

Uncertainty

DSC 106: Data Visualization

Sam Lau

UC San Diego

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slido.com
#7283



Announcements

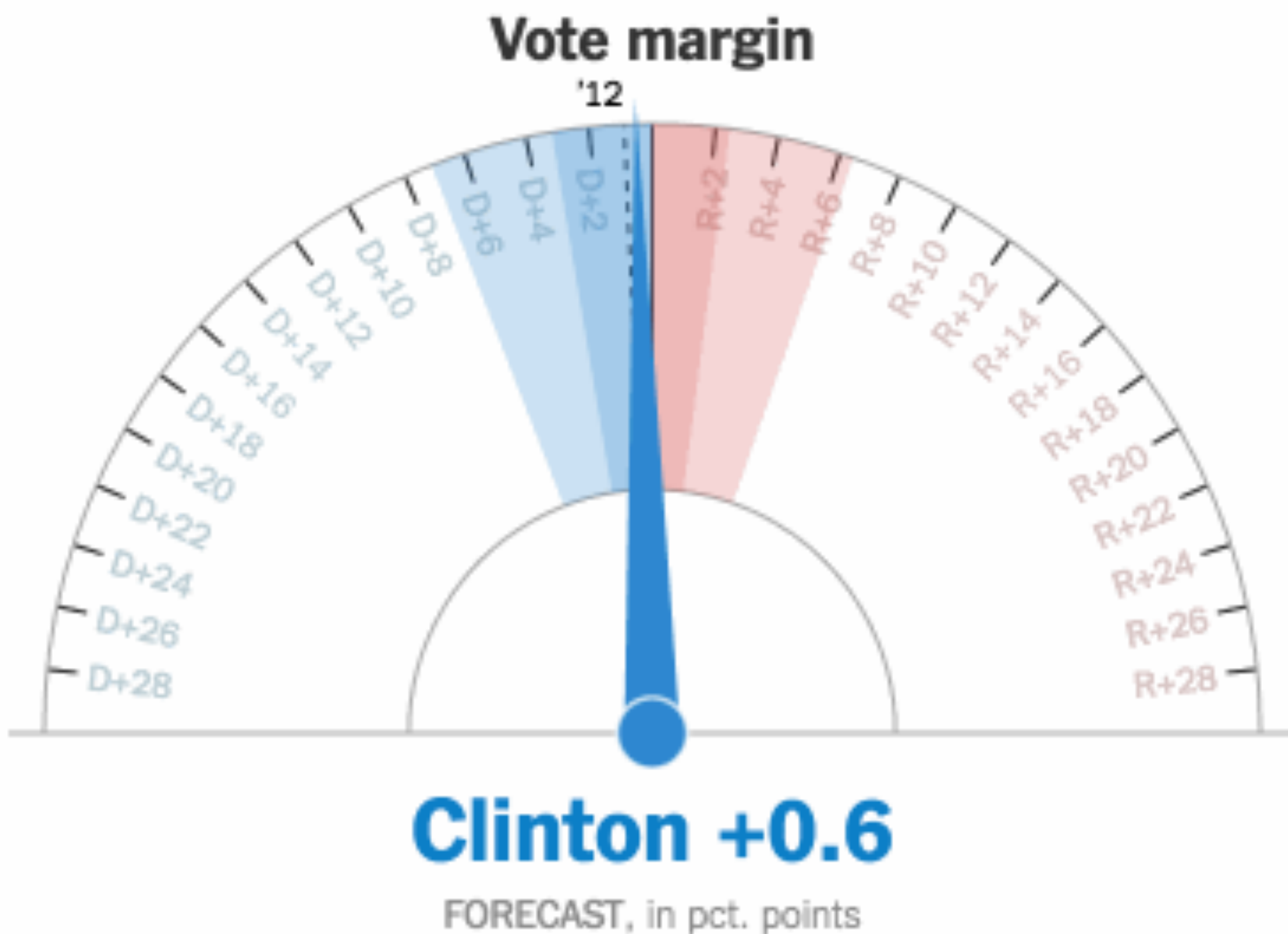
Final Project prototype due tomorrow.

Final Project video due next week Friday.

Lecture next Thurs. is Final Project peer feedback.

FAQs:

1. What is required for the final project prototype? See the website for full rubric.

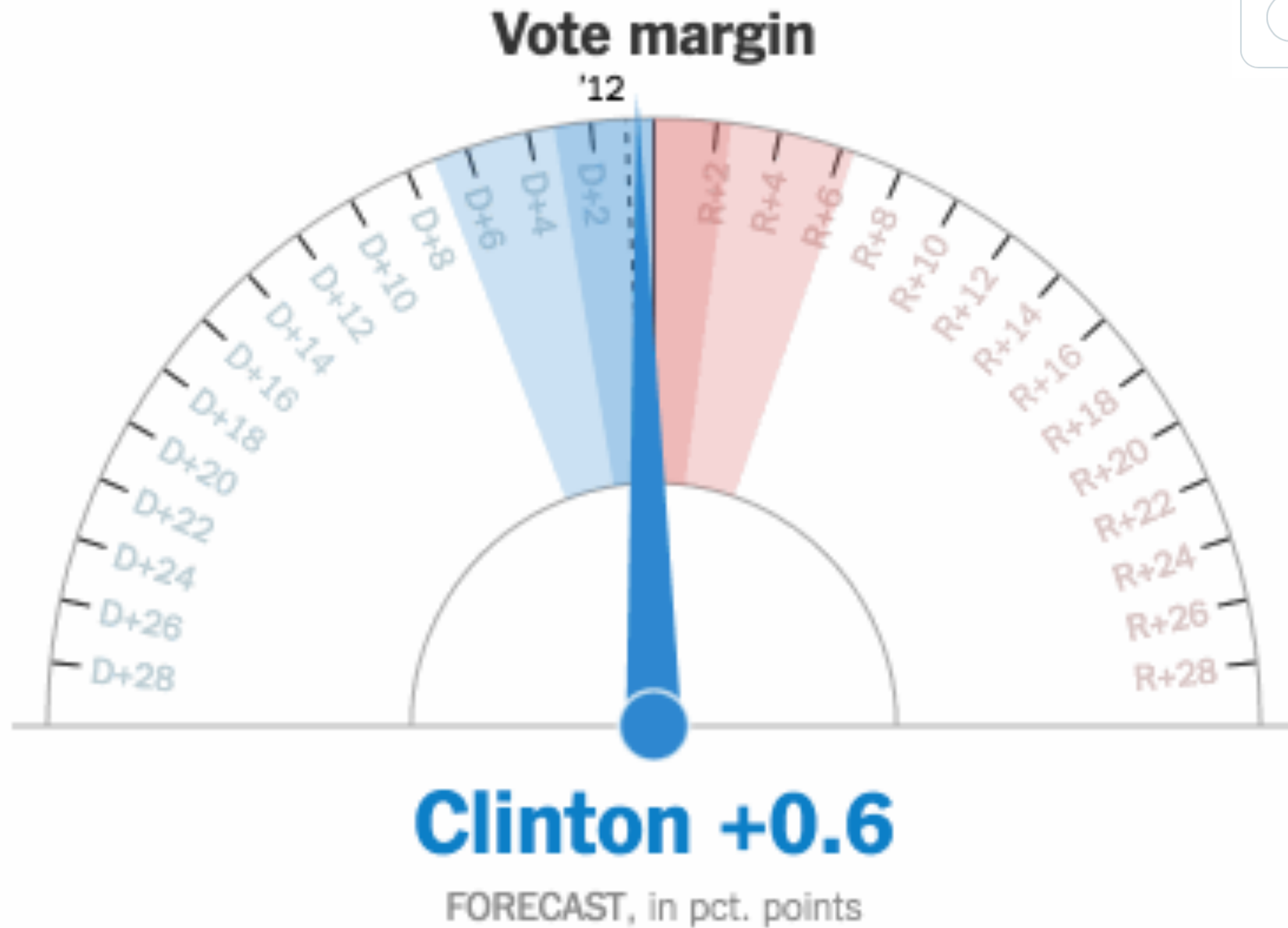


What is being visualized?

What are the strengths and weaknesses of this visualization?

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(gobsmacked)
@nytimes

I'm taking damn NY

10:08 PM ·

2

Danielle Rosen
@Daniel_Rosen · Follow

The NYT needle jittering is going to be in my nightmares no matter what happens tonight.

10:00 PM · Nov 8, 2016

2

Paul D. Shinkman
@PDSrinkman · Follow

Has @nytimes caught on to Dems' election-night hair-greying freakout?

Heads-up: Forecasts may become more trustworthy on

Our best guess right now is the estimates of three key indicators

Chance of Winning Presidency

66% Trump FORECAST

10:03 PM · Nov 8, 2016

Reply

Alp Toker · Nov 8, 2016
@atoker · Follow

Looking for trends in @nytimes's presidential forecast needle? Don't look too hard - the bounce is random jitter from your PC, not live data

Watch on Twitter

Clinton +3.3 FORECAST, in pct. points

278 Clinton FORECAST

```

range_05 = range_05 * damping + range_05_tgt * (1-damping);
range_25 = range_25 * damping + range_25_tgt * (1-damping);
range_75 = range_75 * damping + range_75_tgt * (1-damping);
range_95 = range_95 * damping + range_95_tgt * (1-damping);

var jitter = DITTER.get(jit_id) * jitter_range * 0.5 * (eln_forecast);
// if (opts.class != 'dem') jitter *= -1;
needle.attr('transform', 'scale('+scale+') rotate('+angle(cur_val)');
if (opts.colors) {

```

@gka@vis.social
@driven_by_data · Follow

not just random. this noise is conveying the uncertainty in our forecast (jitter range is from 25th-75th pctl in sims.)

10:01 PM · Nov 8, 2016

33

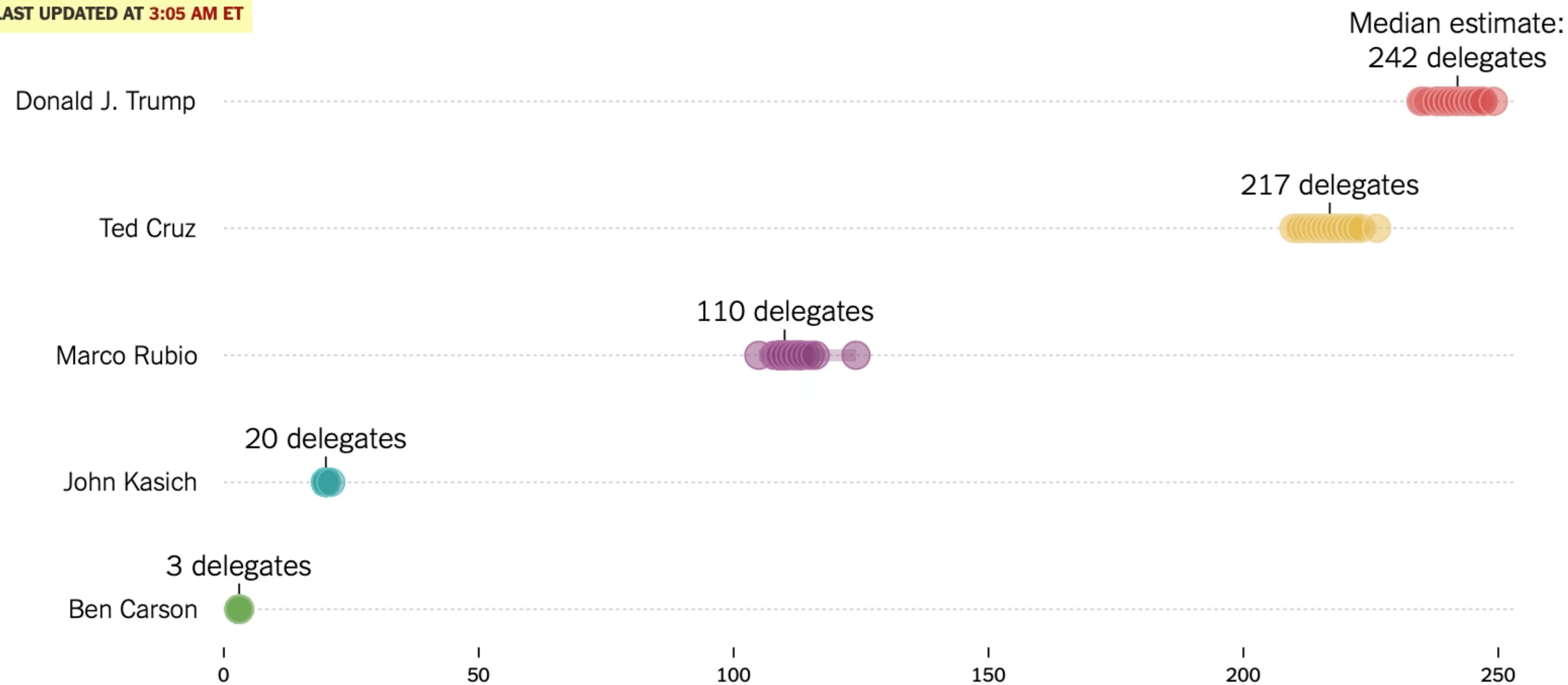
Reply Share

Read 5 replies

Who Will Win Super Tuesday? Live Estimates of Tonight's Final Republican Delegate Count

By AMANDA COX, JOSH KATZ and KEVIN QUEALY MARCH 1, 2016

LAST UPDATED AT 3:05 AM ET



We're simulating the number of delegates each candidate will pick up on Super Tuesday. The dots above represent a range of possible outcomes.

What is being visualized?

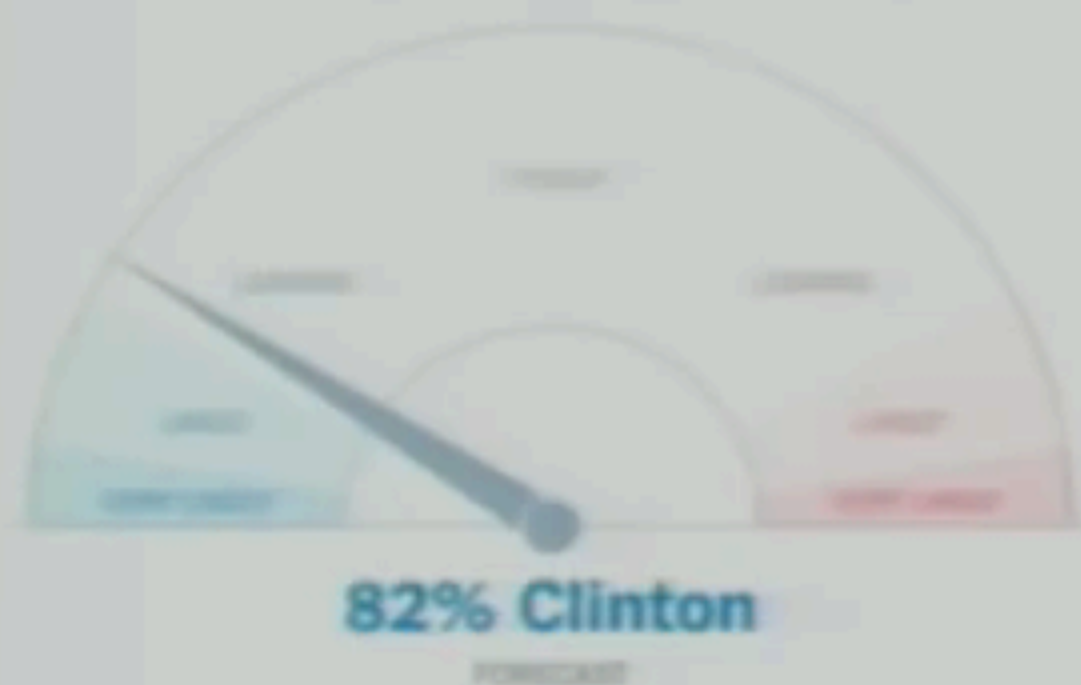
What are the strengths and weaknesses of this visualization?

How does it compare to the needle?

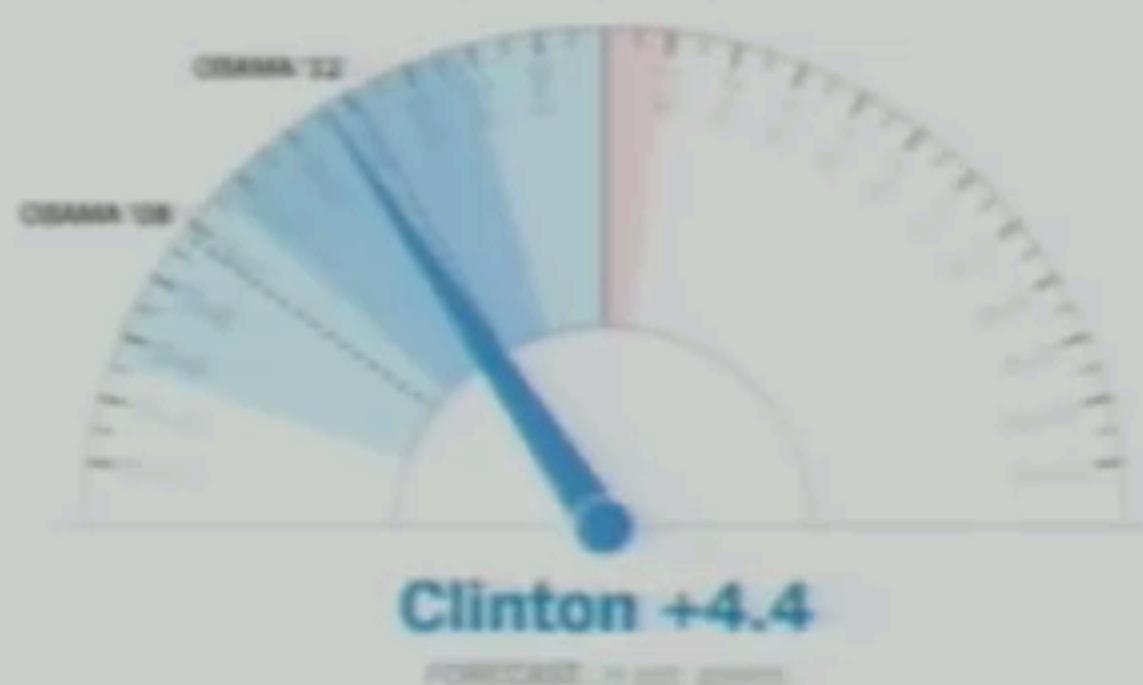
Live Presidential Forecast

Updated 7:55:14 PM ET

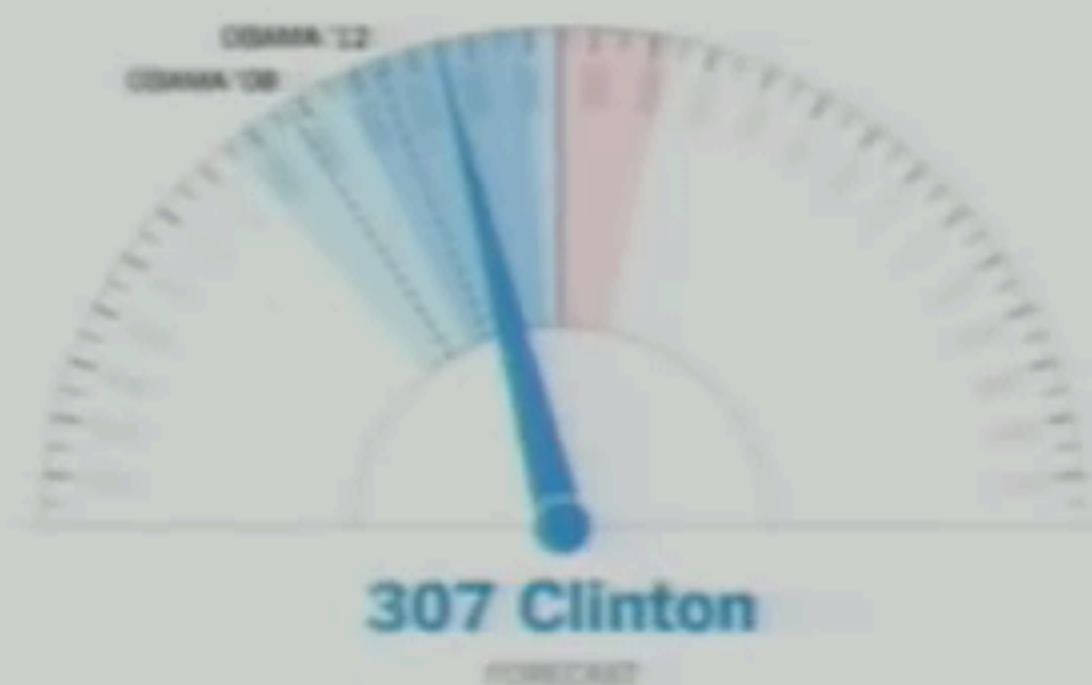
Chance of Winning Presidency



Popular vote margin



Electoral votes



The projections for each state are based on the votes reported so far and how those places have voted in previous elections.

We're showing the closest states by default. [Show all states](#)

State	Est. pct. of voters	Reported margin	NYT projection	NYT win prob.
Michigan	0%		Clinton +6.5	75% Dem.
New Mexico	0%		Clinton +6.4	75% Dem.
Wisconsin	0%		Clinton +5.4	75% Dem.



**OPEN
VIS 2017
CONF**

Uncertainty

What does it mean?

How should I visualize it?

Uncertainty

What does it mean?

How should I visualize it?

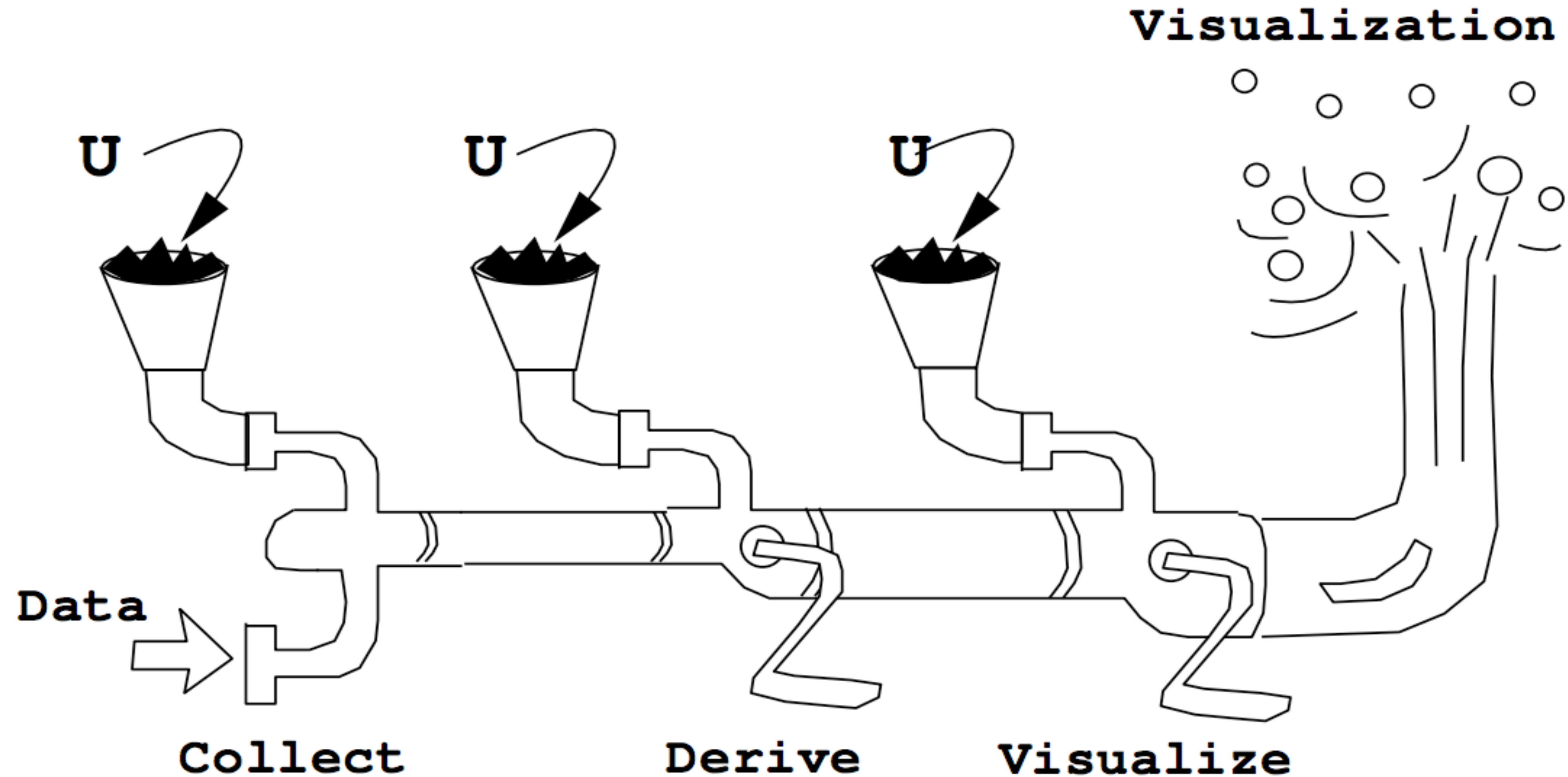
Uncertainty

What does it mean?

How should I visualize it?

Doubt
Risk
Variability
Error
Lack of knowledge
Hedging
etc...

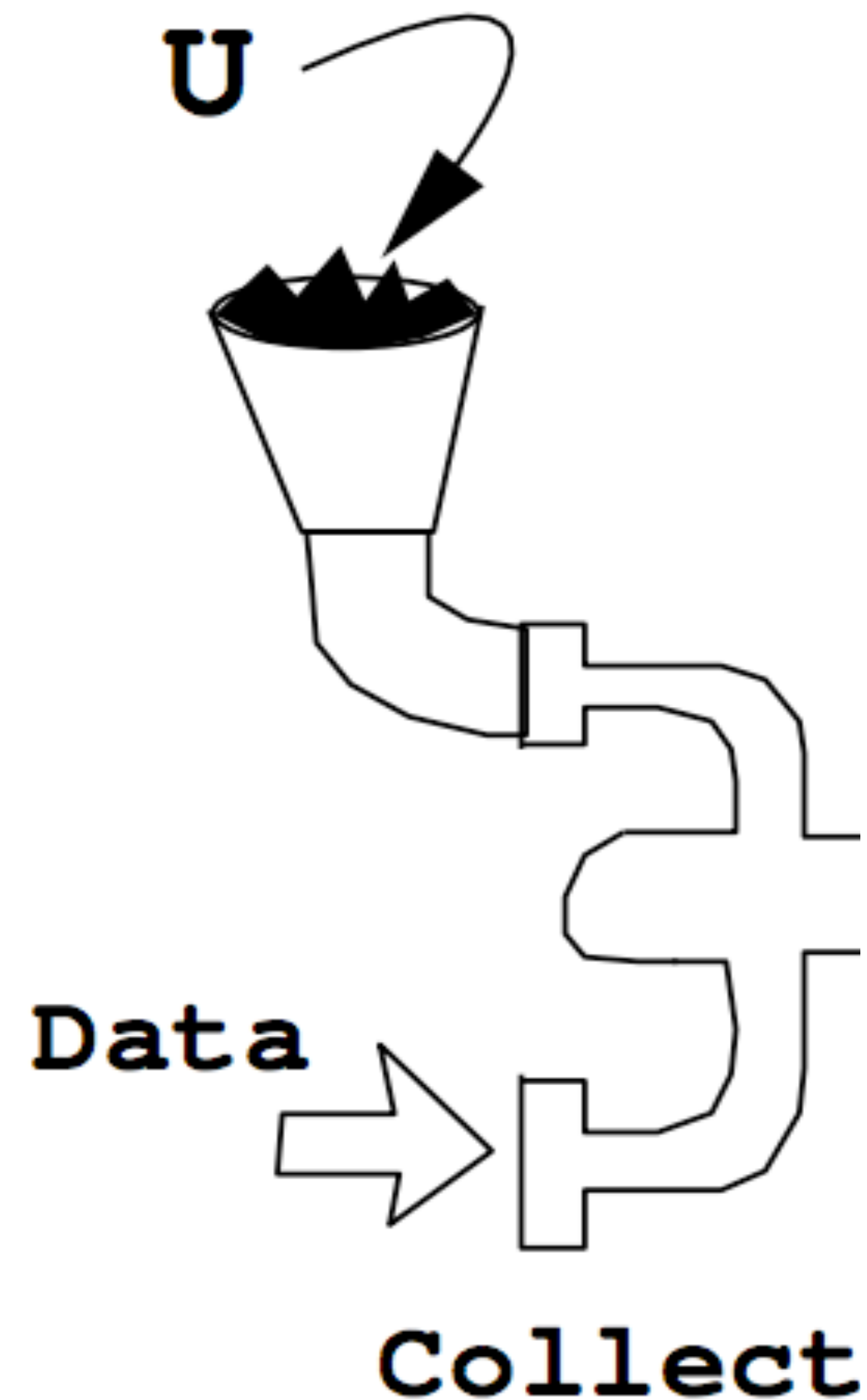
Sources and Types of Uncertainty



Sources and Types of Uncertainty

Measurement Uncertainty

How and how much should we sample the data?



Precision

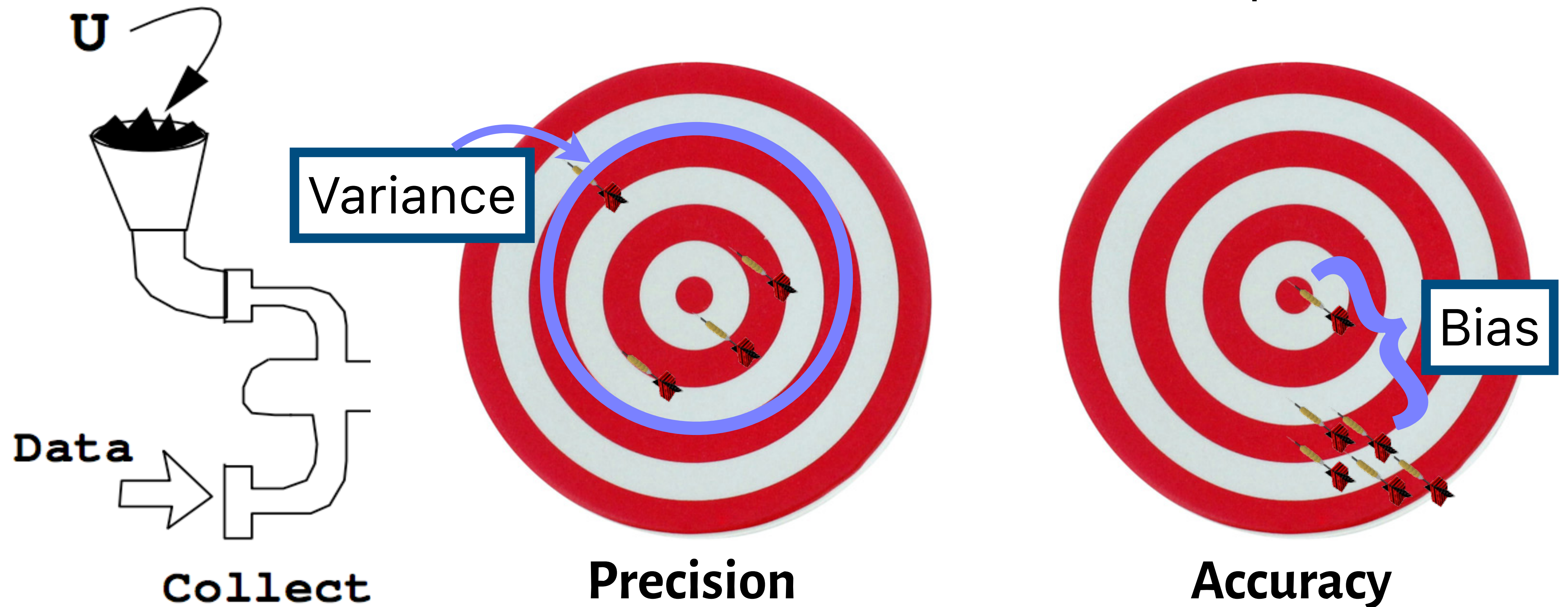


Accuracy

Sources and Types of Uncertainty

Measurement Uncertainty

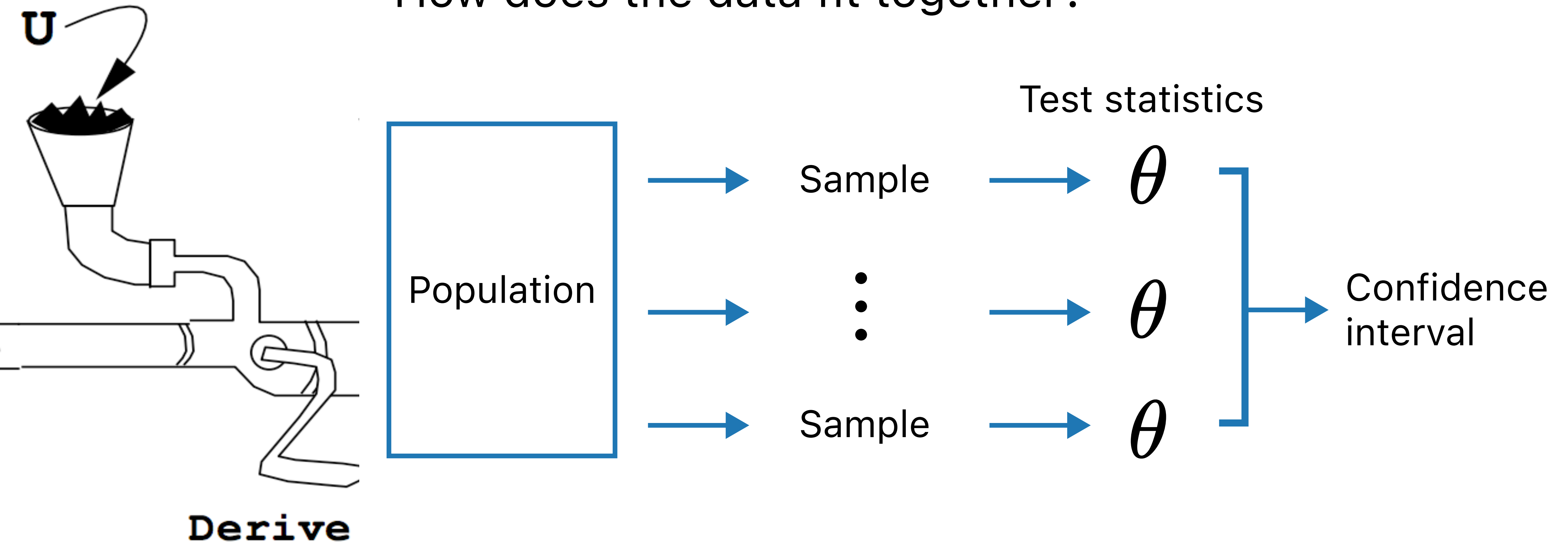
How and how much should we sample the data?



Sources and Types of Uncertainty

Model Uncertainty

How does the data fit together?



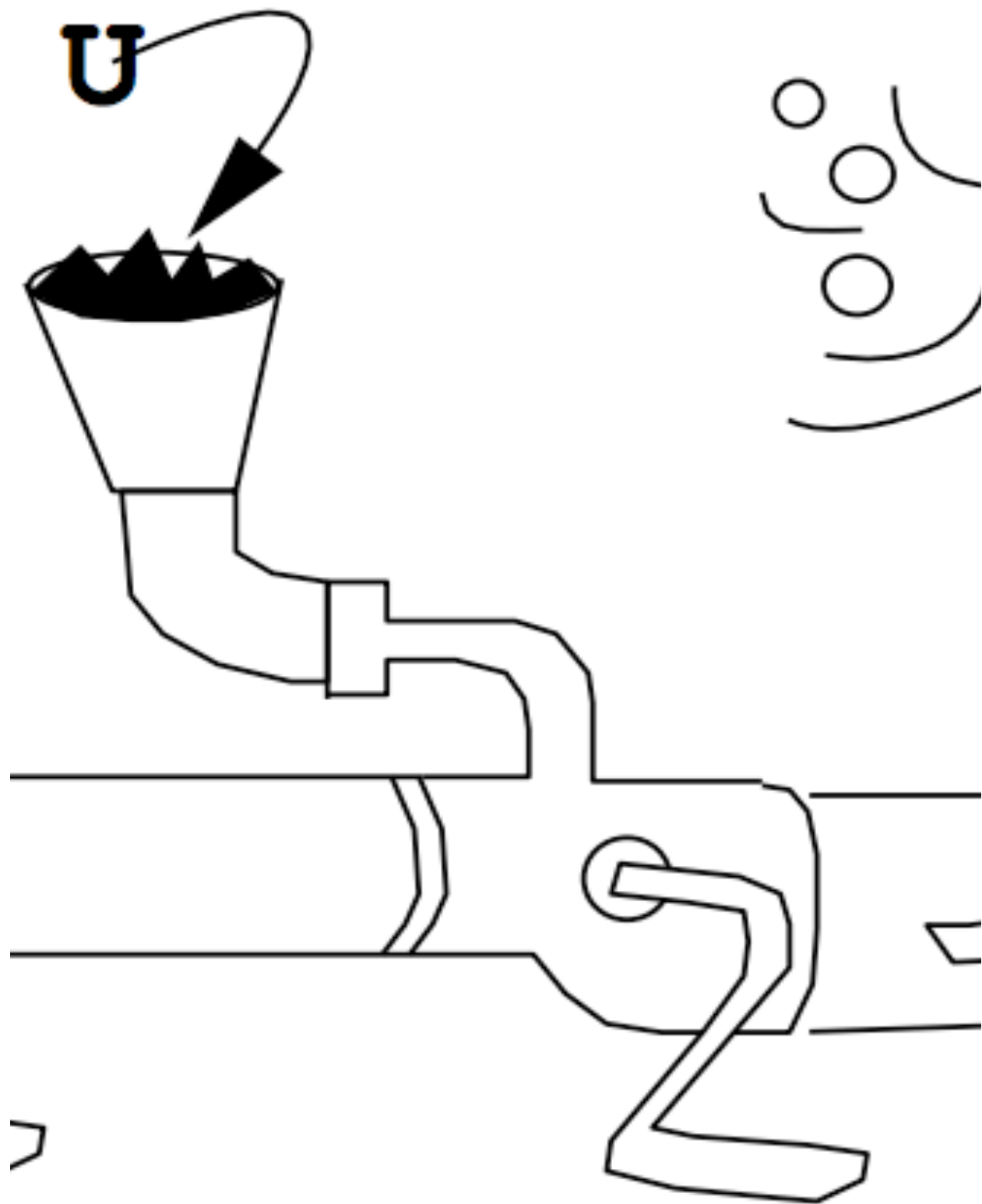
Sources and Types of Uncertainty

Visuali



Decision/Forecast Uncertainty
How do I assess the risk or error?





Visualize

Sources and Types of Uncertainty

Visuali



Visualize

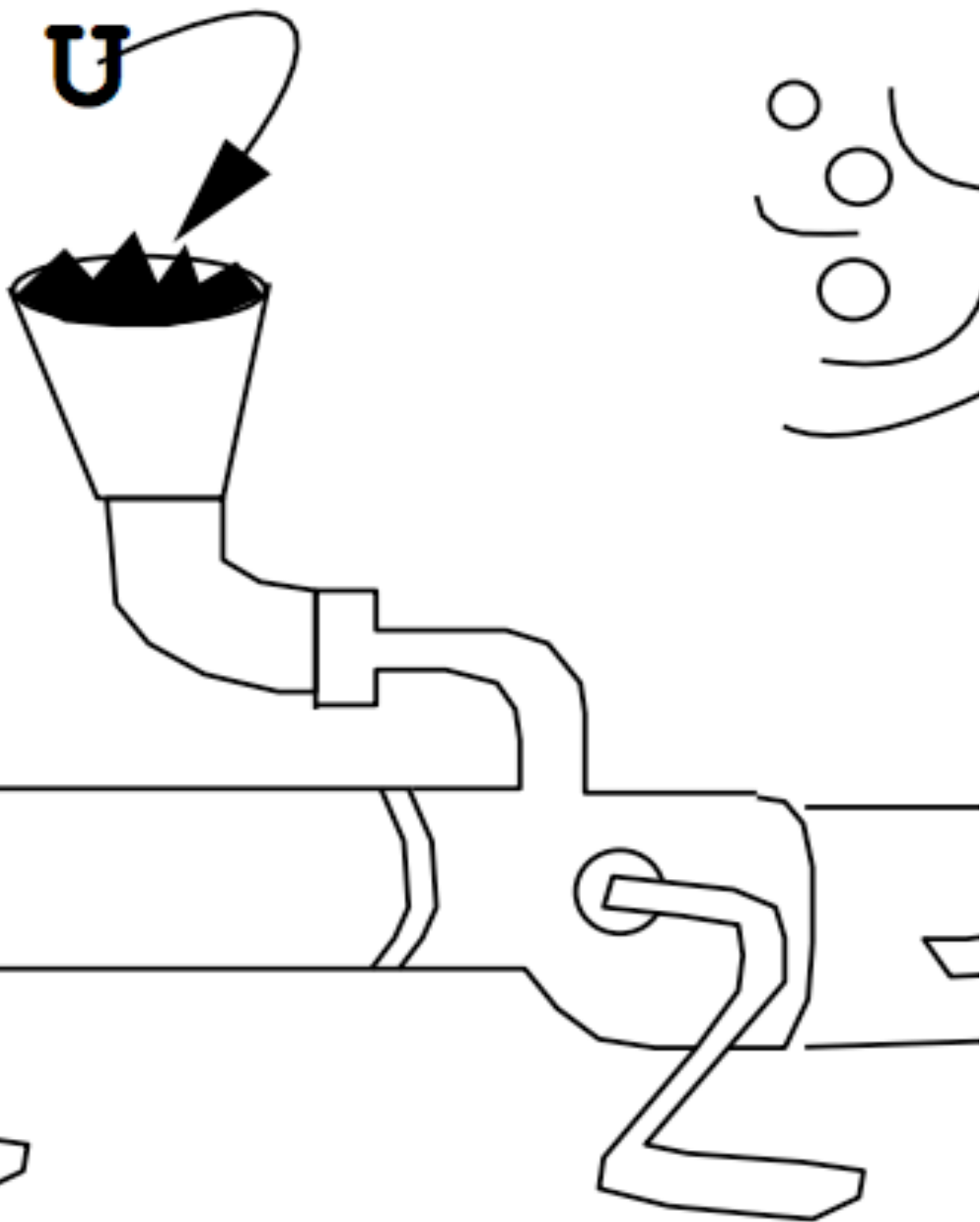
Decision/Forecast Uncertainty

How do I assess the risk or error?



Sources and Types of Uncertainty

Visuali





Visualize

Decision/Forecast Uncertainty

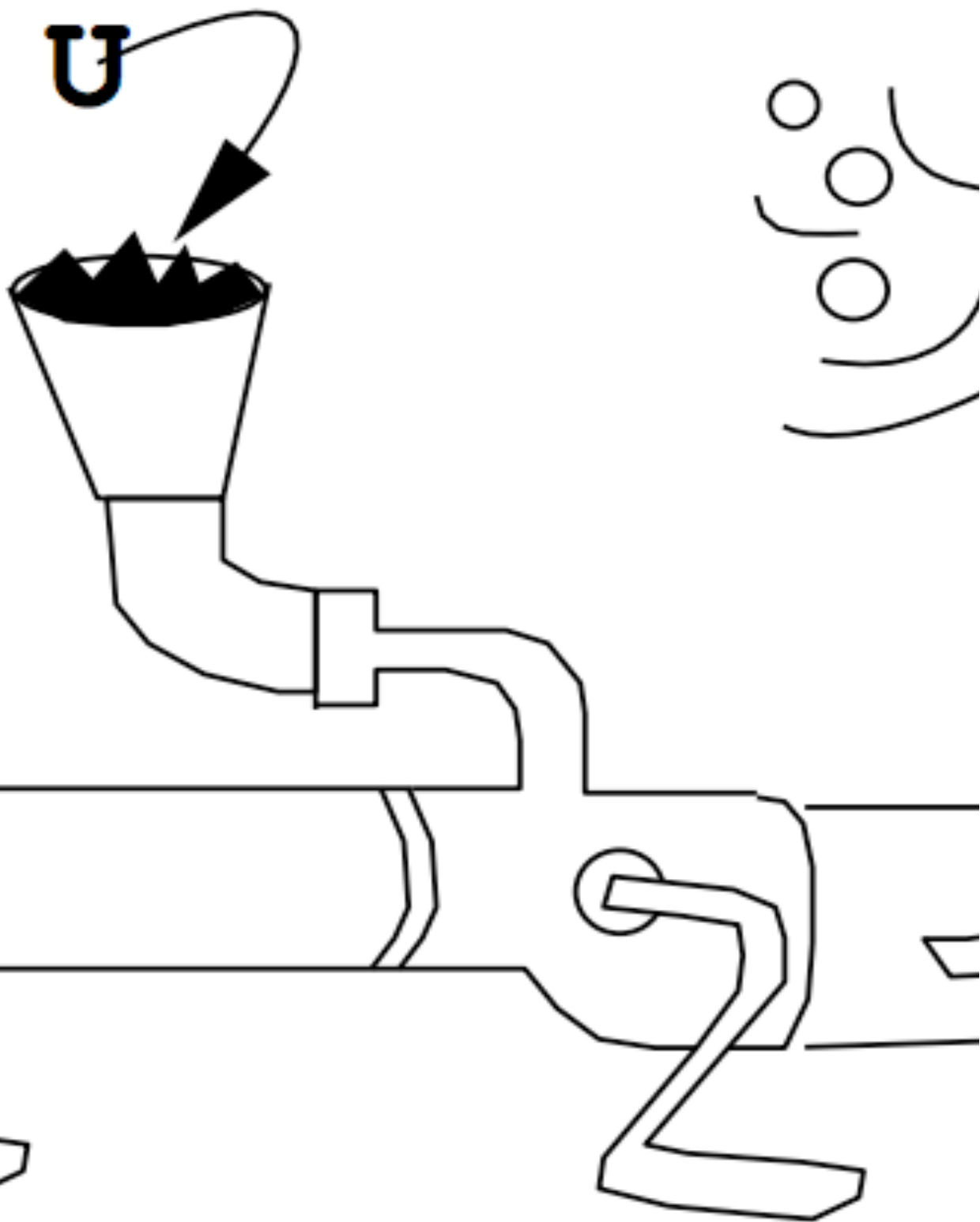
How do I assess the risk or error?



	Type I False Positive
	

Sources and Types of Uncertainty

Visuali





Visualize

Decision/Forecast Uncertainty

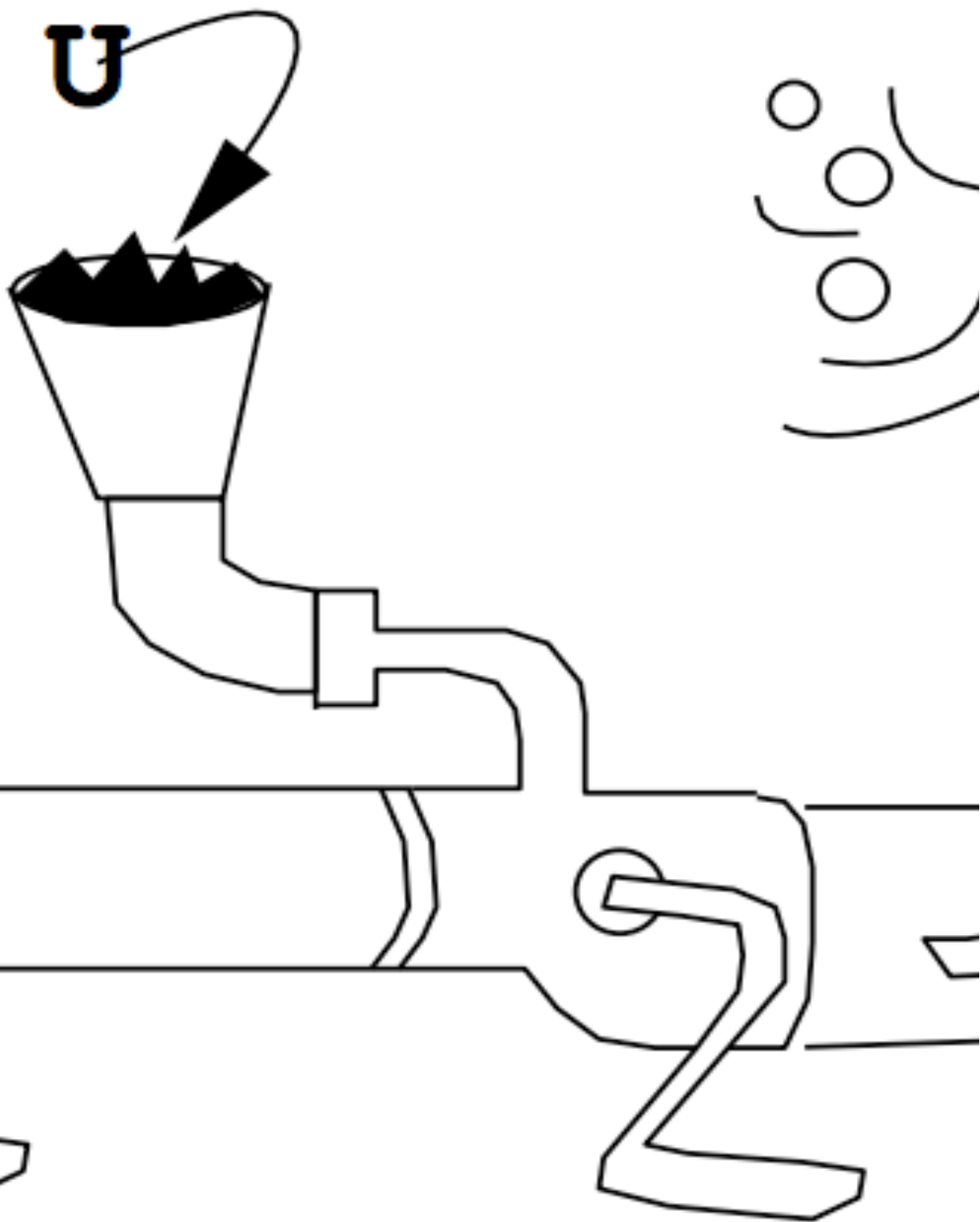
How do I assess the risk or error?



	Type I False Positive
Type II False Negative	

Sources and Types of Uncertainty

Visuali



Visualize

Never confuse Type I and II errors again:

Just remember that the Boy Who Cried Wolf caused both Type I & II errors, in that order.

First everyone believed there was a wolf, when there wasn't. Next they believed there was no wolf, when there was.

Substitute "effect" for "wolf" and you're done.

Kudos to @danolner for the thought. Illustration by Francis Barlow
"De pastoris puero et agricolis" (1687). Public Domain. Via [wikimedia.org](https://commons.wikimedia.org/wiki/File:De_pastoris_puero_et_agricolis.jpg)

Uncertainty

What does it mean?

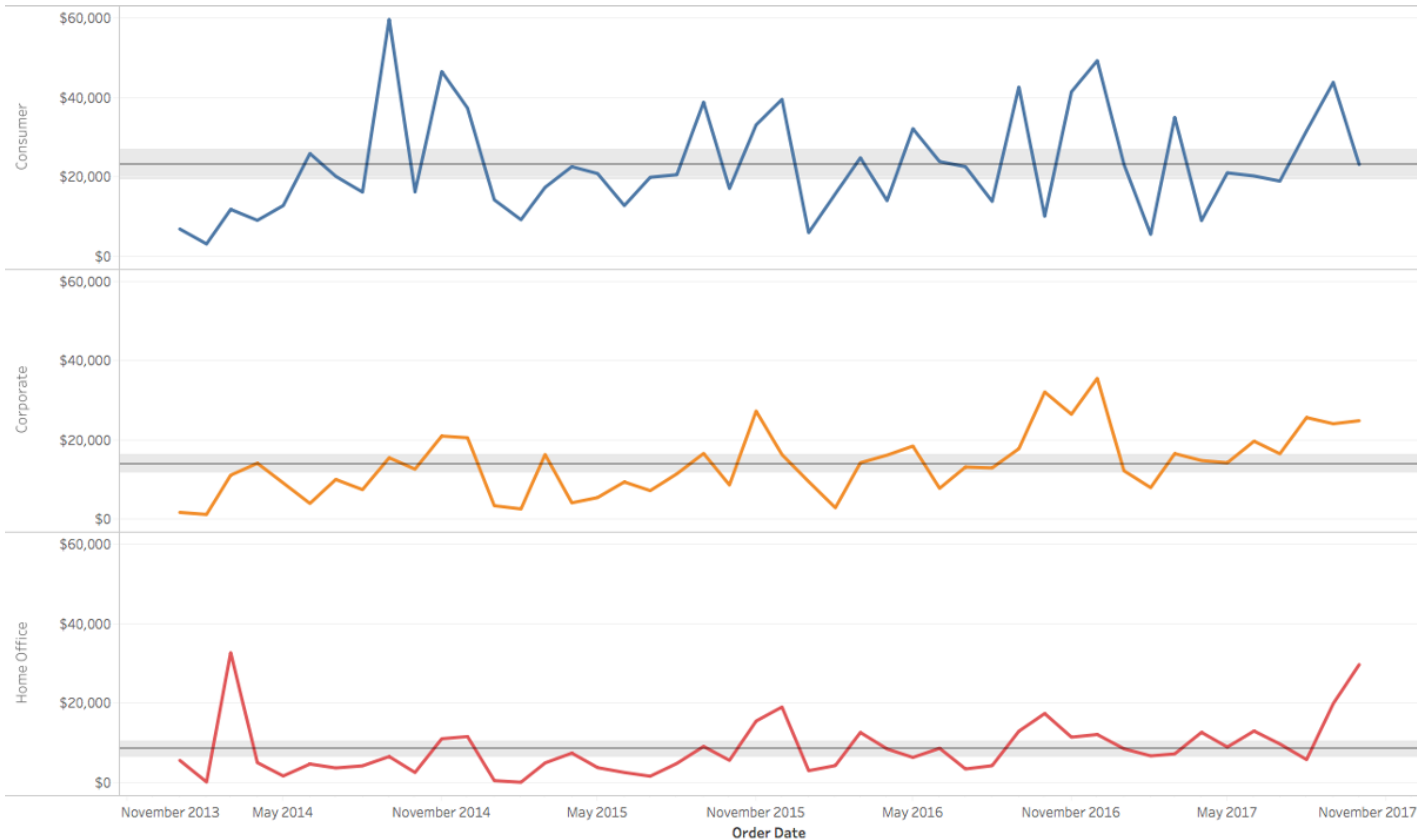
Lots of things!

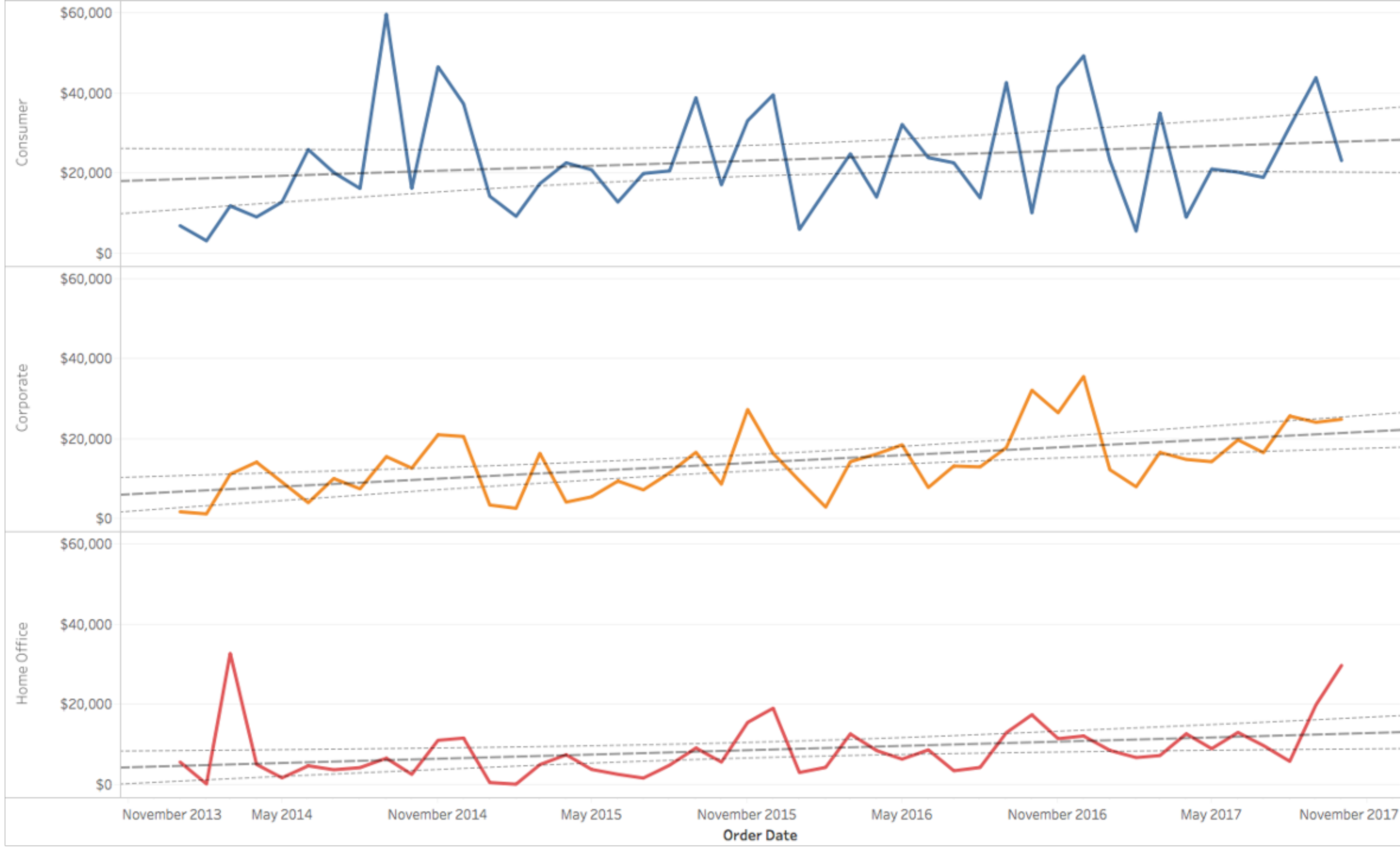
How should I visualize it?

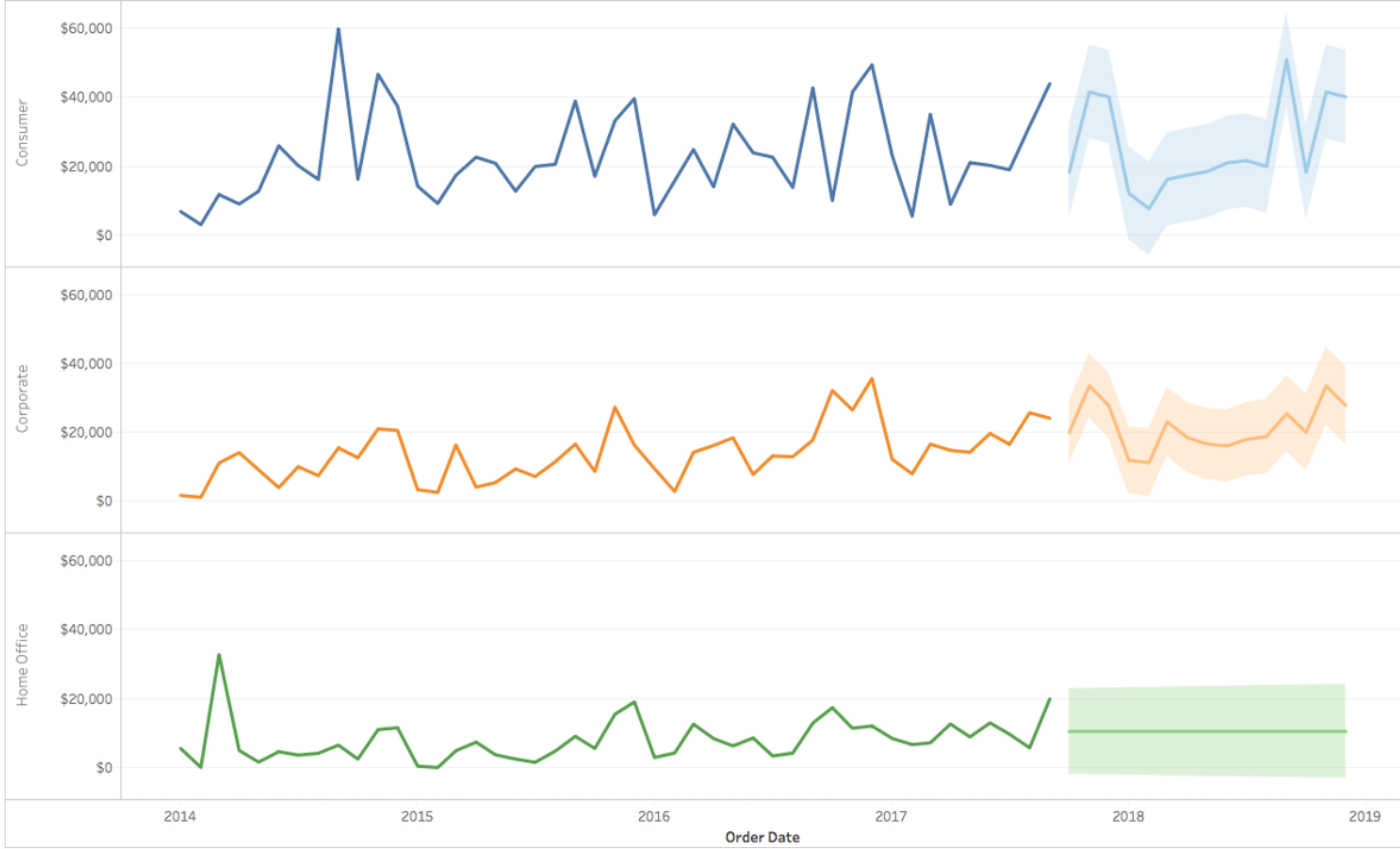
Uncertainty

What does it mean?

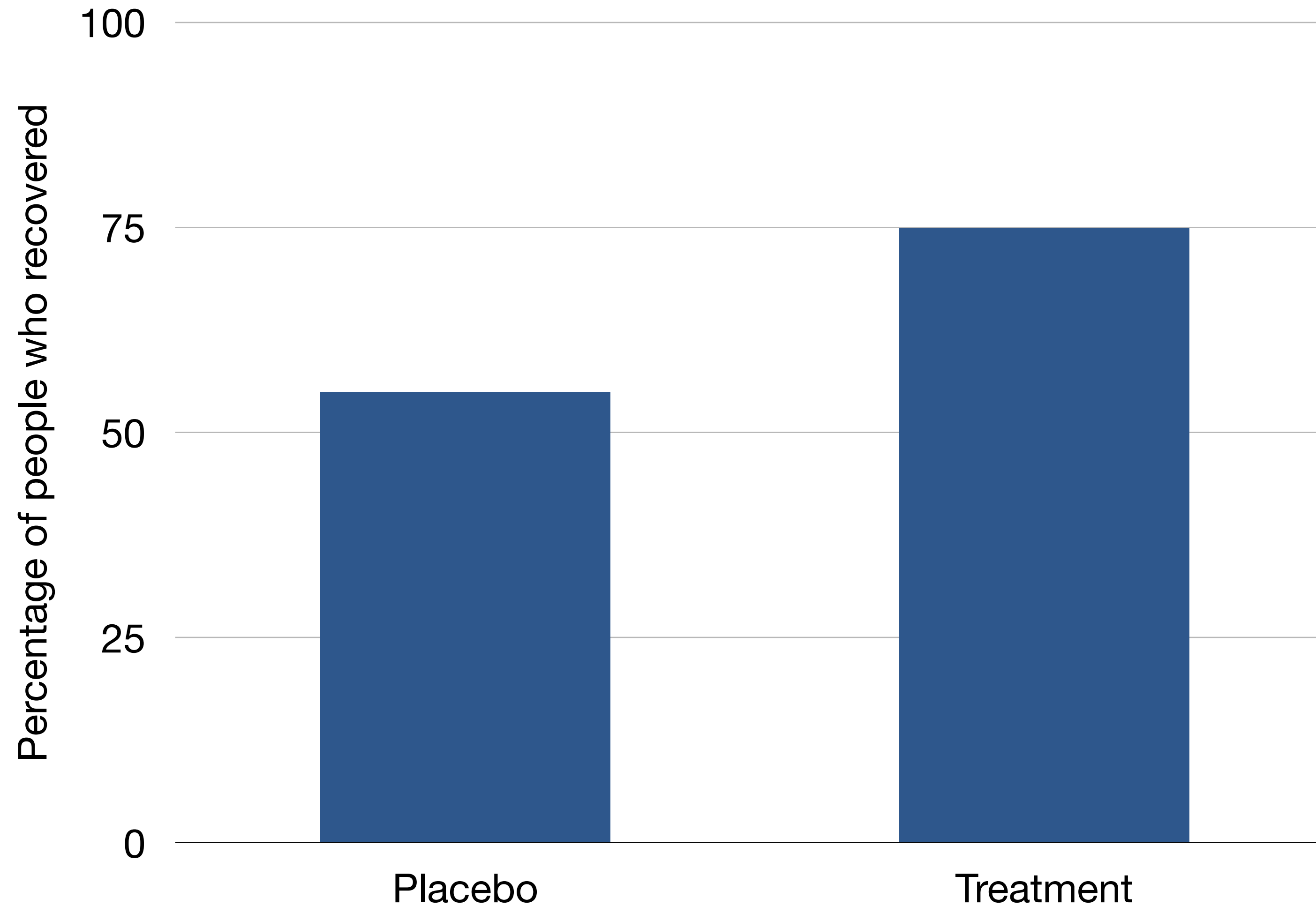
How should I visualize it?



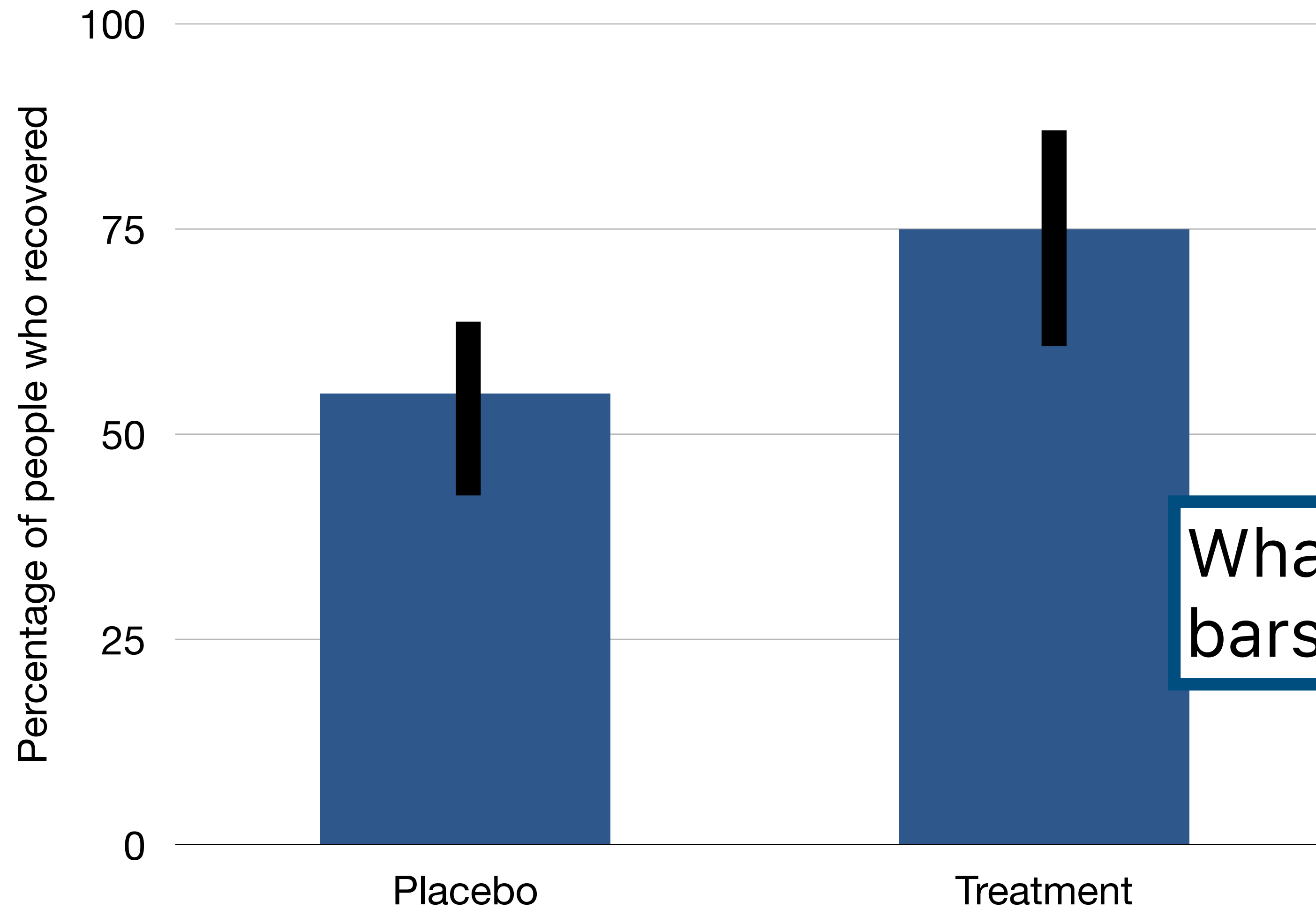




Trial of new medicine



Trial of new medicine

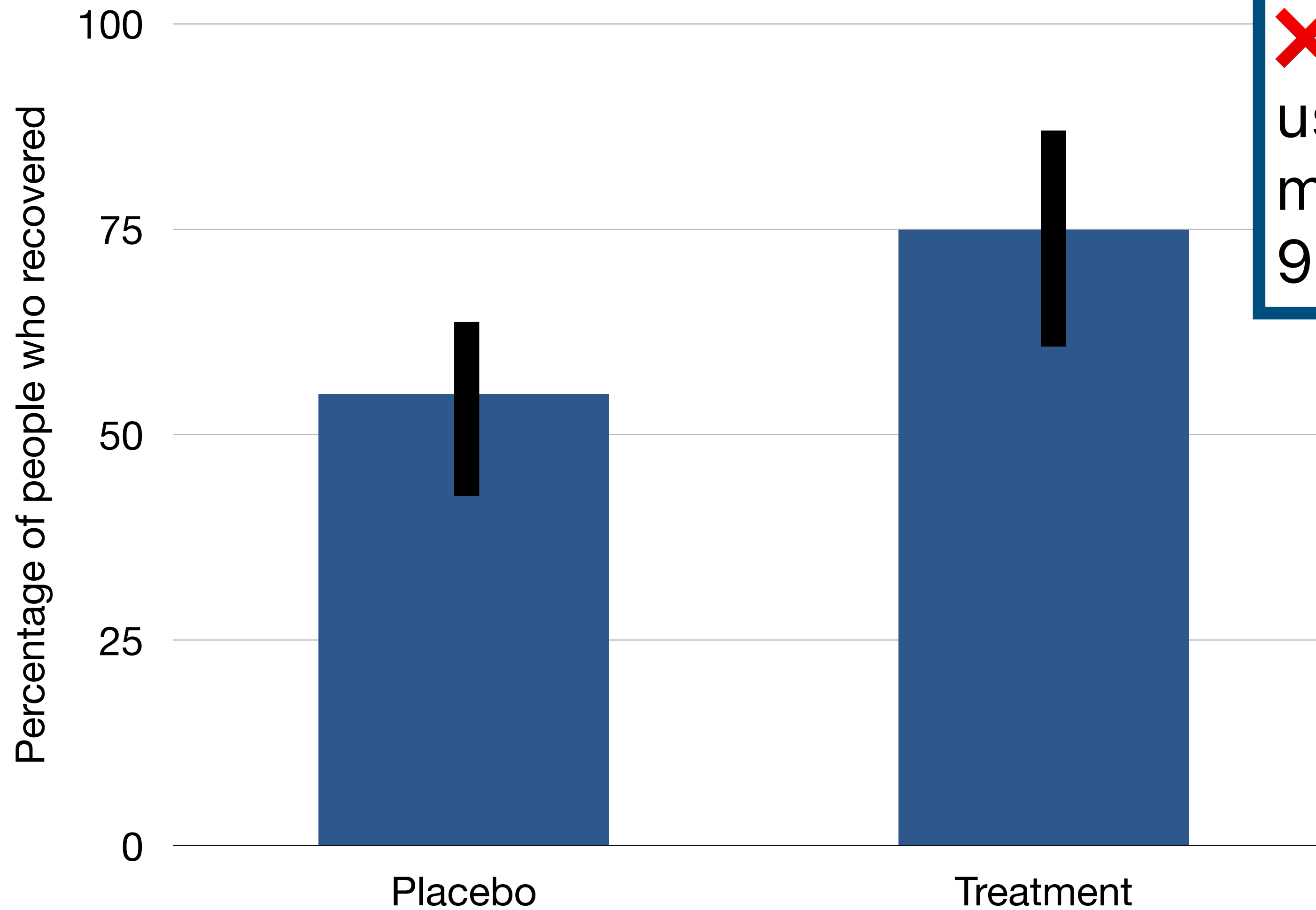


What do you think these error bars are implying?

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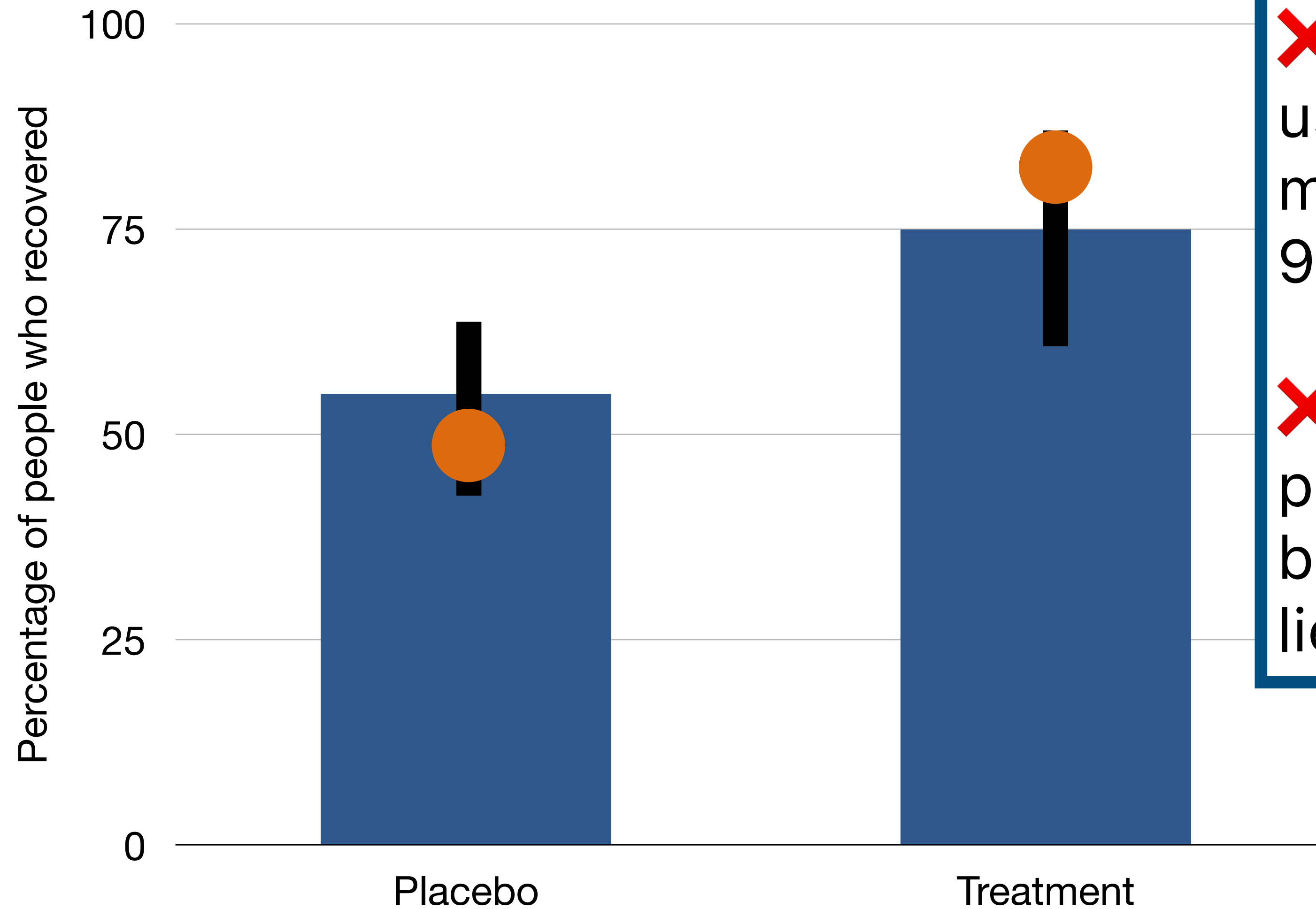
Trial of new medicine



Expressiveness?

✗ Error bars aren't consistently used to visualize the same measure (standard error, IQR, 95% CI, etc.).

Trial of new medicine

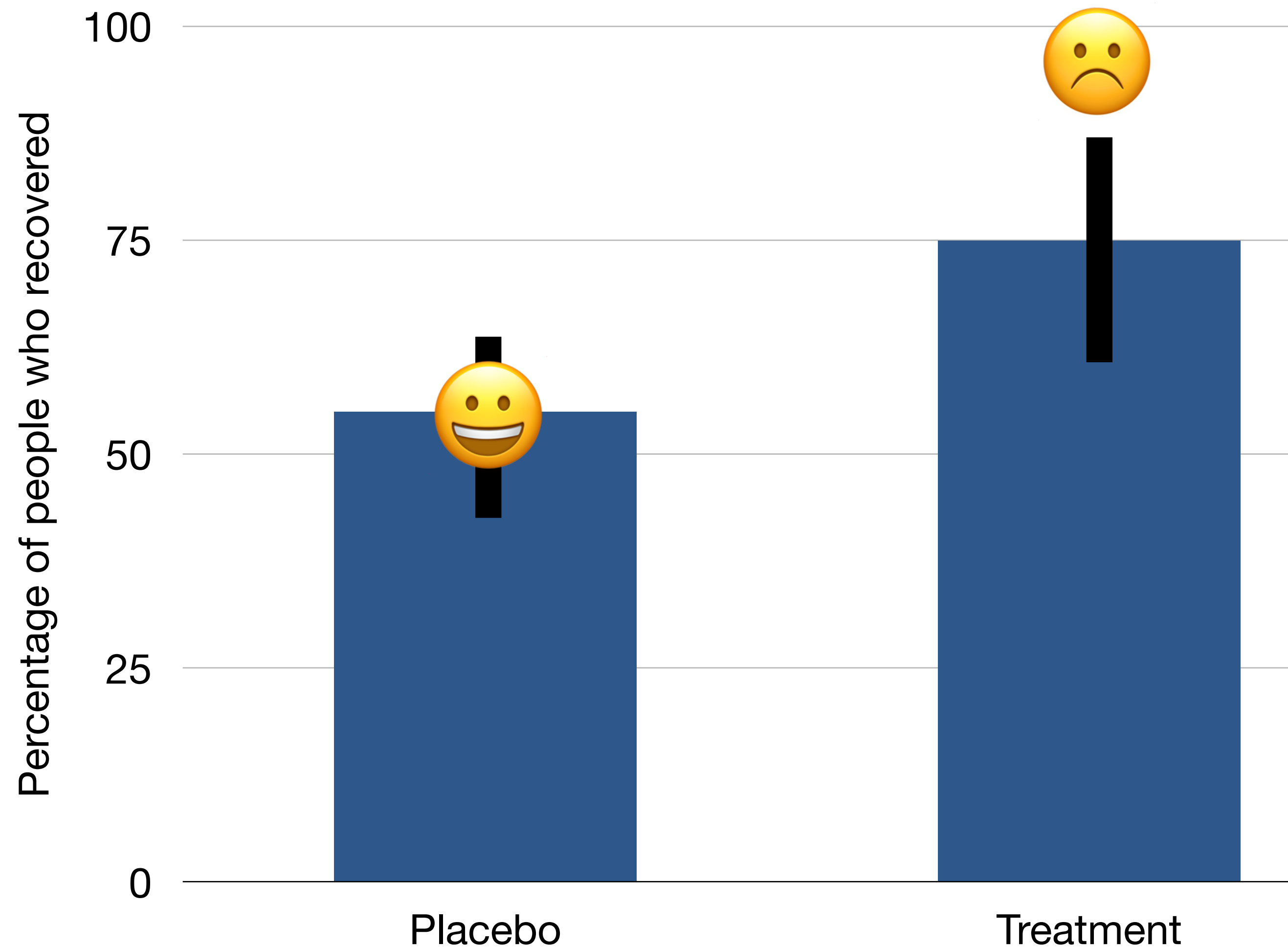


Expressiveness?

✗ Error bars aren't consistently used to visualize the same measure (standard error, IQR, 95% CI, etc.).

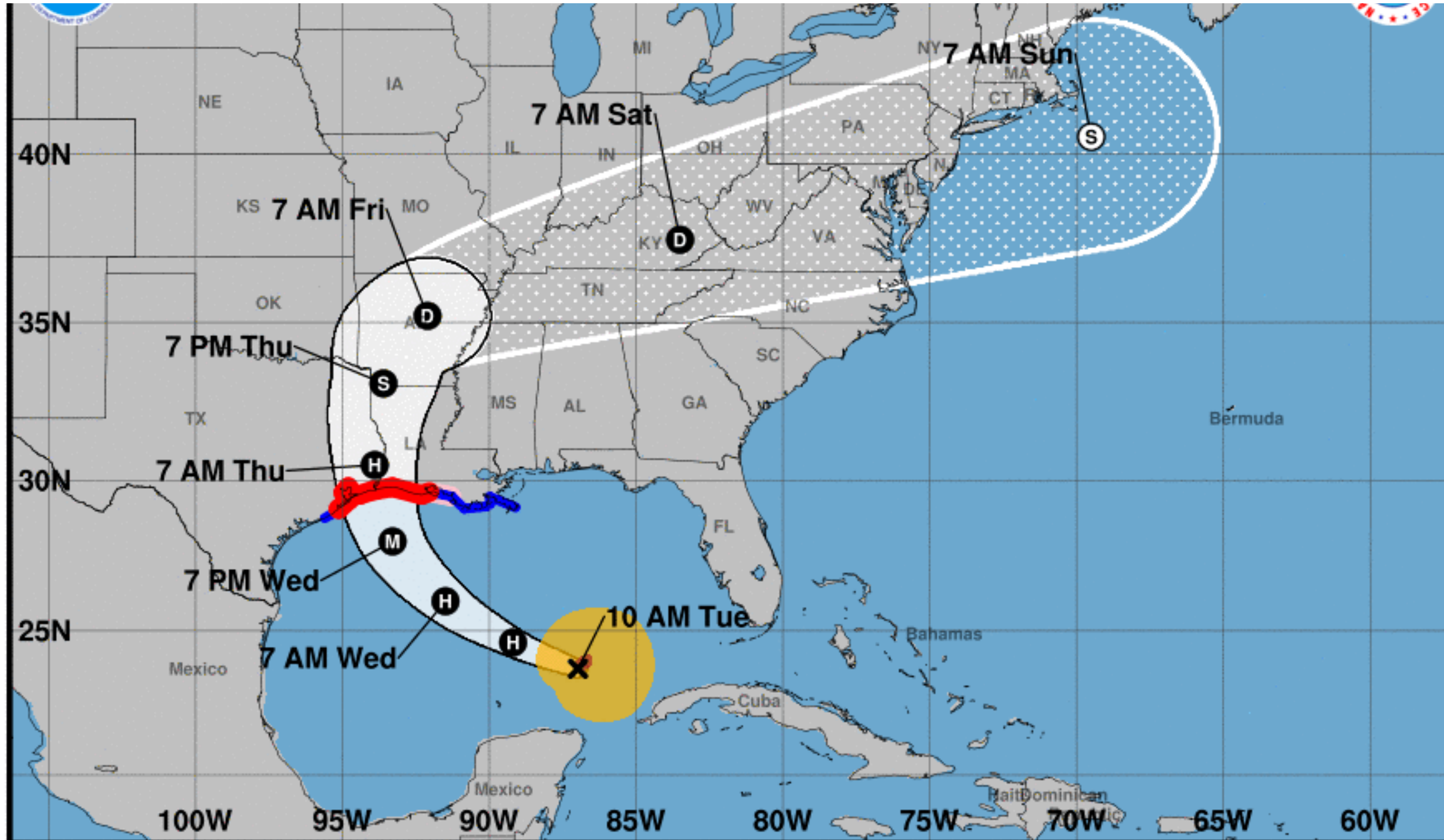
✗ Within-the-bar bias: people perceive points falling within the bar as more likely than those that lie outside.

Trial of new medicine



Expressiveness?

- ✗ Error bars aren't consistently used to visualize the same measure (standard error, IQR, 95% CI, etc.).
- ✗ Within-the-bar bias: people perceive points falling within the bar as more likely than those that lie outside.
- ✗ Binary bias: people perceive values to either be in or out of the margins of error.



Hurricane Laura
 Tuesday August 25, 2020
 10 AM CDT Advisory 23
 NWS National Hurricane Center

Current information: x
 Center location 23.7 N 87.0 W
 Maximum sustained wind 75 mph
 Movement WNW at 16 mph

Forecast positions:
 ● Tropical Cyclone ○ Post/Potential TC
 Sustained winds: D < 39 mph
 S 39-73 mph H 74-110 mph M > 110 mph

Potential track area:
 Day 1-3 Day 4-5

Watches:
 Hurricane Trop Stm

Warnings:
 Hurricane Trop Stm

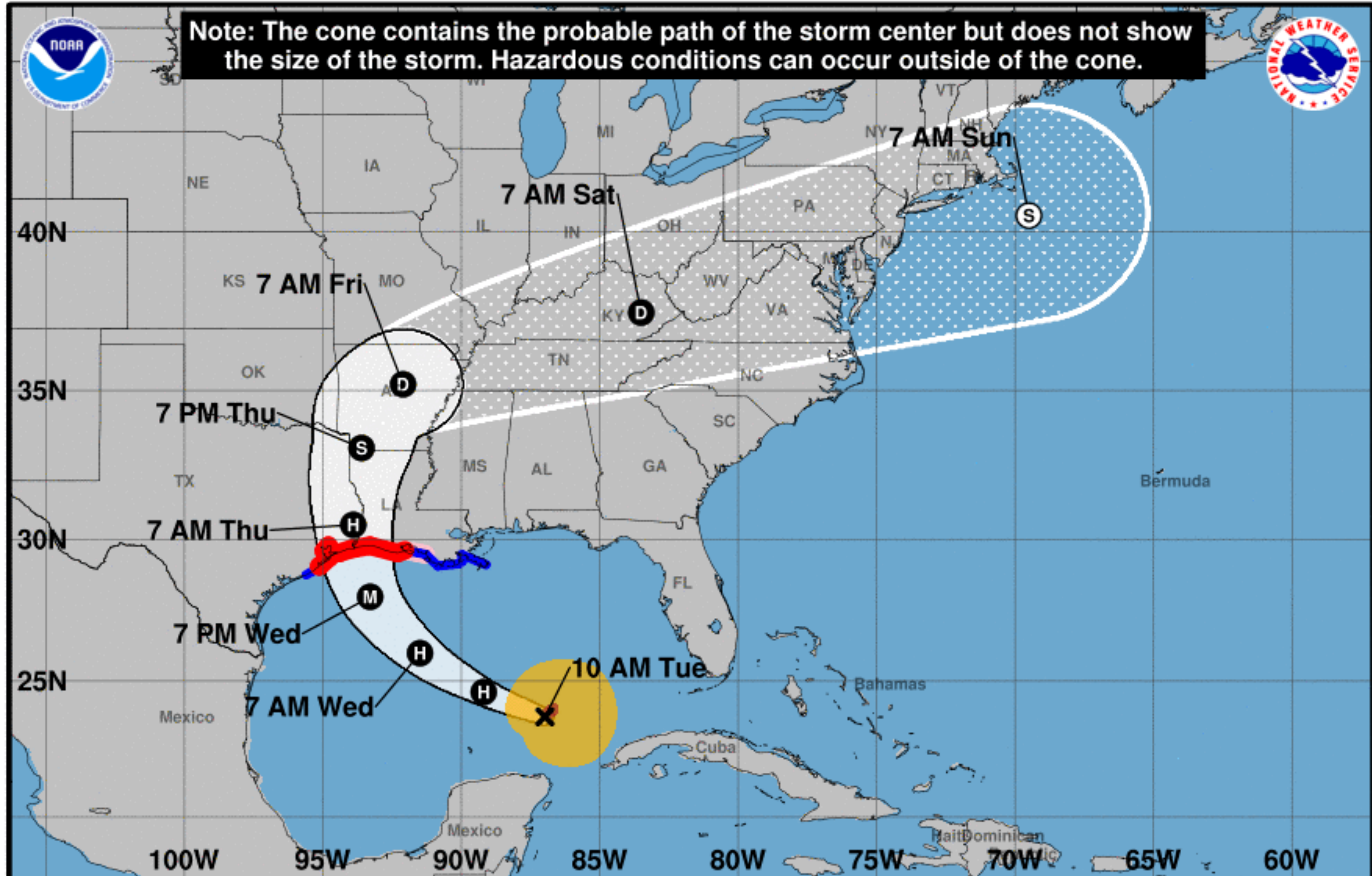
Current wind extent:
 Hurricane Trop Stm

What is being visualized?

What are the strengths and weaknesses of this visualization?

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Note: The cone contains the probable path of the storm center but does not show the size of the storm. Hazardous conditions can occur outside of the cone.

Hurricane Laura
 Tuesday August 25, 2020
 10 AM CDT Advisory 23
 NWS National Hurricane Center

Current information: x
 Center location 23.7 N 87.0 W
 Maximum sustained wind 75 mph
 Movement WNW at 16 mph

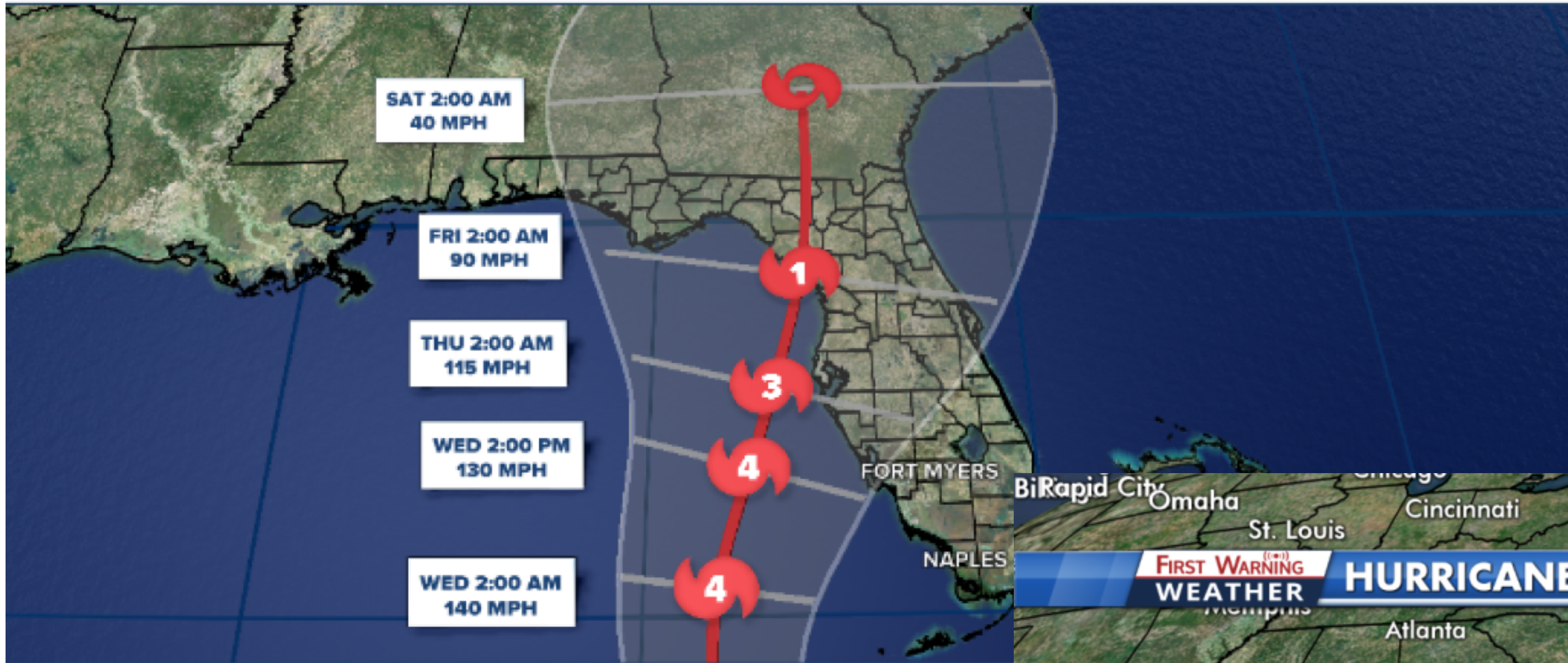
Forecast positions:
 ● Tropical Cyclone ○ Post/Potential TC
 Sustained winds: D < 39 mph
 S 39-73 mph H 74-110 mph M > 110 mph

Potential track area: Day 1-3 (solid line), Day 4-5 (dotted line)
Watches: Hurricane (pink), Trop Stm (yellow)
Warnings: Hurricane (red), Trop Stm (blue)
Current wind extent: Hurricane (brown), Trop Stm (orange)

What is being visualized?
 What are the strengths and weaknesses of this visualization?

FOX 4 HURRICANE IAN

5:00 AM ADVISORY



CURRENT LOCATION: 90 MI SW OF G





Hurricane Dorian Forecast Track and Intensity



Hurricane Dorian
 Thursday August 29, 2019
 11 AM AST Advisory 21
 NWS National Hurricane Center

Current information: x
 Center location 21.4 N 67.2 W
 Maximum sustained wind 85 mph
 Movement NW at 13 mph

Forecast positions:
 ● Tropical Cyclone ○ Post/Potential TC
 Sustained winds: D < 39 mph
 S 39-73 mph H 74-110 mph M > 110 mph

Potential track area: Day 1-3 Day 4-5
Watches: Hurricane Trop Stm
Warnings: Hurricane Trop Stm
Current wind extent: Hurricane Trop Stm

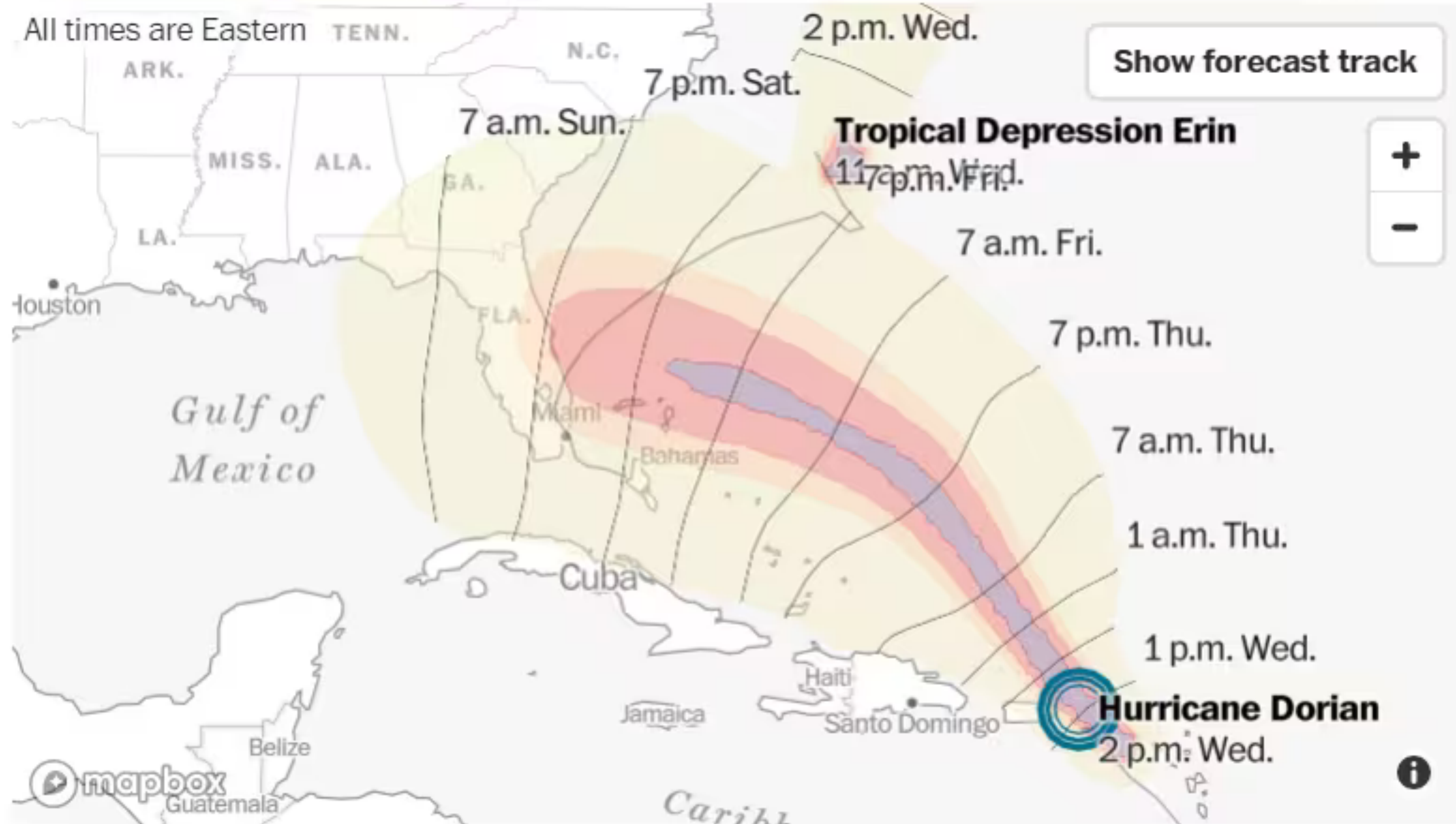


Five-day chance of tropical-storm-force winds



Current extent of tropical-storm-force winds

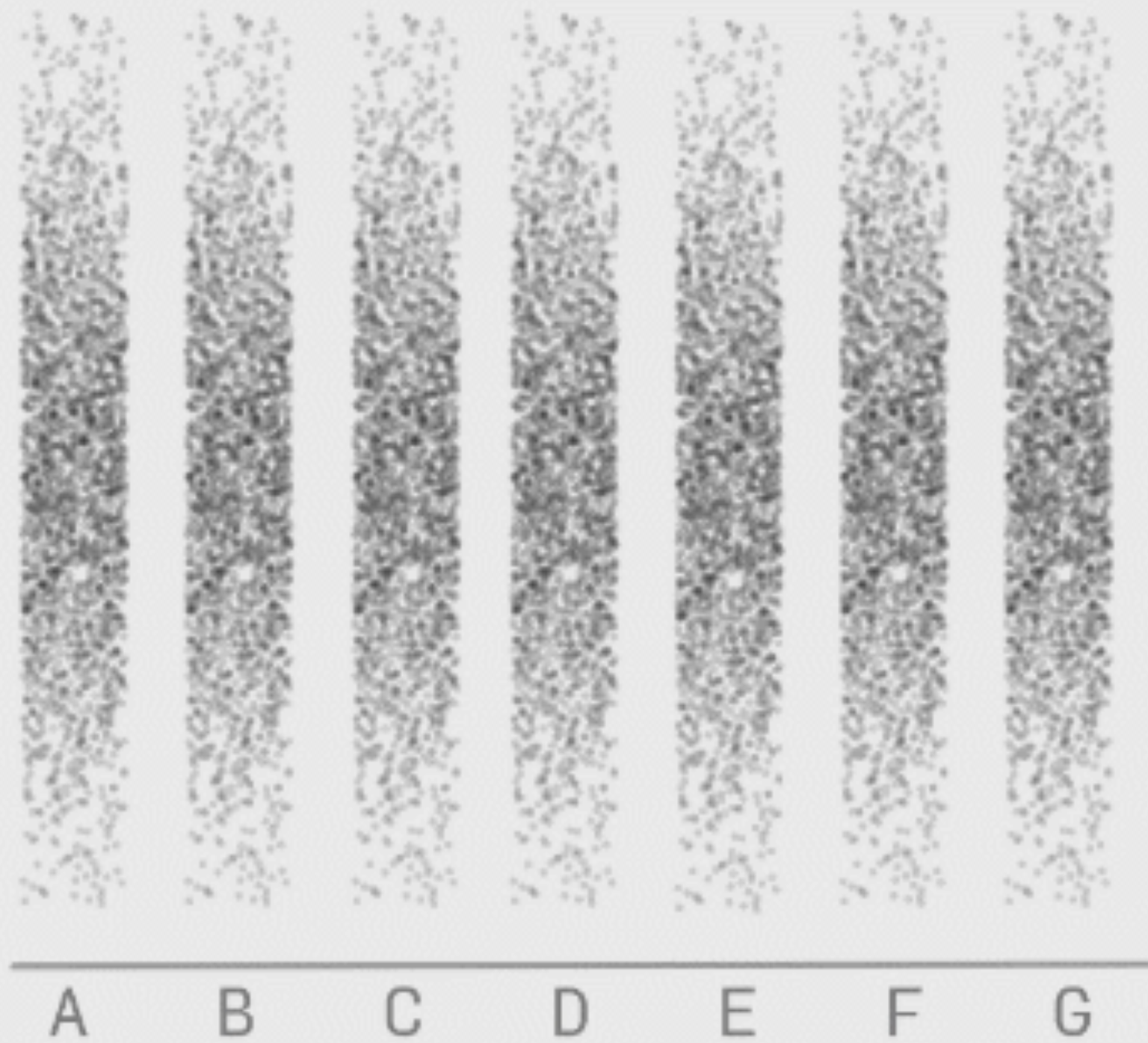
- Major hurricane (>110 mph)
- Hurricane (74-110 mph)
- Tropical storm (39-73 mph)
- Tropical depression (<39 mph)



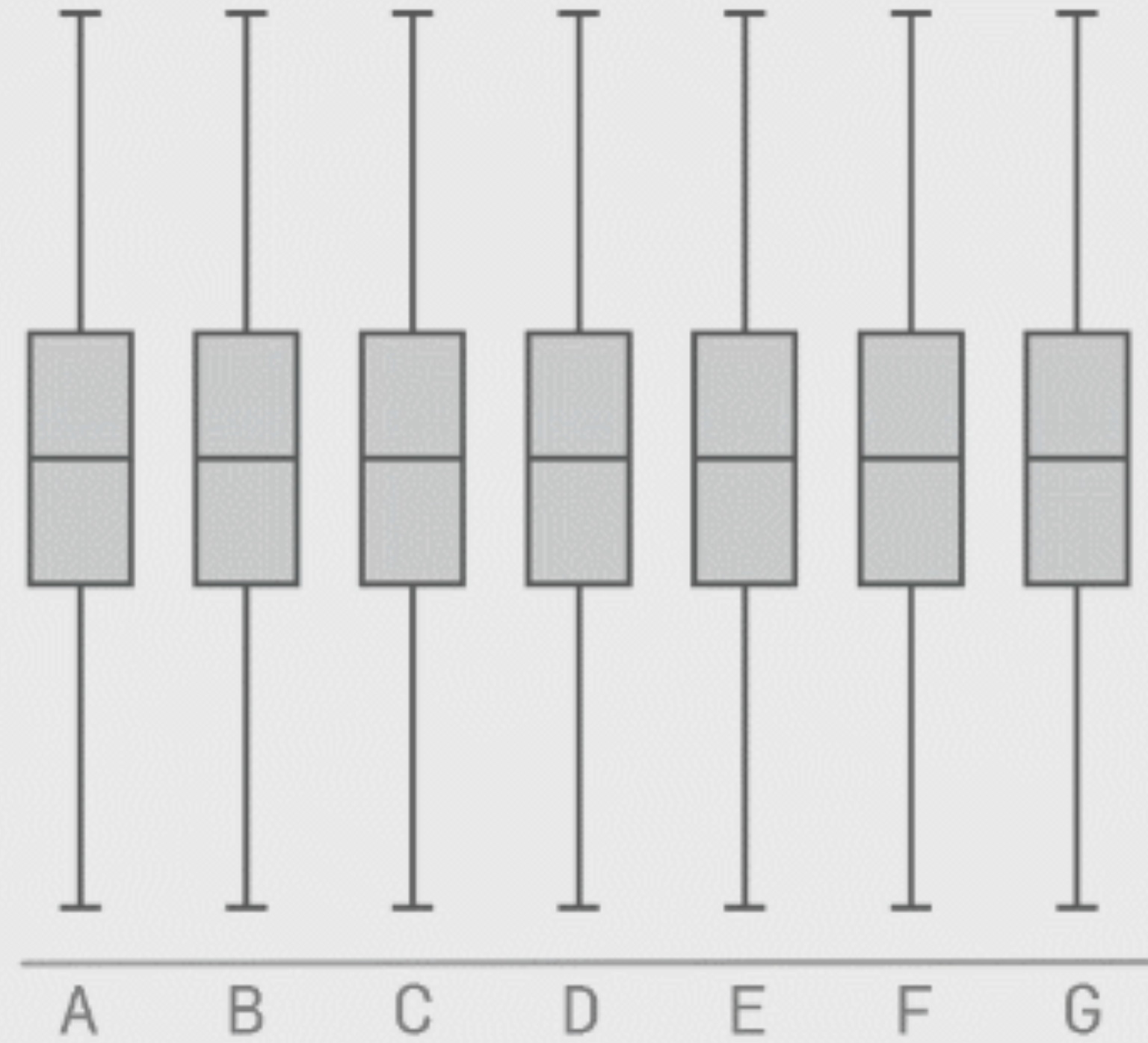
Source: National Weather Service. Note: Impact lines represent the earliest reasonable arrival time of tropical-storm-force winds.

For uncertainty, use **visual variables** instead of visualizing point estimates

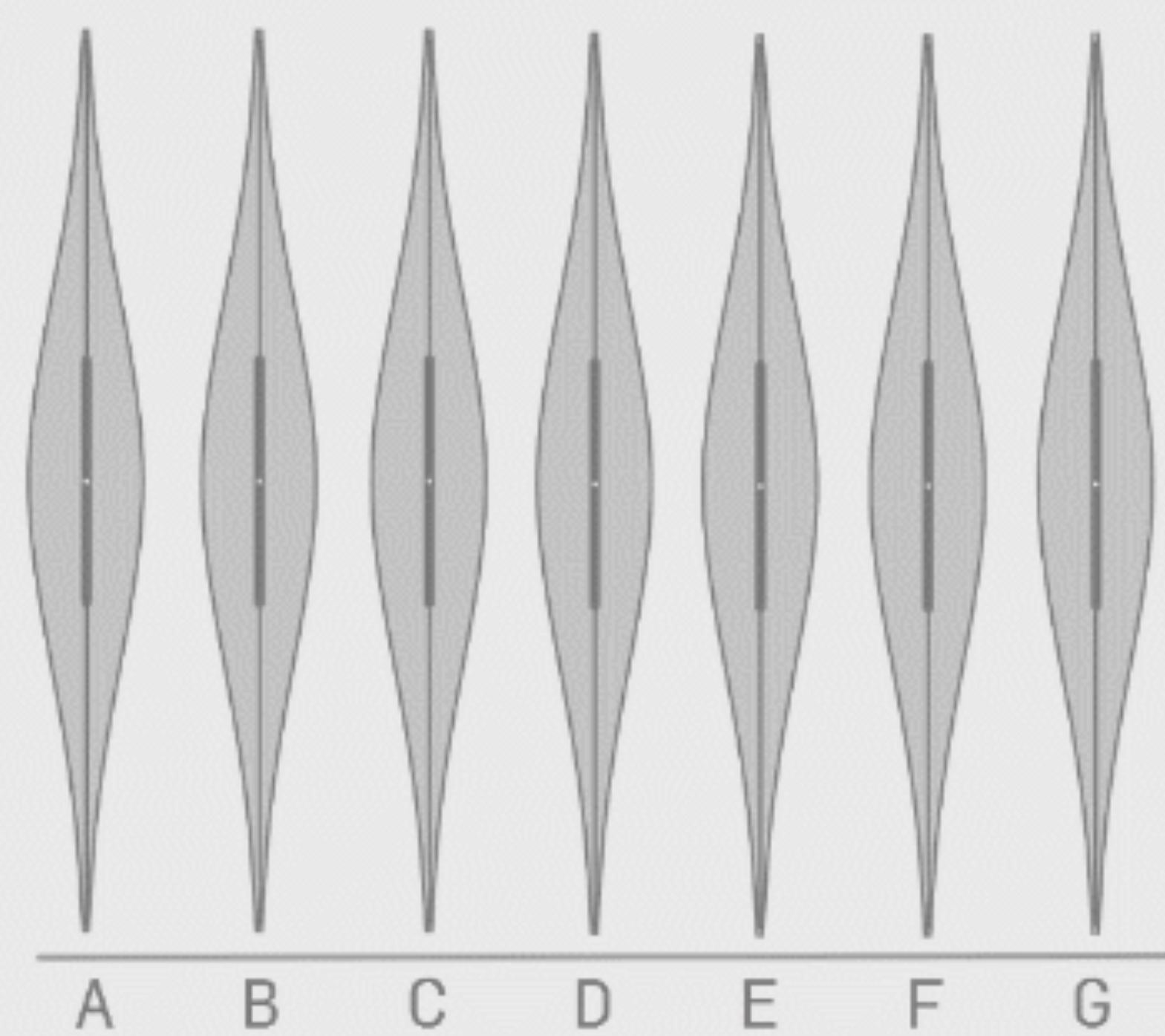
Raw Data



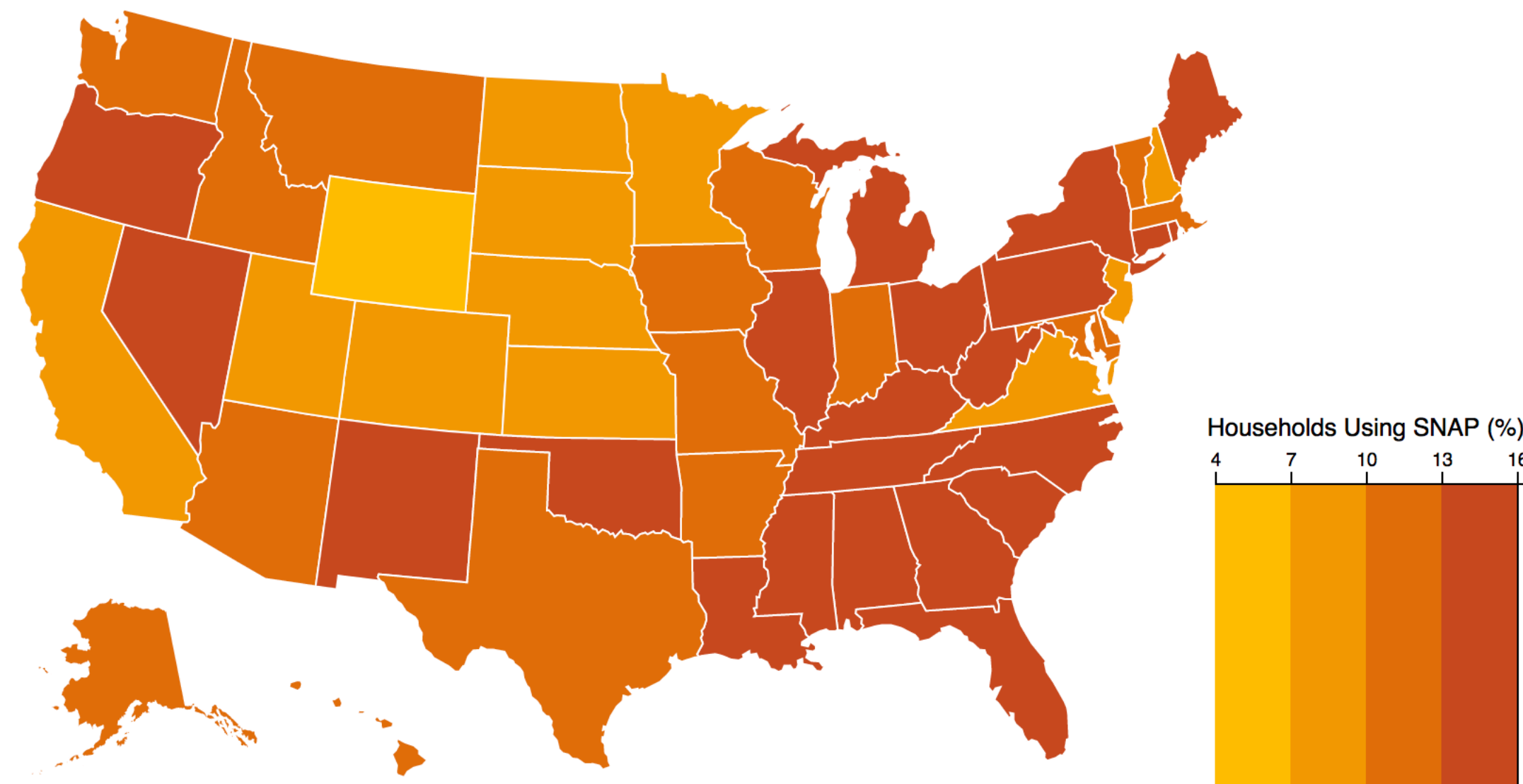
Box-plot of the Data



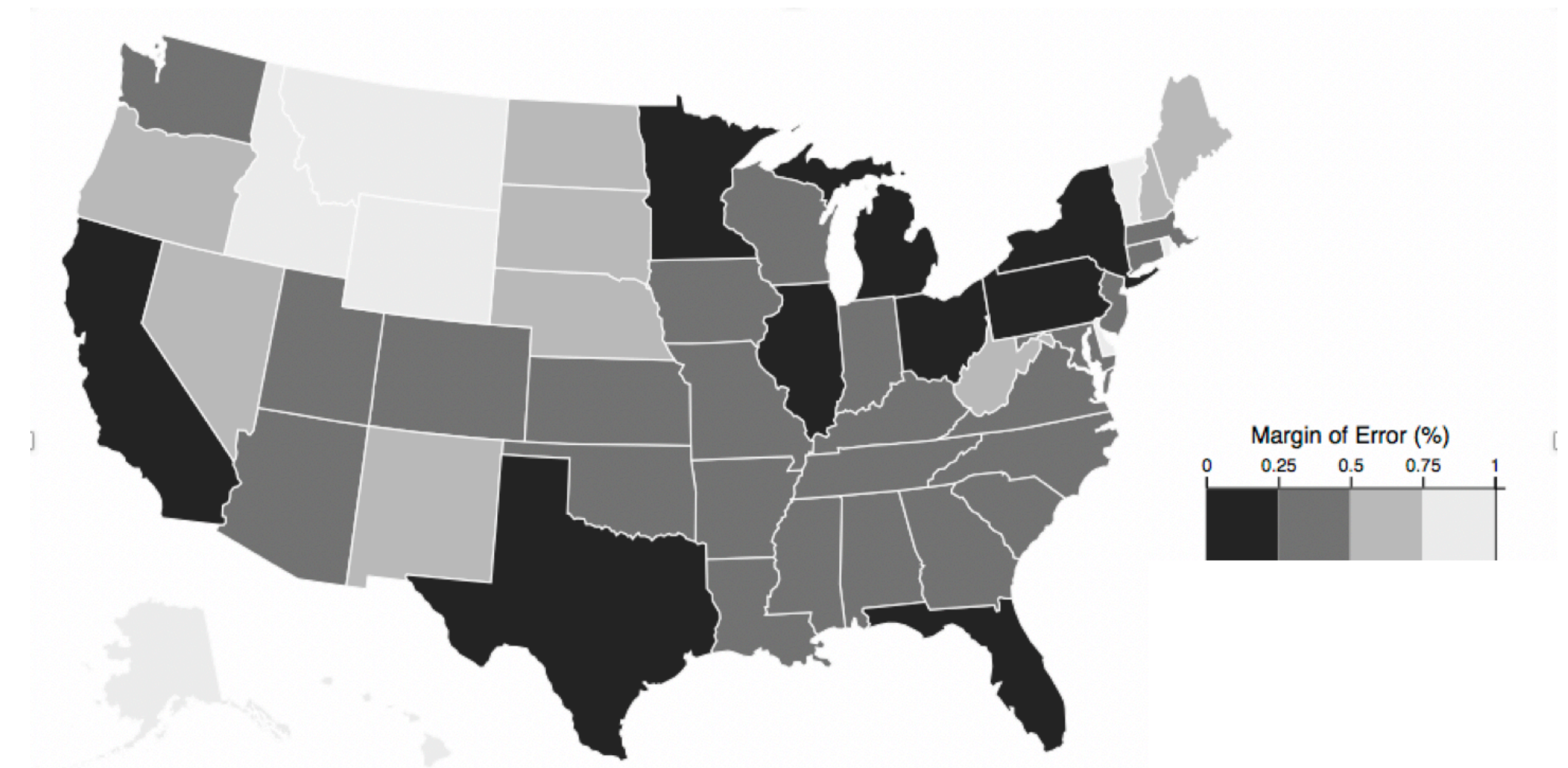
Violin-plot of the Data



For uncertainty, use **visual variables** instead of visualizing point estimates

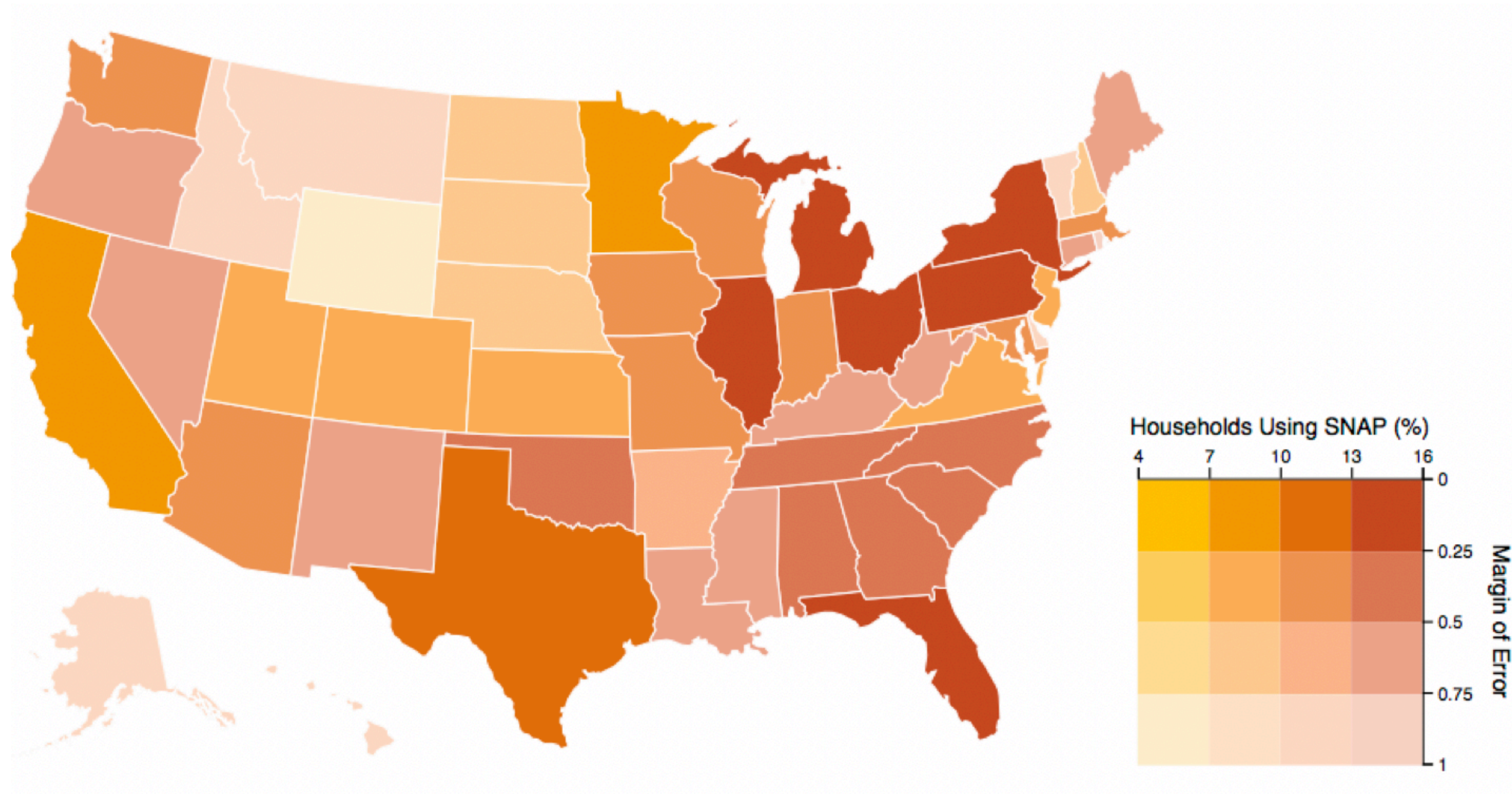


Data Map

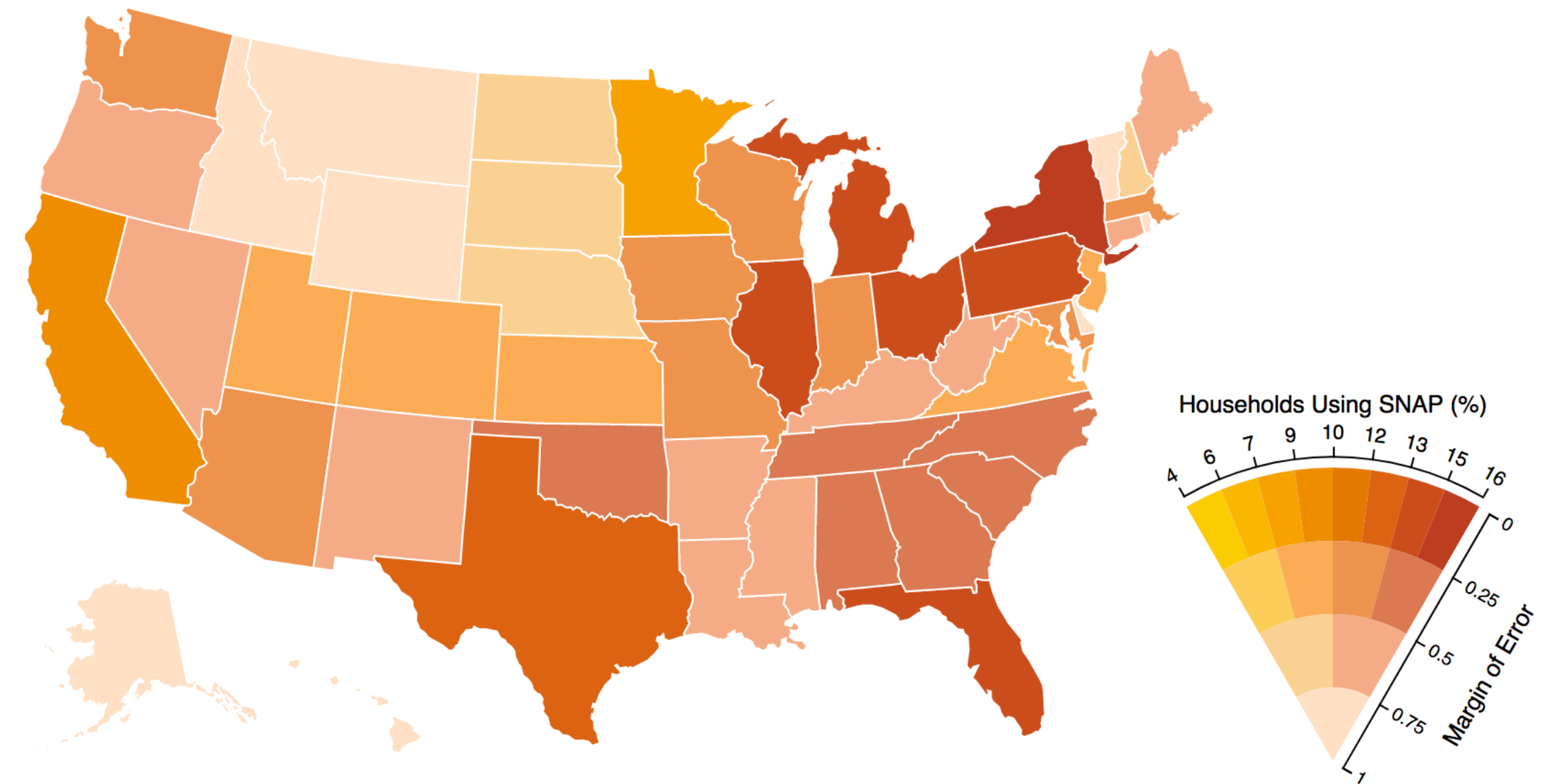


Uncertainty Map

For uncertainty, use **visual variables** instead of visualizing point estimates

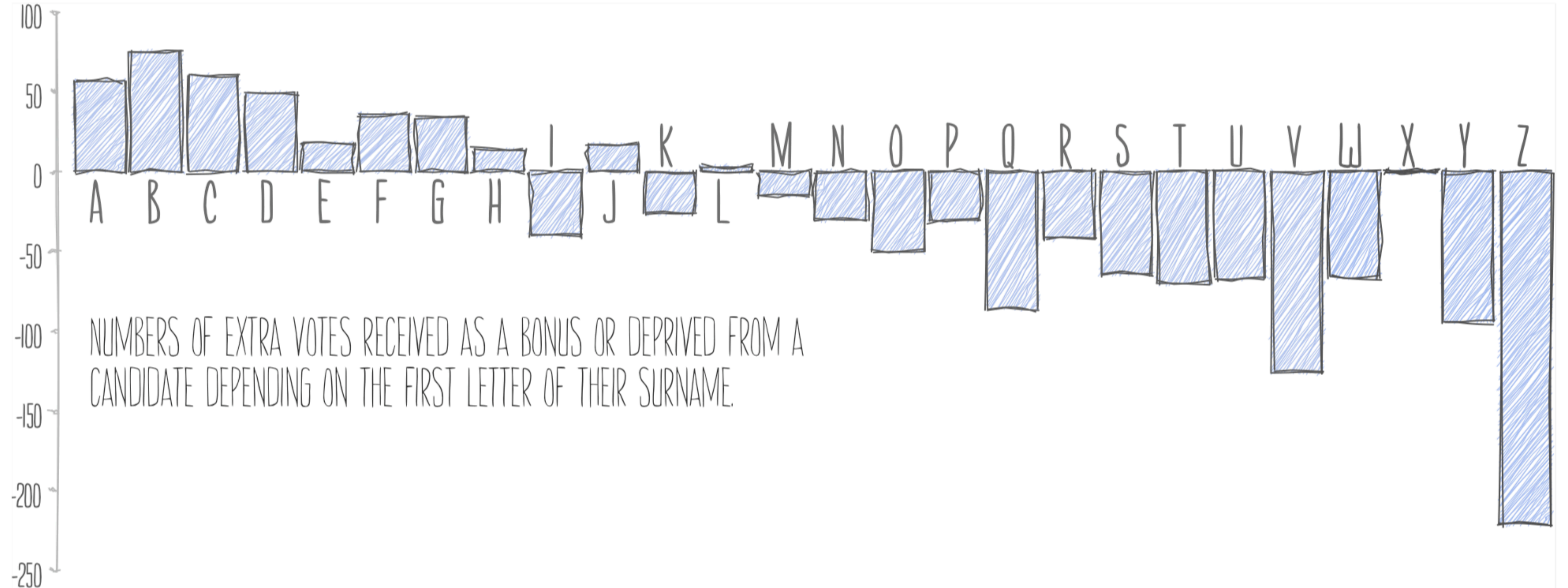


Bivariate Map (Data + Uncertainty)



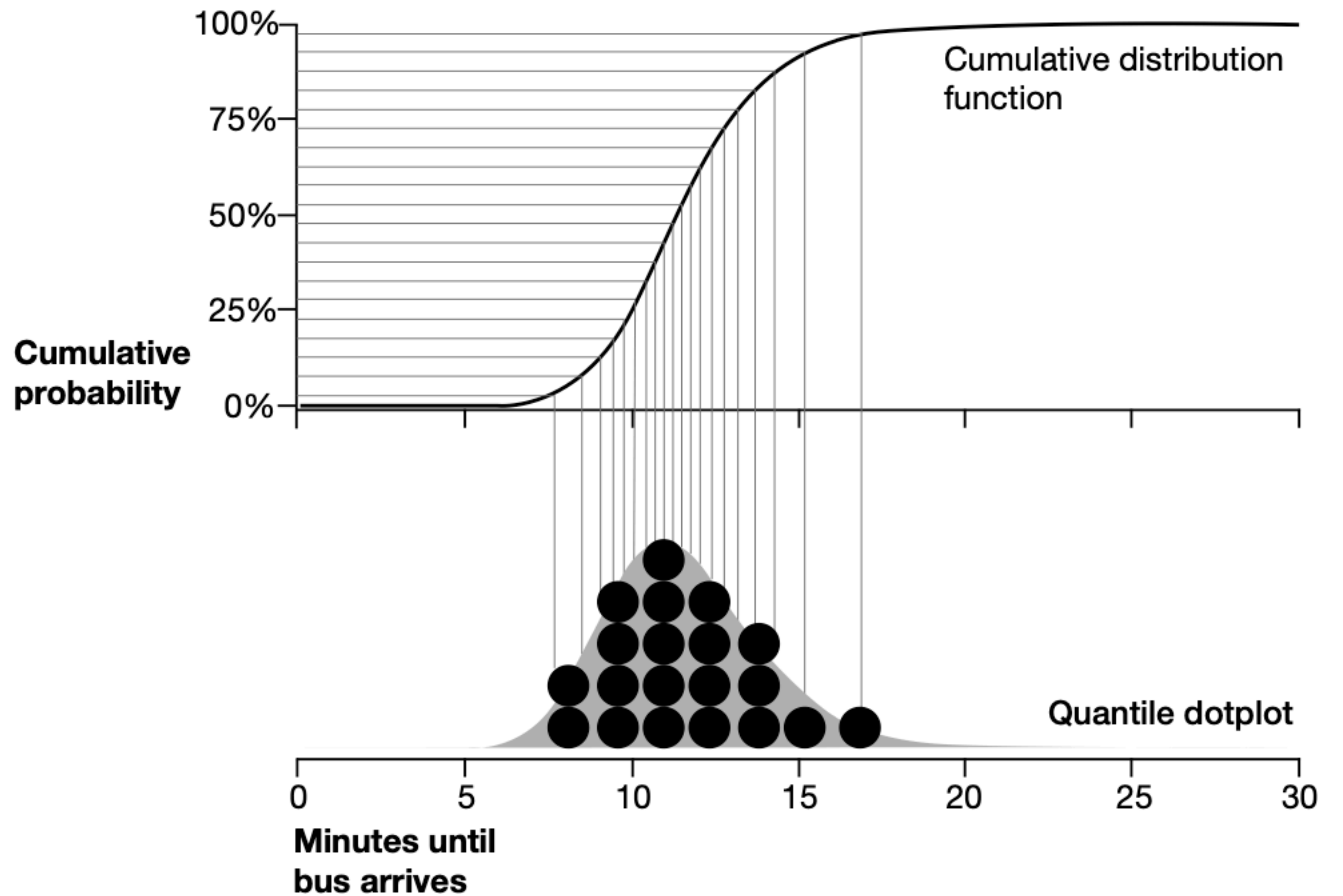
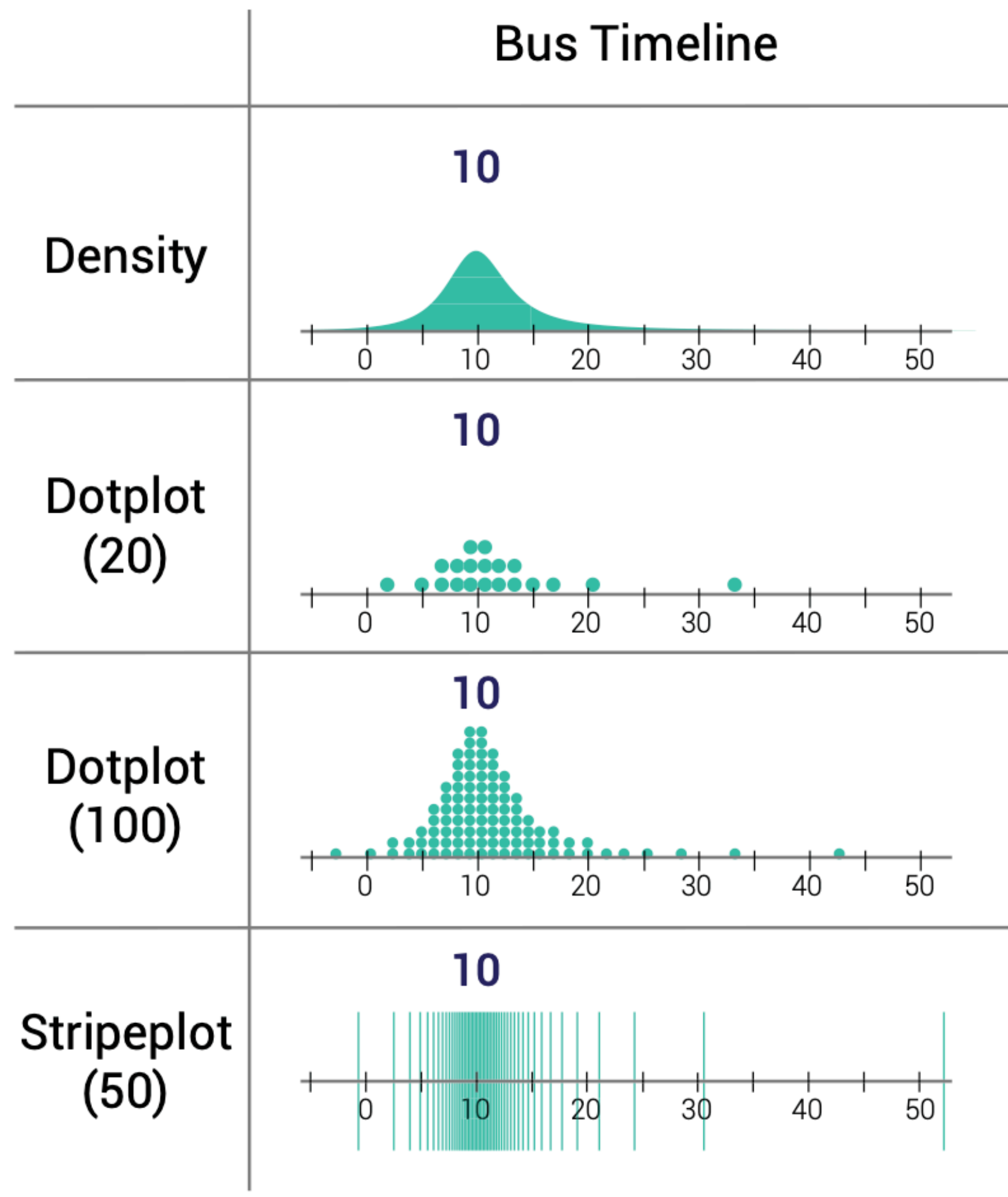
Value-Suppressing Uncertainty Map

For uncertainty, use **visual variables** instead of visualizing point estimates

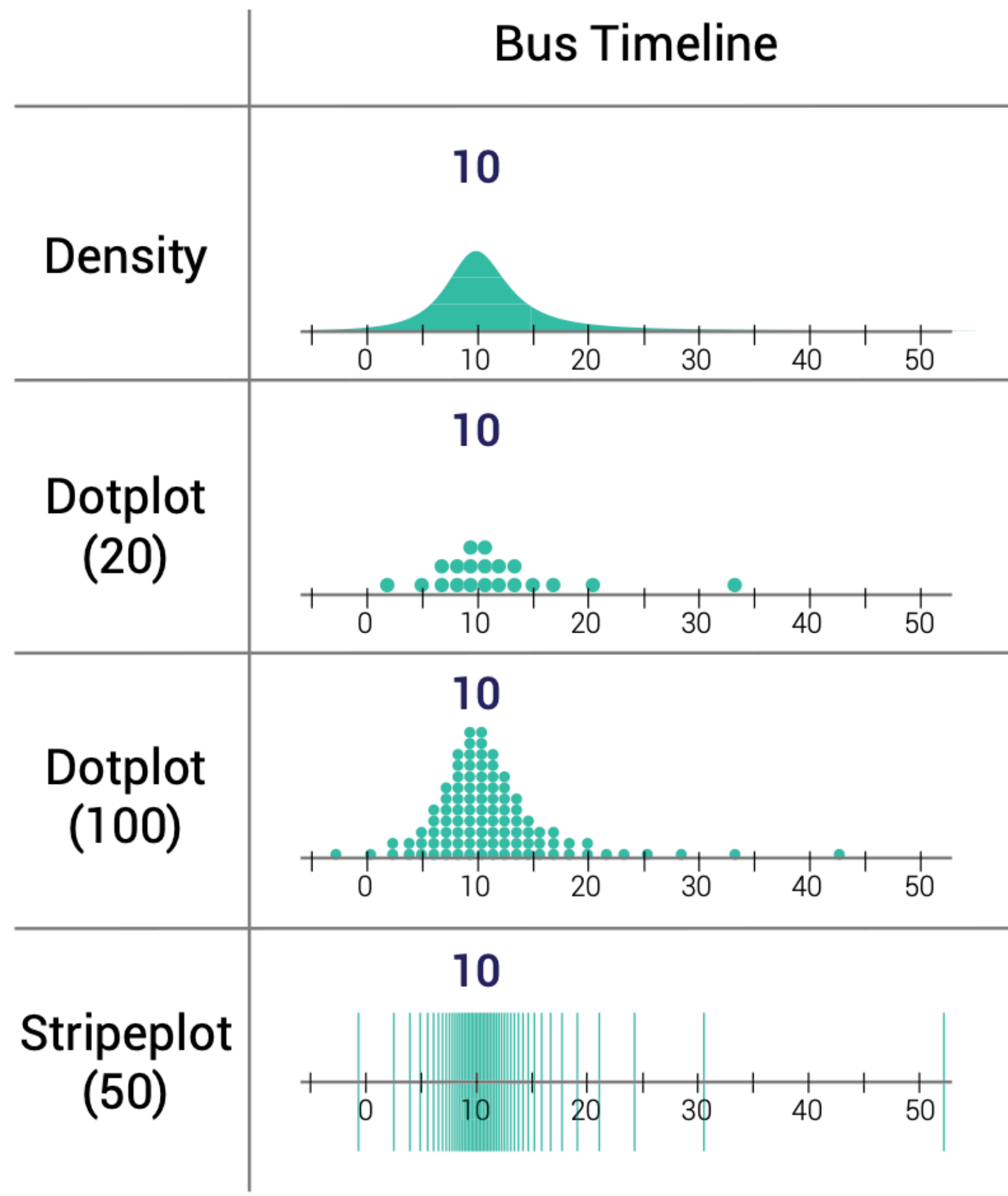


[Wood et al., 2012]
[Boukhelifa et al., 2012]

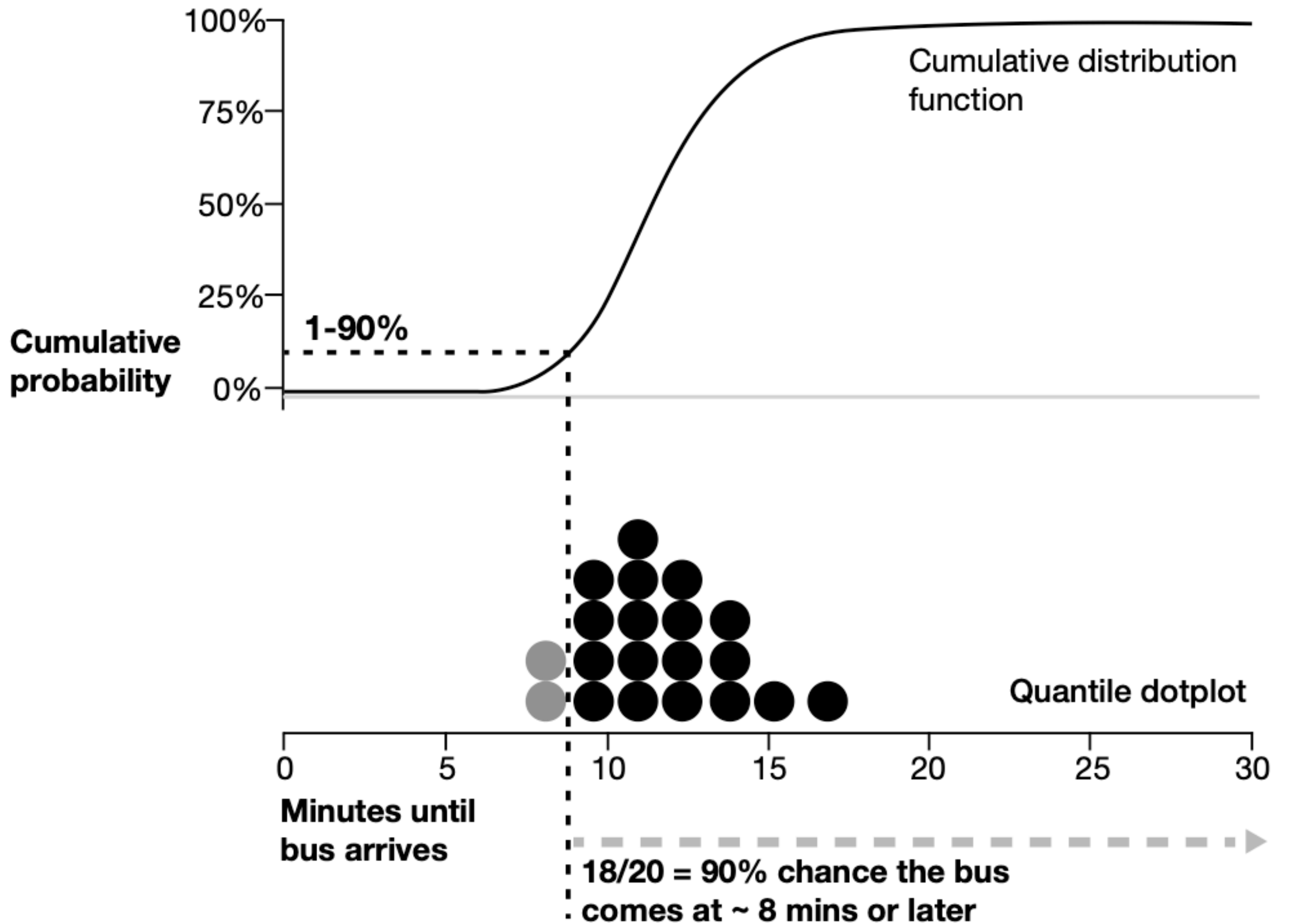
"Set of draws" technique



"Set of draws" technique

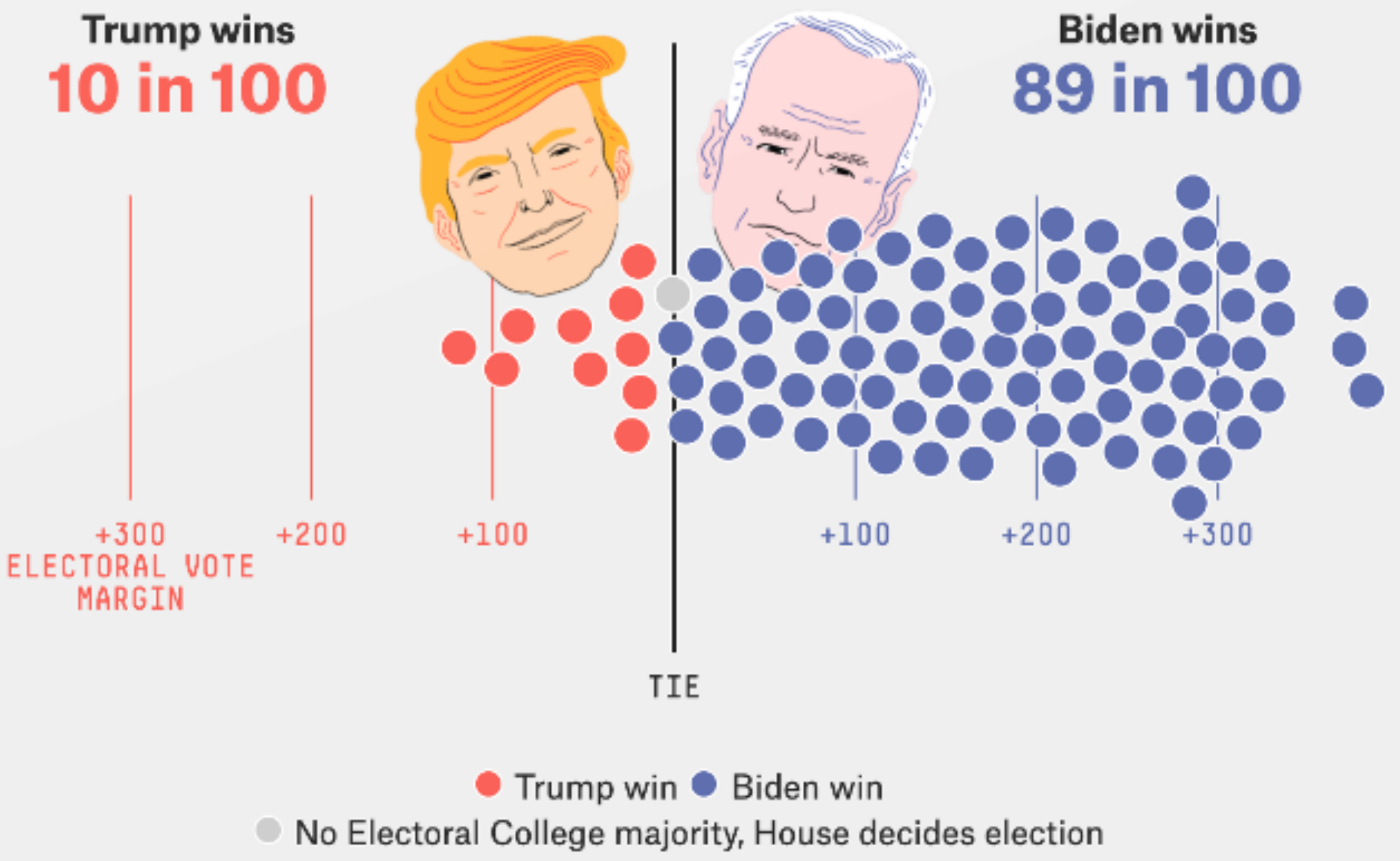


[Kay et al., 2016]



Biden is favored to win the election

We simulate the election 40,000 times to see who wins most often. The sample of 100 outcomes below gives you a good idea of the range of scenarios our model thinks is possible.



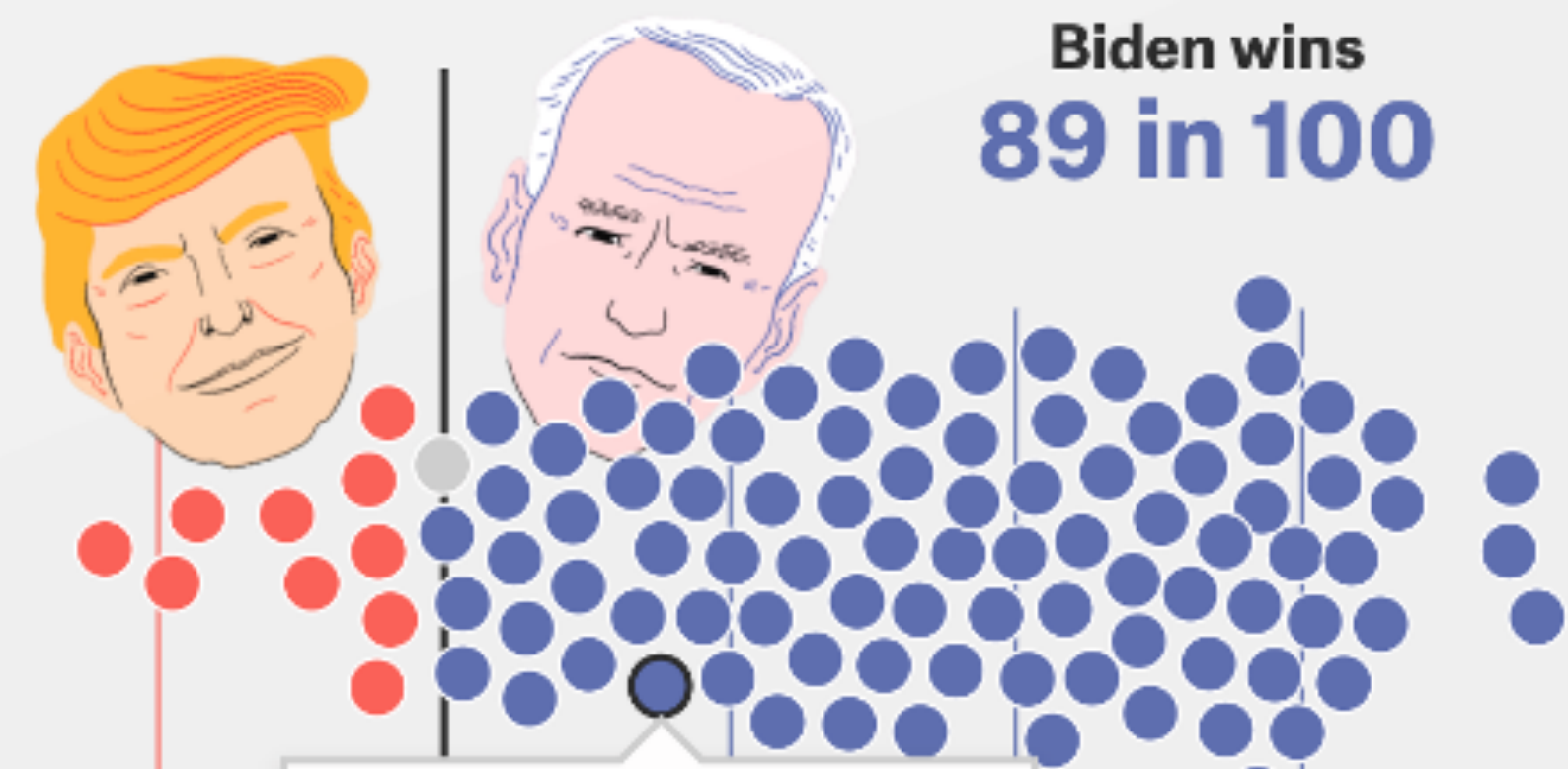
Don't count the underdog out! Upset wins are surprising but not impossible.

Biden is *favored* to win the election

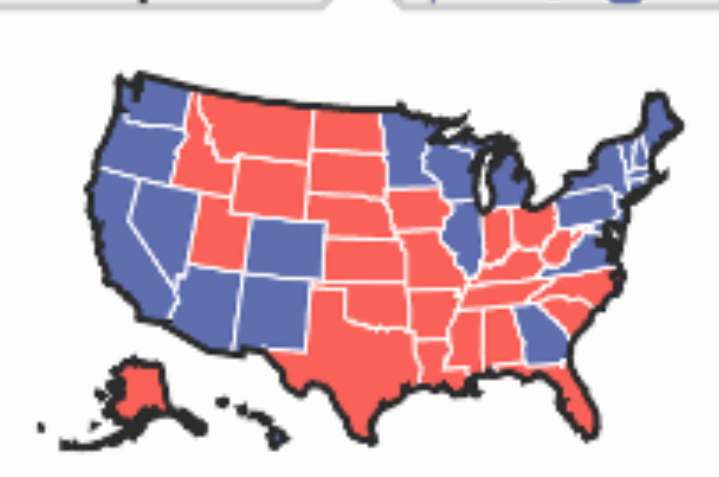
We simulate the election 40,000 times to see who wins most often. The sample of 100 outcomes below gives you a good idea of the range of scenarios our model thinks is possible.

Trump wins
10 in 100

Biden wins
89 in 100



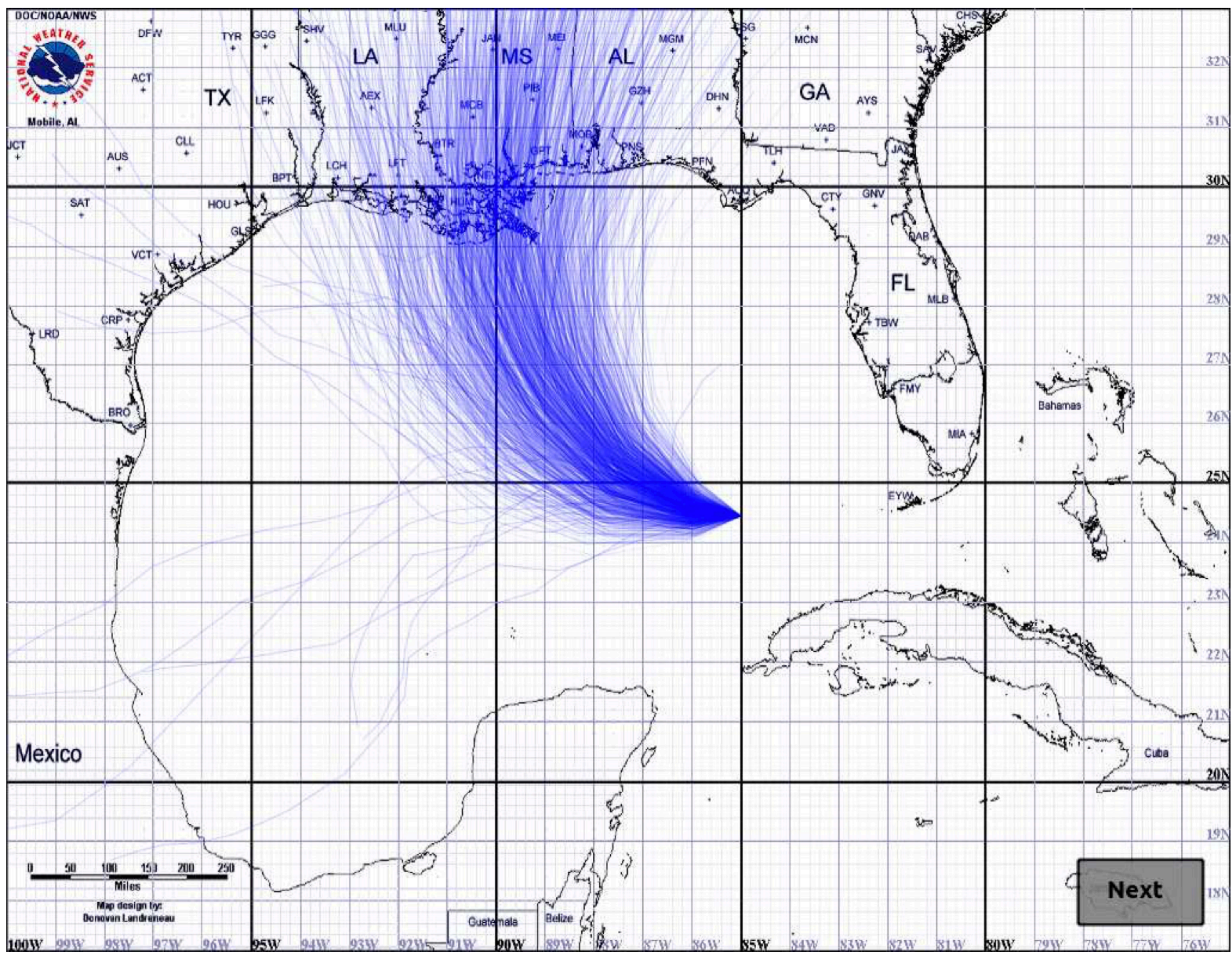
+300
ELECTORAL VOTE
MARGIN



— ELECTORAL VOTES —

Biden ✓ 306 **Trump** 232

Don't count the underdog out! Upset wins are surprising but not impossible.



• TheUpshot

STATISTICAL NOISE

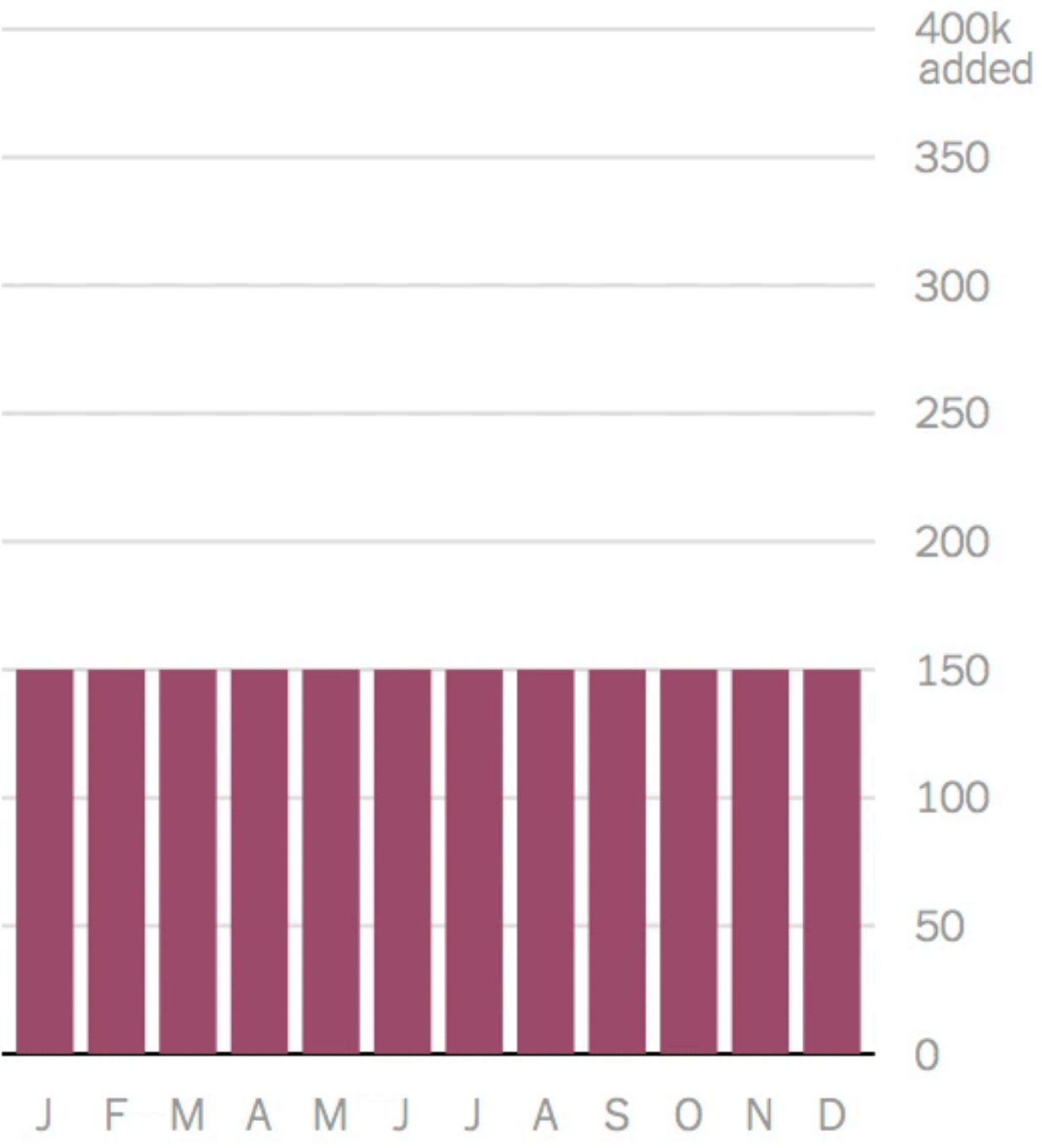
How Not to Be Misled by the Jobs Report

If the economy actually added 150,000 jobs last month, it would be possible to see any of these headlines:

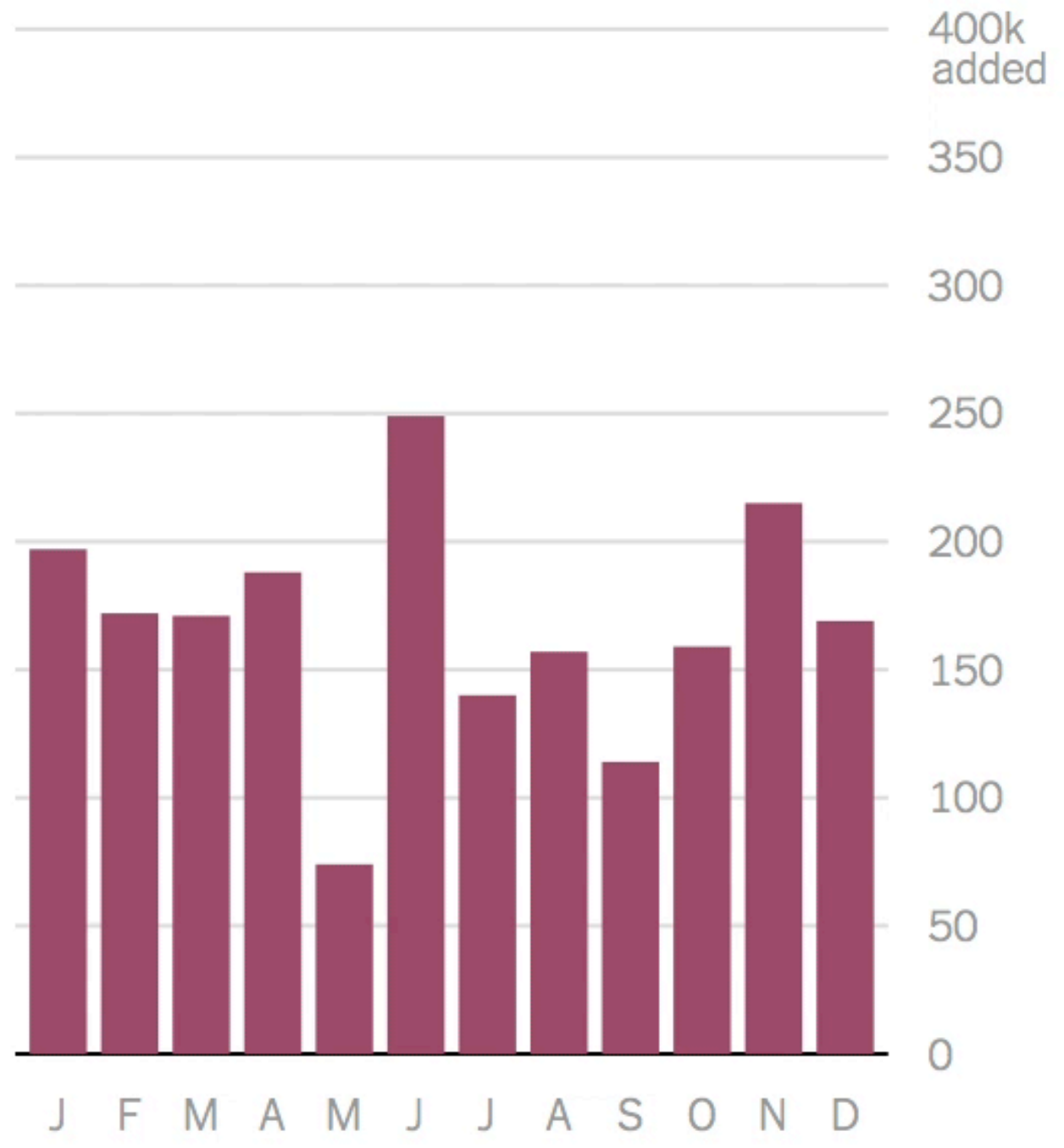
The jobs number is just an estimate, and it comes with uncertainty.



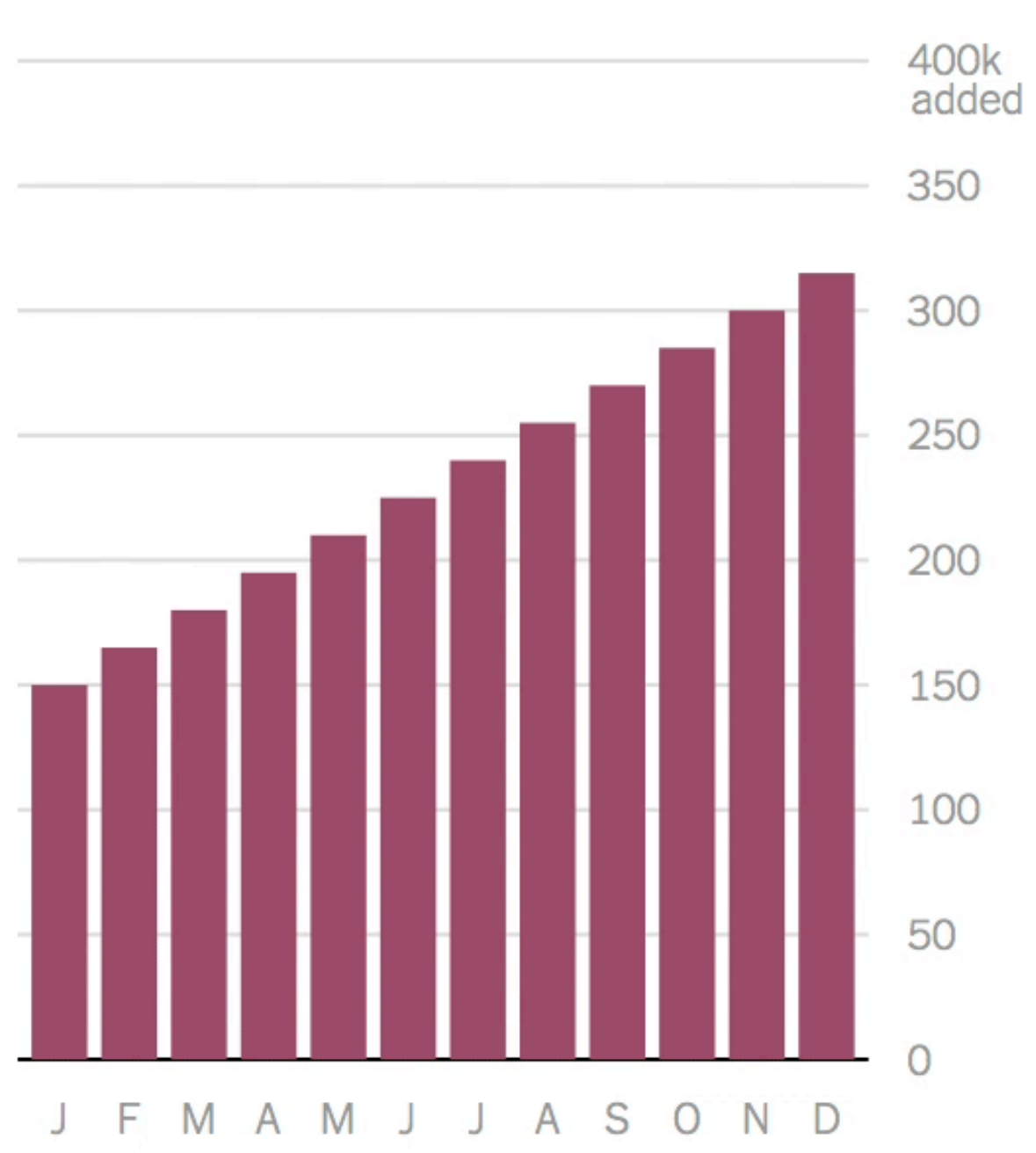
If job growth **were actually steady** over the last 12 months...



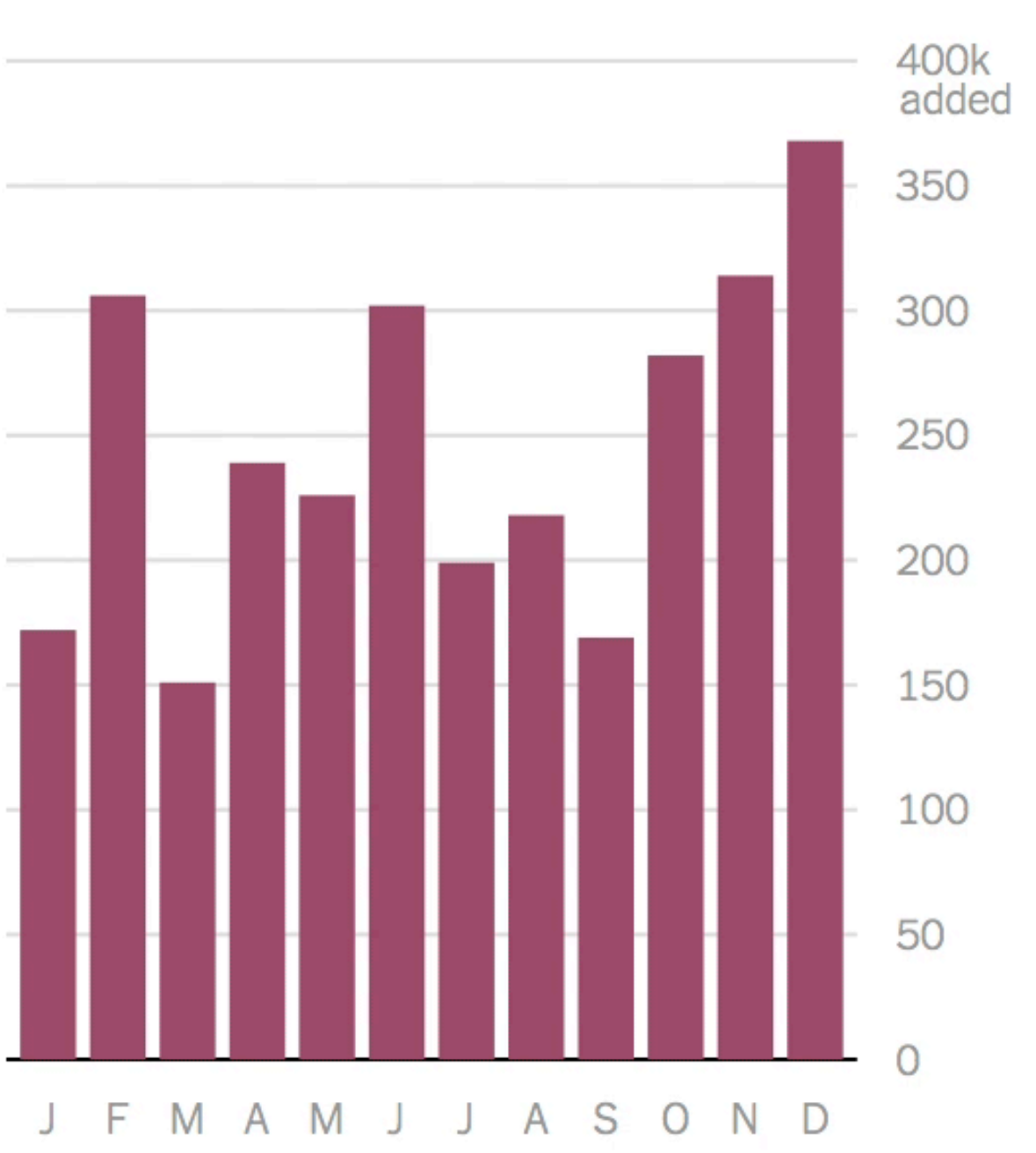
...the jobs report **could look like this:**



If job growth **had been accelerating...**



...the jobs report **could look like this:**



SPIN

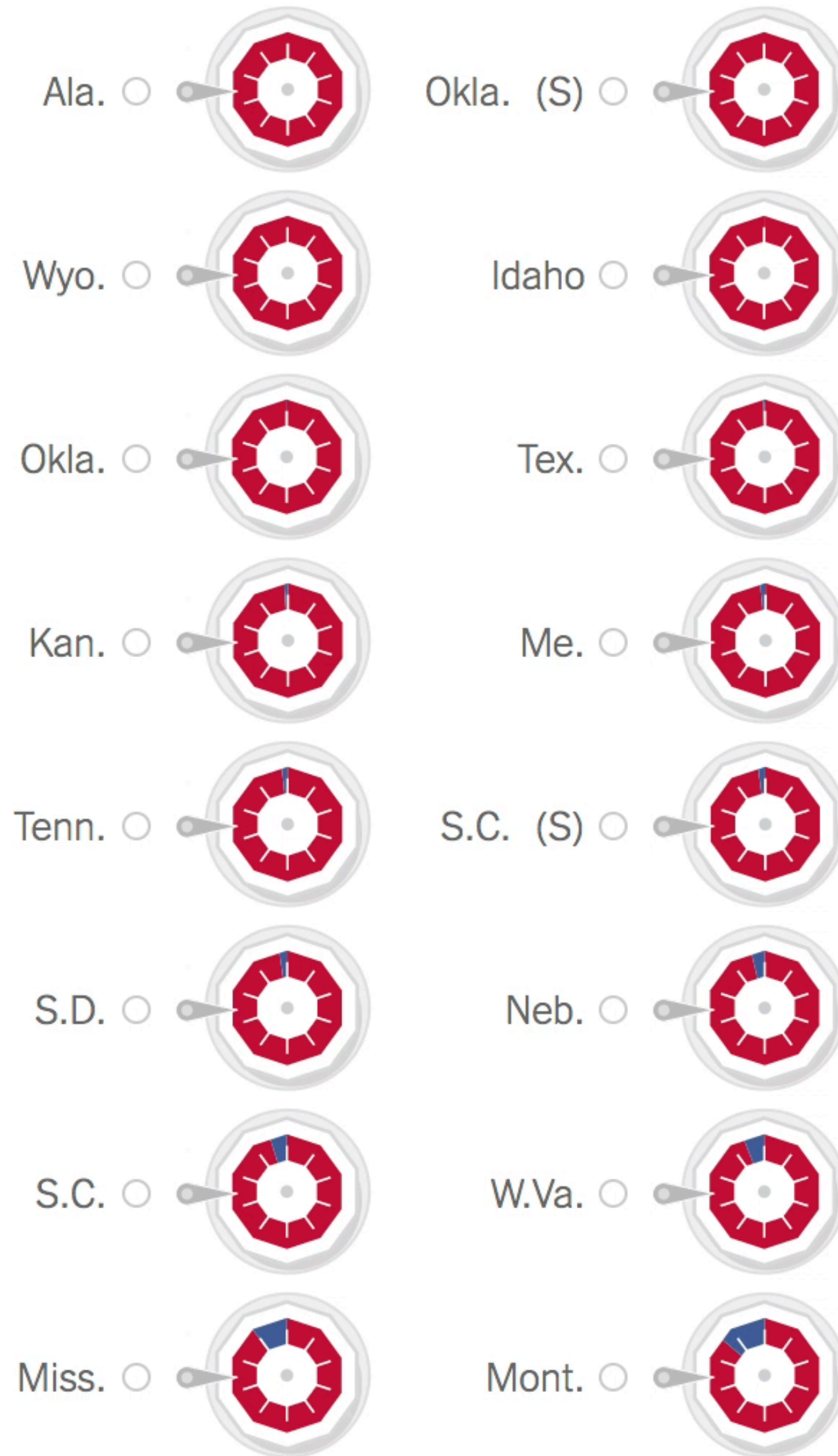
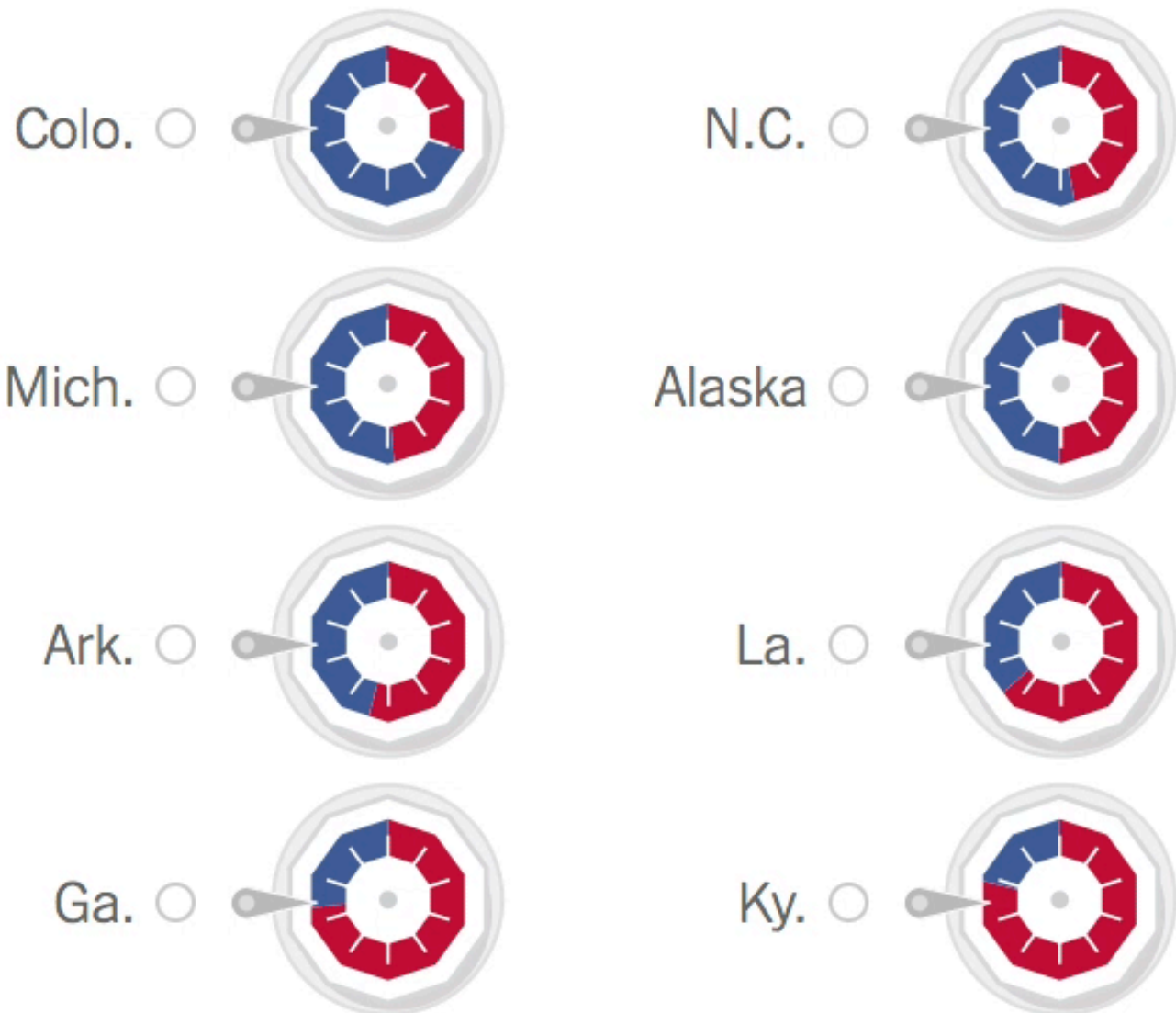
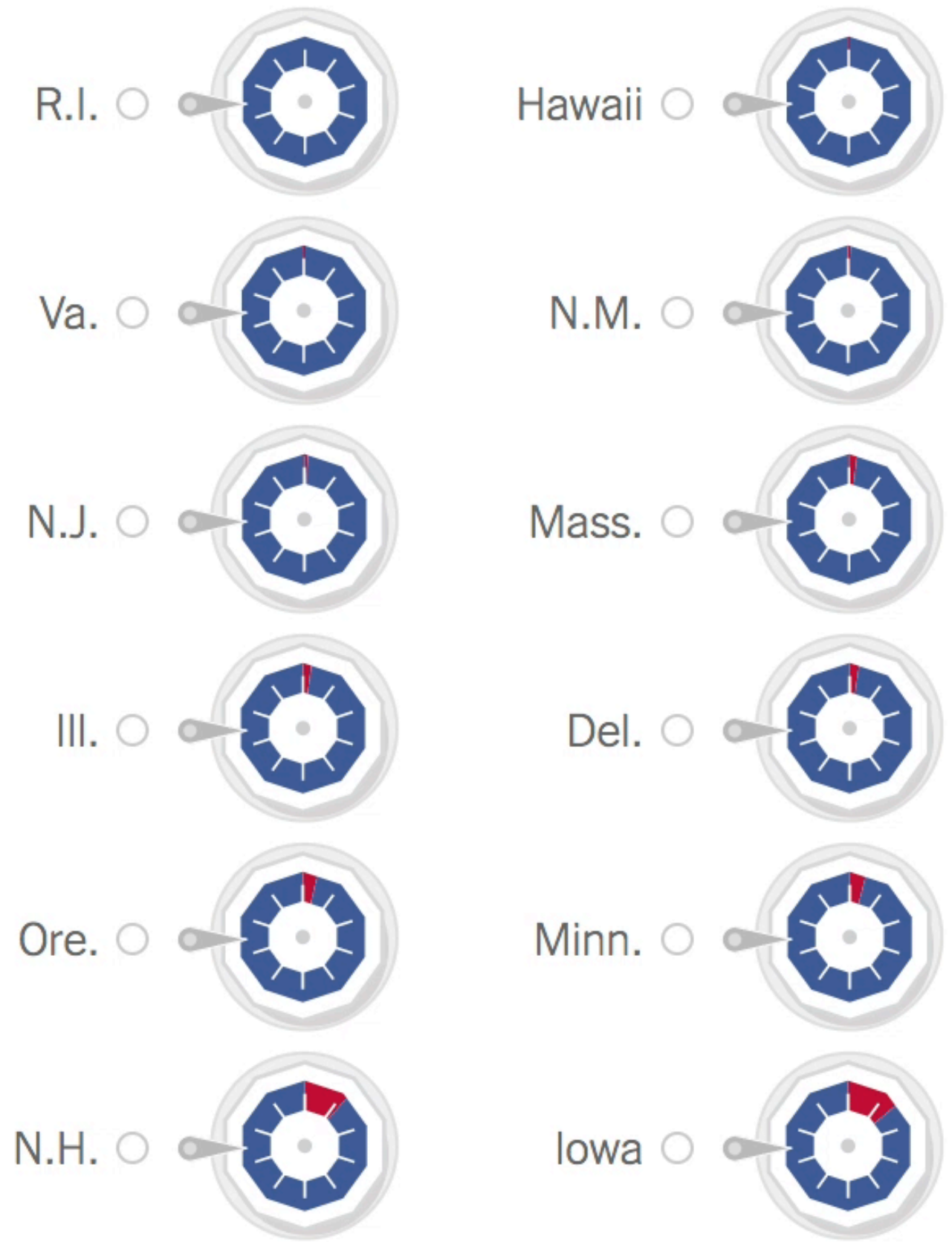
Democrats: ??

Republicans: ??

Likely Democratic

Competitive

Likely Republican



Here's a simulation of who could be in and who could be out if the candidates' averages were rounded to the nearest whole number.

If the averages are correct, but rounding is to the nearest whole number:



Rounding to fewer decimal places could be welcome news for candidates on the cusp like Mr. Santorum (who has already [called](#) the debate rules “a miscarriage”), Mr. Kasich or Mr. Jindal.

Uncertainty

What does it mean?

How should I visualize it?

Building models is necessary to quantify uncertainty.

It is important to communicate the variability in model outcomes.

Dynamic or ensemble displays can help communicate complex models.

Why Authors Sometimes Don't Visualize Uncertainty

A visualization expresses a signal

Authors simplify, crystallize, abstract the complexity of data.

Process validates signal

Authors decide whether process has "low enough" uncertainty.

Uncertainty obfuscates signal

Could distract, or require too much work from the reader.

Uncertainty

What does it mean?

Lots of things!

How should I visualize it?

It depends!