The Value of Visualization

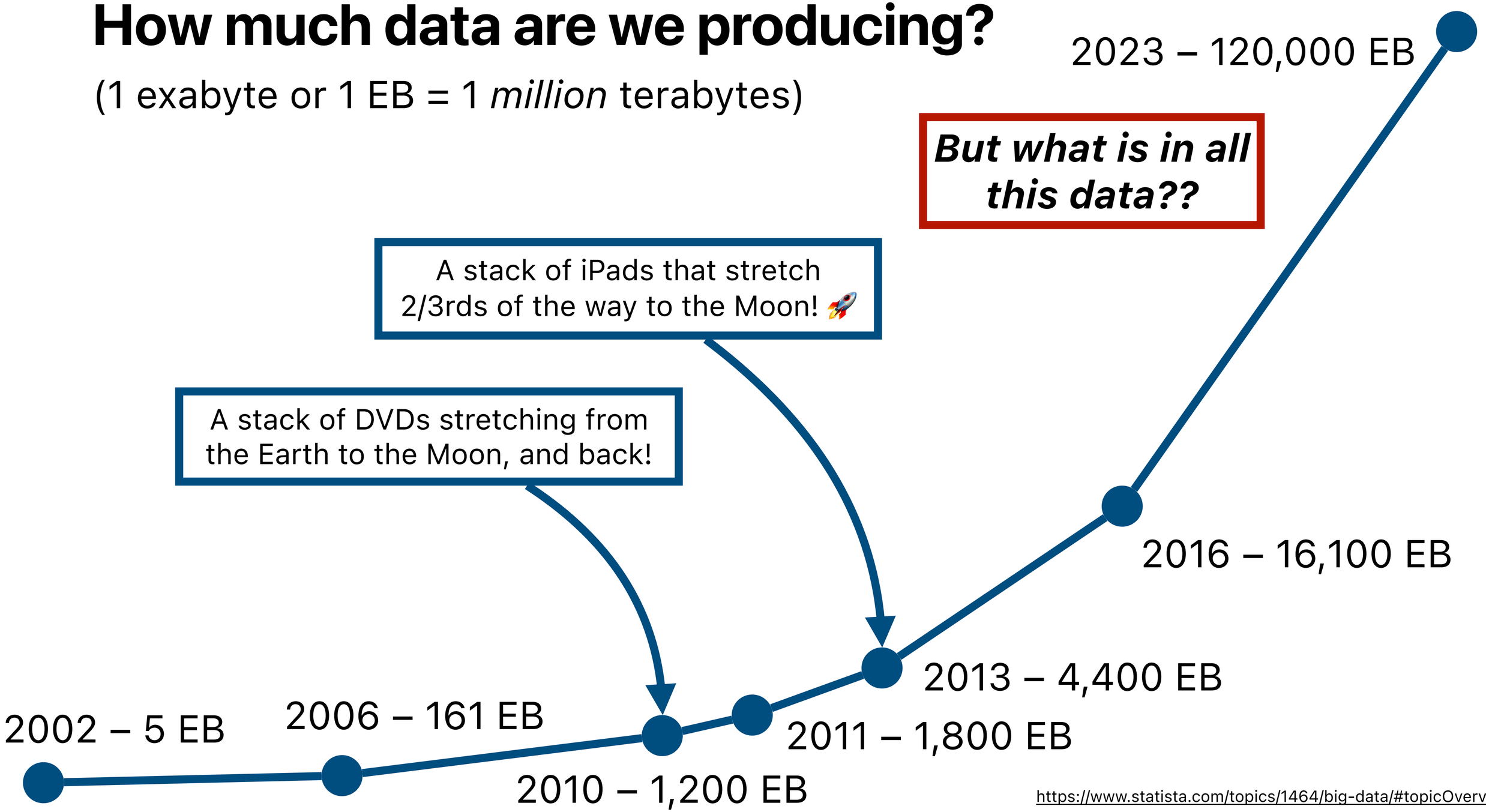
DSC 106: Data Visualization

Sam Lau

UC San Diego

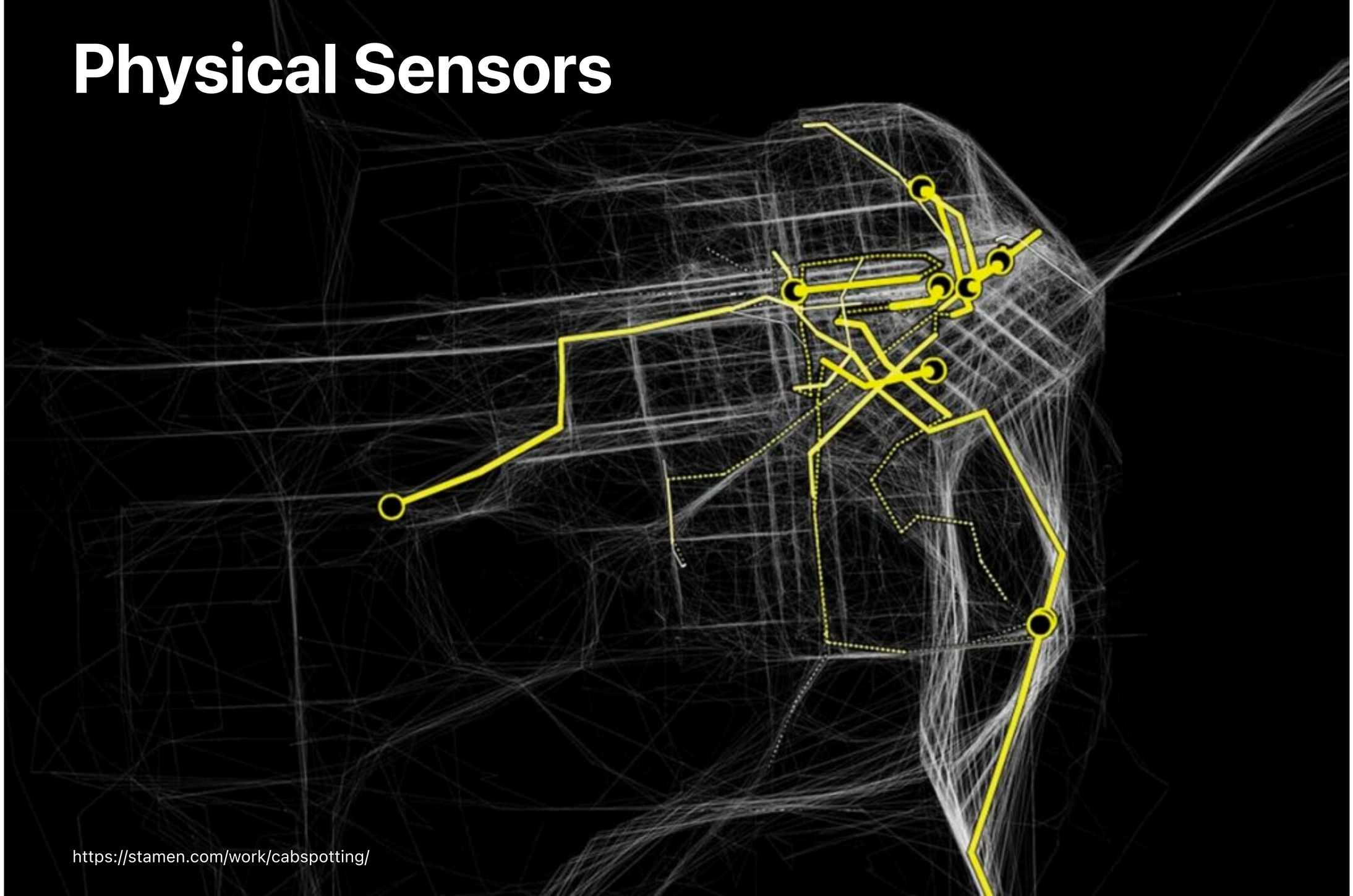
How much data are we producing?

(1 exabyte or 1 EB = 1 *million* terabytes)



https://www.statista.com/topics/1464/big-data/#topicOverview

Physical Sensors



https://stamen.com/work/cabspotting/

Health and 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! e 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,

"free" to whom?

... because now we really do have **essentially free and ubiquitous data**. So the complimentary scarce factor is the ability "ubiquitous" about whom? d extract value from it."

"value" to whose benefit? an, 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 ...

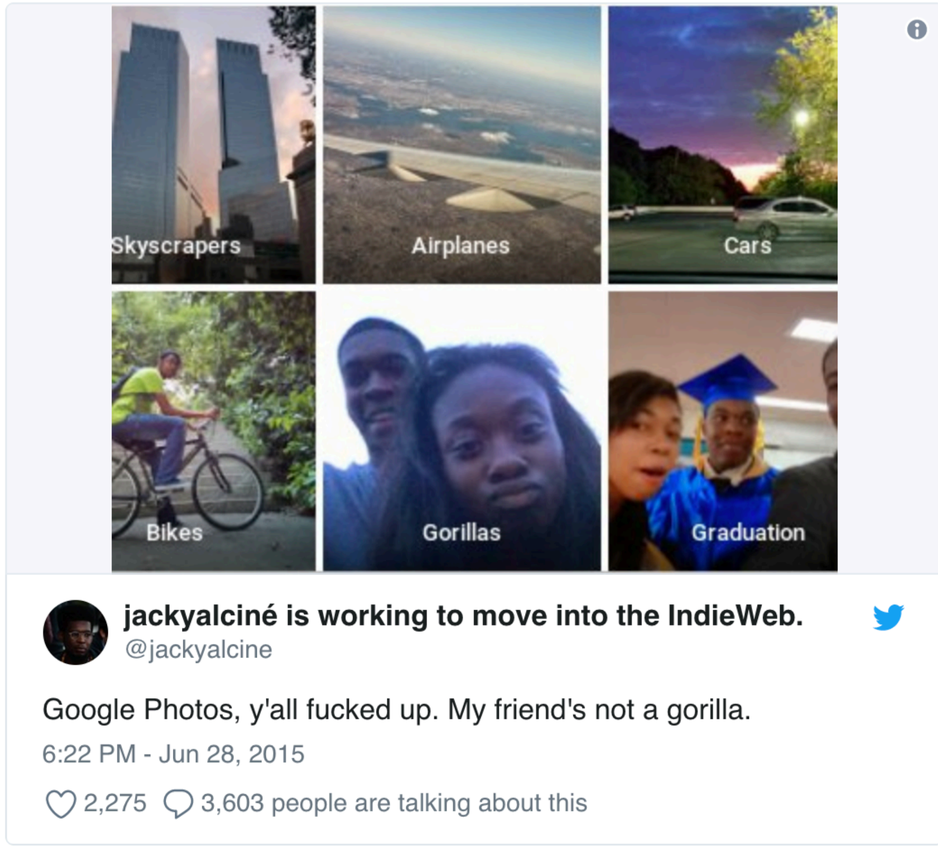
TEXT SIZE − +

High potential for data abuse…

Inequality

Rise of the racist robots – how AI is learning all our worst impulses

There is a saying in computer science: garbage in, garbage out. When we feed machines data that reflects our prejudices, they mimic them – from antisemitic chatbots to racially biased software. Does a horrifying future await people forced to live at the mercy of algorithms?



…amplified by "big data" and ML systems.

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]

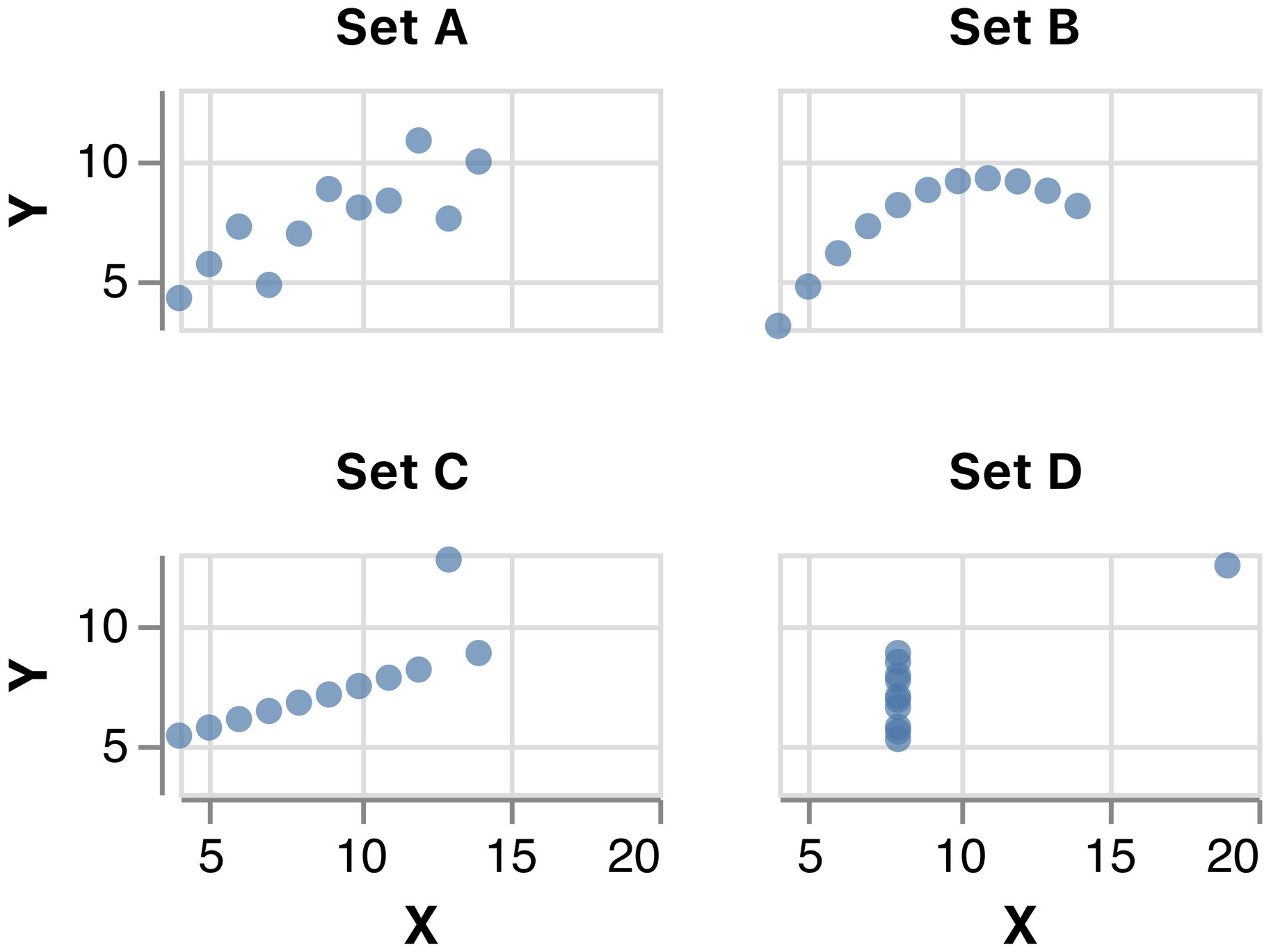
Set A		Set B		Set C		Set D	
X	Y	X	Y	X	Y	X	Y
10	8.04	10	9.14	10	7.46	8	6.58
8	6.95	8	8.14	8	6.77	8	5.76
13	7.58	13	8.74	13	12.74	8	7.71
9	8.81	9	8.77	9	7.11	8	8.84
11	8.33	11	9.26	11	7.81	8	8.47
14	9.96	14	8.1	14	8.84	8	7.04
6	7.24	6	6.13	6	6.08	8	5.25
4	4.26	4	3.1	4	5.39	19	12.5
12	10.8	12	9.11	12	8.15	8	5.56
7	4.82	7	7.26	7	6.42	8	7.91
5	5.68	5	4.74	5	5.73	8	6.89

Summary Statistics **Linear Regression**

$u_X = 9.0$ $\sigma_X = 3.32$ $Y^2 = 3 + 0.5\ X$

$u_Y = 7.5$ $\sigma_Y = 2.03$ $R^2 = 0.67$

[Anscombe 1973]


Set A
Set B
Set C
Set D
Y
10
5
5
10
15
20
X

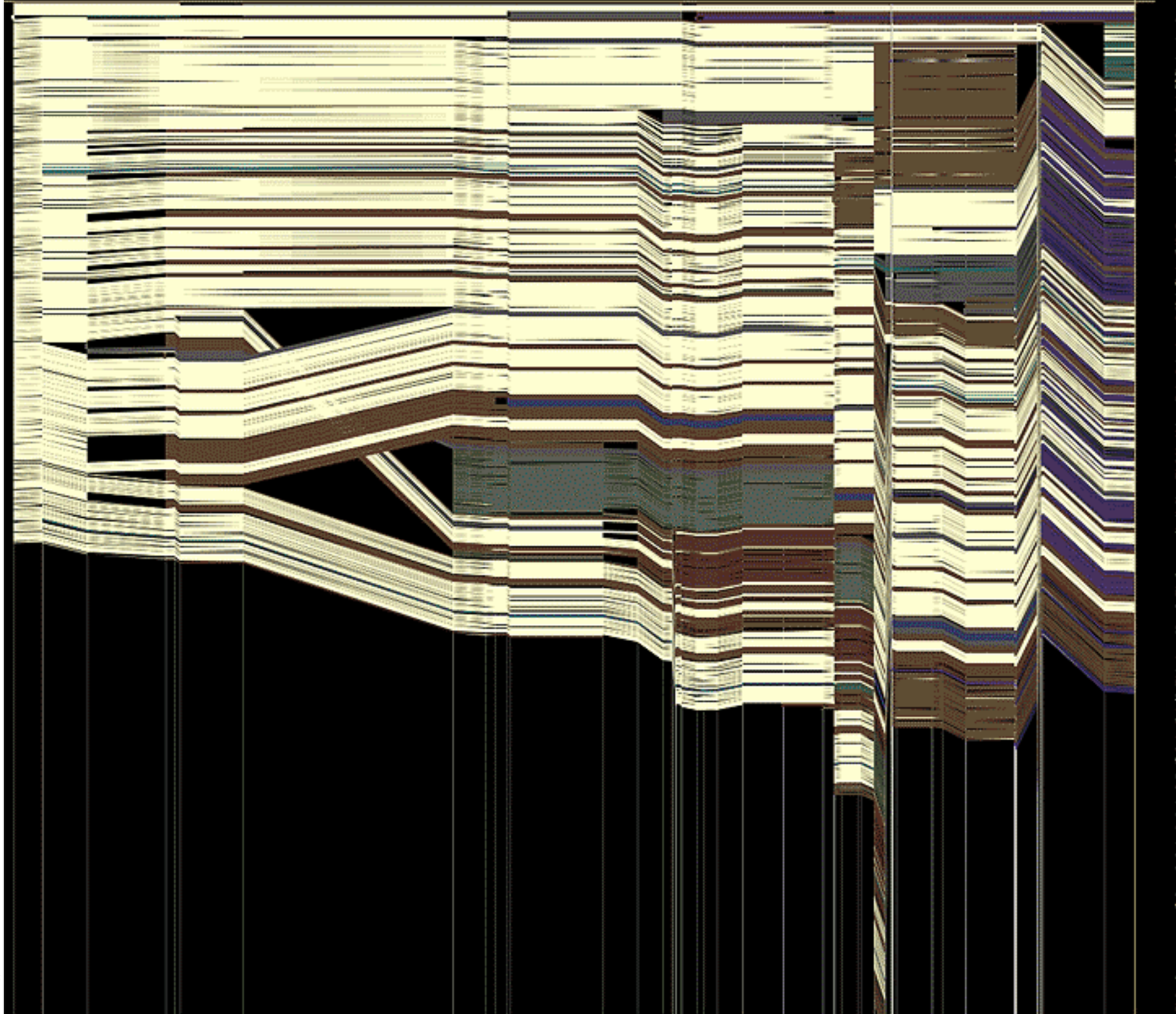
Wikipedia History Flow

Height = amount of text

Color = author

What do you notice?

tryclassbuzz.com: wiki



http://hint.fm/projects/historyflow/

http://hint.fm/projects/historyflow/

Why create visualizations?

Visit https://tryclassbuzz.com/ and make an account if needed, then login.

Code: why-vis

Why create visualizations?

Your contributions:

- understand complex data
- communicating about data
- explain findings to non-technical audiences

The Value of Visualization

Record information

- Blueprints, photographs, seismographs, …

Analyze data to support reasoning **(exploratory visualization)**

- Develop and assess hypotheses
- Find patterns / Discover errors in data
- Expand memory

Communicate information to others **(explanatory visualization)**

- Share and persuade
- Collaborate and revise

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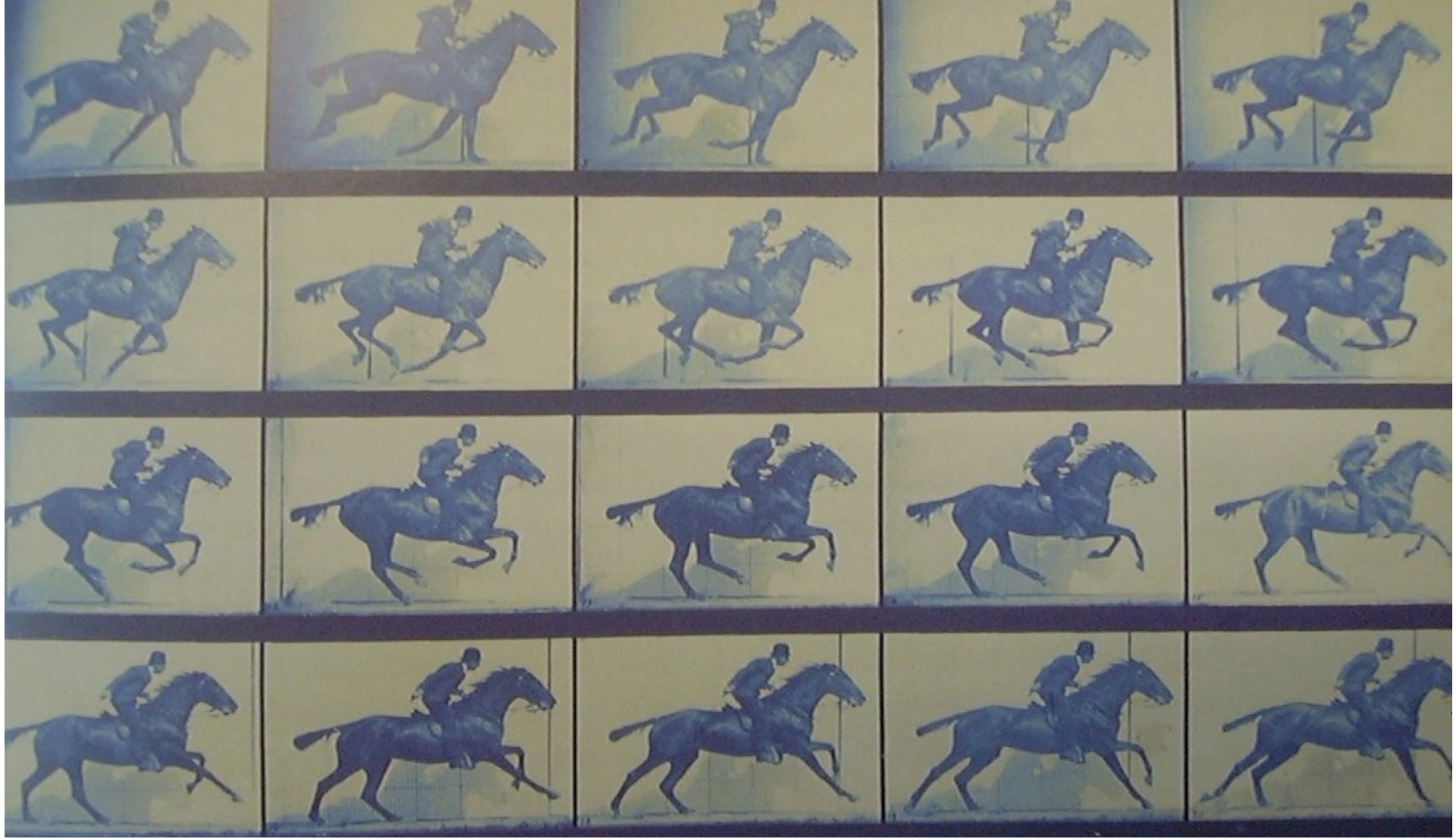
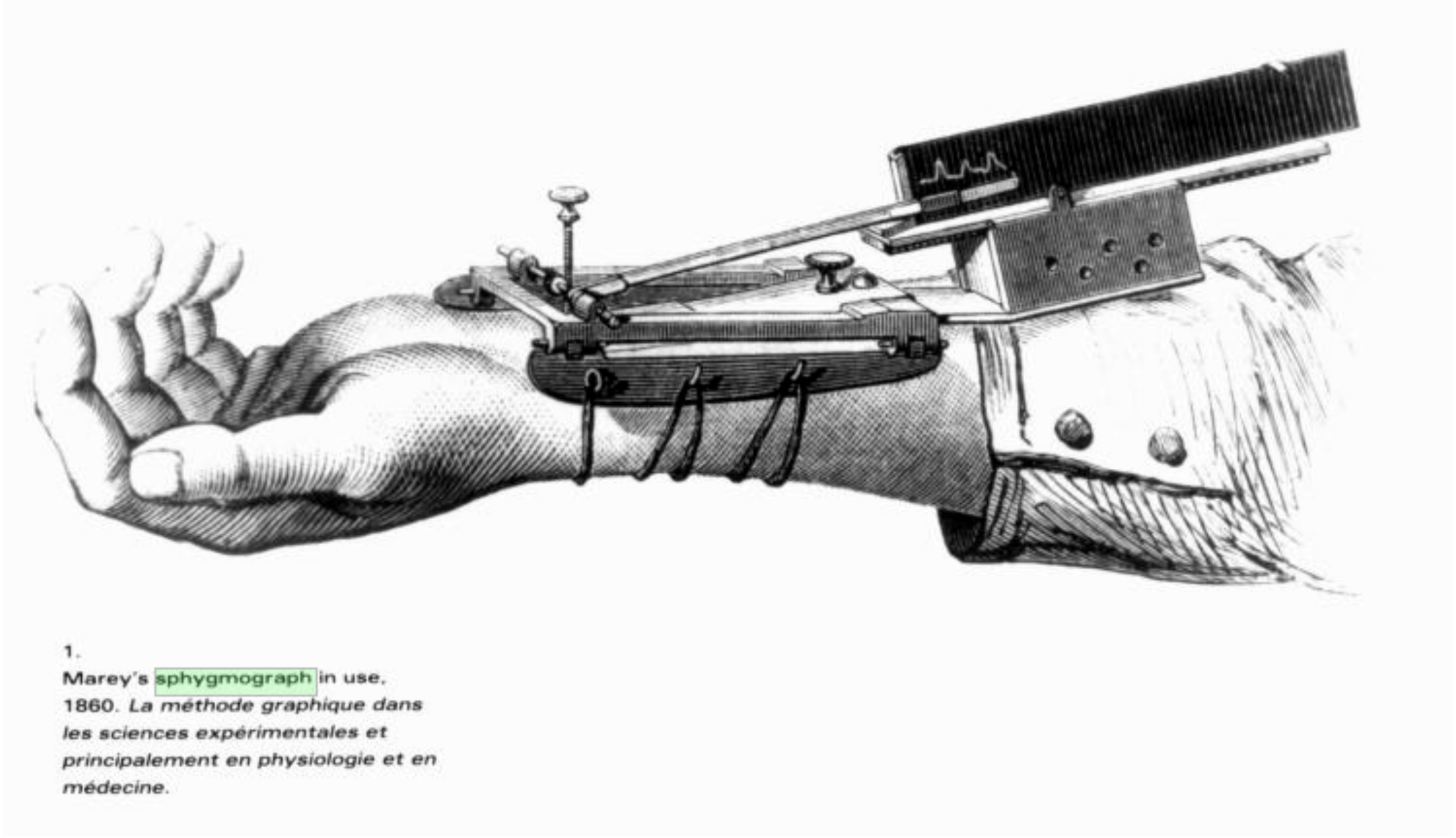
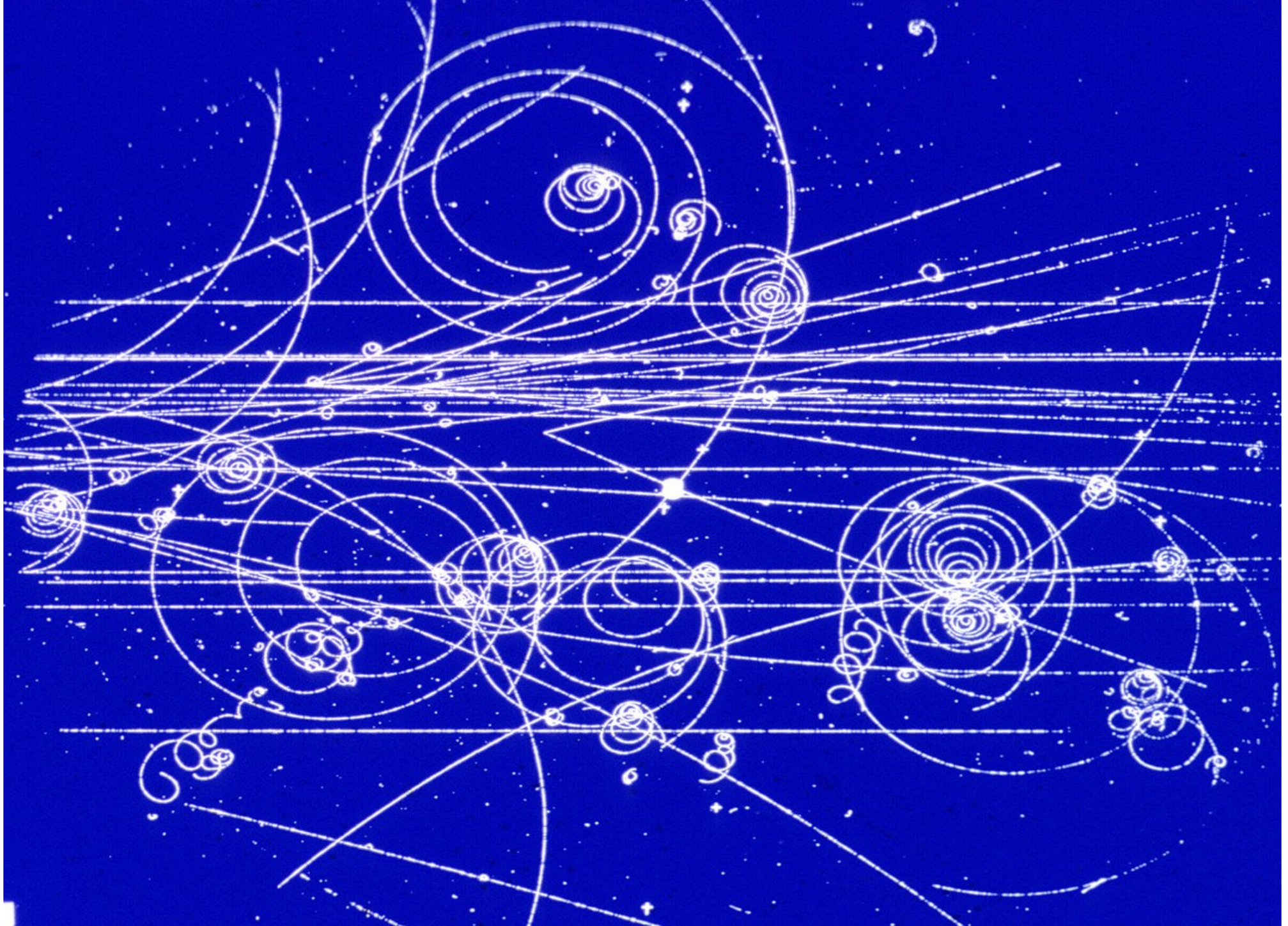


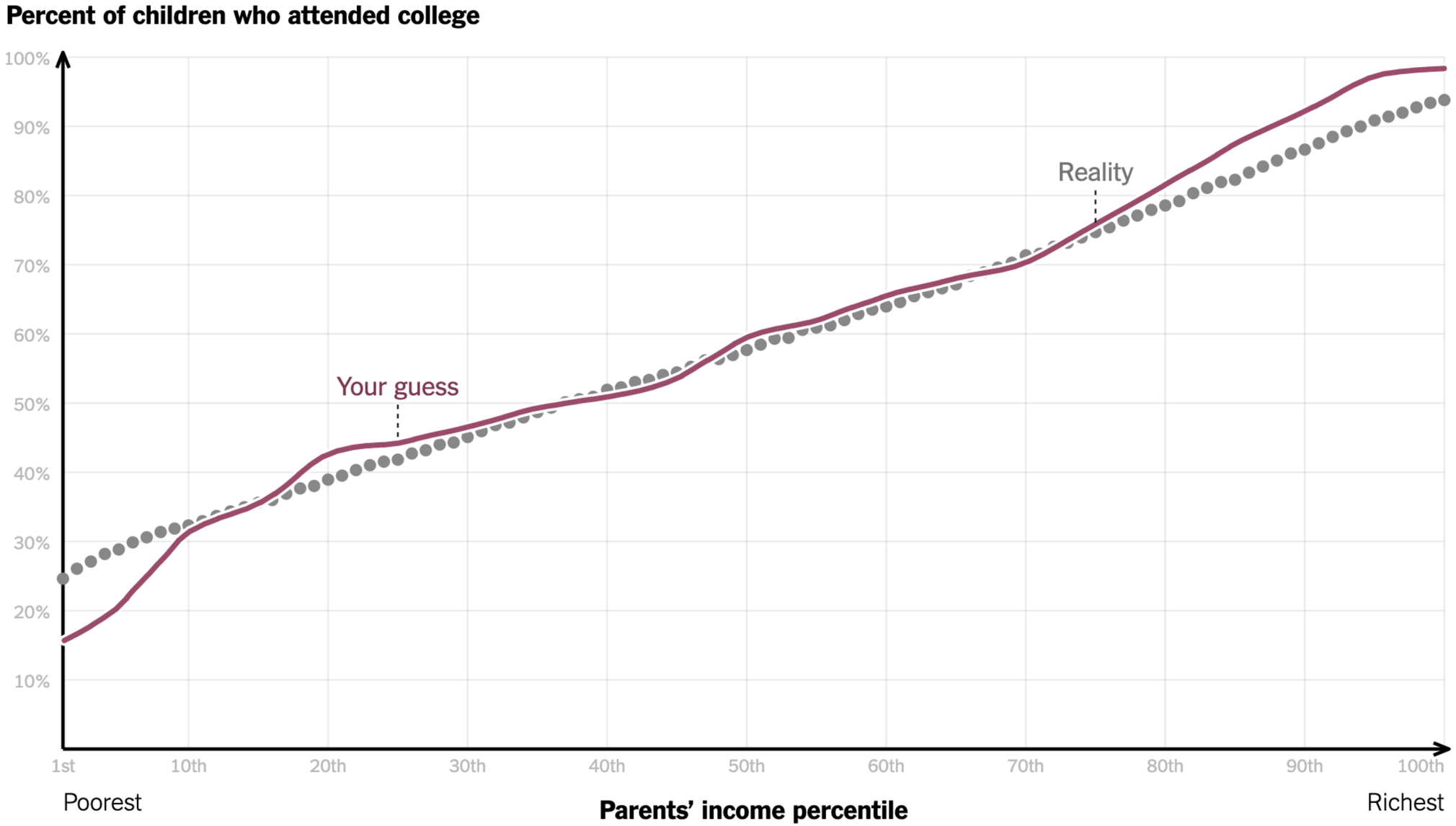
Gallop, Bay Horse “Daisy” [Muybridge]



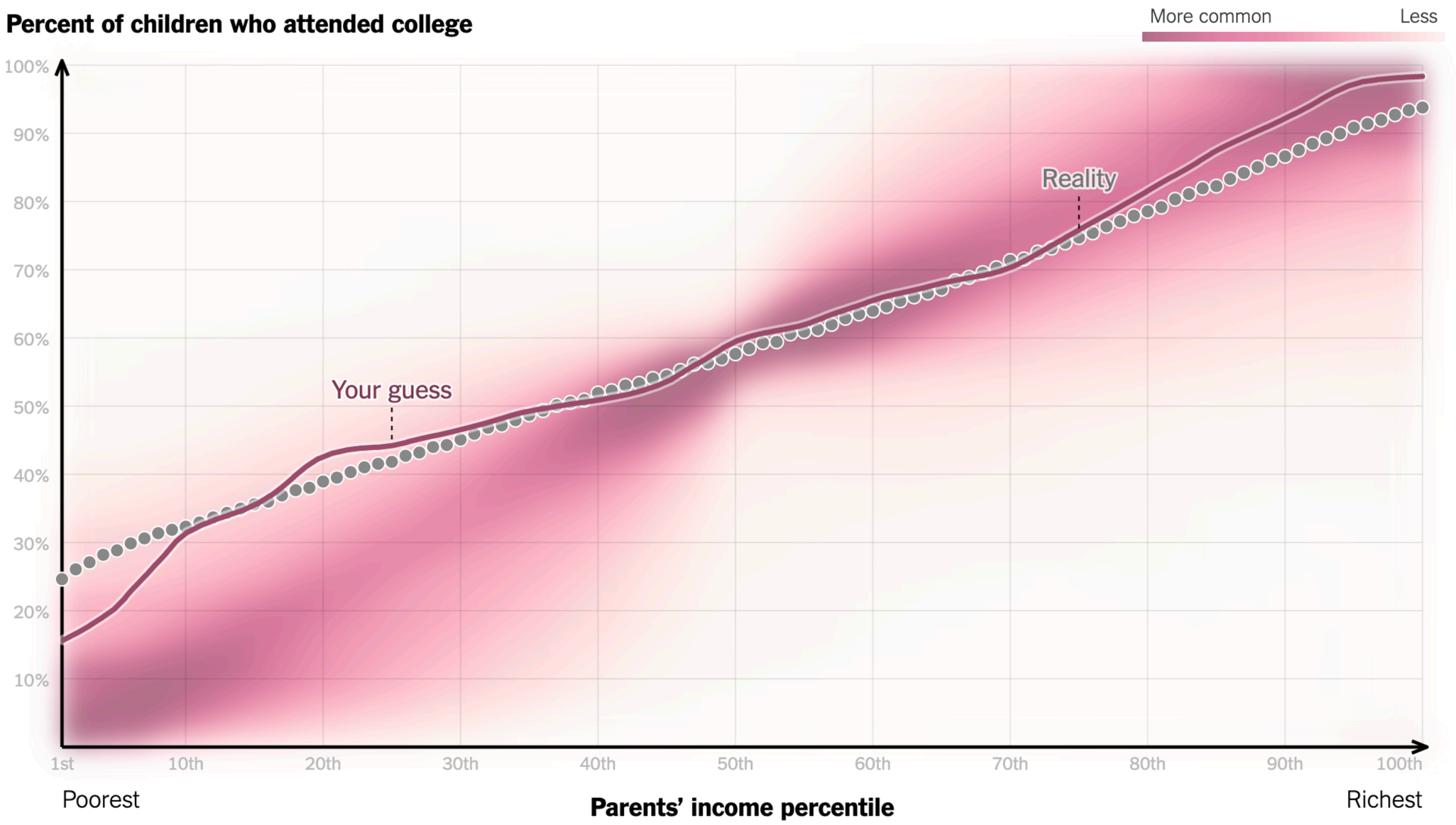
1.
Marey's sphygmograph in use,
1860. *La méthode graphique dans les sciences expérimentales et principalement en physiologie et en médecine.*

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





You Draw It: How Family Income Predicts Children's College Chances
[New York Times, May 28, 2015]



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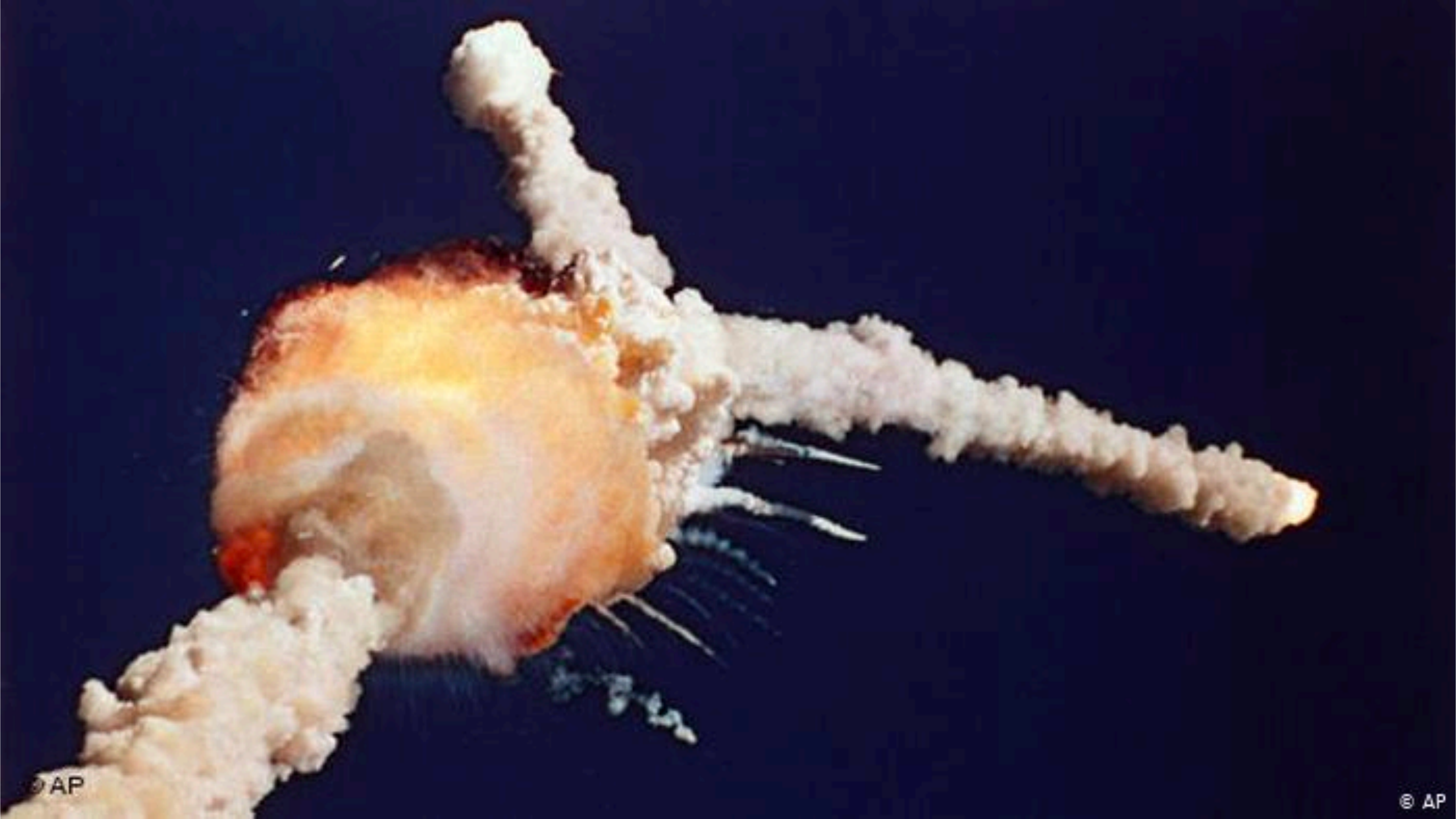

© AP
© AP

HISTORY OF O-RING DAMAGE ON SRM FIELD JOINTS

	SRM No.	Cross Sectional View: Erosion Depth (in.)	Cross Sectional View: Perimeter Affected (deg)	Cross Sectional View: Nominal Dia. (in.)	Top View: Length Of Max Erosion (in.)	Top View: Total Heat Affected Length (in.)	Clocking Location (deg)
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
- 2 CASE JOINTS (80°), (110°) ARC
- MUCH WORSE VISUALLY THAN SRM-22

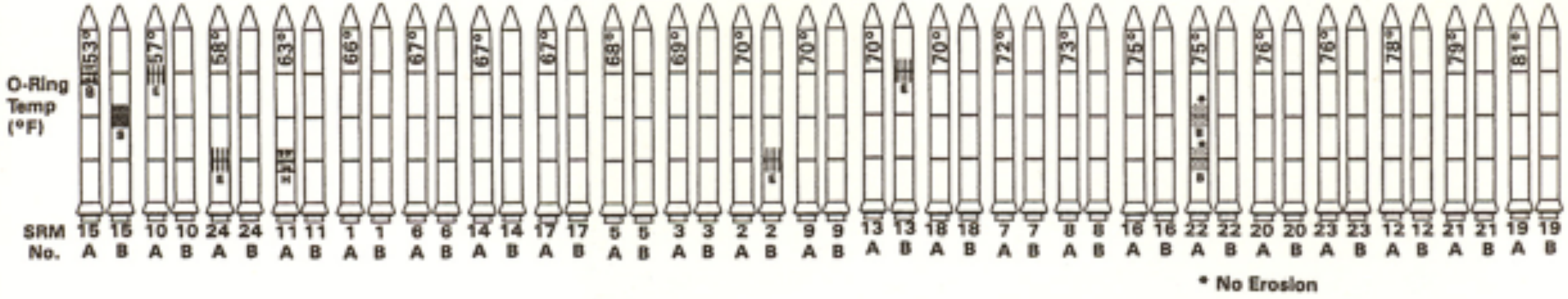
SRM 22 BLOW-BY
- 2 CASE JOINTS (30-40°)

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

HISTORY OF O-RING TEMPERATURES (DEGREES-F)

MOTOR	M&T	AMB	O-RING	WIND
DM-1	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 27	10 MPH 25 MPH

2 of 13 pages of material faxed to NASA by Morton Thiokol [from Tufte 1997]


O-Ring Temp (°F)
53°
57°
58°
63°
66°
67°
67°
67°
68°
69°
70°
70°
70°
70°
72°
73°
75°
75°
76°
76°
78°
79°
81°
SRM No.
15 A 15 B 10 A 10 B 24 A 24 B 11 A 11 B 1 A 1 B 6 A 6 B 14 A 14 B 17 A 17 B 5 A 5 B 3 A 3 B 2 A 2 B 9 A 9 B 13 A 13 B 18 A 18 B 7 A 7 B 8 A 8 B 16 A 16 B 22 A 22 B 20 A 20 B 23 A 23 B 12 A 12 B 21 A 21 B 19 A 19 B
* No Erosion


O-Ring Temp (°F)
53°
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68°
69°
70°
70°
70°
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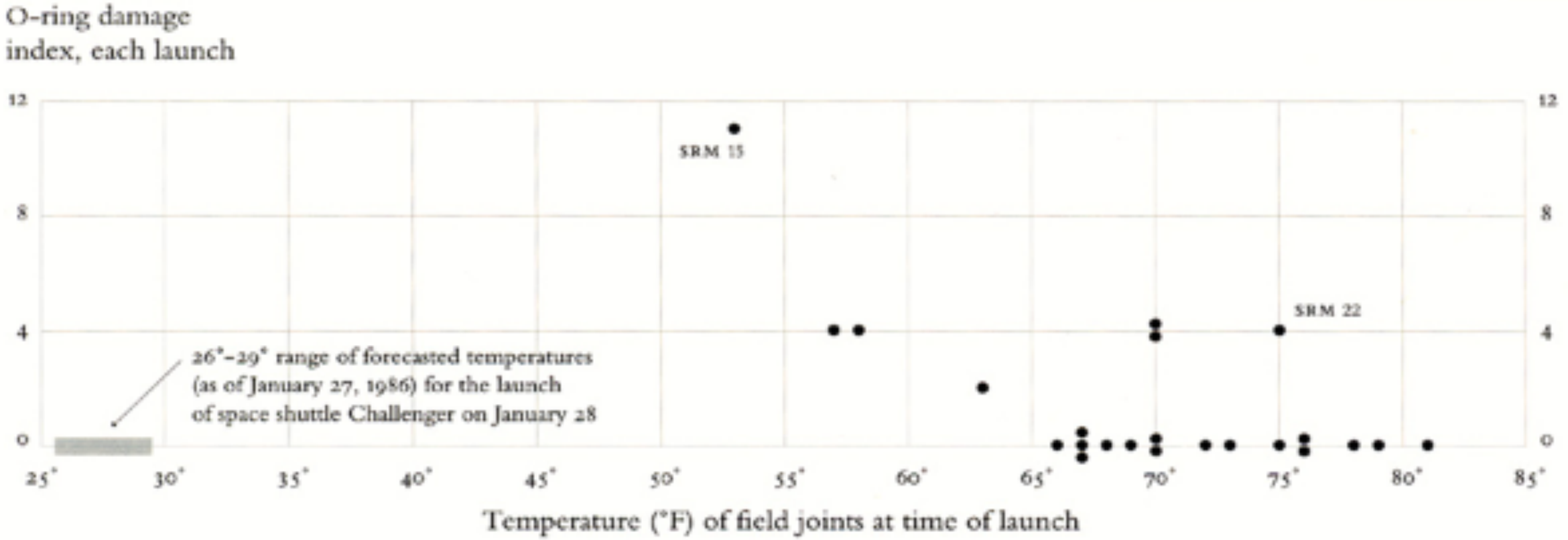
15 A 15 B 10 A 10 B 24 A 24 B 11 A 11 B 1 A 1 B 6 A 6 B 14 A 14 B 17 A 17 B 5 A 5 B 3 A 3 B 2 A 2 B 9 A 9 B 13 A 13 B 18 A 18 B

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

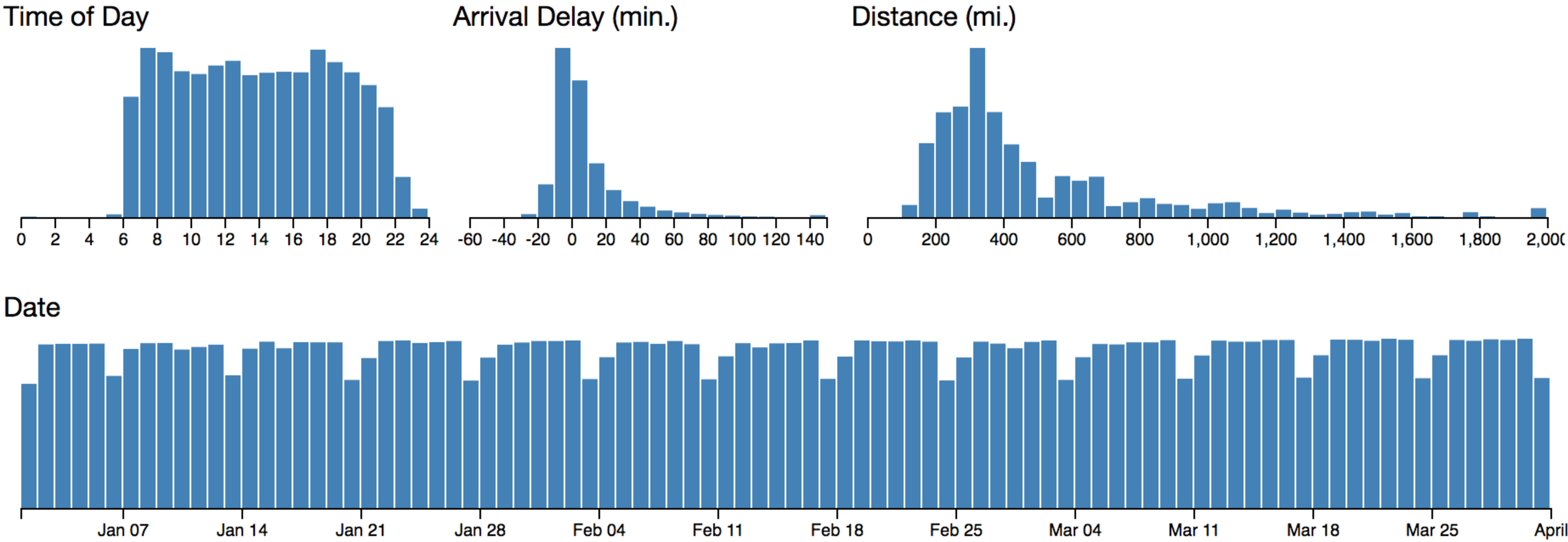


But wait! What is an appropriate "damage index"?
Which temperatures, O-ring or outside air?

Cholera Outbreak (remember DSC 10?)

Cholera Outbreak (remember DSC 10?)

https://square.github.io/crossfilter/



What insights do you notice?

Classbuzz: crossfilter

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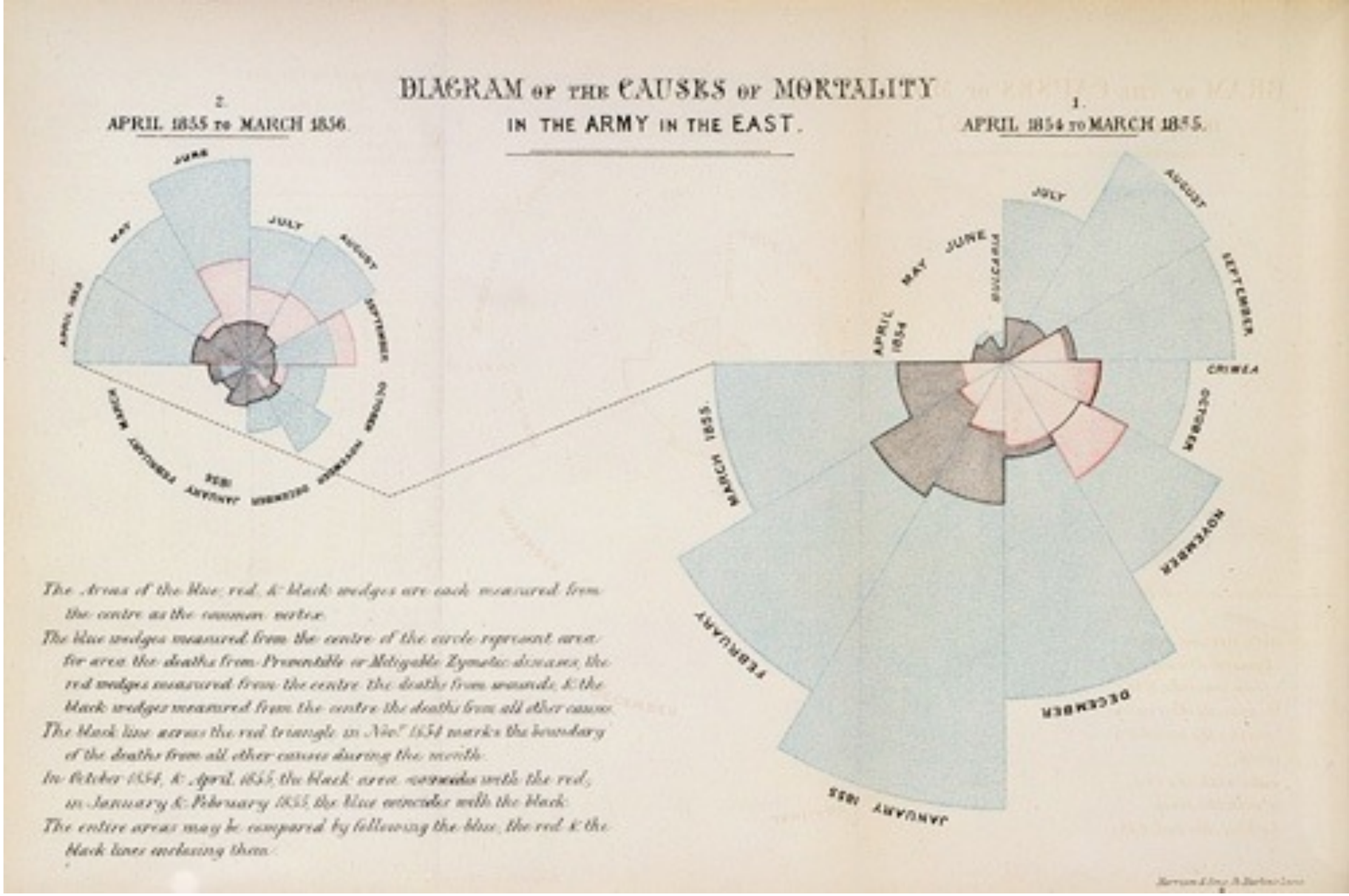
"to affect thro' the Eyes what we fail to convey to the public through their word-proof ears"

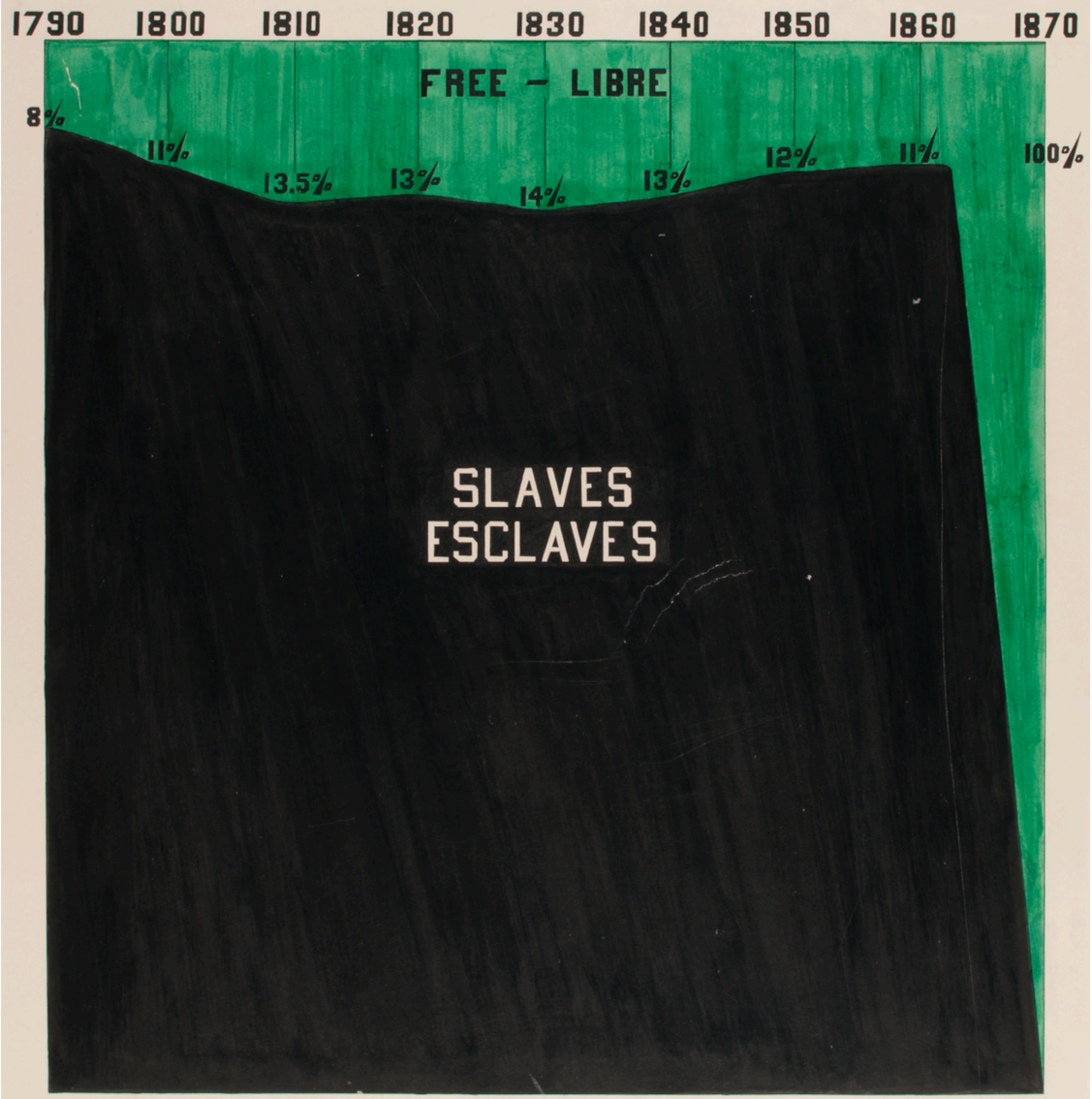


1856 "Coxcomb" of Crimean War Deaths, Florence Nightingale

PROPORTION OF FREEMEN AND SLAVES AMONG AMERICAN NEGROES .

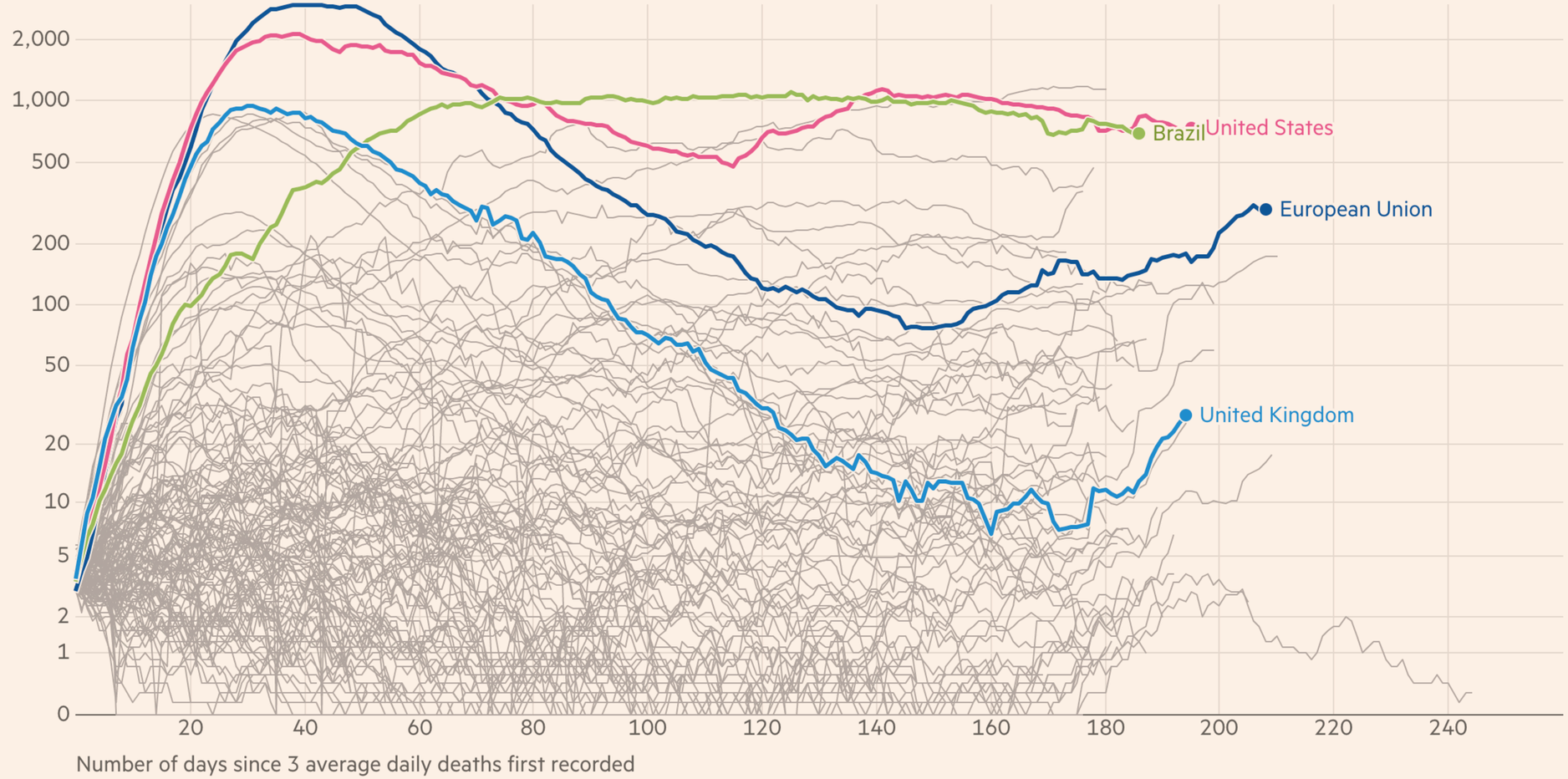
PROPORTION DES NÈGRES LIBRES ET DES ESCLAVES EN AMÉRIQUE .

DONE BY ATLANTA UNIVERSITY .



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



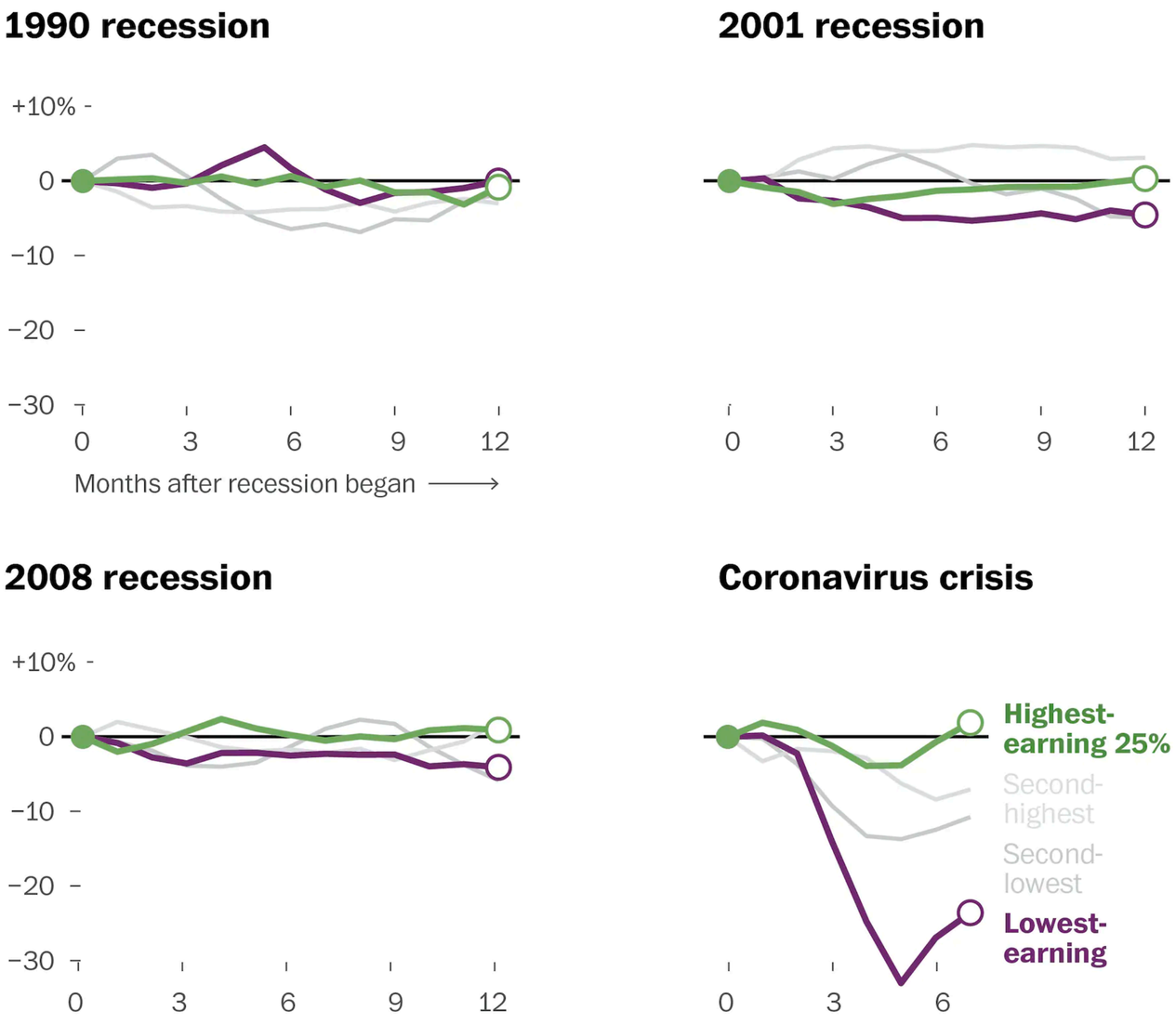
Source: Financial Times analysis of data from the European Centre for Disease Prevention and Control, the Covid Tracking Project, the UK Dept of Health & Social Care and the Spanish Ministry of Health.
Data updated September 25 2020 12.46pm BST. Interactive version: ft.com/covid19

FINANCIAL TIMES

Coronavirus Tracked John Burn-Murdoch & Financial Times

The coronavirus crisis is different

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



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

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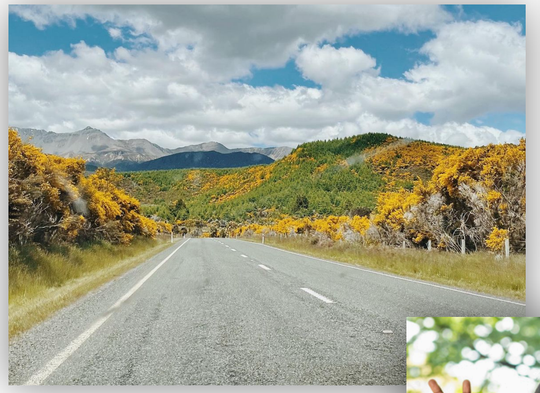
About this Course

About Me

Assistant Teaching Professor, HDSI
lau.ucsd.edu
Email: lau@ucsd.edu

Tools for visualizing programs (Pandas Tutor), curriculum design (Learning Data Science textbook)

What makes me smile:
My wife, good food, traveling, students who put in their best effort!



Course staff

See dsc106.com for our OH times

Instructor

Sam Lau

Teaching Assistants

Giorgia Nicolaou (Head TA)

Smruthi Gowtham

Muchan Li

Questions about course logistics? Email Giorgia!

Tutors

Ethan Cao

Gabriel Cha

Nate del Rosario

Jesse Huang

Anastasiya Markova

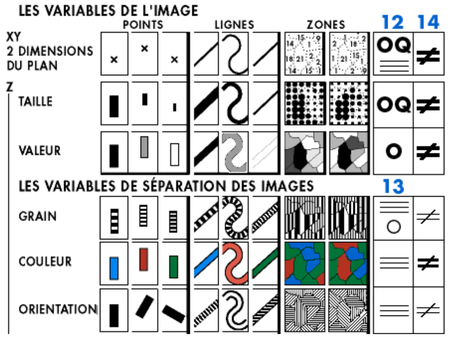
Bill Wang

Lauren Zhang

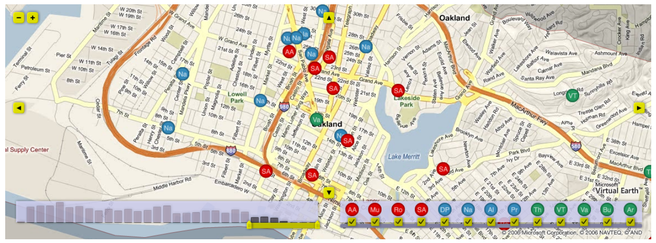
Christopher Lum

Principles

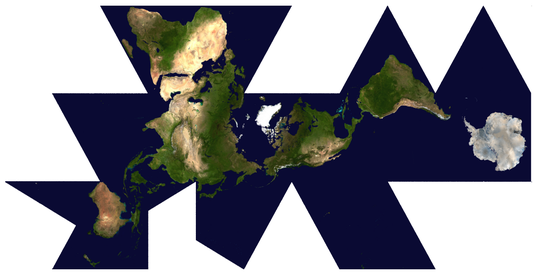
Data and Image Models



Interaction



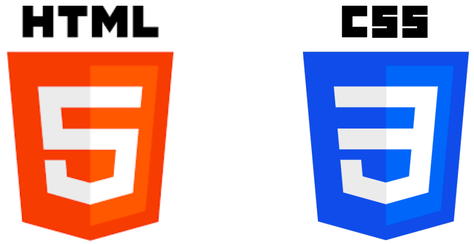
Maps



...and many more!

Techniques

HTML/CSS



JavaScript

D3.js

Learning Objectives

By the end of this course:

- Understand and apply key visualization techniques and theory.
- Design, evaluate, and critique visualization designs.
- Implement interactive data visualizations for the web using D3.js.
- Develop a substantial visualization project.

This Quarter: Health Data (with Prof Ben Smarr)

You will visualize health data in Projects 2, 3, and the Final Project

Ben will give guest lecture on Jan 22 to introduce datasets and background

For Final Project Showcase, we will invite outside guests (industry and medicine)

Grade Breakdown

Component	Weight
Participation	8%
Labs	8%
Project 1	10%
Project 2	15%
Project 3	15%
Project Checkpoints	4%
Final Project	40%

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Participation	8%
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Final Project	40%

1% per week (2 lowest weeks dropped). 3 options:

1. Attend both lectures, discussion, and participate in the lecture activities.
2. Share and critique 1 viz example on Ed.
3. Respond to 2 viz examples on Ed.

See website for full details.

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Project Checkpoints	4%
Final Project	40%

9 labs, 1% per lab, 1 lowest dropped.

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3 open-ended projects

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Final project will span last 4 weeks of course

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Project Checkpoints	4%
Final Project	40%

6 slip days for quarter.

You can use 1 slip day for labs, 2 for project deadlines

But NOT for the Final Project submission deadline

Communication

Use EdStem for all communication (my email is super slammed these days)

Email Giorgia, cc me for private questions related to course

Course website will stay up-to-date (dsc106.com)

Where you're headed: Final Project

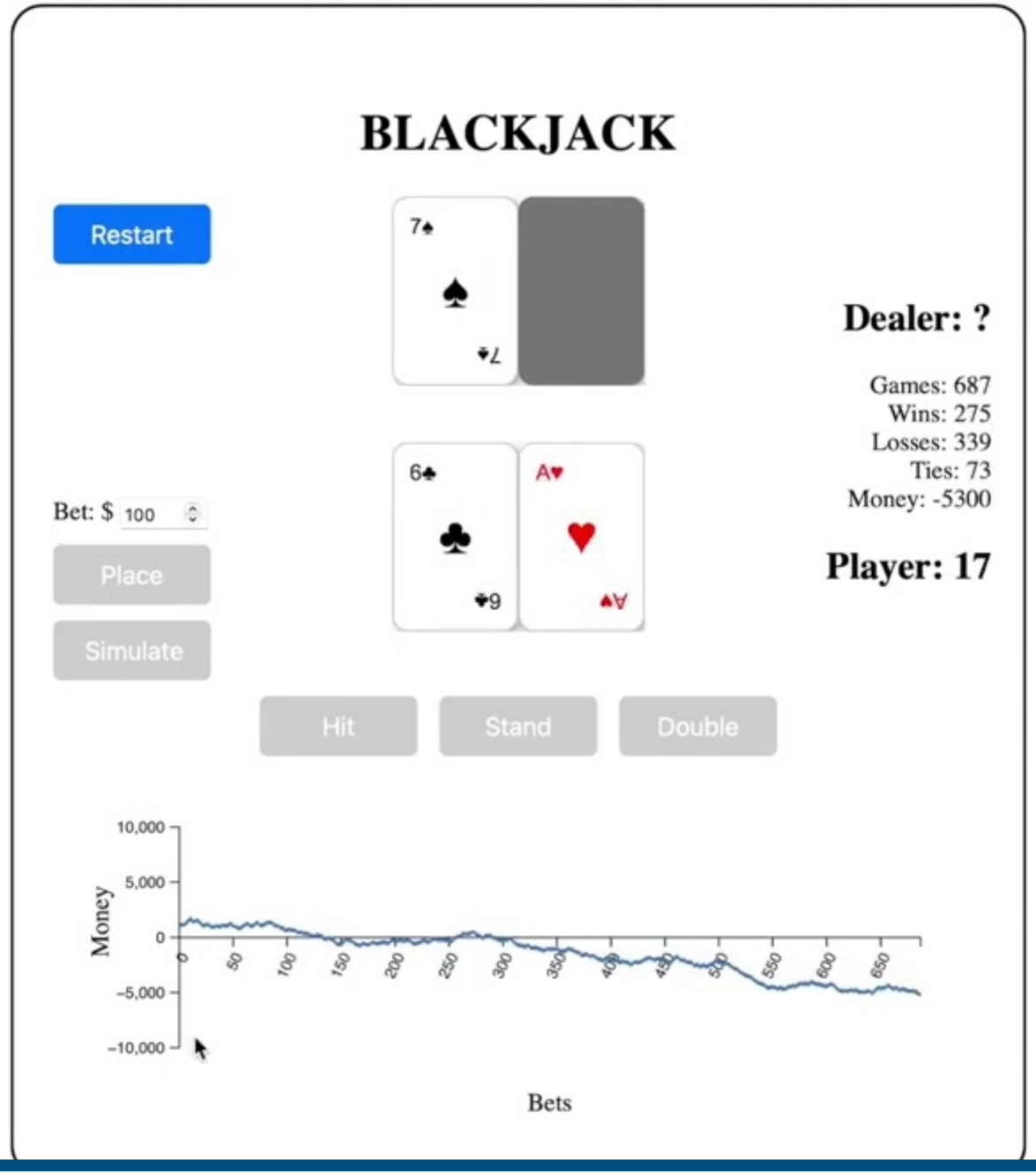
Explorable Explanation for health dataset

Initial **prototype** and **design reviews**

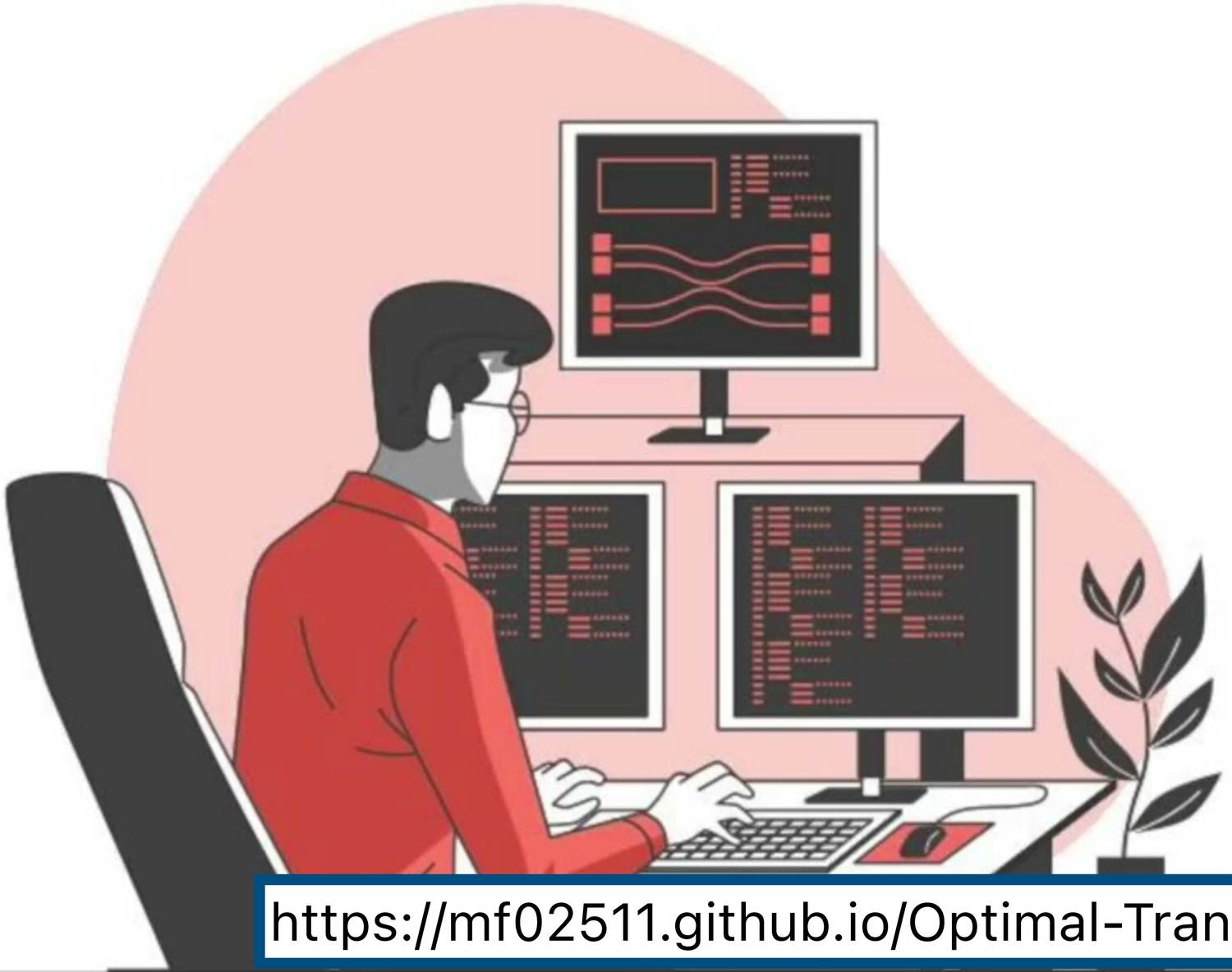
In-class demonstration **videos**

Submit and publish online

On March 18, **Final Project Showcase** (during our scheduled final exam time)



https://lukelin15.github.io/CardCounting/



Optimal Transport Mapping

Ashley Ho & Mizuho Fukuda

https://mf02511.github.io/Optimal-Transport-Visualization/

Lab 1: Introduction to the Web Platform

Lab 1 released, due Friday.

Step 4: Add a photo

1. Create an `images` folder in the root of your repository
2. Find a photo of yourself (or anything else you want) and save it in the `images` folder
3. Add an `<img>` element to your HTML page, with the `src` attribute set to the path to your image file (`images/your-image-file-name.jpg`)
4. Add an `alt` attribute to the `<img>` element with a short description of the image as you would describe it to someone who cannot see it.

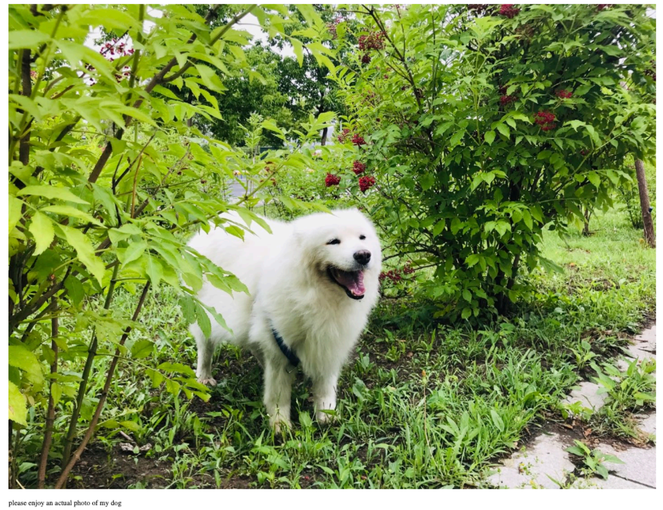


Figure 5: Our page now has a photo!

Project 1: Expository visualization

Create **one static visualization** for a dataset (see course website).

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 Gradescope; see Project 1 page)

Image of your visualization (PNG or JPG format)

Short description + design rationale (≤ 4 paragraphs)

Checkpoint due next Tues

Questions?