How to Lie with Statistics

Supplementary Material for CFB3333/PHY3333

Professors John Cotton and Stephen Sekula

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Based on the following information on the web:

http://www.physics.smu.edu/pseudo/LieStat

Resources

- Huff, Darrell. "How to Lie with Statistics"
  - first published in 1954
  - some of the examples show their age, but they still very effectively communicate the tricks and traps of statistics
- Statistics – what is it?
  - very simply: it is the study of the collection, organization, and interpretation of data
  - used correctly, it's a powerful tool in interpreting the results of an experiment
  - used incorrectly, or misunderstood, it's a powerful tool for manipulating people to get them to agree with you

Digression about Elections

- There is no perfect vote counting system
  - as a result, every vote counting system MUST have an inherent uncertainty (e.g. statistical or systematic, where "systematic" errors are errors of measurement)
- In 2000, President George W. Bush and Vice President Al Gore ended their bids for the Presidency in Florida
  - With other states too close to call, Florida's 25 electoral votes were the "prize to win" to seal victory
  - Bush's lead over Gore was less than 2000 votes, and in one recount narrowed to as little as 300 votes
- This is the first election in U.S. history where the margin of victory for electoral votes was essentially within some measure of uncertainty on the actual vote count.

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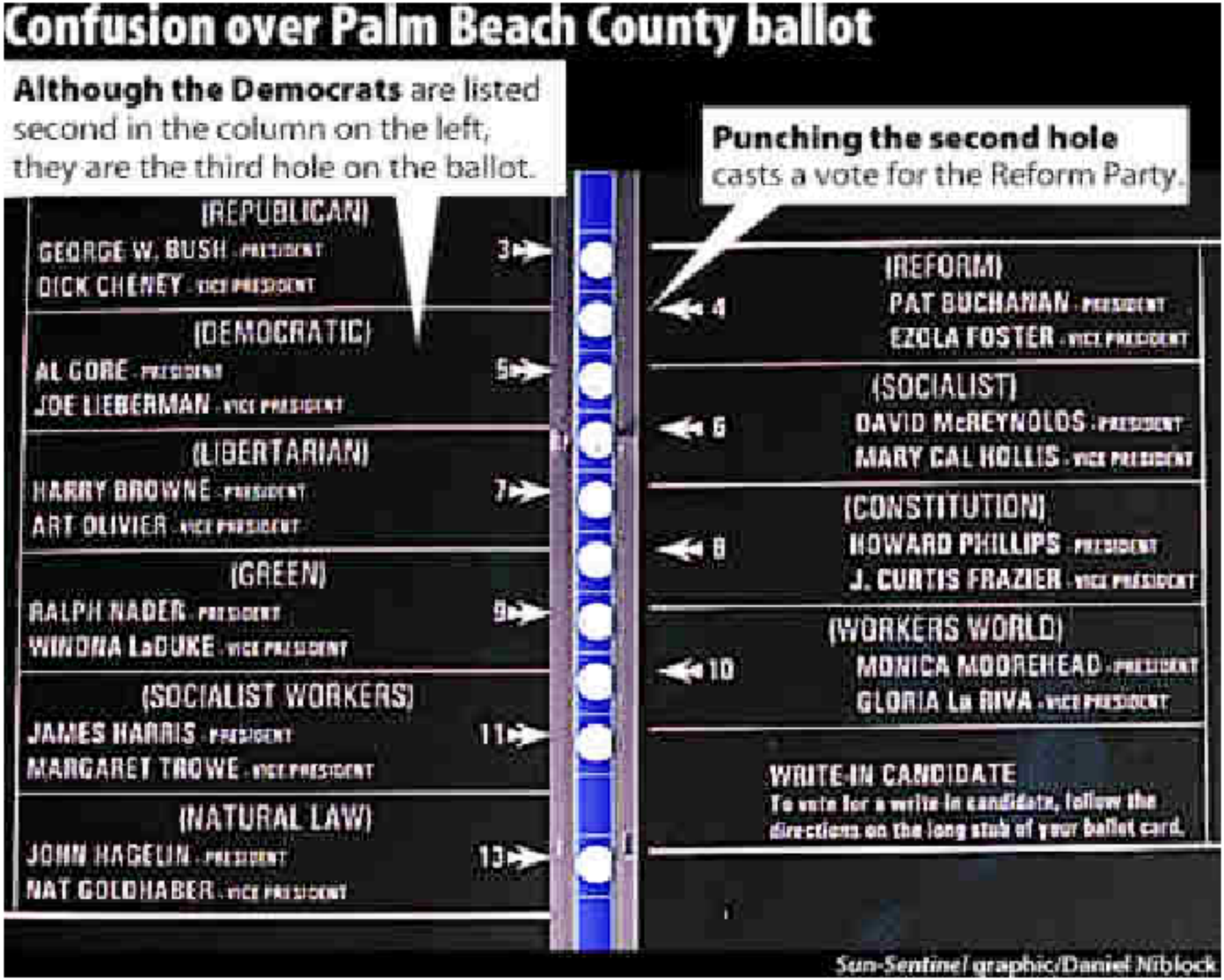

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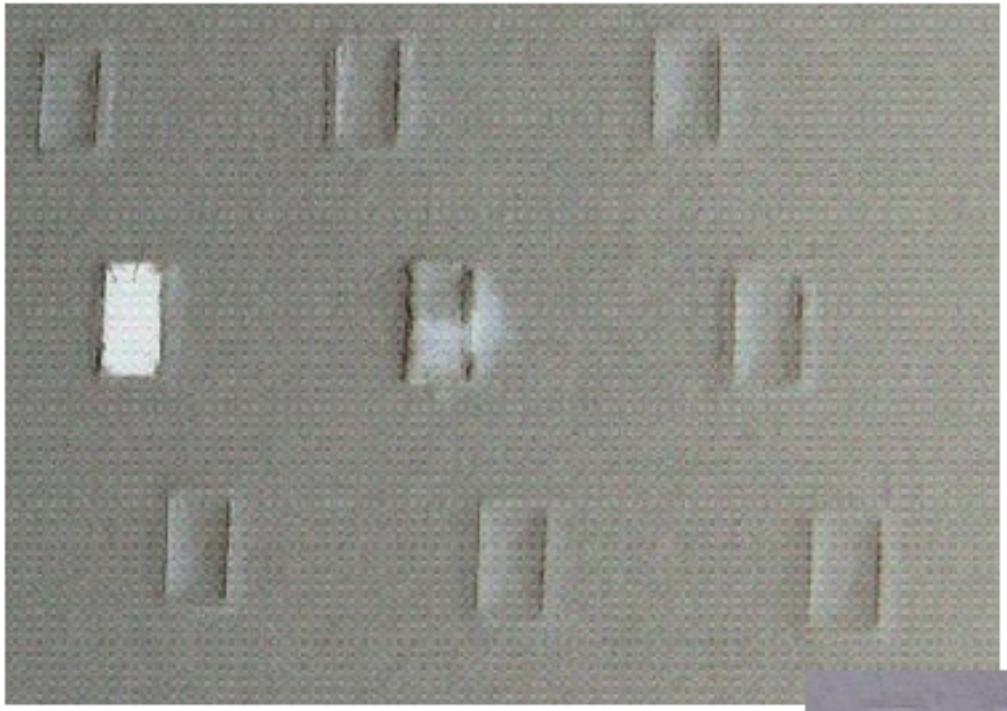

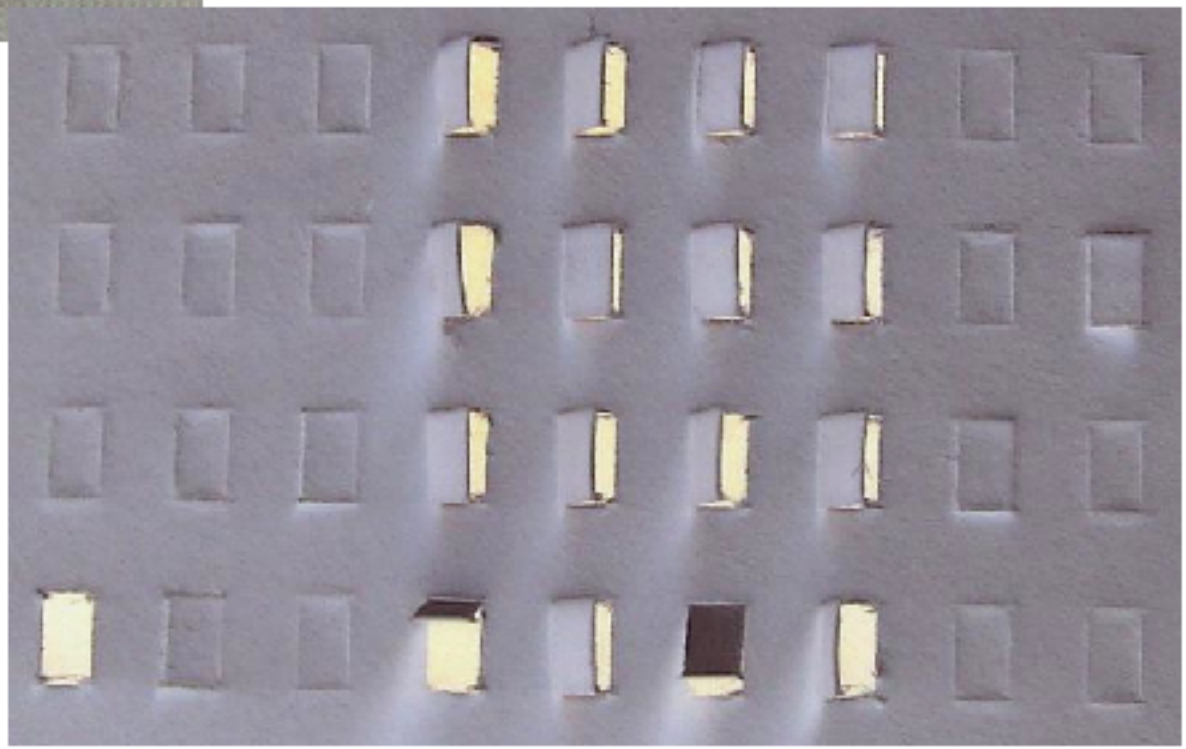

"Proving" a Coin is Biased

- We did this on Monday
  - You "know" that the probability of flipping a coin and getting heads is 50/50
  - But that means that in a large (e.g. infinite) number of coin flips, the number of heads will equal 50% of the total flips
  - In a small set of trials, the chance of getting heads 7,8,9 times is not small and can happen
  - Seeing "biased coins" in a small sample of trials is an example of "cherry picking" data to suit your opinion or ideology. In a small enough number of trials, you can find all kinds of data that appears to support your notions.

Distributions

- You are dealing with a population of data
  - e.g. pilot salaries, or factory worker salaries, incomes in a neighborhood, etc.
- You are asked to summarize the data in some way
- The "Average" is a very common way to do this
  - but . . . which average? There are 3 kinds!
  - Mean, Median, and Mode are all "averages," but can all have different meanings depending on the data

Averages

- Mean: the "arithmetic mean" is when you add up all the numbers in the population and DIVIDE the sum by the total number of data points
- Median: the value such that half of the numbers in the population lie below, and half above, that value ("the middle")
- Mode: the number that appears MOST FREQUENTLY in the population

Example

Salary	Mean	Median	Mode
$8,000	$37,727	$14,000	$23,000
$10,000			
$11,000			
$12,000			
$12,000			
$14,000			
$23,000			
$23,000			
$23,000			
$23,000			
$256,000			

When does it matter?

- When data are distributed according to THE NORMAL DISTRIBUTION (also known as "the bell curve") then it DOESN'T MATTER whether you quote mean, median, or mode as "the average" - they are all basically the same number.
- Otherwise, you need to know which average is being used. Skewed distributions, like those salaries, can be interpreted VERY differently depending on whether we use mean, median, or mode.

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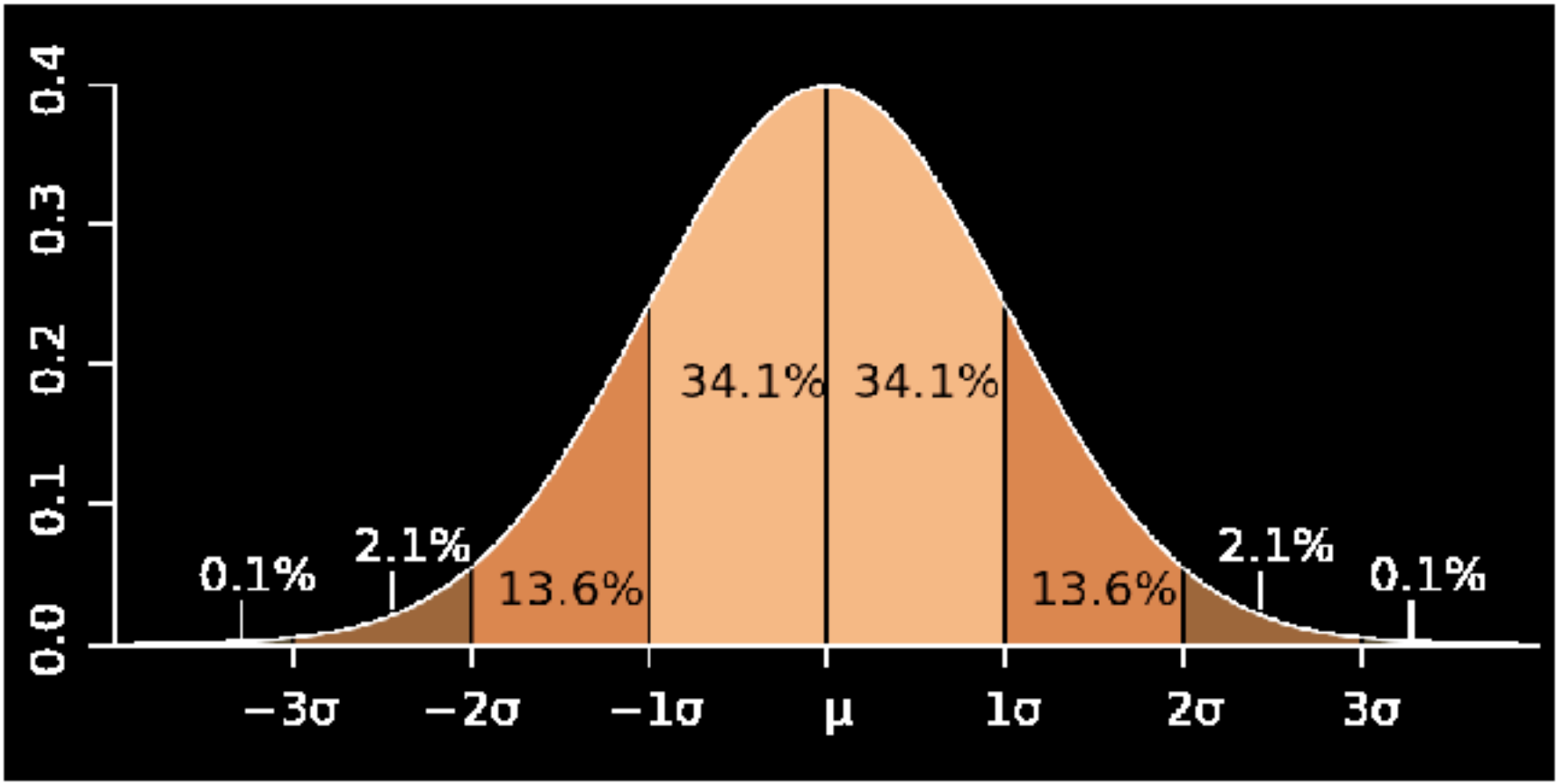

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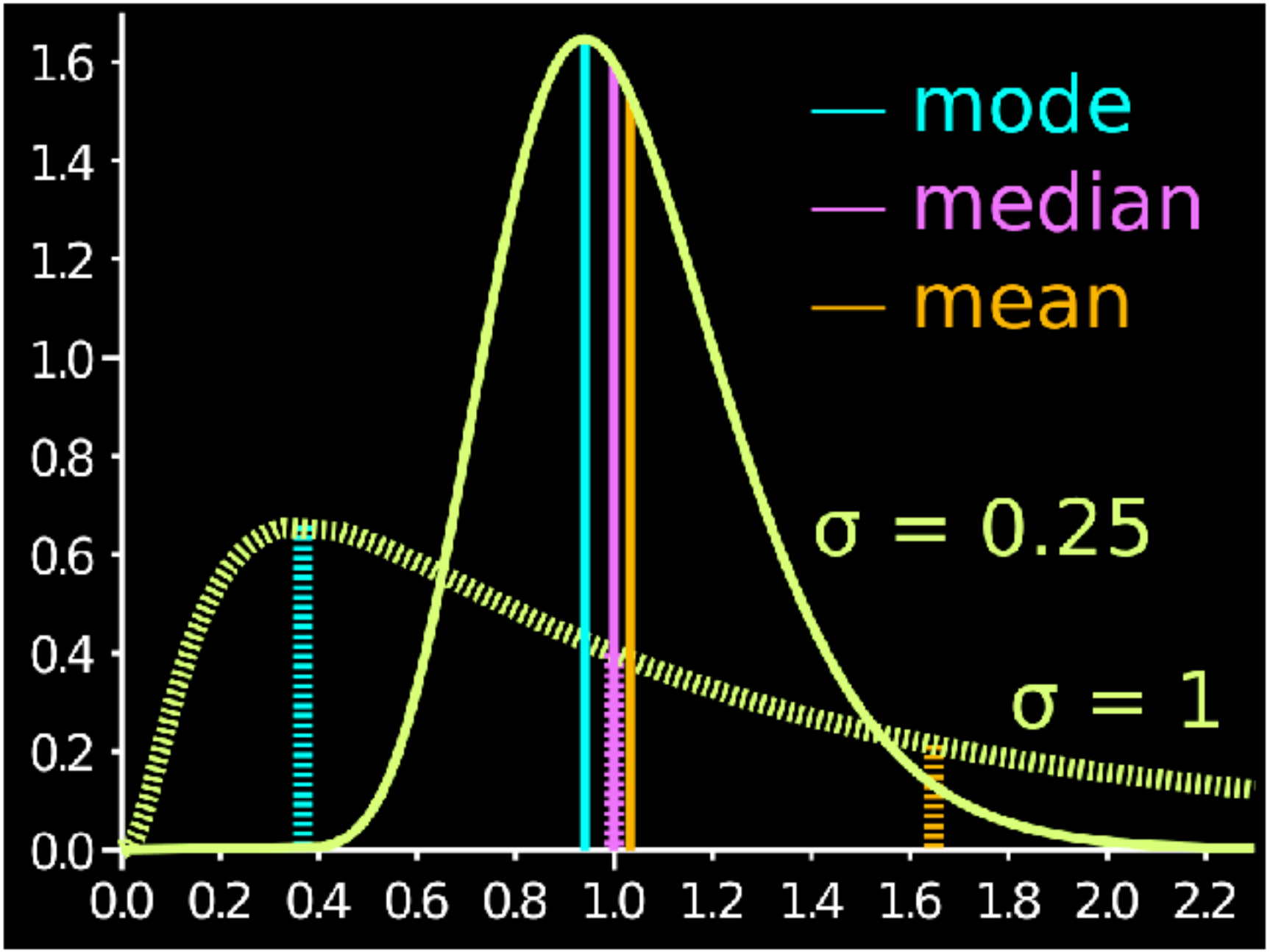

Extrapolation

- This is when you use past behavior of a data sample to infer future behavior
- "I've seen this pattern before, and it's going to happen again."
  - a very common stock broker philosophy
  - it's also usually dead wrong
- Except when well-defined laws are at work in the control of the data outcomes, even if they are probabilistic, extrapolation can be a dangerous and/or deceptive technique.

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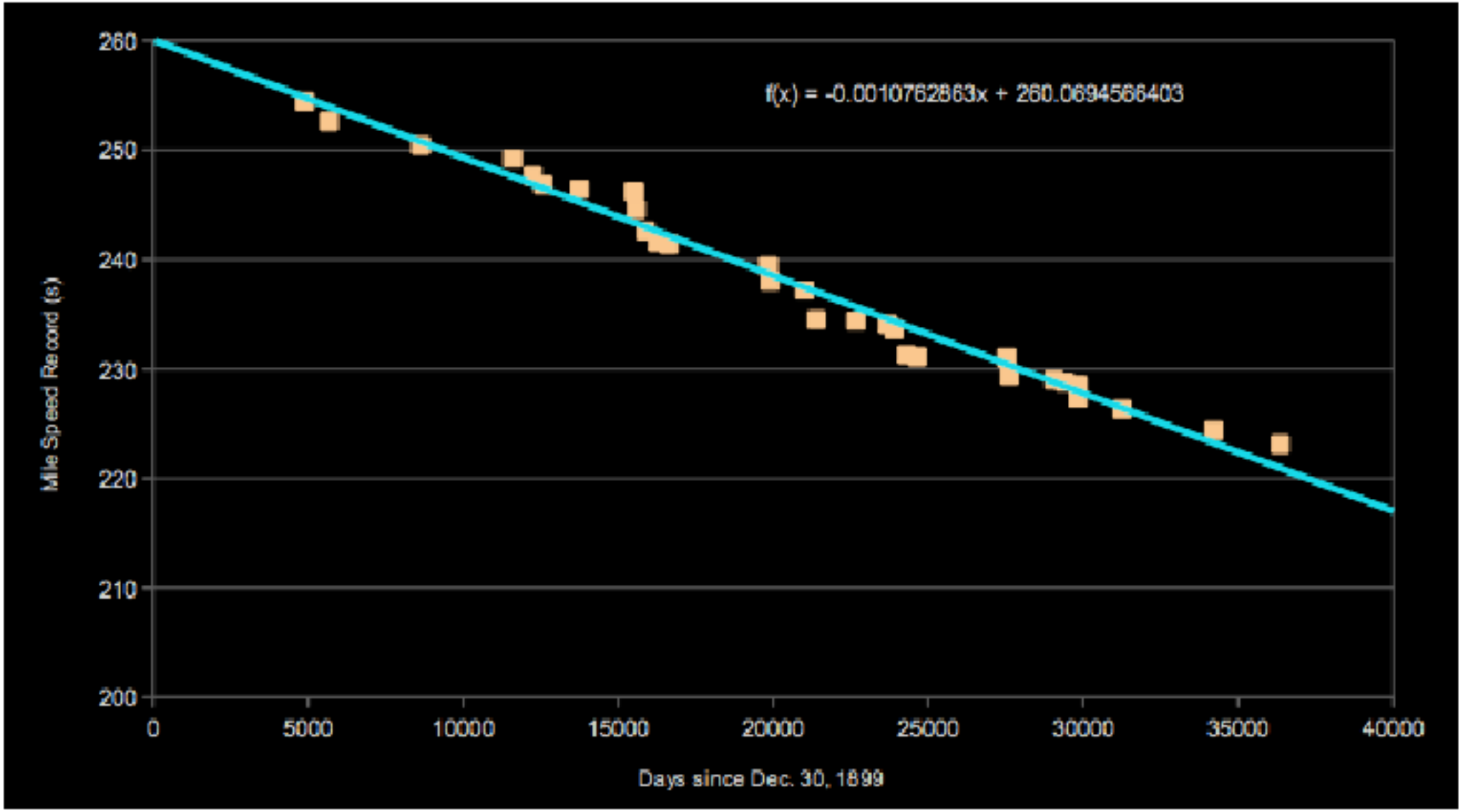

Shown are times (in seconds) measured for the fastest mile runners (y-axis) plotted against the days since Dec. 30, 1899. They appear to decrease linearly, so I fit a trend line to them (a straight line). Extrapolation of the data would suggest that by around the year 2500, humans will be able to run a mile in ZERO SECONDS.

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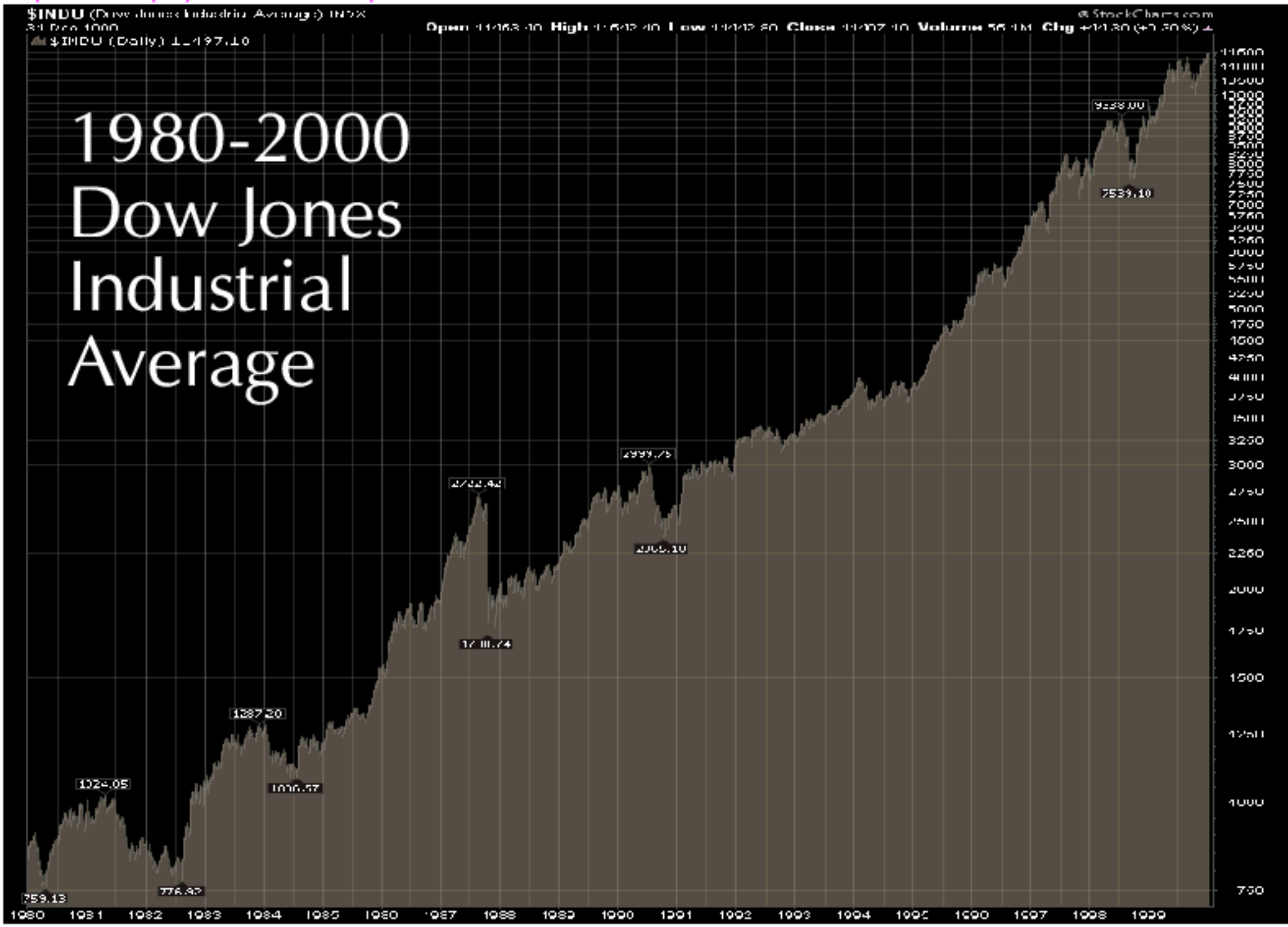

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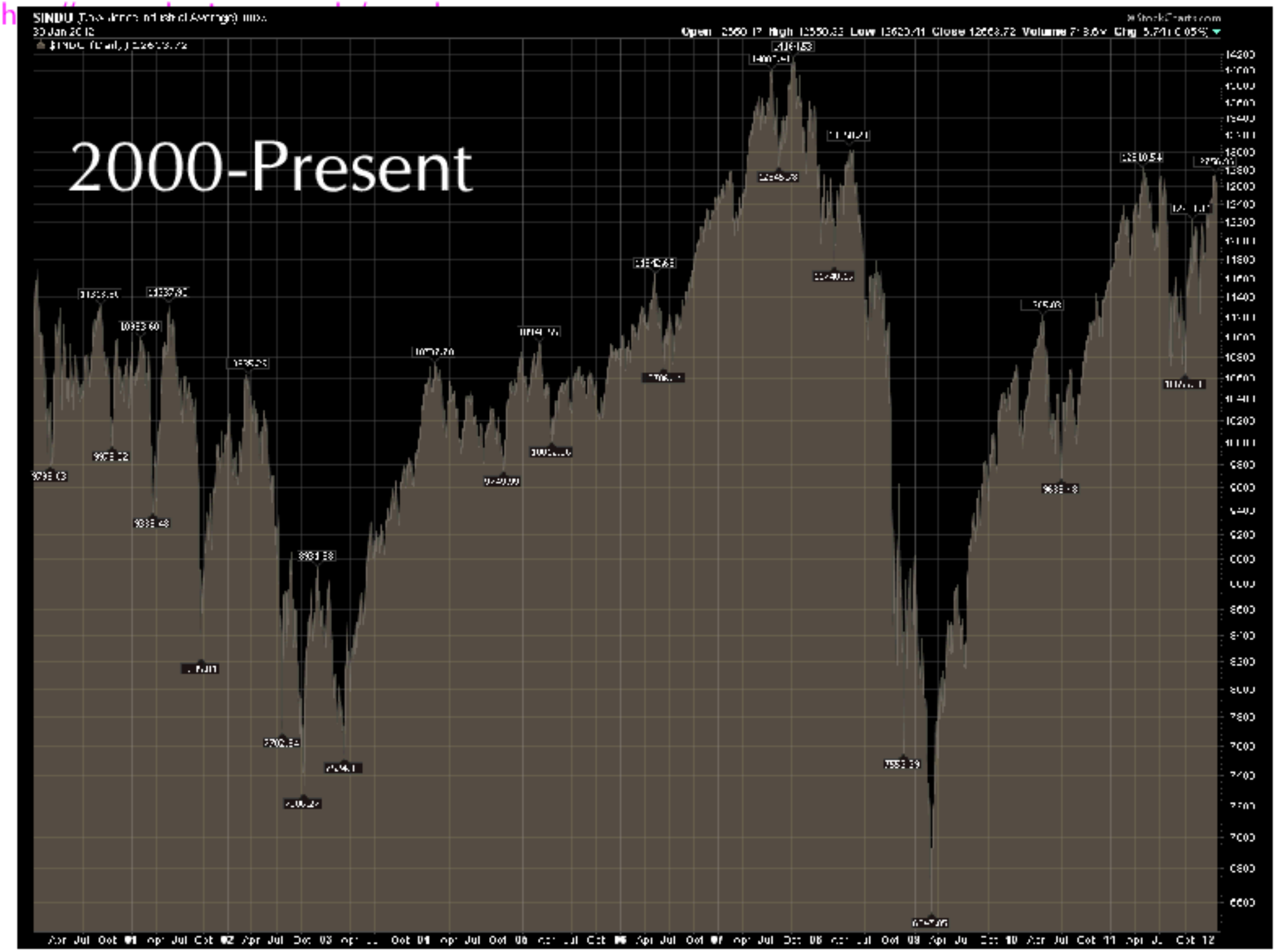
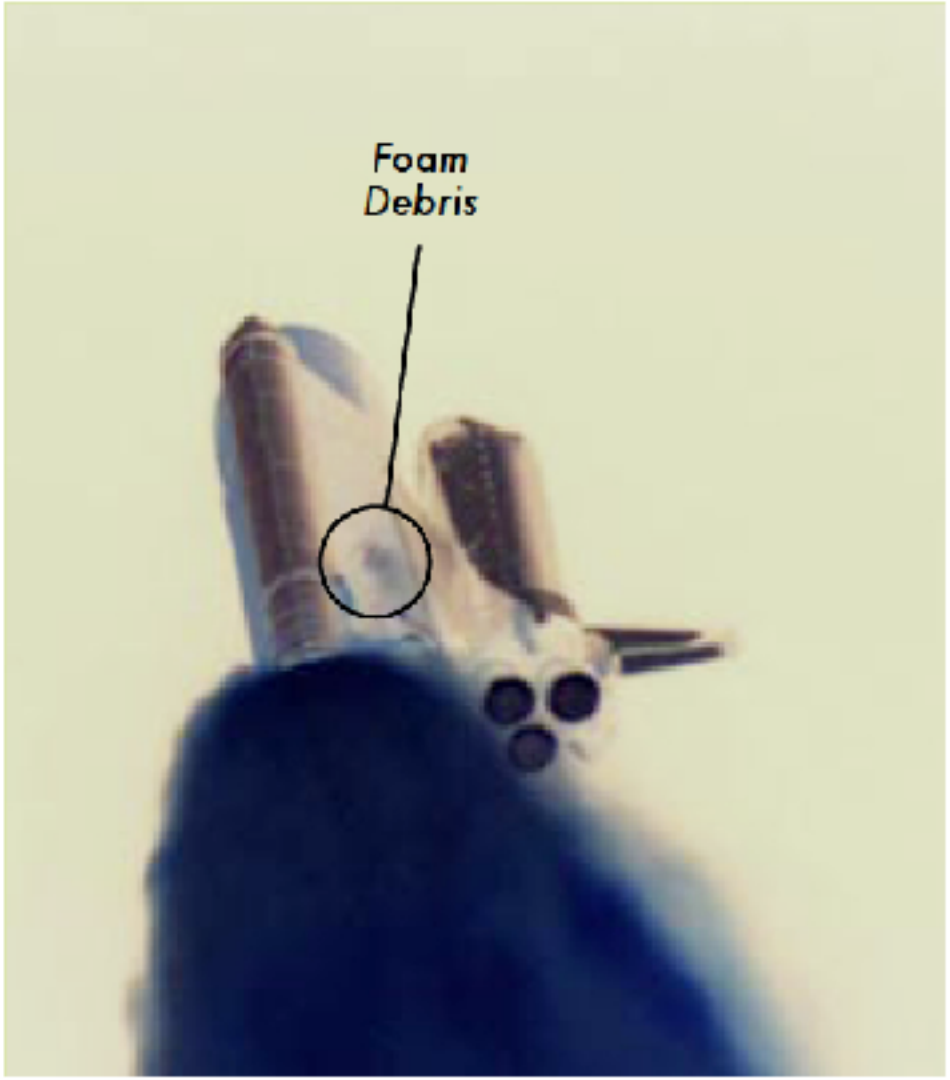
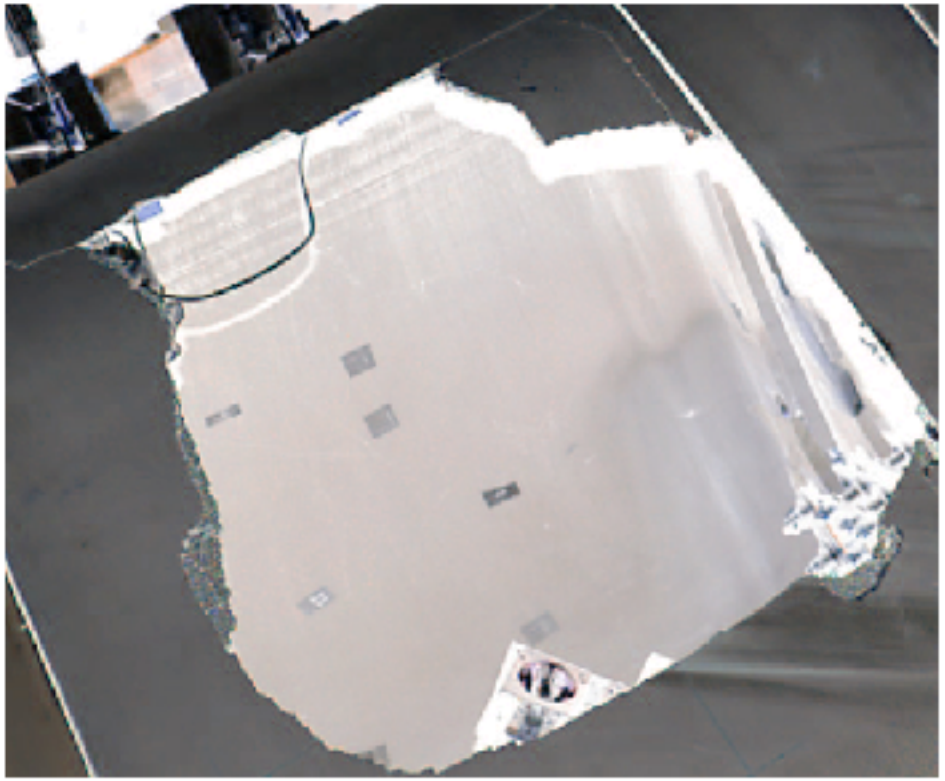

2000-Present





Foam impact experiment, at speeds estimated from video of strike on actual shuttle. Resulting damage. Piece hitting Columbia was 400 times bigger than any previous observed strike – outside experience of foam strike models.

Post-hoc Thinking

- Post Hoc Ergo Propter Hoc – Latin for, "After this, therefore because of this."
- Data are collected after some event; the event is assumed to cause the outcomes in the data
- Darrell Huff uses 1950s college statistics on men and women:
  - 93% of middle-aged Cornell male graduates were married
  - 65% of middle-aged Cornell female graduates were married
  - Conclusion: college is bad for a woman's chance of marrying!
    - is there an alternative explanation of the data?

College Makes You Less Religious?!

- Senator Rick Santorum cited this statistic recently:

  He claimed that "62 percent of kids who go into college with a faith commitment leave without it," but declined to cite a source for the figure. [CBS News. Political Hotsheet Blog. Feb. 23, 2012.]

- Any thoughts on this? Anybody know what is wrong with this kind of post hoc thinking?

What the study actually says

- The study in question was written by Mark Regnerus and Jeremy Uecker, and published on Feb. 5, 2007 in the journal "Social Forces." http://sf.oxfordjournals.org/content/85/4/1667.short
- It finds that:
  - If you attended college and get a bachelors degree, your odds ratio of disaffiliating from a religious institution is about 1.3 – meaning there is a 1.3 x 50% = 65% chance that you stop affiliating with a religious institution.
  - However, the study finds that if you DID NOT attend college, your odds ratio is 1.6! That means a 1.6 x 50% = 80% chance of disaffiliation!