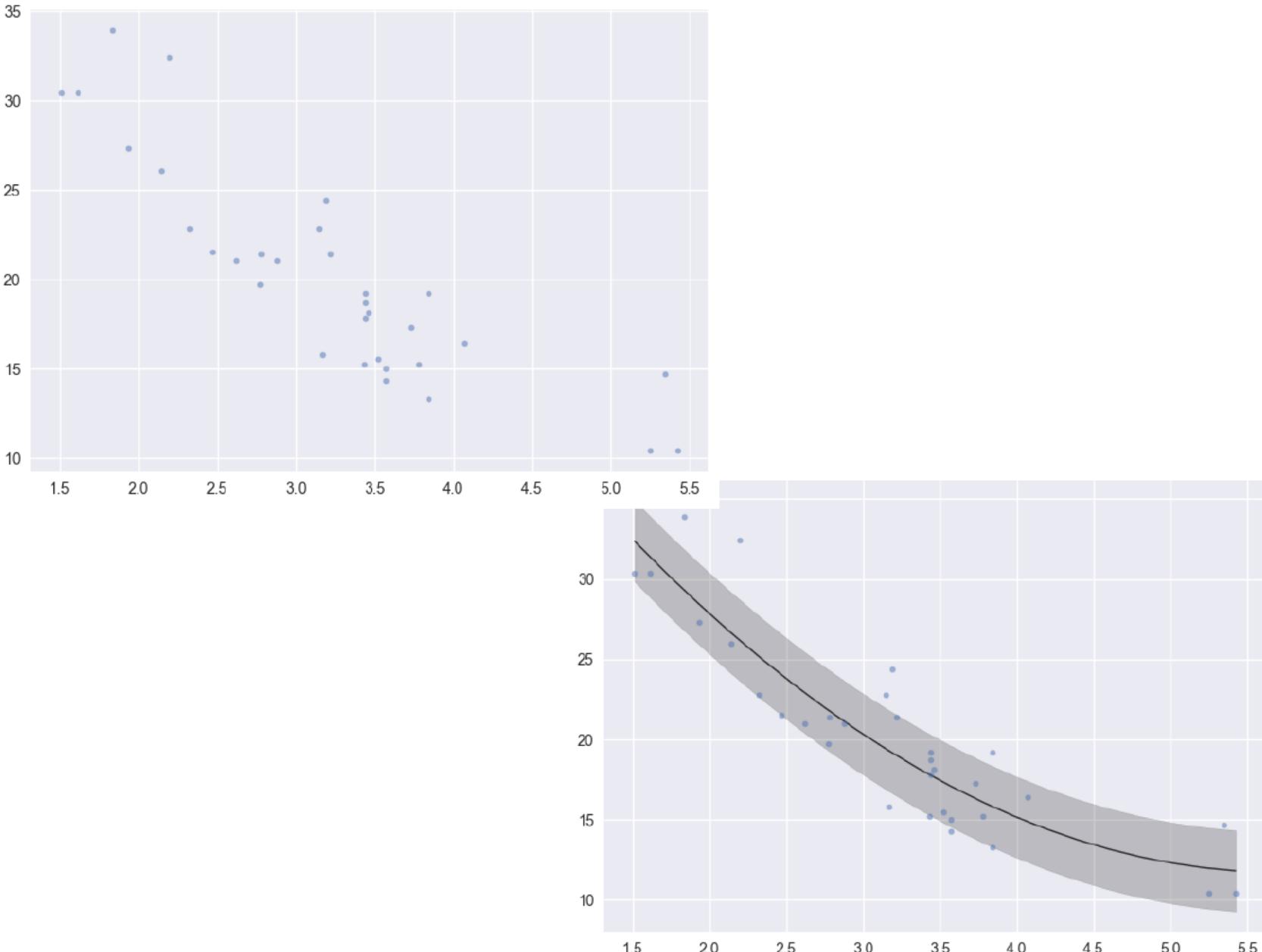


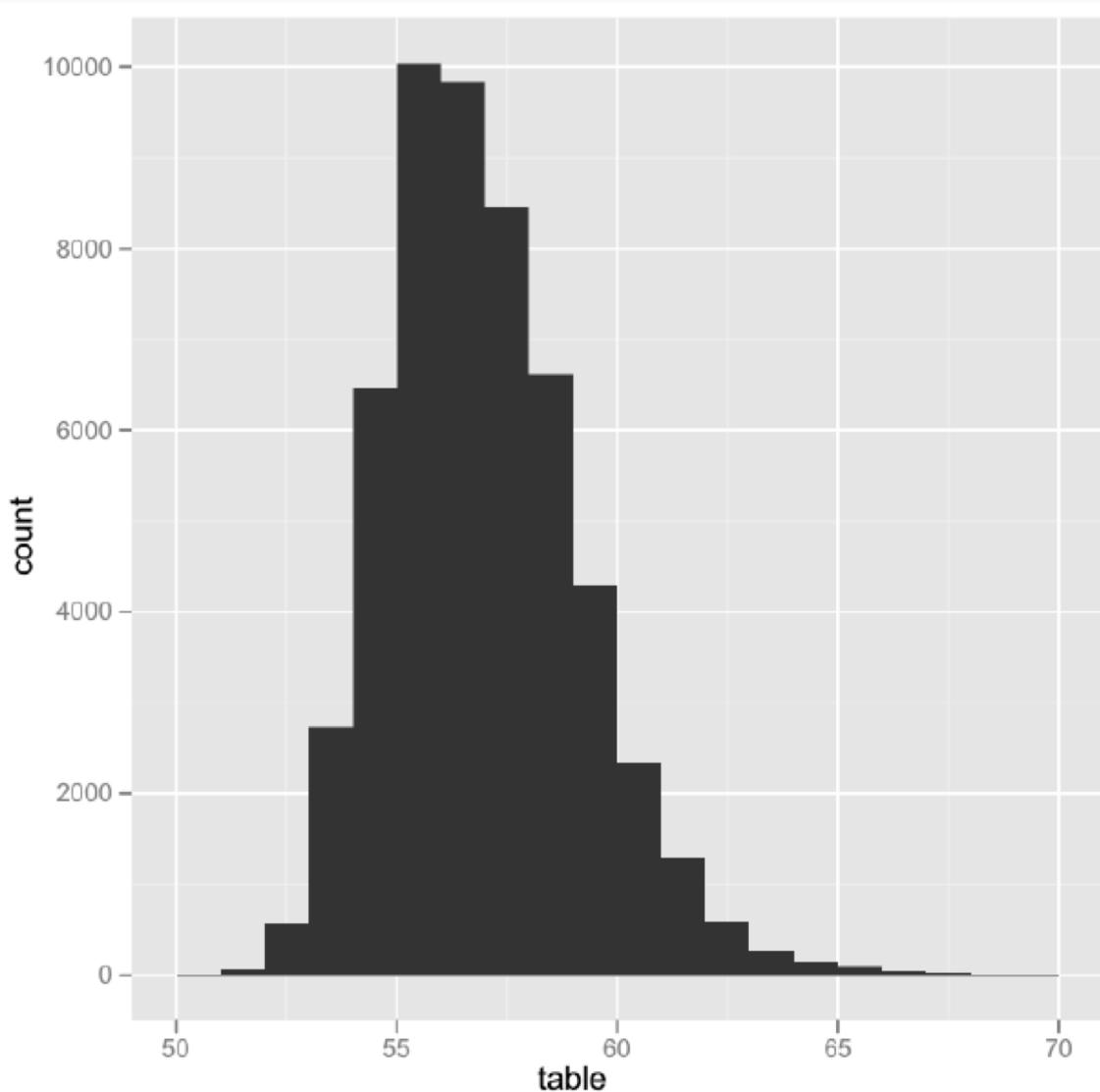
# Displays: trends



# Displays: trends

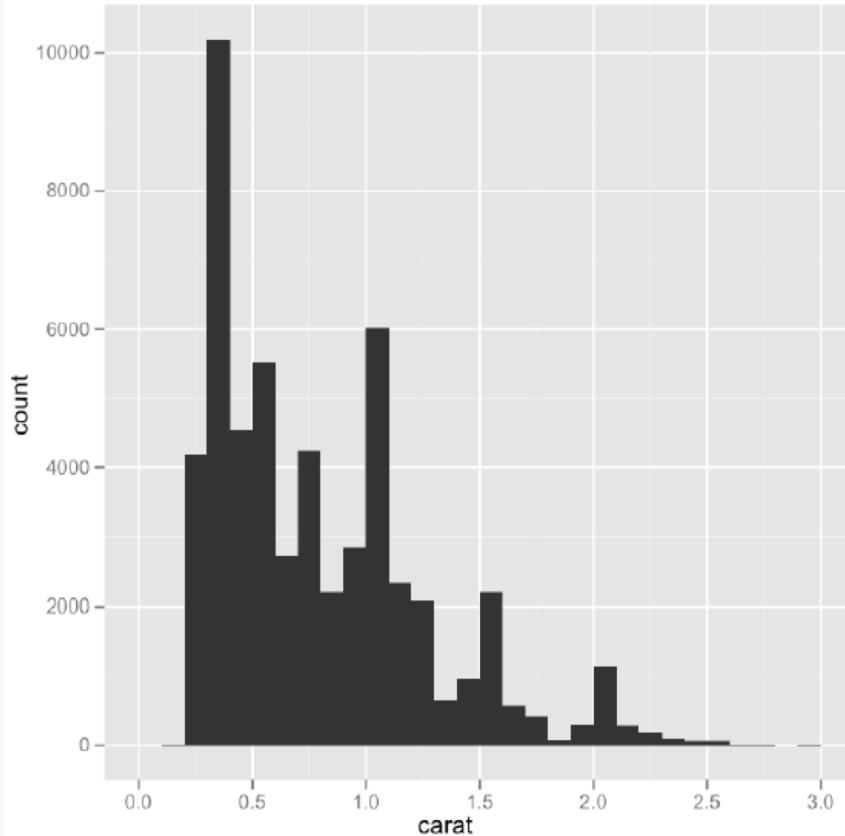


# Displays: distributions

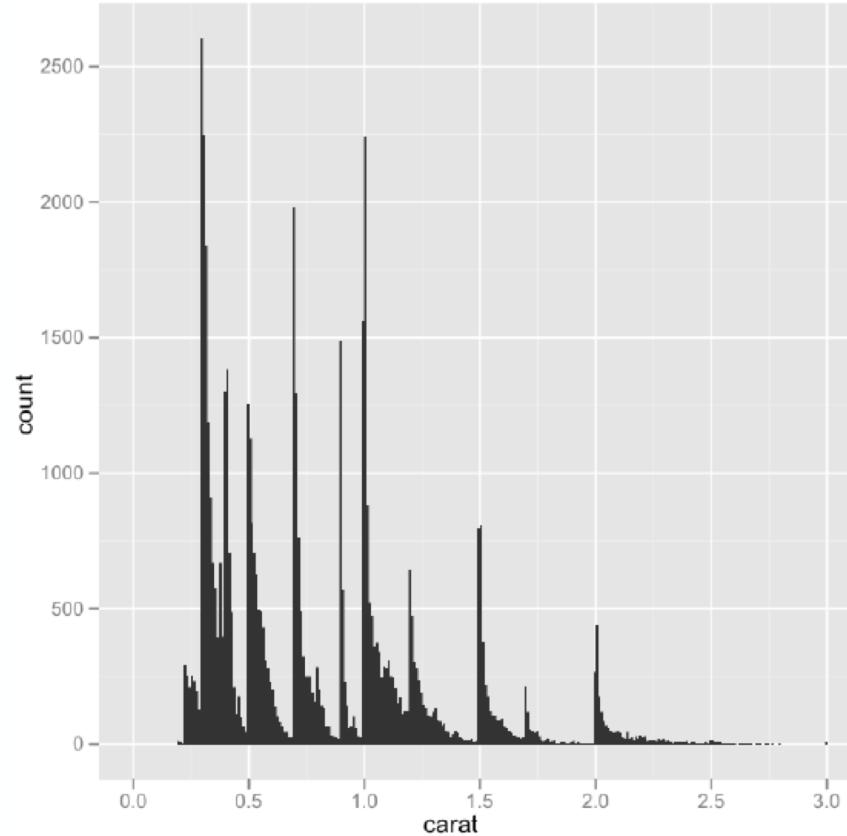


# Displays: distributions

## Bin Width

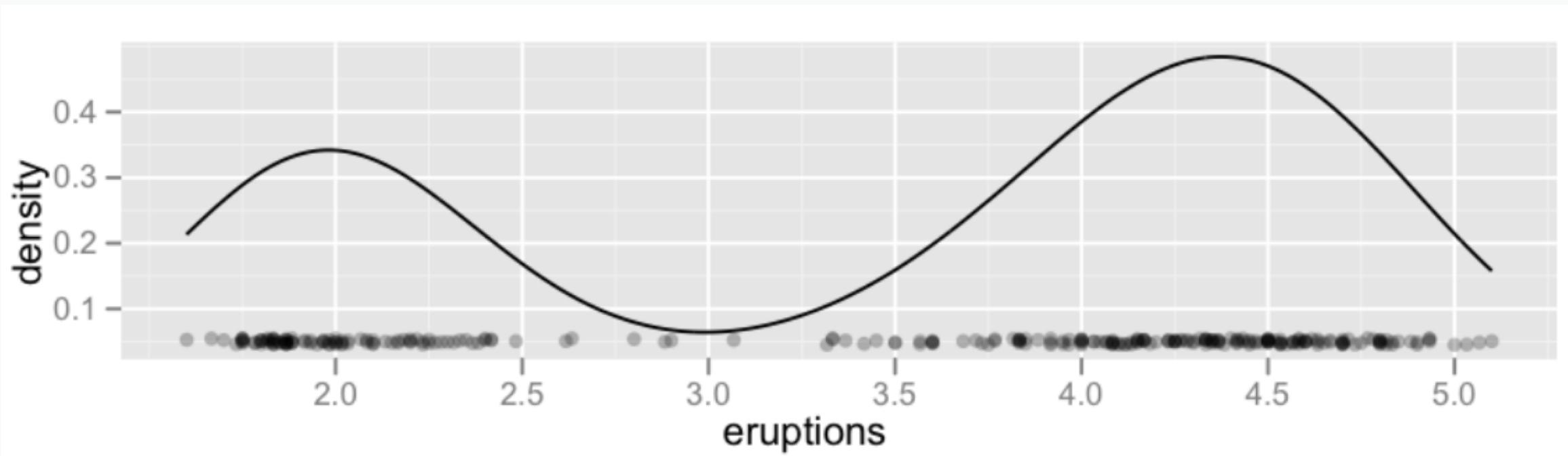


**binwidth = 0.1**

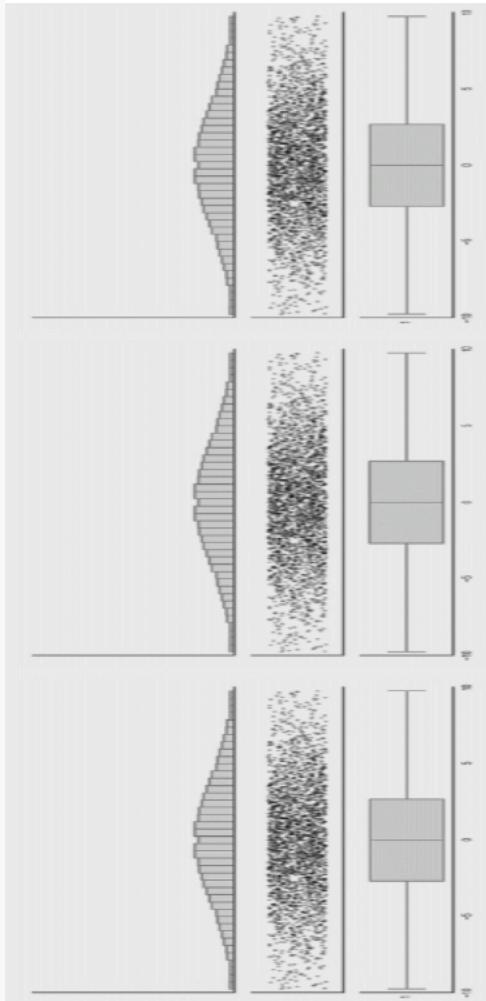


**binwidth = 0.01**

# Displays: density plots

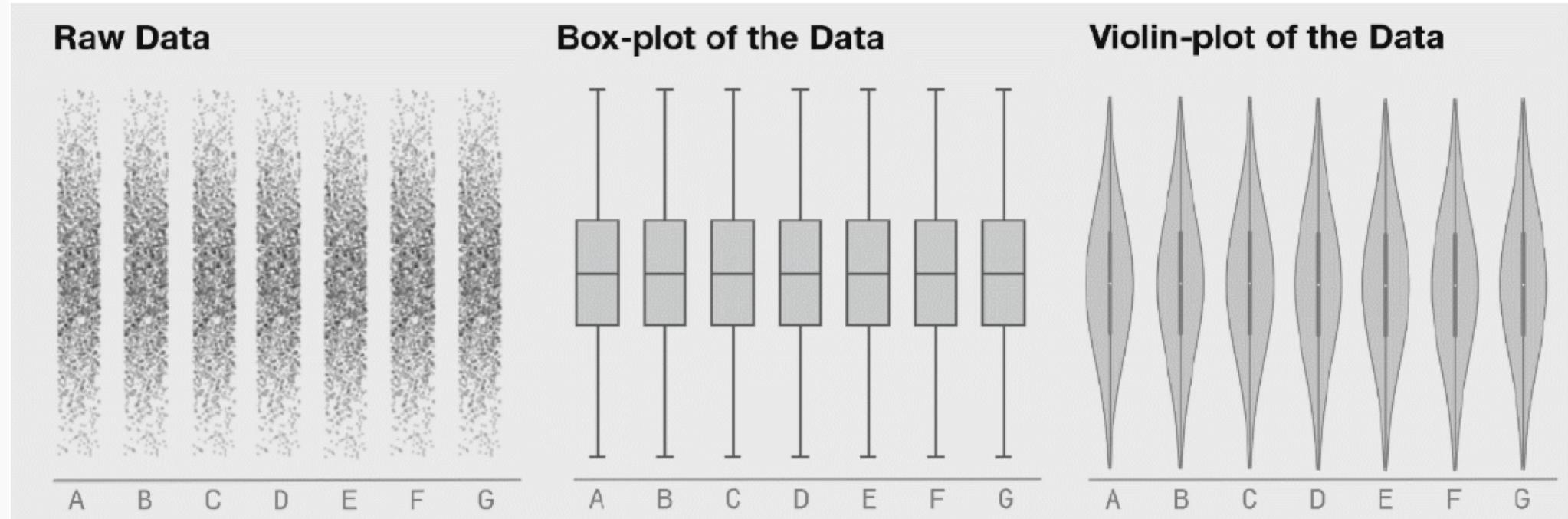


# Displays: density plots

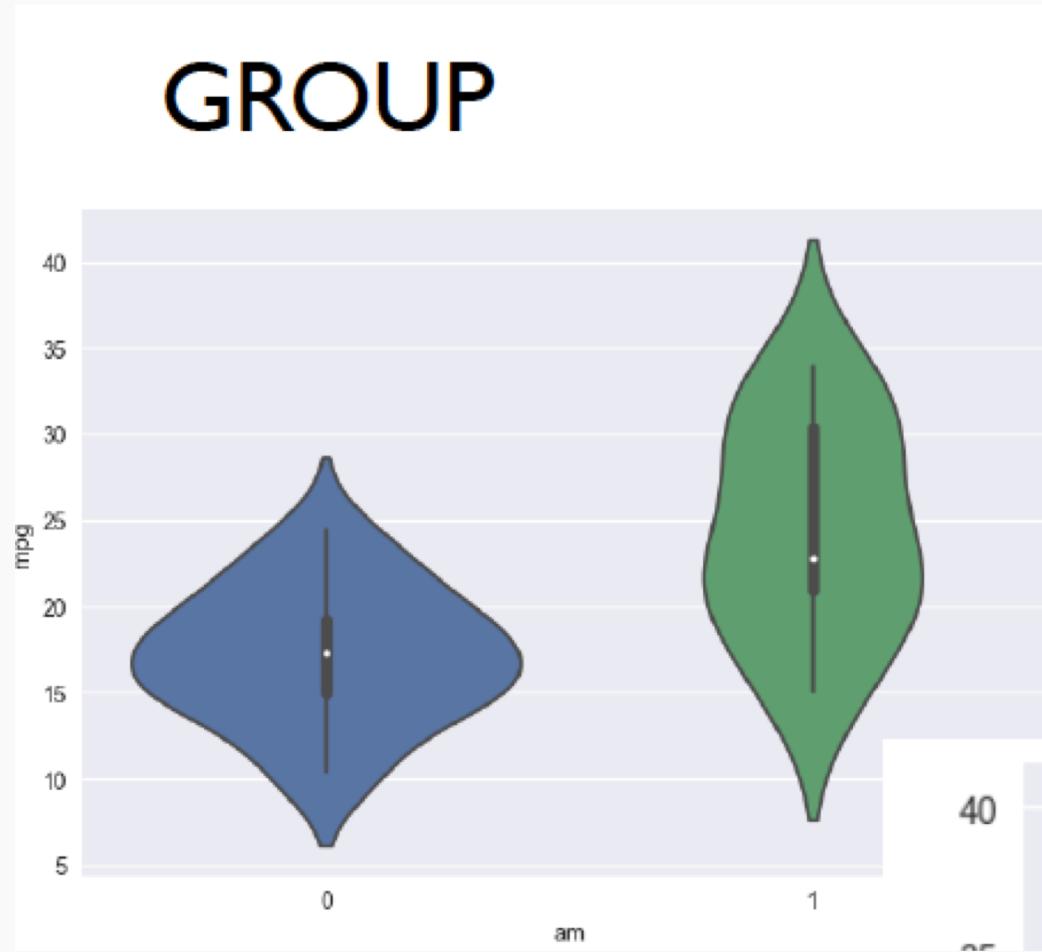


[https://  
www.autodeskresearch.com/  
publications/samestats](https://www.autodeskresearch.com/publications/samestats)

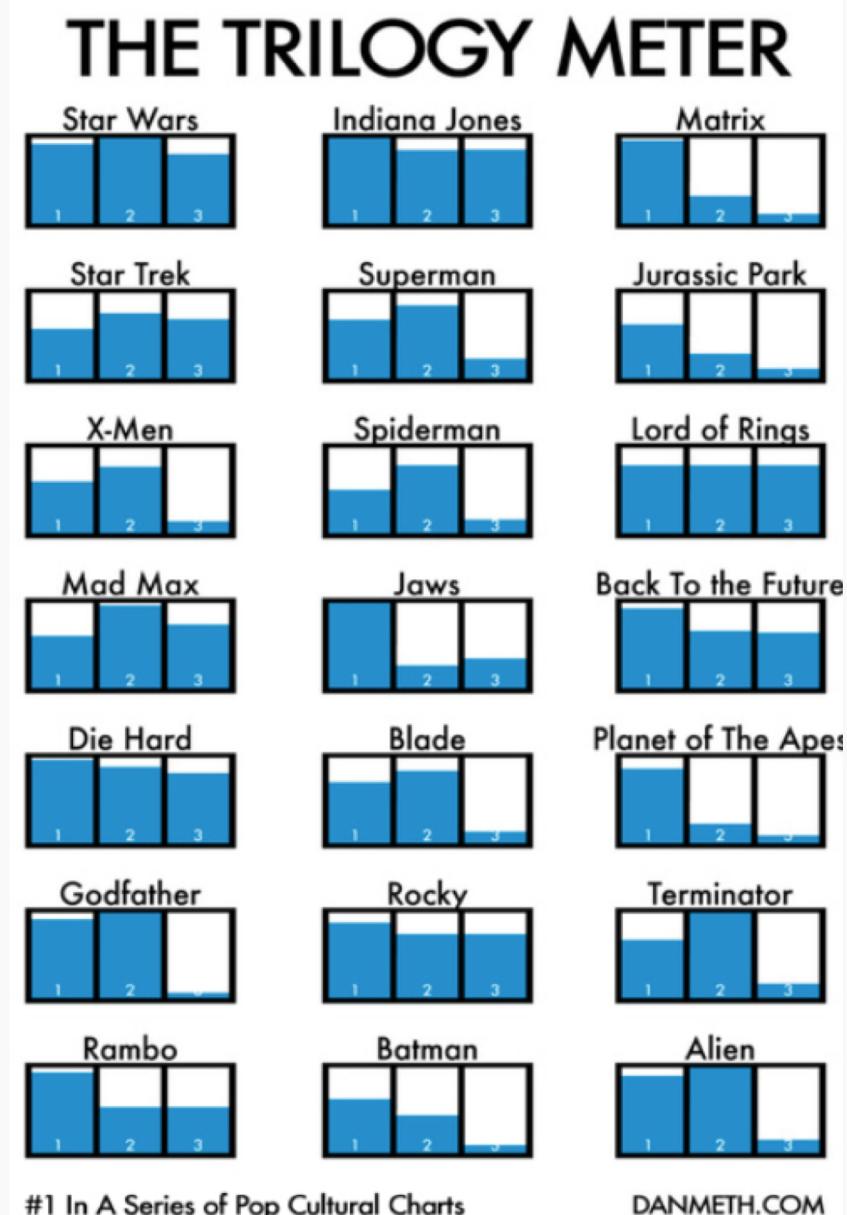
# Displays: density plots



# Displays: density plots

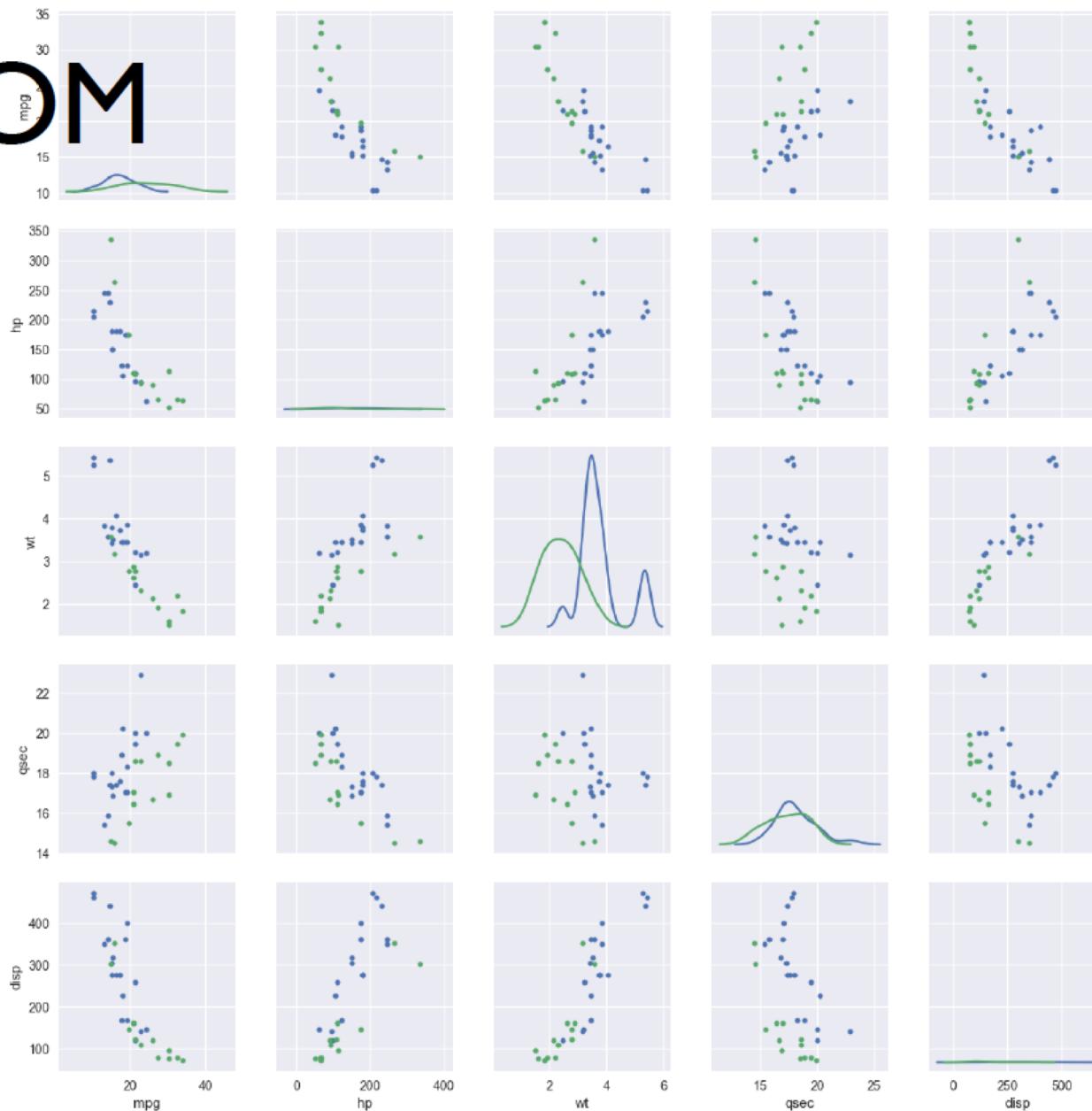


# Displays: small multiples



# Displays: scatter plot matrix

SPLOM



# Displays: hands-on exercise

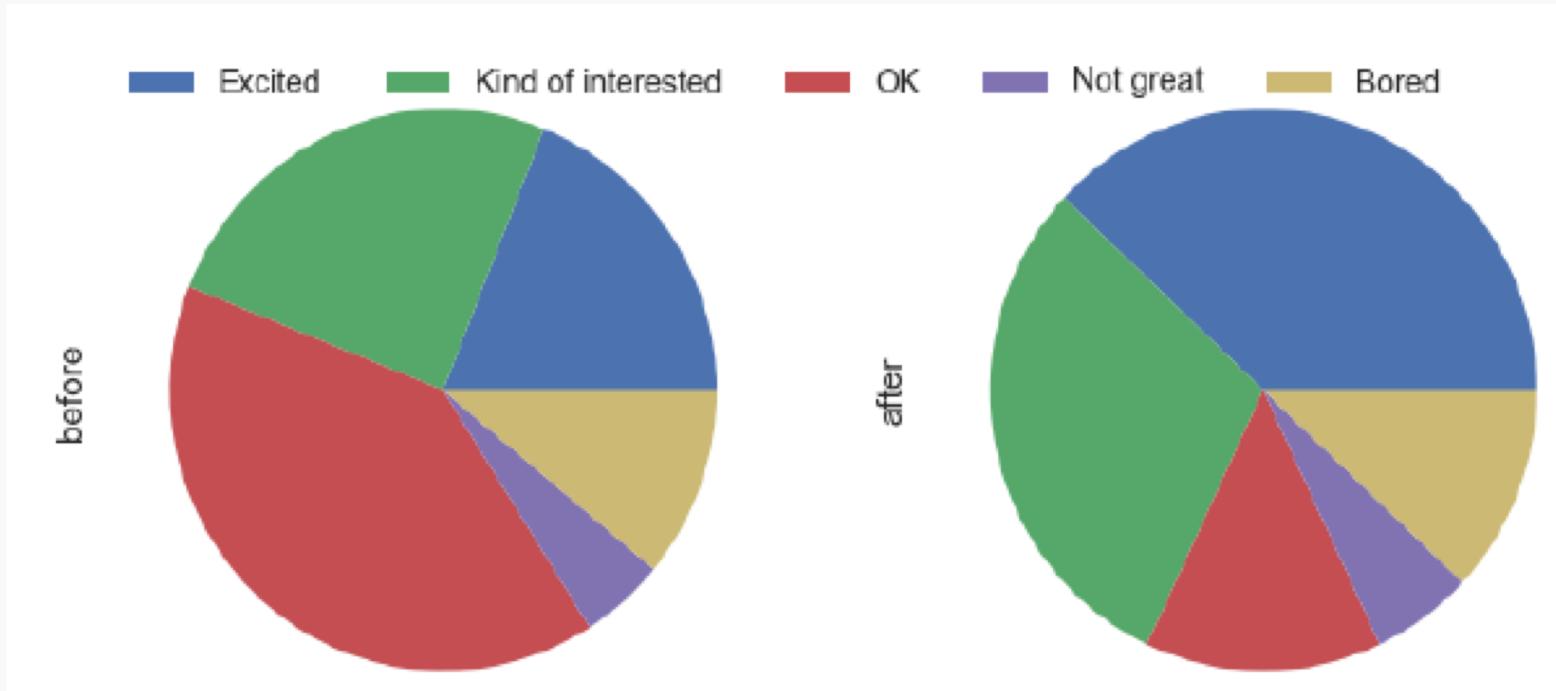
How do you feel about doing science?

Table

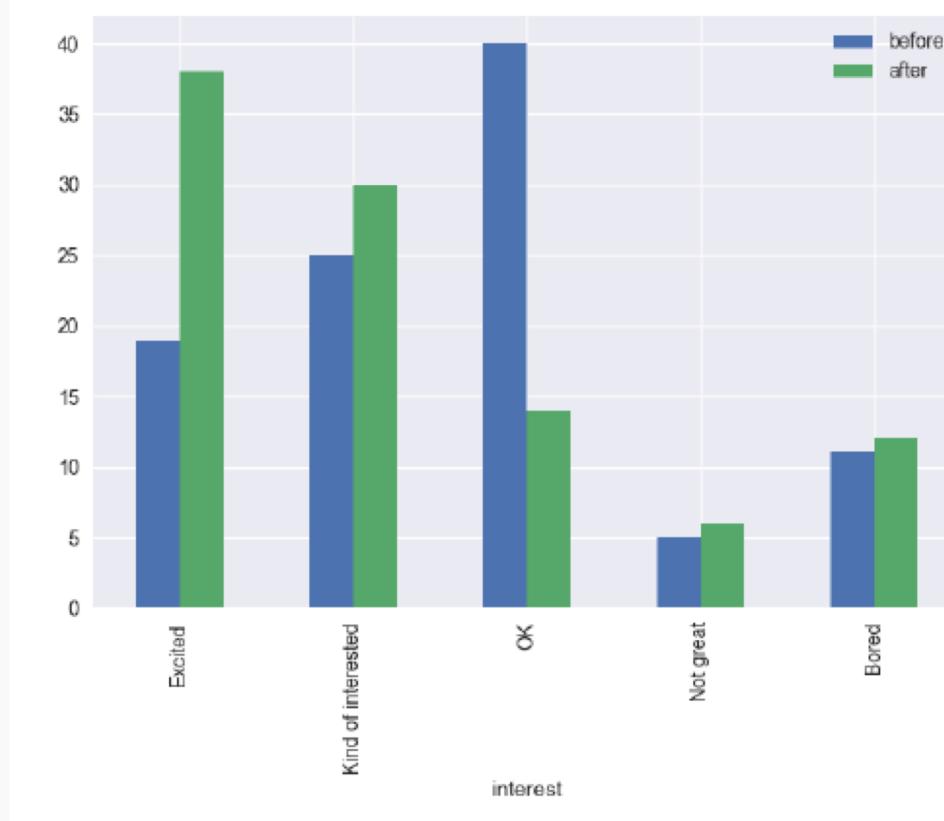
Interest	Before	After
Excited	19	38
Kind of interested	25	30
OK	40	14
Not great	5	6
Bored	11	12

Data courtesy of Cole Nussbaumer

# Displays: exercise options

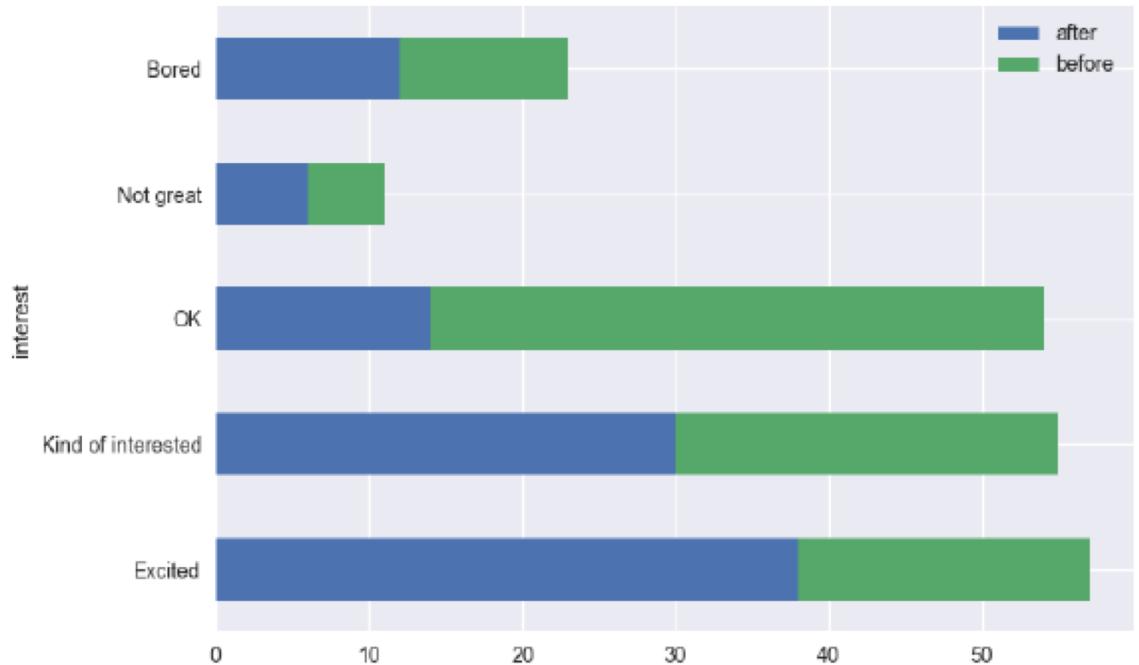


# Displays: exercise options

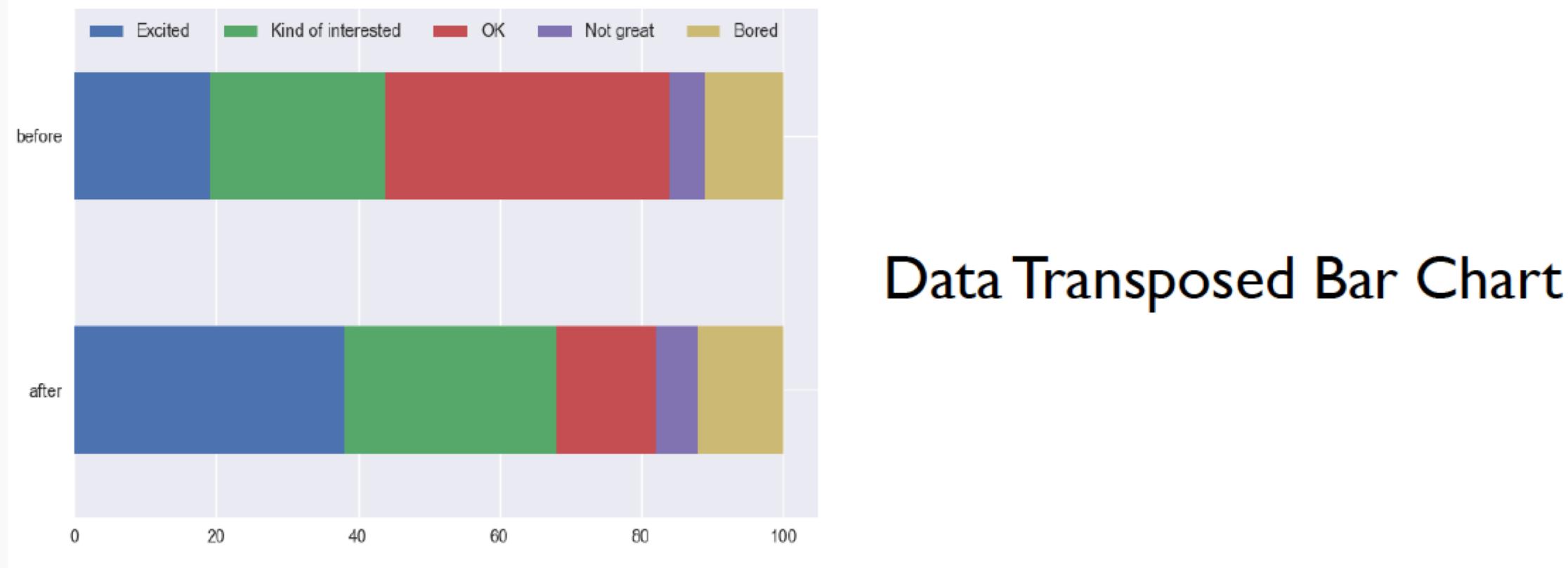


# Displays: exercise options

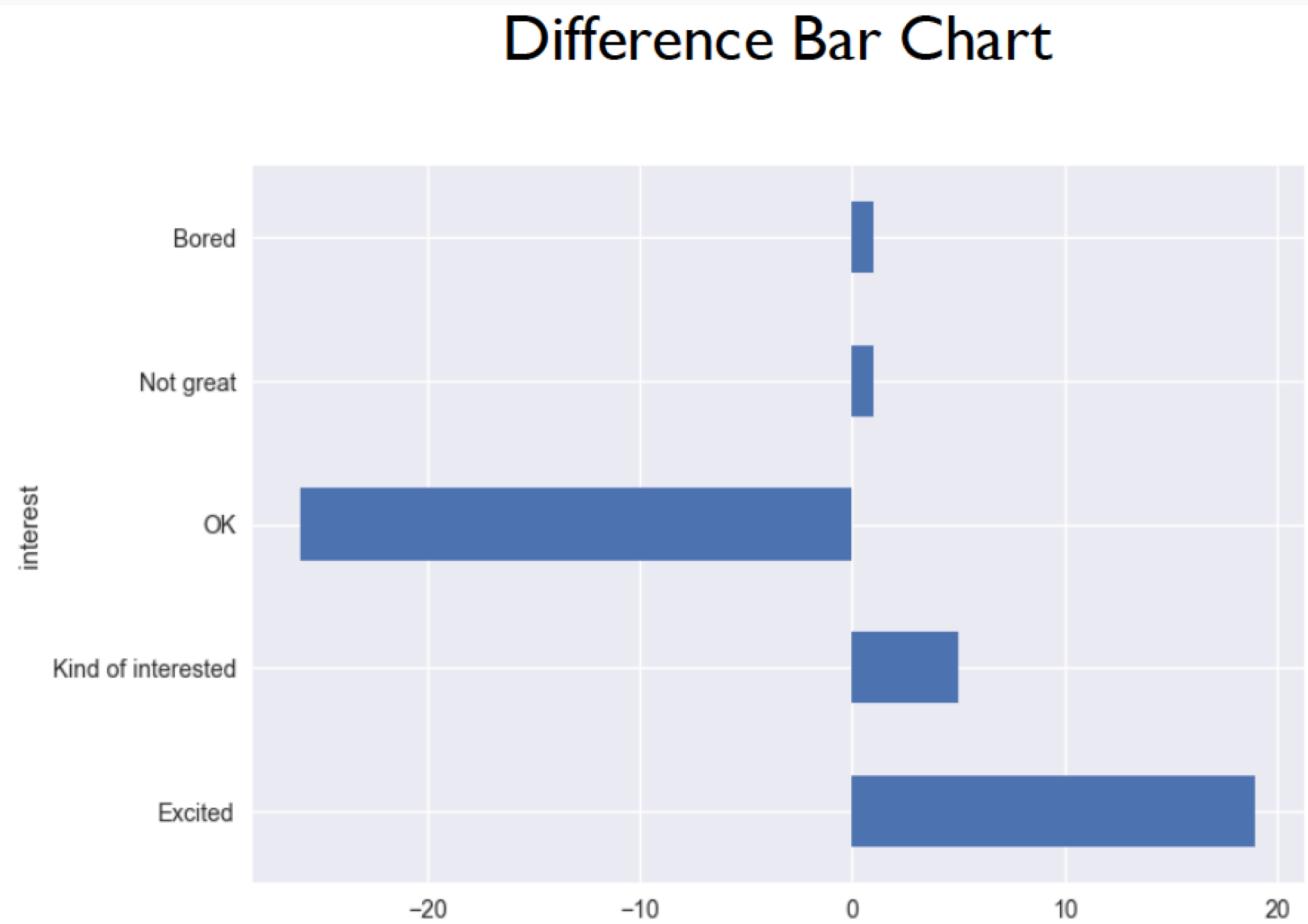
Stacked bar, not very useful



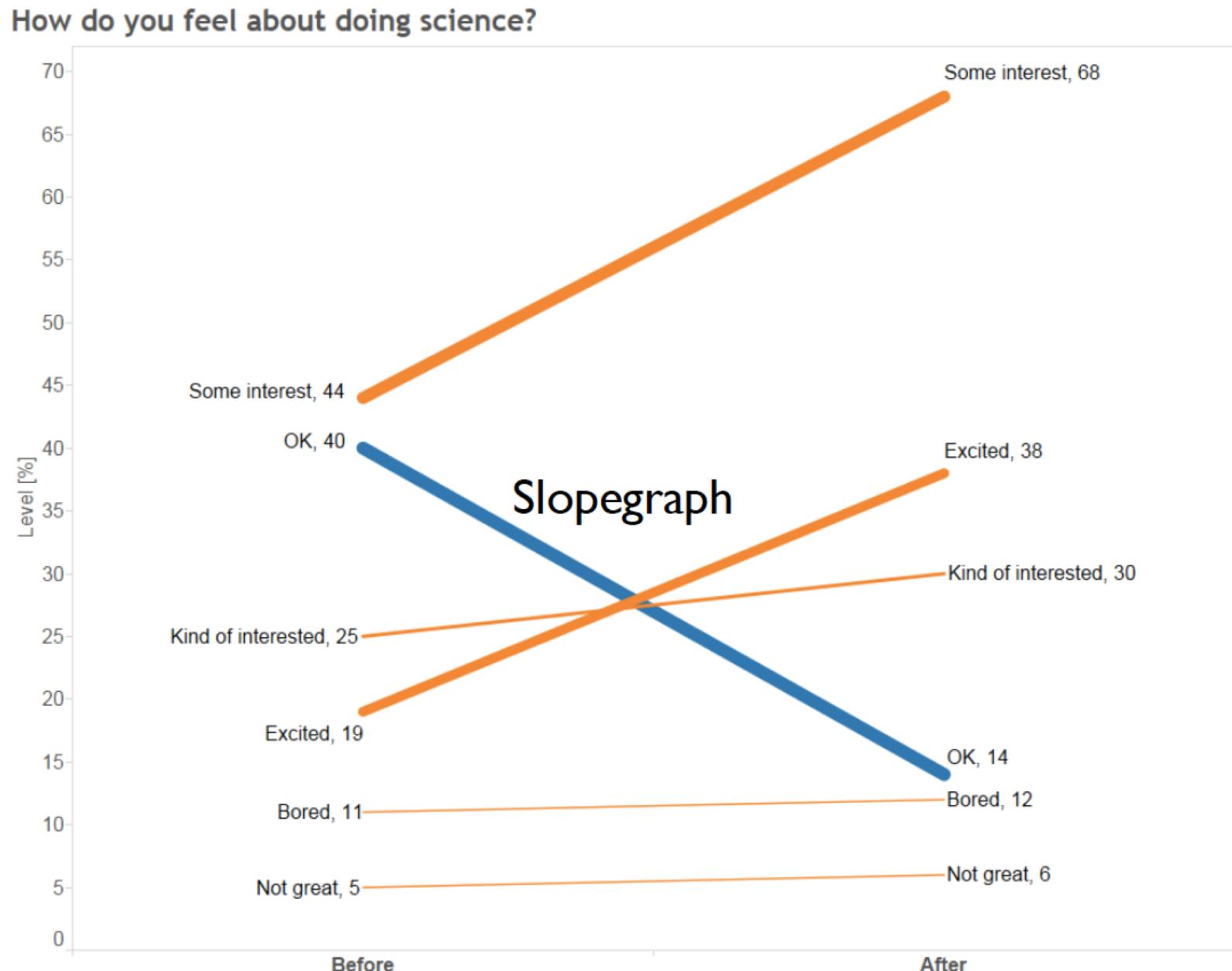
# Displays: exercise options



# Displays: exercise options



# Displays: exercise options



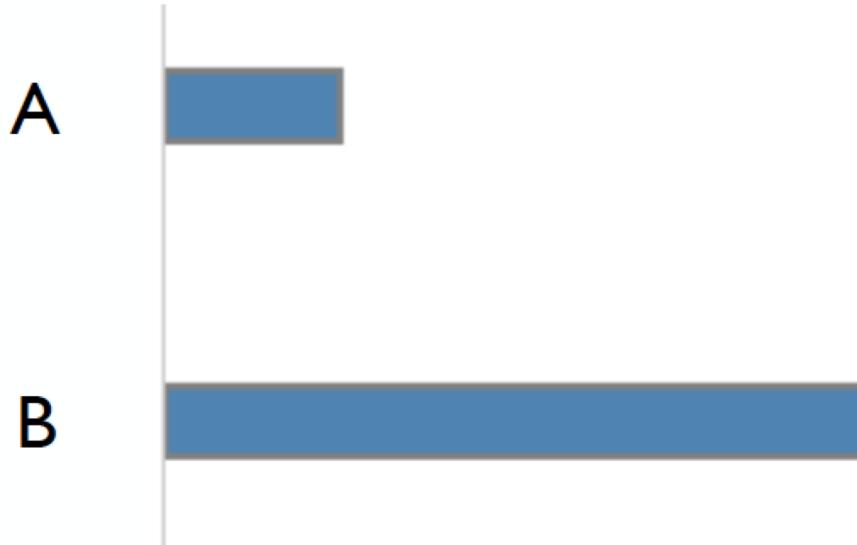
# Displays: exercise options

After the pilot program,

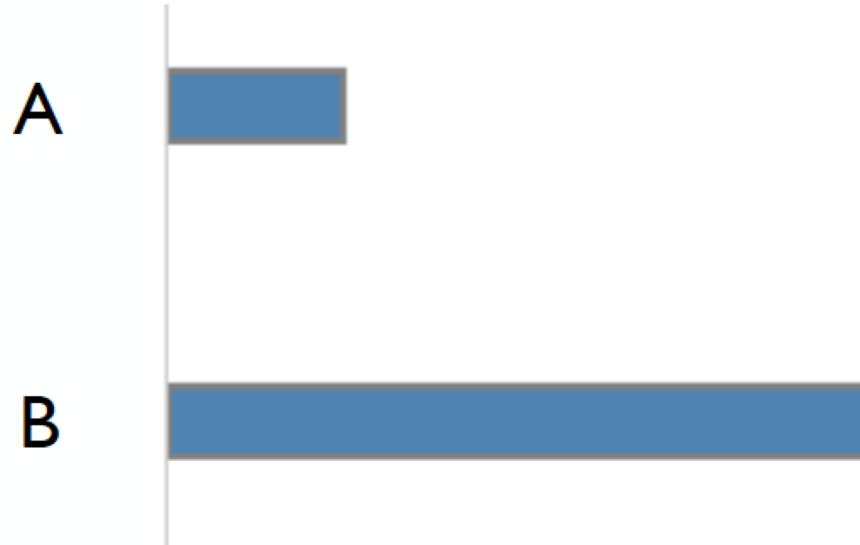
**68%**

of kids expressed interest towards science,  
compared to 44% going into the program.

## How much longer?



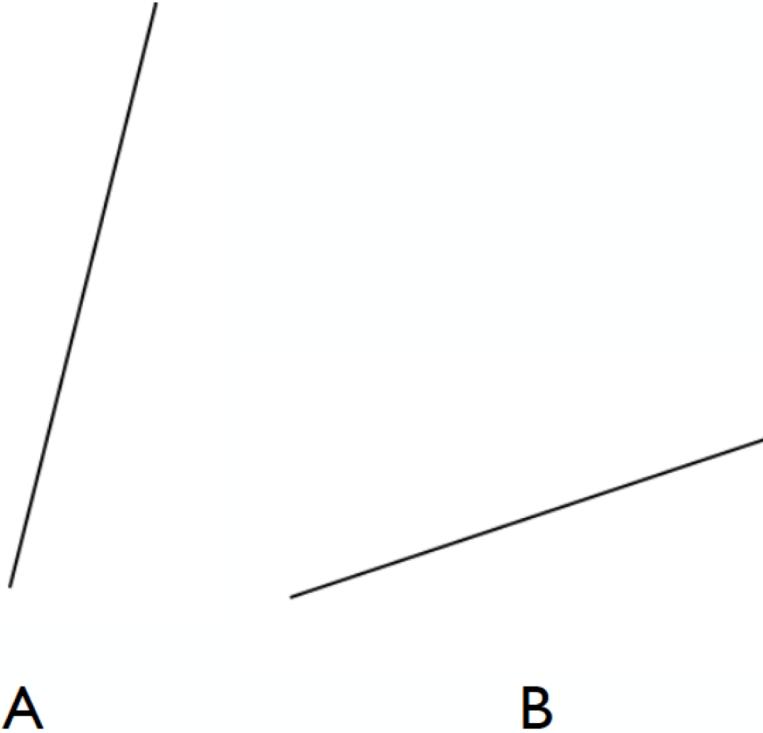
## How much longer?



4x

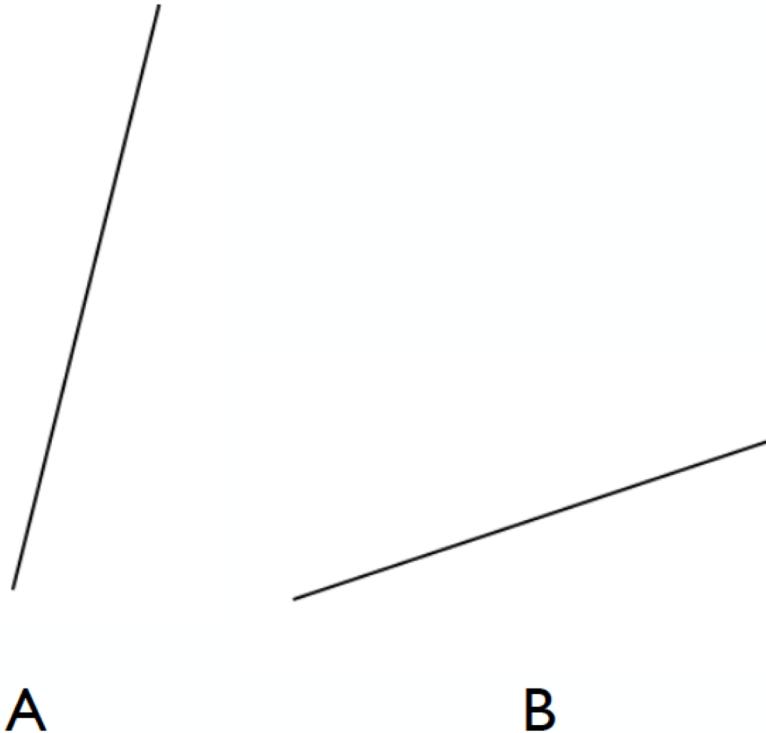
# Displays: perceptual effectiveness

How much steeper slope?



# Displays: perceptual effectiveness

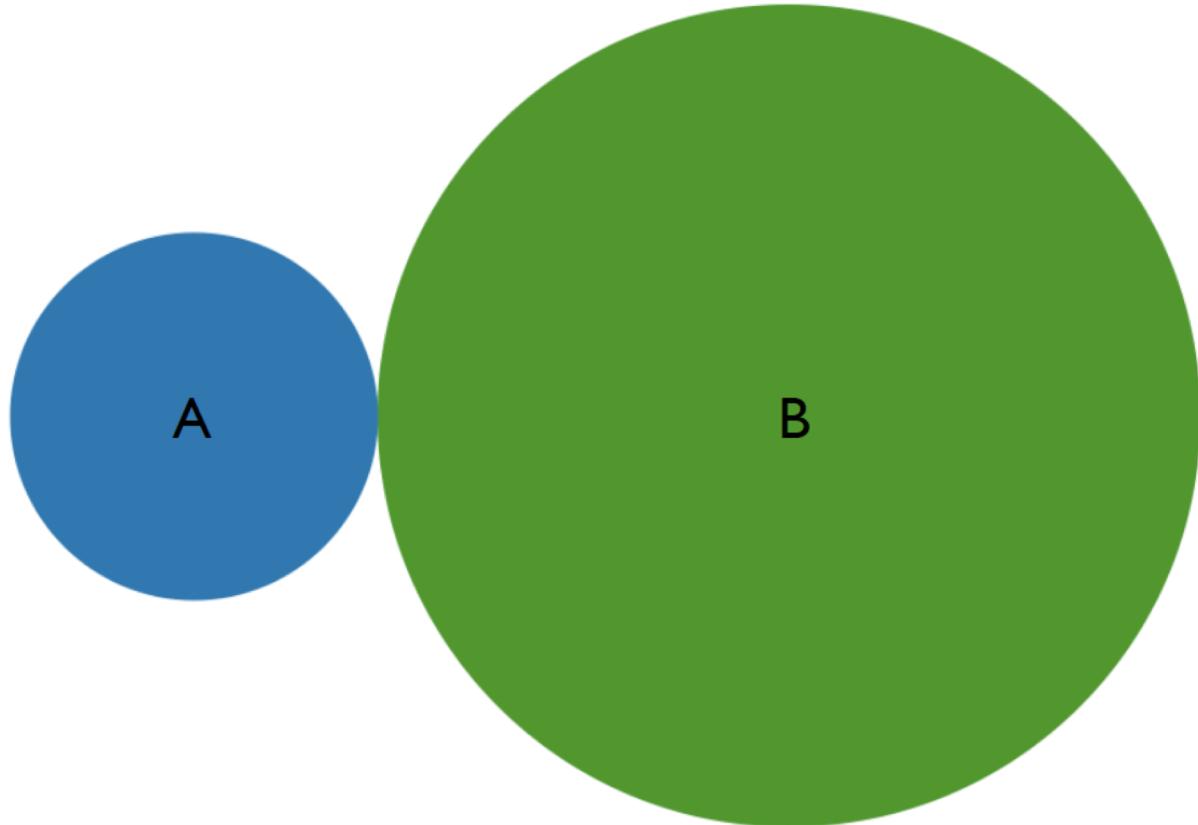
How much steeper slope?



4x

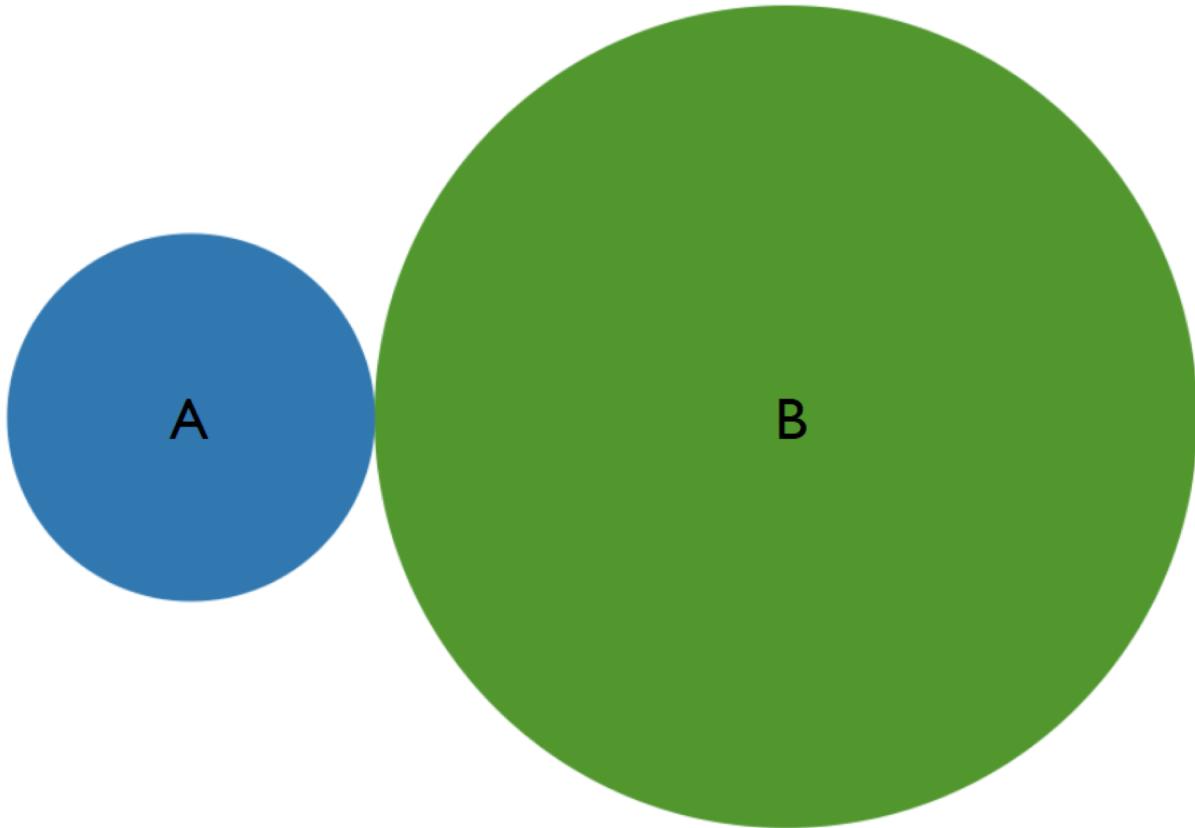
# Displays: perceptual effectiveness

How much larger area?



# Displays: perceptual effectiveness

How much larger area?



10x

# Displays: perceptual effectiveness

How much darker?



# Displays: perceptual effectiveness

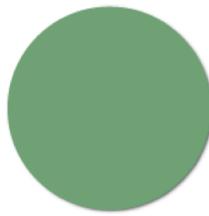
How much darker?



2x

# Displays: perceptual effectiveness

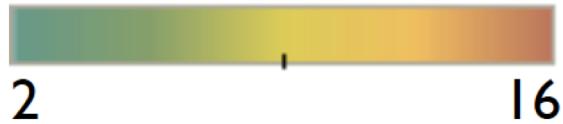
How much bigger value?



A

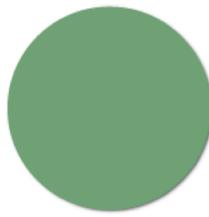


B

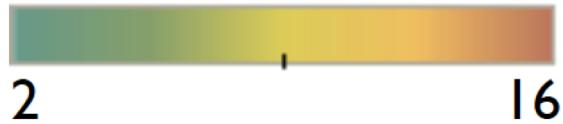


# Displays: perceptual effectiveness

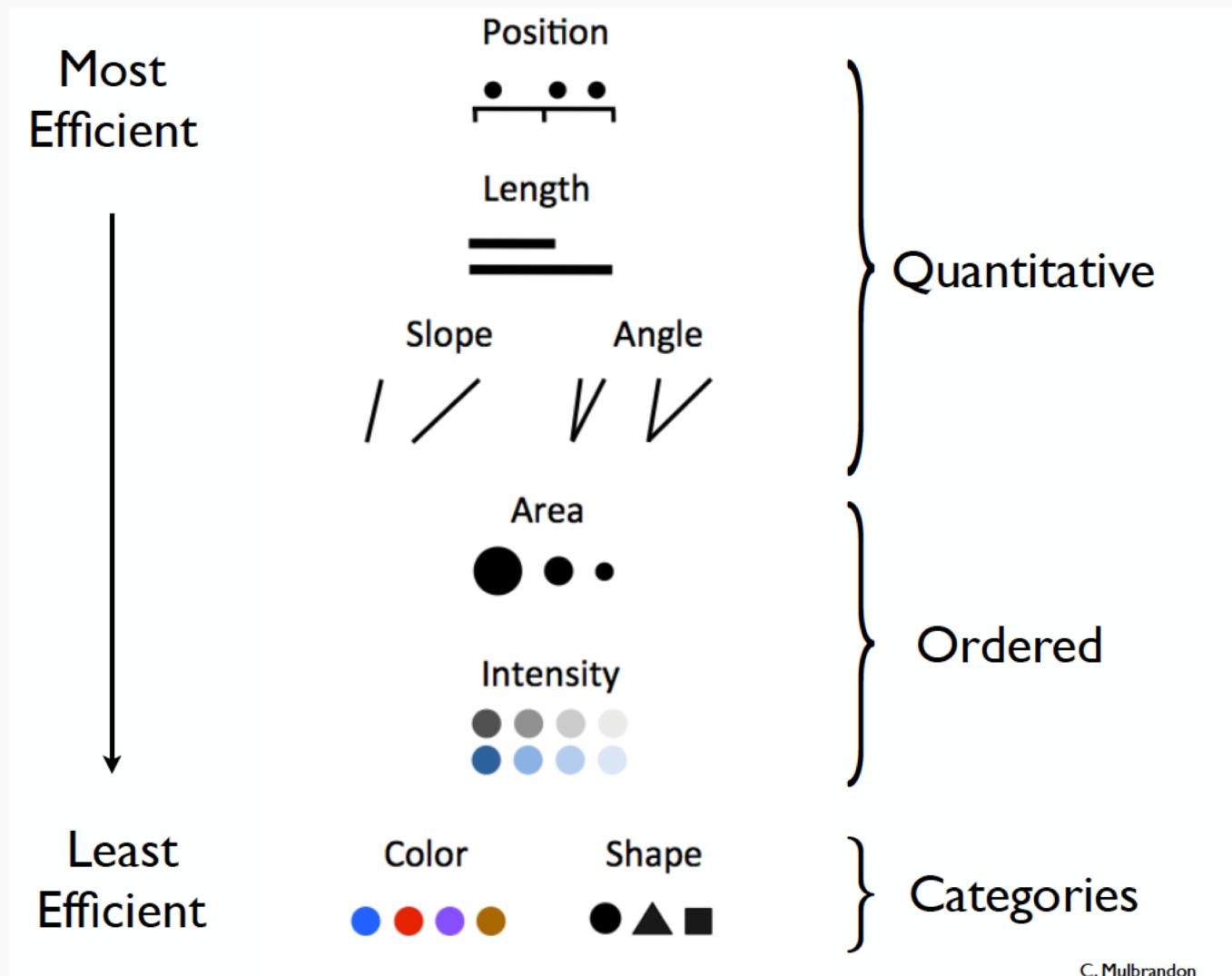
How much bigger value?



4x

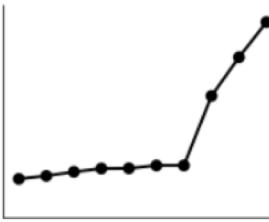


# Displays: perceptual effectiveness

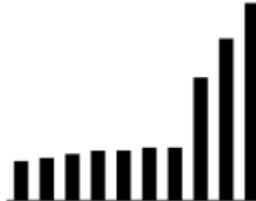


# Displays: perceptual effectiveness

## Most Effective



Position  
● ● ●



Length  
— —

[VisualizingEconomics.com](http://VisualizingEconomics.com)

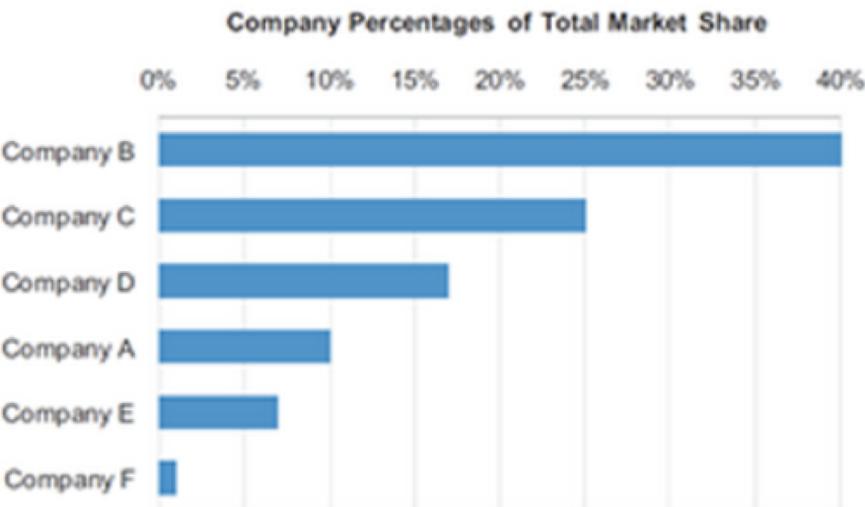
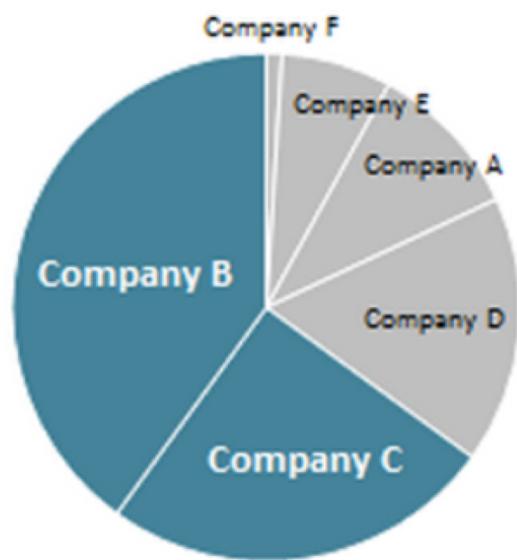
# Displays: perceptual effectiveness

## Less Effective



## Pie vs. Bar Charts

65% of the market is controlled by companies B and C



# Lecture Outline

---

- EDA Refresher
- Effective Visualization
  - Graphical Integrity
  - Scope
  - Displays
  - Sensible Design
- Communication
  - Motivation
  - Key Considerations

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## Colors for Categories

Do not use more than 5-8 colors at once



## Colors for Ordinal Data

Vary luminance and saturation

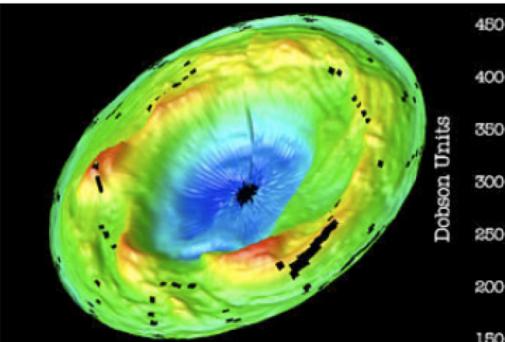


Zeilis et al, 2009, "Escaping RGBland: Selecting Colors for Statistical Graphics"

# Sensible Design: colors

## Colors for Quantitative Data

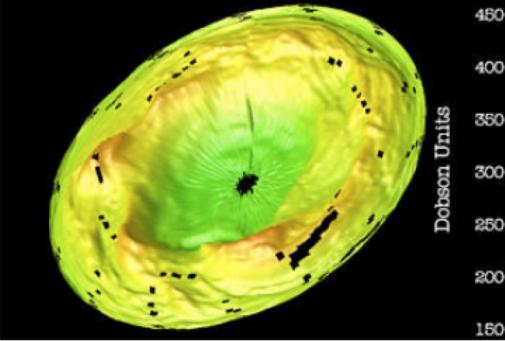
Hue  
(Rainbow)



Dobson Units

480
400
350
300
250
200
150

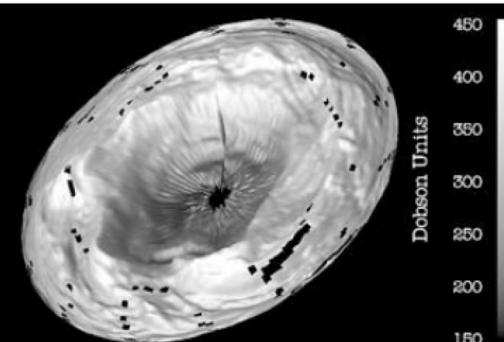
Luminance  
& Hue



Dobson Units

480
400
350
300
250
200
150

Luminance

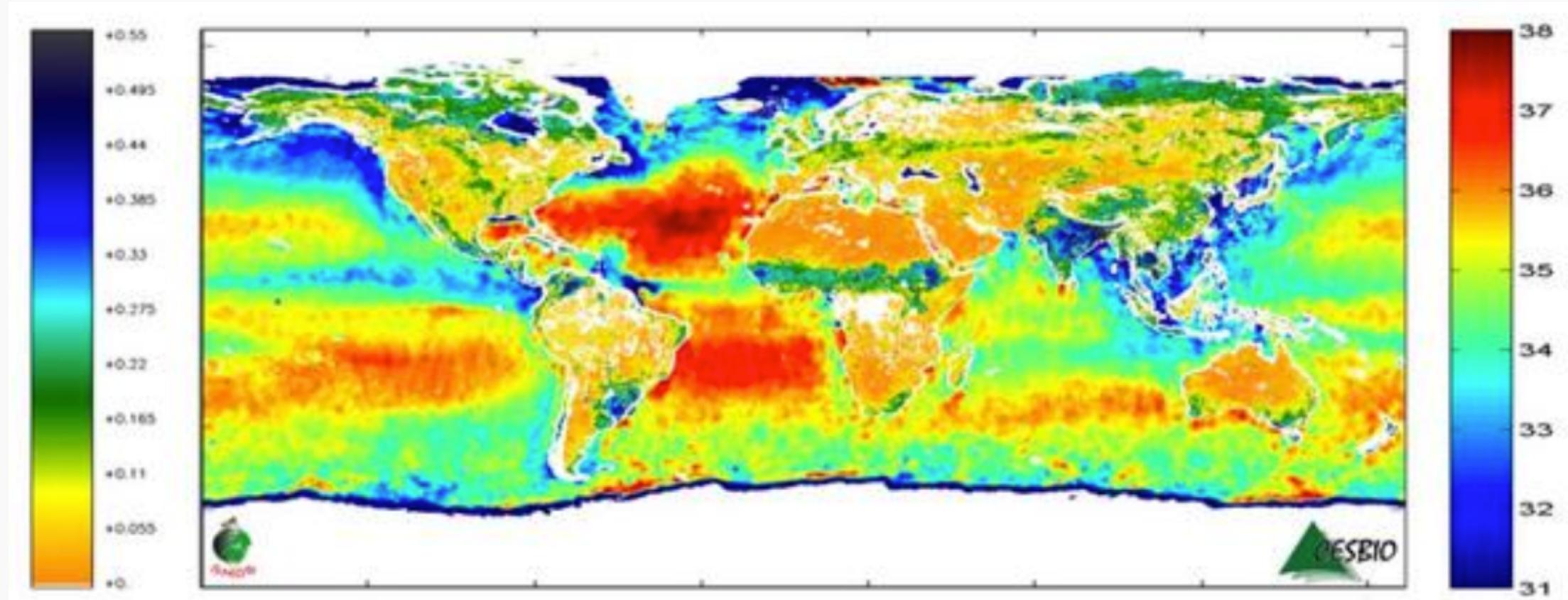


Dobson Units

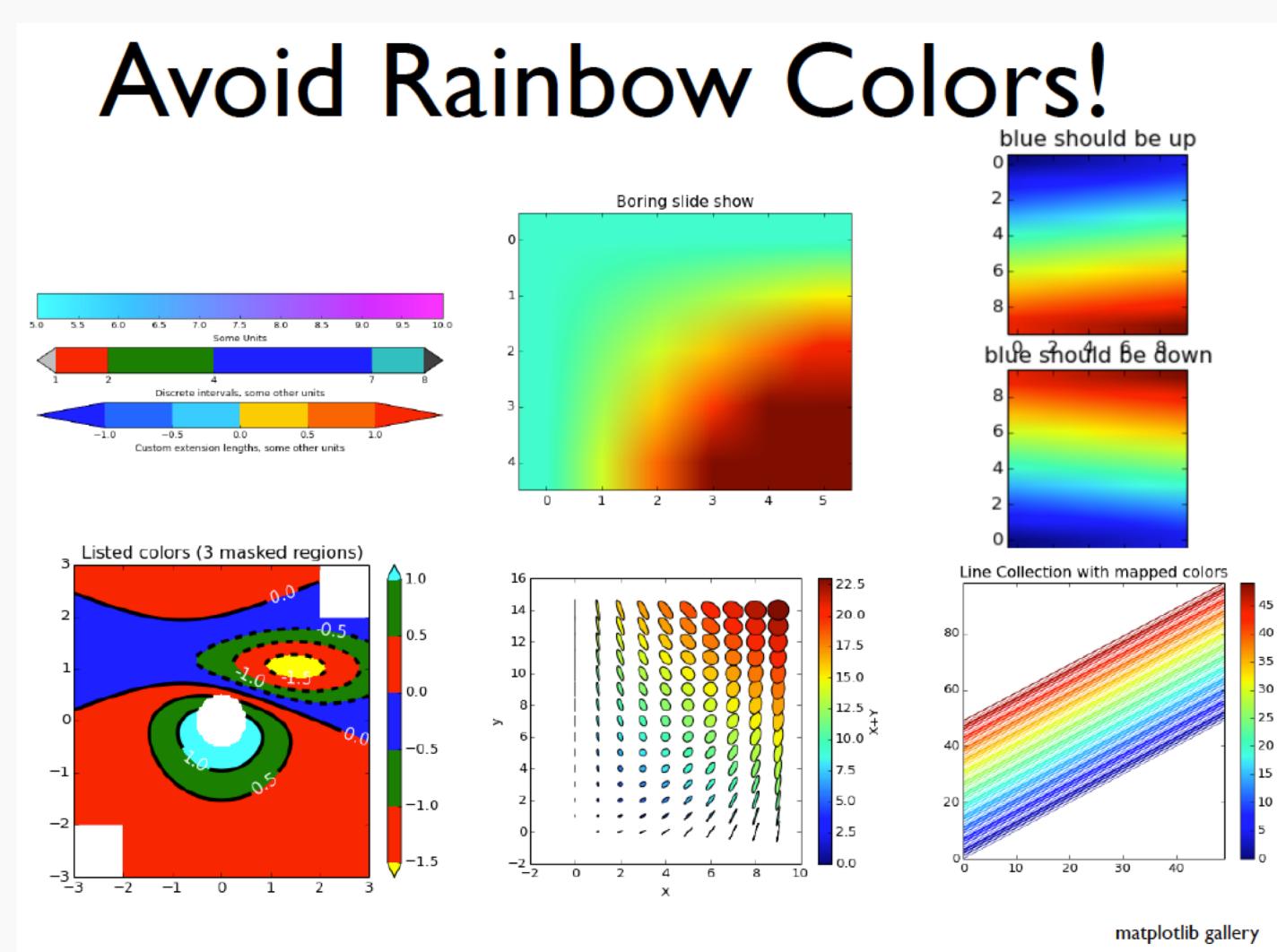
480
400
350
300
250
200
150

Rogowitz and Treinish, Why should engineers and  
scientists be worried about color?

# Sensible Design: colors



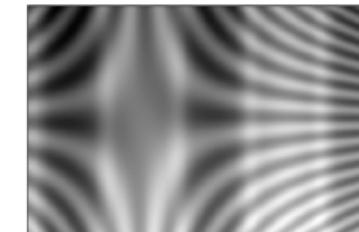
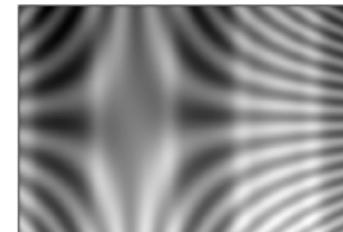
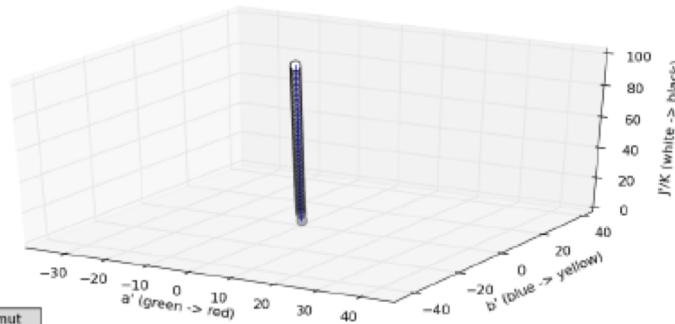
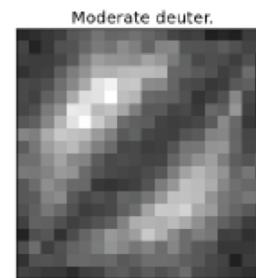
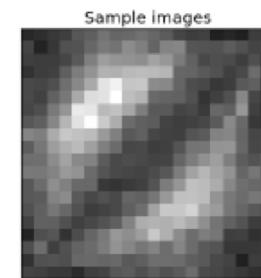
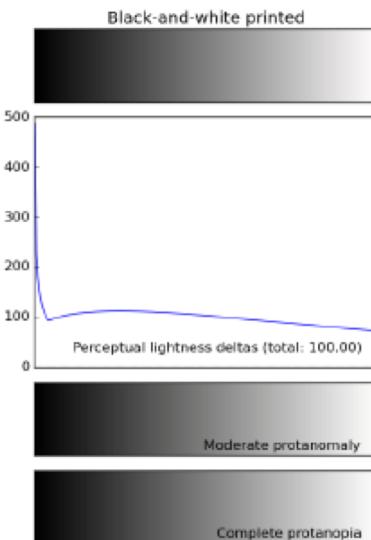
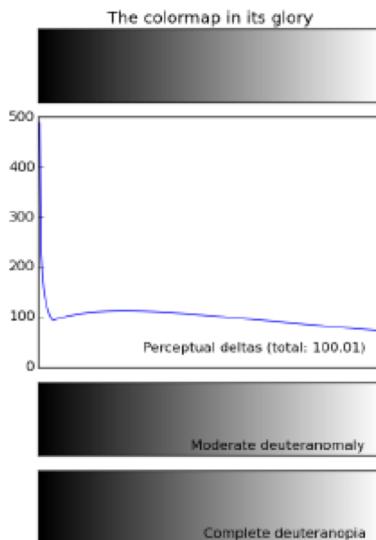
# Sensible Design: colors



# Sensible Design: colors

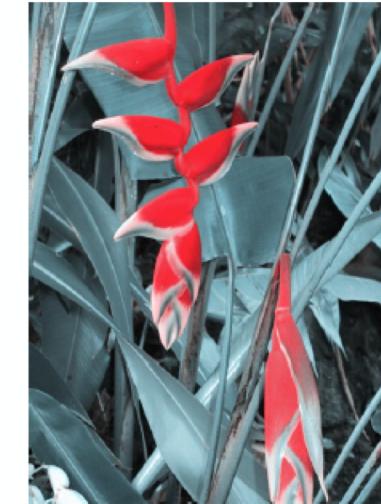
# Gray

### Colormap evaluation: gray



# Sensible Design: colors

## Color Blindness



Protanope

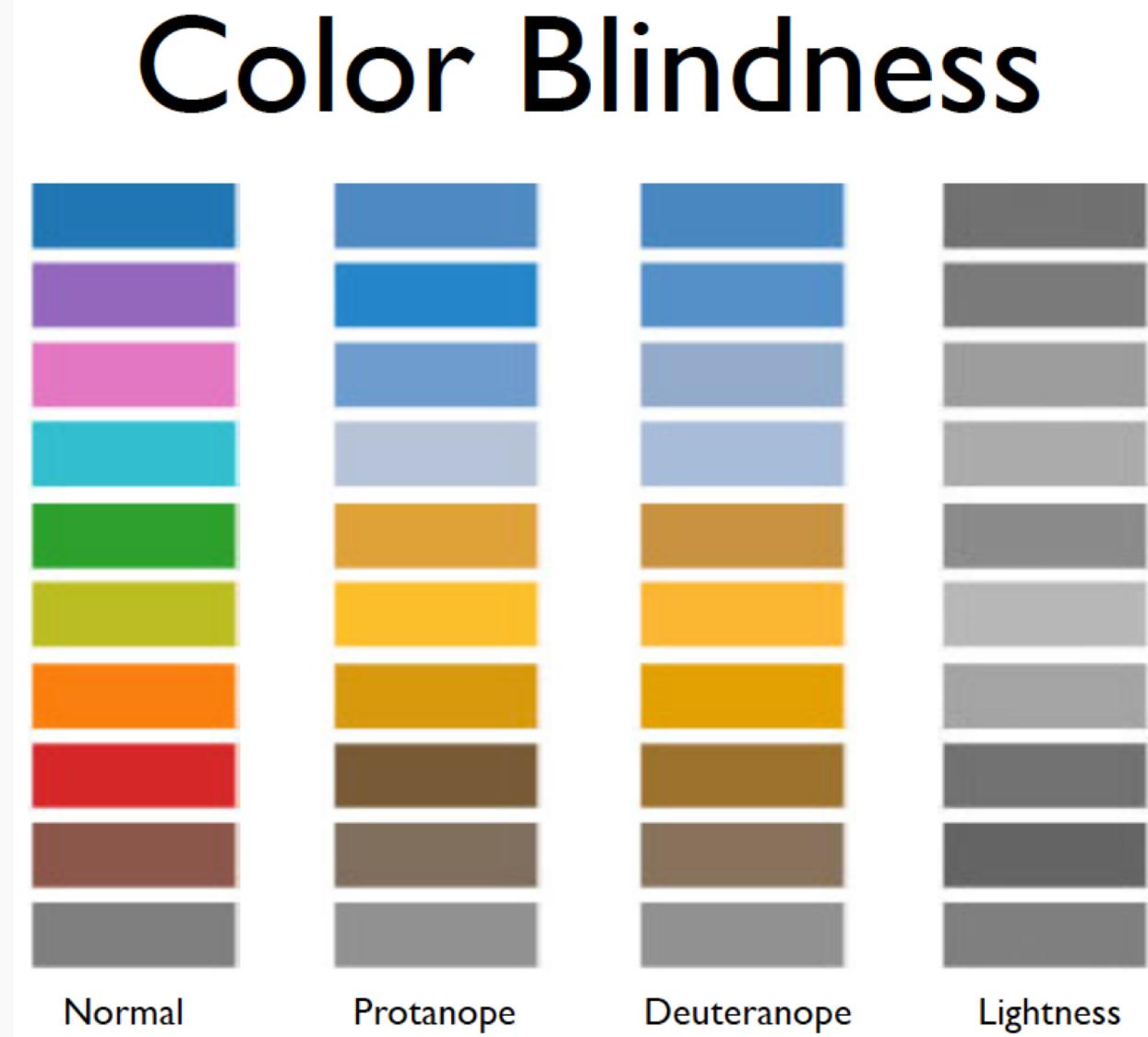
Deuteranope

Tritanope

Red / green  
deficiencies

Blue / Yellow  
deficiency

# Sensible Design: colors



# Sensible Design: colors

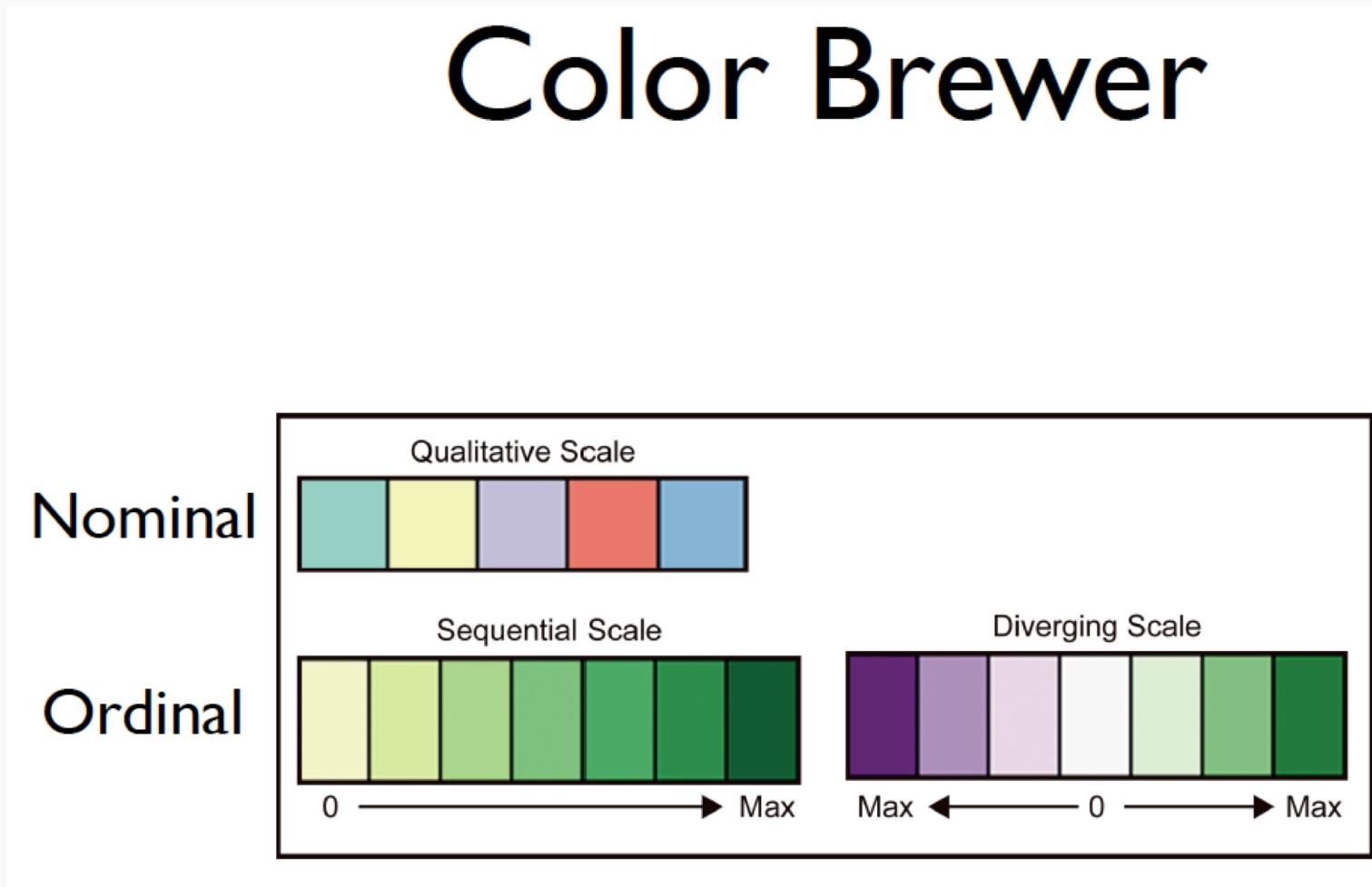
---

Great sites for selecting color schemes:

- <http://colorbrewer2.org>
- <https://coolors.co/>



# Sensible Design: colors

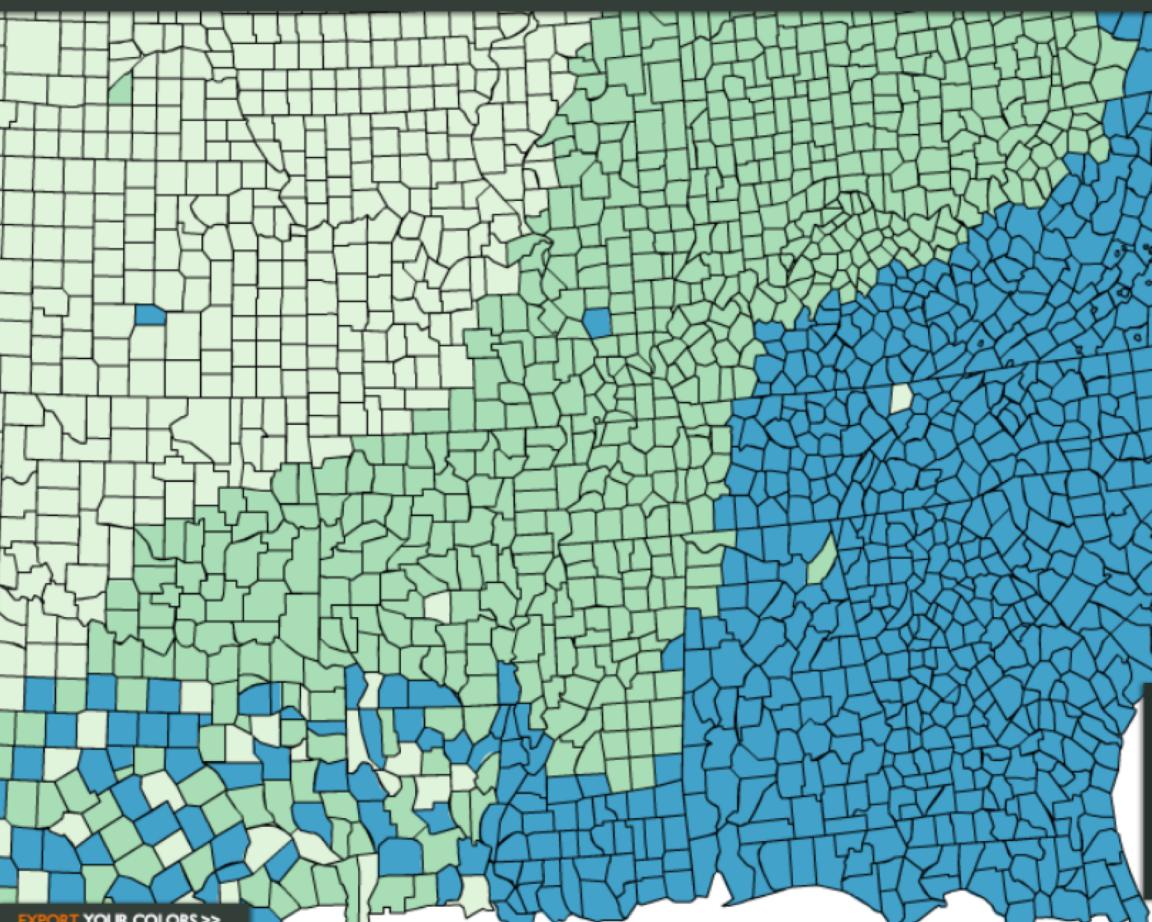


# Sensible Design: colors

number of data classes on your map  
3 [learn more >](#)

the nature of your data  
**sequential** [learn more >](#)

pick a color scheme: GnBu



(optional) only show schemes that are:

colorblind safe  print friendly  
 photocopyable [learn more >](#)

pick a color system

224, 243, 219	<input checked="" type="radio"/> RGB	<input type="radio"/> CMYK	<input type="radio"/> HEX
168, 221, 181			
67, 162, 202			

adjust map context

roads   
 cities   
 borders   
select a background

solid color   
 terrain 

[color transparency](#)

[EXPORT YOUR COLORS >>](#)

© Cynthia Brewer, Mark Harrower and The Pennsylvania State University  
[Support](#)  
[Back to ColorBrewer 1.0](#)

**COLORBREWER 2.0**  
color advice for cartography

axm

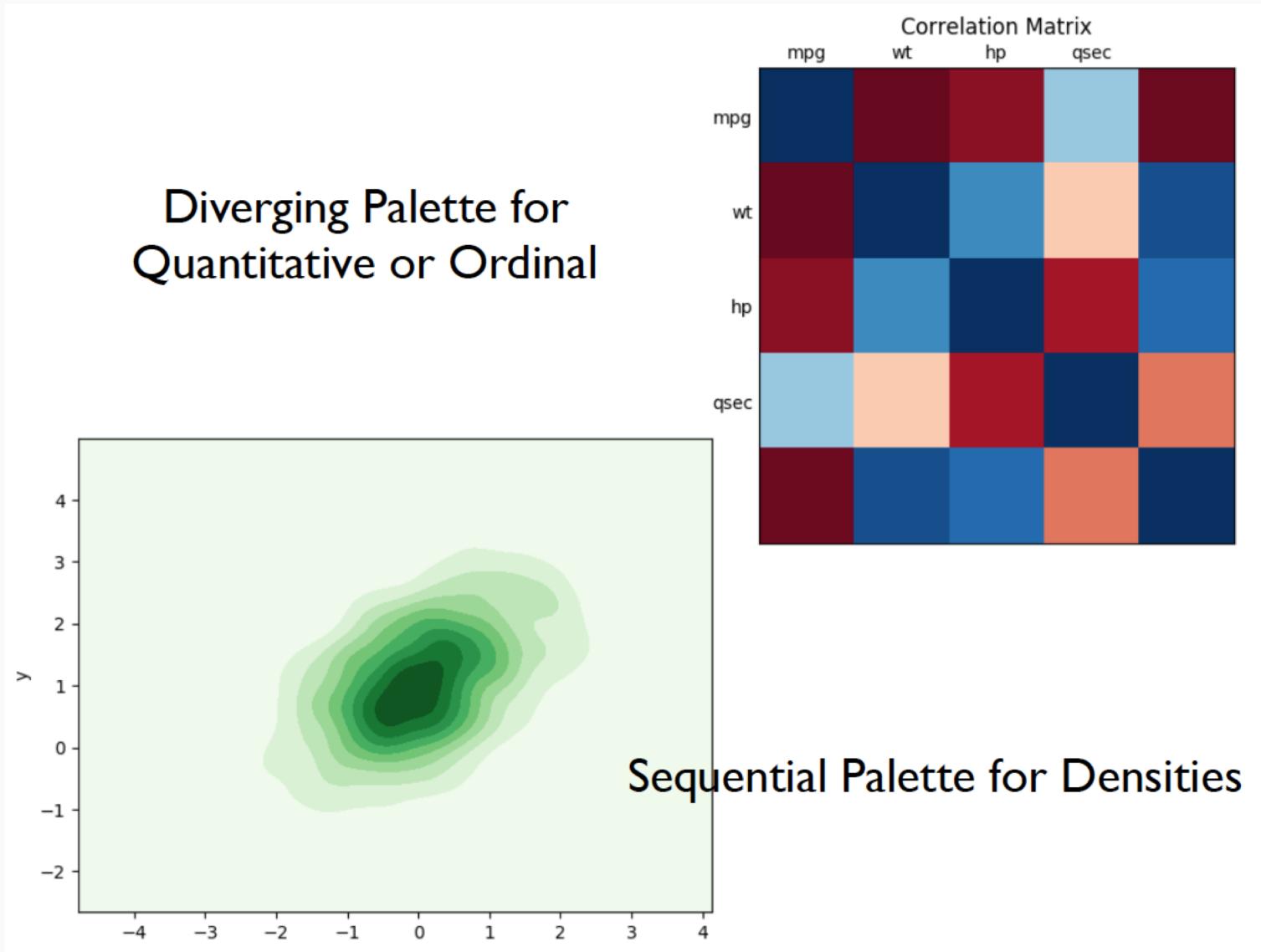


# Sensible Design: colors

The screenshot shows the COOLORS website interface. At the top, there is a navigation bar with the COOLORS logo, a Squarespace trial offer, and links for Generate, Explore, iOS App, Add-on, More, Login, and Sign Up. Below the navigation is a message: "Press the spacebar to generate color schemes!" followed by a series of five color swatches. Each swatch has a hex code and a name below it. To the right of the swatches is a "Vimeo" logo with the text "Before it's complete, it's confidential." and a "Learn more" link. Below the swatches are several icons: a grid, a double-headed arrow, a dashed line, and a lock. The bottom of the page features a footer with the IACS logo and the text "CS109A, PROTOPAPAS, RADER, TANNER".

Color Name	Hex Code
GAINSBORO	#EOE2DB
PASTEL GRAY	#D2D4C8
ASH GREY	#B8BDB5
ROMAN SILVER	#889696
NICKEL	#5F7470

# Sensible Design: colors



# Sensible Design: fonts

---

How much do you trust this text?

# Sensible Design: intuitive

---

The everyday items that are designed the best are the ones that we never have to think about how to use/interact with it.

Can you think of examples?

# Sensible Design

---

**Lesson: design matters**



# Lecture Outline

---

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## Analyze (Exploratory)

- Explore the data
- Assess a situation
- Determine how to proceed
- Decide what to do

## Communicate (Explanatory)

- Present data and ideas
- Explain and inform
- Provide evidence and support
- Influence and persuade

# The Persuasive Power of Data Visualization

Anshul Vikram Pandey

New York University

Anjali Manivannan

New York University

Oded Nov

New York University

Margaret L. Satterthwaite

NYU School of Law, satterth@exchange.law.nyu.edu

Enrico Bertini

New York University

After looking into common effects in attitude formation and change we searched for specific mentions to the graphical appearance of charts as a driver for persuasion. Some of the comments we collected seem to back up the findings we found in our results. Some participants explicitly mention the charts as being the main reason for their change: *"I already knew that increased incarceration didn't lower crime, but I wasn't sure of the statistics. To see it on the graphs is really eye opening."*; *"I was influenced by the bar graph showing the reasons why the survey respondents played video games."*; *"I would not know exact numbers on this issue - the graphs gave a visual and helped identify the numbers"*; *"Seeing the graphs conflicted with my previous opinion, so I feel like I need to reevaluate my stance in a way."*

It is also important to mention that the graphical appearance of charts is not the only factor that has a strong impact on people's attitude. In our collected feedback, we found numerous references to statistics and numbers, suggesting that mere exposure to data does have a persuasive effect – maybe at least partially due to the increased sense of objectivity evidence supported by numbers carries. We found comments like: *"It was concrete data that seemed compelling."*; *"Seeing numbers is a good indicator of change rather than just reading what someone has to say"*; *"It showed a large amount of different sources, which made it more credible"*. More research is needed to disentangle what kind of specific effects each of these components have on persuasion.

# Communicate

755



## Steroids or Not, the Pursuit Is On

Barry Bonds is taking aim at the career home run record. He needs only six more to tie Babe Ruth and 47 to equal Hank Aaron.

Lines are cumulative home runs

**Hank Aaron**  
755 homers  
23 seasons



**Babe Ruth**  
714 homers  
22 seasons



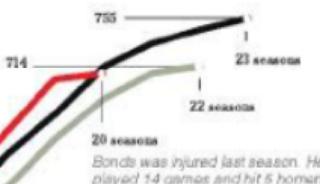
**Barry Bonds**  
708 homers  
20 seasons



**Bonds takes lead**  
Home runs after 16 seasons  
Bonds 567  
Aaron 554  
Ruth 516

400  
14th season

According to allegations in a book about Bonds, he began taking steroids before the 1999 season, his 14th in the league. Two seasons later, he hit 73 home runs, surpassing Aaron's career pace.



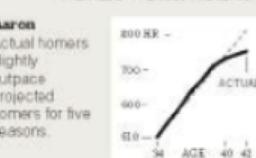
Bonds was injured last season. He played 14 games and hit 5 home runs

## Homer Pace After Age 34

If the accusations are correct, Bonds was 34 in his first season on steroids. Here are projected home run paces for each player after age 34.

PROJECTED PACE BASED ON AVERAGE OF PREVIOUS FIVE SEASONS

**Aaron**  
Actual homers slightly outpace projected homers for five seasons.



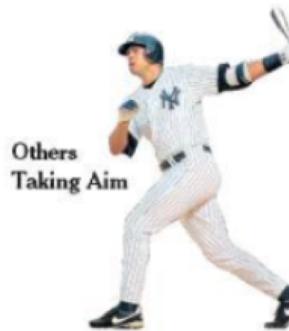
**Ruth**  
Averaged 46.4 homers a season from age 30 to 34. Averaged 42.5 for next four seasons.



**Bonds**  
From age 35 to 39, he averaged 14 more homers a season than projected.



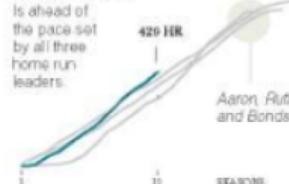
Note: Ages as of July 1 of each season.



## Others Taking Aim

**Alex Rodriguez**

Is ahead of the pace set by all three home run leaders.



Aaron, Ruth and Bonds

**Albert Pujols**

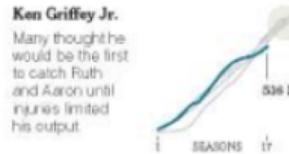
Averaging 40 homers a season, he has started stronger than the three leaders did.



201 HR

**Ken Griffey Jr.**

Many thought he would be the first to catch Ruth and Aaron until injuries limited his output.



536 HR

## Differing Paths to the Top of the Charts

The top seven players on the career home run list, along with a look at Griffey (12th), Rodriguez (37th) and Pujols (tied 257th).

Hank Aaron  
755



15 times hit 30 or more (M.L. most).

Babe Ruth  
714



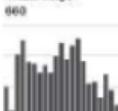
Hit only 20 over first five seasons.

Barry Bonds  
708



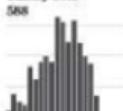
Averaged 52 from 2000 to 2004.

Willie Mays  
669



No one hit more from 1950-69.

Sammy Sosa  
588



Three 60-homer seasons is record.

Frank Robinson  
586



Triple Crown in '66 (49, 122, 316).

Mark McGwire  
583



First to hit 70 in a season.

Ken Griffey Jr.  
536



Only McGwire had more in the 90's.

Alex Rodriguez  
429



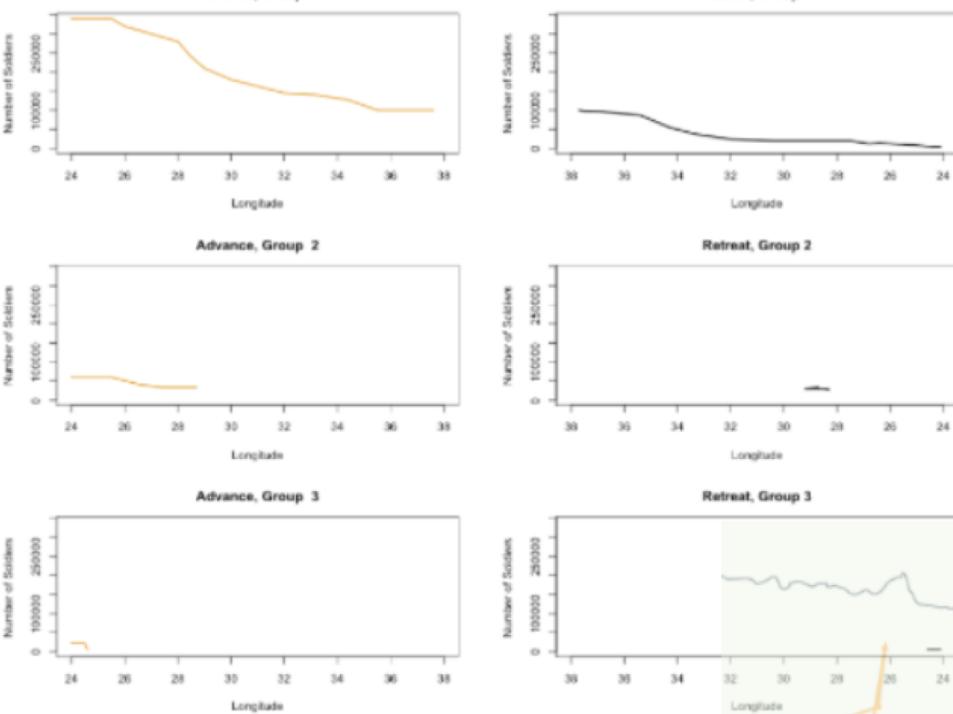
Youngest to reach 400 homers.

Albert Pujols  
201



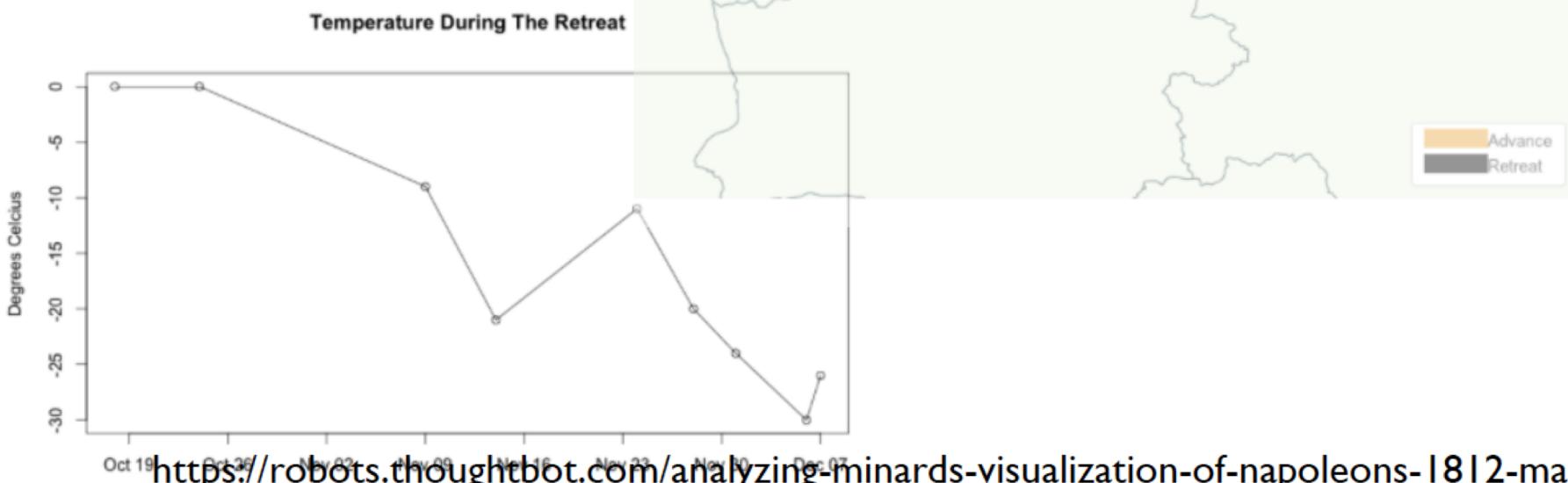
Scored most ever in first year.





# Napoleon's March to Russia

Next, the temperature experienced by his troops when winter settled in on the return trip.



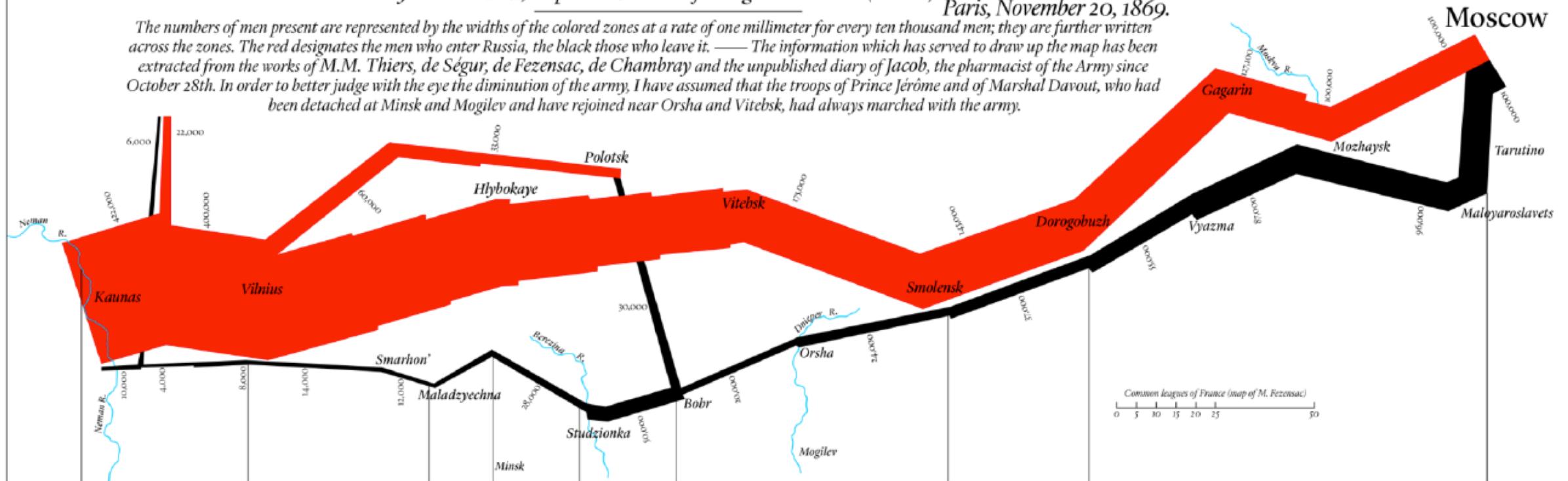
# Minard's Graphic on Napoleon's Russia Campaign

*Figurative Map of the successive losses in men of the French Army in the Russian campaign 1812 ~ 1813*

Drawn by M. Minard, Inspector General of Bridges and Roads (retired).

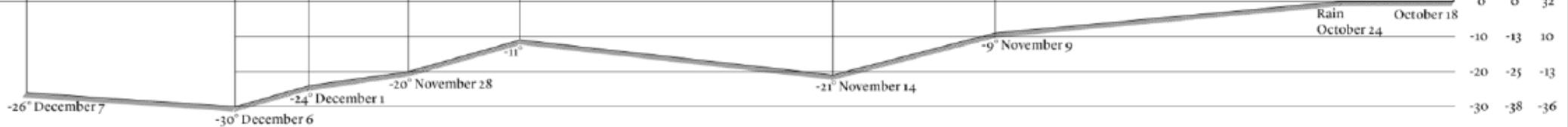
Paris, November 20, 1869.

The numbers of men present are represented by the widths of the colored zones at a rate of one millimeter for every ten thousand men; they are further written across the zones. The red designates the men who enter Russia, the black those who leave it. — The information which has served to draw up the map has been extracted from the works of M.M. Thiers, de Ségrur, de Fezensac, de Chambray and the unpublished diary of Jacob, the pharmacist of the Army since October 28th. In order to better judge with the eye the diminution of the army, I have assumed that the troops of Prince Jérôme and of Marshal Davout, who had been detached at Minsk and Mogilev and have rejoined near Orsha and Vitebsk, had always marched with the army.



GRAPHIC TABLE of the temperature in degrees below zero of the Réaumur thermometer.

The Cossacks pass the frozen Neman at a gallop.



# Lecture Outline

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- EDA Refresher
- Effective Visualization
  - Graphical Integrity
  - Scope
  - Displays
  - Sensible Design
- Communication
  - Motivation
  - Key Considerations

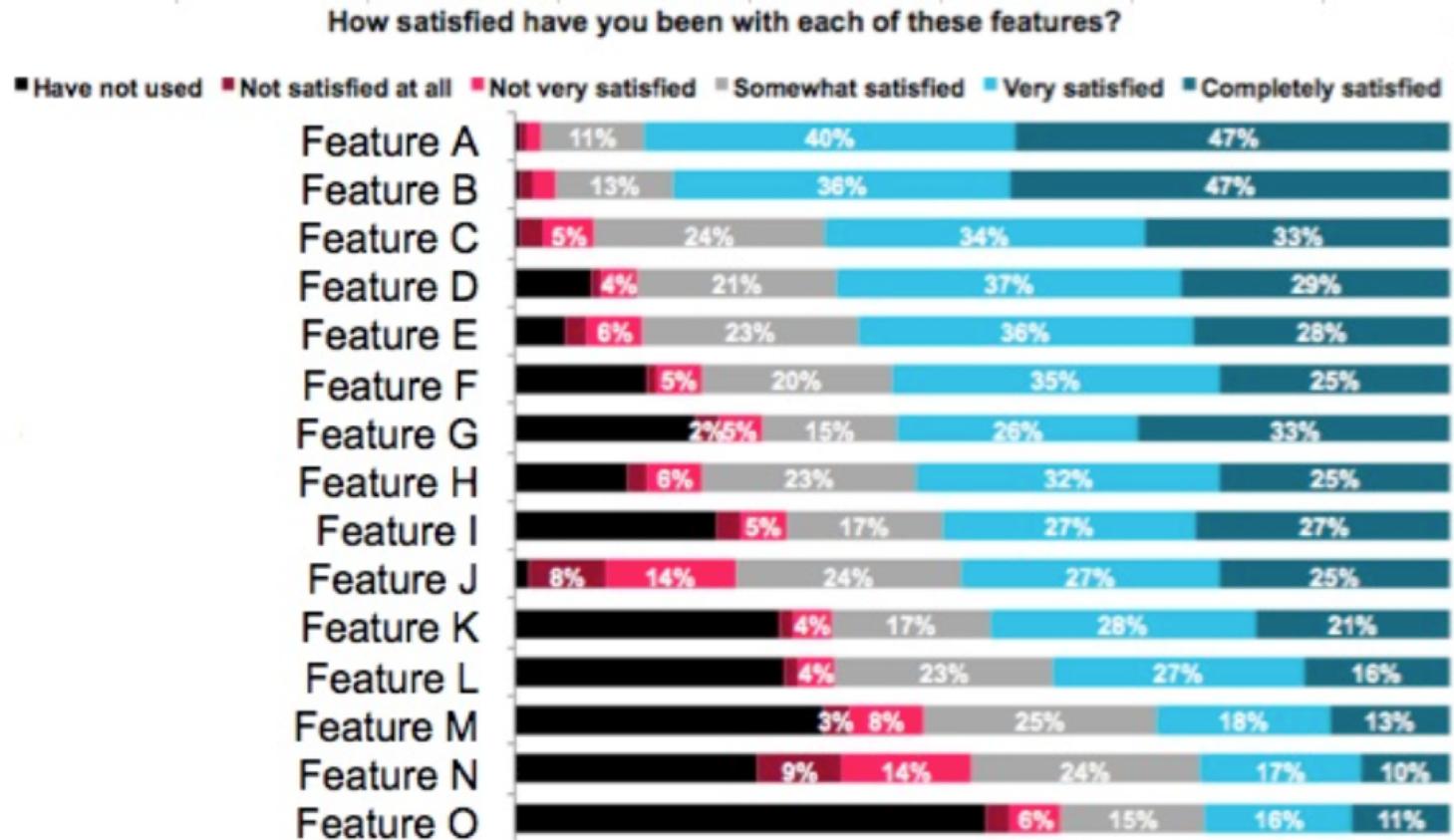
## Key Considerations

- Who is your **audience**
- What questions are you answering?
- Why should the audience care?
- What are your major insights and surprises?
- What change do you want to affect?

# Don't Make Them Think!

- Your audience does not want to spend cognitive effort on things you know and can just show them
- Lead them through the major steps of your story
- Point out interesting key facts and insights using captions and annotations

## Don't Bury the Lead



# Communication

## User satisfaction varies greatly by feature

### Product X User Satisfaction: Features

\* Completely satisfied \* Very satisfied \* Somewhat satisfied \* Not very satisfied \* Not satisfied at all \* Have not used

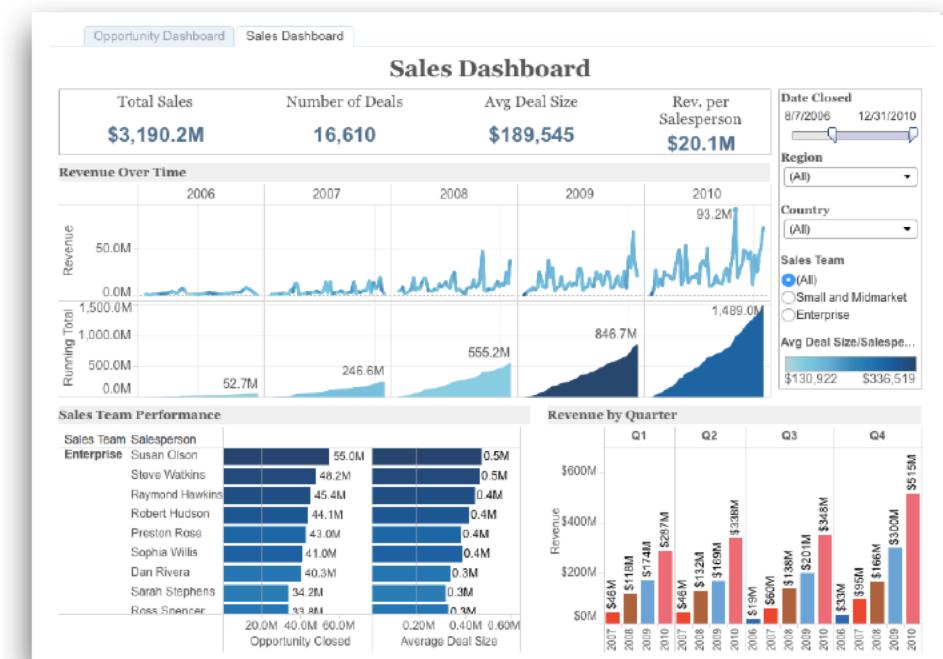


Feature O is least-used feature; what steps can we proactively take with existing users to increase use?

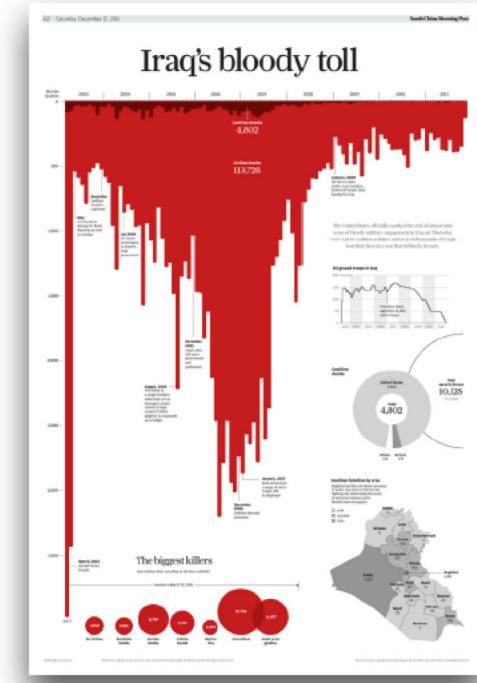
# Communication

# What is the message?

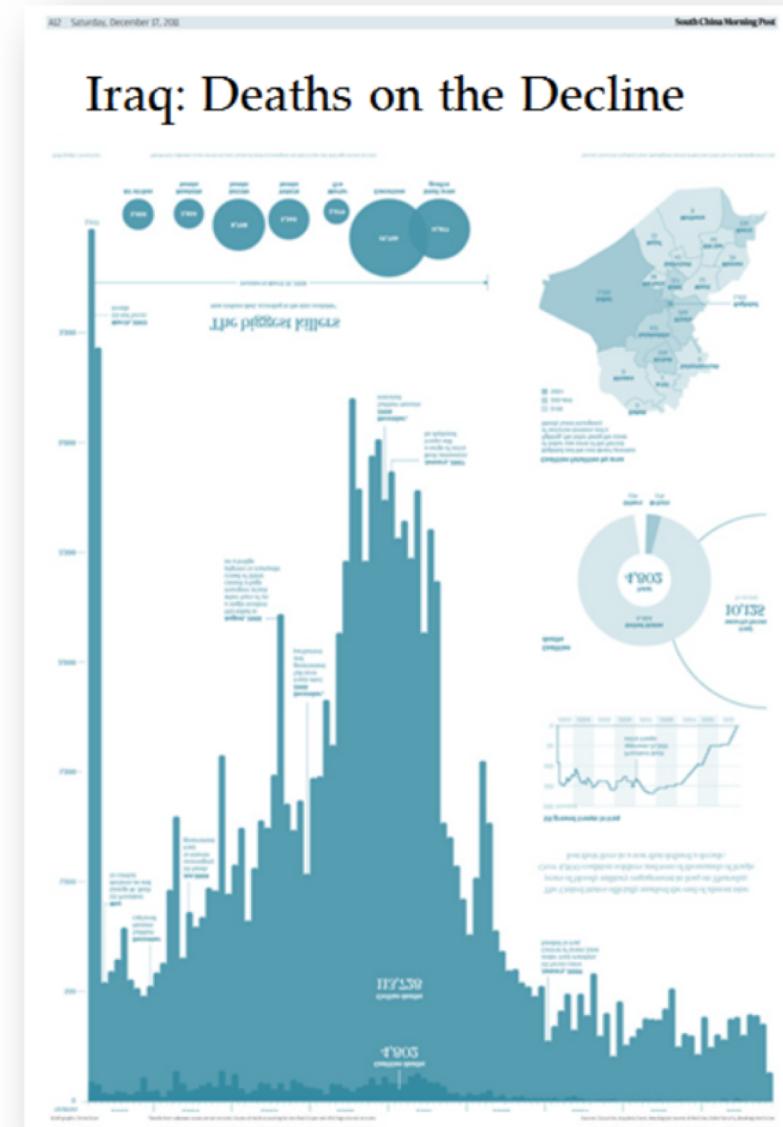
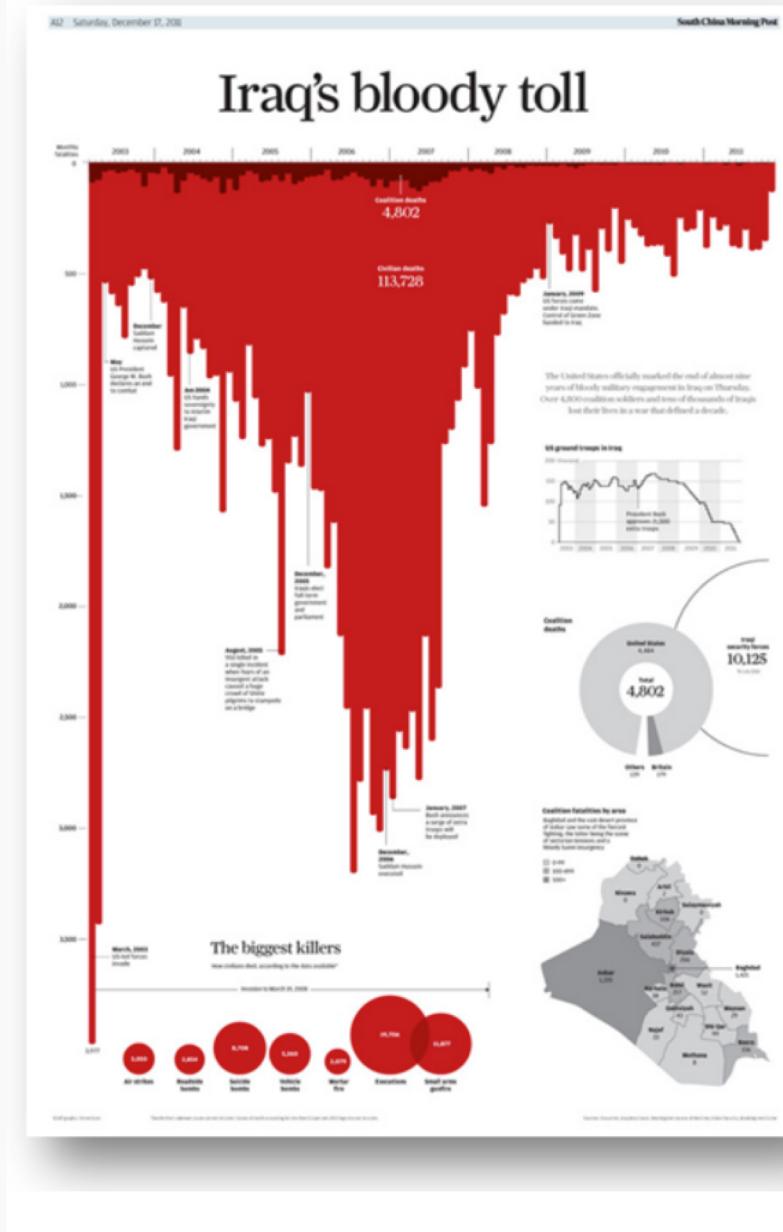
# Exploratory Neutral



# Explanatory Opinionated



# Communication



Andy Cotgreave, Tableau

## Final Takeaways

- How you choose to display your data greatly influences how people interpret the data
- Humans are visual, *emotional* creations; make graphs that don't make others feel confused, insulted, etc
- Your graphs should illicit good feelings and effectively convey your narrative