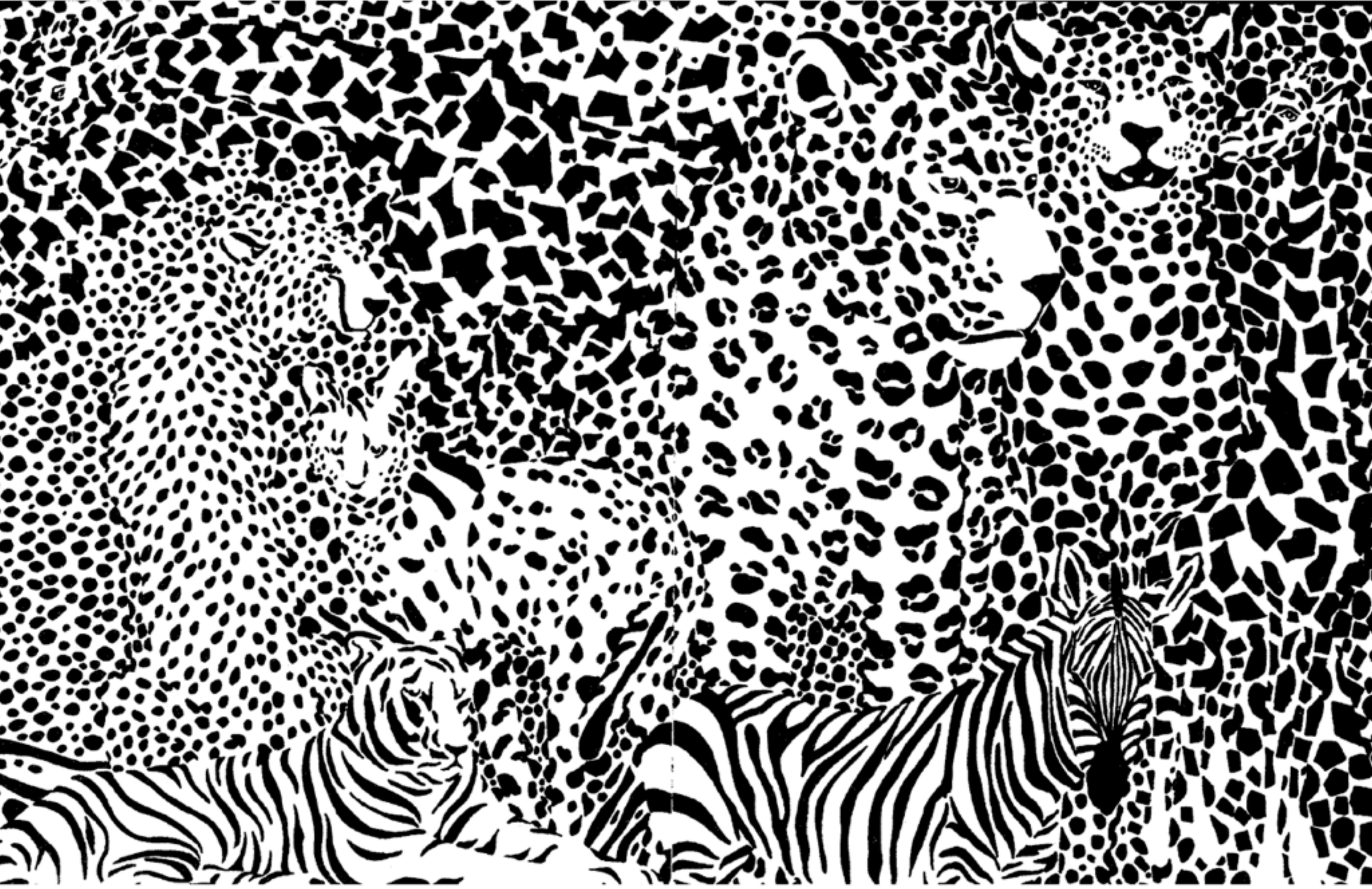
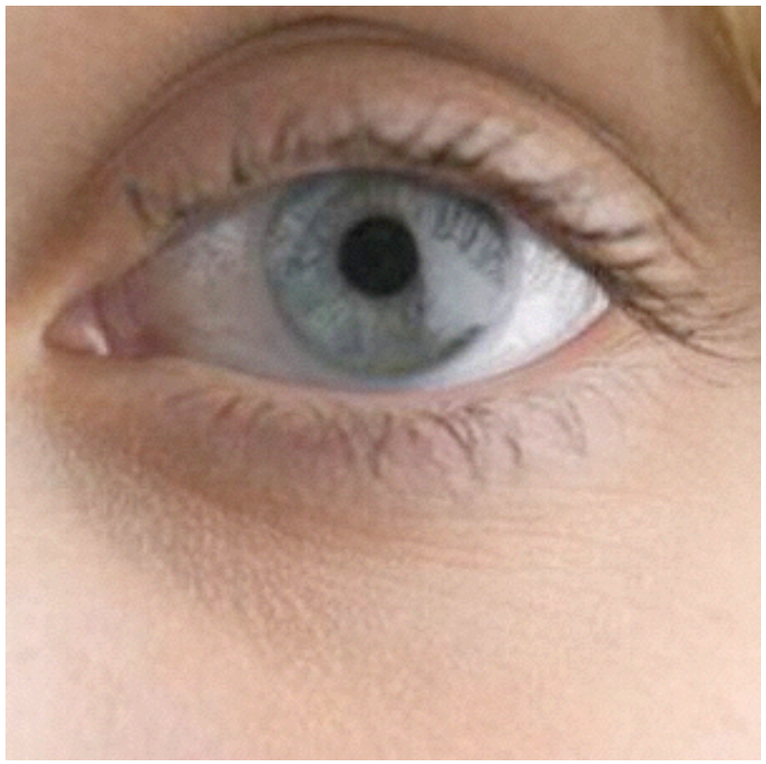
CS 171

Perception

Johanna Beyer (jbeyer@g.harvard.edu)



“Ranger Rick”, ca. 1980s
Courtesy of Terry Yoo / Ross Whitacker

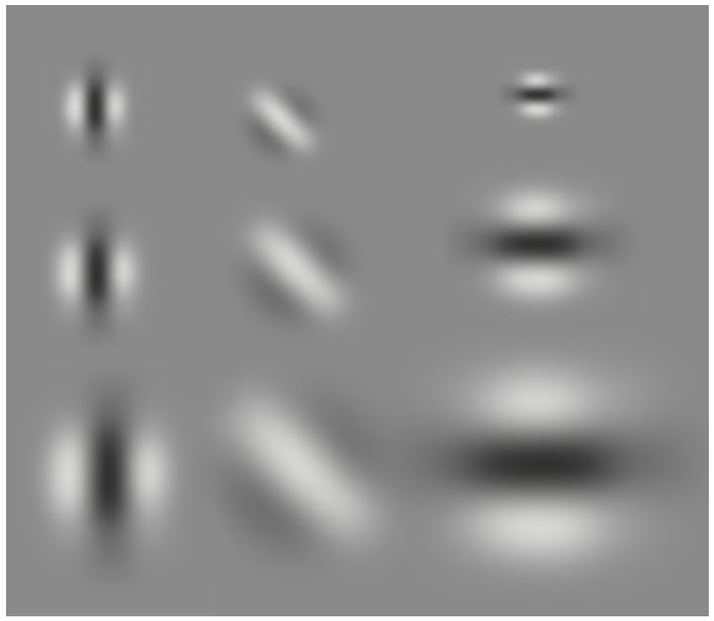


vs.

You see with your brain!

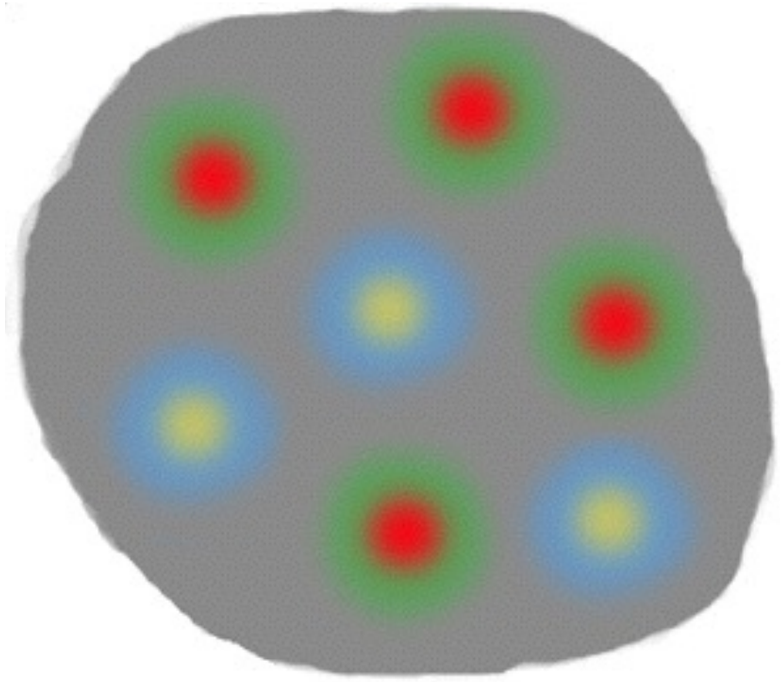
CS 171

Pre-reading: The human visual system can detect…



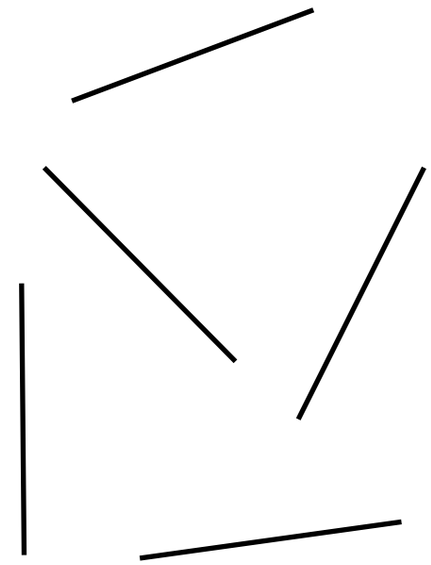
Contrast

Some sensitivity to color



Color

R/G and Y/B changes



Motion

Insensitive to color

C. Ware, ‘Visual Thinking for Design’

Today

Contrast

Color

Motion

Lab Feedback

- Lab slides on Canvas
- Lab length:
  - Our strategy: Lab will **teach** you concepts…you **apply** them in HW
  - Especially lab 2 it is designed to take longer than 90 minutes (for everyone without JS experience)
  - Learning a programming language or library is hard! It takes time!

Feedback

There were many more **great questions** that we cannot address now and here. Please bring them up in studios!

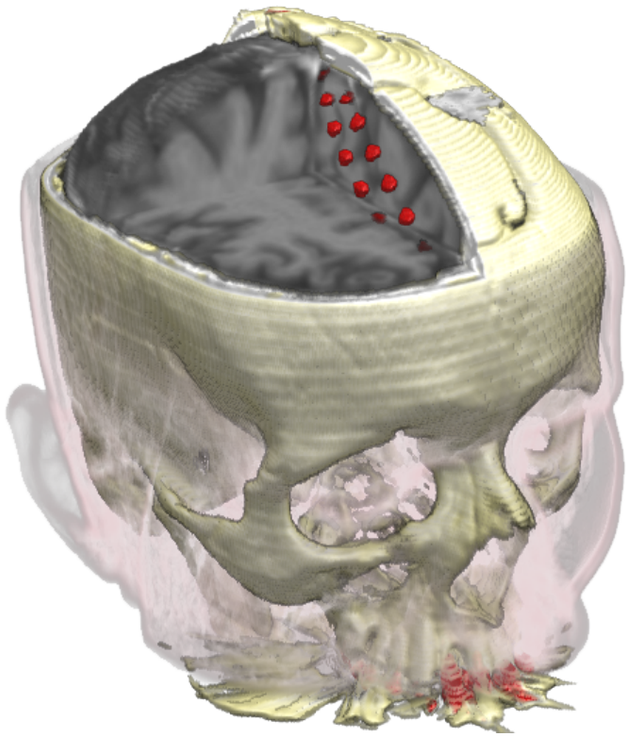
---

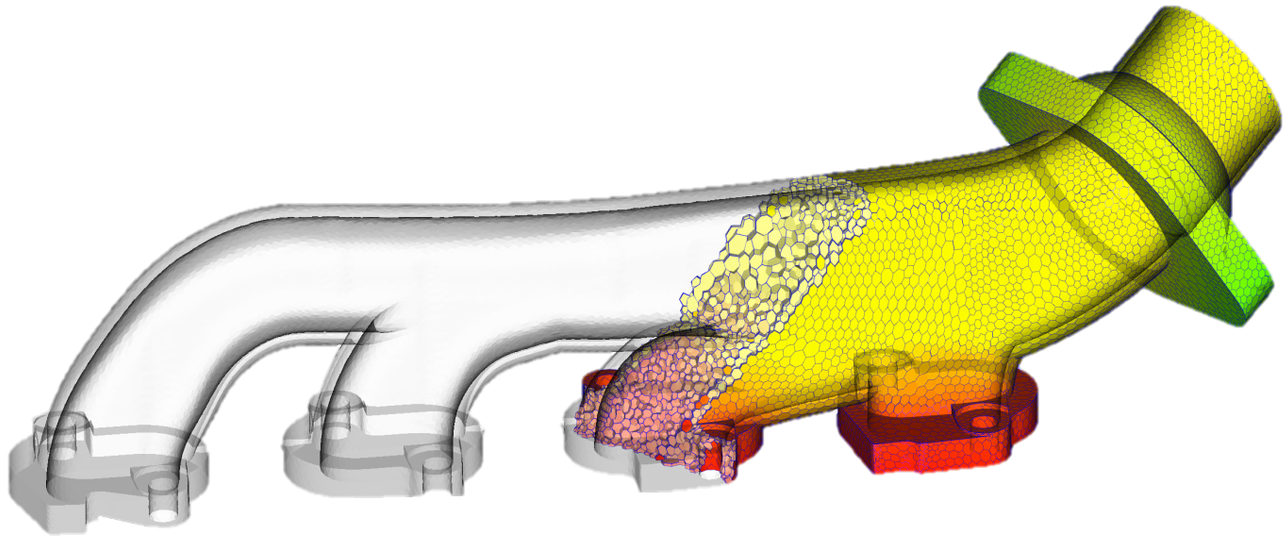
1) How do you balance Tufte's design principles of minimizing clutter with subjective dimensions such as aesthetics and style? What's the correct balance between clutter-free but boring and chart junk?

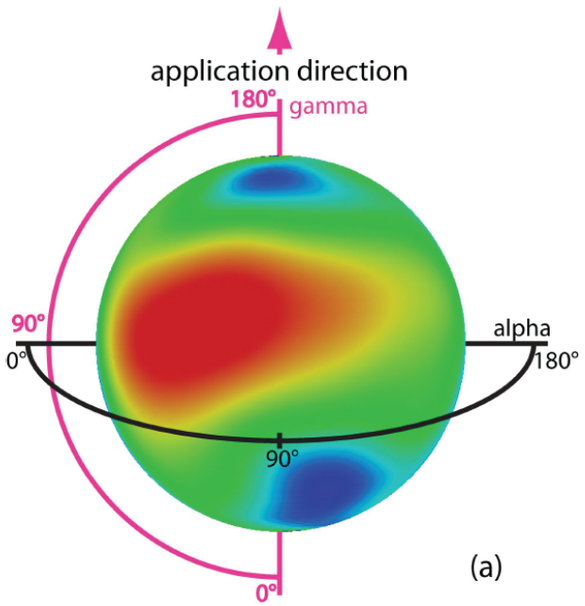
2) Out of countless visualization options for data, I still don't know if I know exactly how to choose the best one. How do I make better designs?

3) When is 3D visualization good?

3D Visualization

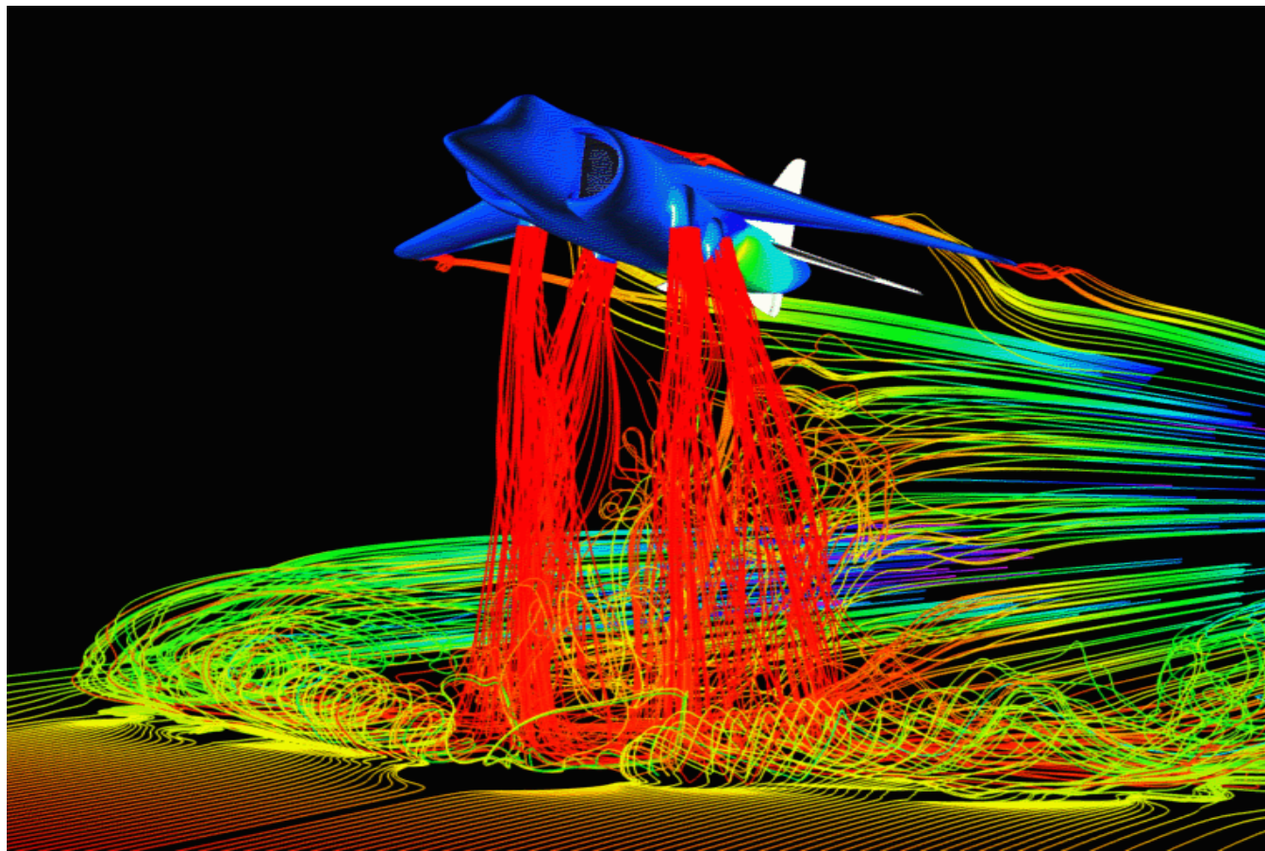






(a)

(b)



Forward Questions

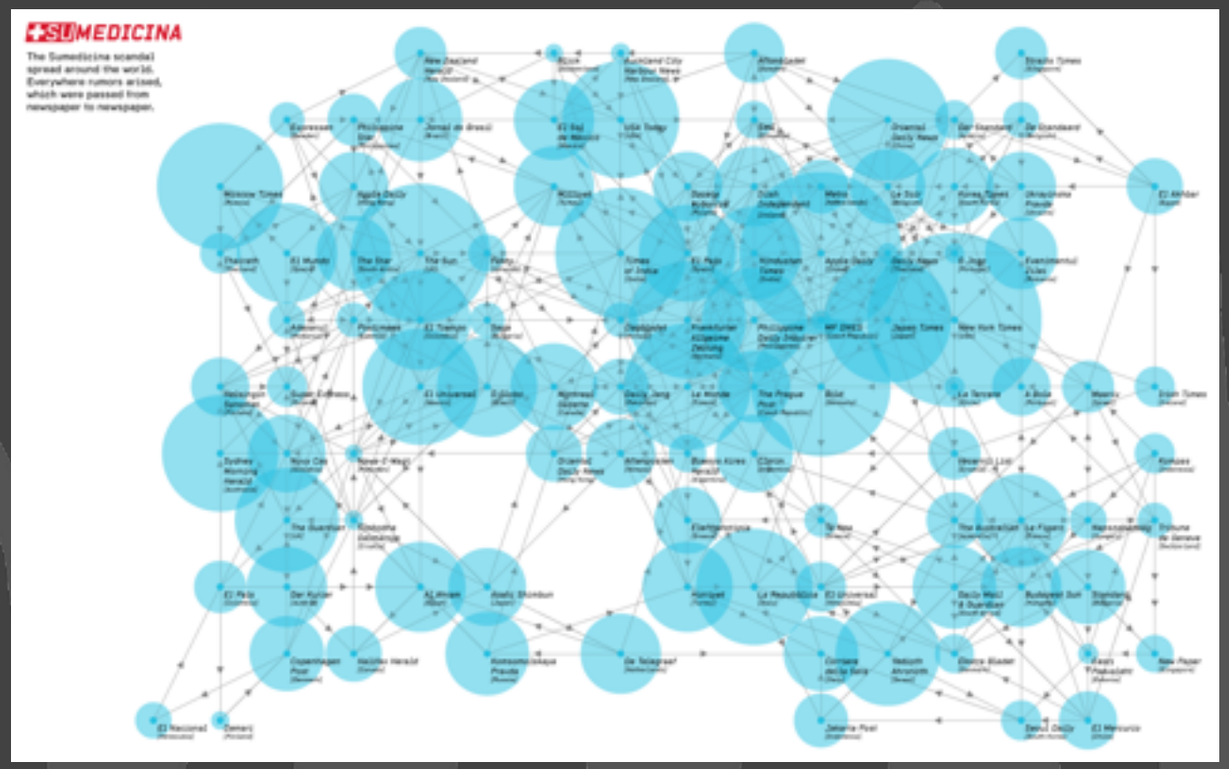
Some questions will be answered later in the course

How can we use interactive visualization to expand possibilities? How do rules change when graphics become interactive? - **Interaction** lecture

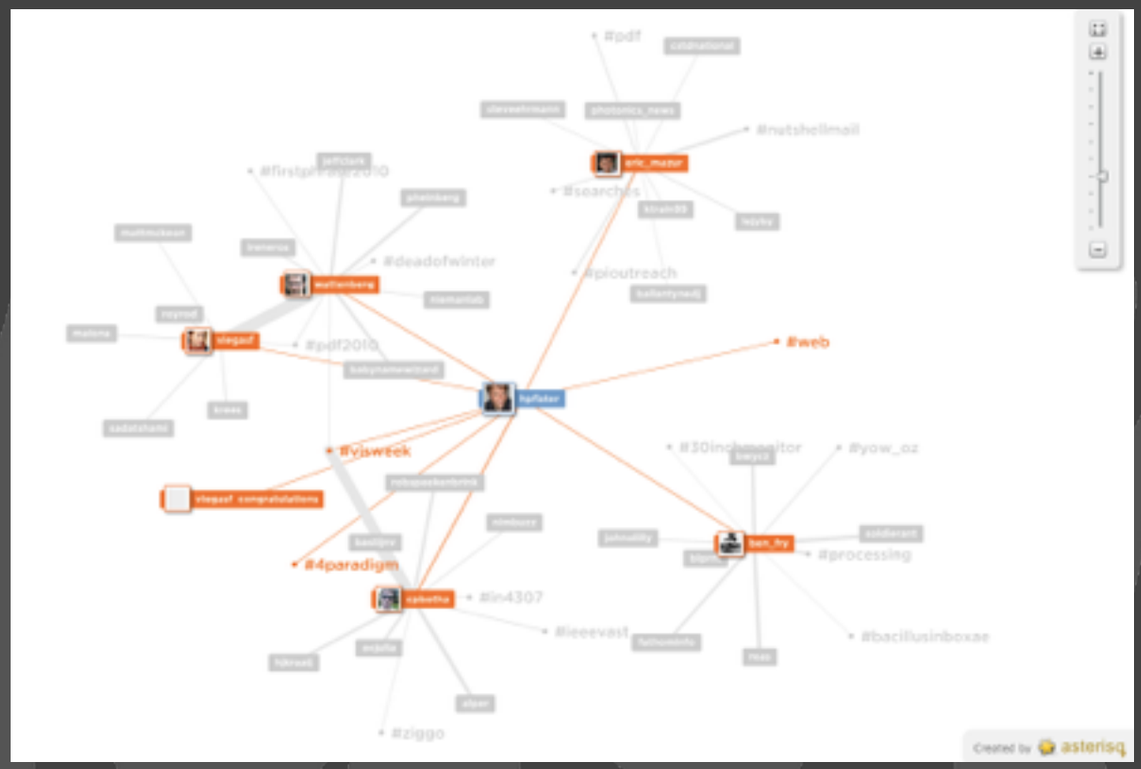
Is there a "correct" way to use color, what are good combinations? What about visualizations for color blind people? - **Today**

Activity

Which of these network visualizations is better (in regards to perception), and why? (1 min)



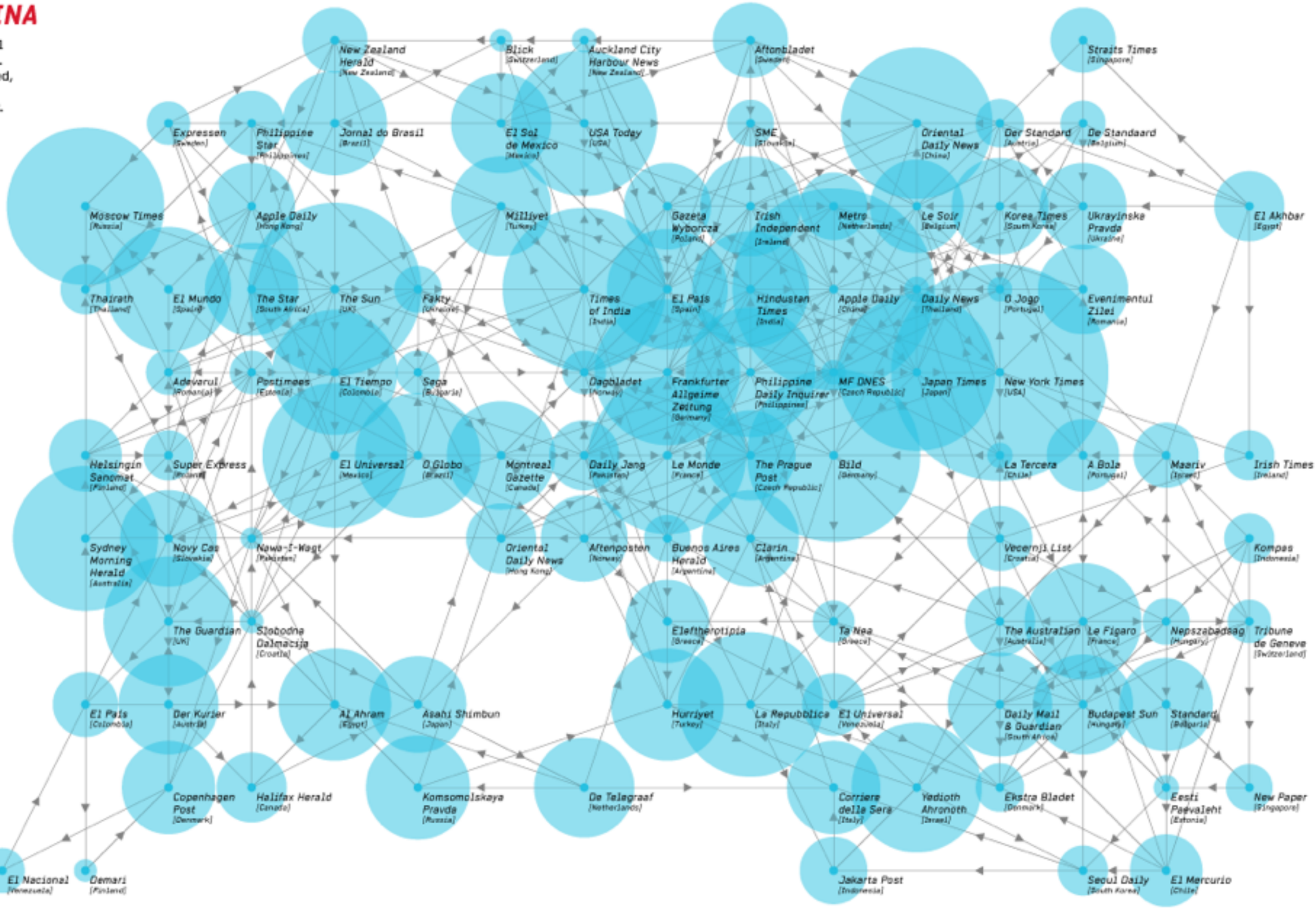
http://kimasendorf.com/sumedicina/



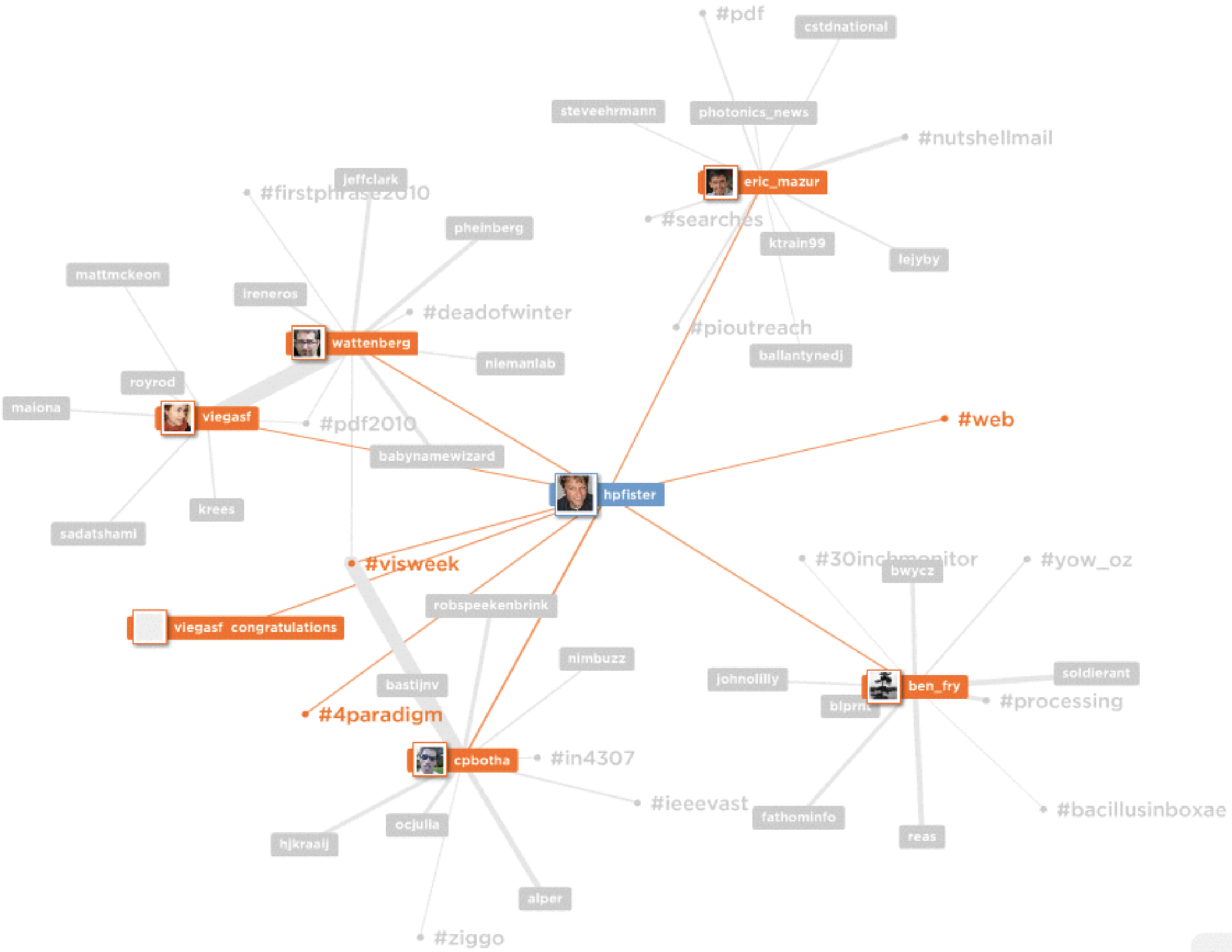
http://mentionmapp.com/

SUMEDICINA

The Sumedicina scandal spread around the world. Everywhere rumors arised, which were passed from newspaper to newspaper.



http://kimasendorf.com/sumedicina/

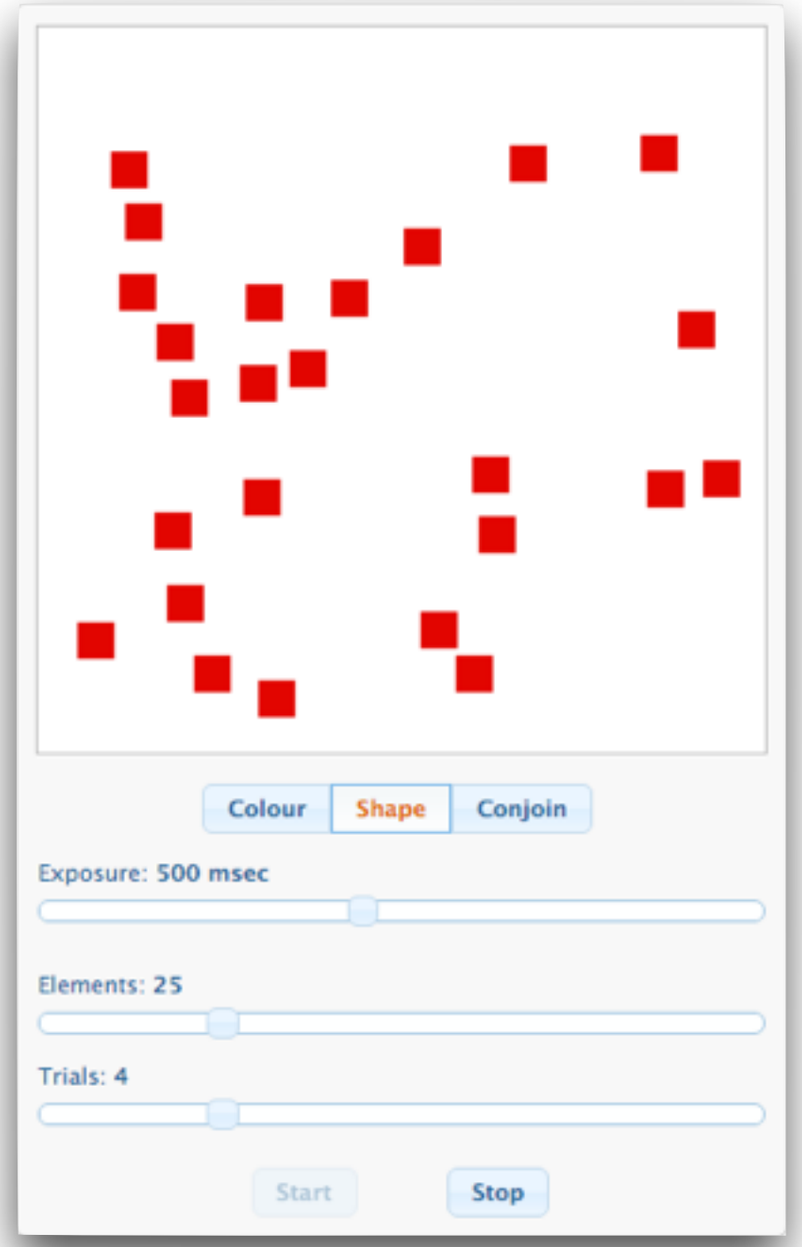


http://mentionmapp.com/

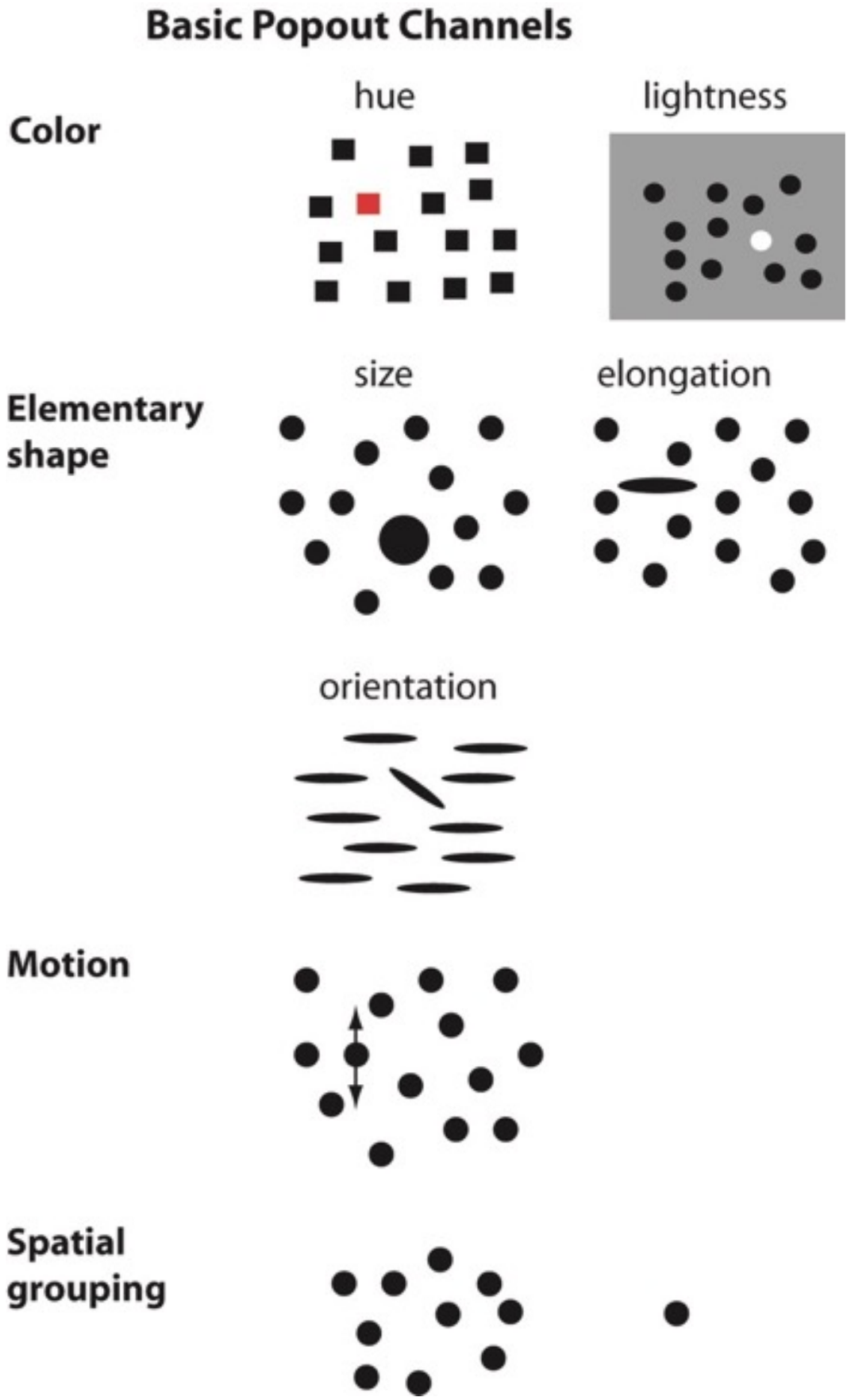
Contrast

CS 171

Things That Pop



Christopher Healey, NC State University
https://www.csc.ncsu.edu/faculty/healey/PP/index.html



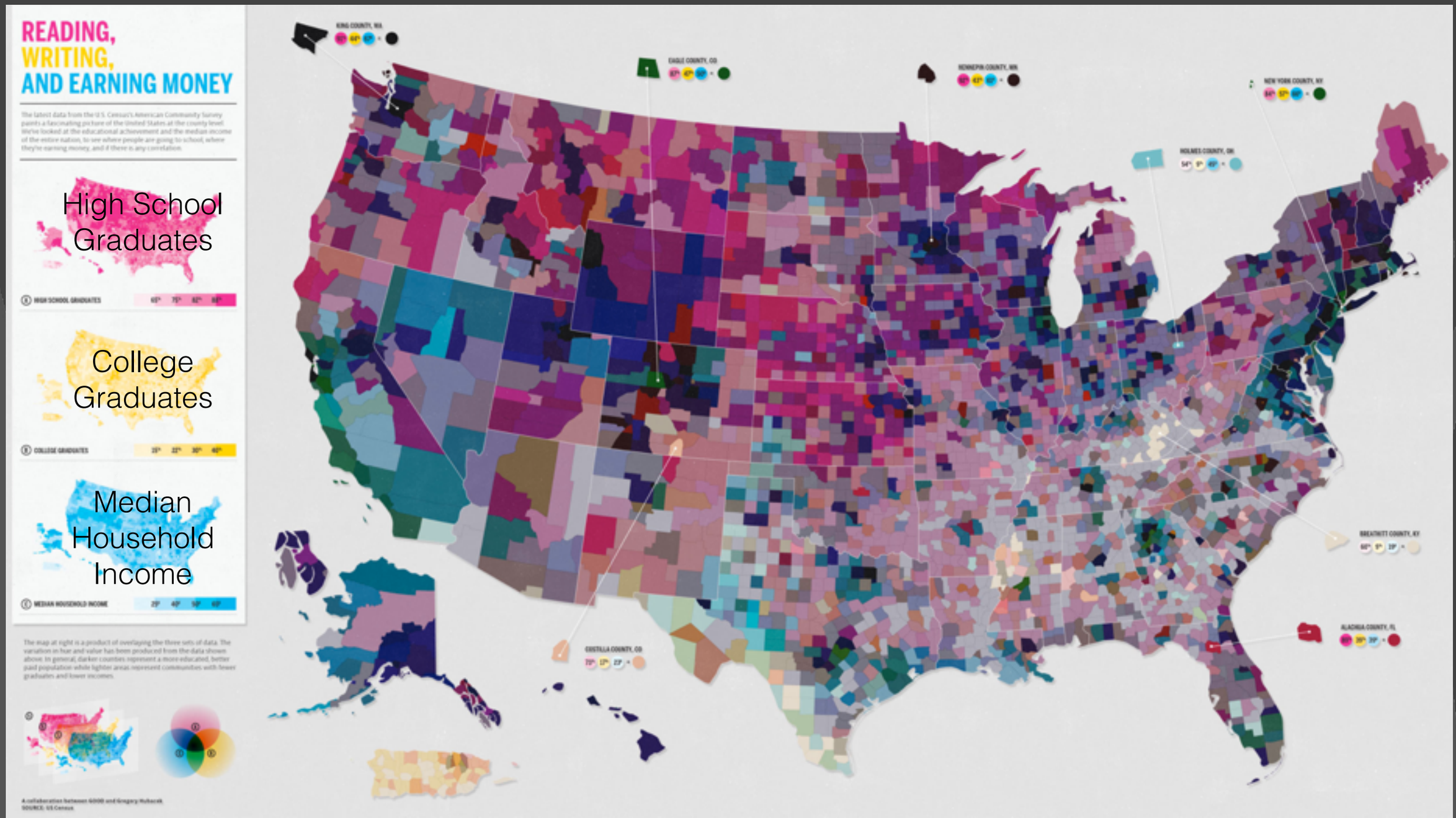
C. Ware, “Visual Thinking for Design”

Activity

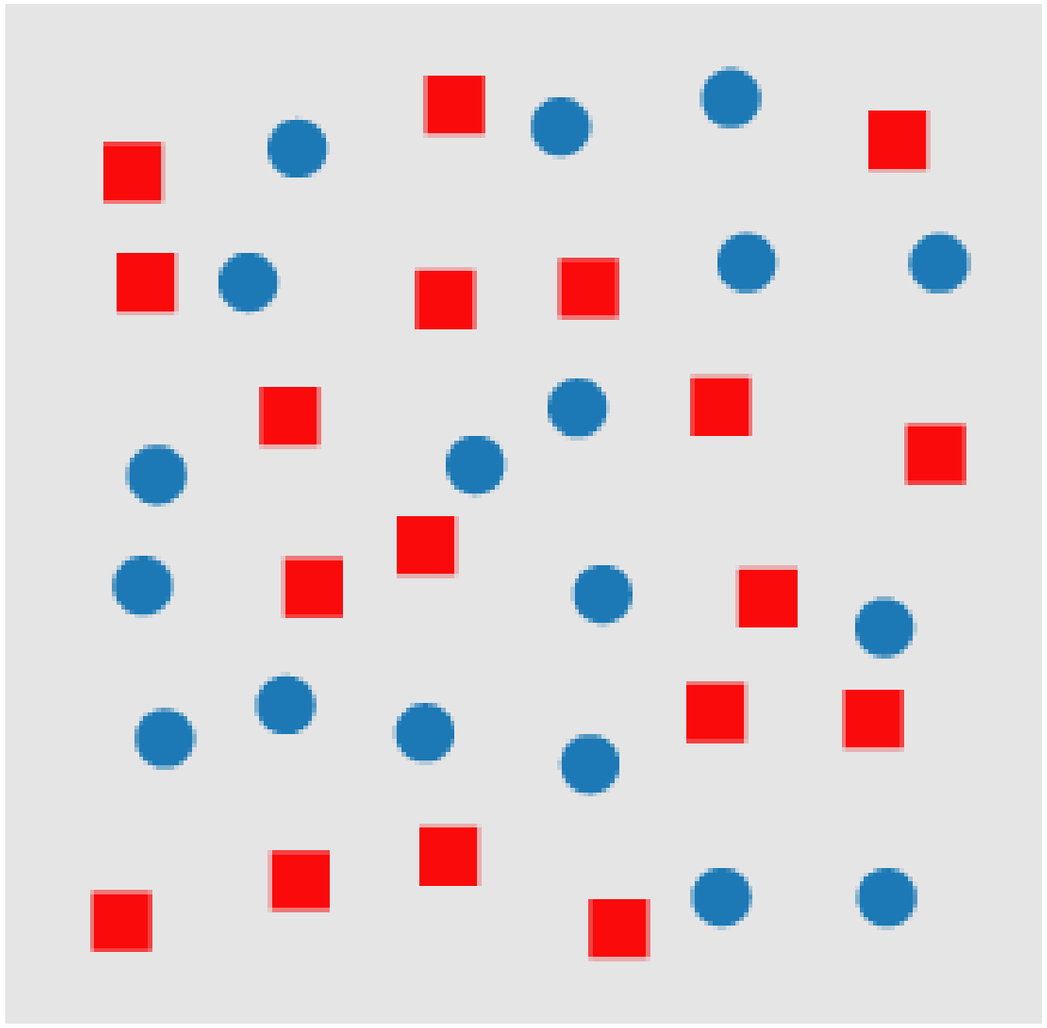
CS 171

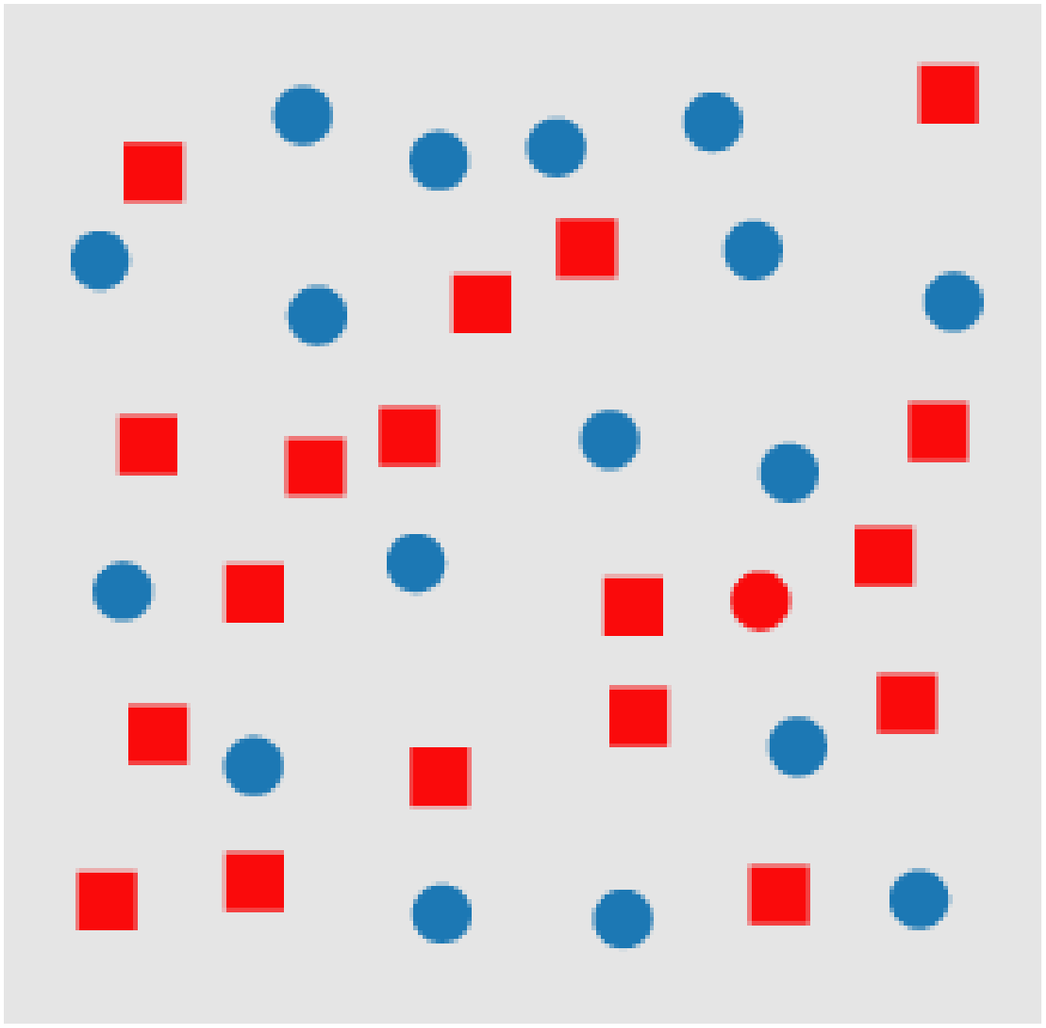
Does this visualization work? Why or why not? (2 min)

bit.ly/good-mag-map



Conjunction

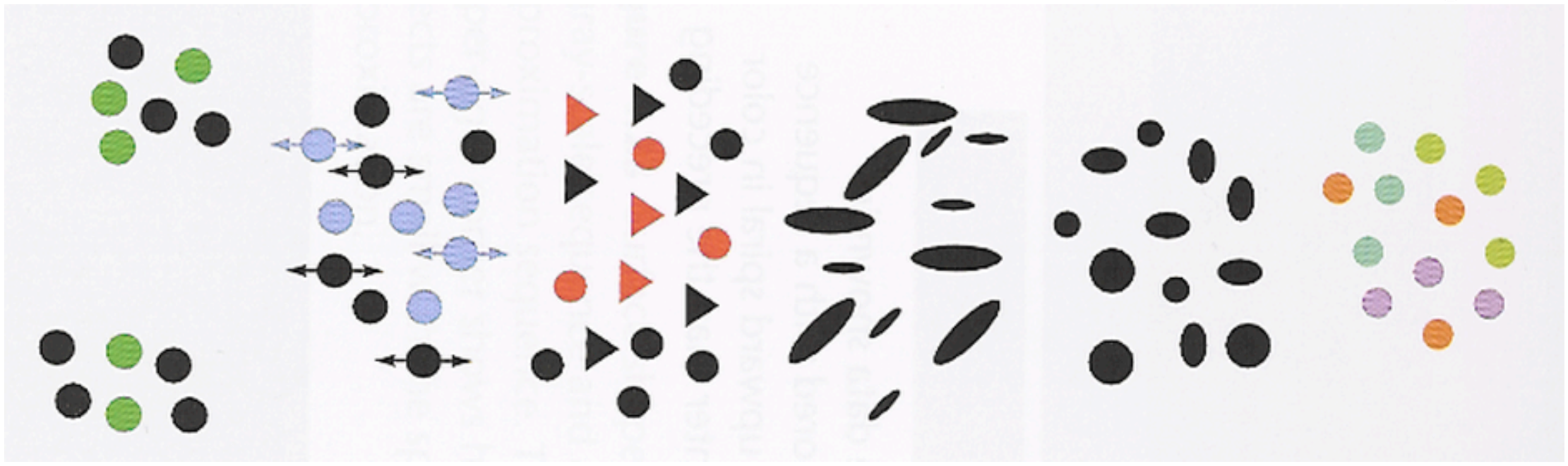




Christopher Healy 2007

Separable - Integral

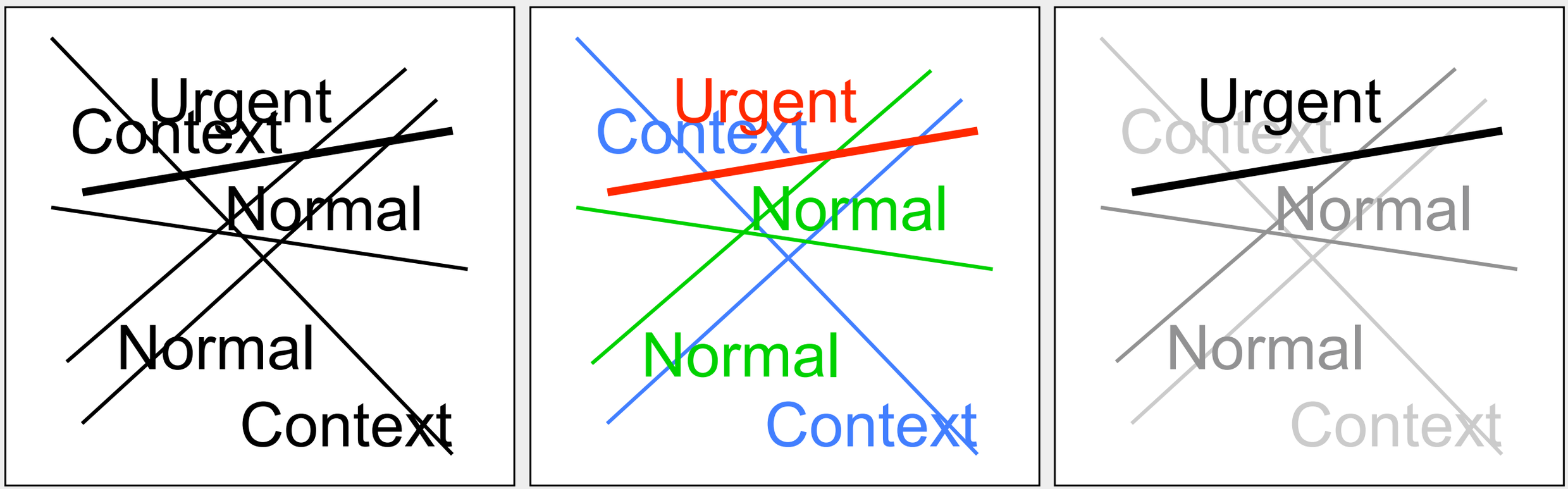
Separable ⟷ Integral



color location | color motion | color shape | size orientation | x-size y-size | red-green yellow-blue

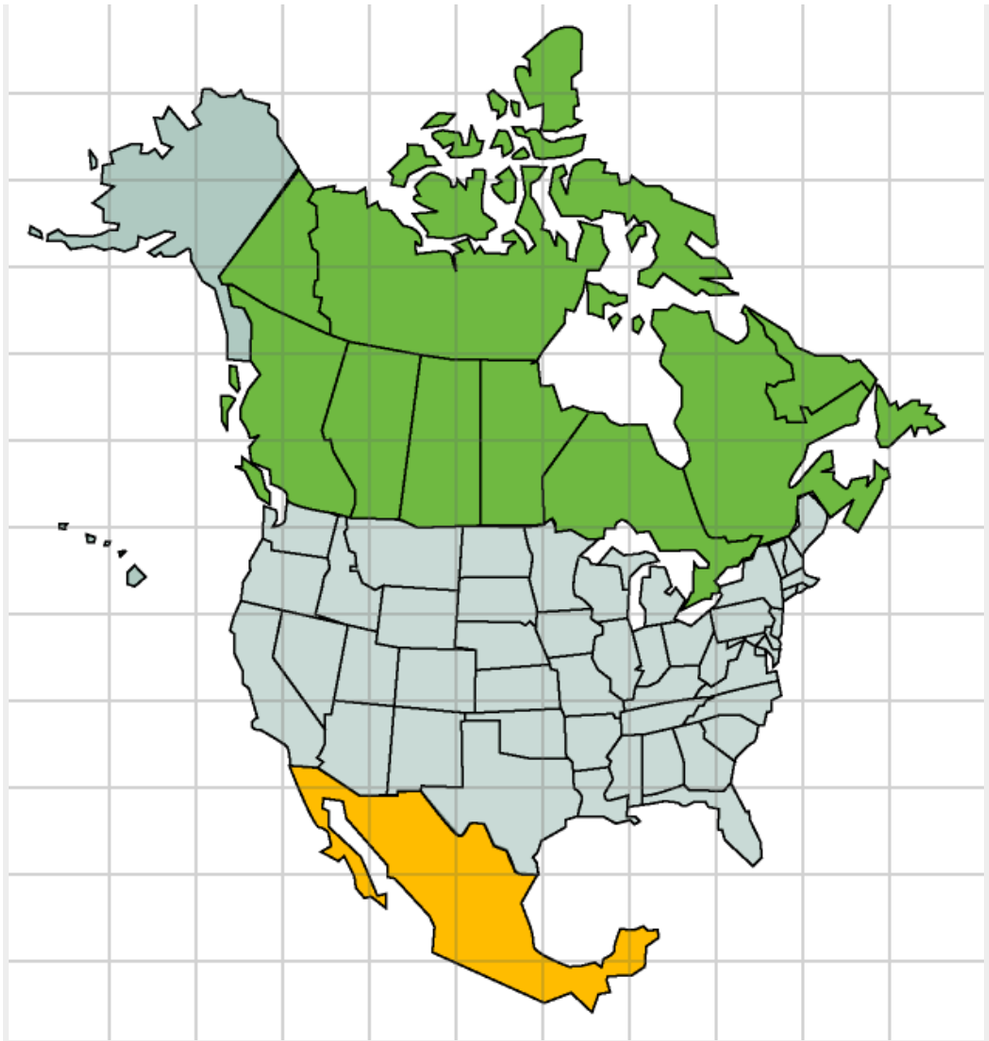
C. Ware, “Information Visualization”

Contrast and Layering

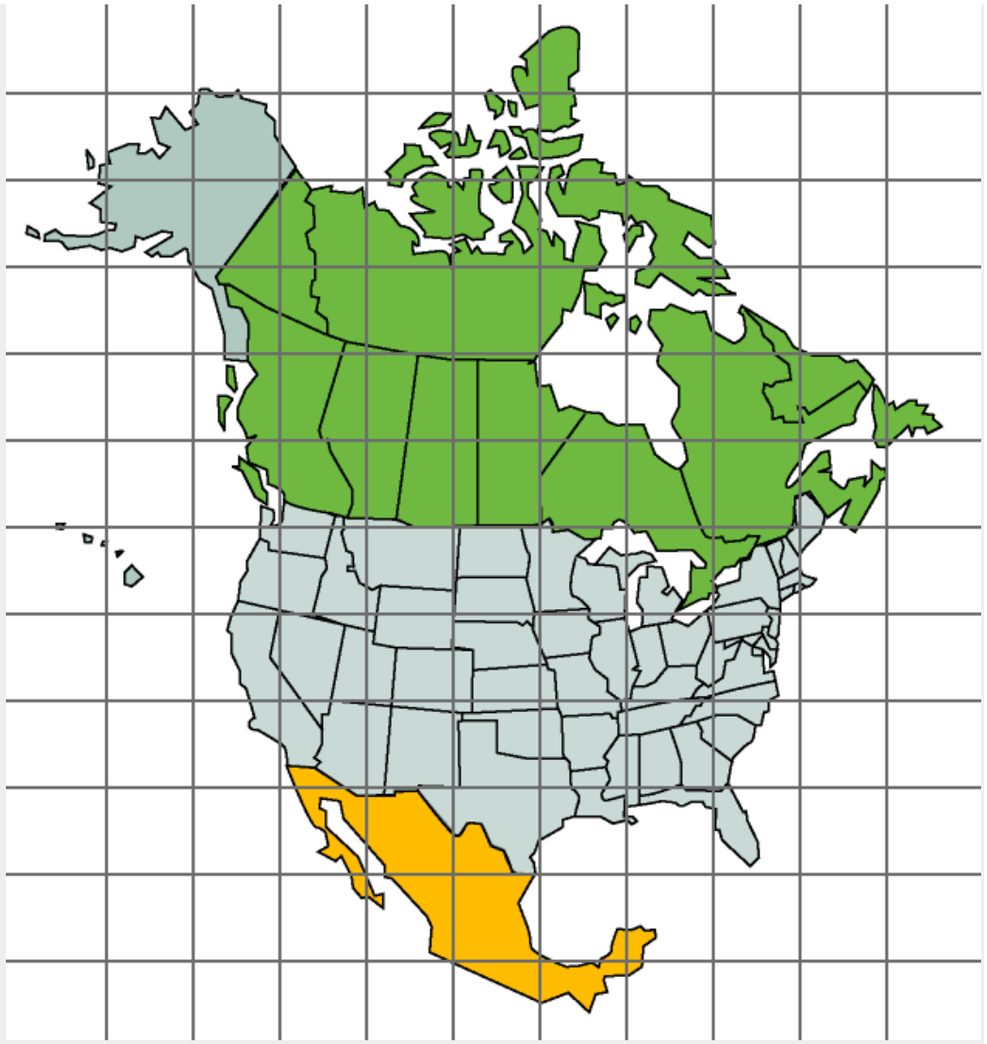


http://colorusage.arc.nasa.gov

Contrast and Layering

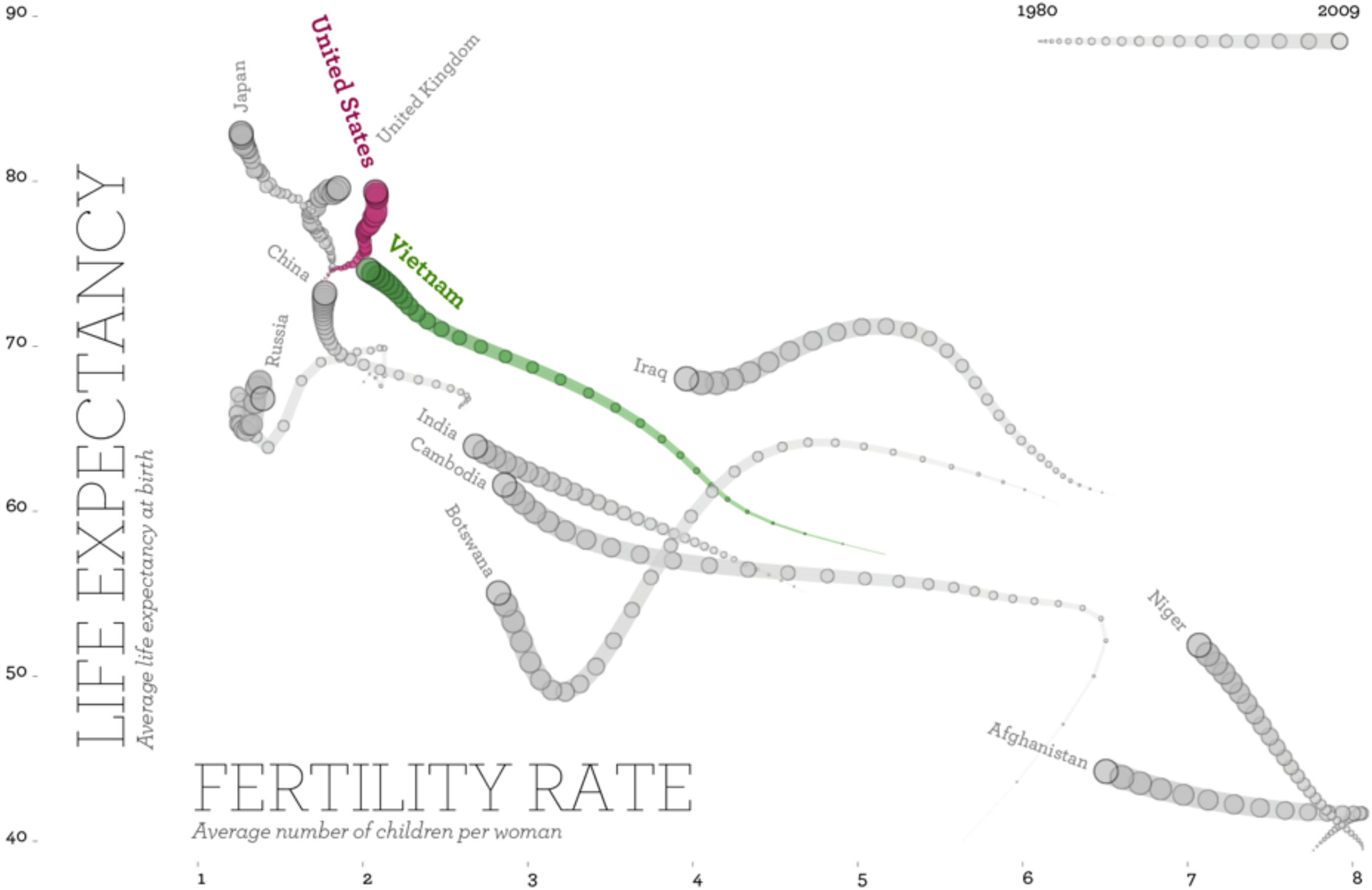


Grid sits unobtrusively in the background



Grid sits in foreground, obscuring map

M. Stone, L. Bartram and D. Gromala
“Great Grids: How and Why?”

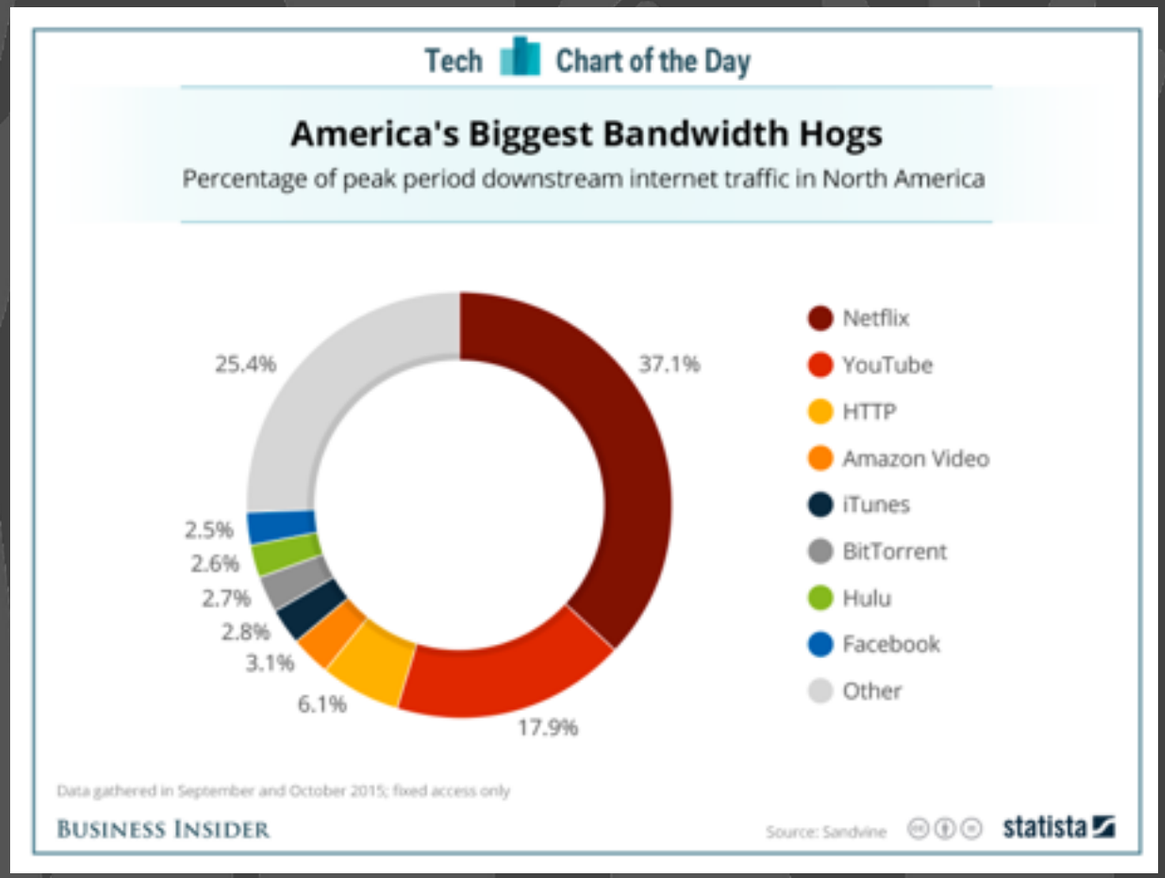


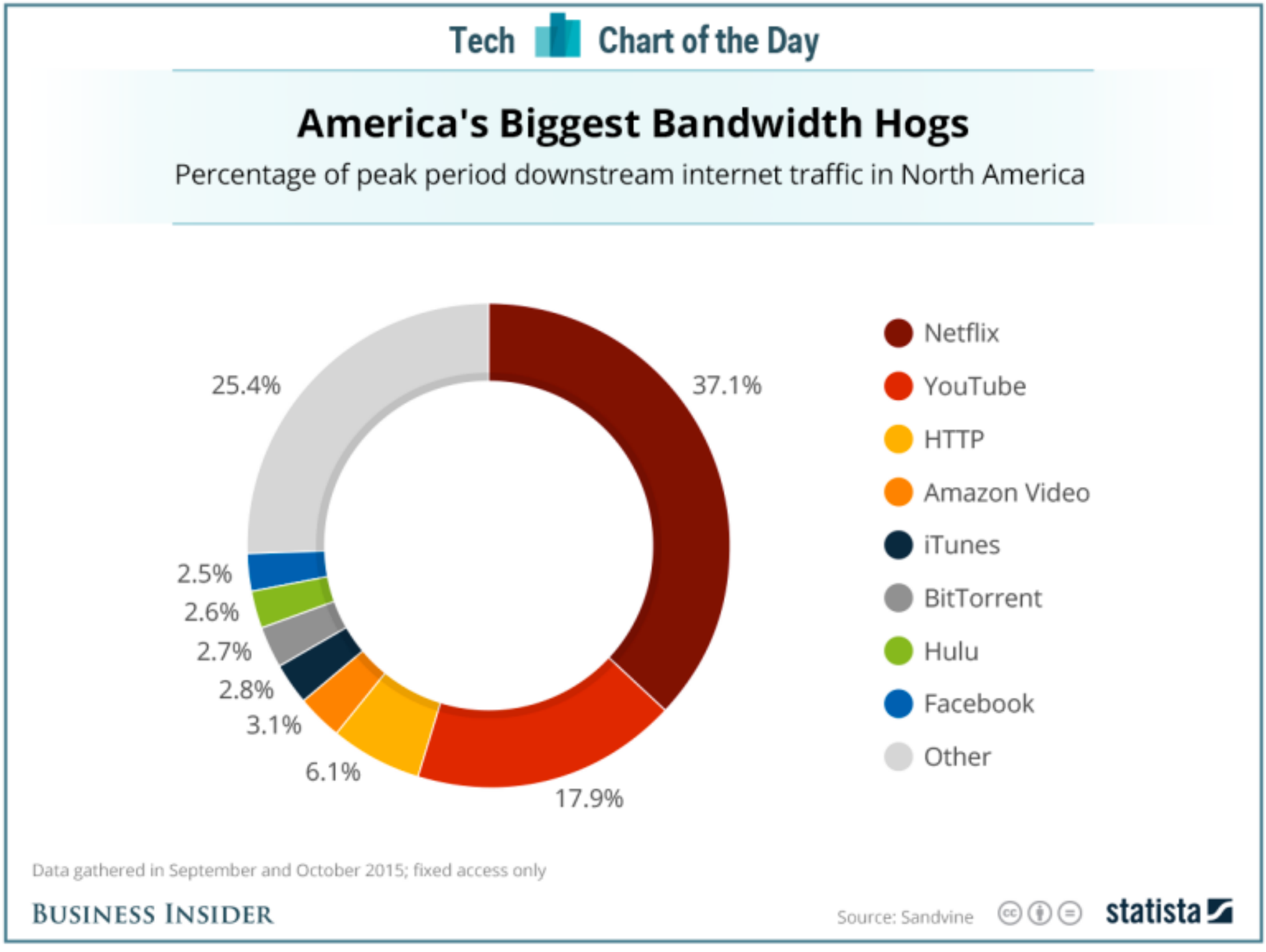
M. Stefaner, “Remixing Rosling”

Activity

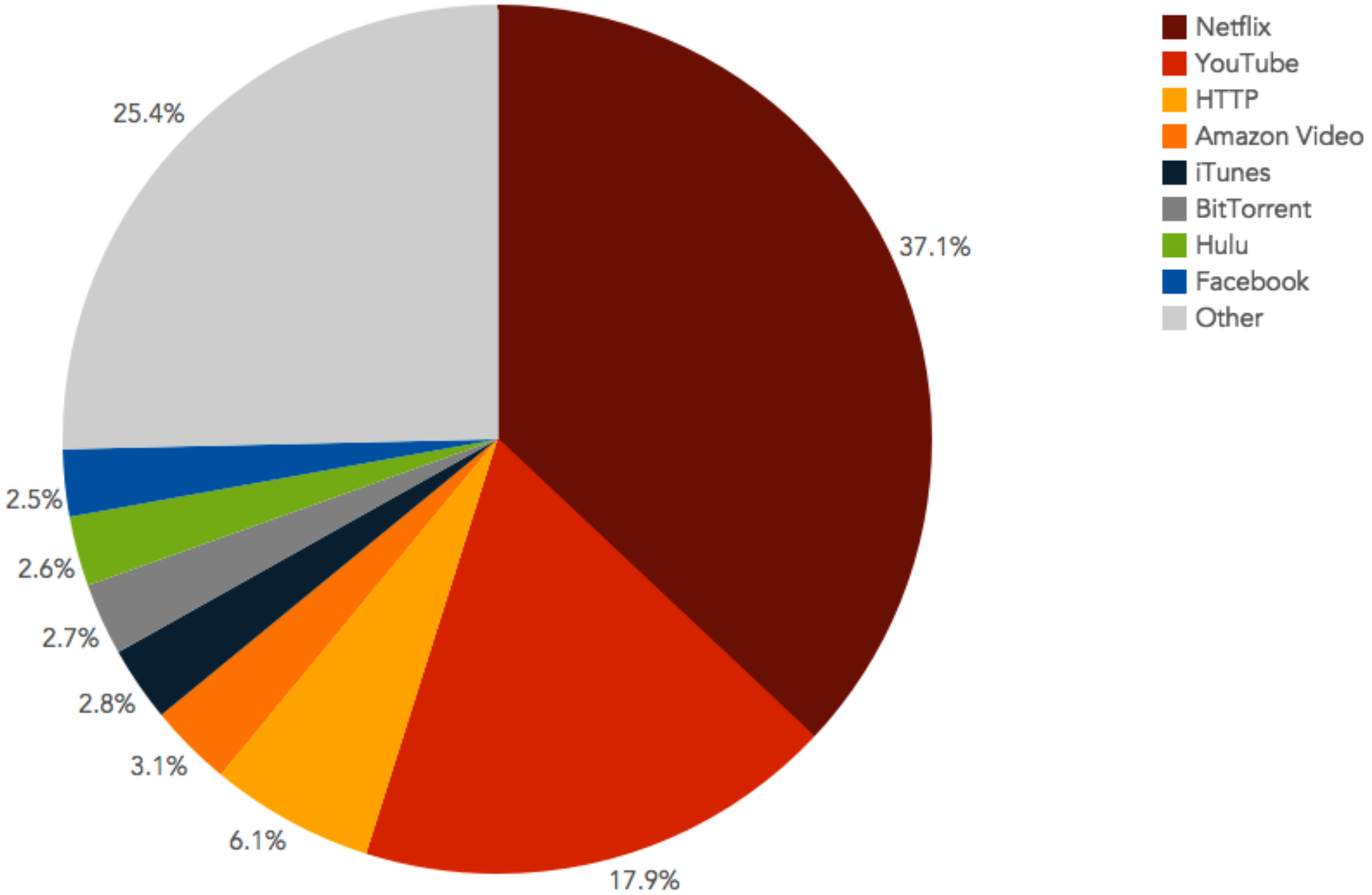
Pair up with your neighbor. Think about a message that you would like to communicate with this data. Use contrast and layering to sketch at least one visualization that conveys your message effectively.

(2 + 4 min)

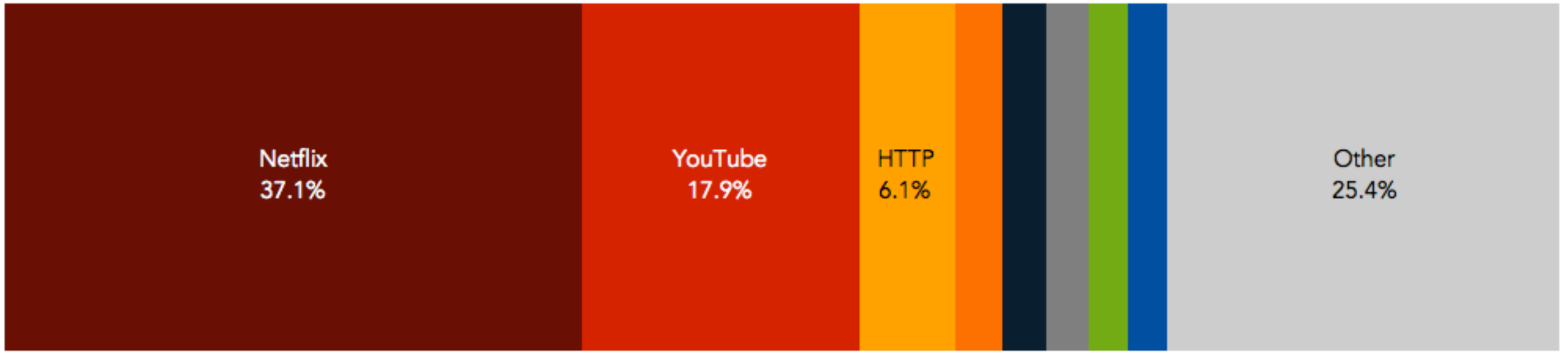




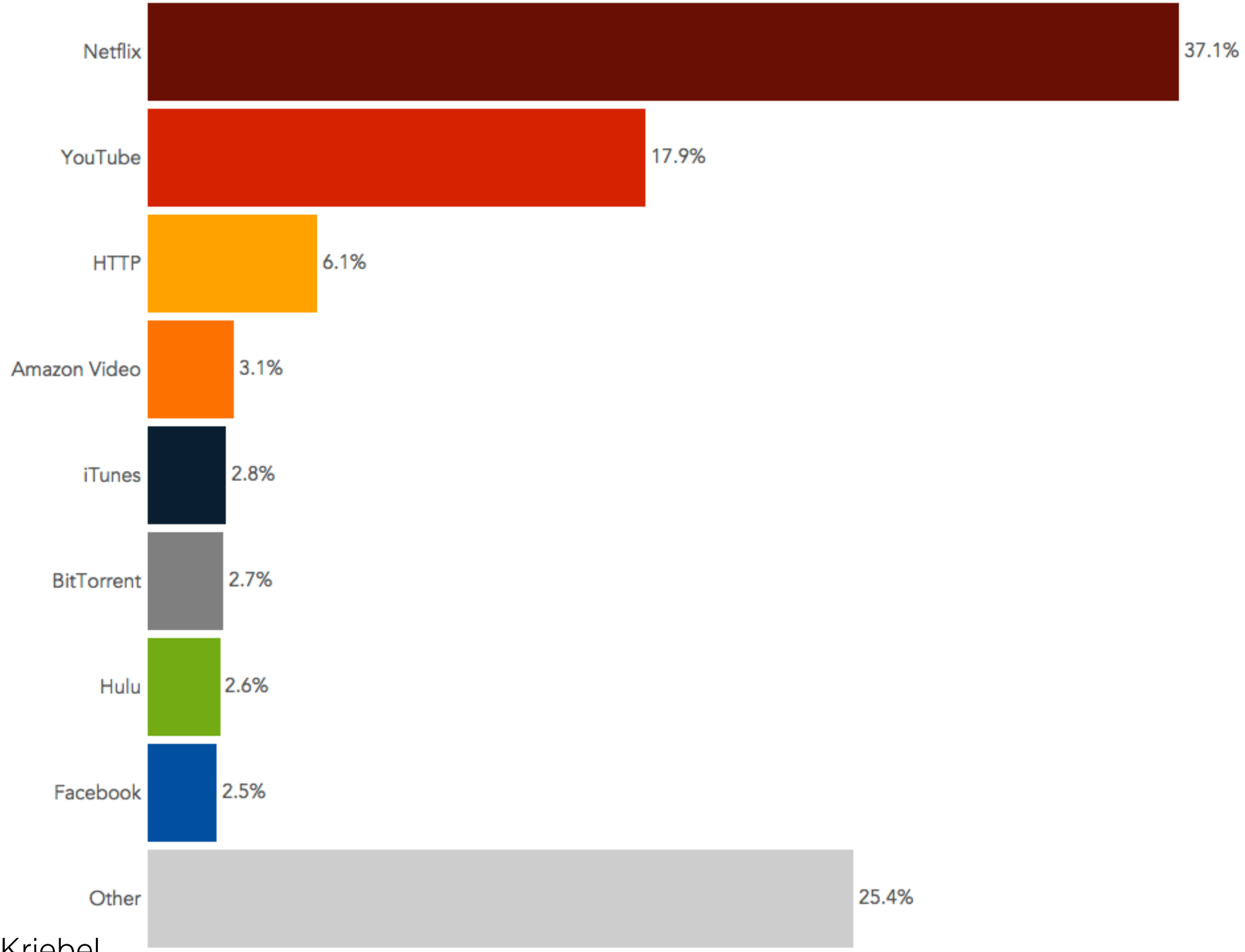
which message? (2 min)
use contrast & layering to communicate msg (4 min)


25.4%
37.1%
2.5%
2.6%
2.7%
2.8%
3.1%
6.1%
17.9%
Netflix
YouTube
HTTP
Amazon Video
iTunes
BitTorrent
Hulu
Facebook
Other

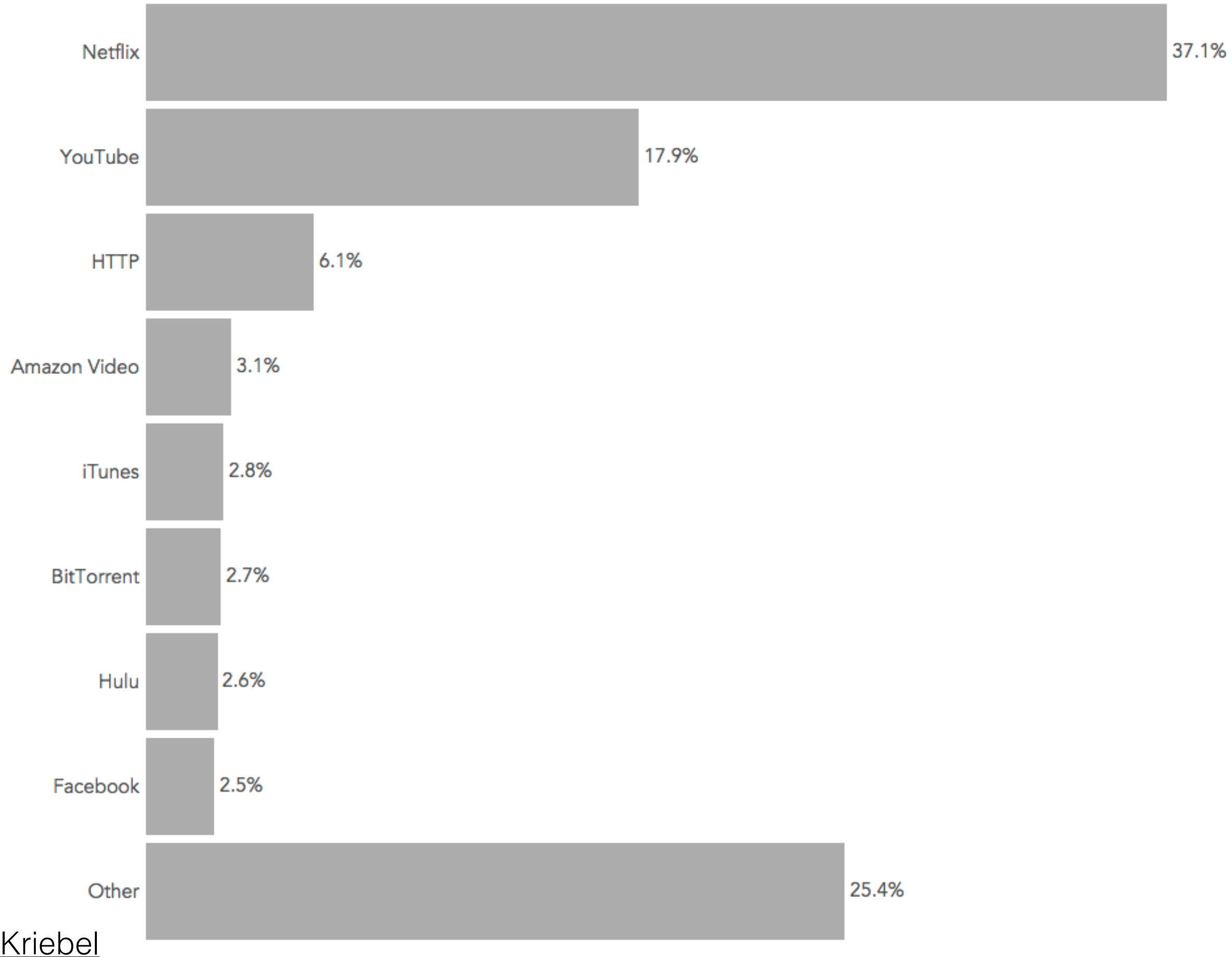
A. Kriebel



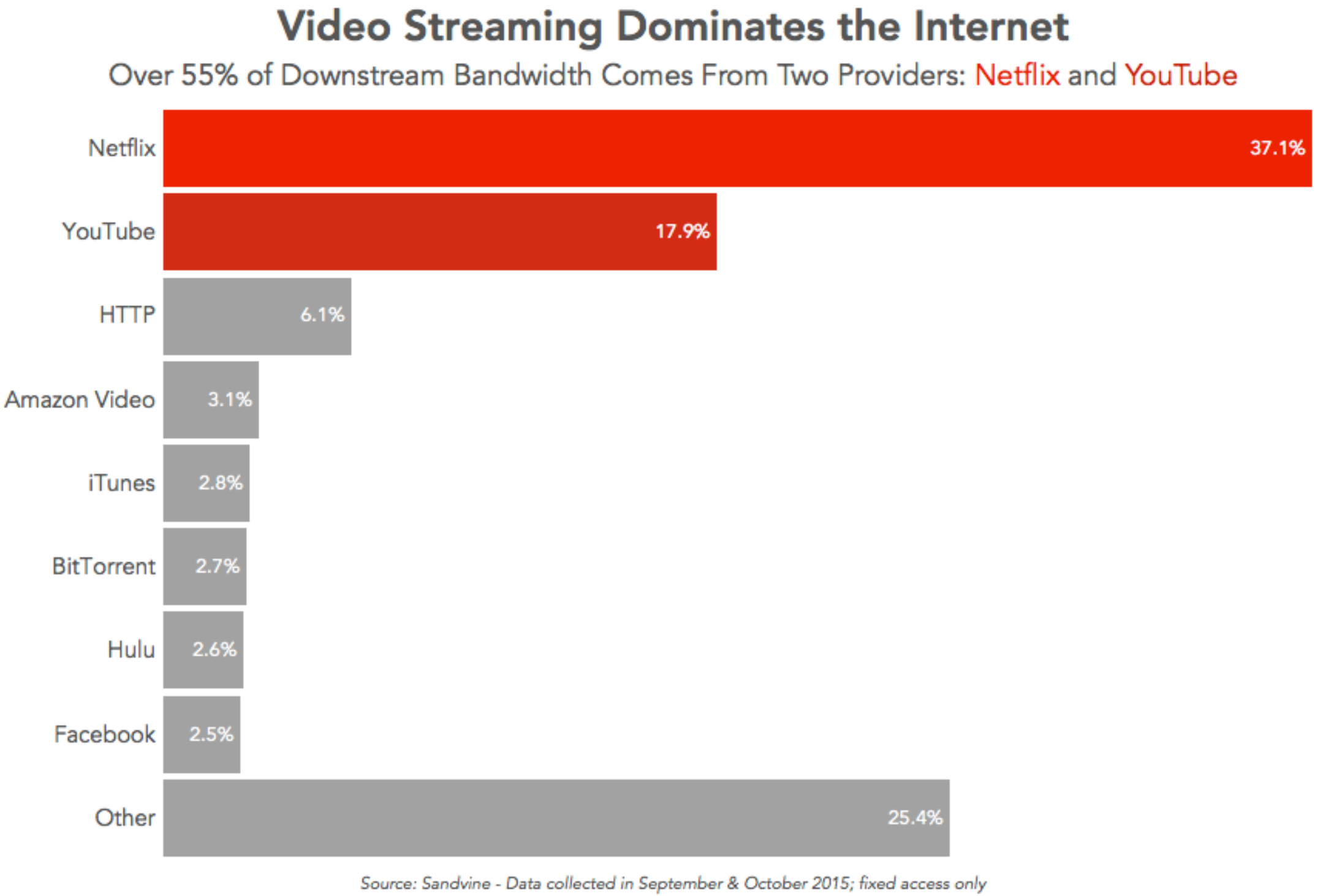
A. Kriebel


Netflix
37.1%
YouTube
17.9%
HTTP
6.1%
Amazon Video
3.1%
iTunes
2.8%
BitTorrent
2.7%
Hulu
2.6%
Facebook
2.5%
Other
25.4%

A. Kriebel


Netflix
37.1%
YouTube
17.9%
HTTP
6.1%
Amazon Video
3.1%
iTunes
2.8%
BitTorrent
2.7%
Hulu
2.6%
Facebook
2.5%
Other
25.4%

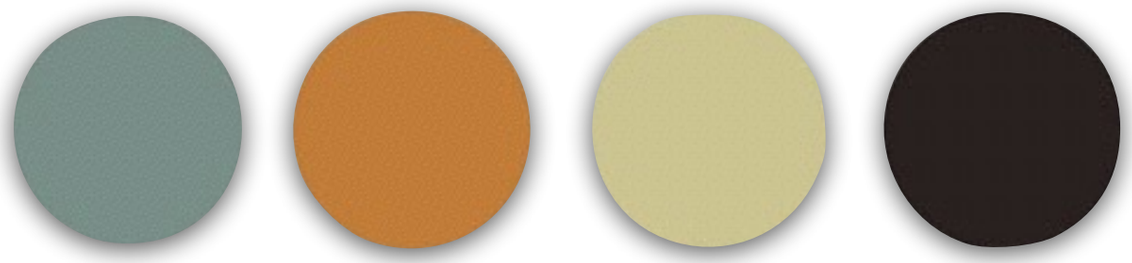
A. Kriebel



http://www.makeovermonday.co.uk/

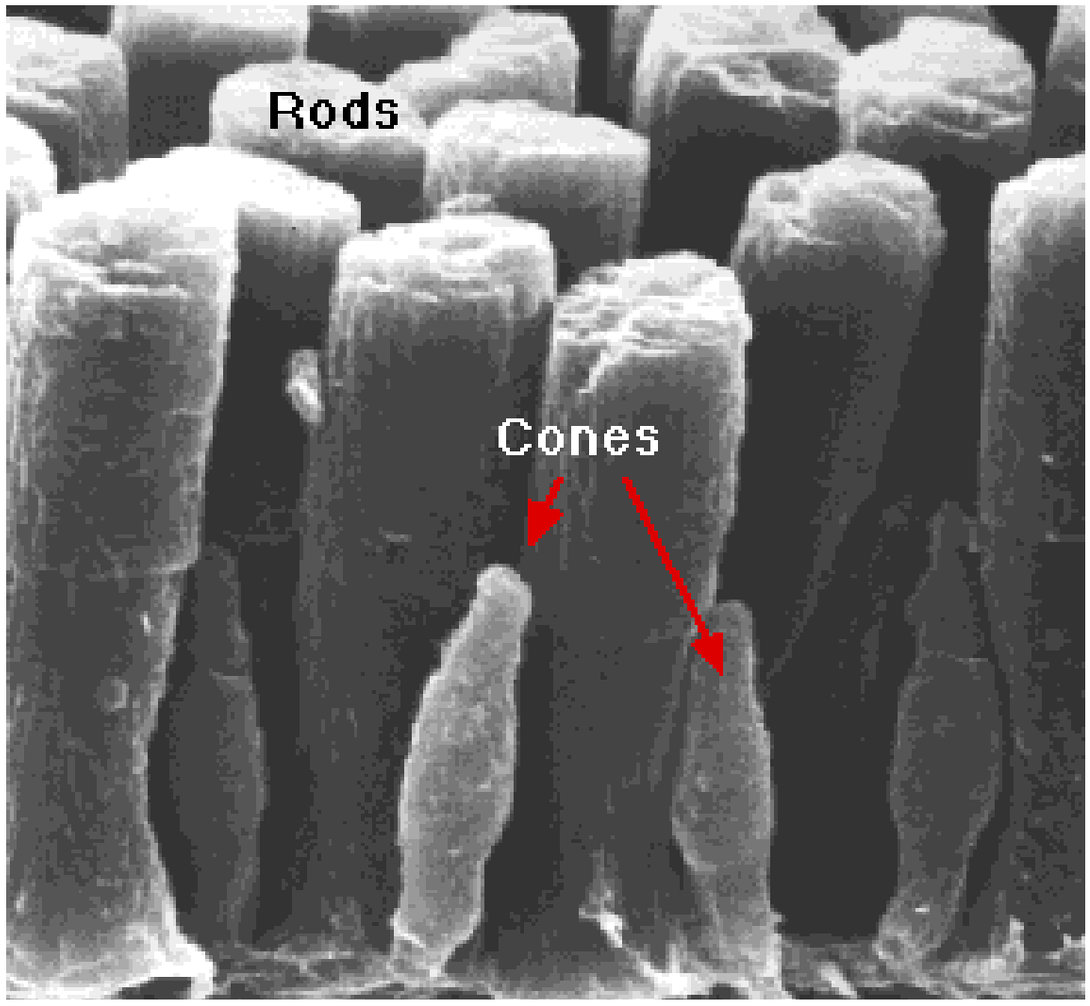
A. Kriebel

Color



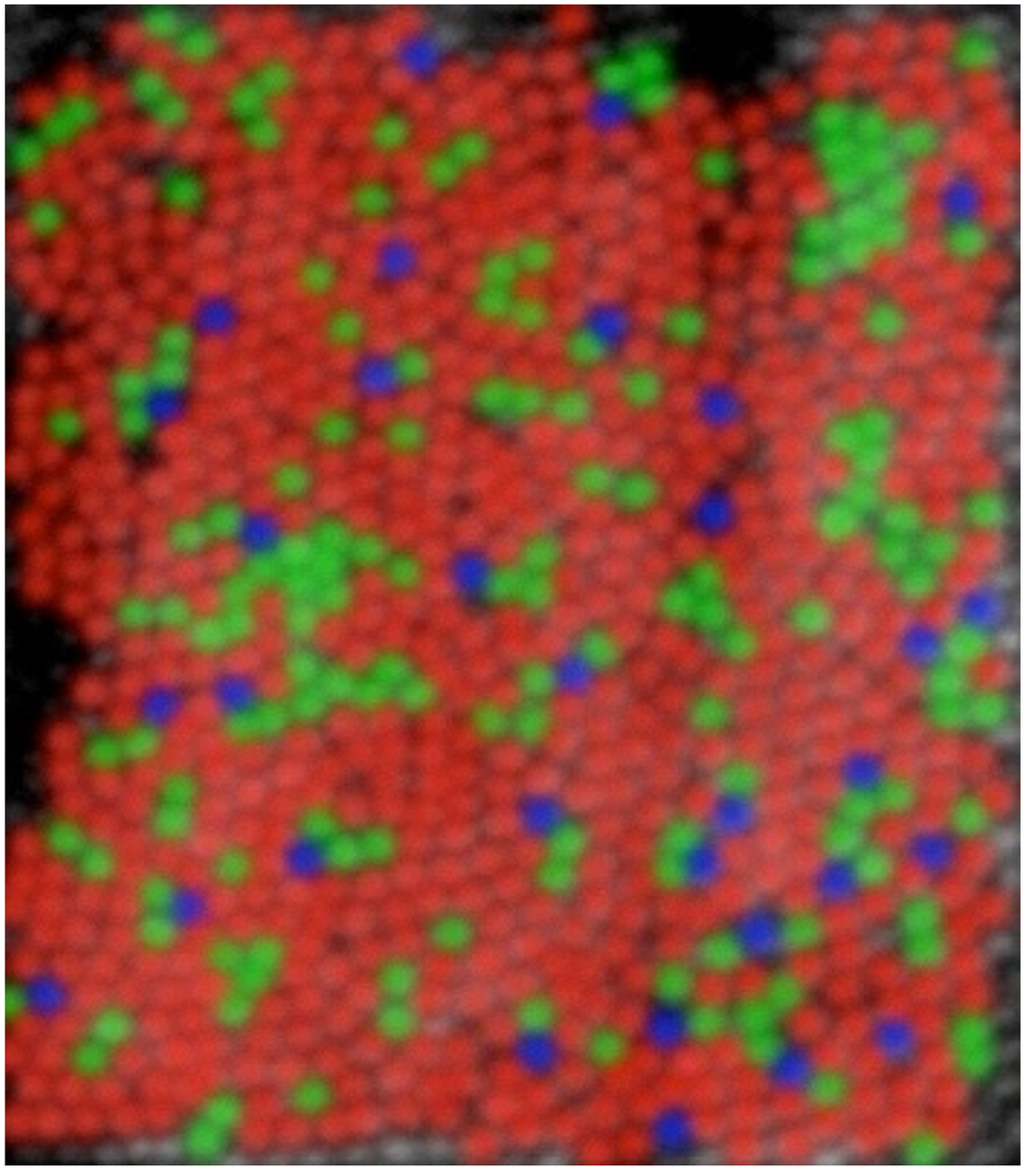
CS
171

http://anotherimg.dazedgroup.netdna-cdn.com/706/azure/another-prod/300/0/300560.jpg



120 million rods

5-6 million cones

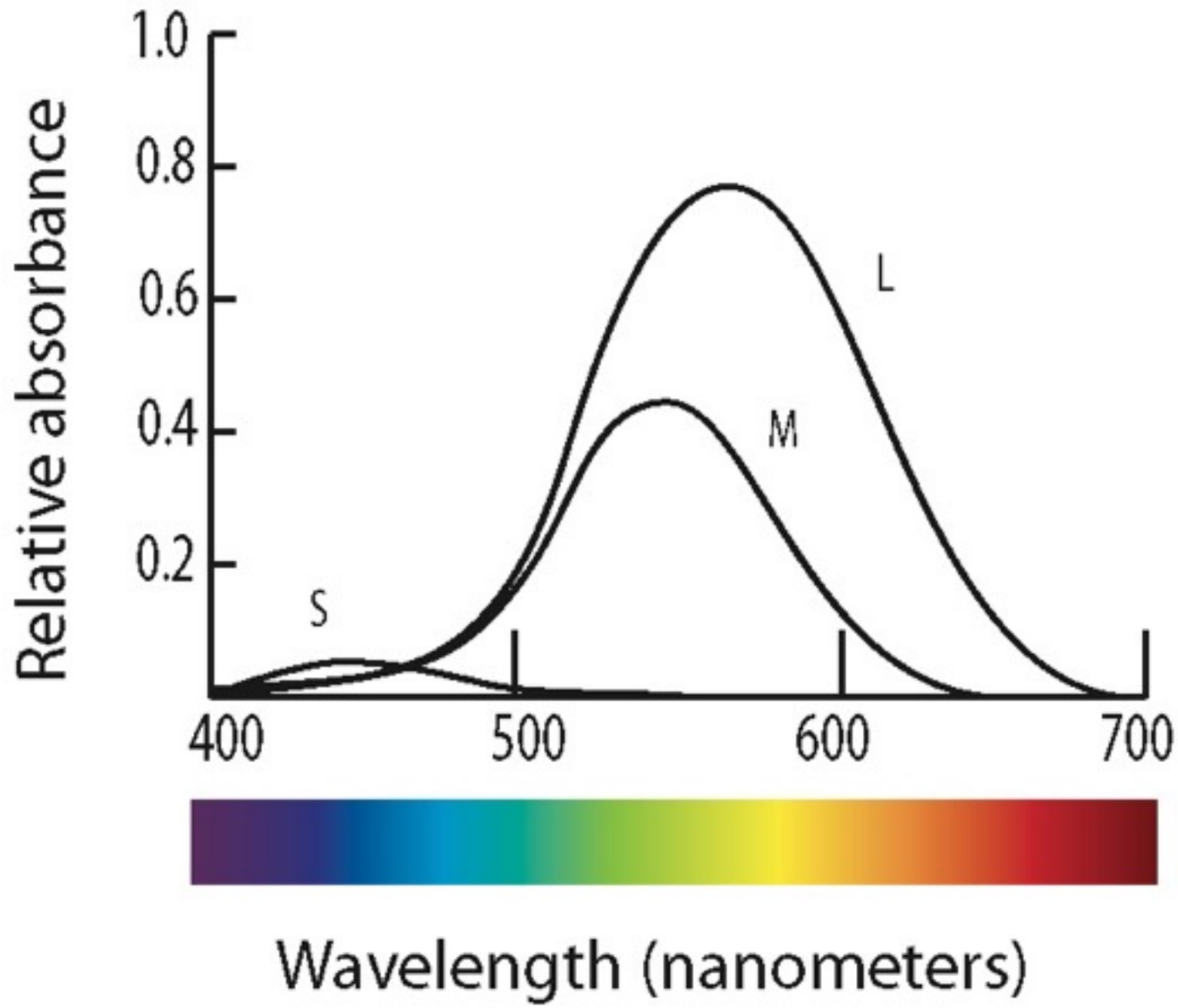


L 63% - M 31% - S 6%

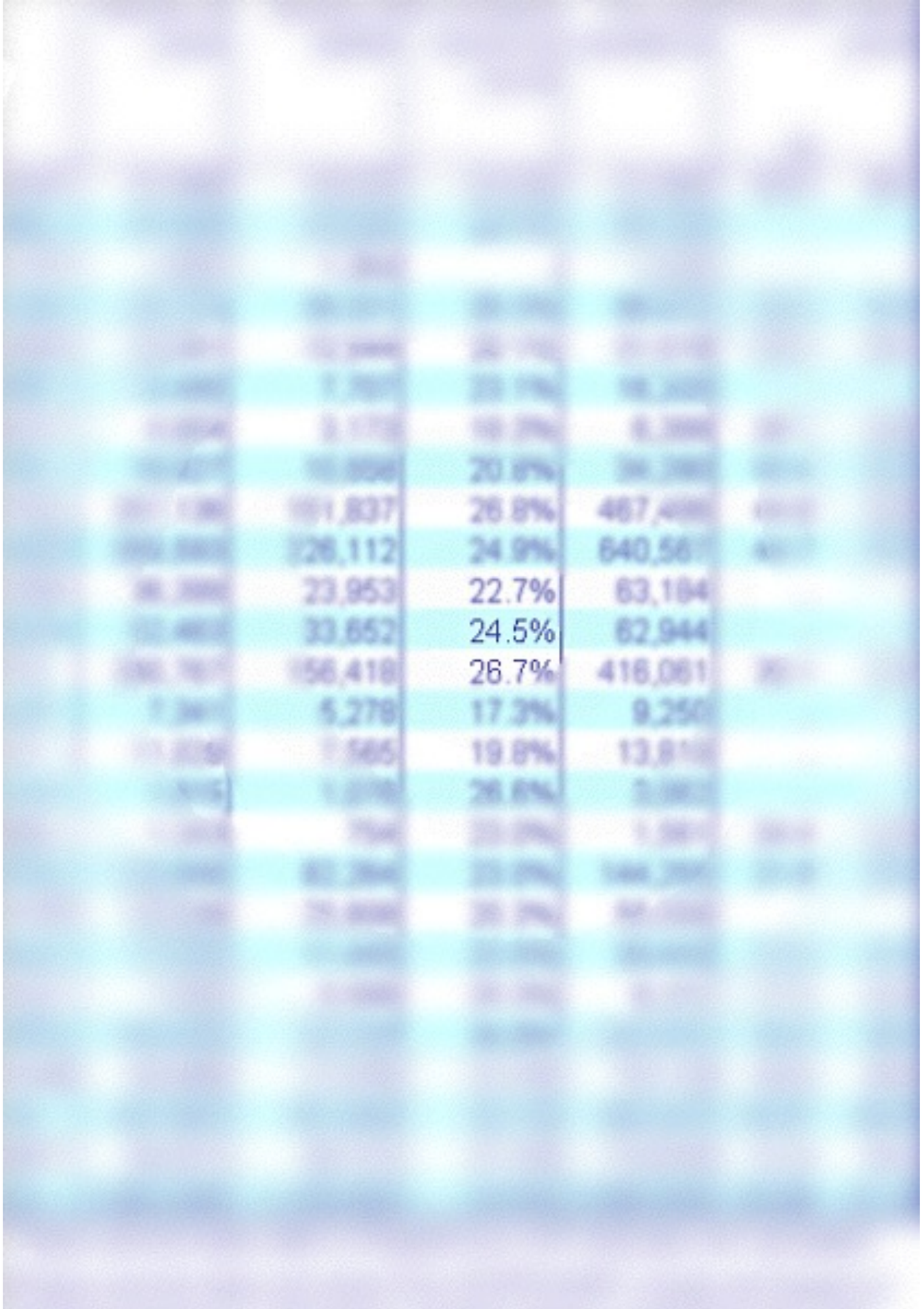
Wandell, “Foundations of Vision” (left)

David R. Williams, Univ. of Rochester (right)

Cone Response



C. Ware, ‘Visual Thinking for Design’



C. Ware, "Visual Thinking for Design"

"… avoiding catastrophe becomes the first principle in bringing color to information: *Above all, do no harm*."

E. R. Tufte

Tufte, "Envisioning Information"

#TheDress

Kim Kardashian West
@KimKardashian
Following

What color is that dress? I see white & gold. Kanye sees black & blue, who is color blind?

RETWEETS 3,996 FAVORITES 6,562

8:41 PM - 26 Feb 2015

+21

Mindy Kaling
@mindykaling
Follow

IT'S A BLUE AND BLACK DRESS! ARE YOU FUCKING KIDDING ME

RETWEETS 9,924 LIKES 17,998

8:43 PM - 26 Feb 2015

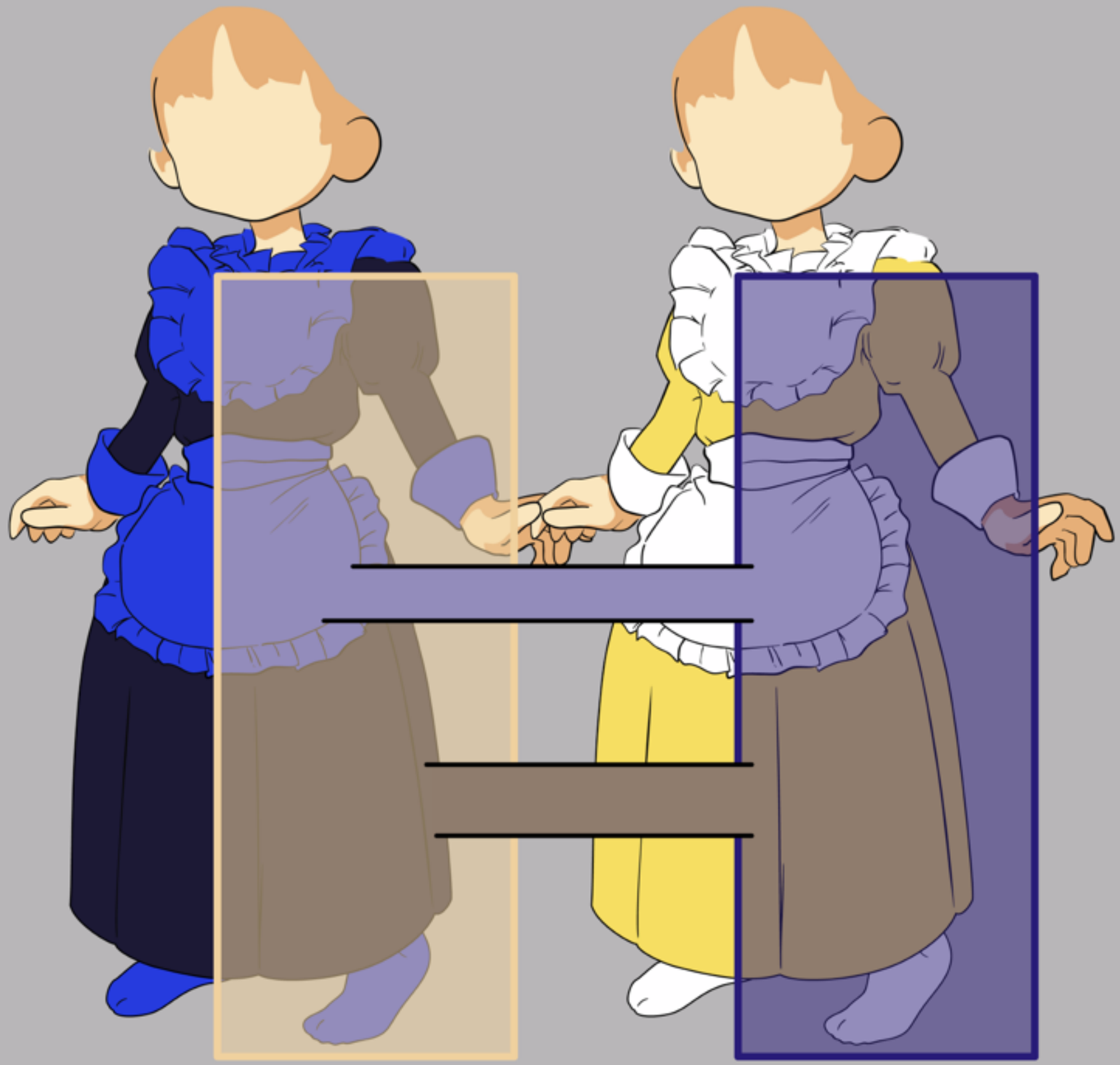
B.J. Novak @bjnovak · 26 Feb 2015
white and gold

2.9K 5.6K

Mindy Kaling @mindykaling · 26 Feb 2015
"@bjnovak: white and gold". ARE YOU INSANE

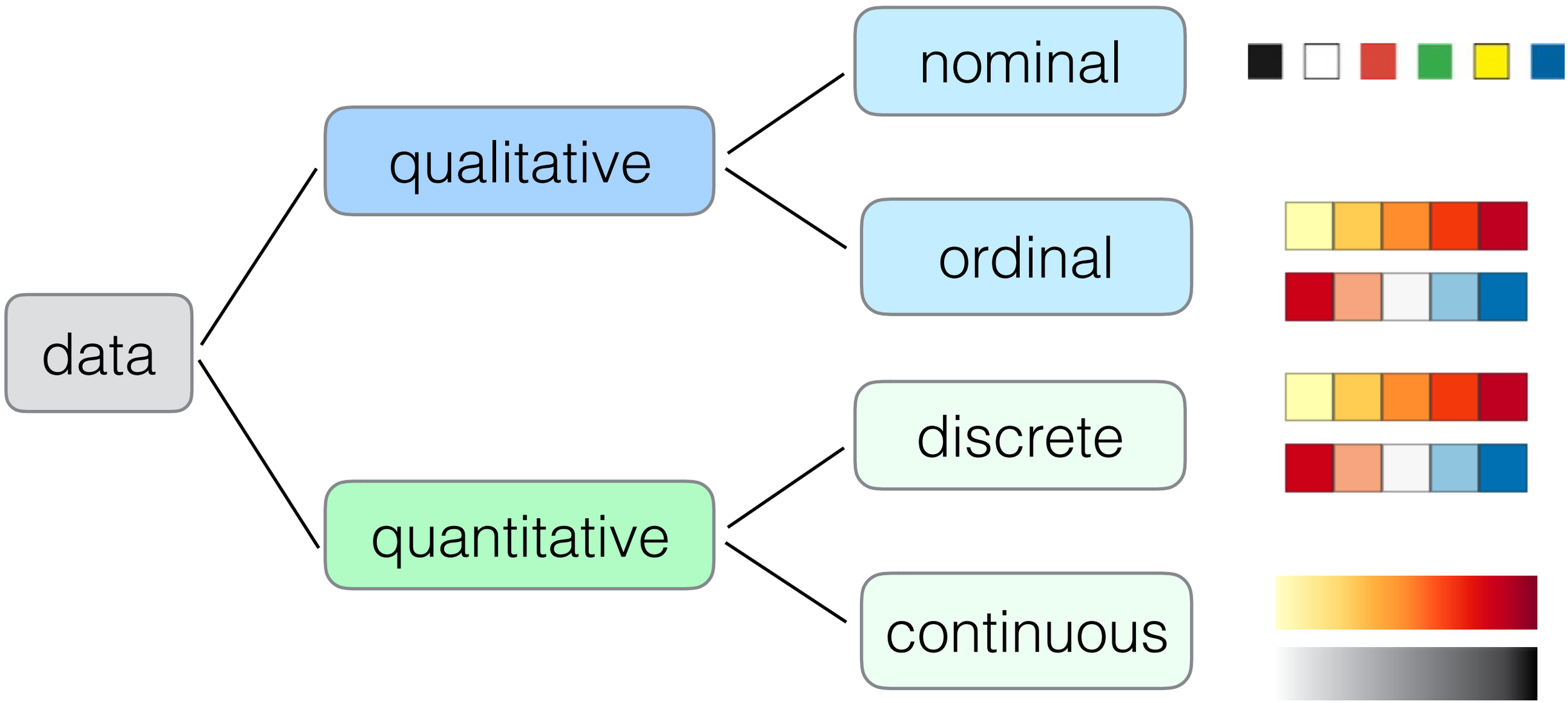
Taylor Swift
@taylorswift13
Follow

I don't understand this odd dress debate
and I feel like it's a trick somehow.
I'm confused and scared.
PS it's OBVIOUSLY BLUE AND BLACK

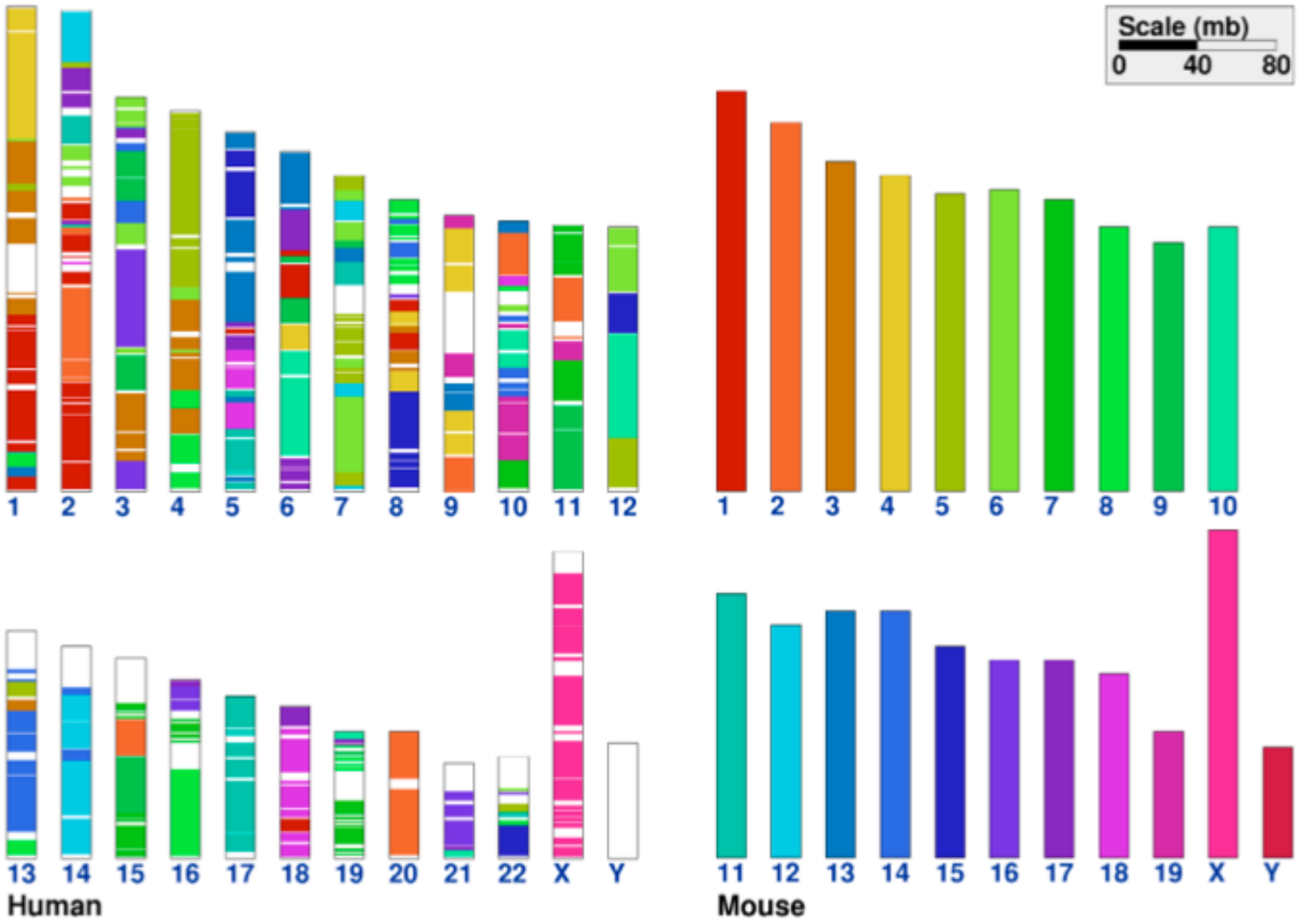


https://en.wikipedia.org/wiki/The_dress

Types of data



Color for Categories



Sinha, *Cell* 2007

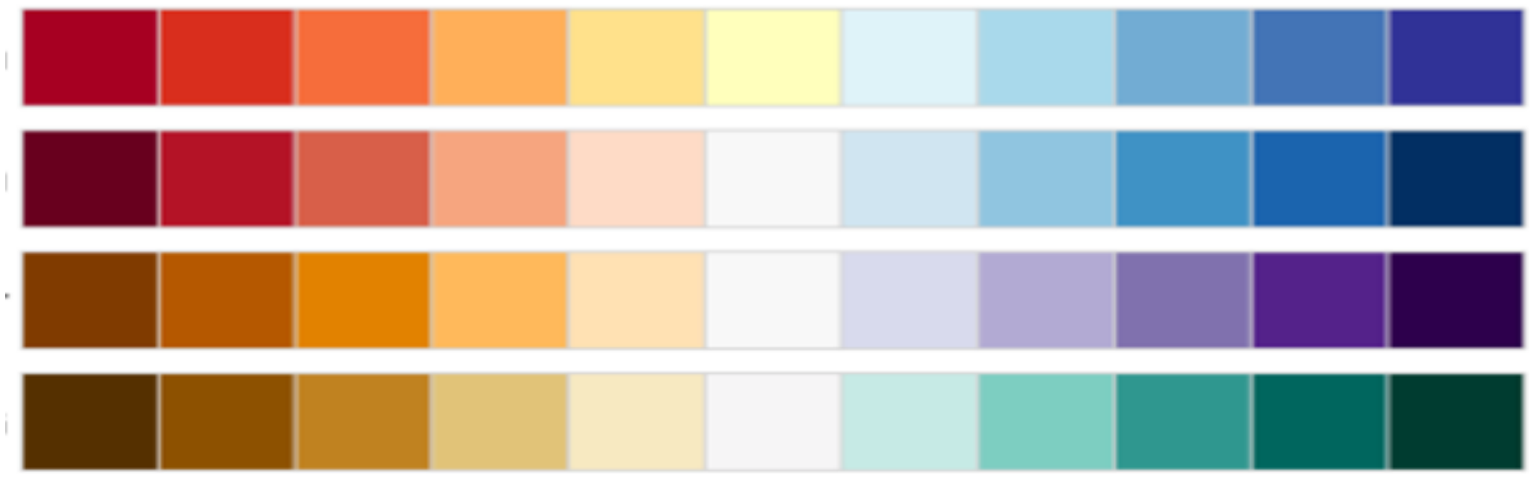
Colors for Categories

Use no more than 5-8 colors at once

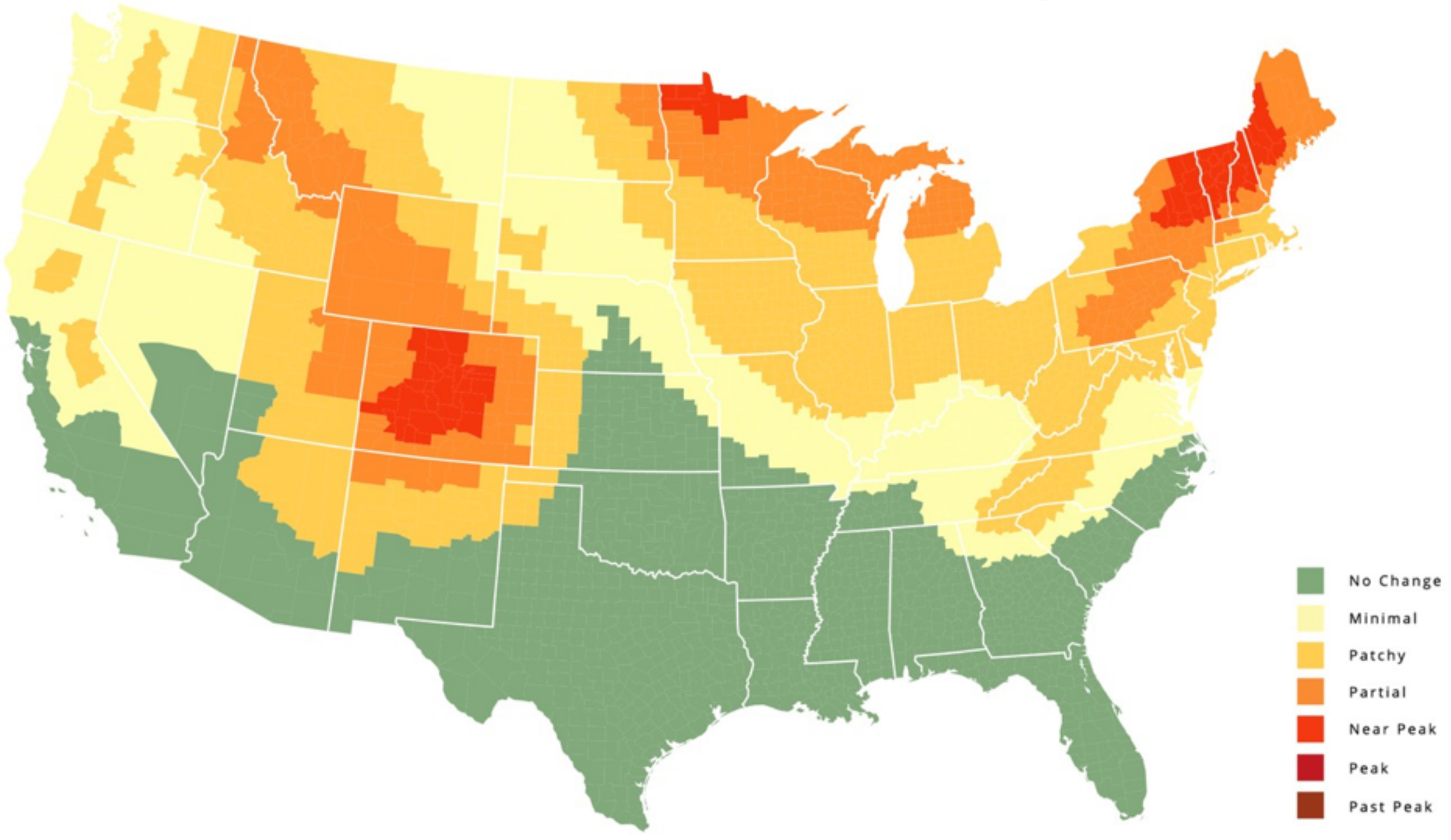
Ware, “Information Visualization”

Colors for Ordered Data

sequential
vs.
diverging

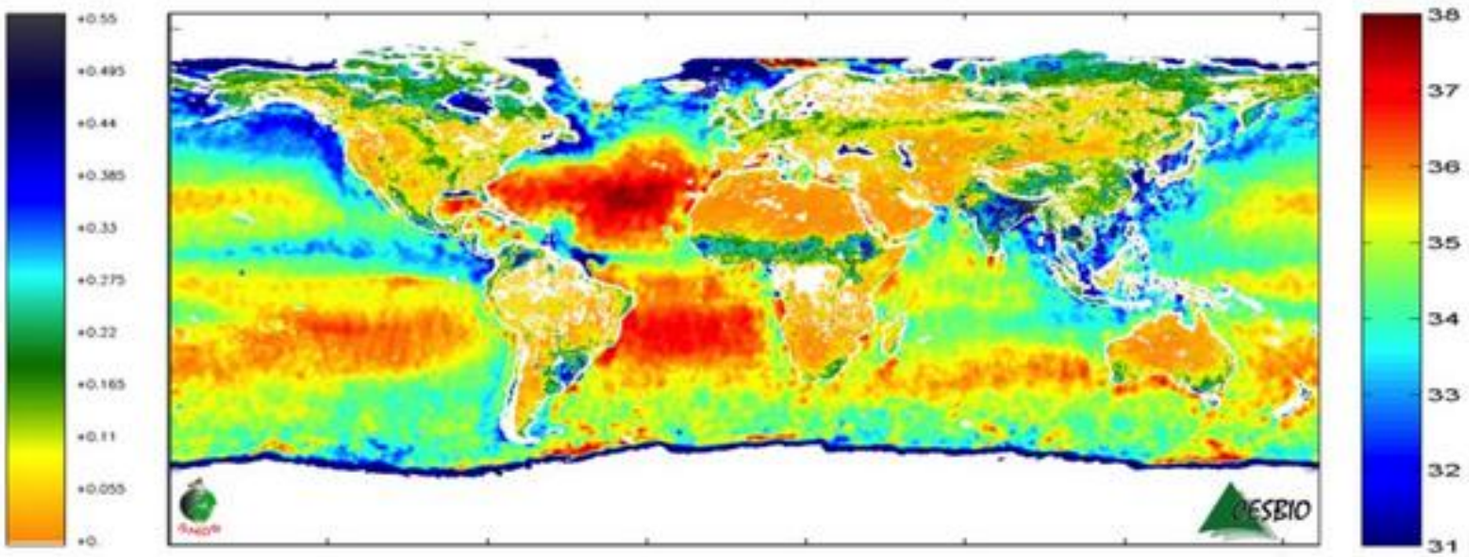


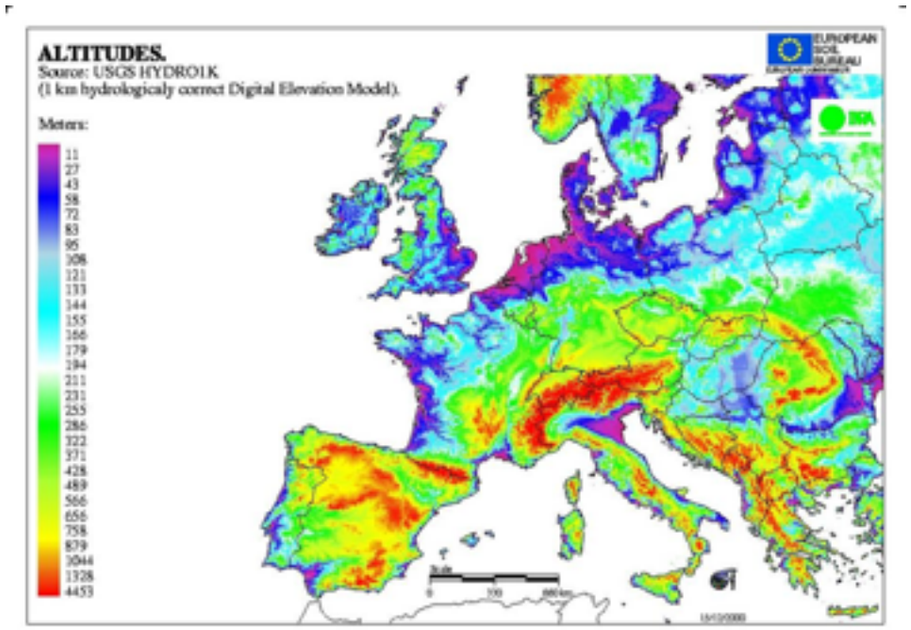
Colors for Maps

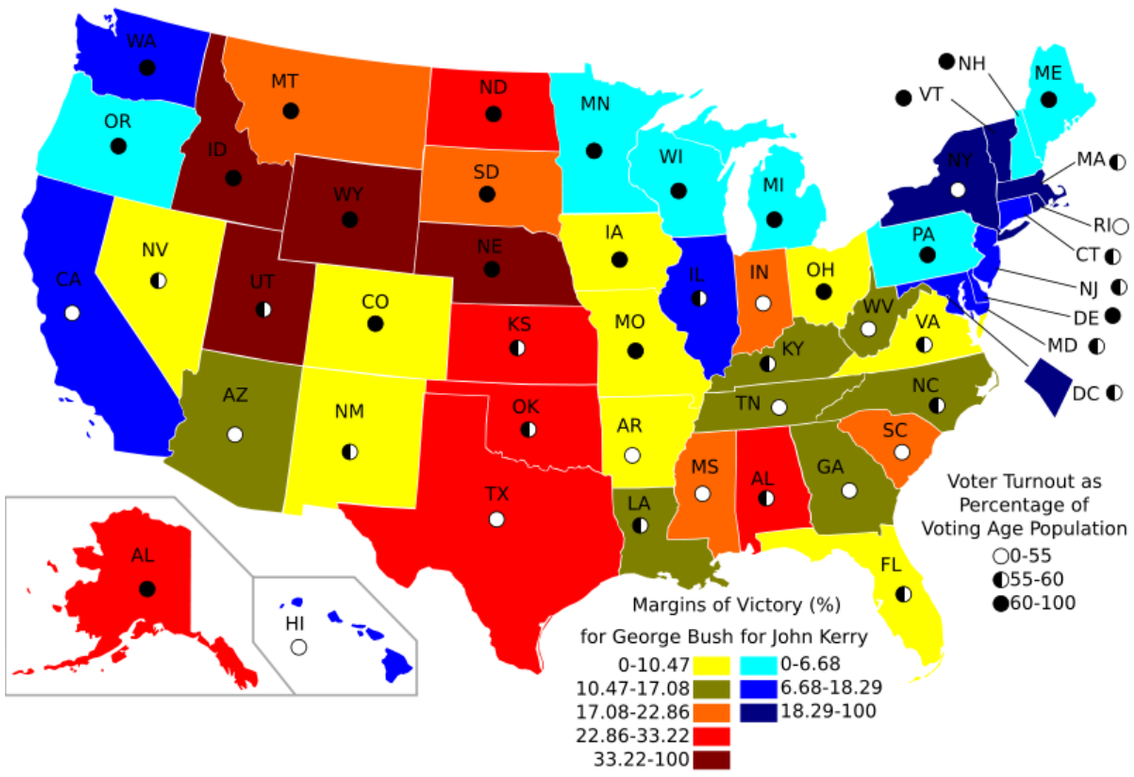


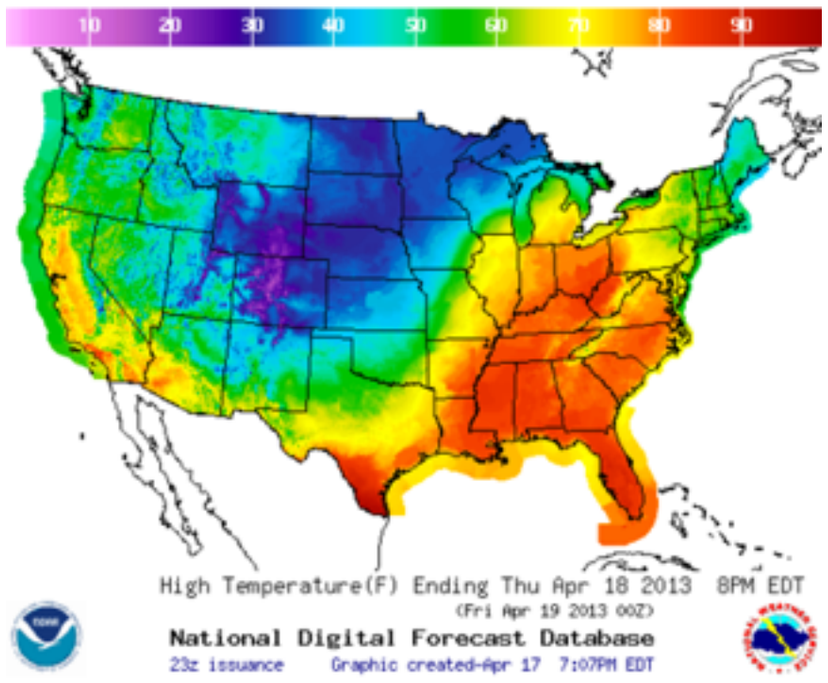
Smoky Mountains

Bad Colors in Maps

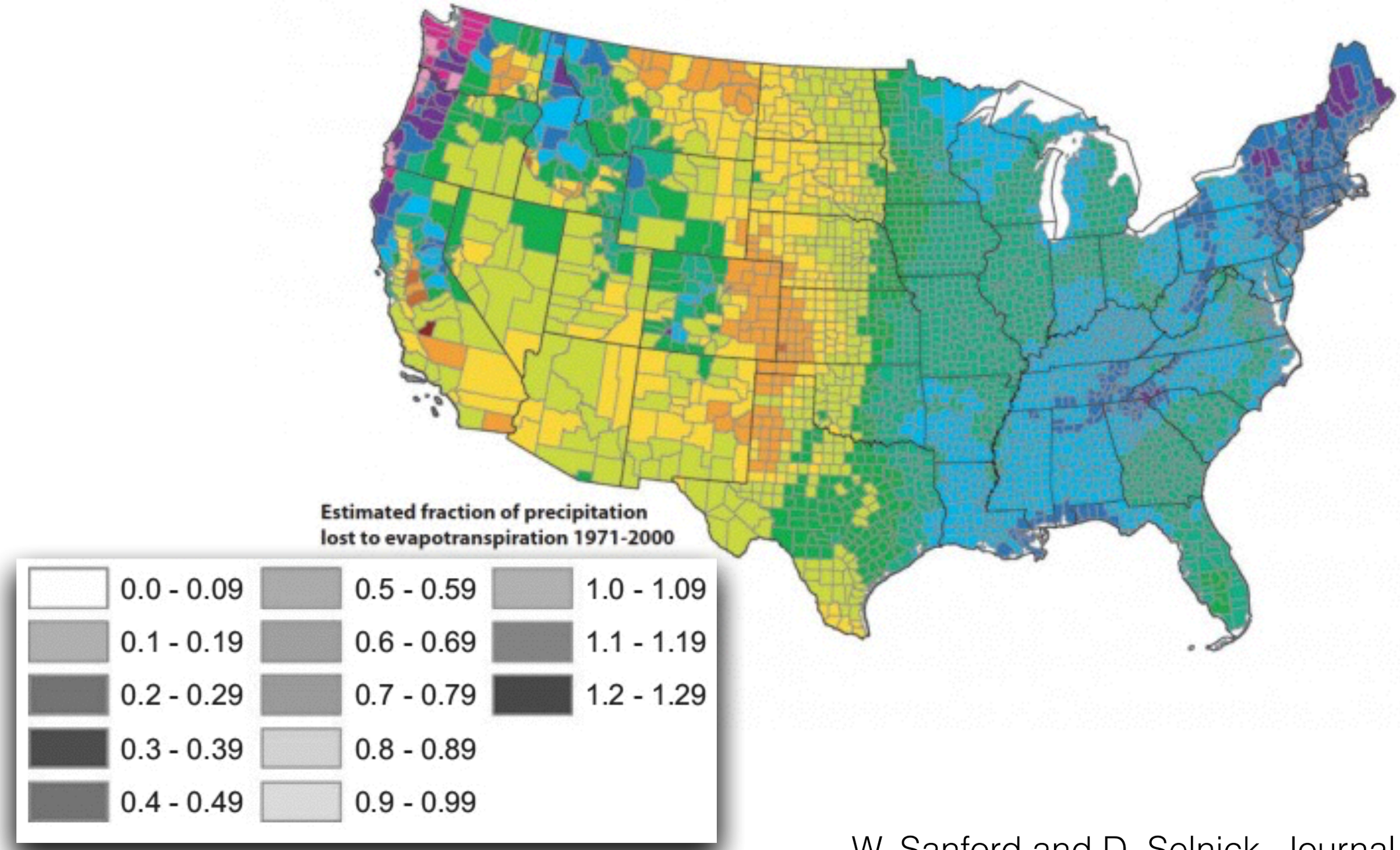








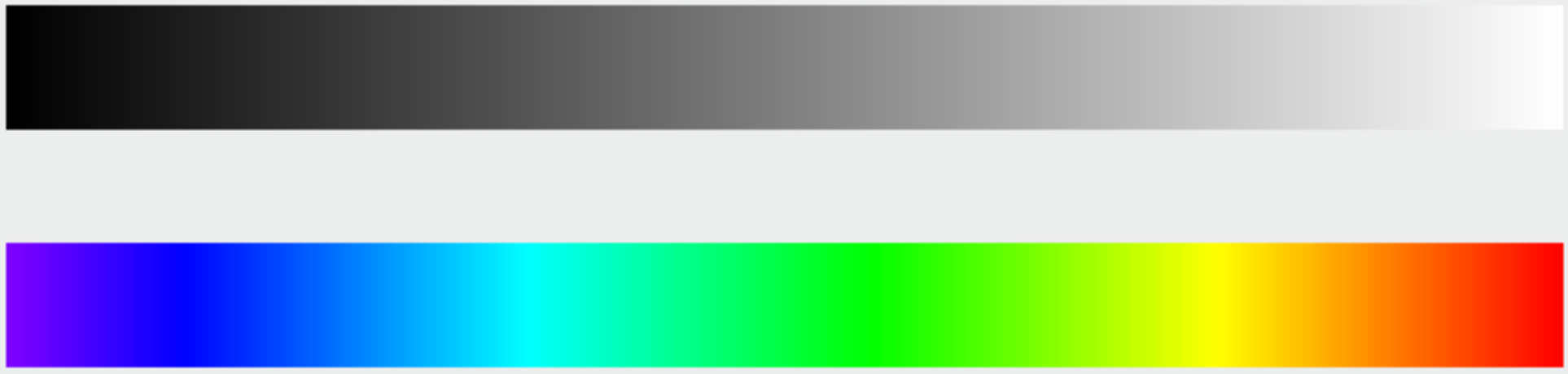
Rainbow Colors



W. Sanford and D. Selnick, Journal of the American Water Resources Association

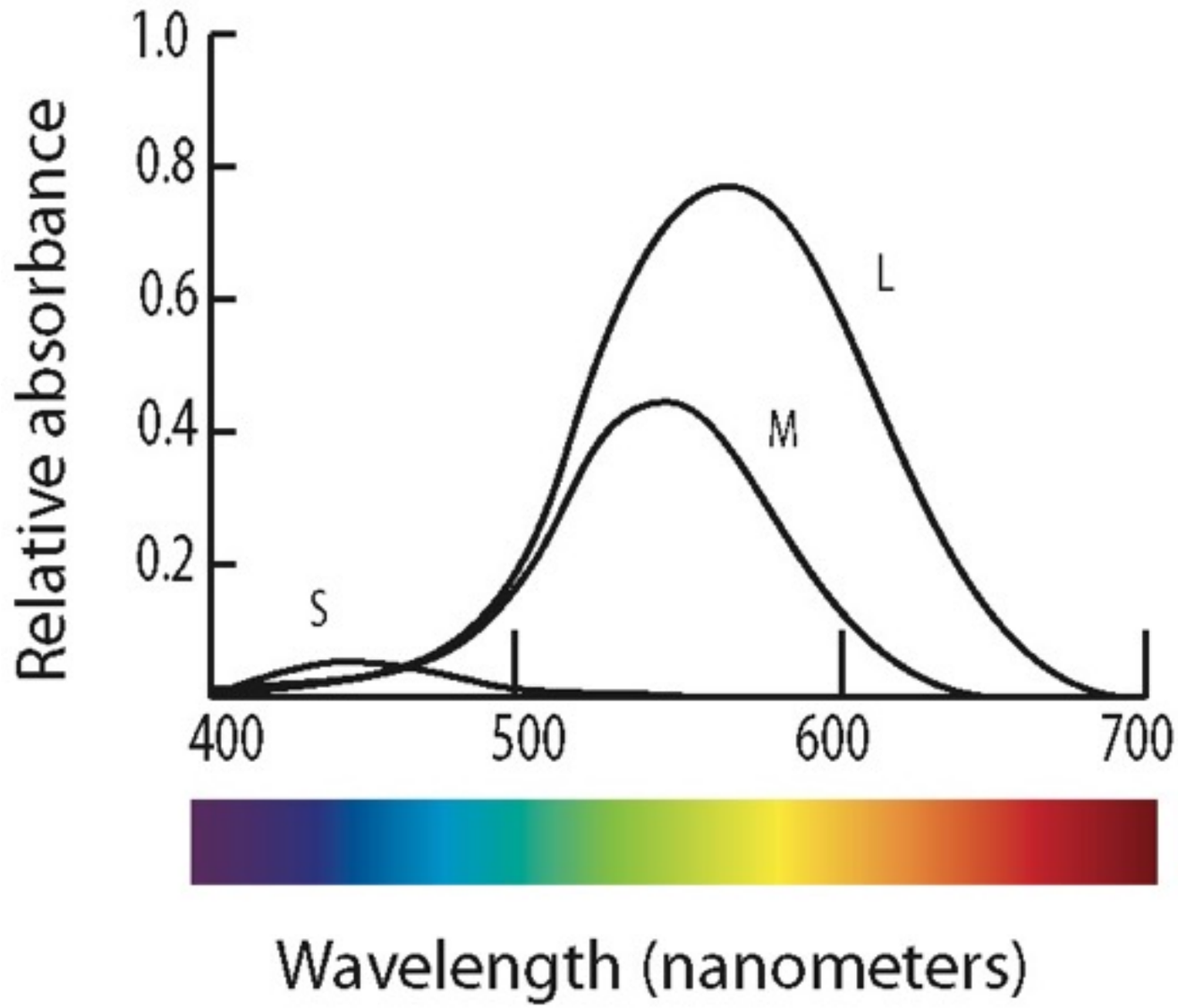
Rainbow Colors

The rainbow colormap is perceptually nonlinear



R. Simmon

Cone Response

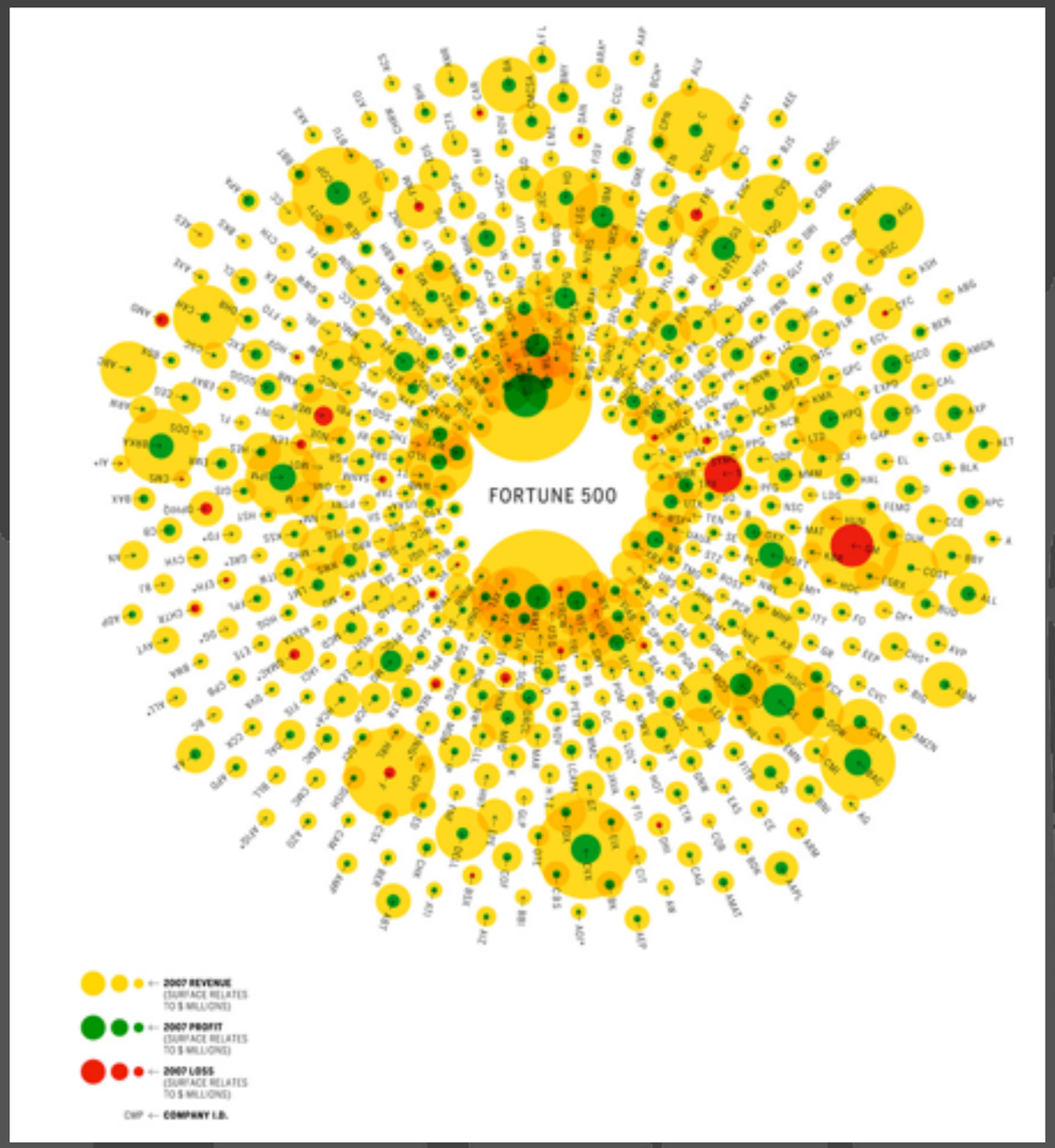


C. Ware, ‘Visual Thinking for Design’

Try to avoid the rainbow!

Activity

What is good and bad about this visualization? [2 min]



Catalogtree

FORTUNE 500

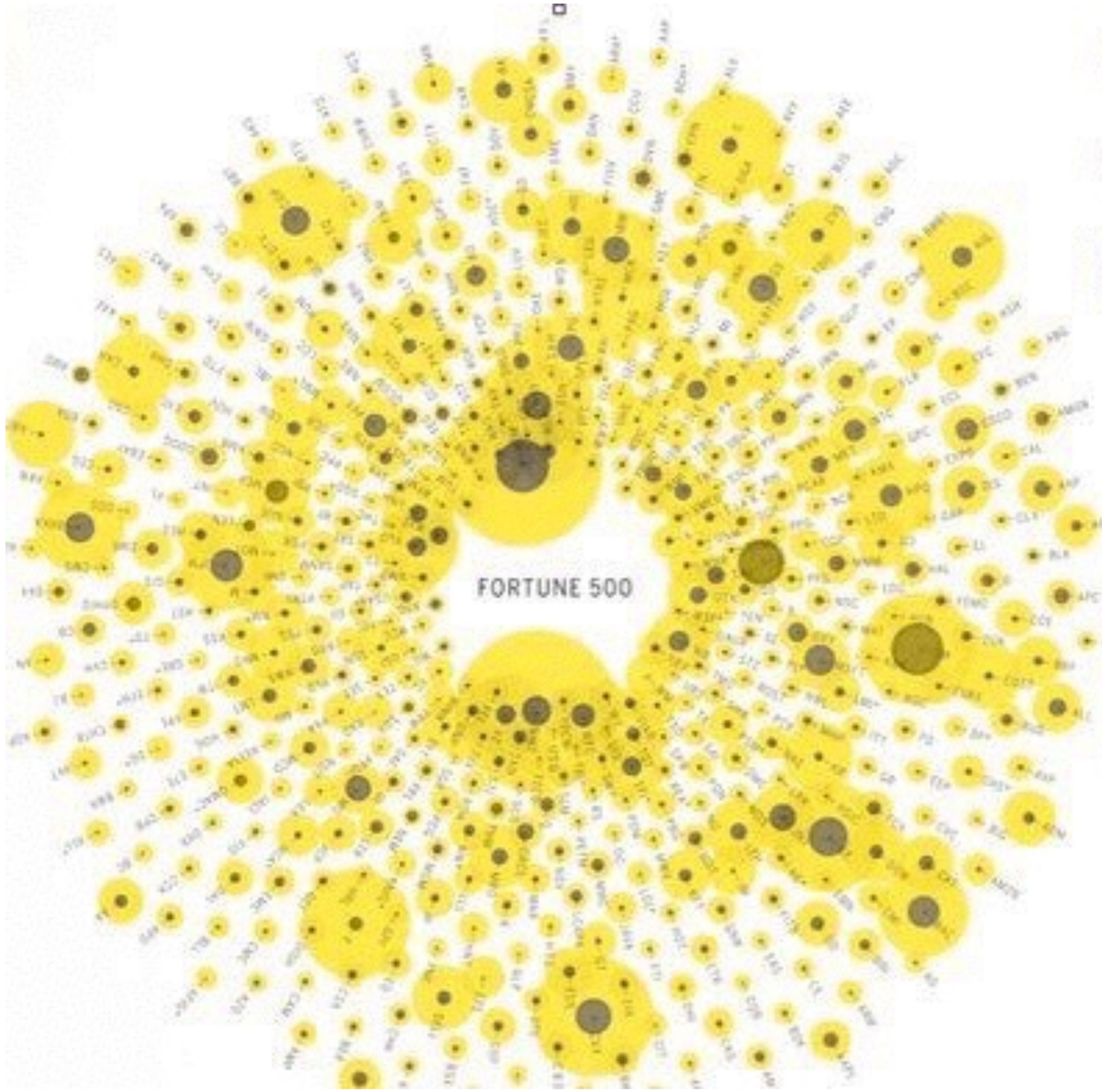
← **2007 REVENUE**
(SURFACE RELATES TO $ MILLIONS)

← **2007 PROFIT**
(SURFACE RELATES TO $ MILLIONS)

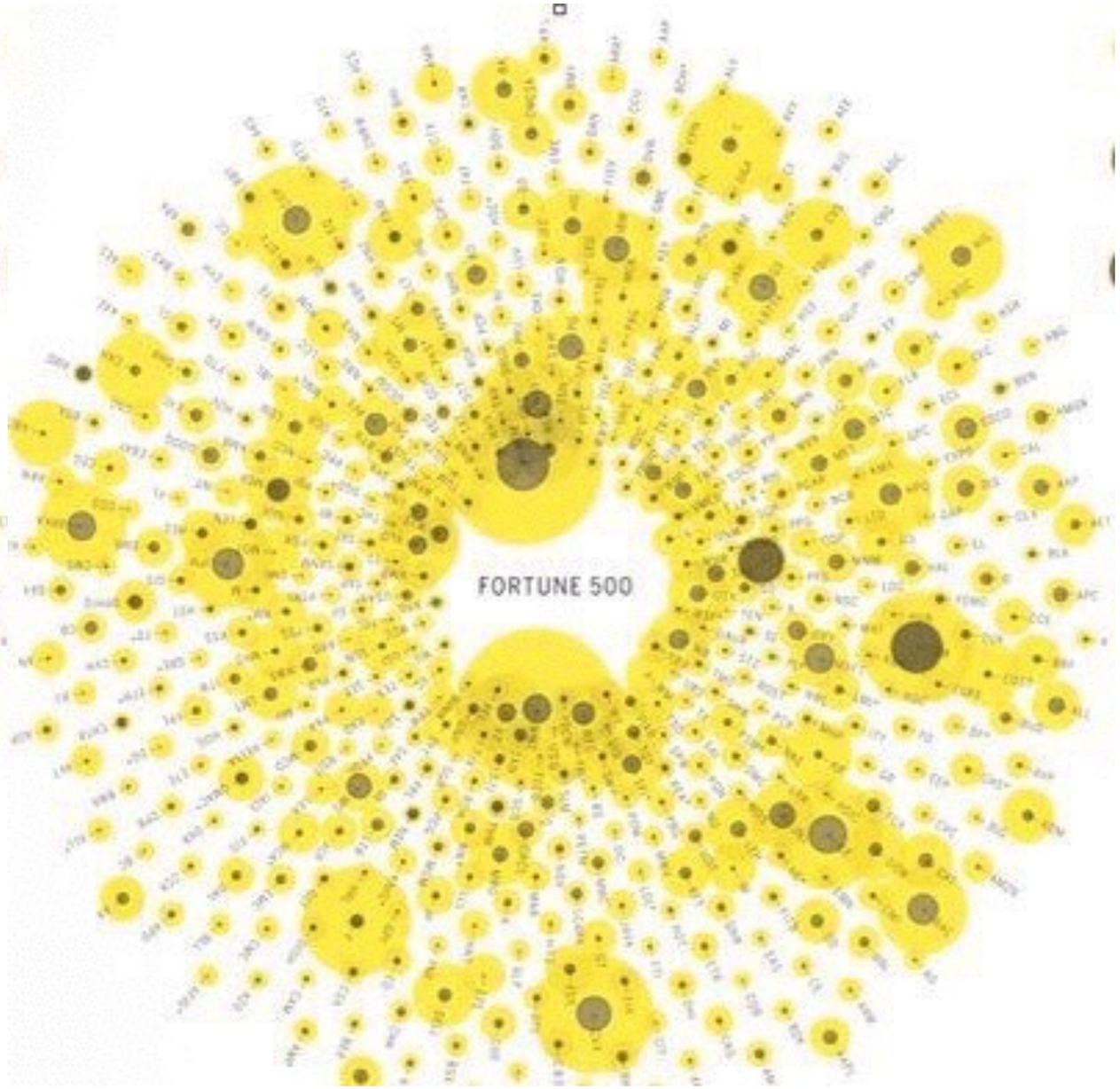
← **2007 LOSS**
(SURFACE RELATES TO $ MILLIONS)

CMP ← **COMPANY I.D.**

Catalogtree, "The Fortune 500 Cosmos"



Deuteranope

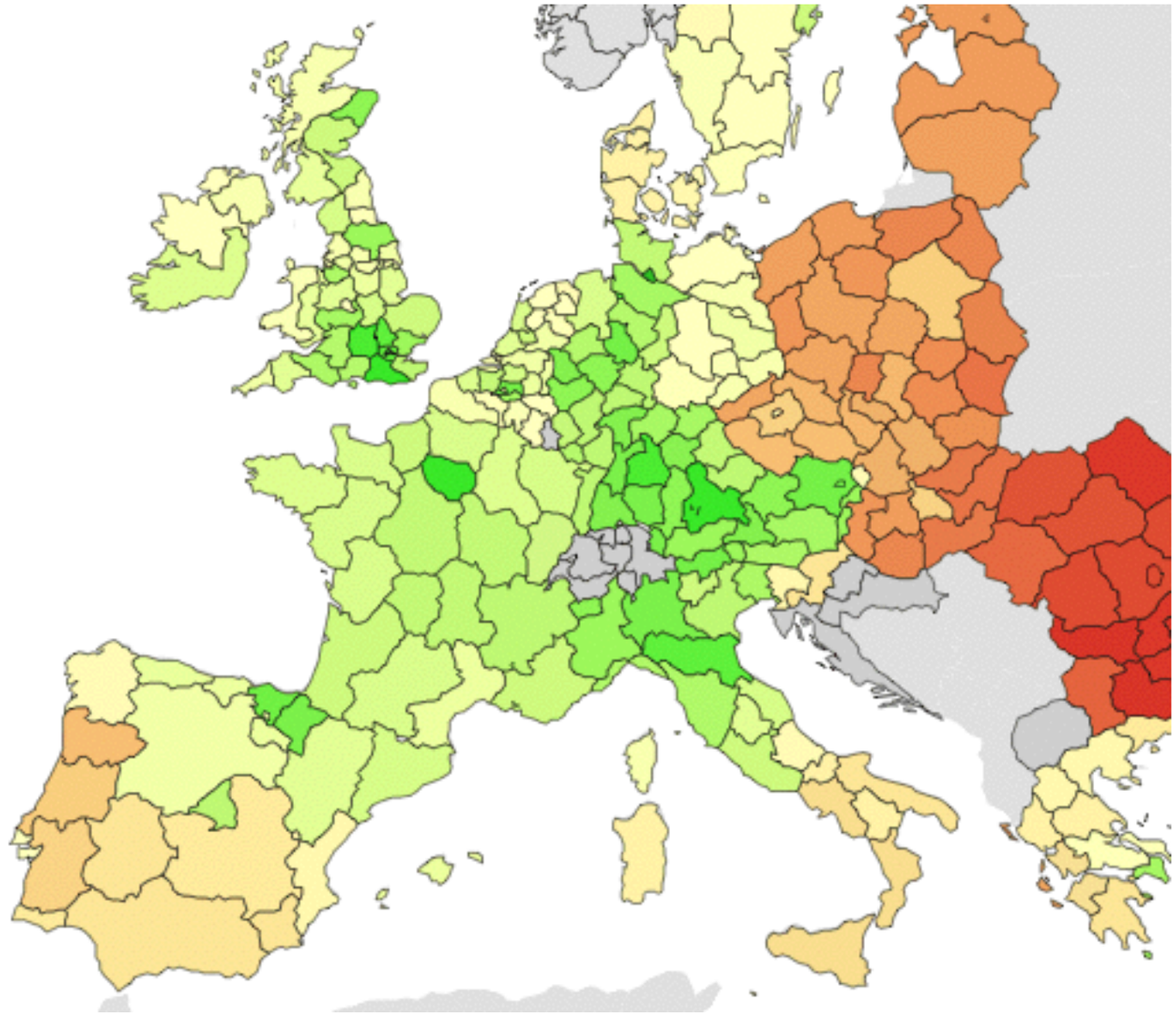


Protanope

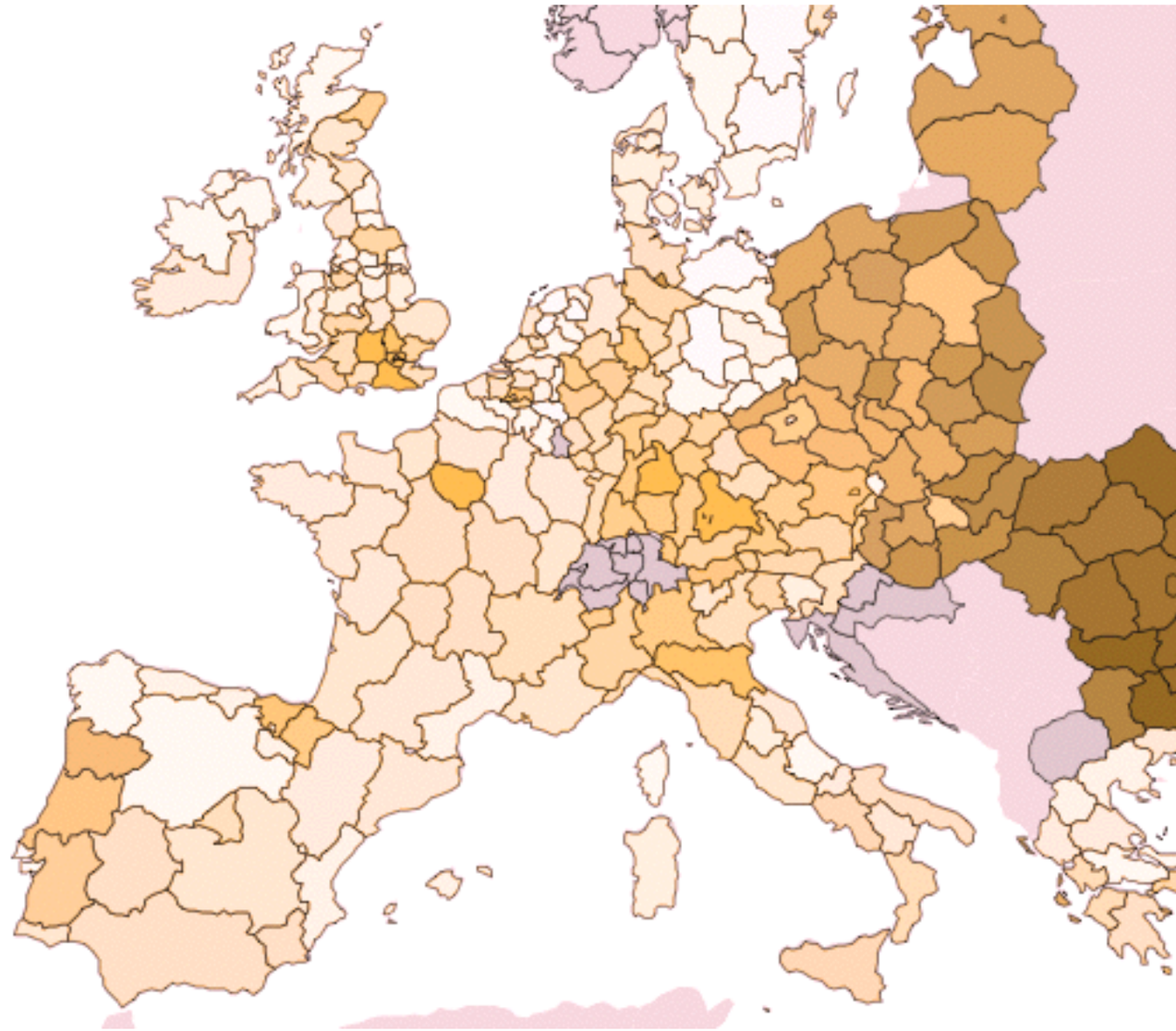
Color Blindness

Based on slide from Stone

Normal Vision

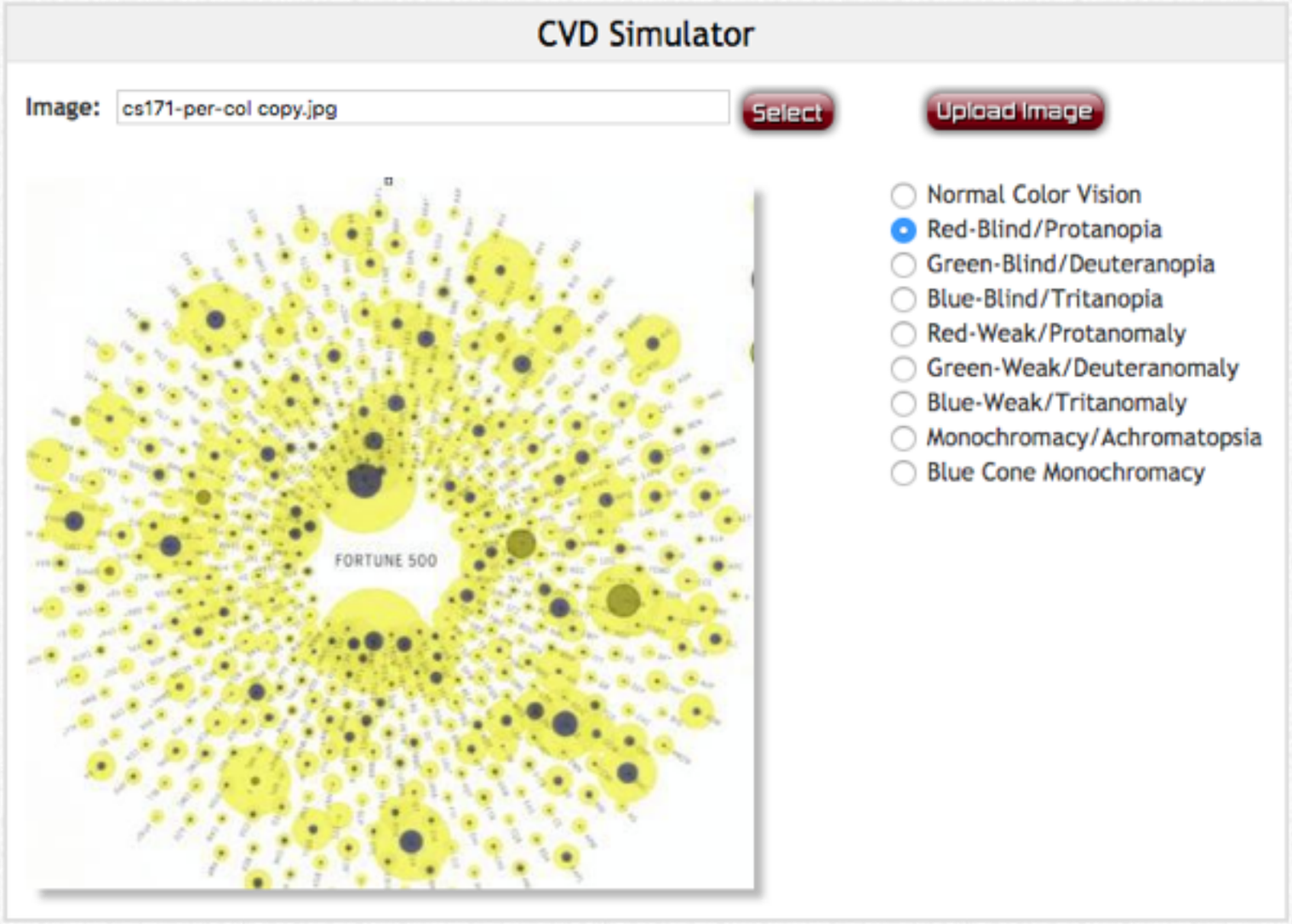


Red-Green Colorblind



Coblis — Color Blindness Simulator

If you are not suffering from a color vision deficiency it is very hard to imagine how it looks like to be colorblind. The **C**olor **BLI**ndness **S**imulator can close this gap for you. Just play around with the sample picture or upload you own images. Please make sure that you just use JPG, GIF or PNG images with a size below 600kB.

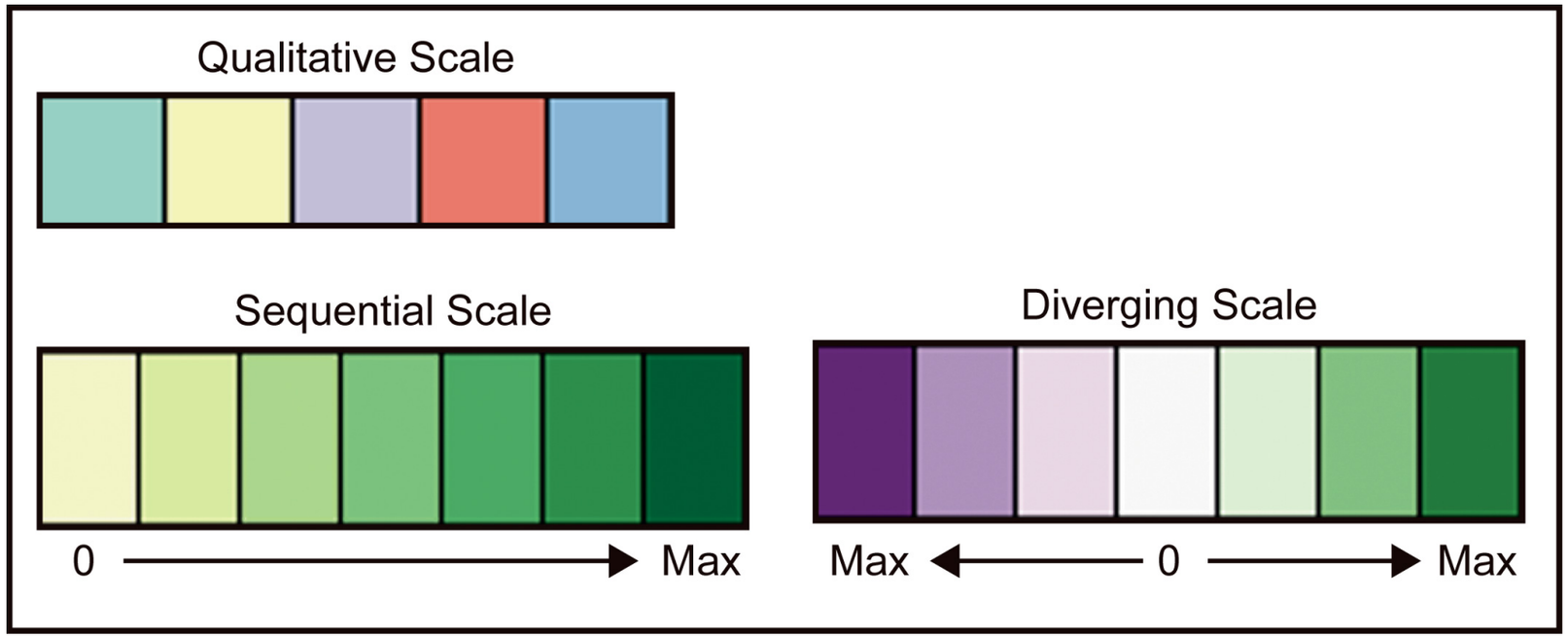


http://www.color-blindness.com/coblis-color-blindness-simulator/

Color Brewer

Nominal

Ordinal



Cynthia Brewer, Color Use Guidelines for Data Representation

how to use | updates | credits

COLORBREWER 2.0

color advice for cartography

number of data classes on your map

3 | learn more >

the nature of your data

sequential | learn more >

pick a color scheme: GnBu

multihue | single hue

(optional) only show schemes that are:

- [x] colorblind safe
- [ ] print friendly
- [ ] photocopy-able

learn more >

pick a color system

224, 243, 219
168, 221, 181
67, 162, 202

(•) RGB ( ) CMYK ( ) HEX

adjust map context

- [ ] roads
- [ ] cities
- [x] borders

select a background

(•) solid color
( ) terrain

color transparency

learn more >

EXPORT YOUR COLORS >>

SCORE CARD

Support

Back to ColorBrewer 1.0

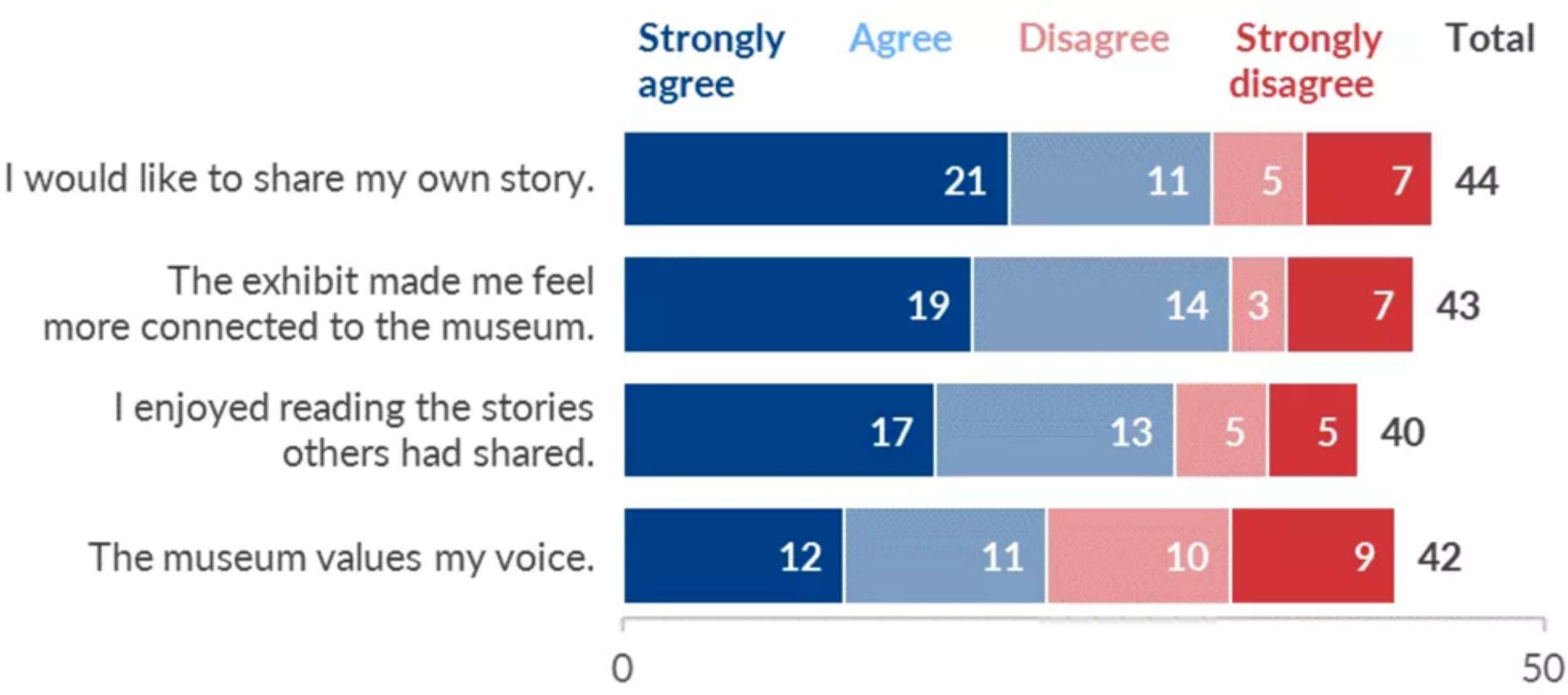
axm

Example

To what degree do you agree or disagree with the following statements?	Strongly agree	Agree	Disagree	Strongly disagree	Total
The museum values my voice.	12	11	10	9	**42**
I enjoyed reading the stories others had shared.	17	13	5	5	**40**
The exhibit made me feel more connected to the museum.	19	14	3	7	**43**
I would like to share my own story.	21	11	5	7	**44**

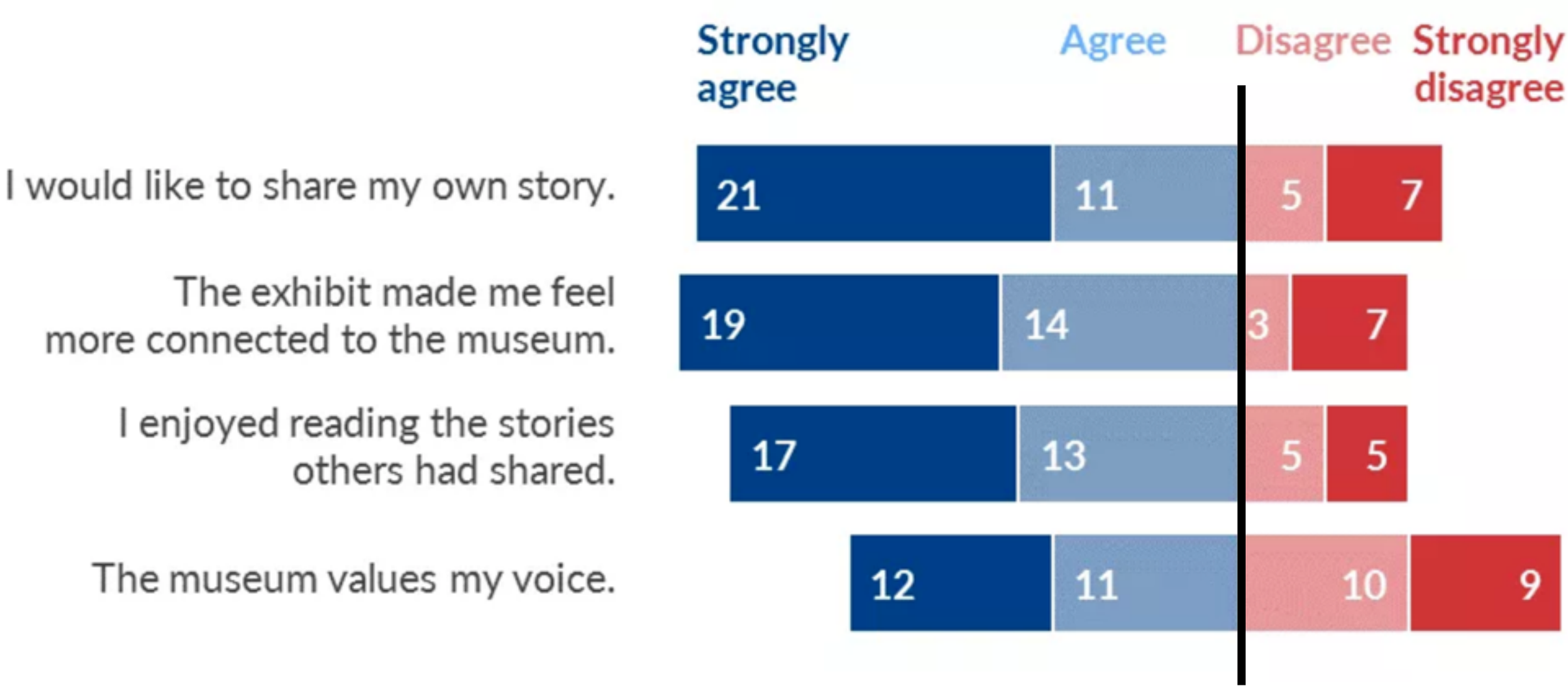
http://annkemery.com/agree-disagree-scales/

Example



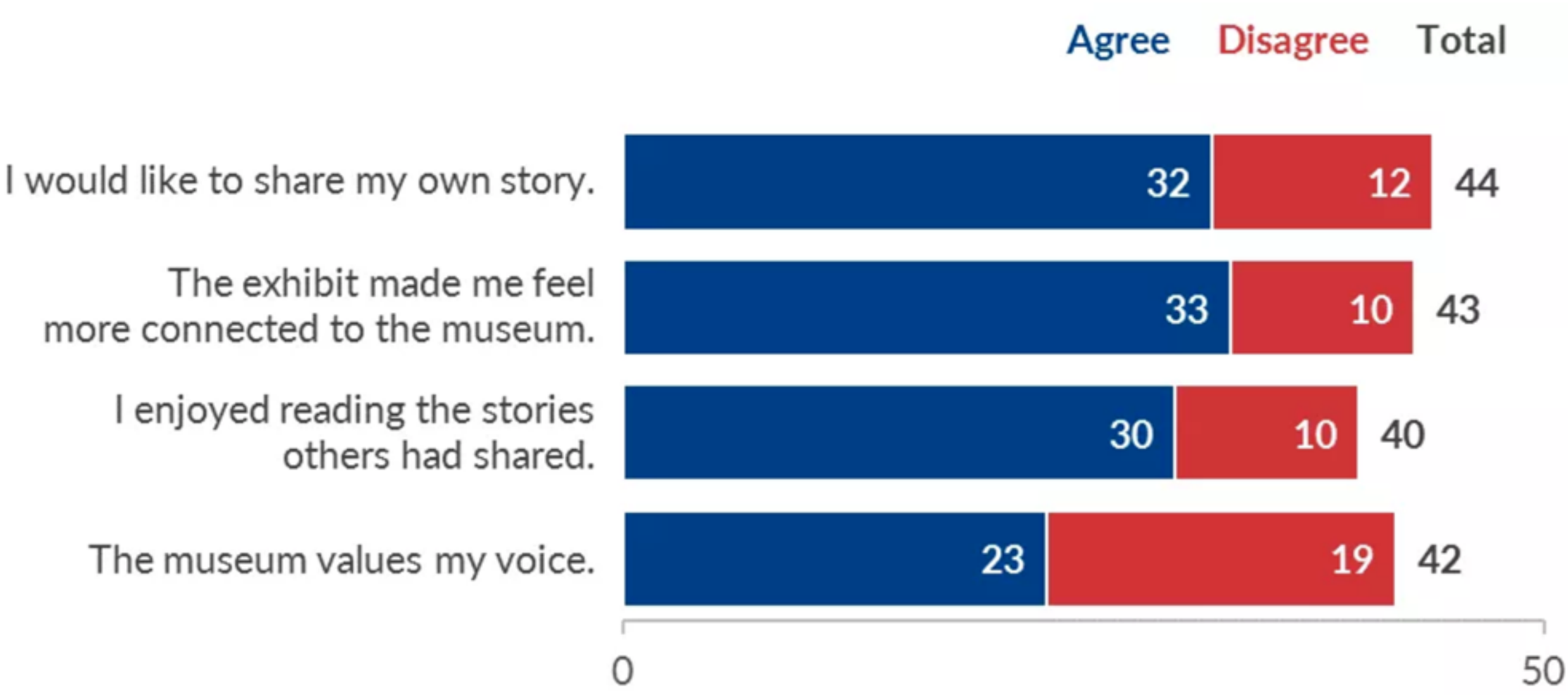
http://annkemery.com/agree-disagree-scales/

Example



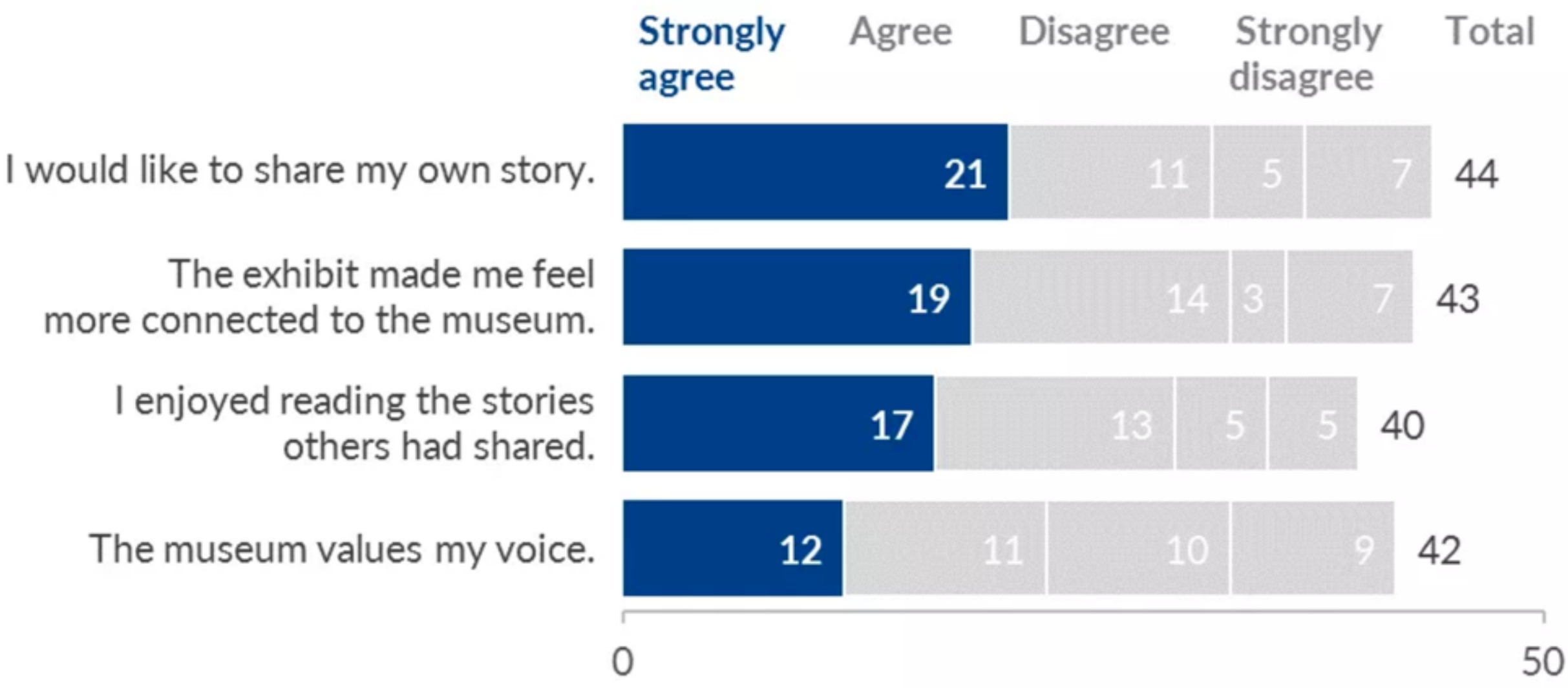
http://annkemery.com/agree-disagree-scales/

Example



http://annkemery.com/agree-disagree-scales/

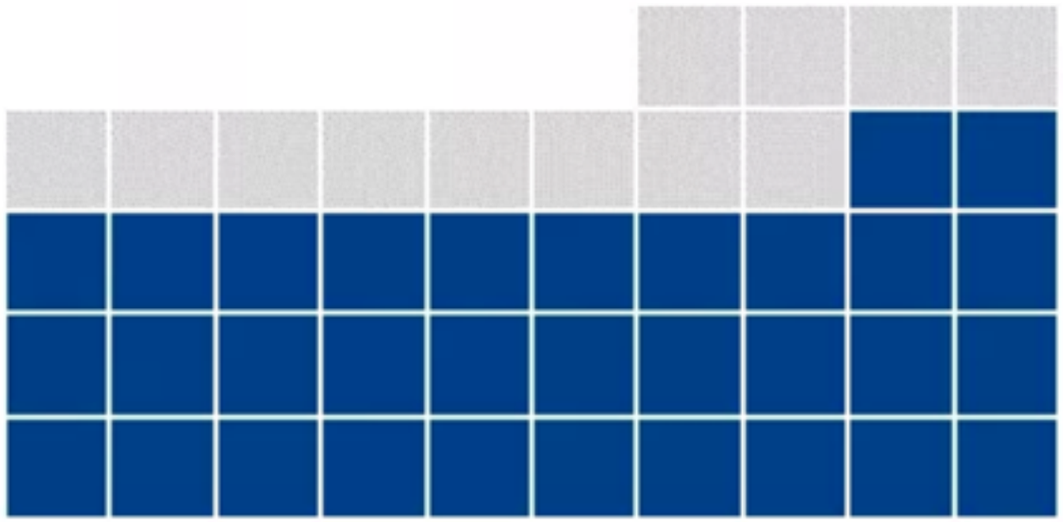
Example



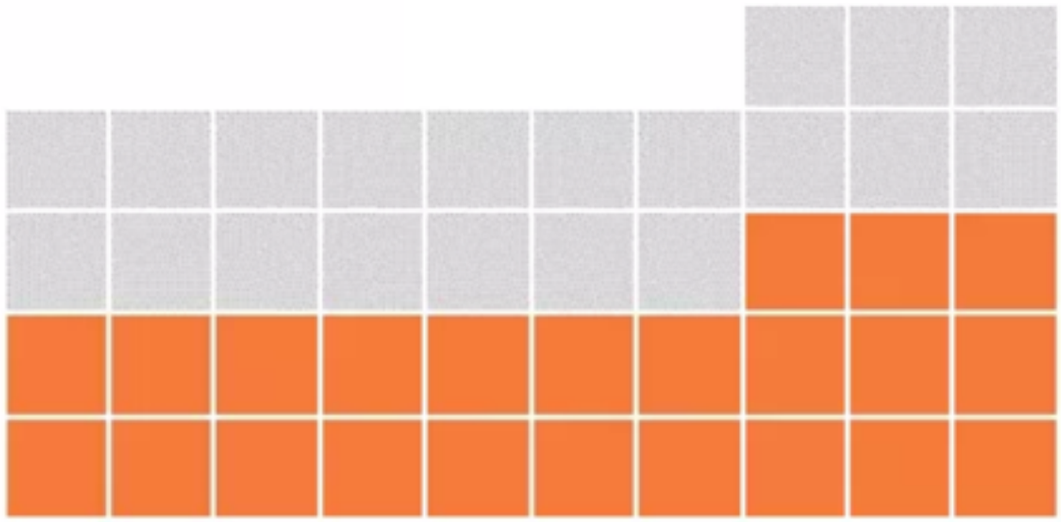
http://annkemery.com/agree-disagree-scales/

Example

32 of 44 people agreed that they
wanted to share their own story



33 of 43 people agreed that
the exhibit made them feel more connected to the museum



http://annkemery.com/agree-disagree-scales/

“Get It Right in Black and White”

M. Stone

National Park Services

“Get It Right in Black and White”

M. Stone

National Park Services

Color guidelines

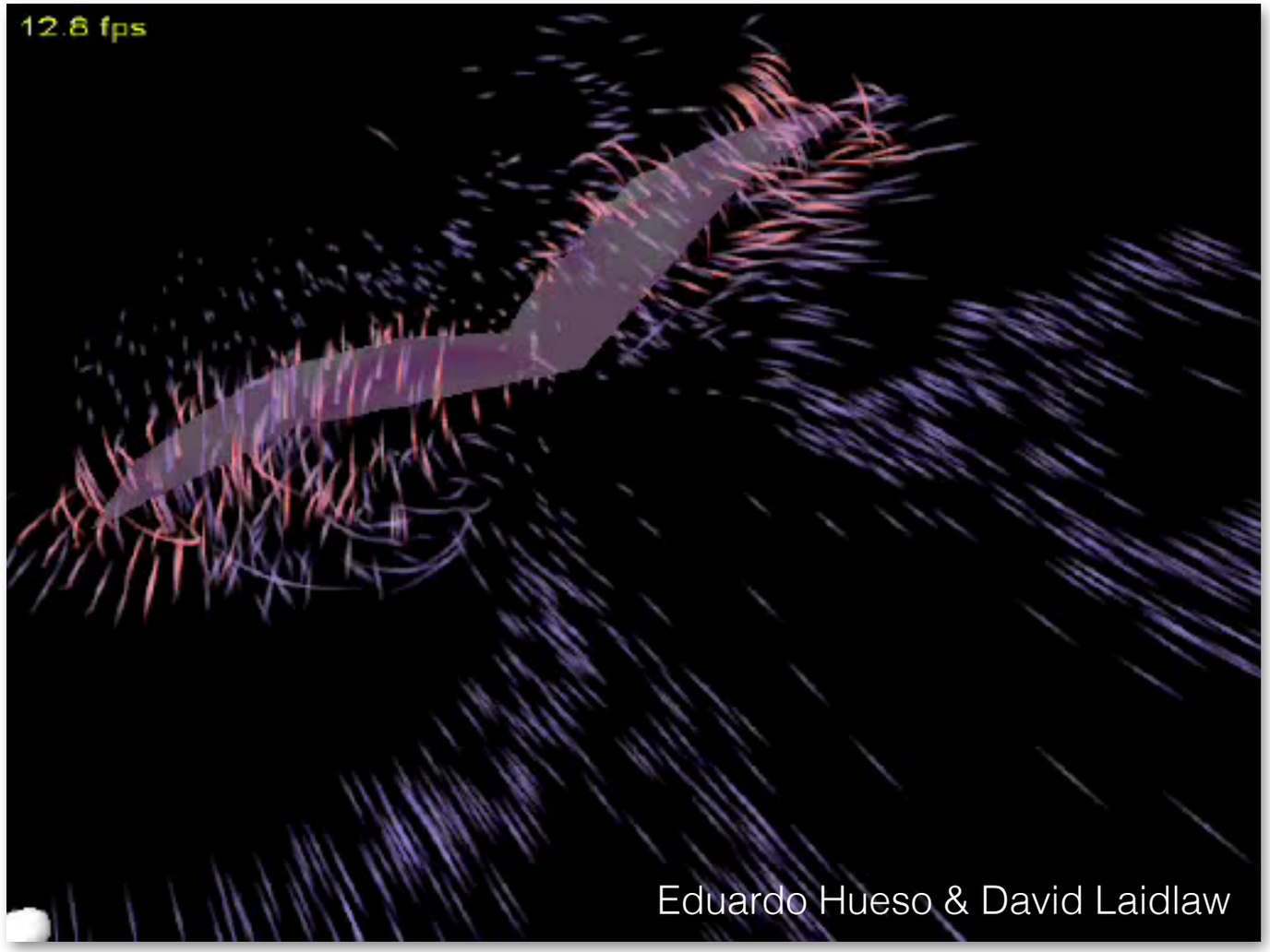
- Use appropriate color scheme (qualitative, sequential vs. diverging)

- Use subtle colors for large areas, brighter colors for smaller parts and lines (contrast & layering)

- Use luminance channel for conveying detail (text, fine lines, fine textures)

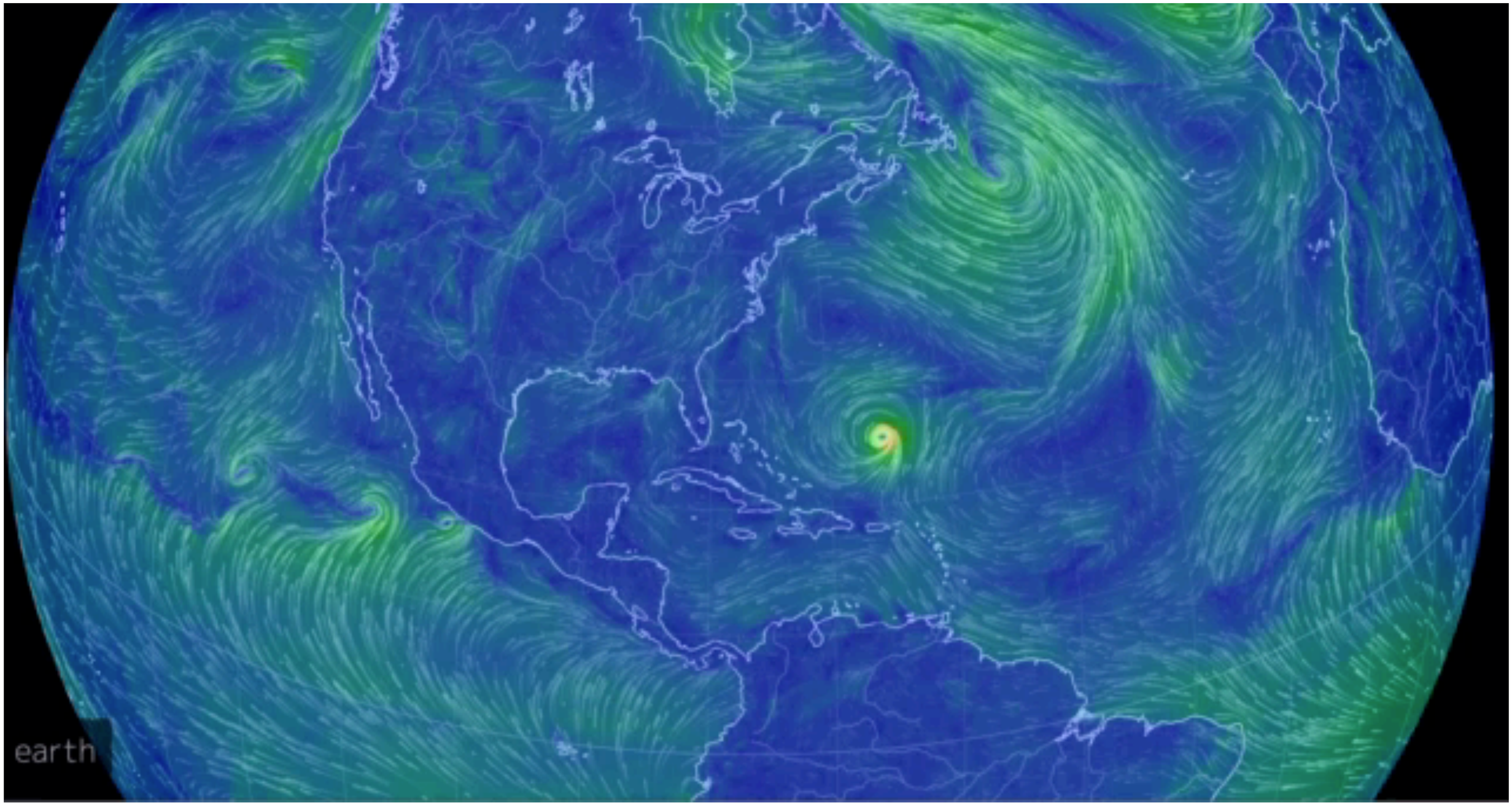
- Consider colorblind and printer friendly colors

Motion



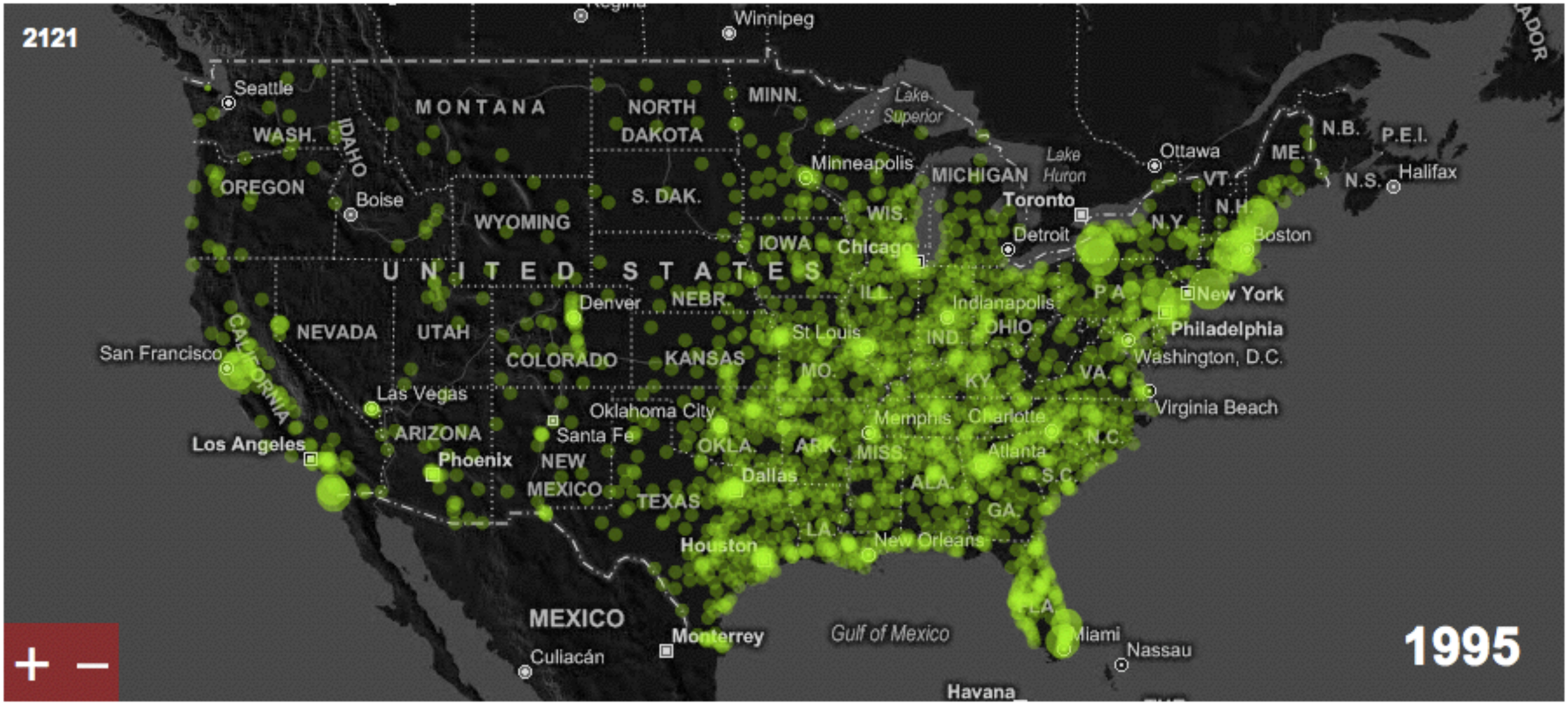
CS
171

Motion as Visual Variable



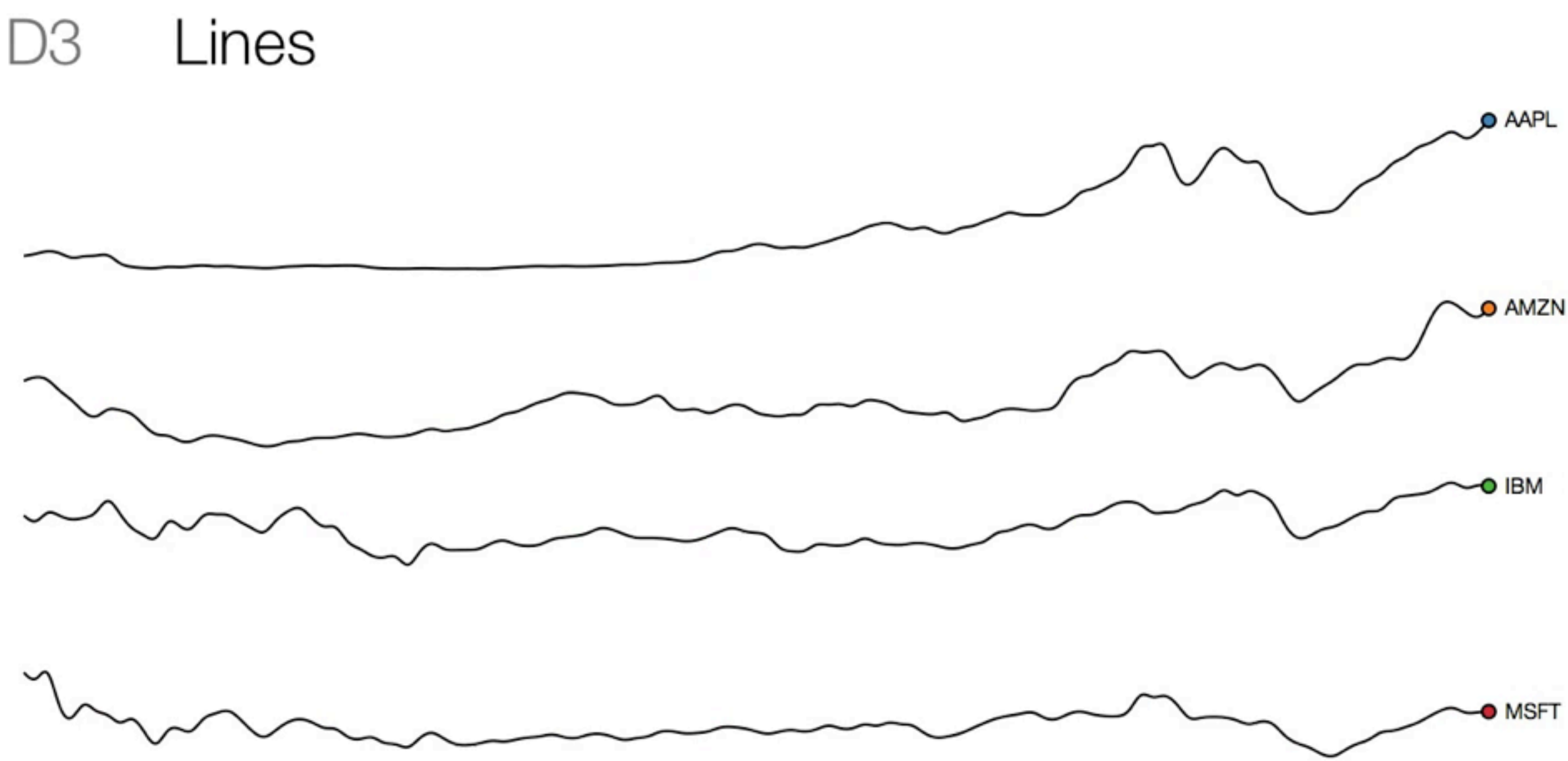
https://earth.nullschool.net

Changes over Time



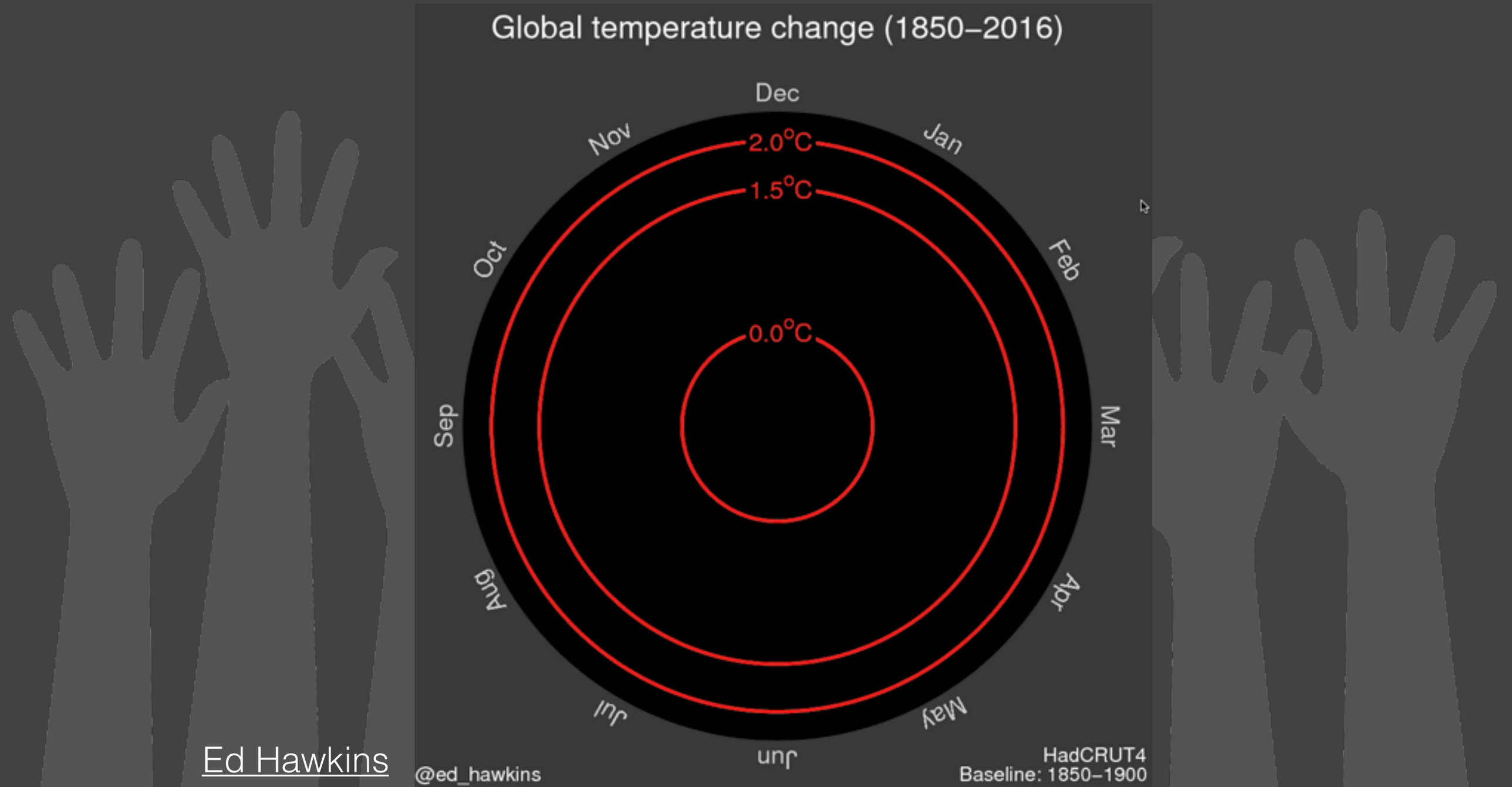
Flowing Data

Transitions



Activity

What is good and bad about this visualization? [2 min]

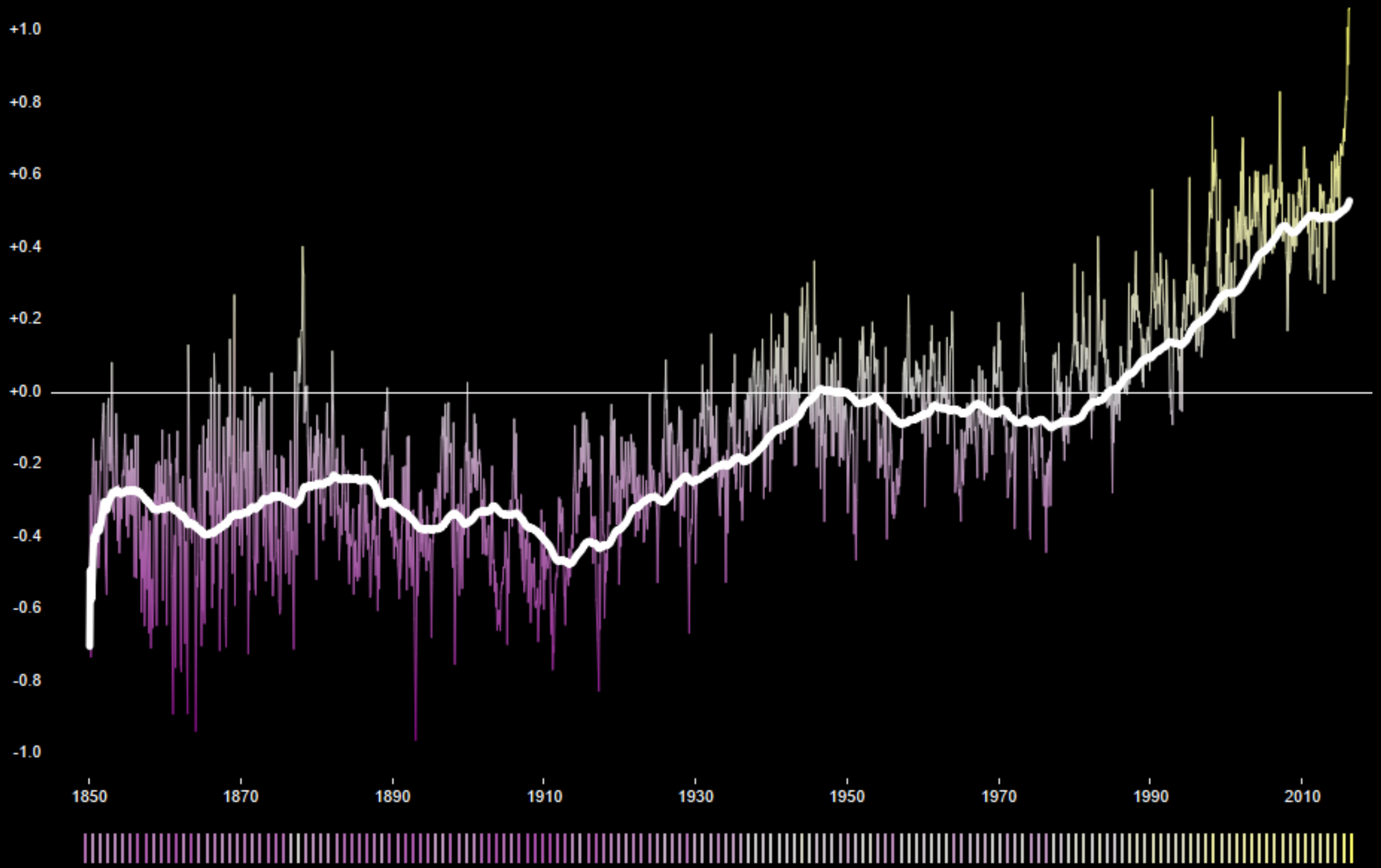


Ed Hawkins

How warm is the Earth becoming?

From January 1860 to March 2016, Earth has warmed +0.8 (deg C)

Monthly global temperature change from 1850-2016 vs. the 1961-1990 average



A. Kriebel - http://www.vizwiz.com/2016/05/makeover-monday-how-warm-is-earth.html

xkcd

A webcomic of romance, sarcasm, math, and language.

Note: Since a lot of new people are here looking for this chart today, I'll be posting Wednesday's comic on Thursday instead.

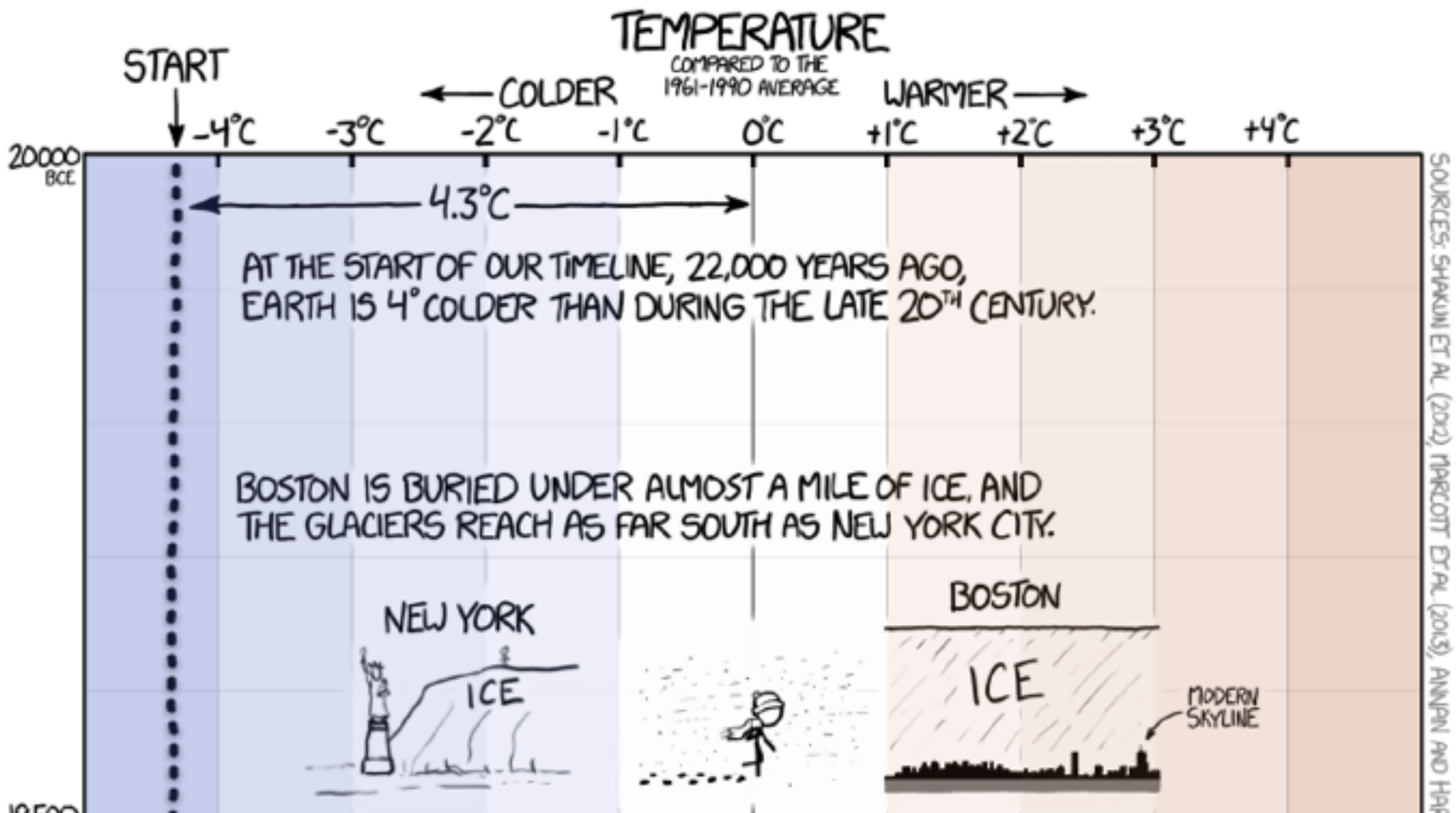
Earth Temperature Timeline

|< < Prev Random Next > >|

A TIMELINE OF EARTH'S AVERAGE TEMPERATURE

SINCE THE LAST ICE AGE GLACIATION

WHEN PEOPLE SAY "THE CLIMATE HAS CHANGED BEFORE," THESE ARE THE KINDS OF CHANGES THEY'RE TALKING ABOUT.



SOURCES: SHAKUN ET AL. (2012), MARCOTT ET AL. (2013), ANNAN AND HARG

Contrast

Pop-Out

Separable-Integral

Color

Categories

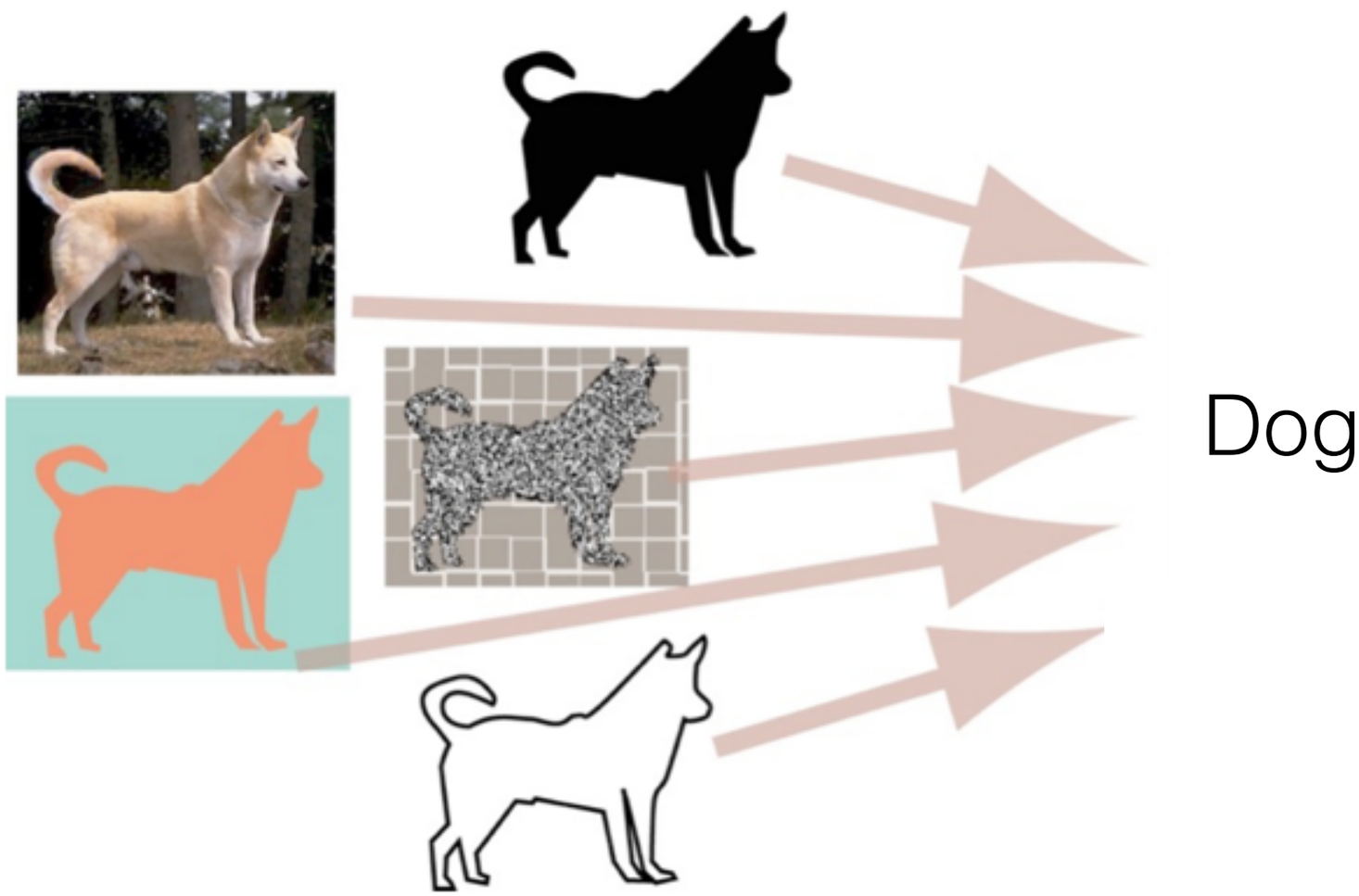
Maps

Motion

Change Over Time

Transitions

Cognition



C. Ware, ‘Visual Thinking for Design’

Next Tuesday…

- Cognition
- Reading: Ware, Chapter 3

Lecture!

This Thursday…

- Introduction to SVG
- Reading: D3 book, Chapter 7 and 8 (p. 67-72, p. 76-84)

Homework (due Monday)…

- Homework 2 - Javascript

One minute paper @ Canvas

Remember this picture