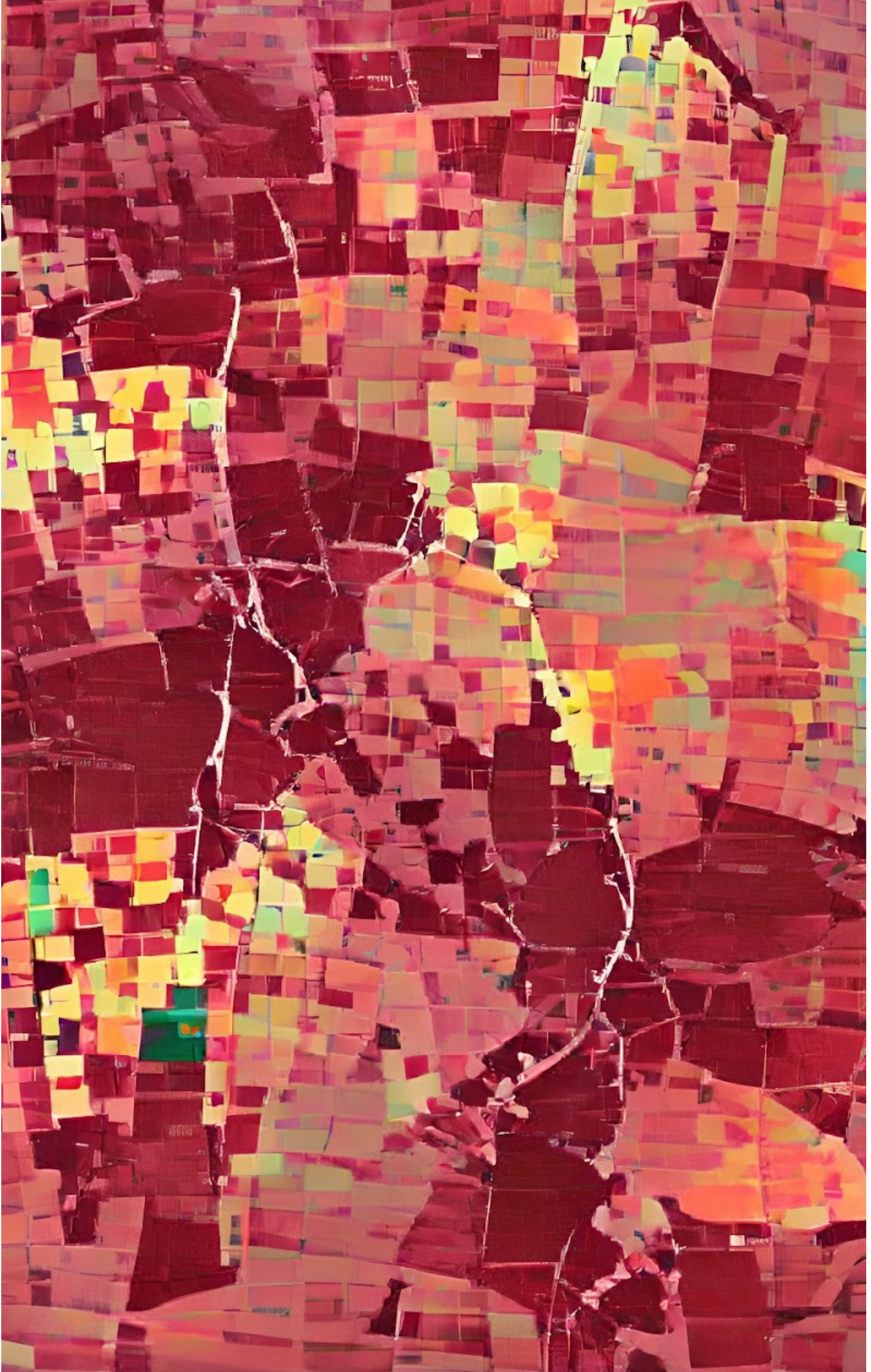


Good for Scientists Bad for Society

What happens when our charts don't change our minds?

University of Colorado Boulder

Evan M. Peck
Associate Professor of Information Science
University of Colorado Boulder

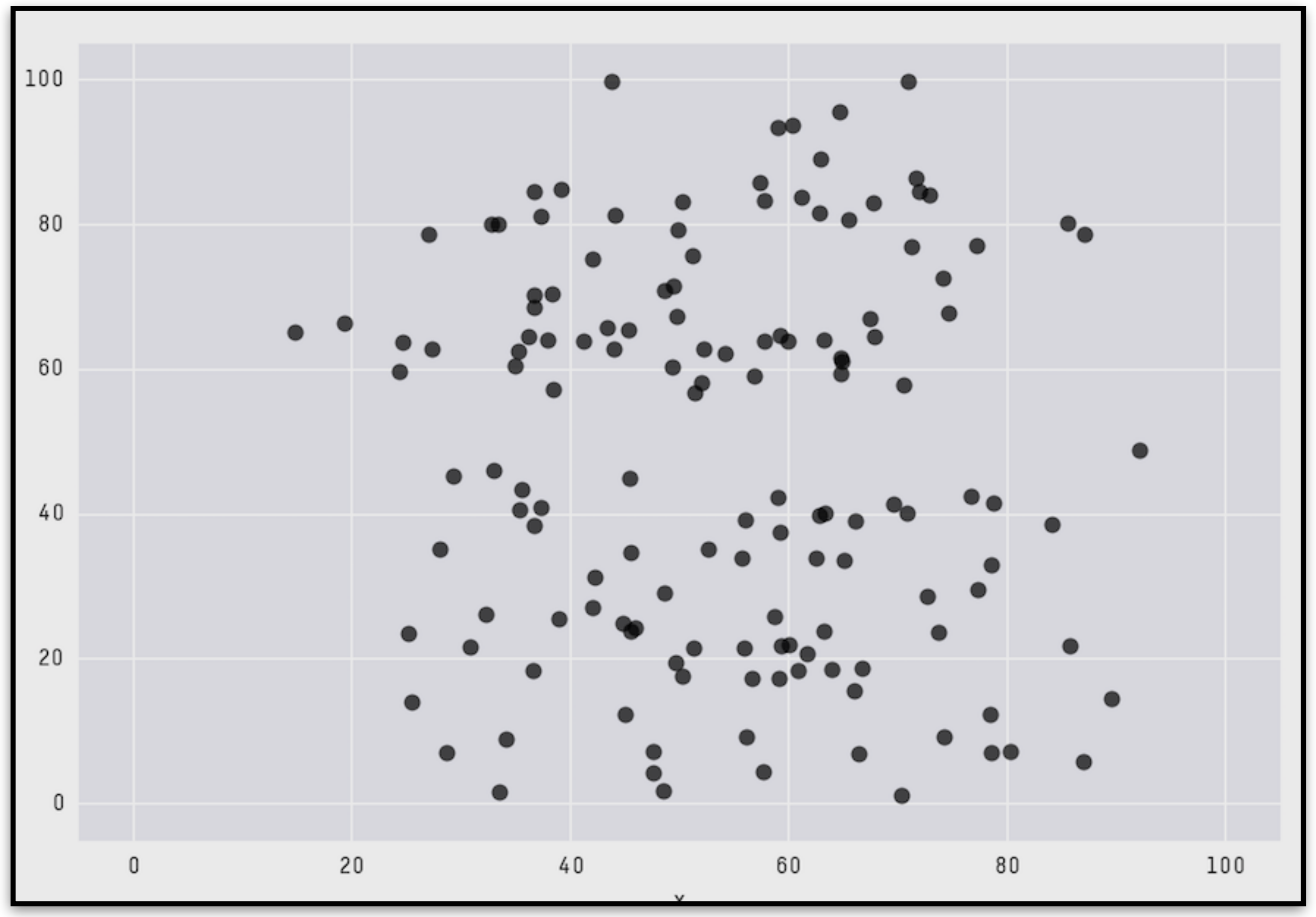
peck.phd
evan.peck@colorado.edu

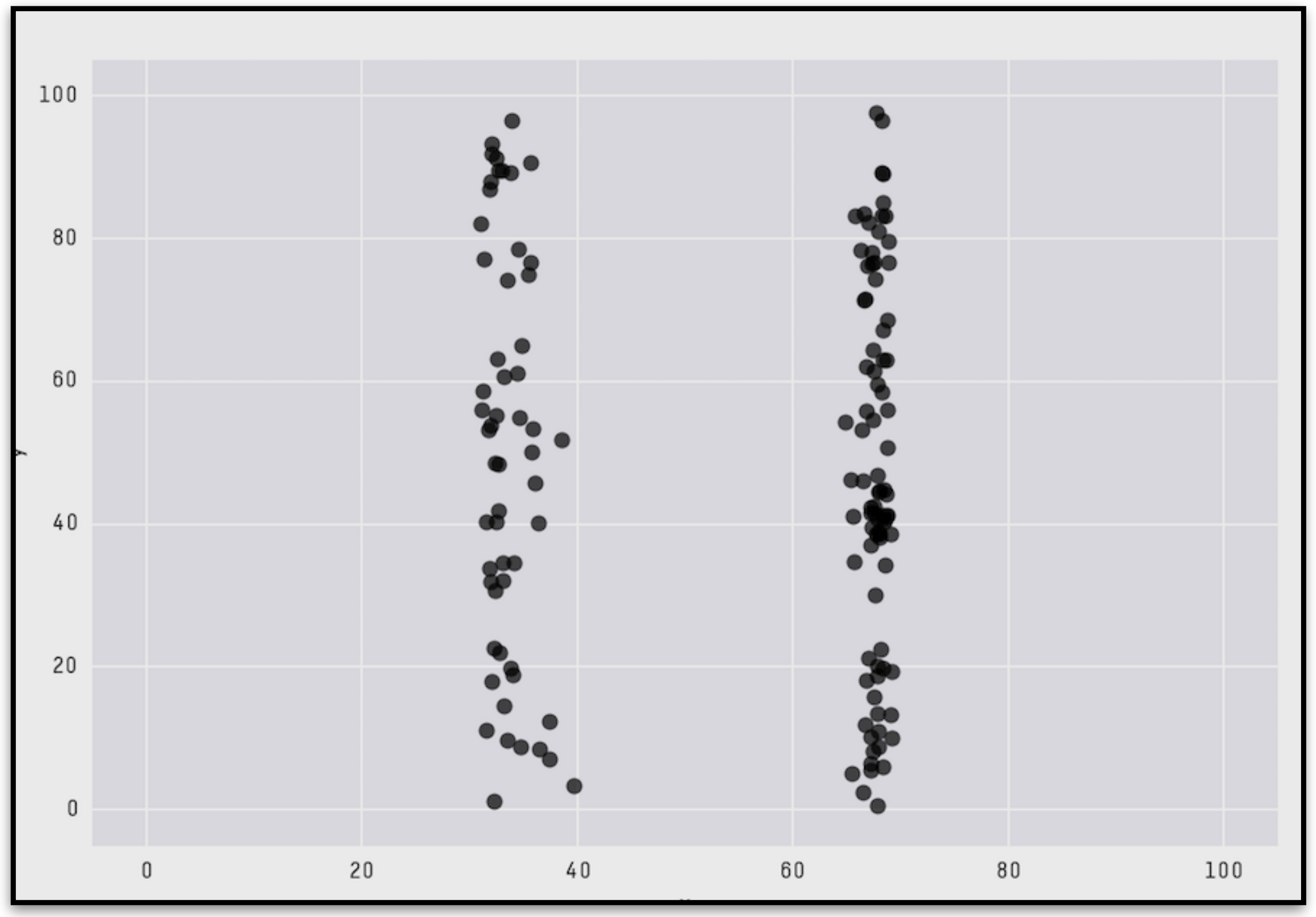

ICE
OUT

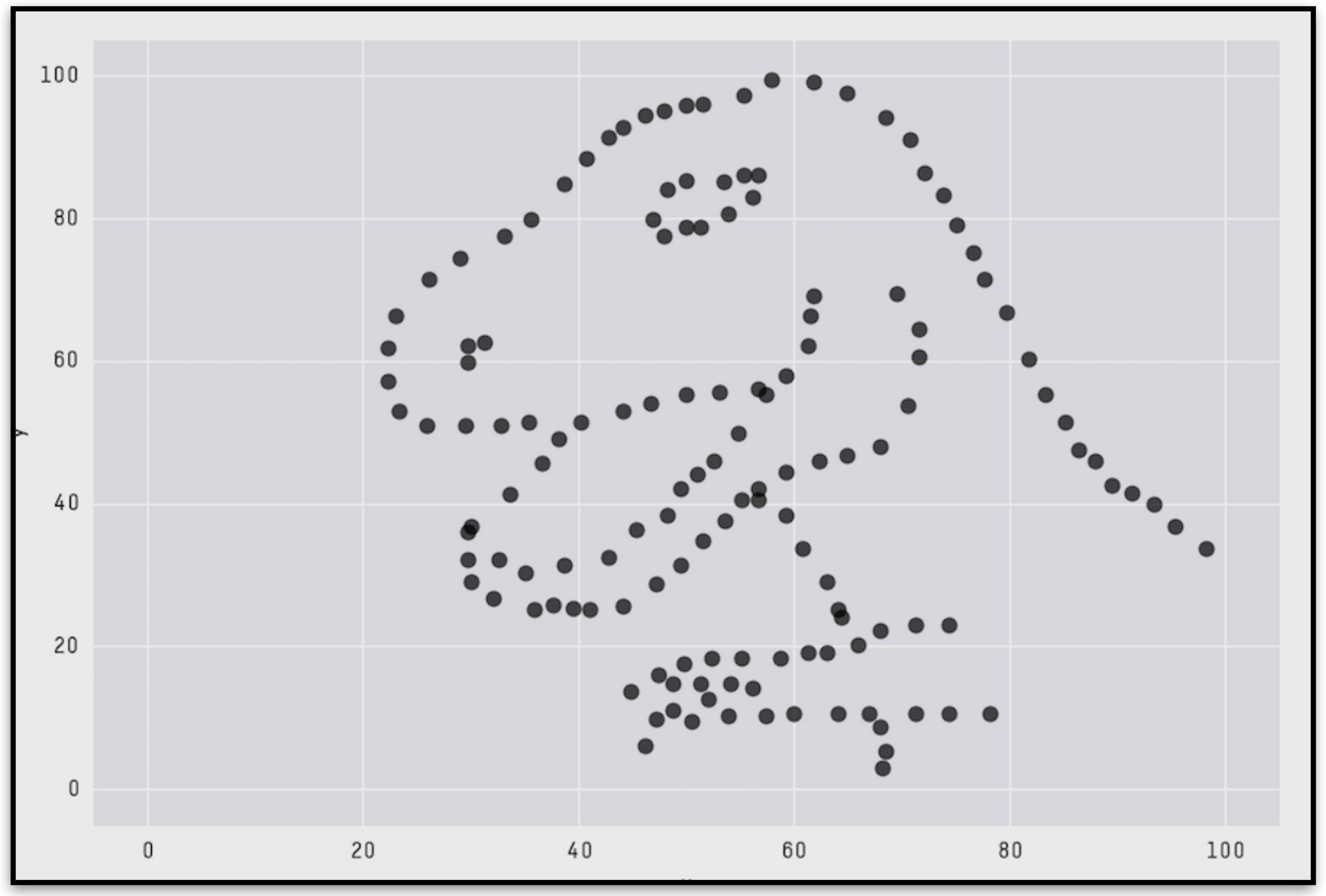
What is the story we tell each other about information visualization?

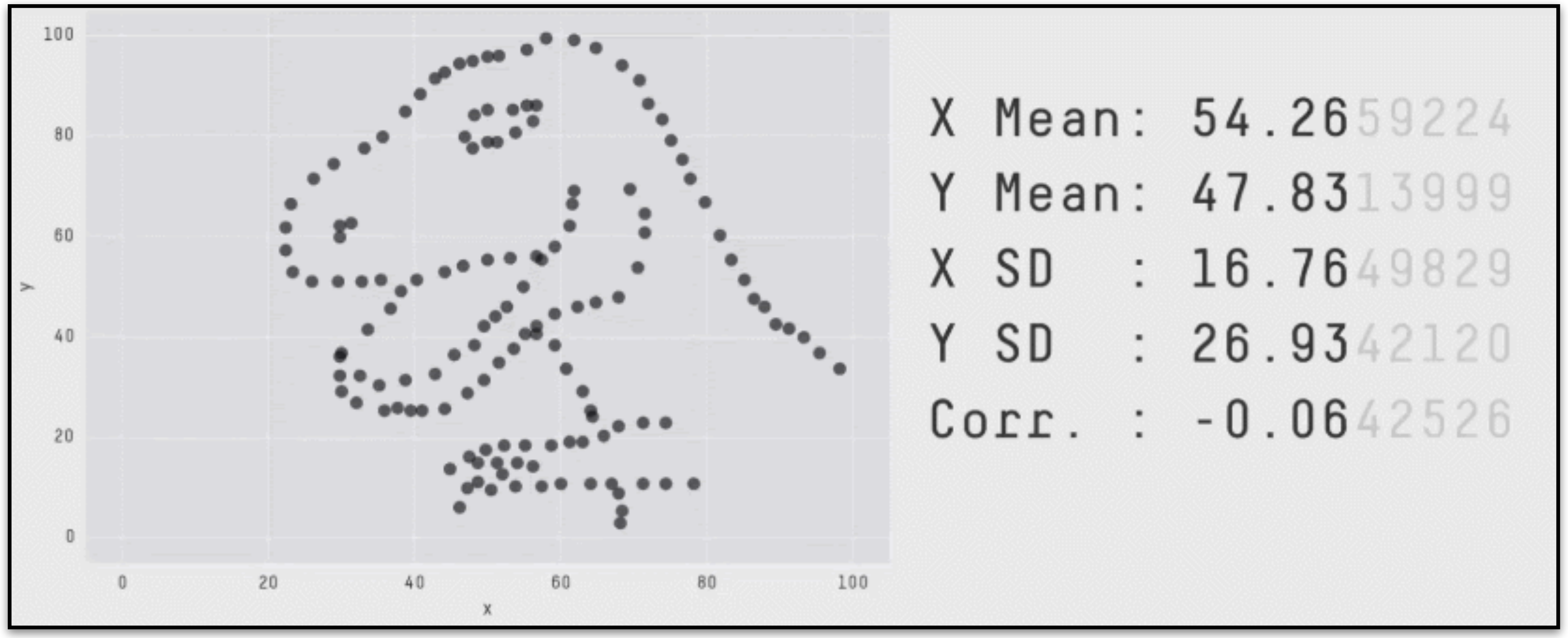
seeing the invisible

X Mean	:	54.26
Y Mean	:	47.83
X SD	:	16.76
Y SD	:	26.93
Corr.	:	-0.06



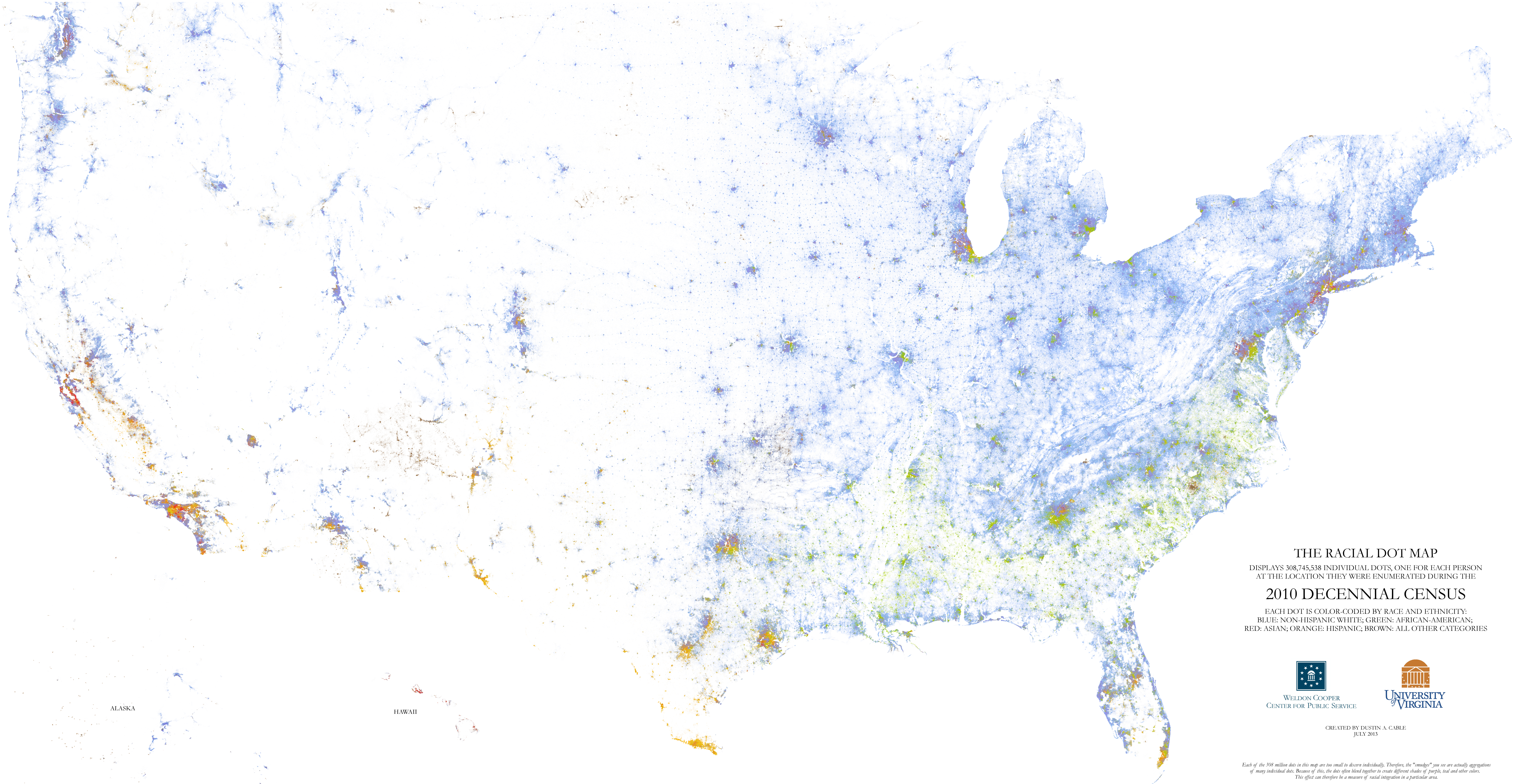






Matejka and Fitzmaurice. Same Stats, Different Graphs: Generating Datasets with Varied Appearance and Identical Statistics through Simulated Annealing. ACM CHI 2017

revealing patterns we live with



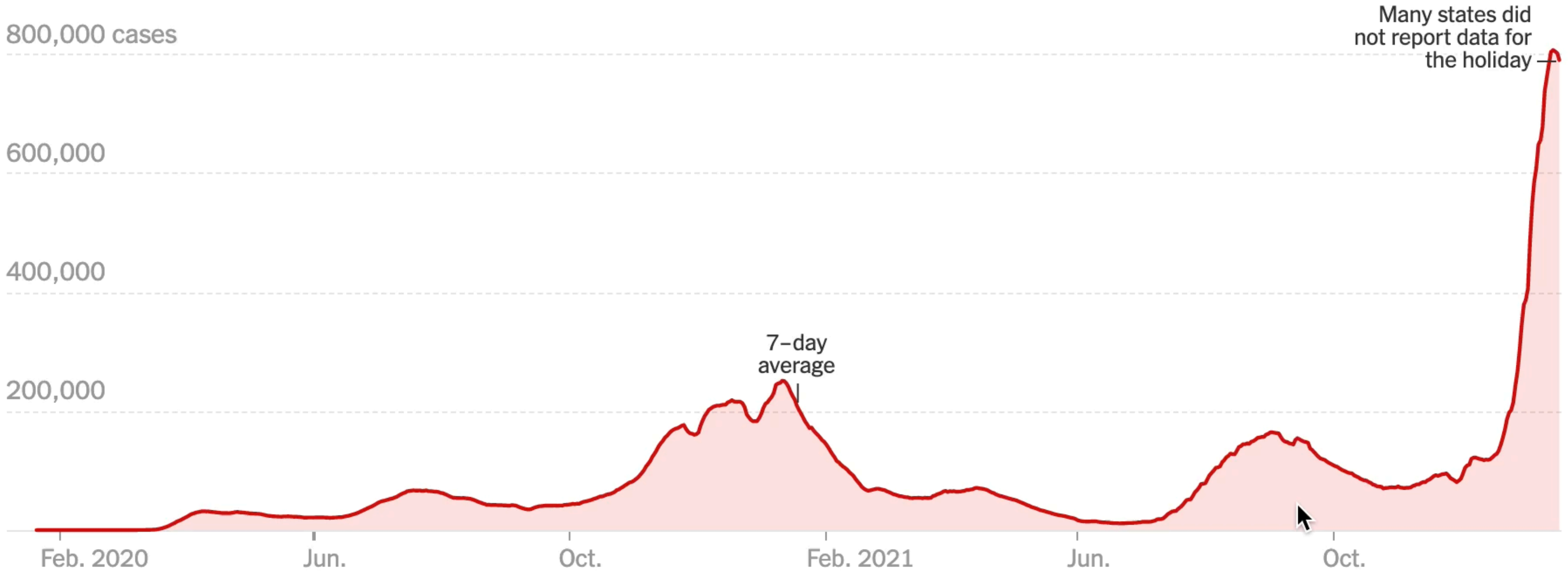
revealing patterns we live with

communicate to *everyone*

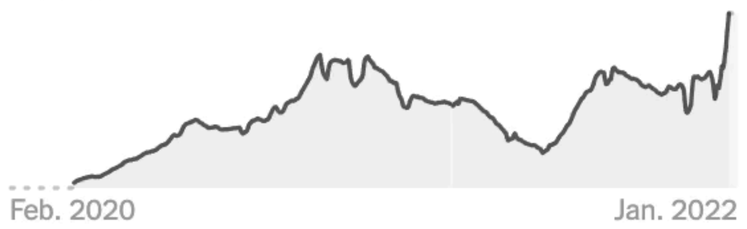
Updated Jan. 18, 2022

New reported cases

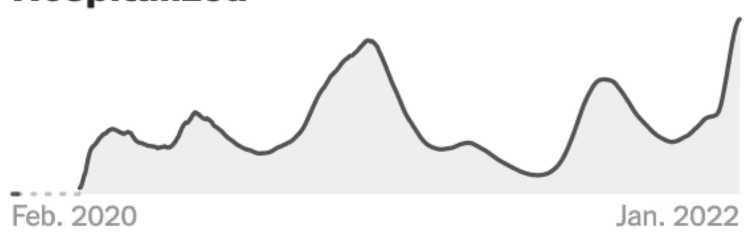
All time | Last 90 days



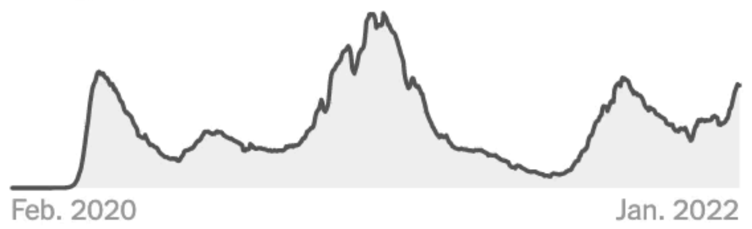
Tests



Hospitalized



Deaths



	DAILY AVG. ON JAN. 17	14-DAY CHANGE	TOTAL REPORTED
Cases	790,553	+62%	66,526,927
Tests	2,505,068	+96%	—
Hospitalized	156,505	+54%	—
Deaths	1,961	+54%	850,750

Vaccinations

	AT LEAST ONE DOSE	FULLY VACCINATED
All ages	75%	63%
12 and up	85%	72%
65 and up	95%	88%

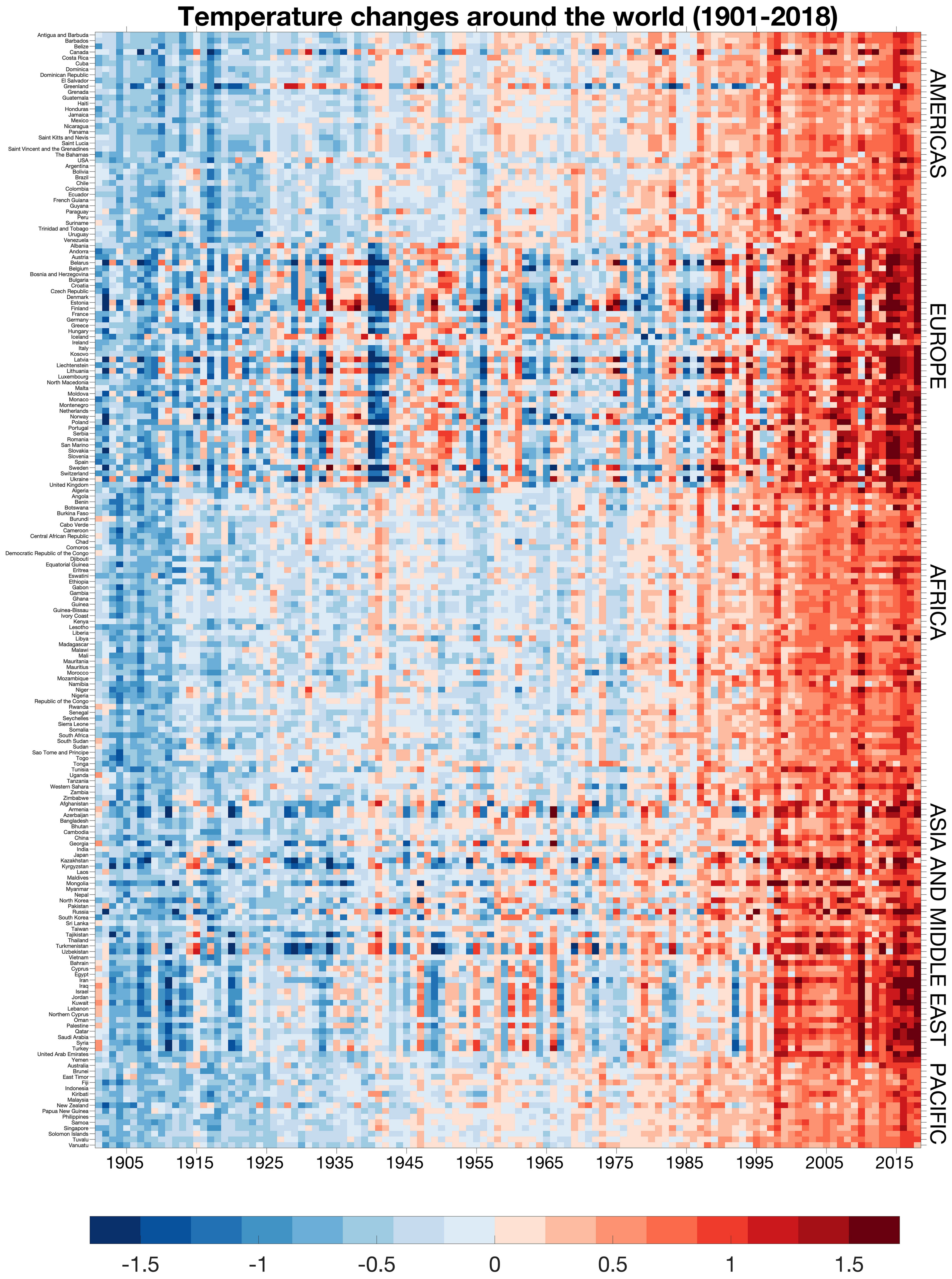
See more details ›

About this data

State of the virus

Update for Jan. 14

- The Omicron variant has pushed the country's daily case reports to record levels, with more than 800,000 new infections being reported each day.
- Most of the country continues to see explosive case growth, but infection levels seem to have peaked in some of the places that were hit first by Omicron. Puerto Rico, Cleveland, Chicago, New York City and Washington, D.C., are among the places beginning to see improvement.
- About 150,000 coronavirus patients are



Why doesn’t our data promote more positive change?

https://www.fastcompany.com/90367577/this-is-one-of-the-simplest-and-best-climate-change-graphics-weve-ever-seen

Reflecting on the long arc of vis research

Franconeri, Steven L., Lace M. Padilla, Priti Shah, Jeffrey M. Zacks, and Jessica Hullman. "The science of visual data communication: What works." Psychological Science in the Public Interest 22, no. 3 (2021): 110-161.

EFFICIENCY evaluation, timelines

UNIVERSALITY principles, presentation

IMPARTIALITY objective, unbiased

EFFICIENCY	CARE
UNIVERSALITY	CONTEXTUALITY
IMPARTIALITY	POSITIONALITY

Scheuerman, Morgan Klaus, Alex Hanna, and Emily Denton. "Do datasets have politics? Disciplinary values in computer vision dataset development." Proceedings of the ACM on Human-Computer Interaction CSCW (2021): 1-37.

EFFICIENCY. CARE.

(how I became a visualization evaluation cynic)

What does visualization evaluation capture?

There is a newly discovered disease, Disease X, which is transmitted by a bacterial infection found in the population. There is a test to detect whether or not a person has the disease, but it is not perfect. Here is some information about the current research on Disease X and efforts to test for the infection that causes it.

Ottley, Alvitta, Evan M. Peck, Lane T. Harrison, Daniel Afergan, Caroline Ziemkiewicz, Holly A. Taylor, Paul KJ Han, and Remco Chang. "Improving Bayesian reasoning: the effects of phrasing, visualization, and spatial ability." IEEE transactions on visualization and computer graphics 22, no. 1 (2016): 529-538.

There is a total of 1000 people in the population. Out of the 1000 people in the population, 10 people actually have the disease. Out of these 10 people, 8 will receive a positive test result and 2 will receive a negative test result. On the other hand, 990 people do not have the disease (that is, they are perfectly healthy). Out of these 990 people, 95 will receive a positive test result and 895 will receive a negative test result.

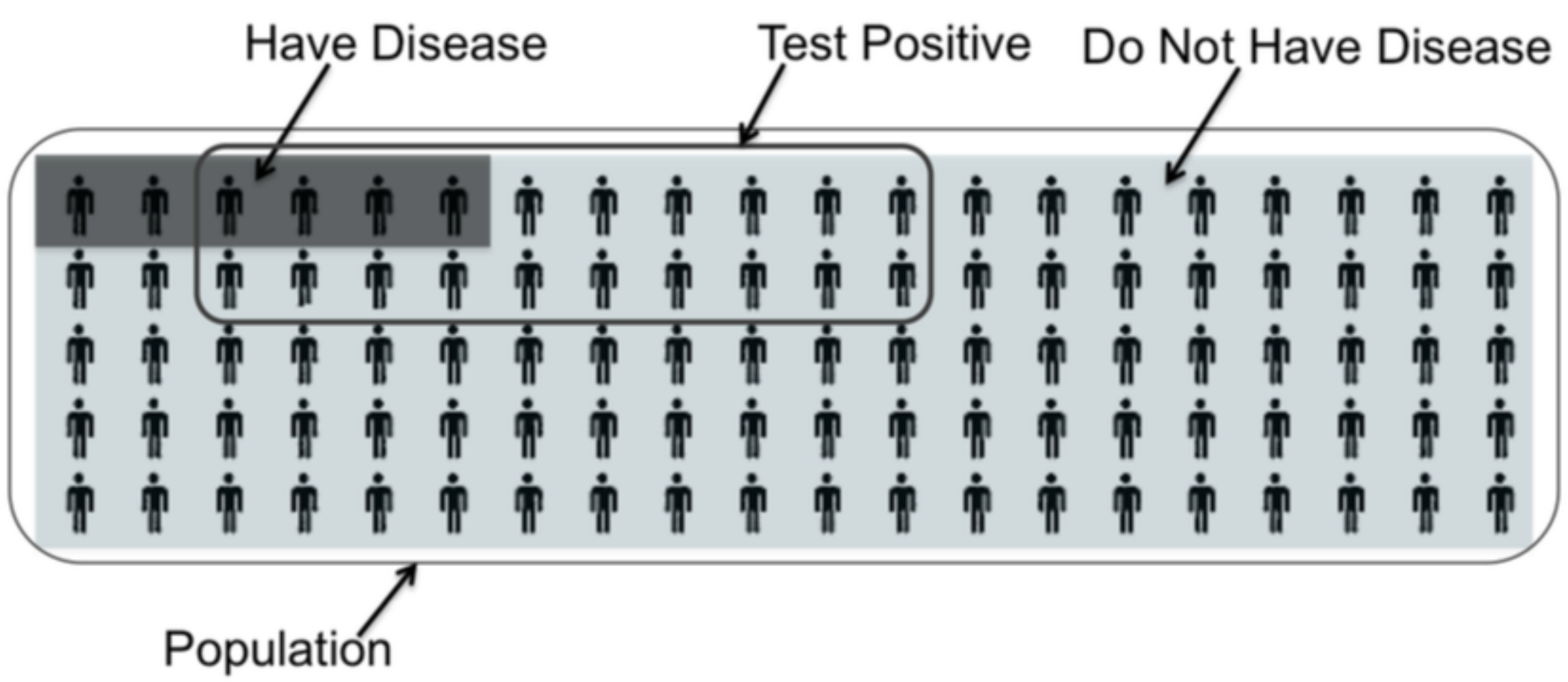
Imagine 1000 people are tested for the disease.
(a) How many people will test positive? ____
(b) Of those who test positive, how many will actually have the disease? ____

~1 out of 4 people answered these questions correctly

Ottley, Alvitta, Evan M. Peck, Lane T. Harrison, Daniel Afergan, Caroline Ziemkiewicz, Holly A. Taylor, Paul KJ Han, and Remco Chang. "Improving Bayesian reasoning: the effects of phrasing, visualization, and spatial ability." IEEE transactions on visualization and computer graphics 22, no. 1 (2016): 529-538.

377 participants on MTurk

74%

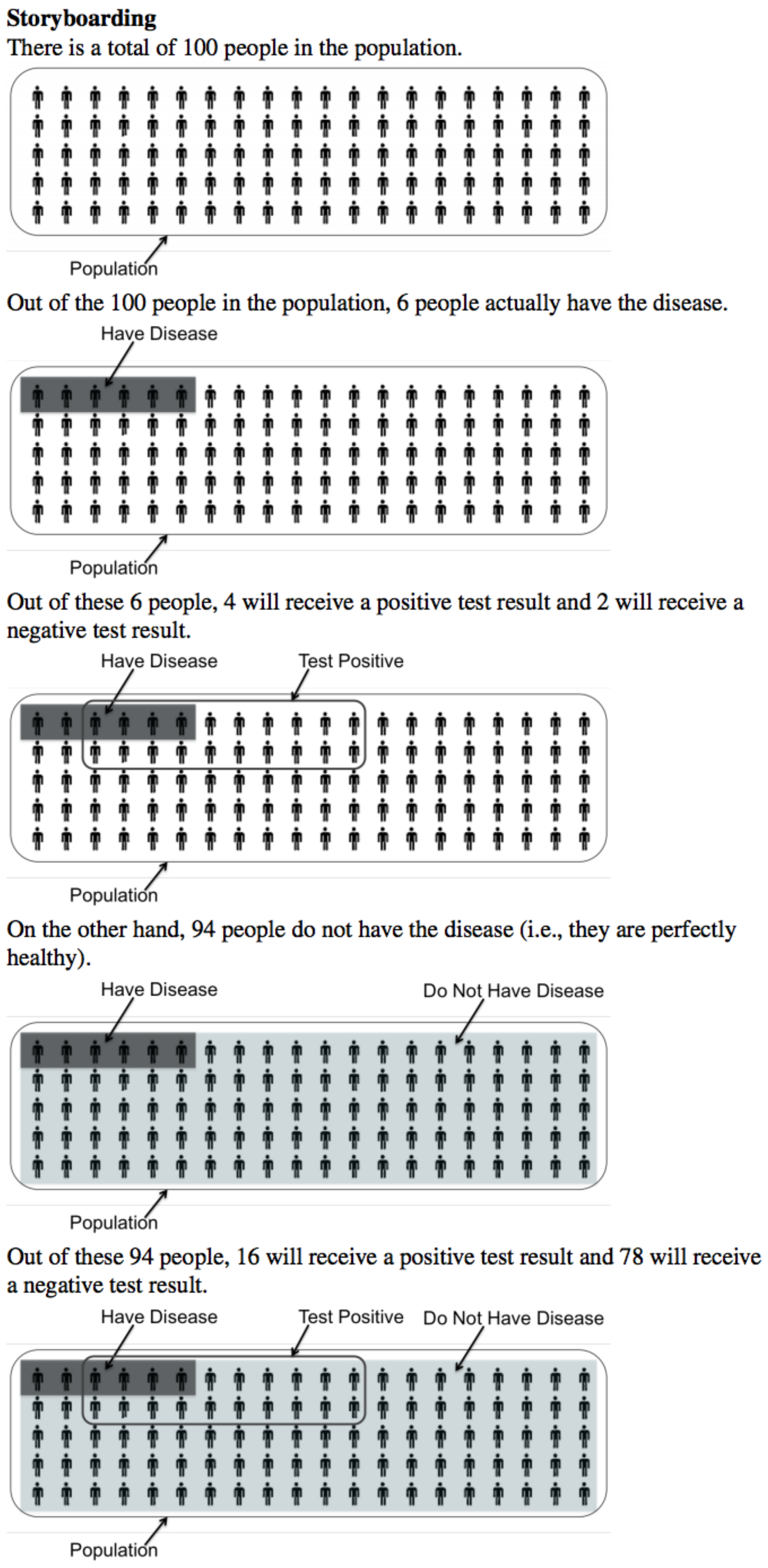


Structured-Text

There is a total of 100 people in the population.
Out of the 100 people in the population,
6 people actually have the disease. Out of these 6 people,
4 will receive a positive test result and
2 will receive a negative test result.
On the other hand, 94 people do not have the disease (i.e., they are perfectly healthy). Out of these 94 people,
16 will receive a positive test result and
78 will receive a negative test result.

Another way to think about this is...
Out of the 100 people in the population,
20 people will test positive. Out of these 20 people,
4 will actually have the disease and
16 will not have the disease (i.e., they are perfectly healthy).
On the other hand, 80 people will test negative. Out of these 80 people,
2 will actually have the disease and
78 will not have the disease (i.e., they are perfectly healthy).

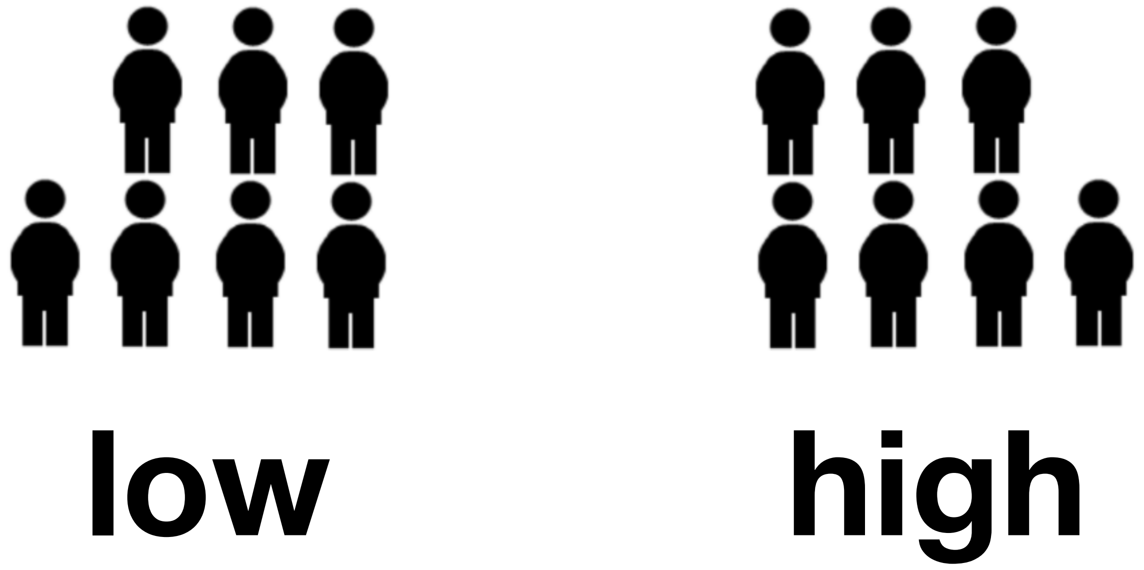
77%

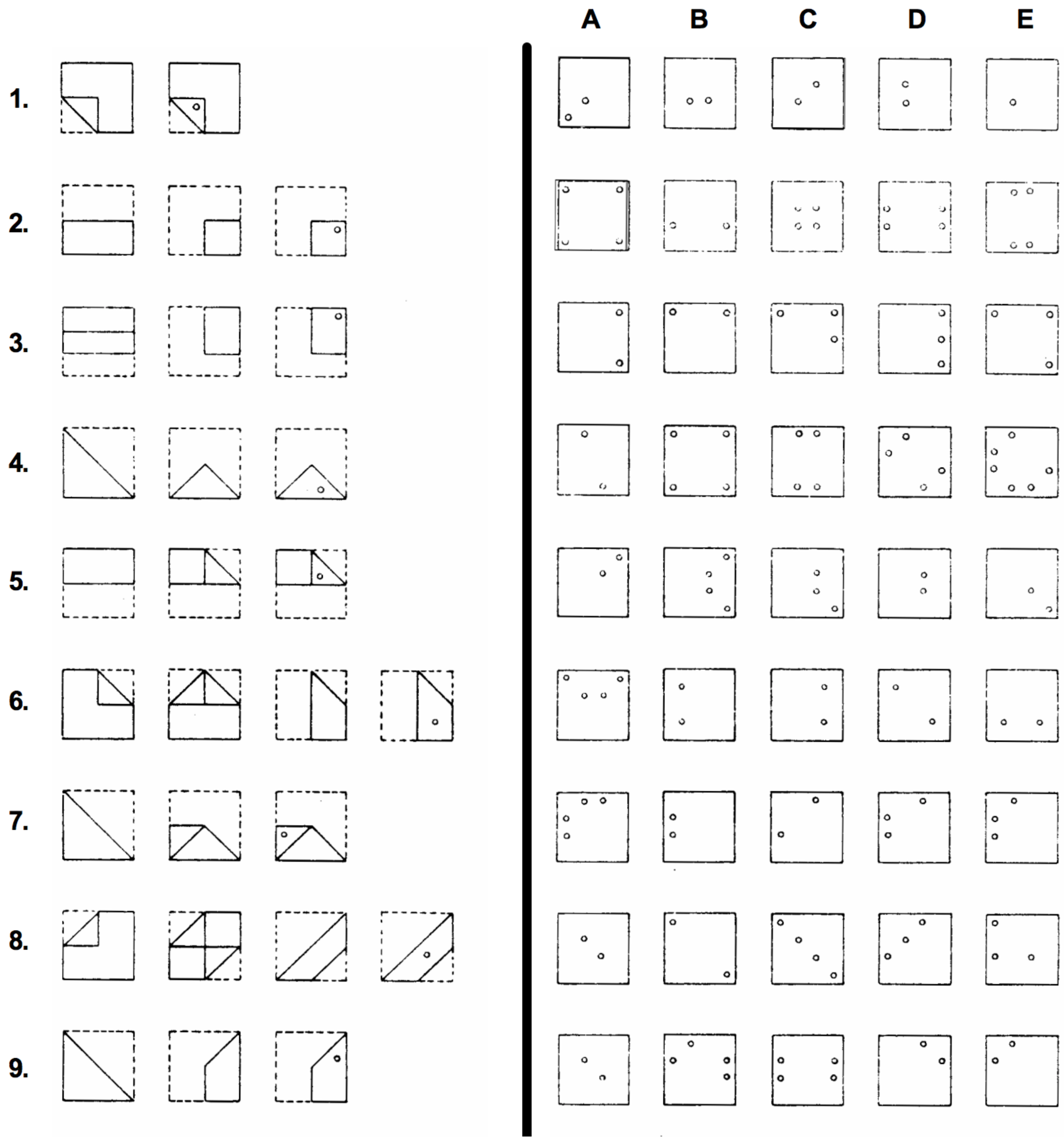


49%

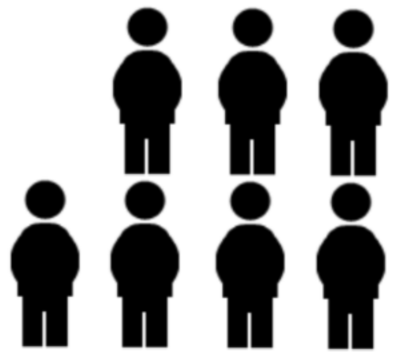
Ottley, Alvitta, Evan M. Peck, Lane T. Harrison, Daniel Afergan, Caroline Ziemkiewicz, Holly A. Taylor, Paul KJ Han, and Remco Chang. "Improving Bayesian reasoning: the effects of phrasing, visualization, and spatial ability." IEEE transactions on visualization and computer graphics 22, no. 1 (2016): 529-538.

Paper folding as a proxy for spatial ability

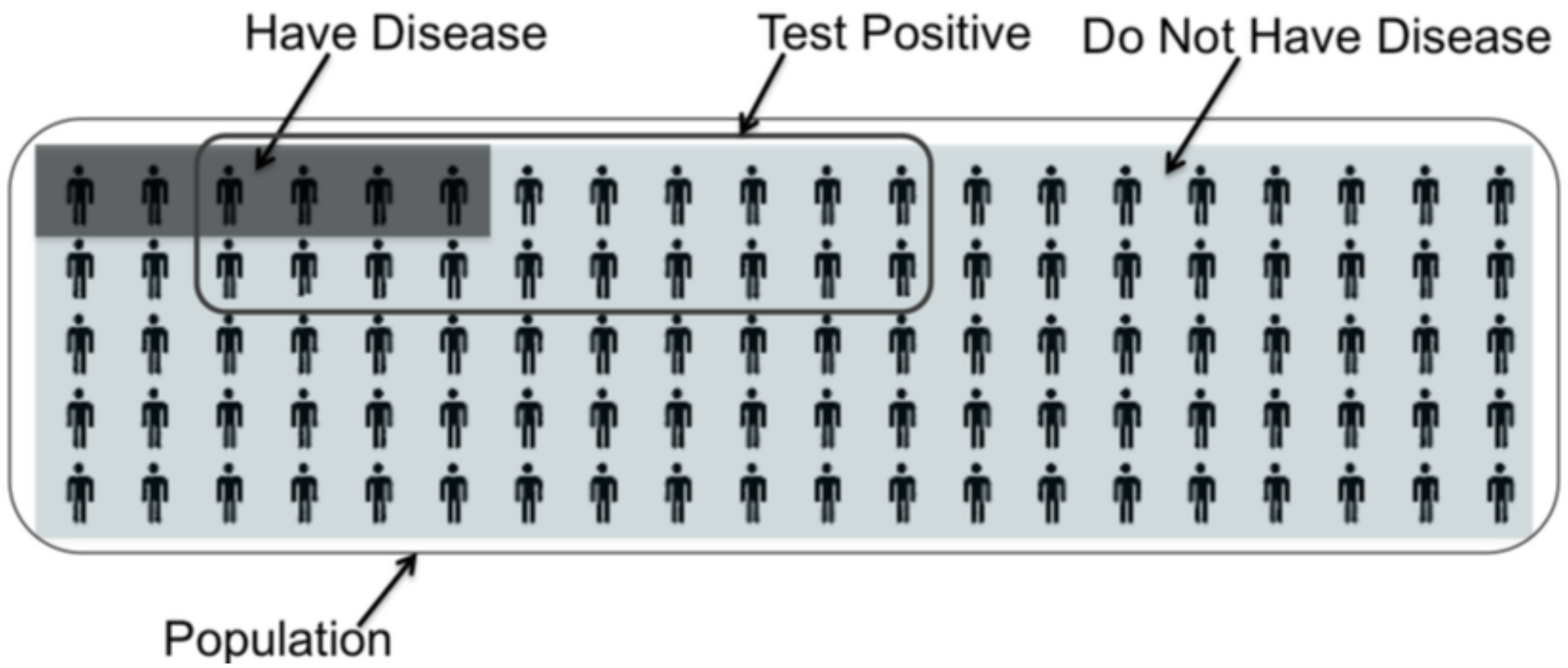




R. B. Ekstrom, J. W. French, H. H. Harman, and D. Dermen. Manual for kit of factor-referenced cognitive tests. Princeton, NJ: Educational Testing Service, 1976



low



74%

50%

Structured Text

There is a t

Out of

6 p

On the other hand, 94 people do not have the disease (i.e., they are perfectly healthy). Out of these 94 people,

16 will receive a positive test result and

78 will receive a negative test result.

Another way to think about this is...

Out of the 100 people in the population,

20 people will test positive. Out of these 20 people,

4 will actually have the disease and

16 will not have the disease (i.e., they are perfectly healthy).

On the other hand, 80 people will test negative. Out of these 80 people,

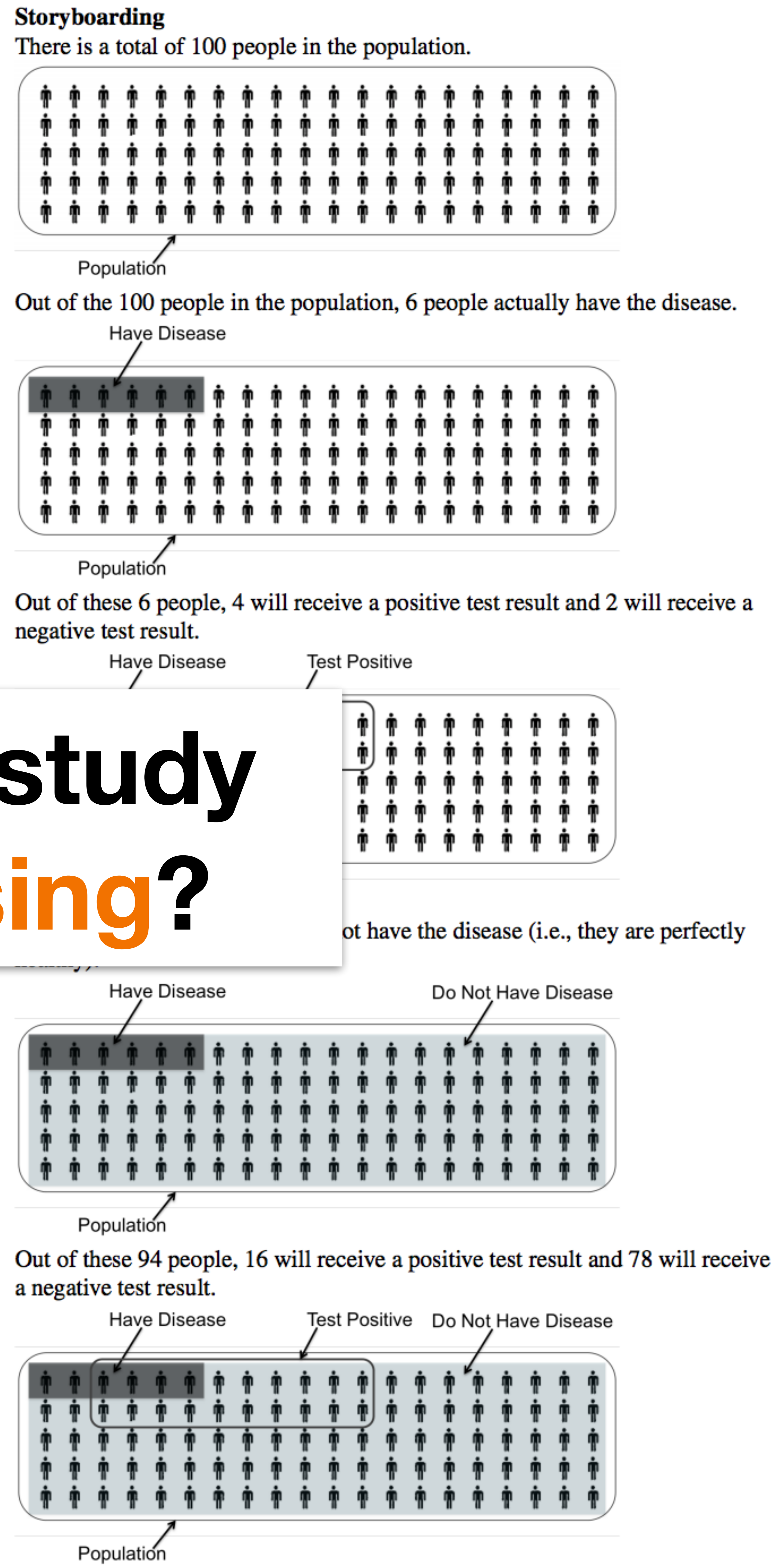
2 will actually have the disease and

78 will not have the disease (i.e., they are perfectly healthy).

77%

50%

In our efficiency-informed study designs, who are we missing?



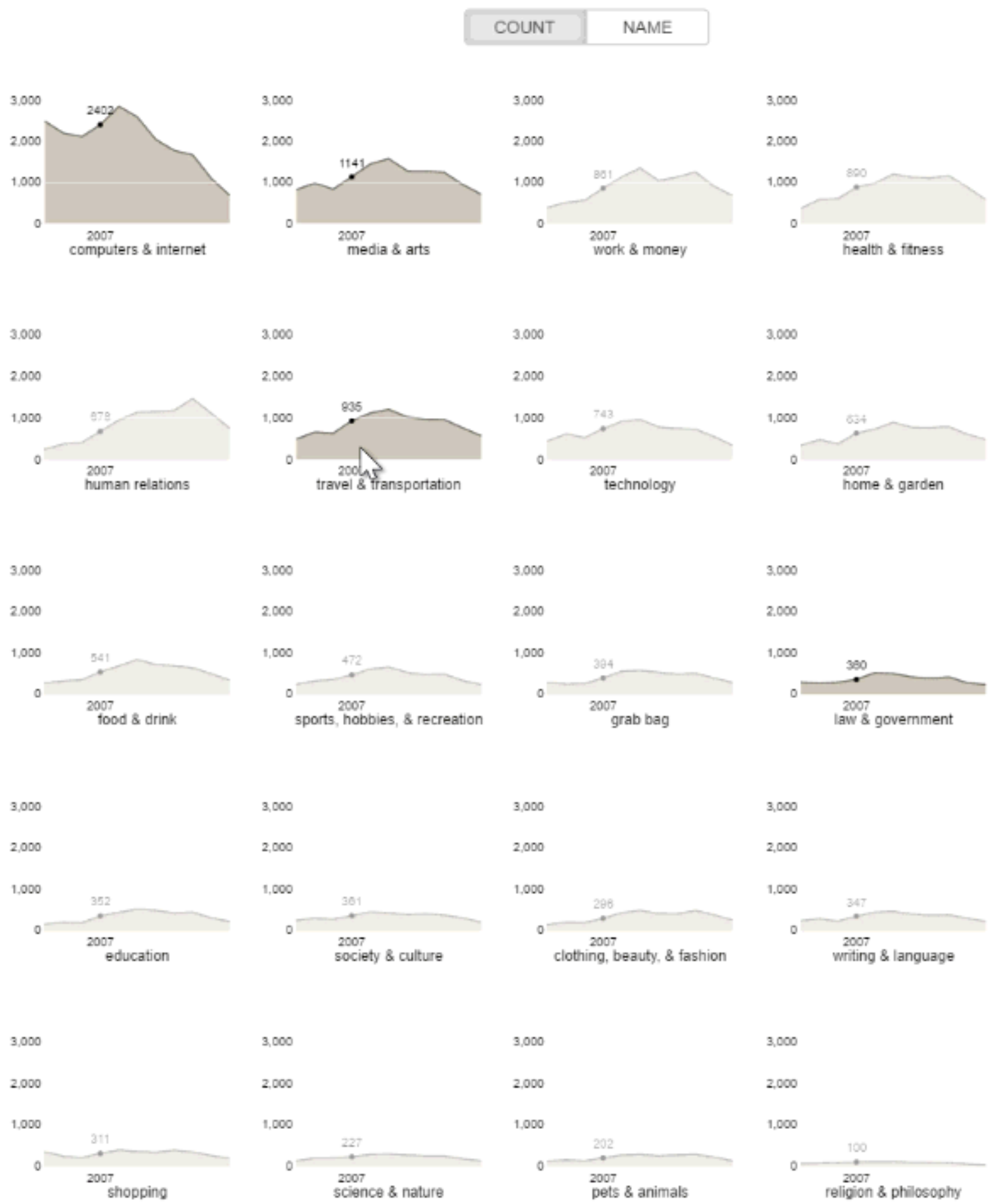
49%

29%

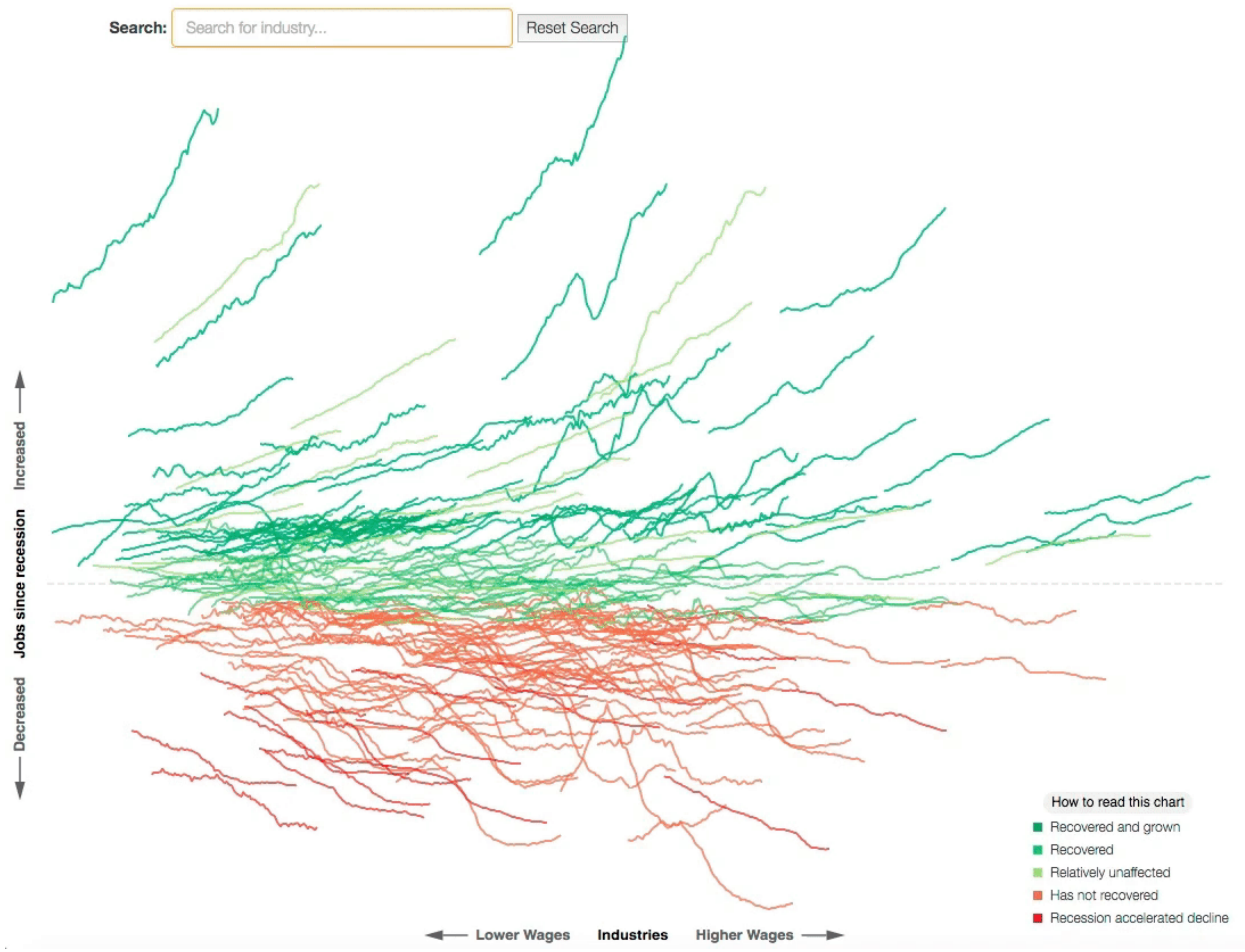
Ottley, Alvitta, Evan M. Peck, Lane T. Harrison, Daniel Afergan, Caroline Ziemkiewicz, Holly A. Taylor, Paul KJ Han, and Remco Chang. "Improving Bayesian reasoning: the effects of phrasing, visualization, and spatial ability." IEEE transactions on visualization and computer graphics 22, no. 1 (2016): 529-538.

Interaction techniques to improve public engagement on the web

Hindsight: personal interaction history



quantifying the effects of search



Feng, Mi, Cheng Deng, Evan M. Peck, and Lane Harrison. "Hindsight: Encouraging exploration through direct encoding of personal interaction history." IEEE transactions on visualization and computer graphics 23, no. 1 (2016): 351-360.

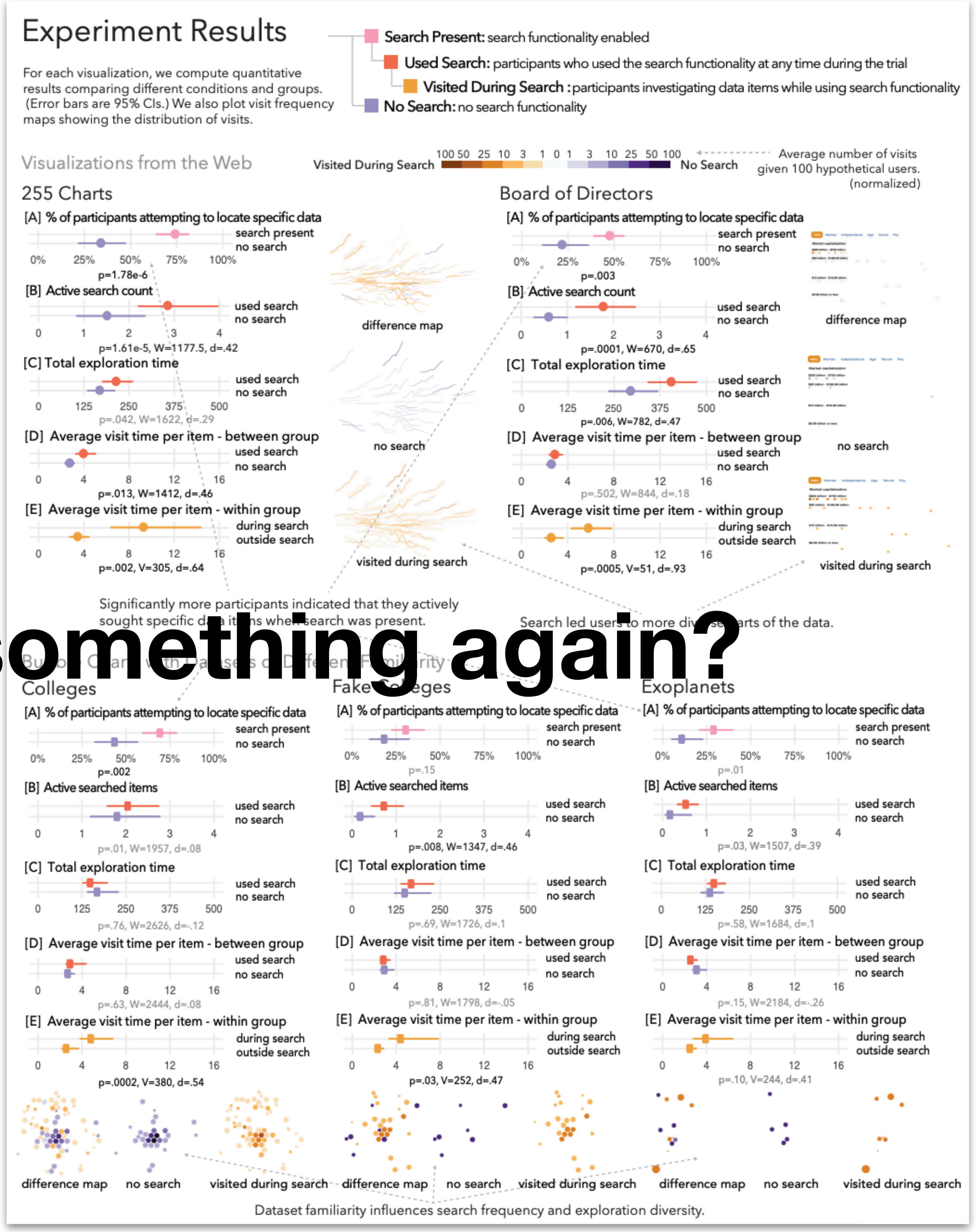
Feng, Mi, Cheng Deng, Evan M. Peck, and Lane Harrison. "The effects of adding search functionality to interactive visualizations on the web." In Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems, pp. 1-13. 2018.

Capturing the impact of interaction

interaction history

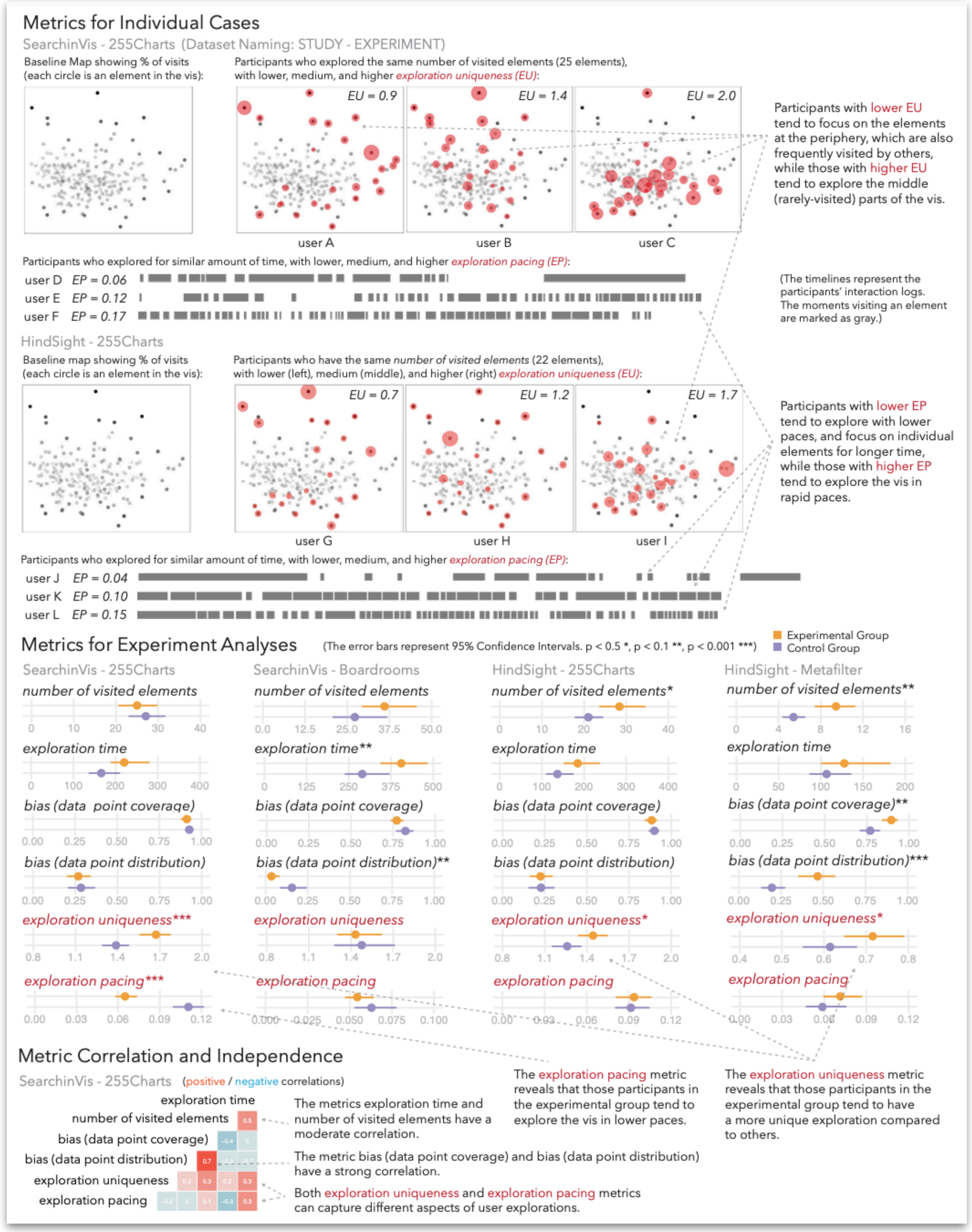
Feng, Mi, Cheng Deng, Evan M. Peck, and Lane Harrison. "Hindsight: Encouraging exploration through direct encoding of personal interaction history." IEEE transactions on visualization and computer graphics 23, no. 1 (2016): 351-360.

impact of search



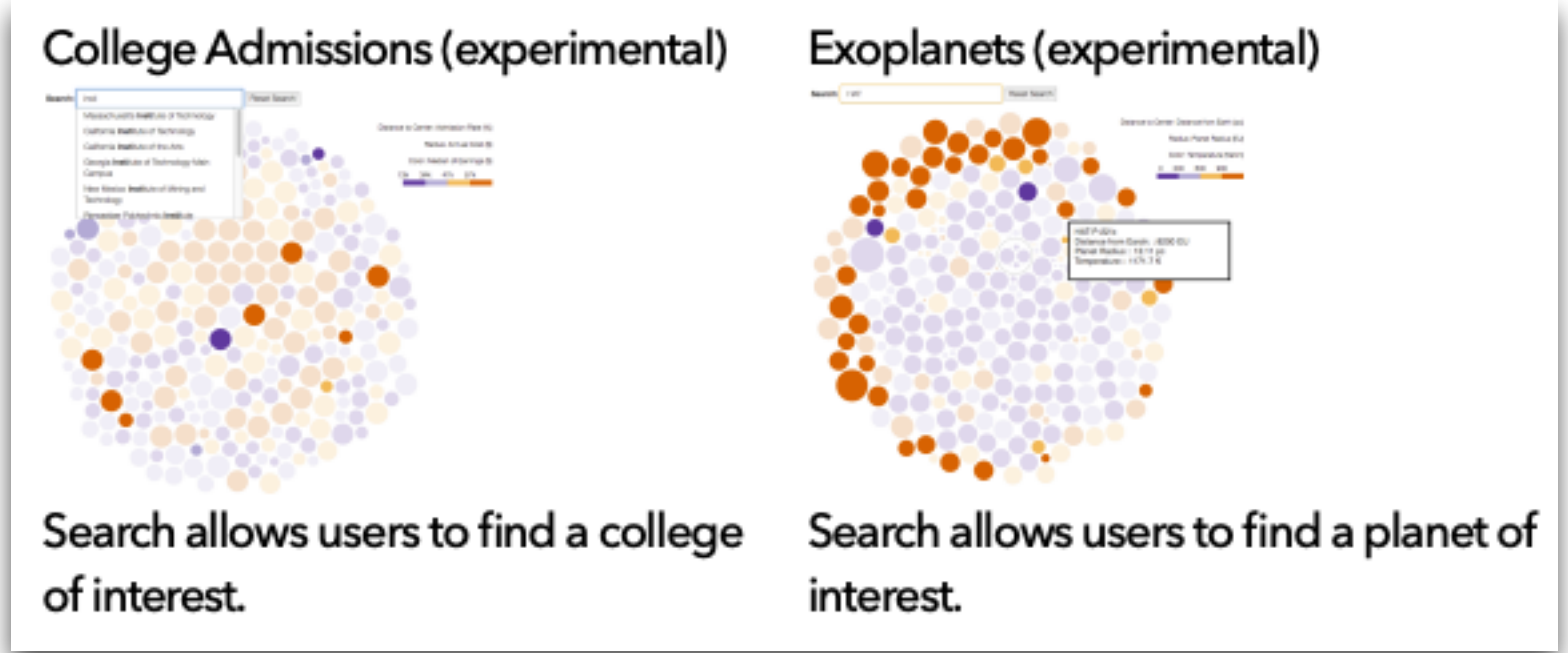
Feng, Mi, Cheng Deng, Evan M. Peck, and Lane Harrison. "The effects of adding search functionality to interactive visualizations on the web." In Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems, pp. 1-13. 2018.

. . . more metrics!



Feng, Mi, Evan M. Peck, and Lane Harrison. “Patterns and Pace: Quantifying Diverse Exploration Behavior with Visualizations on the Web” IEEE TVCG: Transactions on Visualization and Computer Graphics (InfoVis 2018)

Were we missing something again?



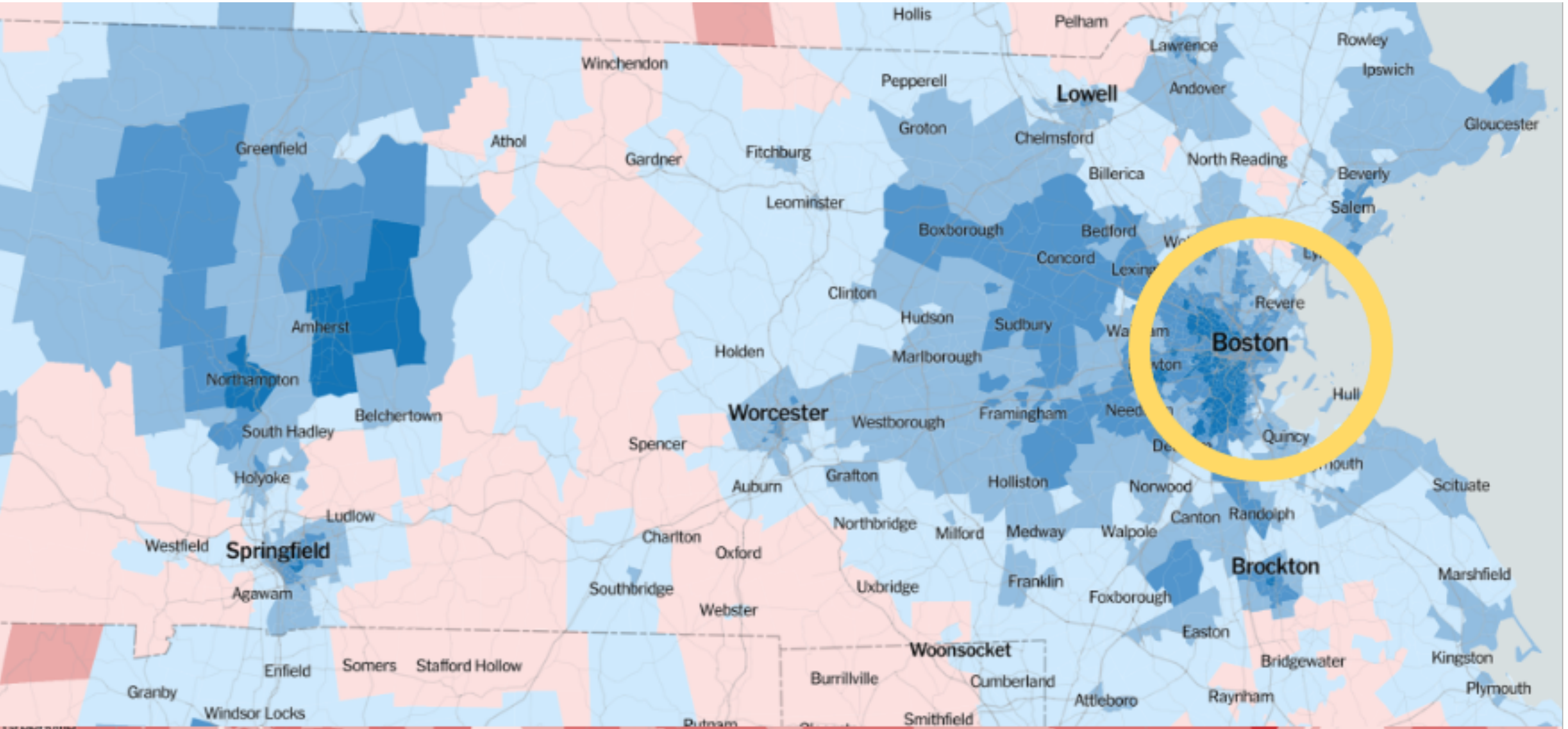
The interaction wasn't nearly as interesting as our relationship to the data.

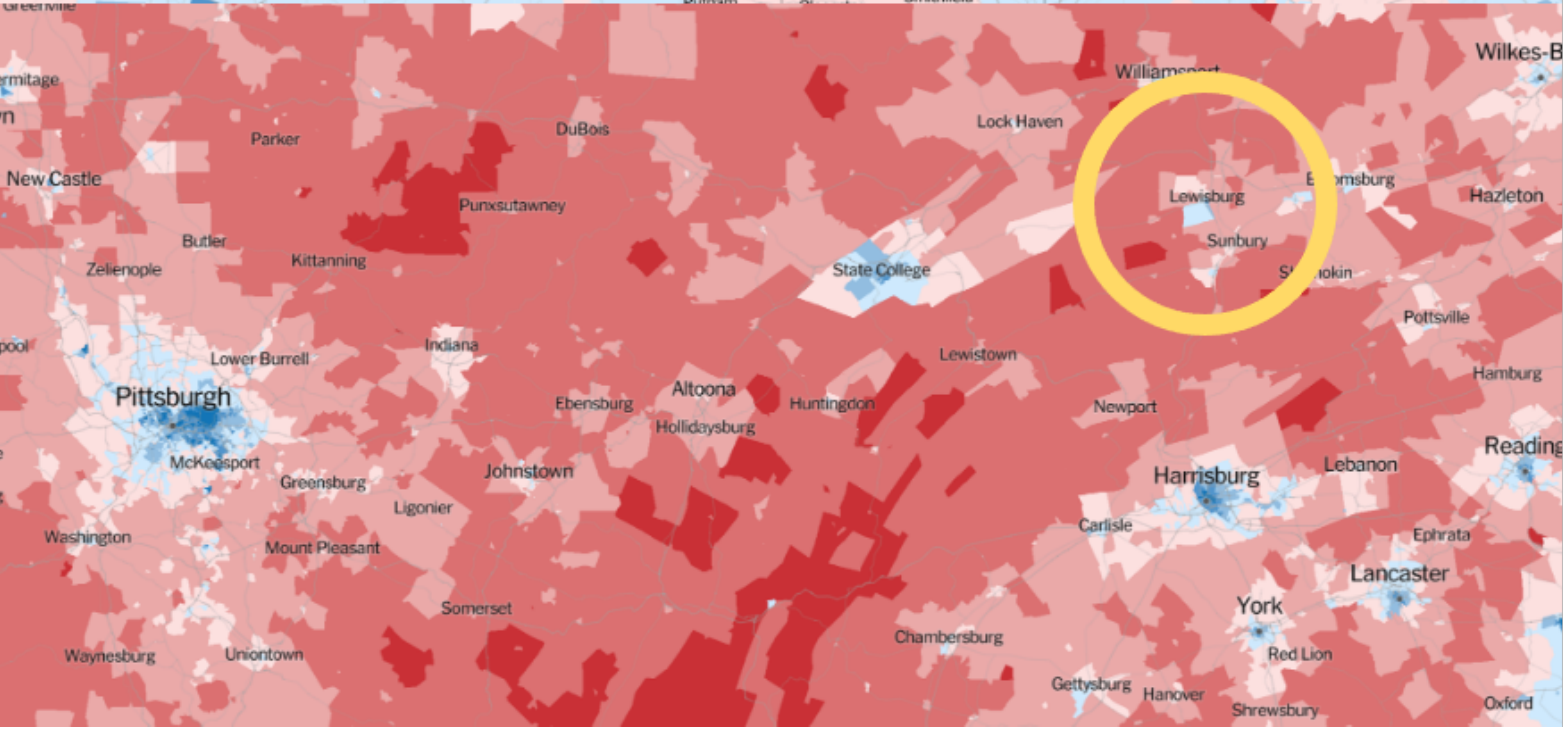
Duke University is very expensive at $61,000 a year… when I was a kid I wanted to go to Duke

Tech colleges promise the most consistent ROI… [I'm] interested in science. Also, my brother applied to these schools

And the evaluation wasn't capturing it

UNIVERSALITY. CONTEXTUALITY.





Do you think we see the world the same way?

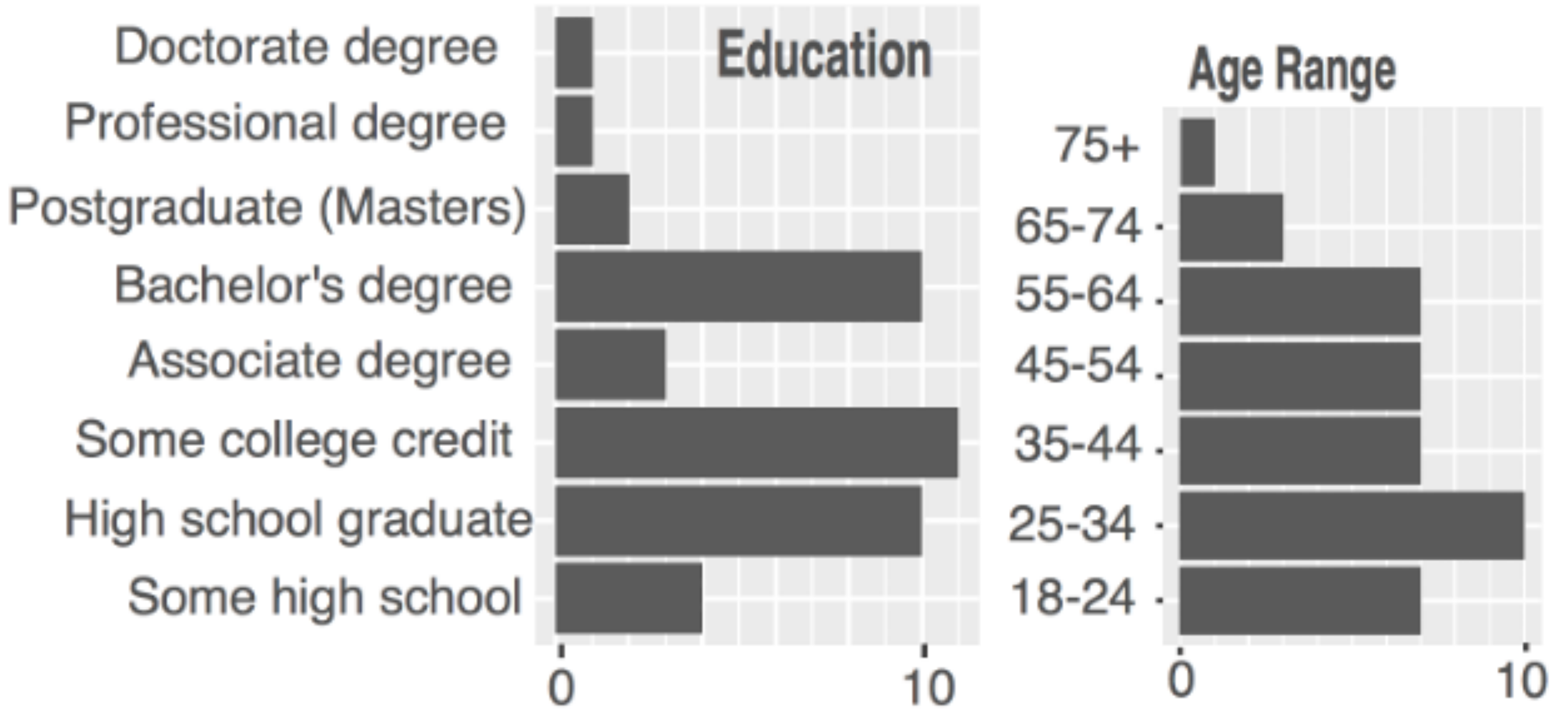
Should we expect that people see charts the same way?

We interviewed 42 community members about charts & graphs

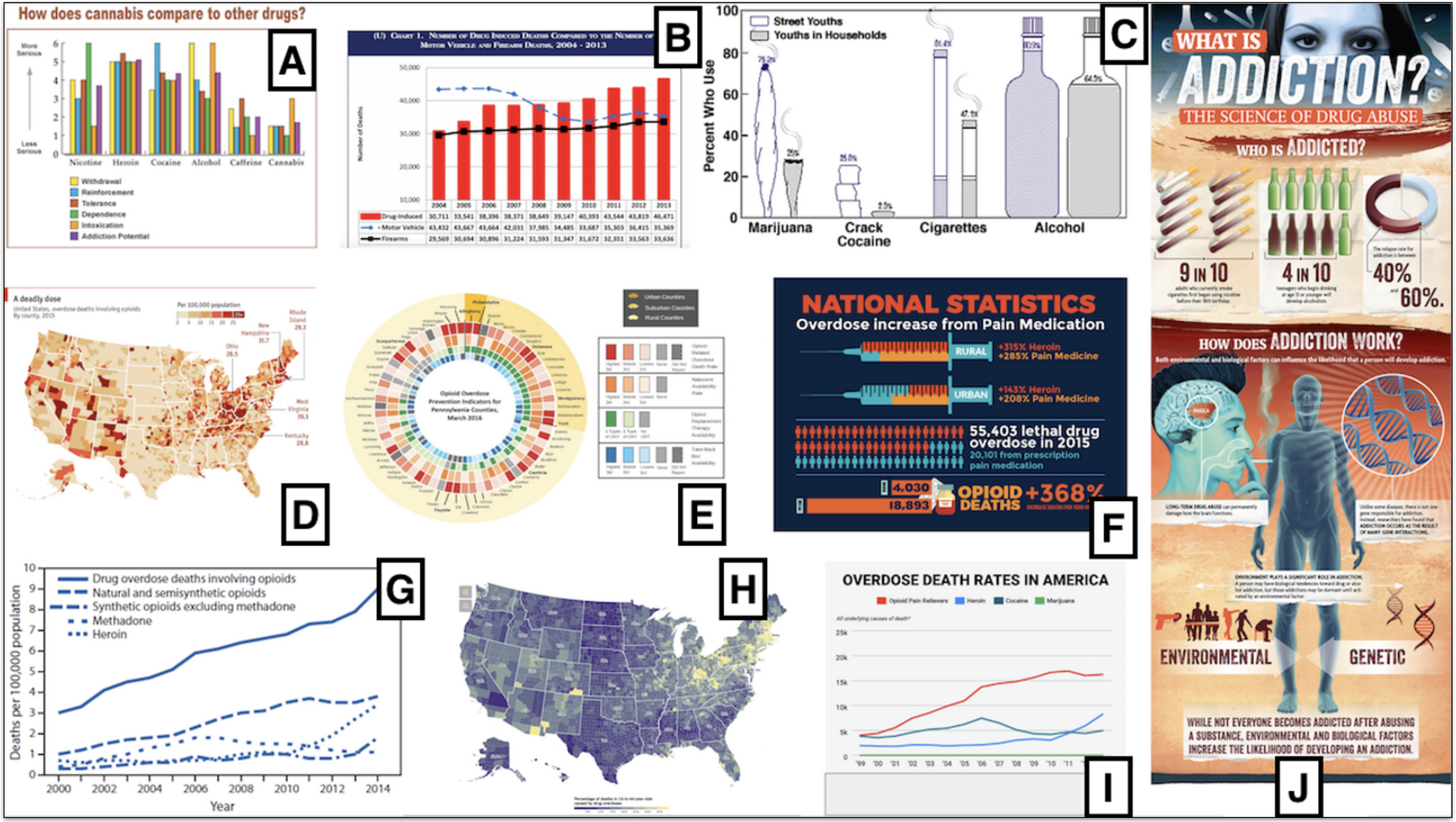
Where

farmers market
construction site
staff @ university

Who

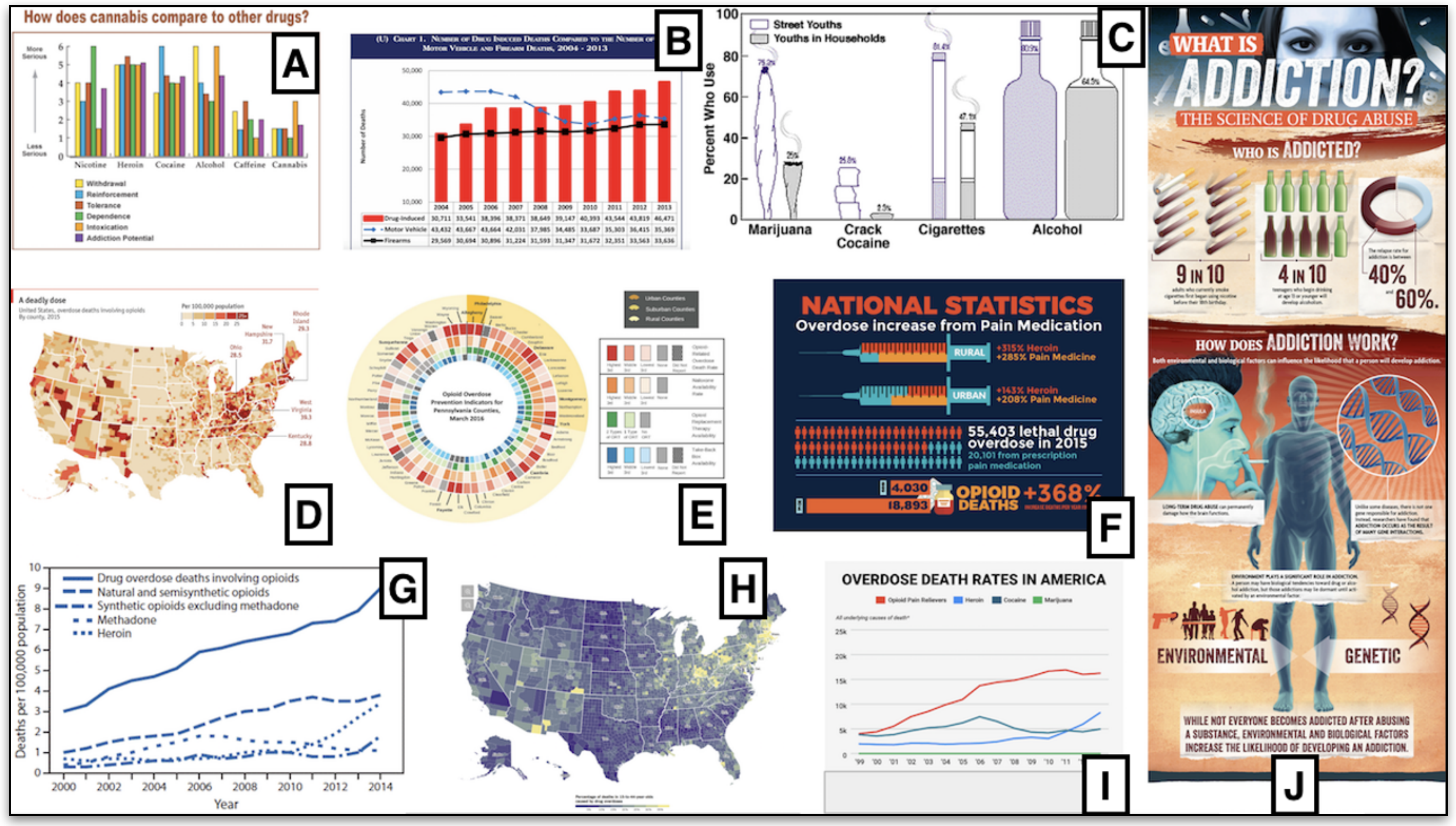


Peck, Evan M., Sofia E. Ayuso, and Omar El-Etr. "Data is personal: Attitudes and perceptions of data visualization in rural pennsylvania." In Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems, pp. 1-12. 2019. Best Paper Award



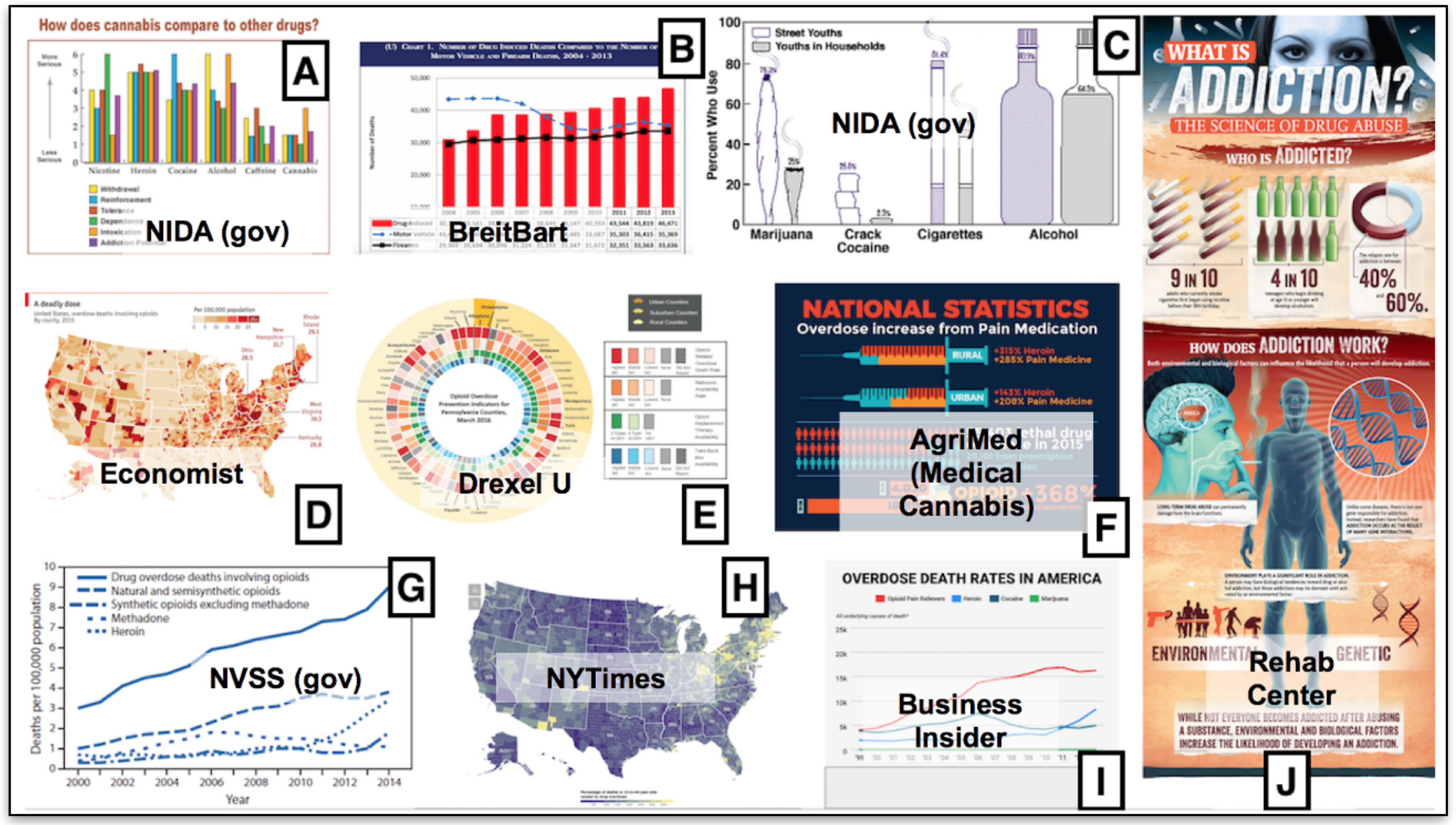
Peck, Evan M., Sofia E. Ayuso, and Omar El-Etr. "Data is personal: Attitudes and perceptions of data visualization in rural pennsylvania." In Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems, pp. 1-12. 2019. Best Paper Award

Rank them



Reveal sources

Rerank



Peck, Evan M., Sofia E. Ayuso, and Omar El-Etr. "Data is personal: Attitudes and perceptions of data visualization in rural pennsylvania." In Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems, pp. 1-12. 2019. Best Paper Award

Data is Personal

People prioritized charts in which they could make **personal connections.**

We found more than 20 instances in which people made person connections with the data.

Peck, Evan M., Sofia E. Ayuso, and Omar El-Etr. "Data is personal: Attitudes and perceptions of data visualization in rural pennsylvania." In Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems, pp. 1-12. 2019. Best Paper Award

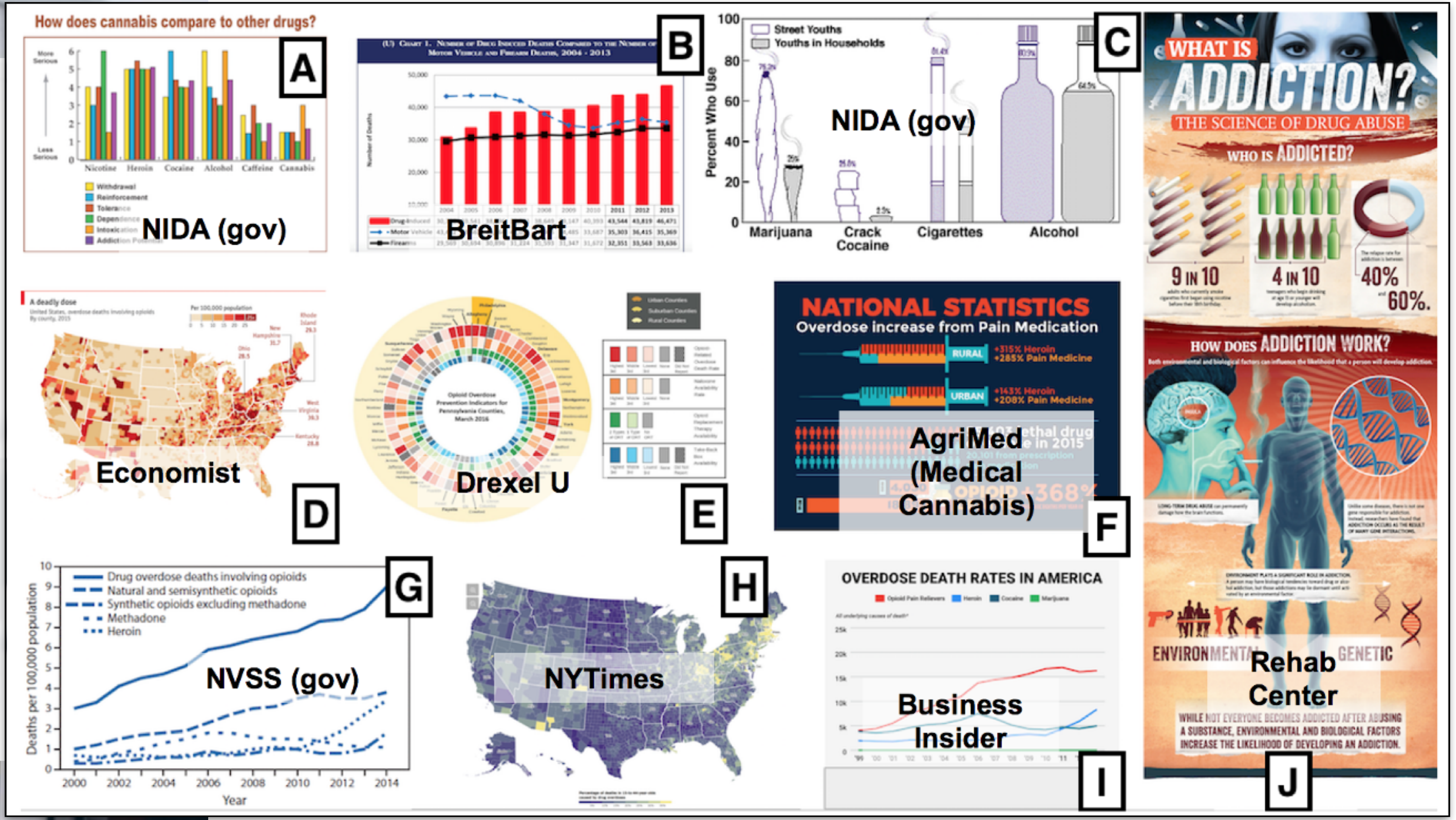
Data is Personal

People prioritized charts in which they could make **personal connections.**

“Information about alcohol.

I’m dealing with a functioning alcoholic… well, was a functioning alcoholic. The most important person in my life is an alcoholic.

Right now, that’s important to me.”



Peck, Evan M., Sofia E. Ayuso, and Omar El-Etr. "Data is personal: Attitudes and perceptions of data visualization in rural pennsylvania." In Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems, pp. 1-12. 2019. Best Paper Award

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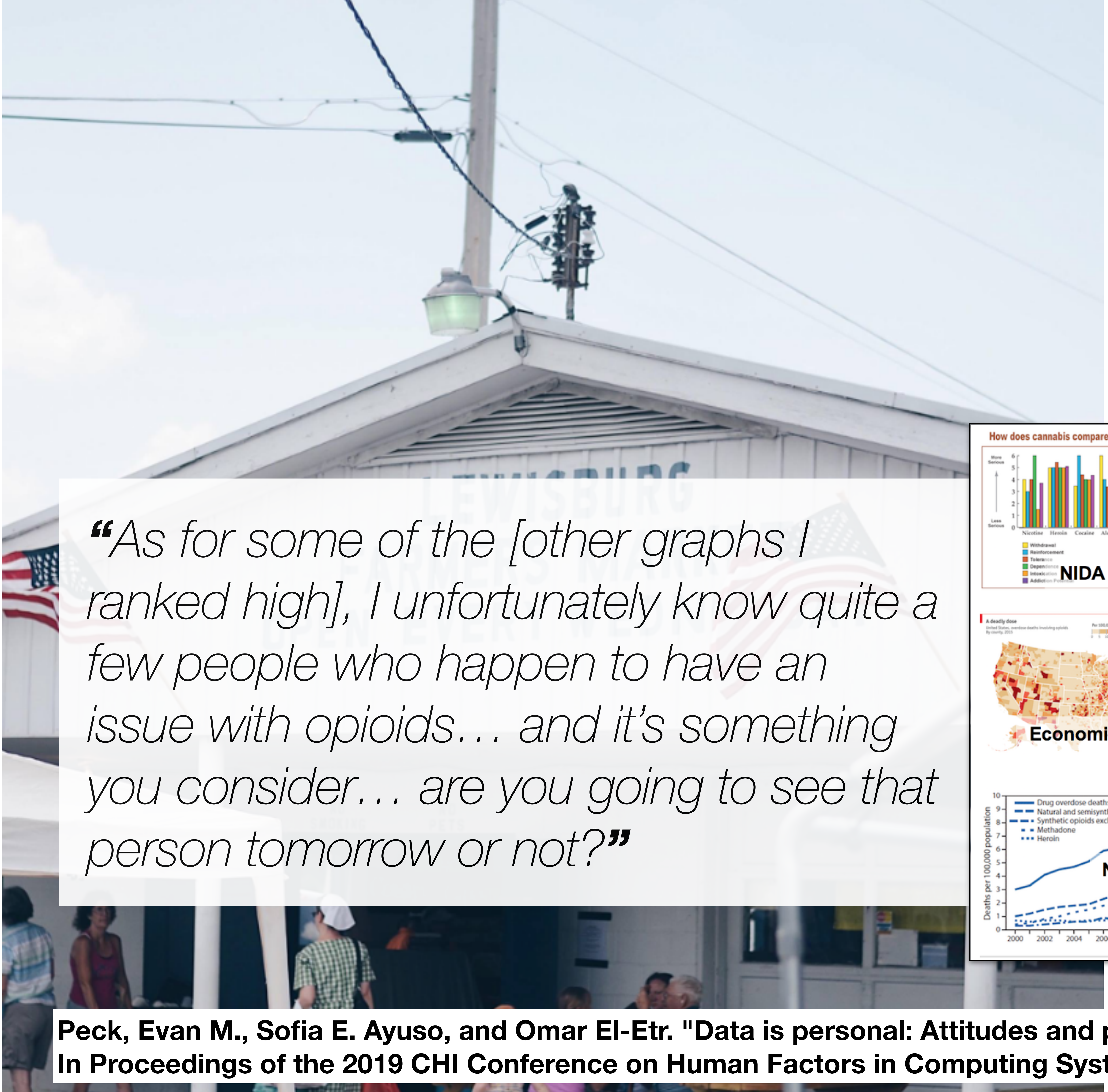
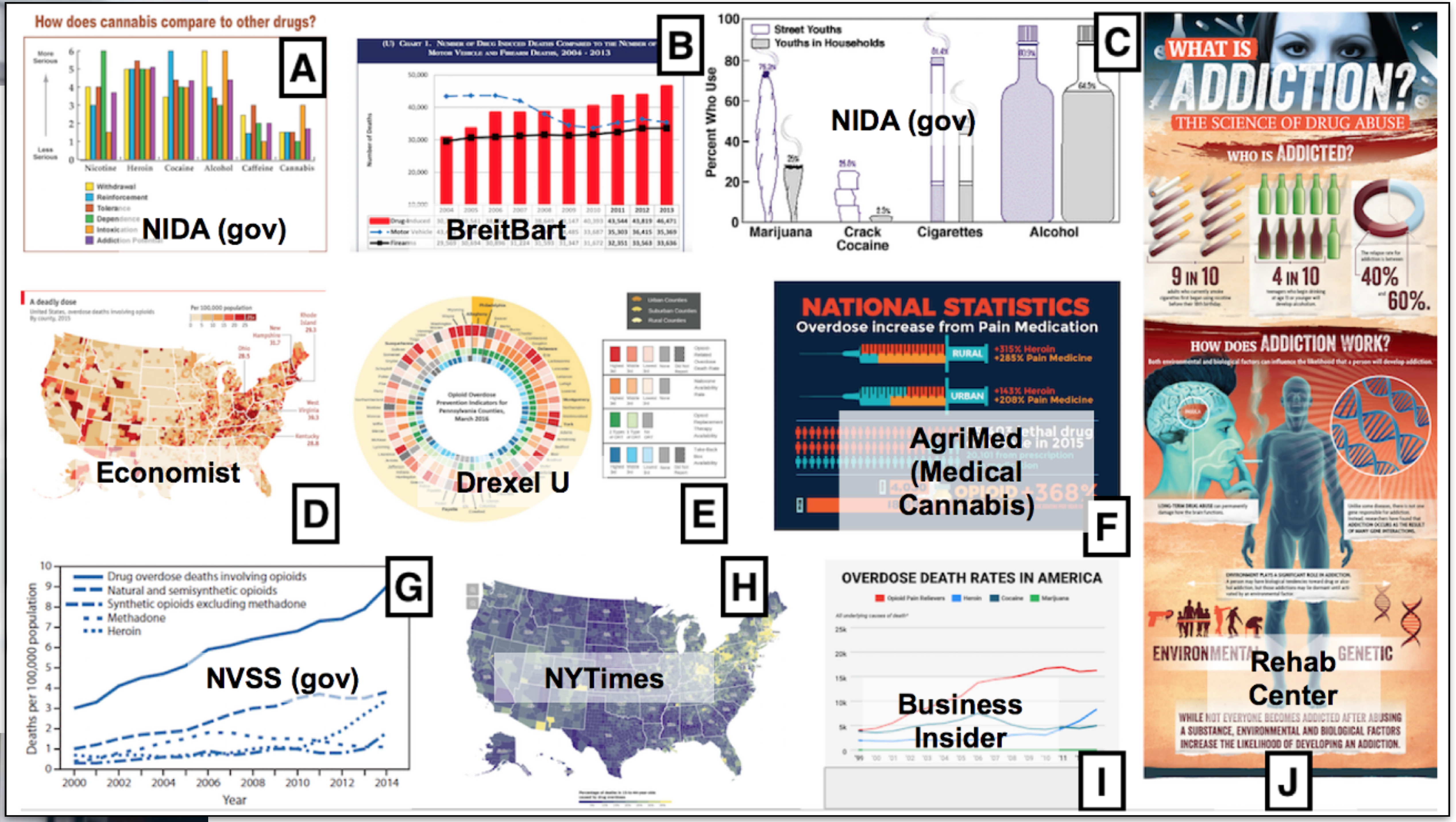
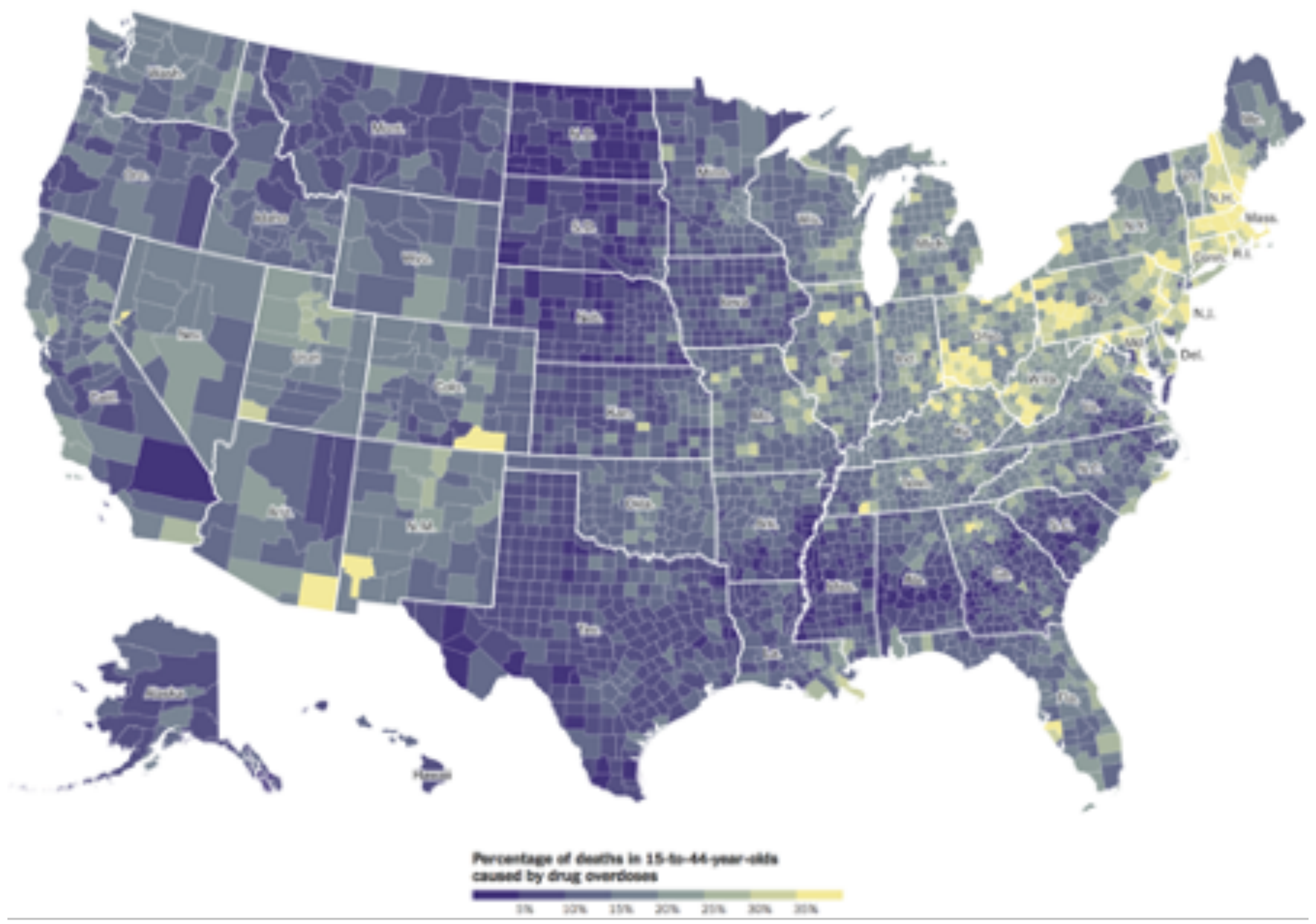
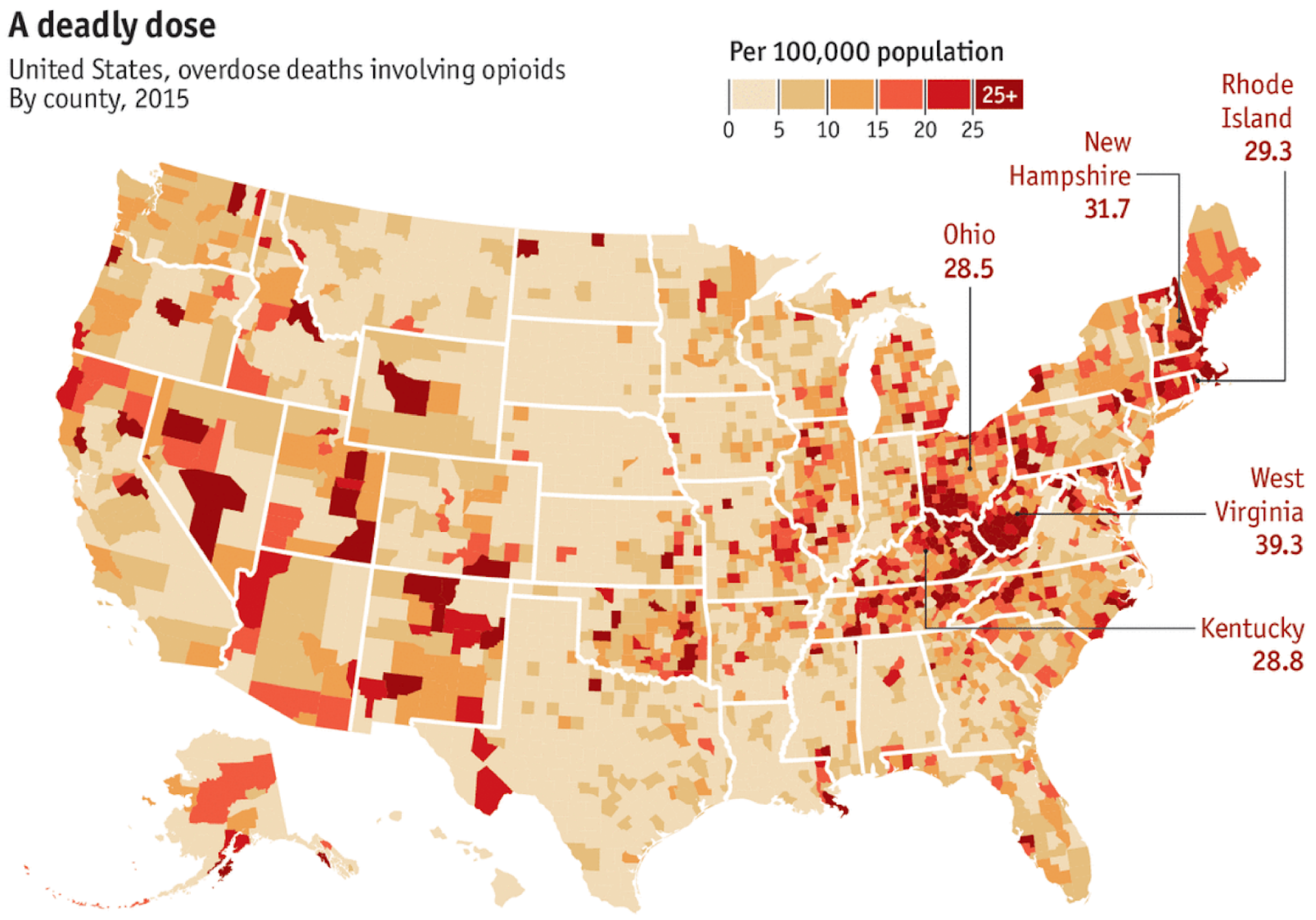


"As for some of the [other graphs I ranked high], I unfortunately know quite a few people who happen to have an issue with opioids… and it's something you consider… are you going to see that person tomorrow or not?"



Peck, Evan M., Sofia E. Ayuso, and Omar El-Etr. "Data is personal: Attitudes and perceptions of data visualization in rural pennsylvania." In Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems, pp. 1-12. 2019. Best Paper Award





Visualization mantra:

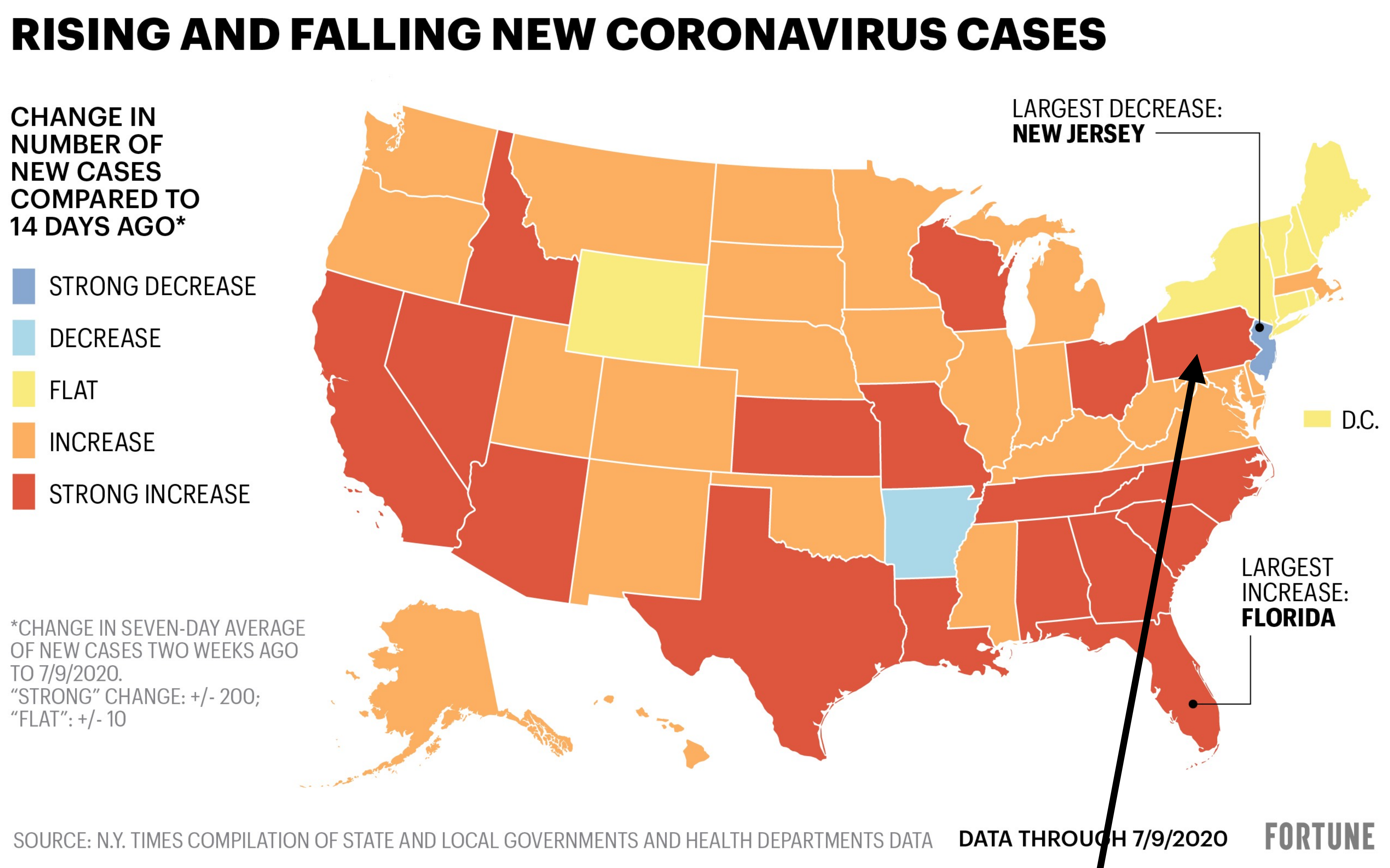
Overview first, Zoom and filter, Details on demand (Shneiderman 1996)

It's just a little more congested… trying to pinpoint where in a state I would be - 45-54 year old

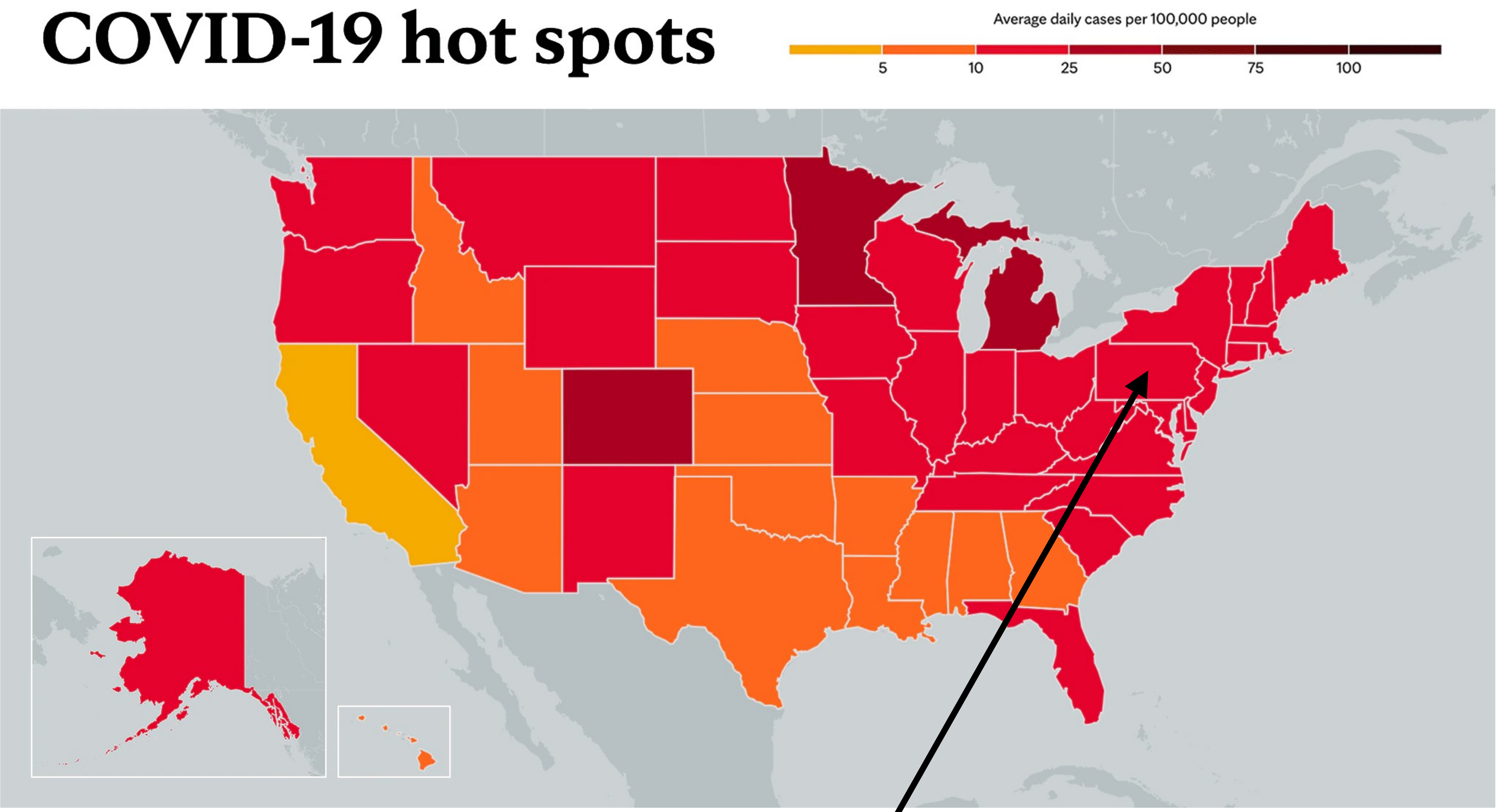
I like them less. It's the whole country; it's so huge. You naturally look at your state. It's too busy. - 65-74 year old

I don't read this newspaper. Even if I did like this picture, I still won't buy the newspaper because I don't live in New York; The Sunbury paper – that's close to here. Then I would read it.. I still won't read that one. - 55-64 year old

The cost of ignoring local context in our design?

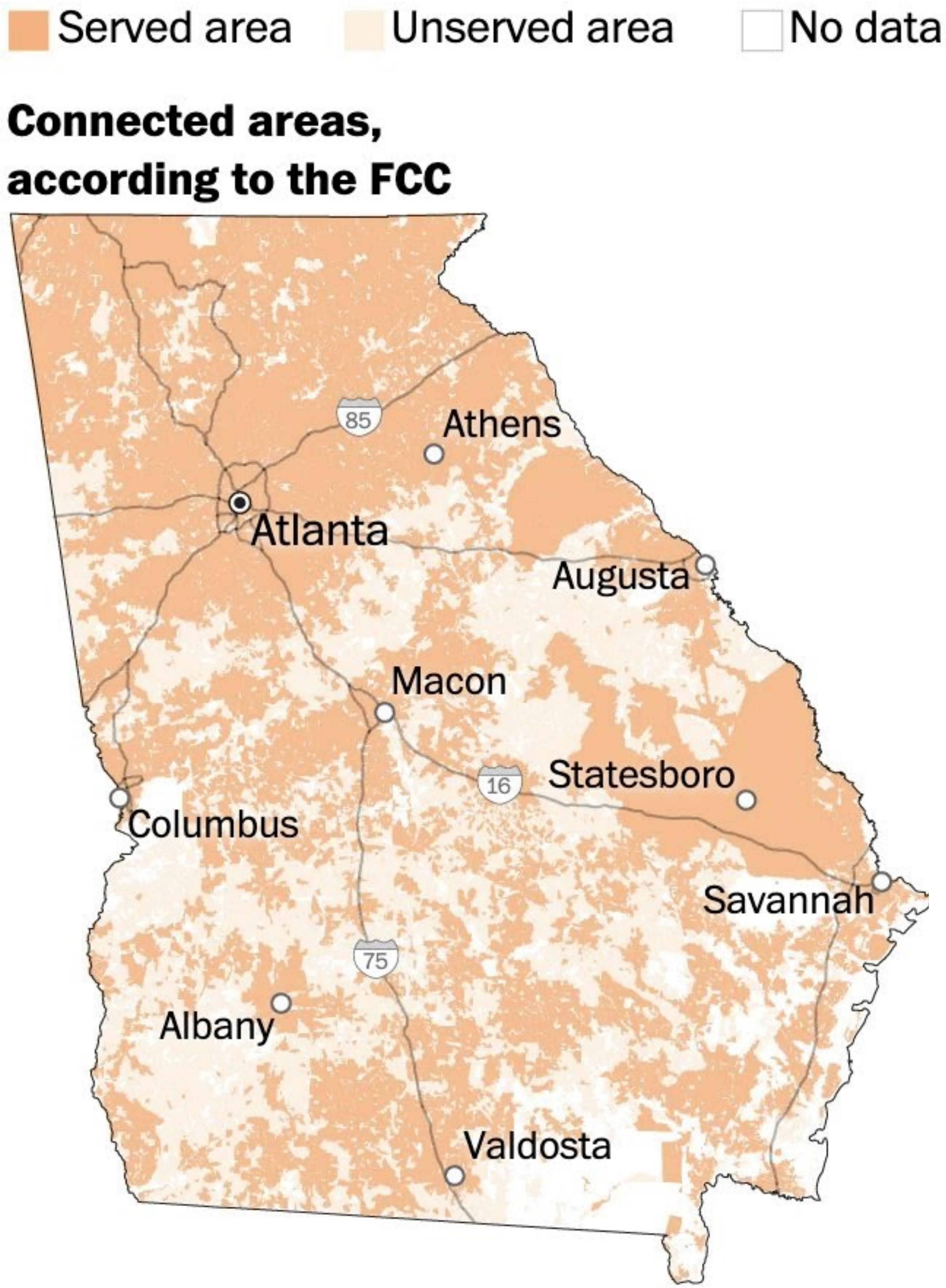


Fortune



Mayo Clinic

Graphs at a moment in which my county in central PA had yet to record a day with more than 2 positive cases



Sources: Census Bureau; Federal Communications Commission; Georgia Broadband Program; University of Georgia's Carl Vinson Institute of Government

Our visualizations fail to contextualize within our data definitions

At least 1 location with 25 Mbps download speeds and upload speeds of 3Mbps

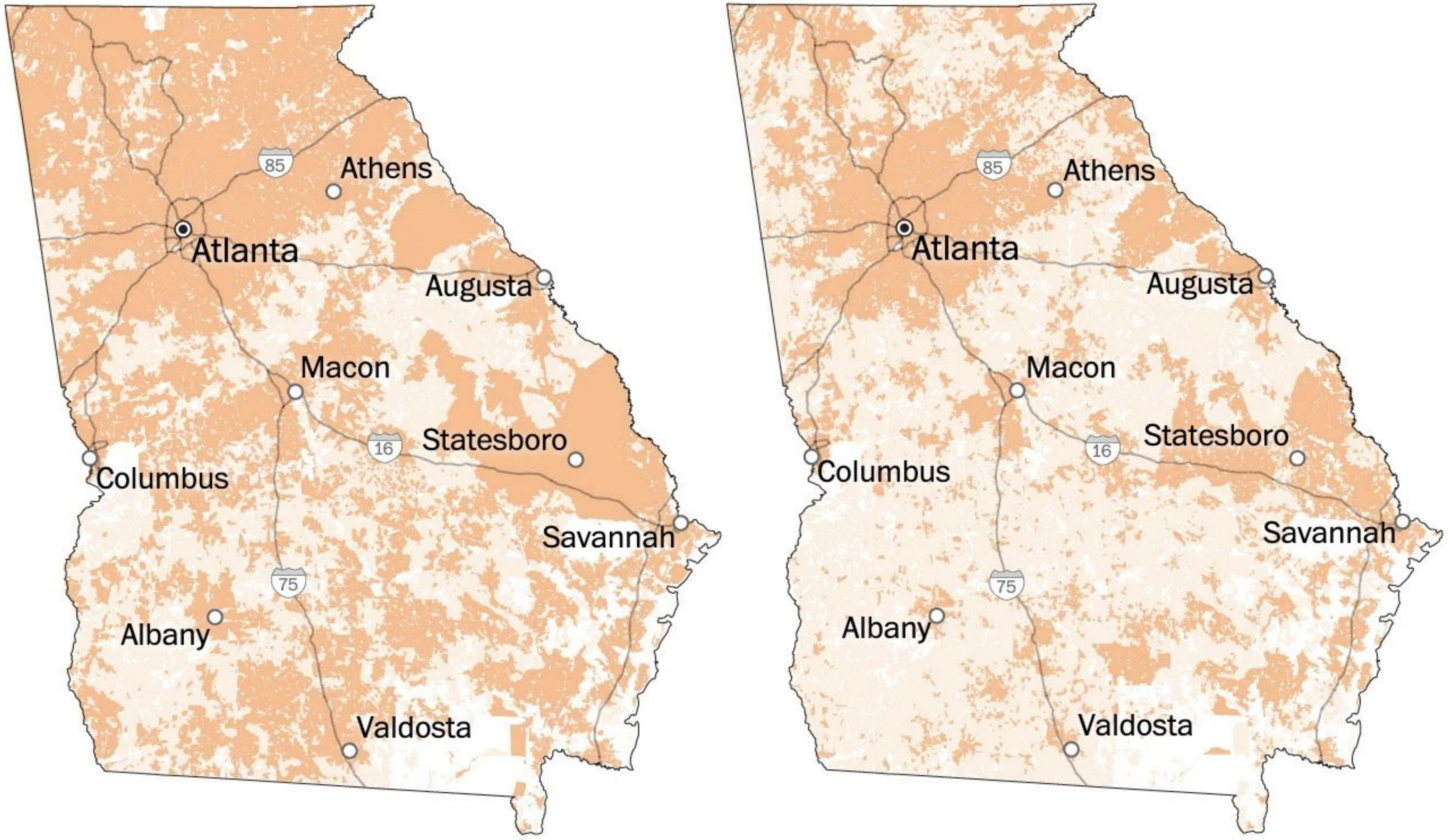
https://www.washingtonpost.com/technology/2021/12/14/bidens-ambitious-broadband-funding-has-key-impediment-an-outdated-map-who-needs-it/

At least 1 80%

Served area Unserved area No data

Connected areas, according to the FCC

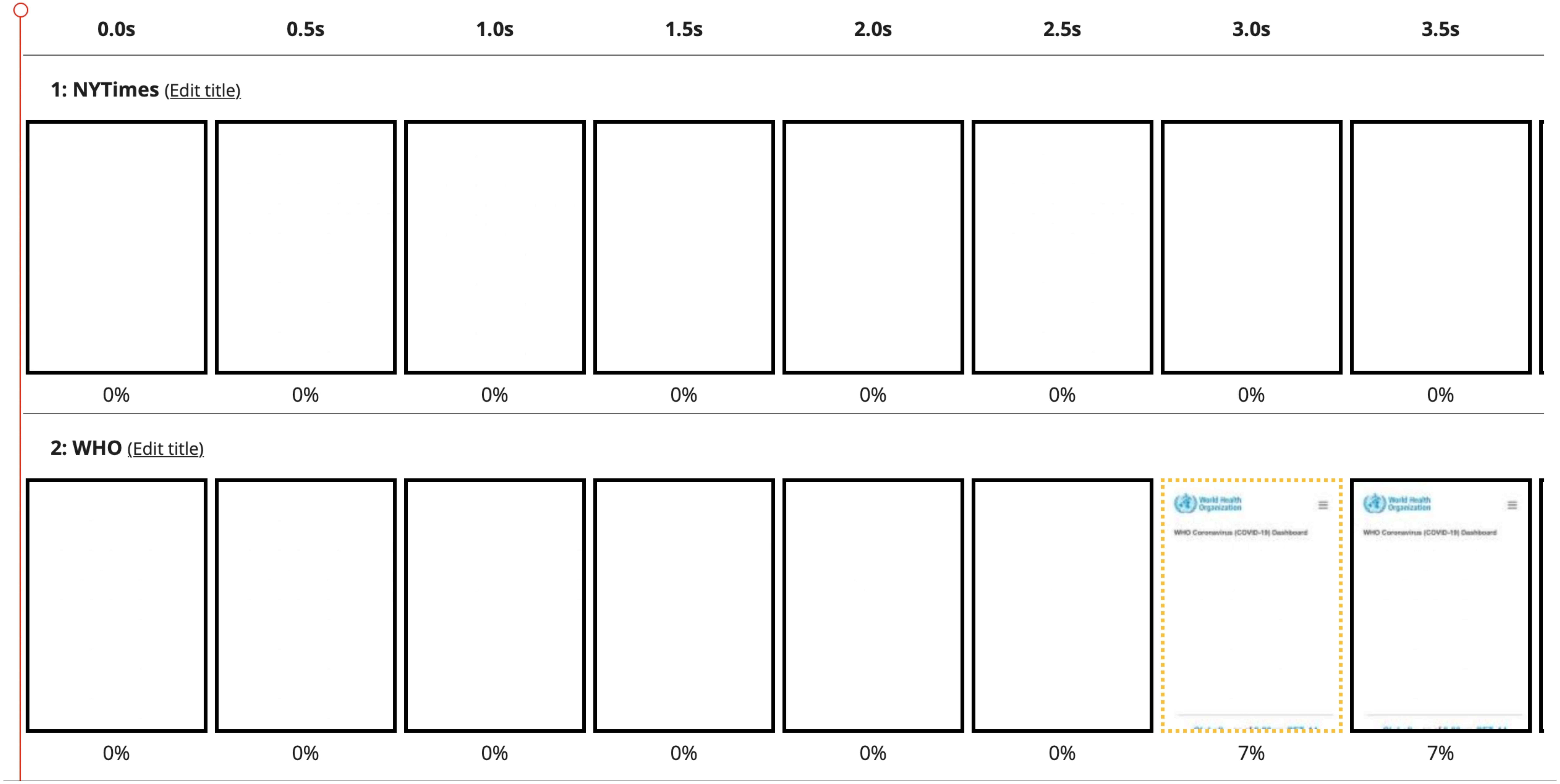
Connected areas, according to Georgia



Sources: Census Bureau; Federal Communications Commission; Georgia Broadband Program; University of Georgia's Carl Vinson Institute of Government

My father's childhood home. It has *never* had stable broadband connectivity. It is in an area defined as broadband coverage

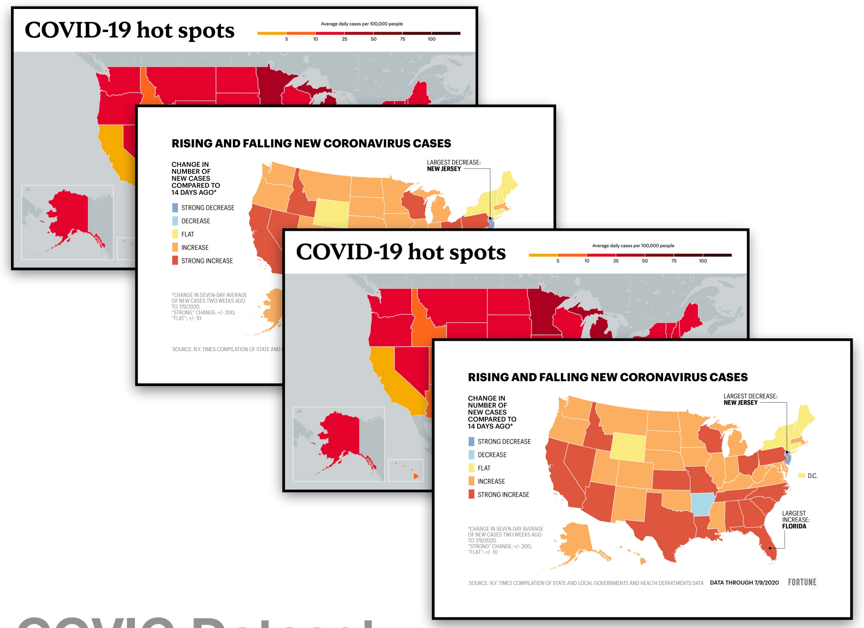
How COVID dashboards load on a phone with 3G



In-progress work - Katrina Wilson, Reva Sharma, Jaehoon Pyon, Evan M. Peck

Who do we design for when we design on the web?

3000+ COVID-19 web visualizations



COVIC Dataset
Paul Kahn, Hugh Dubberly, Dario Rodighiero 2022

Accessibility

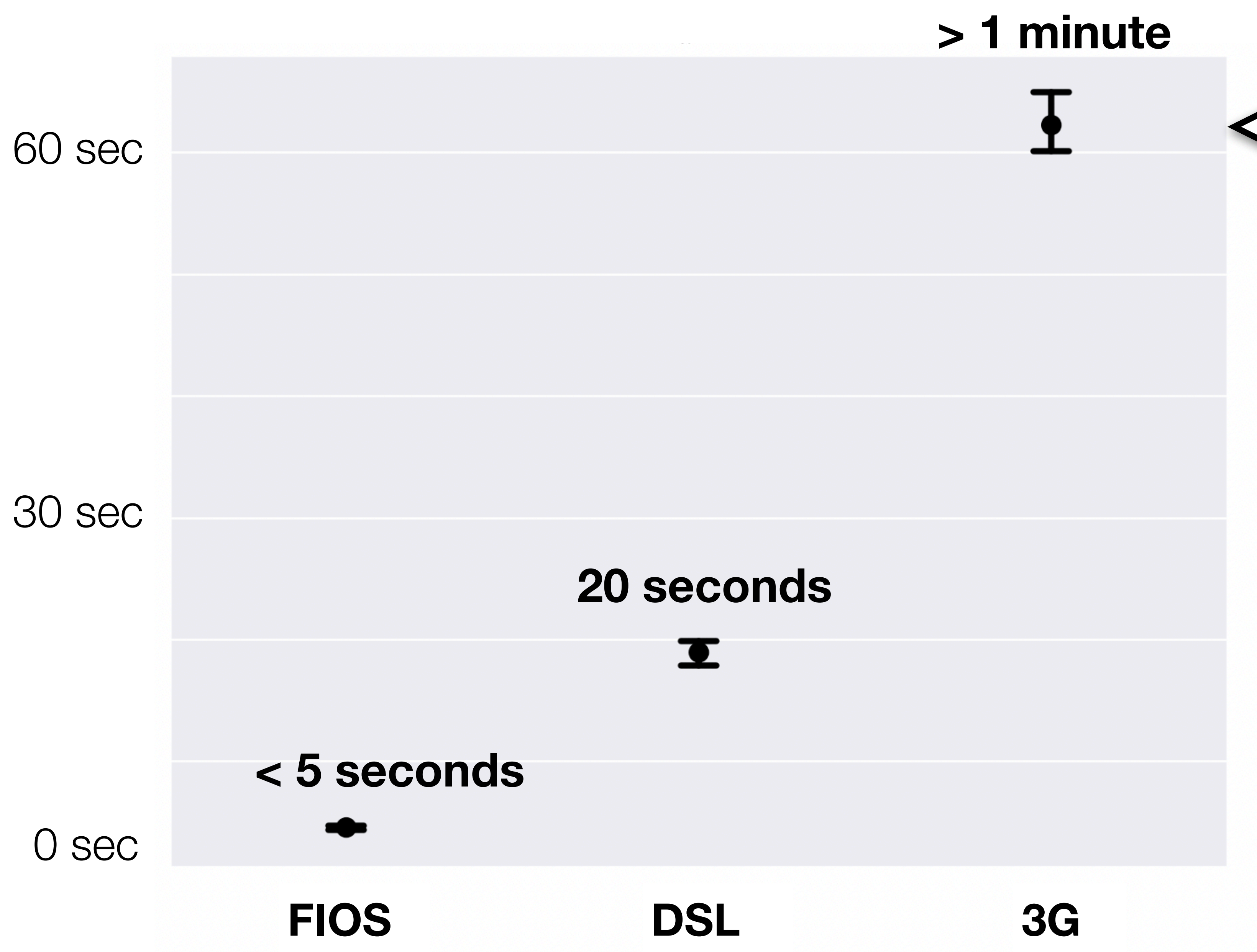
WebAIM
web accessibility in mind

Performance

WebPageTest by catchpoint

3G DSL FIOS

150 GB of performance + accessibility data

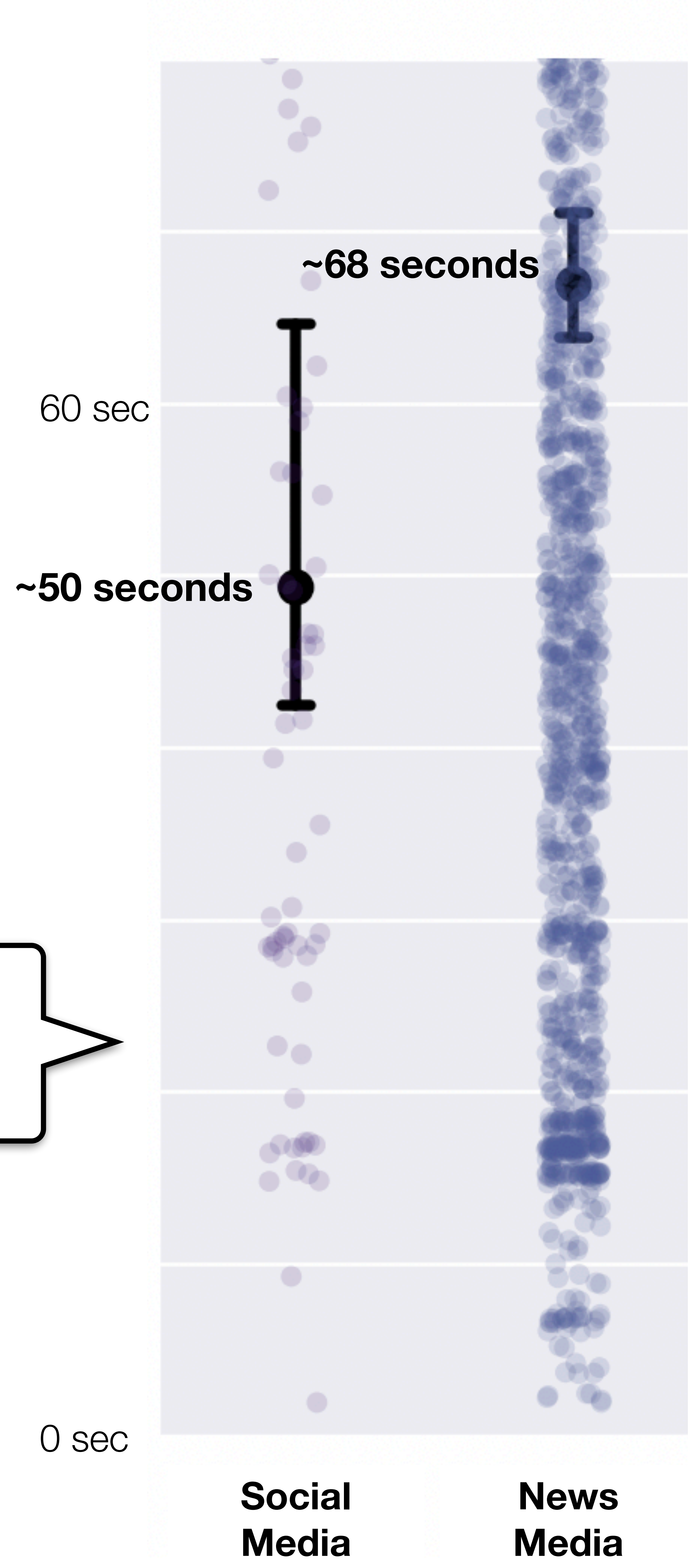


On average, it takes more than 1 minute to access COVID-19 graphs on a slow, mobile connection

COVID-19 graphs on News Media sites take ~30% longer to load than on social media

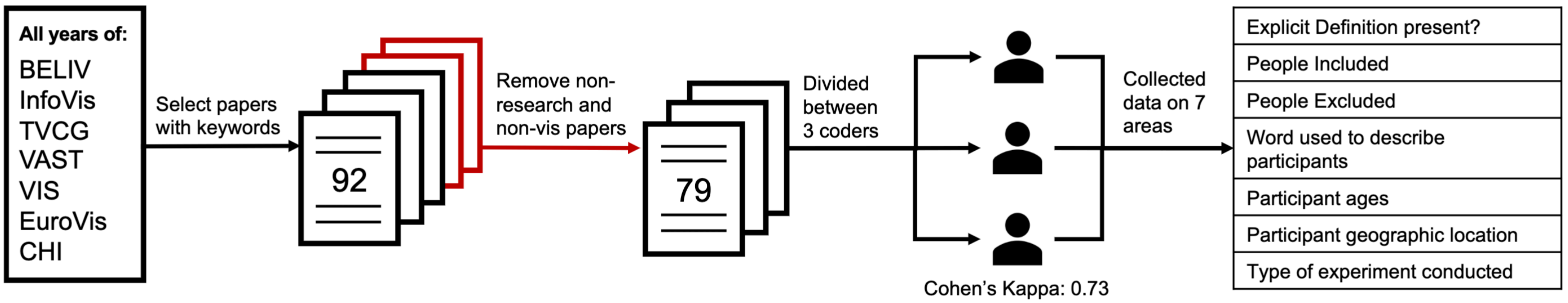
lower income,
racial minorities,
less educated

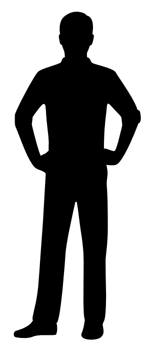
Pew Internet



In-progress work - Katrina Wilson, Reva Sharma, Jaehoon Pyon, Evan M. Peck

Why does our research about novices in visualization often fail?
general public
non-experts





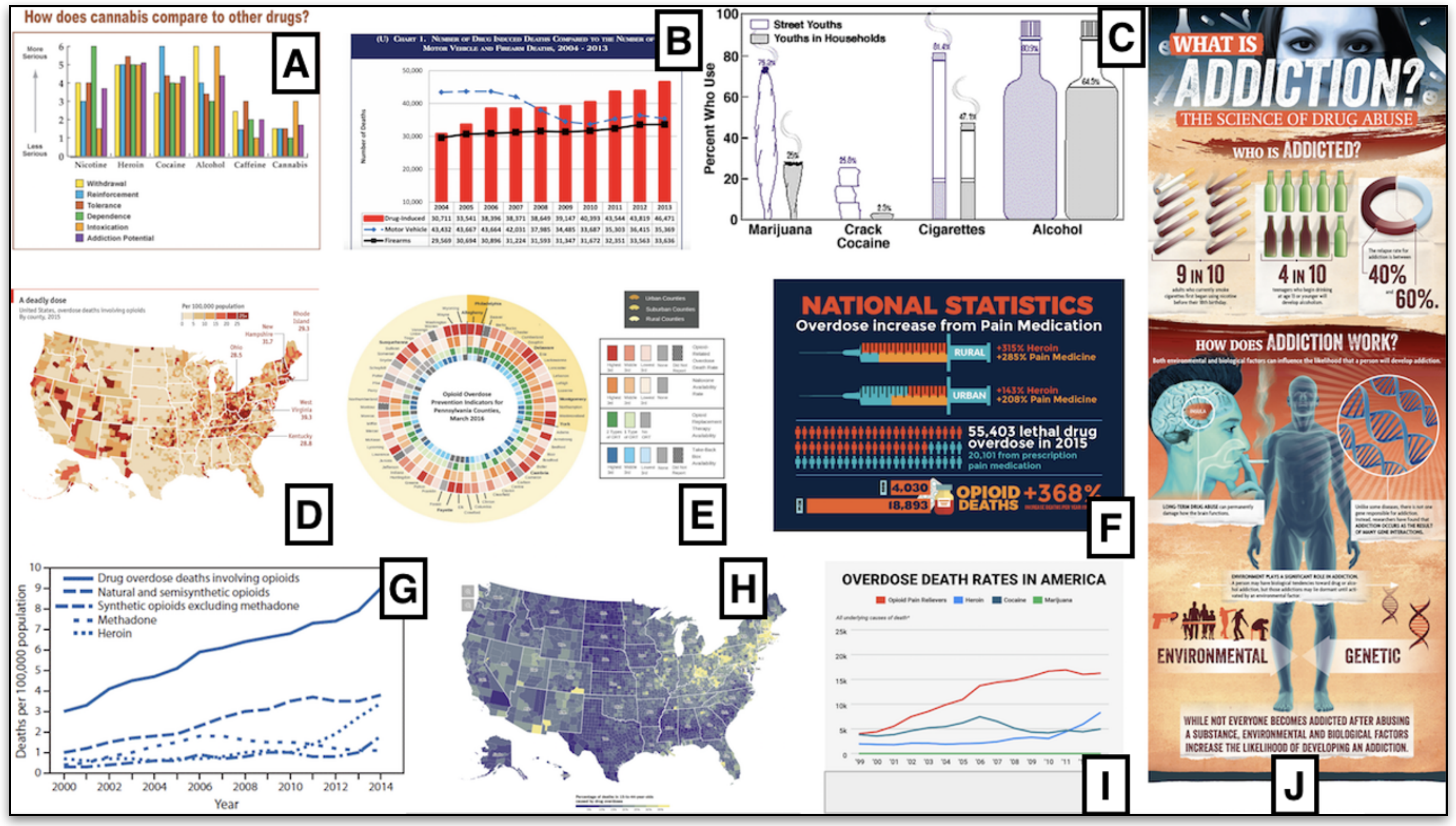
80% of papers rely on implicit definitions for novices (often ambiguous)

Implicitly…

A novice is most likely to be **young**
A novice is most likely to be **a university student**
A novice is most likely to be **a US resident**
A novice is most likely to **lack traditional STEM expertise**

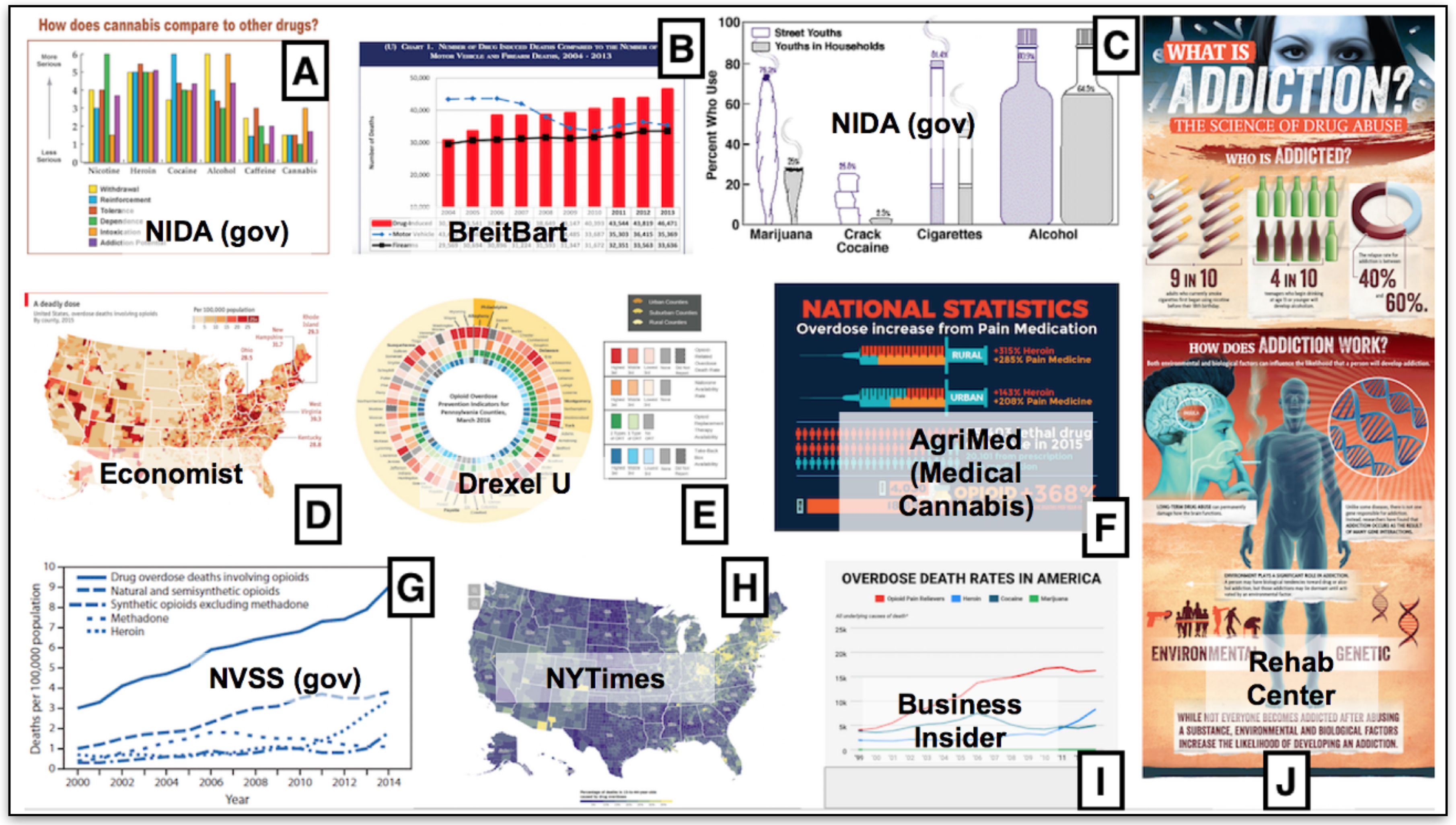
Burns, Alyxander, Christiana Lee, Ria Chawla, Evan M. Peck, and Narges Mahyar. "Who Do We Mean When We Talk About Visualization Novices?" Best Paper Award ACM CHI 2023

Rank them

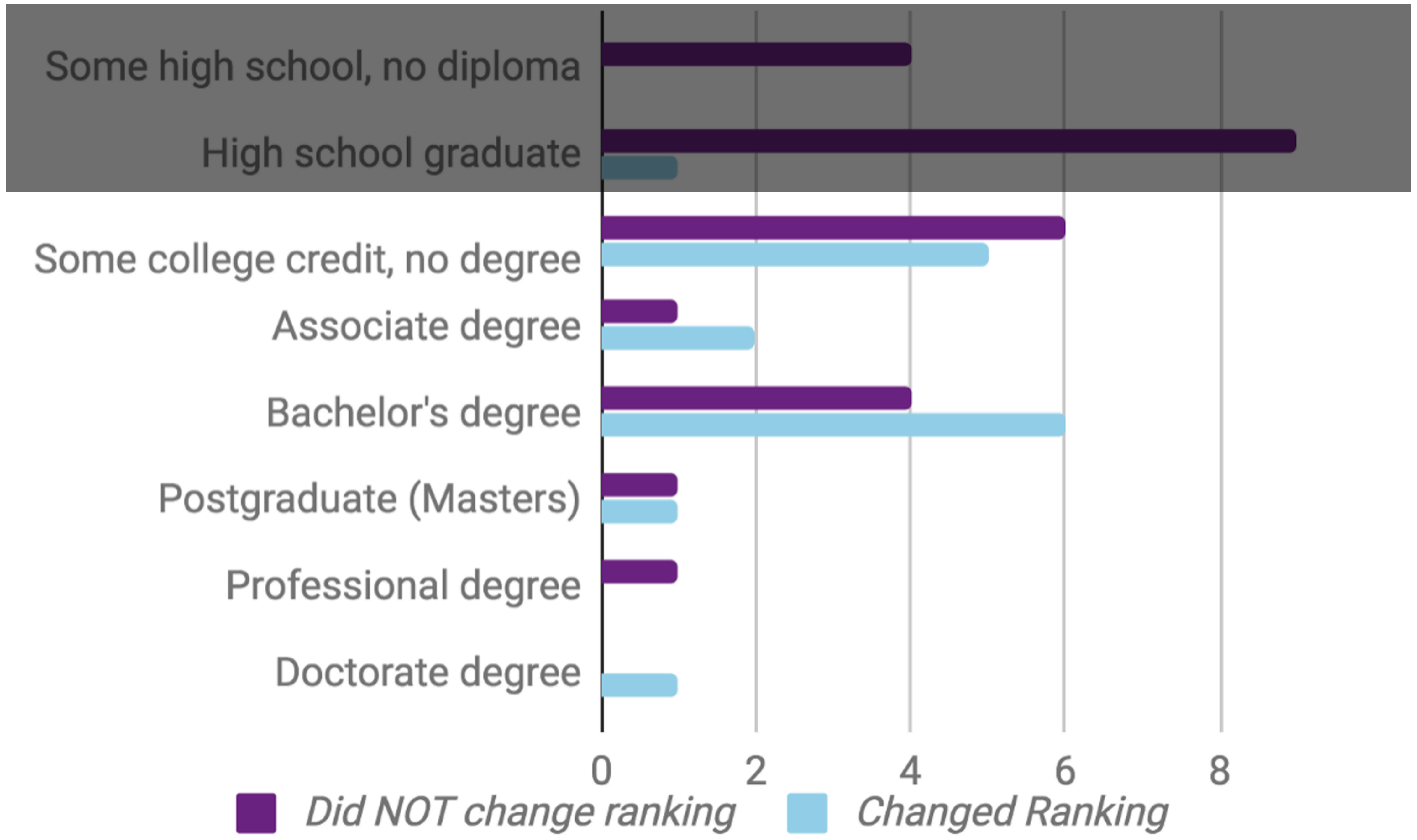


Reveal sources

Rerank

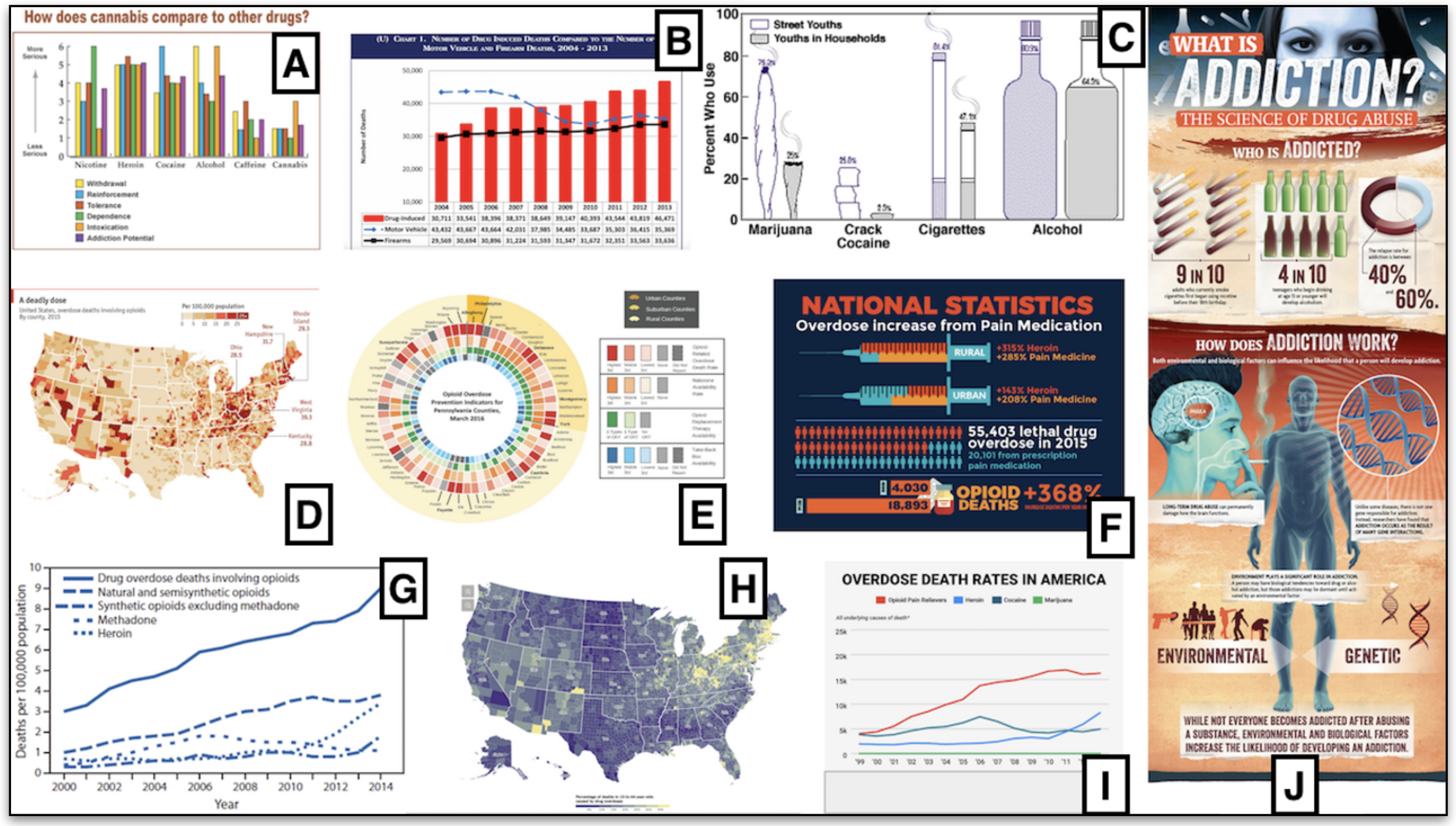


26 out of 42 didn't change any rankings…



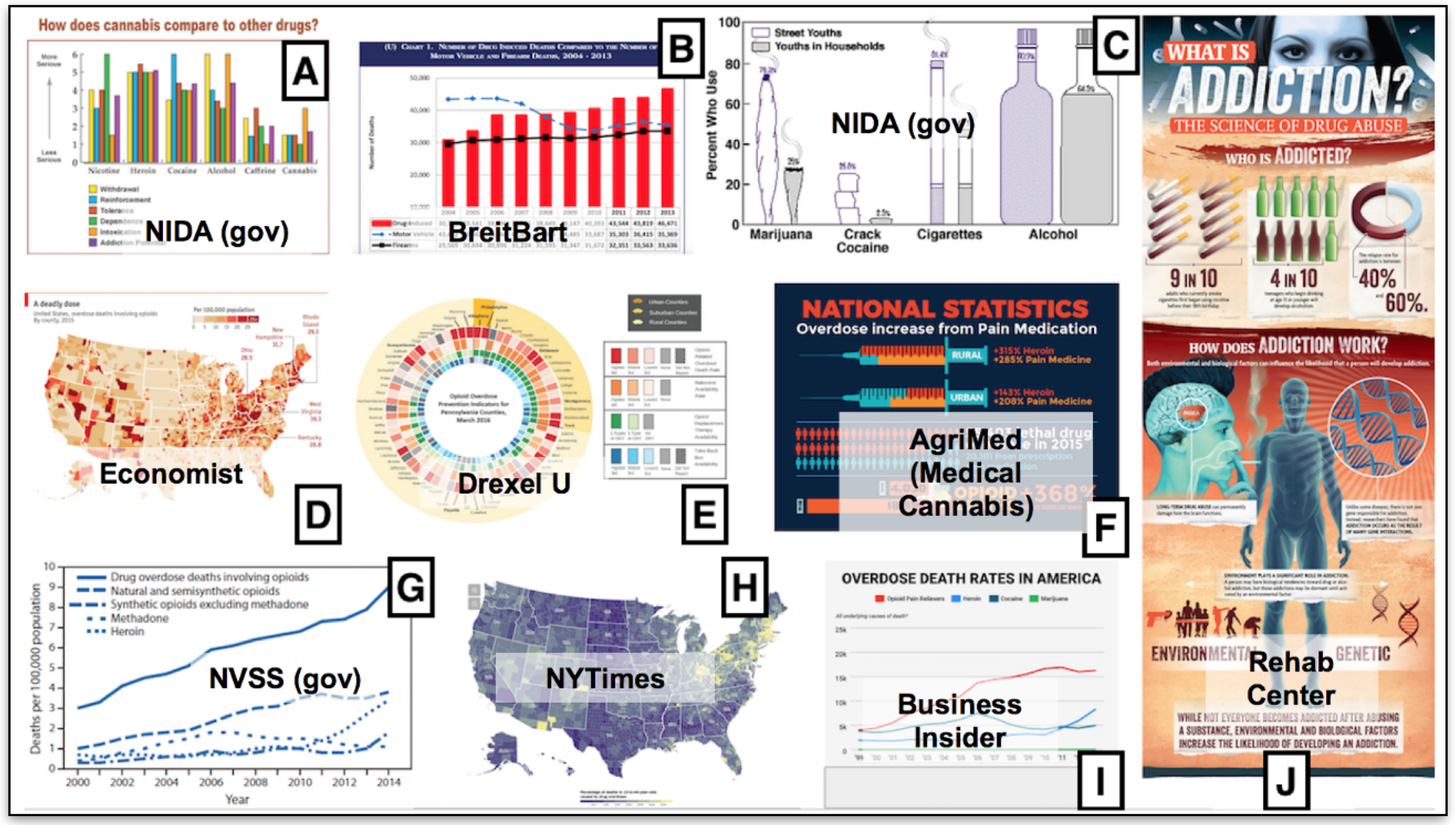
… and people who were less educated were less likely to change their rankings

Rank them

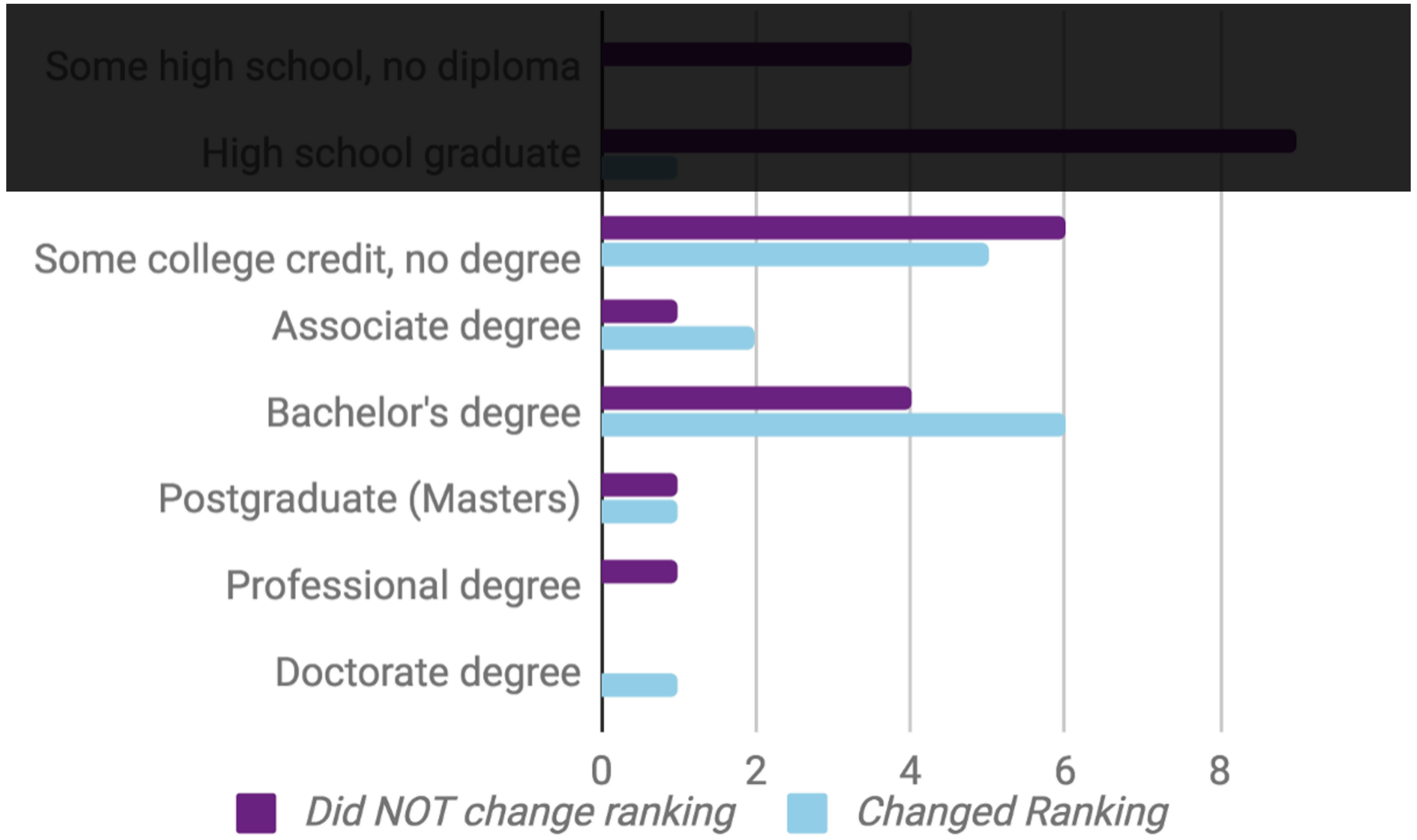


Reveal sources

Rerank



13 out of 28 didn't change any rankings…

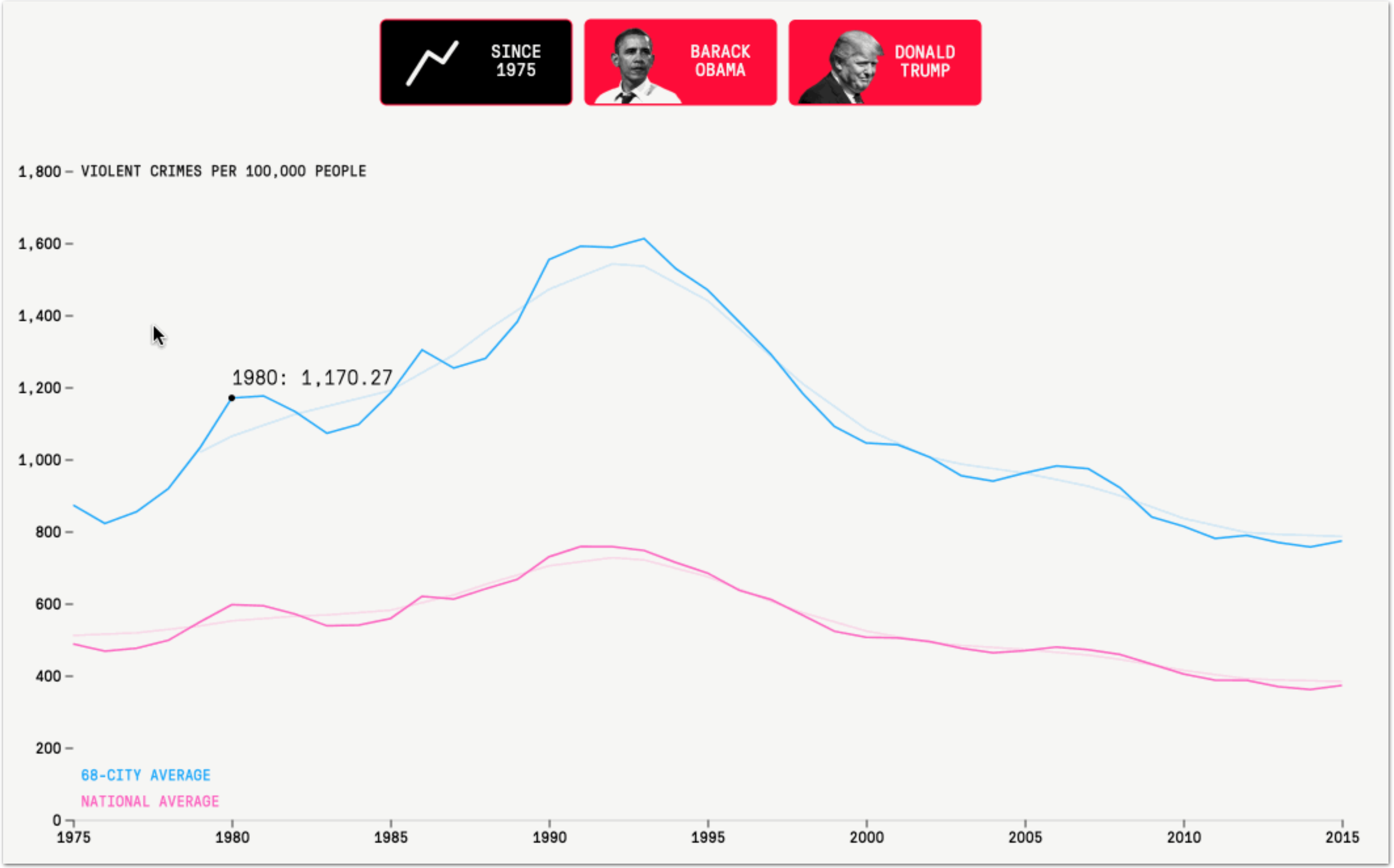


… and we saw no characteristics that correlated with this decision

IMPARTIALITY POSITIONALITY

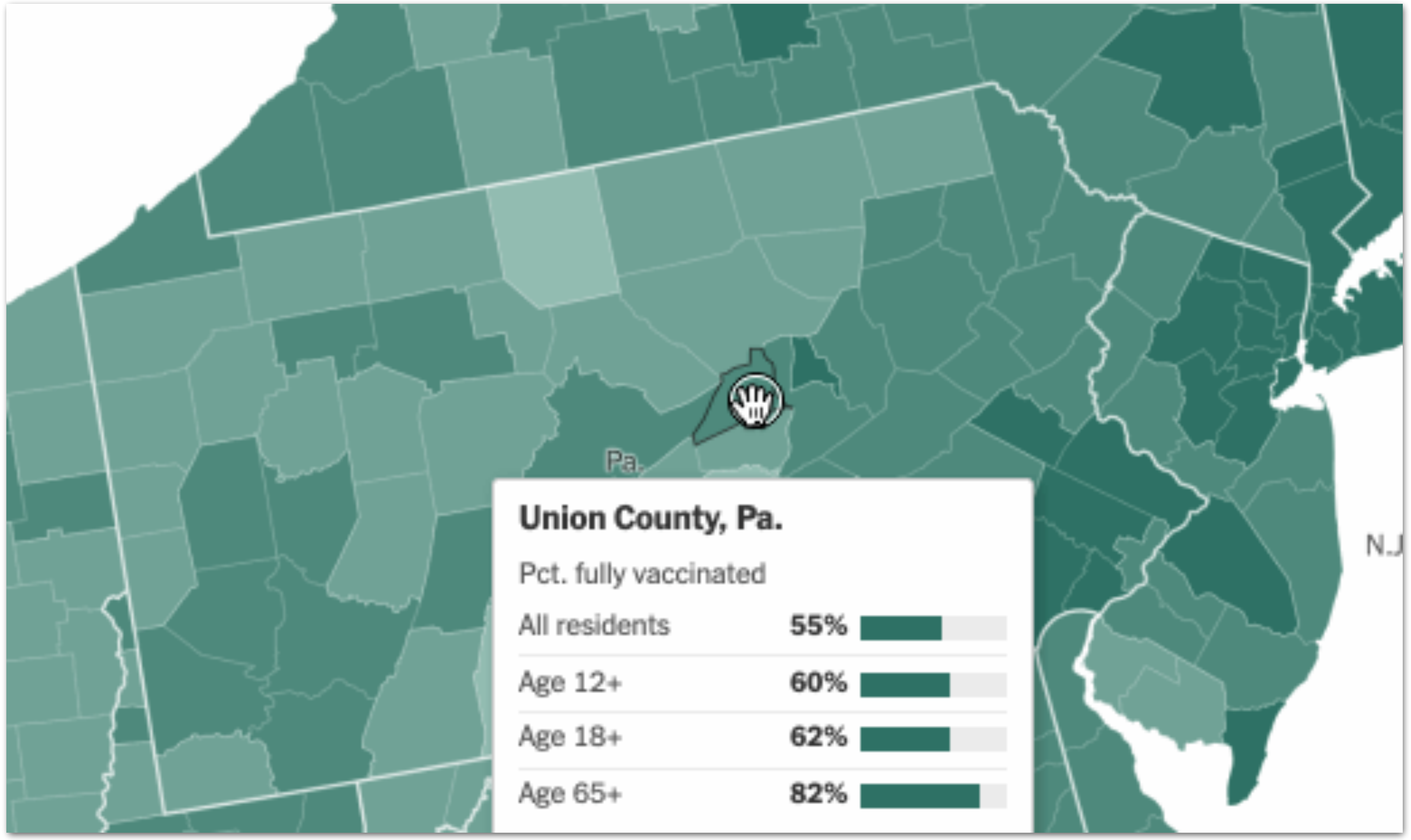
"information is information"

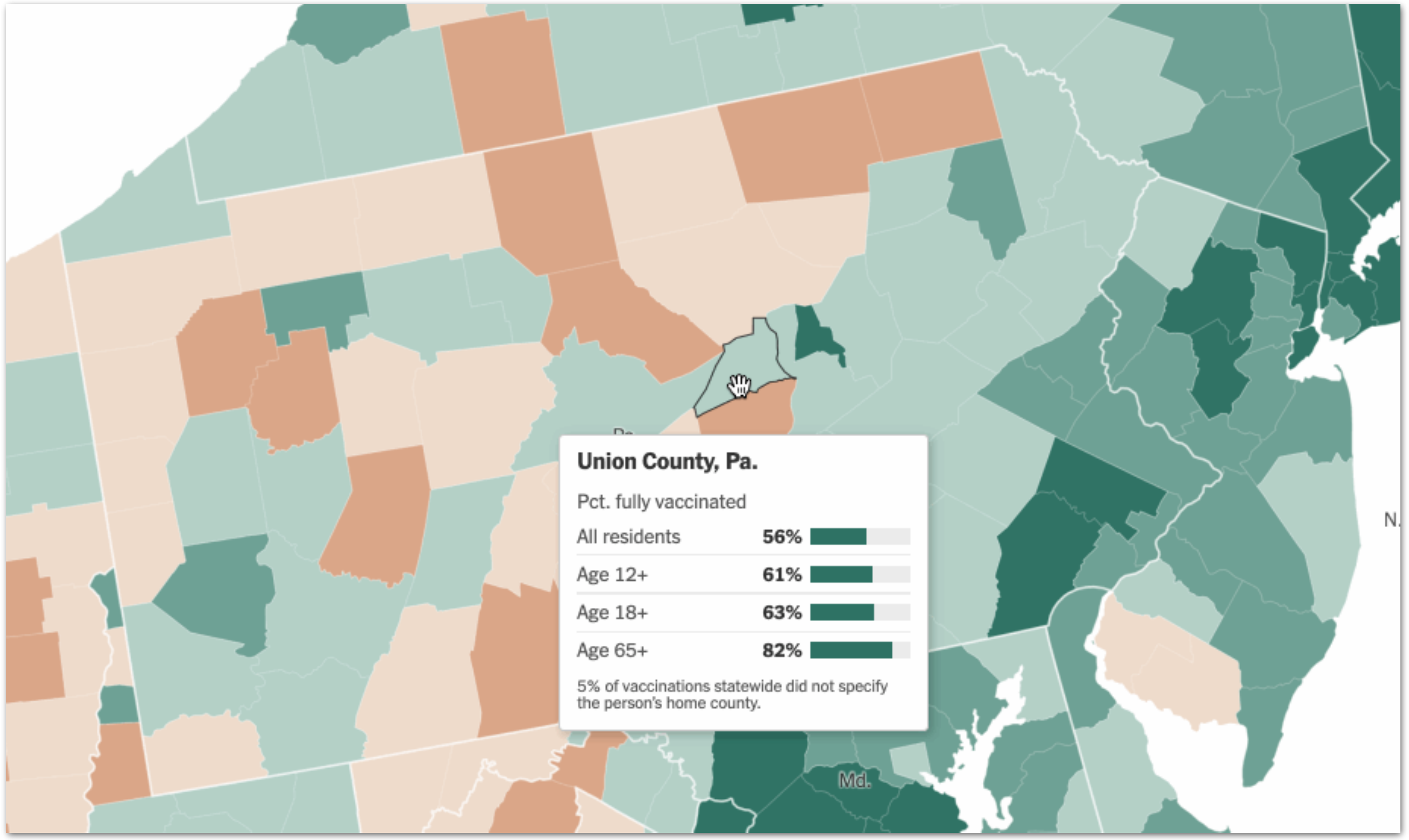
- **Rationale from person who did not change their rankings in our study (among more than a dozen with similar sentiments)**



Exploiting perceived impartiality of data

Invisibility of political decisions





Same graph, almost-identical data, ~1 week apart

https://www.nytimes.com/interactive/2020/us/covid-19-vaccine-doses.html

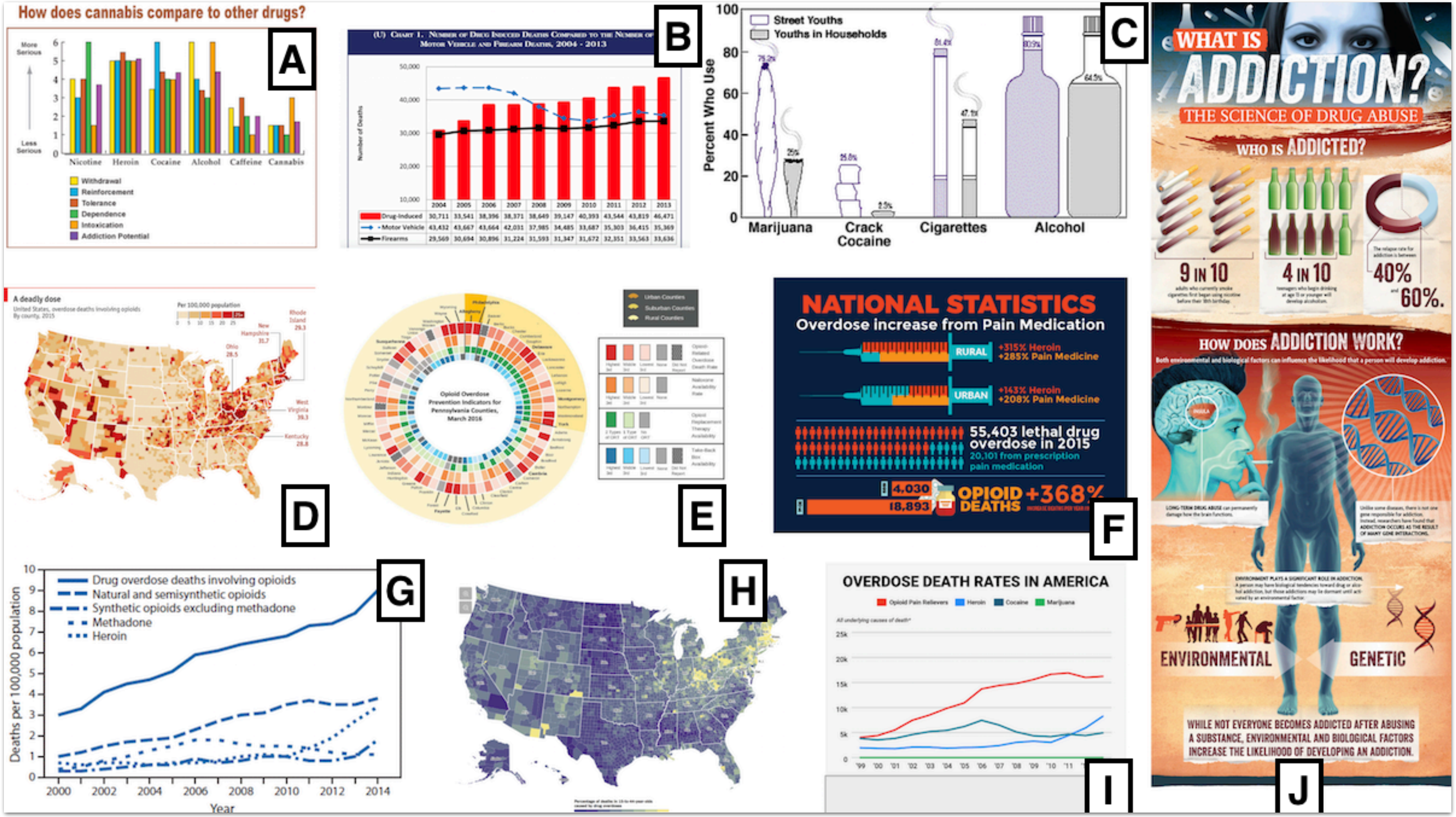
Once trust is lost, the graphs don't matter

"I **don't trust** things if I don't know where it comes from"

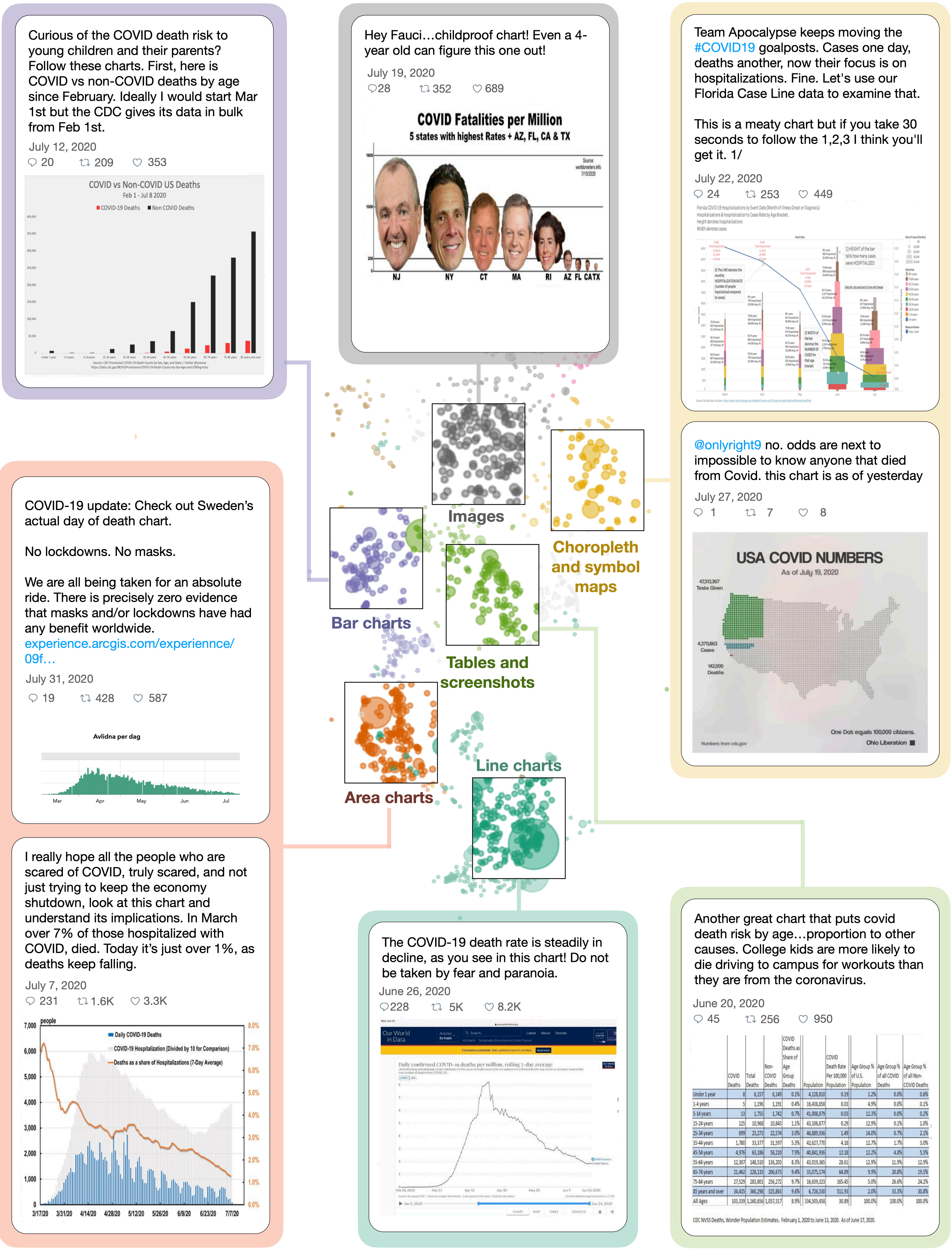
"I would **never trust** something from a drug company or Breitbart, and I would always trust something from the CDC or NIH"

"I **don't trust** the CDC. I believe they hide stuff"

"It's **hard to trust** a lot of information because you could put anything on anything"



Peck, Evan M., Sofia E. Ayuso, and Omar El-Etr. "Data is personal: Attitudes and perceptions of data visualization in rural pennsylvania." In Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems, pp. 1-12. 2019.



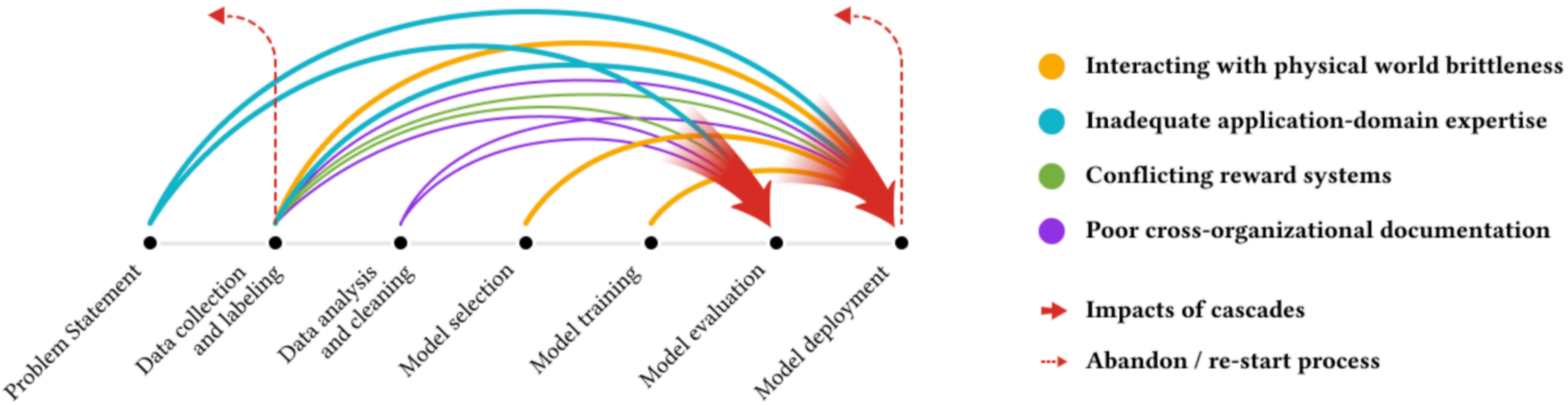
It's not just data literacy

"anti-mask groups are critical about the data sources used to make visualizations in data-driven stories."

"For these users, understanding how and why metrics come to be is crucial to understanding whether the pandemic is as bad as the news makes it out to be… many of these anti-mask groups implored their opponents to simply follow the data, as sound data (and their visualizations) are crucial to making informed decisions."

Lee, Crystal, Tanya Yang, Gabrielle D. Inchoco, Graham M. Jones, and Arvind Satyanarayan. "Viral Visualizations: How Coronavirus Skeptics Use Orthodox Data Practices to Promote Unorthodox Science Online." In Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems, pp. 1-18. 2021.

Public visualization needs to learn from (some of) ML's wrestling with data processes, not just models



Sambasivan, Nithya, Shivani Kapania, Hannah Highfill, Diana Akrong, Praveen Paritosh, and Lora M. Aroyo. "“Everyone wants to do the model work, not the data work”: Data Cascades in High-Stakes AI." In proceedings of the 2021 CHI Conference on Human Factors in Computing Systems, pp. 1-15. 2021.

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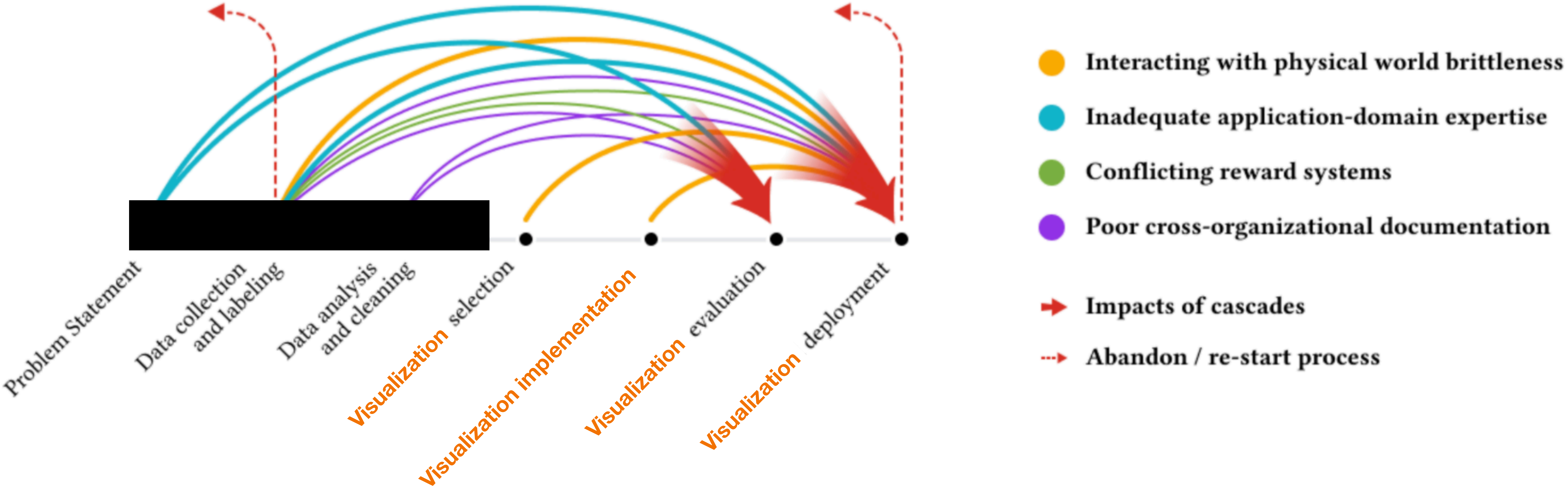

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Processes over Principles

Slide modified from Colin Gray's talk on *Dark Patterns, Ethical Engagement, & the Potential for Action*

Processes over Principles

Designers only see humans as consumers of data

Designers coerce users through deliberate data manipulation

civic/PD

generic capitalist design

asshole design

UCD/HCD

dark patterns

value-centered

evil

Designers try to reduce users' agency & value by constrain access to data or views of data

Slide modified from Colin Gray's talk on *Dark Patterns, Ethical Engagement, & the Potential for Action*

What might it look like to explore design spaces and design processes that reprioritize our values in human-data interaction?

Joe's Pond Ice Out Winners

Year	Winner	Town and State	Date	Time
1988	Edward Bird	West Danville, VT	4/26/88	12:31 p.m.
1989	Bob Kerschner	Sun City, FL	5/5/89	9:05 a.m.
1990	John Reilly	Barre, VT	4/26/90	9:40 a.m.
1991	Scott Lazare	Lido Beach, NJ	4/22/91	4:16 a.m.
1992	Charese McSheffrey	Barre, VT	5/6/92	1:19 p.m.
1993	Ray Strousos	Barre, VT	4/29/93	1:38 p.m.
1994	Jerome Bolkum	Barre, VT	5/4/94	12:12 p.m.
1995	Tom Buzzi	Kent, OH	4/23/95	2:50 p.m.
1996	Nancy Potter	Plainfield, VT	5/1/96	11:29 p.m.
1997	Ralph Bissell	Walden, VT	5/1/97	7:43 a.m.
1998	Andre Jenny	Montpelier, VT	4/16/98	6:41 p.m.
1999	Gilles Moreau	East Barre, VT	4/26/99	2:37 a.m.
2000	Tammy Hatch	West Danville, VT	4/30/00	6:19 a.m.
2001	Kay Scott	St. Johnsbury, VT	5/4/01	1:44 a.m.
2002	N. Mason Jeff Temple Stephen Bean Charlene Zabek	Various	4/18/02	4:18 p.m.
2003	Brodie Frazier	East Montpelier, VT	4/28/03	9:45 a.m.
2004	Janet & Richard Hazen	South Hero, VT	4/21/04	3:25 p.m.
2005	G.D. Lanois	Bonita Springs, FL	4/21/05	2:50 p.m.
2006	Pam Desrochers Frenchie Cutting Lucille Dente	St. Johnsbury, VT Swanton, VT Barre, VT	04/16/06	3:20 p.m.
2007	Dr. Bob Marshall	Montpelier, VT	5/1/07	4:45 p.m.
2008	Janet Egizi Roxanne Gorham Joe Kelly Don Rogers	St. Johnsbury, VT Lyndonville, VT Barre, VT Swartz Creek, MI	4/25/08	5:25 p.m.
2009	Ash Desmond	Richmond, VT	4/20/09	10:21 p.m.
2010	Bill Barber	St Johnsbury, VT	4/05/10	2:46 p.m.
2011	Karen Brouillette	Websterville, VT	4/27/11	10:17 p.m.
2012	Judy Lavely	Danville, VT	4/8/12	5:25 p.m.
2013	Gary Clark	Barre, VT	4/24/13	8:46 a.m.
2014	Kelsey Phillips Bill Brochu	Iowa City, IA Springfield, MA	4/29/14	10:06 a.m.
2015	Mary Numa	West Haven, CT	4/29/15	6:14 p.m.
2016	Pamela Swift	Barre, VT	4/12/16	5:04 p.m.
2017	Emily Wiggett	North Danville, VT	4/23/17	4:32 p.m.
2018	Michael S. Cody	Barre, VT	5/4/18	11:27 a.m.
2019	Robynn L. Albert	Essex Junction, VT	4/25/19	5:39 a.m.
2020	Angela Buttura Nancy Durand	Essex Junction, VT Hardwick, VT	4/15/20	6:07 a.m.

Ice out contests at Joe's Pond in rural Vermont

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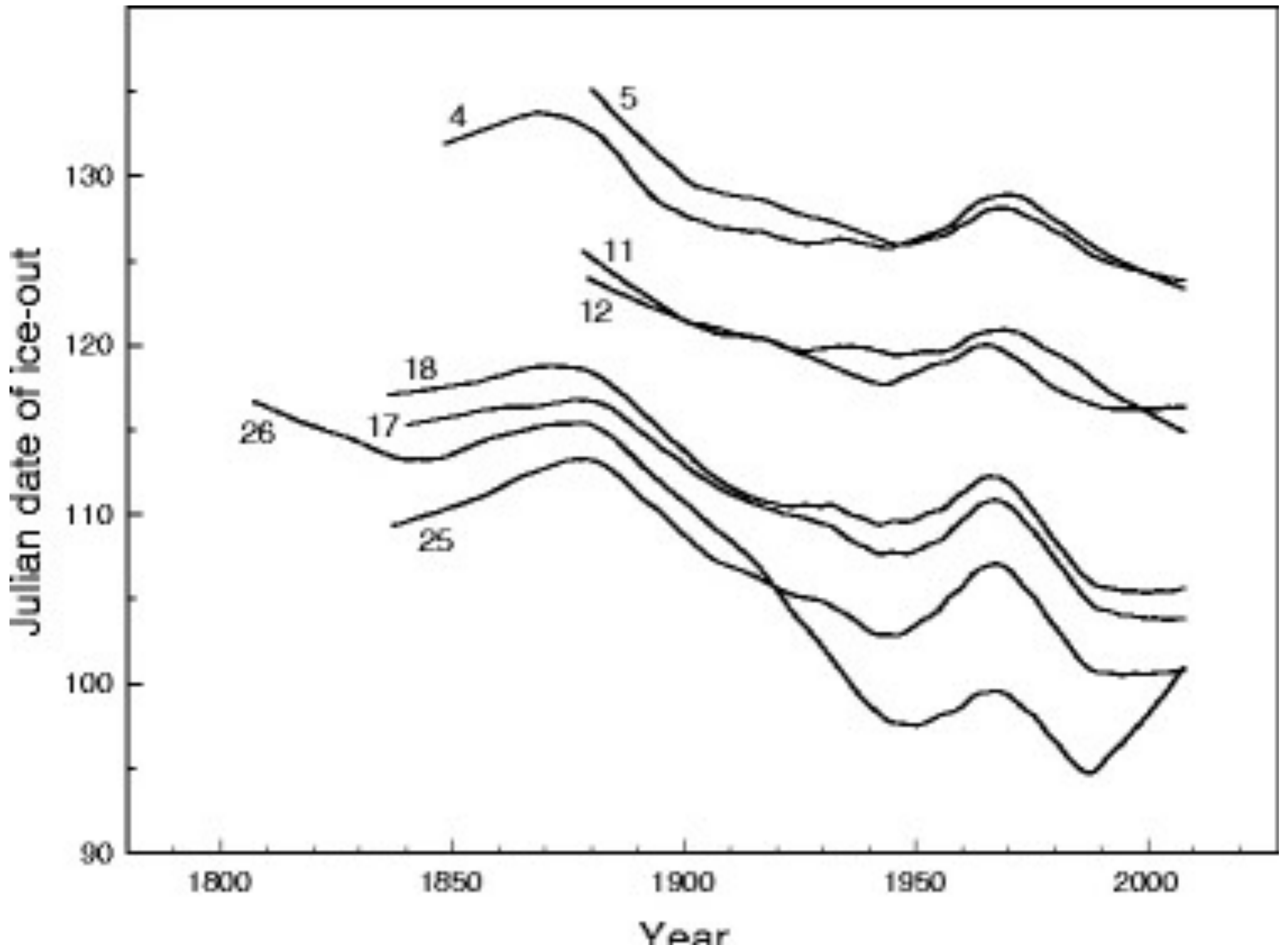
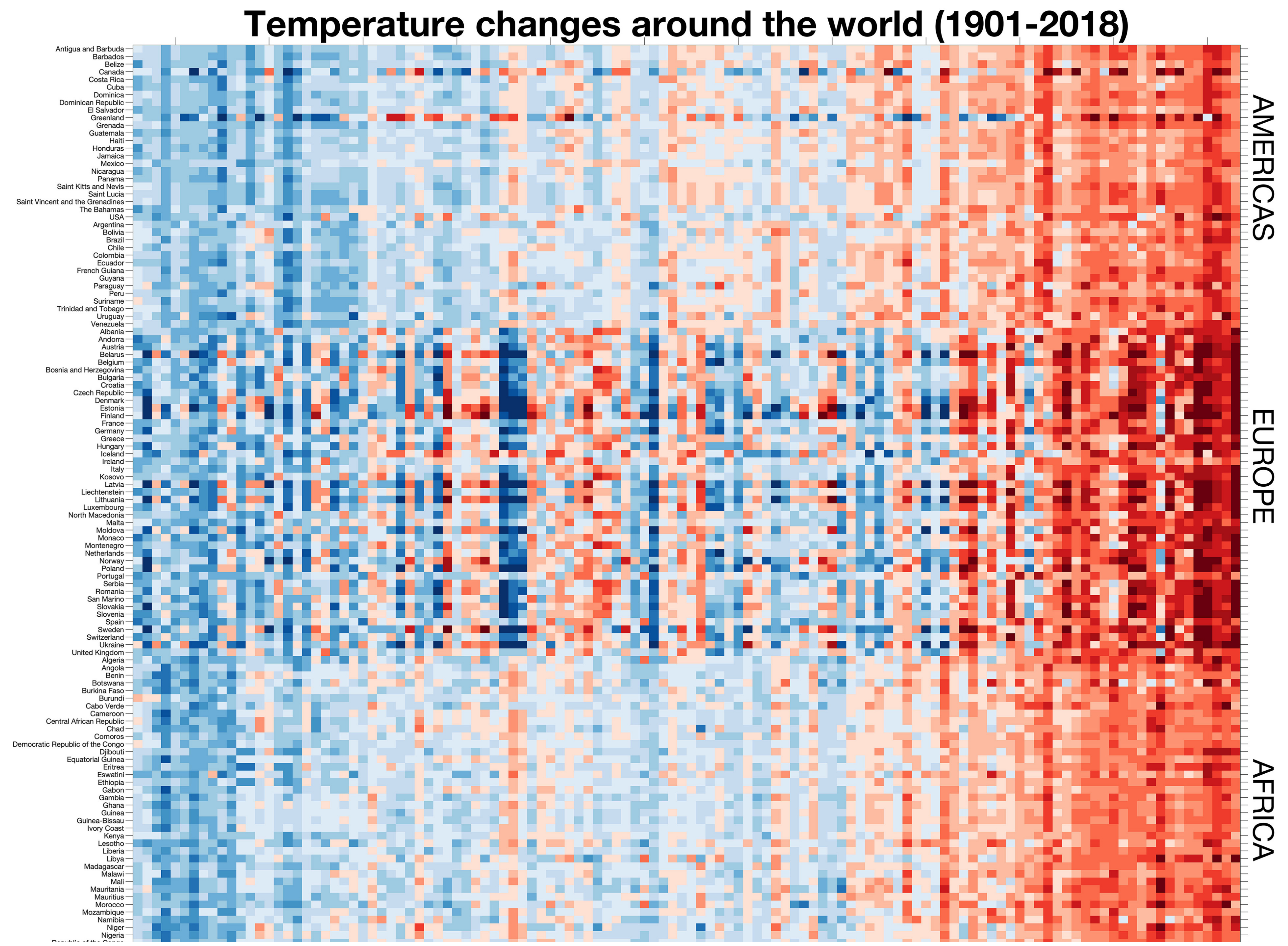
Ice-out events recorded for over 150 years in ponds and lakes across New England

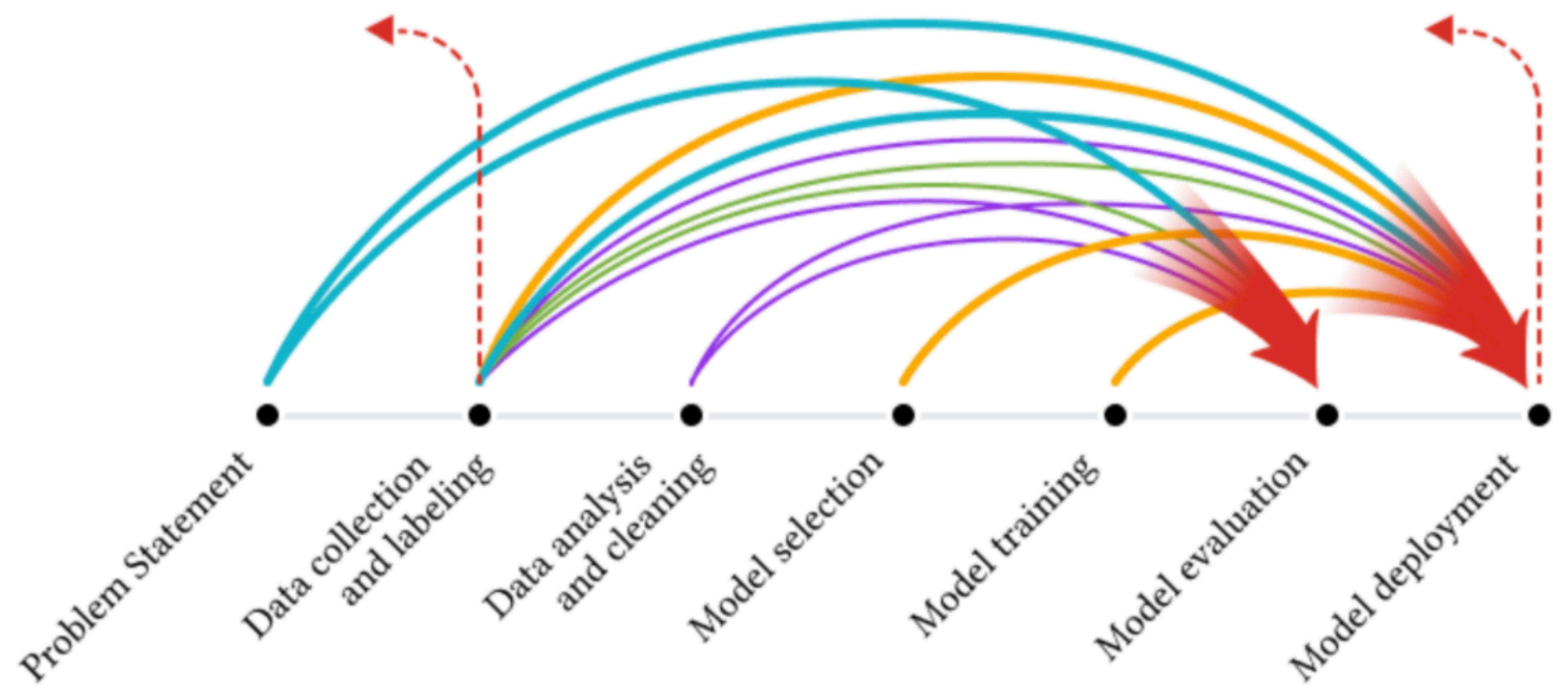


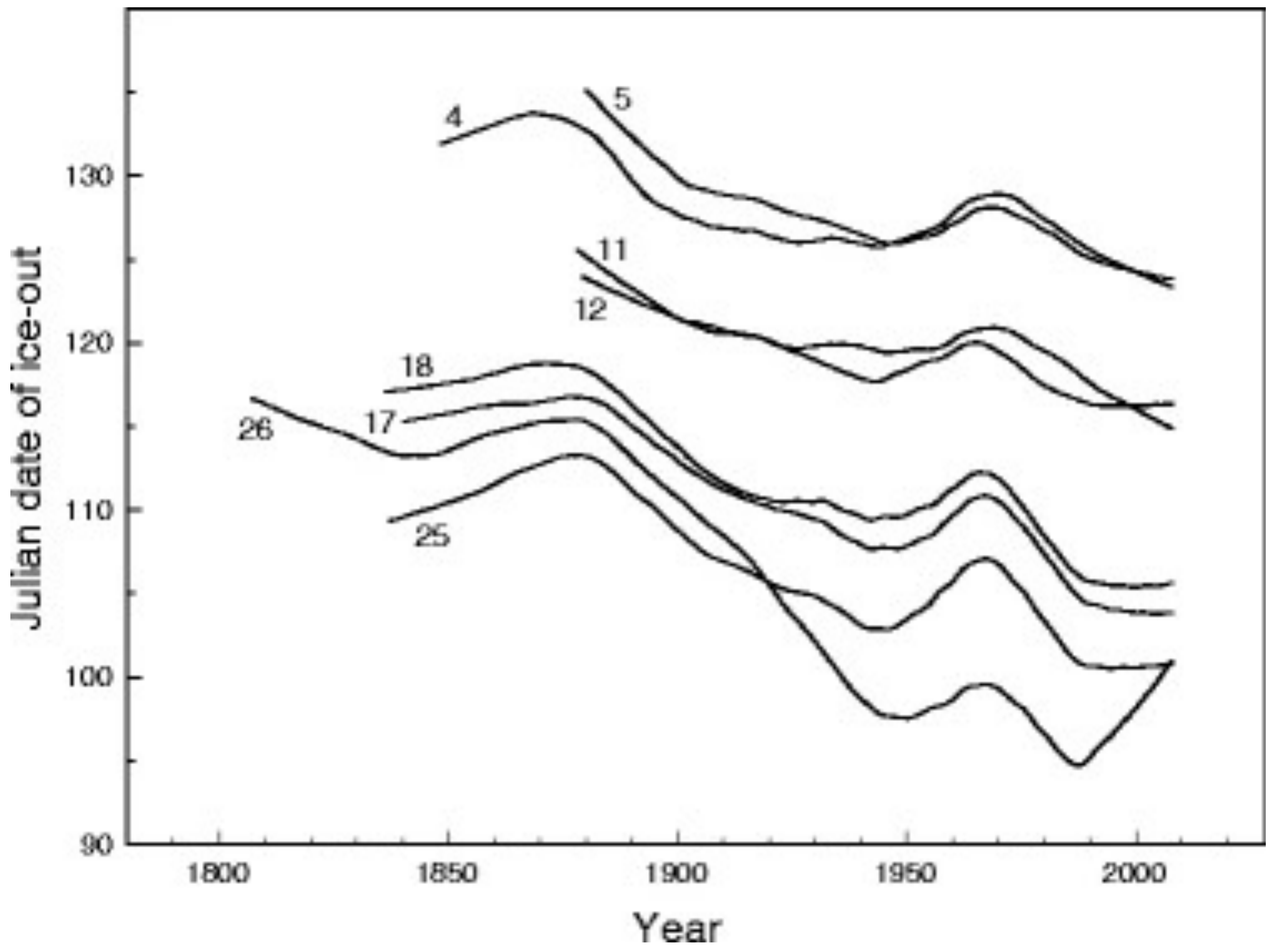


EFFICIENCY **CARE**

UNIVERSALITY **CONTEXTUALITY**

IMPARTIALITY **POSITIONALITY**





SLOW

LONG

IMPRECISE

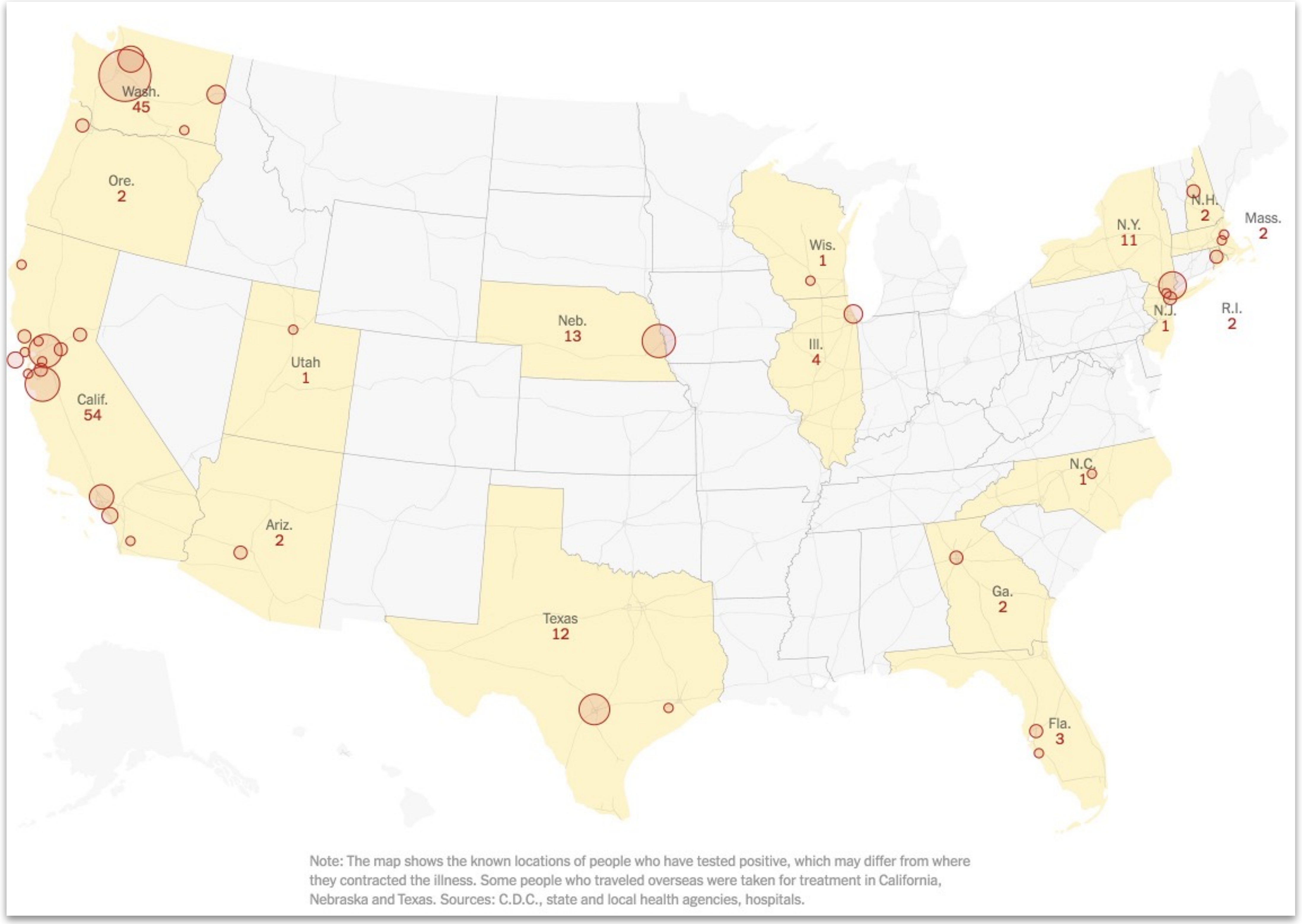
PHYSICAL

LOCAL

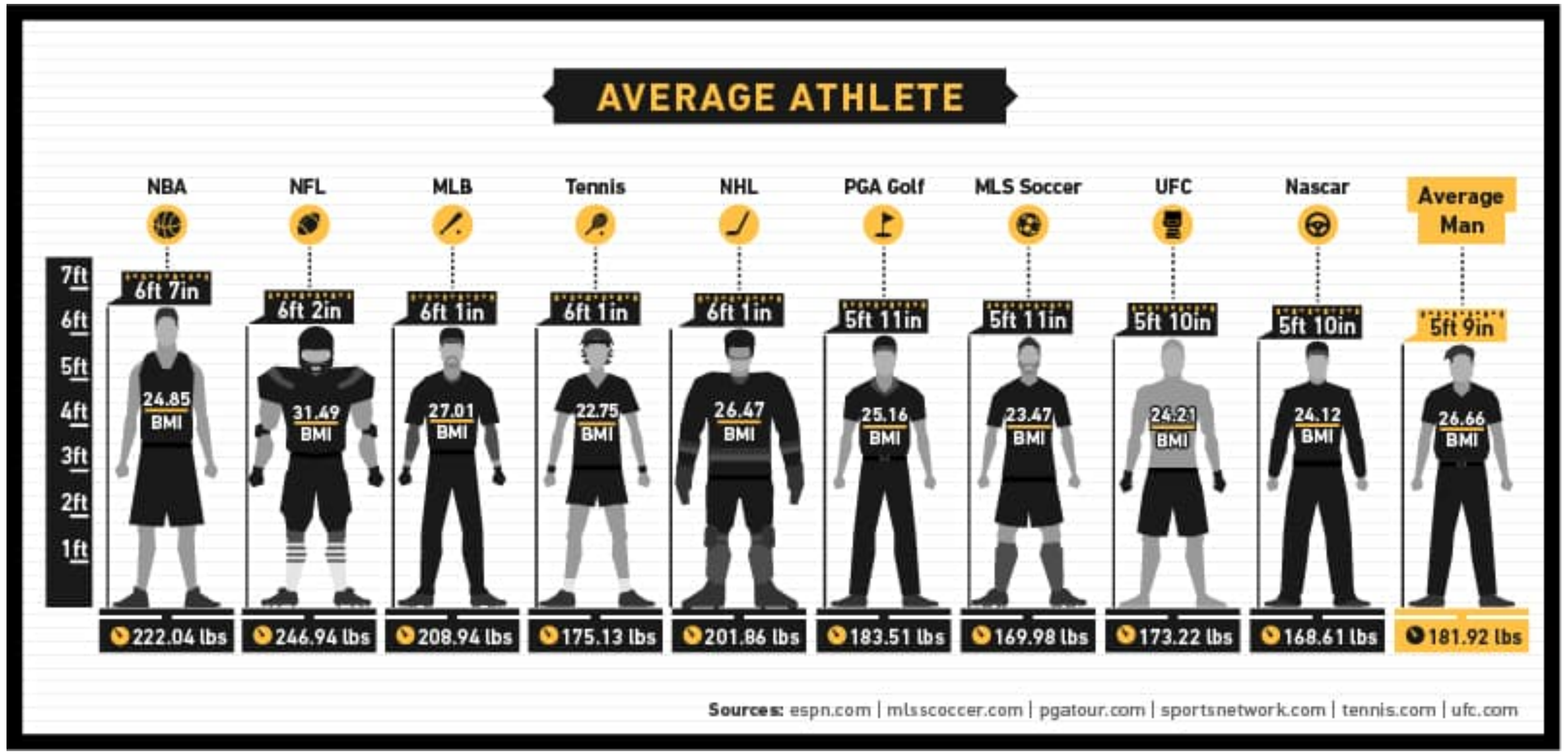
VISIBLE

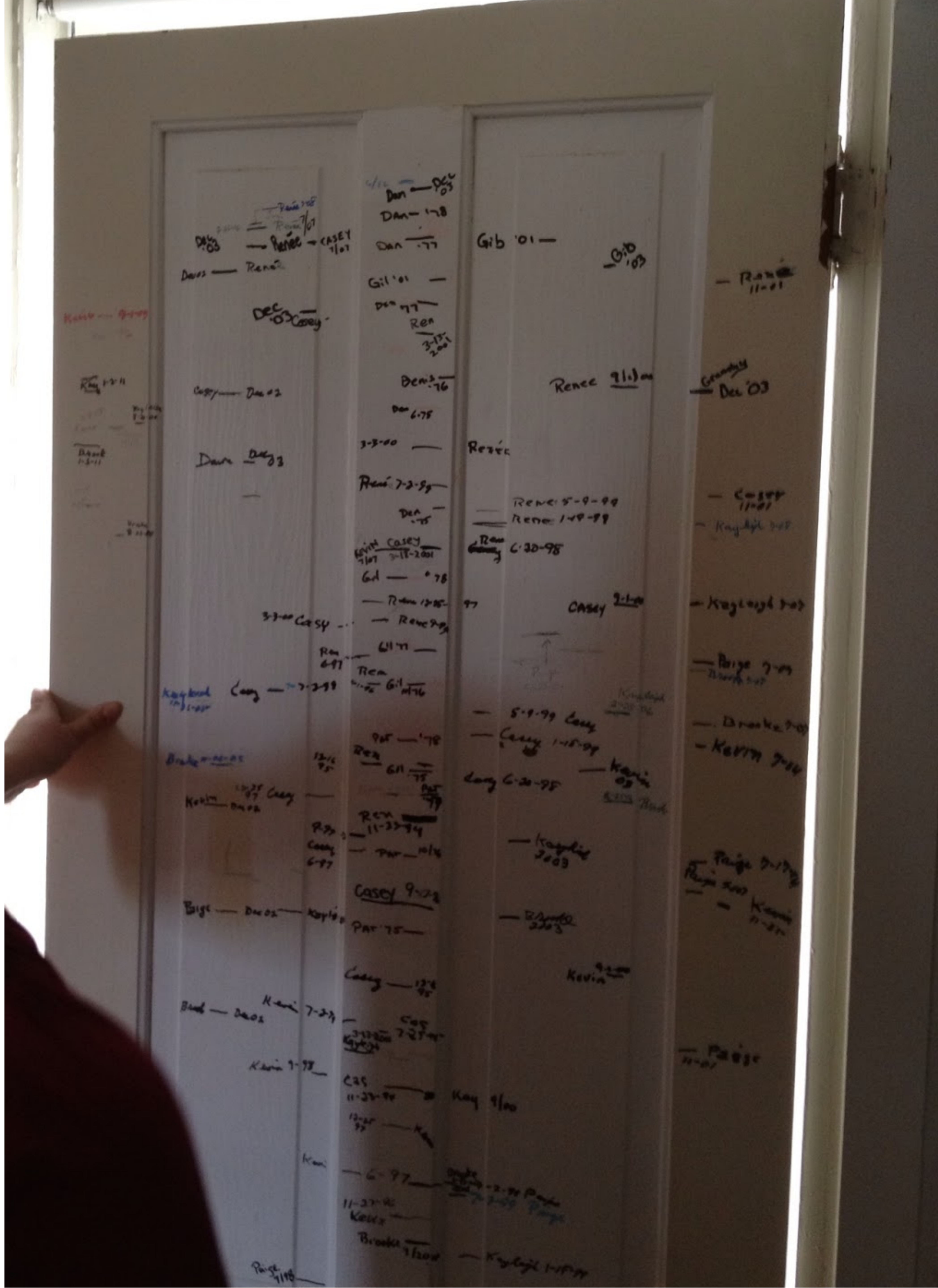
Joe's Pond Ice Out Crew Connects Block To Clock
caledonianrecord.com

What do data visualizations look like when they are local and participatory vs. universal and designer-centered?



What does it mean when visualizations are long, slow, and personal vs. fast, short-lived, and universal?





What *should* information visualization focus on?

... interrogating our data processes
not just our visual designs

... including people as participants
not just as consumers

... creating visualizations for communities
not just universal outlets

... making visible our framing and bias
not just assuming objectivity
(*It's not possible!*)

What *should* information visualization focus on?

… interrogating our data processes,
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(*It's not possible!*)

Evan M. Peck
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University of Colorado Boulder

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evan.peck@colorado.edu