CSE 332
Introduction to Visualization

Introduction

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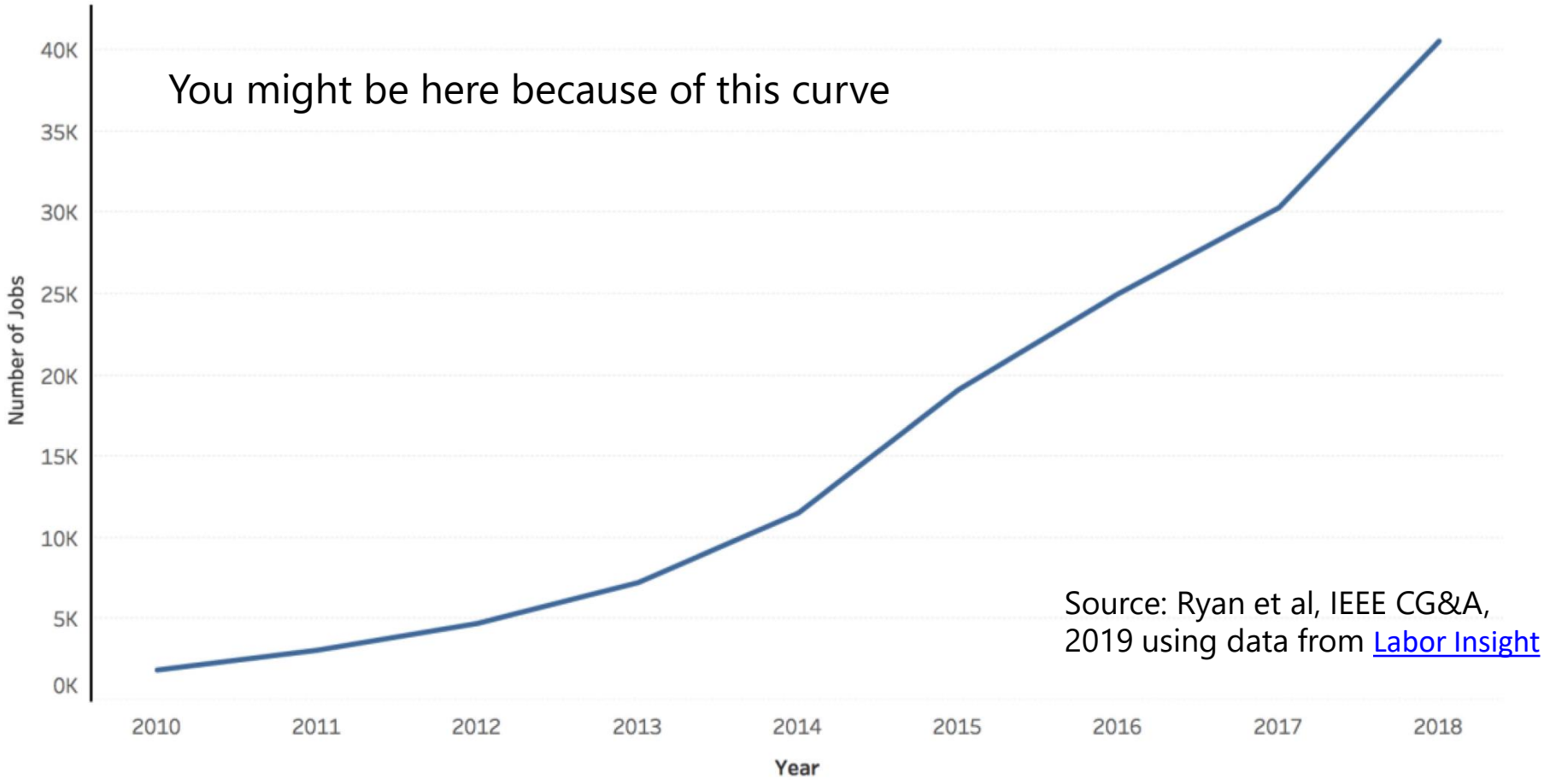
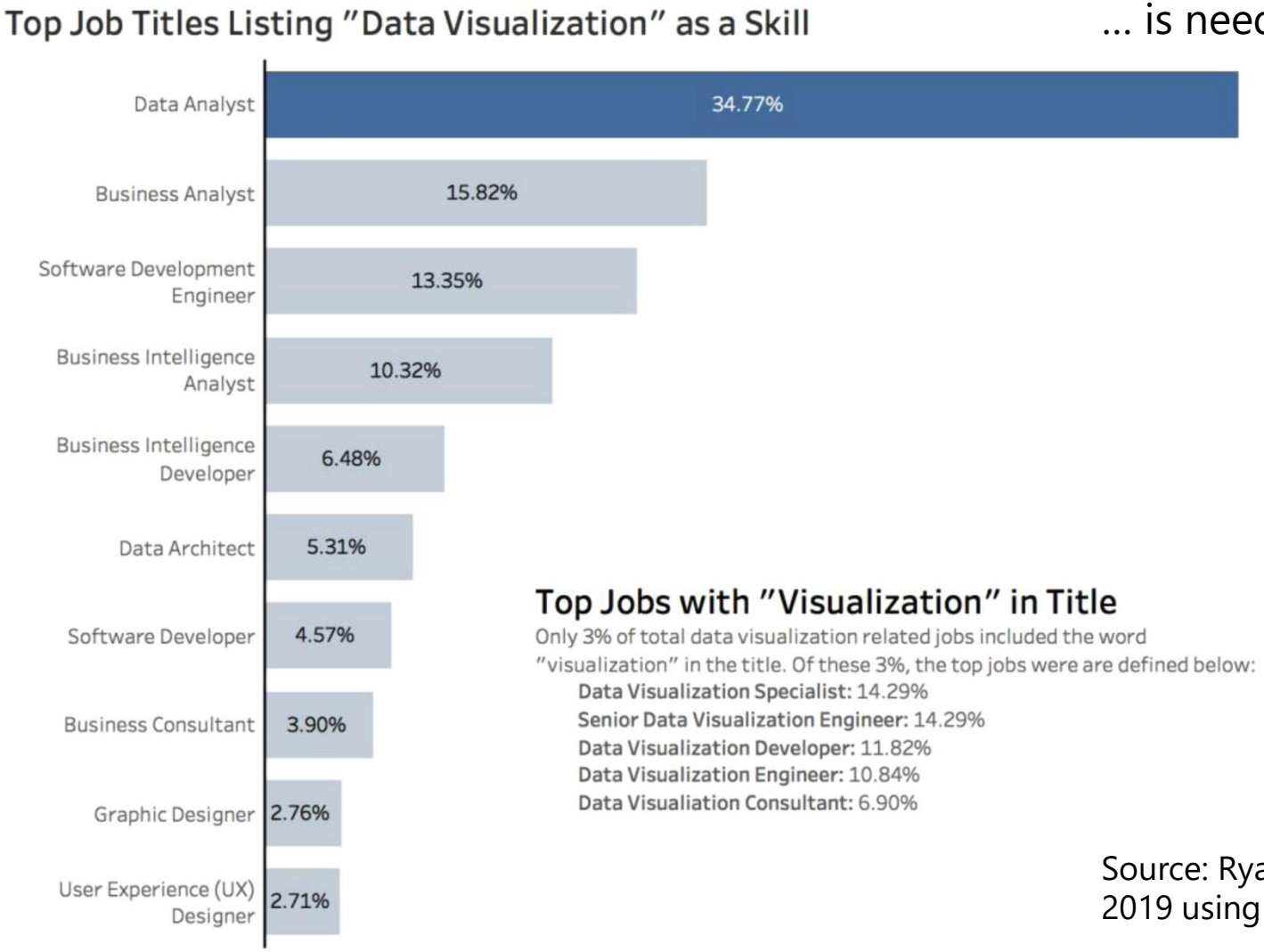
Why Are You Here?



The growth of jobs mentioning “data visualization” as a skill from 2010 through 2017 has steadily increased from only 1,888 jobs in 2010 to 30,327 jobs in 2017 (16×growth)

"Visualization" Skill…

… is needed everywhere



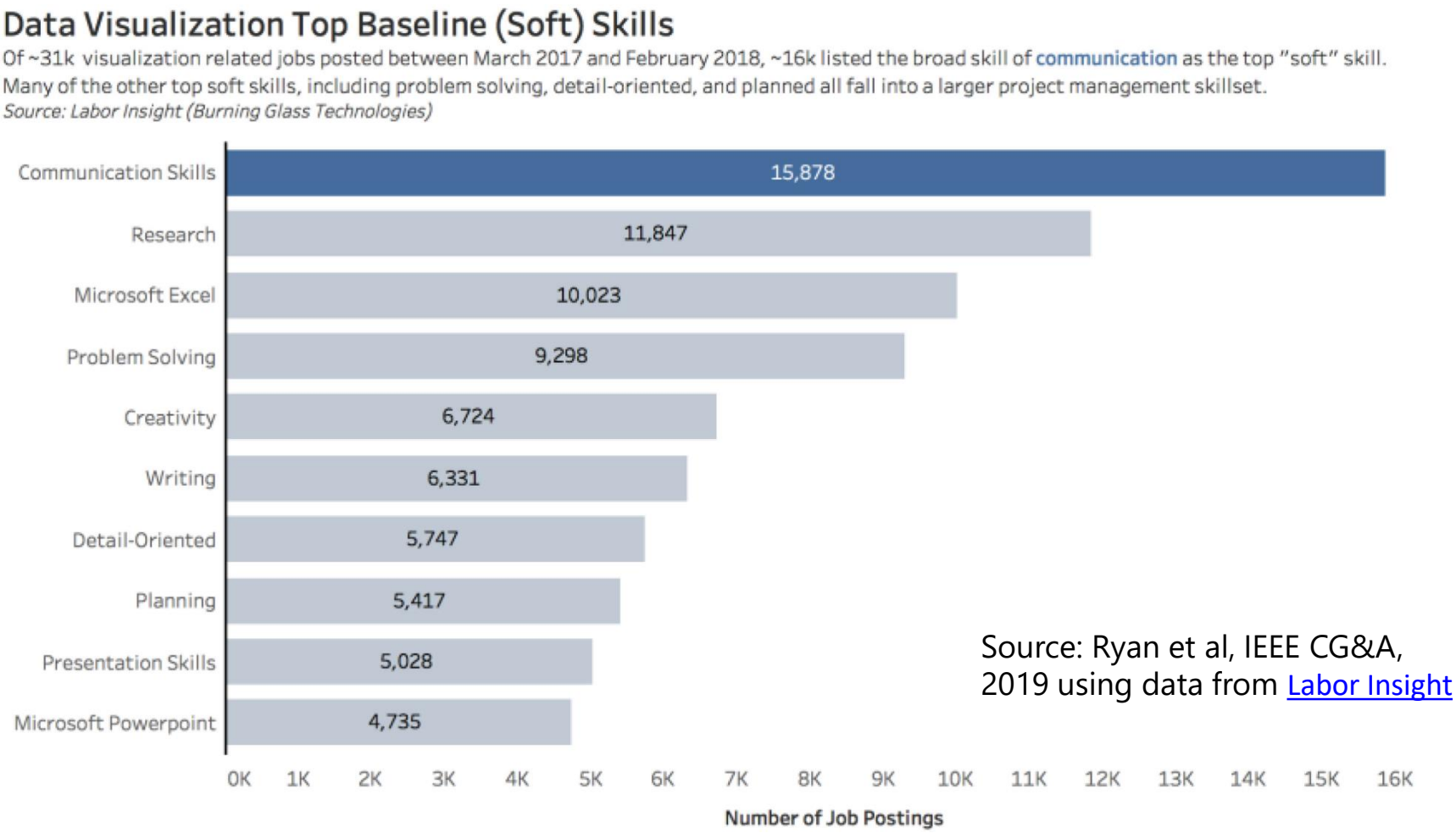
Top Jobs with "Visualization" in Title

Only 3% of total data visualization related jobs included the word "visualization" in the title. Of these 3%, the top jobs were are defined below:

- **Data Visualization Specialist:** 14.29%
- **Senior Data Visualization Engineer:** 14.29%
- **Data Visualization Developer:** 11.82%
- **Data Visualization Engineer:** 10.84%
- **Data Visualiation Consultant:** 6.90%

Source: Ryan et al, IEEE CG&A, 2019 using data from Labor Insight

What Other Skills?



Source: Ryan et al, IEEE CG&A, 2019 using data from Labor Insight

Baseline, or “soft” skills listed for these 30k “Data Visualization” jobs.

Skills, Reading Between The Lines

Communication, when mentioned in conjunction with data visualization really means:

- communication of information derived from data
- *visual* story telling with data
- half of the data analytics projects fail due to poor communication
  (according to L. Kart, N. Neudecker, F. Buytendijk, Gartner Report GG0255160, 2013)

Apart from the specialized skills, these general skills (or proficiencies) are also often listed:

- SQL
- Tableau (41%),
- Excel (34%), PowerPoint (16%)
- Python (30%), SAS (22%), R (16%), Plotly (?%)
- JavaScript & JavaScript-based data-driven documents D3.js (13%)

Source: Ryan et al, IEEE CG&A, 2019 using data from Labor Insight

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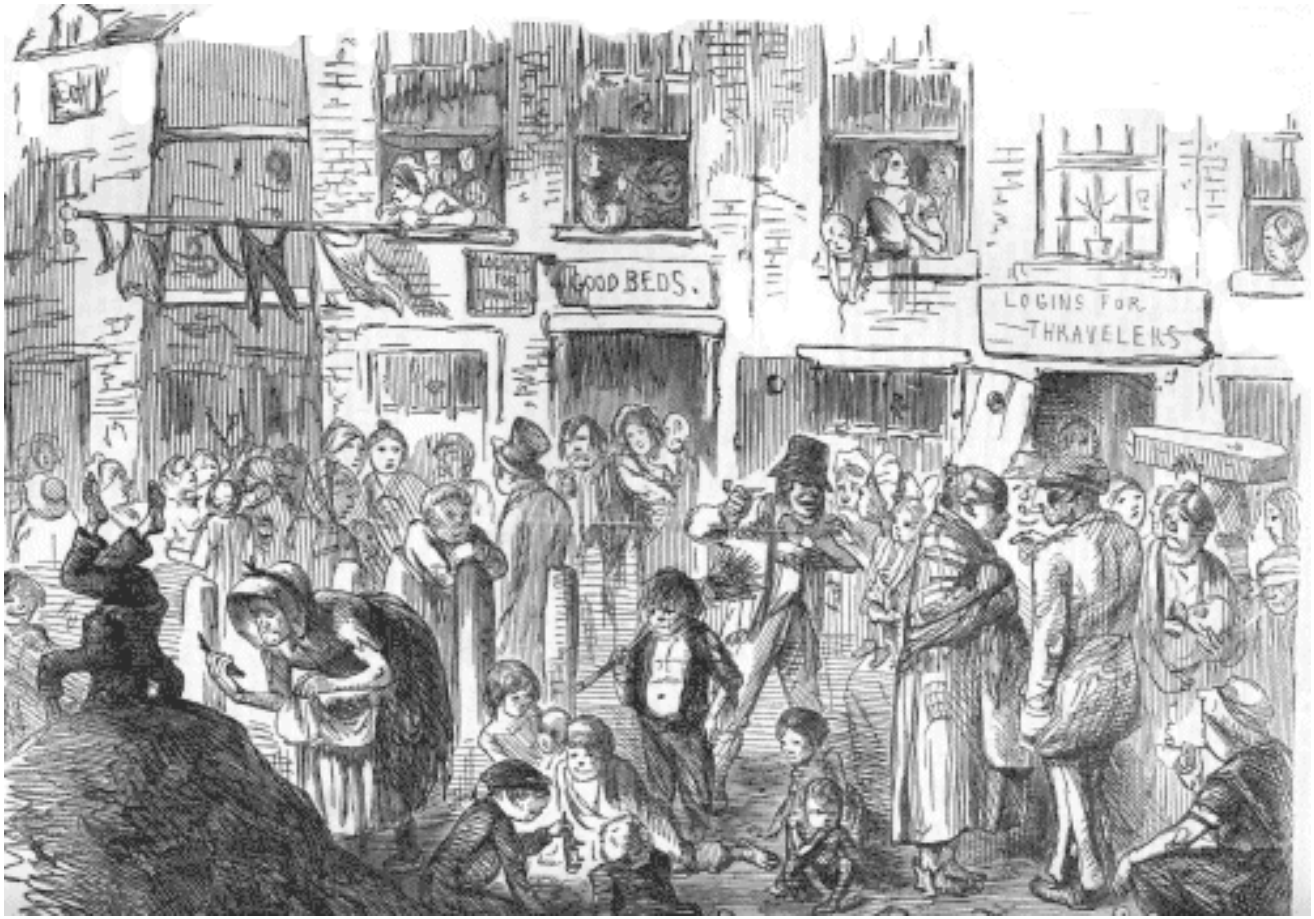
Visualization is not new

Rich History

Let’s go back some 160 years to 1854, London, England



Newsflash, 1854

The most terrible outbreak of cholera which ever occurred in this kingdom, is probably that which is taking place in Broad Street, Golden Square, and adjoining streets.

Within two hundred and fifty yards of the spot where Cambridge Street joins Broad Street, there are upwards of five hundred fatal attacks of cholera in ten days.

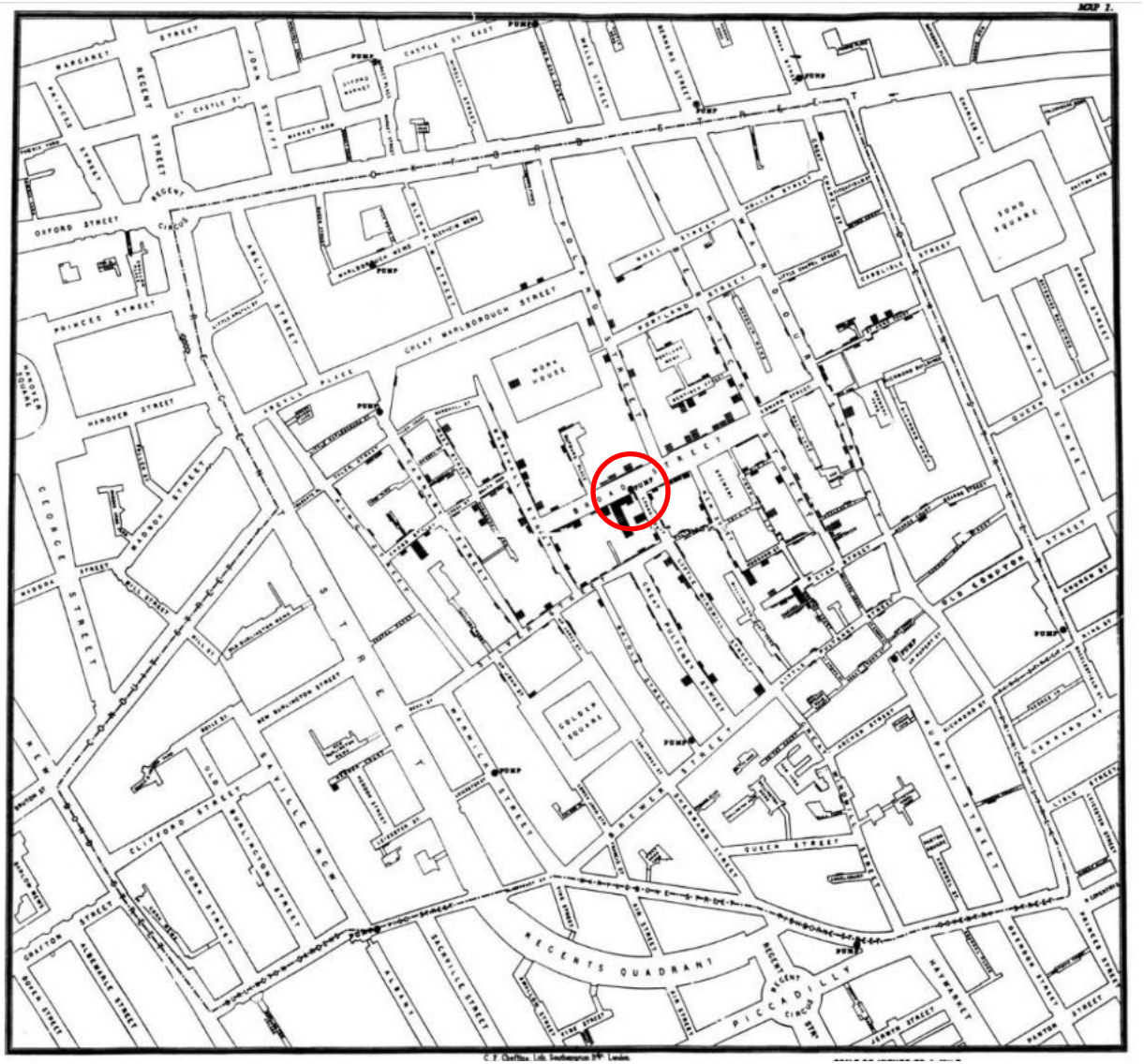
The mortality in this limited area probably equals any that was ever caused in this country, even by the plague; and it is much more sudden, as the greater number of cases terminated in a few hours.

What Can We Do?

What Is The Cause?

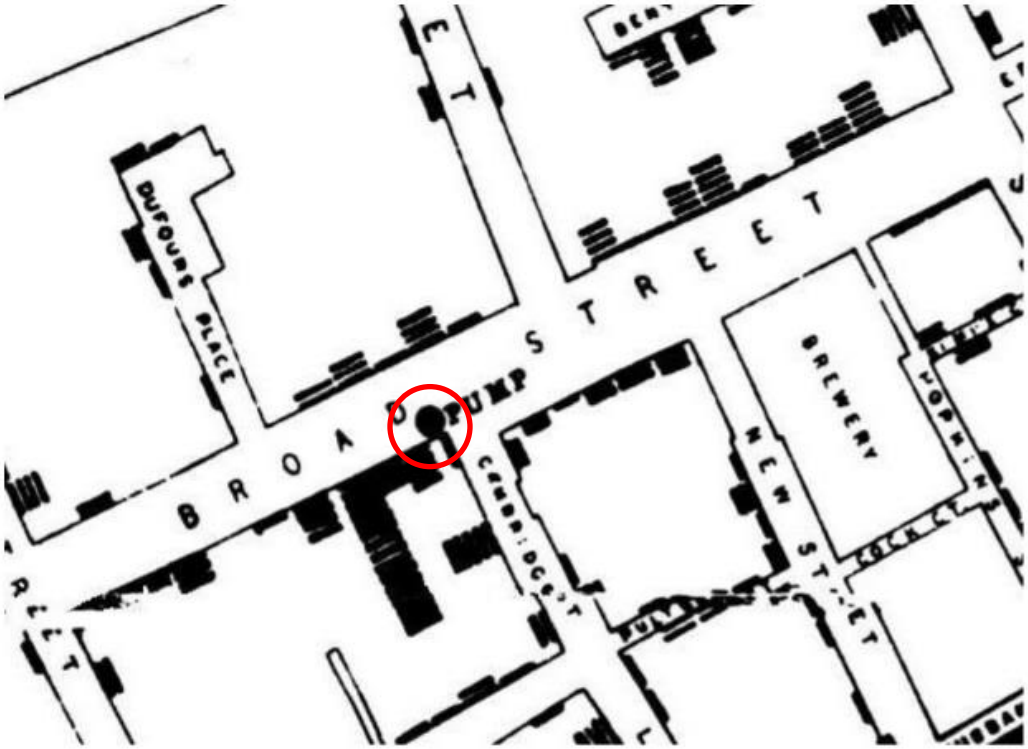
How Can We Eliminate It?

Time For "Imagination"



John Snow

Time For "Imagination"



John Snow

Proved The Hypothesis

Hypothesis: cholera spreads through water

- and not via some other fantastic causes
- one said it rose out of the burying grounds of plague victims from two centuries earlier
- the bacteria was discovered later, in 1886

A real-life experiment (often the case with observational data)

- established the mode of cholera transmission
- and consequently the method of prevention: keep drinking water, food, and hands clear of infected sewage

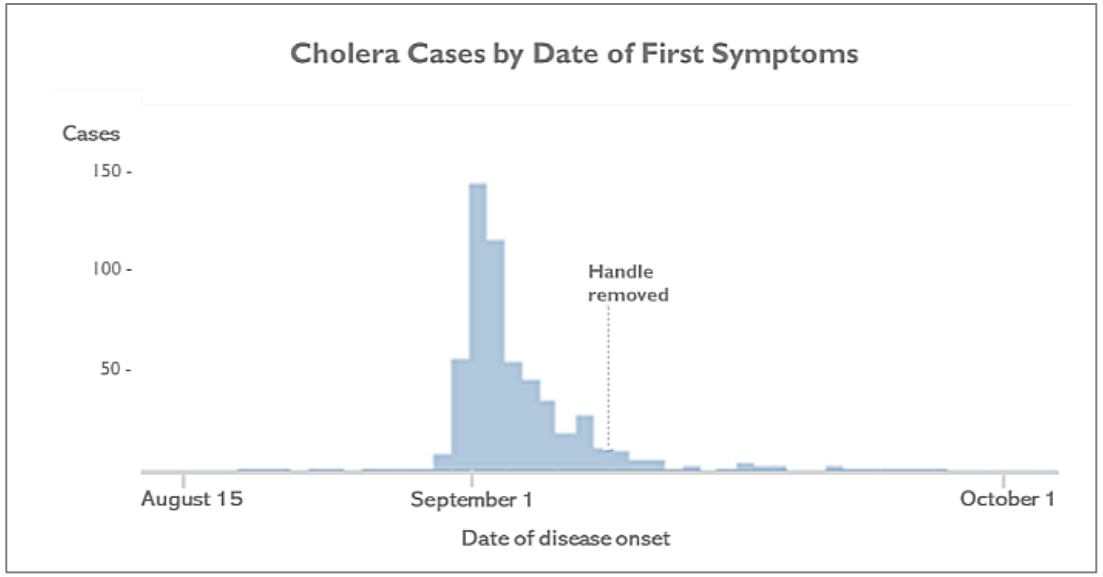
Visualization provided

- inspiration
- convincing arguments to justify actions (removing the pump handle)
- led to Dr. John Snow's historic immortality
- a bar near the old Broad Street pump bears his name (safe drinking)

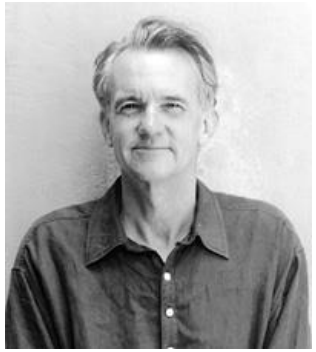
Graphed Over Time

Turns out that the handle was removed at the end of the outbreak

- graphing deaths over time revealed this
- also done by Dr, Snow but far less publicized
- but likely prevented a new outbreak



Much Later

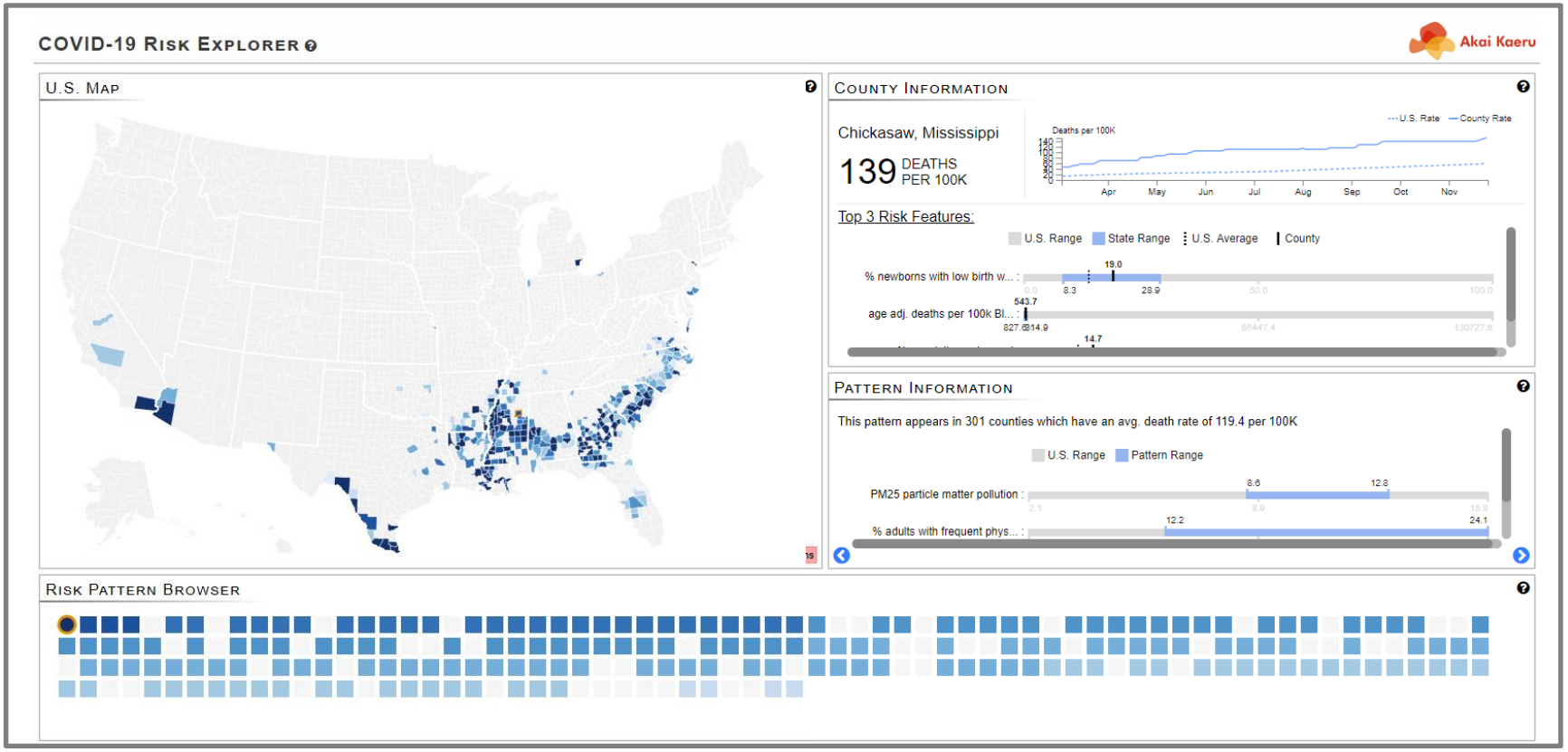


Edward Tufte redrew the map

- only kept the most critical street and building details
- switched out Dr. Snow's dashes for dots
- Focused the visual emphasis on Cholera victims and well locations, and not the features of the ground
- better data-to-ink ratio

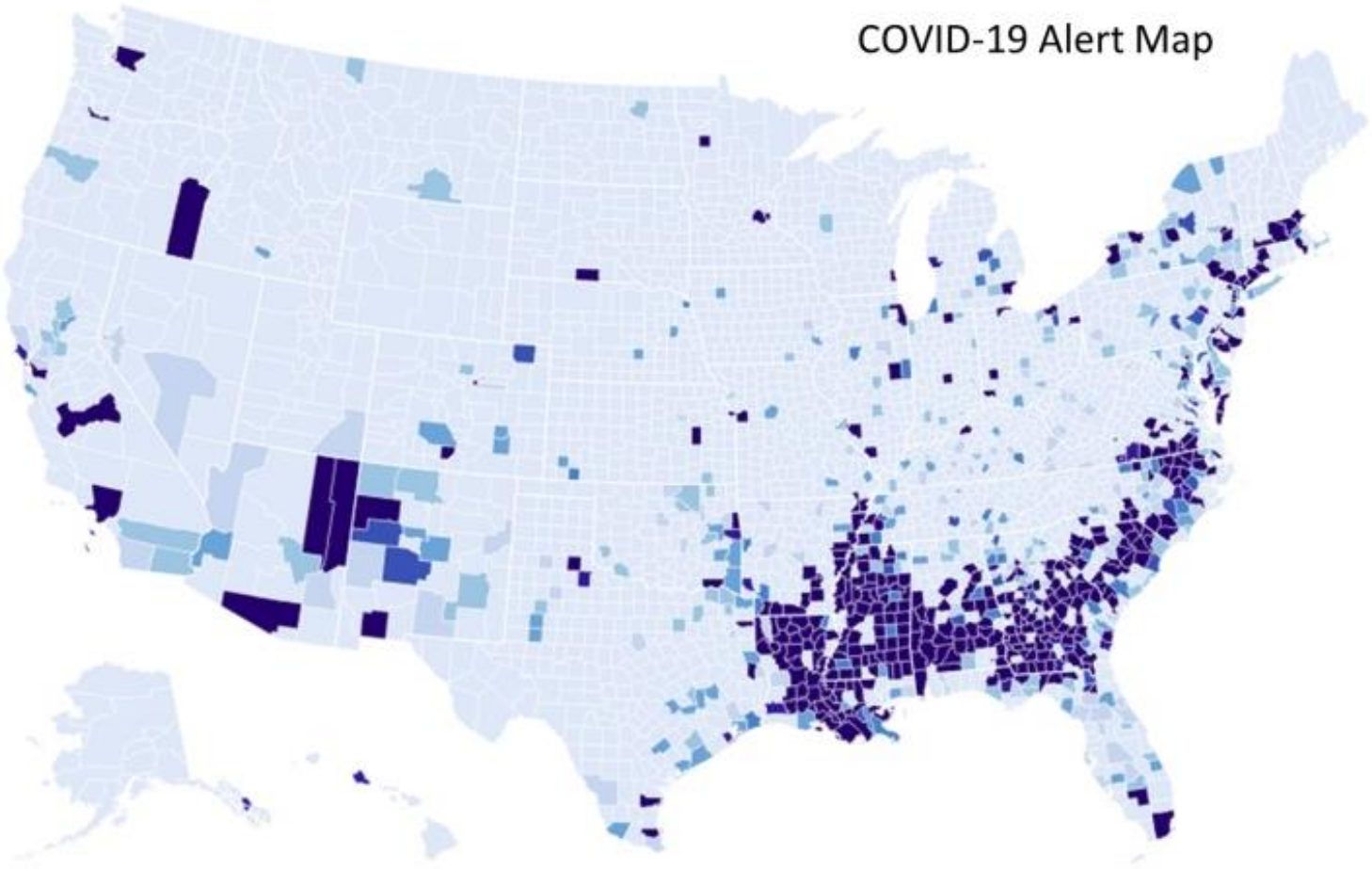
COVID-19 Risk Map

Use pattern analysis of US county socio-economic vulnerability risk factors to predict the initial spread of the virus



COVID-19 Risk Map

created
May 10, 2020

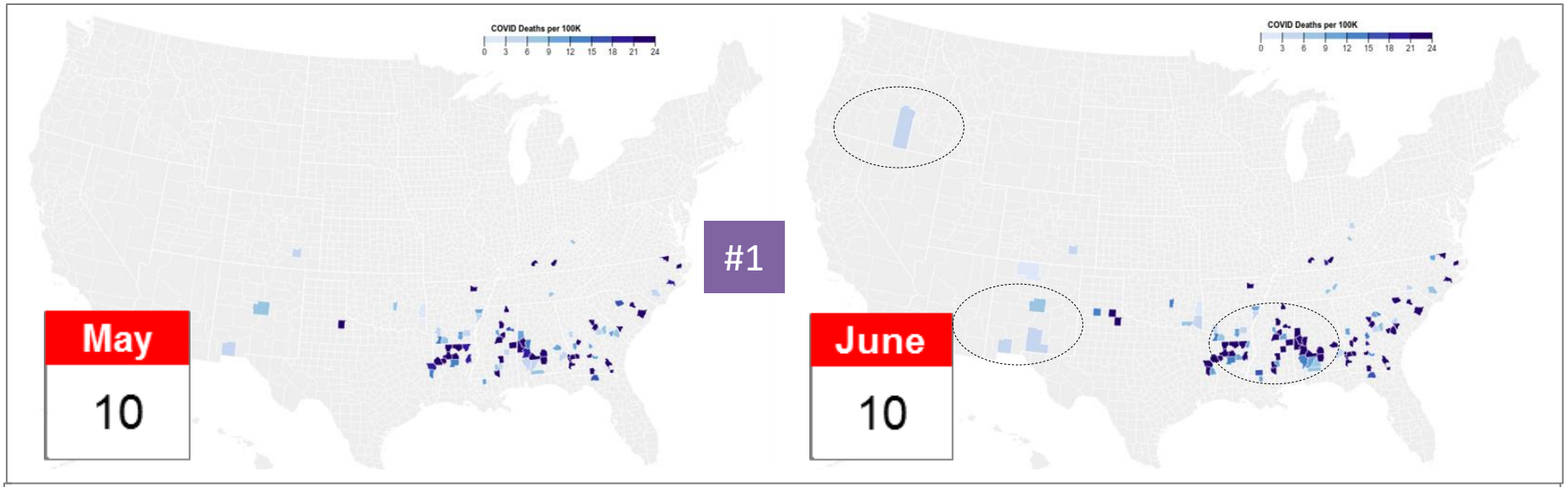


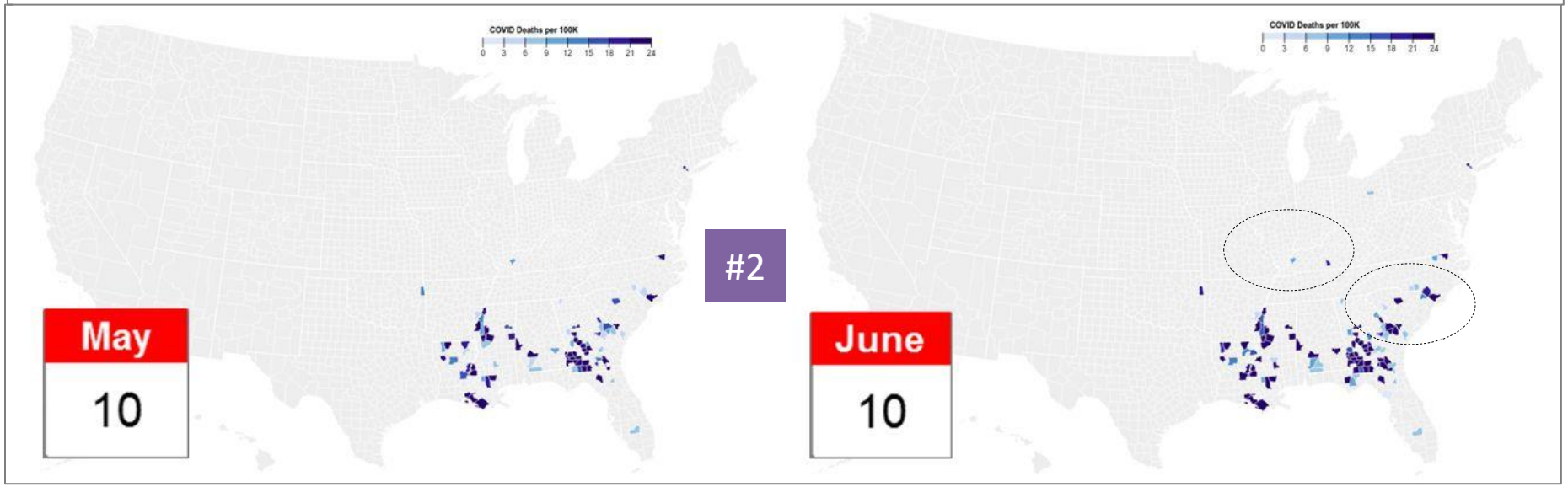
Color mapping:

- the number of times a U.S. county is part of a “high risk” set
- the higher level of risk a county has for high COVID-19 death rates the darker the color

Only counties with at least 1 death on May 10, 2020 are shown

Pattern-Based Predictions (2020)





Published in…

K, Mueller, E. Papenhausen, "Demographic Pattern Analysis to Predict COVID-19 Fatalities on the US County Level," *ACM Digital Government: Research and Practice,* 2 (1): 1-11, 2020.

D. Coelho, N. Gupta, E. Papenhausen, K. Mueller, "Patterns of Social Vulnerability – An Interactive Dashboard to Explore Risks to Public Health on the US County Level," AMIA *Workshop on Visual Analytics in Healthcare,* November, 2022

What Is Needed for Visualization?

What Is Needed for Visualization – Some Appropriate Answers

Data (wide variety)

Algorithms

- data mining
- data analytics

Computer

- run those algorithms
- data storage

Humans

- with a purpose/need to understand their data
- endowed with cognitive faculties, creative thought, intuition
- domain expertise

Understanding of humans

- perception, cognition, HCI issues
- we can gain it through experimentation with humans

What Is Needed for Visualization – Some Appropriate Answers

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Computer

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= Visual Analytics

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Dr. John Snow: A Visual Analytics Pioneer

Dr. John Snow's London Cholera Map of 1854

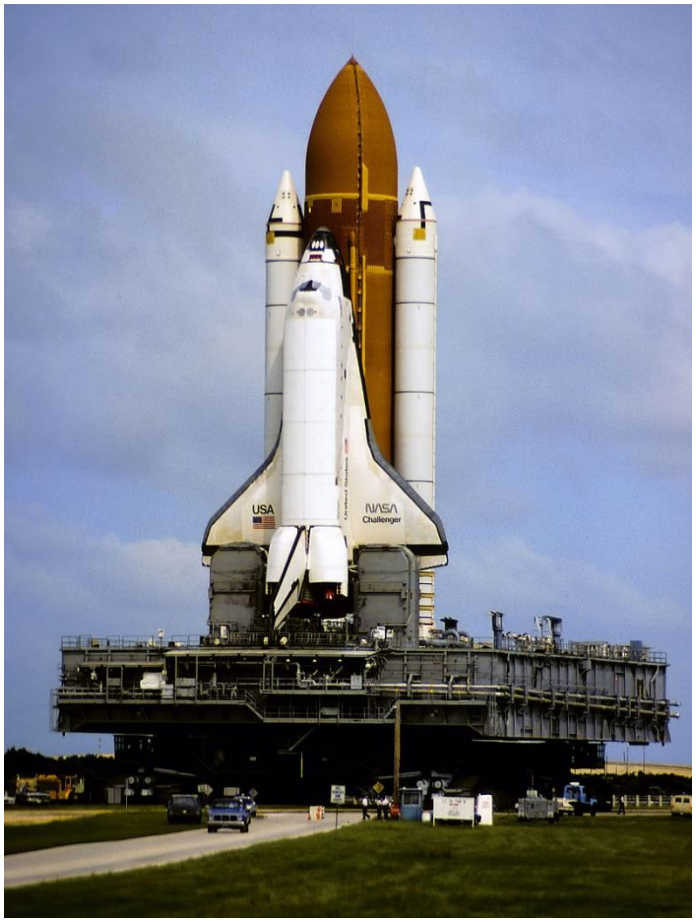
- data collection
- data assimilation
- statistical testing
- visualization
- computational analysis (brain)
- domain knowledge

Very early example of visual analytics

More Recent History

Let's go back some 40 years to 1986, JFK Space Center, FL

The crew of Space Shuttle mission STS-51-L 11/15/85. Back row, left to right: Ellison S. Onizuka, Sharon Christa McAuliffe, Greg Jarvis, Judy Resnik. Front row, left to right: Michael J. Smith, Dick Scobee, Ron McNair.



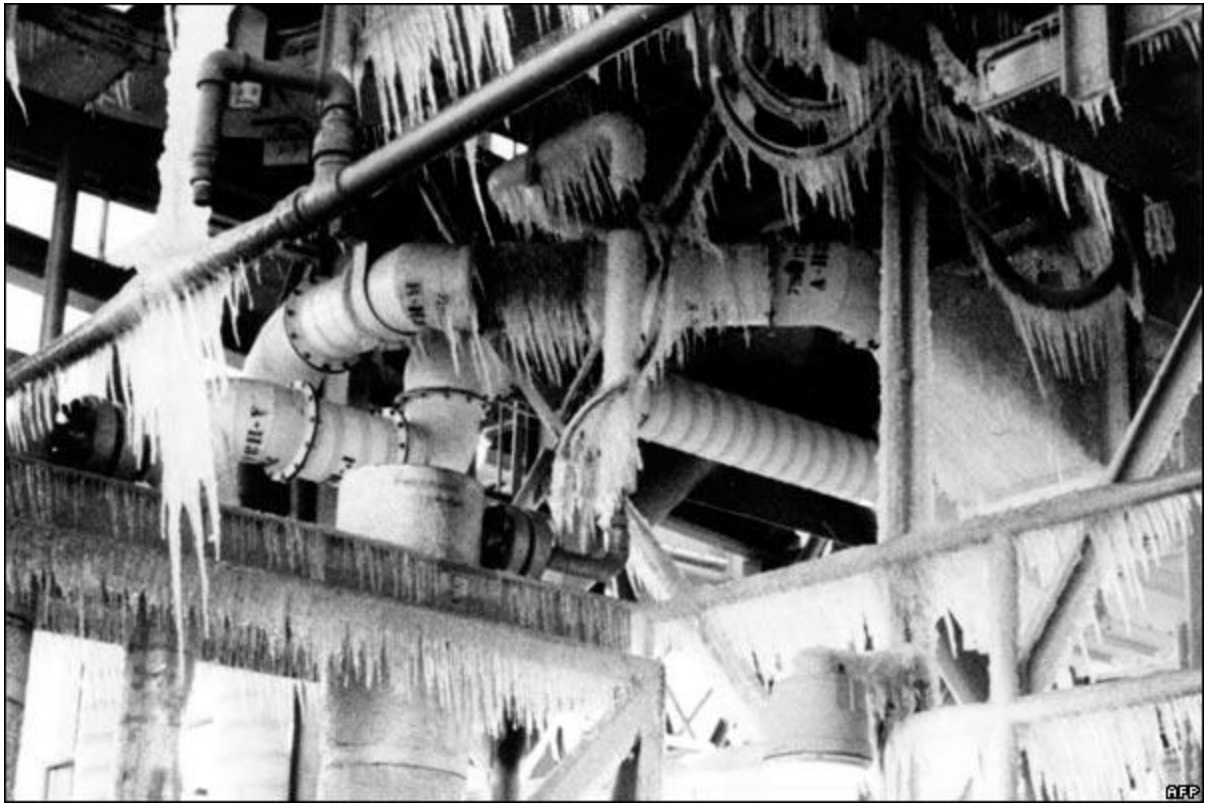
73 Seconds After Lift-off

What Happened?

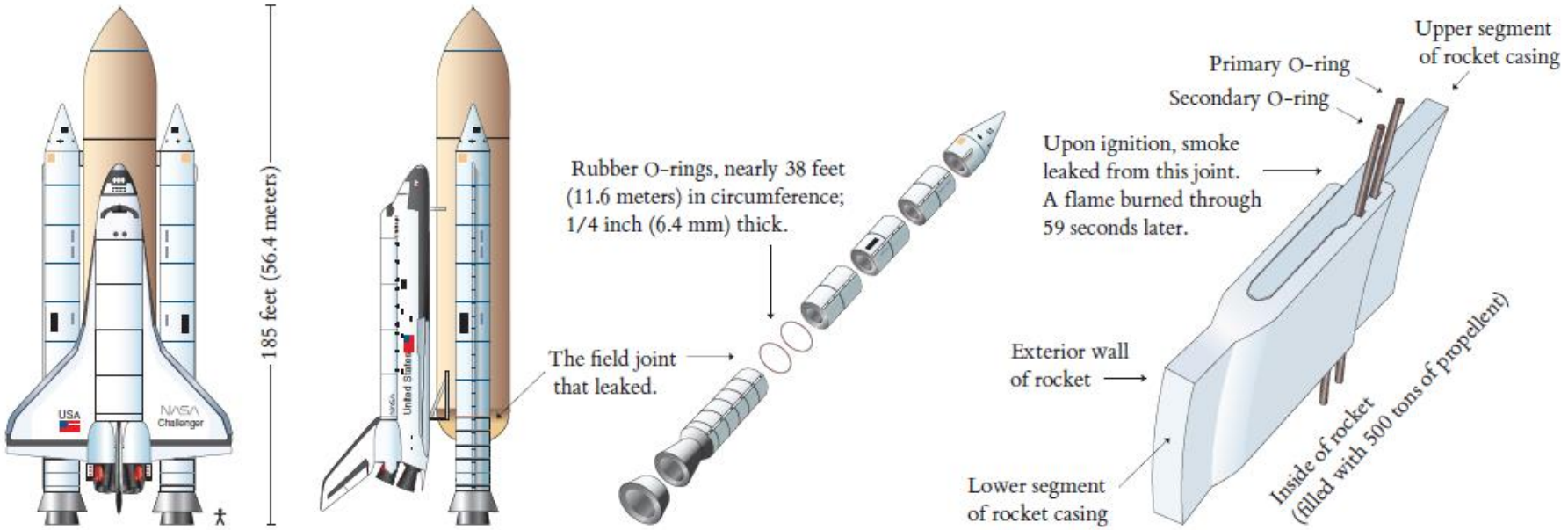
What Was The Cause?

The Day of The Launch

36 degrees F on Launch Pad 39



Space Shuttle 101



Fast Forward
58 Seconds After Ignition

What Happened?

What Was The Cause?

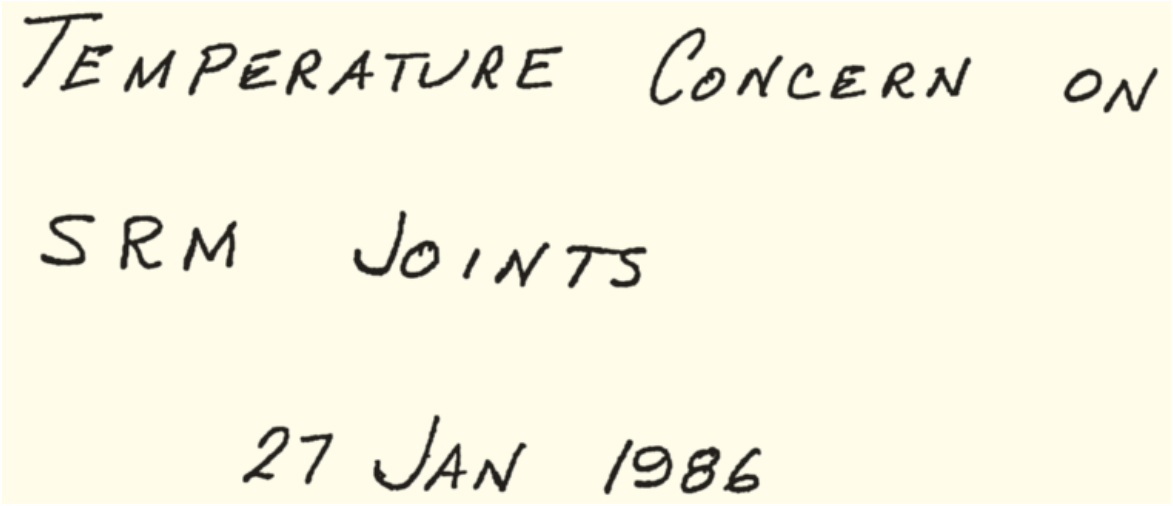
Could It Have Been Prevented?

Engineers At Thiokol Had A Hunch

Two days before launch they presented their concerns

- created 13 charts to make their case

Slide #1:



- SRM – Solid Rocket Motor

SLIDE #2

Teaches about past damages to O-ring

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.

SLIDES #2 AND 3

Teaches about O-ring damage mechanics and erosion

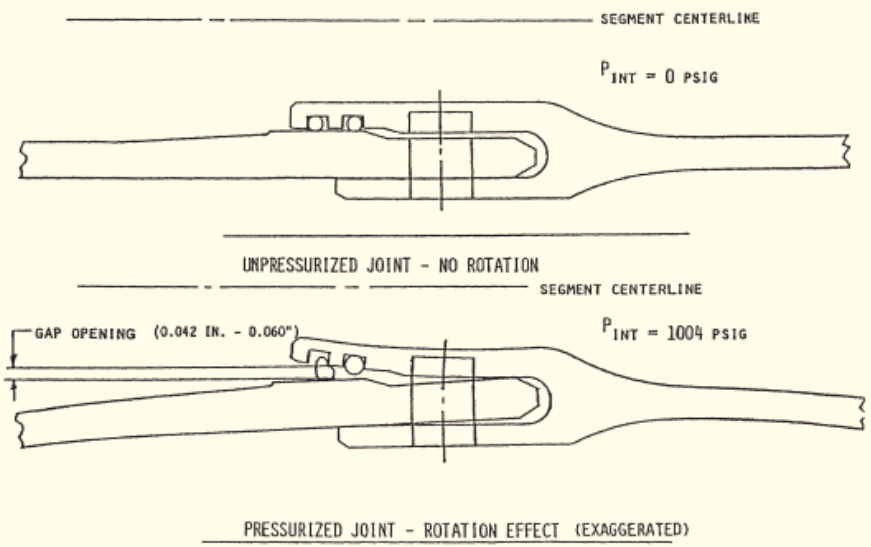
PRIMARY CONCERNS -

FIELD JOINT - HIGHEST CONCERN

- EROSION PENETRATION OF PRIMARY SEAL REQUIRES RELIABLE SECONDARY SEAL FOR PRESSURE INTEGRITY
  - IGNITION TRANSIENT - (0-600 MS)
    - (0-170 MS)HIGH PROBABILITY OF RELIABLE SECONDARY SEAL
    - (170-330 MS) REDUCED PROBABILITY OF RELIABLE SECONDARY SEAL
    - (330-600 MS) HIGH PROBABILITY OF NO SECONDARY SEAL CAPABILITY

- STEADY STATE - (600 MS - 2 MINUTES)
  - IF EROSION PENETRATES PRIMARY O-RING SEAL - HIGH PROBABILITY OF NO SECONDARY SEAL CAPABILITY
    - BENCH TESTING SHOWED O-RING NOT CAPABLE OF MAINTAINING CONTACT WITH METAL PARTS GAP OPENING RATE TO MEOP
    - BENCH TESTING SHOWED CAPABILITY TO MAINTAIN O-RING CONTACT DURING INITIAL PHASE (0-170 MS) OF TRANSIENT

PRIMARY CONCERNS - CONT



SLIDES #4 AND 5

Lists temperature and blow-by history for two SRMs

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	MBT	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

Assume You're a NASA Manager

Given the information provided in the company slides

- would you vote for a launch?
- ignore you know about the consequences

Be keenly aware of the immense PR pressures

- President Reagan's upcoming State of the Union speech
- the first civilian in space
- NASA's funding problems

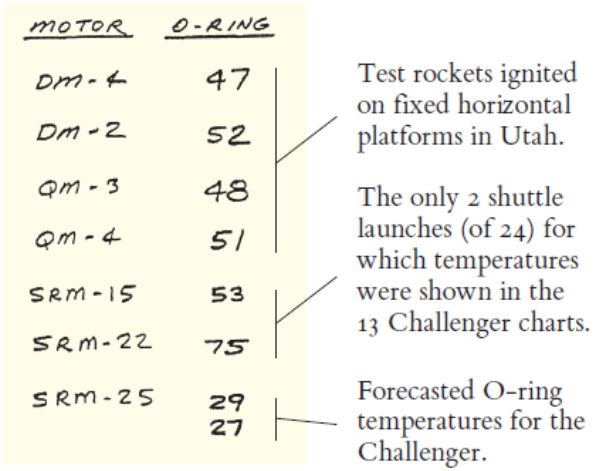
Launch:

- No: OK with a PR disaster & possible budget cuts down the road
- Yes: the rocket company is too cautious & concerns are unproven

Why The Recommendation Failed

Presentation only has exactly two shuttle flights

- one with two blow-by's and high temperature
- one with two blow-by's and low temperature
- ignores all other 22 shuttle flights (SRM)



Statistically weak

Recommendation

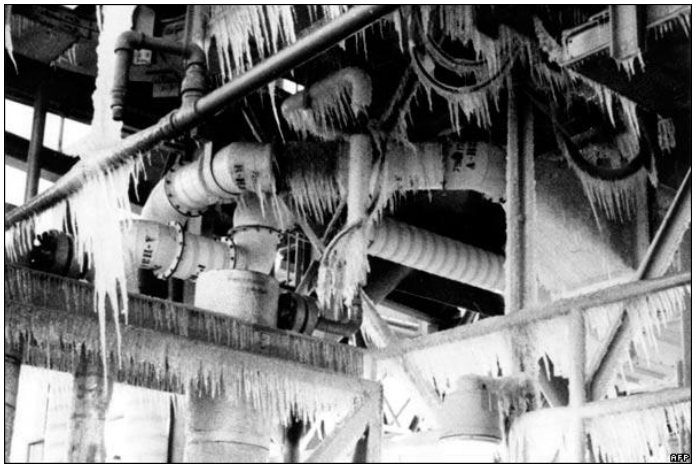
- "O-ring temp must be >53°F at launch"

- is only based on a sample size of 1
- context of other flights is missing
- no statistical leverage

Deficiencies

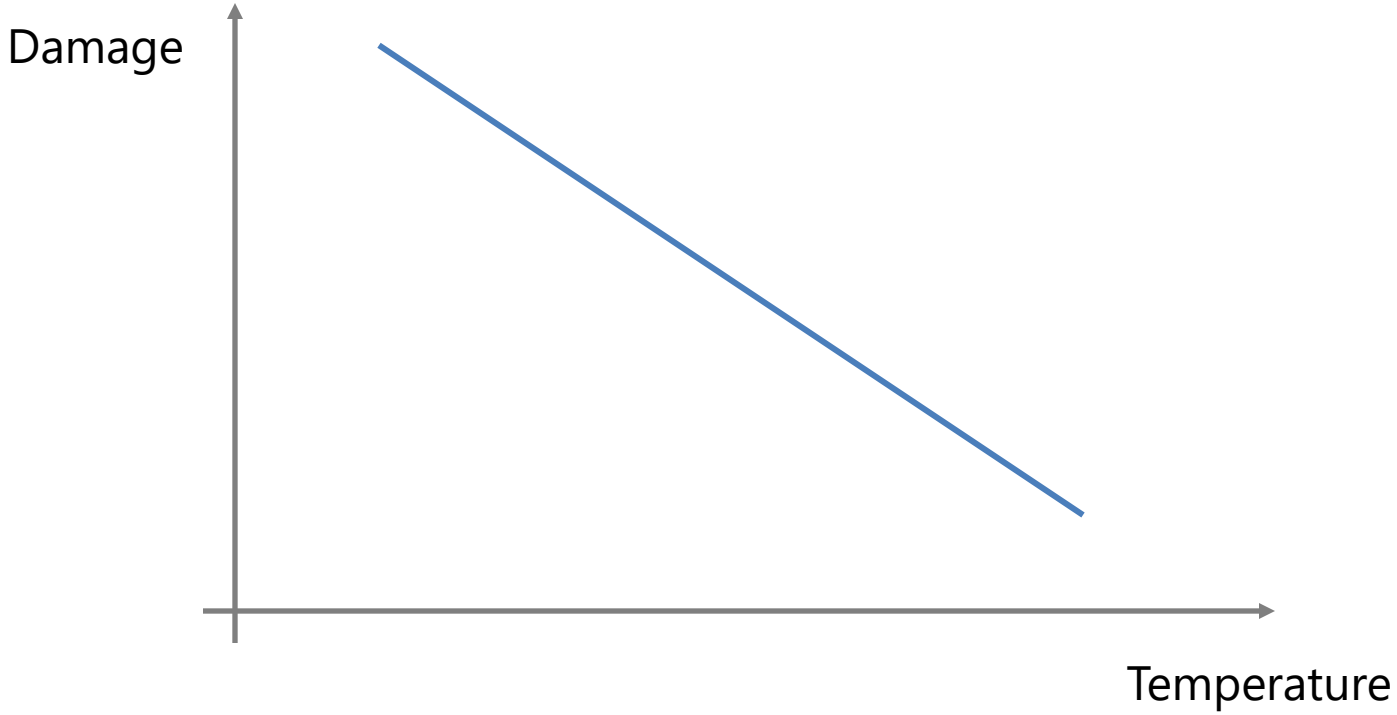
Lots of numbers and facts

But no causal evidence that could predict



What is needed?

What Is Needed?

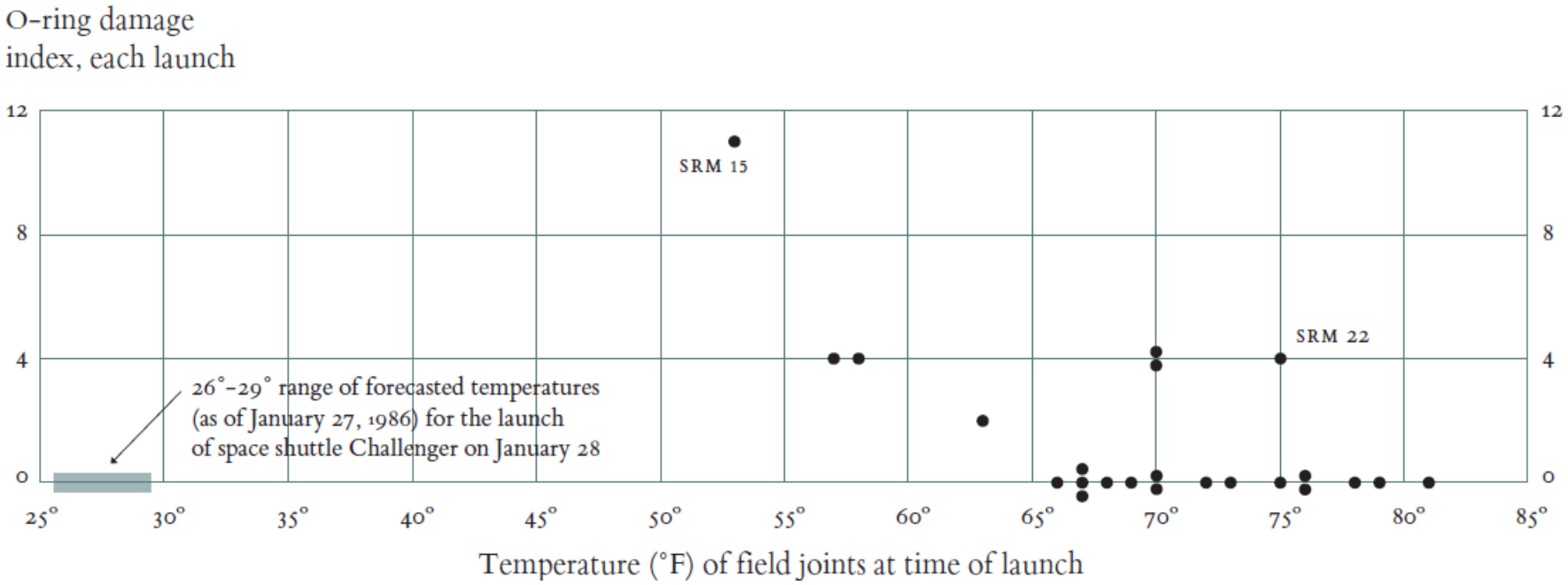


Need a measure for damage

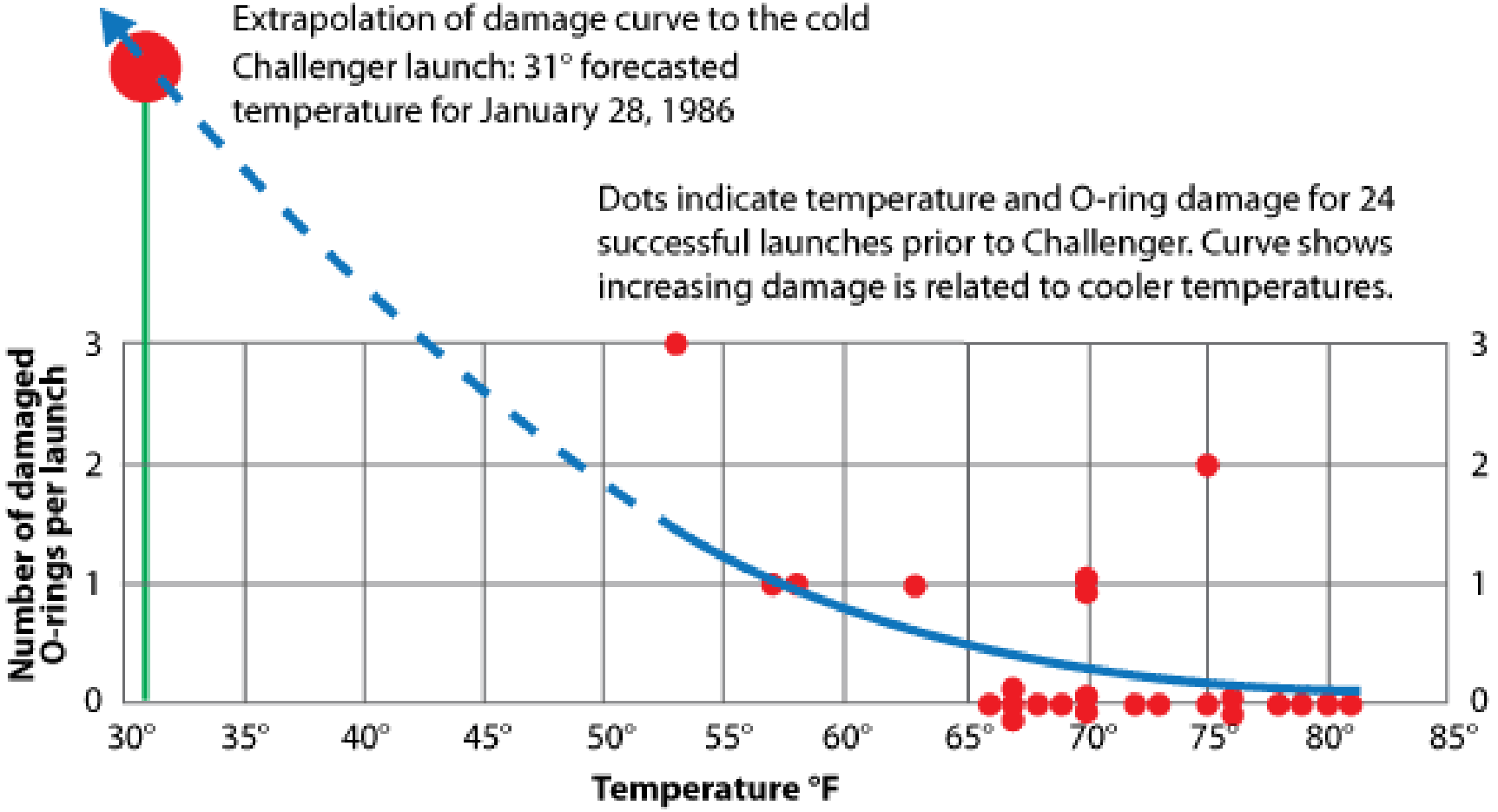
Damage Index

Flight	Date	Temperature °F	Erosion incidents	Blow-by incidents	Damage index	Comments
51-C	01.24.85	53°	3	2	11	Most erosion any flight; blow-by; back-up rings heated.
41-B	02.03.84	57°	1		4	Deep, extensive erosion.
61-C	01.12.86	58°	1		4	O-ring erosion on launch two weeks before Challenger.
41-C	04.06.84	63°	1		2	O-rings showed signs of heating, but no damage.
1	04.12.81	66°			0	Coolest (66°) launch without O-ring problems.
6	04.04.83	67°			0	
51-A	11.08.84	67°			0	
51-D	04.12.85	67°			0	
5	11.11.82	68°			0	
3	03.22.82	69°			0	
2	11.12.81	70°	1		4	Extent of erosion not fully known.
9	11.28.83	70°			0	
41-D	08.30.84	70°	1		4	
51-G	06.17.85	70°			0	
7	06.18.83	72°			0	
8	08.30.83	73°			0	
51-B	04.29.85	75°			0	
61-A	10.30.85	75°		2	4	No erosion. Soot found behind two primary O-rings.
51-I	08.27.85	76°			0	
61-B	11.26.85	76°			0	
41-G	10.05.84	78°			0	
51-J	10.03.85	79°			0	
	06.27.82	80°			?	O-ring condition unknown; rocket casing lost at sea.
51-F	07.29.85	81°			0	

Visualize It – Just The Facts

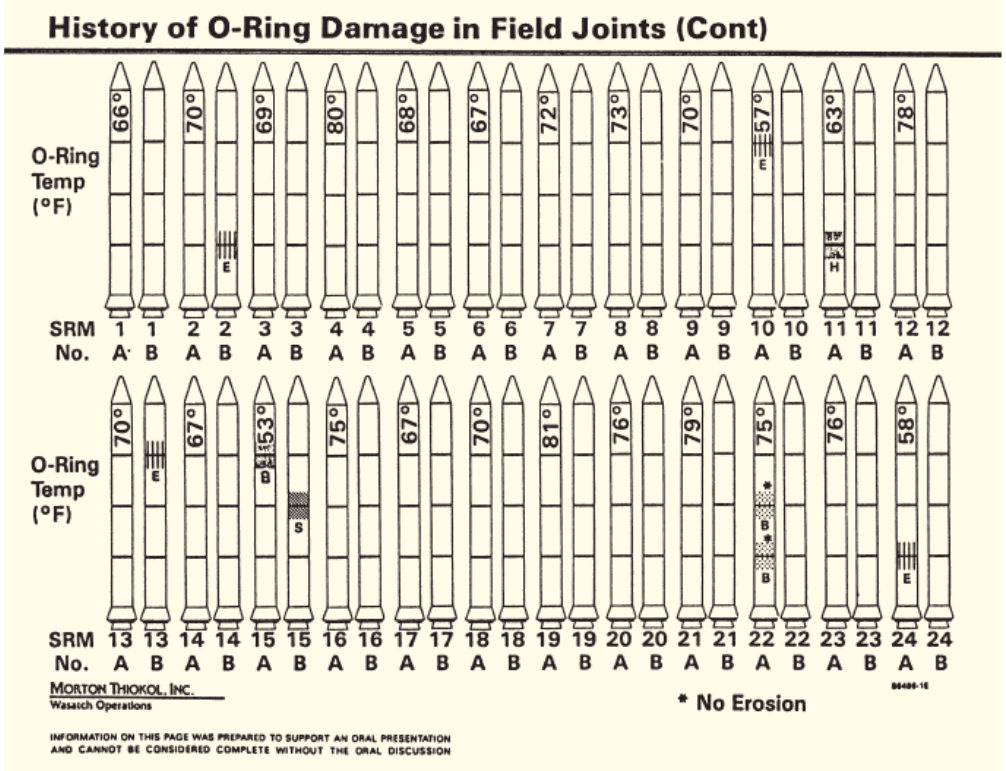


Visualize It – Tell The Story



Shown at Congressional Hearings

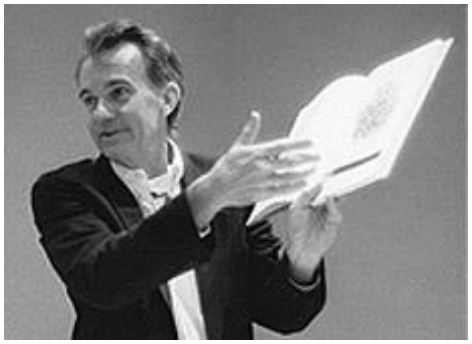
Used these charts



All information is there

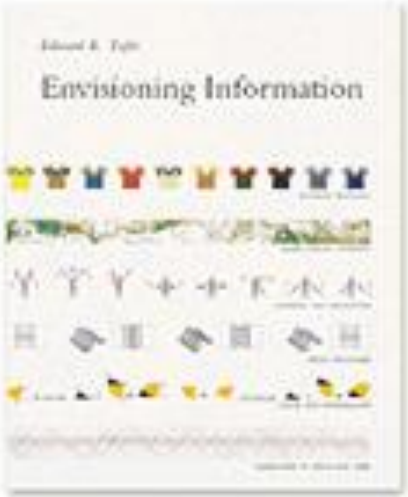
- but very hard to identify and assimilate
- why?

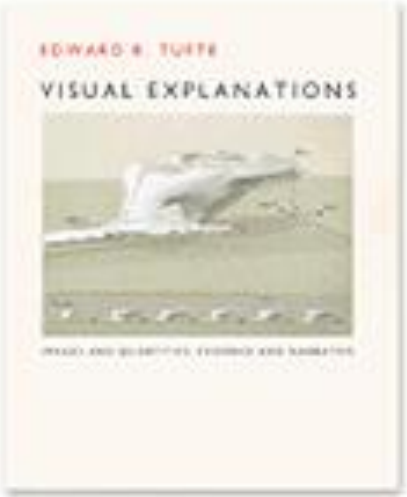
Source: Edward Tufte



Four seminal books

- standard literature for every visualization enthusiast
- written 1983, 1990, 1997, 2006

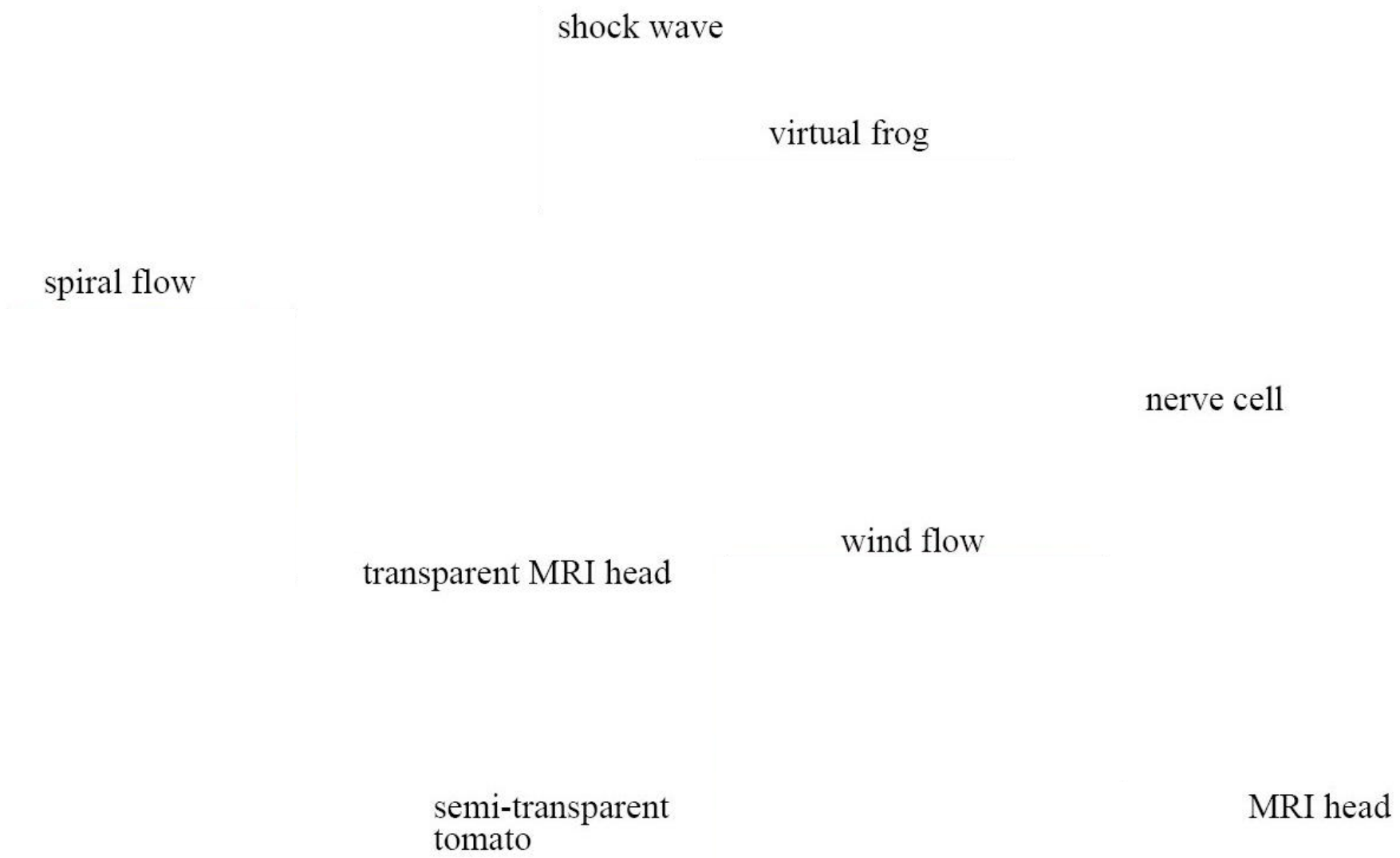




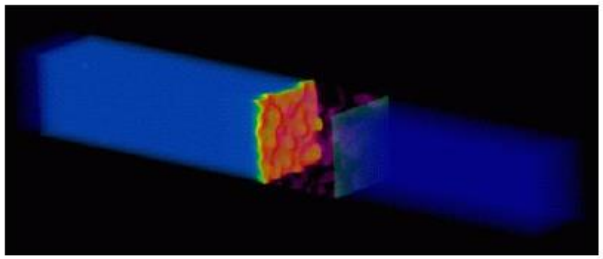
- taught information design at Princeton University
- now a professor at Yale University

Course Topics

Spatial Data

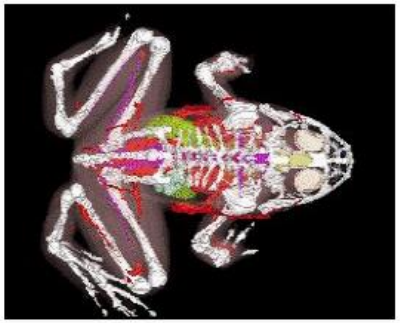


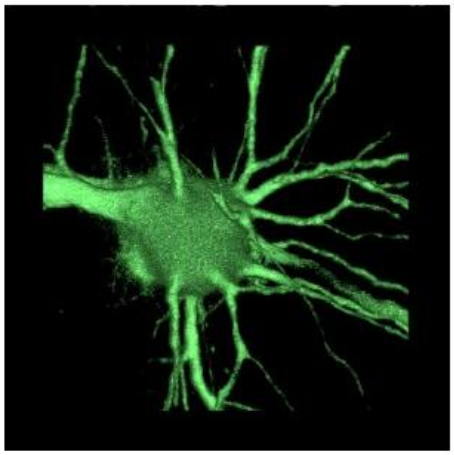
Spatial Data



shock wave

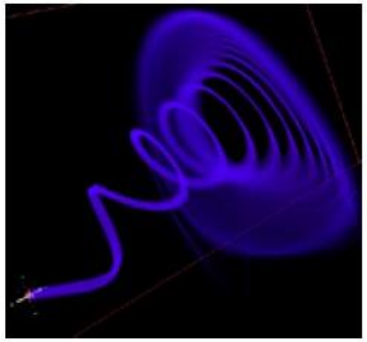
virtual frog

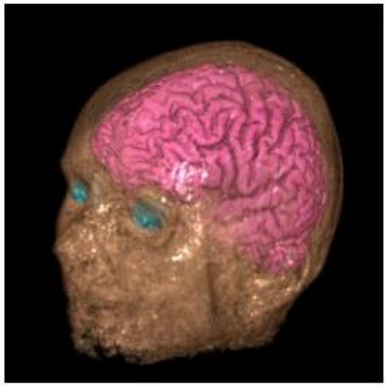




nerve cell

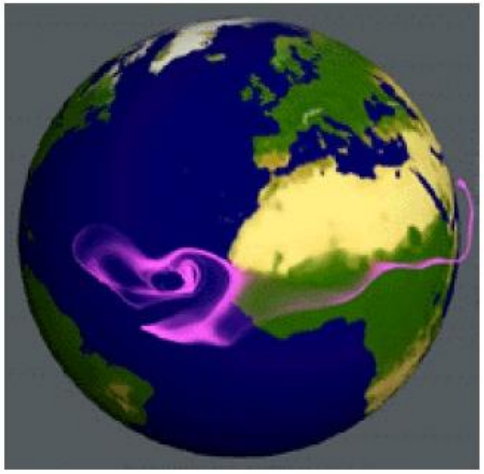
spiral flow





transparent MRI head

wind flow



MRI head

semi-transparent tomato

Spatial Data

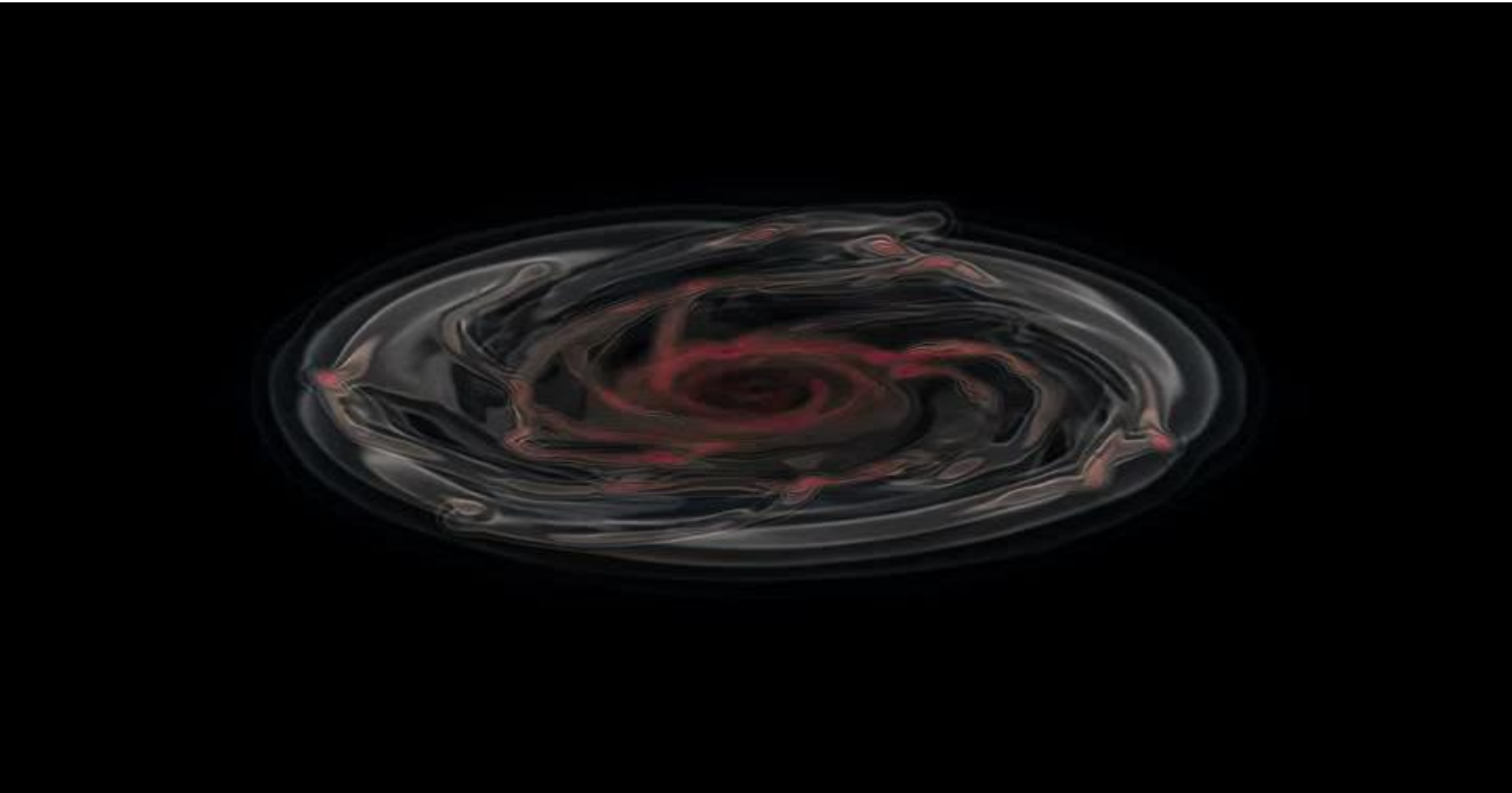
Example: Datasets obtained by 3D volumetric scans (CT, MRI)

- what are some questions you might have?

Spatial Data

Example: Datasets obtained by 3D Simulations

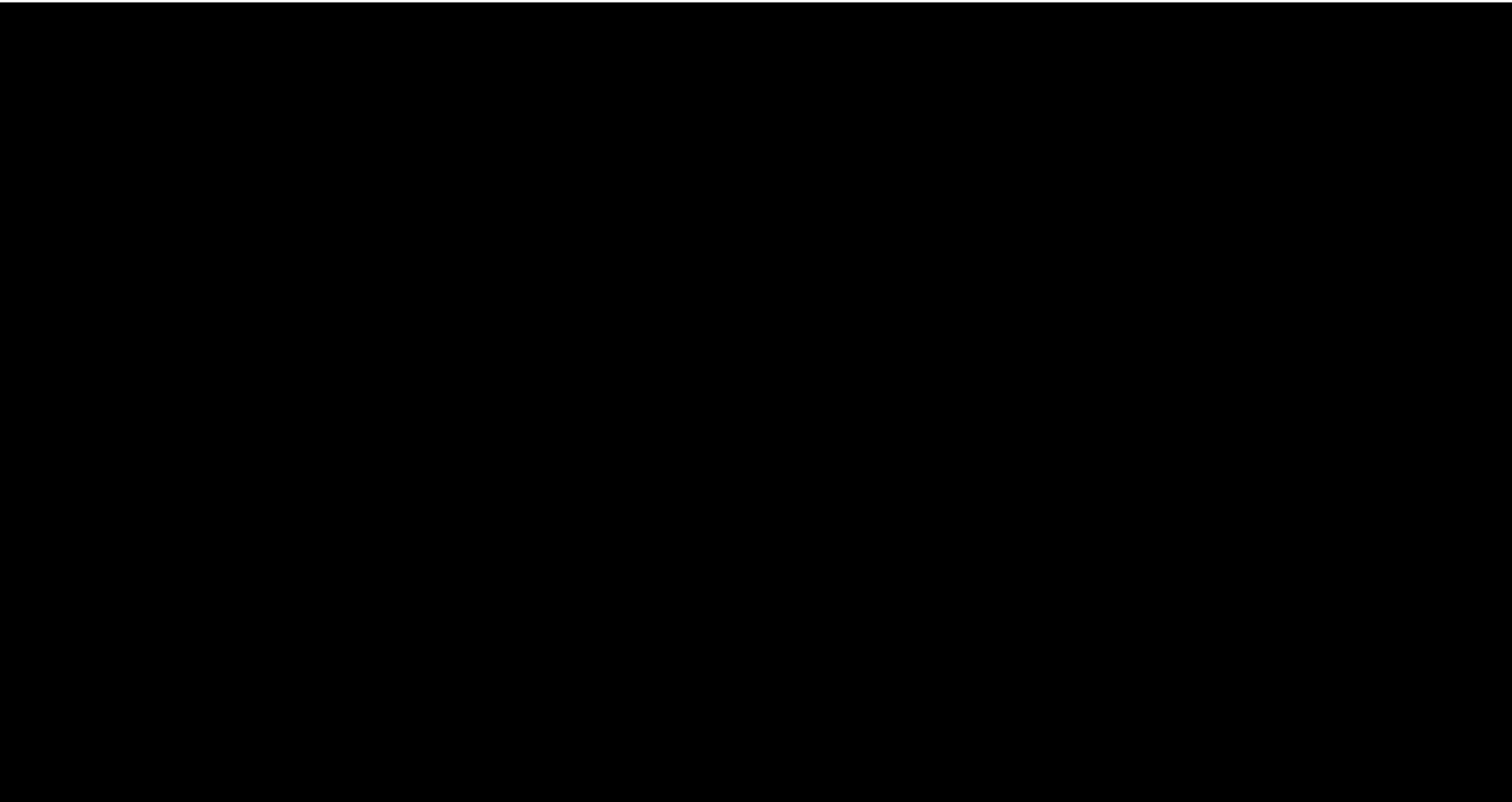
- what are some questions you might have?



Spatial Data

Example: Data obtained by observation-supported simulations

- what are some questions you might have?



Non-Spatial Data

The salient features of a car:

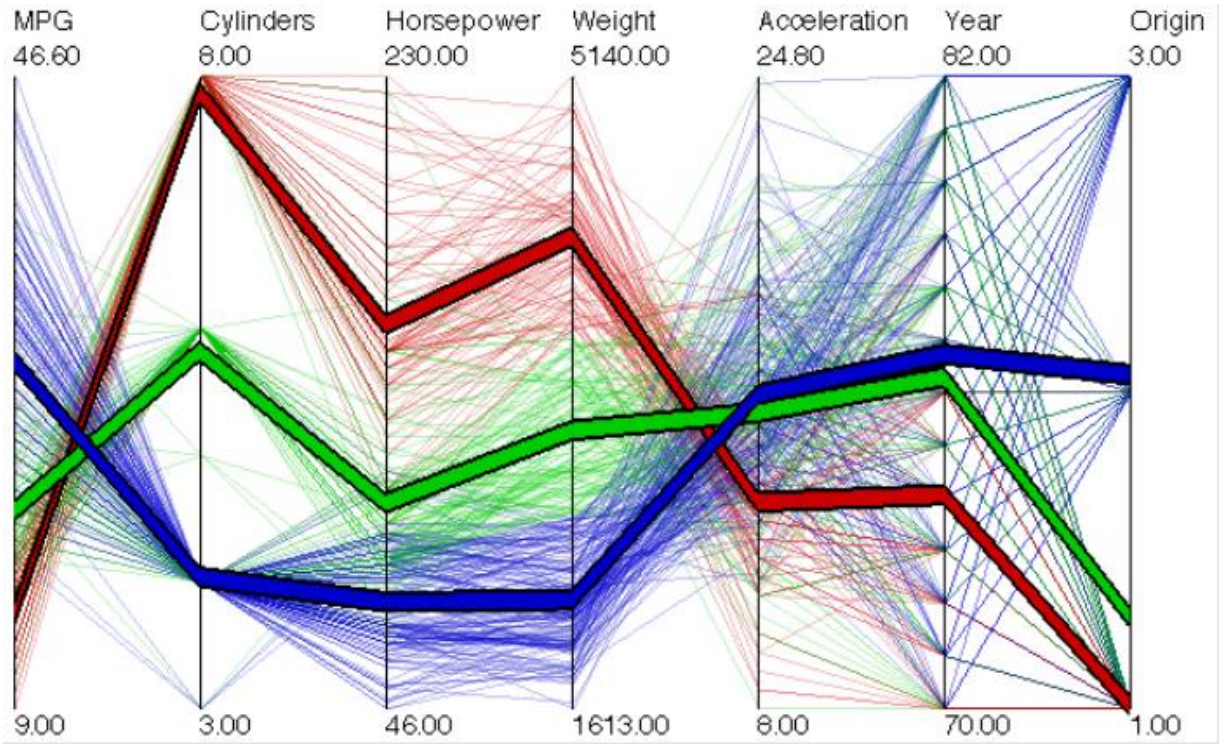
- miles per gallon (MPG)
- top speed
- acceleration
- number of cylinders
- horsepower
- weight
- year
- country origin
- brand
- number of seats
- number of doors
- reliability (# of breakdowns)
- and so on...

Can You Visualize Them Like This?

	A	B	C	D	E	F	G	H	I	J	K	L
1	Year Purchased	Year Sold	Model Year	Type	Make	Model	Engine Size (L)	Engine Type	Induction	Transmission	Drive	Make Countr
2	1994	2000	1985	Auto	Pontiac	Fiero 2M4	2.5	I-4	Normally Aspirated	5 speed manual	RWD	United State
3	1996	1997	1985	Auto	Pontiac	Fiero 2M4	2.5	I-4	Normally Aspirated	5 speed manual	RWD	United State
4	1996	1999	1987	Auto	Pontiac	Fiero 2M4	2.5	I-4	Normally Aspirated	5 speed manual	RWD	United State
5	2000	2003	1991	Auto	Mitsubishi	3000 GT VR-4	3.0	V-6	Turbocharged	5 speed manual	AWD	Japan
6	2001	2008	1984	Auto	Citation	Formula Ford	1.6	I-4	Normally Aspirated	4 speed manual	RWD	United State
7	2002	2004	2002	Truck	Dodge	Dakota	4.2	V-8	Normally Aspirated	5 speed manual	AWD	United State
8	2004	2004	1996	SUV	Chevrolet	Tahoe	5.7	V-8	Normally Aspirated	4 speed automatic	AWD	United State
9	2004	2007	1997	Auto	Audi	A4	1.8	I-4	Turbocharged	5 speed manual	AWD	Germany
10	2006	2006	2004	Motorcycle	Suzuki	GSX-R 1000	1.0	I-4	Normally Aspirated	6 speed manual	RWD	Japan
11	2006	2009	2004	Auto	Audi	S4	4.2	V-8	Normally Aspirated	6 speed manual	AWD	Germany
12	2007	2009	2006	Truck	Dodge	Durango	5.7	V-8	Normally Aspirated	5 speed automatic	AWD	United State
13	2007	2012	2005	Auto	Lotus	Elise	1.8	I-4	Normally Aspirated	6 speed manual	RWD	United Kingdo
14	2009	2011	2003	Auto	Audi	RS6	4.2	V-8	Turbocharged	5 speed automatic	AWD	Germany
15									Turbocharg			

How are MPG, weight, HP, and reliability related? Are there tradeoffs? Which car is best for me?

High-Dimensional Data Visualization



Big Data


12+ TBs
of tweet data
every day
? TBs of
data every day
25+ TBs of
log data every day
Google
Reader
ootalk
more »
Google
Google | Analytics
YouTube


30 billion RFID
tags today
(1.3B in 2005)
4.6
billion
camera
phones
world wide
100s of
millions
of GPS
enabled
devices
sold
annually
130 m
2+
billion
people on
the Web
by end
2011
http://www.
76 million smart
meters in 2009…
200M by 2014

The Scientific Method

In the Age of Data Science

Formulate Question

Generate Hypothesis

Form Experiment (find data sources)

Form Testable Prediction

Collect Data (scrape, mine)

Analyze Data

Test Prediction (visualize)

Publish Results

MODERN DATA SCIENTIST

21th century, requires a mixture of
, computer science, communicatio
who a data scientist is, is equally h
the modern data scientist really i

MATH & STATISTICS

- Machine learning
- Statistical modeling
- Experiment design
- Bayesian inference
- Supervised learning: decision trees, random forests, logistic regression
-
-

PROGRAMMING & DATABASE

- Computer science fundamentals
- Scripting language e.g. Python
- Statistical computing packages, e.g., R
- Databases: SQL and NoSQL
- Relational algebra
-

DOMAIN KNOWLEDGE & SOFT SKILLS

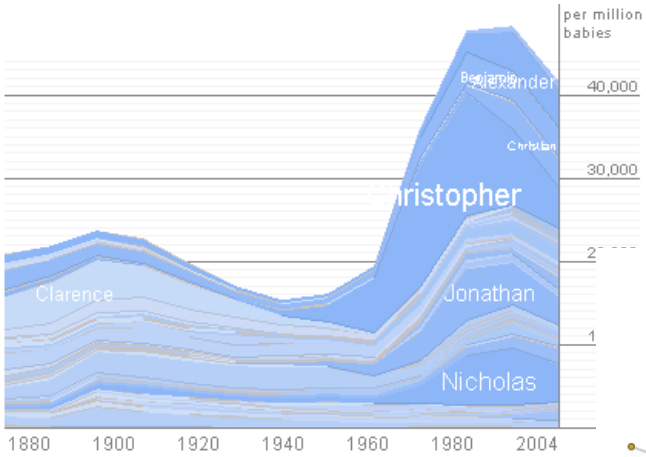
- Passionate about the business
- Curious about data
- Influence without authority
- Hacker mindset
- Problem solver
- Strategic, proactive, creative, innovative and collaborative

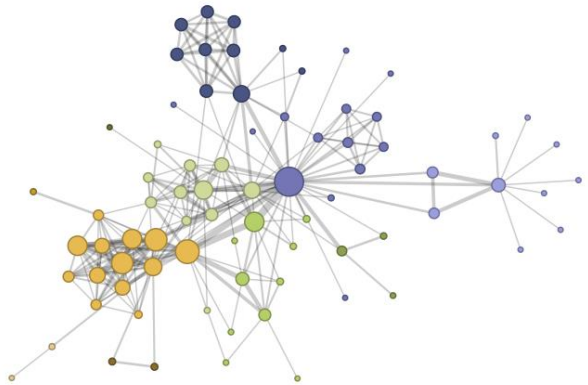
COMMUNICATION & VISUALIZATION

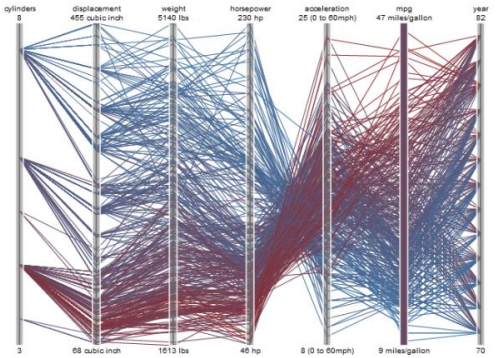
- Able to engage with senior management
- Story telling skills
- Translate data-driven insights into decisions and actions
- Visual art design
- R packages like ggplot or lattice
- Knowledge of any of visualization tools e.g. Flare, D3.js, Tableau

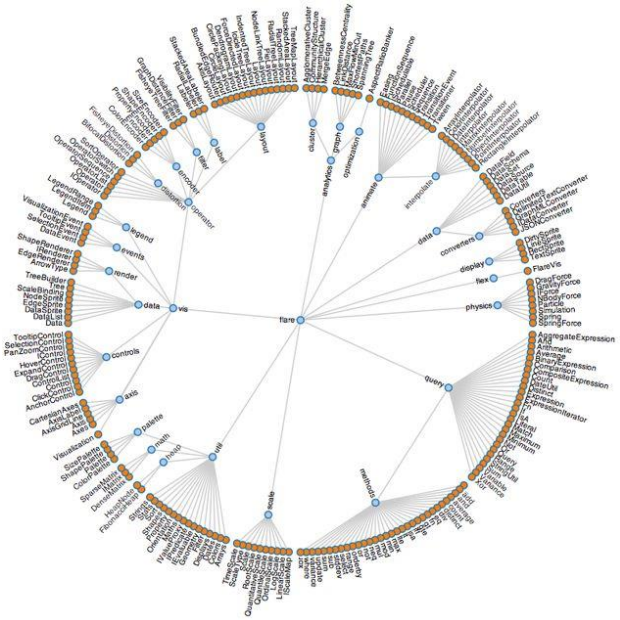
Visualization Can Be Beautiful

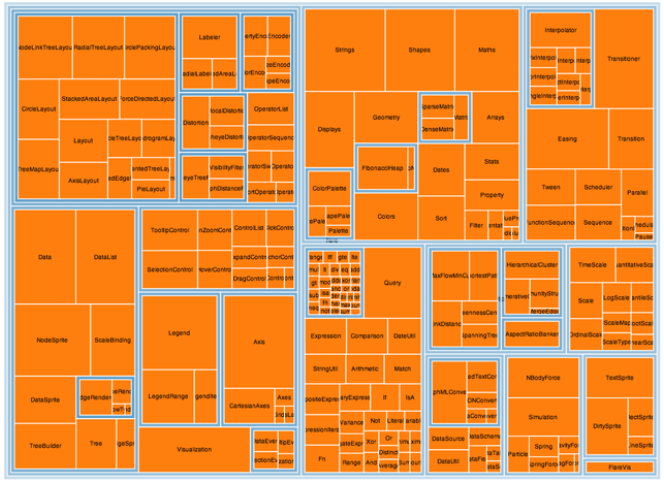
Visualization Can Be Beautiful

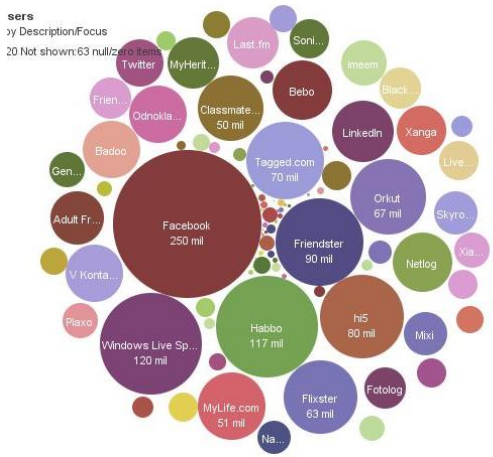




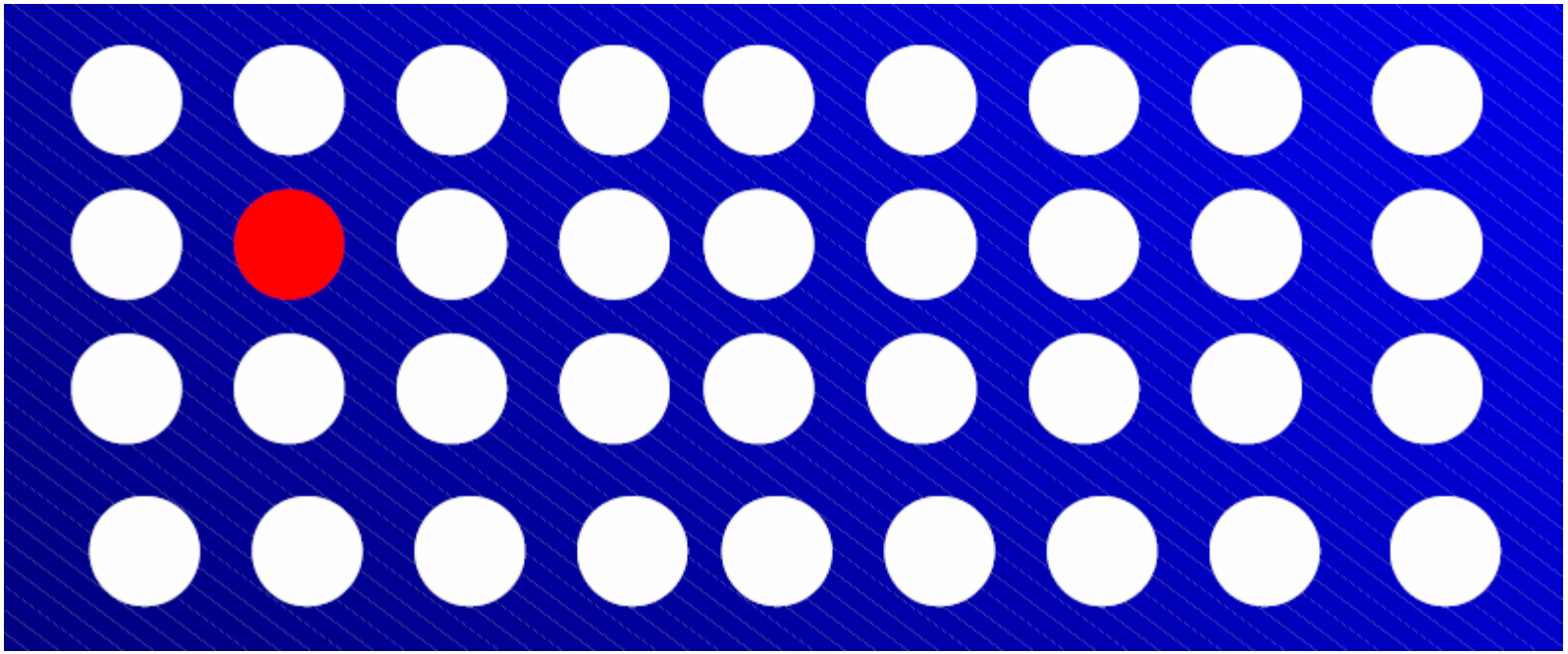






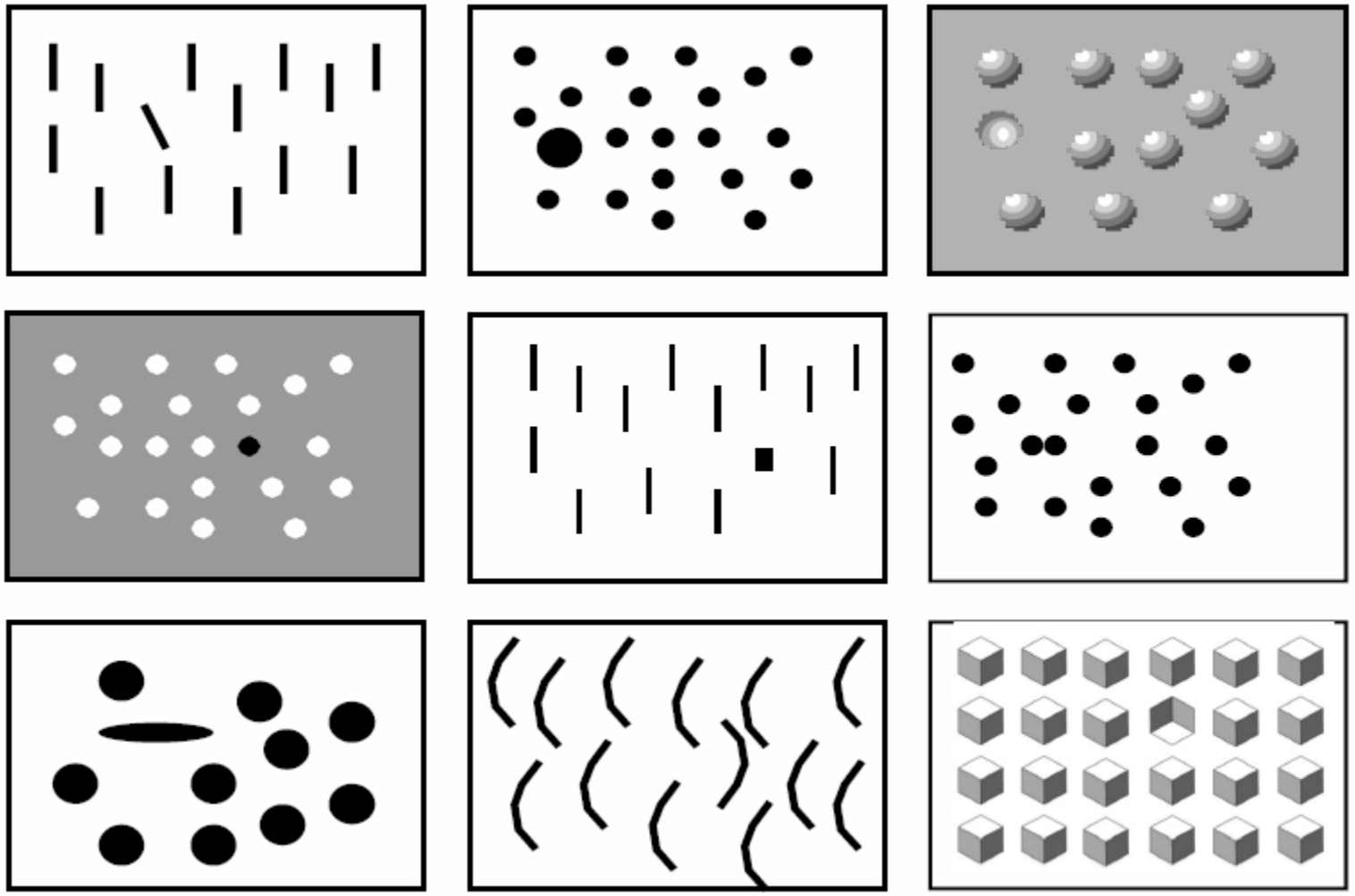


Visualization Is Fast

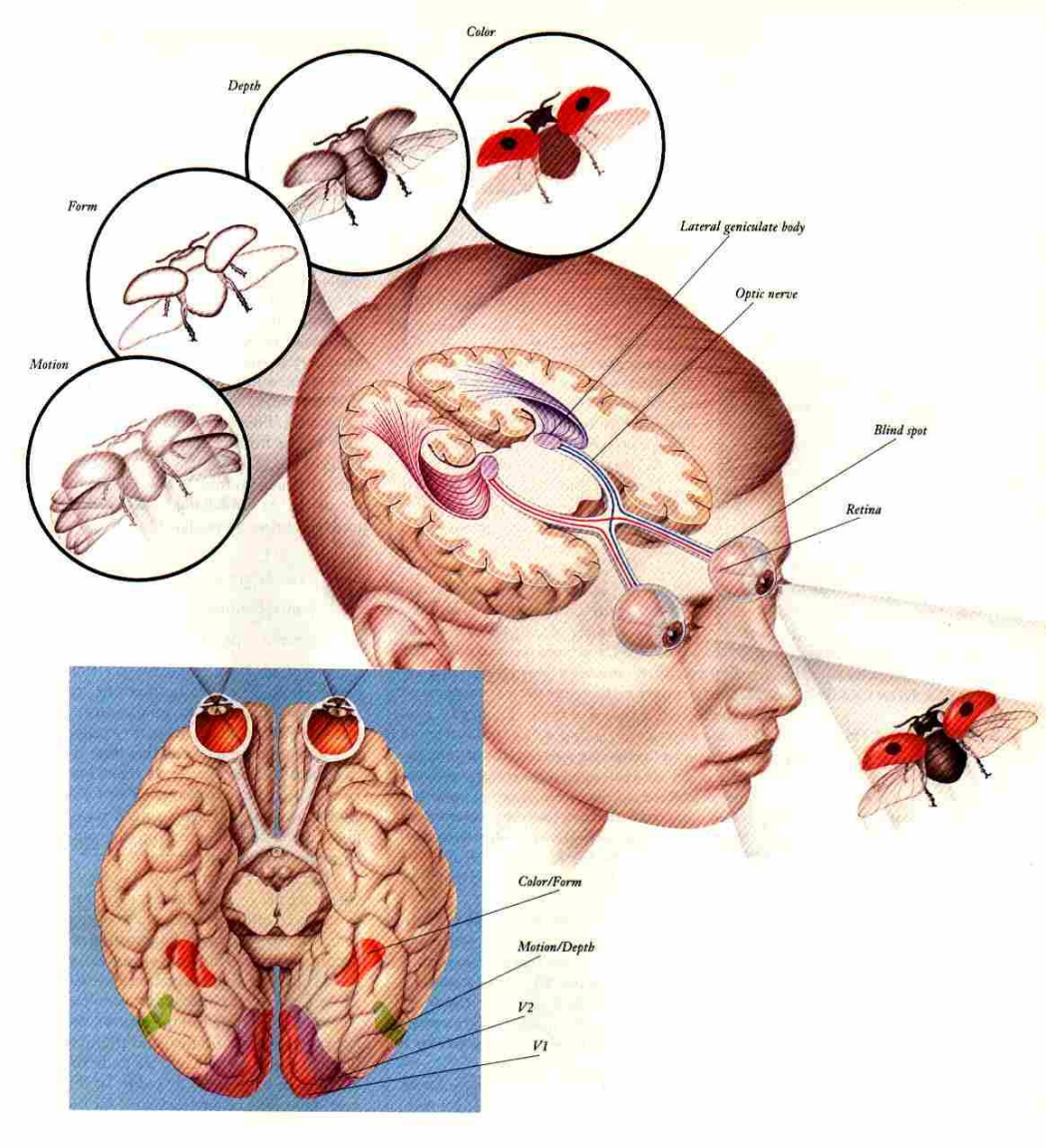


< 200 ms to recognize the red dot

Visualization Is Fast



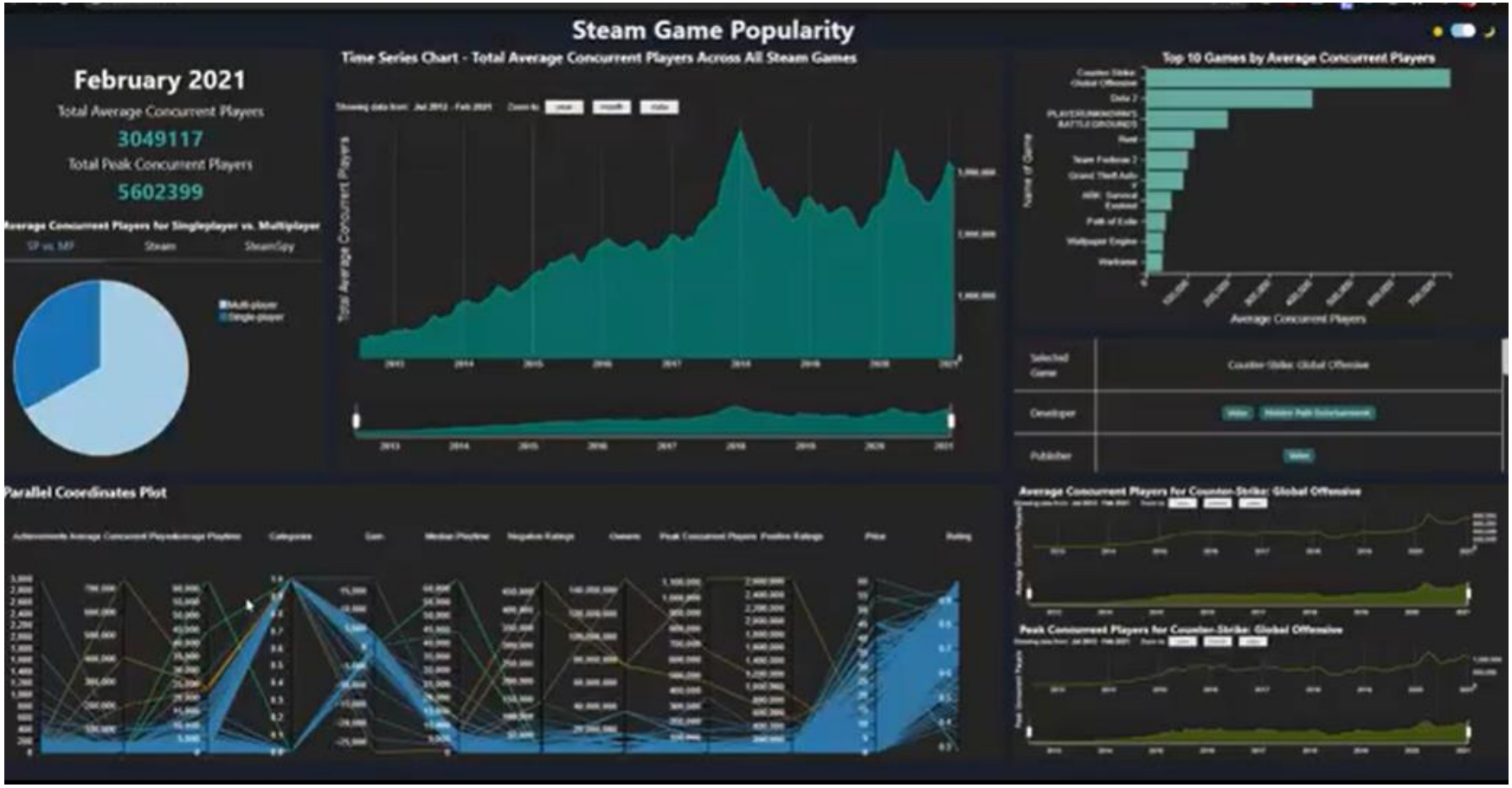
Vision Is Massively Parallel



more than 50% of the brain

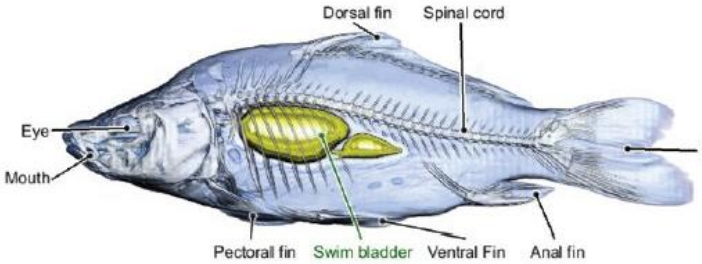
Visualization Can Be Interactive

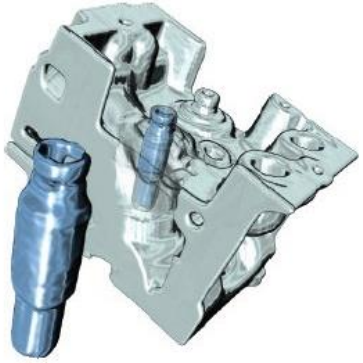
youtube

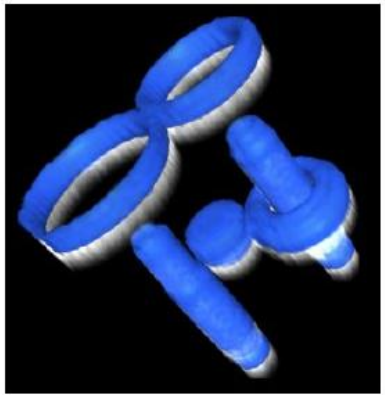


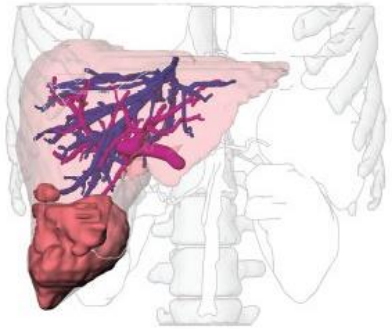
Visualization Has a Long History

Visualization Can be Inspired by Art

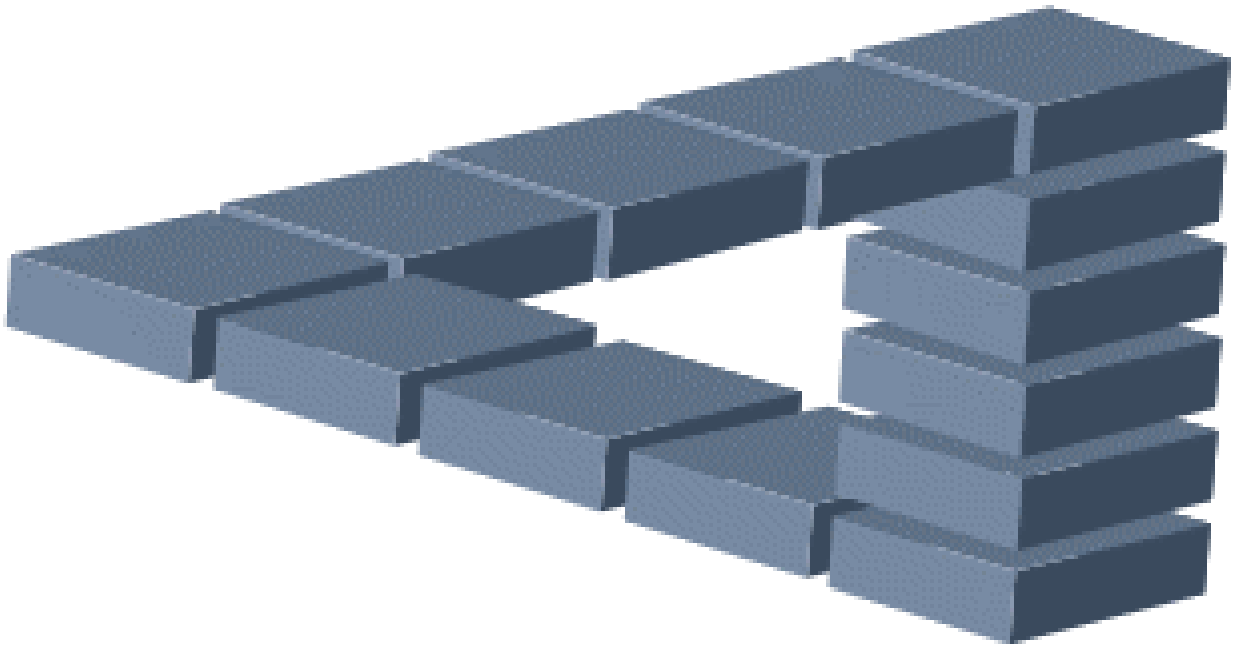






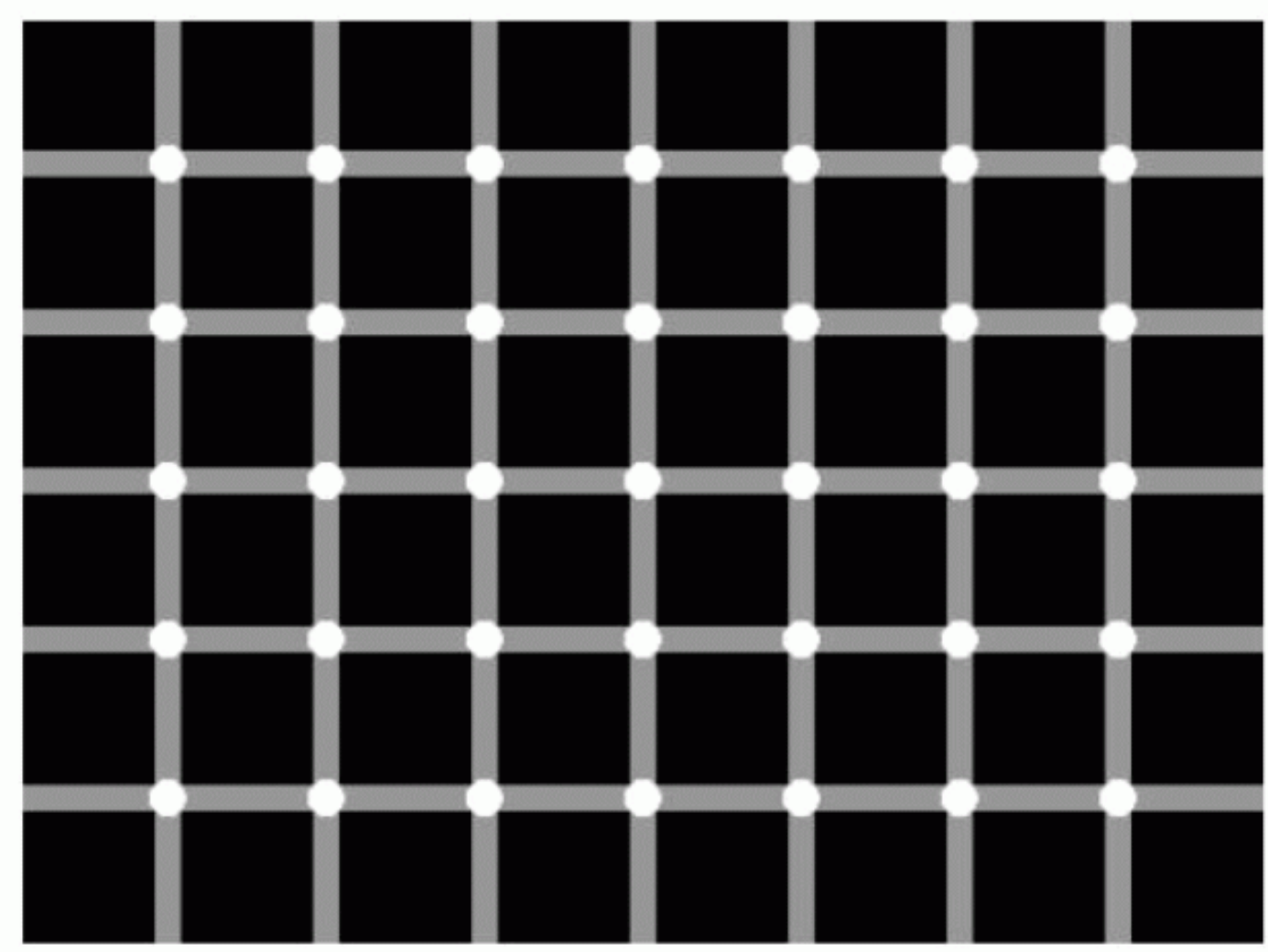


Visualization Can be Deceptive



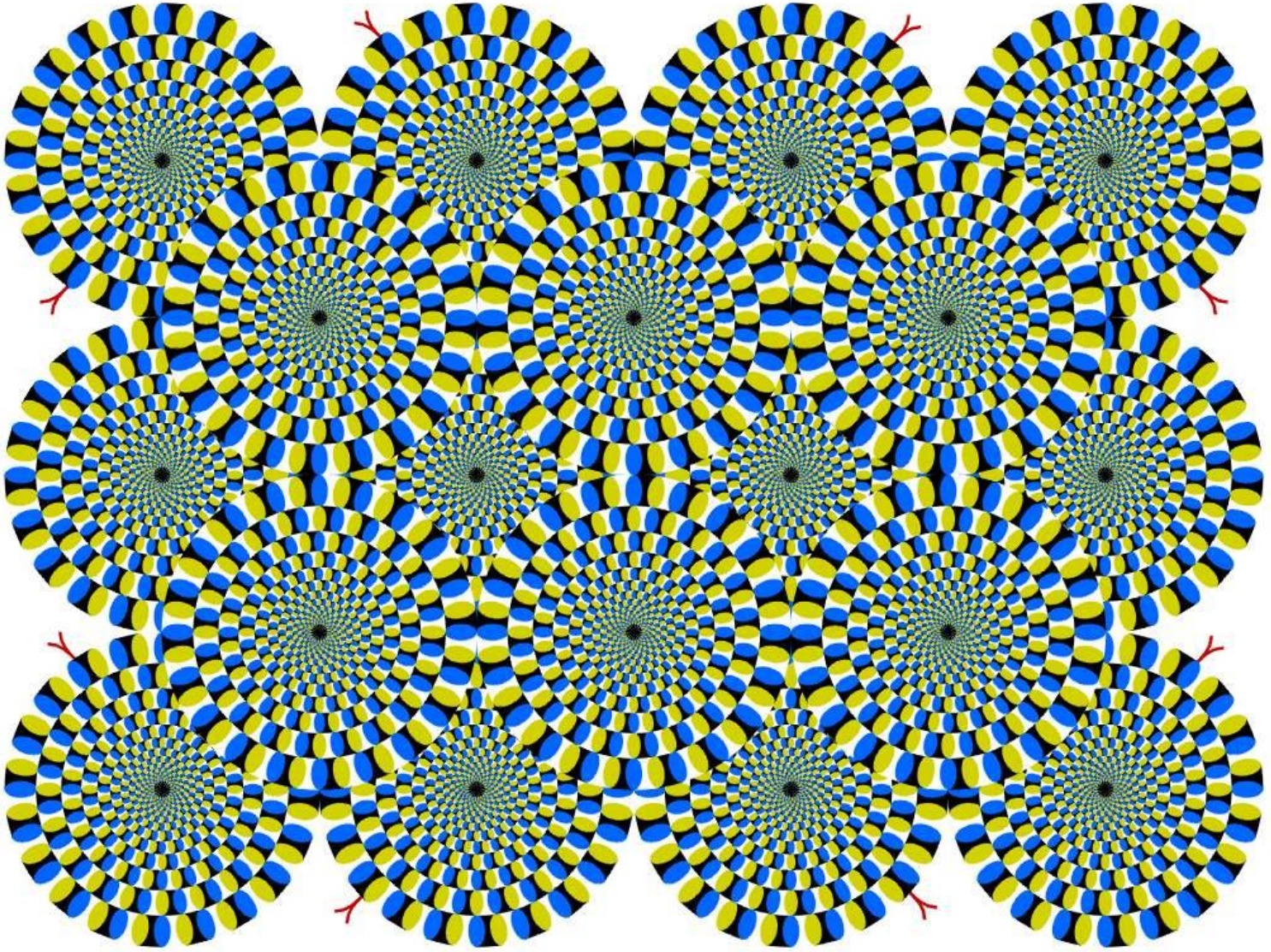
Visualization Can be Deceptive

Visualization Can be Deceptive

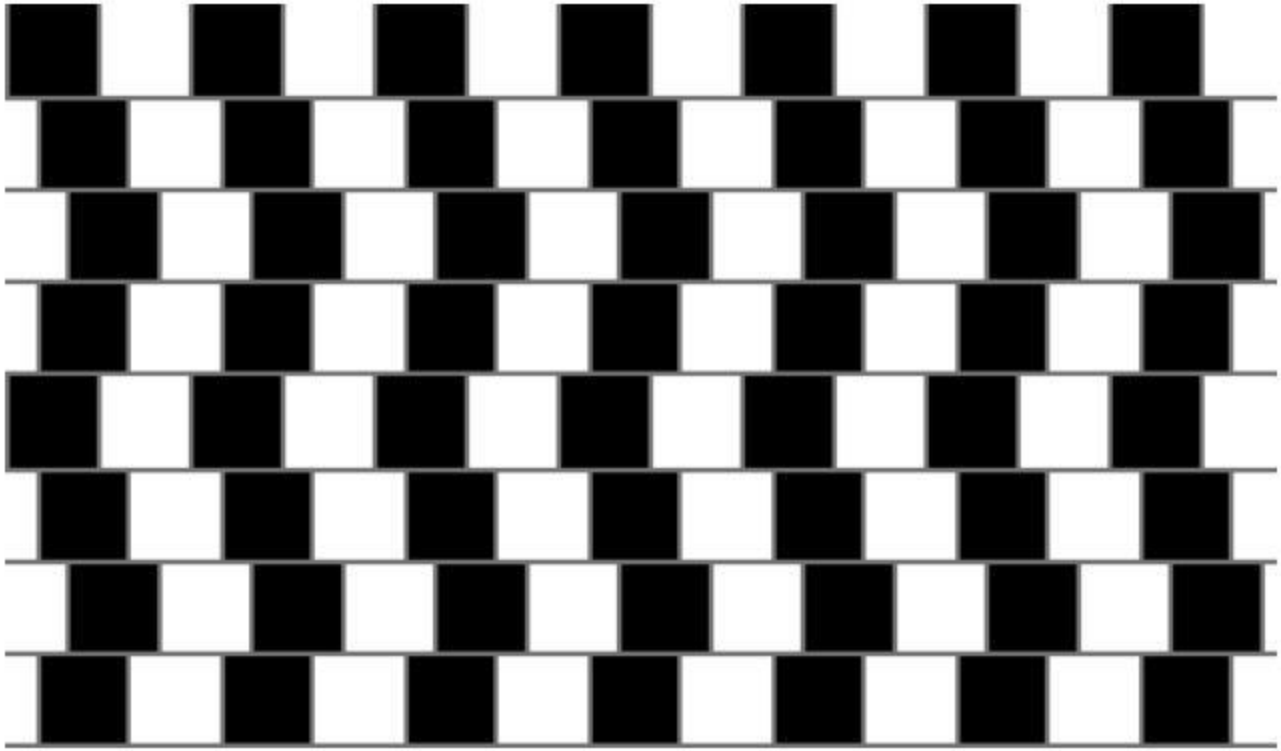


Count the number of black dots

Visualization Can be Deceptive

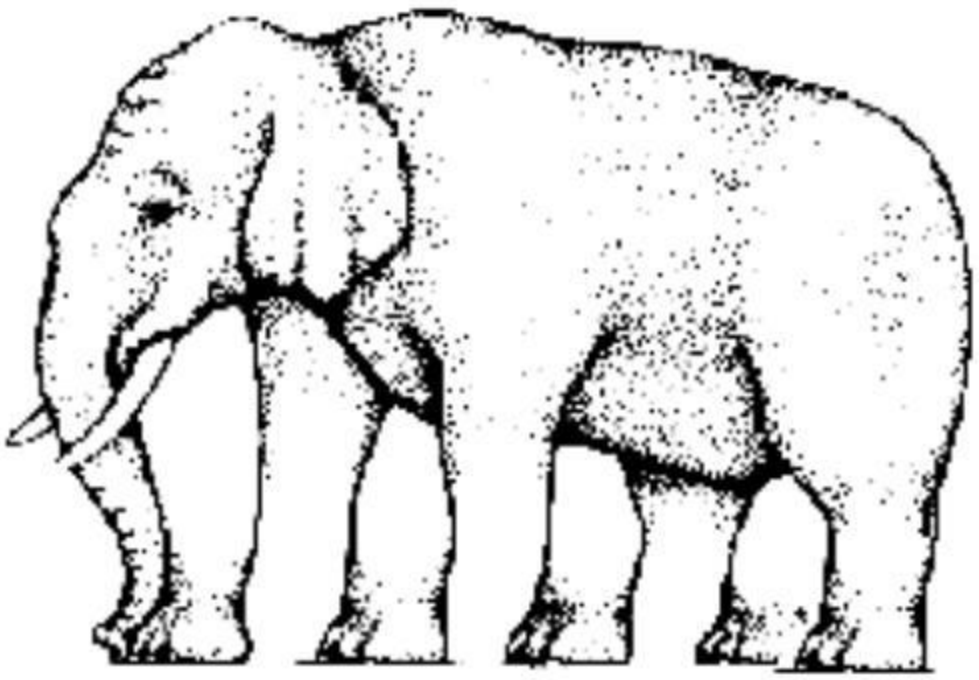


Visualization Can be Deceptive



Are the horizontal lines parallel or do they slope?

Visualization Can be Deceptive

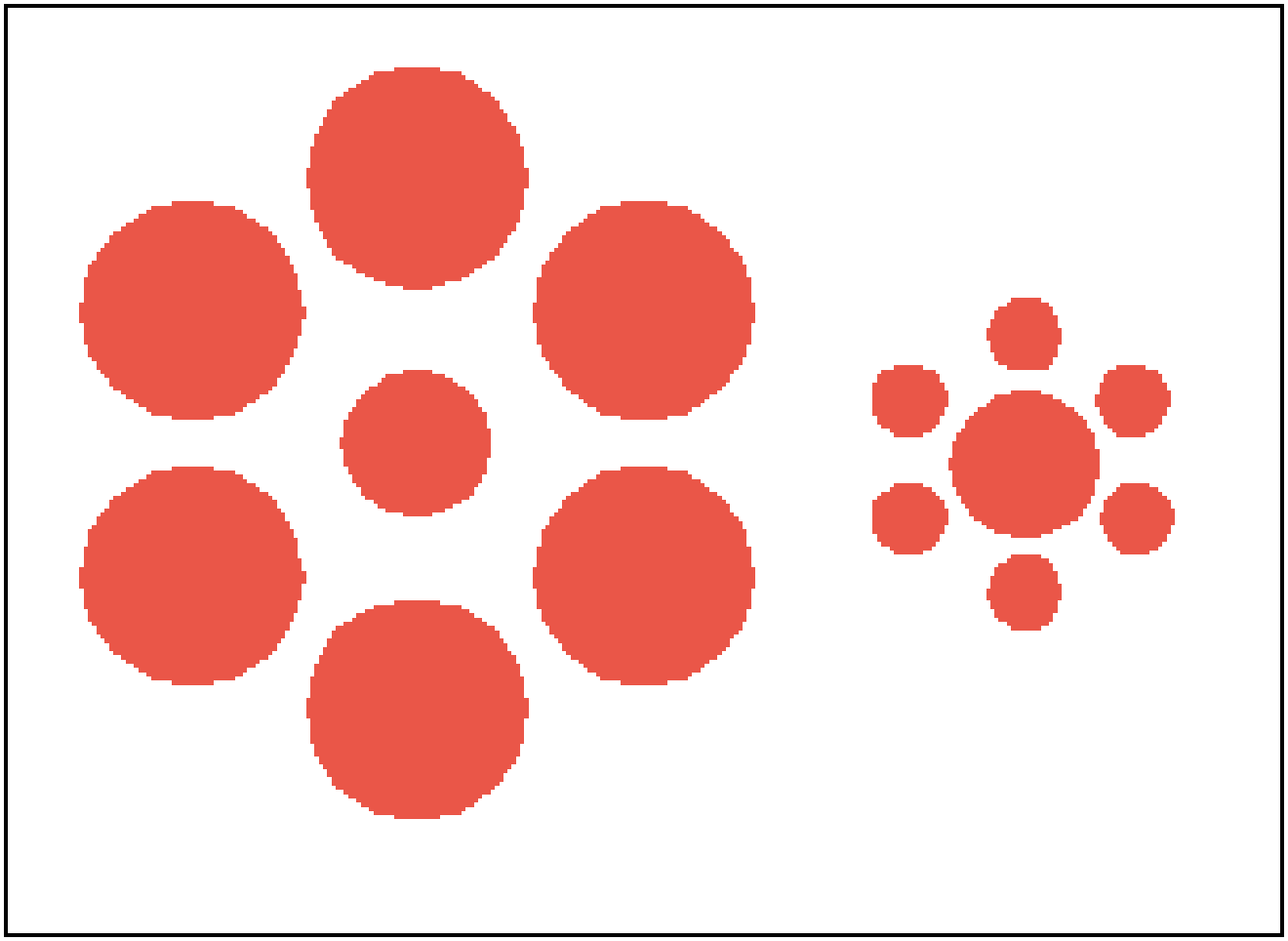


How many legs does this elephant have?

Visualization Can be Deceptive

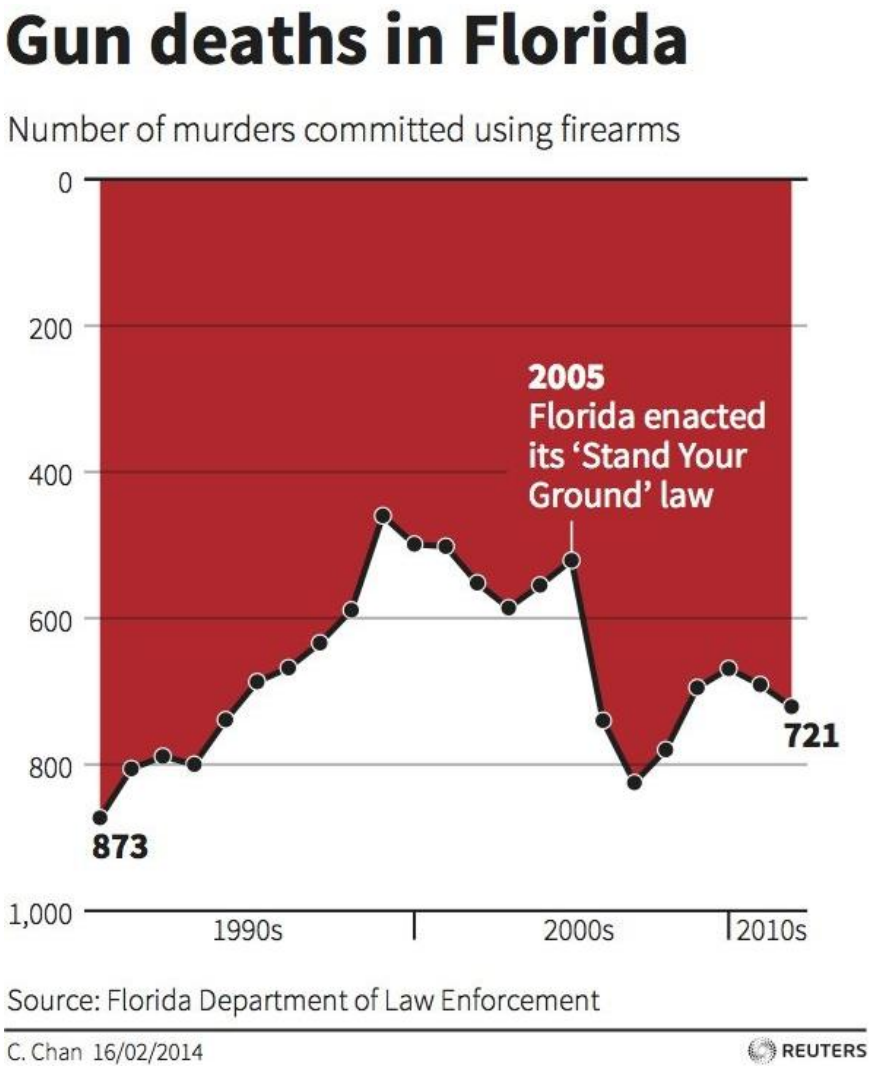
Julian Beever

Visualization Can be Deceptive

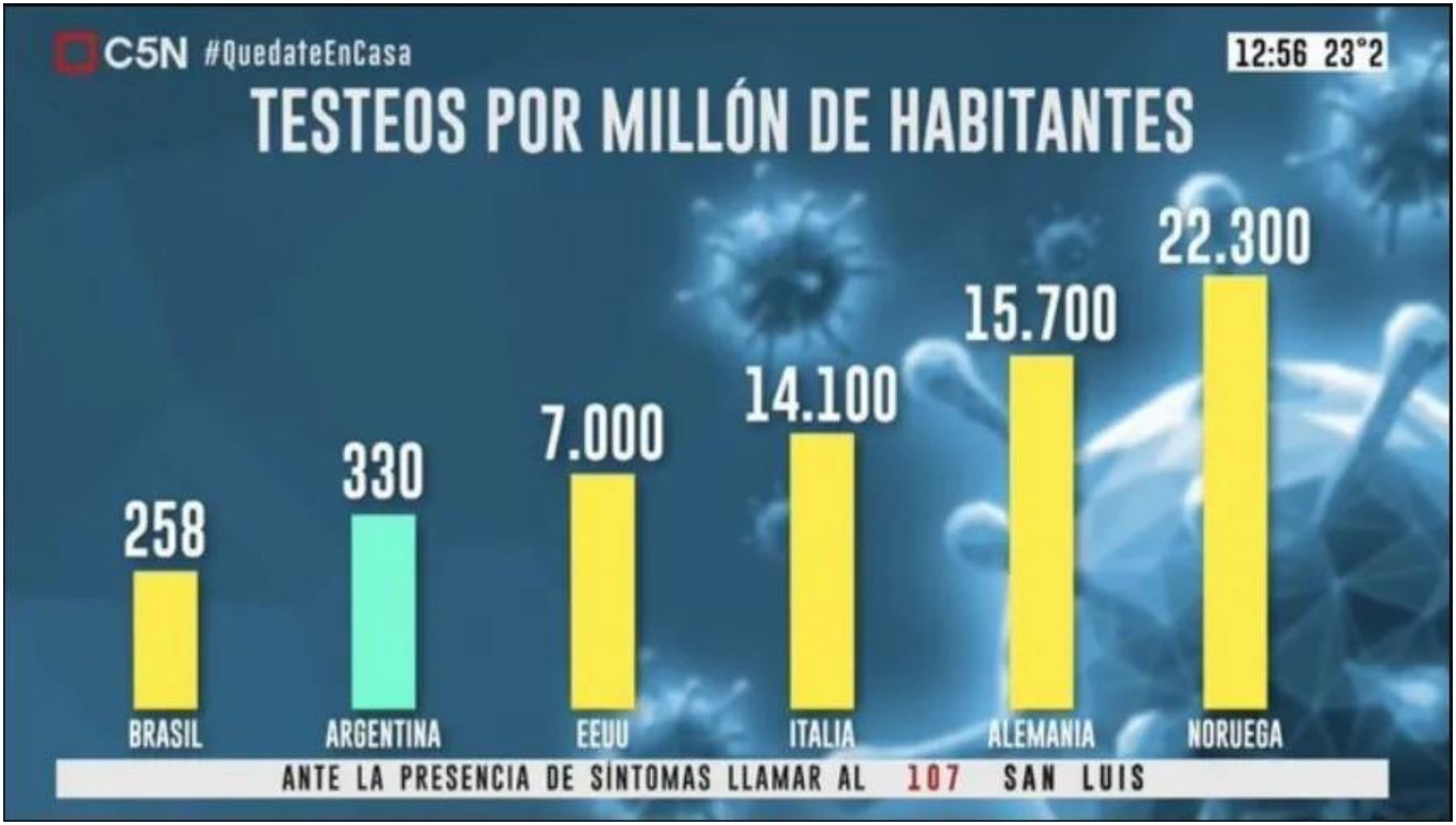


Which circle in the middle is bigger?

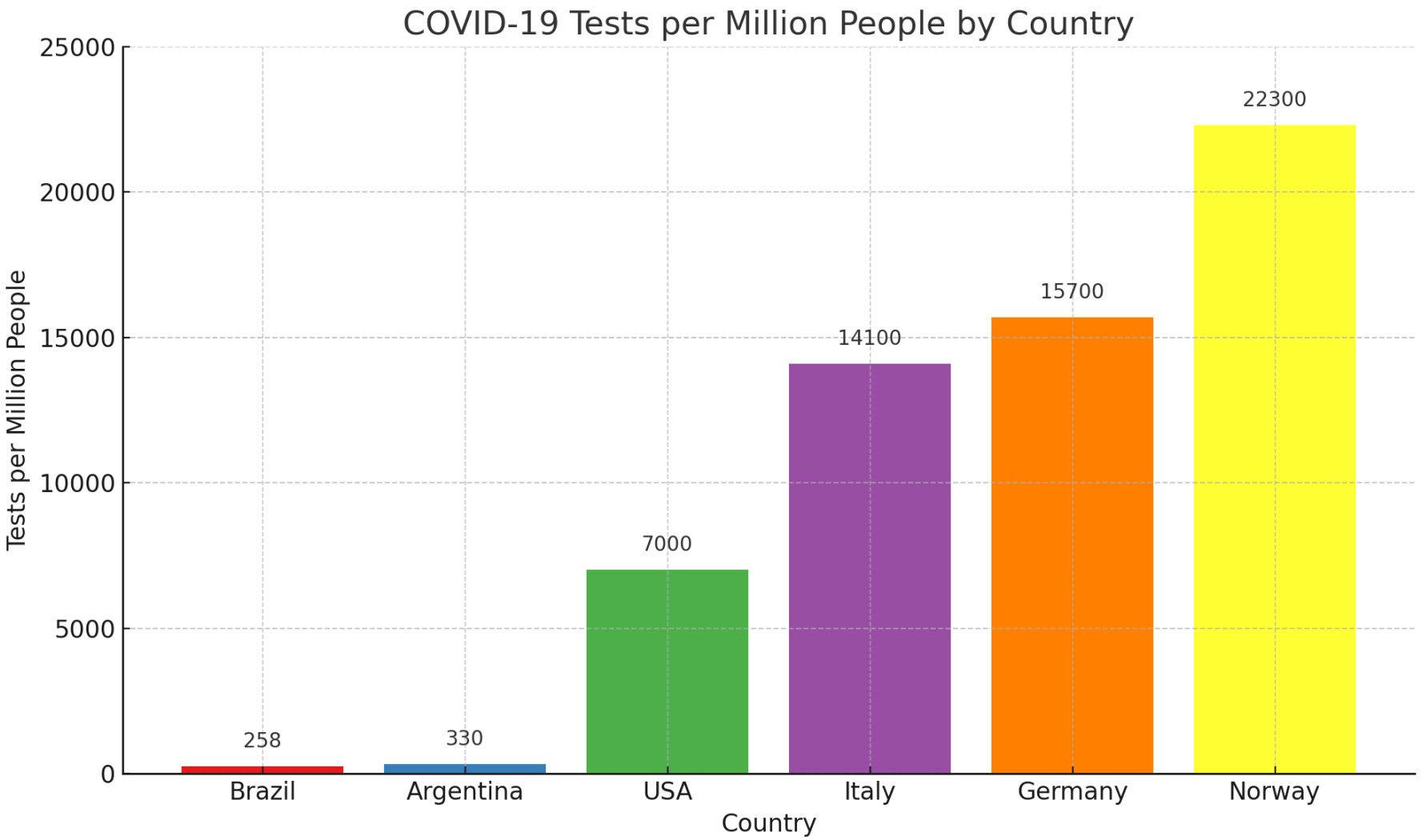
Visualization Can be Deceptive



Visualization Can be Deceptive



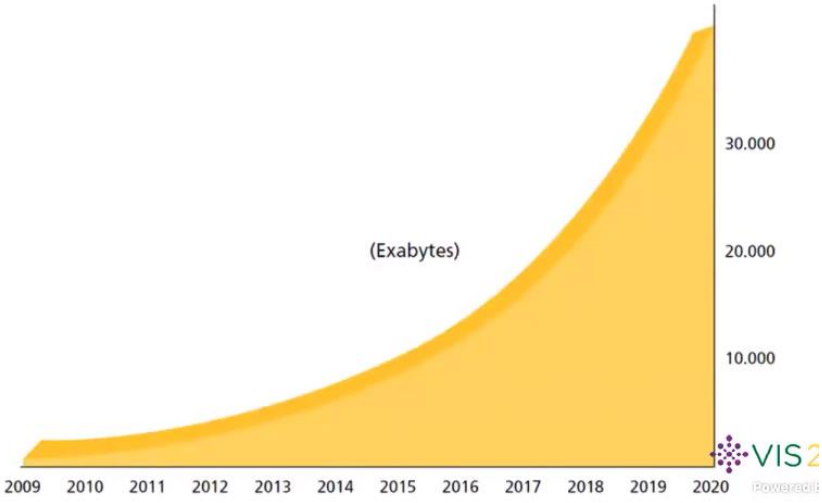
Fixed....


COVID-19 Tests per Million People by Country
Tests per Million People
25000
20000
15000
10000
5000
0
258
330
7000
14100
15700
22300
Brazil
Argentina
USA
Italy
Germany
Norway
Country

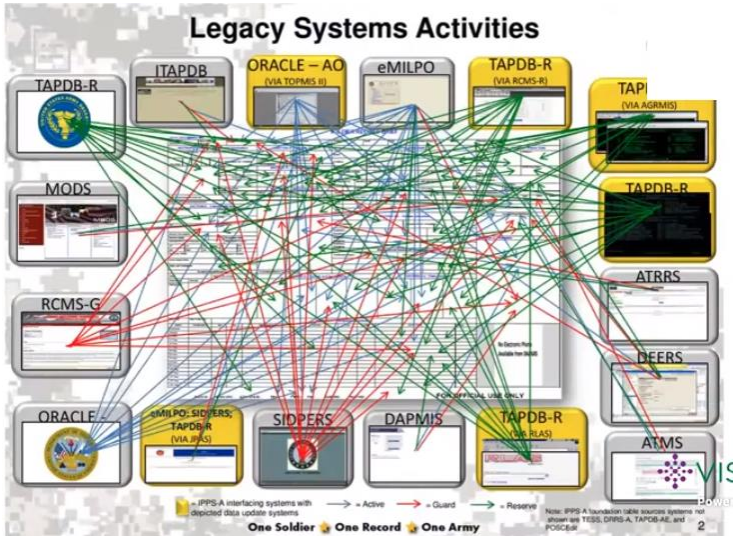
Visualization Can Be BS*

From Michael Correll's alt.vis 2021 talk (link)

- Don't relate to the real world
- Don't really help people understand their data
- Don't even have the decency to *lie* to you



"Stock footage chart"

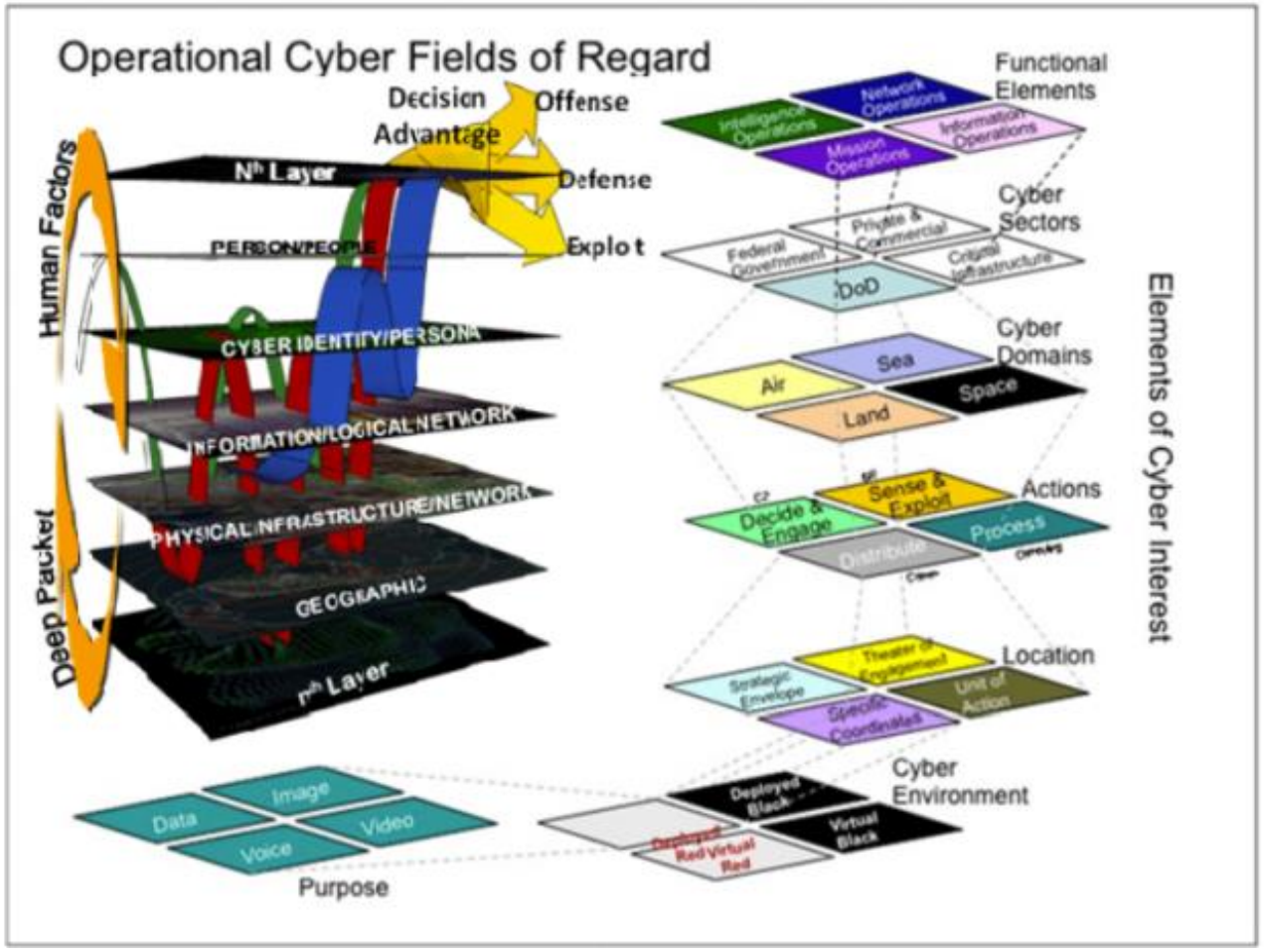


"Novocaine chart"

This stuff is way too complex for you to understand. Aren't you glad there's somebody smart like me taking care of it?

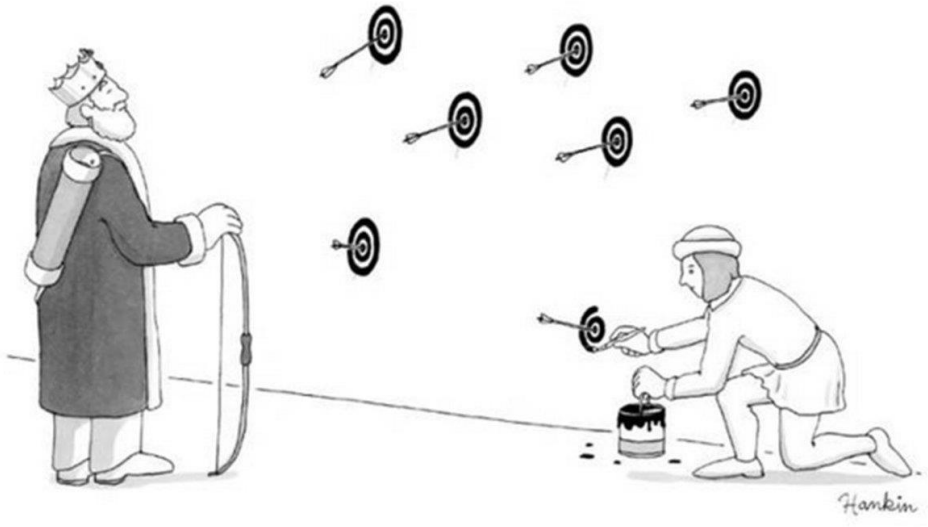
* Bullshit

Visualization Can Be BS



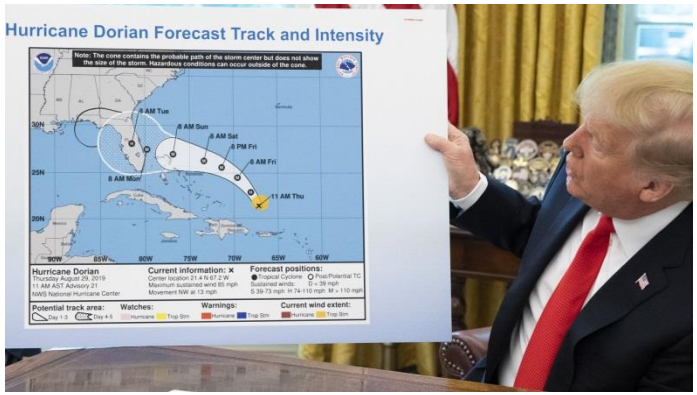
Hwang's @DefenseCharts Twitter account, "dedicated to the presentational aesthetics of the defense-industrial complex"

Visualization Can Be BS



"Texas sharpshooter chart"

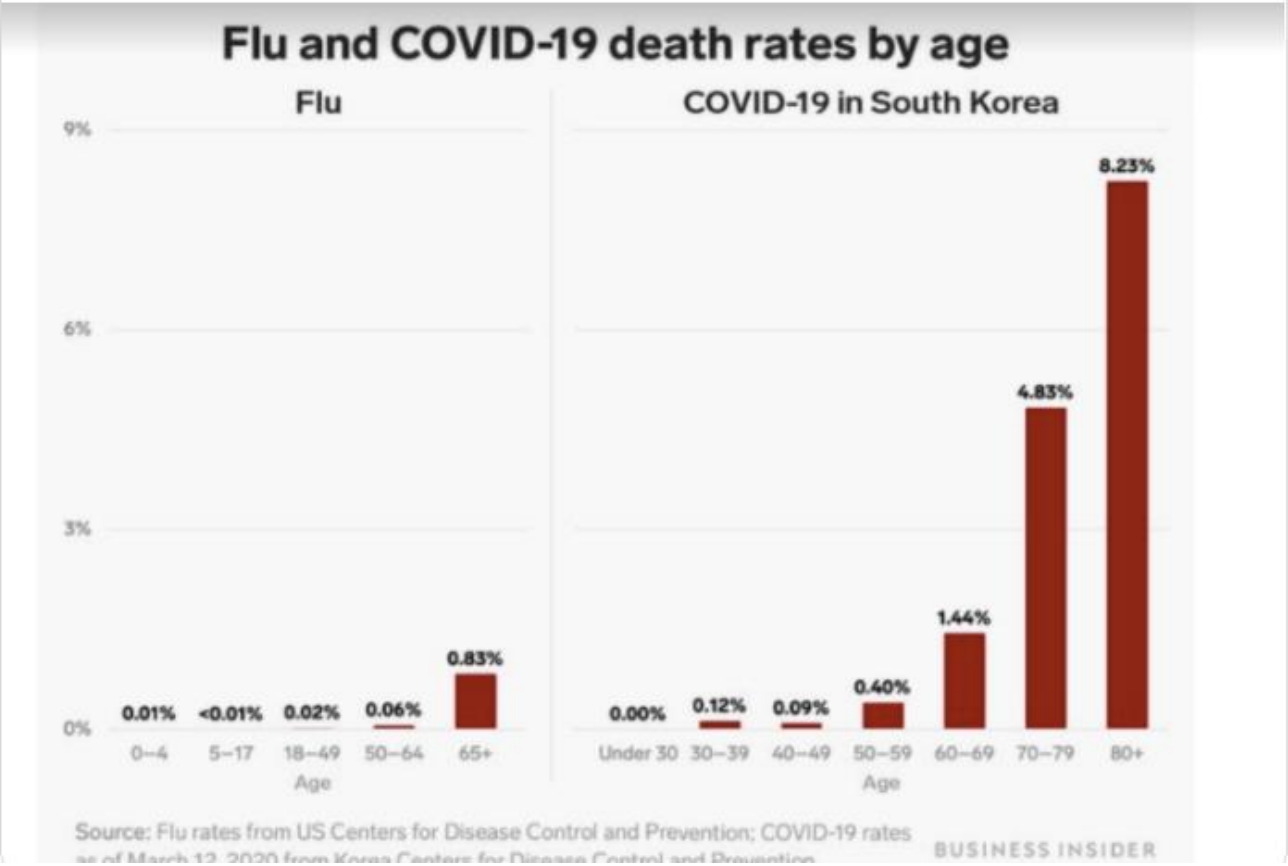
Example: Sharpiegate



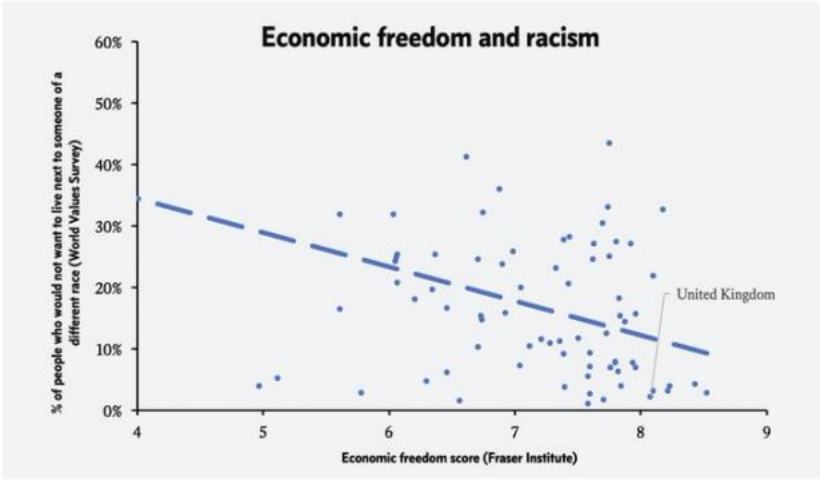
Visualization Can Be BS

Ann Coulter @AnnCoulter

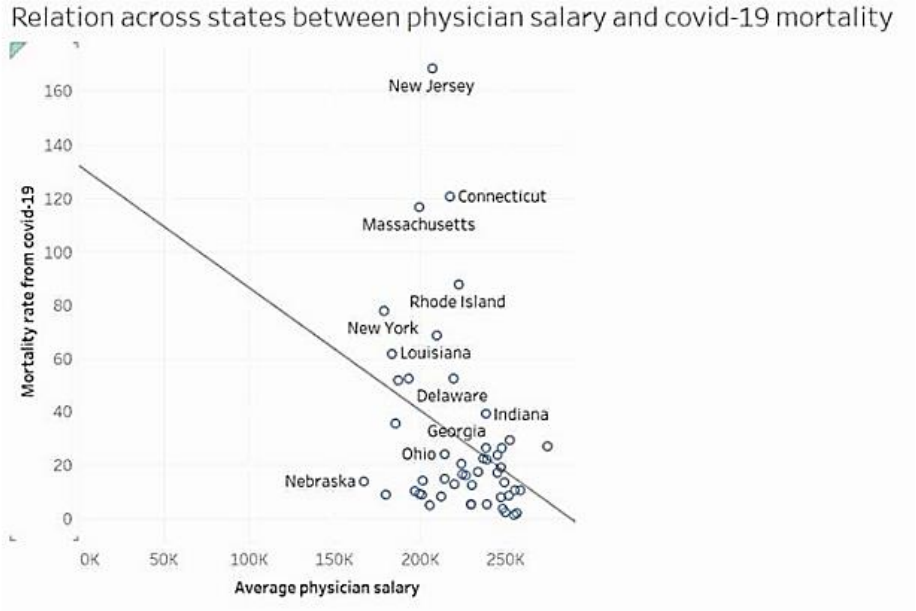
For people under 60, coronavirus is LESS dangerous than the seasonal flu:



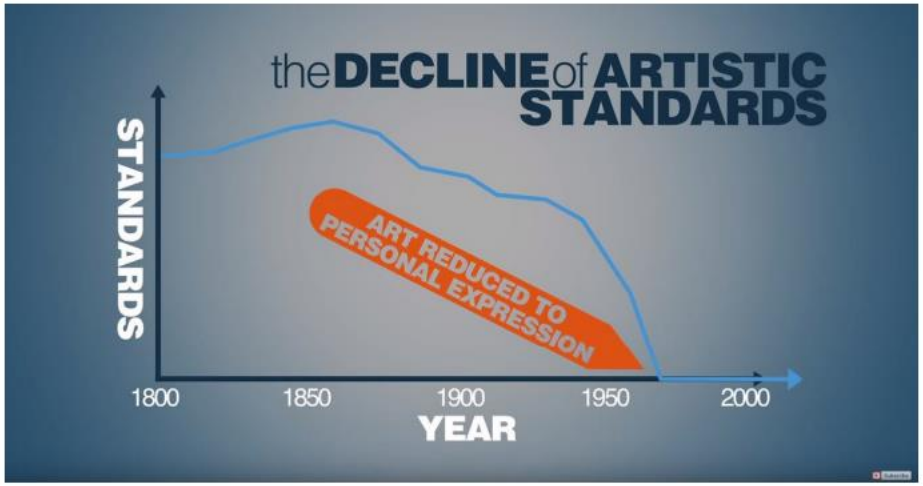
Visualization Can Be BS



To show: "Countries with more economic freedom have less racist attitudes"



To show: "States where physicians are highly paid have lower COVID-19 mortality per capita"



Artificial noise added to make the chart look like there is a complex metric being measured precisely over time (when it is really not)

The Power of The Visual System

The human visual system is not perfect, but it's extremely powerful

Vision is an integral part of life

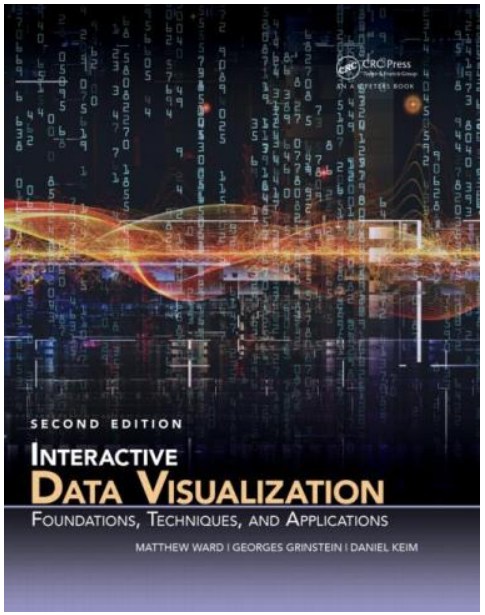
Vision is the gateway to higher-level regions of the brain

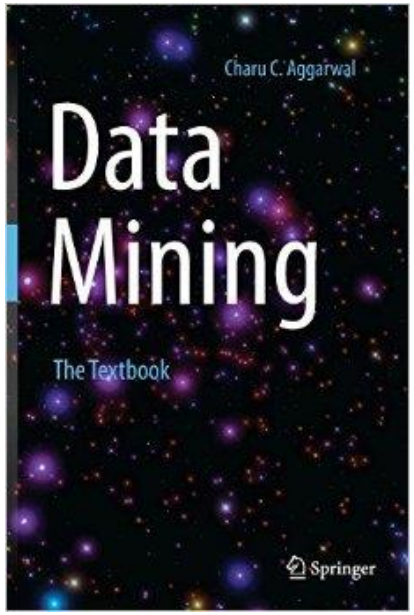
Exploit this fast and powerful processor for

- complex data analyses, creative tasks, communicating ideas

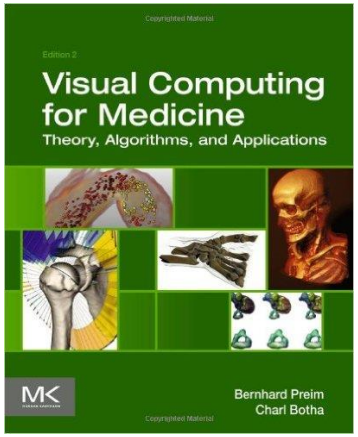
→ The science of visualization and visual analytics

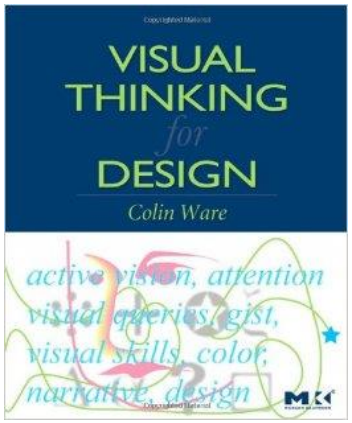
Text Books

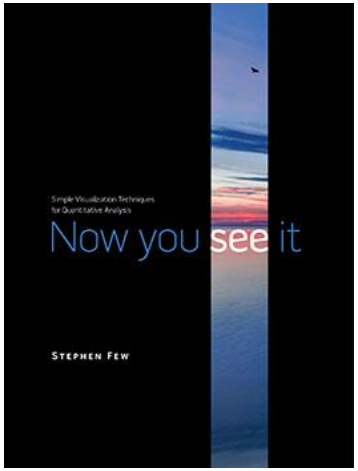


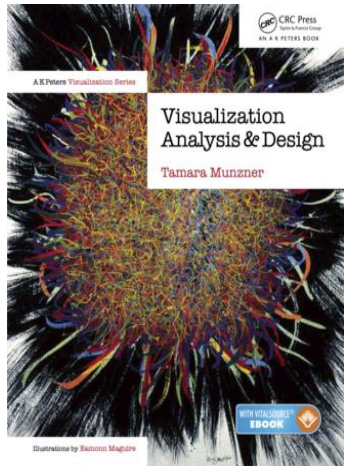


Required









Optional

Tentative Schedule

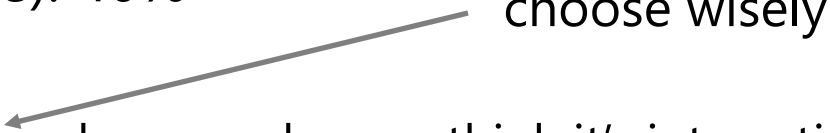
Lecture	Topic	Projects
1	Intro, schedule, and logistics	
2	Applications of visual analytics, data, and basic tasks	
3	Basic vis techniques for non-spatial data	Project 1 out
4	Data preparation and reduction	
5	Perception and cognition, visual design and aesthetics	
6	Foundations of statistics	
7	Introduction to D3 and Vega-Lite	Project 2 out
8	Data types, notion of similarity and distance	
9	Data mining techniques: clusters, text, patterns, classifiers	
10	Data mining techniques: clusters, text, patterns, classifiers	
11	High-dimensional data, dimensionality reduction	
12	Computer graphics and volume rendering	Project 3 out
13	Techniques to visualize spatial (3D) data	
14	Scientific and medical visualization	
15	Scientific and medical visualization	
16	Non-photorealistic rendering	
17	Midterm	
18	Principles of interaction	Project 4 out
19	Visual analytics and the visual sense making process	
20	Correlation and causal modeling	
21	Big data: data reduction, summarization	
22	Visualization of graphs and hierarchies	
23	Visualization of text data	Project 5 out
24	Visualization of time-varying and time-series data	
25	Memorable visualizations, visual embellishments	
26	Evaluation and user studies	
27	Narrative visualization and storytelling	
28	Data journalism	

Grading

Midterm (1st part of the course): 30%

Final (2nd part of the course): 40%

Projects (5): 30%



- propose a dataset DS and argue why you think it's interesting (5%)
- code up a set of basic interactive visualizations for DS (5%)
- implement a set of suitable data analytics (python) for DS (5%)
- interlude: create some spatial visualizations using ImageVis3D (5%)
- create an interactive visual analytics dashboard for DS (10%)

Participation:

- expected to attend each lecture (attendance is not taken)

For late submission policy see course website

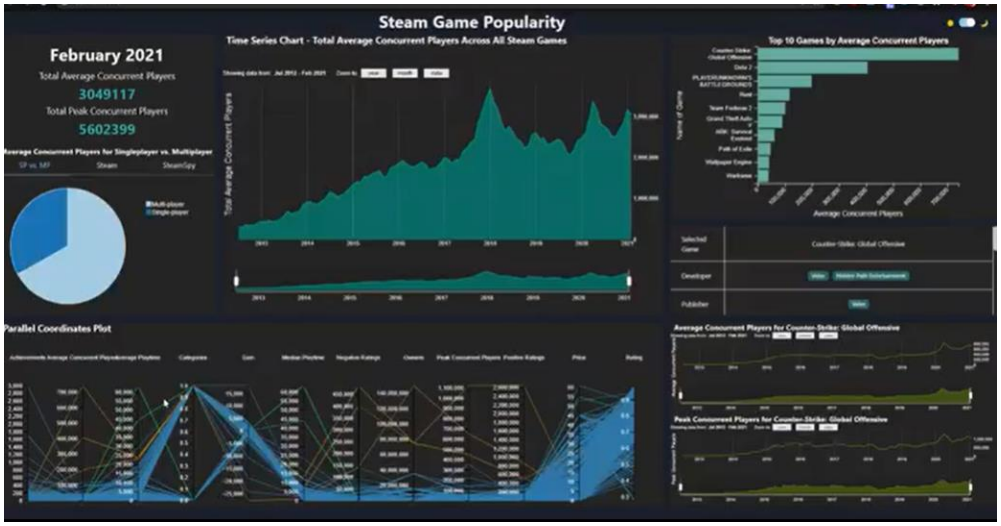
- course website will publish all course materials

What's A VA Dashboard?

See a really good example on youtube

Programmed with:

- python
- html
- JavaScript
- D3 API



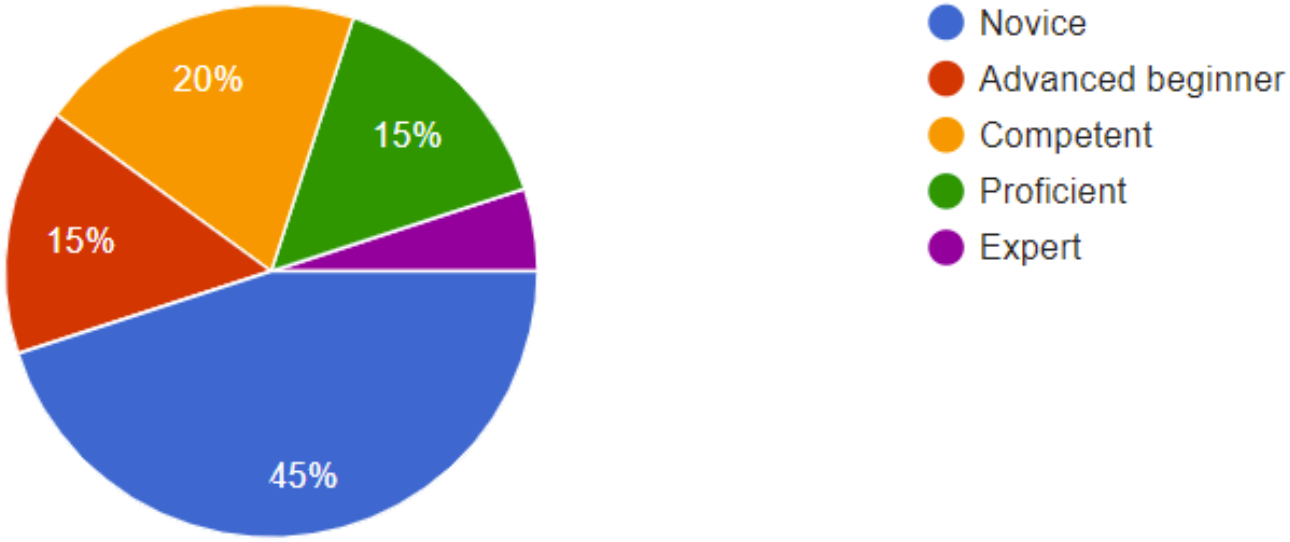
Your path to this:

- a dashboard is a collection of data visualizations linked together
- you will program all the individual dashboard components in lab 2 and lab 3
- then, in lab 5 you will put (some of) them all on one page and connect them in a meaningful way so they together can support users in interactive data analysis explorations

Capabilities of CSE/ISE 332 Fall 21

HTML programming

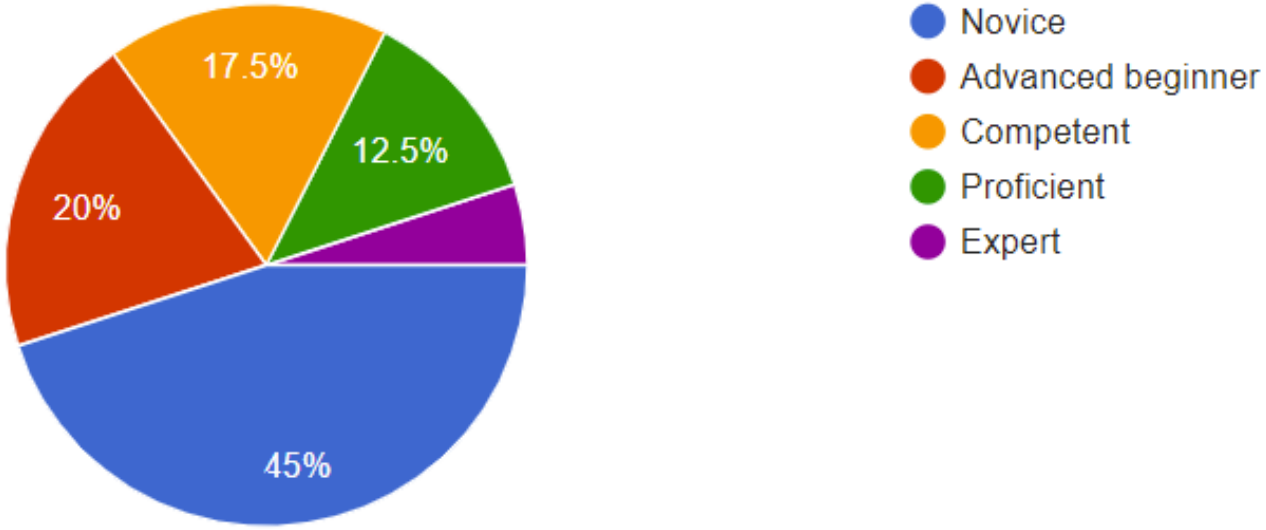
40 responses



Capabilities of CSE/ISE 332 Fall 21

JavaScript programming (note, JavaScript is not Java)

40 responses



Reading Assignment

You have 3 weeks to get up to speed with html and js

- 9/13 is the first programming assignment requiring it (3 weeks from now)

Fortunately there is a great and easy resource

- W3schools html
- W3schools JavaScript

HTML part, focus on:

- HTML Tutorial (specifically the sections *Home* to *Layout*)
- HTML Graphics
- will take you 2 days max

JavaScript part, focus on:

- JS Tutorial
- JS Objects, JS Functions, JS Async
- JS HTML DOM (Document Object Model)
- JS JSON (JavaScript Object Notation)
- will take you 2 weeks (one hour each day, ~15-20 hours total)

from here

PROGRAMMING ASSIGNMENT

This will check your newly gained html and js capabilities

- successful completion will be evidence that you're ready for the lab assignments
- please do this yourself, copying it from somewhere will defeat the purpose of the exercise
- submit to Brightspace and gain 5% of extra credit (due 9/14)

Create a html page which supports the following

- allow a user to enter some text into a webpage text widget
- write a simple js program that will
  - count the number of non-white space characters
  - produce a list that shows how many instances of each character are in the text (called a histogram, say a: 5, b: 4, c: 3,….)
  - calculate and show the total number of empty spaces and words
  - do some simple spellchecking, like too many instances of the same character in sequence (more than 2 is generally impossible in the English language) and either highlight them in the text or write our an error message

Code Editor

Several free code development environments are available

- Visual Studio Code (recommended)
- Atom
- Sublime Text

Browsers to run and develop your code

- Chrome
- Firefox
- IE and Edge are not overly suitable
- Chrome and Firefox also have panels where you can see and edit your code
- comes in handy when you want to change values of variables

Taking up Help With Coding

D3 and dashboard templates

- OK it take code snippets and templates to get you going
- not OK to take entire implementations and label them as yours
- must credit the source of snippets and templates

ChatGPT

- OK to ideate approaches as a learning tool
- OK to write code snippets
- not OK to have it do all of your project
- must credit ChatCPT on the role it played in code development