Visual Analytics– Communicating Uncertainty

Dr. Ab Mosca (they/them)

Slides based off Medium articles by Jessica Hullman and Matthew Kay (https://medium.com/multiple-views-visualization-research-explained/uncertainty-visualization-explained-67e7a73f031b)

Plan for Today

- What is it?
- How do we show it?

What we mean when we say Uncertainty

- In visualization we're talking about the different values the data could possibly be
- Ex. We have some value we want to know about some population (*parameter* in stats), but we must estimate that value through a *sample* of the population

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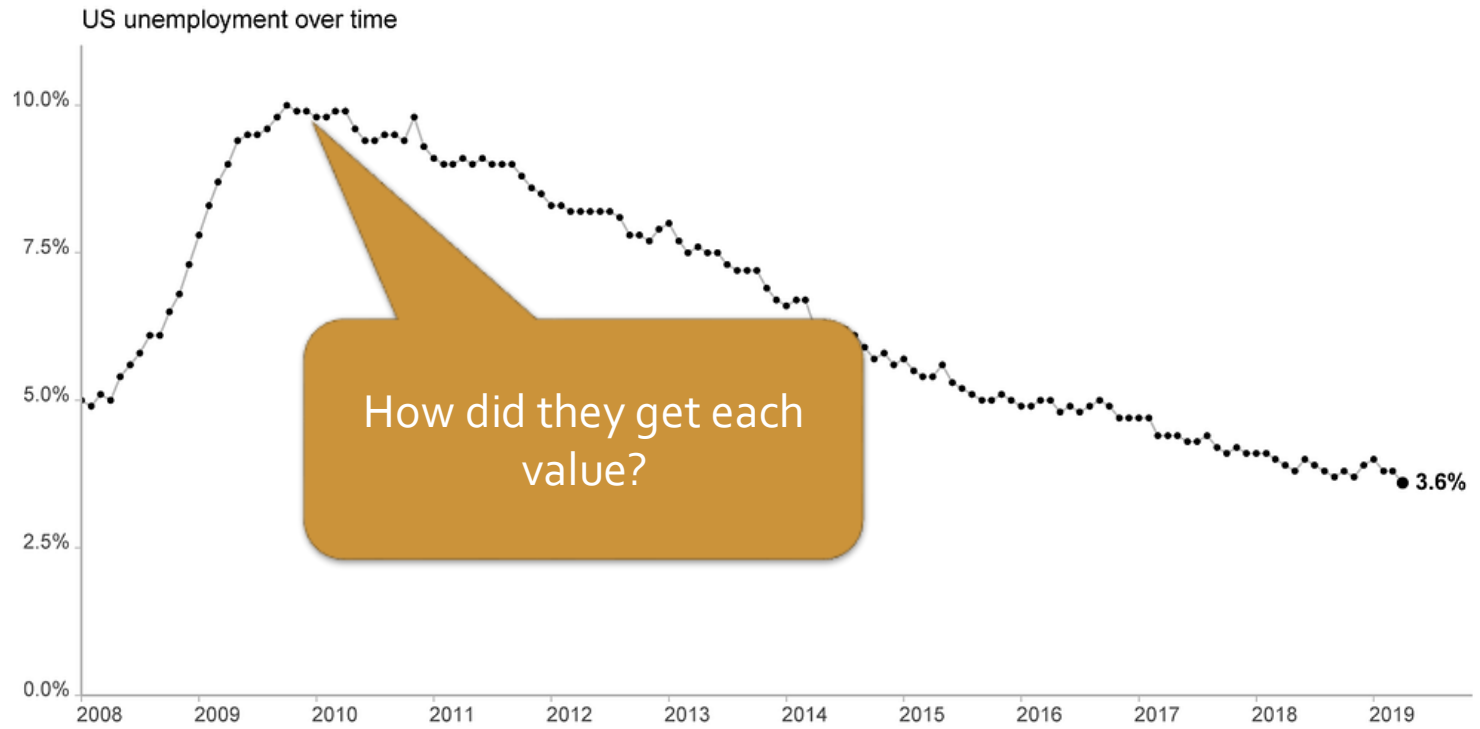
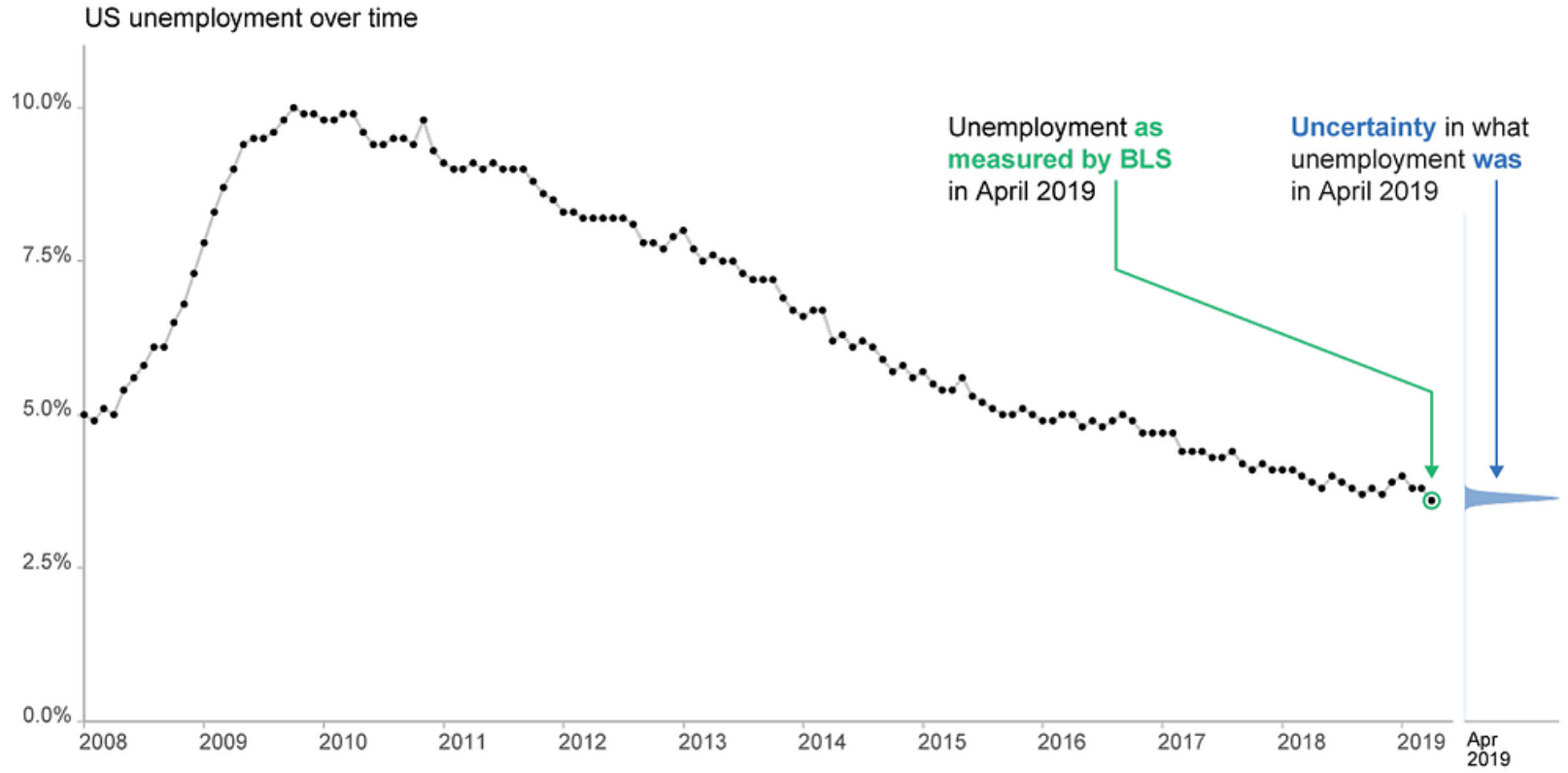
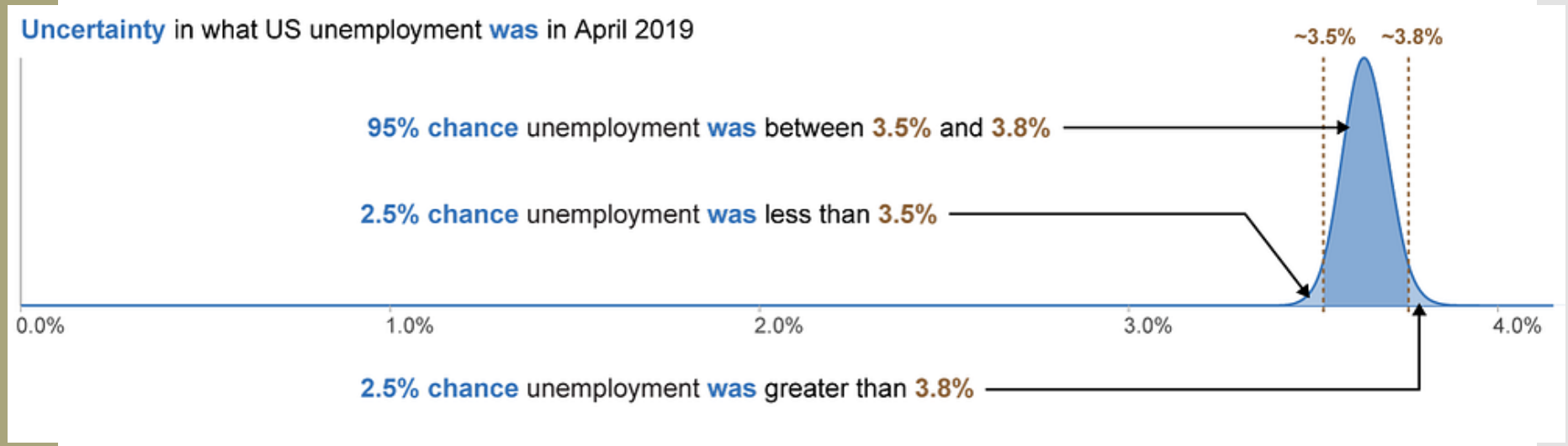


Estimated Values

- A statistical model is used to estimate a parameter
- The model quantifies the uncertainty around the estimate by considering all values it *could* be (and how likely each is)
- Hence, a parameter's uncertainty can be characterized by a probability distribution

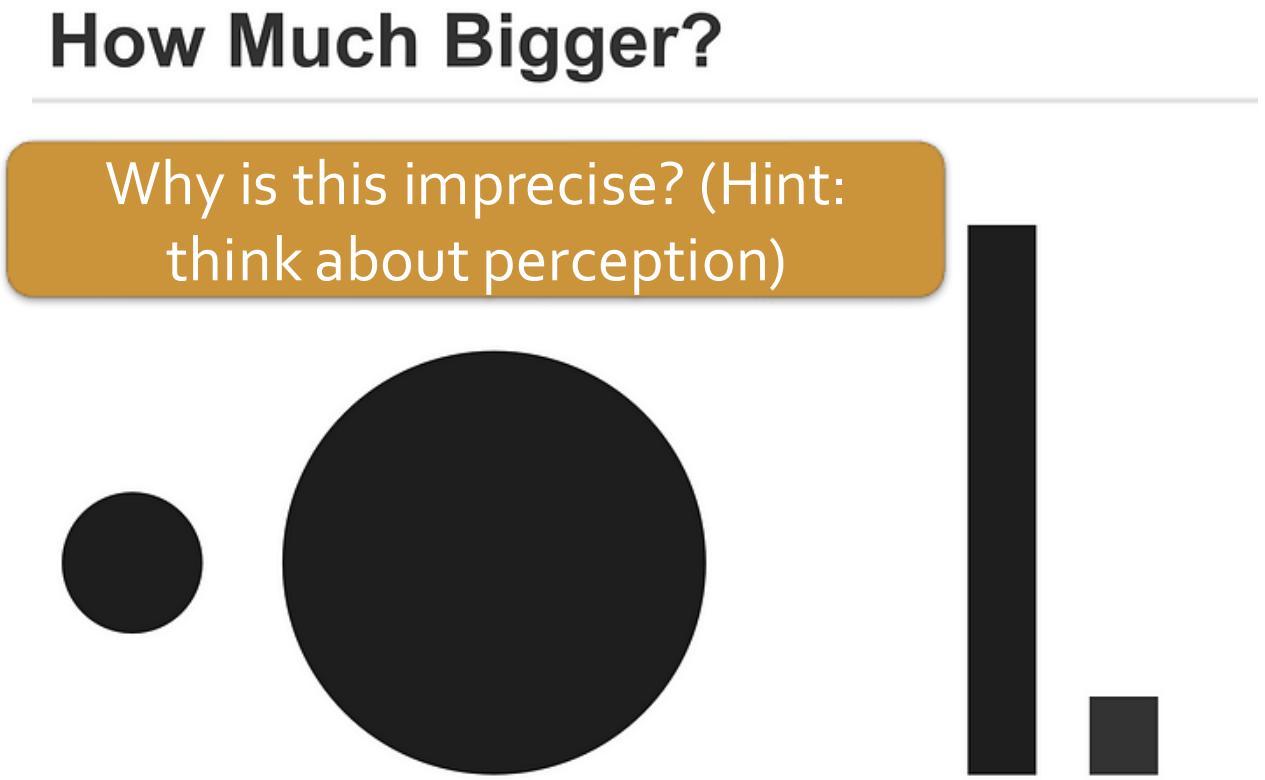


Probability Distributions



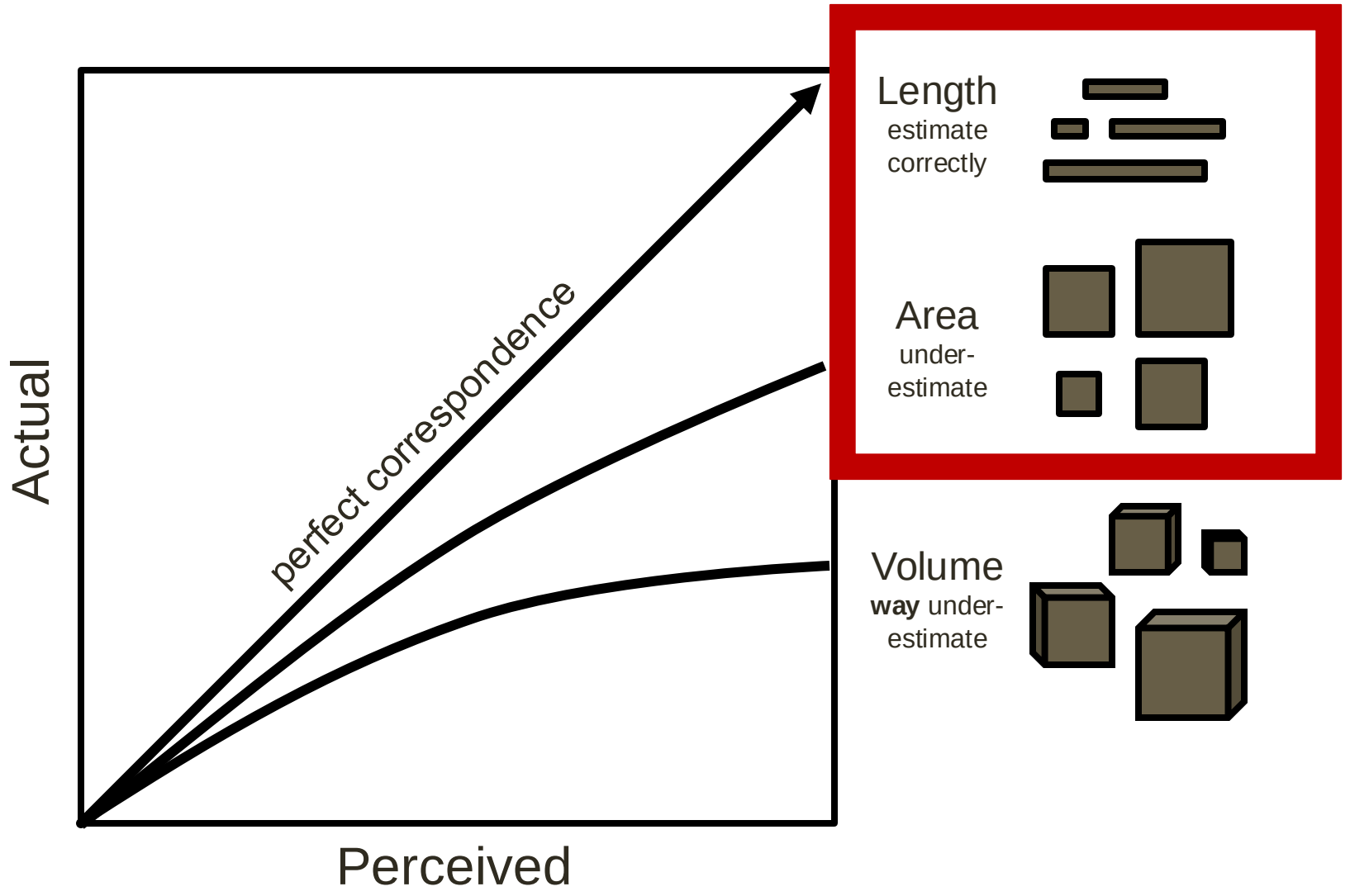
Communicating Uncertainty

- Imprecise ways to communicate uncertainty:
  - Rounding
  - Choosing a visualization technique that is harder for people to read



Attentive processing

"Apparent" magnitude



http://makingmaps.net/2007/08/28/perceptual-scaling-of-map-symbols/

Communicating Uncertainty

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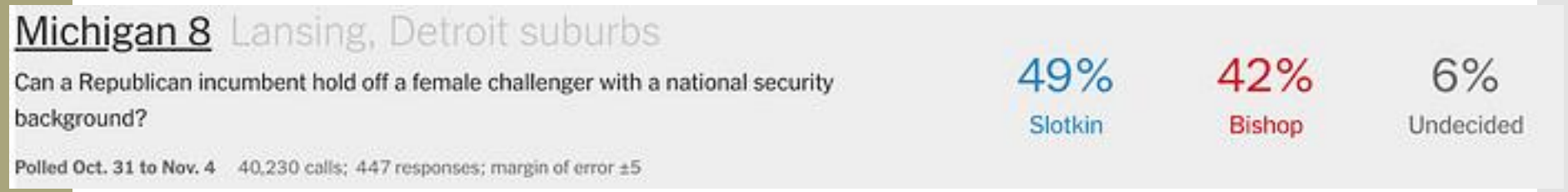
What drawbacks do you see to these methods?

Communicating Uncertainty

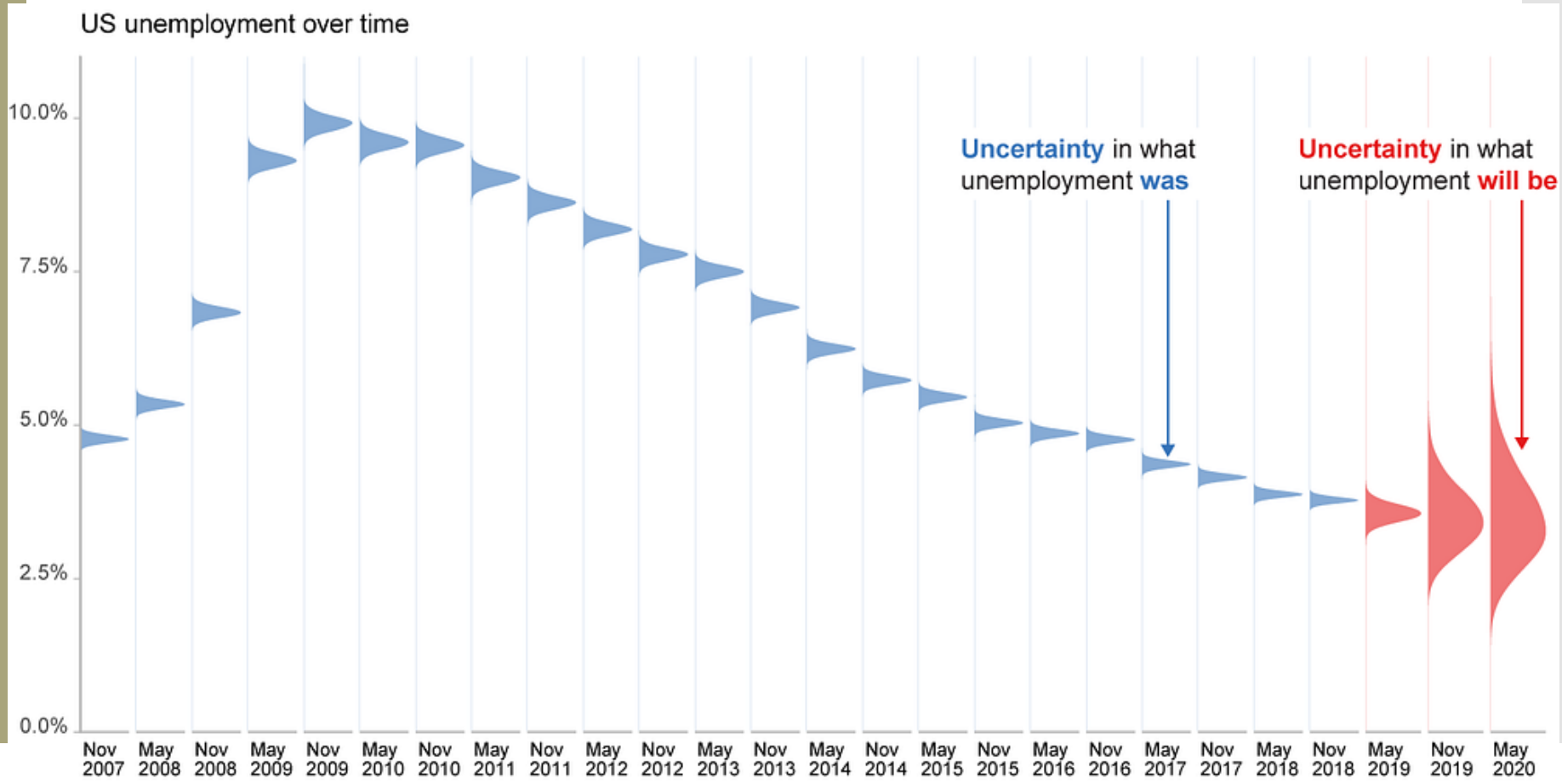
- Subtle ways to communicate uncertainty:



  - Can you see the uncertainty estimate?

Communicating Uncertainty

- Direct ways to communicate uncertainty:
  - Map probability density to a visual channel



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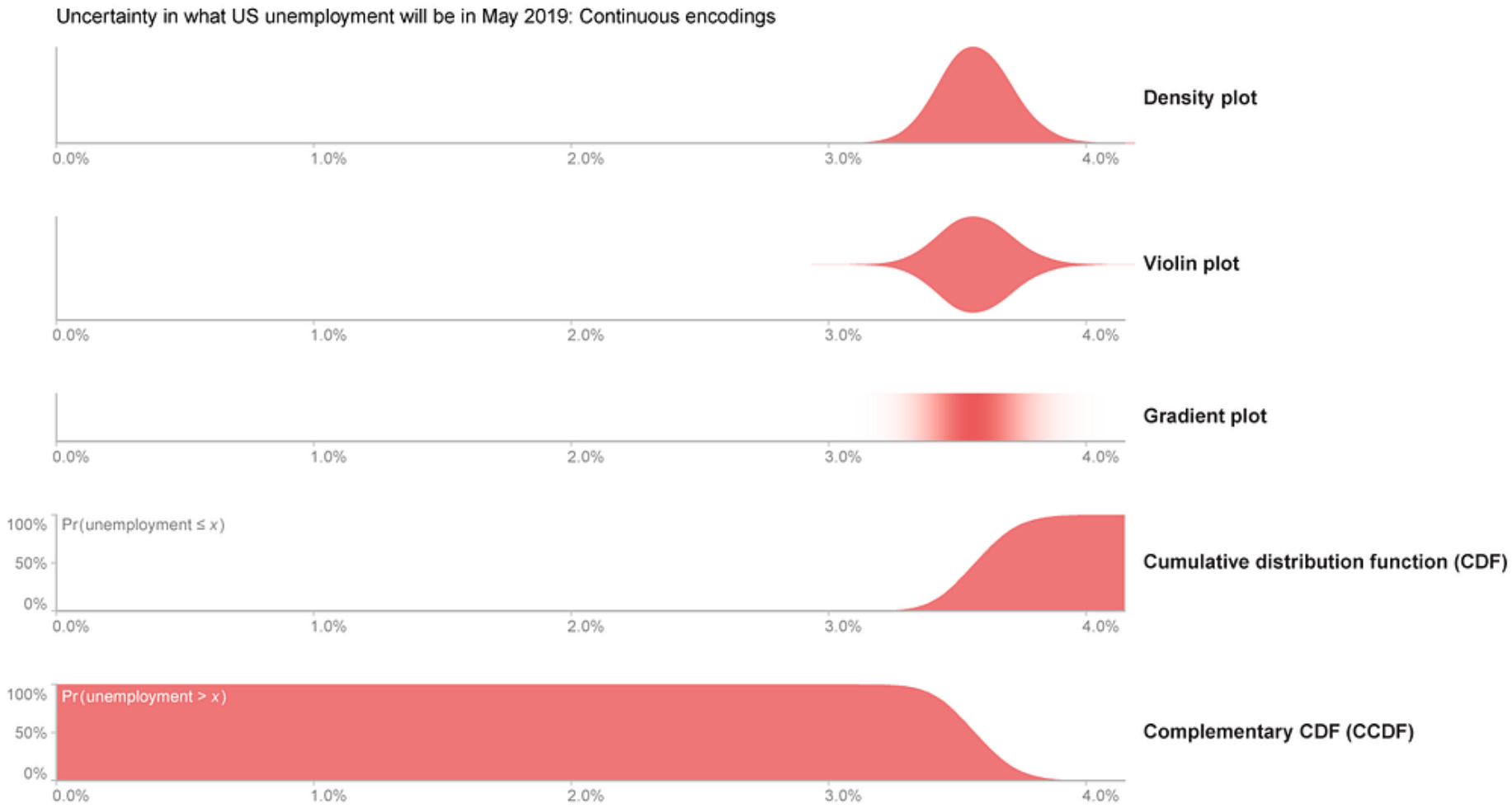

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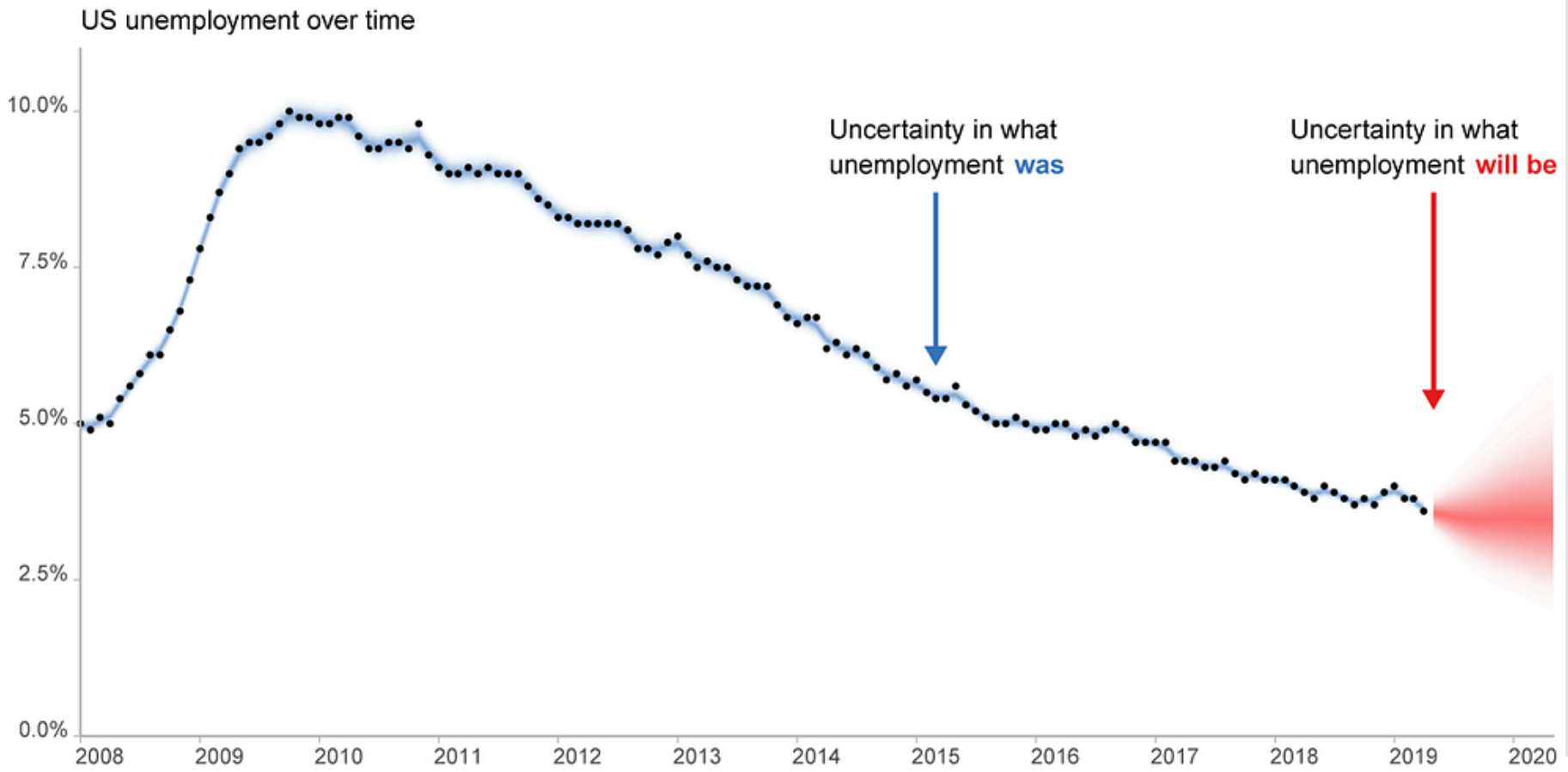

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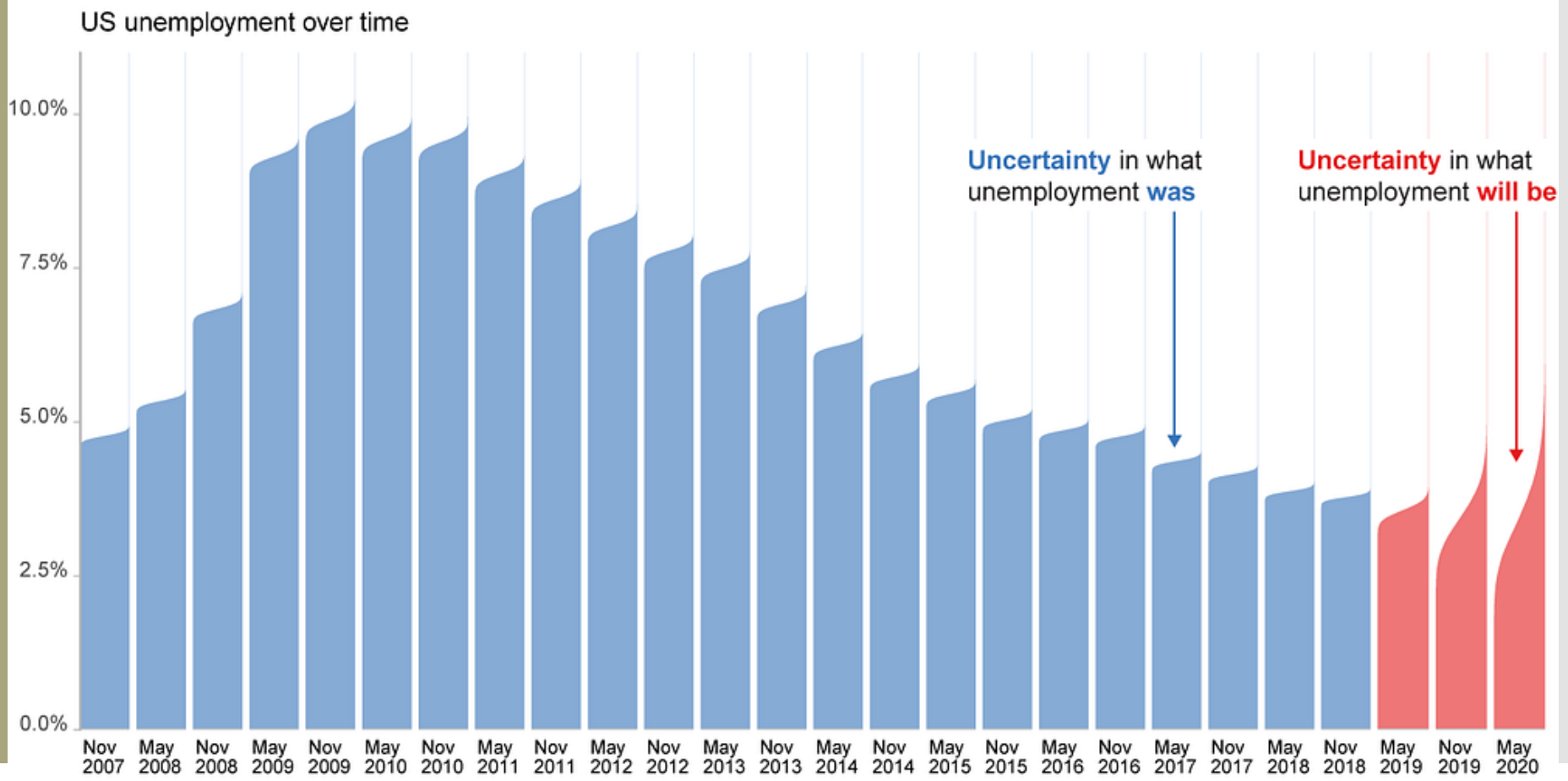
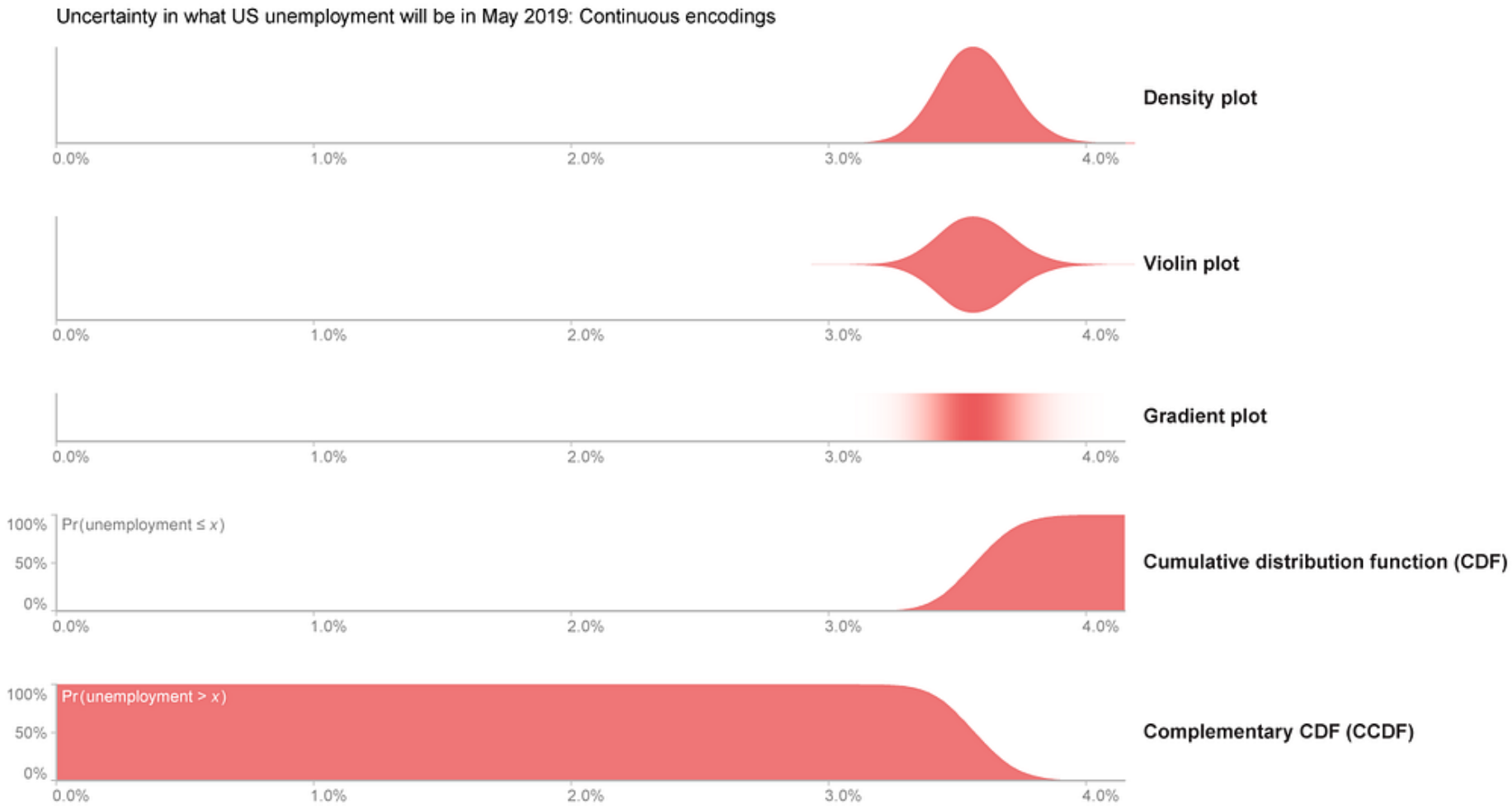


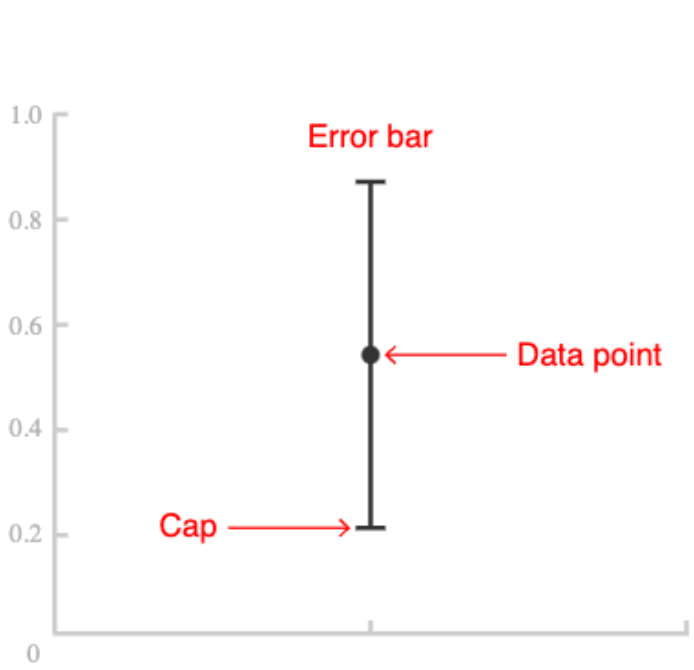
Communicating Uncertainty

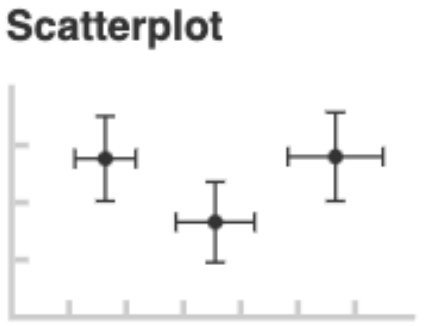
- How should we decide between encodings?

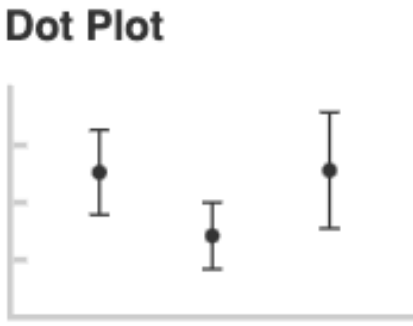


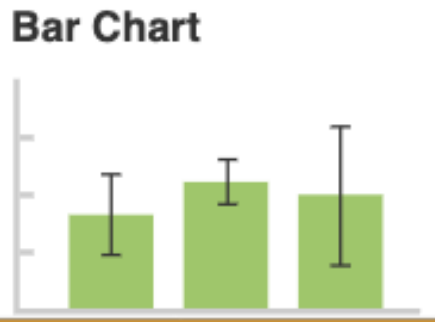
Communicating Uncertainty

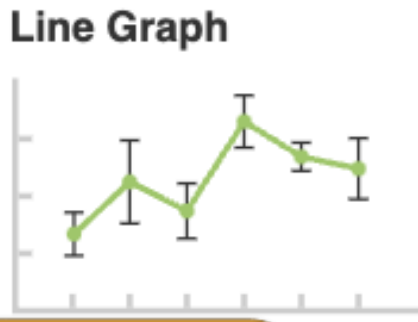
- Direct ways to communicate uncertainty:
  - Error Bars









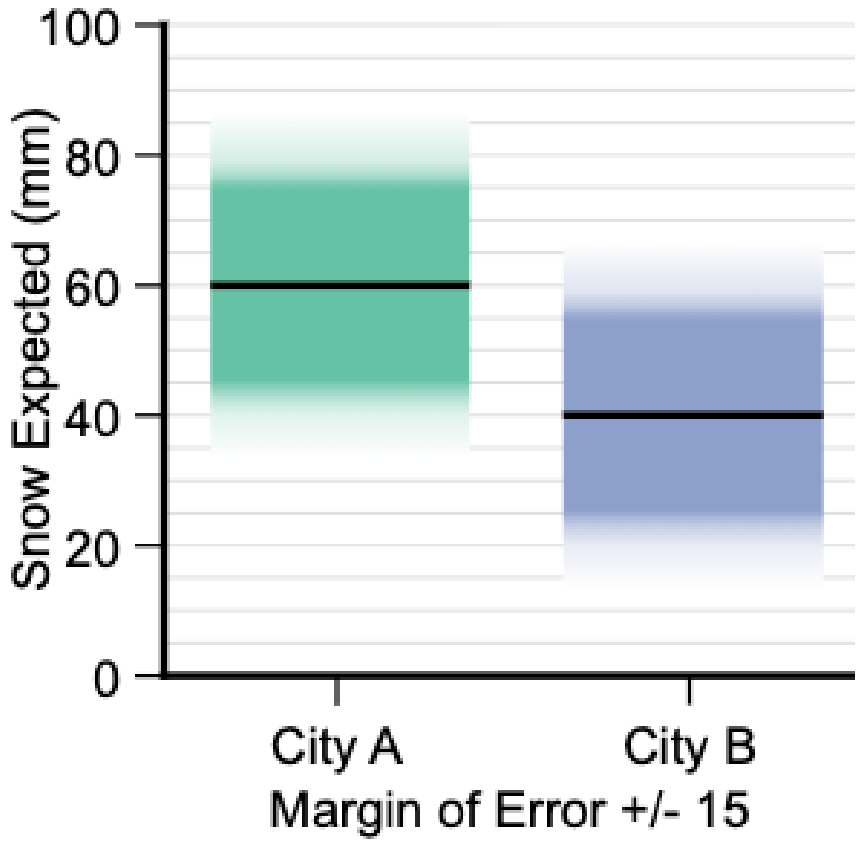


Proceed with caution! How do you think readers might misinterpret error bars?

https://datavizcatalogue.com/methods/error_bars.html

Communicating Uncertainty

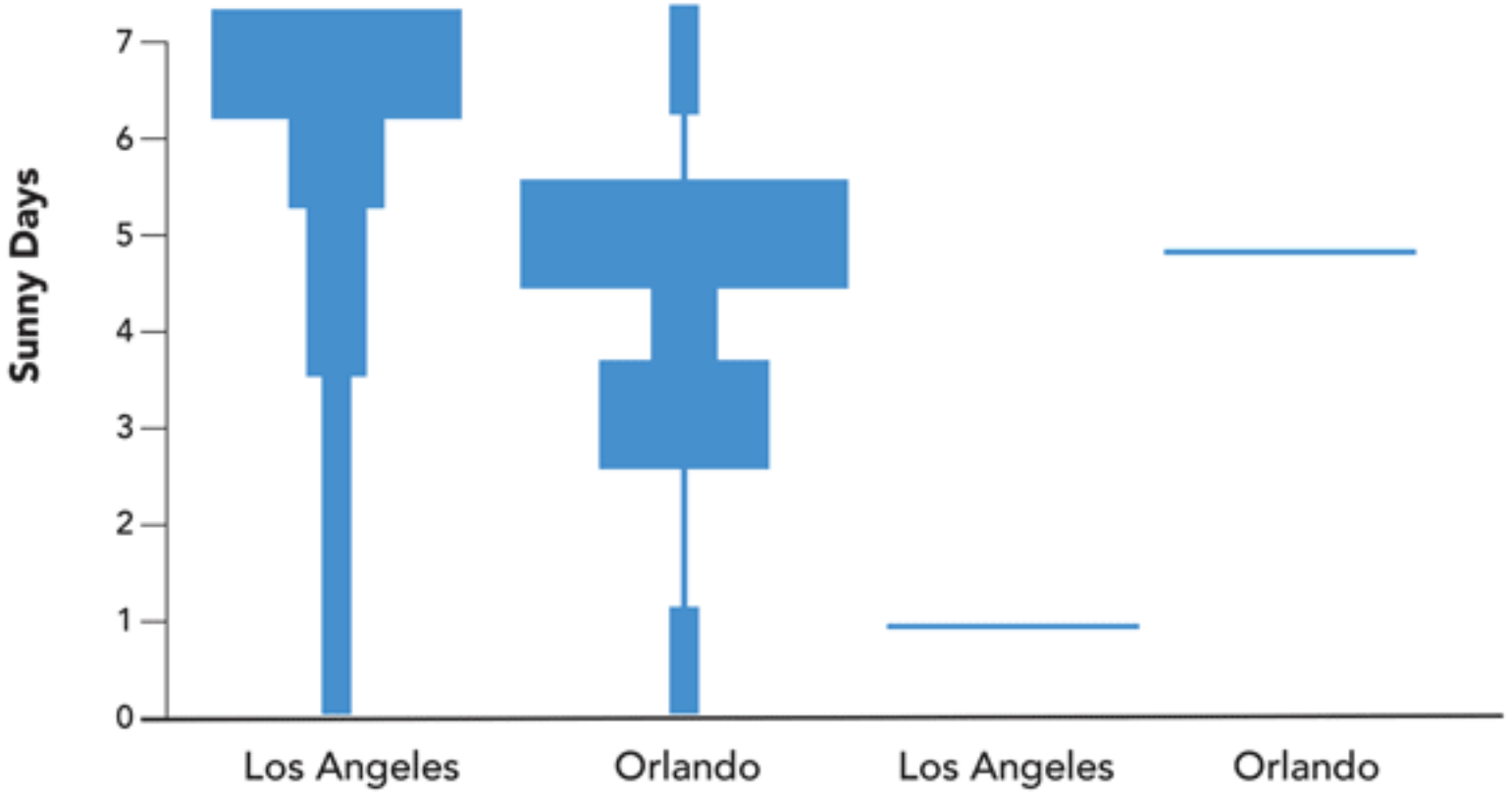
- Direct ways to communicate uncertainty:
  - Gradient Plots



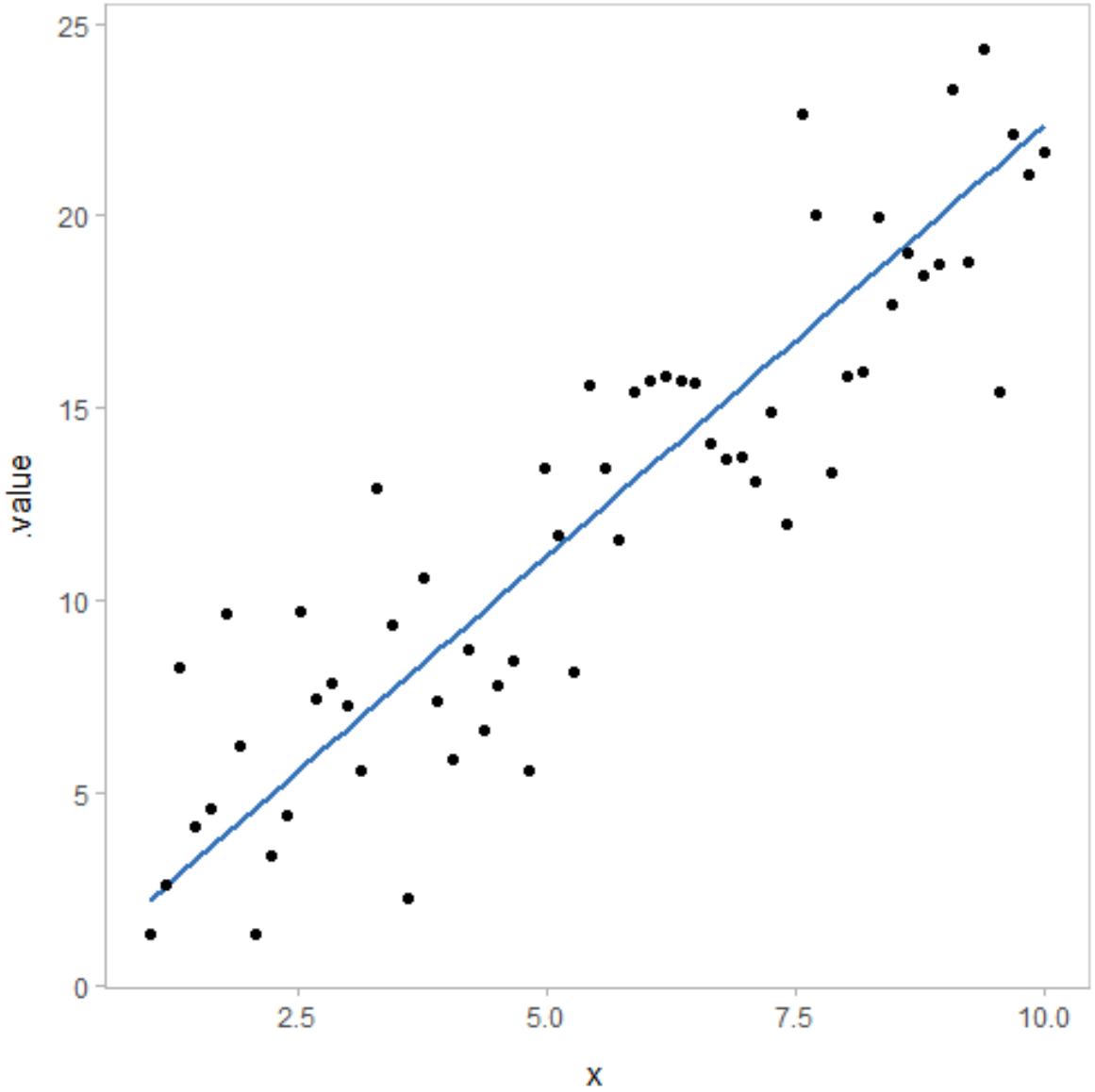
What advantage does this encoding have over error bars?

Communicating Uncertainty

- Direct ways to communicate uncertainty:
  - Show animated visualizations where each frame is a draw from the probability distribution
    - Ex. Hypothetical Outcome Plots (HOPs)



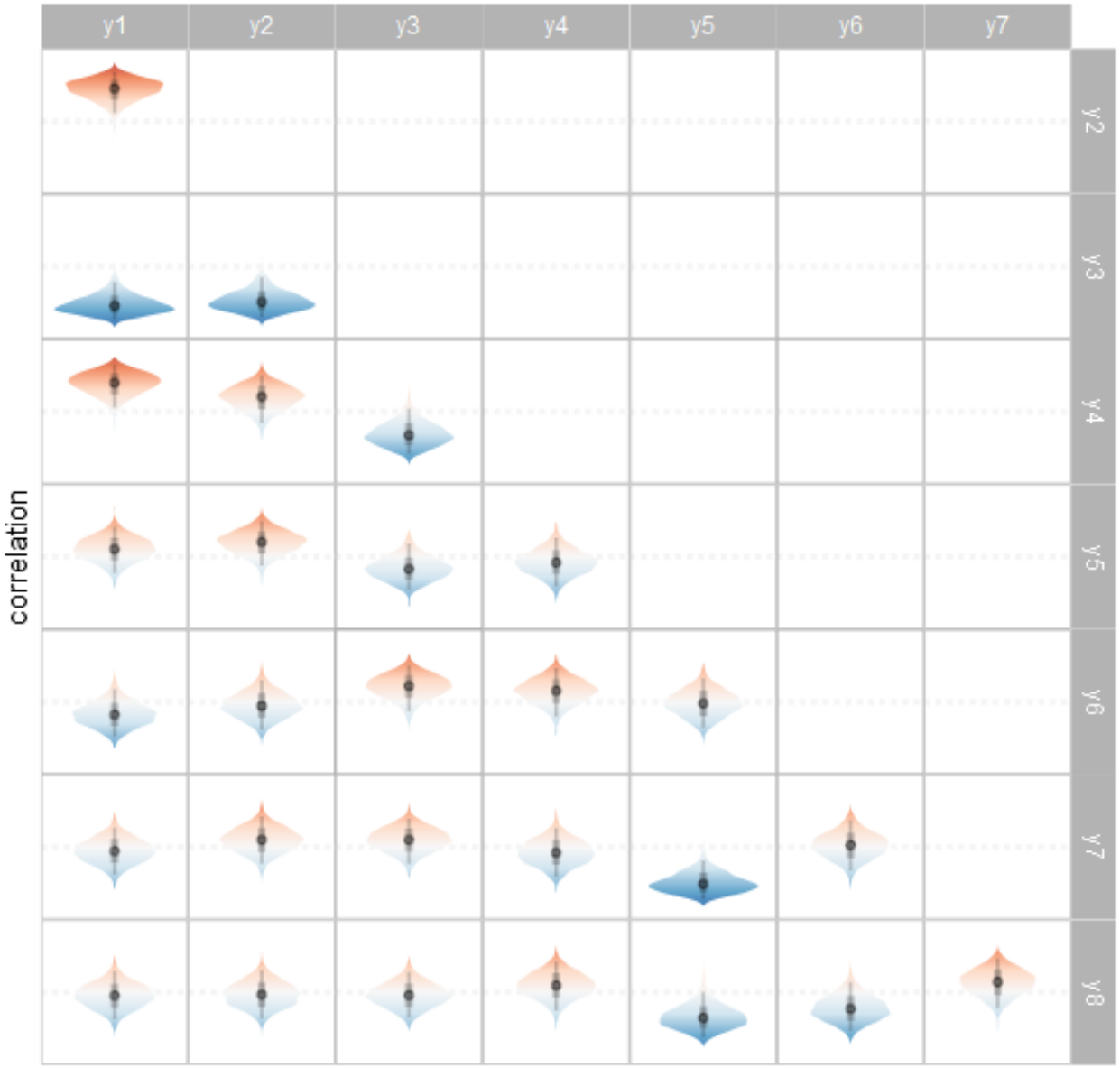
Linear Regression



$$y = mx + b$$

https://github.com/mjskay/uncertainty-examples/blob/master/linear-regression.md

Multivariate Regression



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Demos

- R and Python Uncertainty Visualization Demos are on the course website. Work through one with a partner