Lecture 1: Introduction to Econometrics

ECON 480 - Econometrics - Fall 2018

Ryan Safner

August 27, 2018

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What is Econometrics?

The Basic Empirical Research Process

About the Course

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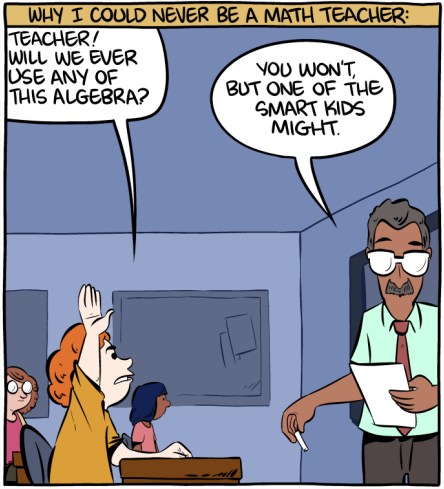
What is Econometrics?

Why Everyone, Yes *Everyone*, Should Learn Statistics



SMBC

Why Everyone, Yes *Everyone*, Should Learn Statistics

SMBC

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We're Not so Good at Statistics: Votes

- Votes in the U.S. House of Representatives in favor of passing the Civil Rights Act of 1964:

Democrat	Republican
61%	80%

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- Simple enough: "on average, Republicans tended to vote for passage more than Democrats"

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We're Not so Good at Statistics: Votes II

- Suppose we break it down further between Dems vs. Reps from Northern vs. Southern states:

	Democrat	Republican
North	94% (145/154)	85% (138/162)
South	7% (7/94)	0% (0/10)
Overall	61% (152/248)	80% (138/172)

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- In *both* North and South, Democrats are more likely to vote for passage than Republicans, despite a higher proportion of Republicans *overall* voted for the act than Democrats!

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We're Not so Good at Statistics: Votes III

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- The 7% of southern Democrats voting for the act dragged down the Democrats' overall percentage much more than the 0% of southern Republicans

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- In clinical trials, treatment A was effective for a higher overall percentage of patients than treatment B
- But, treatment B was effective for a higher percentage of patients in *both* groups (large and small stones)
- How can this be?

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We're Not so Good at Statistics: Kidney Stones II

- From a real medical study:

	Treatment A	Treatment B
Small Stones	93% (81/87)	87% (234/270)
Large Stones	73% (192/263)	69% (55/80)
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- A **lurking variable** in the study is the *severity* of the case: doctors tended to give *B* for less severe cases

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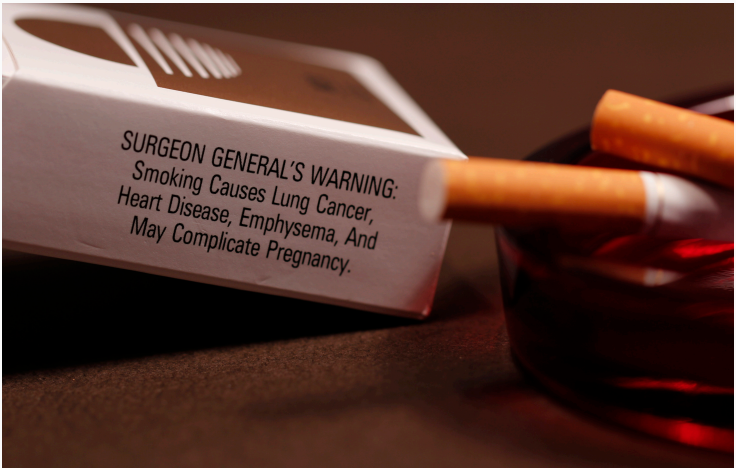
Simpson's Paradox

The correlation between two variables can change (even reverse!) when additional variables are considered

We're Not so Good at Statistics: Smoking

- 1964: U.S. Surgeon General issued a report claiming that cigarette smoking causes lung cancer



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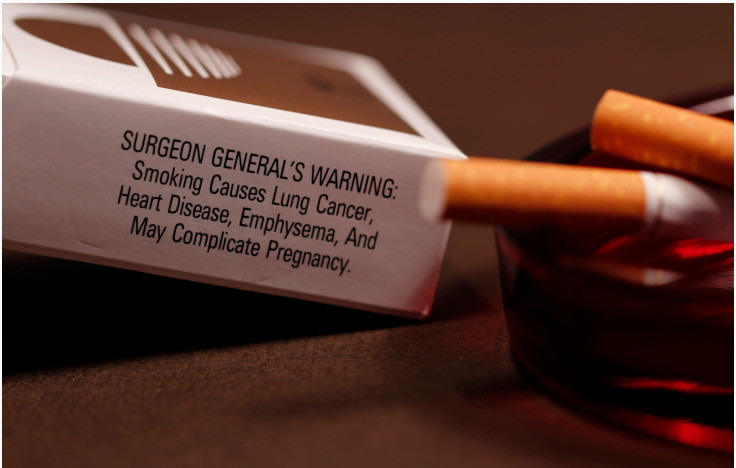
- Evidence based primarily on *correlations* between cigarette smoking and lung cancer



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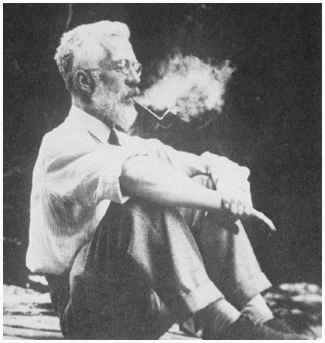
We're Not so Good at Statistics: Smoking II

- Tobacco companies attacked the report, naturally

We're Not so Good at Statistics: Smoking III

- But so did Ronald Fisher, the "father of modern statistics"



Ronald A. Fisher

1890–1924

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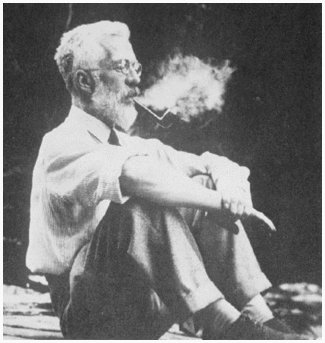
- There could be a lurking variable (genetics?) that causes *both* lung cancer *and* people wanting to smoke (i.e. nicotine craving)



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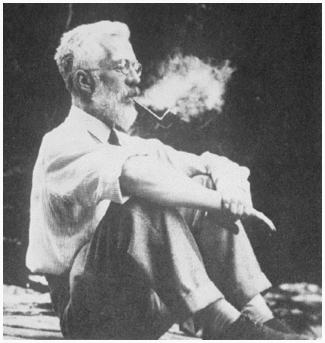
- There could be a lurking variable (genetics?) that causes *both* lung cancer *and* people wanting to smoke (i.e. nicotine craving)
- If true: despite correlation between smoking and lung cancner, decision to smoke or not would have *no impact* on whether or not you get lung cancer!



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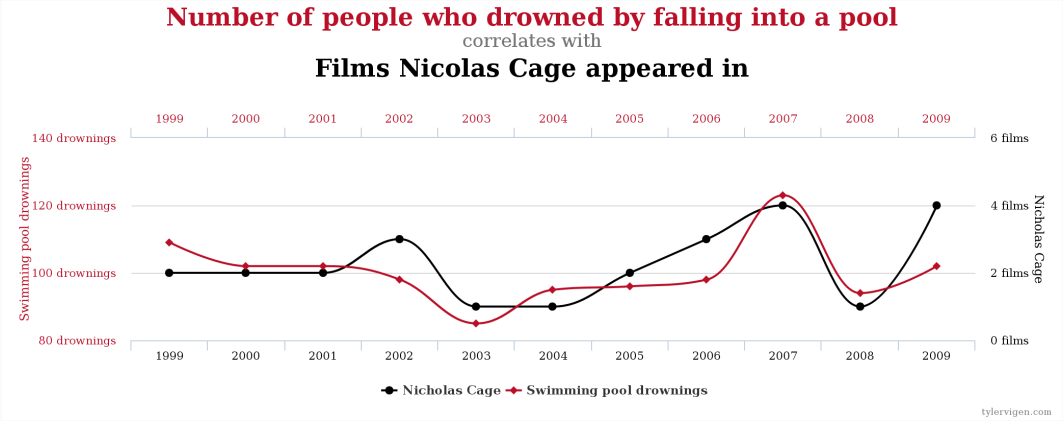
- May be other confounding variables (e.g. *Z*, etc) that affect *X* and/or *Y*
- May be reverse causation (maybe *Y* causes *X*, or both cause each other)

We're Not so Good at Statistics: Correlation vs. Causation I



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- This is where econometrics comes in

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- Uses real data to:
  - test economic hypotheses
  - estimate quantitatively the causal effects between economic variables
  - make forecasts of future events

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  - "For every additional police officer in a metropolitan district, crime rates decrease by 0.12%, on average"
  - "Each additional year of education tends to increase a person's yearly wages by $2,500, on average"
  - "For every 1% tariffs are lowered, a country's GDP growth rate rises by 0.025%, on average"

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Example
Does reducing class size improve elementary school education?

- Claim: with smaller class sizes, students get more one-on-one attention, learn better

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- What is the precise effect of class size on performance?
- A policy-relevant tradeoff with a budget constraint
- Biases due to wealthy school districts?

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Example
Is there racial discrimination in home mortgage lending?

- Boston Fed: 28% of African-Americans are denied mortgages compared to only 9% of White Americans

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Example
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- What factors determine whether a person is denied a mortgage?

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- What factors determine whether a person is denied a mortgage?
- How many denials are explained *purely* by race, vs. other factors?

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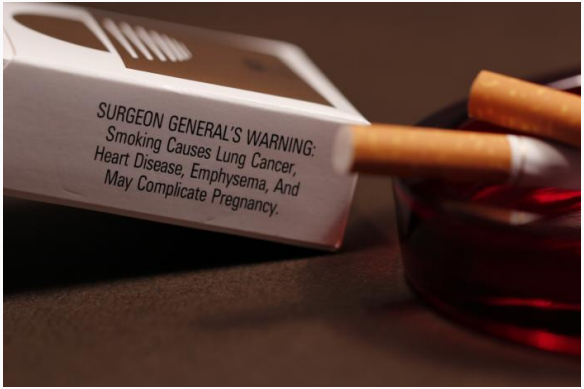
How much do state cigarette taxes reduce smoking rates?

- Econ 101: raise price $\Longrightarrow$ lower quantity consumed



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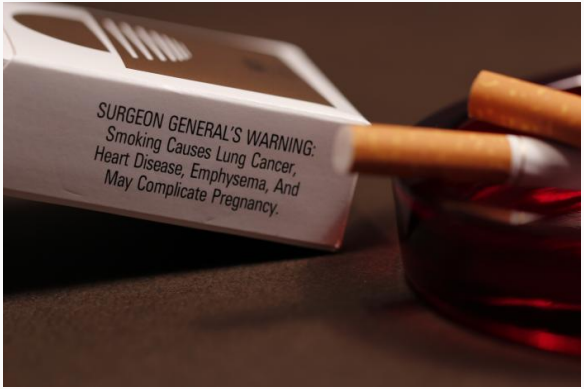
- What is the *price elasticity of demand* for smoking?



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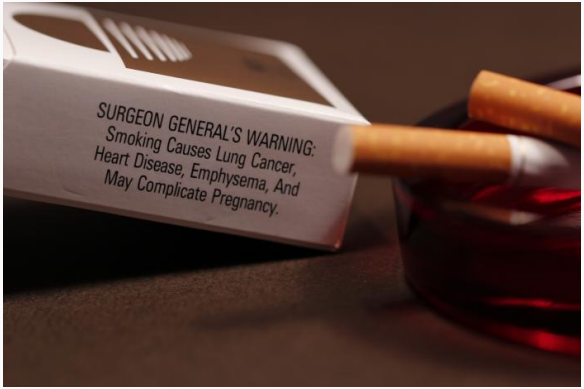

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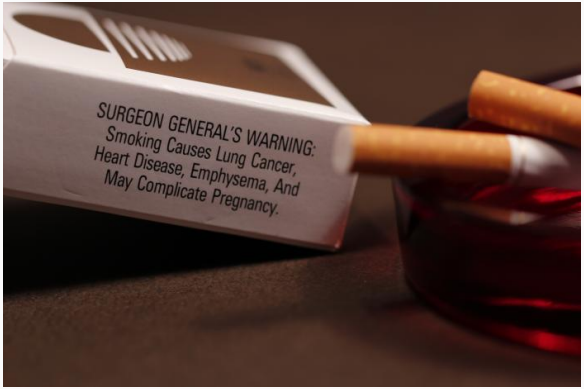
- Might more smokers also cause low cigarette taxes?



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Example
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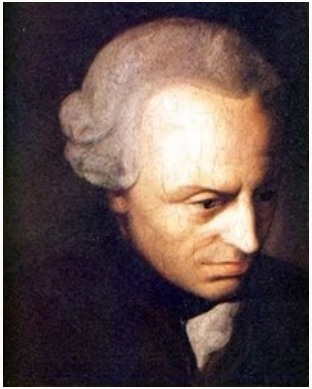
What will the inflation rate be next year?

- Banks, governments, businesses make forecasts about economic indicators to make future plans
- This course is less about forecasting

The Basic Empirical Research Process

"Experience without theory is blind, but theory without experience is mere intellectual play."



Immanuel Kant

1724-1804

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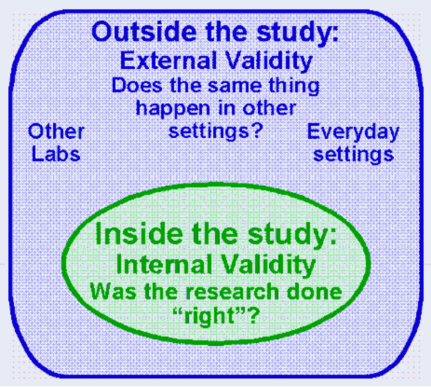
- We need a theory to tell us how and why phenomena cause each other! Otherwise all we have are correlations!

- We need a good theory for external validity of a study



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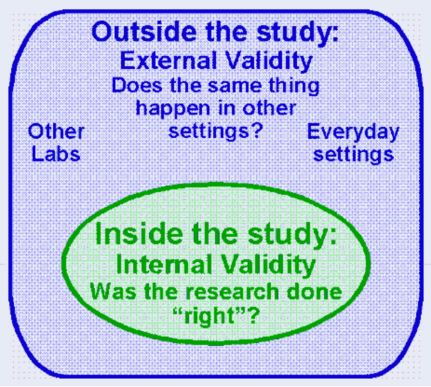

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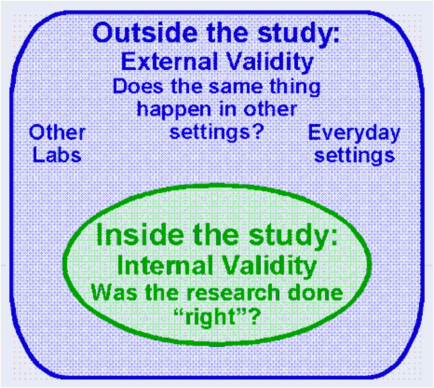
  - Lucas (1976) critique: can't base policy off of historical econometric relationships that, when changed, will cause people to change their behavior!



- Economic theorizing often involves building a formal model to relate economic phenomena and build intuitions

Example
Becker (1968) famously models crime as a rational choice:

$$y = f(x_1, x_2, x_3, x_4, x_5, x_6, x_7)$$

y:	hours spent on criminal activities	x_1:	hourly "wage" of criminal activity
x_2:	hourly wage for legal employment	x_3:	other income
x_4:	probability of getting caught	x_5:	probability of conviction if caught
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- We can at least predict the "sign" of each relationship between y and each x_i (then estimate the quantitative impact)

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- ϵ is the error term
  - It is **stochastic** (random)
  - We can never measure the error term

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Example

$$wage = \beta_0 + \beta_1 educ + \beta_2 expr + \epsilon$$

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- Suppose we (hypothetically) find that:
  - $\hat{\beta}_0 = 6.2$
  - $\hat{\beta}_1 = 4.1$
  - $\hat{\beta}_2 = 7.1$
- Then we can make predictions based on our empirical model of the causal relationship between X's and Y

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Example

$$\widehat{wage} = 6.2 + 4.1educ + 7.1expr$$

- Predictions based on our empirical model of the causal relationship between X's and Y

$$\widehat{wage} = 6.2 + 4.1(10) + 7.1(3) = \$68.5 \text{ thousand}$$

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- Predictions based on our empirical model of the causal relationship between X's and Y
  - A year of education (holding experience constant) increases wages by \$4.1 thousand
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  - For someone with 10 years of education and 3 years of experience, their predicted wage is

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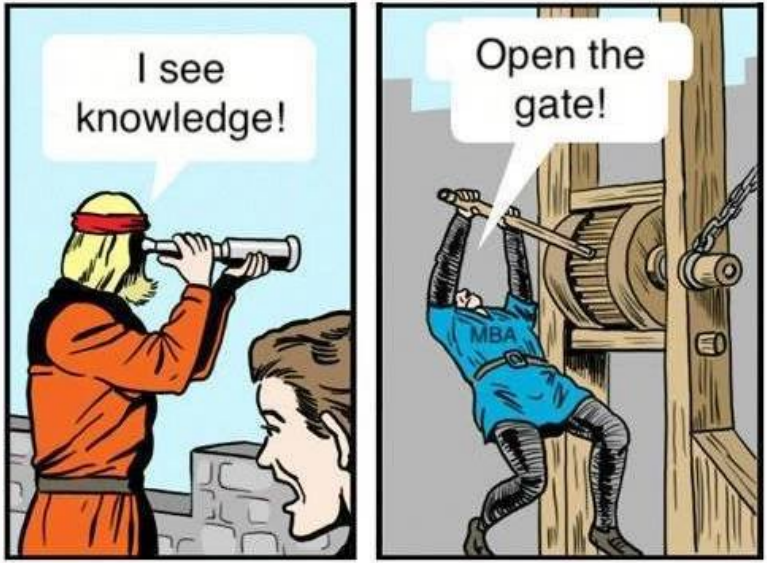
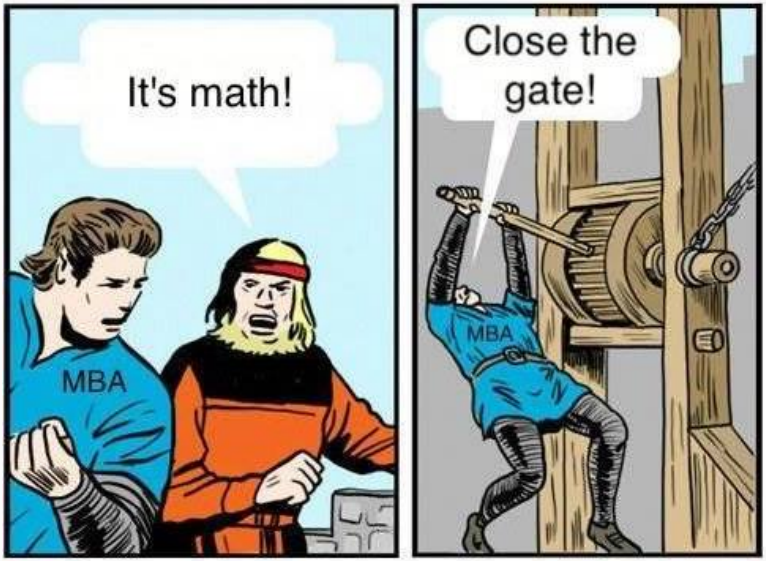
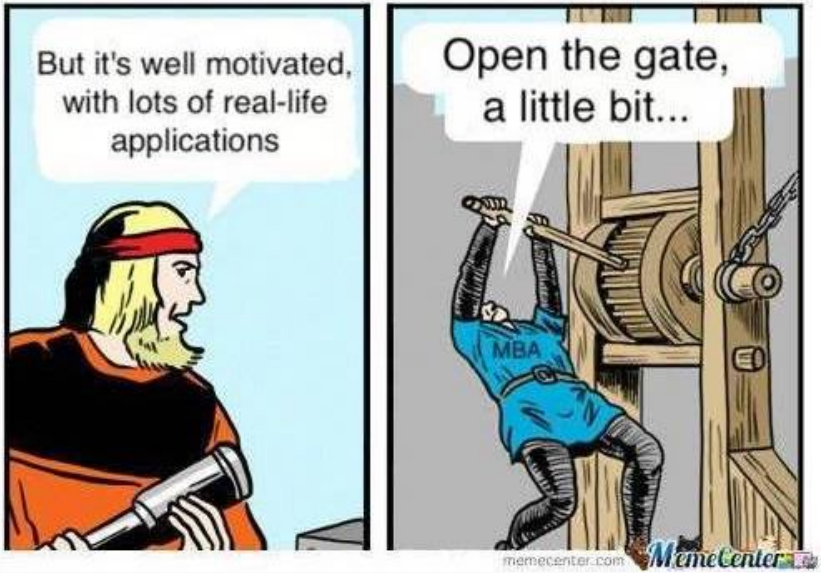
About the Course


I see knowledge!
Open the gate!
MBA


It's math!
MBA
Close the gate!
MBA

Real Talk III



Real Talk IV

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- Yes, you can still get an A

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R Studio

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    3.3 Ambitious: managing workflow and reproducibility with *R Markdown*

R Studio

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You are in Demand

DATA

Data Scientist: The Sexiest Job of the 21st Century

by Thomas H. Davenport and D.J. Patil

FROM THE OCTOBER 2012 ISSUE

Harvard Business Review

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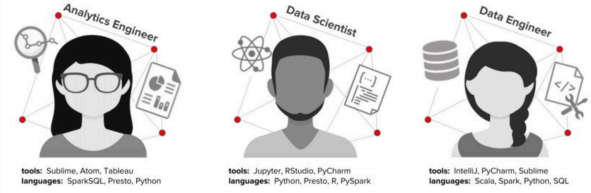
You are in Demand II

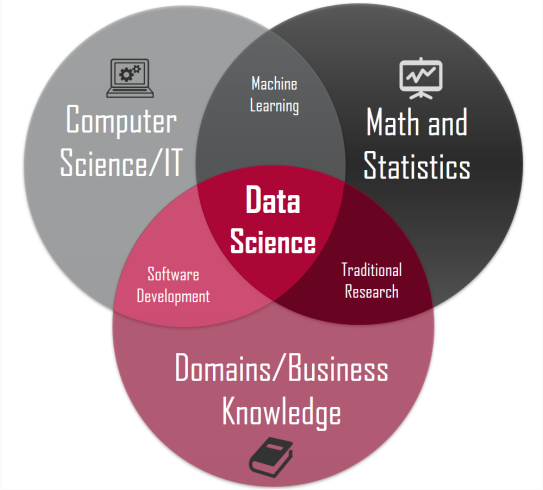
Data roles at Netflix

- business analyst
- data analyst
- quantitative analyst
- algorithm engineer
- analytics engineer
- data engineer
- data scientist
- machine learning scientist
- research scientist



The Netflix Tech Blog

You are budding Data-Scientists



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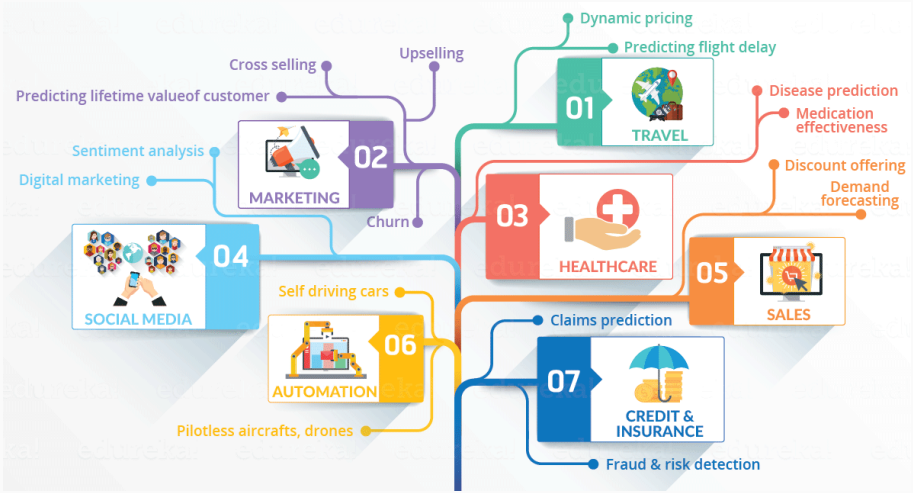

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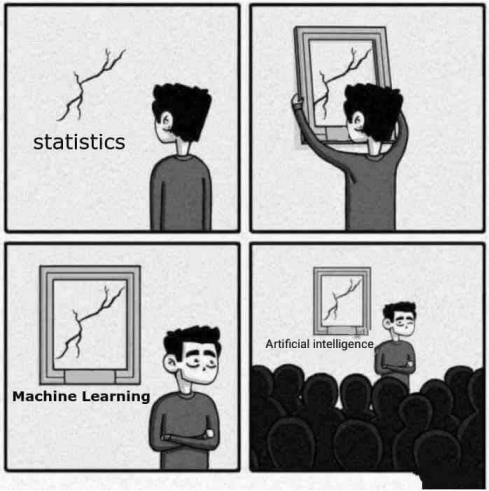
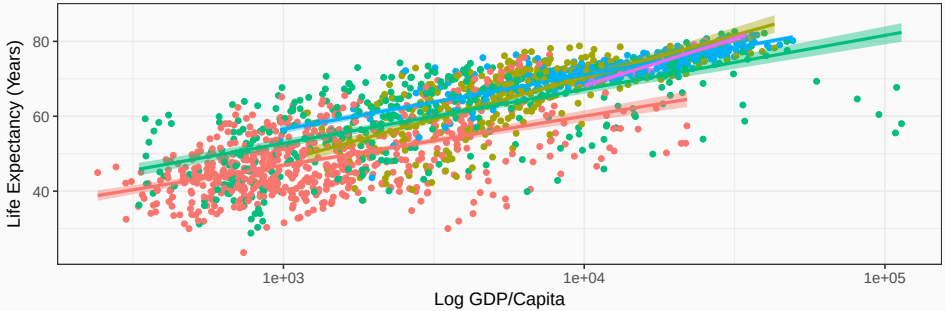
The Sexiest Industry Terms are Basically Just Statistics

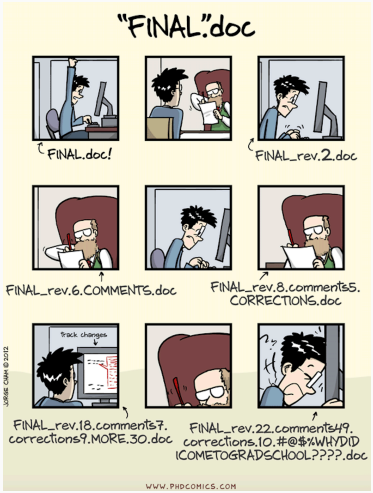


R is Very Powerful: I Literally Ran the Code in This Slide

```
ggplot(data = gapminder, aes(x = gdpPercap,
    y = lifeExp, color = continent, fill= continent))+
    geom_point()+geom_smooth(method = "lm") +
    scale_x_log10()+ylab("Life Expectancy (Years)")+
    xlab("Log GDP/Capita")
```



End This Nightmare!



PhD Comics

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.Rmd files

An R Markdown (.Rmd) file is a record of your research. It contains the code that a scientist needs to reproduce your work along with the narration that a reader needs to understand your work.

Reproducible Research

At the click of a button, or the type of a command, you can rerun the code in an R Markdown file to reproduce your work and export the results as a finished report.

Dynamic Documents

You can choose to export the finished report as a html, pdf, MS Word, ODT, RTF, or markdown document; or as a html or pdf based slide show.

From R Markdown Cheatsheet

- Reproducible research: you run my code (e.g. the last slide) and you will get the same graph as me, *every time*.

Ambitious: Use *R Markdown* to Think About Your Workflow

- Reproducible research: you run my code (e.g. the last slide) and you will get the same graph as me, *every time*.
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- *R Markdown* is a simple human- and machine-readable language: do *all* your work in one file, export to PDF, Word, HTML, Slides

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    - Advanced: version control with GitHub

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