1.1 — Introduction to Econometrics

ECON 480 • Econometrics • Fall 2022

Dr. Ryan Safner
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About Me

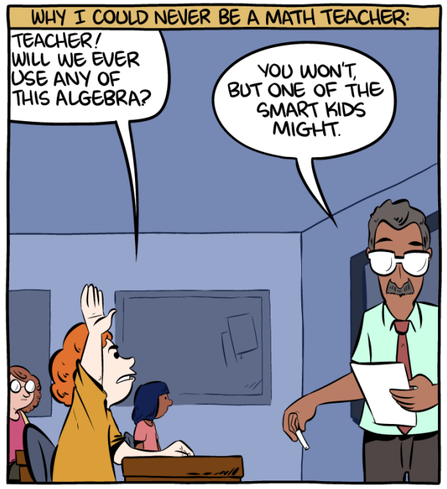
- Ph.D (Economics) — George Mason University, 2015
- B.A. (Economics) — University of Connecticut, 2011
- Specializations:
  - Law and Economics
  - Austrian Economics
- Research interests
  - modeling innovation & economic growth
  - political economy & economic history of intellectual property

The Reason I'm Busy Behind the Scenes

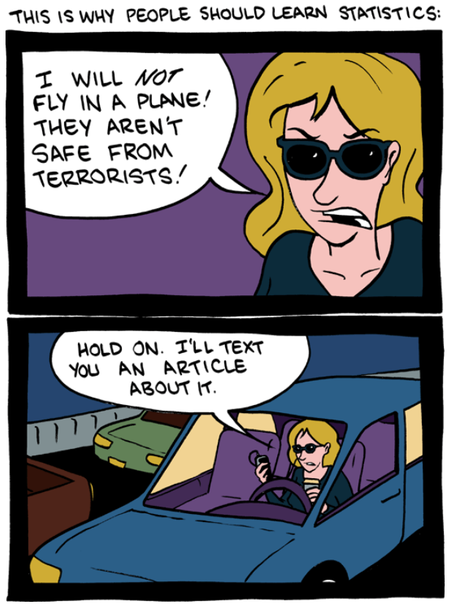
Miles

What is Econometrics?

Why Everyone, Yes *Everyone*, Should Learn Statistics



SMBC



SMBC

We're Not So Good at Statistics: Votes I

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

Democrat	Republican
61%	80%

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

We're Not So Good at Statistics: Votes

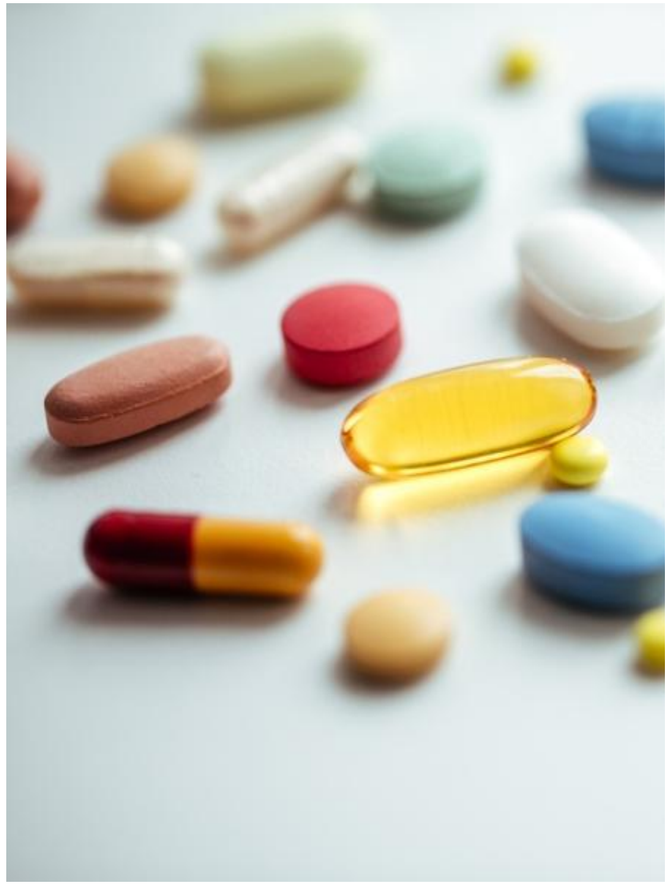
- Votes in the U.S. House of Representatives in favor of **passing** the *Civil Rights Act of 1964*:

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

- Larger proportion of Democrats ($\frac{94}{248}$, 38%) than Republicans ($\frac{10}{172}$, 6%) were from South
- The 7% of southern Democrats voting *for* the Act dragged down the Democrats' *overall* percentage more than the 0% of southern Republicans

We're Not So Good at Statistics: Kidney Stones

- Suppose you suffer from kidney stones, your doctor offers you **treatment A** or **treatment B**
- In clinical trials, **Treatment A** was effective for a higher percentage of patients with *large* stones and a higher percentage of patients with *small* stones
- **Treatment B** was effective for a larger percentage of patients overall than **treatment A**
- Wait, what?



We're Not So Good at Statistics: Kidney Stones

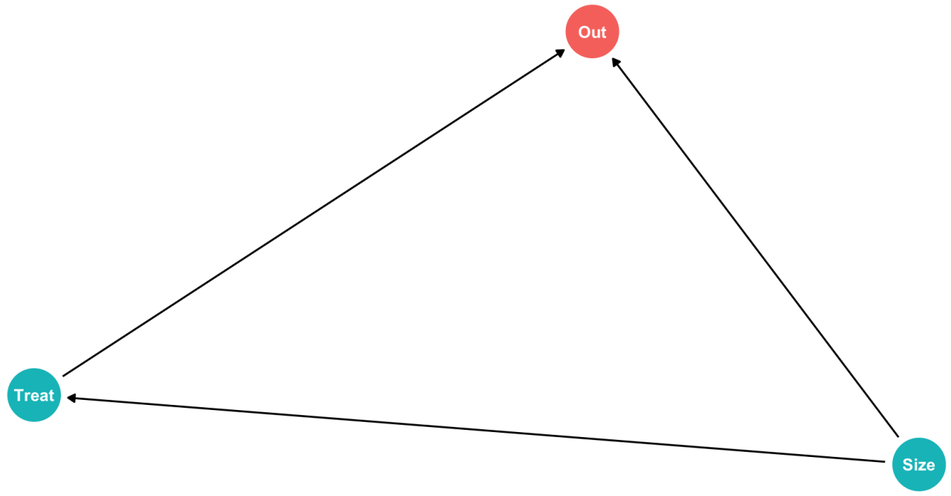
From a real medical study:

	Treatment A	Treatment B
Small Stones	**93%**	87%
	(81/87)	(234/270)
Large Stones	**73%**	69%
	(192/263)	(55/80)
Overall	78%	**83%**
	(273/350)	(289/350)

C R Charig, D R Webb, S R Payne, and J E Wickham, 1986, "Comparison of treatment of renal calculi by open surgery, percutaneous nephrolithotomy, and extracorporeal shockwave lithotripsy," *Br Med J* (Clin Res Ed) 292(6524): 879–882.

- The *sizes* of the two groups (i.e. who gets A vs B) are *very* different

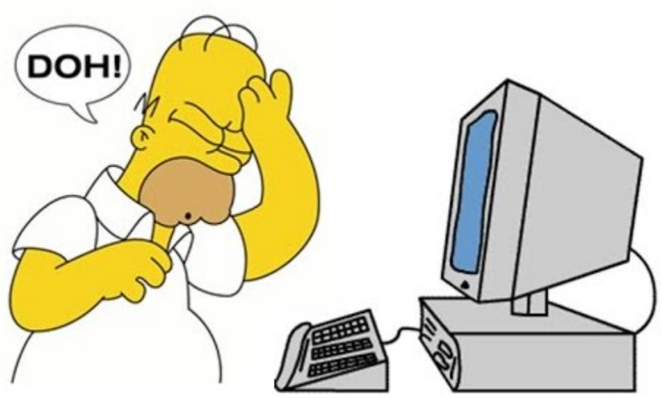
We're Not So Good at Statistics: Kidney Stones



- The *sizes* of the two groups (i.e. who gets A vs B) are *very* different
- A **lurking variable** in the study is the severity of the case: doctors tended to give treatment B for less severe cases

Simpson's Paradox

Simpson's Paradox: The correlation between two variables can change (even reverse!) when additional variables are considered]



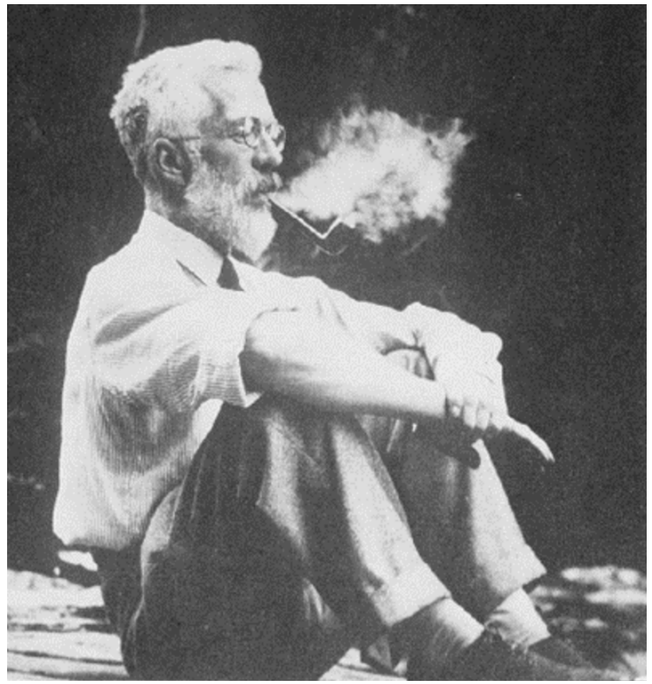
We're Not so Good at Statistics: Smoking

- 1964: U.S. Surgeon General issued a report claiming that cigarette smoking causes lung cancer
- Evidence based primarily on *correlations* between cigarette smoking and lung cancer

We're Not so Good at Statistics: Smoking

- Tobacco companies attacked the report, naturally

We're Not so Good at Statistics: Smoking



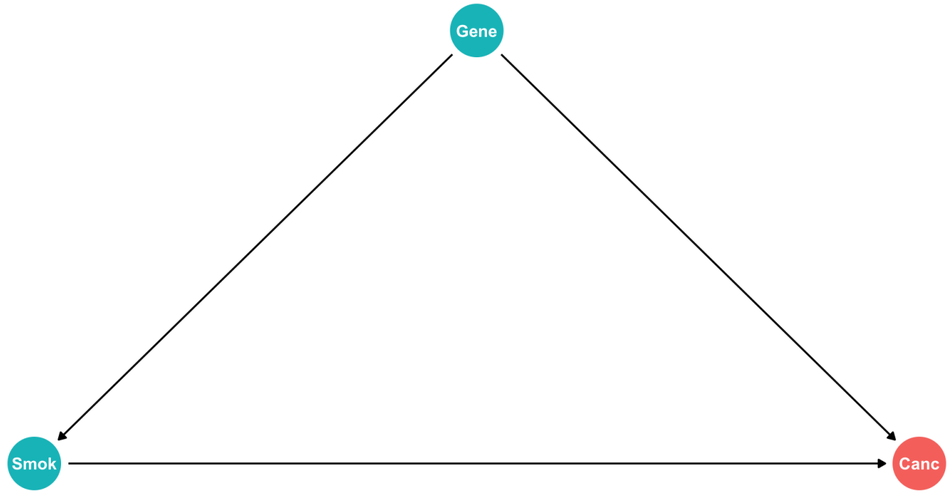
Ronald A. Fisher

1890—1924

- But so did R. A. Fisher, the "father of modern statistics"

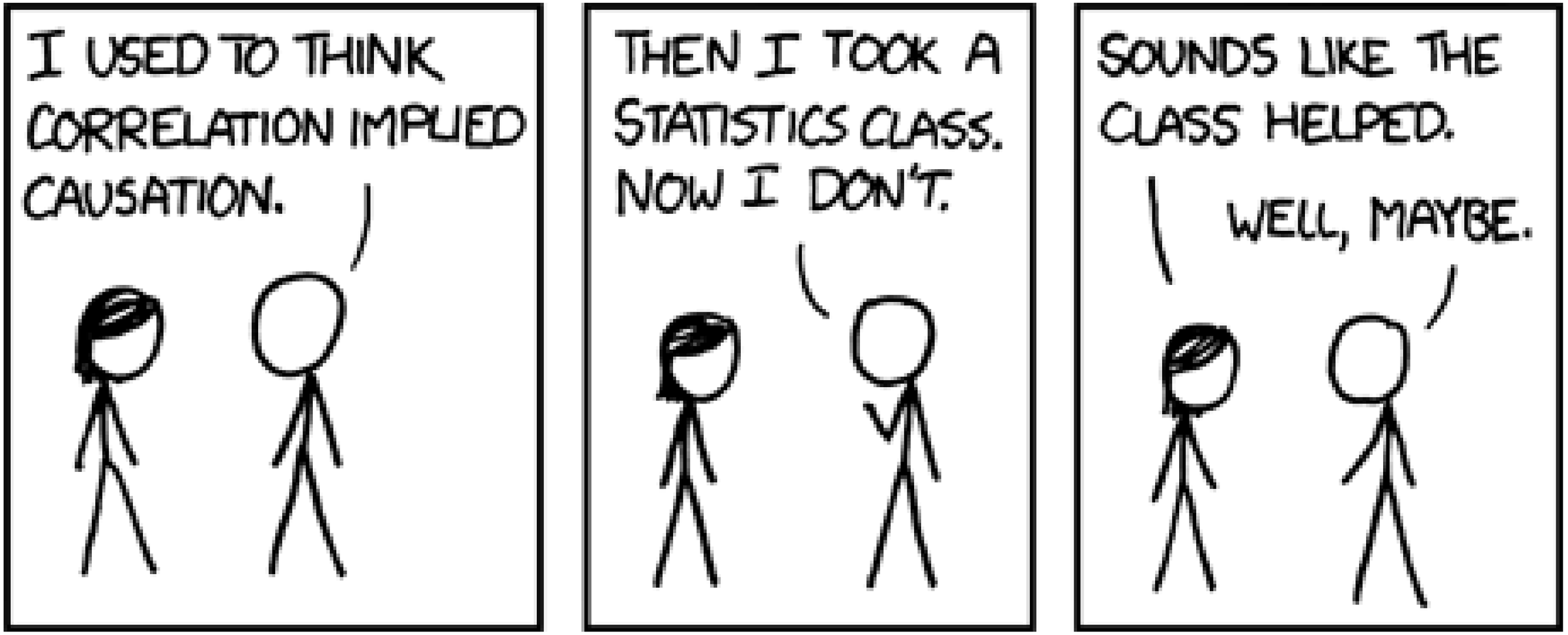
We're Not so Good at Statistics: Smoking

- There could be a confounding variable ("smoking gene") that causes *both* lung cancer *and* the urge to smoke
- Would imply: decision to smoke or not would have *no impact* on lung cancer!
- Correlation between smoking and cancer is spurious!



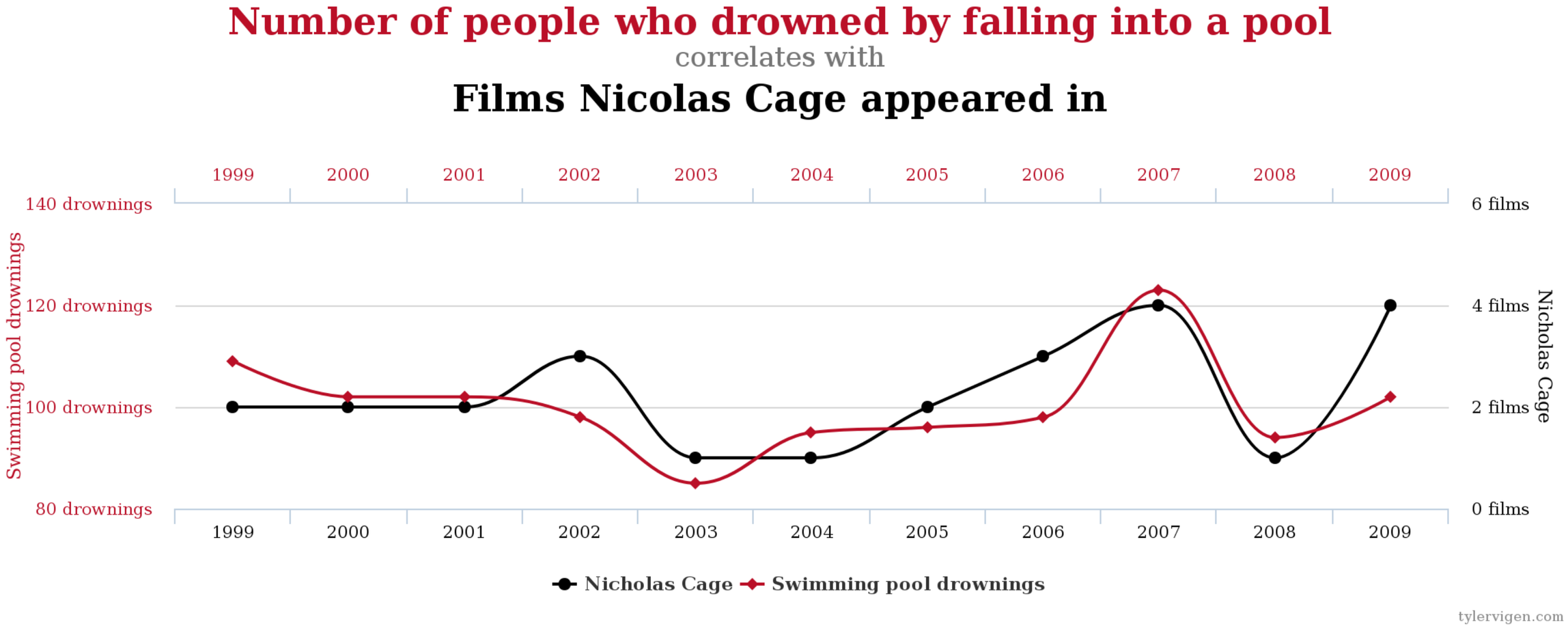
Correlation Does Not Imply Causation

- The goal of every intro statistics class ever



XKCD: Correlation

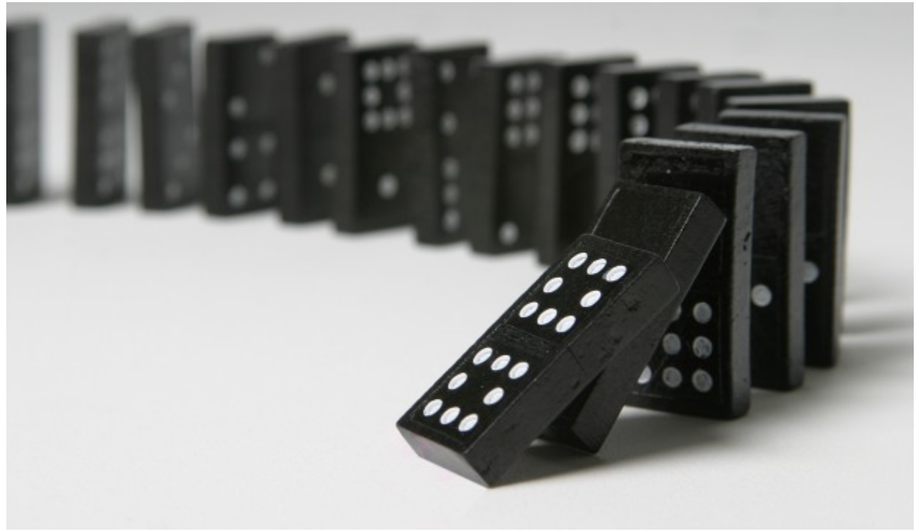
Correlation Does Not Imply Causation



Spurious Correlations

Correlation Does Not Imply Causation...

- It's always good to be skeptical of causal claims
- But this is actually where **econometrics** shines

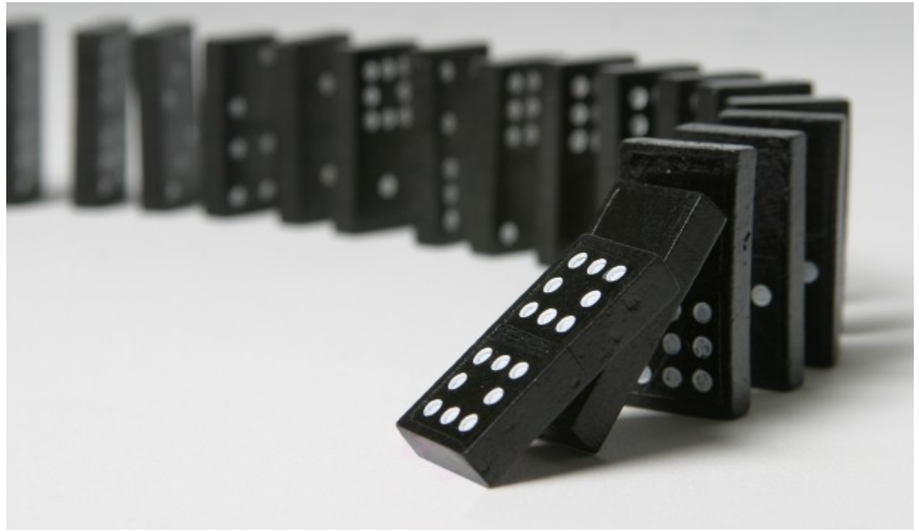


Econometrics

- **Econometrics** is the application of statistical tools to *quantify* economic relationships in the real world
- Uses real data to
  - test economic hypotheses
  - quantitatively estimate the magnitude of relationships between economic variables
  - forecast future events

Econometrics and Causal Inference

- What sets econometrics apart from mere statistics (or uses of statistics in other disciplines) is its role in **causal inference**
- We can, with proper tools and interprations, make *quantitative causal* claims
  - about the effects of individual choices
  - about the effects of policy interventions
  - about the impact of political institutions
  - about economic history and economic development
  - etc...



Causal Inference: Examples

A 50% increase in police presence in a metropolitan area lowers crime rates by 15%, on average[1]

Being an incumbent in office raises the probability of re-election by 40-45 percentage points[2]

European cities with at least one printing press in 1500 were at least 29% more likely to become Protestant by 1600[3]

1. Klick, Jonathan and Alexander Tabarrok, 2005, "Using Terror Alert Levels to Estimate the Effect of Police on Crime," *Journal of Law and Economics* 48(1): 267-279

2. Lee, David S, 2001, "The Electoral Advantage to Incumbency and Voters' Valuation of Politicians' Experience: A Regression Discontinuity Analysis of Elections to the U.S," *NBER Working Paper* 8441

Example 1: Education

Example

- Does reducing class sizes improve student performance?

. . .

- A policy-relevant tradeoff with a budget constraint
- What is the *precise* effect of class size on performance?
- Is it worth hiring new teachers and building more schools over?

Example 2: Discrimination in Lending

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
- Is this due to factors such as credit history, income, or discrimination *purely* because of race?

Example 3: Public Health and Public Finance

Example

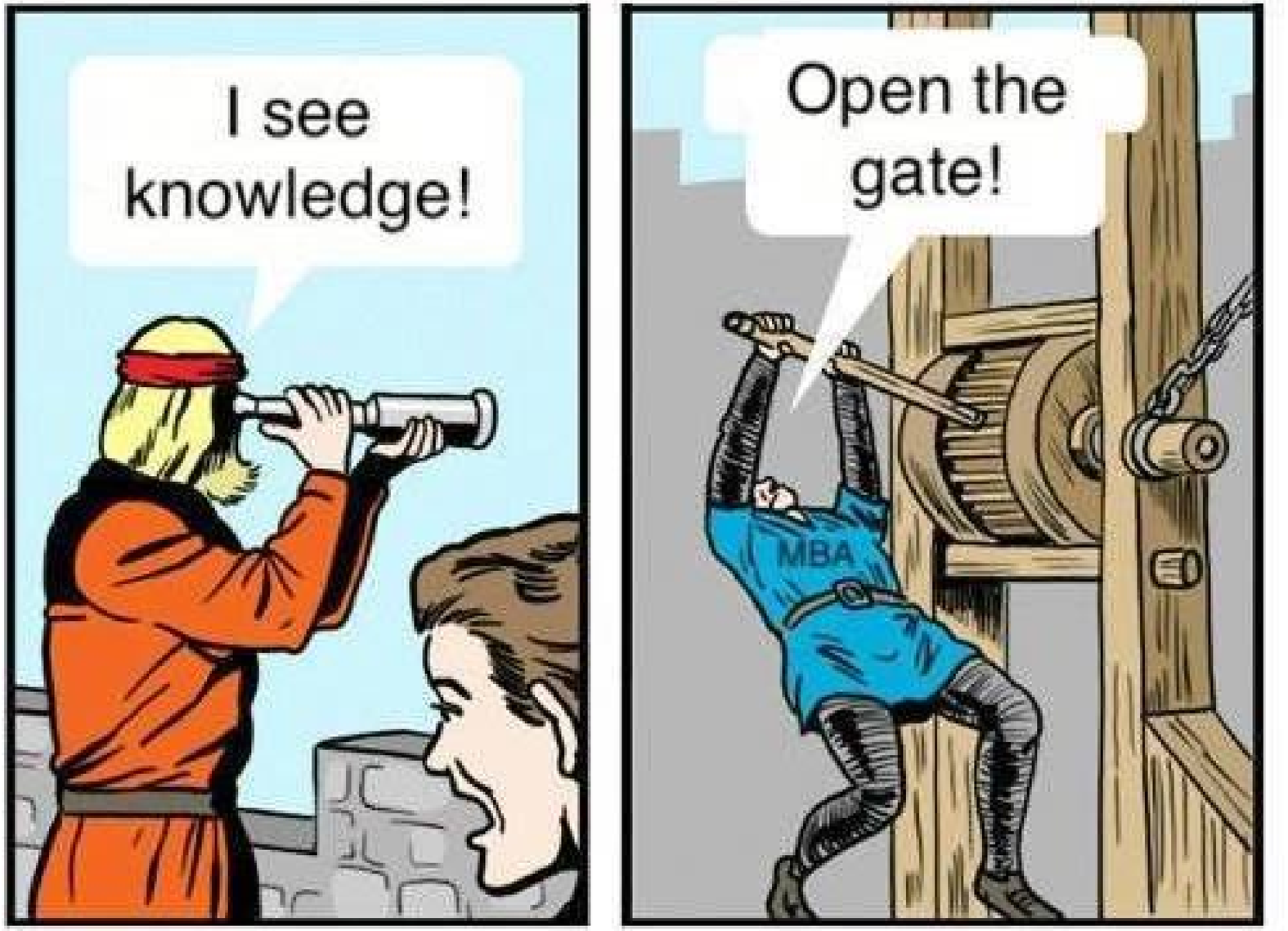
- How much do state cigarette taxes reduce smoking rates?

. . .

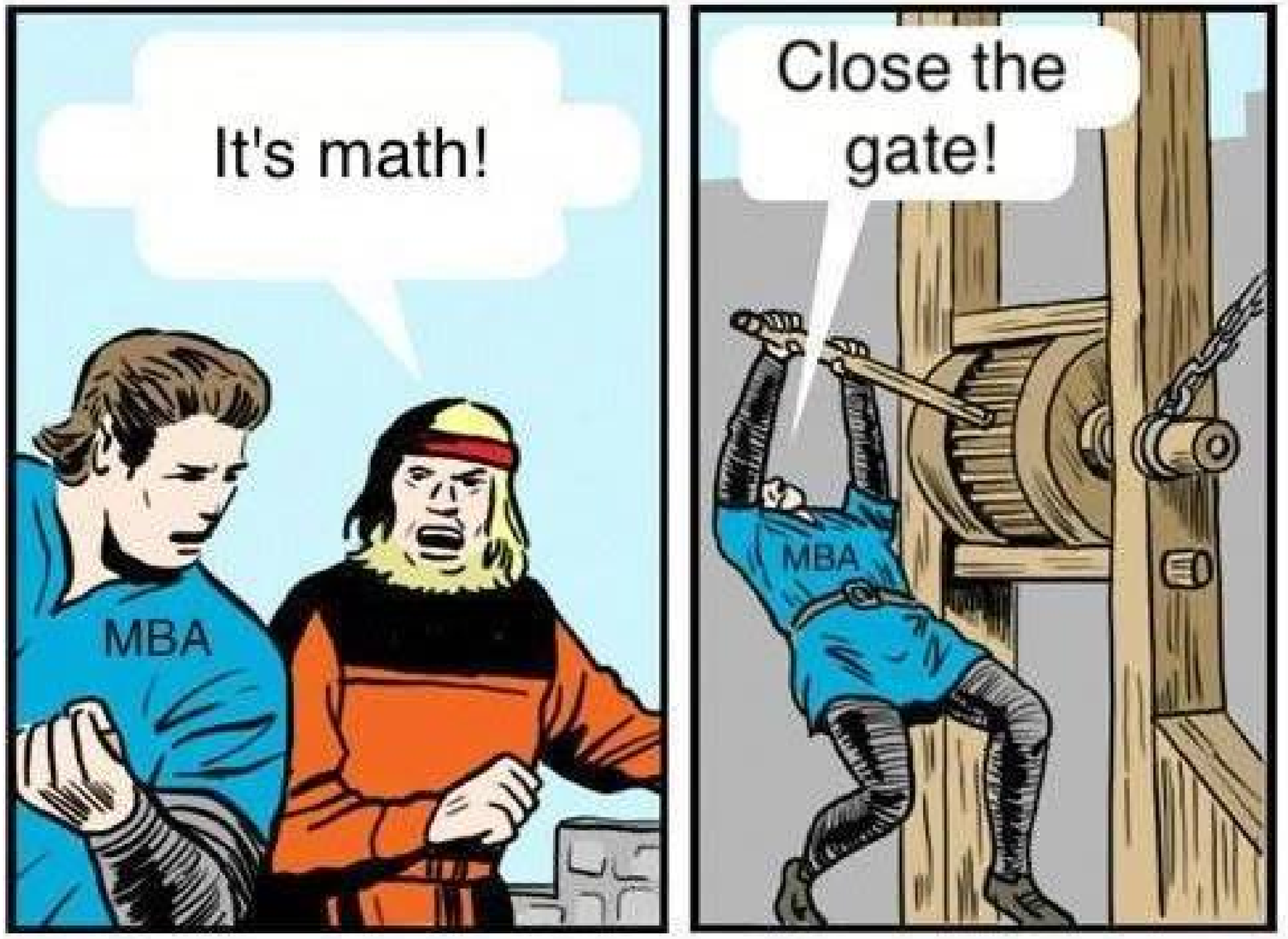
- Econ 101: raise price $\implies$ lower quantity consumed
- What is the *price elasticity of demand* for smoking?
- How much tax revenue will this generate?
- Probably: $Taxes \rightarrow Smokers$
- Maybe?: $Taxes \leftarrow Smokers$

About This Course

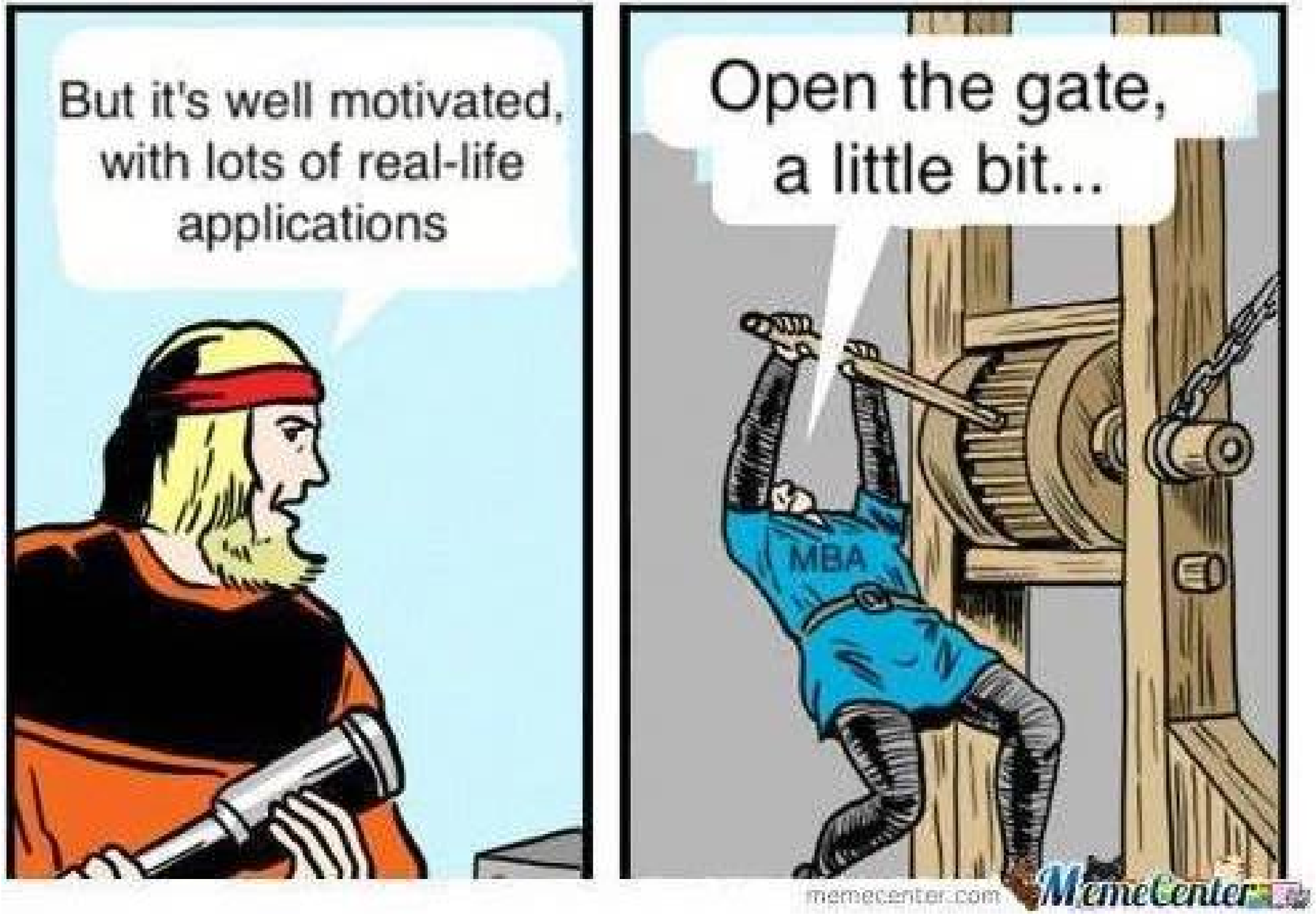
Real Talk: The Math



Real Talk: The Math

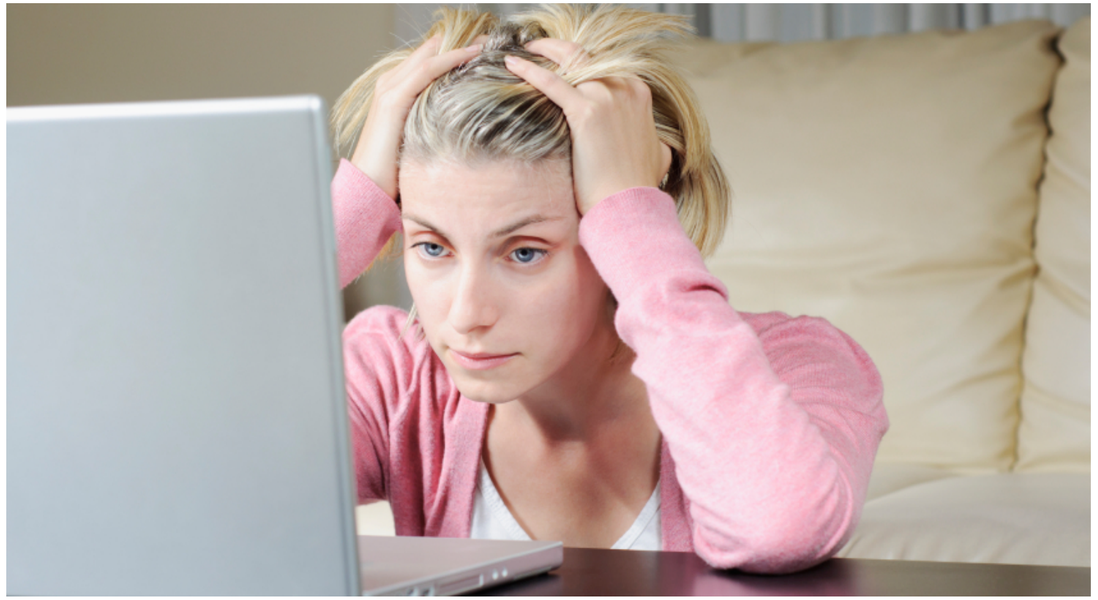


Real Talk: The Math



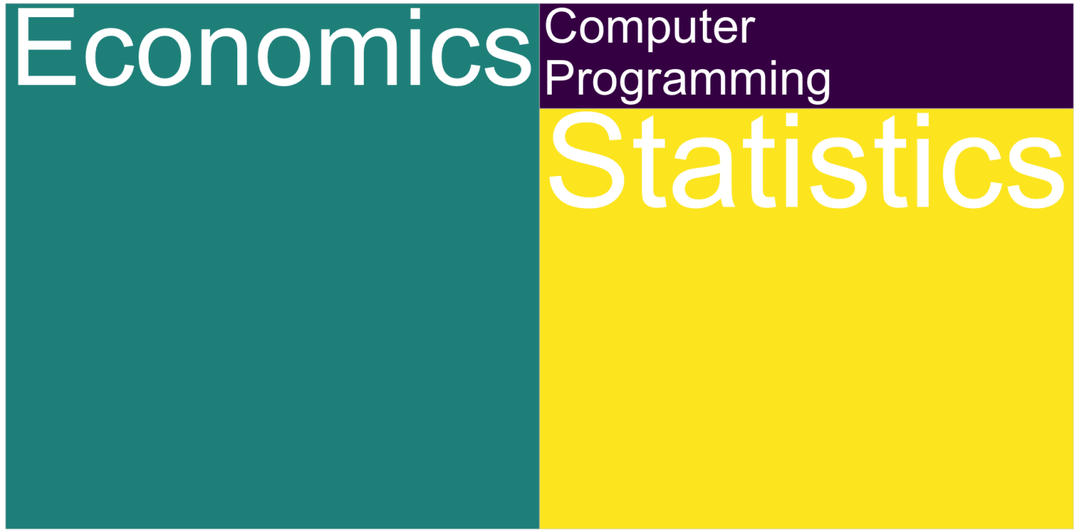
Real Talk: Difficulty

- This will be one of the hardest courses you take at Hood
- There will be moments where you have no idea WTF is going on (*this is normal*)
- Yes, you can still get an **A**



This Class Is

- **Economics**: take your *preexisting* intuition and models for causal inference
- **Statistics**: add regression and statistical inference
- **Computer Programming**: using R and R Studio for analyzing and presenting data]



This Class Is

Old School Statistics Courses

- $\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$
- $\sigma_x = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2}$
- $r_{xy} = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2 \sum_{i=1}^{n}(y_i - \bar{y})^2}}$
- Use pre-cleaned "toy" data, if at all

Hip New "Data Science" Courses

```
1 mean(x)
2 sd(x)
3 cor(x, y)
```

- Import, tidy, and manipulate raw data from scratch (like *real life*!)

Prerequisites

- **Officially (Courses)**:
  - ECON 205
  - ECON 206
  - ECON 305 or ECON 306
  - MATH 112 or ECMG 212
- **Math Skills**:
  - Basic algebra
  - Probability-ish
  - Statistics-ish
- **Computer Science Skills**:
  - None

What You'll Get Out of This Class

By the end of this semester, you will:

1. understand how to evaluate statistical and empirical claims;
2. use the fundamental models of causal inference and research design;
3. gather, analyze, and communicate with real data in R.

This Class Opens Doors

Regressions!

[redacted]@hood.edu> Thu, Jun 6, 11:06 AM

to Ryan

Hi Dr. Safner,

I hope all is well and you are enjoying the start to summer. I changed jobs in March to work as a researcher at an investment fund right outside of DC in Virginia.

I often find myself running regressions (unfortunately my boss doesn't understand R so I have to use Python!) and using time series data; however I am in need of some notes from our courses together. Would you be willing to pass along past lecture presentations from Econometrics? I have hard copy notes to go along, but they are less useful than with the slides.

That is probably the single most influential class I have taken, especially given my new job function and I would certainty benefit from a refresher.

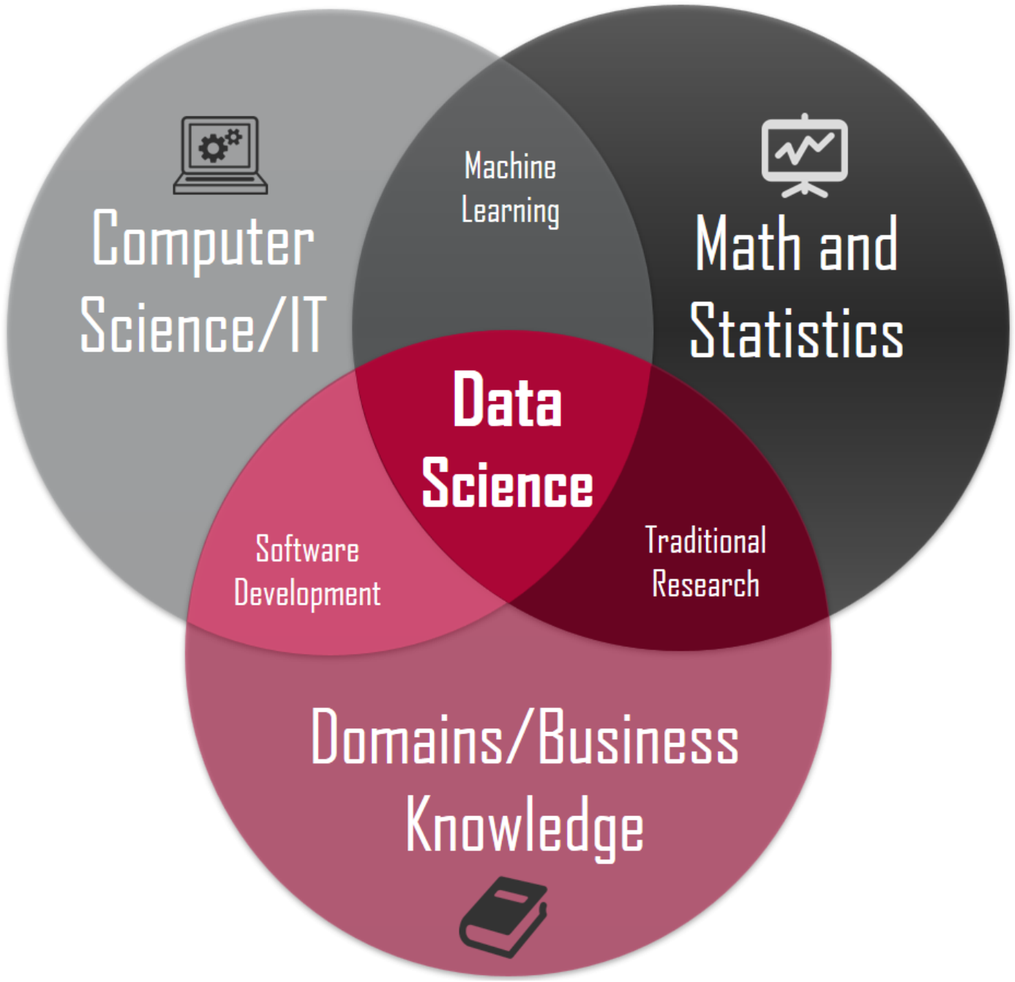
Best Regards,

[redacted]

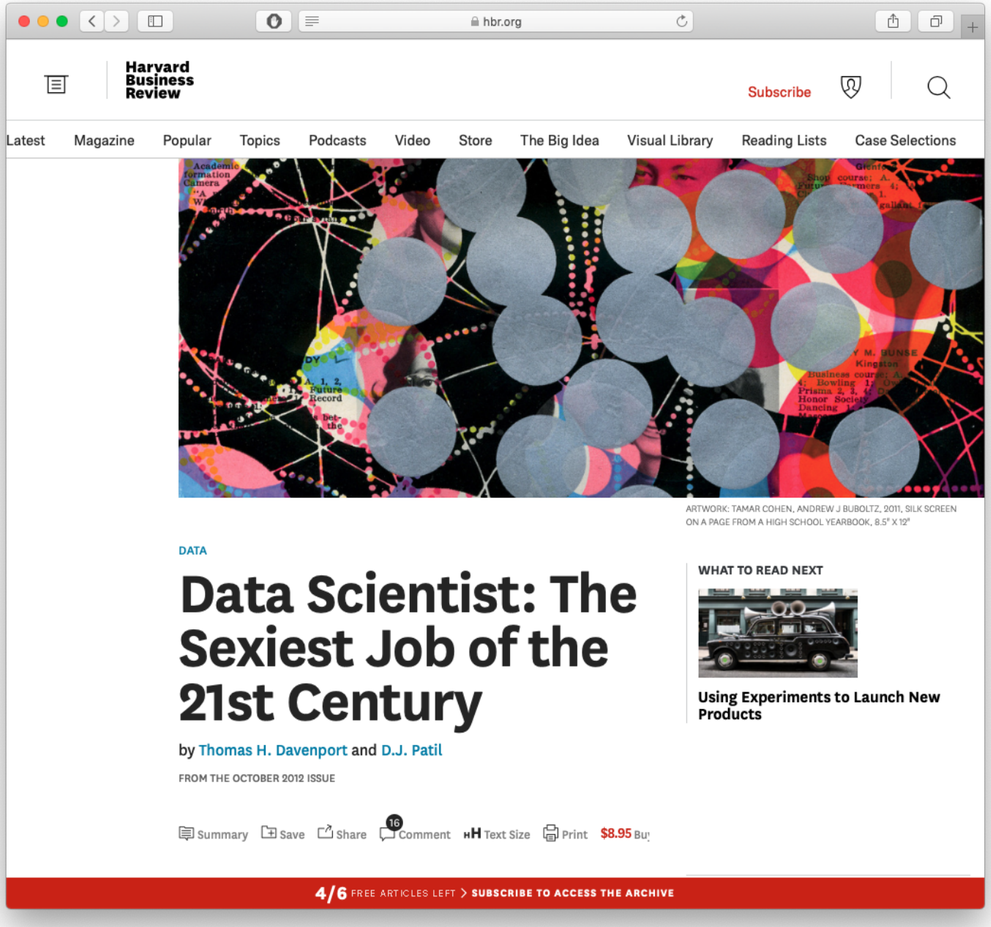
Hood College, B.A. Economics

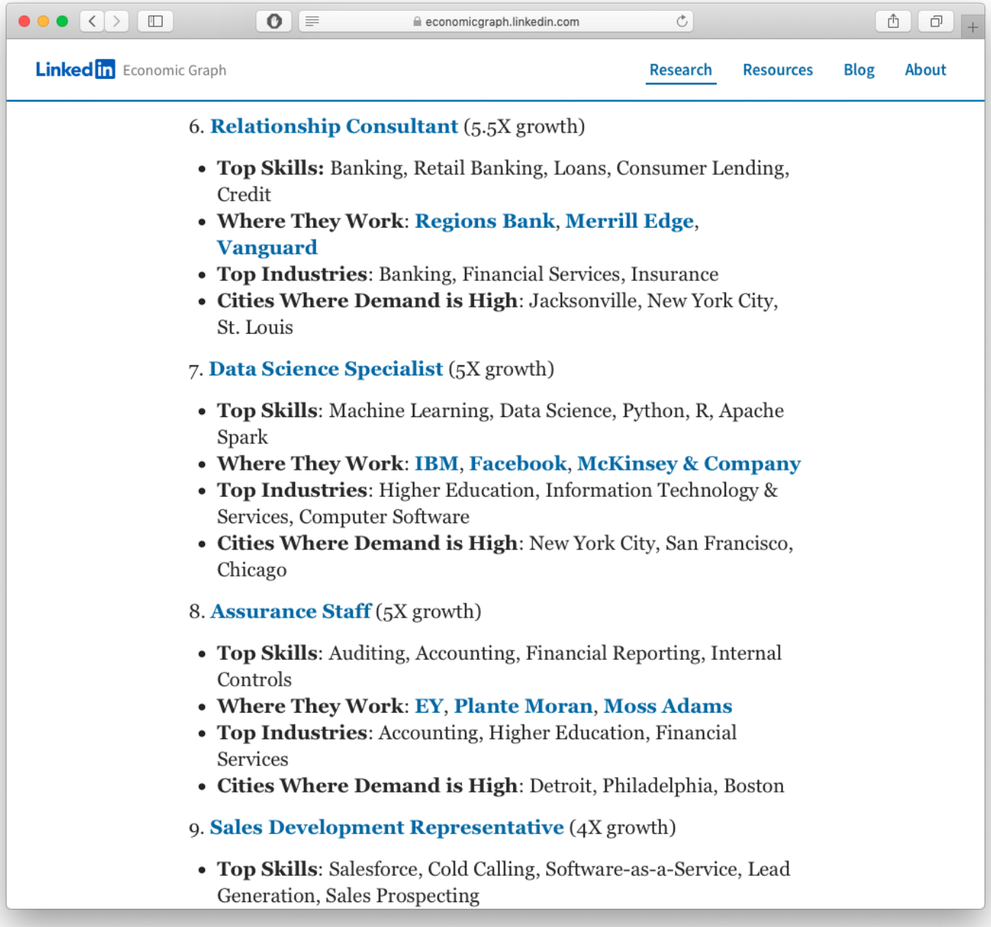
Class of 2018

Building Industry-Demanded Data Science Skills



Building Industry-Demanded Data Science Skills

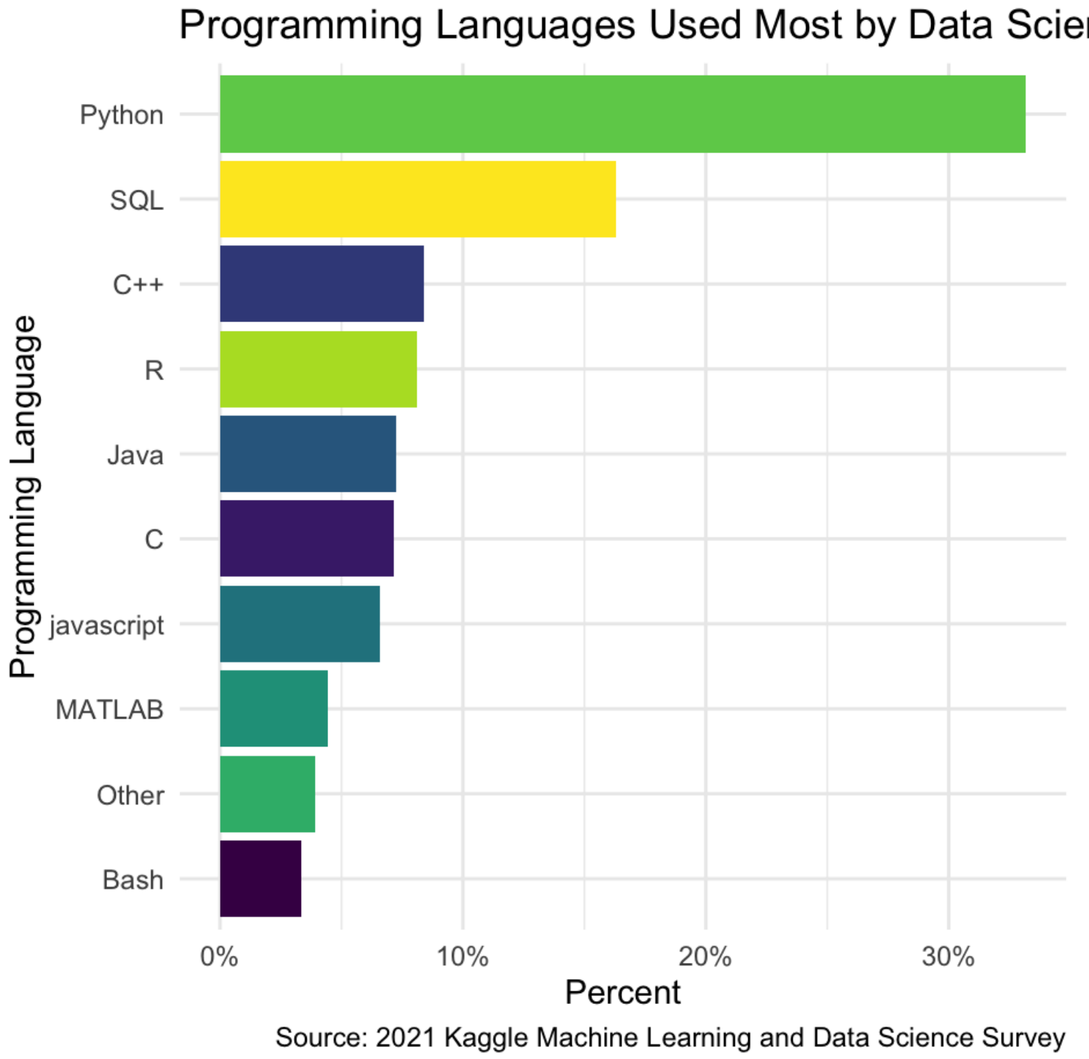


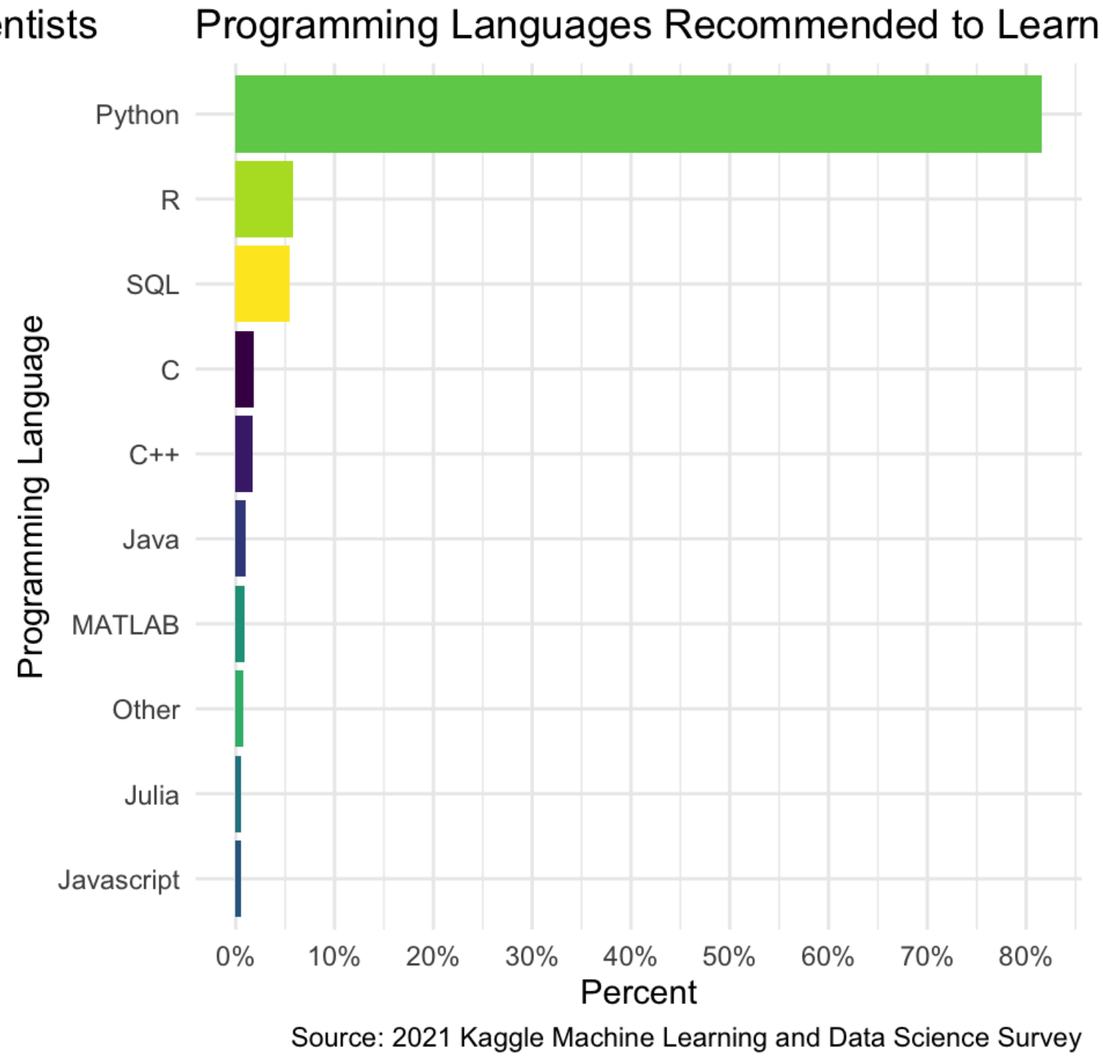


Harvard Business Review

LinkedIn 2018 Emerging Jobs Report

R Can Be Used for Data Science





But Remember

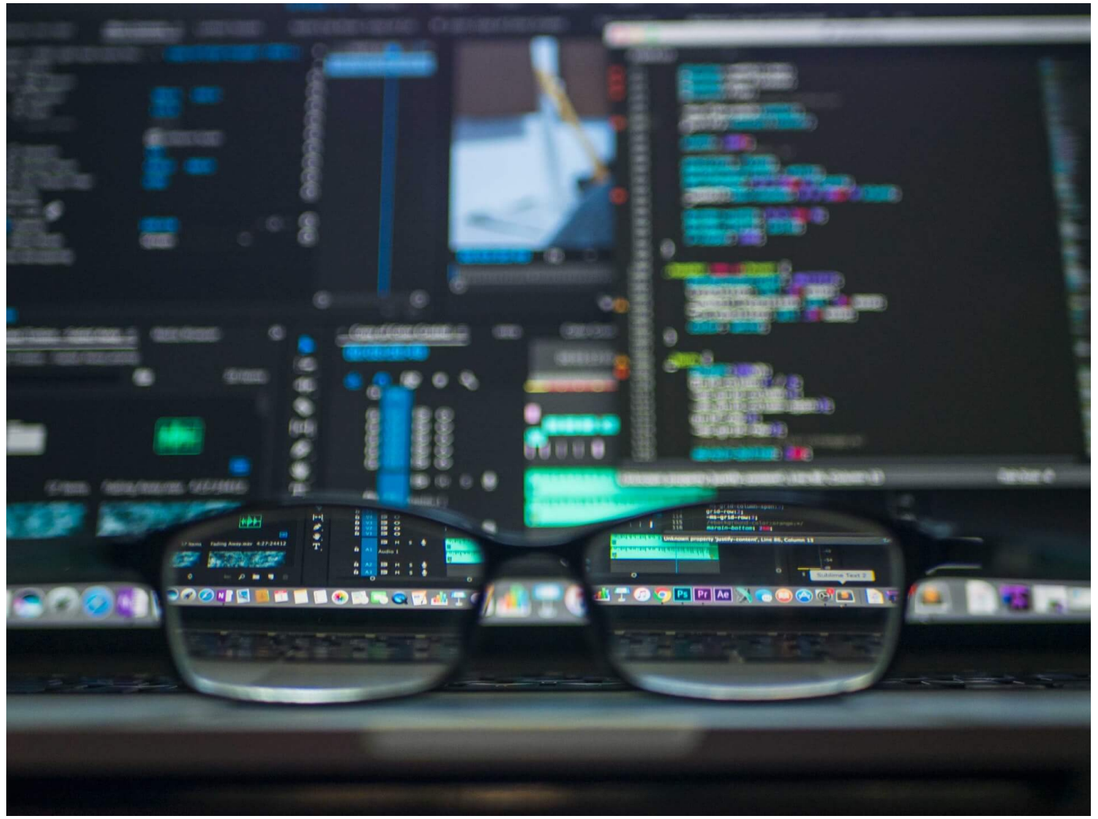
- This is an economics course, not a data science course
- Other software economists use (STATA, SASS, SPSS, Excel) is not on here!

Two Uses For Econometrics

$$Y = f(X)$$

1. **Causal inference**: how changes in X *cause* changes in Y

- Care more about accurately estimating f than getting an accurate $\hat{Y}$
- Measure the **causal effect** of $X \mapsto Y$ (e.g., $\hat{\beta}_1$)



2. **Prediction**: predict $\hat{Y}$ using an estimated f

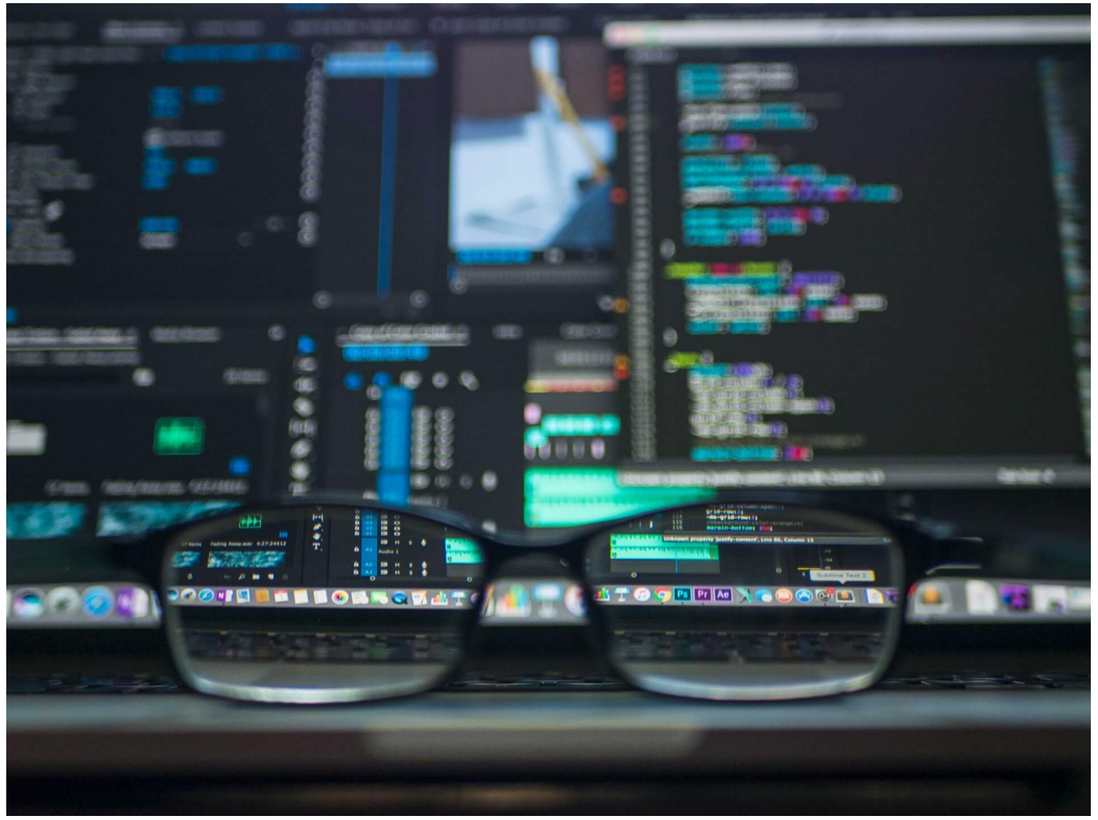
- Care more about getting $\hat{Y}$ as accurate as possible, f is an unknown "black-box"
- **Forecasting**: predict future *values* of Y

(inflation, sales, GDP)

- **Classification**: predict the *category* of an outcome (success or failure, cat picture or not cat picture)
- We care (in this class at least) only about the first

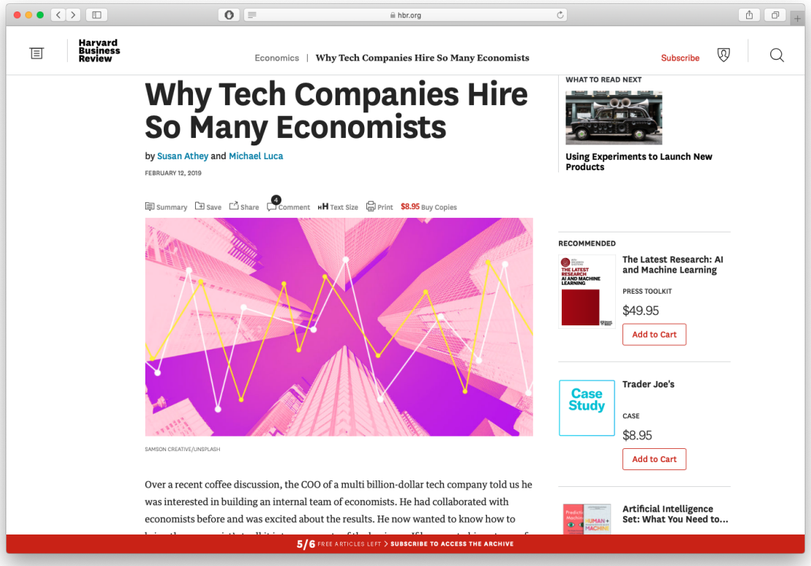
Causal Inference — Economists' Comparative Advantage

- Machine learning and artificial intelligence are "dumb"[1]
- With the right models and research designs, we *can* say "X causes Y" and quantify it!
- Economists are in a unique position to make *causal* claims that mere statistics cannot



1. For more, see my blog post, and Pearl & MacKenzie (2018), *The Book of Why*

Causal Inference — Economists' Comparative Advantage

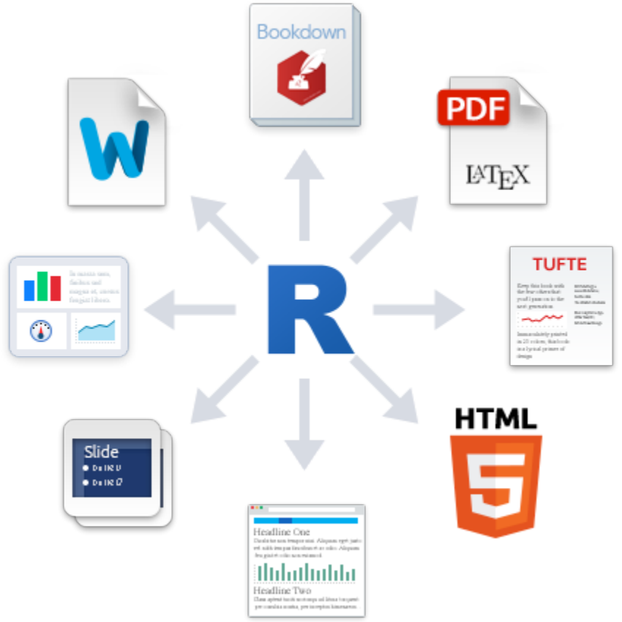


Harvard Business Review

"[T]he field of economics has spent decades developing a toolkit aimed at investigating empirical relationships, focusing on techniques to help understand which correlations speak to a causal relationship and which do not. This comes up all the time — does Uber Express Pool grow the full Uber user base, or simply draw in users from other Uber products? Should eBay advertise on Google, or does this simply syphon off people who would have come through organic search anyway? Are African-American Airbnb users rejected on the basis of their race? These are just a few of the countless questions that tech companies are grappling with, investing heavily in understanding the extent of a causal relationship."

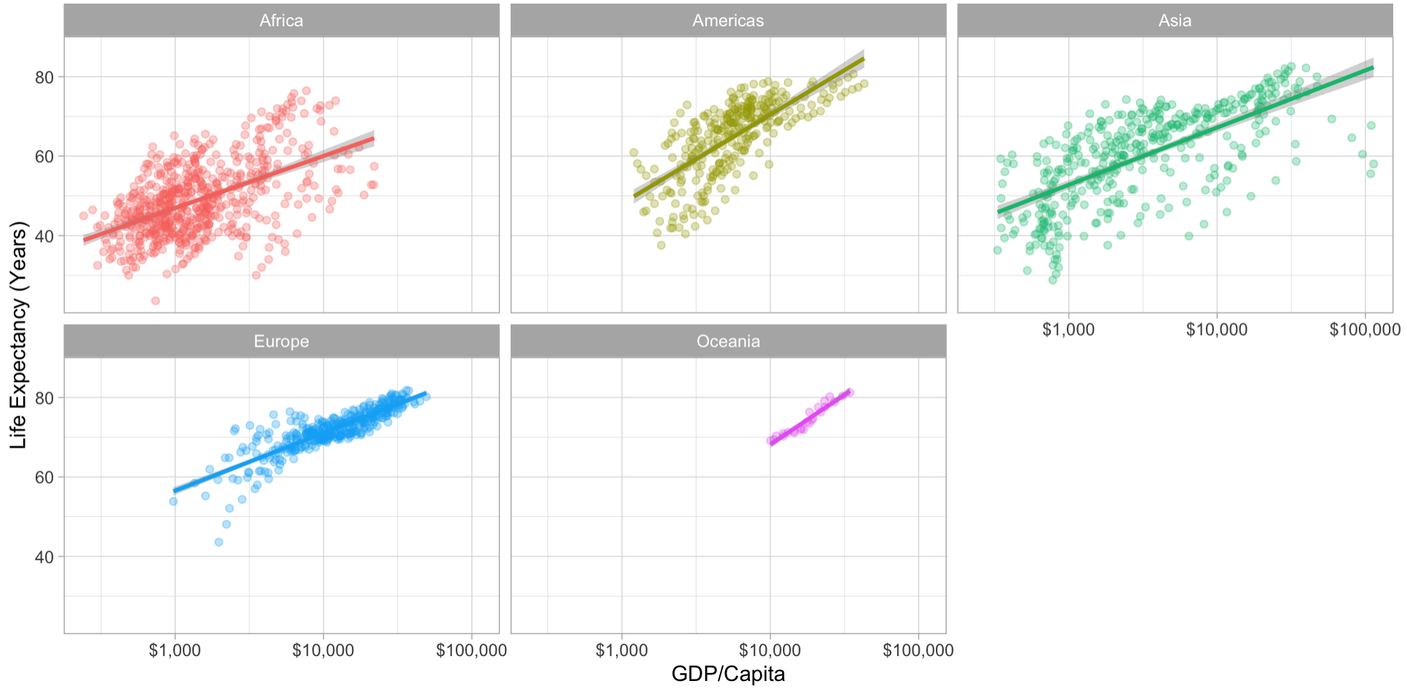
Building Good Workflow Habits

- I will show you the tools to make your workflow:
  - Reproducible
  - Computer- and Human-Readable (!)
  - Automated
  - All in one program



For Example

Output | Code



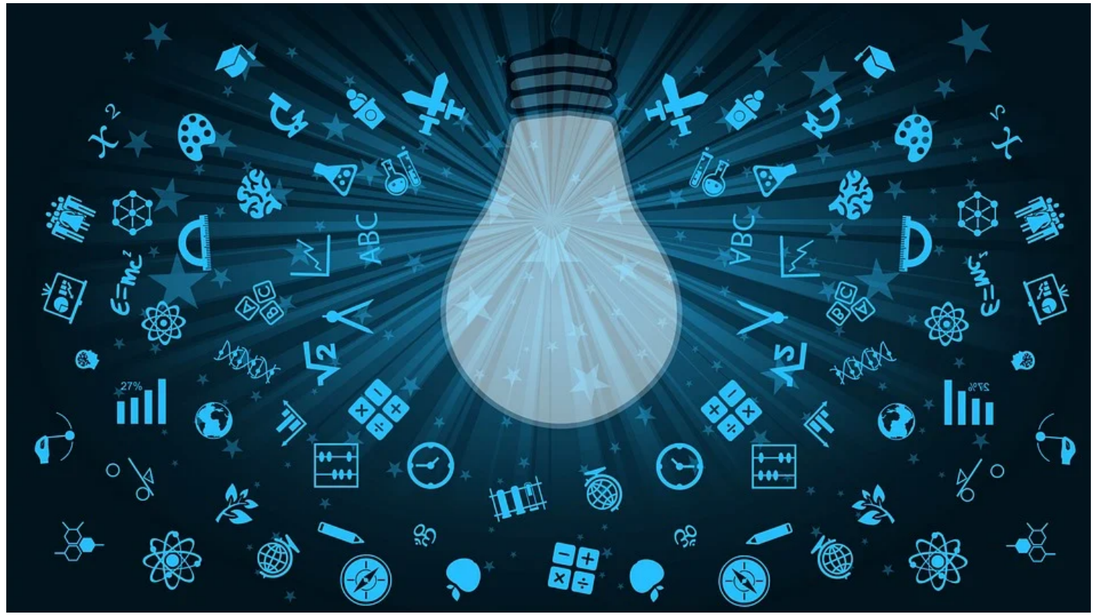
Assignments

- Research project:
  - Come up with a testable research question
  - Find data
  - Analyze data
  - Present your results (in writing and verbally)
- HWs
- Midterm, Final exam

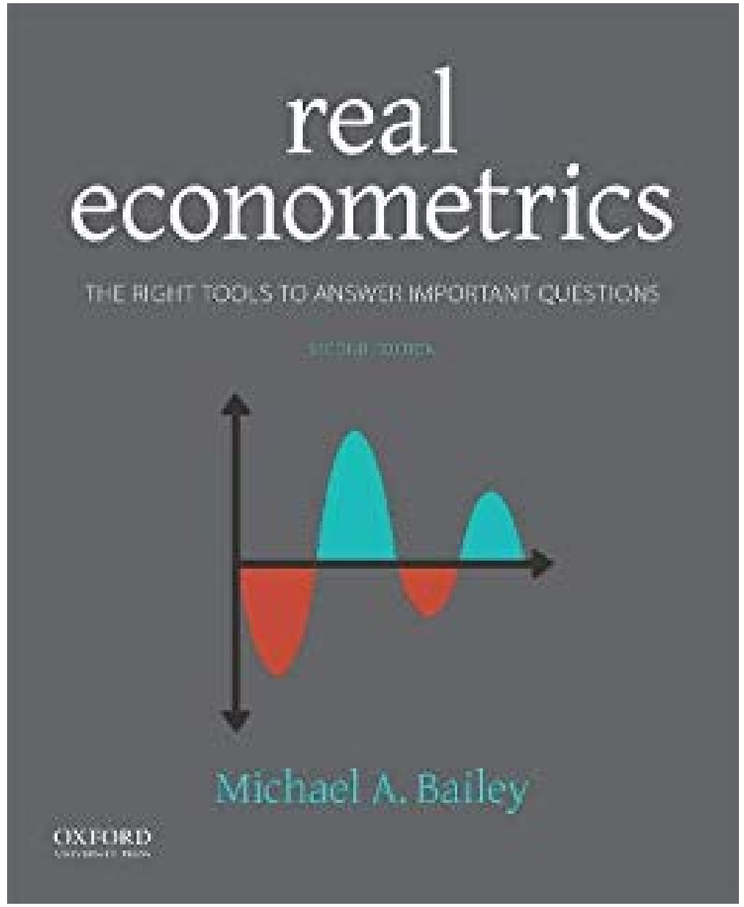
	Assignment	Percent
1	Research Project	30%
n	Homeworks (Average)	25%
1	Midterm	20%
1	Final	25%

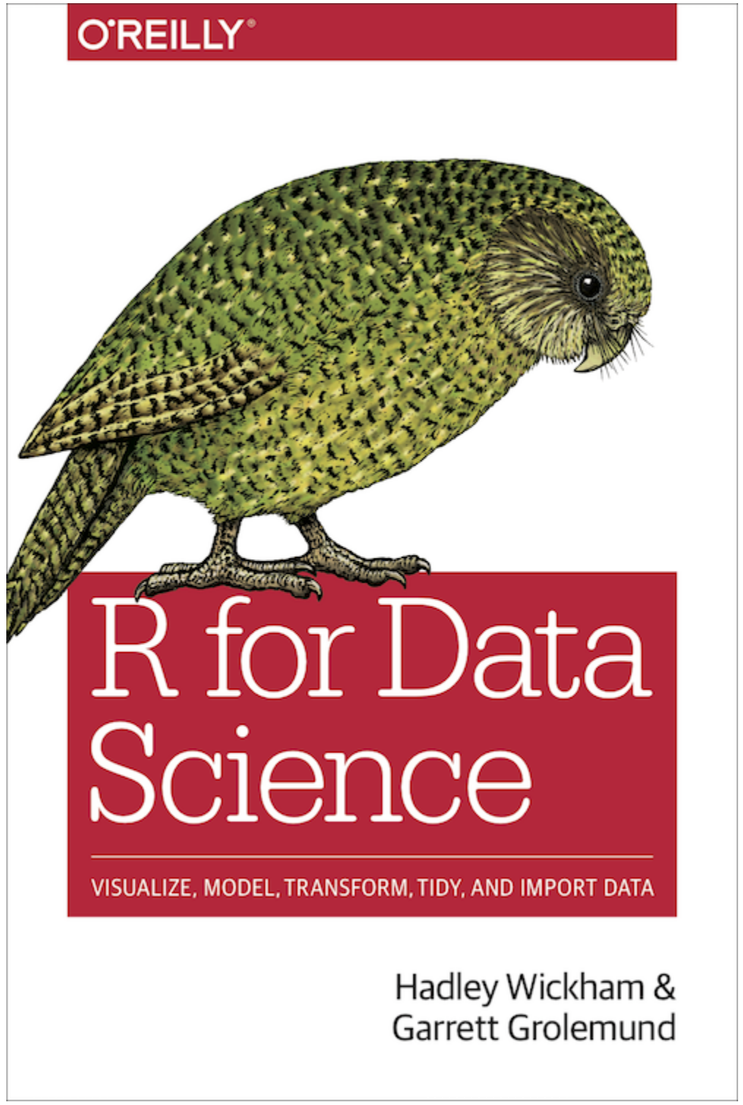
Logistics

- Office hours: M/W 10:00-11:00 AM & by appt
  - Office: 110 Rosenstock
- Slack channel `#c-306-metrics`
- Recorded videos in Blackboard Panopto
- Attendance — **Kahoot!s**
- Teaching Assistant(s): TBD
  - grade HWs & hold office hours
- See the resources page for tips for success and more helpful resources



Your Textbooks





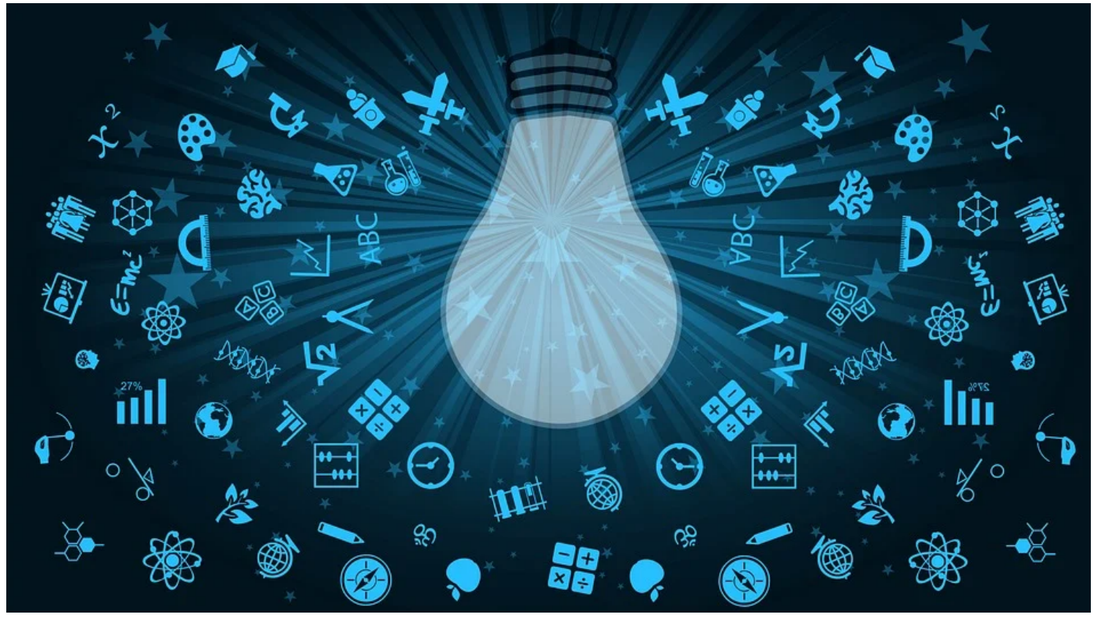
You Can Do This.

And I am Here To Help

- Don’t forget to prioritize your mental health
- Come talk to me! It’s not scary!

Tips for Success in This Course

- *Take notes. On paper. Really.*
- **Work together** on assignments and study together.
- Ask questions, come to office hours. Don't struggle in silence, you are not alone!
- **The biggest skill you are developing is learning how to learn**[1]
- See the reference page for more



1. A properly worded Google search will become your secret weapon. Believe me. It's still mine.

Course Website

Econometrics

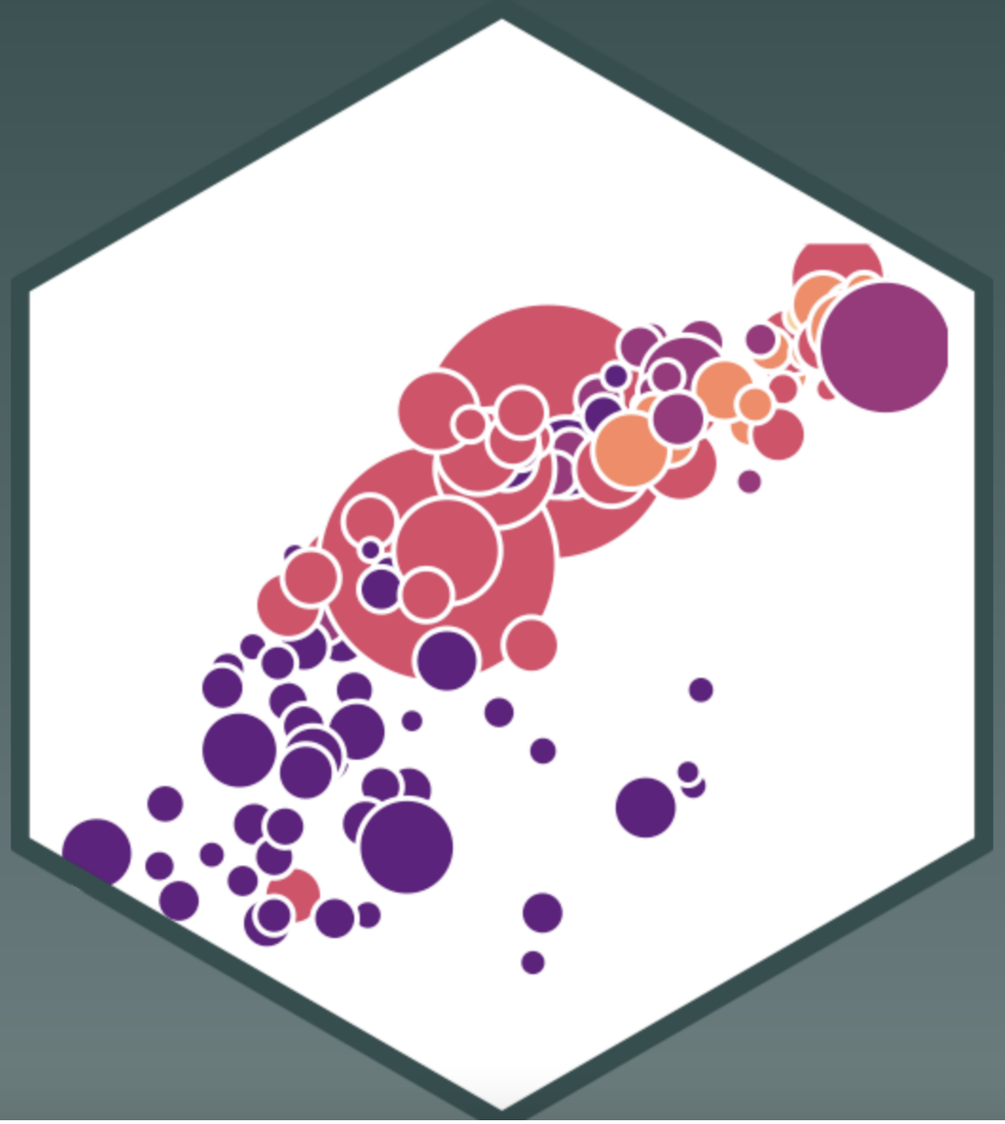
ECON 480 • Fall 2021 • Hood College

Learn how to analyze data using the canonical models of econometics with R.

By the end of this course, you will:

1. understand how to evaluate statistical and empirical claims;
2. use the fundamental models of causal inference and research design;
3. gather, analyze, and communicate with real data in R.

Schedule | Syllabus



metricsF21.classes.ryansafner.com

Roadmap for the Semester

Data Analysis with R

R & R Studio | R Markdown

Data Wrangling | Data Visualization

→

Linear Regression

OLS | Fit, Bias, Precision

Statistical Inference | Hypothesis Tests

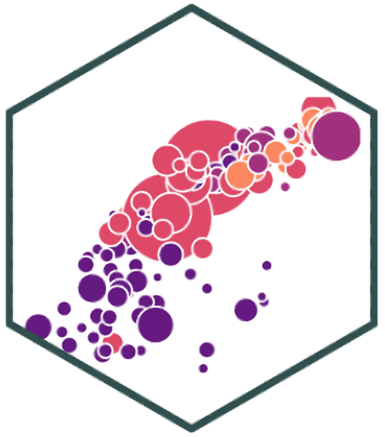
→

Causal Inference

Causal Inference | DAGs

Multivariate OLS | Nonlinear OLS

↓



Econometrics

Panel Data & Advanced

Diff-in-Diffs | Fixed Effects

IVs | Binary Y Variables