

# Uncertainty

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**DSC 106: Data Visualization**

Sam Lau

UC San Diego

# Announcements

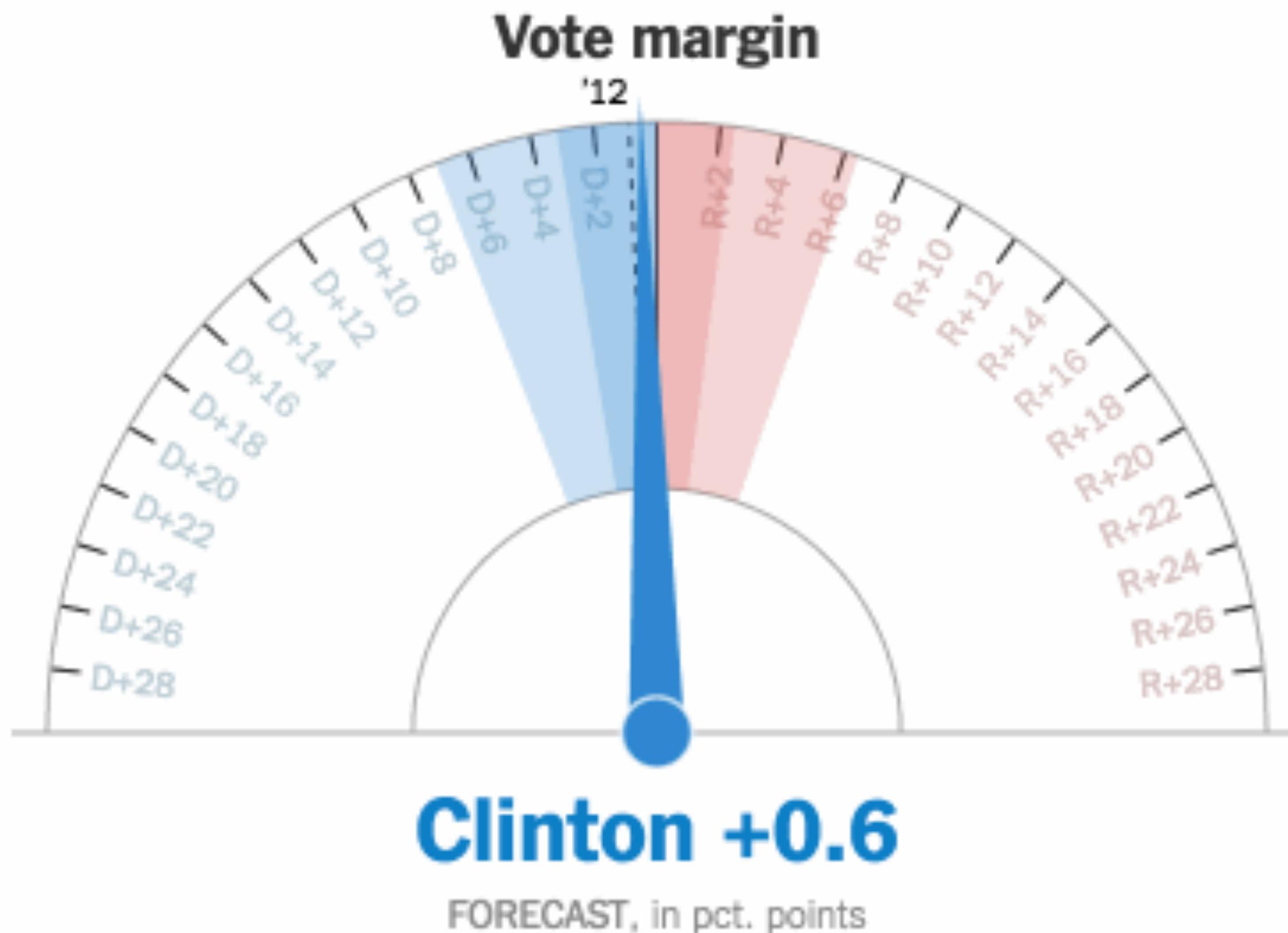
Lab 7 due Friday.

Final project proposal (and teams) due next week Tuesday.

No lectures next week since Sam is traveling (only need to attend discussion for attendance).

## FAQs:

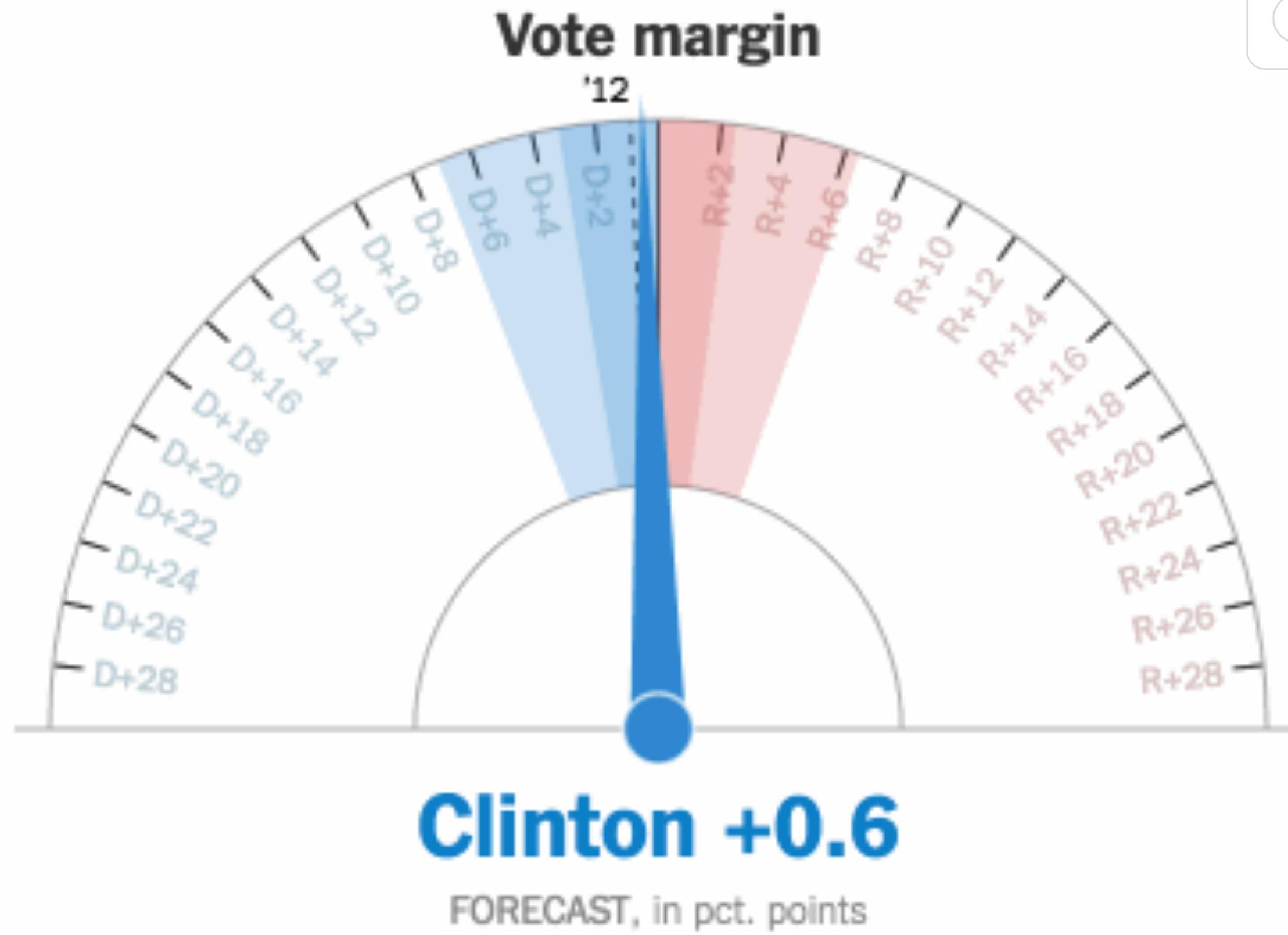
1.



What is being visualized?

What are the strengths and weaknesses of this visualization?

[tryclassbuzz.com](http://tryclassbuzz.com)  
Code: **needle**



(gobsmacked) @nv... · 10:08 PM · Nov 8, 2016

I'm taking damn NY

10:08 PM · 2 · 1

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

Paul D. Shinkman @PDShinkman · Follow

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



10:03 PM · Nov 8, 2016

1 · Reply · S

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

**Popular vote margin**

Clinton +3.3  
278 Clinton

Watch on Twitter

Network Timeline Profiles Application Security Help

general-main.js x

```
range_85 = range_85 * damping + range_85_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_foreca
// if (opts.class != 'dem') jitter *= -1;
needle.attr('transform', 'scale('+scale+') rotate('+angle(cur_val
```

GIF

@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

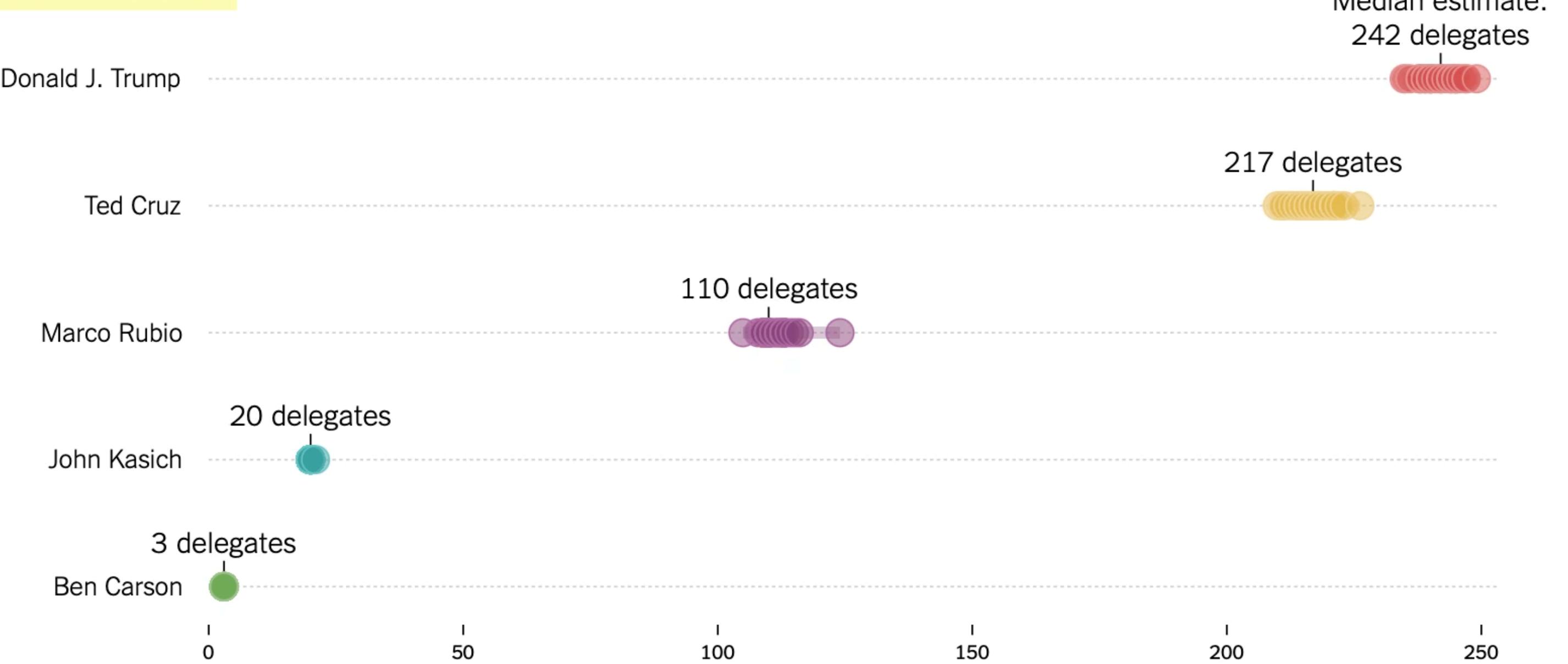
33 · Reply · S · Share

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



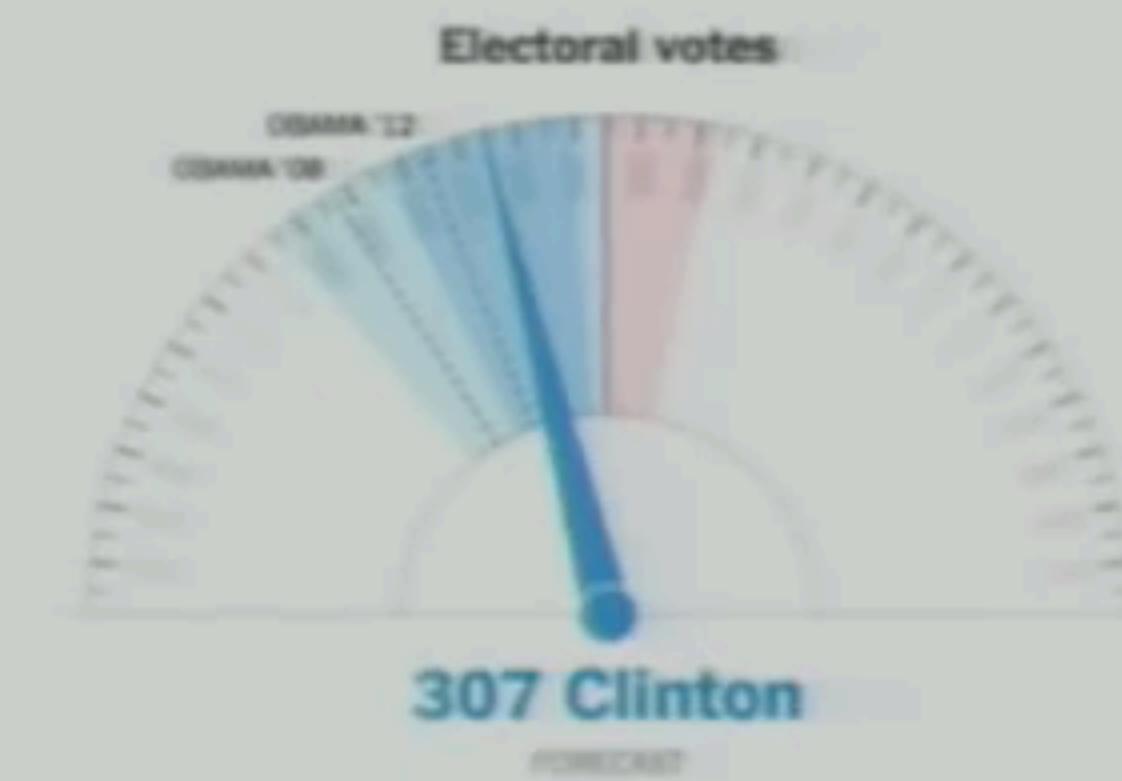
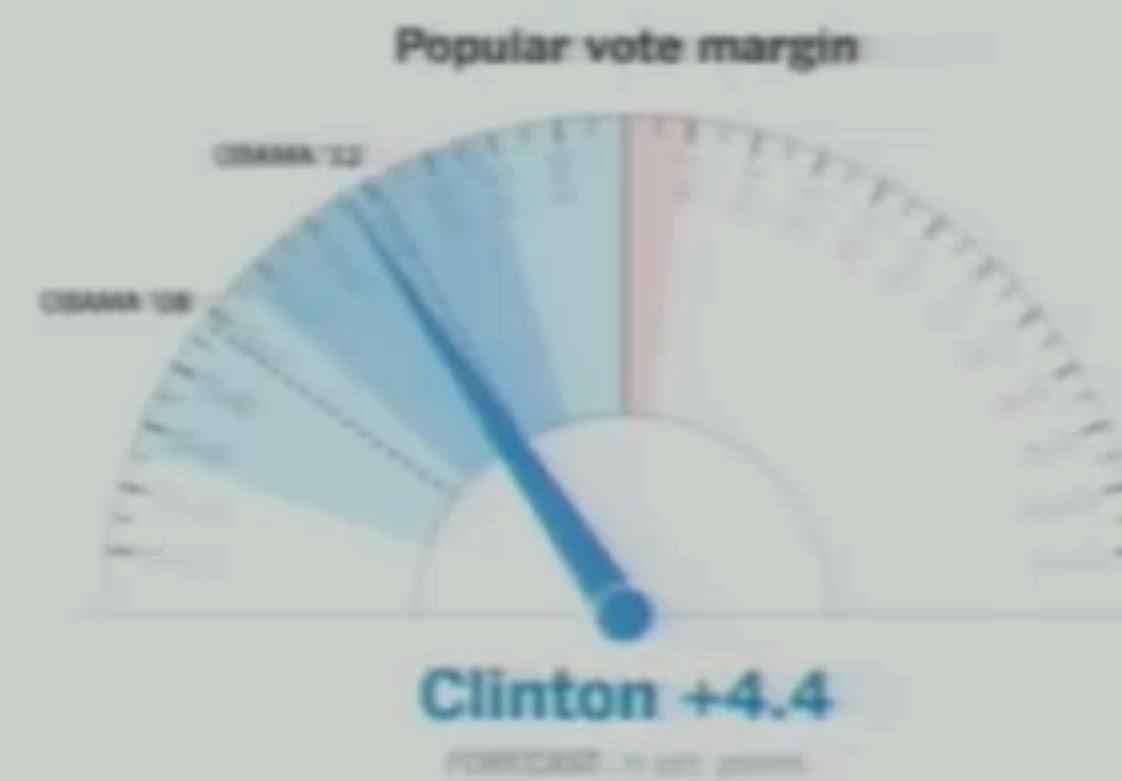
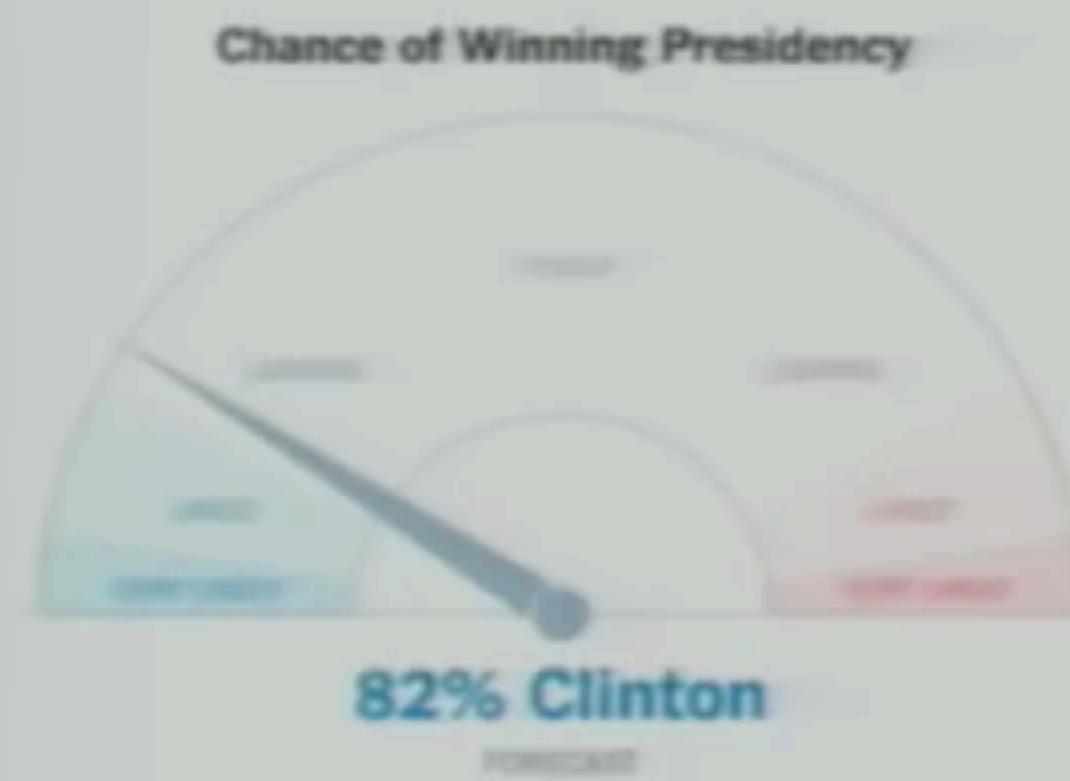
We're simulating the number of delegates each candidate will pick up on Super Tuesday. The dots above represent a range of possible outcomes.

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

How does it compare to  
the needle?

# Live Presidential Forecast

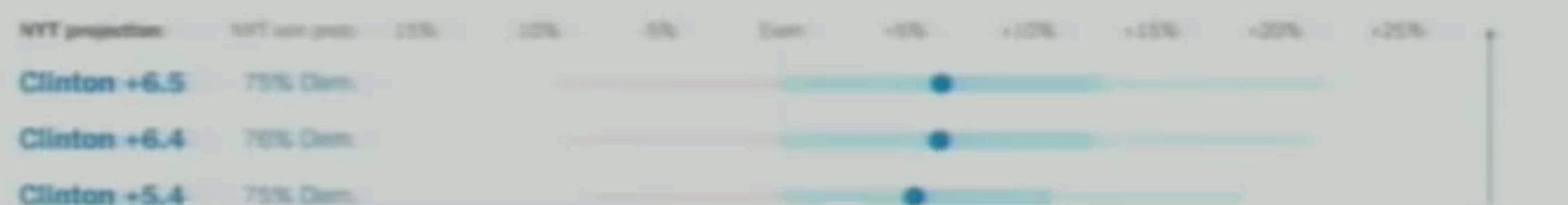
Updated 7:58:14 PM ET



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](#)

Name	Est. perf. of states	Estimated margin
Michigan	0%	Clinton +6.5
New Mexico	0%	Clinton +6.4
Wisconsin	0%	Clinton +5.4



OPEN  
VIS 2017  
CONF

# Uncertainty

What does it mean?

How should I visualize it?

# Uncertainty

What does it mean?

How should I visualize it?

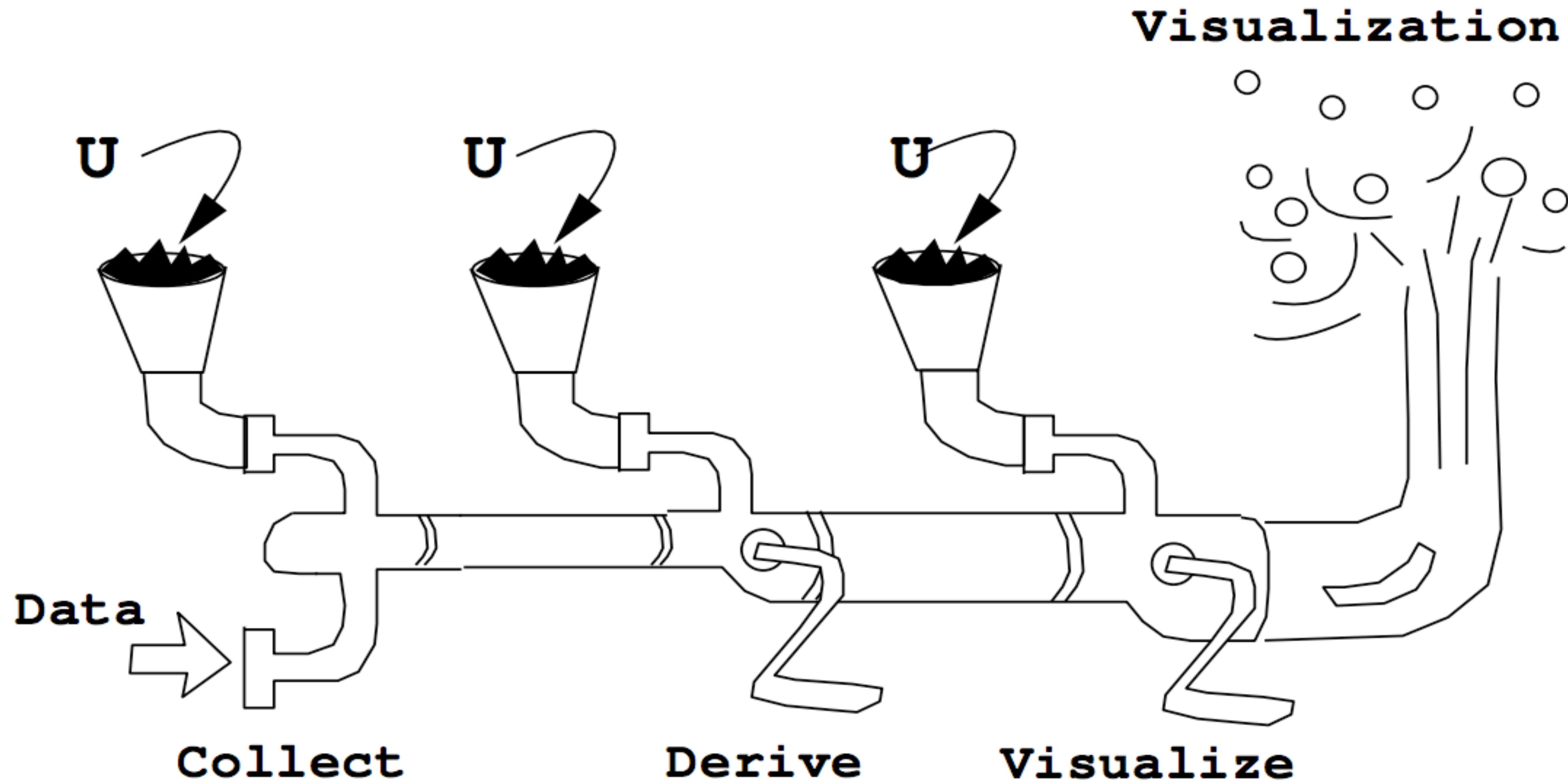
# Uncertainty

What does it mean?

How should I visualize it?

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

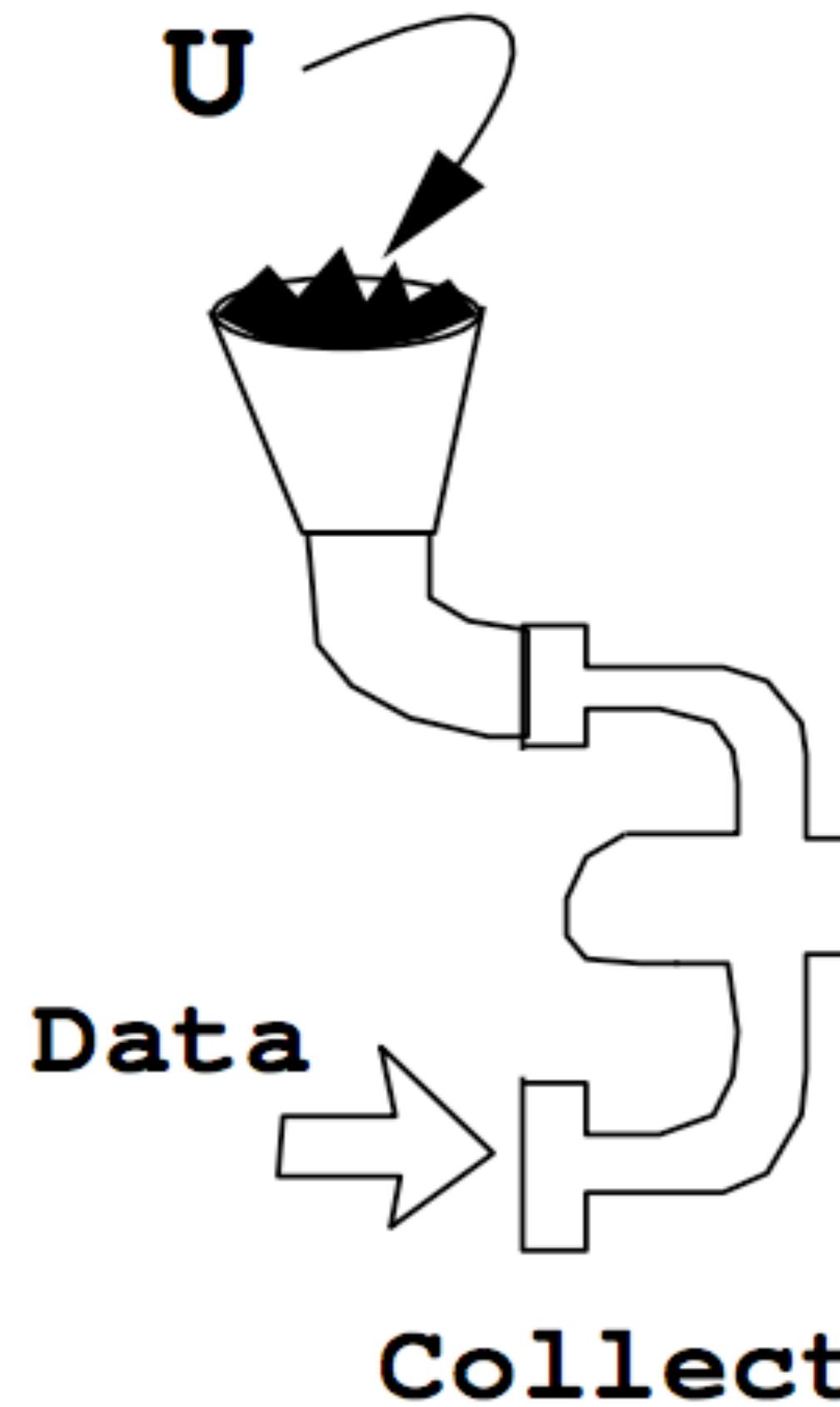
# Sources and Types of Uncertainty



# Sources and Types of Uncertainty

## Measurement Uncertainty

How and how much should we sample the data?



Precision

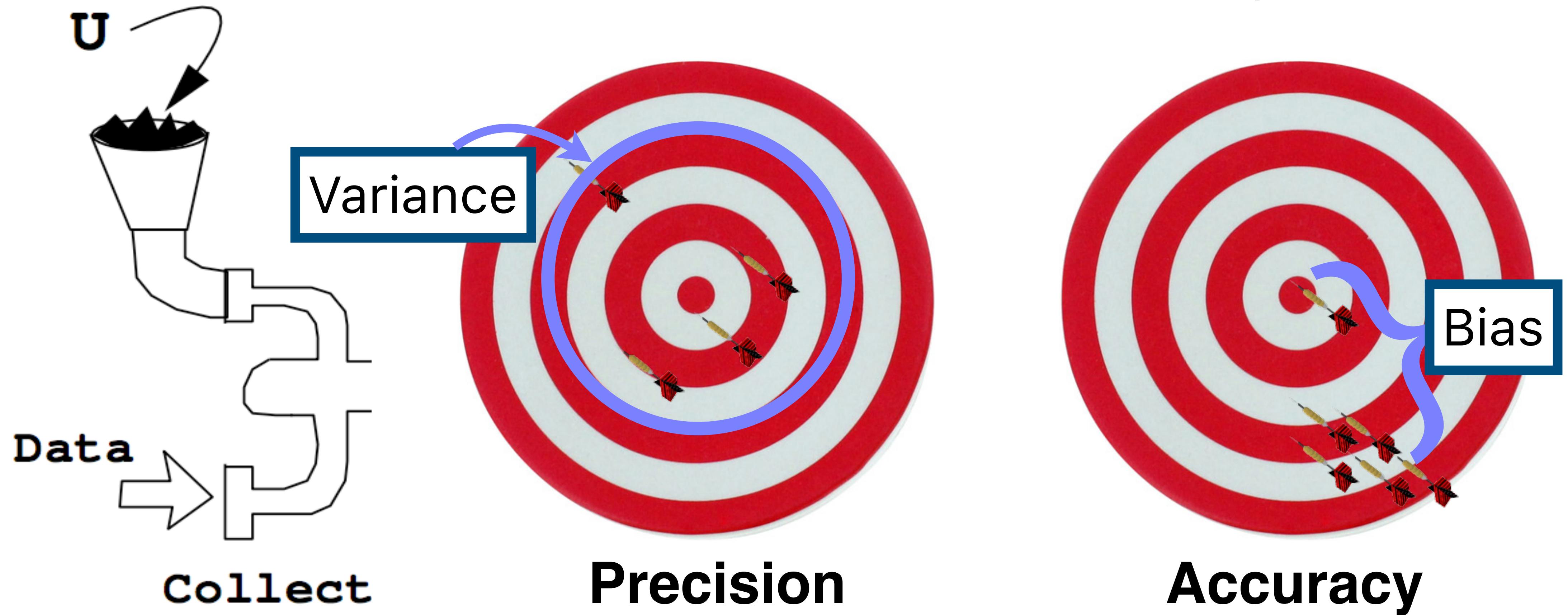


Accuracy

# Sources and Types of Uncertainty

## Measurement Uncertainty

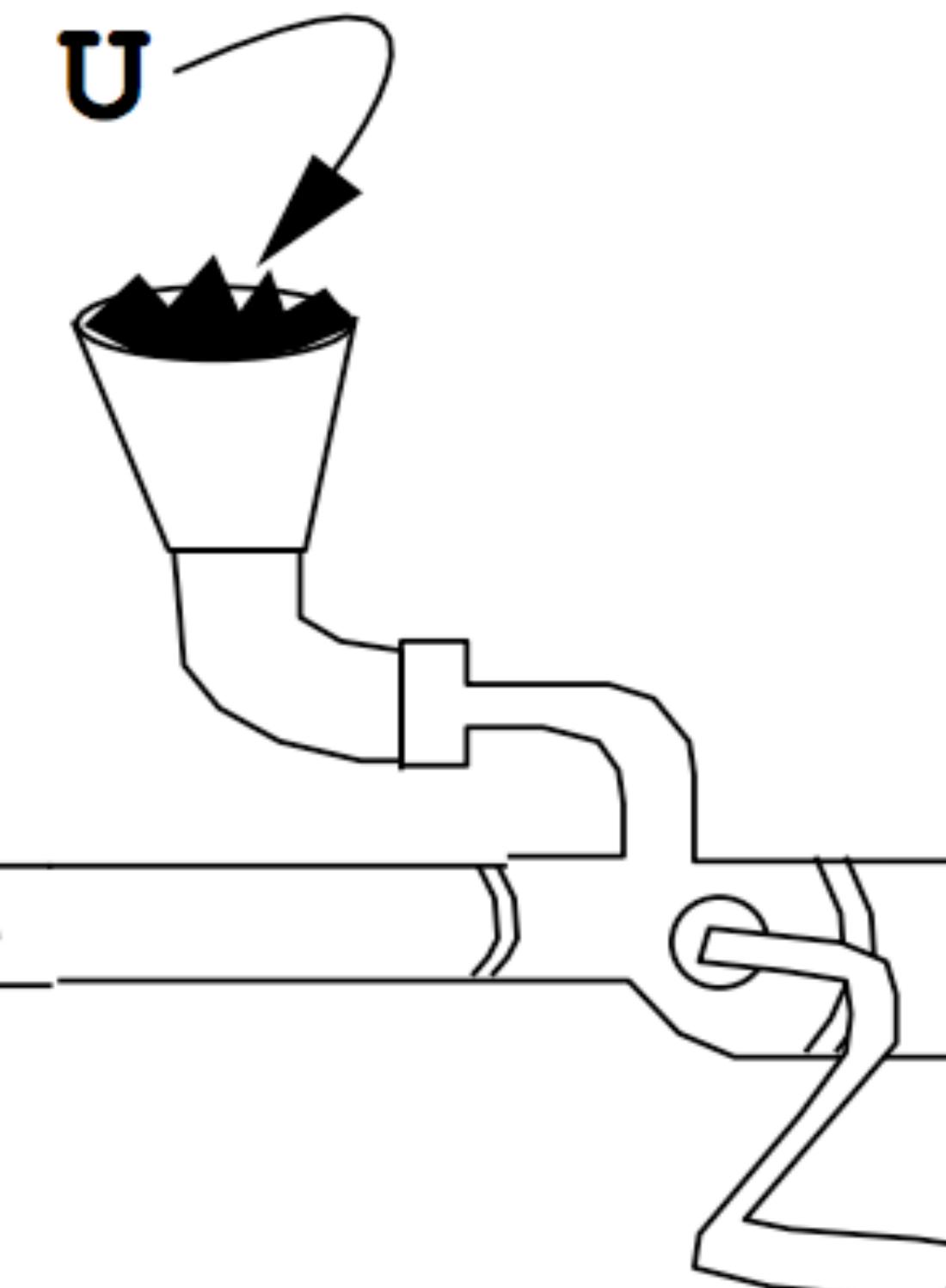
How and how much should we sample the data?



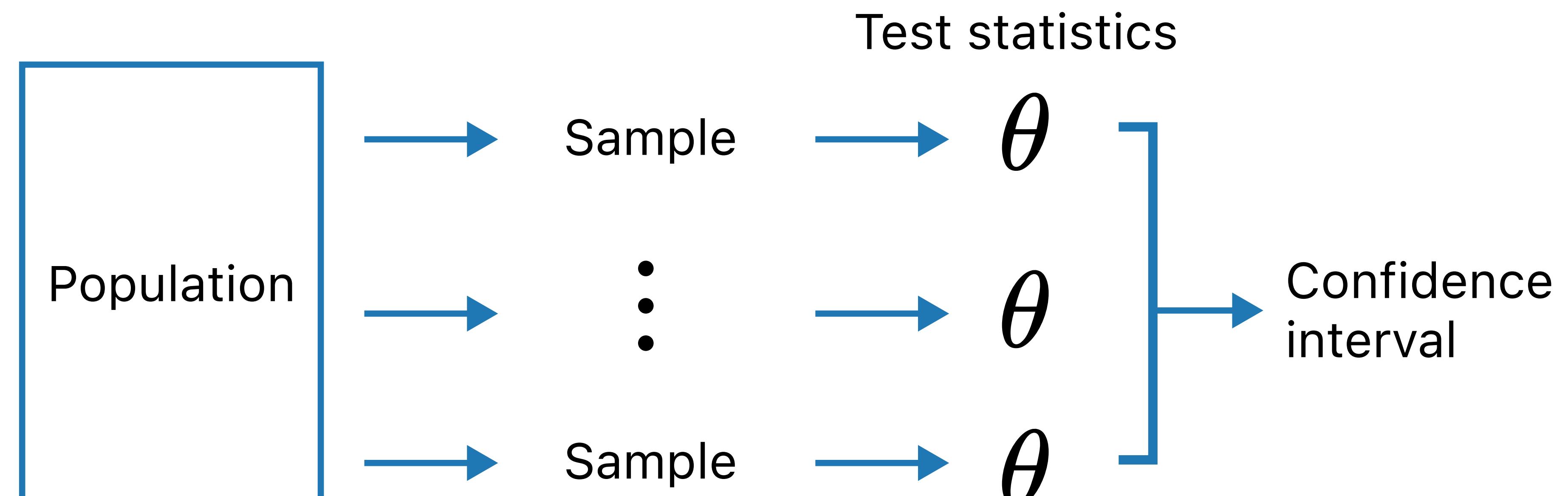
# Sources and Types of Uncertainty

## Model Uncertainty

How does the data fit together?

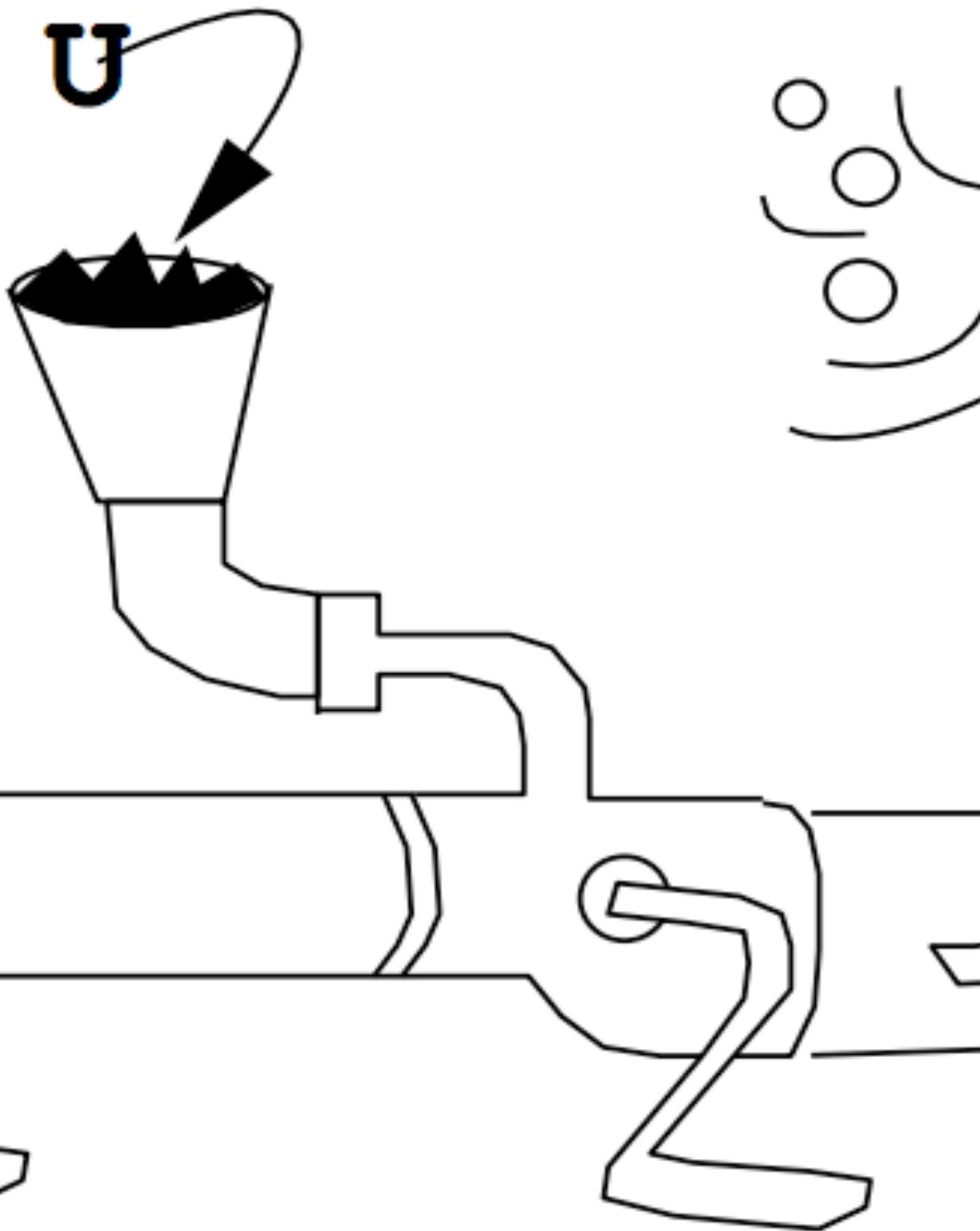


**Derive**



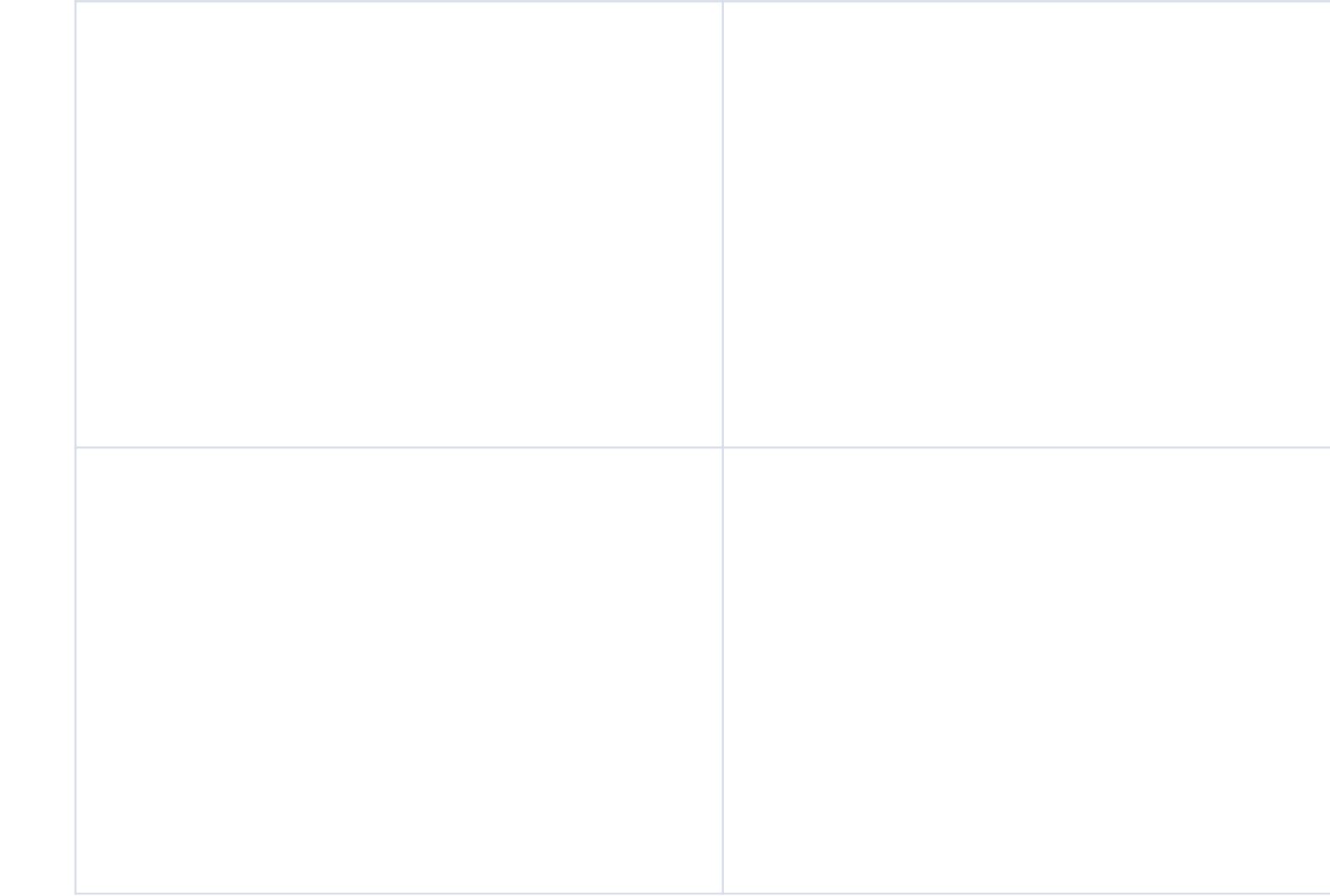
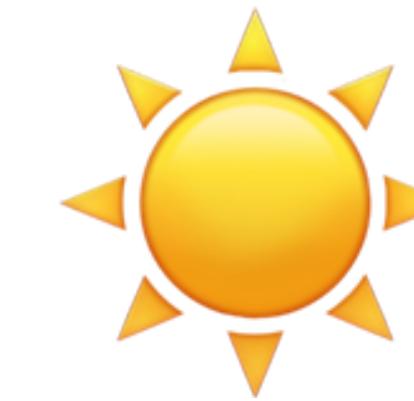
# Sources and Types of Uncertainty

visualize



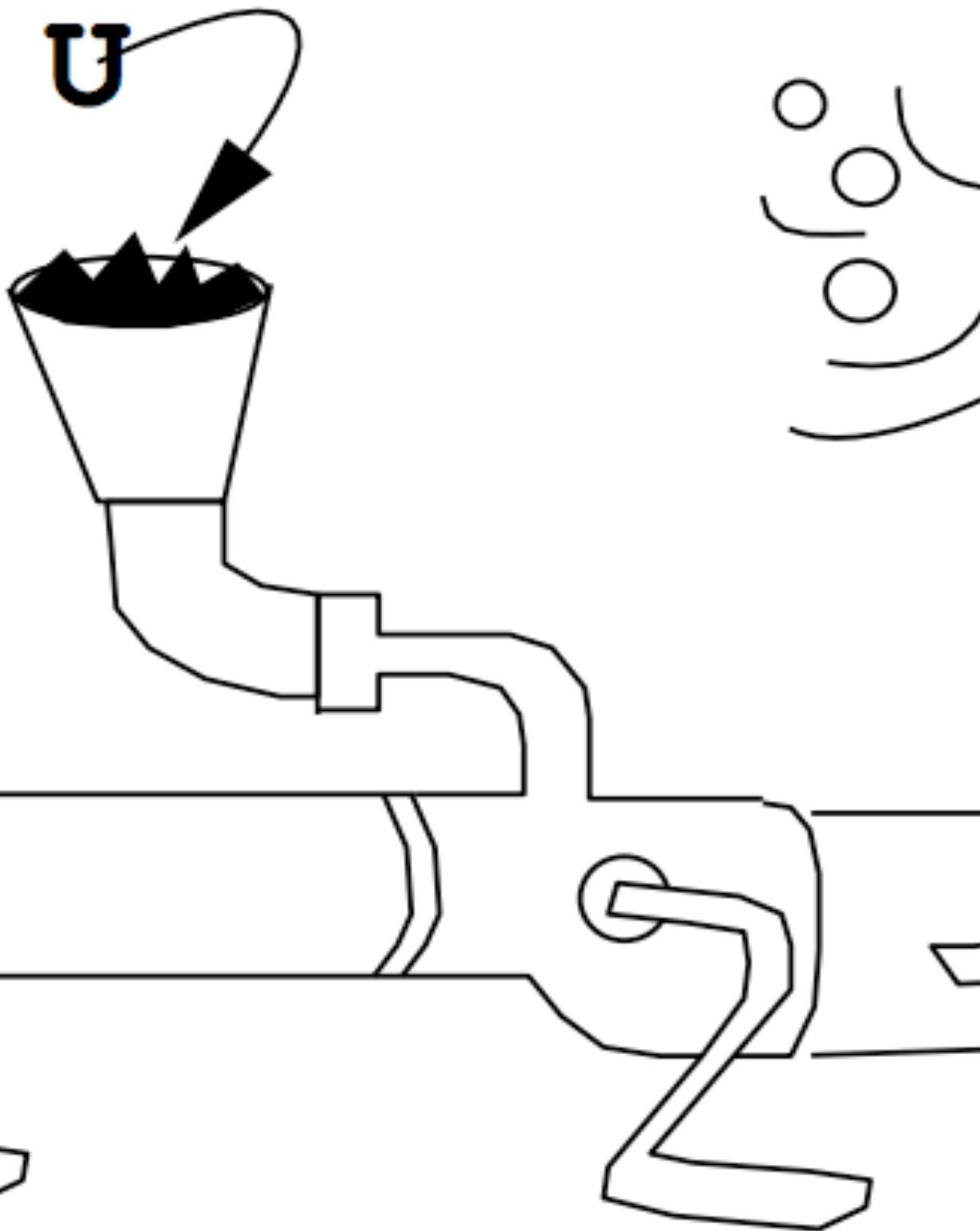
Visualize

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



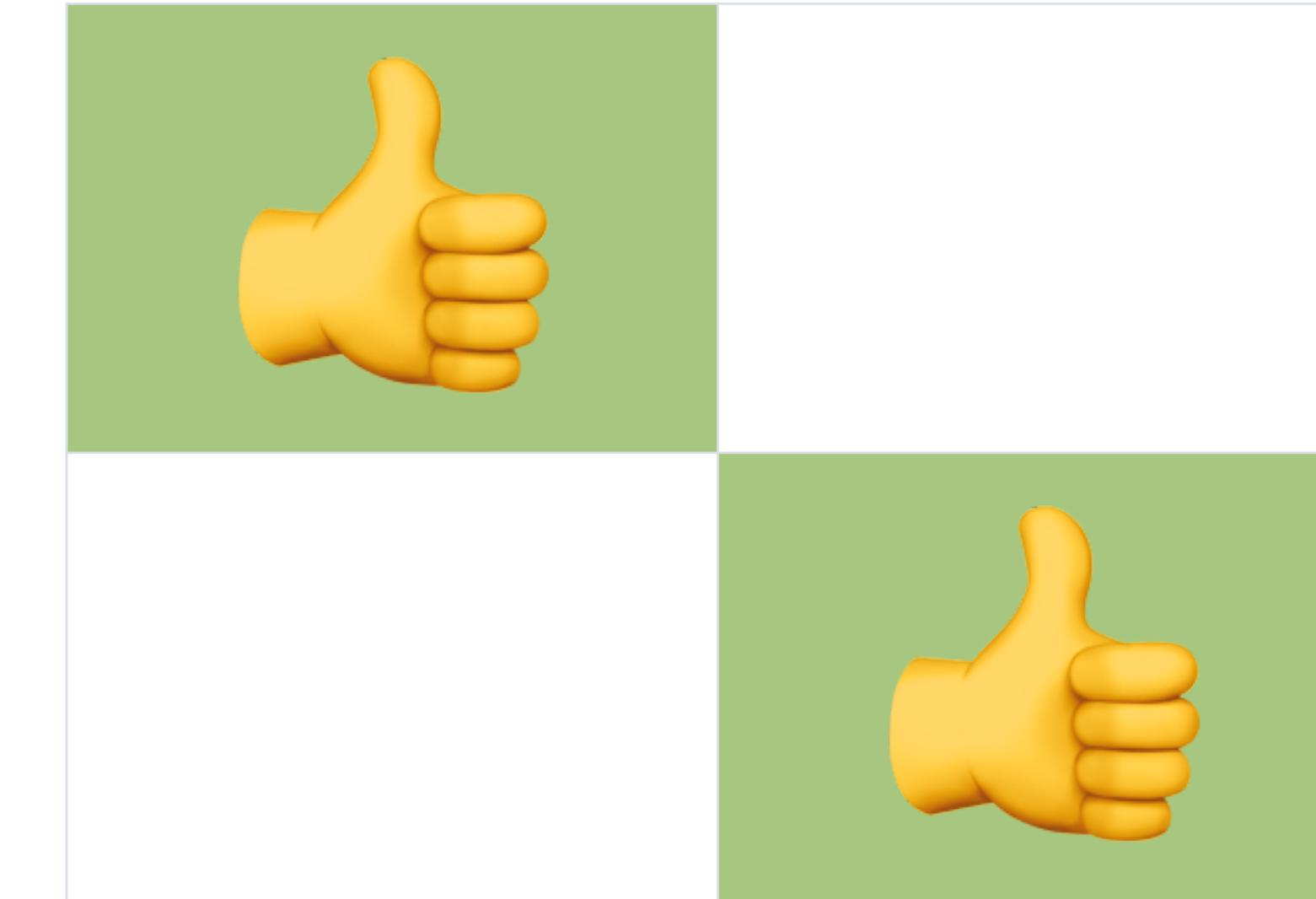
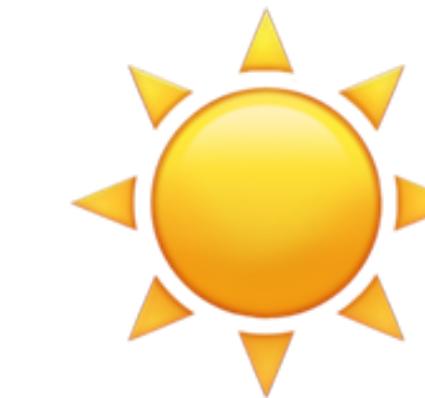
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visualize



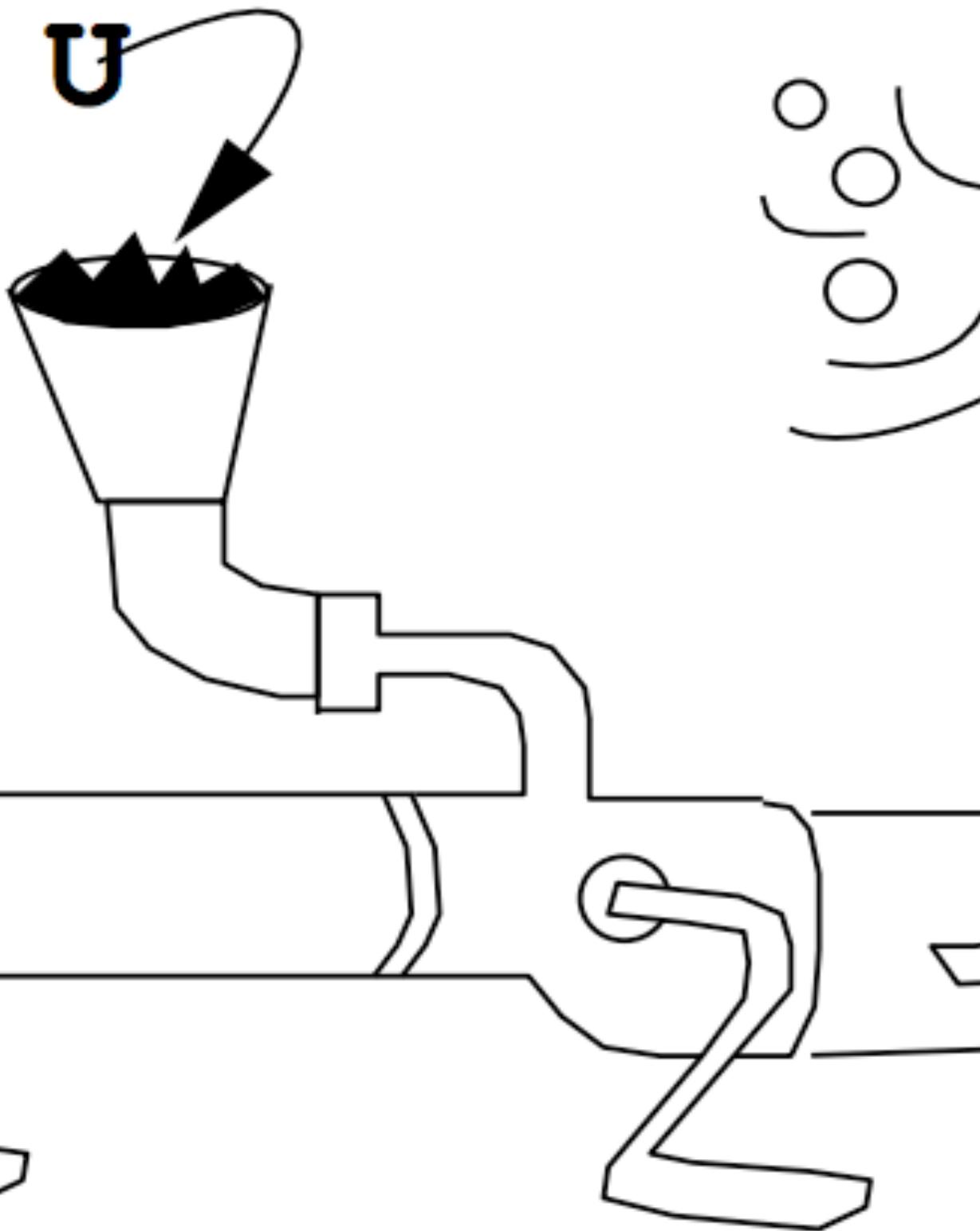
visualize

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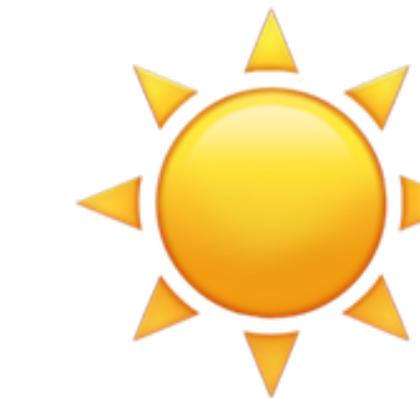
# Sources and Types of Uncertainty

visualize



visualize

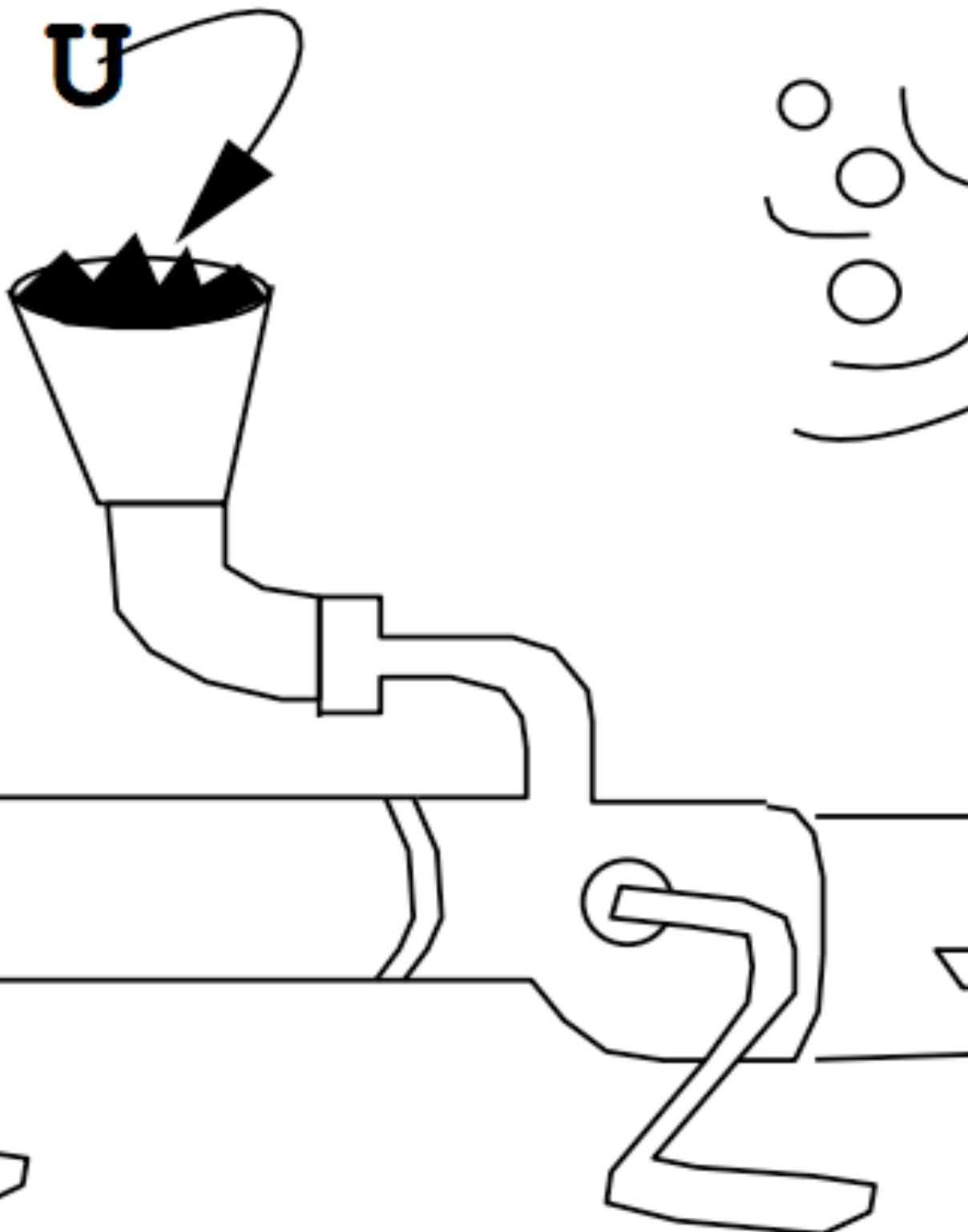
**Decision/Forecast Uncertainty**  
How do I assess the risk or error?



	<b>Type I False Positive</b>

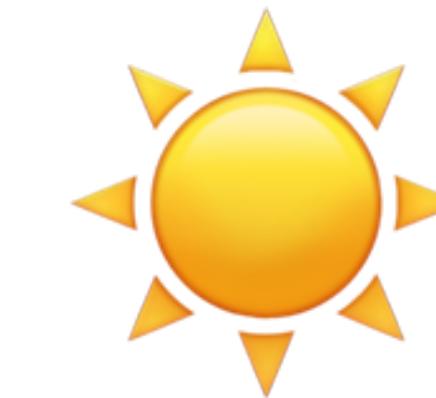
# Sources and Types of Uncertainty

visualize



visualize

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



	<b>Type I False Positive</b>
<b>Type II False Negative</b>	

# Uncertainty

What does it mean?

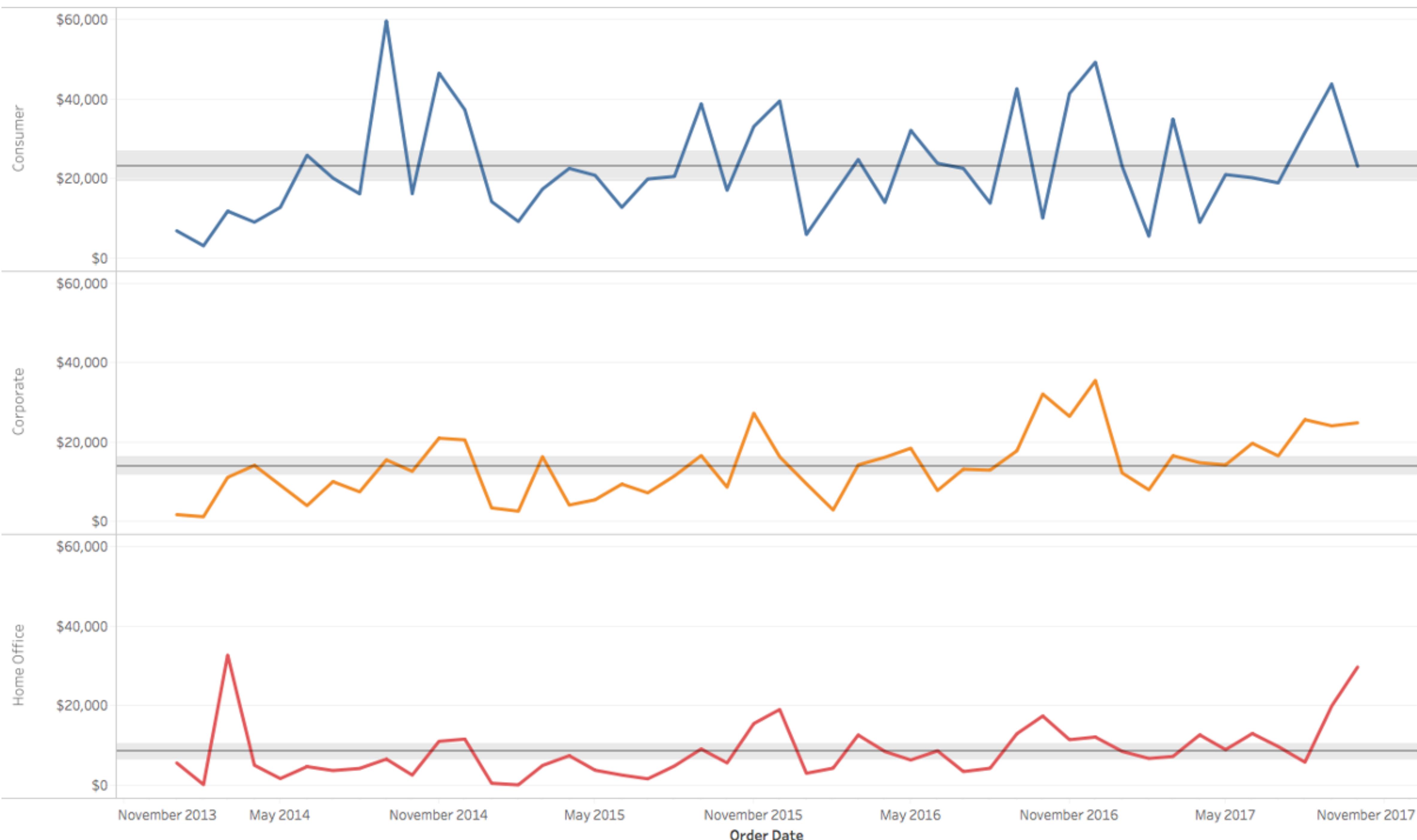
Lots of things!

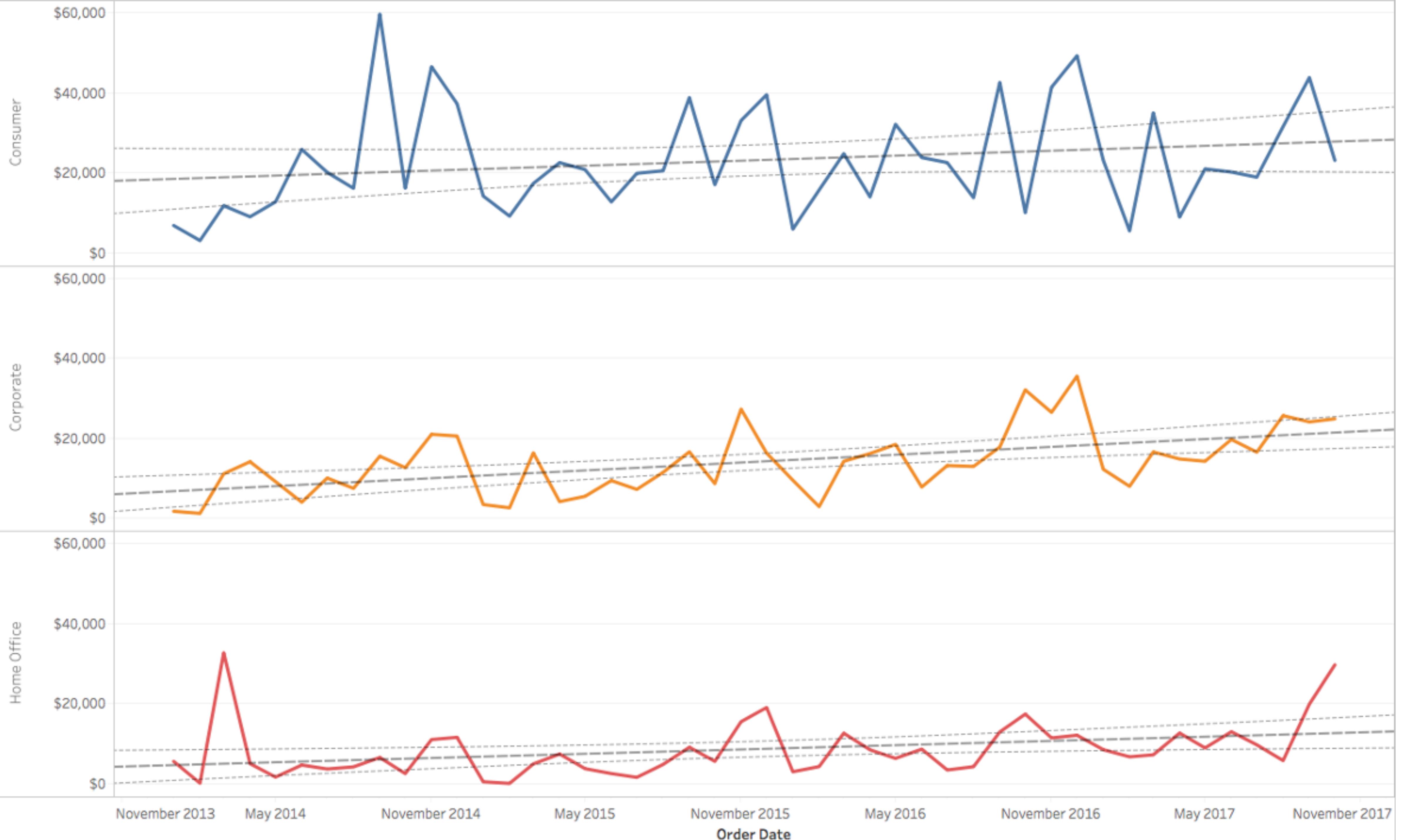
How should I visualize it?

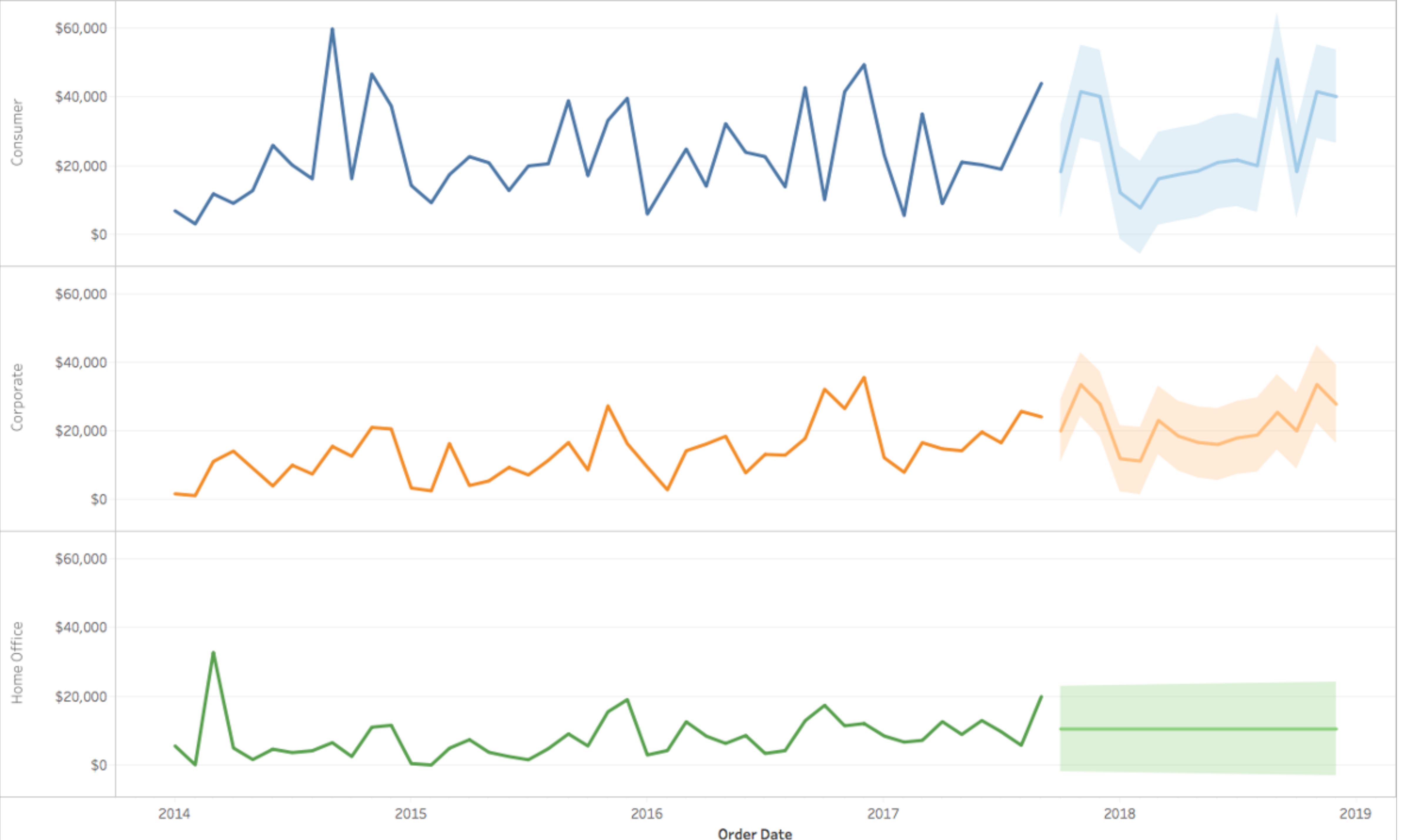
# Uncertainty

What does it mean?

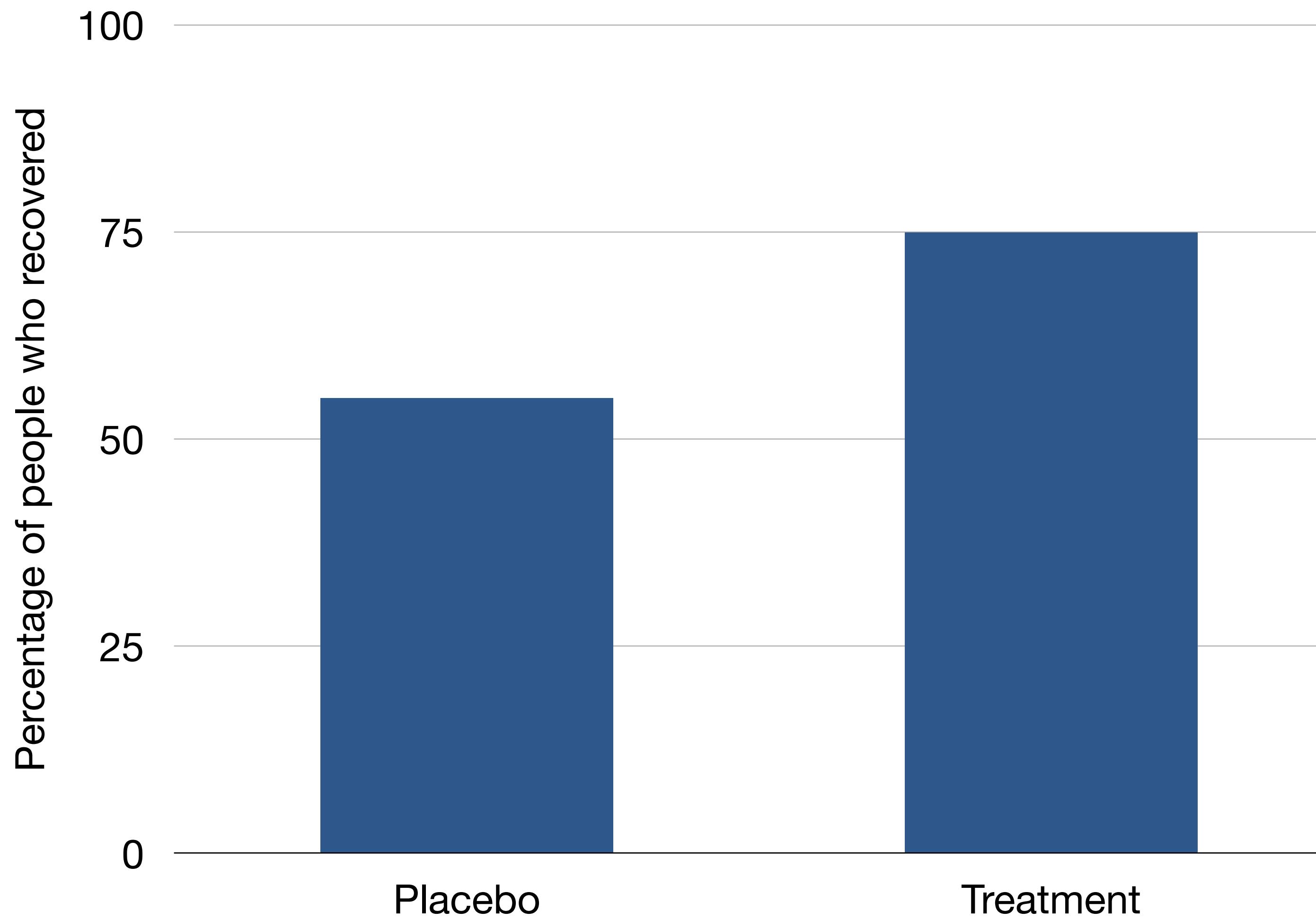
How should I visualize it?



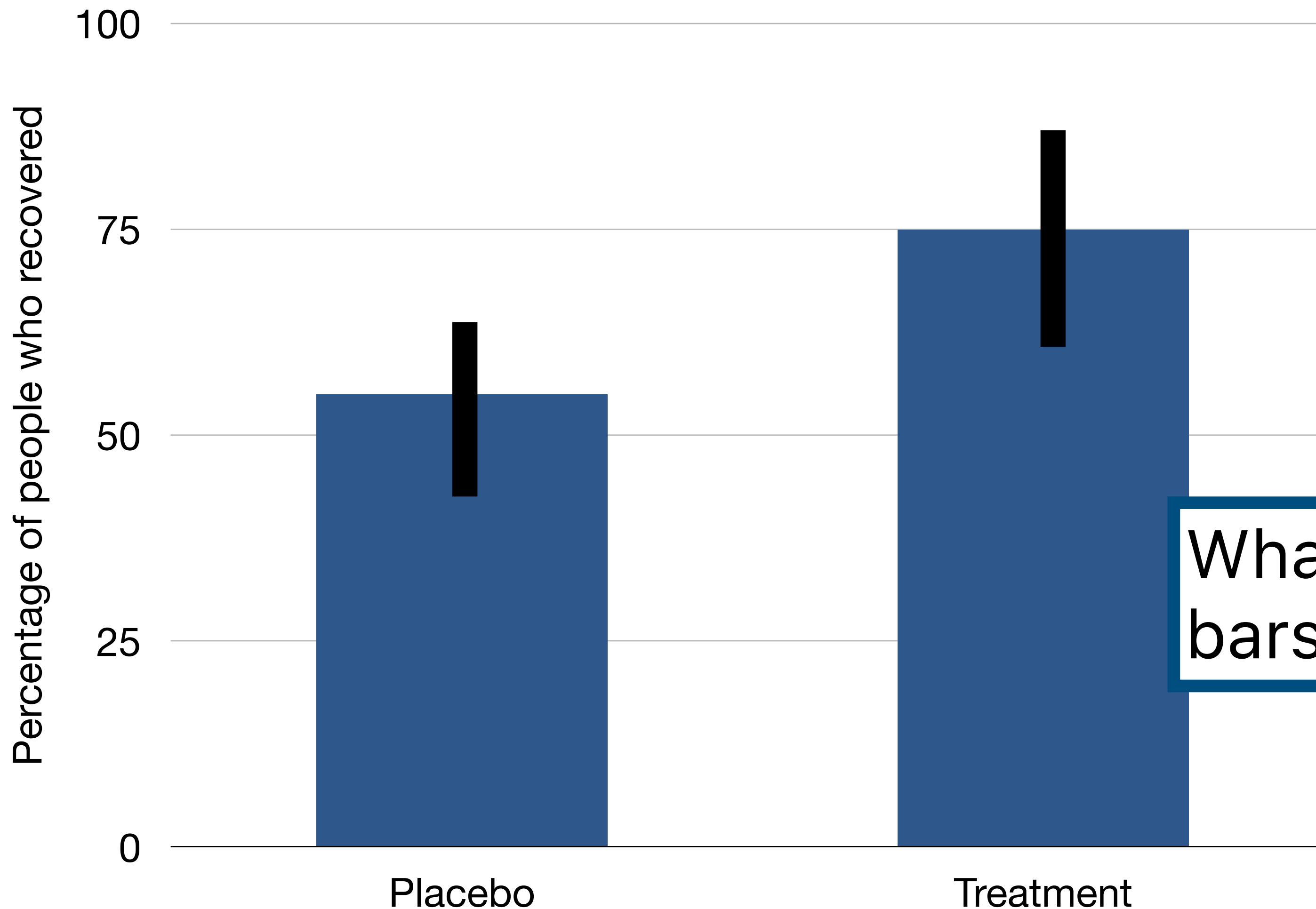




## Trial of new medicine

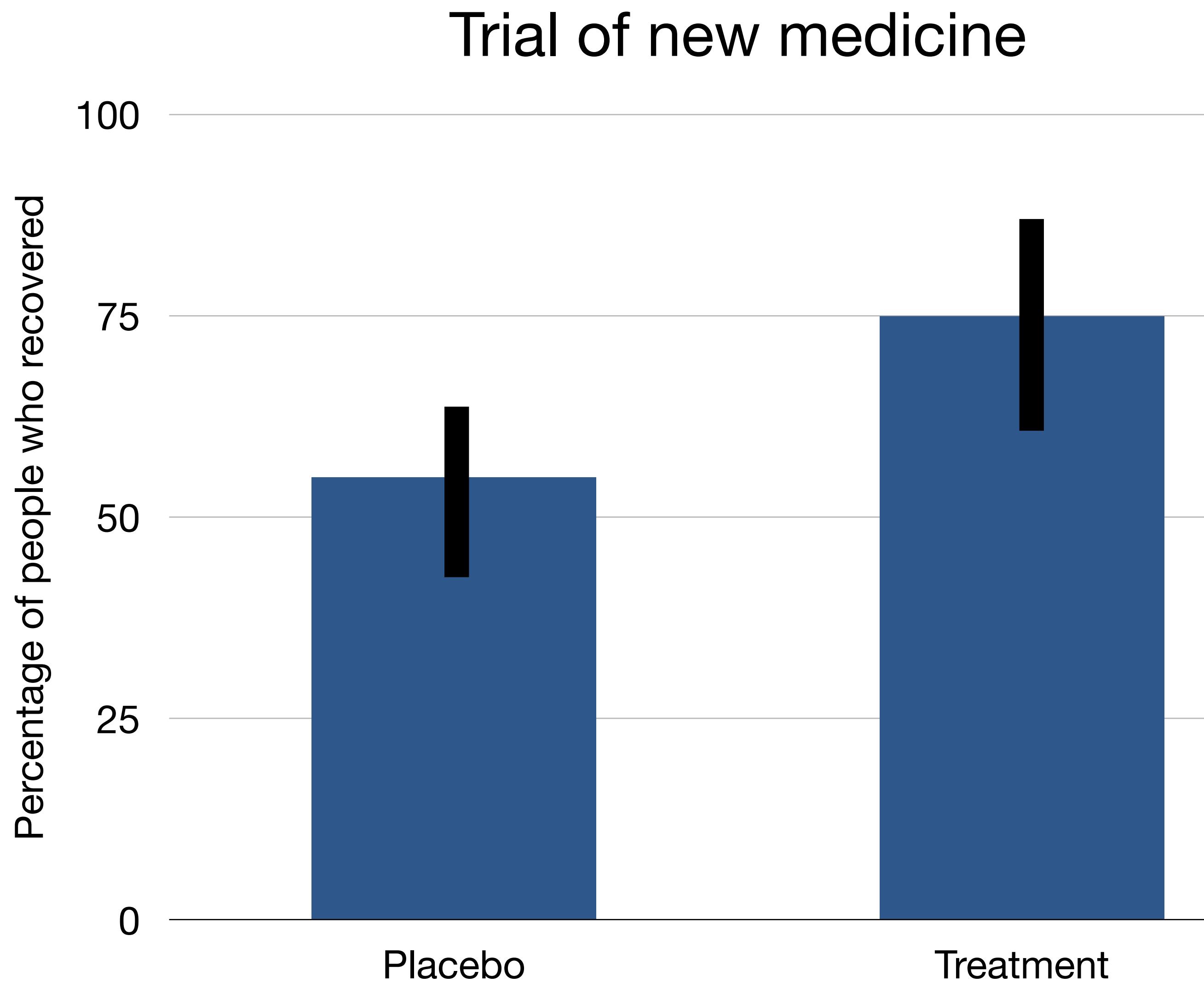


## Trial of new medicine



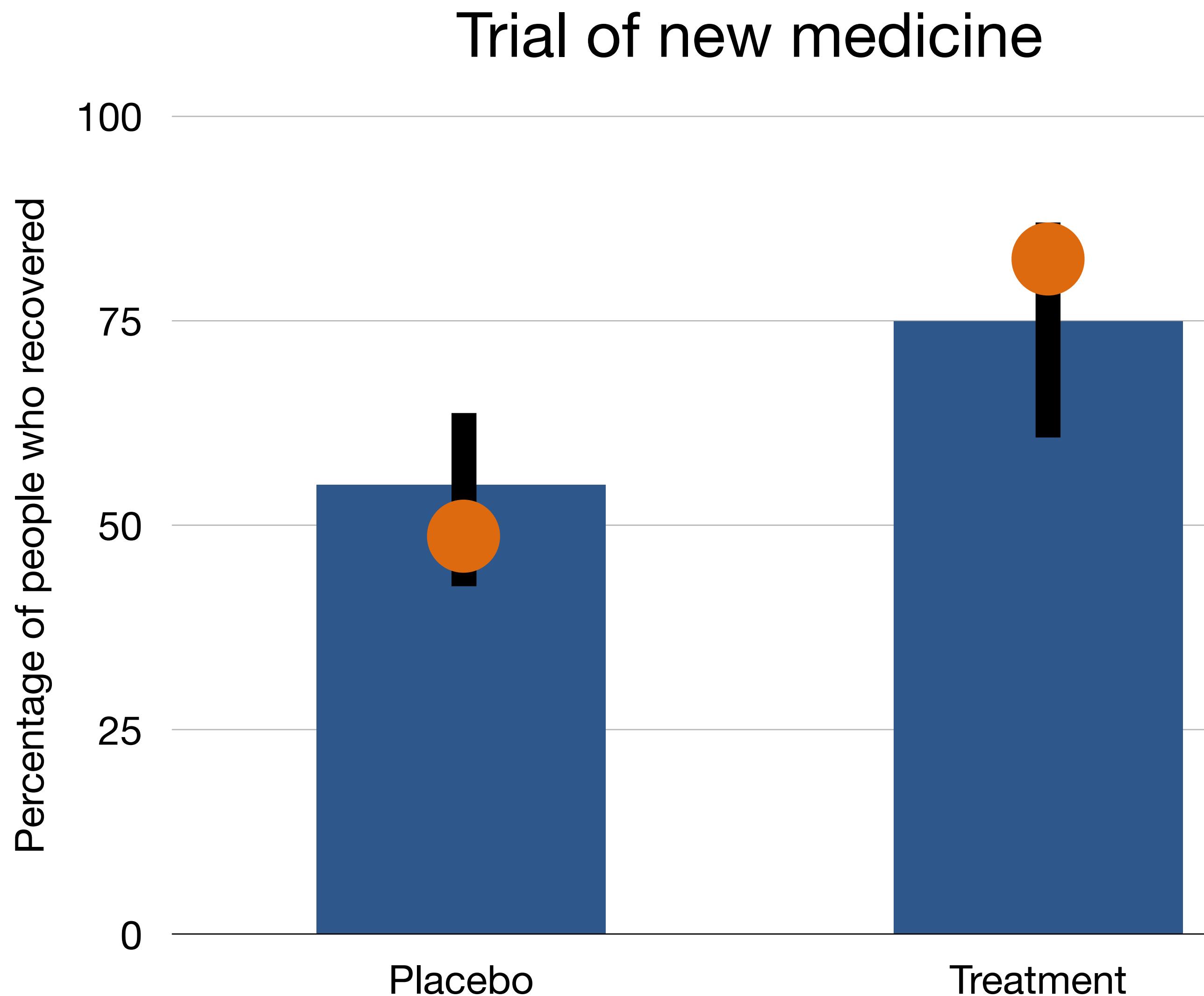
What do you think these error  
bars are implying?

[tryclassbuzz.com](http://tryclassbuzz.com)  
Code: **errorbars**



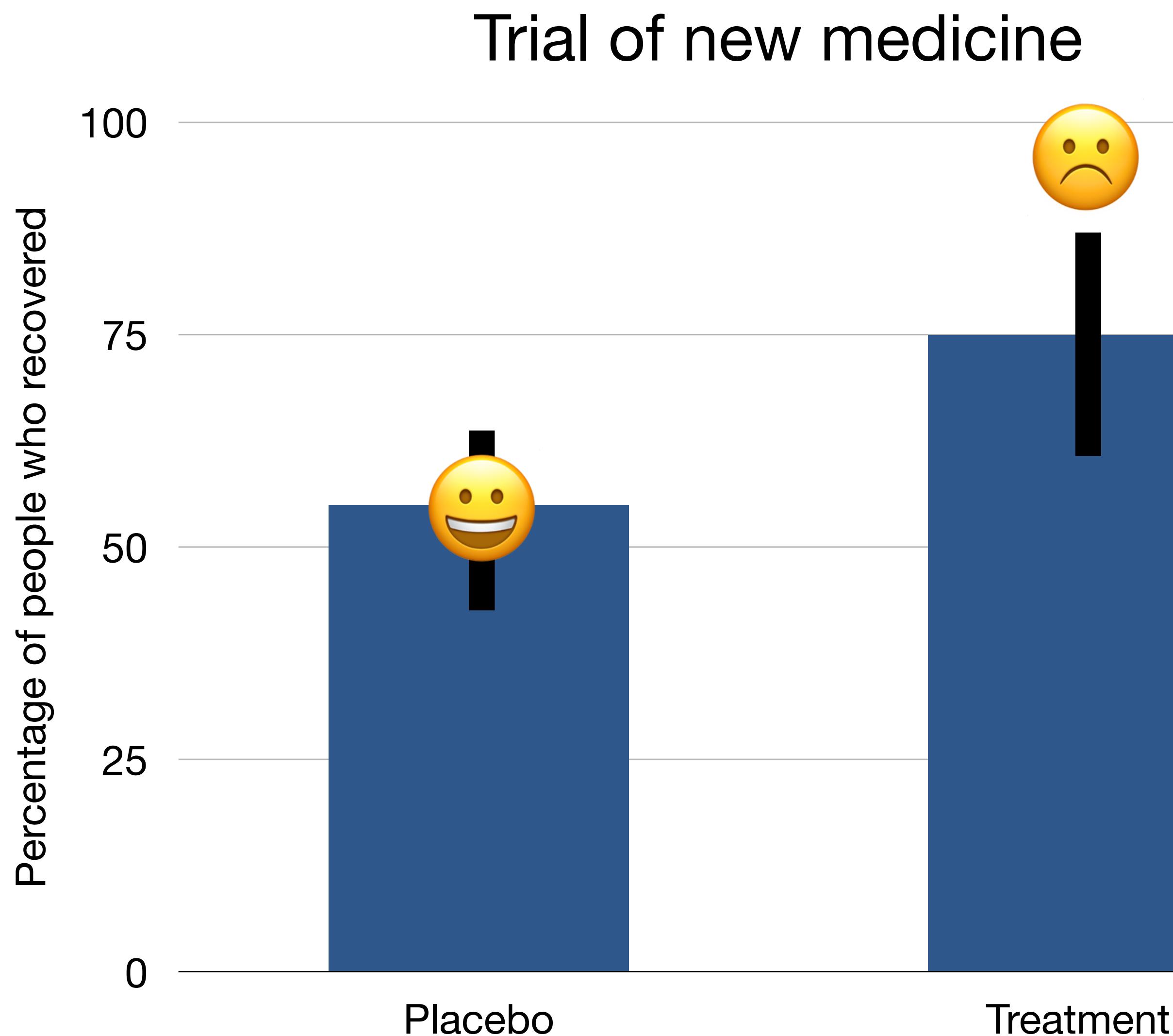
## Expressiveness?

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



## Expressiveness?

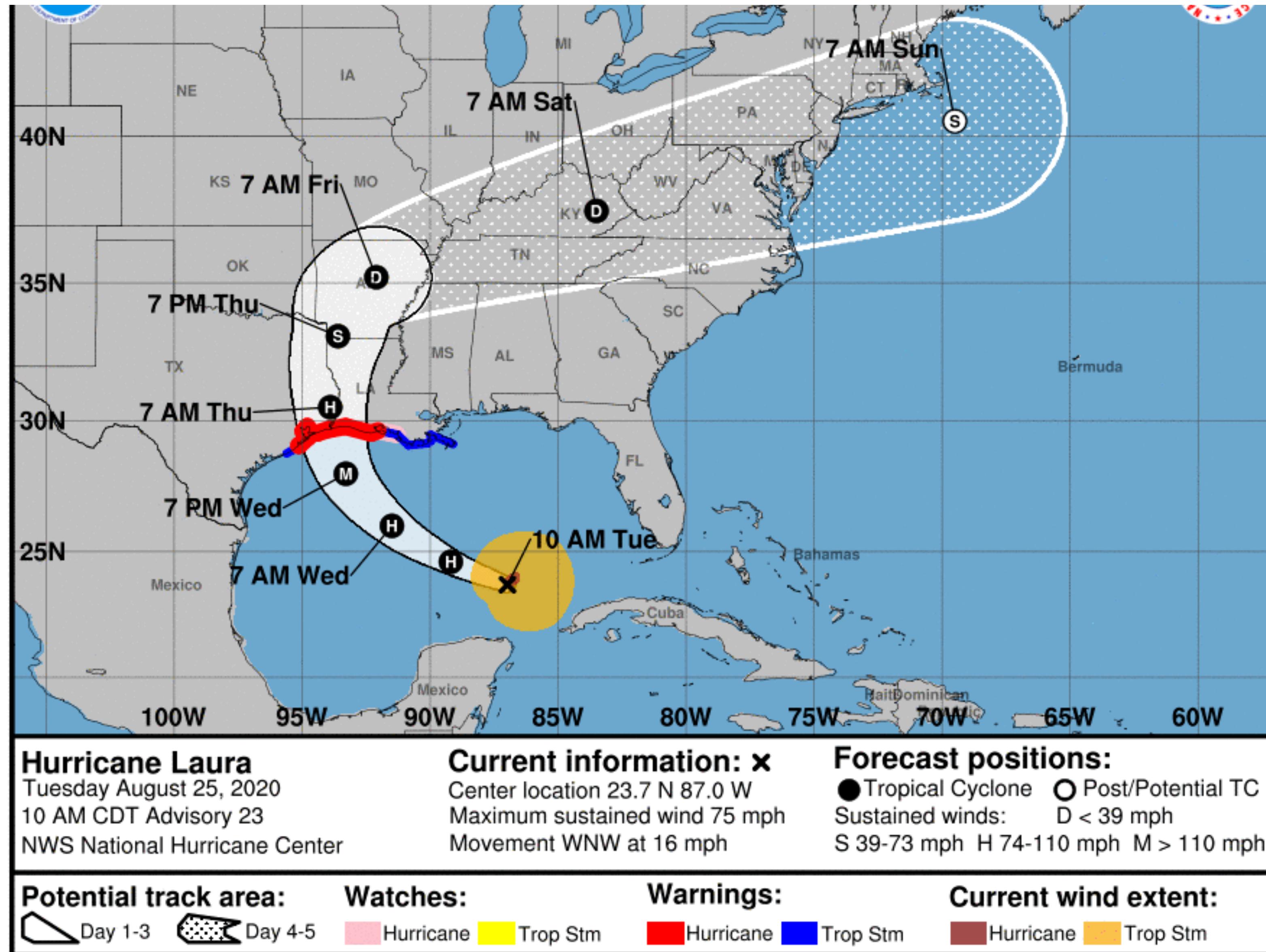
- ✖ Error bars aren't consistently used to visualize the same measure (standard error, IQR, 95% CI, etc.).
- ✖ Within-the-bar bias: people perceive points falling within the bar as more likely than those that lie outside.



## 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.

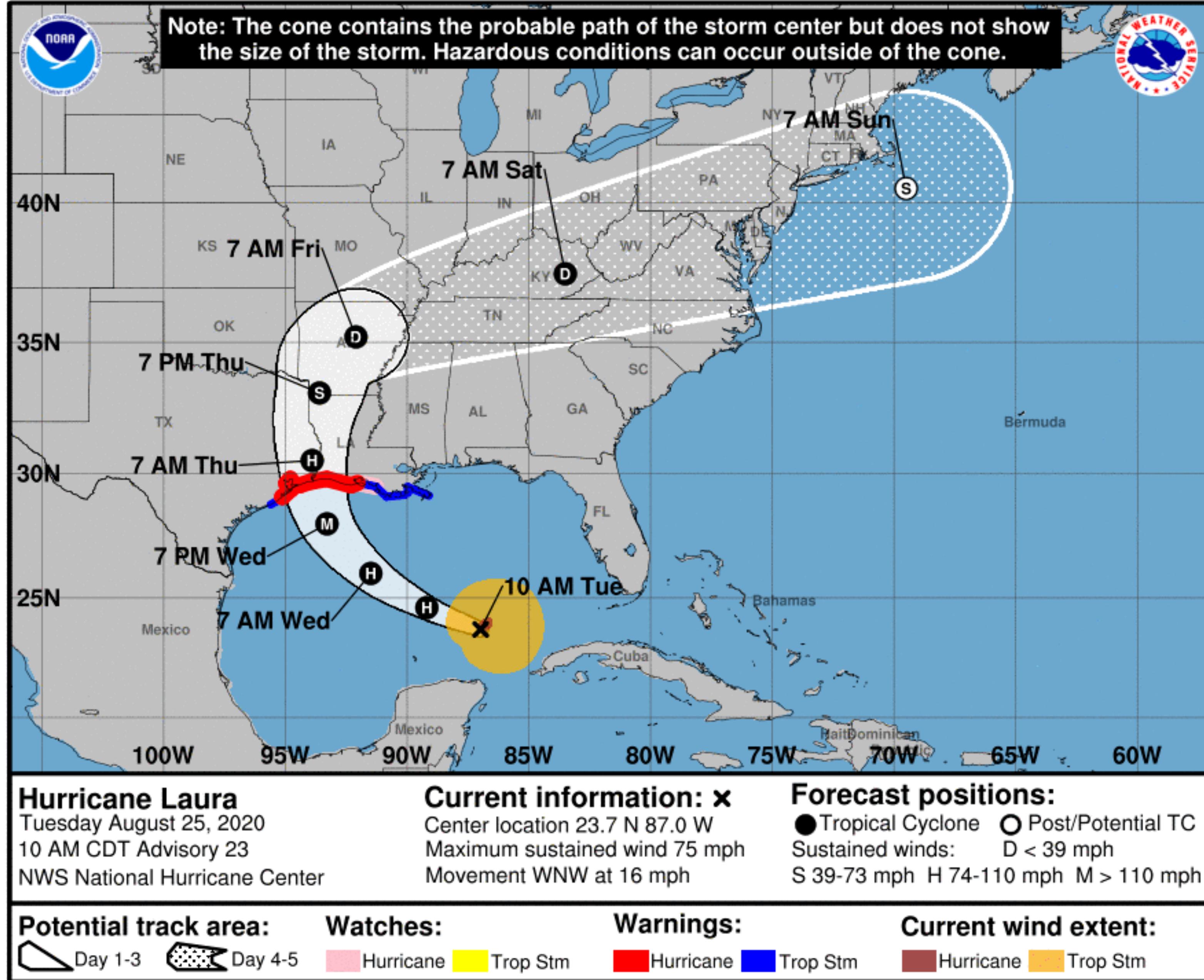
[Newman & Scholl, 2012]  
[Correll & Gleicher, 2014]



What is being visualized?

What are the strengths and weaknesses of this visualization?

[tryclassbuzz.com](http://tryclassbuzz.com)  
Code: hurricane



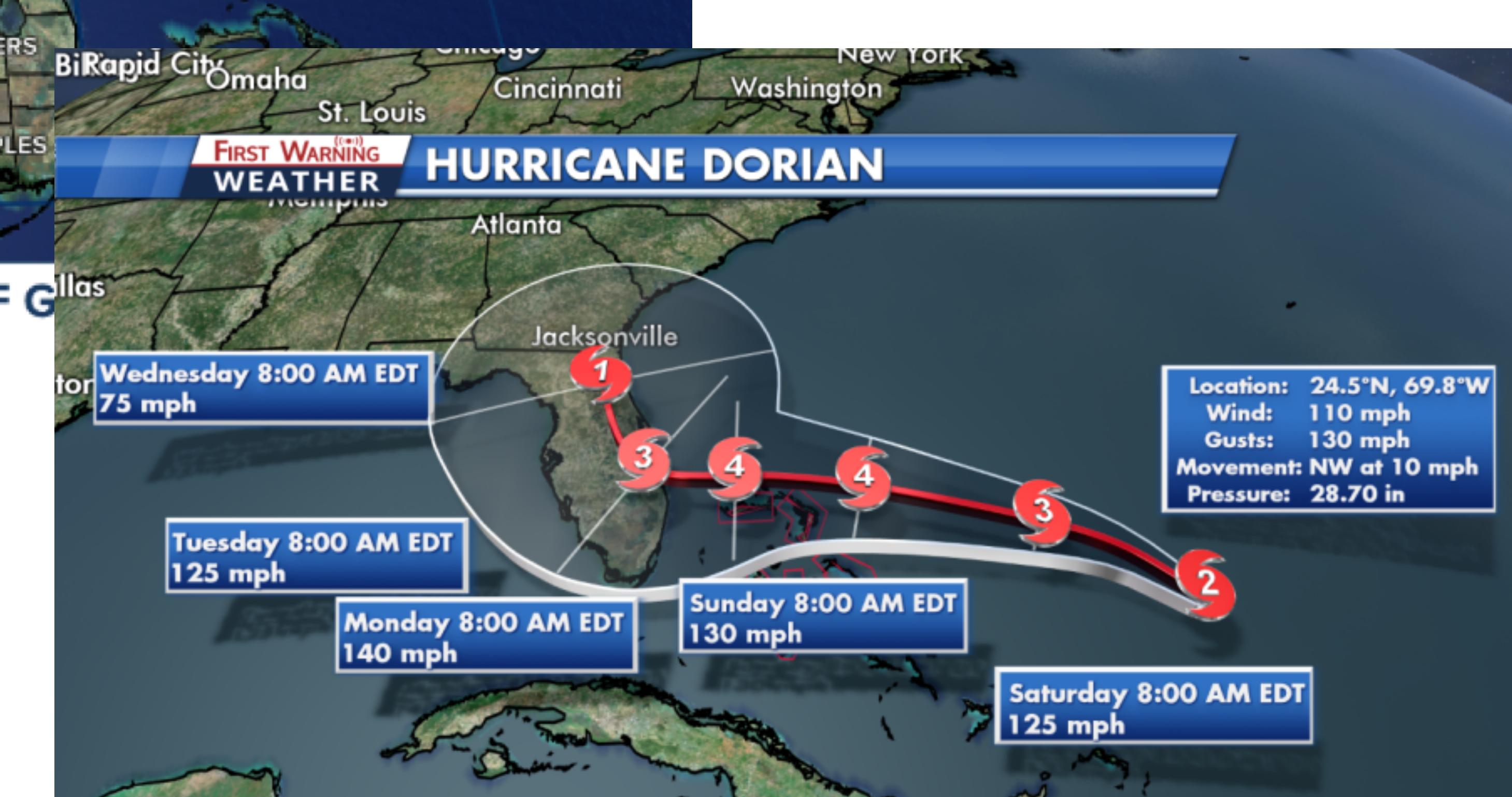
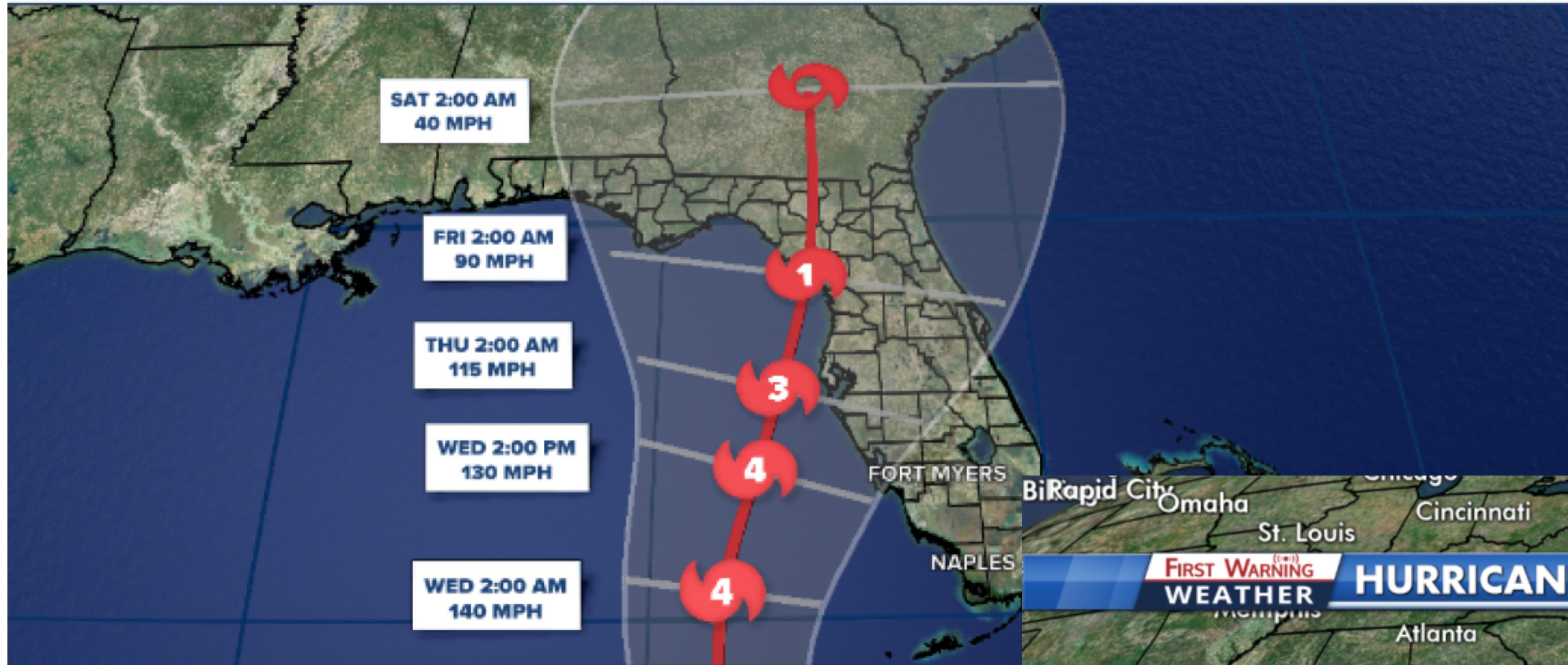
What is being visualized?

What are the strengths and weaknesses of this visualization?

**FOX 4**

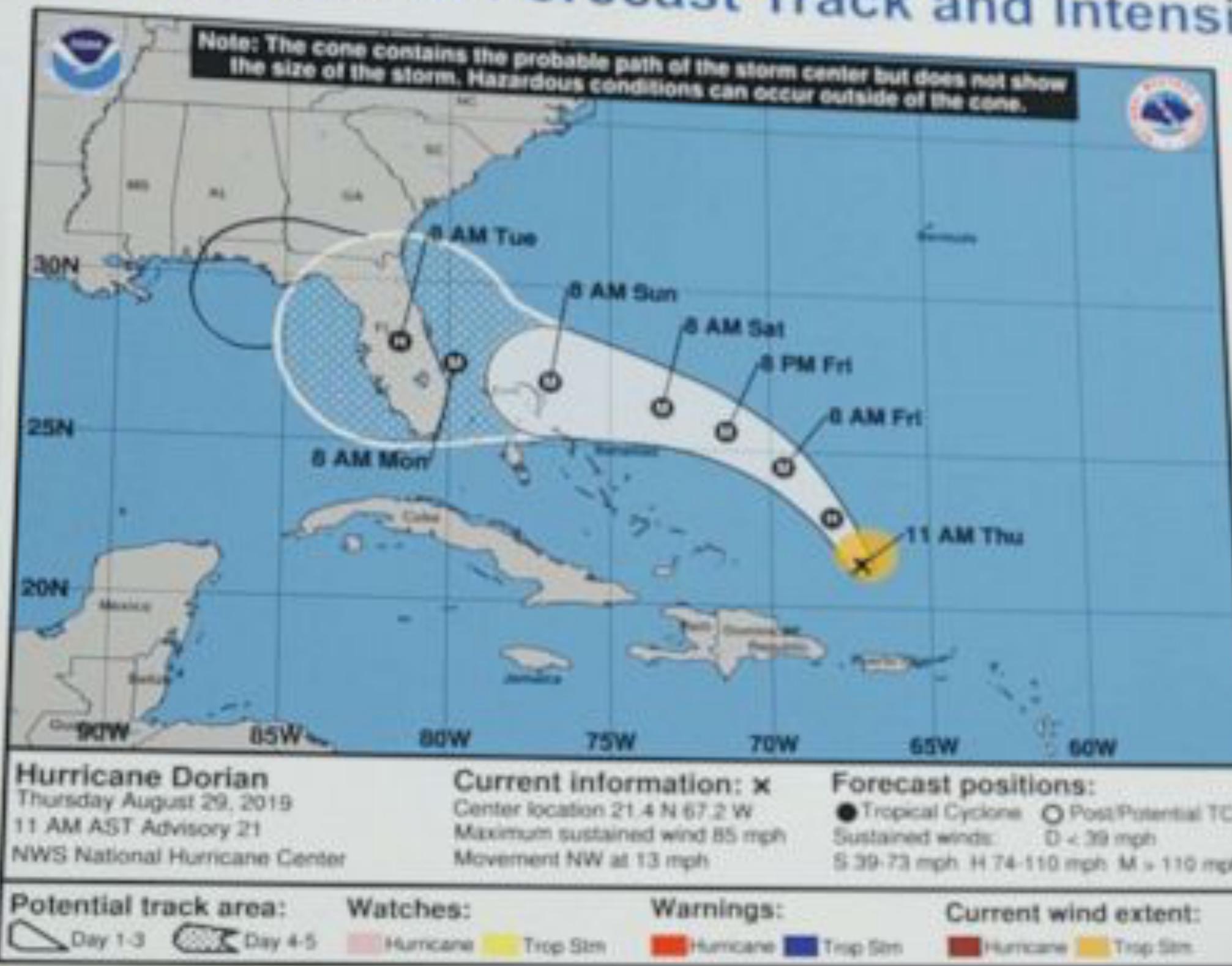
# HURRICANE IAN

## 5:00 AM ADVISORY





## Hurricane Dorian Forecast Track and Intensity

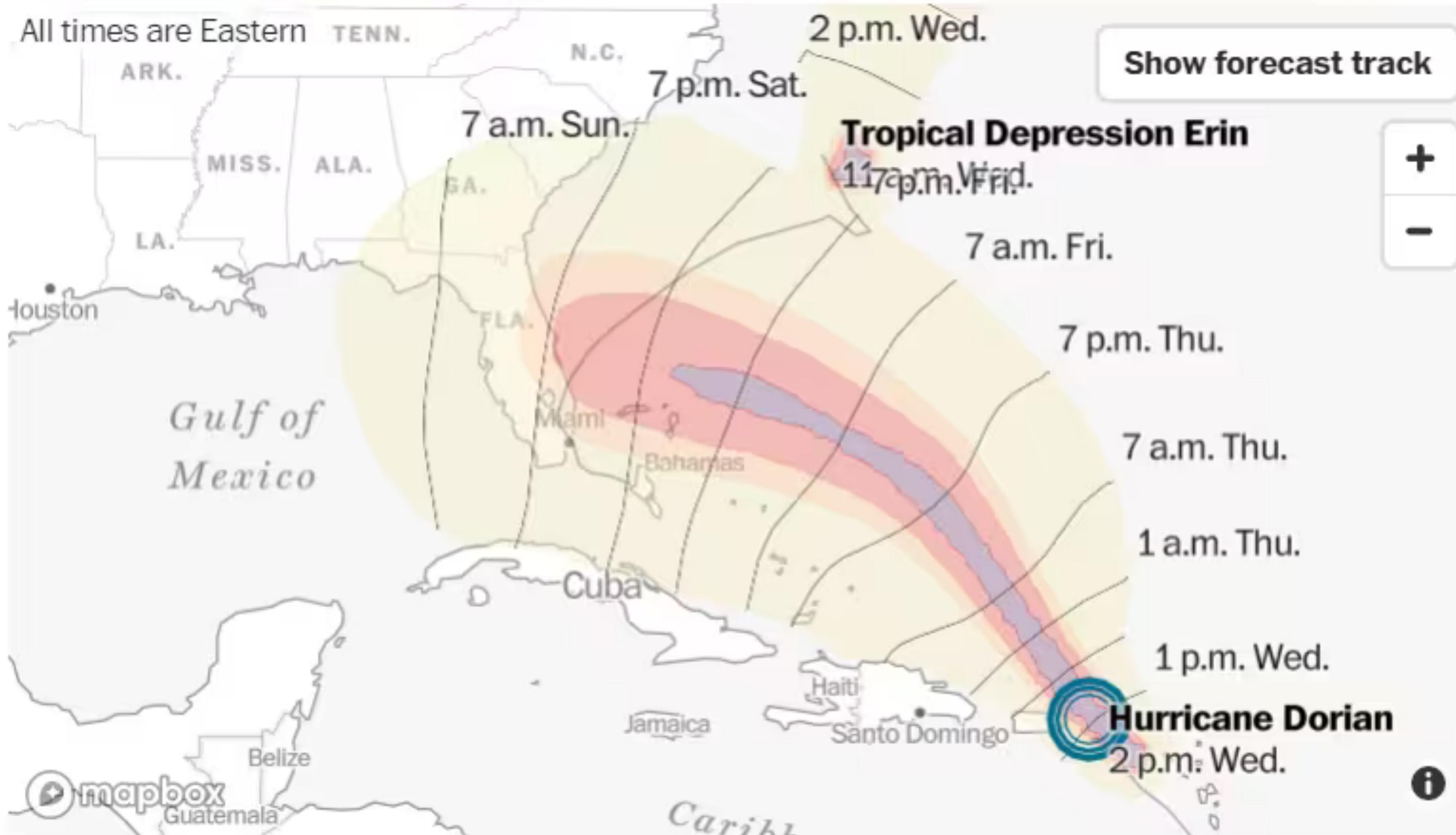


## Five-day chance of tropical-storm-force winds

5      50      70      90%

Current extent of tropical-storm-force winds

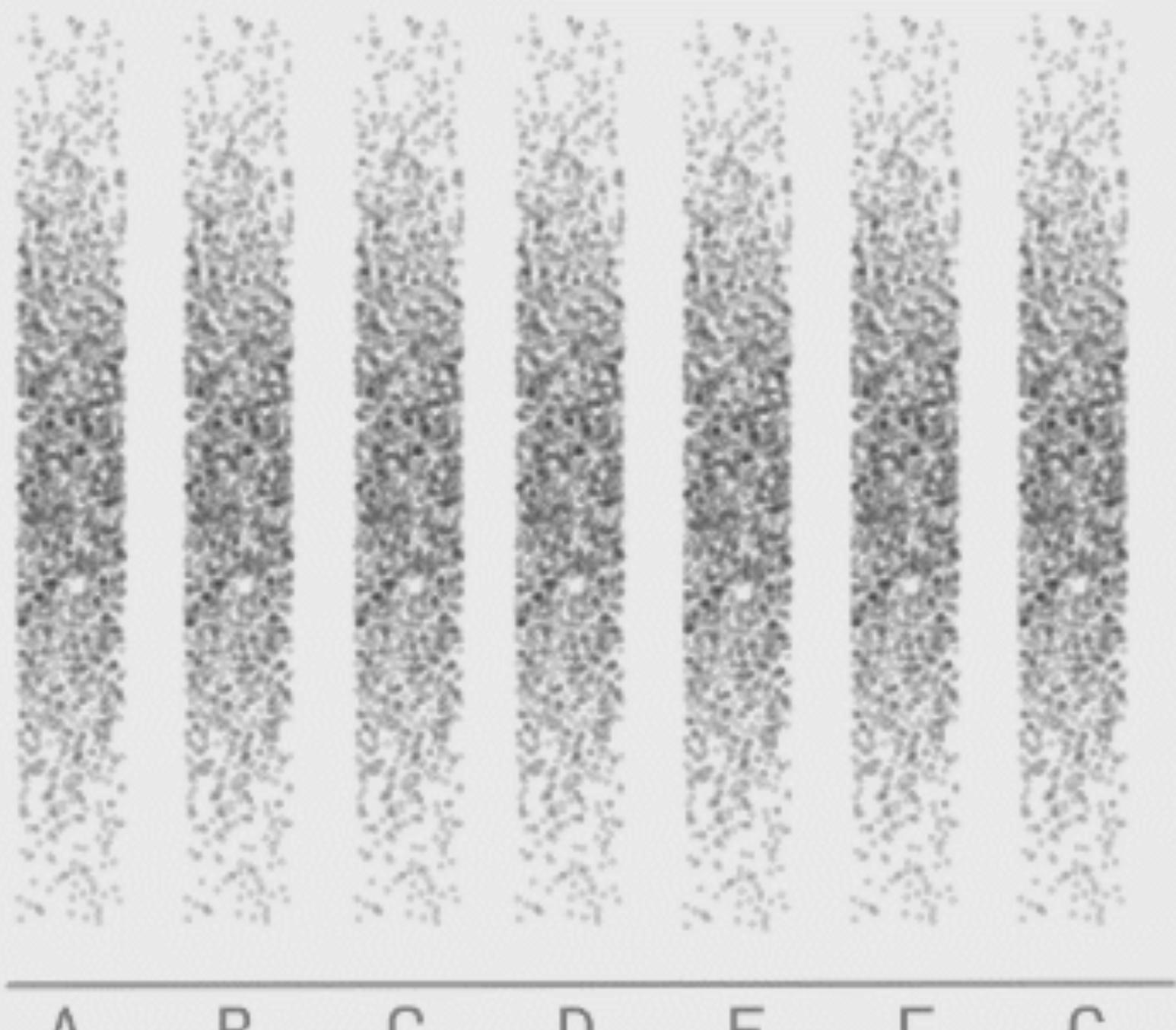
- Major hurricane (>110 mph)
- Hurricane (74-110 mph)
- Tropical storm (39-73 mph)
- Tropical depression (<39 mph)



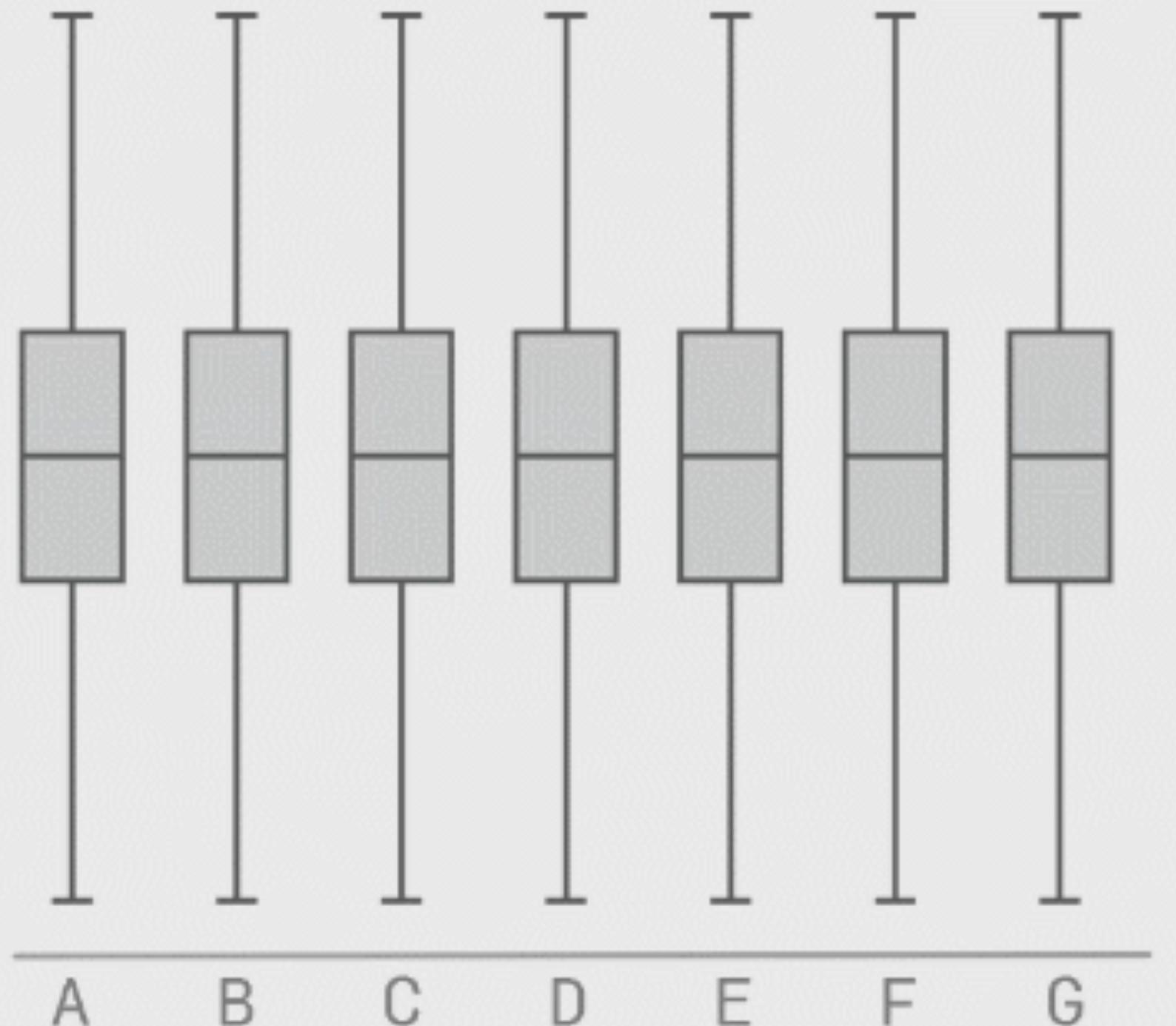
Source: National Weather Service. Note: Impact lines represent the earliest reasonable arrival time of tropical-storm-force winds.

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

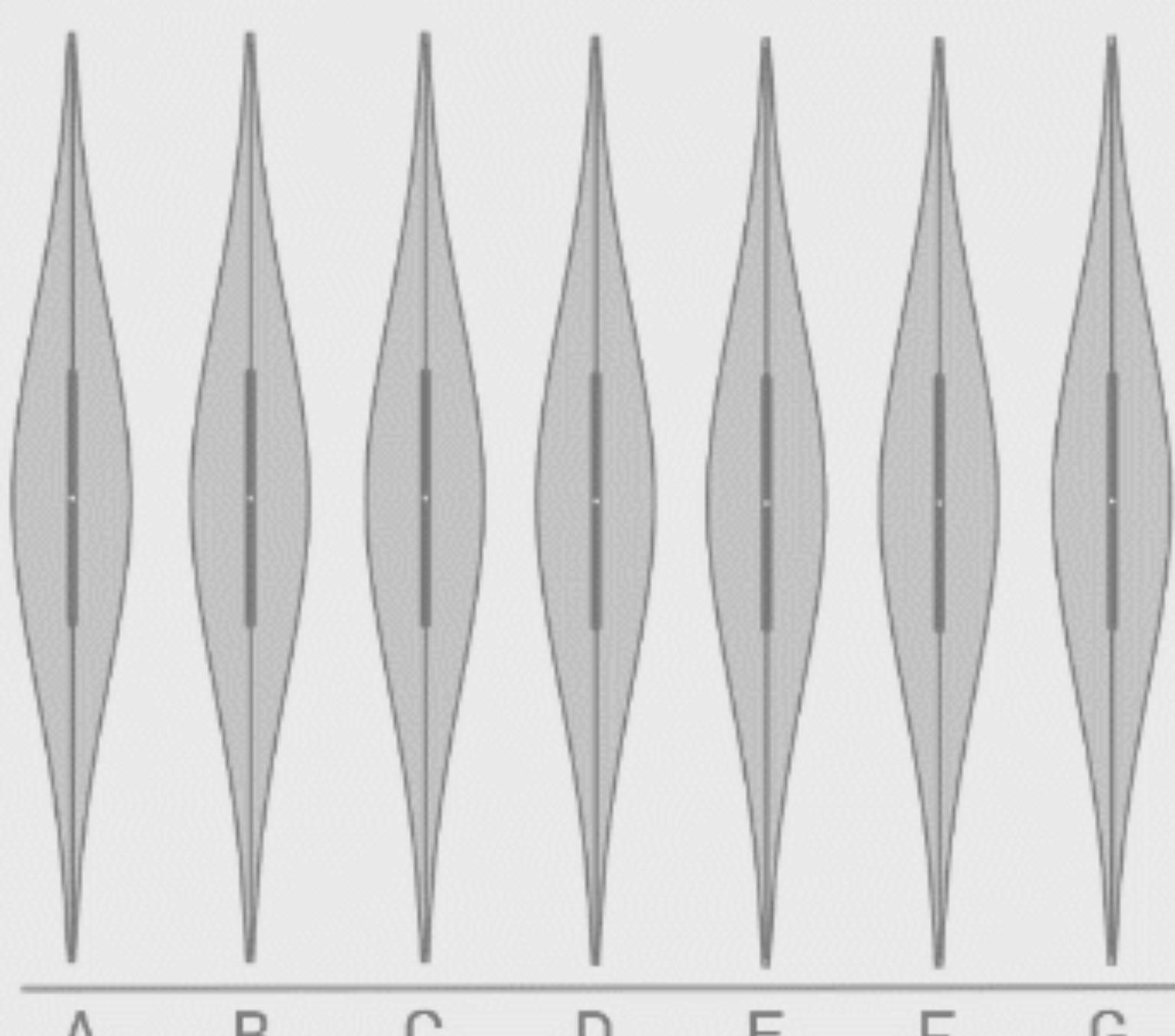
**Raw Data**



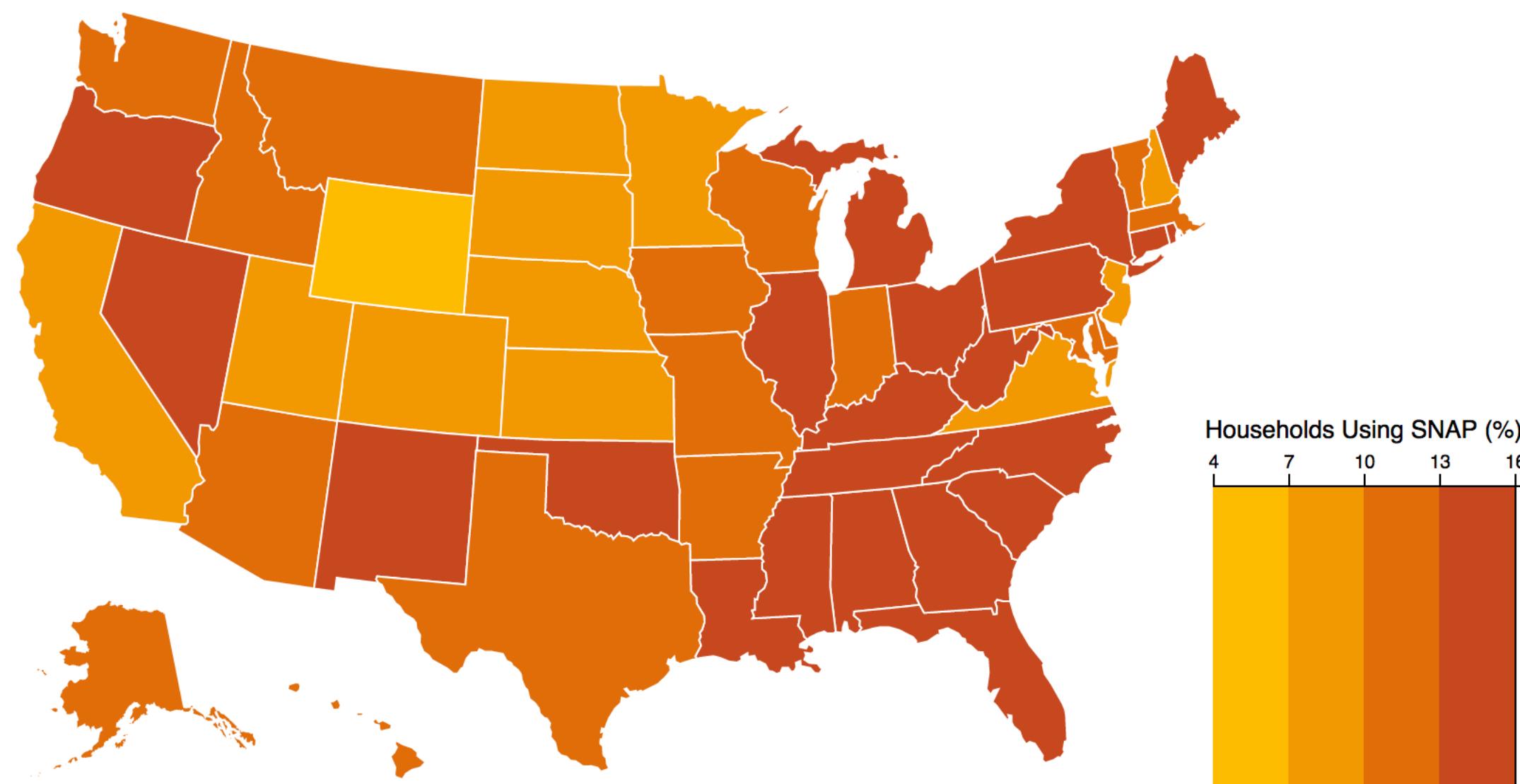
**Box-plot of the Data**



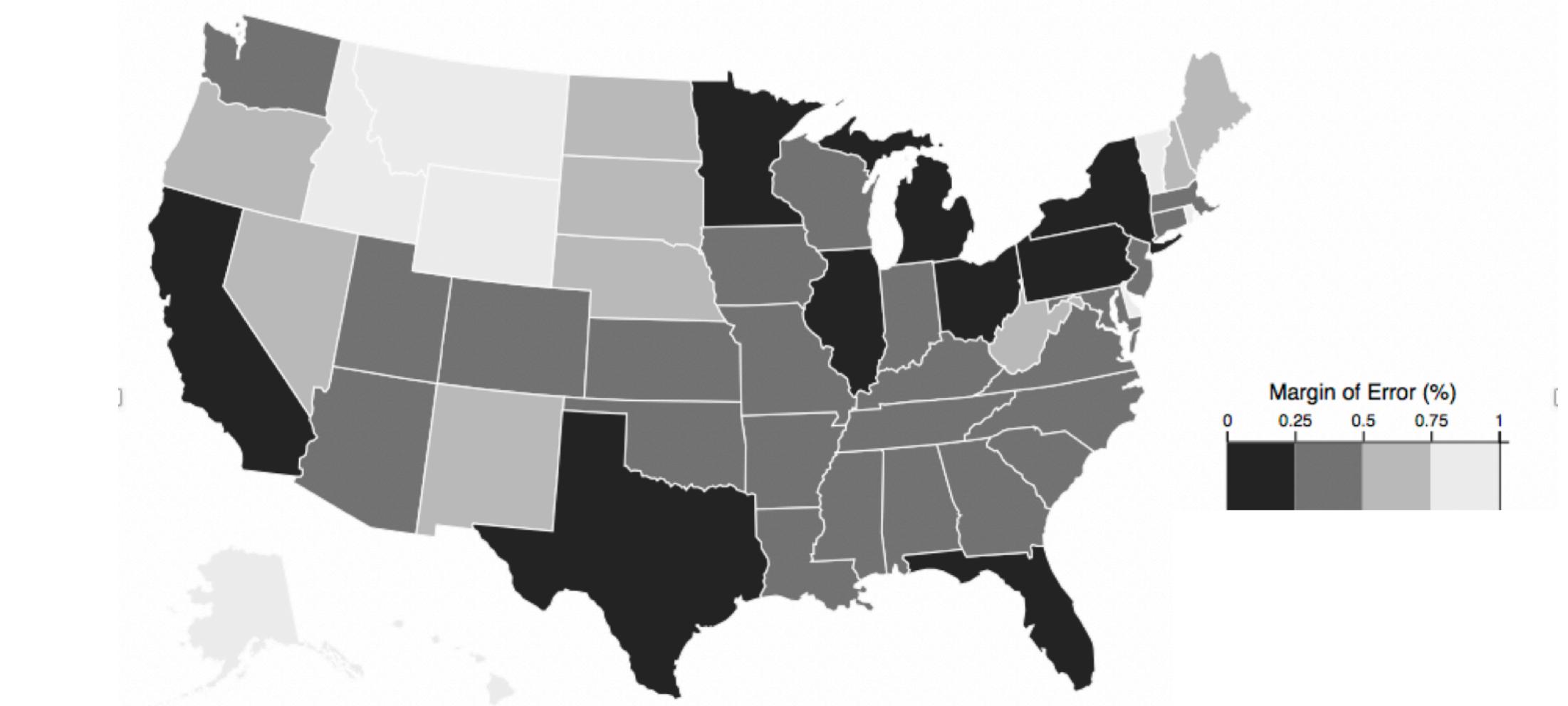
**Violin-plot of the Data**



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

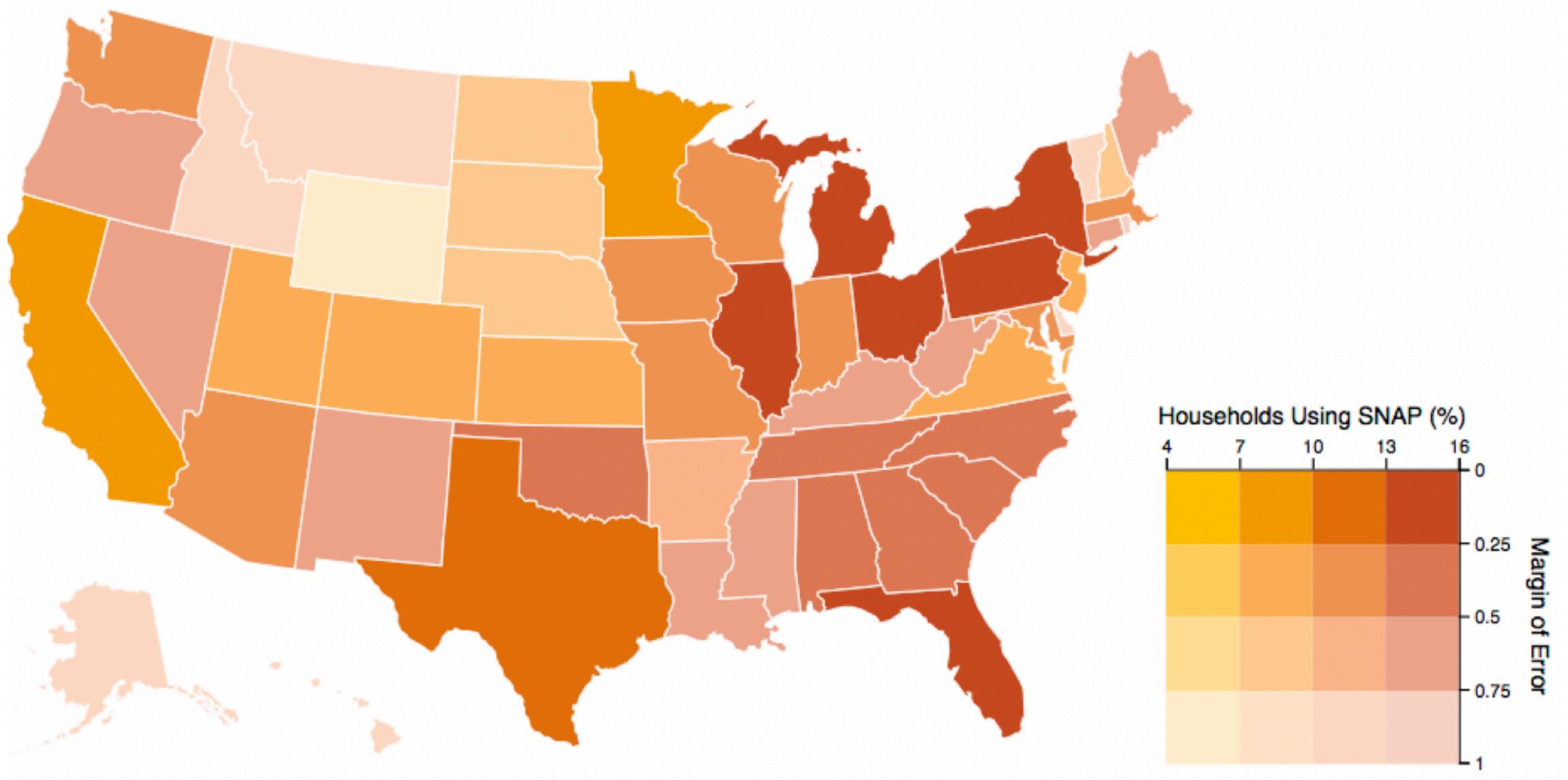


Data Map

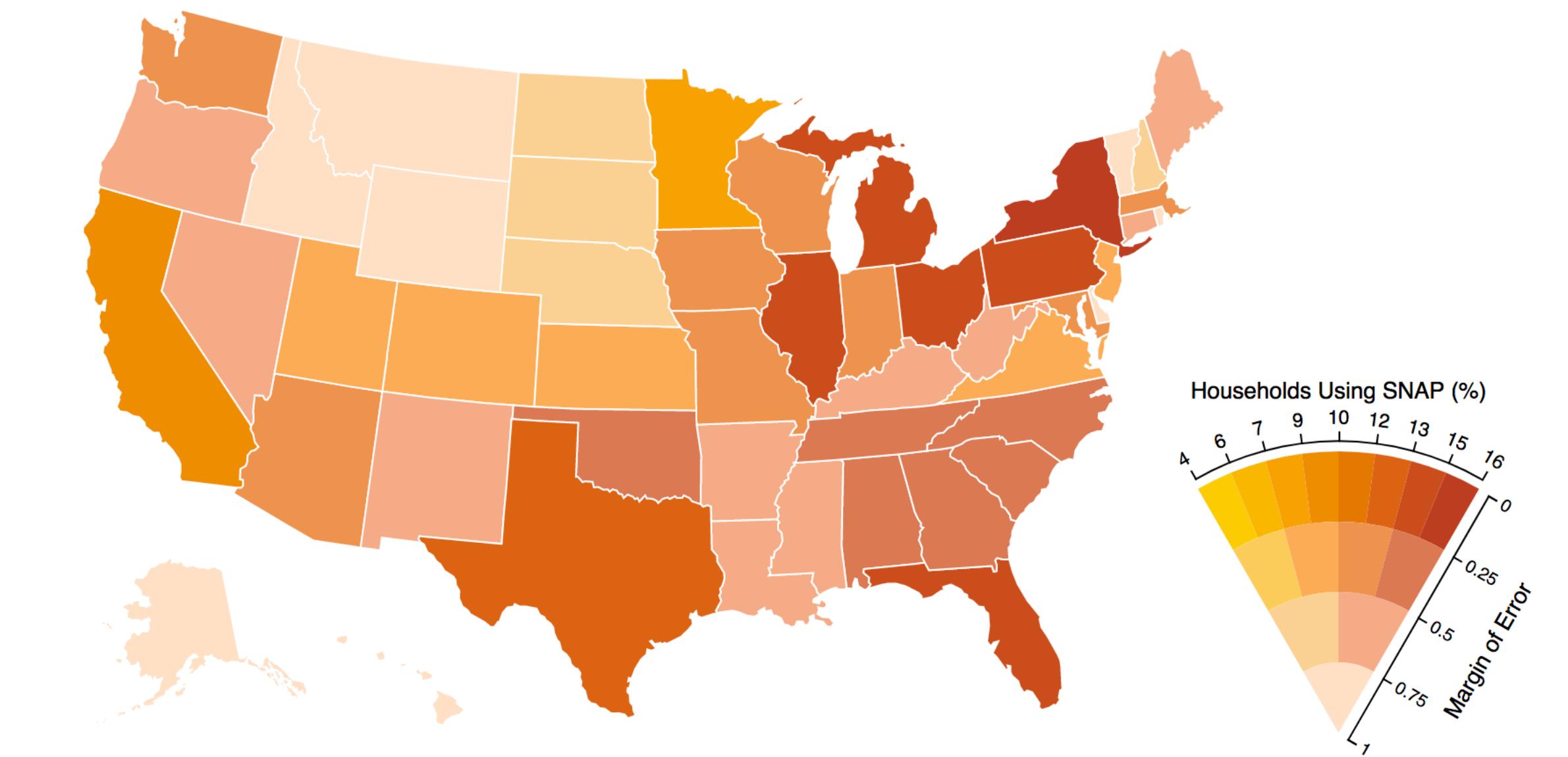


Uncertainty Map

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

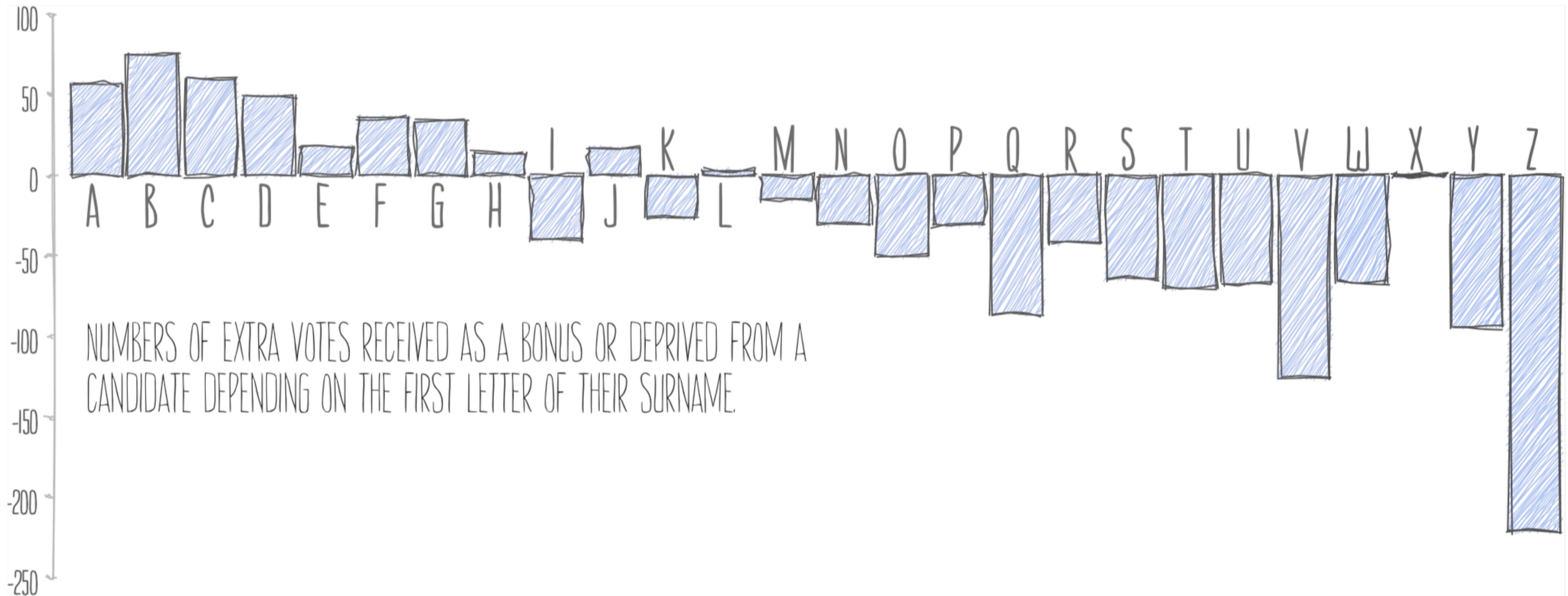


Bivariate Map (Data + Uncertainty)



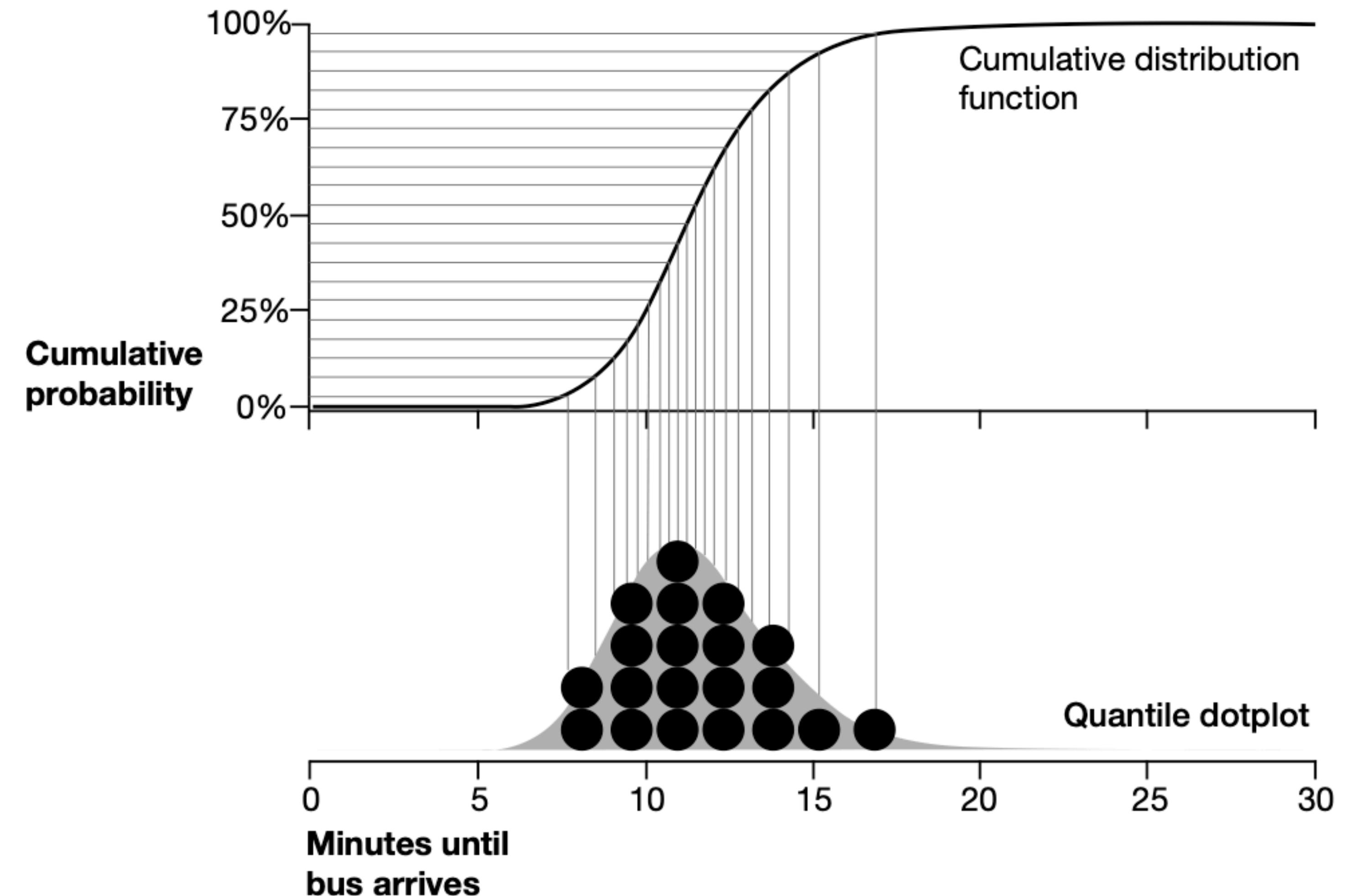
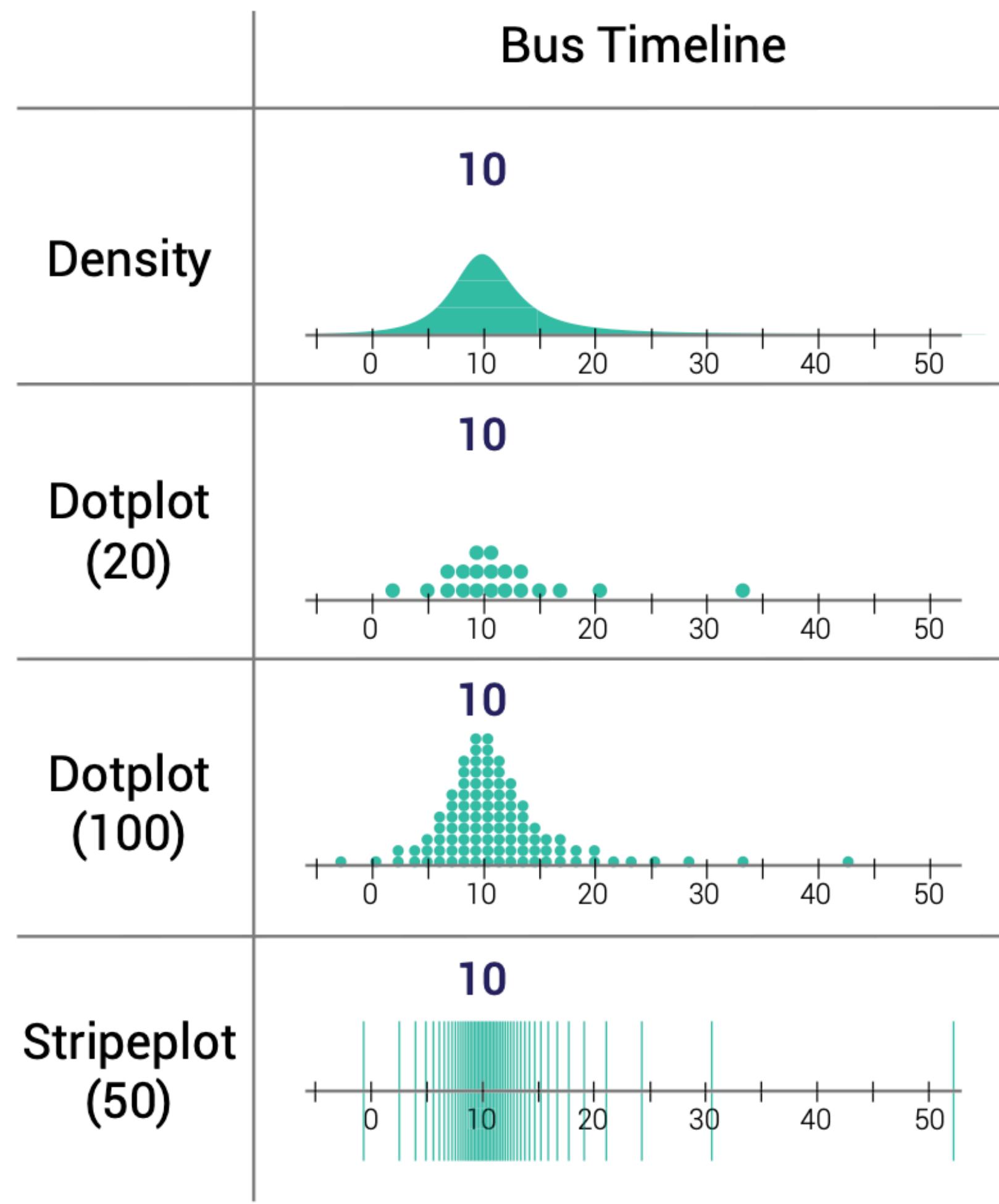
Value-Suppressing Uncertainty Map

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

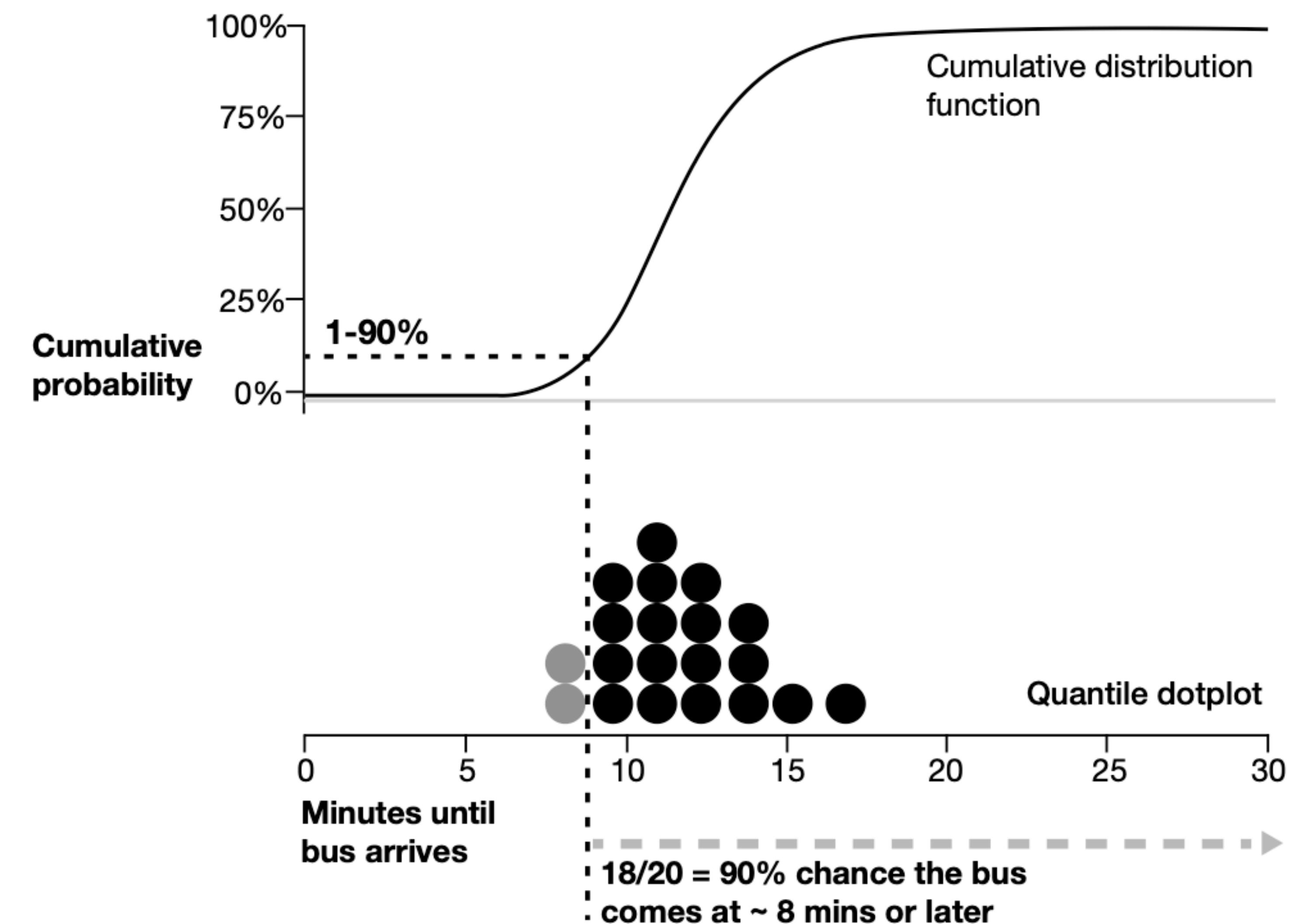
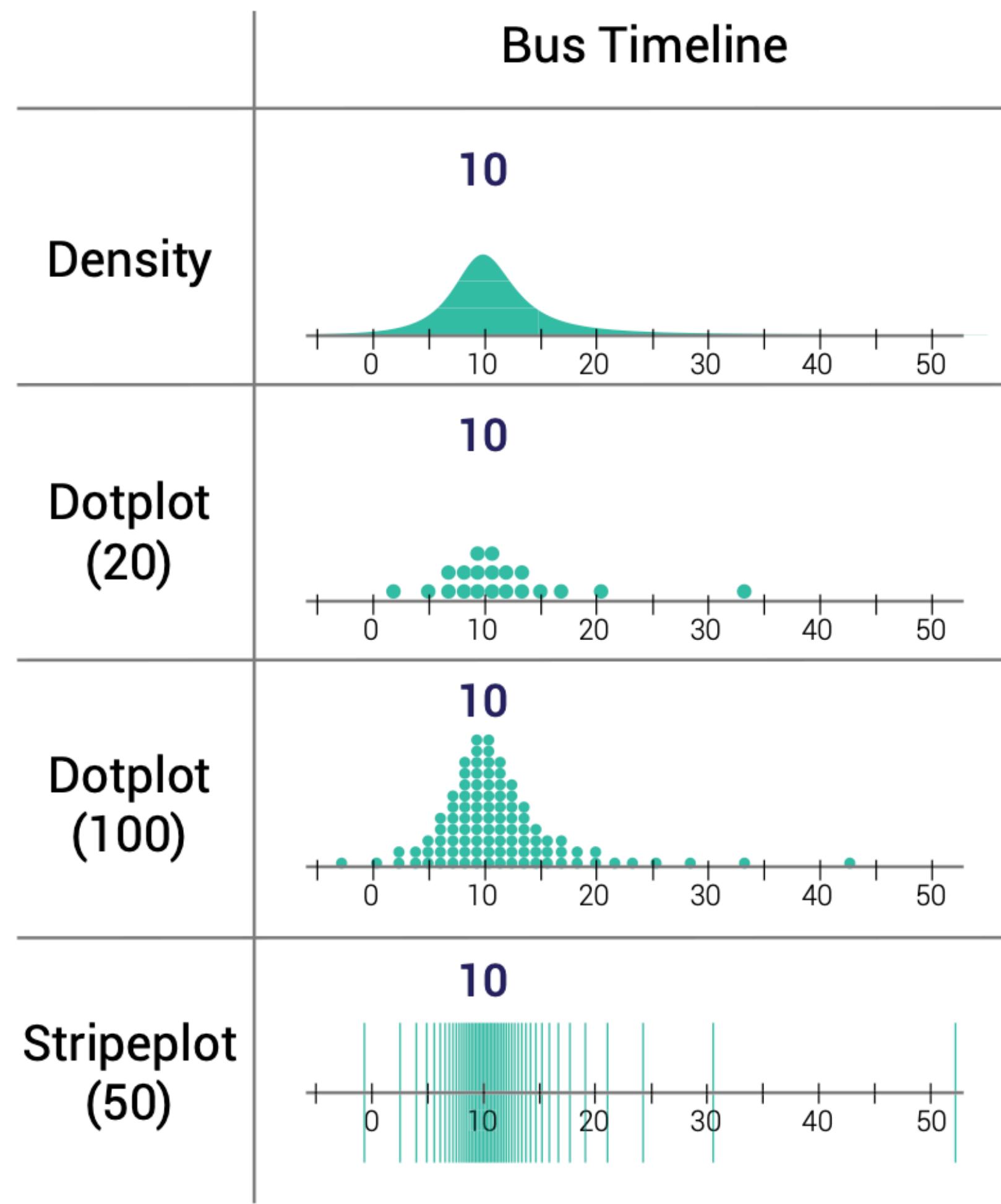


[Wood et al., 2012]  
[Boukhelifa et al., 2012]

# "Set of draws" technique

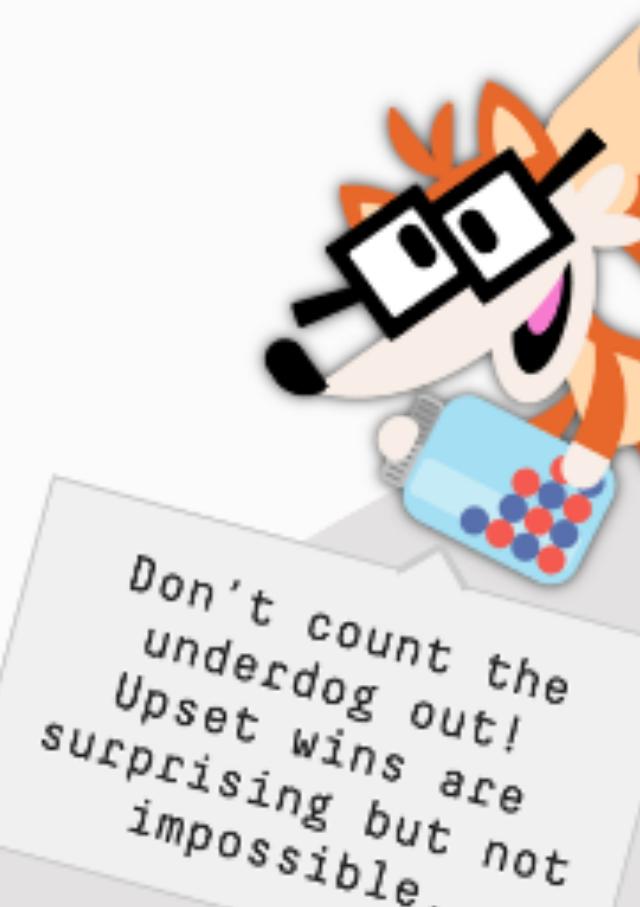
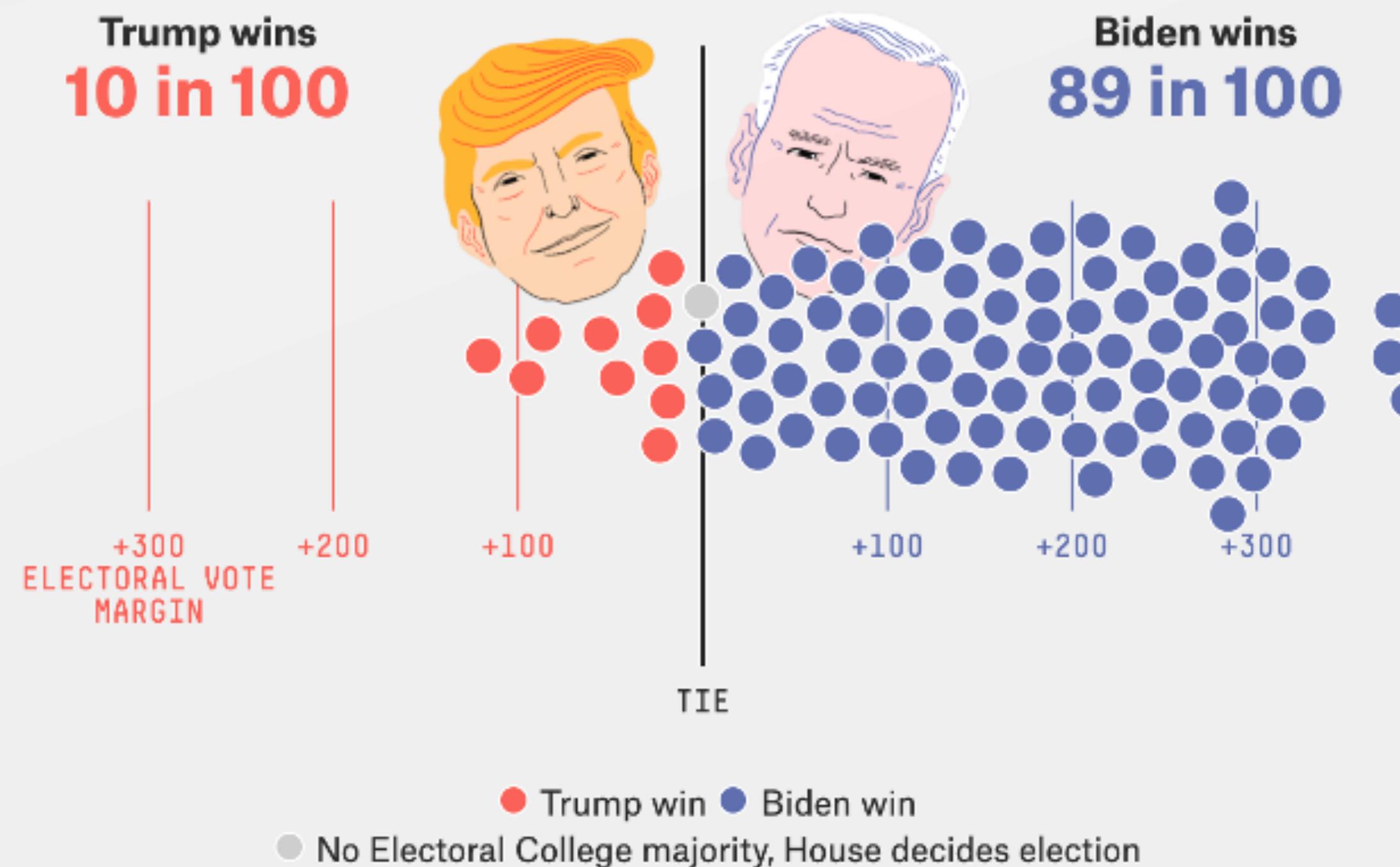


# "Set of draws" technique



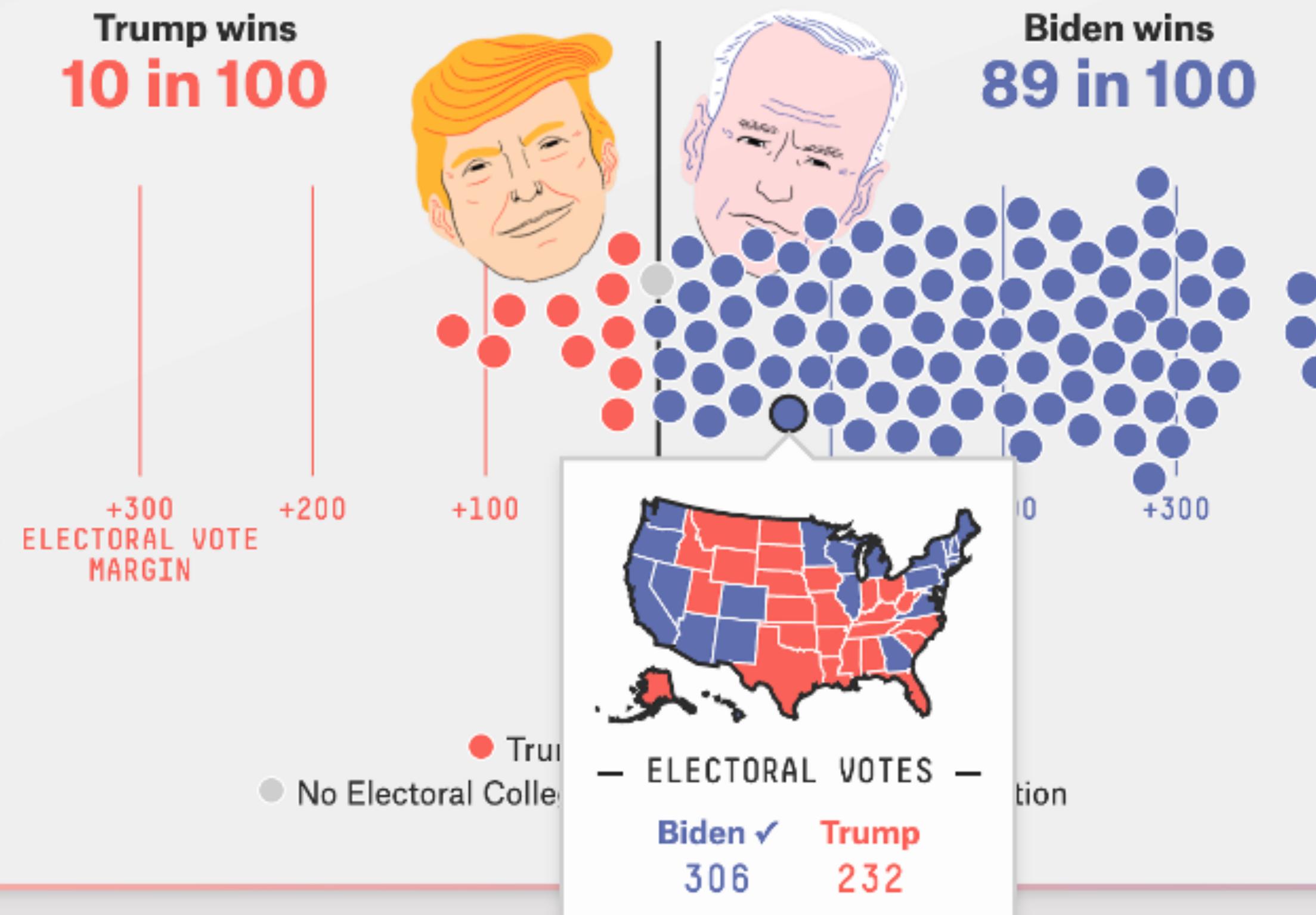
## Biden is *favored* to win the election

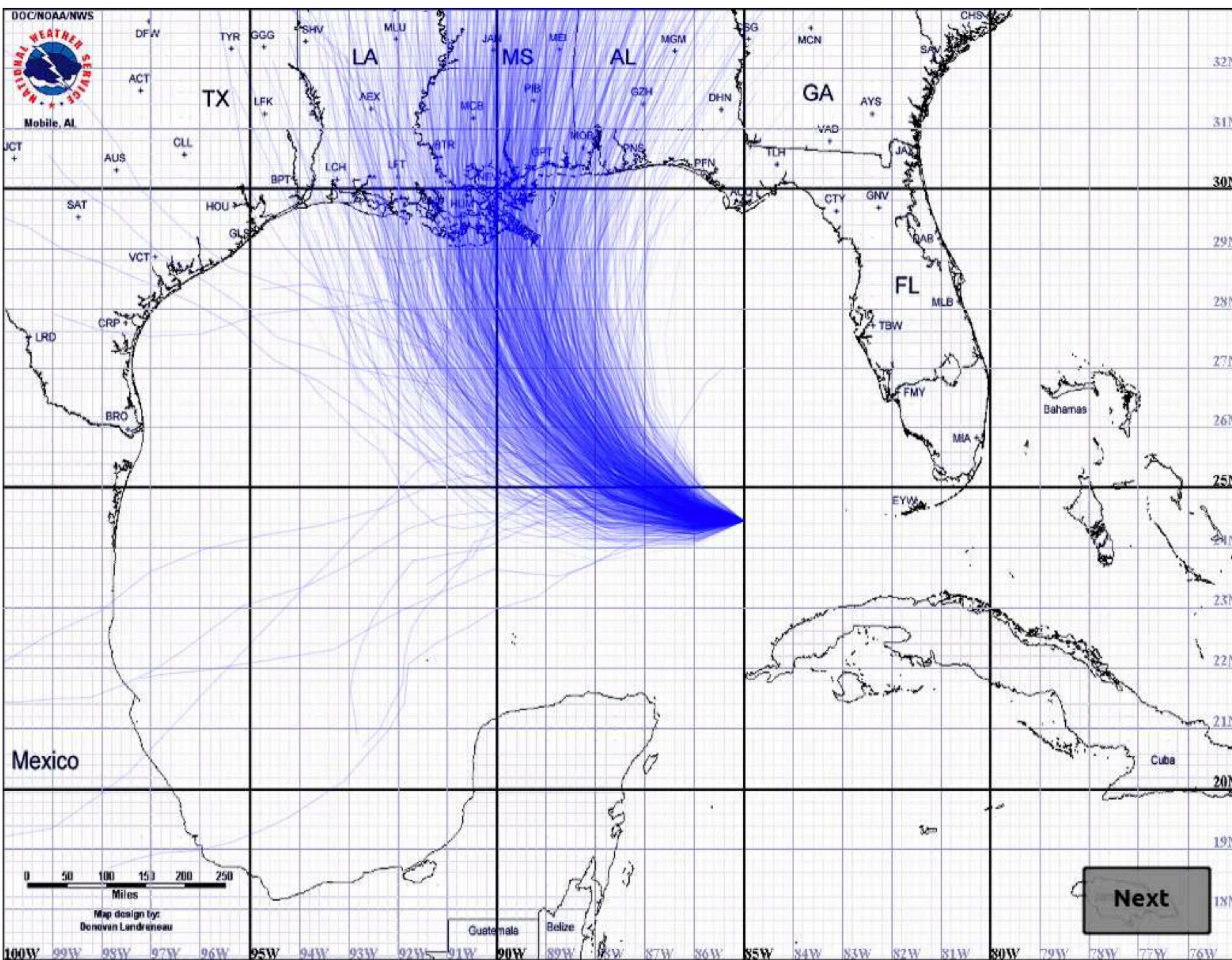
We simulate the election 40,000 times to see who wins most often. The sample of 100 outcomes below gives you a good idea of the range of scenarios our model thinks is possible.



## 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.





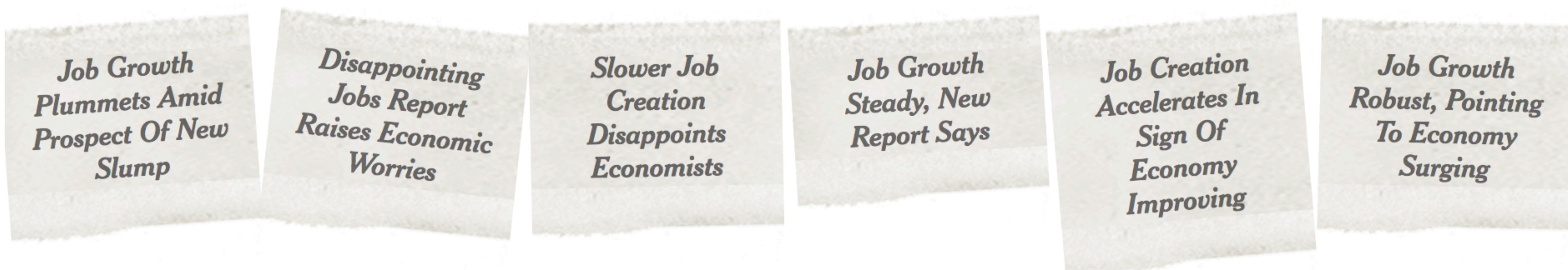
 **TheUpshot**

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.



Under 55,000 jobs  
4% chance

55,000 to 110,000  
19% chance

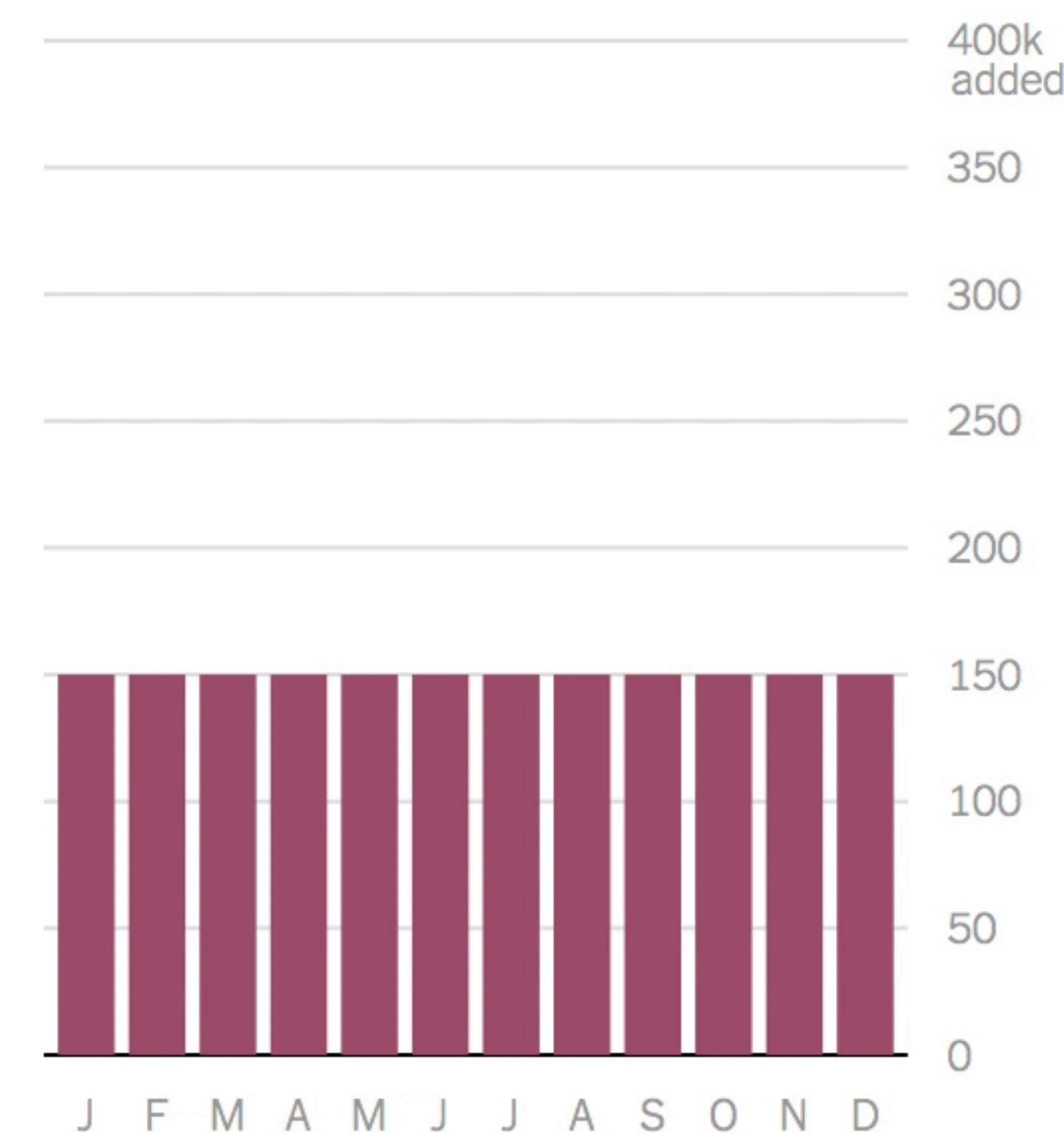
110,000 to 140,000  
19% chance

160,000 to 190,000  
19% chance

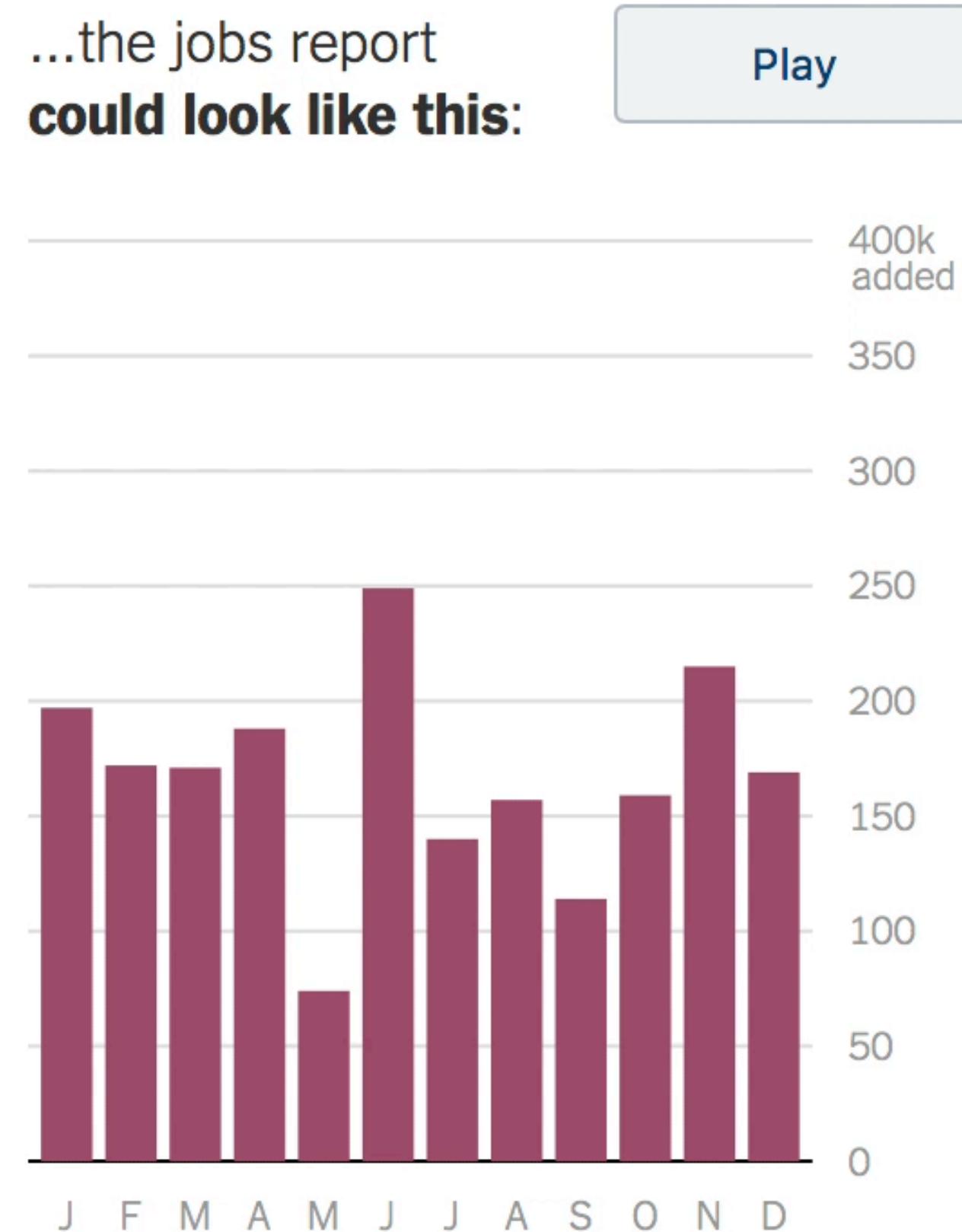
190,000 to 245,000  
19% chance

245,000+  
4% chance

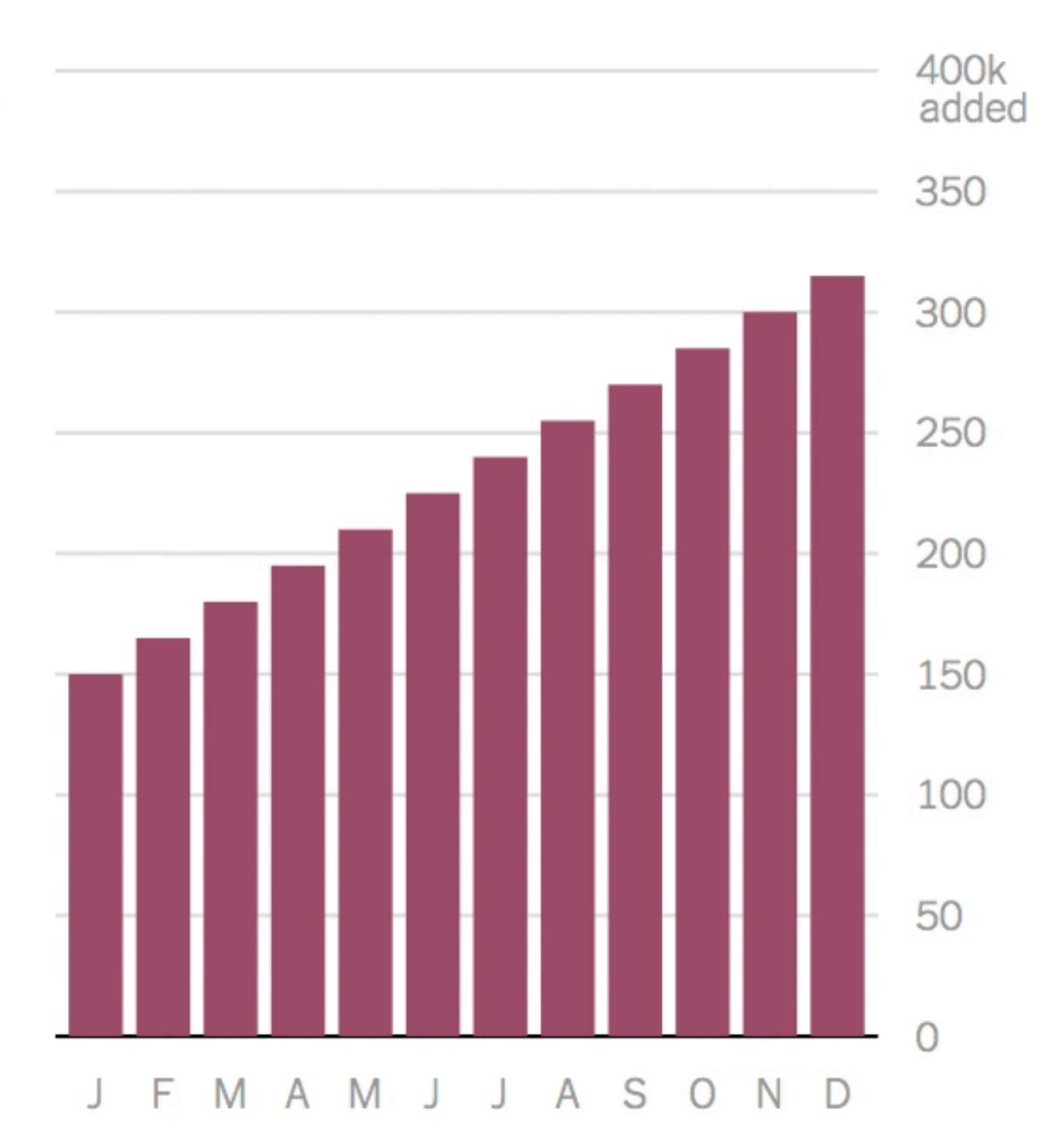
If job growth **were actually steady**  
over the last 12 months...



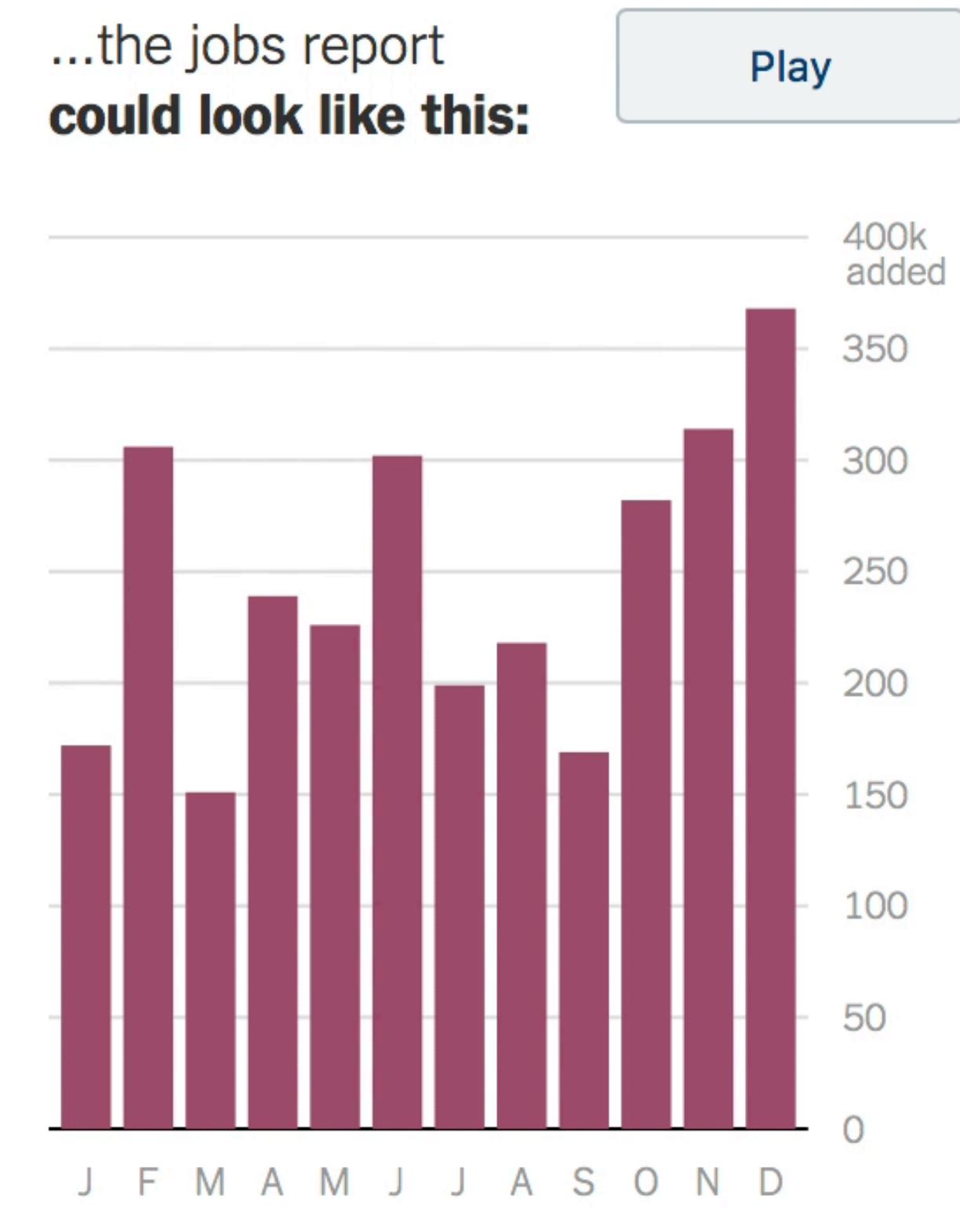
...the jobs report  
**could look like this:**



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



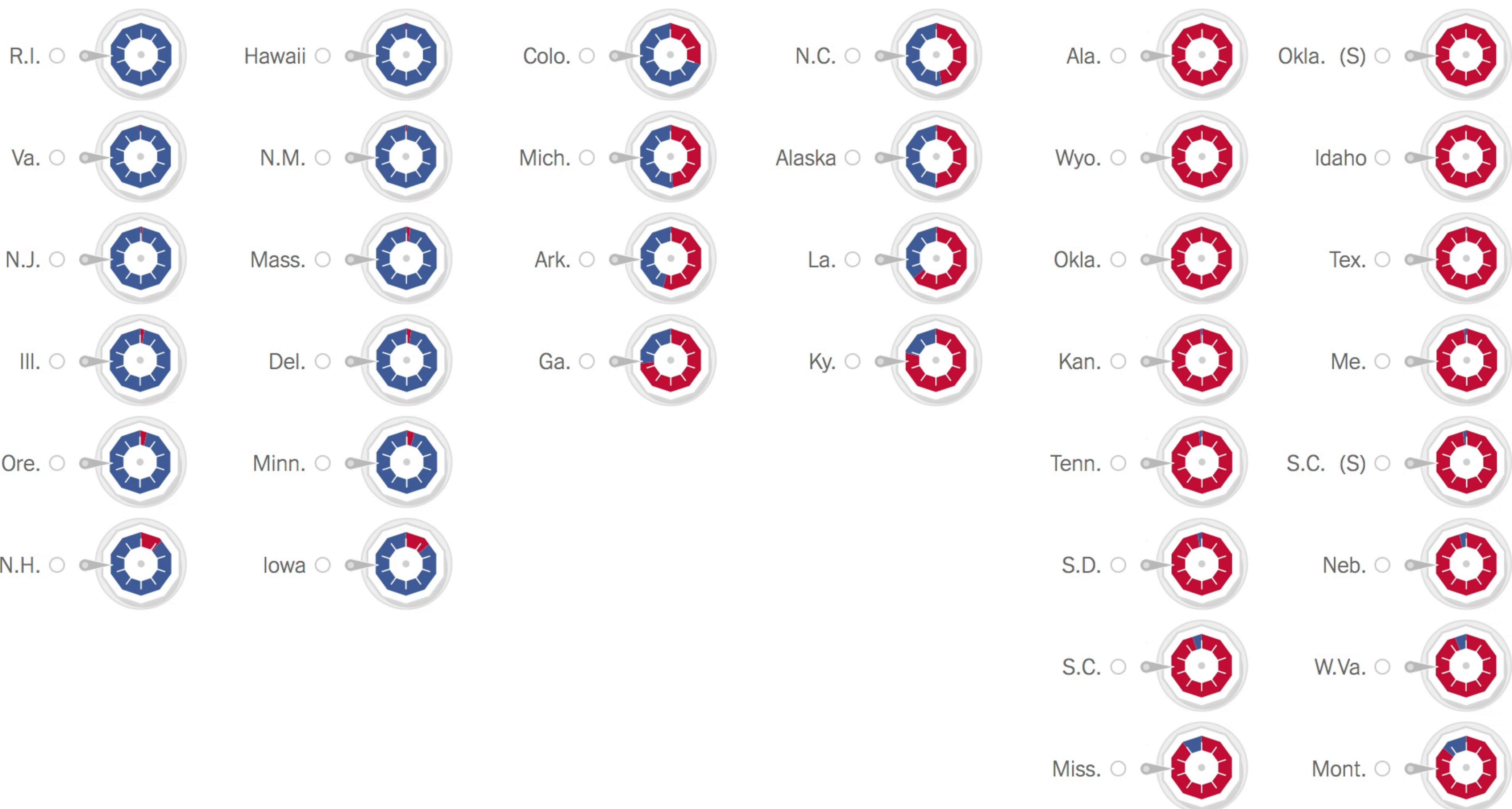
...the jobs report  
**could look like this:**



Likely Democratic

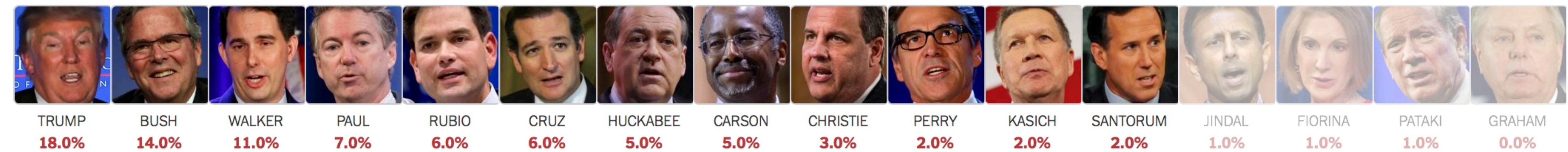
Competitive

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?

Building models is necessary to quantify uncertainty.

It is important to communicate the variability in model outcomes.

How should I visualize it?

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!