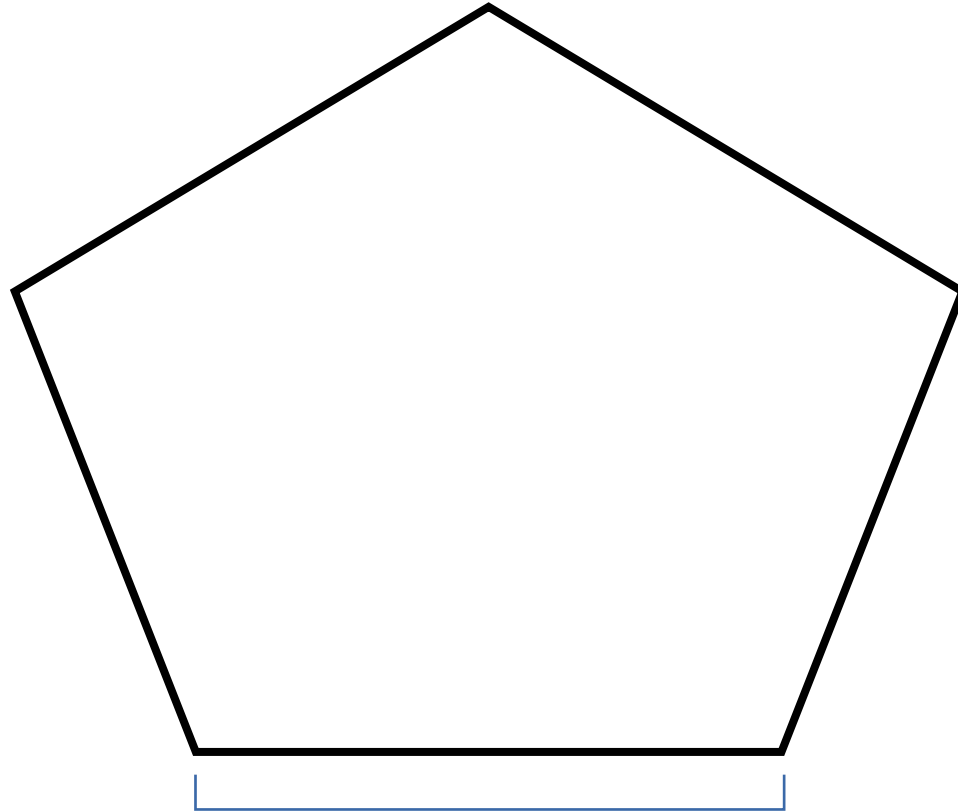


Imprecise and Ambiguous Math

Avi Swartz

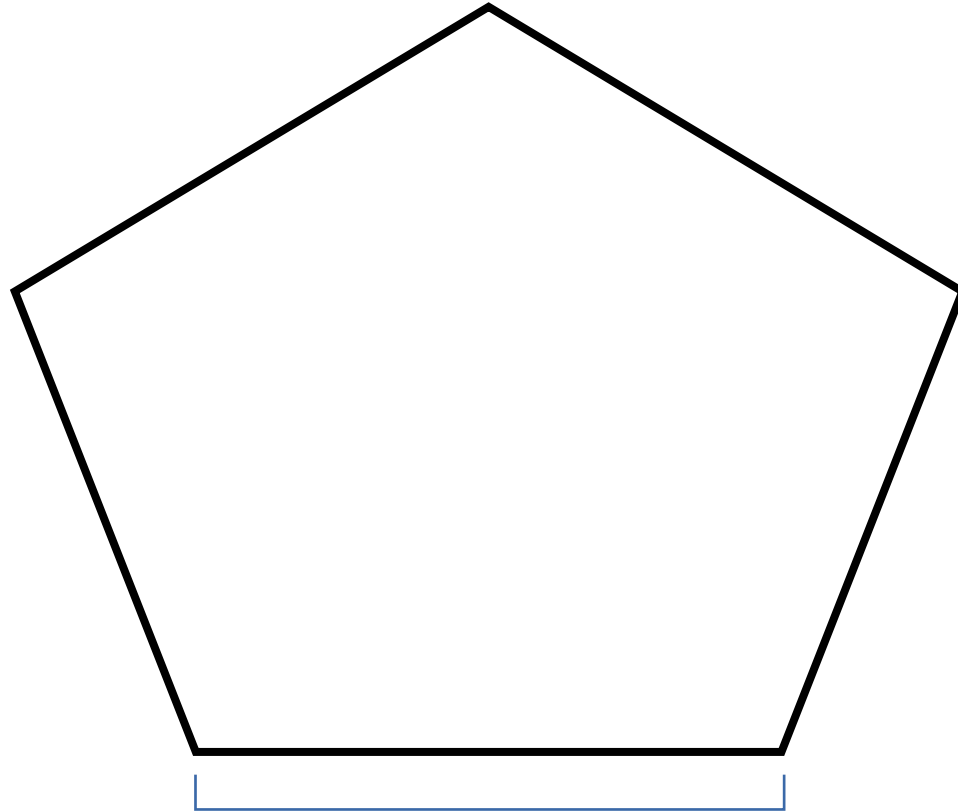
UNC Awards Ceremony 2017

Measurements to a mathematician



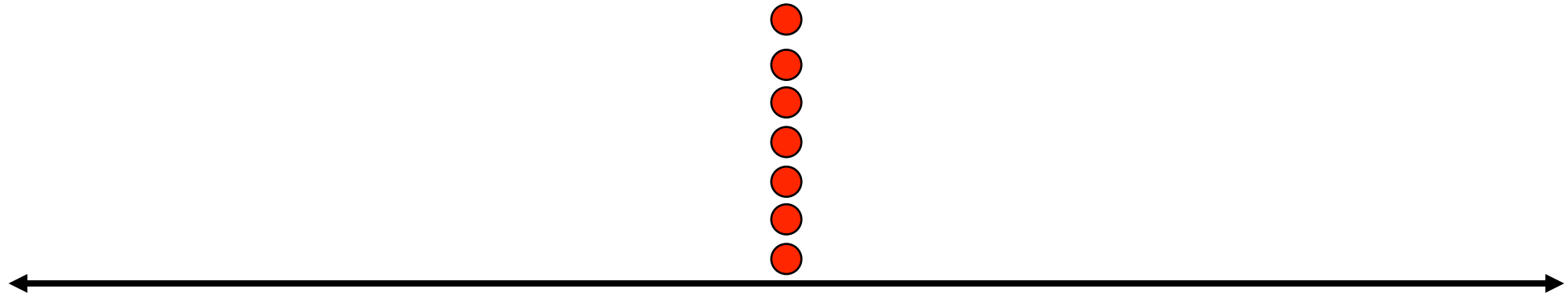
This segment is exactly
 $17\sqrt{2}$ units long

Measurements to an experimental scientist

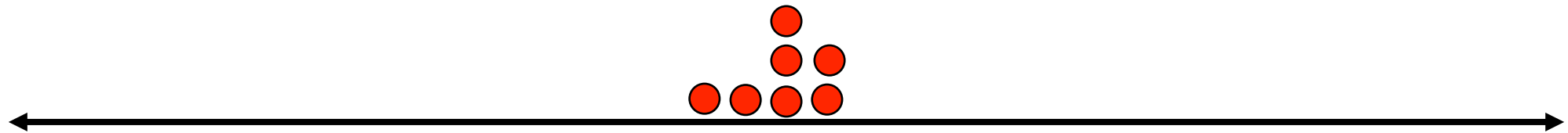


I'm 95% confident that
this segment is between
24.0 and 24.1 units long

Repeated Measurements



In theory



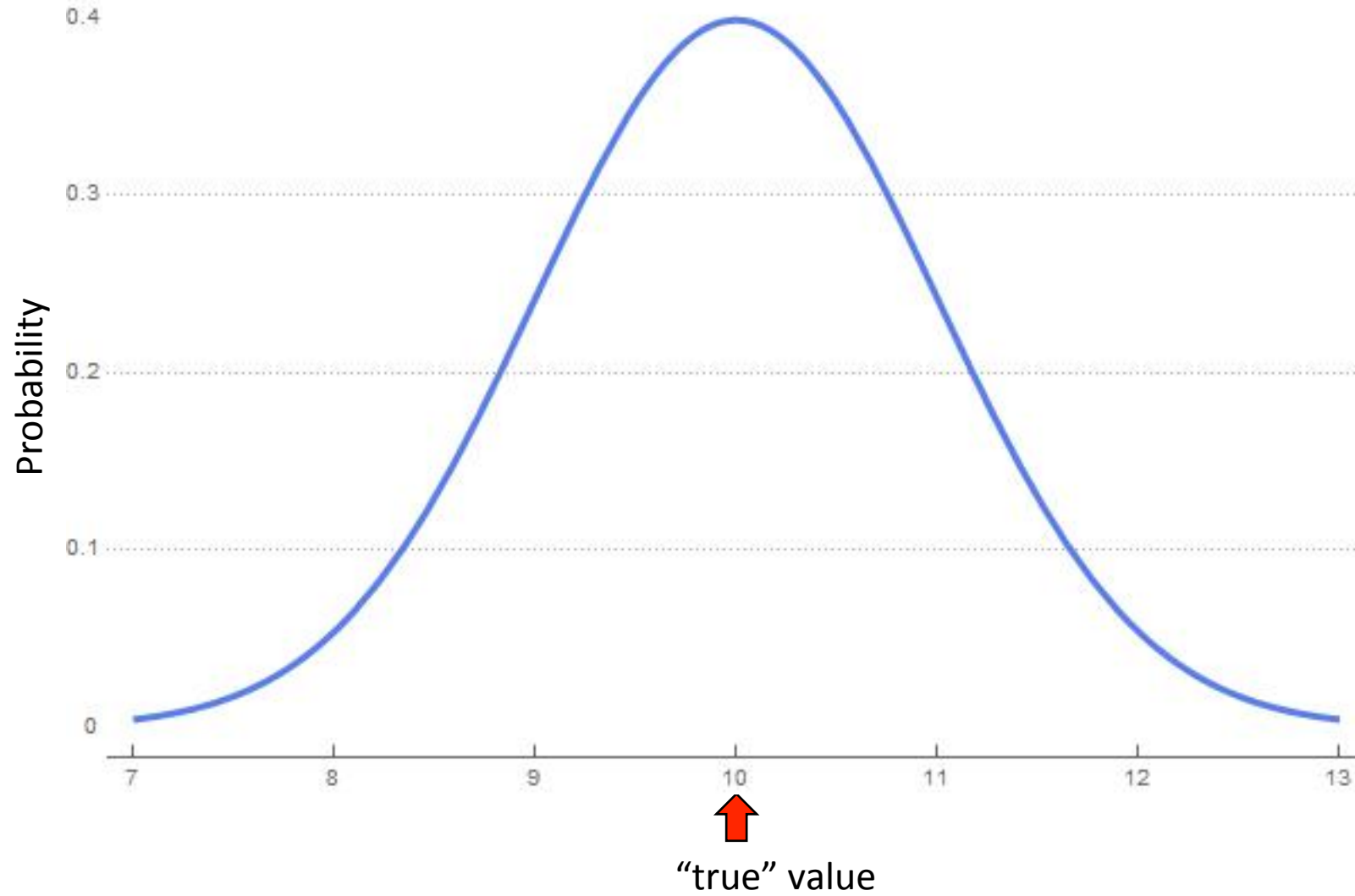
In practice

Motivating Questions

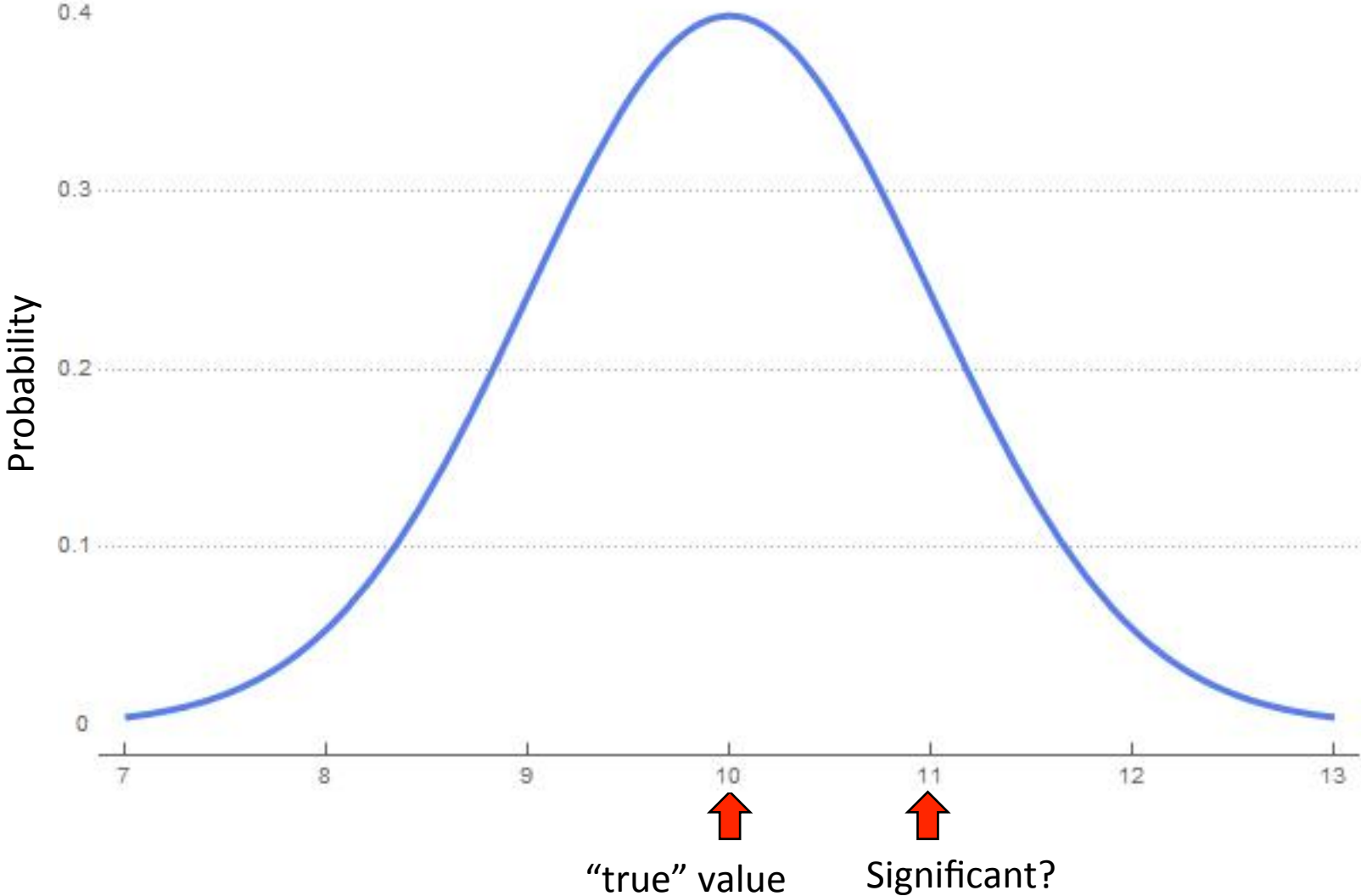
How accurate is a measurement?

Is an observed result due to chance?

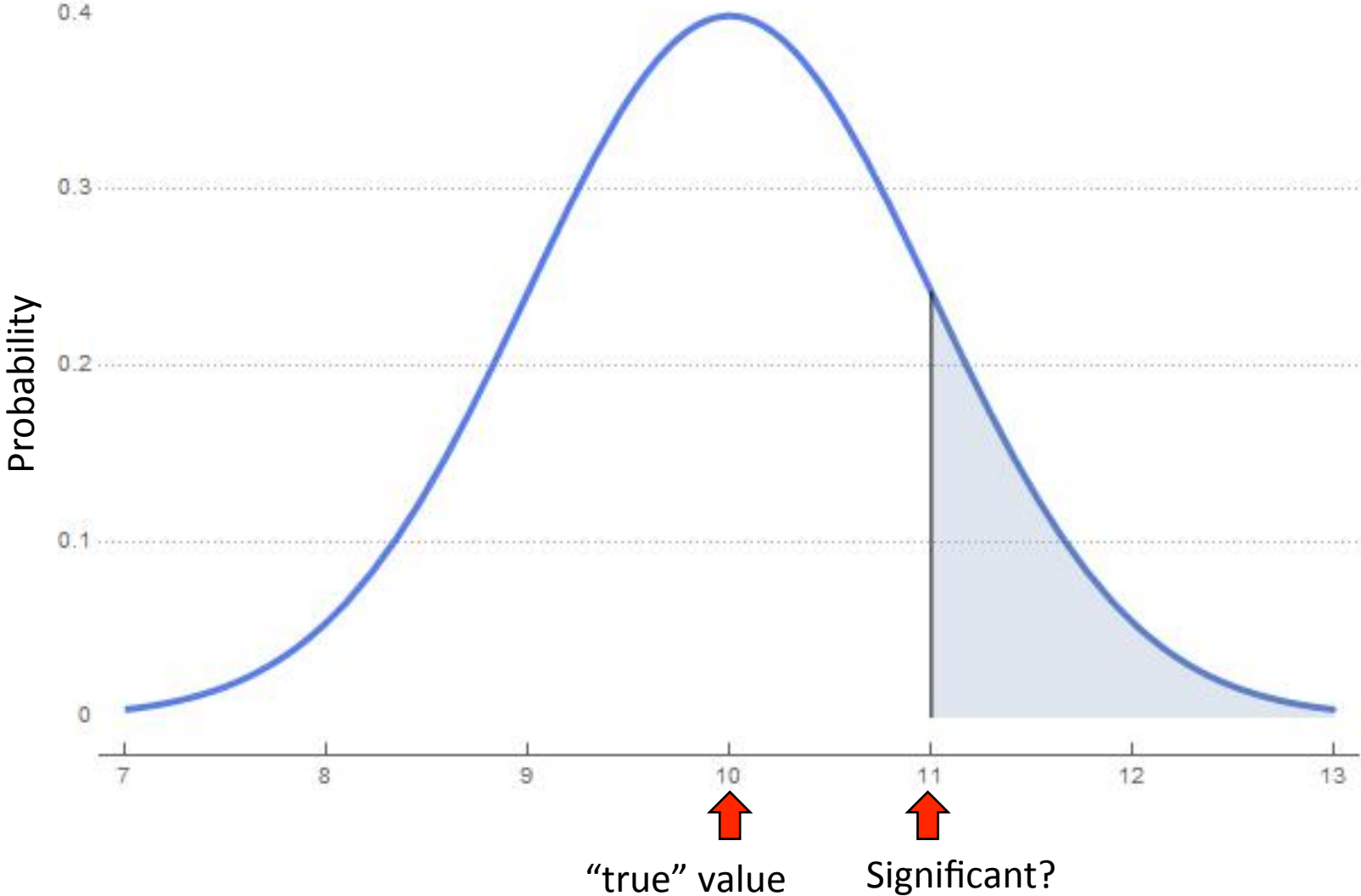
Distributions



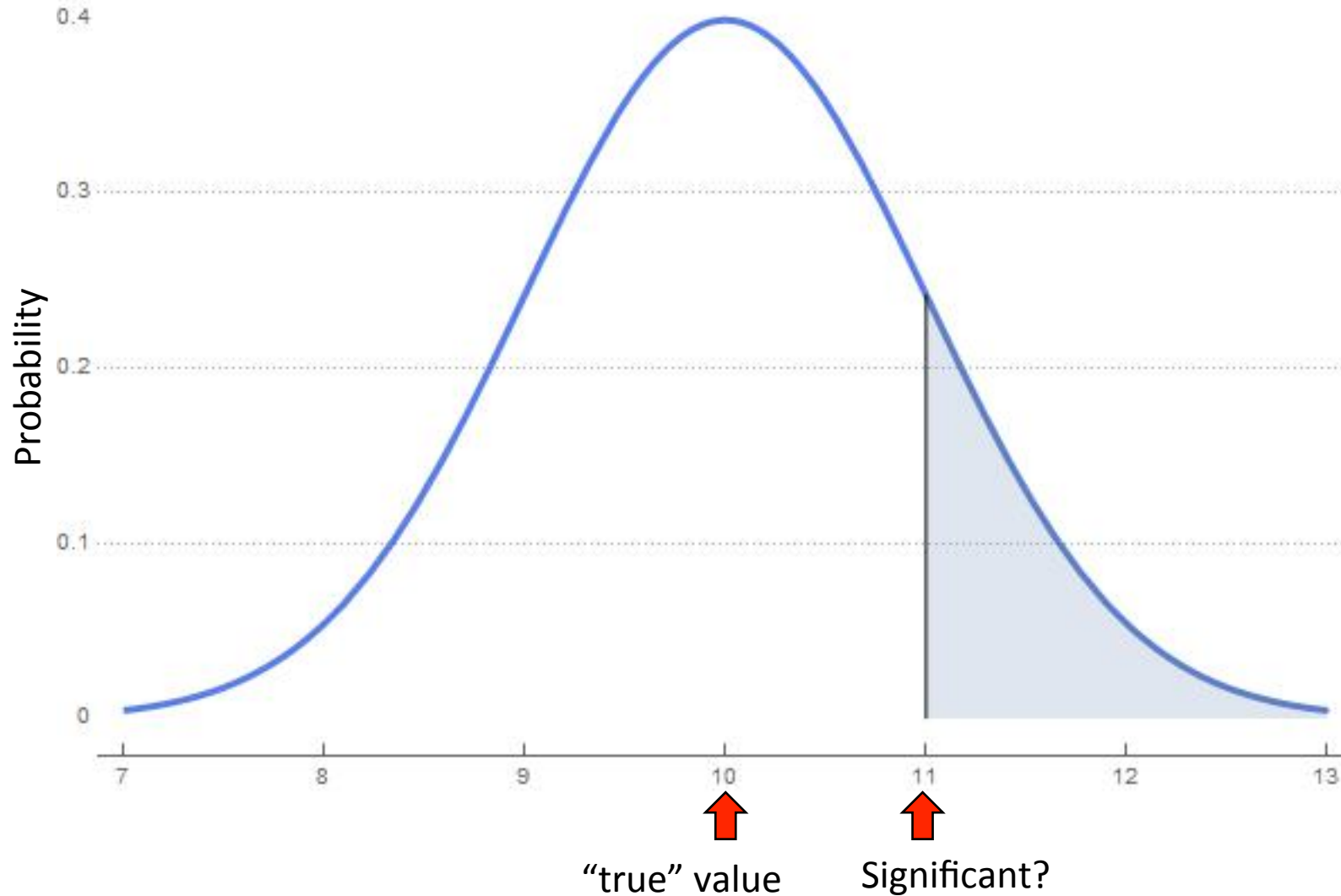
Significance



P values



P values



The shaded area can be determined by integrating

$$\frac{e^{-\frac{(x-\mu)^2}{2\sigma^2}}}{\sqrt{2\pi}\sigma}$$

where μ is the mean and σ is the standard deviation.

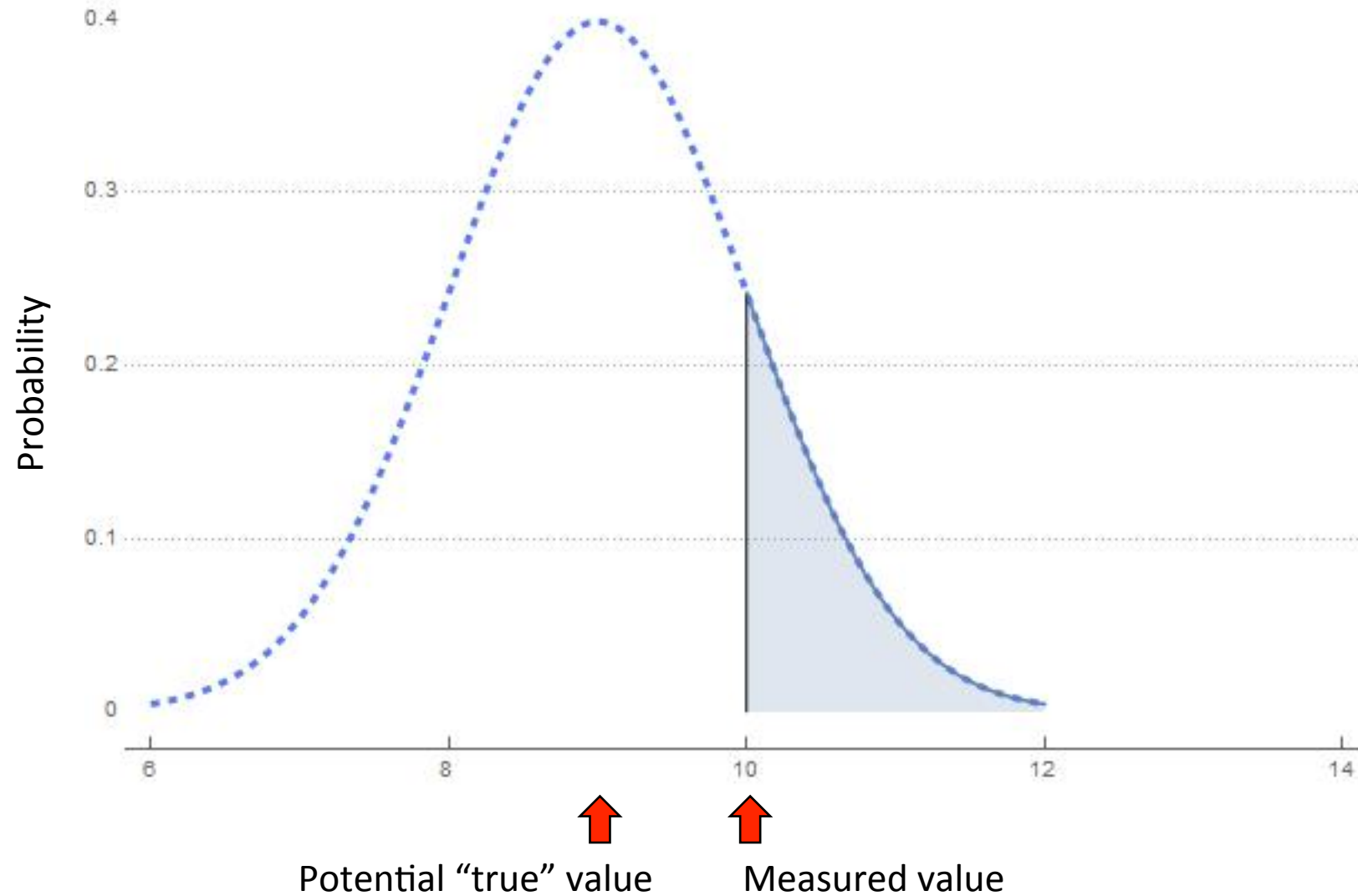
Statistical Test

When practicing for the AIME, you average a 12. On the actual contest, you get a 7. Did you just have a bad day, or was there a problem with your practice sessions?

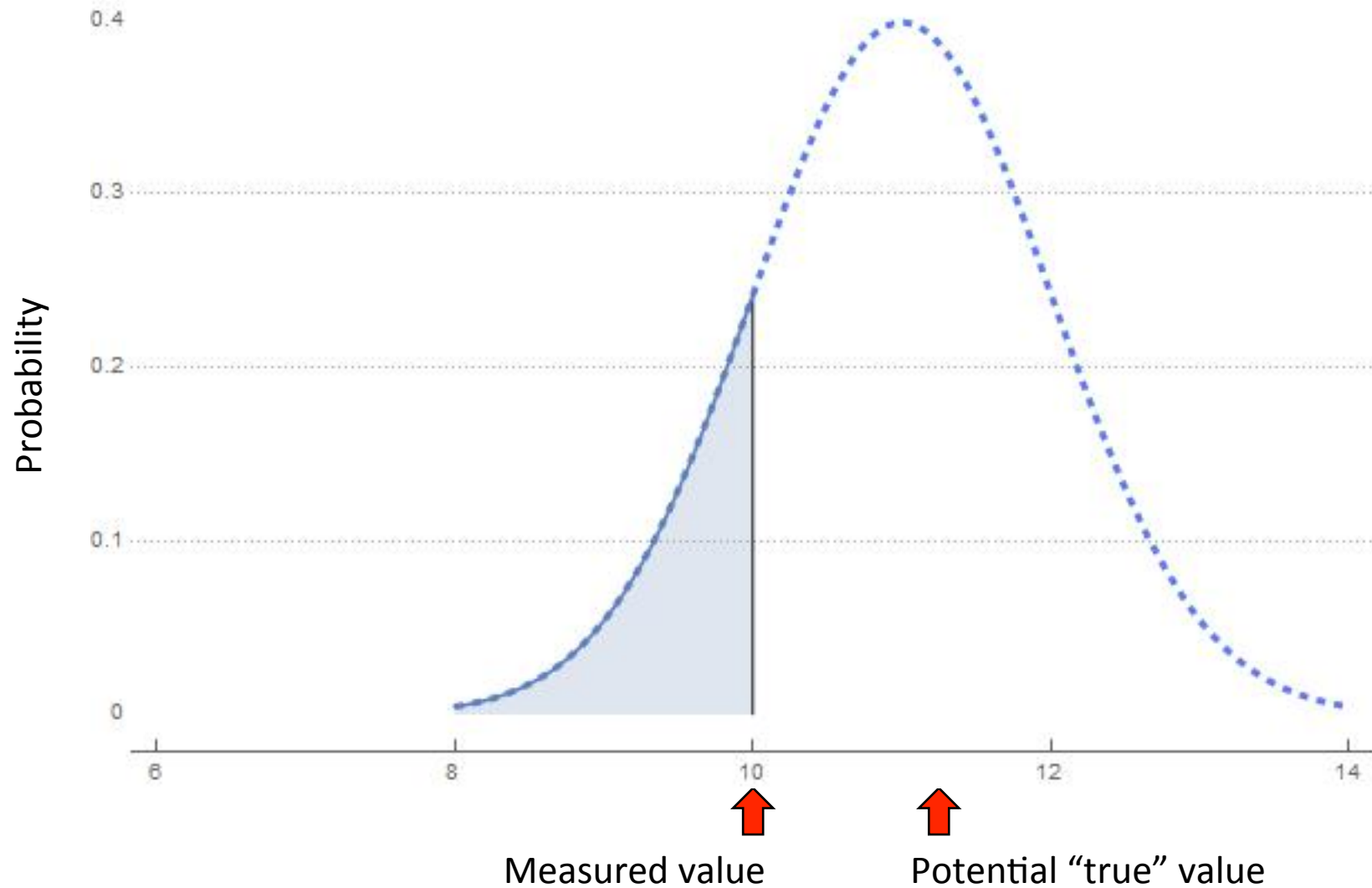
Statistical Test

1. Assume something
 - I assume my AIME average is 12.
2. Determine how likely the observed outcome is under the assumption
 - Given an average of 12, the p value of scoring 7 or worse is 0.001.
3. Assess the likelihood of the assumption
 - If my average was 12, there was only a 0.001 chance of scoring 7 this time. Therefore, my true average is not 12.

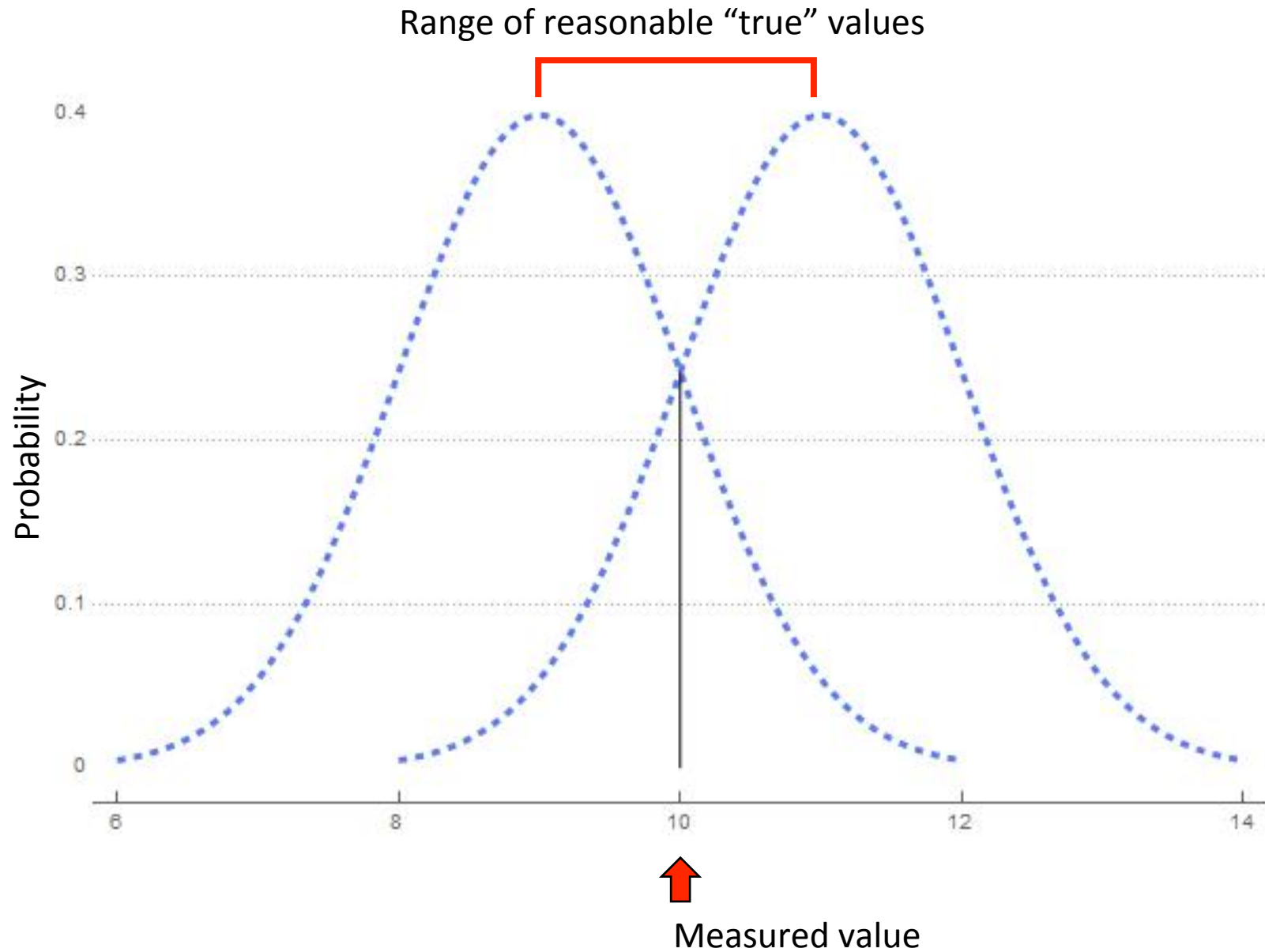
Confidence Intervals



Confidence Intervals



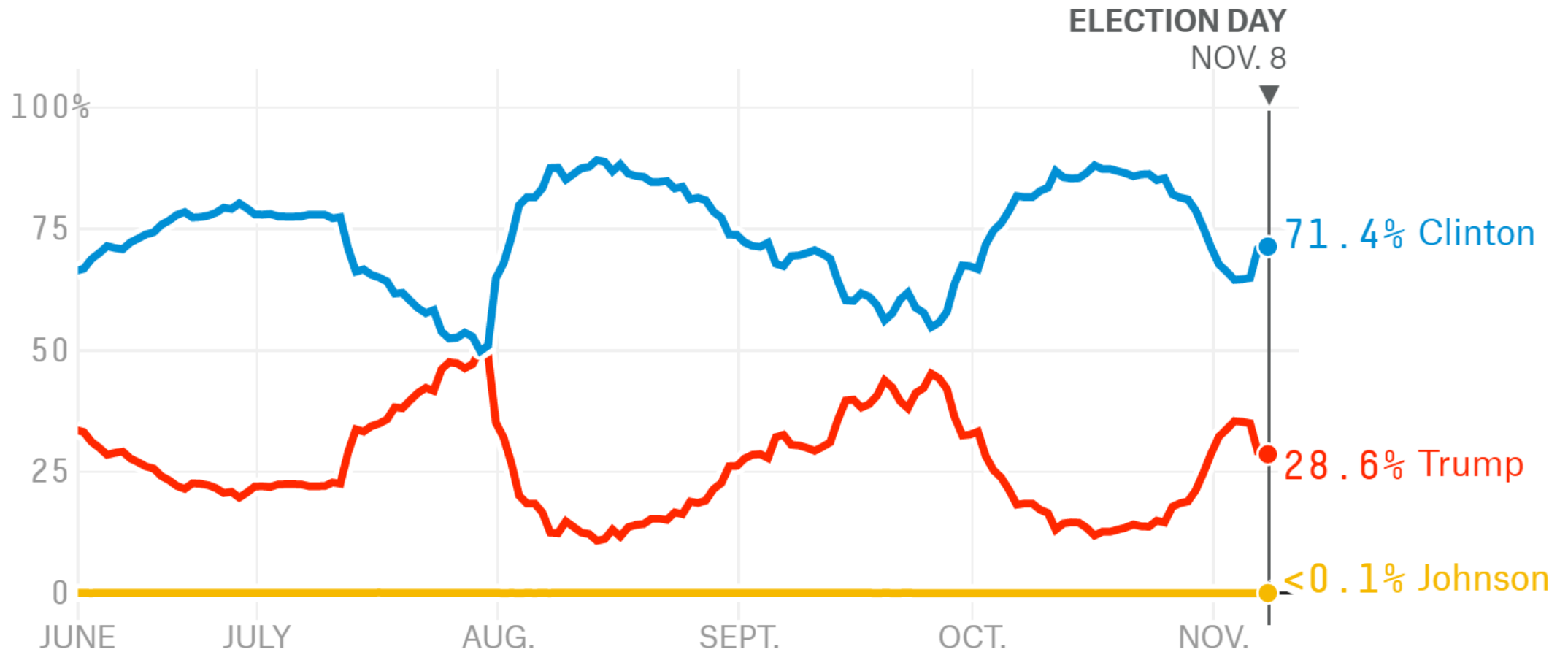
Confidence Intervals



Caveats with statistics

- Significance does not mean importance
 - Significance only means not due to chance
 - Spending a million dollars on a new car design significantly increases its fuel efficiency by 0.01 mpg
 - Significant? Yes
 - Worth the cost? Probably not
- Statistics can be abused
 - Check the assumptions
 - Correlation does not imply causation

Who is going to win?



The problem with polling

- The Electoral College
 - National popular vote predictions were closer in 2016 than 2012
- Polls don't match the voting population
 - Non response bias
- Shy responders
 - Who's going to admit to voting for Trump?
- Margins of error are forgotten
- Polling is slow and things change
- Things still rest on probability

Improbable Things Happen

- Littlewood's law
 - You witness events with one and a million chance once every month
- Someone has to win the lottery
- If something unlikely happens to you, statistics wasn't wrong
 - You were the (un)lucky outlier

Final question

- Was this presentation “significant”?