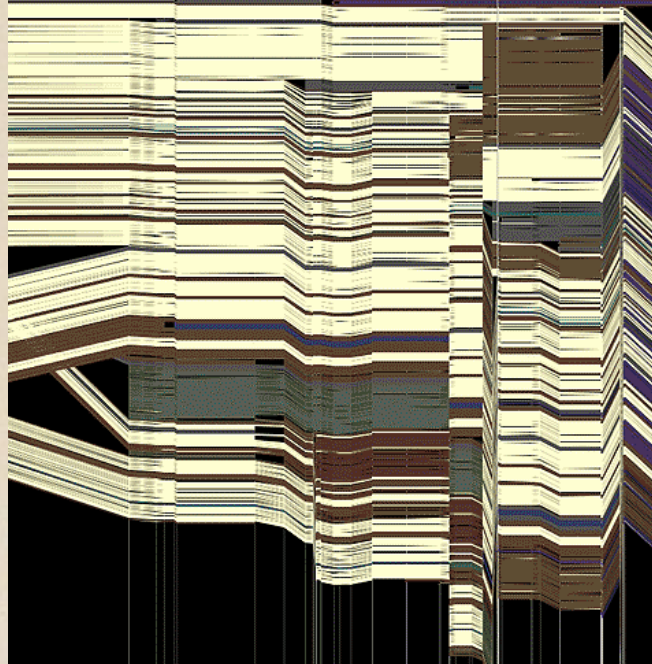
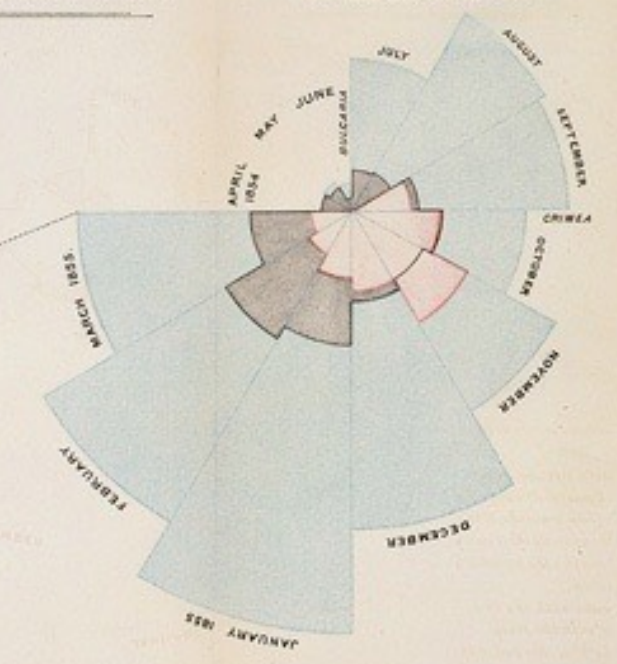


CSE 442 - Data Visualization

# The Value of Visualization

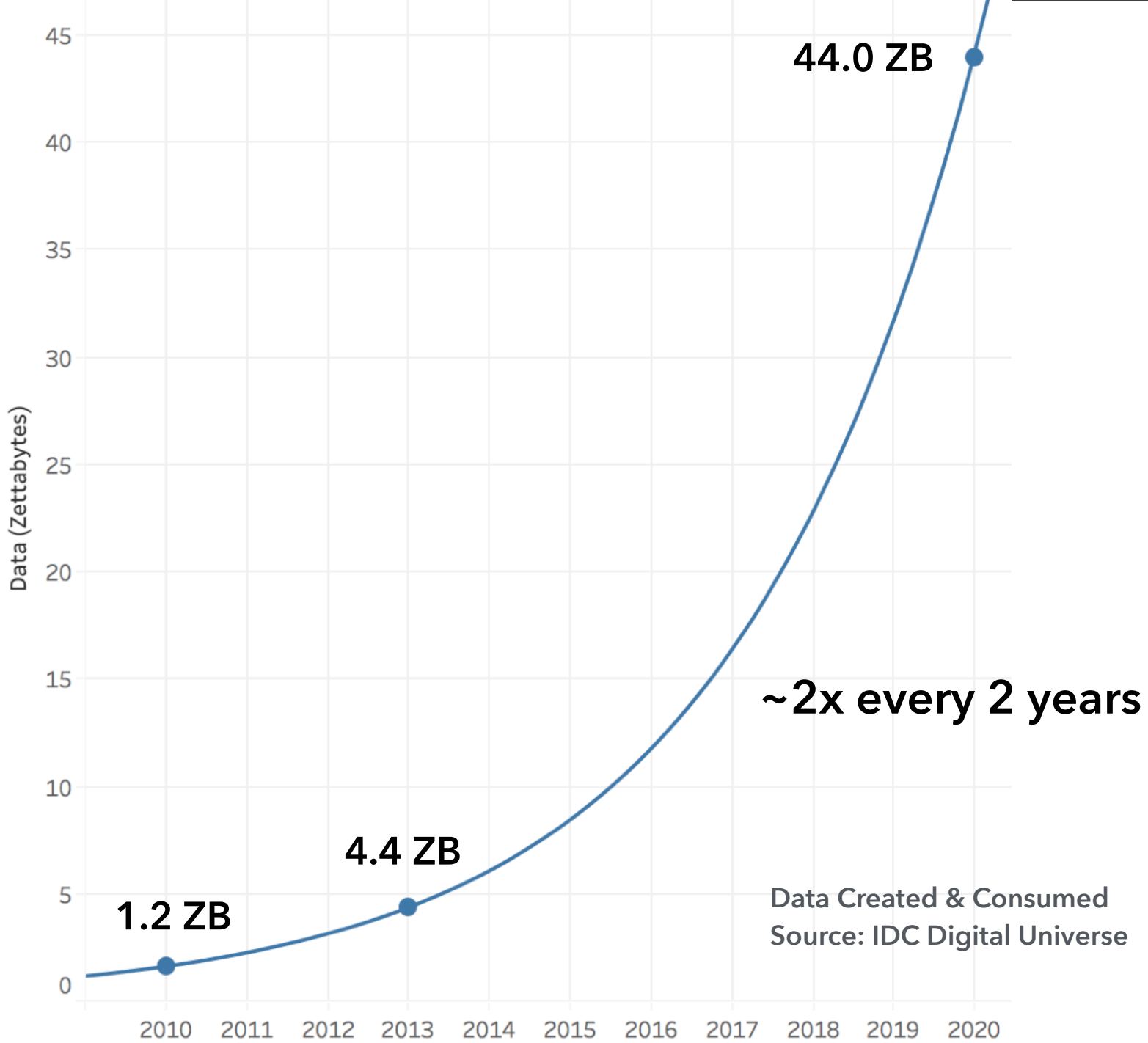


Jeffrey Heer University of Washington

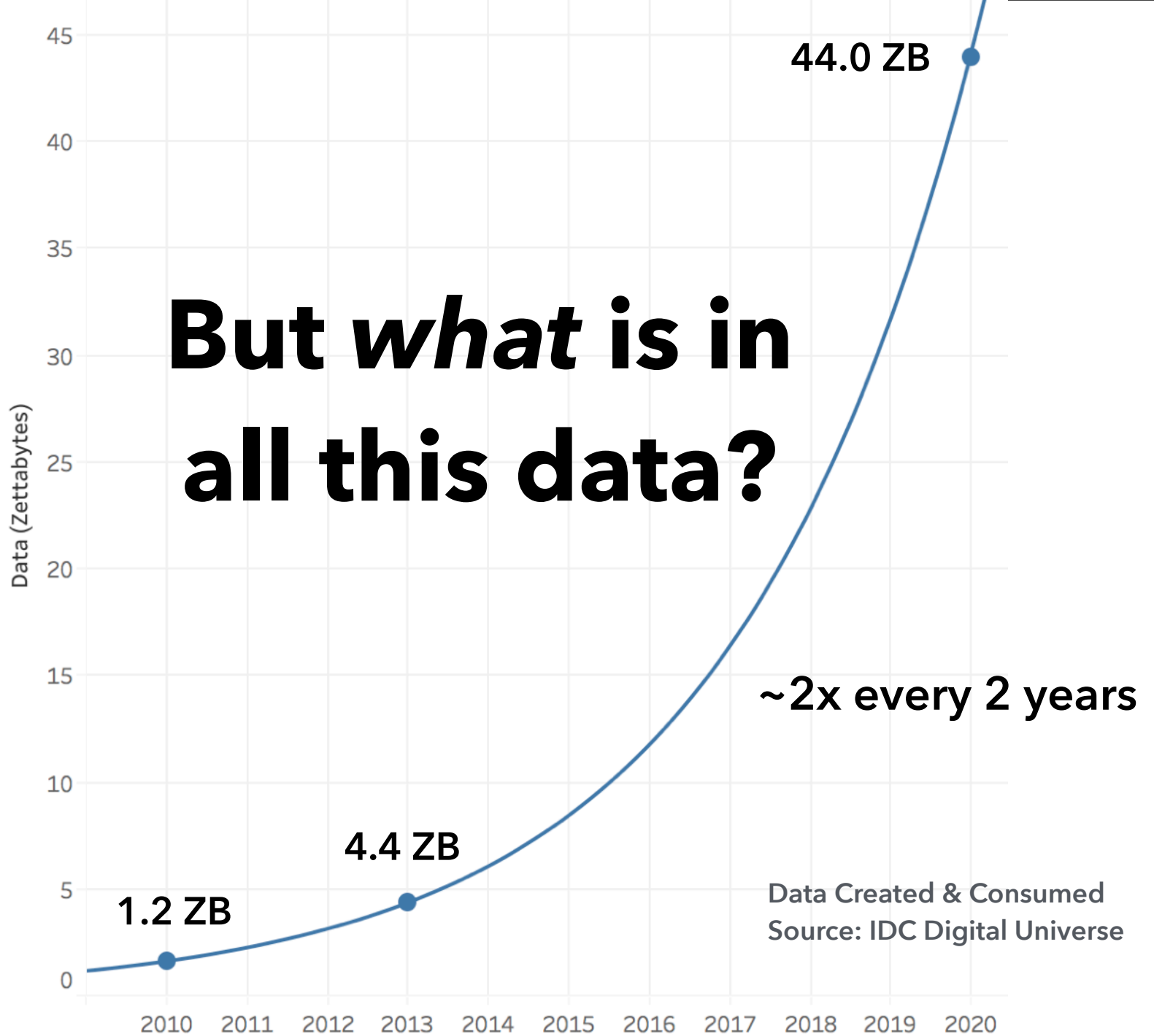
**How much data (bytes)  
did we produce in 2010?**

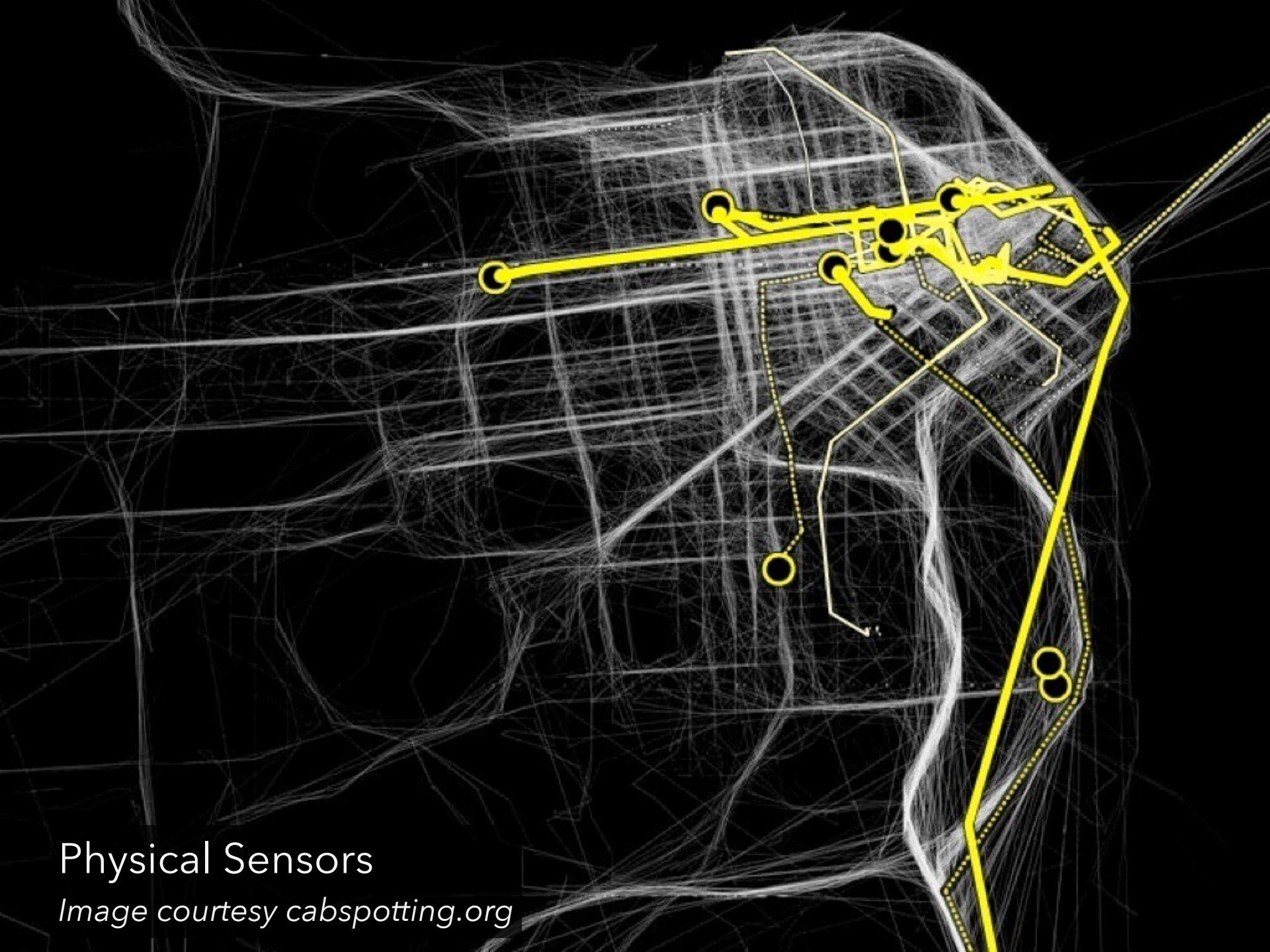
**2010: 1,200 exabytes**  
and exponential growth...

Gantz et al., 2008, 2010



# But *what* is in all this data?





# Physical Sensors

*Image courtesy cabspotting.org*



157

HR/ECG  
1/min

130/65

Art  
mmHg sys/dia

93

SpO2  
%

RR/CO2  
1/min

97

HR/ECG  
1/min

82/60

Art  
mmHg sys/dia

99

SpO2  
%

RR/CO2  
1/min

79

HR/ECG  
1/min

152/79

Art  
mmHg sys/dia

95

SpO2  
%

RR/CO2  
1/min

64

HR/ECG  
1/min

93/55

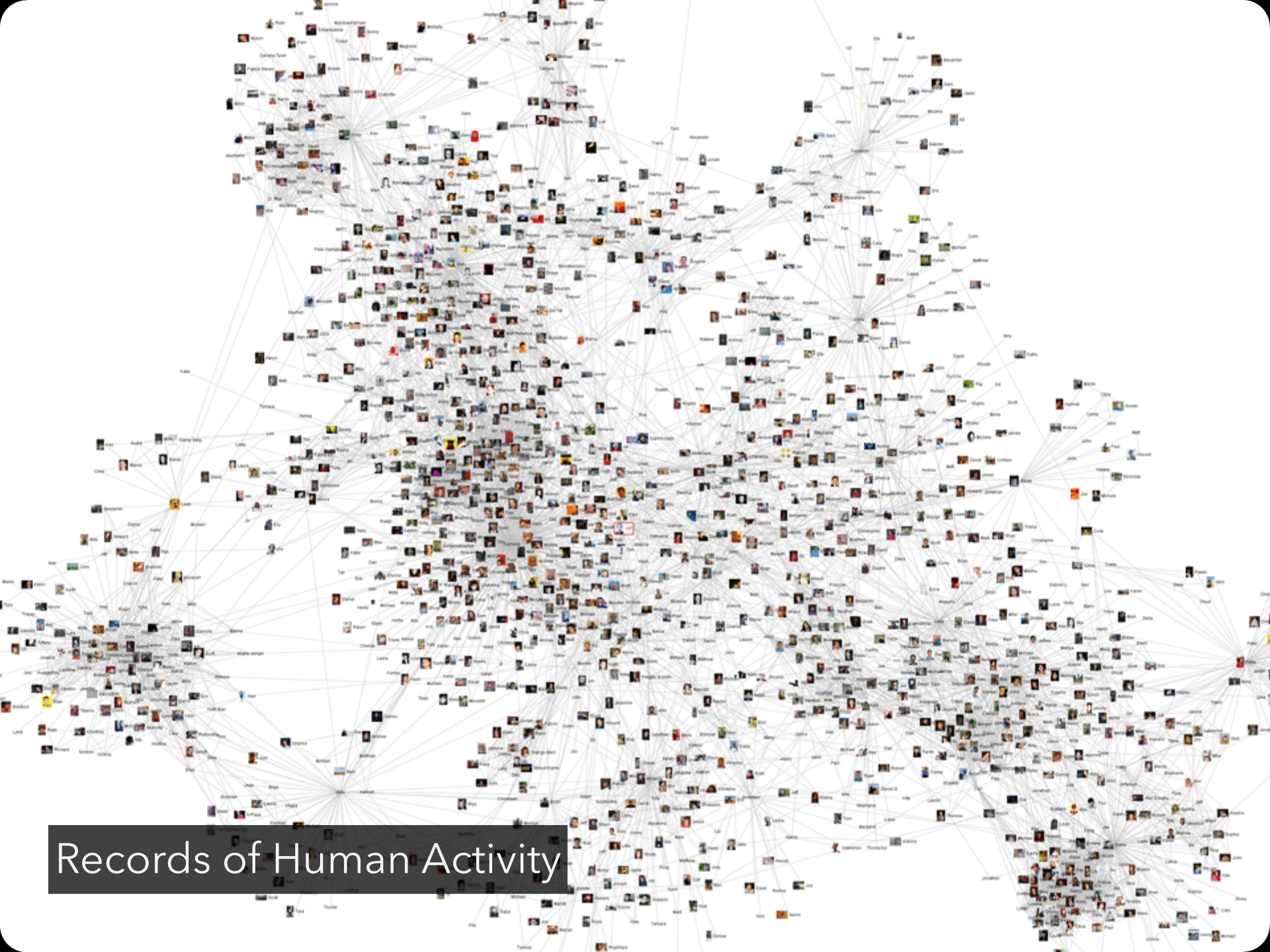
mmHg sys/dia

99

SpO2  
%

RR/Imp  
1/min

Health & Medicine



Records of Human Activity



The ability to take data—to be able to **understand** it, to **process** it, to **extract value** from it, to **visualize** it, to **communicate** it—that's going to be a hugely important skill in the next decades, ... because now we really do have **essentially free and ubiquitous data**. So the complimentary scarce factor is the ability to understand that data and extract value from it.

Hal Varian, Google's Chief Economist  
*The McKinsey Quarterly*, Jan 2009

## But wait!

The ability to take data—to be able to **understand** it, to **process** it, to **extract value** from it, to **visualize** it, to **communicate** it—that's going to be a hugely important skill in the next decade **"free" to whom?** because now we really do have **essentially free and ubiquitous data**. So the complimentary scarce factor is **"ubiquitous" about whom?** and extract value from it. **...to whose benefit?**

Hal Varian, Google's Chief Economist  
*The McKinsey Quarterly*, Jan 2009



Life-size cutouts of Facebook CEO Mark Zuckerberg are displayed by a progressive advocacy group on the lawn of the U.S. Capitol on Tuesday.

Carolyn Kaster / Reuters

## My Facebook Was Breached by Cambridge Analytica. Was Yours?

How to find out if you are one of the 87 million victims

ROBINSON MEYER | APR 10, 2018 | TECHNOLOGY

[Share](#) [Tweet](#) [...](#)

TEXT SIZE

- +



## Psychology's Replication Crisis Can't Be Wished Away

It has a real and heartbreaking cost.

ED YONG | MAR 4, 2016 | SCIENCE

[Share](#) [Tweet](#) [...](#)

TEXT SIZE

- +

High potential for data abuse...

How might we use **visualization**  
to **empower understanding** of  
data and analysis processes?

# What is Visualization?

“Transformation of the symbolic into the geometric”

[McCormick et al. 1987]

“... finding the artificial memory that best supports our natural means of perception.” [Bertin 1967]

“The use of computer-generated, interactive, visual representations of data to amplify cognition.”

[Card, Mackinlay, & Shneiderman 1999]

## Set A

X	Y
10	8.04
8	6.95
13	7.58
9	8.81
11	8.33
14	9.96
6	7.24
4	4.26
12	10.84
7	4.82
5	5.68

## Set B

X	Y
10	9.14
8	8.14
13	8.74
9	8.77
11	9.26
14	8.1
6	6.13
4	3.1
12	9.11
7	7.26
5	4.74

## Set C

X	Y
10	7.46
8	6.77
13	12.74
9	7.11
11	7.81
14	8.84
6	6.08
4	5.39
12	8.15
7	6.42
5	5.73

## Set D

X	Y
8	6.58
8	5.76
8	7.71
8	8.84
8	8.47
8	7.04
8	5.25
19	12.5
8	5.56
8	7.91
8	6.89

**Summary Statistics**

$$u_X = 9.0 \quad \sigma_X = 3.317$$

$$u_Y = 7.5 \quad \sigma_Y = 2.03$$

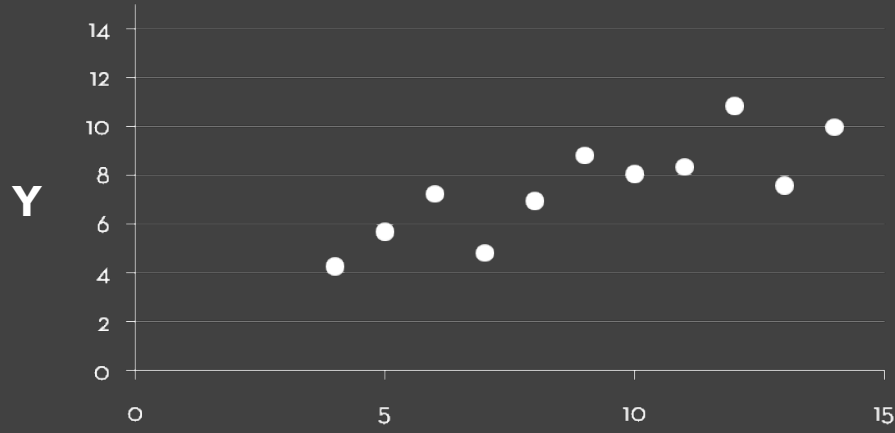
**Linear Regression**

$$Y = 3 + 0.5 X$$

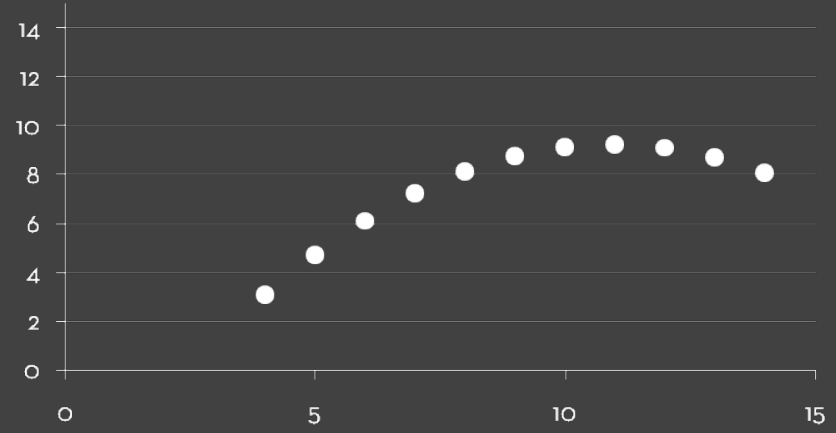
$$R^2 = 0.67$$

[Anscombe 1973]

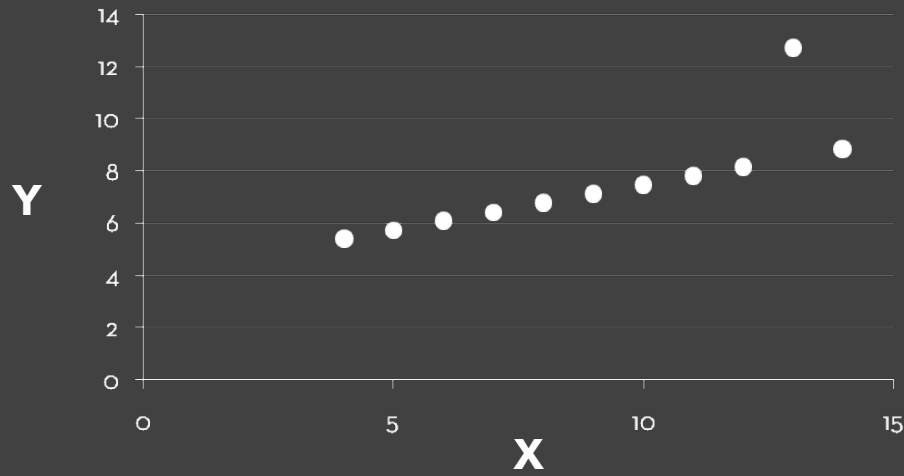
### Set A



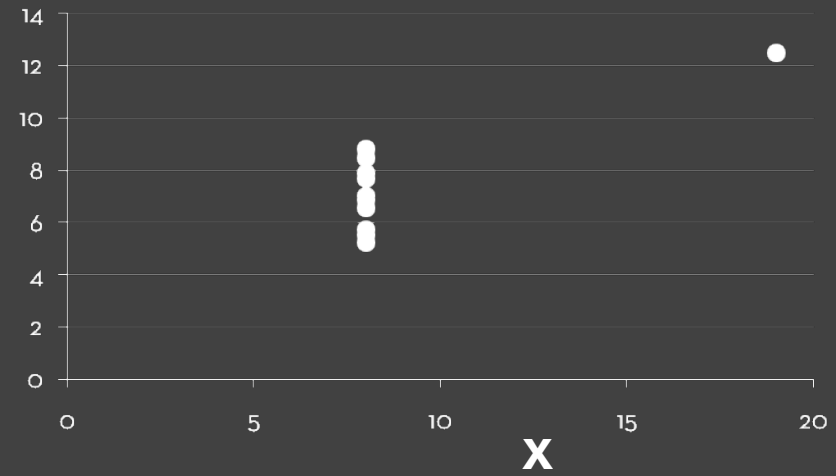
### Set B



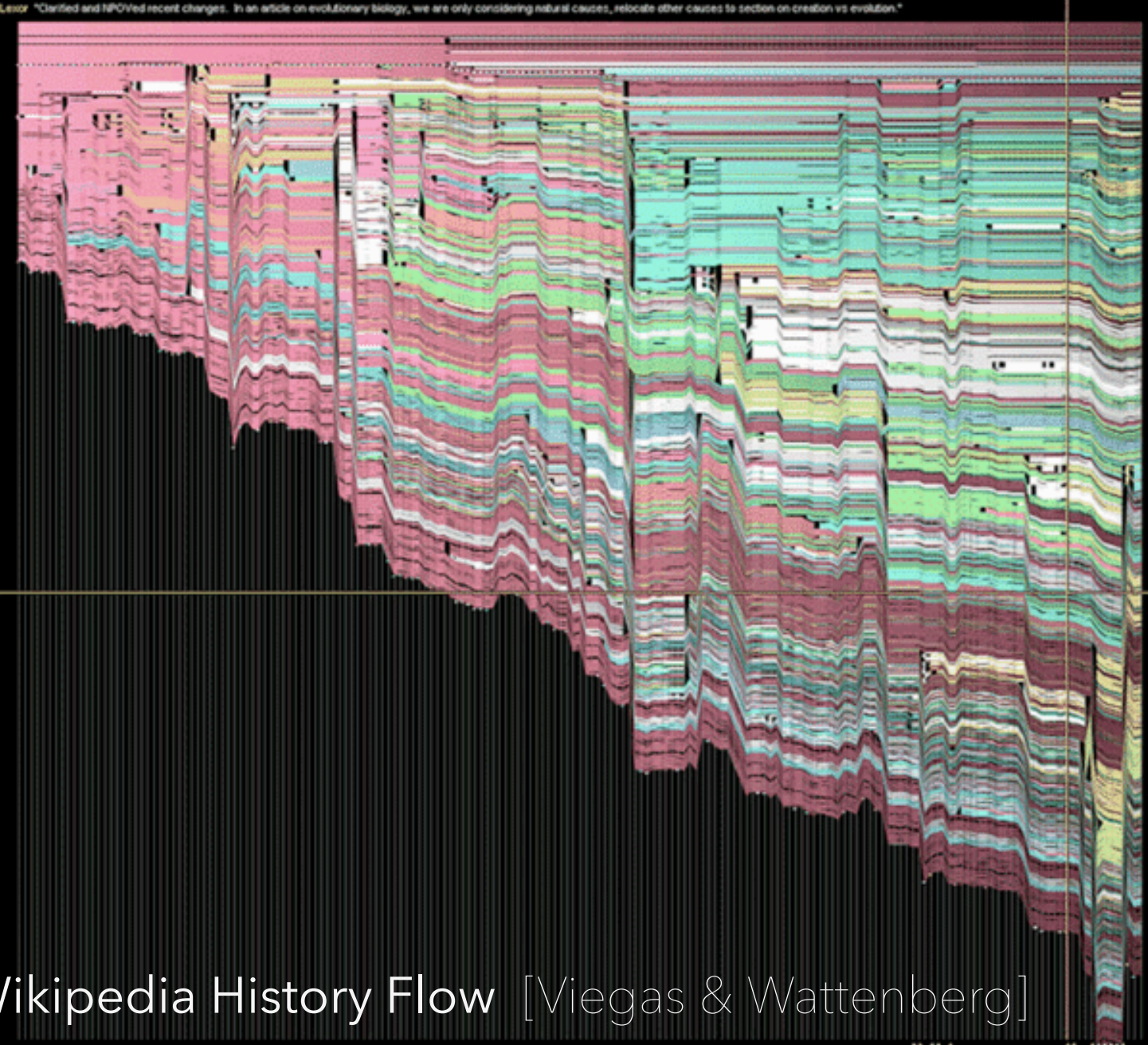
### Set C



### Set D



authors	posts
Doverill	3
Hannes Herzl	3
Ed Poor	4
Taw	2
Suzanne Elzasser	1
Paul Drye	1
AvielBohdit	4
Conversion script	1
Ripenble	2
Straubenstein	12
Bryan Derksen	1
Maveric149	6
Vicki Rosenzweig	1
Josh Gresse	1
Robert Merkel	1
PierreAbbat	1
Fredboudier	1
Tijmz	1
Gog	4
Emmett	3
Q	1
Jahnouse	5
Caenibert	1
Graft	3
Dwisyers	1
AdenFitchless	17
Chas ZZZ brown	2
Heron	1
Rygzusu	1
The Anome	1
Alan Peakal	1
Snelalchu	1
Boquence	7
Mabusz	1
Cyde	3
Rik	1
Fred Daudier	1
MVSchmid	1
Michael	1
Rowry	1
Zoe	1
Levor	13
Someone else	1
Tarvin	1
Zunderk	1
Jenfsink	1
Mirose	1
Darje Abghiel	1



Therefore, over time, the types of orga have traits better *adapted* to their envi tend to become the dominant ones in an environment, while organisms poorly ad their environment will become extinct. *Natural selection* also provides for a mechanism which life can sustain itself over time. S long run, environments always change, successive generations did not develop, which allowed them to survive and rep species would simply die out as their bi niches die out. Therefore, life is allowe over great spans of time, in the form of species. The central role of natural sele evolutionary theory has created a strong between that field and the study of ecol

Genetic drift

Genetic drift describes changes in gene that cannot be ascribed to selective pres are due instead to events that are unrel inherited traits. This is especially impo mating populations, which simply cannot enough offspring to maintain the same g distribution as the parental generation. f fluctuations in gene frequency between generations may result in some genes d from the population. Two separate popu begin with the same gene frequency mu therefore, "drift" by random fluctuation divergent populations with different gene genes that are present in one have been other). *Rare sporadic events* (volcanic e meteor impact, etc.) might contribute to drift by altering the gene frequency over "normal" selective pressures.

Development of evolutionary

As science has uncovered more and mo information about the basic operations o as genetics and molecular biology, thes evolution have changed. The general tra been not to overturn well-supported the supplant them with more detailed and th more complex ones.

While transmutation was accepted by a number of scientists before 1859, it was publication of Charles Darwin's *The Ori Species* which provided the first cogent by which evolutionary change could per mechanism of *natural selection*. The ex outlines the major steps of evol Earth as expounded by this theory's pro

Following the dawn of *molecular biology*, clear that a major mechanism for variat population is the *mutagenesis* of DNA. A component to evolutionary theory is the *cell cycle*. DNA is copied fairly, but not e faithfully. When these rare copying erro they are said to introduce genetic mutas three general consequences relative to environment: good, bad, or neutral. B individuals with "good" mutations will ha stronger propensity to propagate, indivi "bad" mutations will have less of a chan successful reproduction, and those carry "neutral" mutations will have neither an nor a disadvantage. These definitions as the environment remains stable. Consid level of a single gene, these variants y described represent different genetic al. Following environmental change, alleles their classification of good, bad, or neut shift into one of the other categories. I carrying alleles formerly classified as e can be "good", as they bear favoura

Wikipedia History Flow [Viegas & Wattenberg]





**Edit War...**

Wikipedia History Flow [Viegas & Wattenberg]

# Why Create Visualizations?

# Why Create Visualizations?

Answer questions (or discover them)

Make decisions

See data in context

Expand memory

Support graphical calculation

Find patterns

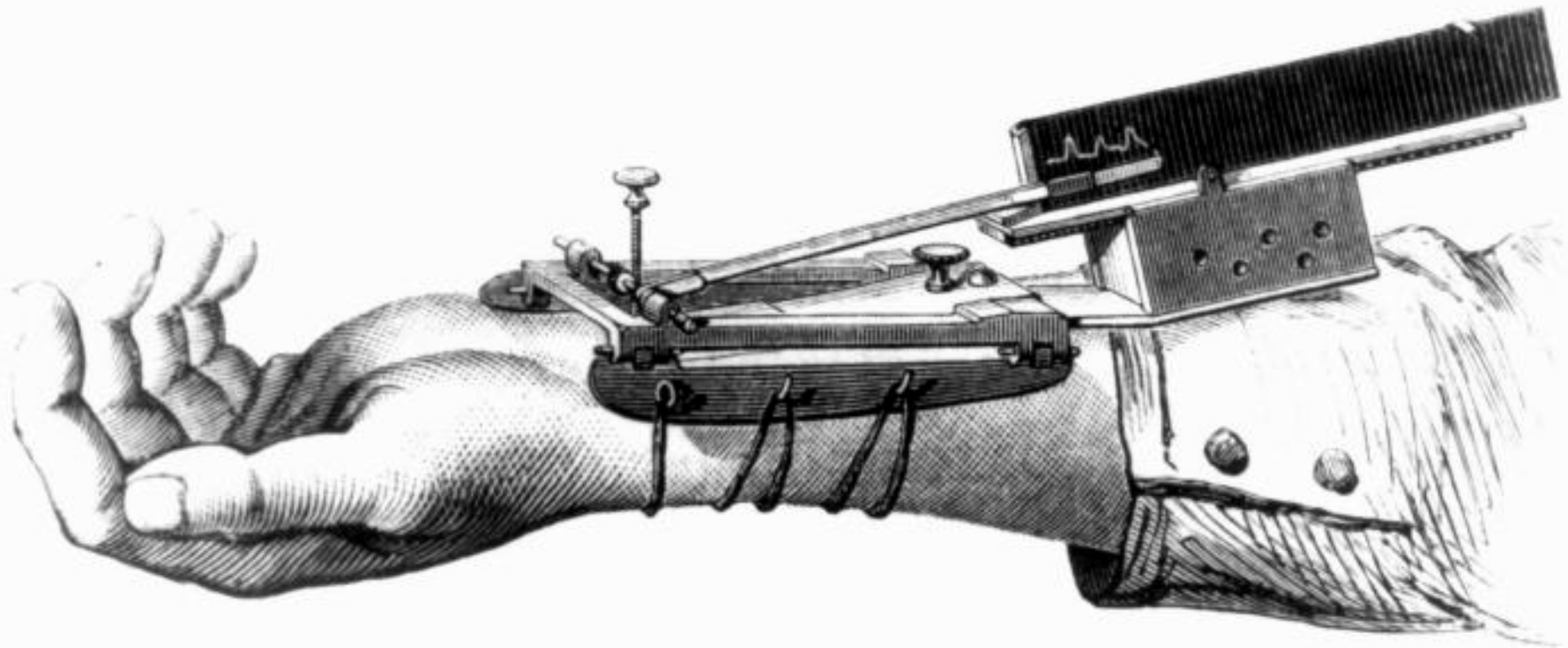
Present argument or tell a story

Inspire

# Record Information

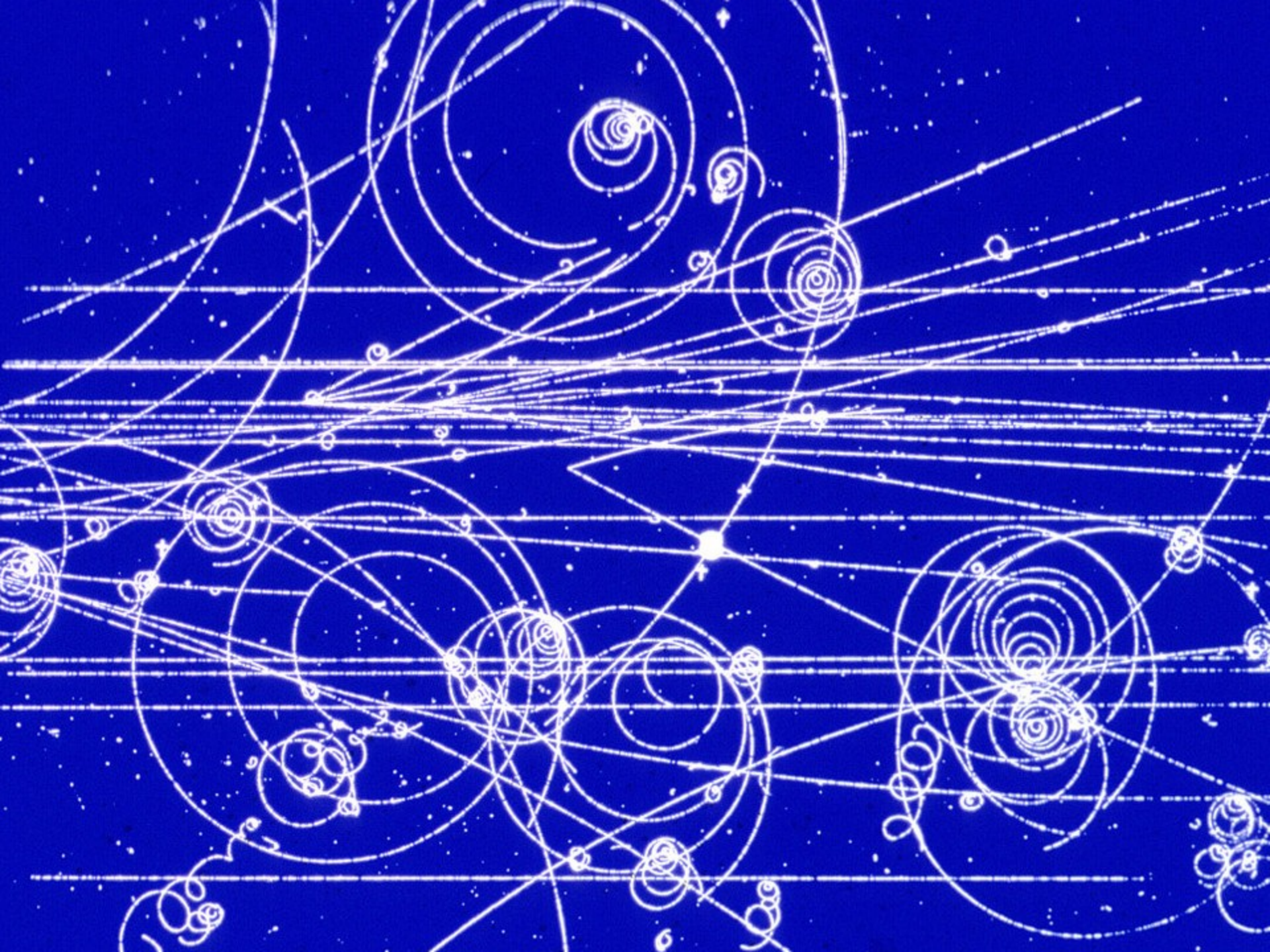


Gallop, Bay Horse "Daisy" [Muybridge]

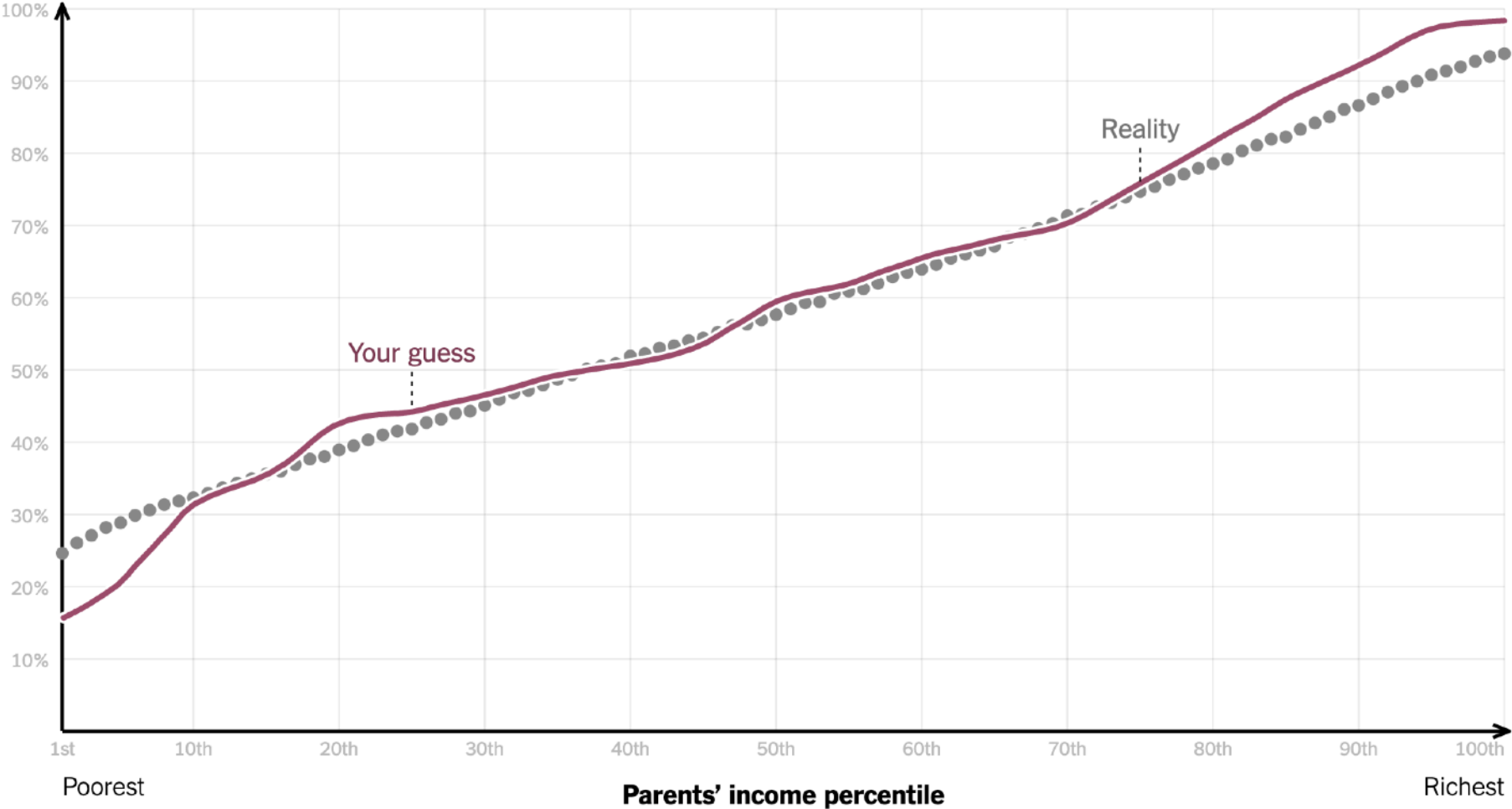


1.  
Marey's **sphygmograph** in use,  
1860. *La méthode graphique dans  
les sciences expérimentales et  
principalement en physiologie et en  
médecine.*

E.J. Marey's sphygmograph [from Braun 83]



# Percent of children who attended college

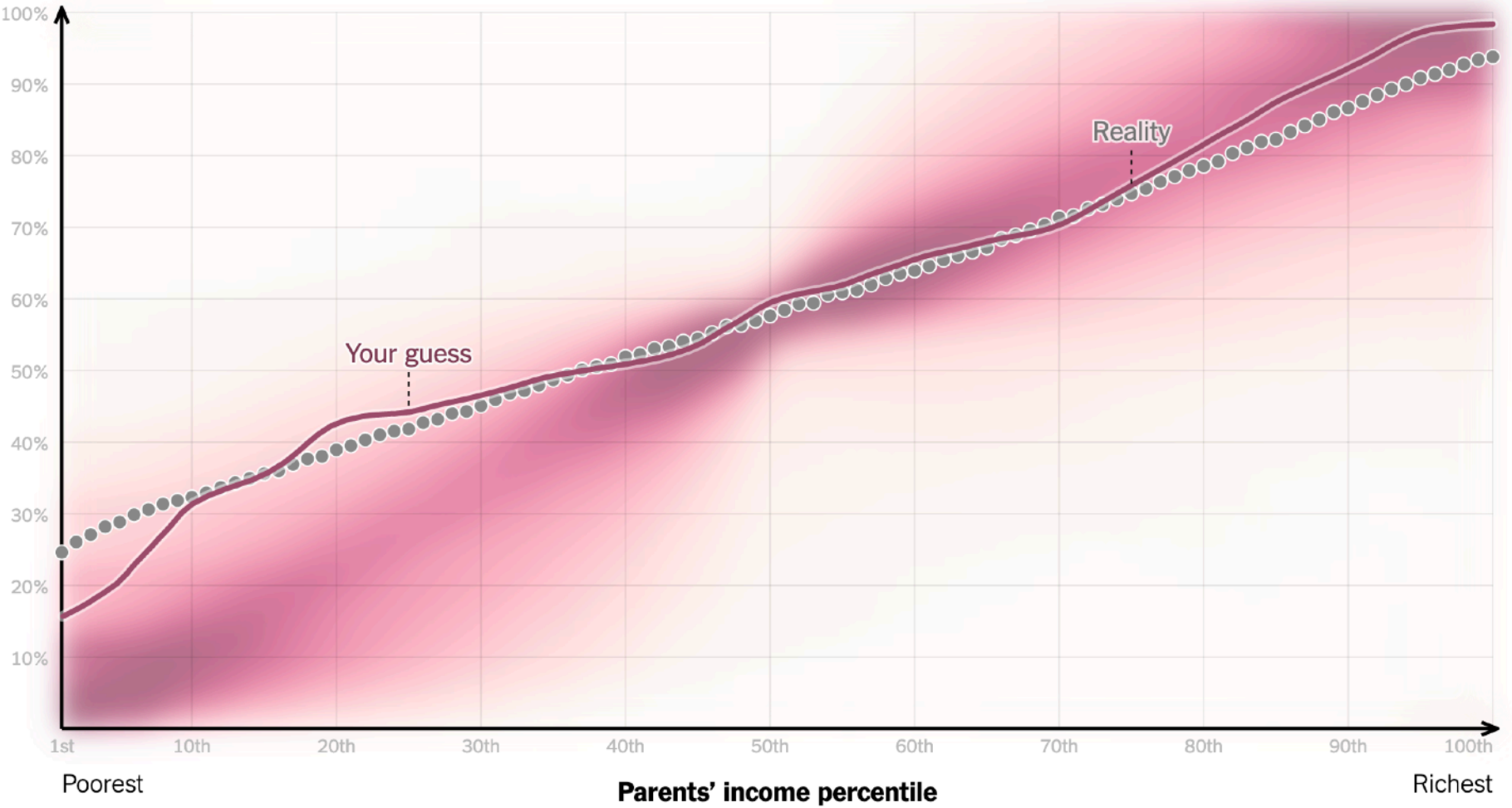


You Draw It: How Family Income Predicts Children's College Chances

[New York Times, May 28, 2015]



# Percent of children who attended college



You Draw It: How Family Income Predicts Children's College Chances

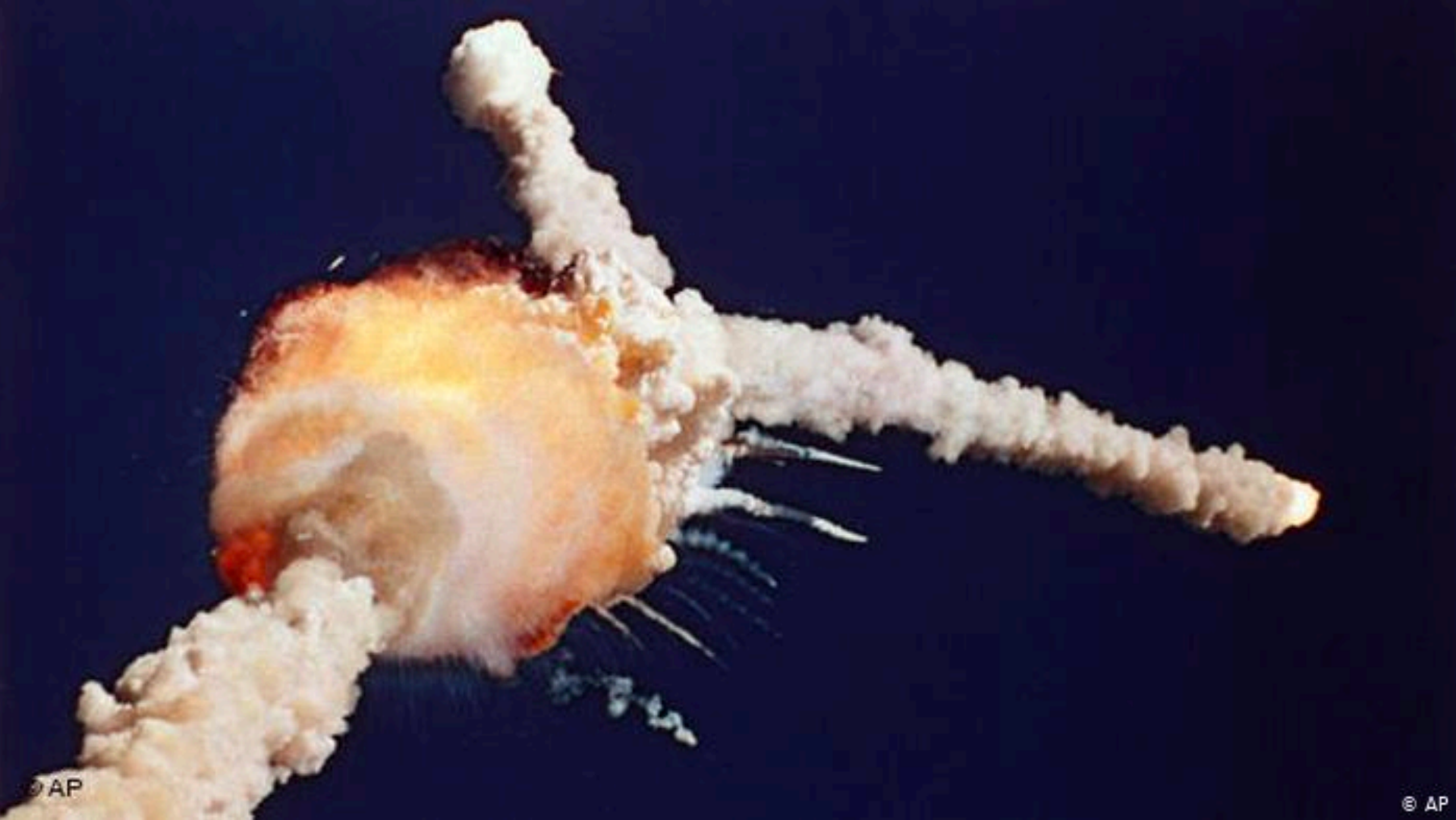
[New York Times, May 28, 2015]

# Support Reasoning



© AP

© AP



© AP

© AP

HISTORY OF O-RING DAMAGE ON SRM FIELD JOINTS

1161  
Oct 30, 1985  
y

SRM No.	Cross Sectional View			Top View		Clocking Location (deg)	
	Erosion Depth (in.)	Perimeter Affected (deg)	Nominal Dia. (in.)	Length Of Max Erosion (in.)	Total Heat Affected Length (in.)		
61A LH Center Field**	22A	None	None	0.280	None	None	36° - 66°
61A LH CENTER FIELD**	22A	NONE	NONE	0.280	NONE	NONE	338° - 18°
51C LH Forward Field**	15A	0.010	154.0	0.280	4.25	5.25	163
51C RH Center Field (prim)***	15B	0.038	130.0	0.280	12.50	58.75	354
51C RH Center Field (sec)***	15B	None	45.0	0.280	None	29.50	354
41D RH Forward Field	13B	0.028	110.0	0.280	3.00	None	275
41C LH Aft Field*	11A	None	None	0.280	None	None	--
41B LH Forward Field	10A	0.040	217.0	0.280	3.00	14.50	351
STS-2 RH Aft Field	2B	0.053	116.0	0.280	--	--	90

\*Hot gas path detected in putty. Indication of heat on O-ring, but no damage.  
 \*\*Soot behind primary O-ring.  
 \*\*\*Soot behind primary O-ring, heat affected secondary O-ring.

Clocking location of leak check port - 0 deg.

OTHER SRM-15 FIELD JOINTS HAD NO BLOWHOLES IN PUTTY AND NO SOOT NEAR OR BEYOND THE PRIMARY O-RING.

SRM-22 FORWARD FIELD JOINT HAD PUTTY PATH TO PRIMARY O-RING, BUT NO O-RING EROSION AND NO SOOT BLOWBY. OTHER SRM-22 FIELD JOINTS HAD NO BLOWHOLES IN PUTTY.

BLOW BY HISTORY

SRM-15 WORST BLOW-BY  
 o 2 CASE JOINTS (80°), (110°) ARC  
 o MUCH WORSE VISUALLY THAN SRM-22

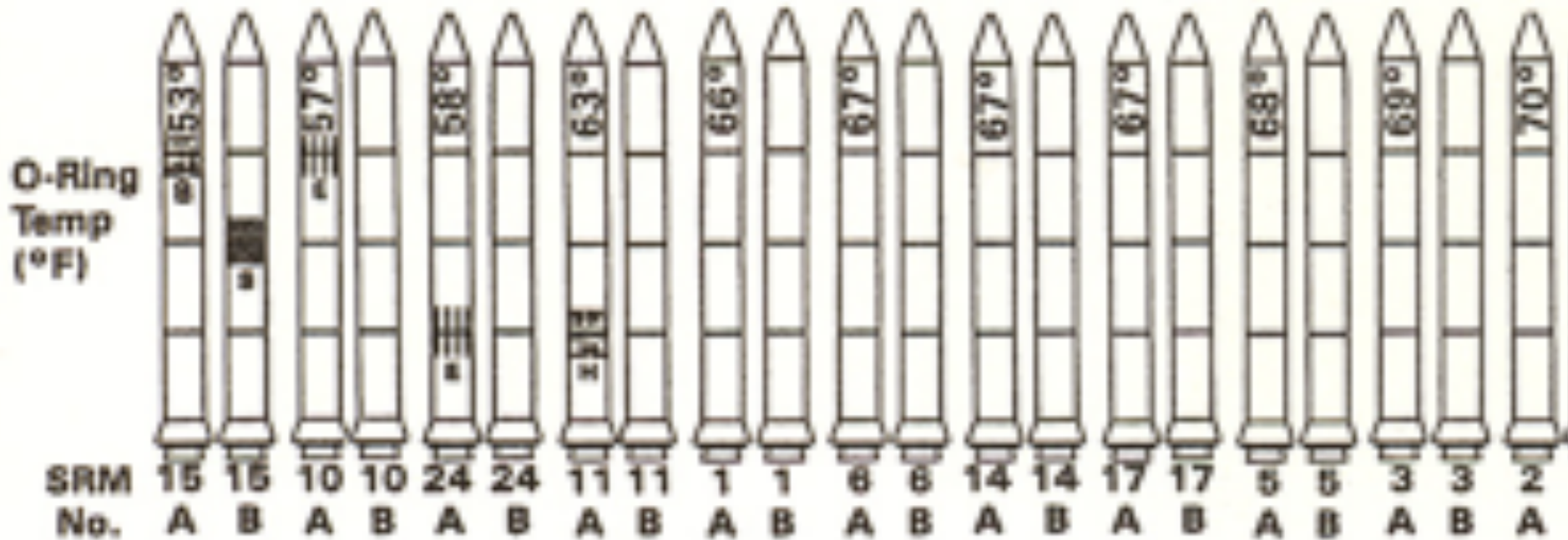
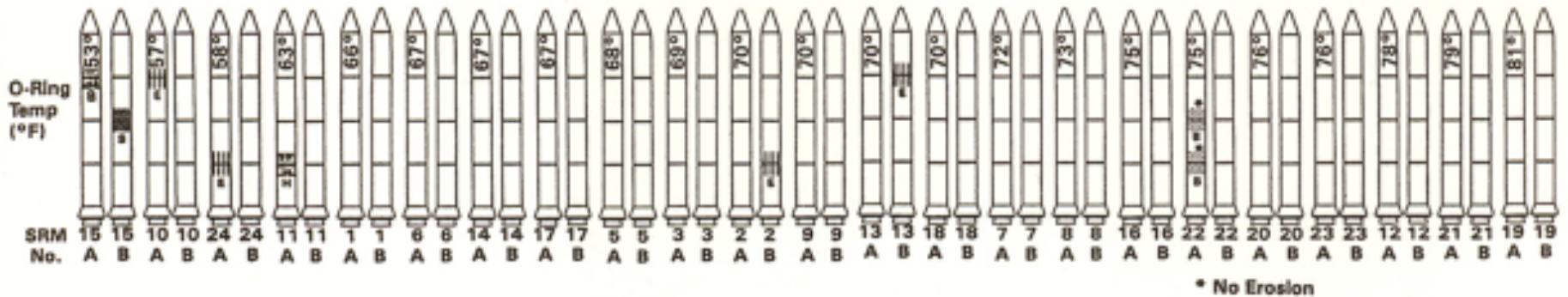
SRM 22 BLOW-BY  
 o 2 CASE JOINTS (30-40°)

SRM-13A, 15, 16A, 18, 23A 24A  
 o NOZZLE BLOW-BY

HISTORY OF O-RING TEMPERATURES (DEGREES - F)

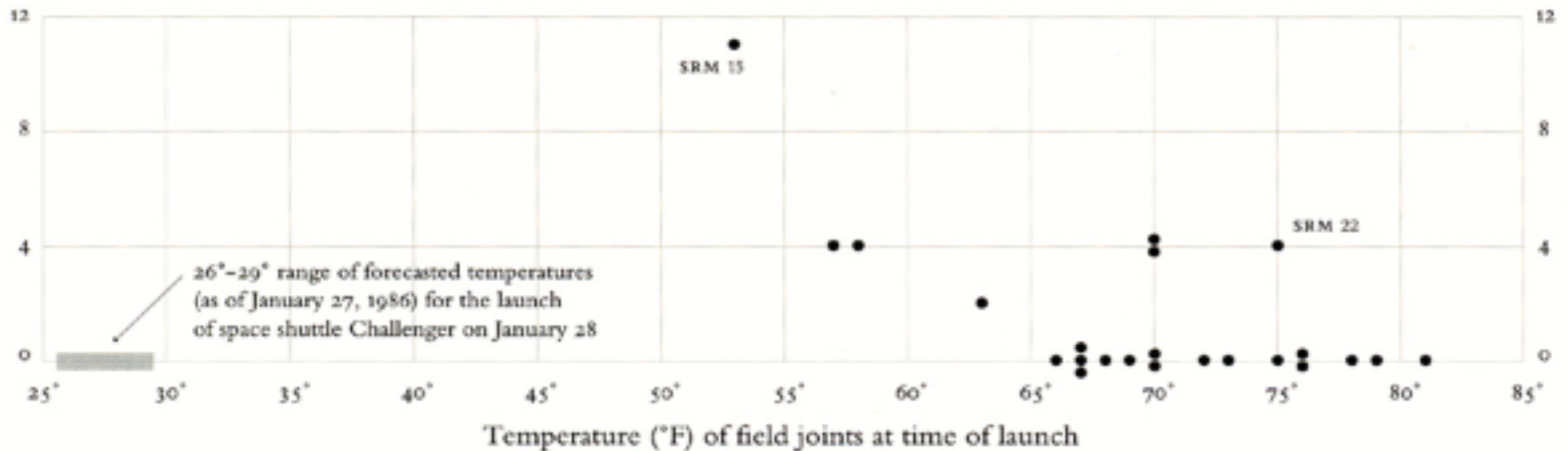
MOTOR	MBT	AMB	O-RING	WIND
DM-4	68	36	47	10 MPH
DM-2	76	45	52	10 MPH
QM-3	72.5	40	48	10 MPH
QM-4	76	48	51	10 MPH
SRM-15	52	64	53	10 MPH
SRM-22	77	78	75	10 MPH
SRM-25	55	26	29	10 MPH
			27	25 MPH

# Make Decisions: Challenger



# Make Decisions: Challenger

O-ring damage index, each launch



**But wait! What is an appropriate "damage index"?  
Which temperatures, O-ring or outside air?**

Chart of temperatures vs. O-ring damage [Tufte 97]

# Data in Context: Cholera Outbreak



In 1854 John Snow plotted the position of each cholera case on a map. [from Tufte 83]



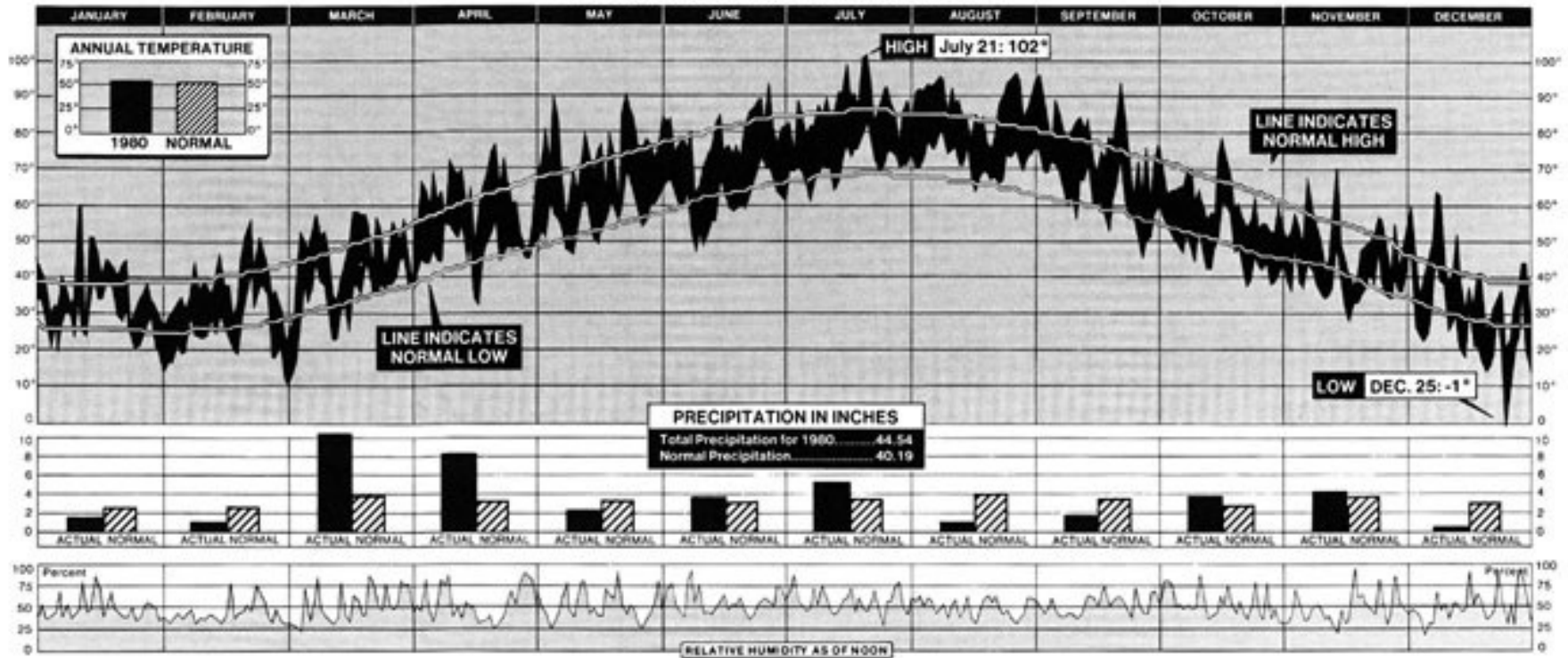
# Data in Context: Cholera Outbreak



Used map to hypothesize that pump on Broad St. was the cause. [from Tufte 83]

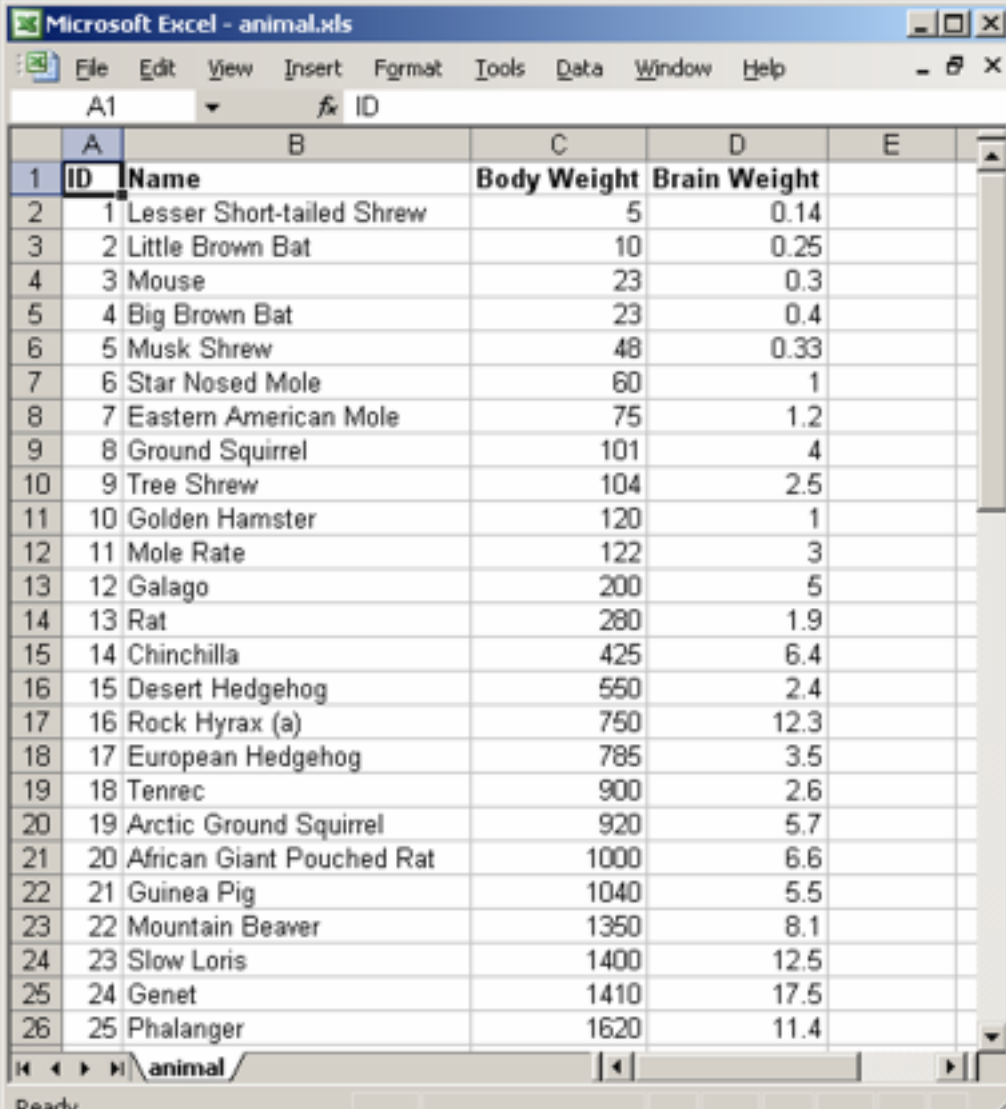
# Find Patterns: NYC Weather

NEW YORK CITY'S WEATHER FOR 1980



[New York Times 1981]

# Answer Questions: Brain Power?



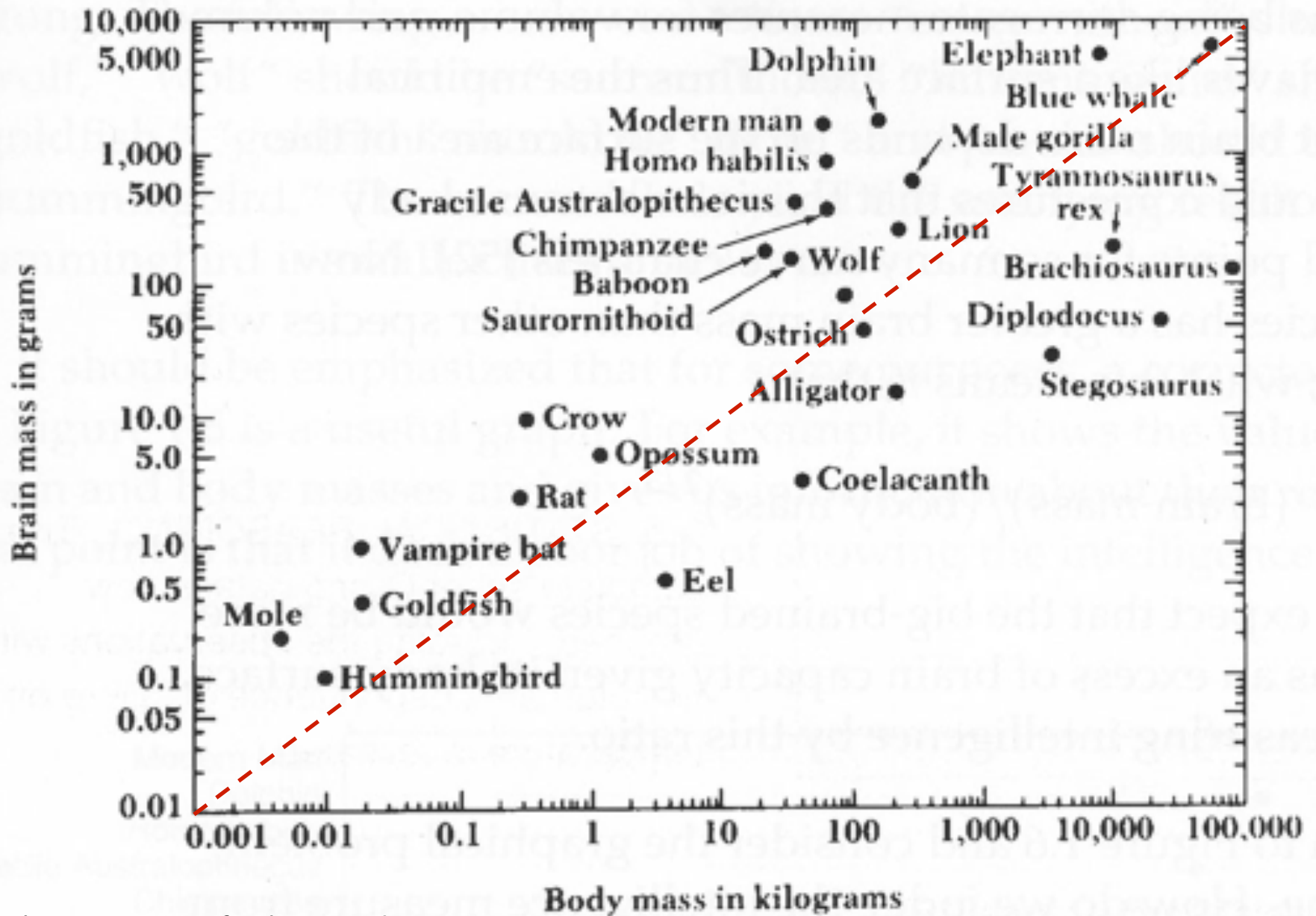
Microsoft Excel - animal.xls

File Edit View Insert Format Tools Data Window Help

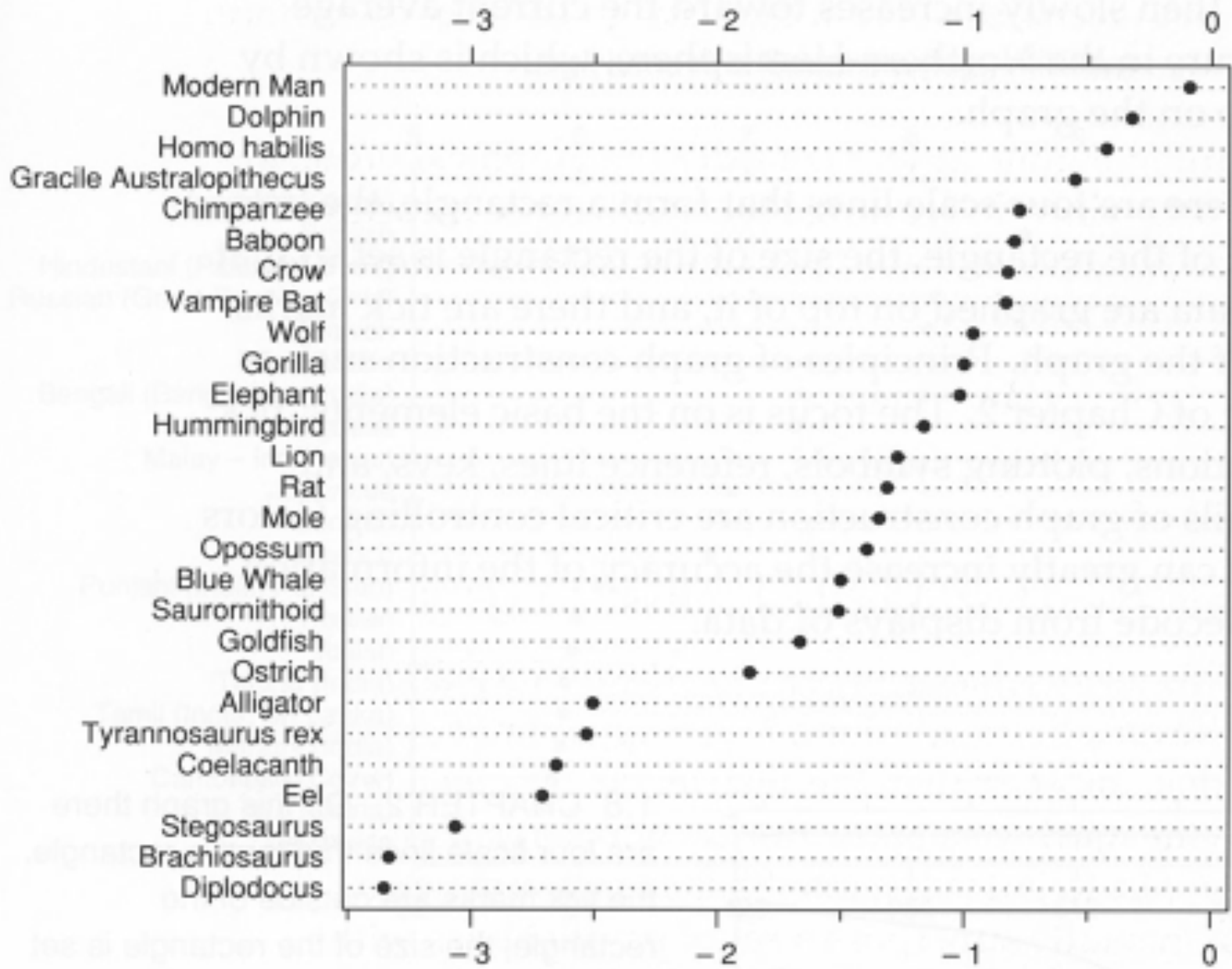
A1 fx ID

	A	B	C	D	E
1	ID	Name	Body Weight	Brain Weight	
2	1	Lesser Short-tailed Shrew	5	0.14	
3	2	Little Brown Bat	10	0.25	
4	3	Mouse	23	0.3	
5	4	Big Brown Bat	23	0.4	
6	5	Musk Shrew	48	0.33	
7	6	Star Nosed Mole	60	1	
8	7	Eastern American Mole	75	1.2	
9	8	Ground Squirrel	101	4	
10	9	Tree Shrew	104	2.5	
11	10	Golden Hamster	120	1	
12	11	Mole Rate	122	3	
13	12	Galago	200	5	
14	13	Rat	280	1.9	
15	14	Chinchilla	425	6.4	
16	15	Desert Hedgehog	550	2.4	
17	16	Rock Hyrax (a)	750	12.3	
18	17	European Hedgehog	785	3.5	
19	18	Tenrec	900	2.6	
20	19	Arctic Ground Squirrel	920	5.7	
21	20	African Giant Pouched Rat	1000	6.6	
22	21	Guinea Pig	1040	5.5	
23	22	Mountain Beaver	1350	8.1	
24	23	Slow Loris	1400	12.5	
25	24	Genet	1410	17.5	
26	25	Phalanger	1620	11.4	

Ready



The Dragons of Eden [Carl Sagan]



The Elements of Graphing Data

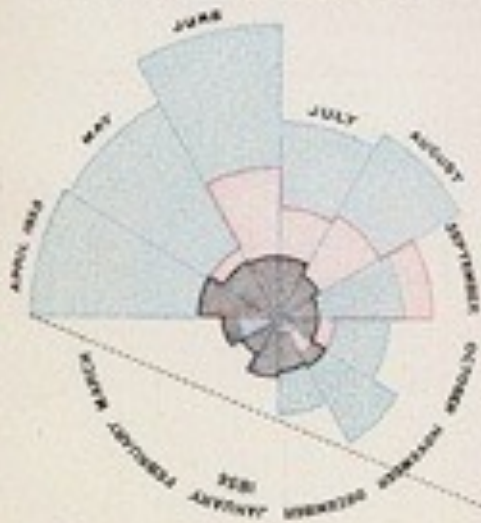
[Cleveland]

$\text{Log}_{10} \text{ Brain Weight} - \frac{2}{3} \text{Log}_{10} \text{ Body Weight}$

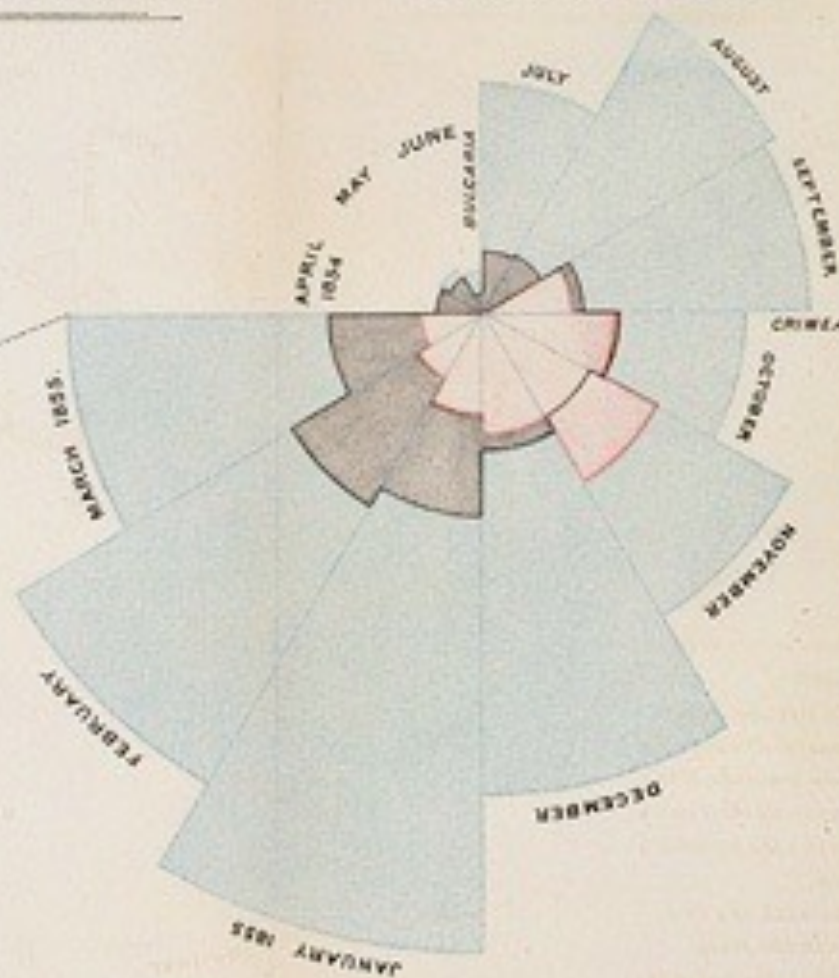
# Convey Information

DIAGRAM OF THE CAUSES OF MORTALITY  
IN THE ARMY IN THE EAST.

2.  
APRIL 1855 TO MARCH 1856.



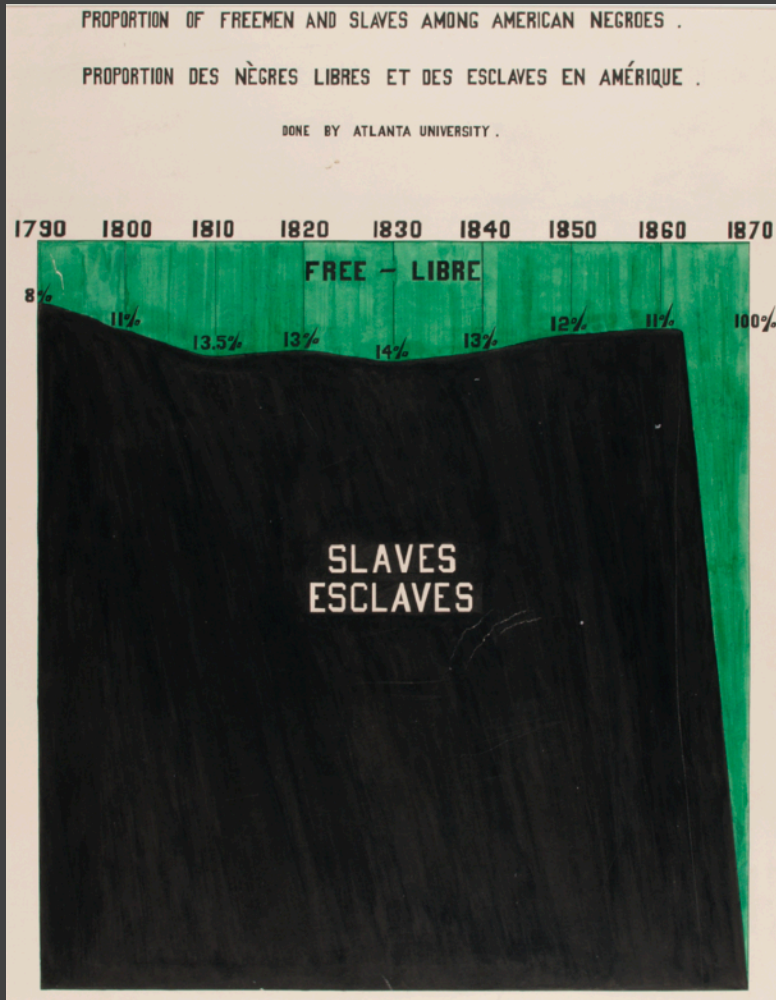
1.  
APRIL 1854 TO MARCH 1855.



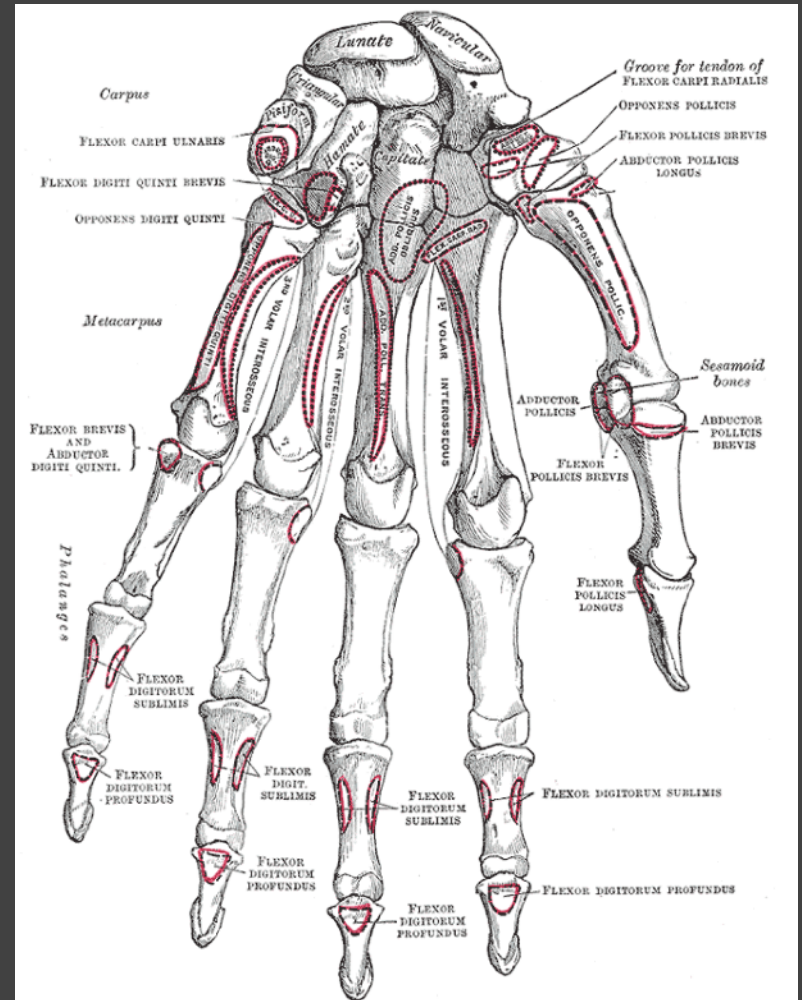
“to affect thro’ the Eyes  
what we fail to convey to  
the public through their  
word-proof ears”

1856 “Coxcomb” of Crimean War Deaths, Florence Nightingale

# Communicate, Inform, Inspire



Visualizing Black America, Du Bois et al. 1900

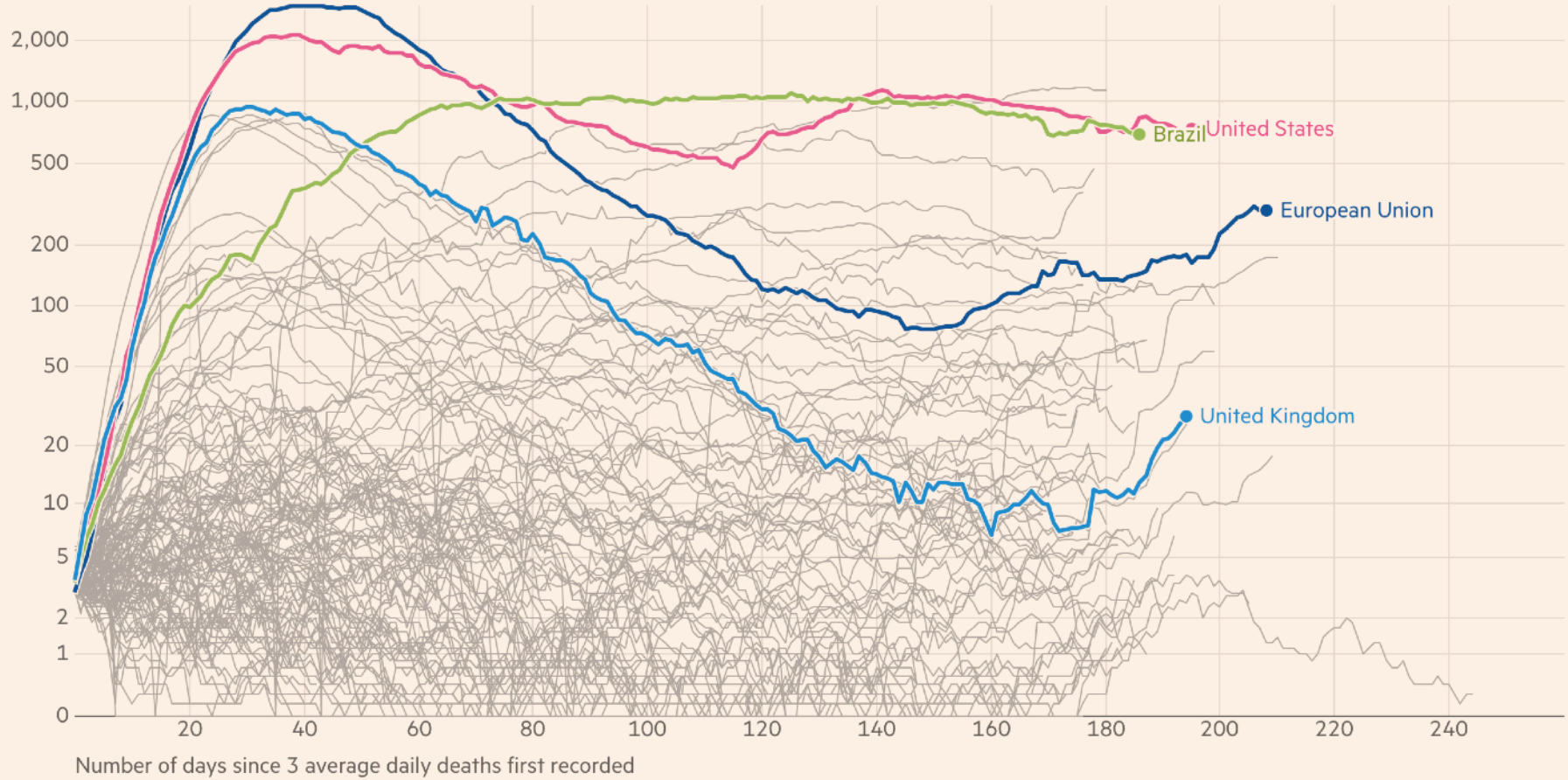


Bones in hand, Gray's Anatomy 1918 ed.



# New deaths attributed to Covid-19 in European Union, United States, Brazil and United Kingdom

Seven-day rolling average of new deaths, by number of days since 3 average daily deaths first recorded



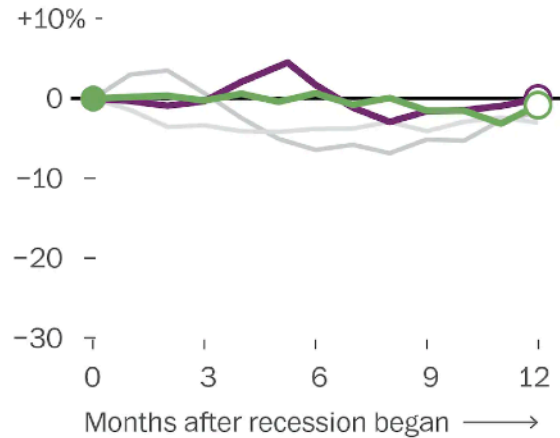
Source: Financial Times analysis of data from the European Centre for Disease Prevention and Control, the Covid Tracking Project, the UK Dept of Health & Social Care and the Spanish Ministry of Health.  
Data updated September 25 2020 12.46pm BST. Interactive version: [ft.com/covid19](https://ft.com/covid19)

FINANCIAL TIMES

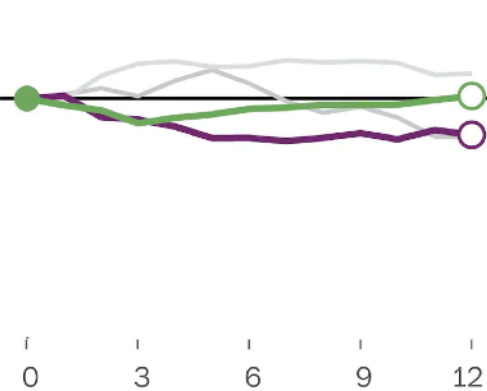
# The coronavirus crisis is different

Job growth (or loss) since each recession began, based on weekly earnings

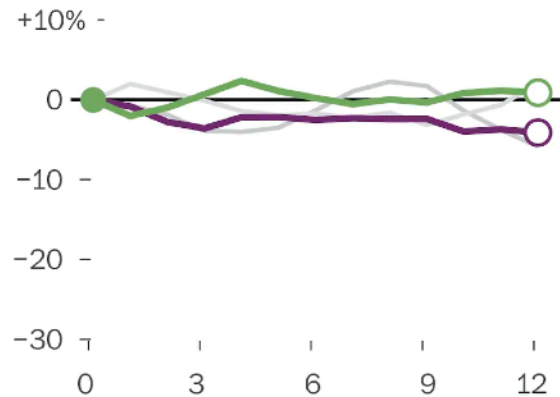
## 1990 recession



## 2001 recession



## 2008 recession



## Coronavirus crisis



Notes: Based on a three-month average to show the trend in volatile data.

Source: Labor Department via IPUMS, with methodology assistance from Ernie Tedeschi of Evercore ISI

THE WASHINGTON POST

The Covid Economy

Washington Post

# The Value of Visualization

**Record** information

Blueprints, photographs, seismographs, ...

**Analyze** data to support reasoning

Develop and assess hypotheses

Find patterns / Discover errors in data

Expand memory

**Convey** information

Communicate, inform, inspire

Collaborate and revise

# Goals of Visualization Research

**1 Understand** how visualizations convey information

What do people perceive / comprehend?

How do visualizations inform mental models?

**2 Develop principles and techniques** for creating effective visualizations and supporting analysis

Leverage perception & augment cognition

Improve ties between visualization & mental model

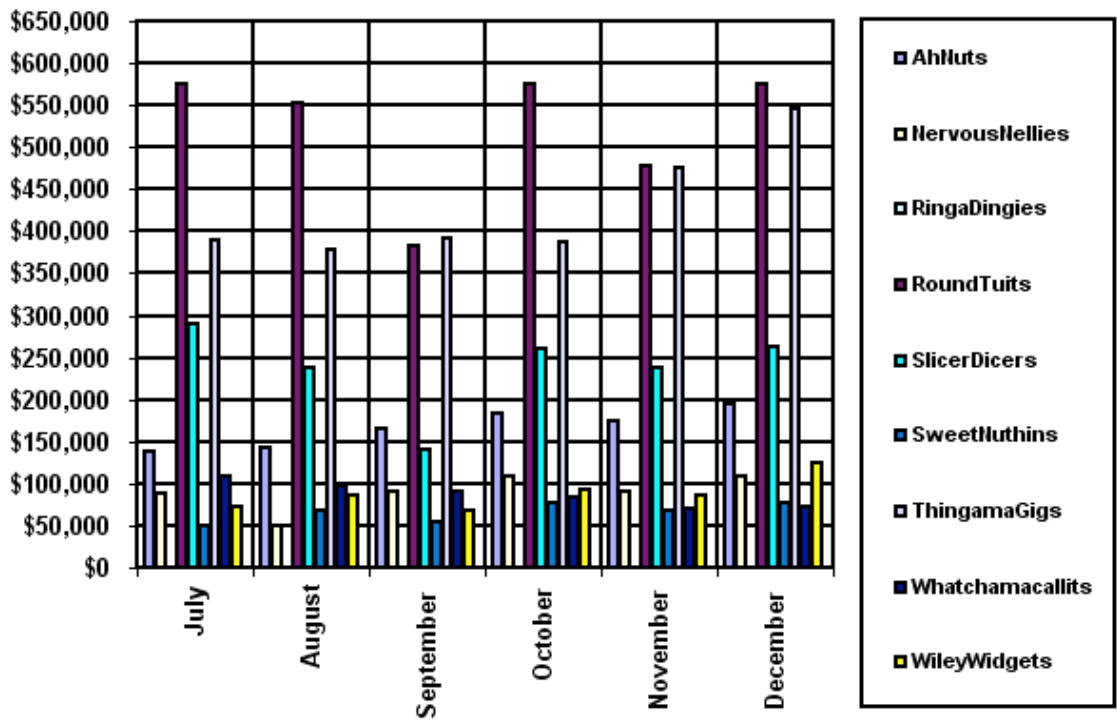
# Course Topics

# Data and Image Models

LES VARIABLES DE L'IMAGE										
			POINTS	LIGNES	ZONES	12	14			
Z	XY 2 DIMENSIONS DU PLAN									
	TAILLE									
	VALEUR									
LES VARIABLES DE SÉPARATION DES IMAGES										
Z	GRAIN									
	COULEUR									
	ORIENTATION									

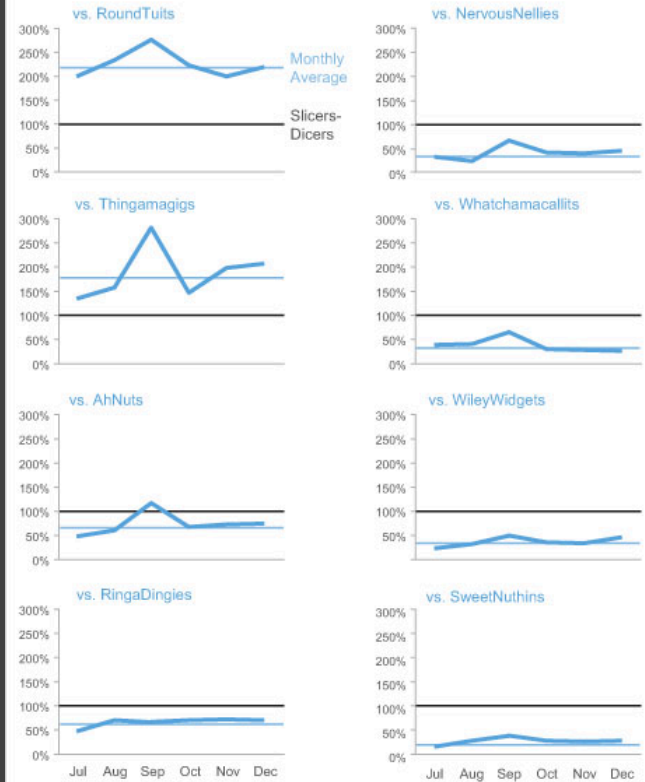
# Visualization Design

SlicerDicers' Sales Compared to Other Products



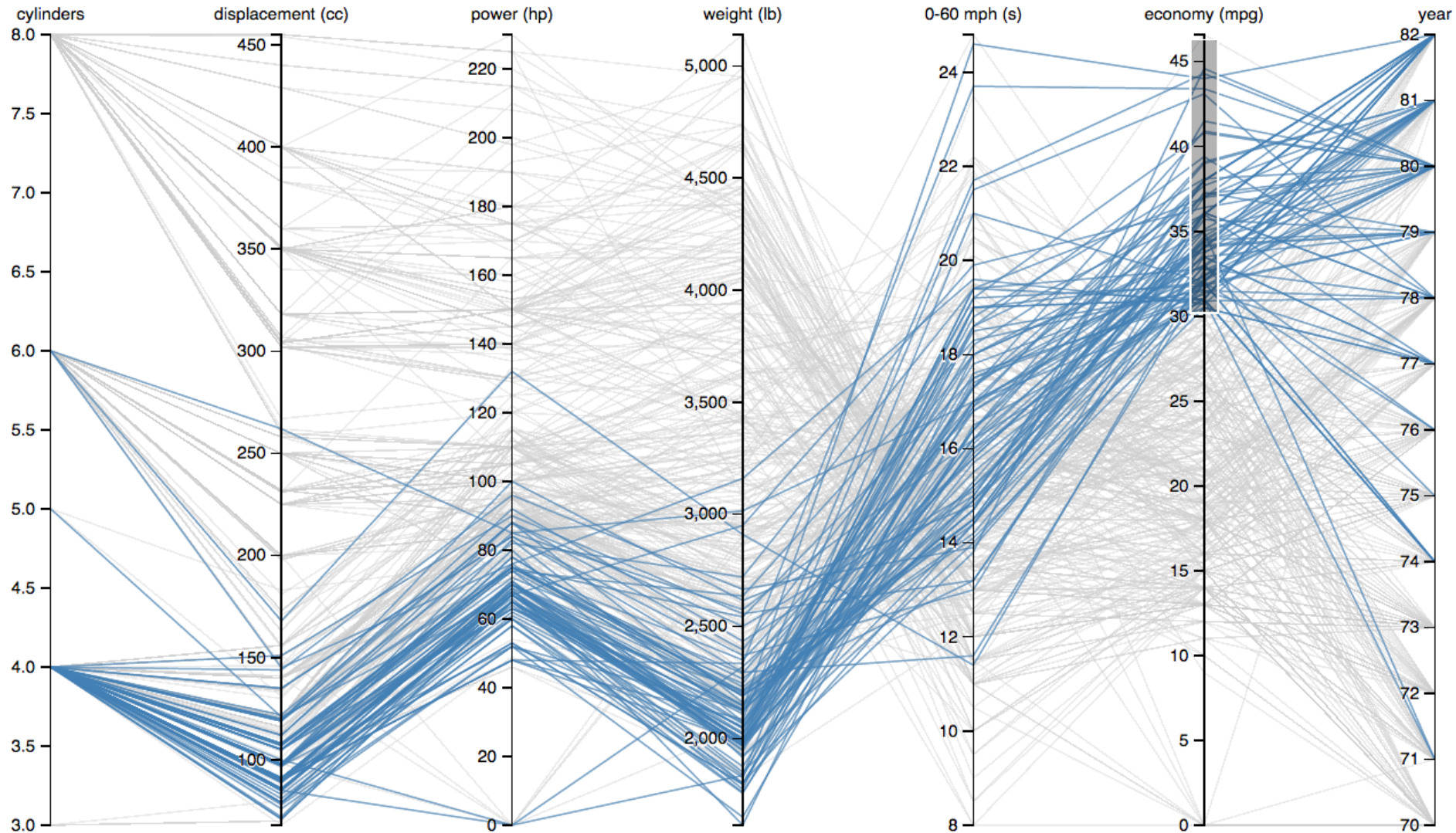
Problematic design

Sales of SlicersDicers Compared to Sales of Other Products  
July - December, 2011



Redesign

# Exploratory Data Analysis



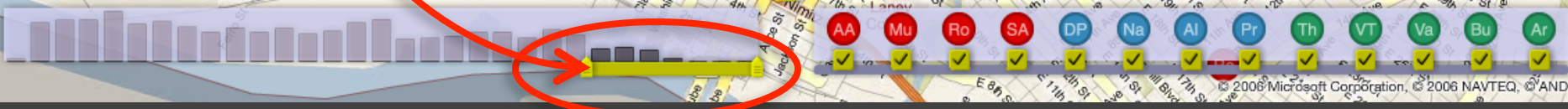


# Interaction

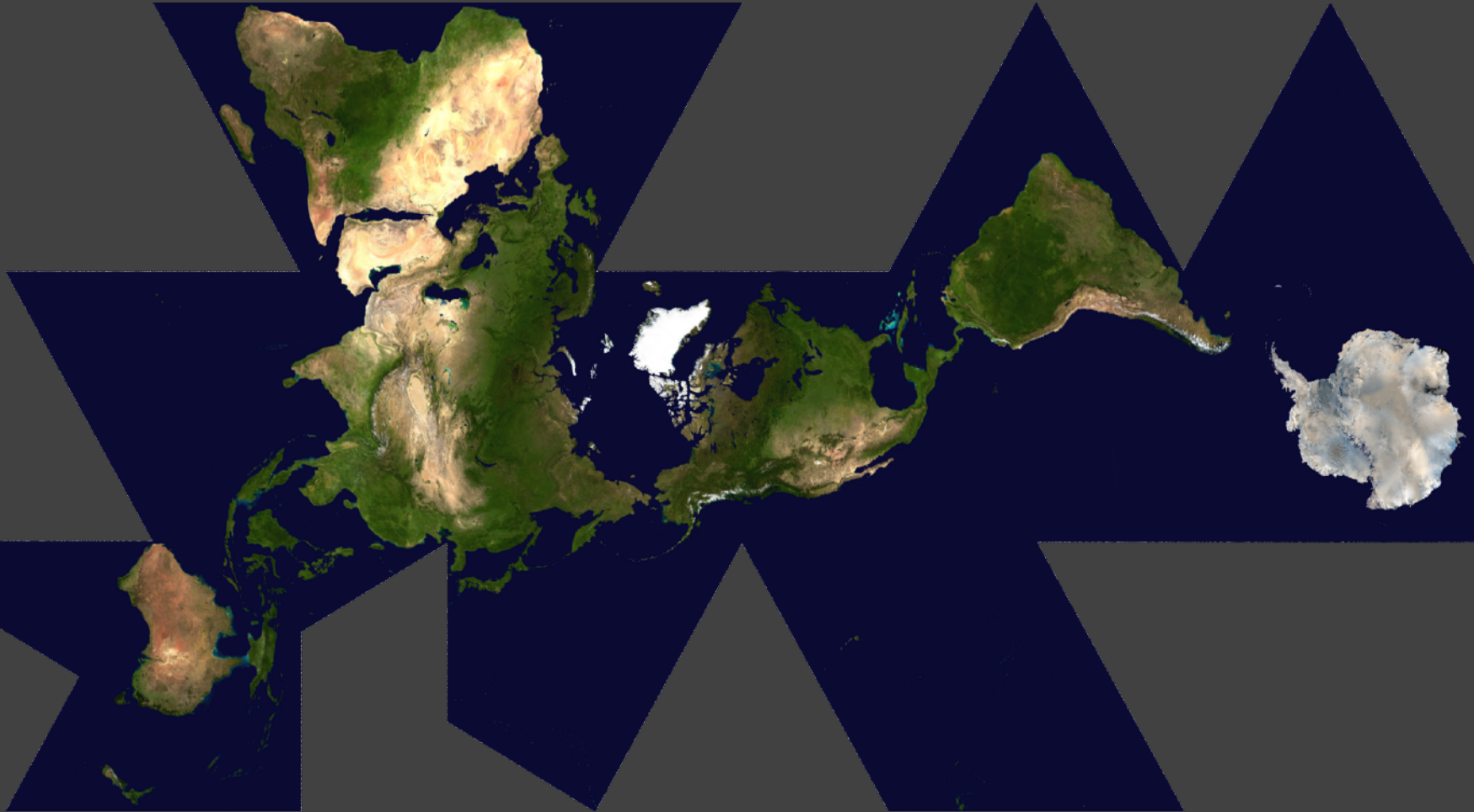
Friday, December 12, 2008  
154 reports



Crimespotting.org



# Maps



Dymaxion Maps [Fuller 46]

Recent elections have placed a heavy emphasis on “swing states” — Ohio, Florida and the other competitive states. In the past, many more states shifted between the Democratic and Republican parties. A look at how the states stacked up in the election and how they have shifted over past elections.

# Narrative

- Each box represents a state sized by number of electoral votes.
- Each curve shows how much it shifted left or right between elections.

Chart Size of Lead  
Chart Electoral Votes

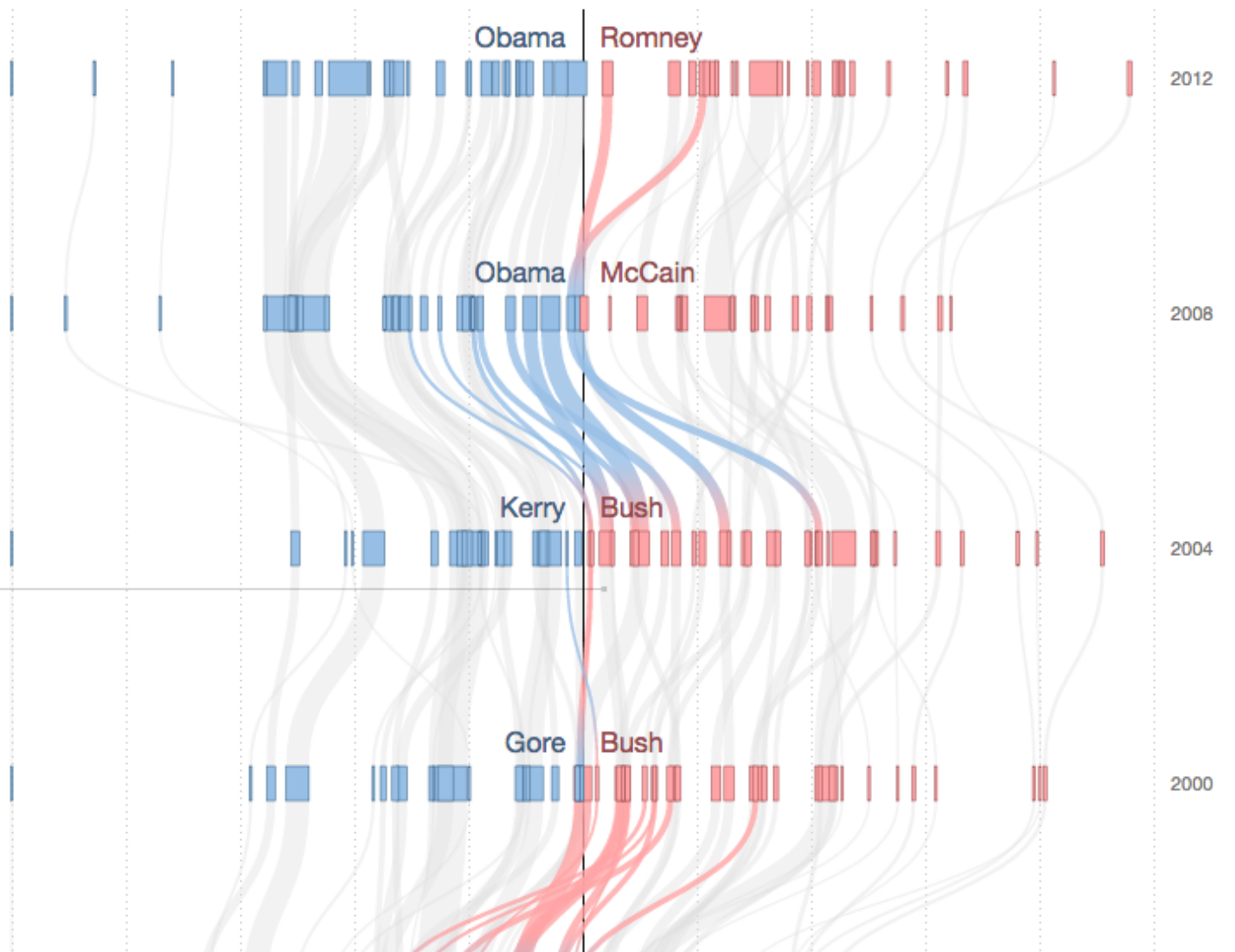
← MORE DEMOCRATIC | MORE REPUBLICAN →  
 ≥50% +40% +30% +20% +10% +10% +20% +30% +40% ≥50%

**Obama Re-elected**  
 The country voted about 5 percentage points more Republican in 2012 than in 2008. Obama lost North Carolina and Indiana, but won every tossup except Florida, which remains too close to call.

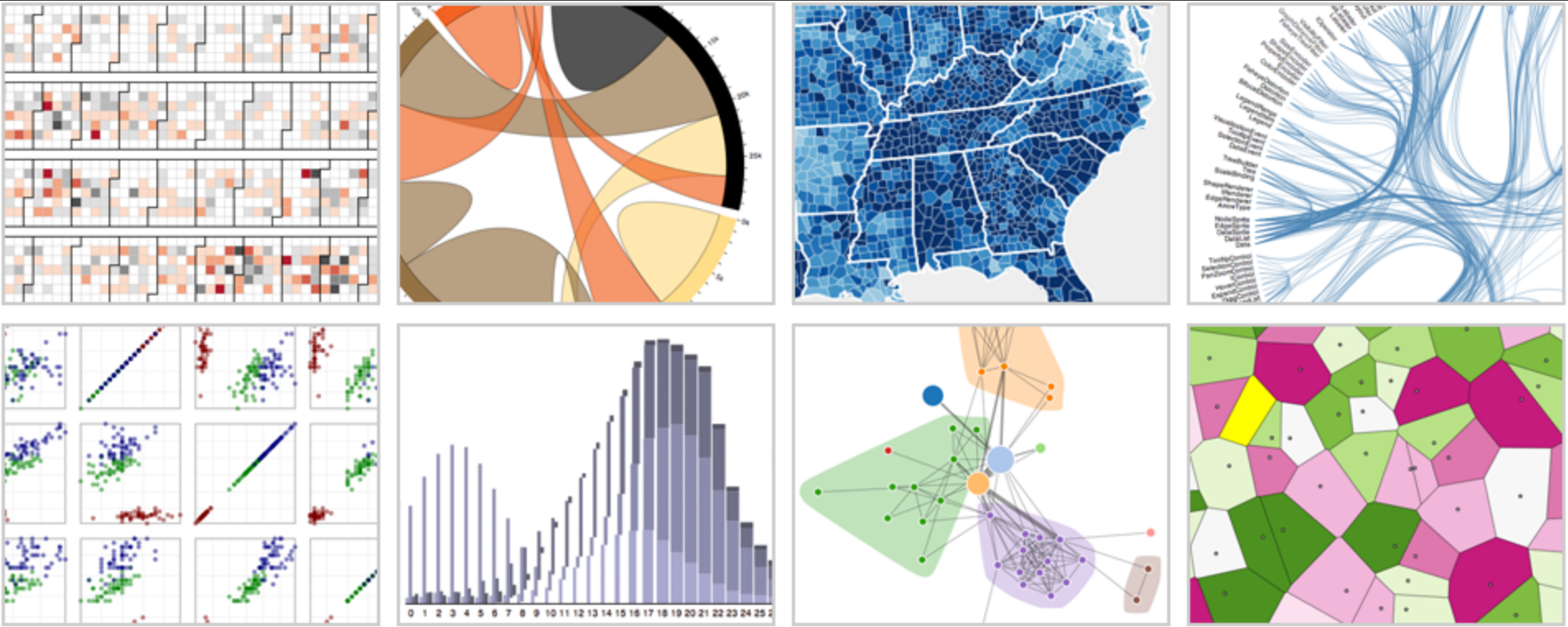
Highlight Tossups

**As Goes Ohio**  
 Ohio, which has voted for the winner in every election since 1964, provided the decisive electoral votes in 2004, and it is the state likeliest to play that role again this year, according to the FiveThirtyEight model.

Highlight Ohio

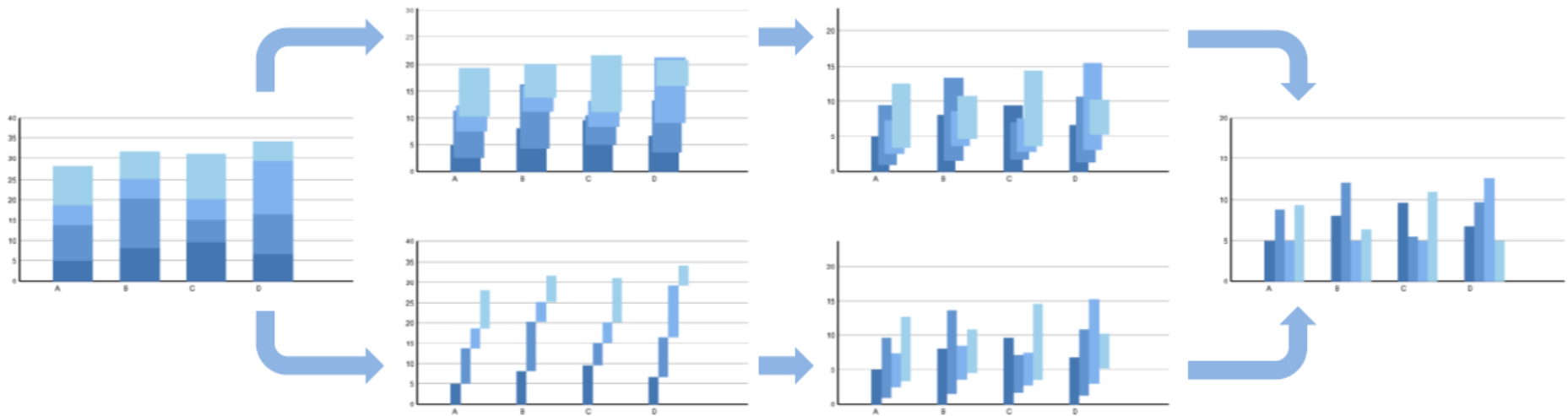


# Visualization Software



D3: Data-Driven Documents  
Vega-Lite / Altair

# Animation

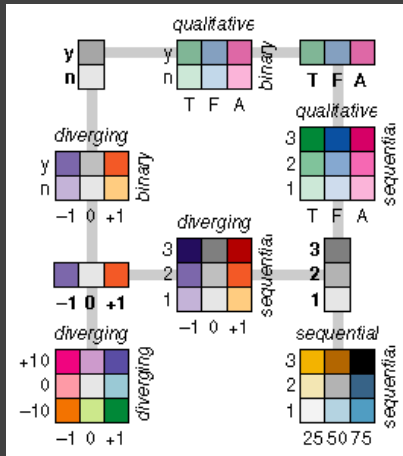
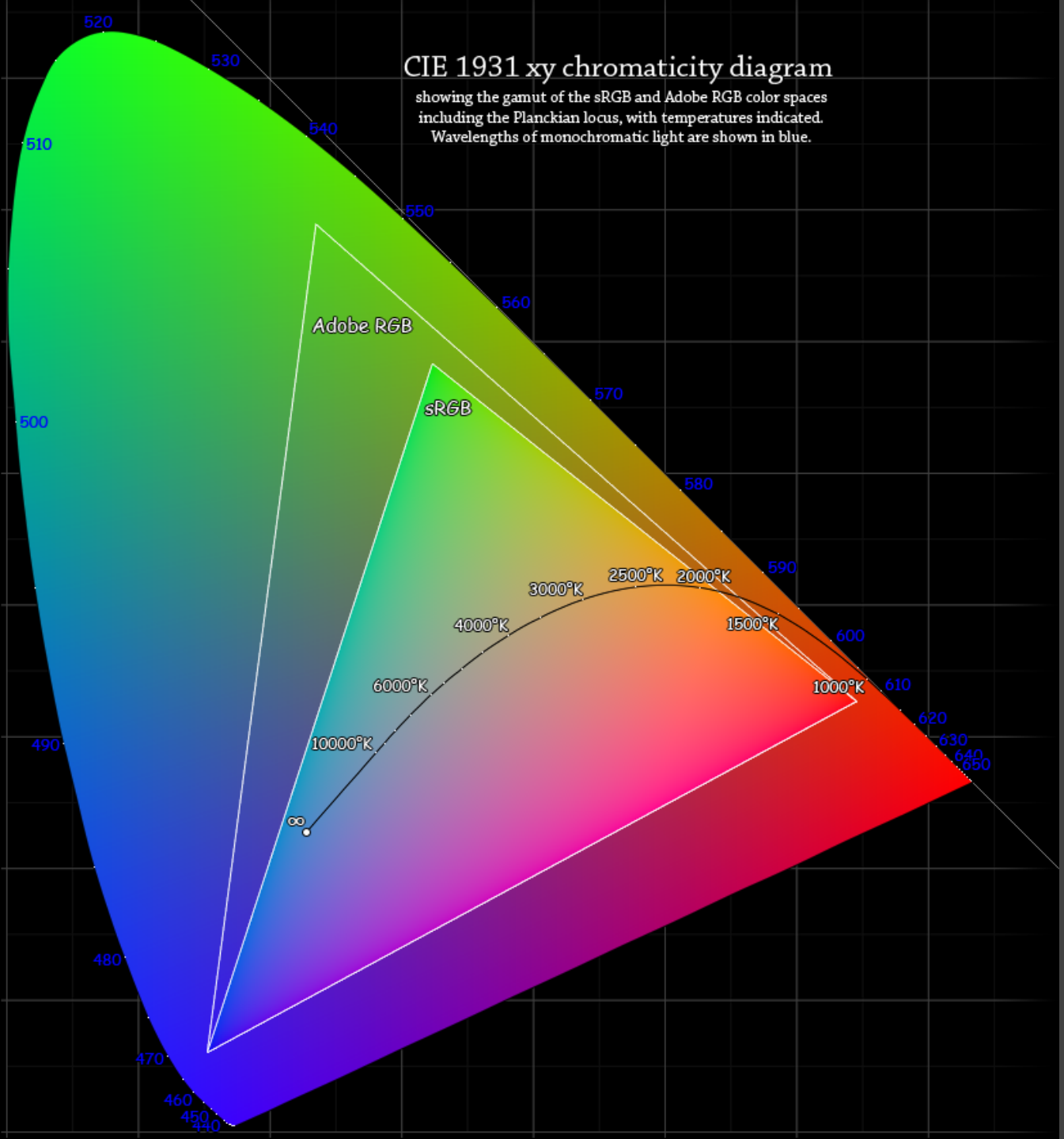


Animated transitions in statistical data graphics [Heer & Robertson 07]

# Color

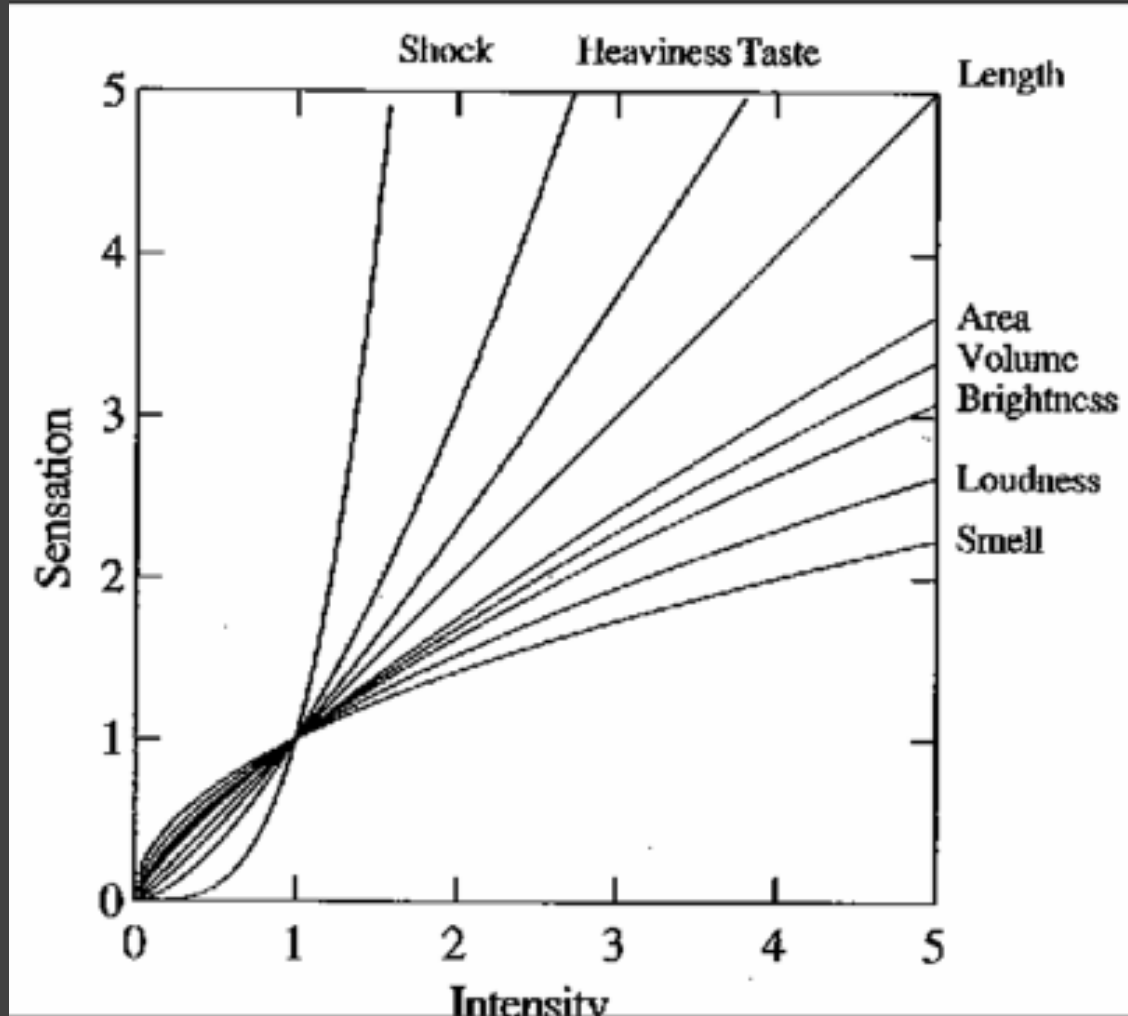
## CIE 1931 xy chromaticity diagram

showing the gamut of the sRGB and Adobe RGB color spaces including the Planckian locus, with temperatures indicated. Wavelengths of monochromatic light are shown in blue.



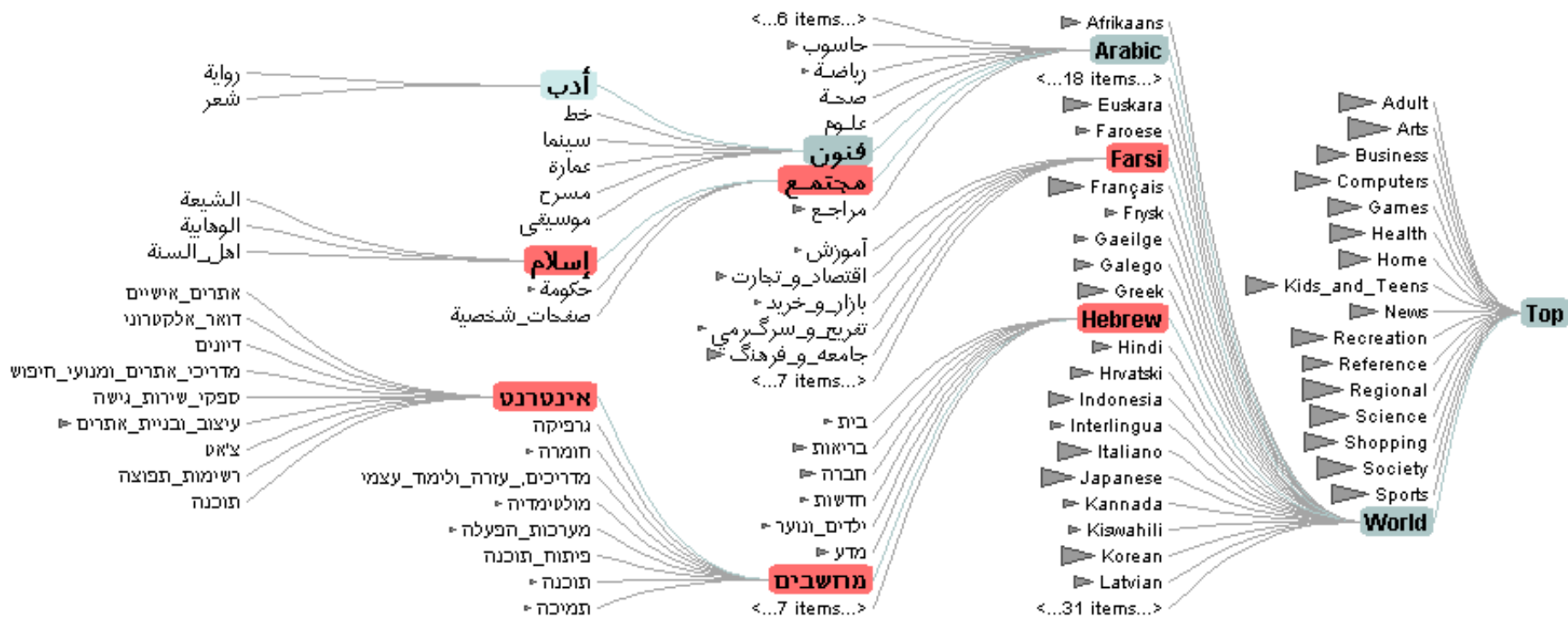
## Color Brewer

# Graphical Perception



The psychophysics of sensory function [Stevens 61]

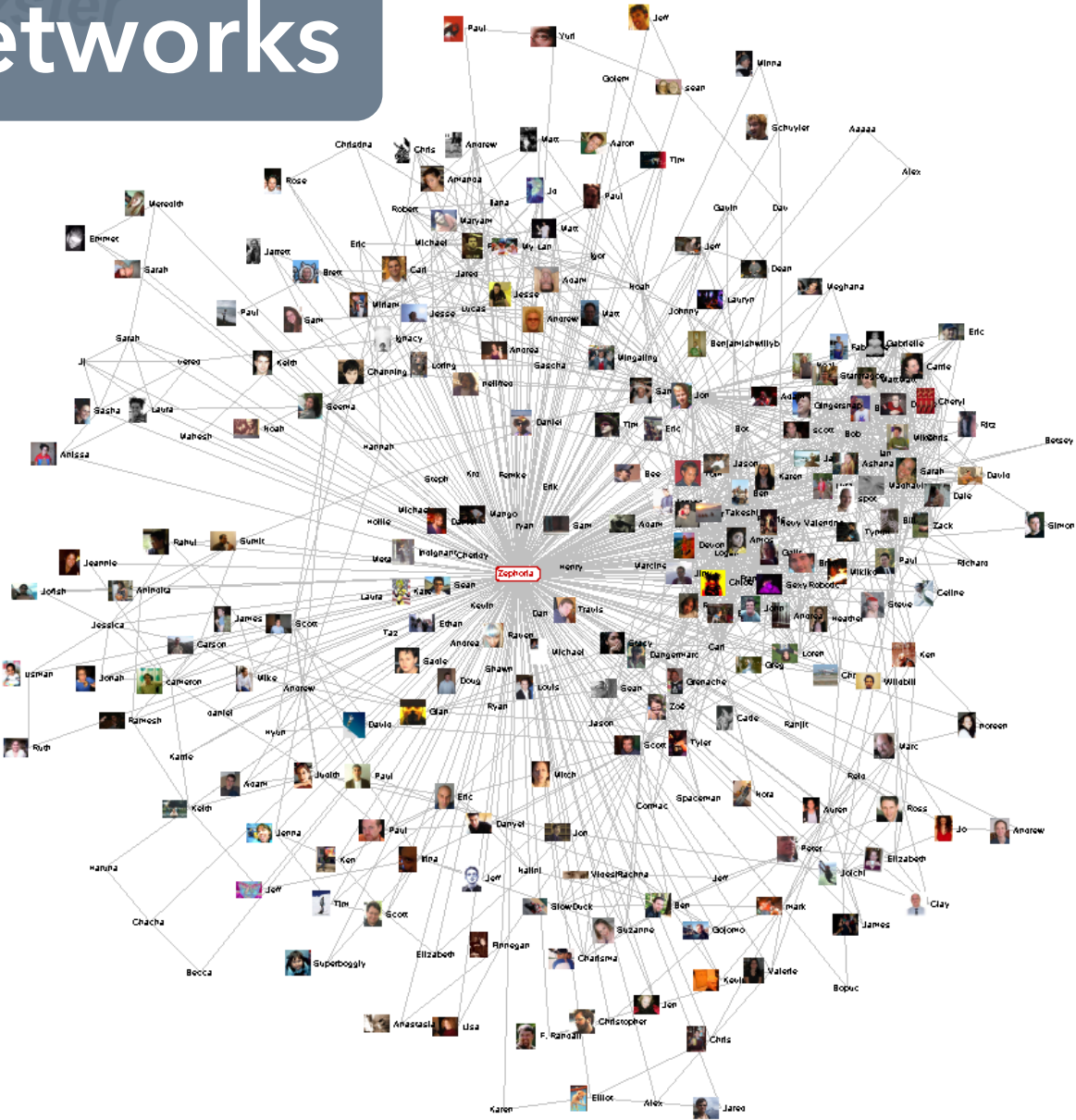
# Hierarchies



Degree-Of-Interest Trees [Heer & Card 04]



# Networks



community >>

Enable

search >>

## Zephoria

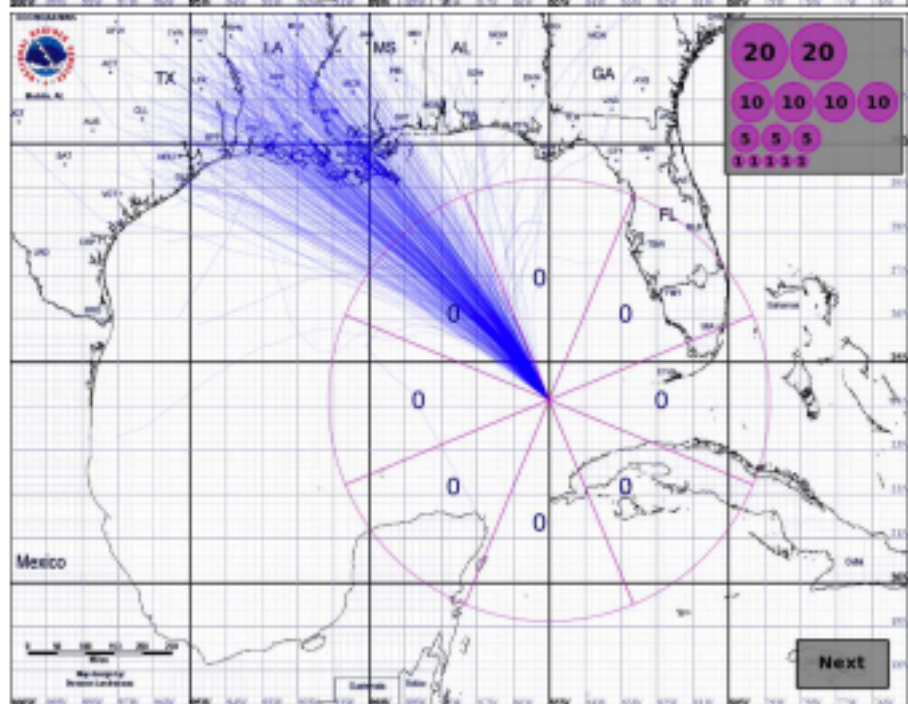
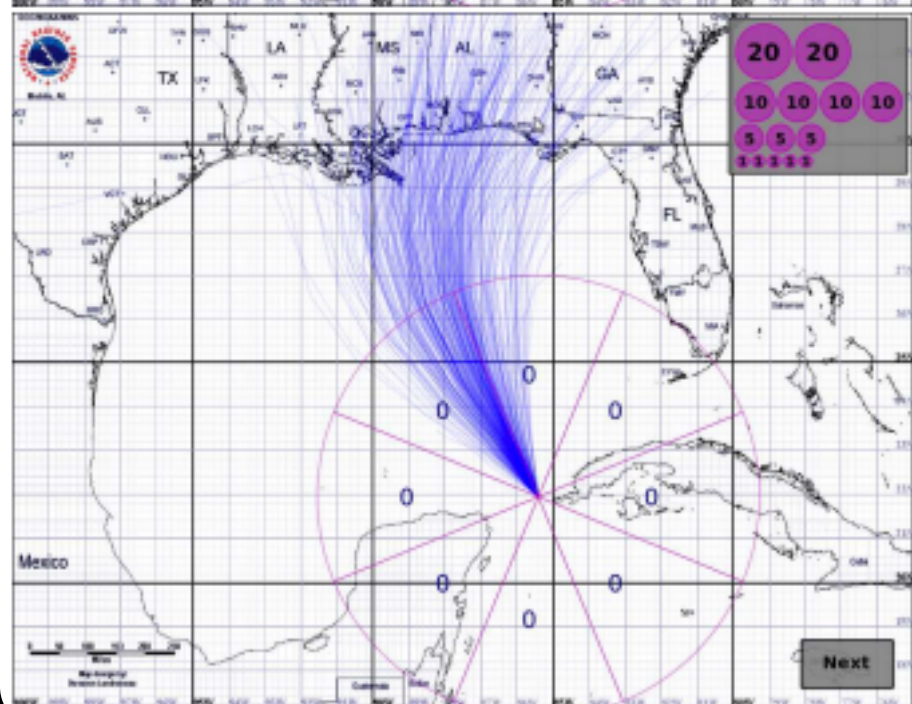
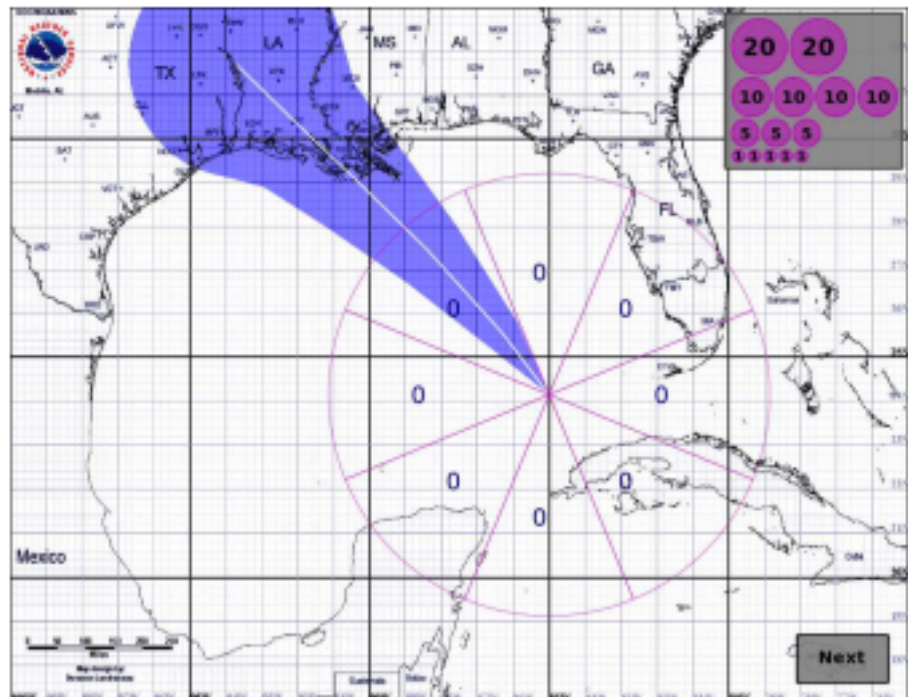
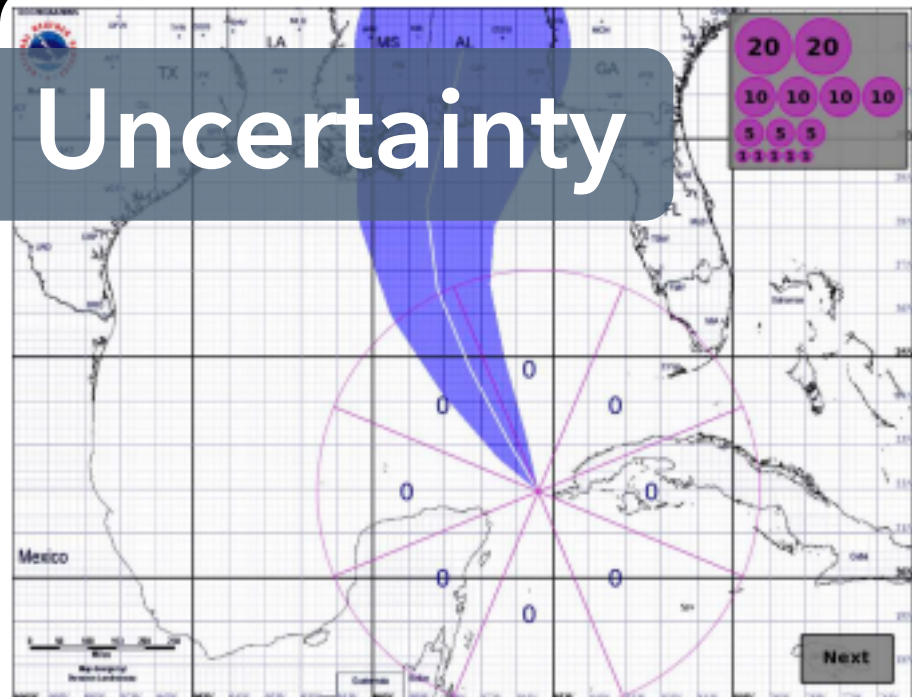
User ID	21721
Friends	<input type="checkbox"/> 266
Age	??
Gender	<input type="checkbox"/> Female
Status	<input type="checkbox"/> Single
Location	San Francisco, CA
Hometown	Lancaster, PA
Occupation	researcher: social networks, identity, context
Interests	apophenia, observing people, culture, questioning power, reading, buddhism, ipseity, computer-mediated communication, social networks, technology, anthropology, stumping
Music	psytrance/goa/trance [Infected Mushroom, Son Kite... Iboga/Digital Structures], Ani Difranco, downtempo, Thievery Corporation, Beth Orton, Morcheeba, Ween, White Stripes
Books	Authors: Erving Goffman, Stanley Milgram, Jeanette Winterson, Eric Schlosser, Leslie Feinberg, Dorothy Allison, Italo Calvino, Hermann Hesse
TV Shows	??
Movies	Koyaanisqatsi, Amelie, Waking Life, Tank Girl, The Matrix, Clockwork Orange, American Beauty, Fight Club, Boys Don't Cry
Member Since	??
Last Login	2003-10-21
Last Updated	2003-10-21
About	[Some know me as danah...]

I'm a geek, an activist and an academic, fascinated by people and society. I see life as a very large playground and enjoy exploring its intricacies. I revel in life's chaos, while simultaneously providing my own insane element.

My musings:  
<http://www.zephoria.org/thoughts/>

**Want to Meet** Someone who makes life's complexities seem simply elegant.

# Uncertainty

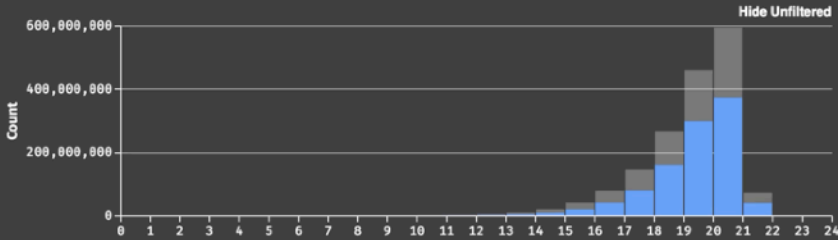


# Scalability

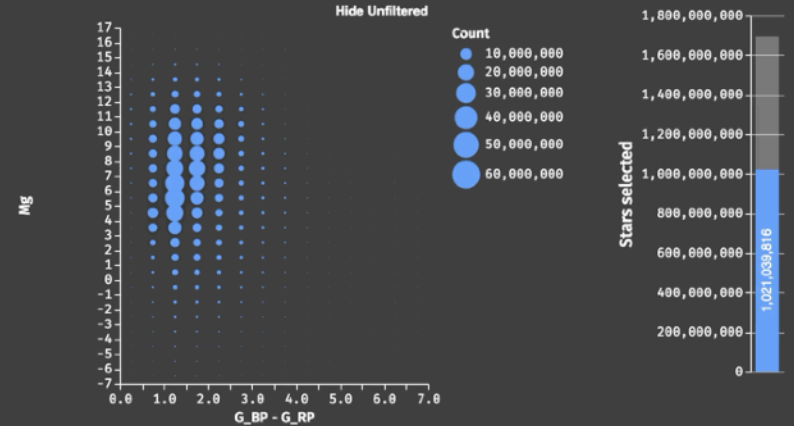
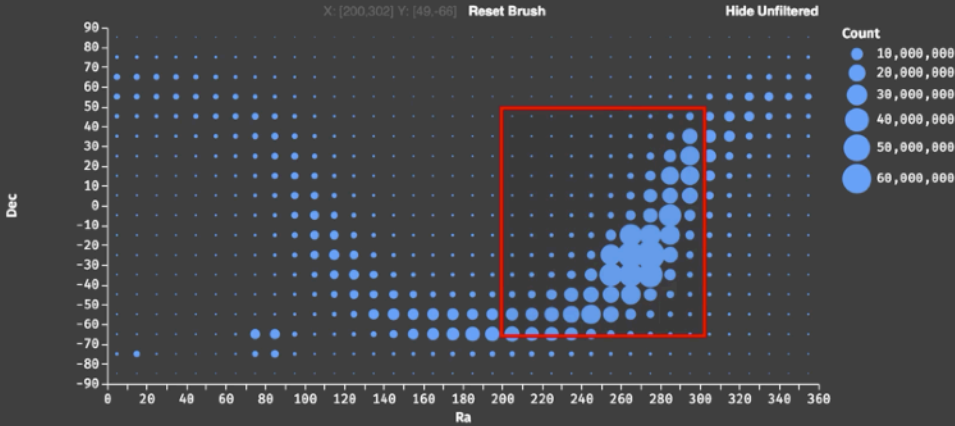
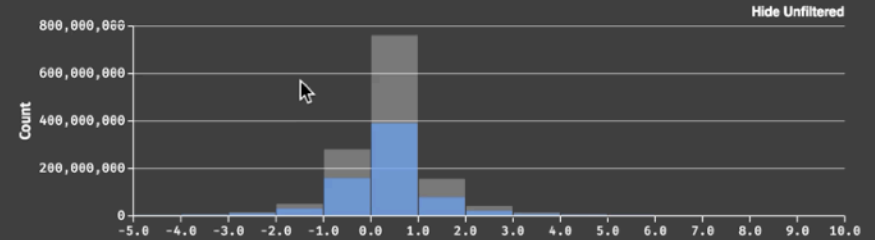
localhost:1234



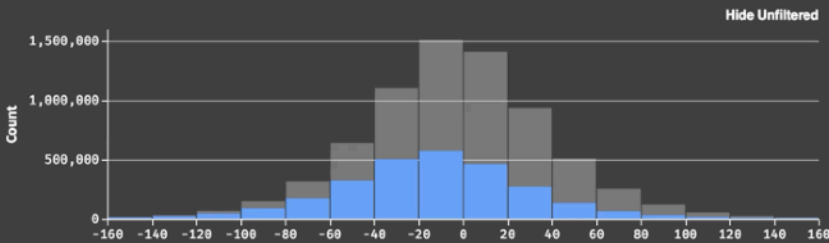
Magnitude



Parallax



Radial Velocity



Interactive querying of 1.7B stars  
(1.2TB) in Falcon [Moritz et al. 2019]

# Course Mechanics

# You should expect to:

- 1 *Evaluate and critique* visualization designs
- 2 *Learn* visualization techniques & theory
- 3 *Implement* interactive data visualizations
- 4 *Develop* a substantial visualization project

# Instructors

cse442@cs

## *Instructor*

**Jeffrey Heer**

OH: *Tue 10-11am*

## *Teaching Assistants*

**Abhishek Babu**

OH: *Online / By Appt.*

**Reiden Chea**

OH: *Fri 1-2pm*

**Vishal Devireddy**

OH: *Wed 2-3pm*

**Firn Teanklin**

OH: *Online / By Appt.*

**Han Zhang**

OH: *Online / By Appt.*

**Yueqian Zhang**

OH: *Mon 2:30-3:30pm*

# Abhishek Babu

**Email** babua@cs

**Office Hours** By appointment



I'm an MS student in the BS/MS program and I'm interested in machine learning and data engineering.

Relevant technical skills: JavaScript, TypeScript, HTML/CSS, D3.js, general web dev (and other data wrangling libraries in Python)

I enjoy Spikeball! (check out Husky Roundnet Club)

# Reiden Chea

Email reidec@cs

Office Hours Fri 1-2pm



Undergraduate final quarter student

## Interests:

- ML/AI with poli sci/talent sourcing applications
- Classification pipelines/models

## Experience:

- Design process, HTML/CSS/JS
- Observable, Processing (P5)

## Hobbies:

- 3D printing
- Baking
- Powerlifting
- Twisty puzzling





# Vishal Devireddy

**Email** vishald@cs

**Office Hours** Wed 2-3pm

I'm a BS/MS student interested in interactive web development, HCI, and cool graphs.

## Ask me about...

- JavaScript + CSS
- Web design
- Web accessibility
- Observable
- D3
- Idyll





# Nussara (Firn) Tieanklin

*nussara@cs.washington.edu*

**Office hour:** *By appointment*

## Research

- Seattle Community Networks  
providing internet access to resource-constrained community
- Evaluate the impact of Air Pollution on Grab motorcycle drivers/riders

## Technical Experience

User research, Design process, Data Management, Web-programming

## (Covid) Hobbies

- Gardening
- Badminton
- Playing computer games
- Travelling

# Han Zhang (she/her)

2nd year, CSE

[micohan@cs.washington.edu](mailto:micohan@cs.washington.edu)

## Skills

- Familiar with many data visualization tools, such as Tableau, D3.js, Chart.js, ggplot2, Seaborn, Plotly, etc.
- Experienced in designing interactive visualizations

## Other interests

- Badminton
- Play piano (recently like to play Mariage D'Amour)



# Yueqian Zhang

OH: Monday 2:30 pm - 3:30 pm

I am a BS/MS student.

I am interested in **Accessibility** and **Graphics**.

Outside of CS I enjoy **design** and **drawing**.

Come talk to me! I'd love to meet everyone :)

Some of my artworks:



# Lectures & Office Hours

All lectures will be recorded / live-streamed.  
Please attend lecture in real-time if possible.  
Do **NOT** attend in-person if you feel ill.

All office hours will be held on Zoom.  
Links are available on Canvas.

We strongly encourage using Ed to post questions and seek help!

# Readings

From books, notebooks, and linked articles.

Material in class will loosely follow readings.

Readings should be read by start of class.

Complete non-scored quizzes on Canvas.

Post comments on class forum.

One comment or peer reviews each week.

Post comments by Friday 11:59pm.

You have 1 discussion “pass” for the quarter.

# Textbook

*An Introduction to Designing With D3*



O'REILLY®

Scott Murray

## Interactive Data Visualization for the Web, 2nd Edition

*For learning D3!*

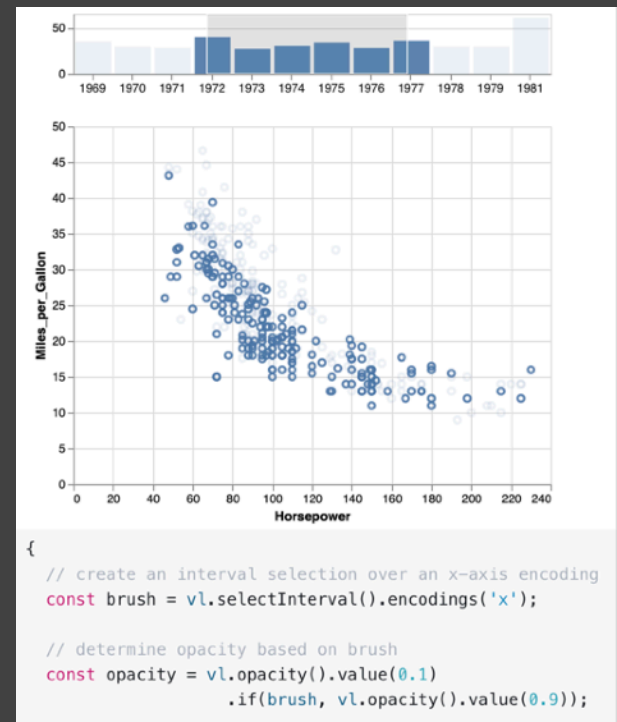
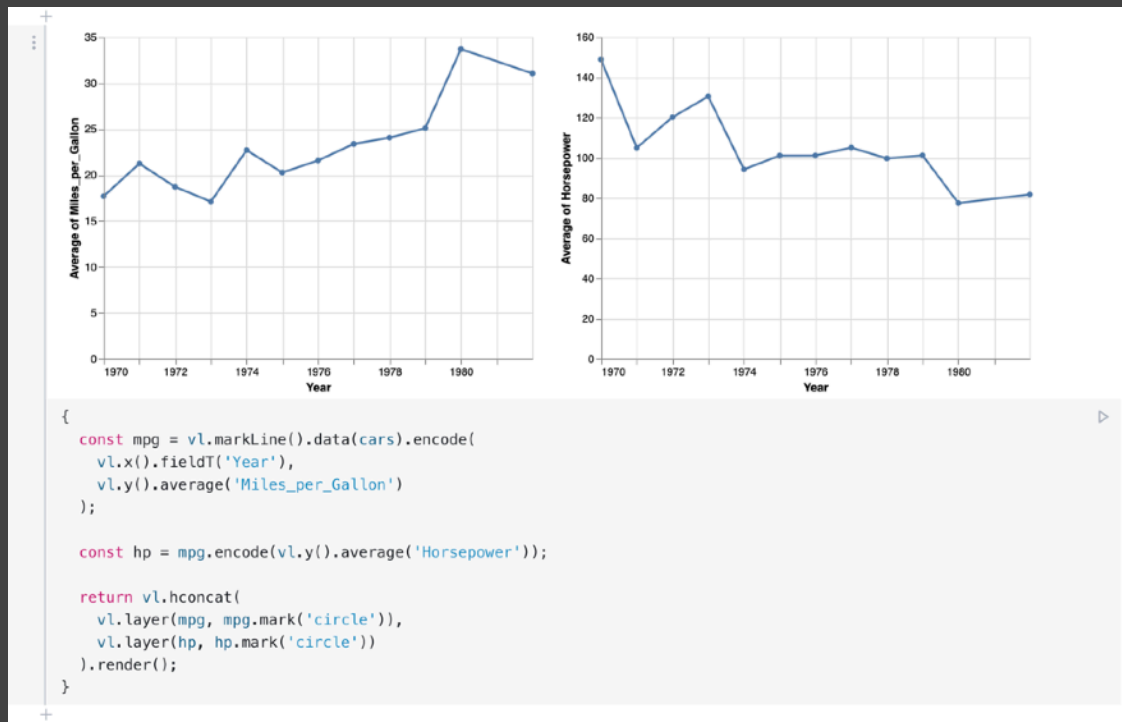
Book available online.

Code / examples on GitHub.

We will be using **D3 v7**.

<https://d3js.org>

# Interactive Vega-Lite Notebooks



Hands-on engagement with course concepts and tools using Observable (JavaScript) notebooks.



# Assignments

**CP** Class Participation (10%)

**A1** Expository Visualization (10%) - *Due 1/12*

**A2** Deceptive Visualization (15%) - *Due 1/26*

Peer Review (5%) - *Due 1/31*

**A3** Interactive Prototype (20%) - *Due 2/14*

Peer Review (5%) - *Due 2/21*

**FP** Final Project (35%)

Proposal - *Due 2/18*

Demonstration Video - *Due 3/9*

Final Prototype - *Due 3/14*

# Grading Philosophy

We use a 10 point scale for assignment grading.

A score of 9.0 means you met the requirements, and maps to an "A" (~3.7 GPA). Scores above 9.0 reward work that goes above and beyond.

There is subjectivity in visualization design and assignments differ in many regards!

We provide high-level rubrics and also consider and partially rank the larger assignment pool.

# Final Project

Produce an **explorable visual explanation**

Initial **prototype** and **design review**

**Final deliverables** and **video presentation**

Submit and **publish online** (GitHub)

Projects from **previous classes** have been:

- Published as research papers
- Shared widely (some in the New York Times!)
- Released as successful open source projects

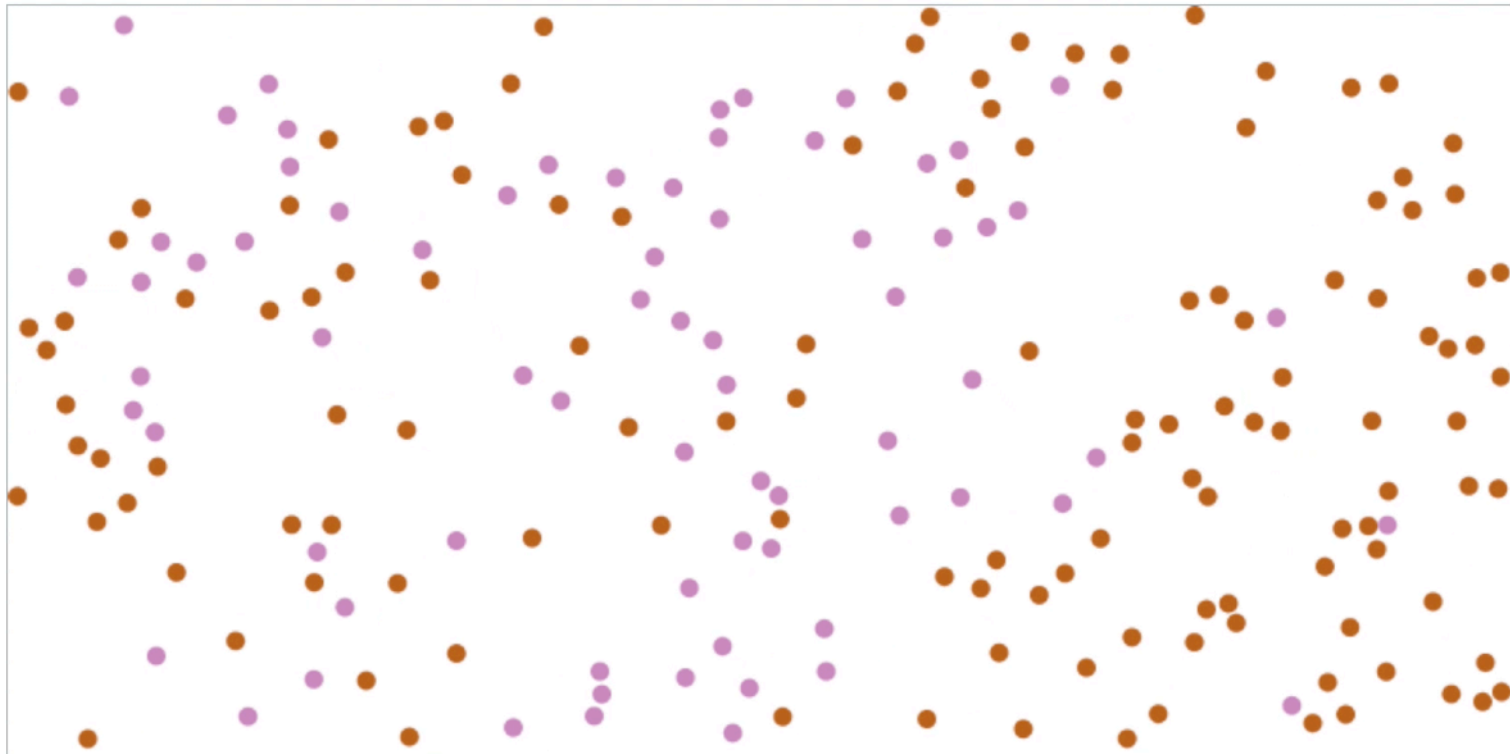
# Why outbreaks like coronavirus spread exponentially, and how to “flatten the curve”

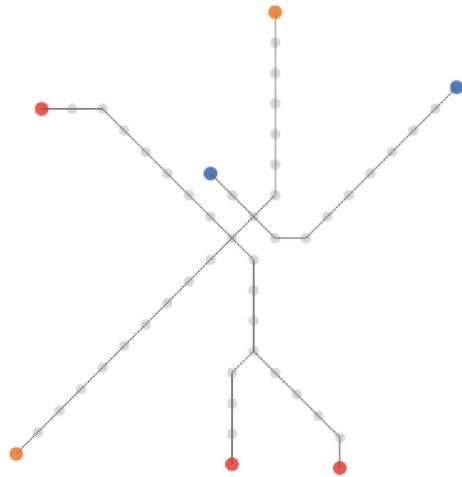
Harry Stevens, Washington Post 2020

## Count

Recovered **73**  
Healthy **0**  
Sick **127**

## Change over time

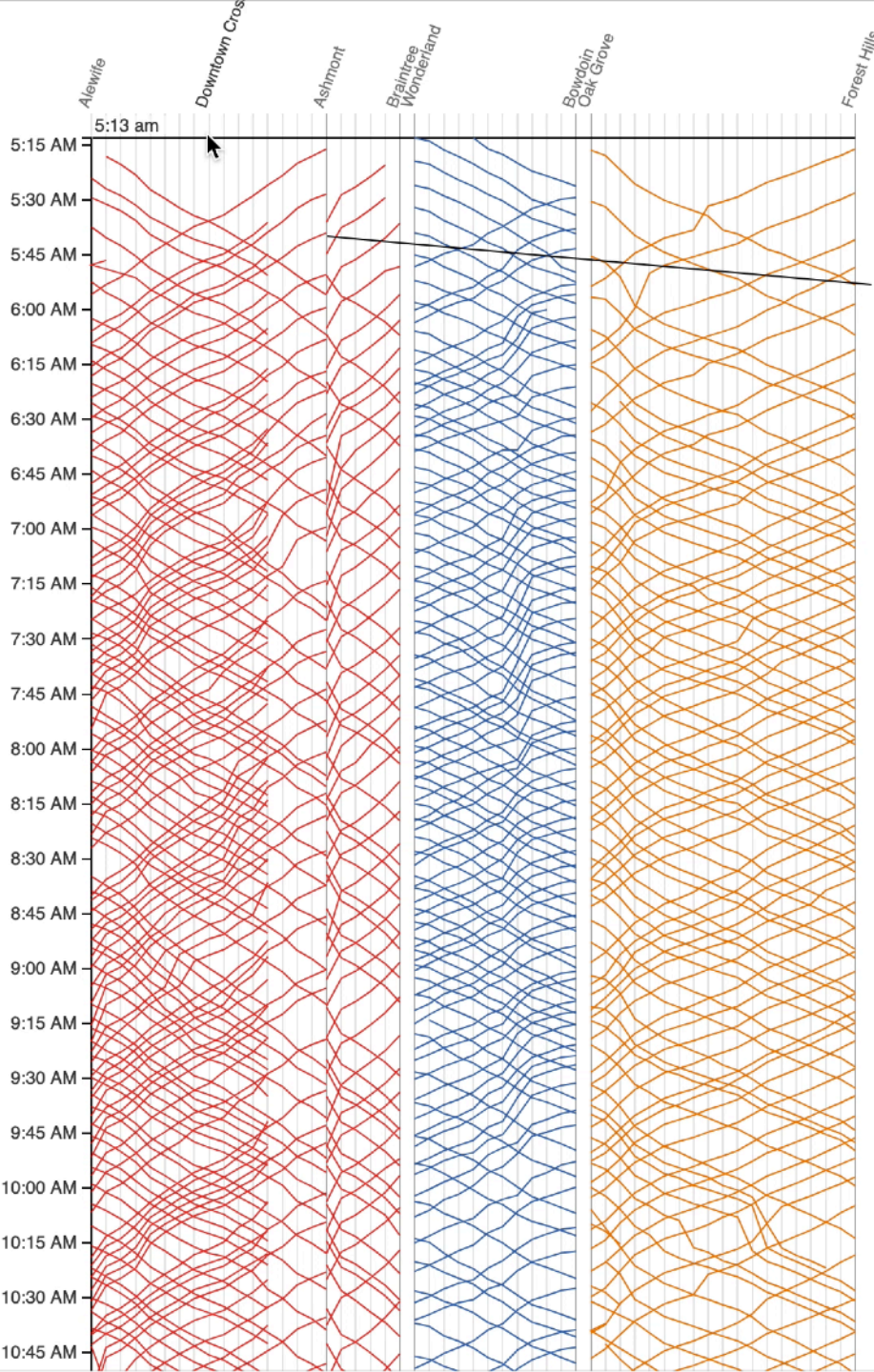




Locations of each train on the [red](#), [blue](#), and [orange](#) lines at 5:13 am. Hover over the diagram to the right to display trains at a different time.

Trains are on the right side of the track relative to the direction they are moving.

See the [morning rush-hour](#), [midday lull](#), [afternoon rush-hour](#), and the [evening lull](#).



Service starts at 5AM on Monday morning. Each line represents the path of one train. Time continues downward, so steeper lines indicate slower trains.

Since the red line splits, we show the Ashmont branch first then the Braintree branch. Trains on the Braintree branch "jump over" the Ashmont branch.

Train frequency increases around 6:30AM as morning rush hour begins.

# MBTA Viz

Barry & Card

# KEYBOARD WALKING

Passwords with a “keyboard walking” pattern start at an arbitrary key, then move in a direction (usually right or down) while continuing to hit keys. Sometimes this is combined with holding down the `SHIFT` key, so that some characters are uppercase or symbols to improve complexity.

While the generated password may seem to be random and unhackable, password crackers [check for these keyboard patterns](#) and guess them early on.

Many passwords in the leaked passwords dataset have a spatial pattern. Other than the numeric passwords like `123456`, common keyboard walking offenders include `qwerty` and `1qaz@wsx`.

Password:  Guess time: 1 minute



## Semantic Passwords

Vishal Devireddy (CSE 512, Spring '21)

**Questions?**

# Observable + Data Tutorial

**Friday Jan. 7, 4:30-6pm on Zoom**

Introduction to Observable notebooks, JavaScript basics, and data management and transformation, led by Firn.

Zoom link is available on Canvas.

The tutorial will be recorded.



# A1: Expository Visualization

**Design a static visualization for a data set.**

The climate of a place can have a tremendous impact on people's lived experience. You will examine average monthly climate measurements for six major U.S. cities, roughly covering the edges of the continental United States.

You must choose the message you want to convey. What question(s) do you want to answer? What insight do you want to communicate?

# A1: Expository Visualization

Pick a **guiding question**, use it to title your vis.

Design a **static visualization** for that question.

You are free to **use any tools** (inc. pen & paper).

**Deliverables** (upload via Canvas; see A1 page)

Image of your visualization (PNG or JPG format)

Short description + design rationale ( $\leq 4$  paragraphs)

Due by **11:59 pm, Wed Jan 12.**