All of Statistics with One Weird Trick

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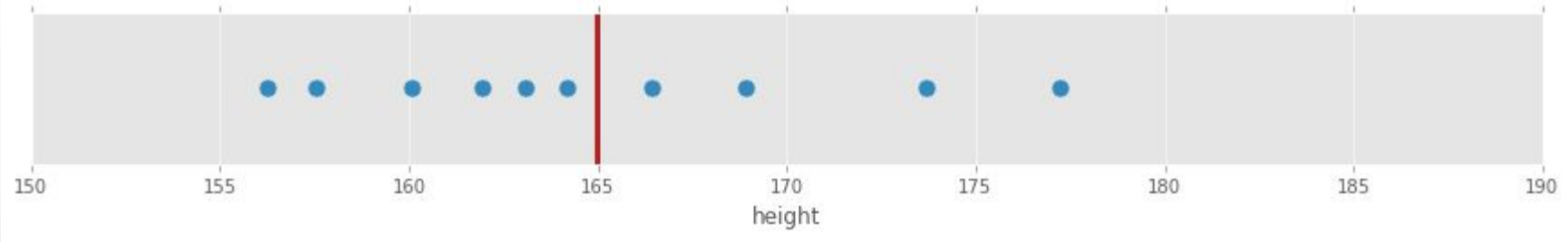
NICAR 2016

Resampling!

Make as much fake (but useful) data as you want.

Confidence Intervals

Margin of error of a survey



What's the 95% confidence interval
on the average height of N journalists?

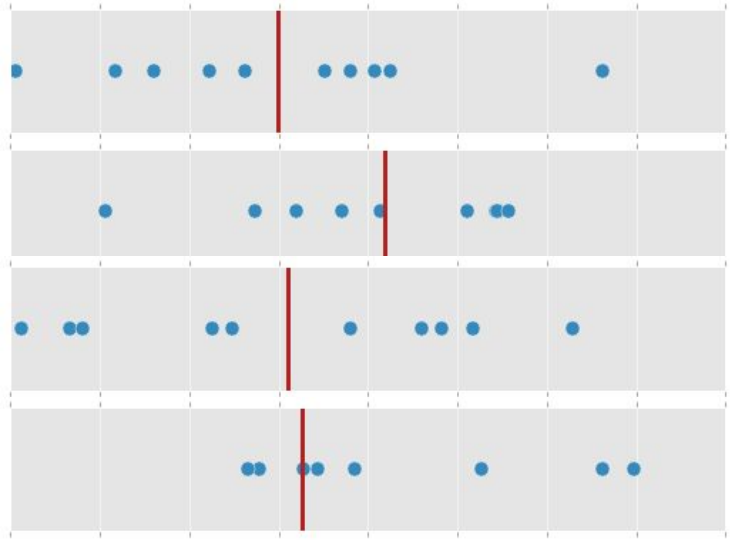
Margin of error of a survey

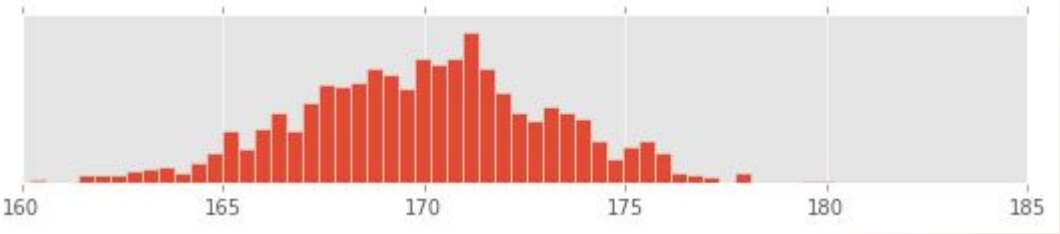
$$s = \sqrt{\frac{\sum (x - \bar{x})^2}{n - 1}}$$

$$\bar{X} \pm 1.96\, \sigma / \sqrt{n}$$

What's the 95% confidence interval on the average height of N journalists?

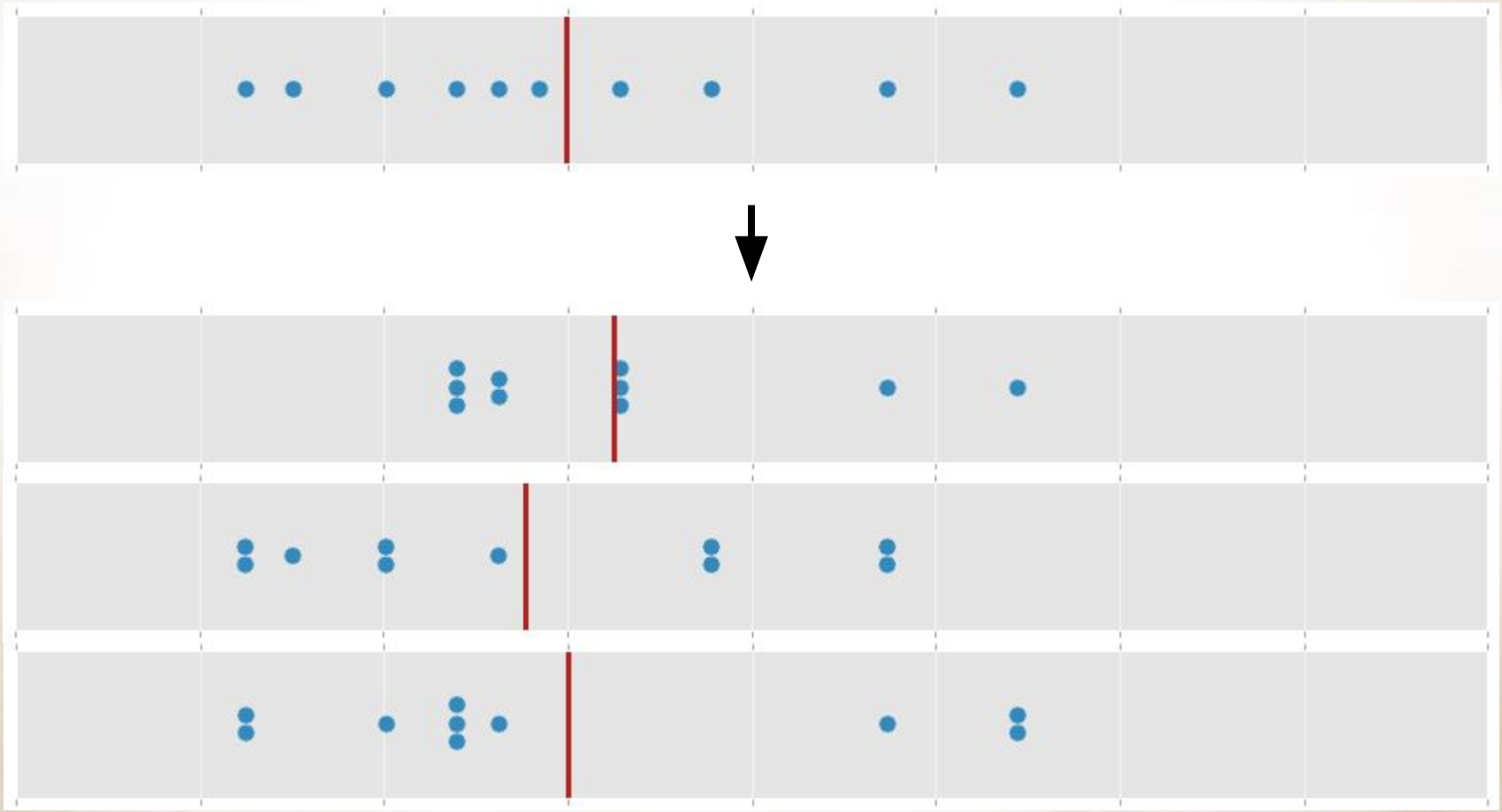
If we could repeat the survey many times…



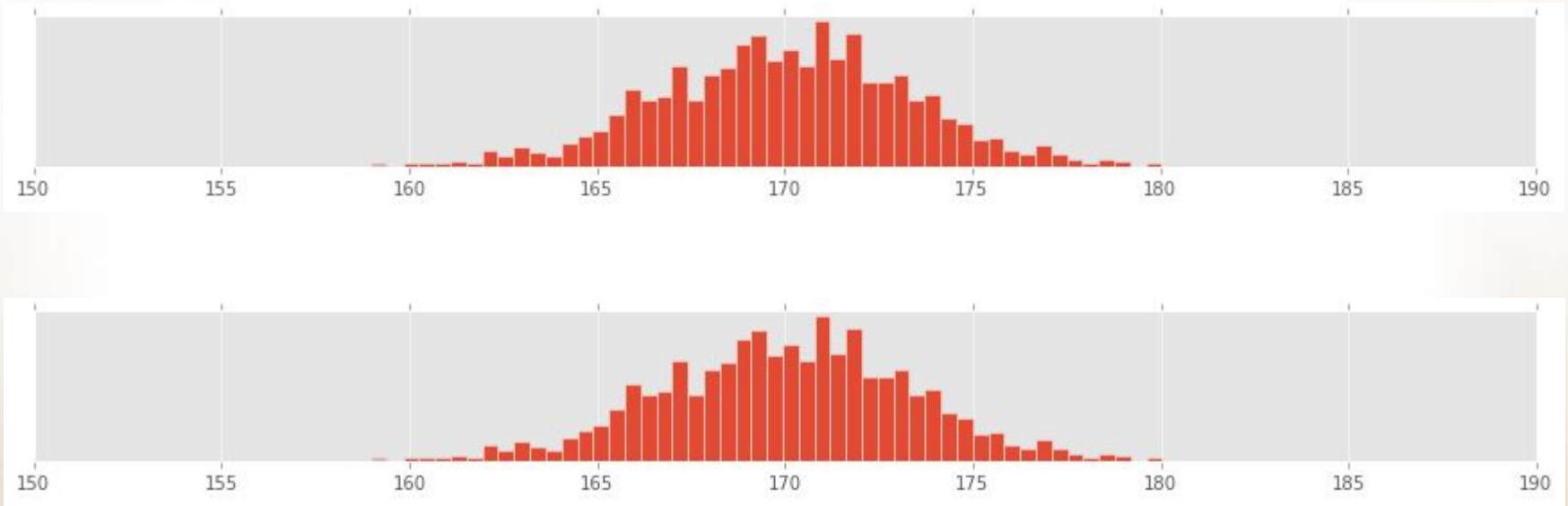


…we could just look at the distribution of average values

New samples from the data



1000 resamples as good as 1000 real samples!

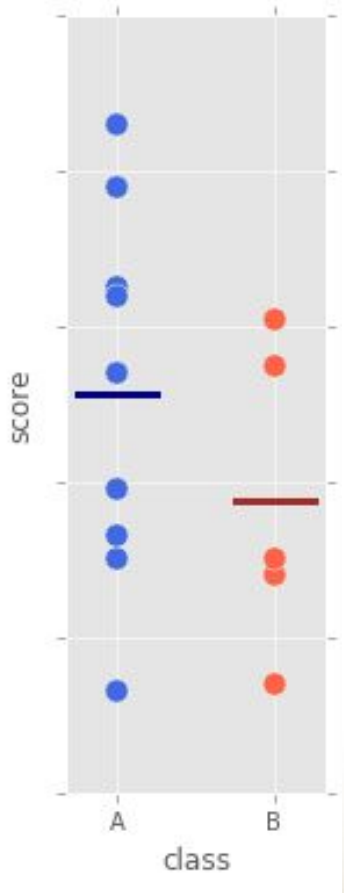


Same standard deviation and confidence intervals

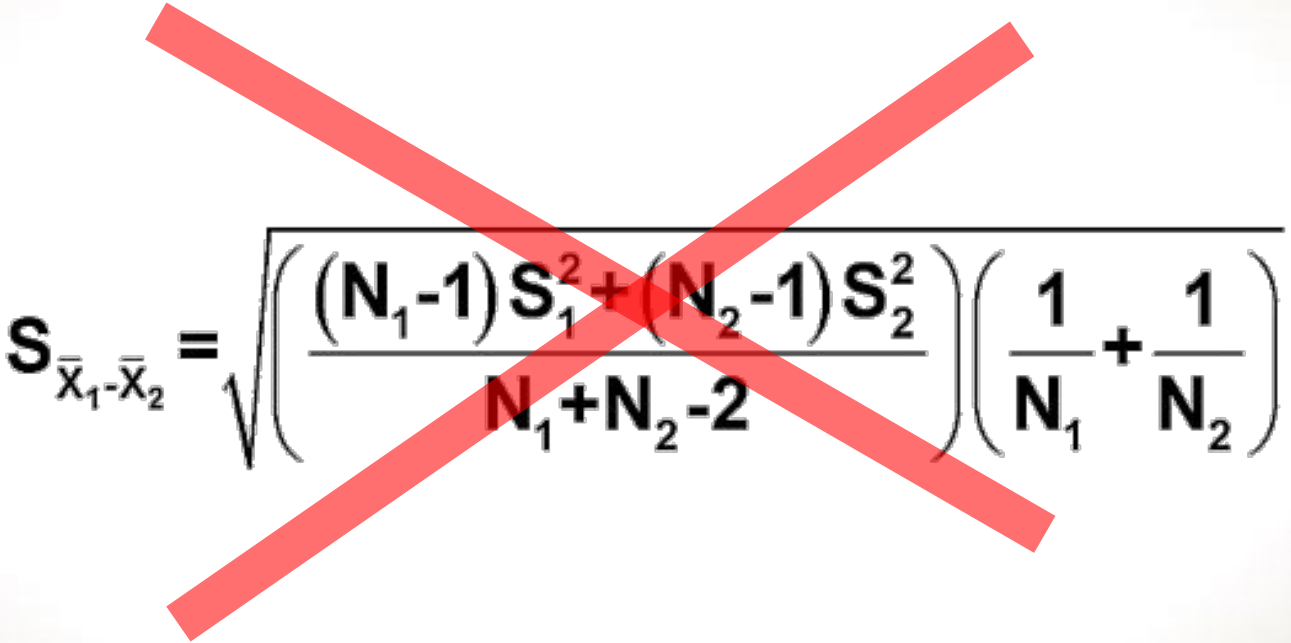
Significance Testing

Is one classroom really better than another?

Score	Class
0.90	A
0.93	A
1.25	A
1.24	A
1.38	A
0.99	A
1.14	A
1.46	A
0.73	A
1.15	B
0.88	B
0.90	B
0.74	B
1.21	B



Is one classroom really better than another?



T-test for two groups with different variance

Reasons for the difference

Things that depend on which classroom a student is in

Things that don’t depend on which classroom they’re in

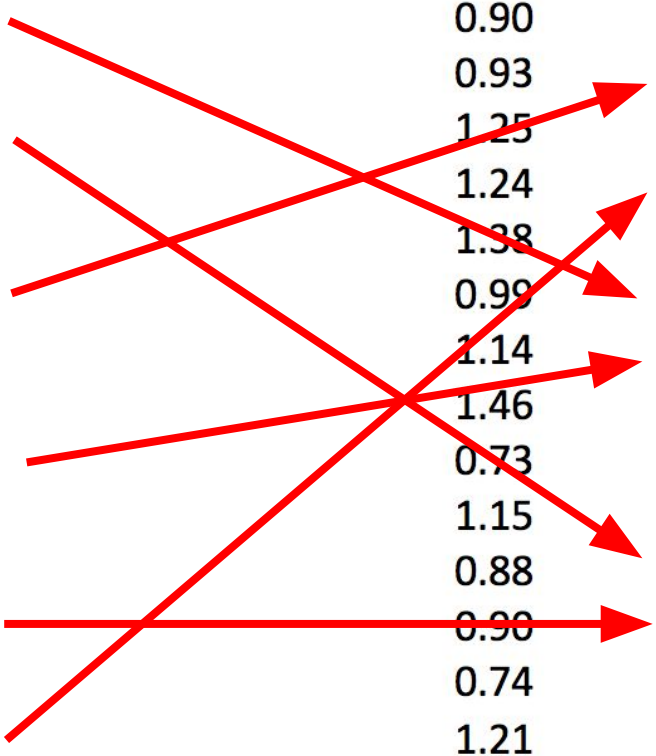
Reasons for the difference

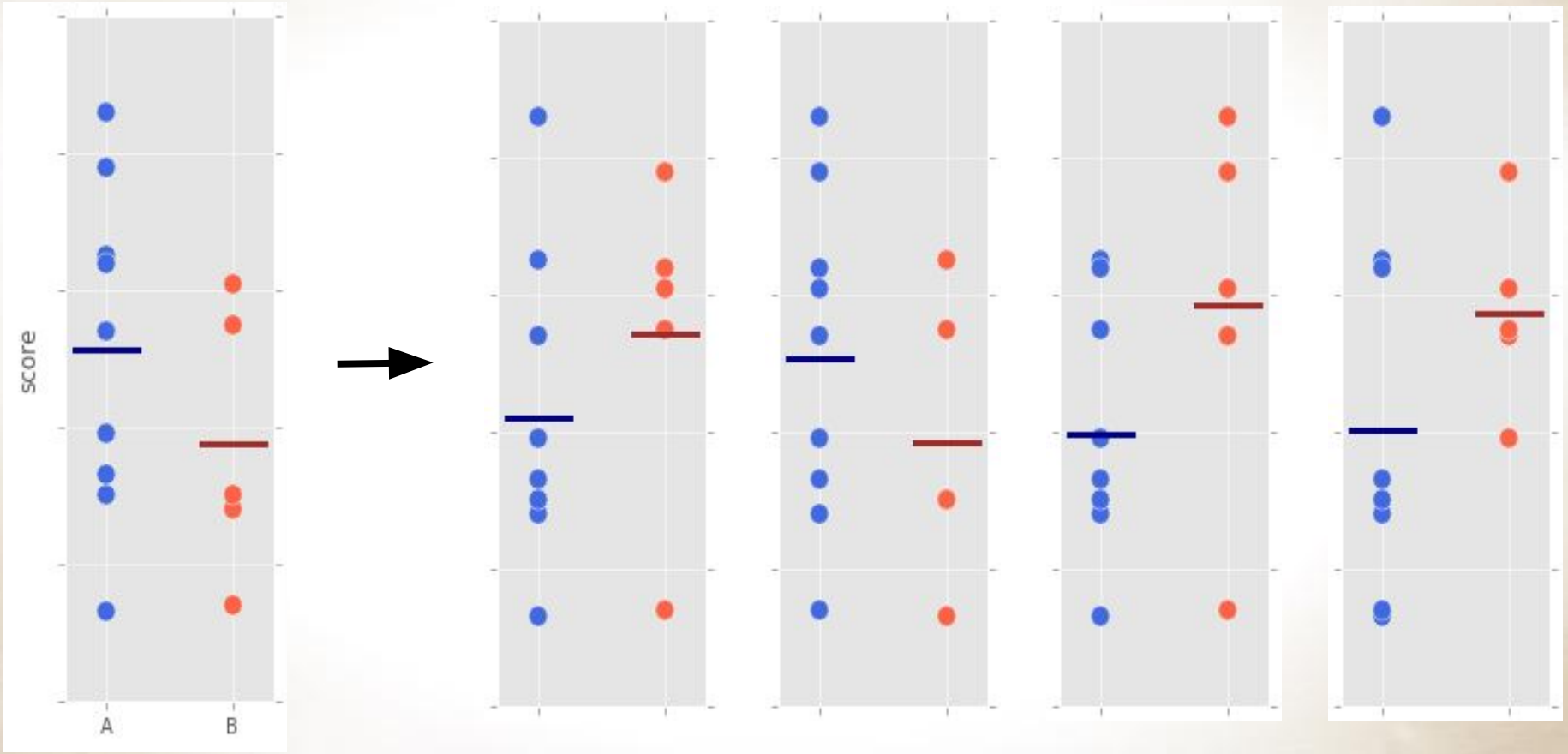
Things that depend on which classroom a student is in

Things that don’t depend on which classroom they’re in

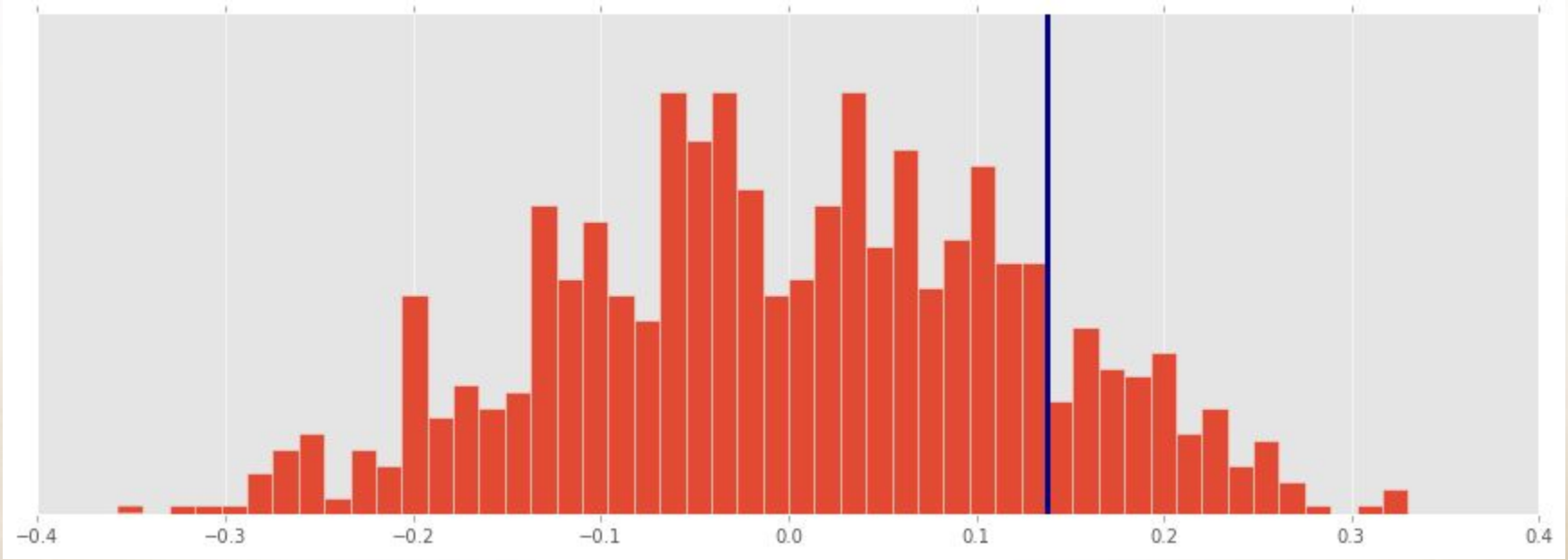
Break the relationship!

Score	Class	Score	Class
0.90	A	0.90	B
0.93	A	0.93	A
1.25	A	1.25	A
1.24	A	1.24	B
1.38	A	1.38	A
0.99	A	0.99	A
1.14	A	1.14	A
1.46	A	1.46	A
0.73	A	0.73	B
1.15	B	1.15	B
0.88	B	0.88	A
0.90	B	0.90	B
0.74	B	0.74	A
1.21	B	1.21	A

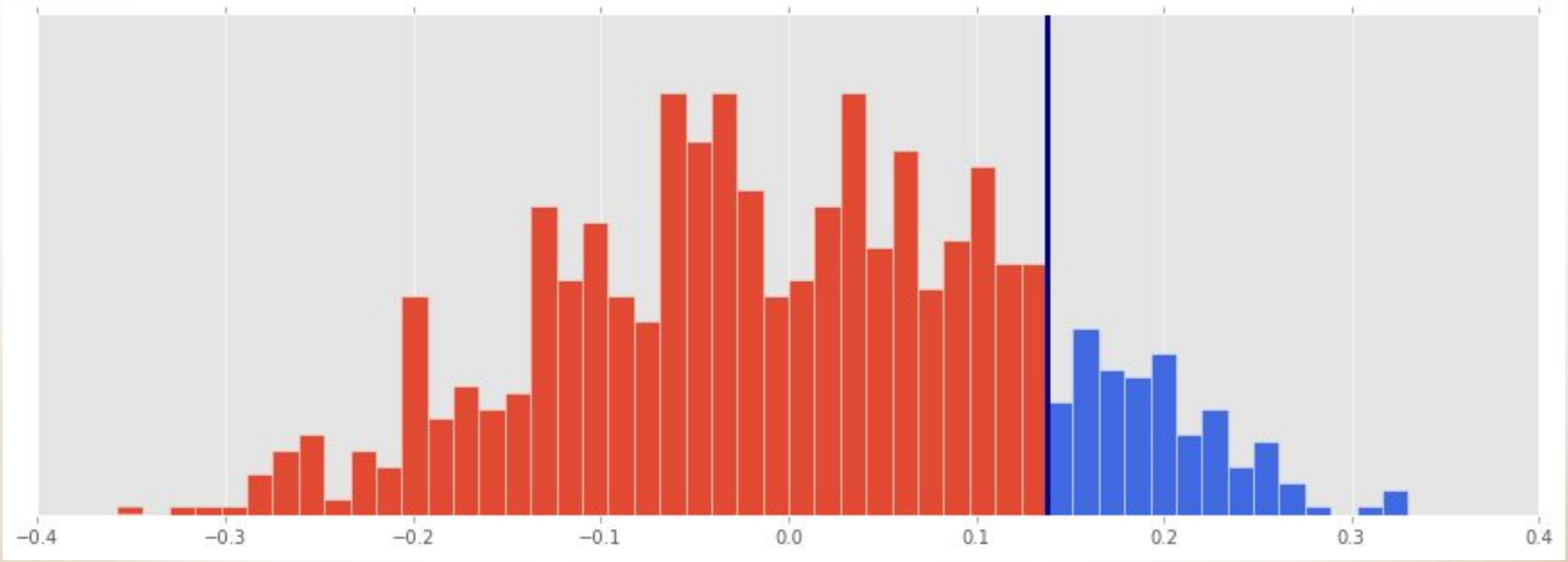



score
A
B

observed difference
between classes



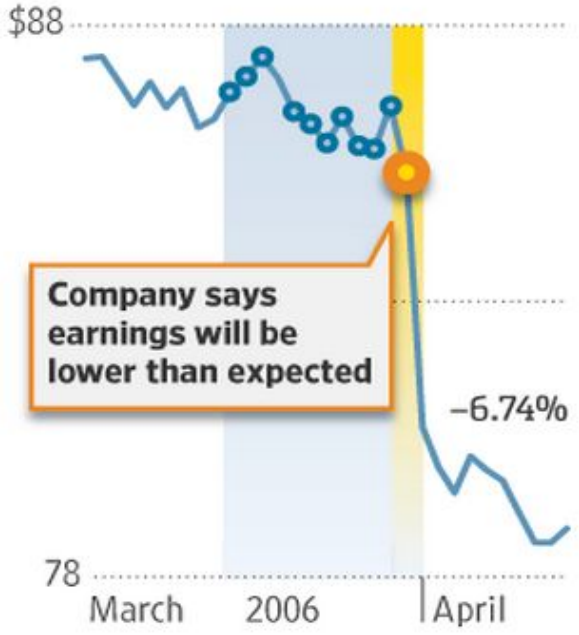
observed difference between classes



14% of all resamples have a class difference > observed, so **p = 0.14**

Insider Trading

Resampling to detect insider trading



Jeffrey Lorberbaum

Chairman and CEO of Mohawk Industries

$10.4 MILLION SALE OF STOCK

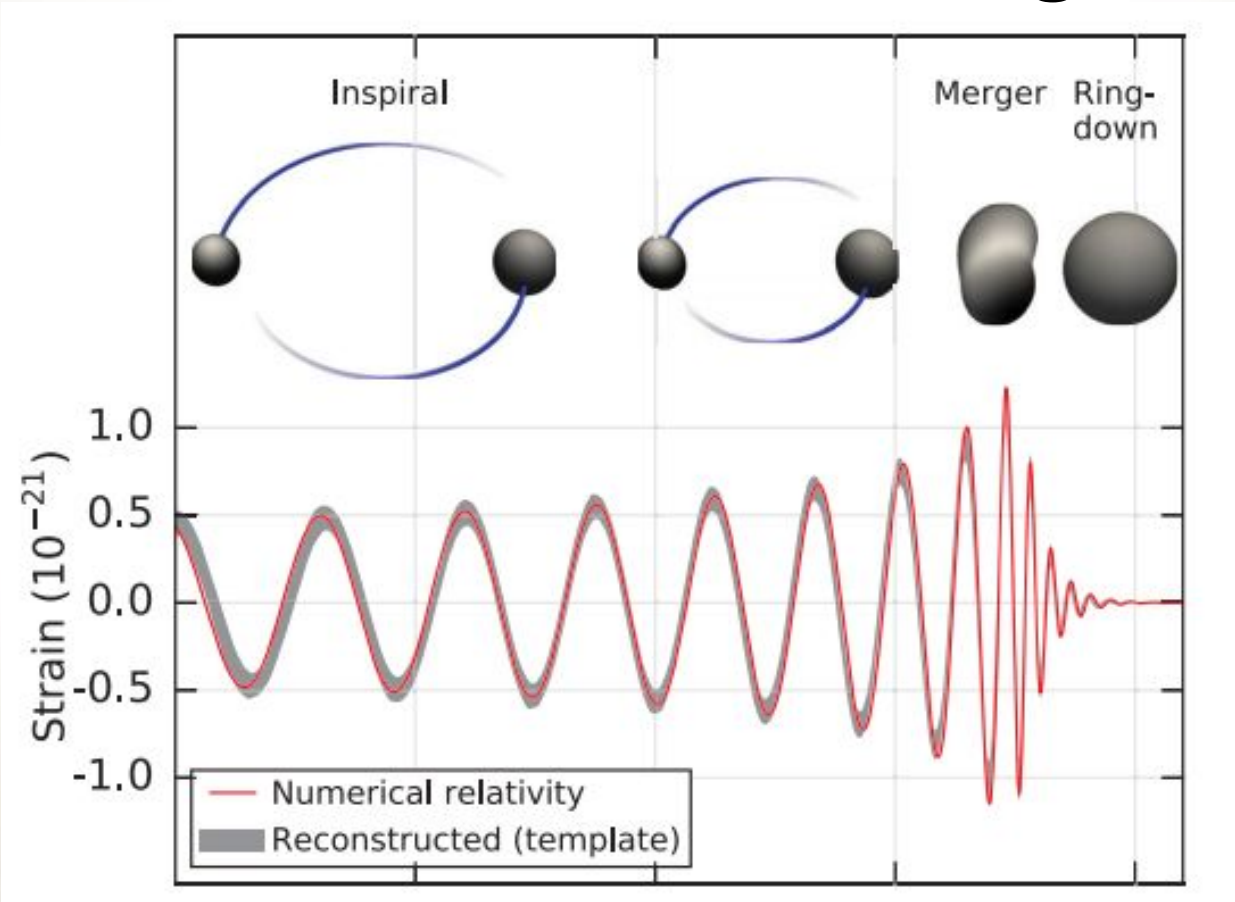
« 1 2 3 4 5 6 »

“The simulation worked by sprinkling executives’ trades at random over the stock they were trading and counting the number of times the random trades’ returns were as good as – or better than – those actually achieved by the executive.

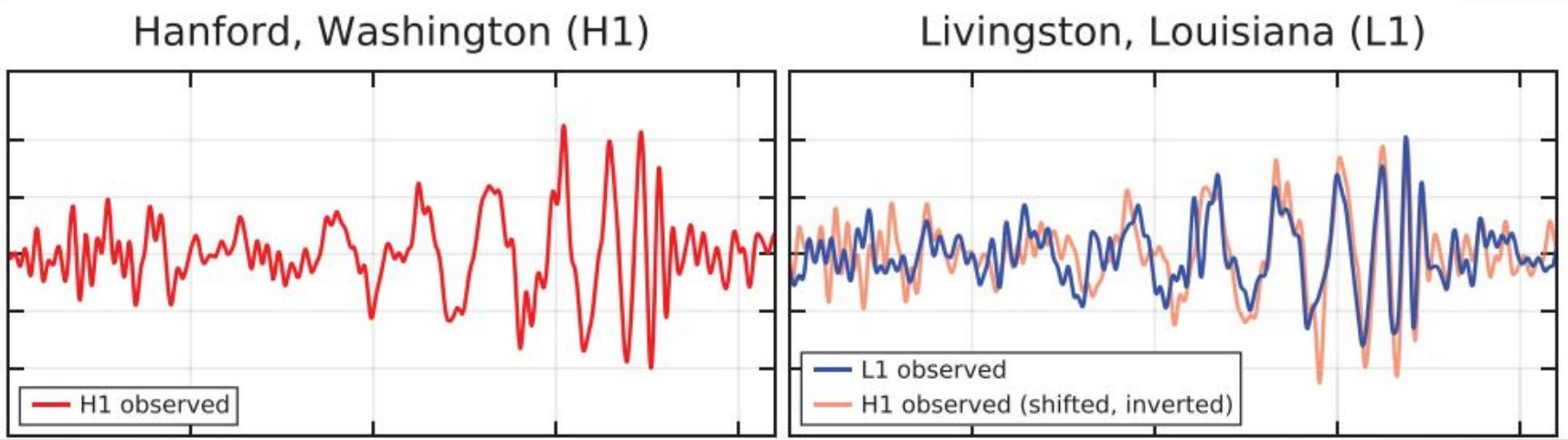
By performing this process several trillion times, reporters were able to identify hundreds of executives whose trading before news was not only profitable, but also immensely fortuitous.”

GRAVITY WAVES!!!

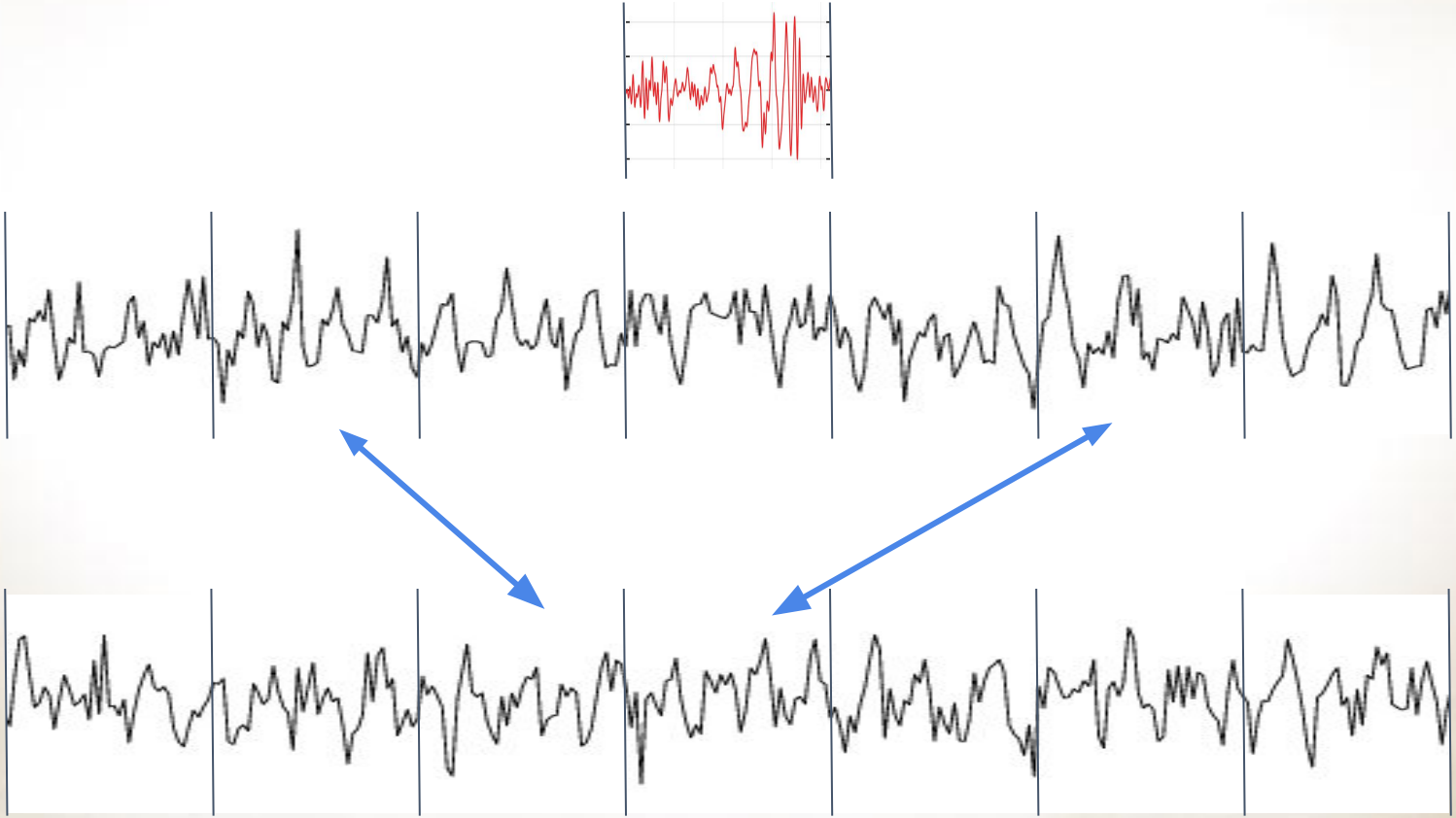
Black holes colliding?



How often will noise look like this signal?



Compare random pieces of data between detectors, same length as signal



MASSIVE BLACK HOLES COLLIDING!