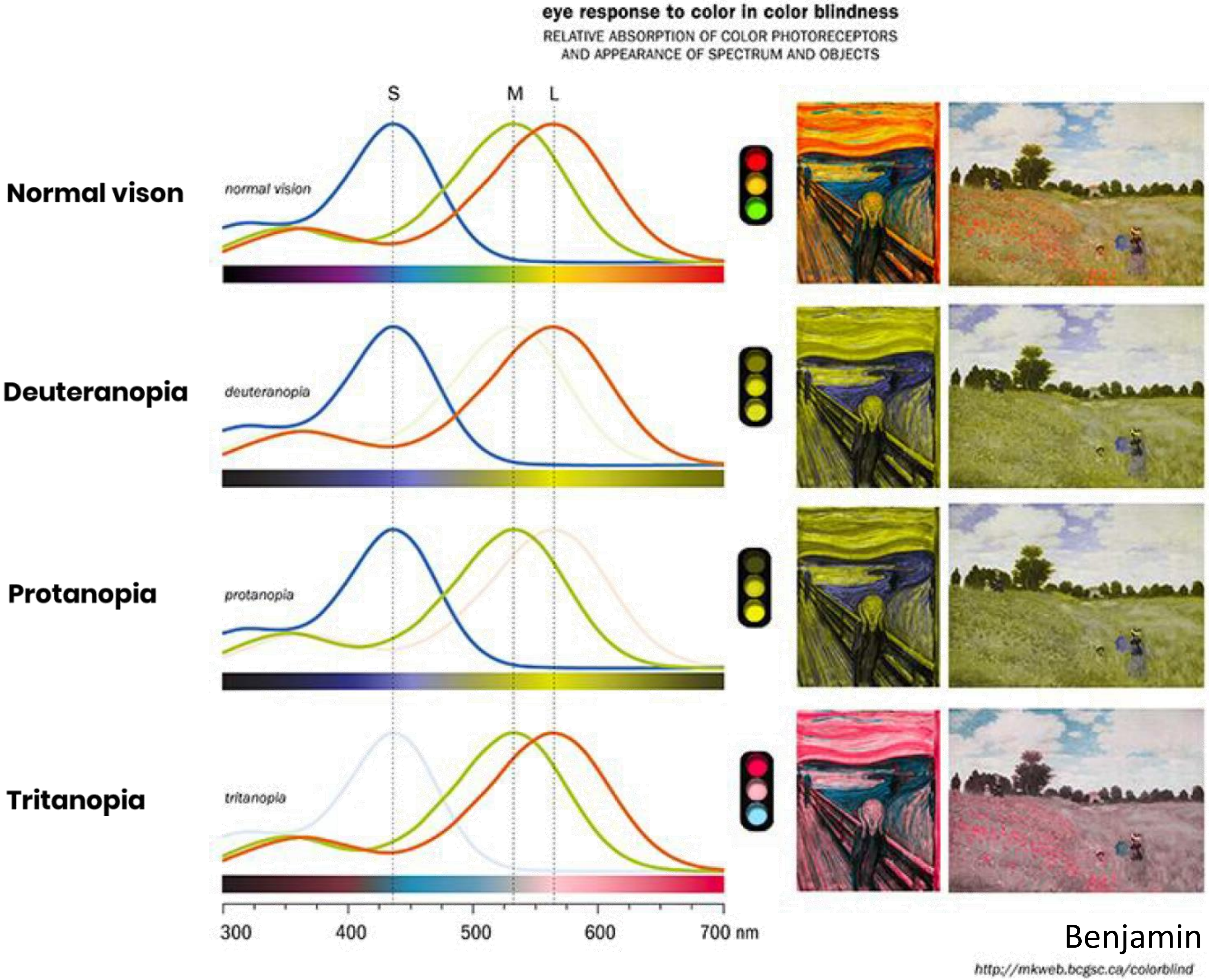
https://medialab.github.io/iwanthue/

Data Visualization - Palettes



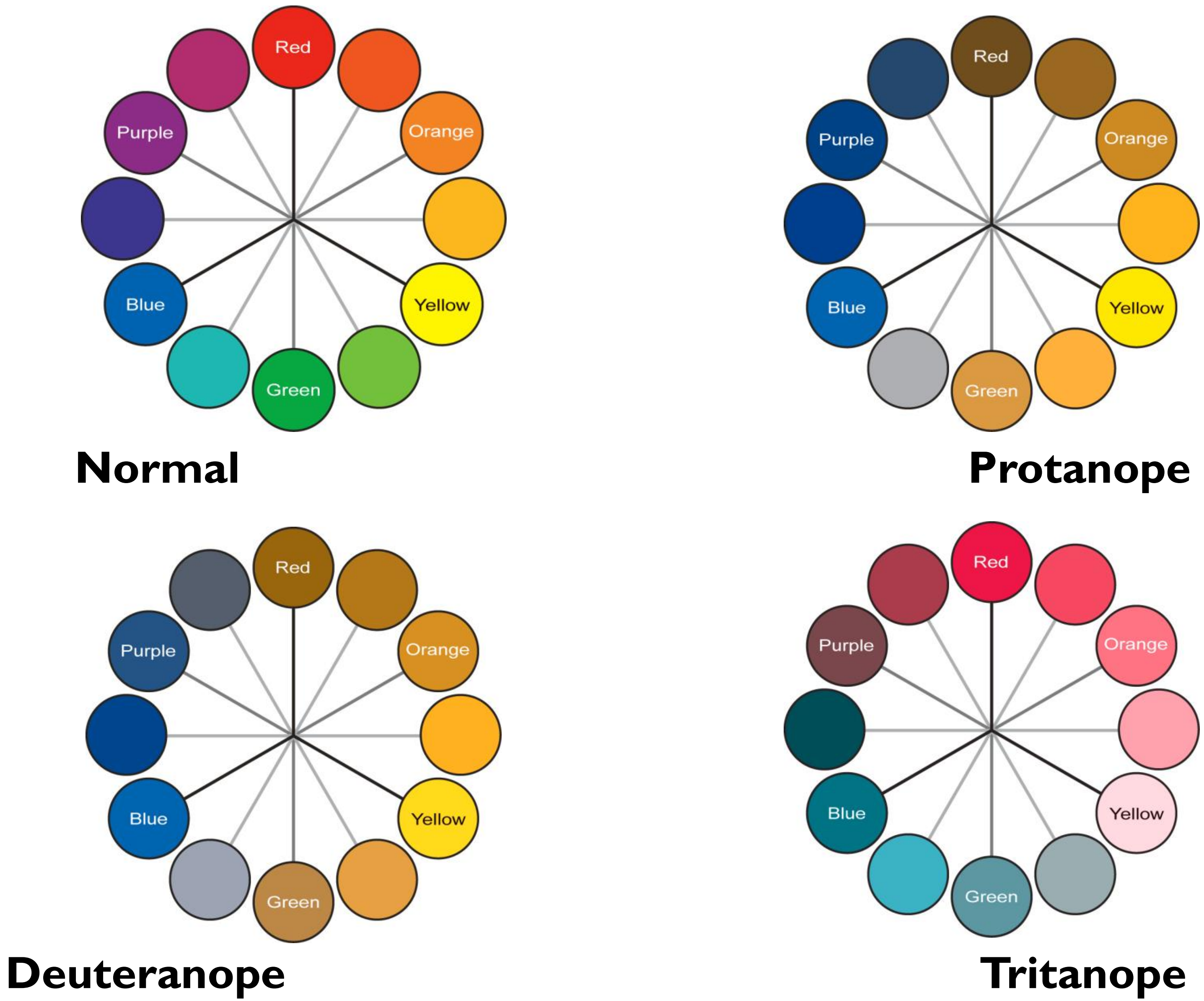
https://projects.susielu.com/viz-palette

Color deficiency aka Color blindness or color vision deficiency (CVD)

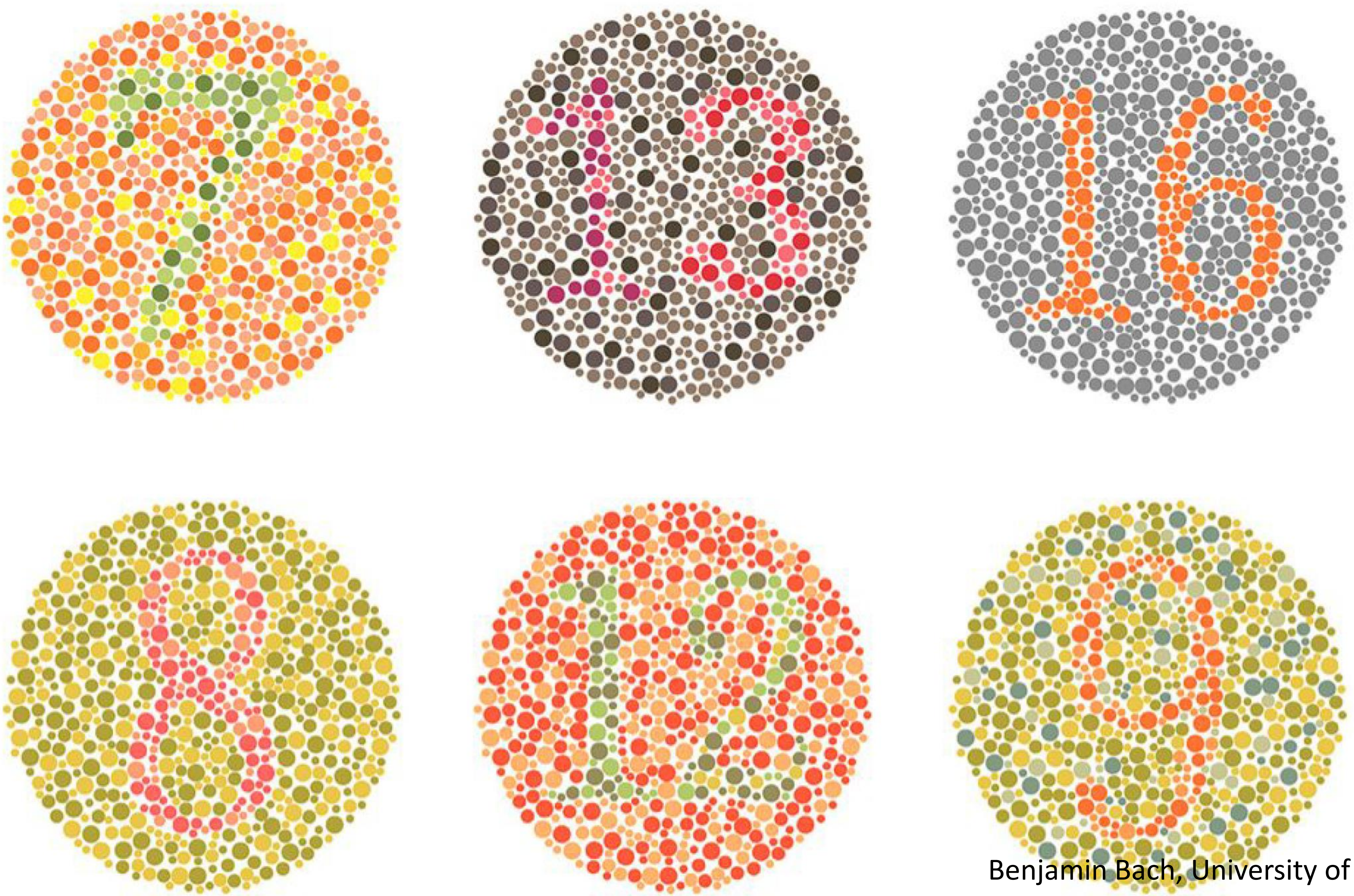


Benjamin Bach, University of Edinburgh

Color deficiency: Reduces color to 2 dimensions



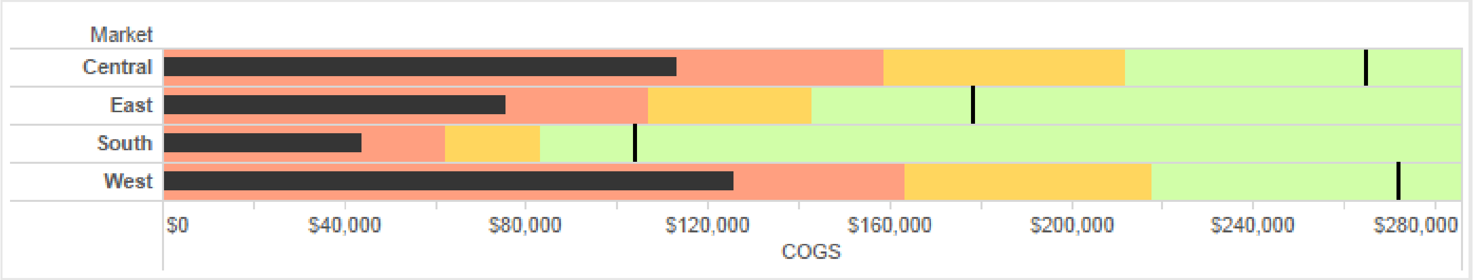
[Seriously Colorful: Advanced Color Principles & Practices. Stone.Tableau Customer Conference 2014.]

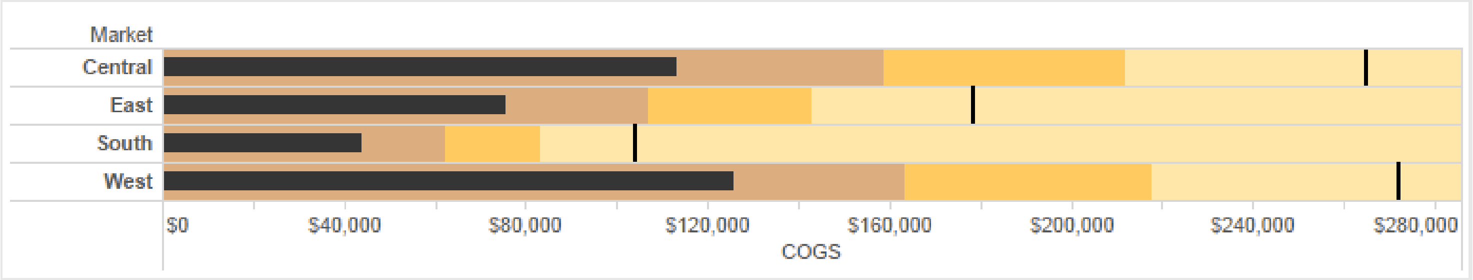


Benjamin Bach, University of Edinburgh

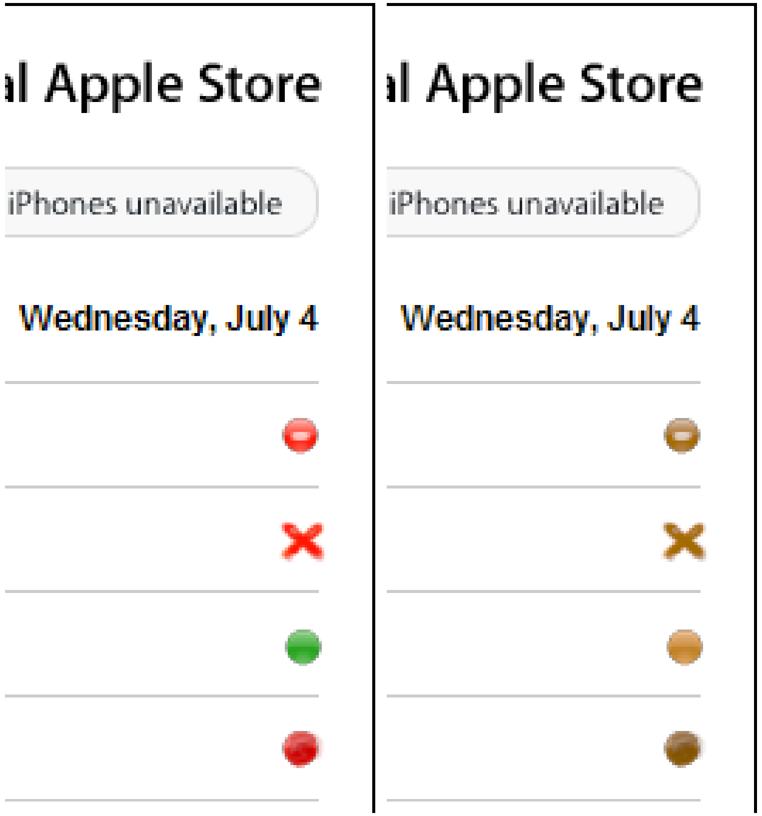
Designing for color deficiency: Avoid encoding by hue alone

- redundantly encode
  - vary luminance
  - change shape





Deuteranope simulation



Change the shape

Vary luminance

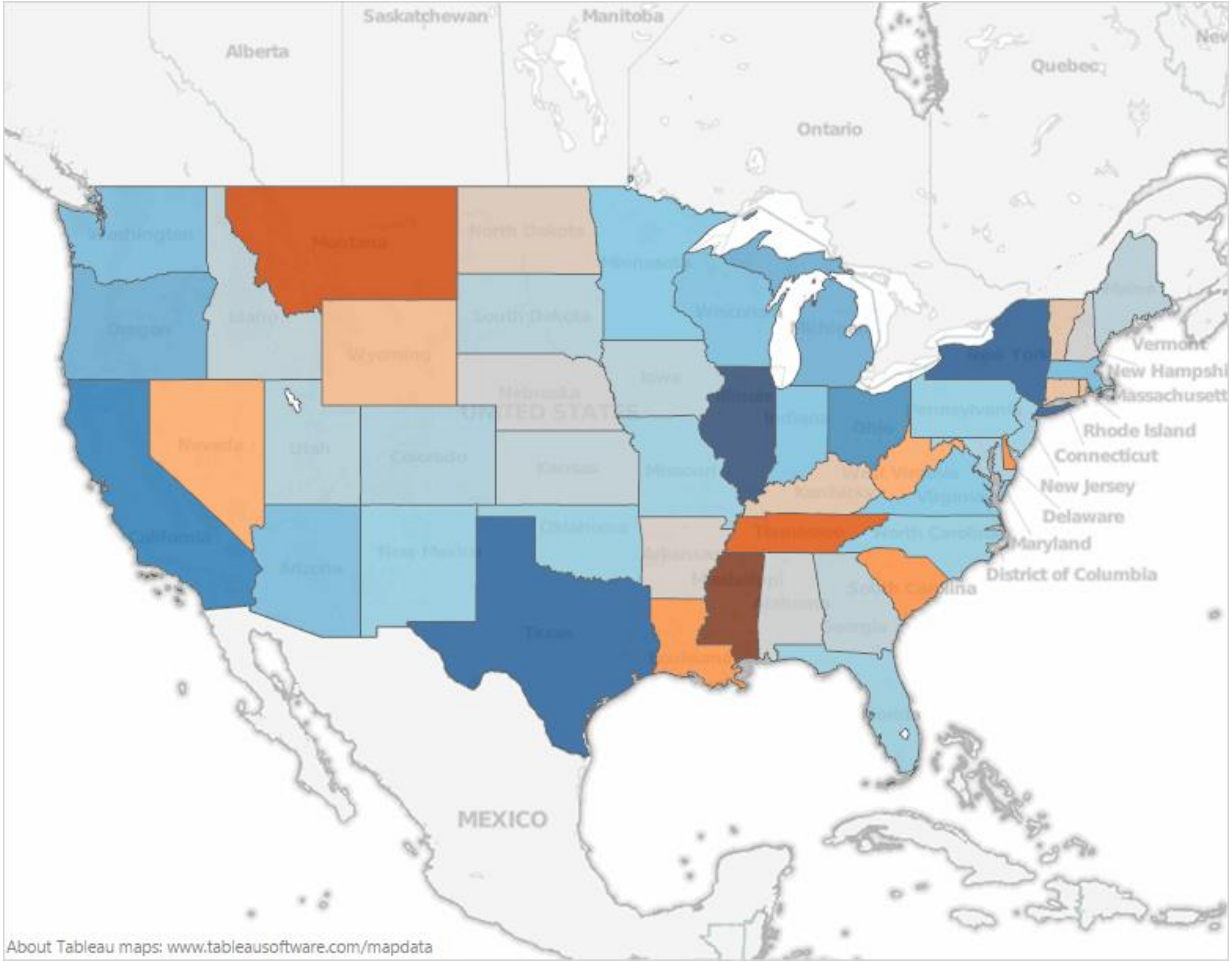
[Seriously Colorful: Advanced Color Principles & Practices. Stone.Tableau Customer Conference 2014.]

Color deficiency

- Population of northern european descent

		Protanopia	Deuteranopia	Tritanopia
Men	91.4%	2.45%	6.1%	0.011%
Women	99.6%	0.04%	0.36%	0.04%
Overall	95.5%	1.25%	3.24%	0.025%

Designing for color deficiency: Blue-Orange is safe



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