

# Evaluation, data science, and the causal revolution

January 15, 2020

PMAP 8521: Program Evaluation for Public Service  
Andrew Young School of Policy Studies · Georgia State University  
Spring 2020

# Plan for today

Data science and public service

Evidence, evaluation, and causation

Class details

Getting staRted!

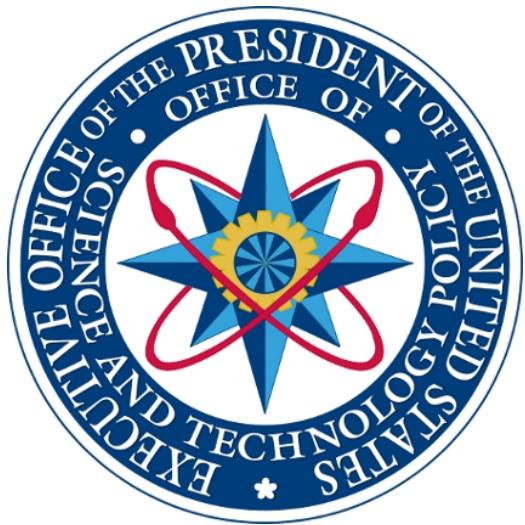
Data science and  
public service

# WHY UNIVERSITIES NEED 'PUBLIC INTEREST TECHNOLOGY' COURSES

POLICYMAKERS AT ALL levels of government are struggling to thoughtfully harness data in the service of public values. Many public servants grew up in an era of firmly separate disciplines: You were either an engineer or an economist, either a programmer or a social worker, but never both. In an era in which data is everything, the risks to core democratic principles—equity, fairness, support for the most vulnerable, delivery of effective government services—caused by technological illiteracy in policymakers, and policy illiteracy in computer scientists, are staggering.

field aimed at addressing precisely this gap in interdisciplinary opportunities. This new area, "public interest technology," is still being defined; it encompasses designing public policy and laws with an awareness of how technology actually works, as well as ensuring that technology is being used to serve public values of fairness and equity. It means consciously thinking about the welfare of society in general, rather than the incentives of a single company.

# Data and government



THE U.S. DIGITAL SERVICE



**"To responsibly  
unleash the power  
of data to benefit  
all Americans"**

**The White House**

Office of the Press Secretary

For Immediate Release

June 30, 2016

# FACT SHEET: Launching the Data-Driven Justice Initiative: Disrupting the Cycle of Incarceration

*"[O]ur criminal justice system isn't as smart as it should be. It's not keeping us as safe as it should be. It is not as fair as it should be.*

*Mass incarceration makes our country worse off, and we need to do something about it."* -

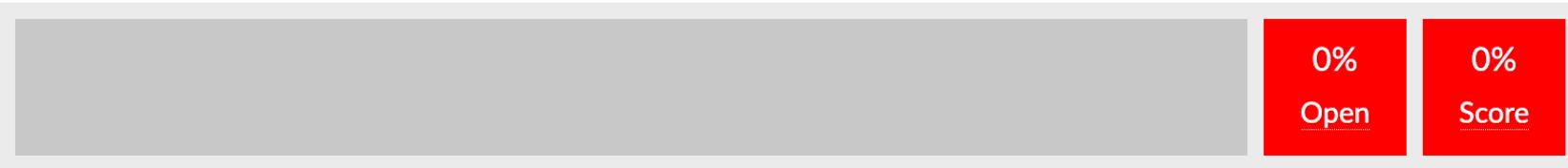
President Barack Obama, July 14, 2015





# U.S. CITY OPEN DATA CENSUS

POWERED BY OPEN DATA CENSUS



## Breakdown

Dataset	Breakdown	Year	Score	↑
Budget				
Business Listings				
Code Violations				
Construction Permits				
Crime Reports				
Emergency Calls				
Employee Salaries				
Lobbyist Activity				
Parcels				
Police Use-of-Force				
Procurement Contracts				
Property Assessment				
Property Transfers				
Public Facilities				
Restaurant Inspections				
Service Requests				
Spending				

# Google Dataset Search

Beta

Search for Datasets



Try [boston education data](#) or [weather site:noaa.gov](#)

Google Dataset Search

salt lake city



Salt Lake City Police Department  
moto.data.socrata.com

Updated Aug 26, 2018

Salt Lake City Police Department

[moto.data.socrata.com](#)

254 scholarly articles cite this dataset ([View in Google Scholar](#))



Precipitation Depth Table from  
Salt Lake City Zoo Station  
[www.hydroshare.org](#)

**Dataset created** Dec 2, 2015

**Dataset updated** Aug 26, 2018

**Dataset published** Dec 2, 2015



Data from: Case Outcomes  
Following Investigative  
Interviews of Suspected...  
[www.icpsr.umich.edu](#)  
[datamed.org](#)

Available download formats from providers

CSV , RSSXML , RDFXML , XML

**Description**

Salt Lake City Police Department incident dataset

**How do you use all this data  
to make the world better?**

# What is “statistics”?

Collecting and analyzing data from a representative sample in order to make inferences about a whole population

# What is “data science”?

**Big data**

**Algorithms**

**Machine  
learning**

**Data mining**

**Neural  
networks**

**Cloud computing**

**Artificial  
intelligence**

**PR-speak for  
“statistics”**

# What is “data science”?

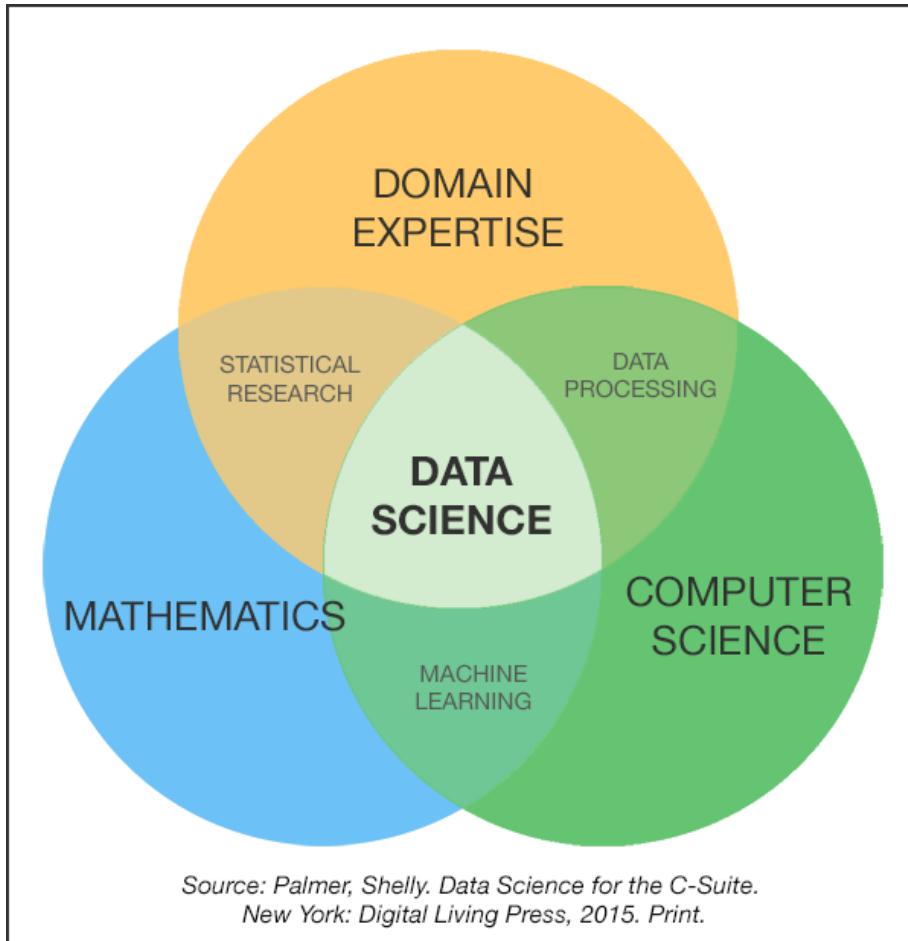
Turning raw data into  
understanding, insight,  
and knowledge

Collect

Analyze

Communicate

# What's the difference?



Statistics

Collect

Analyze

Communicate

# What is “program evaluation”?

**Measuring the effect of social  
programs on society**

**Data and statistics**

**Communication**

**Causal inference  
(econometrics)**

Evidence, evaluation,  
and causation

**What is the relationship between  
social science research and  
public policy & administration?**

# Evidence-based medicine



# Modern evidence-based medicine

Apply evidence to clinical  
treatment decisions

Move away from clinical judgment  
and “craft knowledge”

Is this good?

**Can we find and  
measure evidence for  
policies and programs?**

# Evidence-based policy

RAND health insurance study

Oregon Medicaid expansion

HUD's Moving to Opportunity

Tennessee STAR

# Policy evidence industry

Jameel Poverty Action Lab (J-PAL)

Campbell Collaboration

**Should we have evidence for  
every policy or program?**

**No!**

**Science vs. art/craft/intuition**



Ellie Murray

@EpiEllie

Follow

| IF U DONT SMOKE,  
U ALREADY  
BELIEVE IN  
CAUSAL INFERENCE  
WITHOUT  
RANDOMIZED TRIALS  
|

(^\_\_^) ||  
(•ㅅ•) ||  
/\_ づ

#HistorianSignBunny #Epidemiology

10:13 PM - 12 Jul 2018

200 Retweets 612 Likes



29

200

612

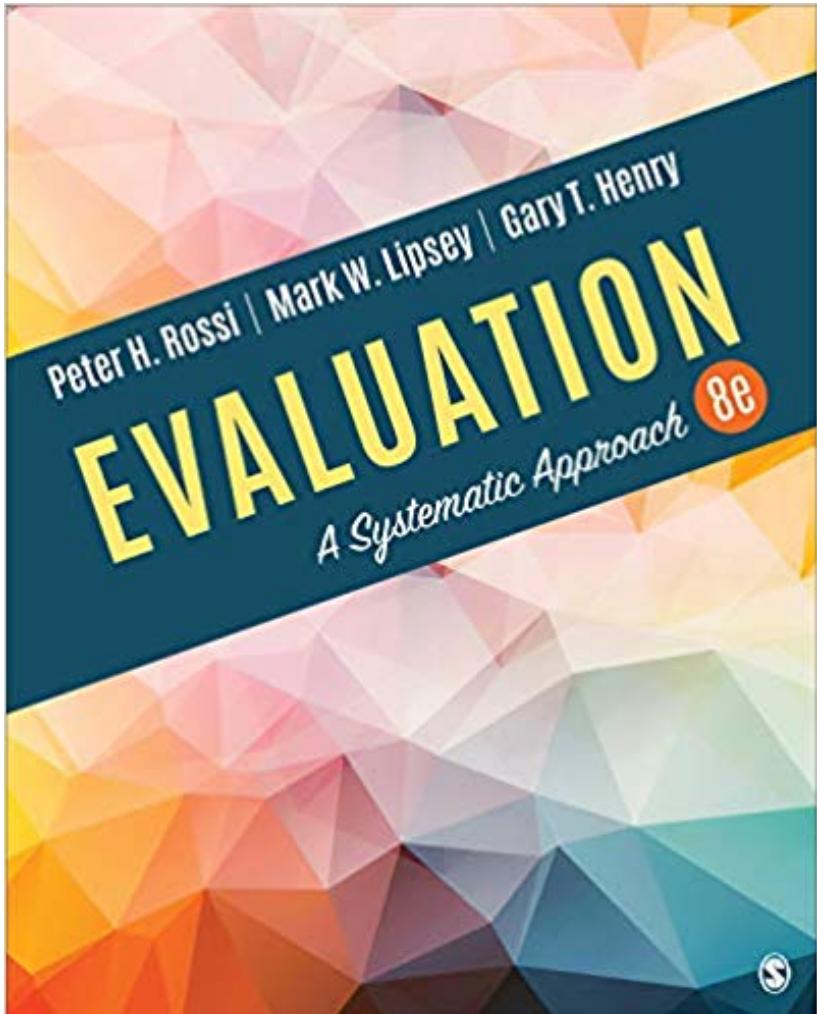


PLEASE  
BE PREPARED  
TO SHOW  
I.D.  
**NO ONE  
UNDER 21 WILL  
BE SERVED**

# **Where does program evaluation fit with all this?**

**It's a method for collecting evidence for policies and programs**

# Types of evaluation



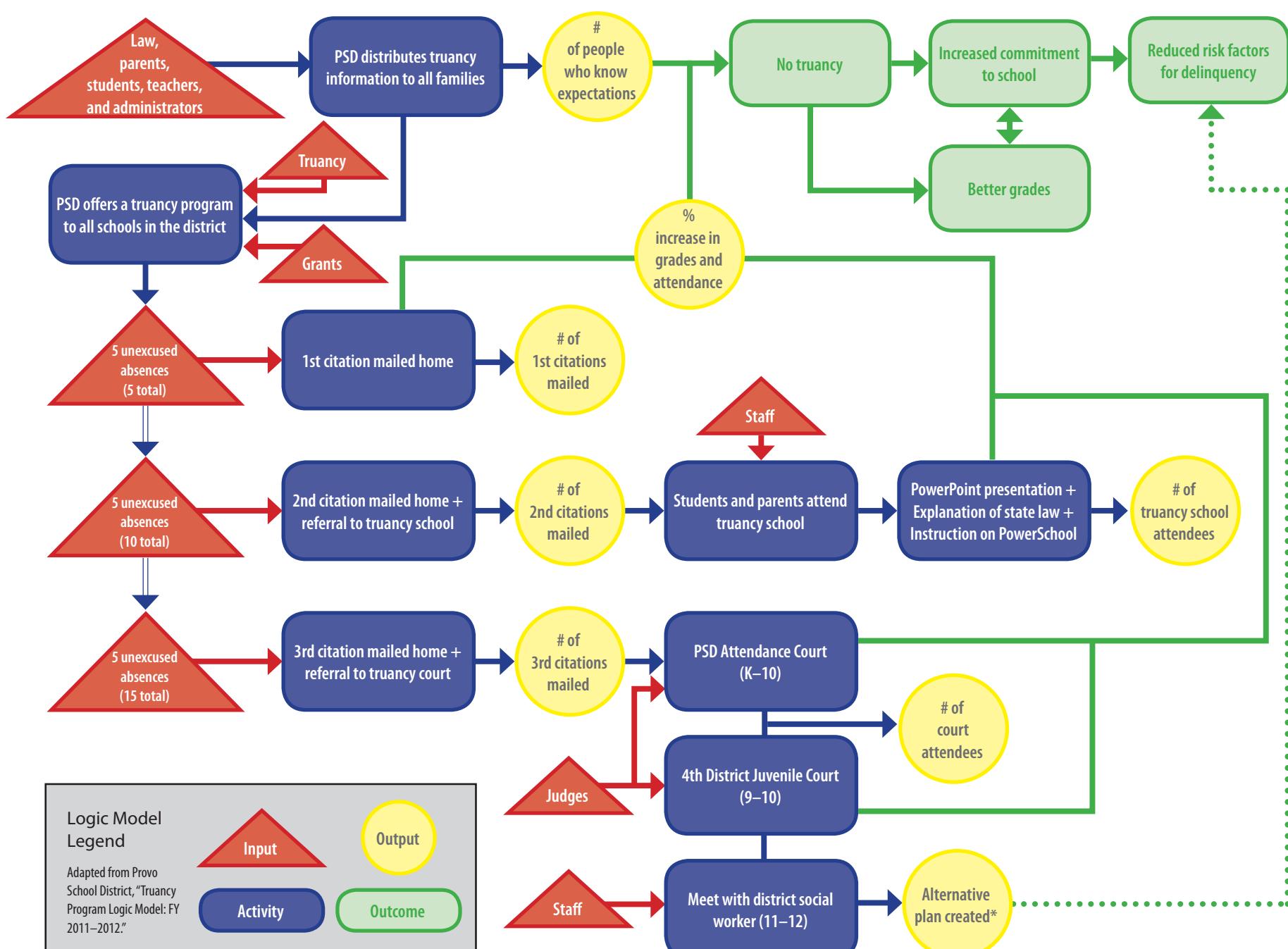
Needs assessment

Design and theory assessment

Process evaluation  
and monitoring

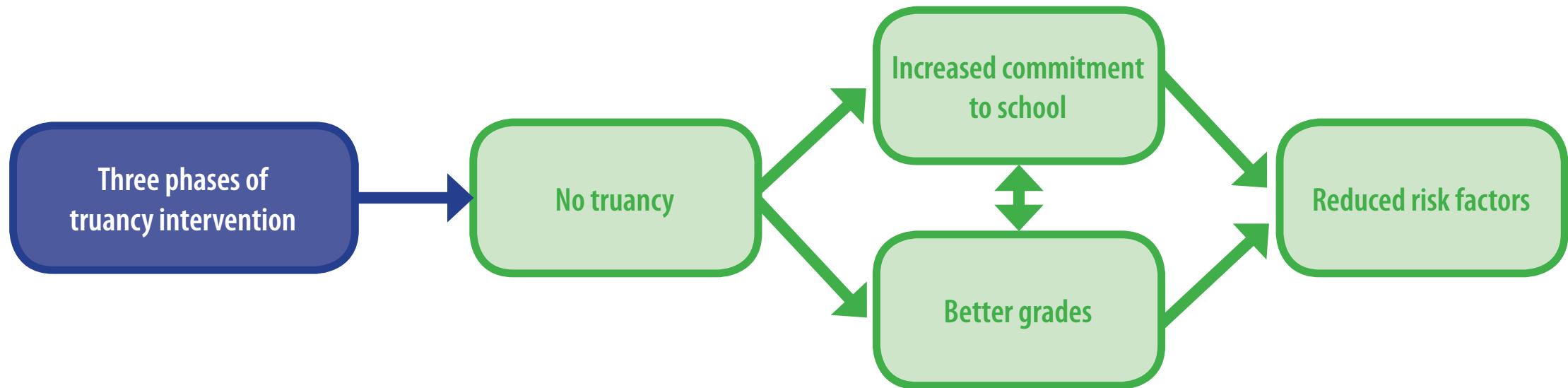
Impact evaluation

Efficiency evaluation (CBA)



\* Because 11th and 12th graders who receive 3rd citations are generally unable to graduate from high school, district social workers no longer attempt to increase their commitment to school. As such, any outcomes that occur as a result of the alternative plans made for these students (work study programs, career development assistance, etc.) are only tangentially related to the outcomes of the truancy program itself. The system for creating alternative plans is an entirely separate program with its own logic model, goals, and outcomes.

# Theories of change



Impact evaluation!

# Impact Evaluation in Practice

SECOND EDITION

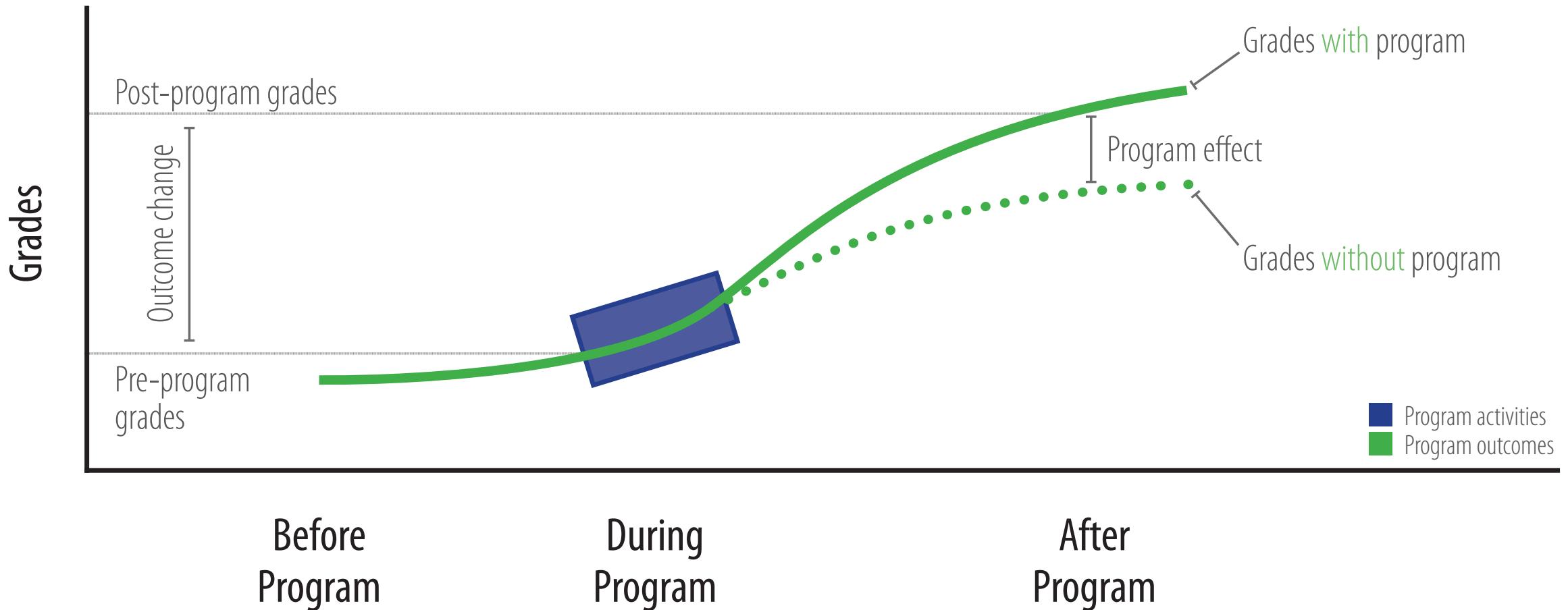
Paul J. Gertler, Sebastian Martinez,  
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and Christel M. J. Vermeersch



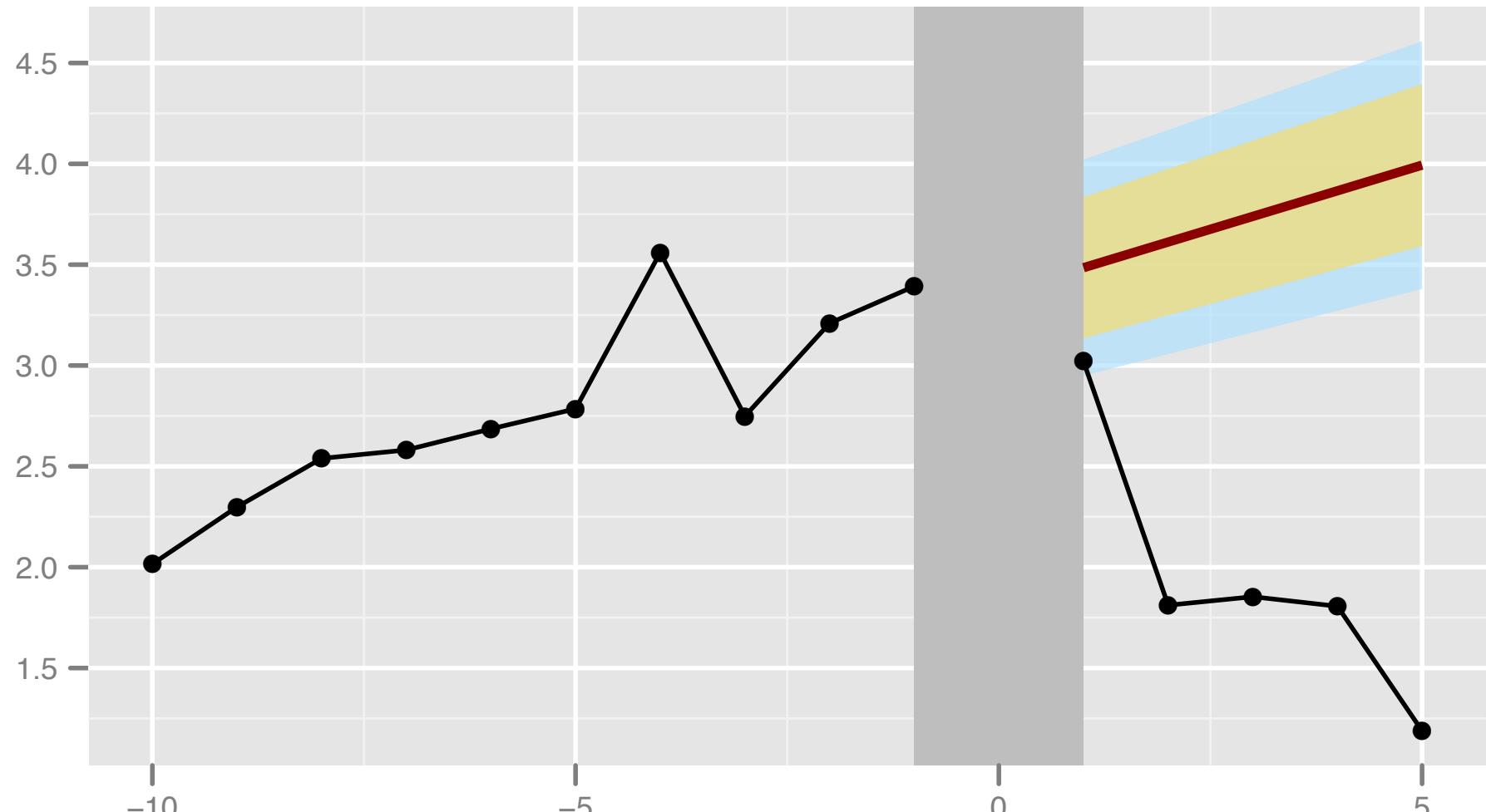
WORLD BANK GROUP



# Theory → impact



Average number of absences



Weeks before/after truancy intervention

**Lines**

- Actual
- Predicted

**Colors**

- 80% Confidence
- 95% Confidence
- Truancy intervention

# Godwin's law

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From Wikipedia, the free encyclopedia

**Godwin's law** (or **Godwin's rule of Hitler analogies**)<sup>[1][2]</sup> is an [Internet adage](#) asserting that "As an online discussion grows longer, the probability of a comparison involving [Nazis](#) or [Hitler approaches 1"](#);<sup>[2][3]</sup> that is, if an online discussion (regardless of topic or scope) goes on long enough, sooner or later someone will compare someone or something to Adolf Hitler or his deeds, the point at which effectively the discussion or thread often ends. Promulgated by the American attorney and author [Mike Godwin](#) in 1990,<sup>[2]</sup> Godwin's law

# Godwin's Law for statistics

Correlation does not  
imply causation

Except when it does

Even if it doesn't,  
this phrase is useless  
and kills discussion

Not everyone found the news believable. "Facepalm. Correlation doesn't imply causation," wrote one unhappy Internet user. "That's pretty much how I read this too... correlation is NOT causation," agreed a Huffington Post superuser, seemingly distraught. "I was surprised not to find a discussion of correlation vs. causation," cried someone at Hacker News. "Correlation does not mean causation," a reader moaned at Slashdot. "There are so many variables here that it isn't funny."

# Correlation vs. causation

**How do we figure out  
correlation?**

**Math and statistics**

**How do we figure out  
causation?**

**Philosophy. No math.**



**John B. Holbein** @JohnHolbein1 · Apr 7

Causality isn't achieved; it's approached.



3



1



8



[Show this thread](#)



**John B. Holbein** @JohnHolbein1 · Apr 7

Causality isn't binary; it's a continuum.



1



5



13



[Show this thread](#)

# How do we know if X causes Y?

X causes Y if...

...we intervene and change X  
without changing anything else...

...and Y changes

**Y “listens to” X**

**X isn’t the only thing that causes Y**

**A light switch causes a light to go on, but not if bulb is burned out (no Y despite X) or if the light was already on (Y without X)**

# Causal relationships?

**Lighting fireworks causes noise**

**Rooster crows are followed by sunrise**

**Getting an MPA increases your earnings**

**Colds go away a few days  
after you take vitamin C**

# Causation

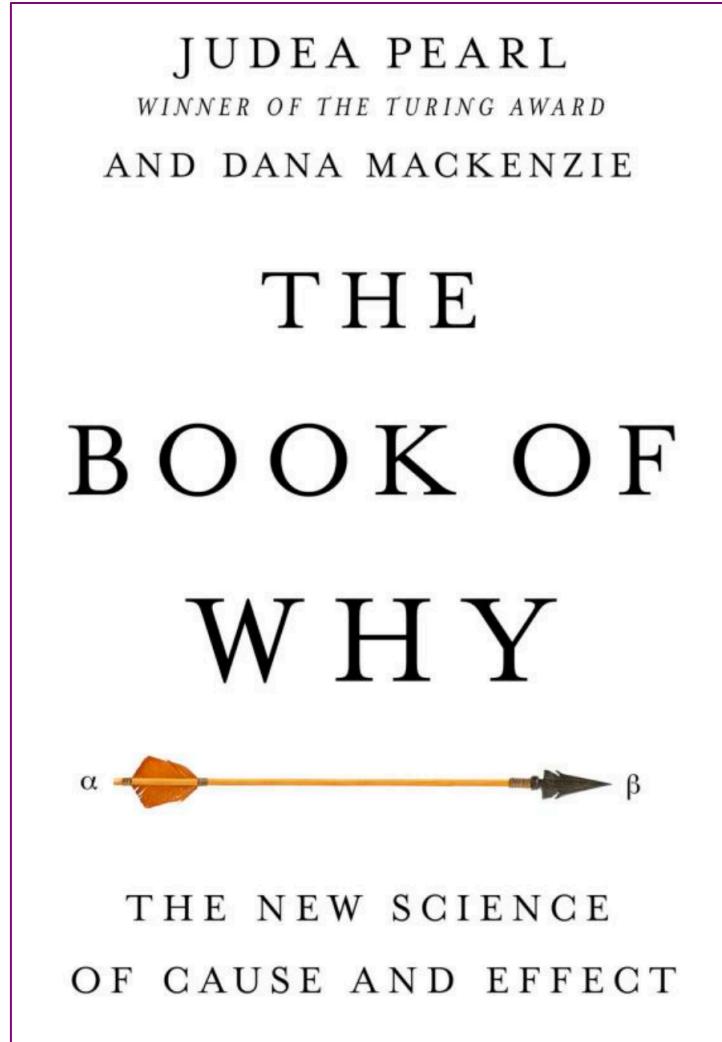
**Causation =  
Correlation + time order +  
all other factors ruled out**

**How do you know if you have it right?**

**You need a philosophical model**

**That's what this class is for!**

# The causal revolution



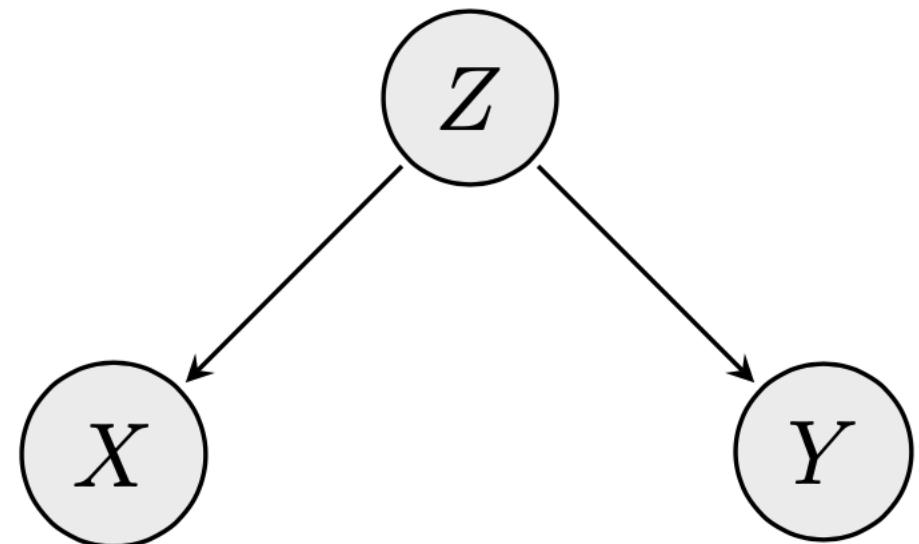
# Causal diagrams

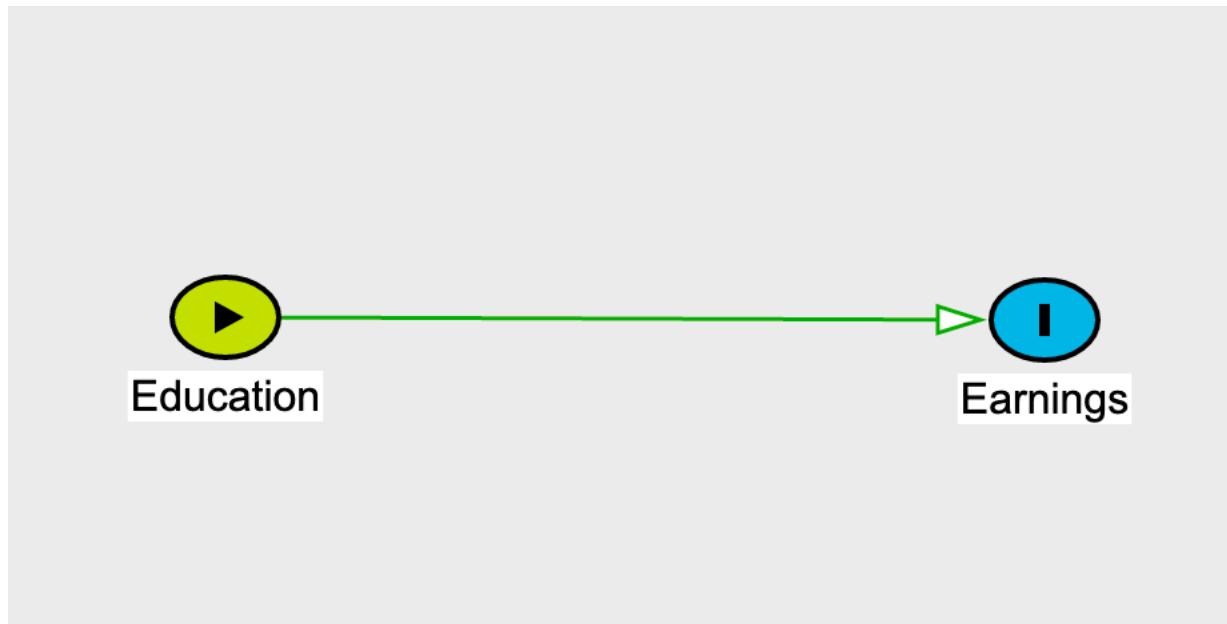
## Directed acyclic graphs (DAGs)

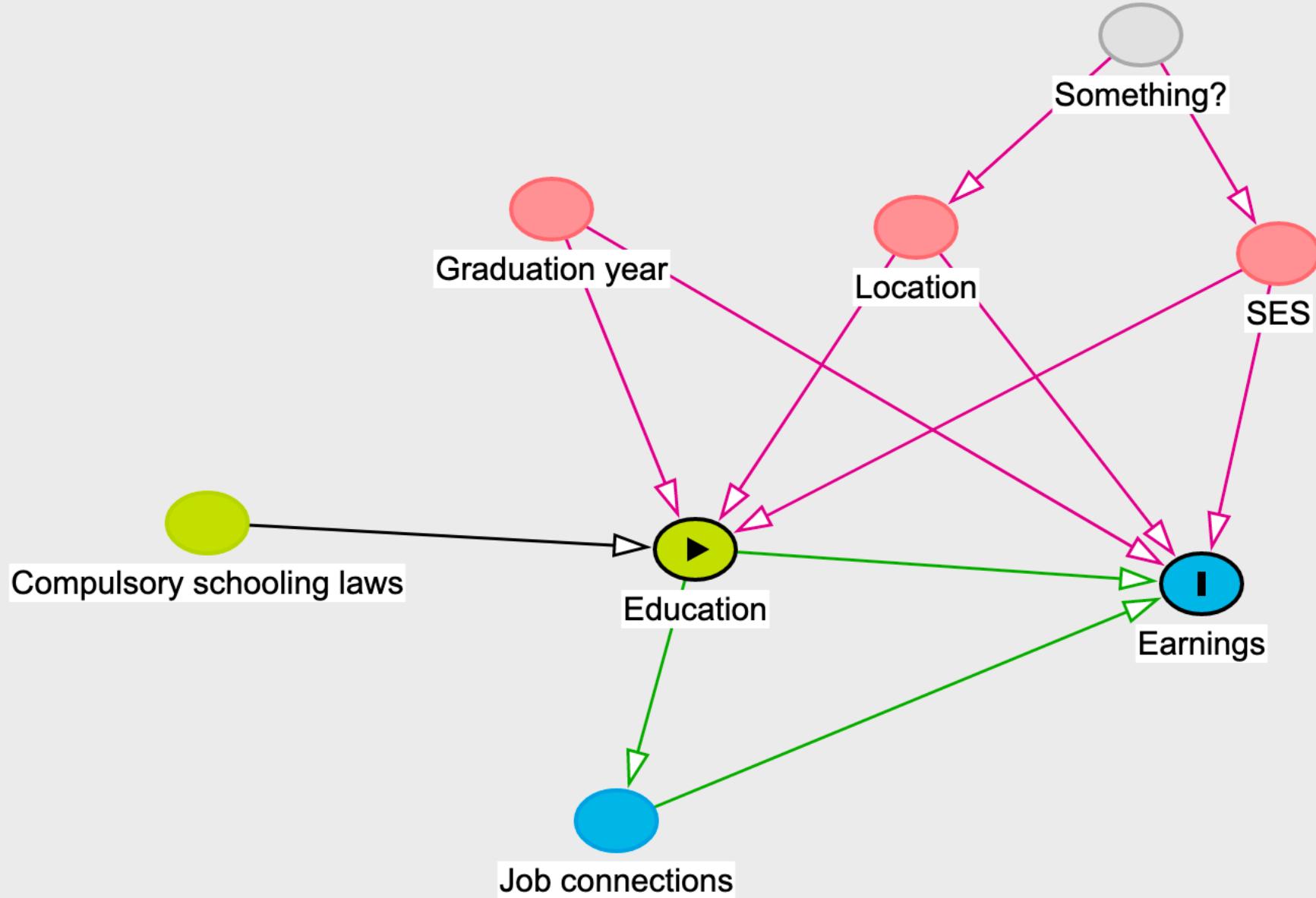
Graphical model of the process  
that generates the data

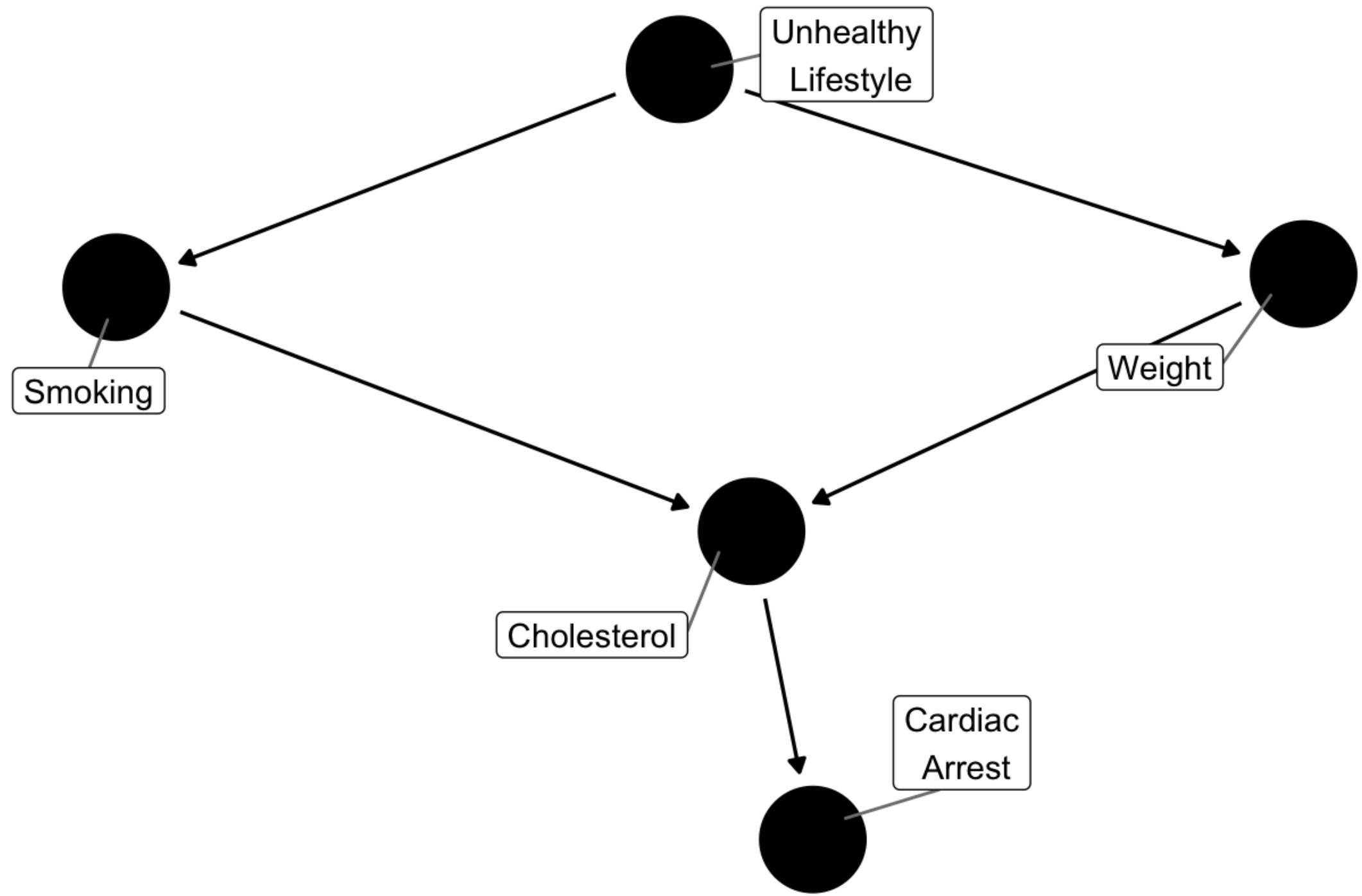
Maps your philosophical model

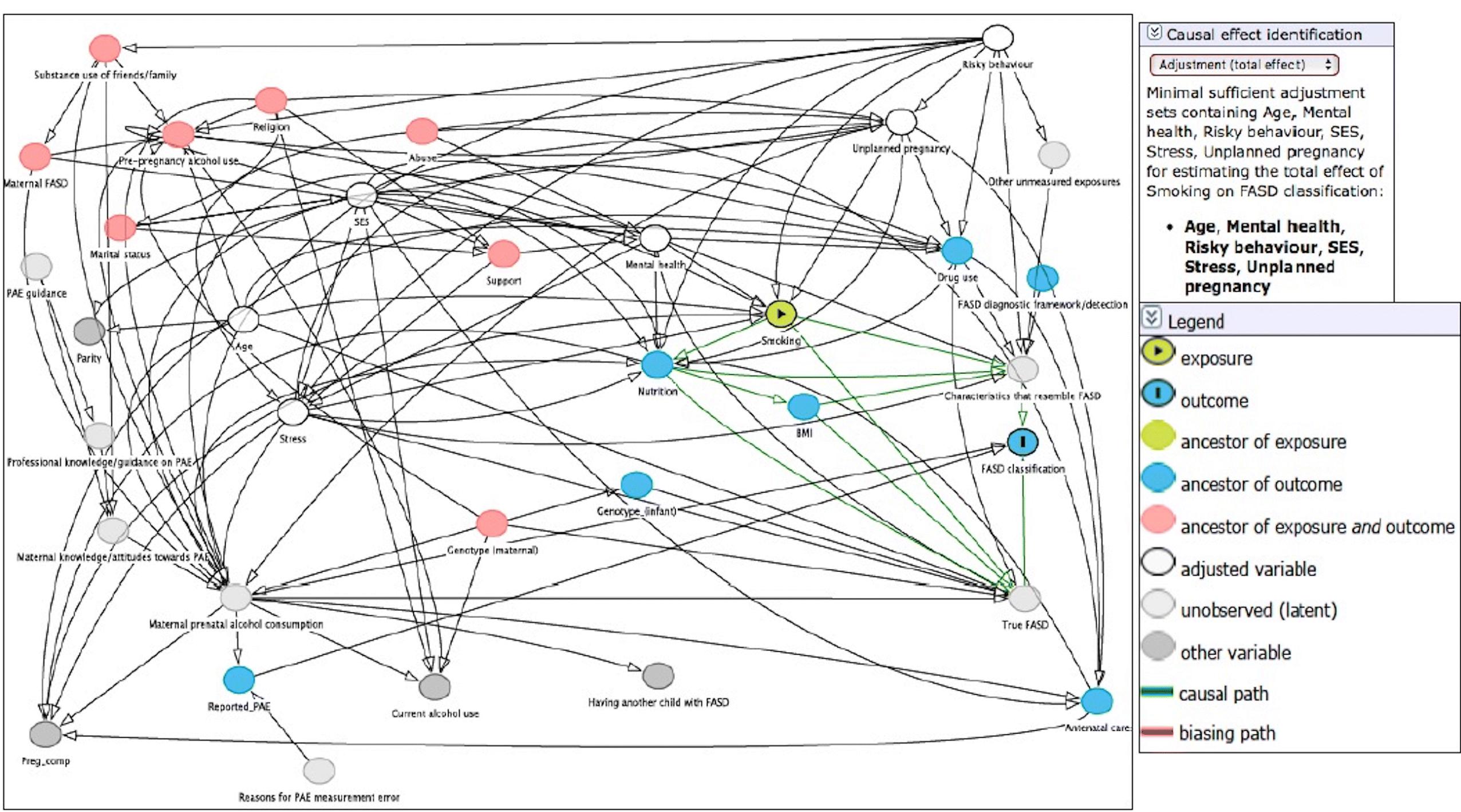
Fancy math (“do-calculus”)  
tells you what to control for to  
find causation













NYT Health  
@NYTHealth

Want to live longer? Try going to the opera. Researchers in Britain have found that people who reported going to a museum or concert even once a year lived longer than those who didn't.



Another Benefit to Going to Museums? You May Live Longer

Researchers in Britain found that people who go to museums, the theater and the opera were less likely to die in the study period than those who didn't.

[nytimes.com](http://nytimes.com)

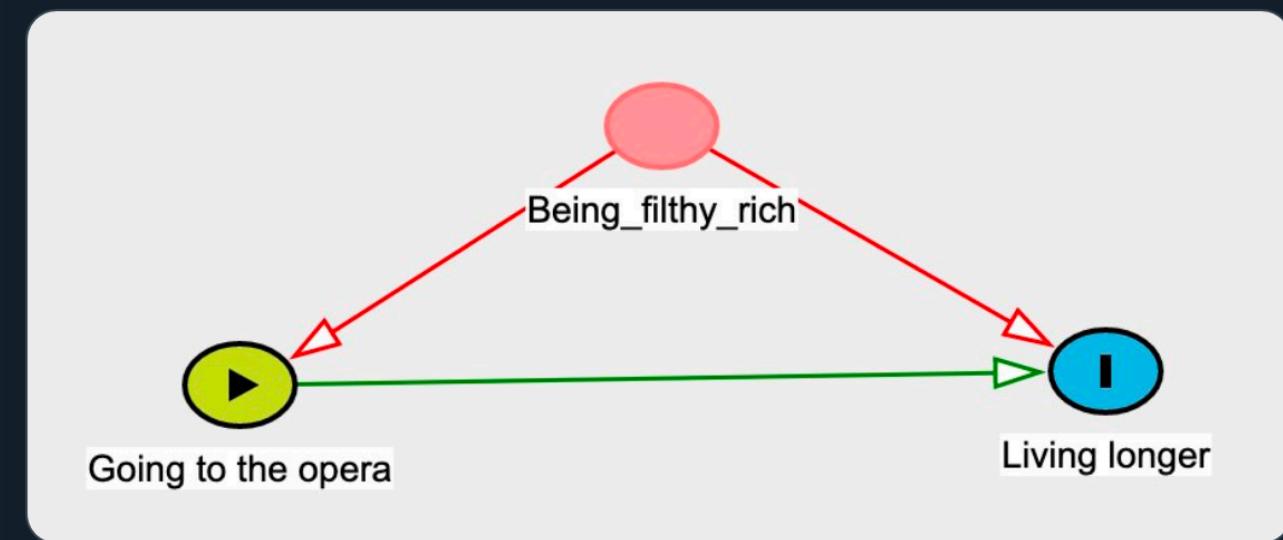
9:19 AM · Dec 22, 2019 · SocialFlow

336 Retweets 1.3K Likes



Andrew Heiss  
@andrewheiss

ooh ooh i can draw the dag for this one!



NYT Health @NYTHealth · Dec 22, 2019

Want to live longer? Try going to the opera. Researchers in Britain have found that people who reported going to a museum or concert even once a year lived longer than those who didn't. [nyti.ms/2Q9AmZV](http://nyti.ms/2Q9AmZV)

2:47 PM · Dec 22, 2019 · Twitter Web App

View Tweet activity

837 Retweets 3.9K Likes

# Break

Set up an RStudio.cloud account if you haven't

Go to <https://andhs.co/rstudio>  
to join the class workspace

Ask me anything!

# Class details

## Evaluation and causation

Program theories

Logic models   Measurement

DAGs   Potential outcomes

## Tools and methods

Randomization   Matching

Difference-in-differences

Regression discontinuity

Instrumental variables

## Applied evaluation

Preregistration   Ethics

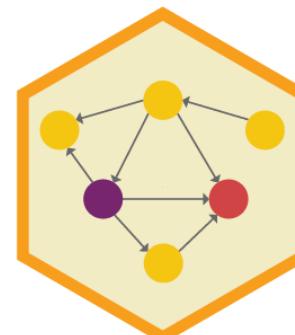
Communication

Other evaluations

## R and the tidyverse

Data manipulation   Modeling

R Markdown   Visualization

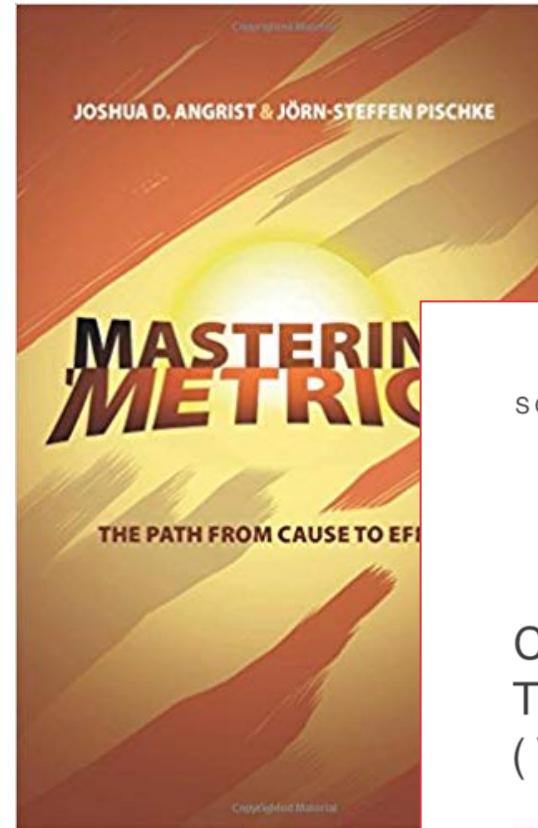


# Program Evaluation for Public Service

# Impact Evaluation in Practice

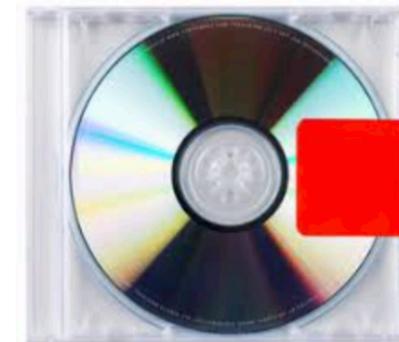
SECOND EDITION

Paul J. Gertler, Sebastian Martinez,  
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and Christel M. J. Vermeersch



SCOTT CUNNINGHAM

CAUSAL INFERENCE:  
THE MIXTAPE  
(V. 1.7)





**Stage 1:** Regress each column of  $\mathbf{X}$  on  $\mathbf{Z}$ , ( $X = Z\delta + \text{errors}$ ):

$$\hat{\delta} = (Z^T Z)^{-1} Z^T X,$$

and save the predicted values:

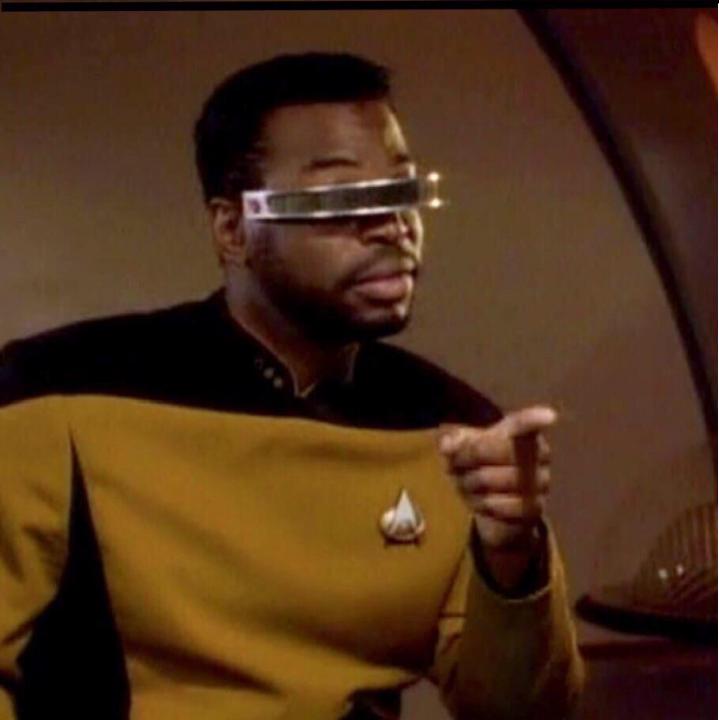
$$\widehat{X} = Z\hat{\delta} = Z(Z^T Z)^{-1} Z^T X = P_Z X.$$

**Stage 2:** Regress  $\mathbf{Y}$  on the predicted values from the first stage:

$$Y = \widehat{X}\beta + \text{noise},$$

which gives

$$\beta_{2SLS} = (X^T P_Z X)^{-1} X^T P_Z Y.$$



```
model_2sls <- iv_robust(  
  health ~ bed_net | treatment,  
  data = bed_nets)
```

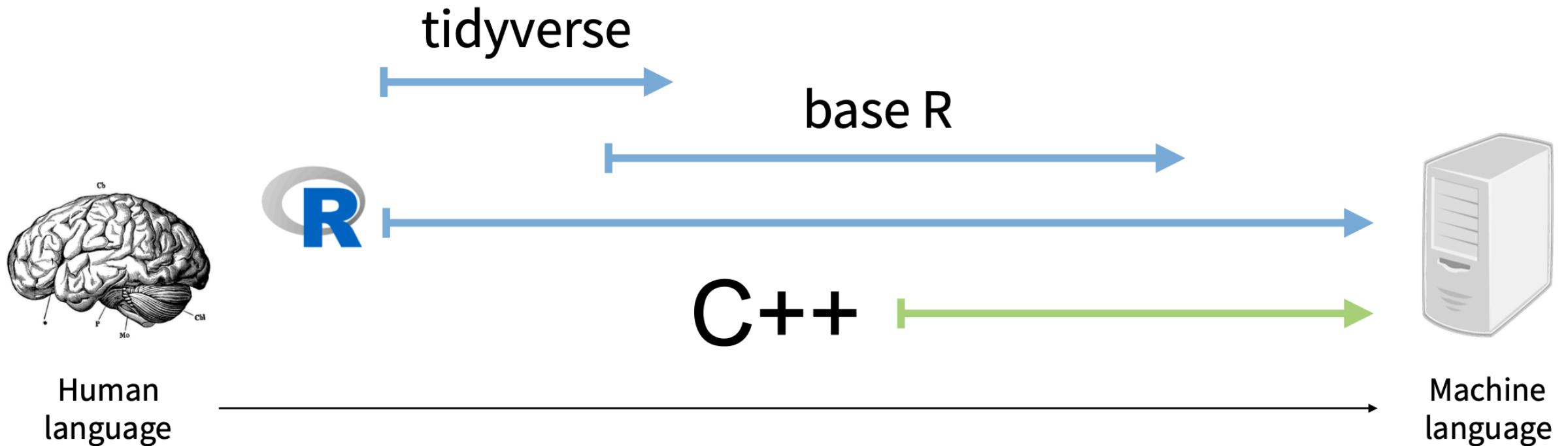
# Class technology



# The tidyverse



# The tidyverse



# R code, but reads like English!

```
strike_damages_month <- bird_strikes %>%
  group_by(Month) %>%
  summarize(total_damages = sum(Cost, na.rm = TRUE),
            average_damages = mean(Cost, na.rm = TRUE))

ggplot(data = strike_damages_month,
        mapping = aes(x = Month, y = total_damages)) +
  geom_col() +
  scale_y_continuous(labels = dollar) +
  labs(x = "Month",
       y = "Total damages",
       title = "Really expensive collisions happen in the fall?",
       subtitle = "Don't fly in August or October?",
       source = "Source: FAA Wildlife Strike Database")
```

# Sucking

There is no way to go from knowing nothing about a subject to knowing something about a subject without going through a period of much frustration and suckiness

**Push through. You'll suck less.**

Hadley Wickham, author of ggplot2 and the tidyverse

# Sucking



Dude, sucking at something is the first step towards being sort of good at something

The New York Times

Opinion

SPORTING

## (It's Great to) Suck at Something

By Karen Rinaldi

April 28, 2017



# Am I making you computer scientists?

No!

You don't need to be a mechanic  
to drive a car safely

You don't need to be a computer  
scientist or developer to use R safely

# Learning R



**Jesse Maegan**

@kierisi

Following



My **#rstats** learning path:

1. Install R
2. Install RStudio
3. Google "How do I [THING I WANT TO DO] in R?"

Repeat step 3 ad infinitum.

7:19 AM - 18 Aug 2017

You can do this.

# Goals for the class

**Become an expert with R**

**Speak and do causation**

**Design rigorous evaluations**

**Change the world with data**

# Prerequisites

**Math skills**

Basic algebra

**Computer science skills**

None

**Statistical skills**

Regression and differences in means

(ideally; you can survive without it, though)

# Miscellanea



# Class expectations

Late work

Technology

Participation

Other?

# Getting staRted!

[andhs.co/survey](http://andhs.co/survey)