

# Evaluation and the causal revolution

**Session 1**

PMAP 8521: Program evaluation  
Andrew Young School of Policy Studies

# Plan for today

Data science and public service

Evidence, evaluation, and causation

Class details

# Data science and public service

# Data and government



THE U. S. DIGITAL SERVICE



DJ Patil

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

**The White House**

Office of the Press Secretary

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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." -*

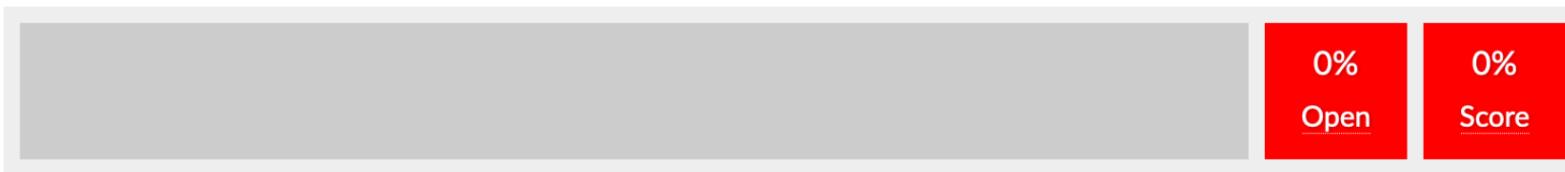
President Barack Obama, July 14, 2015



## U.S. CITY OPEN DATA CENSUS

POWERED BY OPEN DATA CENSUS

Rank	Place	Budget	Crime Reports	Parcels	Construction Permits	Zoning	Service Request	Code Violations	Employee Salaries	Business Listings	Spending	Restaurant Inspections	Public Facilities	Traffic Crashes	Property Assessment	Procurement Contracts	Emergency Calls	Lobbyist Activity	Police Use-of-Force	Website Analytics	Property Transfers	Score
1	Cincinnati, OH	<div style="width: 94%;"></div>	<div style="width: 94%;"></div>	<div style="width: 94%;"><span>1</span></div>	<div style="width: 94%;"></div>	<div style="width: 94%;"></div>	<div style="width: 94%;"></div>	<div style="width: 94%;"></div>	<div style="width: 94%;"><span>+ Add</span></div>	<div style="width: 94%;"></div>	<div style="width: 94%;"></div>	<div style="width: 94%;"></div>	<div style="width: 94%;"></div>	<div style="width: 94%;"></div>	<div style="width: 94%;"></div>	<div style="width: 94%;"></div>	<div style="width: 94%;"></div>	<div style="width: 94%;"></div>	<div style="width: 94%;"></div>	<div style="width: 94%;"></div>	94%	
2	Las Vegas, NV	<div style="width: 89%;"></div>	<div style="width: 89%;"></div>	<div style="width: 89%;"></div>	<div style="width: 89%;"></div>	<div style="width: 89%;"></div>	<div style="width: 89%;"><span>+ Add</span></div>	<div style="width: 89%;"></div>	<div style="width: 89%;"></div>	<div style="width: 89%;"></div>	<div style="width: 89%;"></div>	<div style="width: 89%;"></div>	<div style="width: 89%;"></div>	<div style="width: 89%;"></div>	<div style="width: 89%;"></div>	<div style="width: 89%;"><span>+ Add</span></div>	<div style="width: 89%;"></div>	<div style="width: 89%;"></div>	<div style="width: 89%;"><span>+ Add</span></div>	<div style="width: 89%;"></div>	89%	
3	San Francisco, CA	<div style="width: 85%;"></div>	<div style="width: 85%;"></div>	<div style="width: 85%;"></div>	<div style="width: 85%;"></div>	<div style="width: 85%;"></div>	<div style="width: 85%;"></div>	<div style="width: 85%;"></div>	<div style="width: 85%;"></div>	<div style="width: 85%;"></div>	<div style="width: 85%;"></div>	<div style="width: 85%;"></div>	<div style="width: 85%;"></div>	<div style="width: 85%;"></div>	<div style="width: 85%;"></div>	<div style="width: 85%;"><span>+ Add</span></div>	<div style="width: 85%;"></div>	<div style="width: 85%;"></div>	<div style="width: 85%;"></div>	<div style="width: 85%;"></div>	85%	
4	Virginia Beach, VA	<div style="width: 79%;"></div>	<div style="width: 79%;"></div>	<div style="width: 79%;"></div>	<div style="width: 79%;"></div>	<div style="width: 79%;"></div>	<div style="width: 79%;"><span>+ Add</span></div>	<div style="width: 79%;"></div>	<div style="width: 79%;"></div>	<div style="width: 79%;"></div>	<div style="width: 79%;"></div>	<div style="width: 79%;"></div>	<div style="width: 79%;"></div>	<div style="width: 79%;"></div>	<div style="width: 79%;"><span>+ Add</span></div>	<div style="width: 79%;"></div>	<div style="width: 79%;"></div>	<div style="width: 79%;"></div>	<div style="width: 79%;"></div>	<div style="width: 79%;"></div>	79%	
5	Baton Rouge/E.B.R. Parish, LA	<div style="width: 78%;"></div>	<div style="width: 78%;"></div>	<div style="width: 78%;"></div>	<div style="width: 78%;"></div>	<div style="width: 78%;"></div>	<div style="width: 78%;"><span>+ Add</span></div>	<div style="width: 78%;"></div>	<div style="width: 78%;"><span>+ Add</span></div>	<div style="width: 78%;"></div>	<div style="width: 78%;"><span>+ Add</span></div>	<div style="width: 78%;"></div>	<div style="width: 78%;"></div>	<div style="width: 78%;"></div>	<div style="width: 78%;"><span>+ Add</span></div>	<div style="width: 78%;"></div>	<div style="width: 78%;"><span>+ Add</span></div>	<div style="width: 78%;"></div>	<div style="width: 78%;"><span>+ Add</span></div>	<div style="width: 78%;"><span>+ Add</span></div>	78%	



## 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  Search

Salt Lake City Police Department [moto.data.socrata.com](http://moto.data.socrata.com)  
Updated Aug 26, 2018

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

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

Salt Lake City Police Department [moto.data.socrata.com](http://moto.data.socrata.com)  
254 scholarly articles cite this dataset ([View in Google Scholar](#))

Dataset created Dec 2, 2015  
Dataset updated Aug 26, 2018  
Dataset published Dec 2, 2015

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?**

Analyze it and  
uncover insights!

(and take this class!)

# What is "statistics"?

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

# What is "data science"?

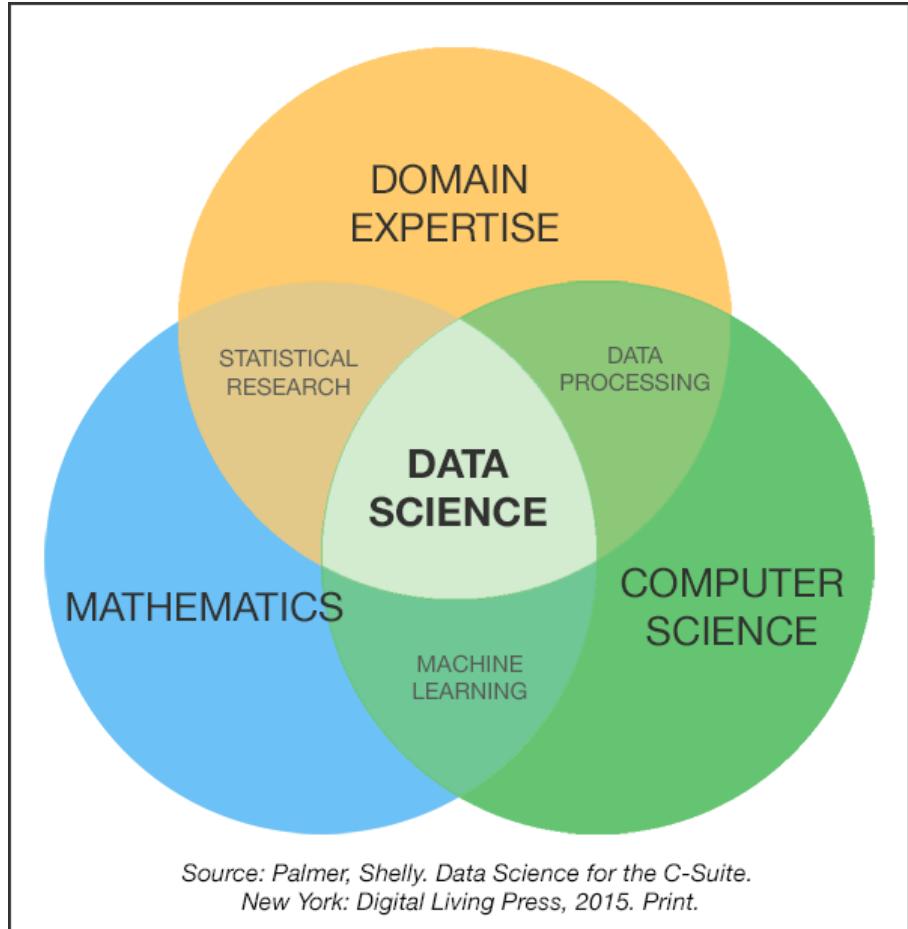
Turning raw data into  
understanding, insight,  
and knowledge

Collect

Analyze

Communicate

# What's the difference?



Collect

Analyze

Communicate

# What is "program evaluation"?

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

**Data science**  
(data + statistics +  
communication)

**Causal inference**  
(DAGs + econometrics)

# Evidence, evaluation, and causation

# Evidence-based medicine



# Modern evidence-based medicine

Apply evidence to clinical  
treatment decisions

Move away from clinical judgment  
and "craft knowledge"

Is this good?

# 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

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(•ㅅ•) ||  
/ づ

#HistorianSignBunny #Epidemiology

10:13 PM - 12 Jul 2018

200 Retweets 612 Likes



29

200

612



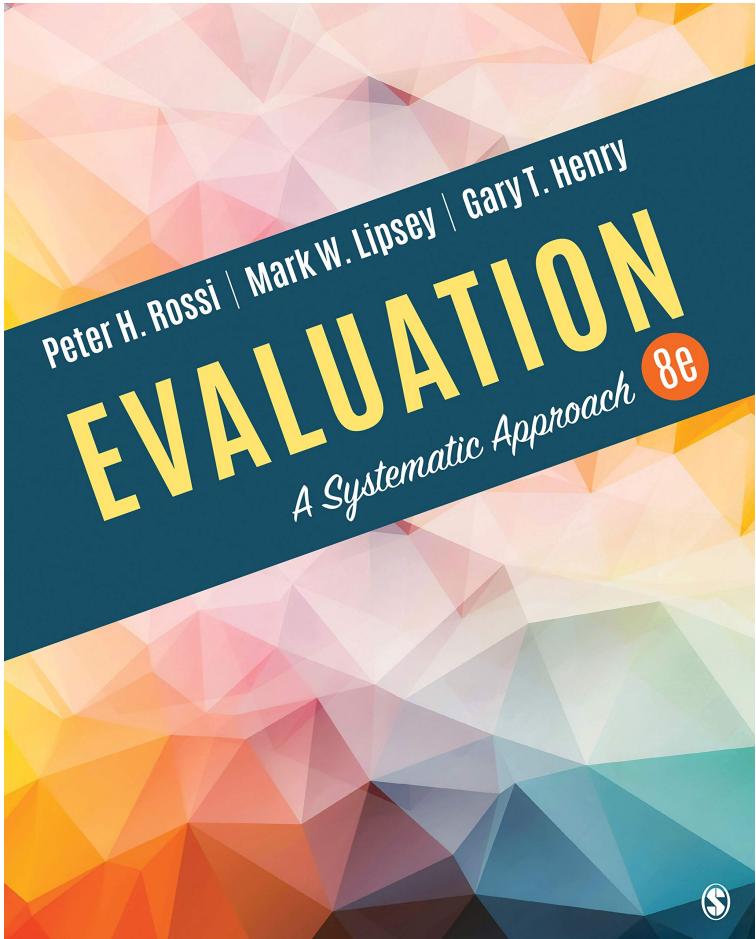
PLEASE BE  
PREPARED TO  
SHOW I.D.

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



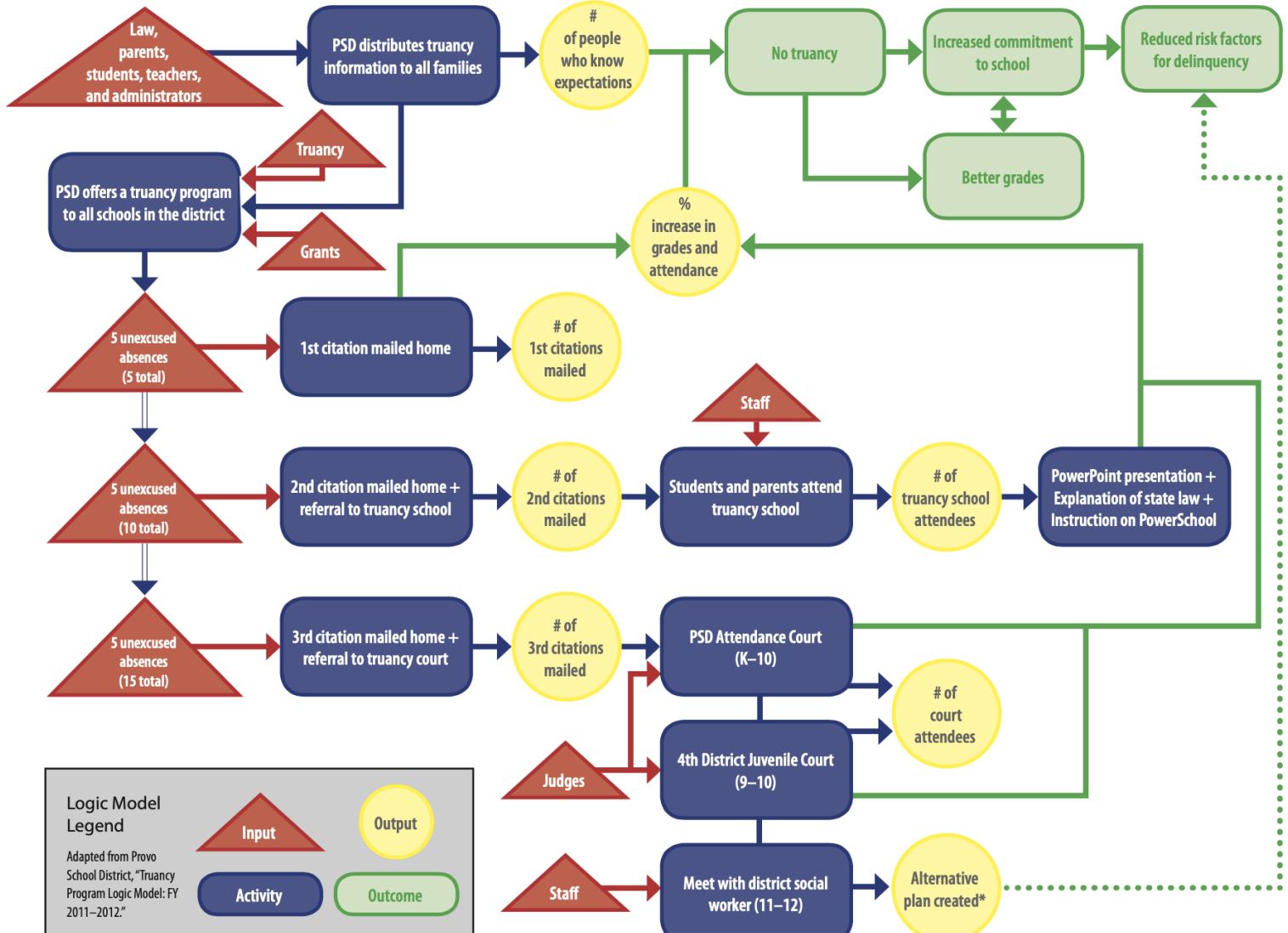
Needs assessment

Design and theory assessment

Process evaluation and monitoring

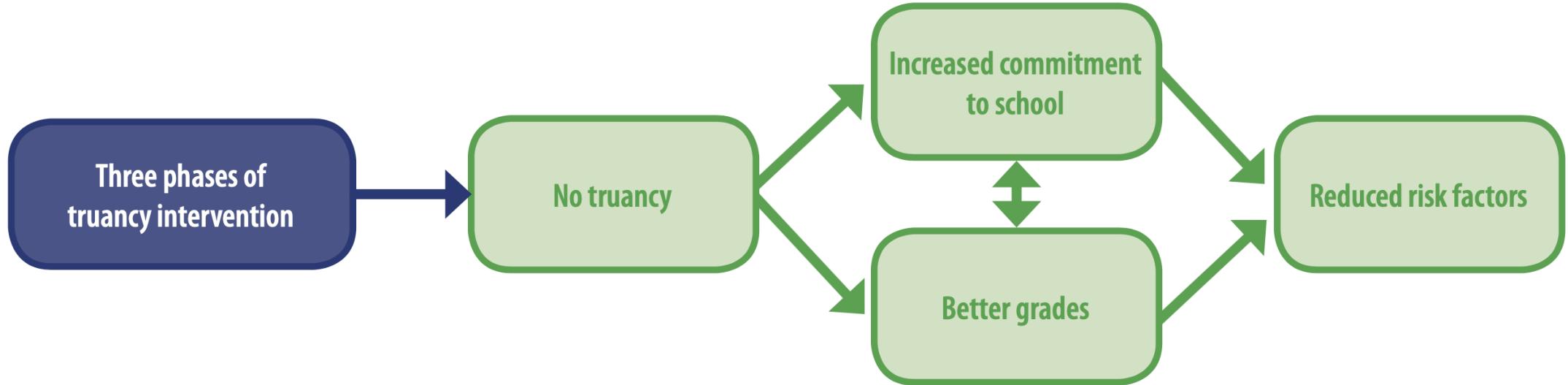
Impact evaluation

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

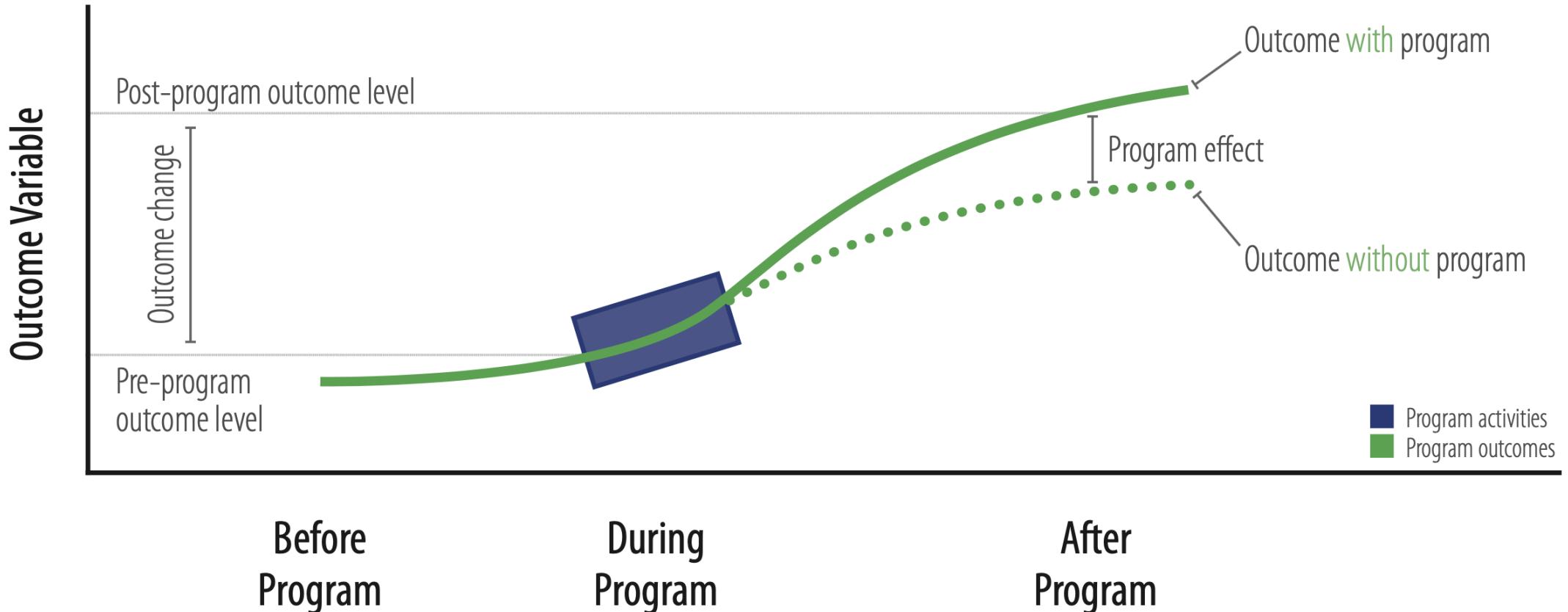
Paul J. Gertler, Sebastian Martinez,  
Patrick Premand, Laura B. Rawlings,  
and Christel M. J. Vermeersch

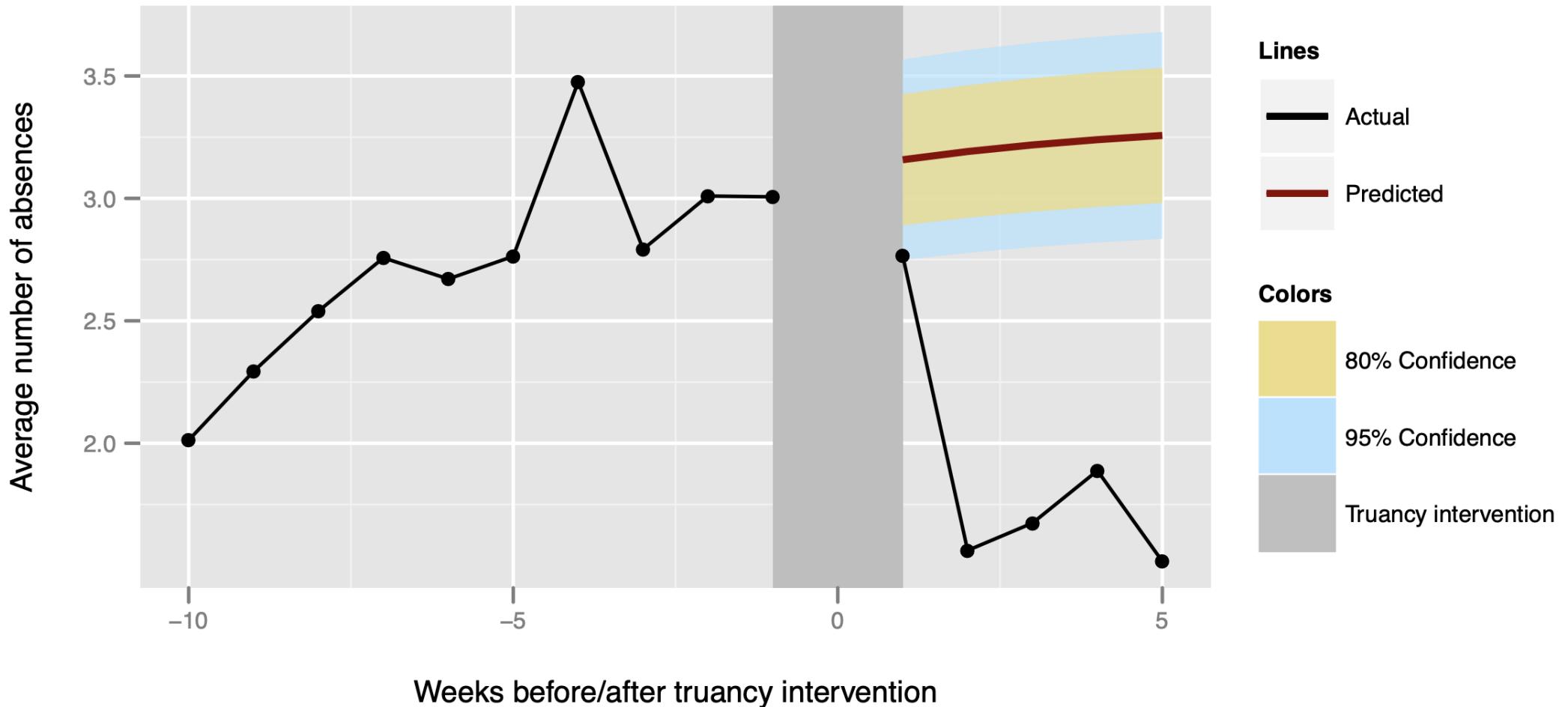


WORLD BANK GROUP



# Theory → impact





# 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 originally

# 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**

# The Internet Blowhard's Favorite Phrase

Why do people love to say that correlation does not imply causation?

By DANIEL ENGBER

OCT 02, 2012 • 8:33 AM

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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?

How do we figure  
out causation?

# Correlation vs. causation

How do we figure  
out correlation?

Math and statistics

How do we figure  
out causation?

# 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 does 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

"A variable **X** is a cause of a variable **Y** if **Y** in any way relies on **X** for its value.... **X** is a cause of **Y** if **Y** listens to **X** and decides its value in response to what it hears"

(Pearl, Glymour, and Jewell 2016, 5–6)

Y doesn't necessarily listen only to X

A light switch causes a light to go on, but not if the 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 cause the sunrise**

**Getting an MPA/MPP increases your earnings**

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

# Causation

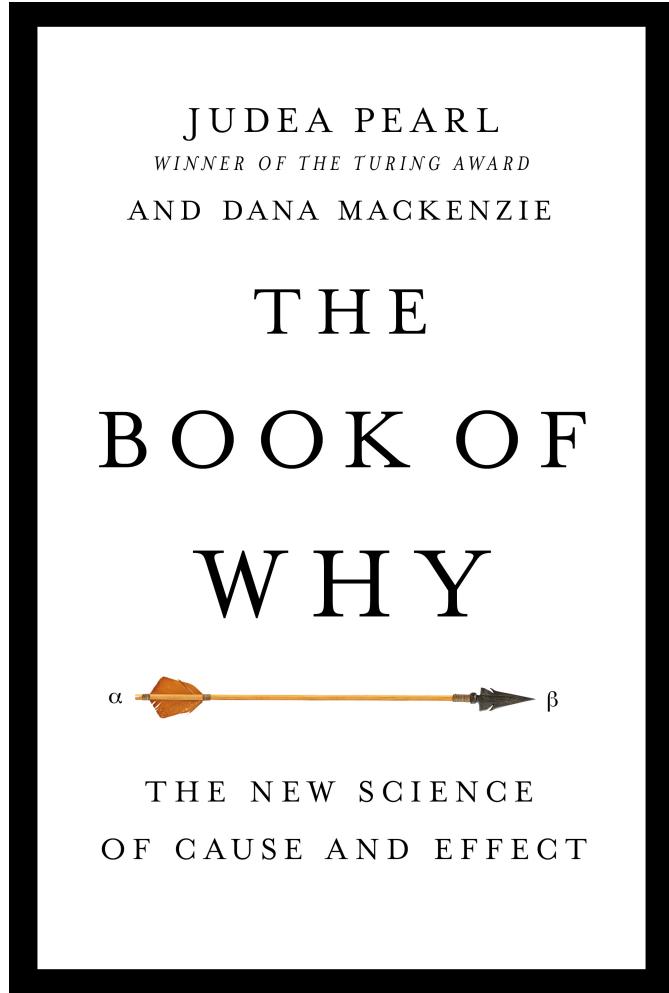
**Causation =  
Correlation + time order +  
nonspuriousness**

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

**You need a philosophical model**

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

# The causal revolution



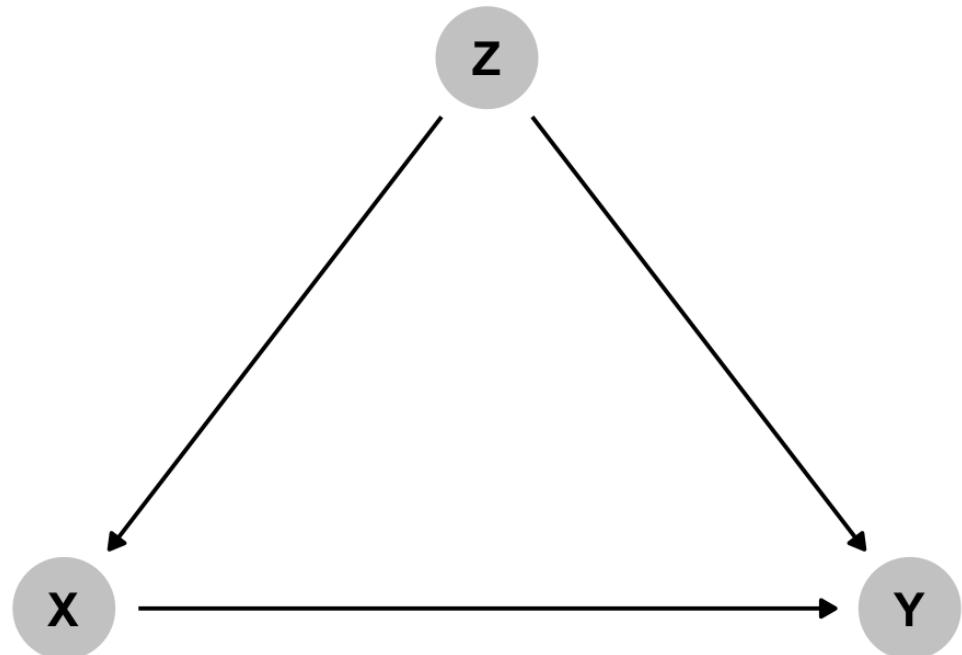
# Causal diagrams

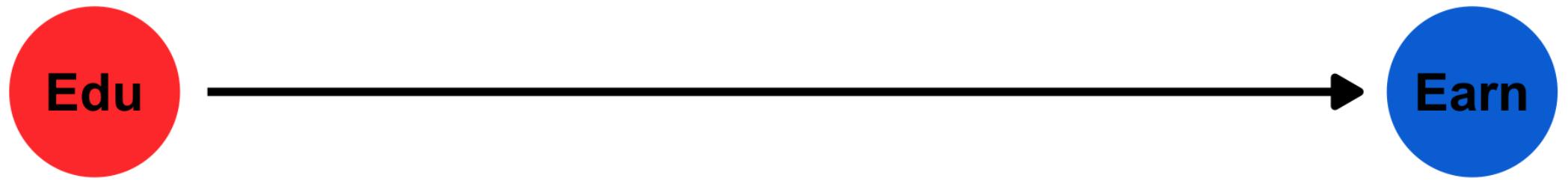
## Directed acyclic graphs (DAGs)

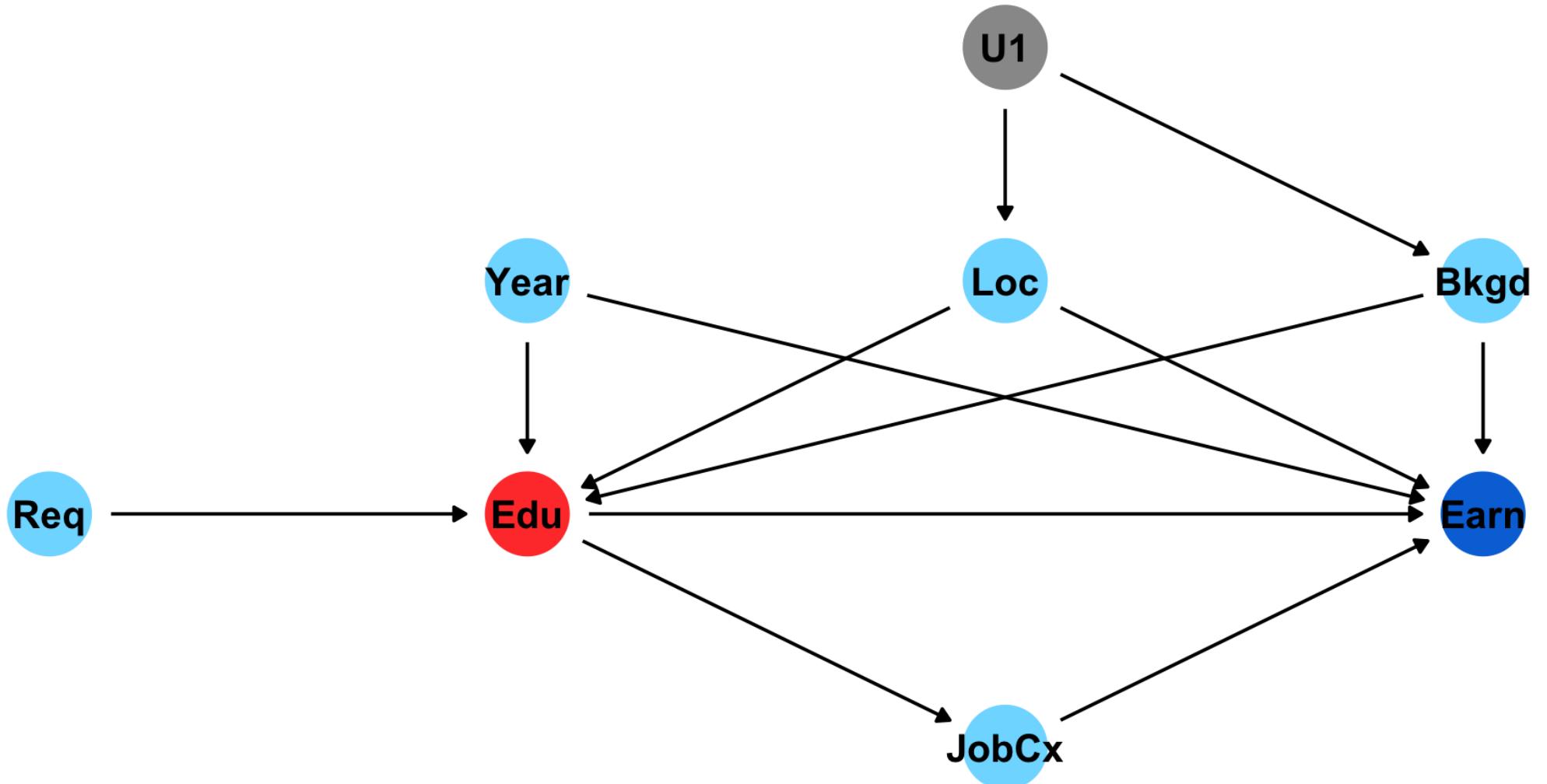
Graphical model of the process  
that generates the data

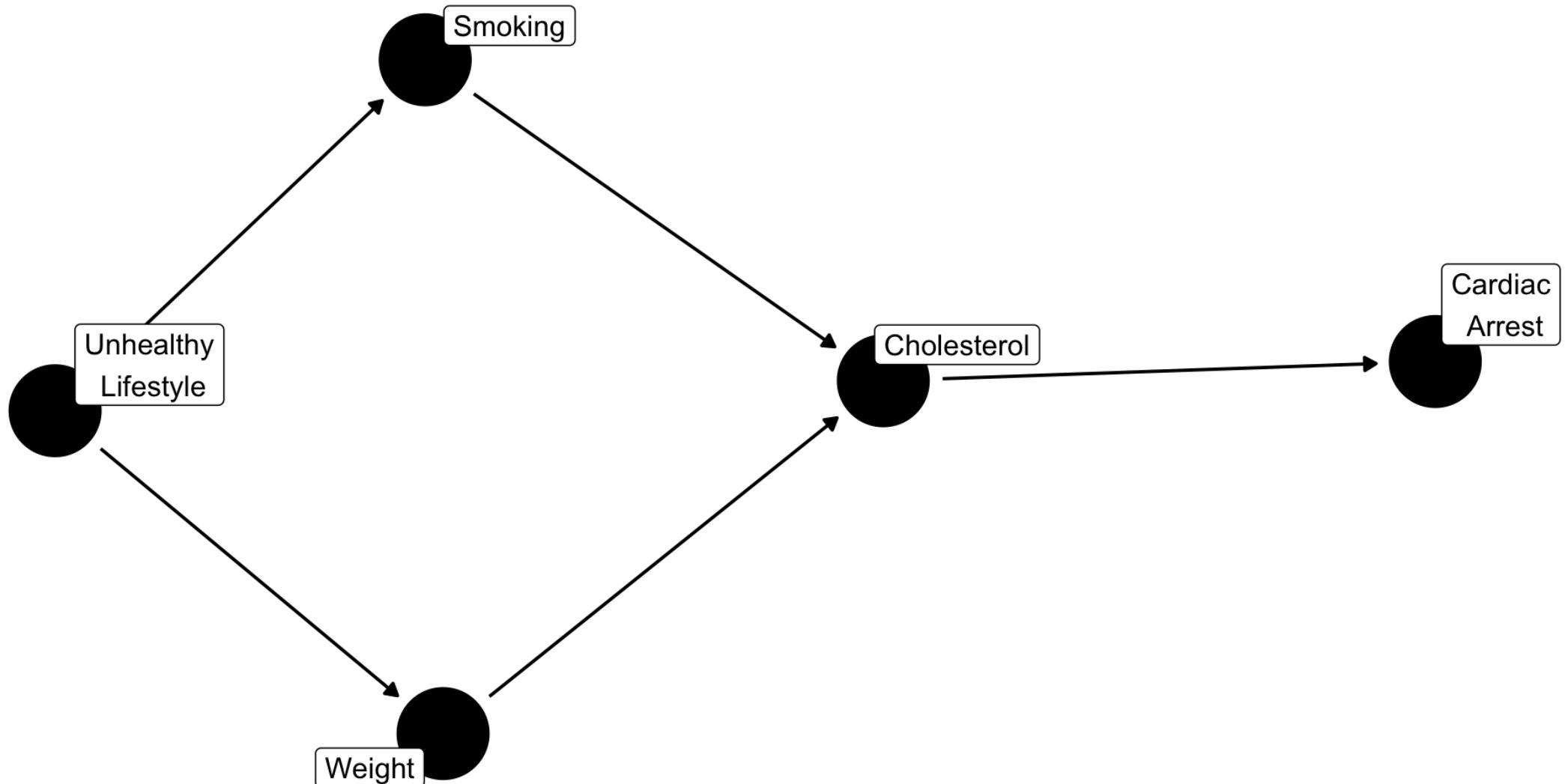
Maps your philosophical model

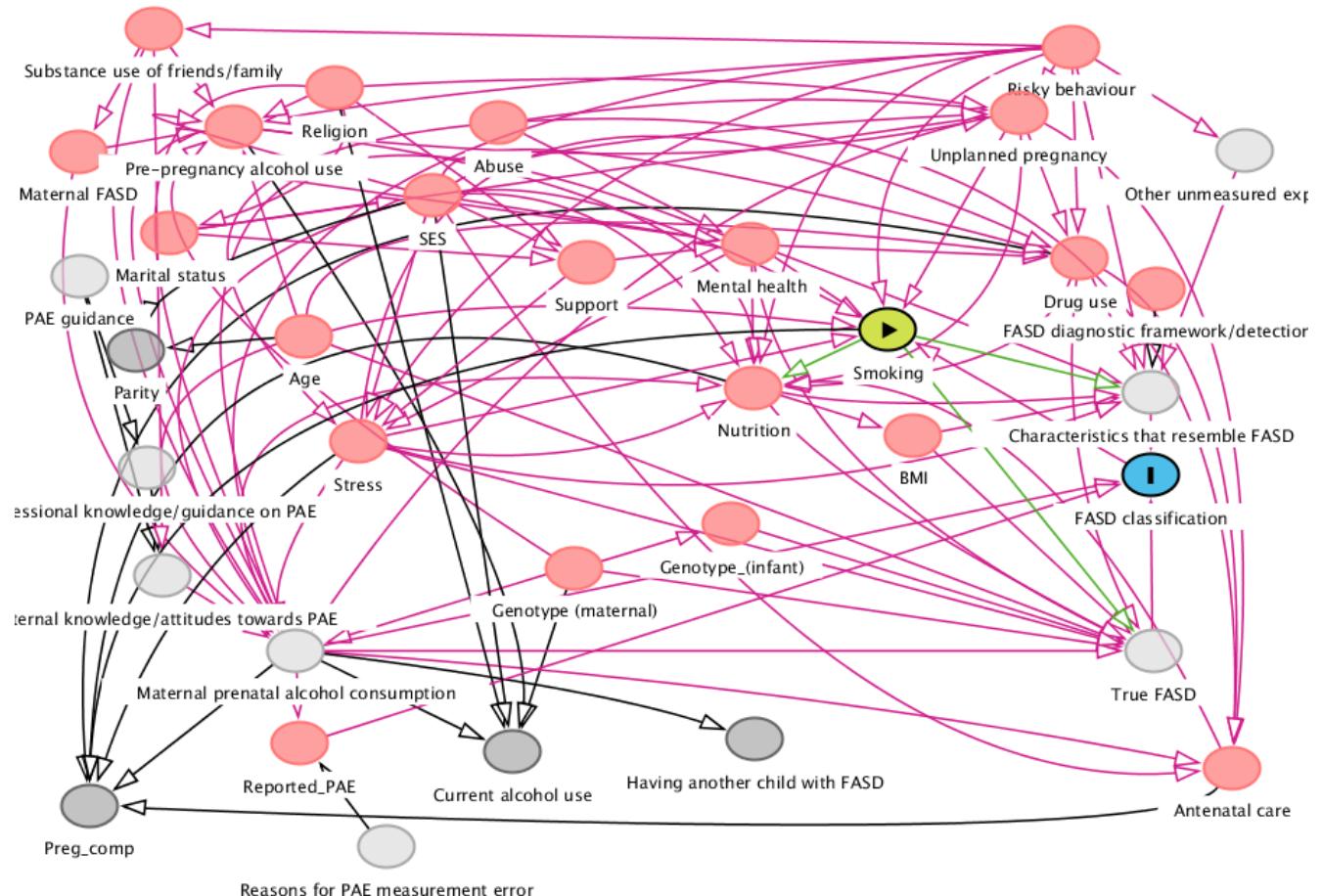
Fancy math ("*do-calculus*") tells  
you what to control for to isolate  
and identify causation







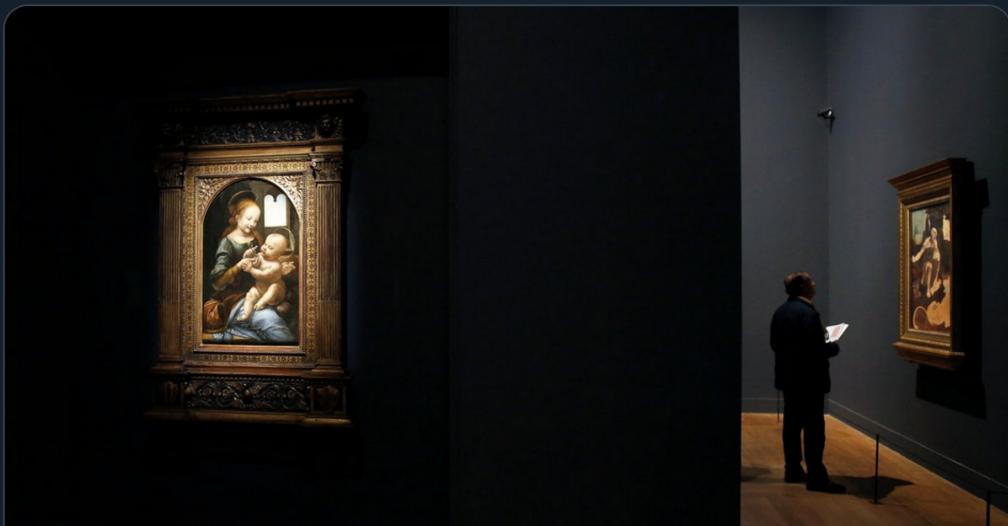




## Effect of smoking on fetal alcohol syndrome



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](https://nytimes.com)

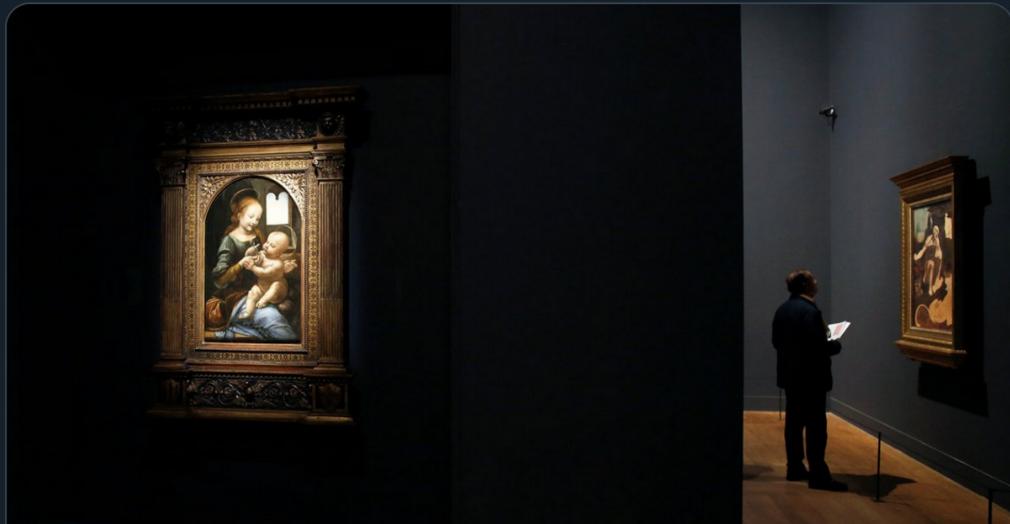
9:19 AM · Dec 22, 2019 · SocialFlow

336 Retweets 1.3K Likes





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.



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

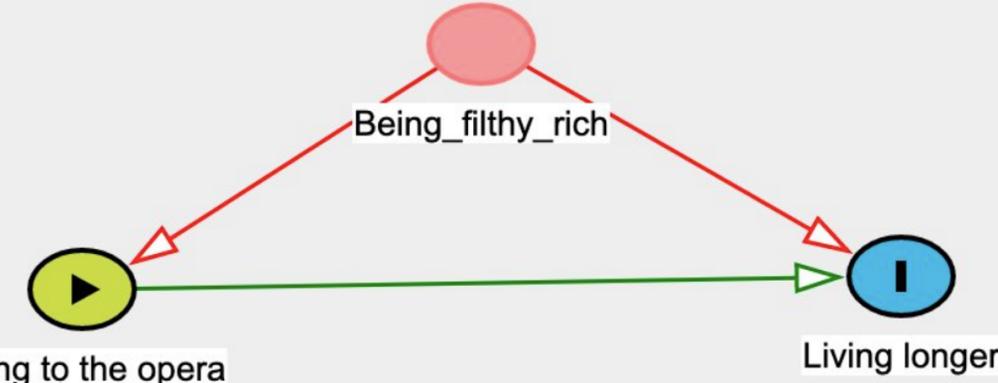
9:19 AM · Dec 22, 2019 · SocialFlow

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)

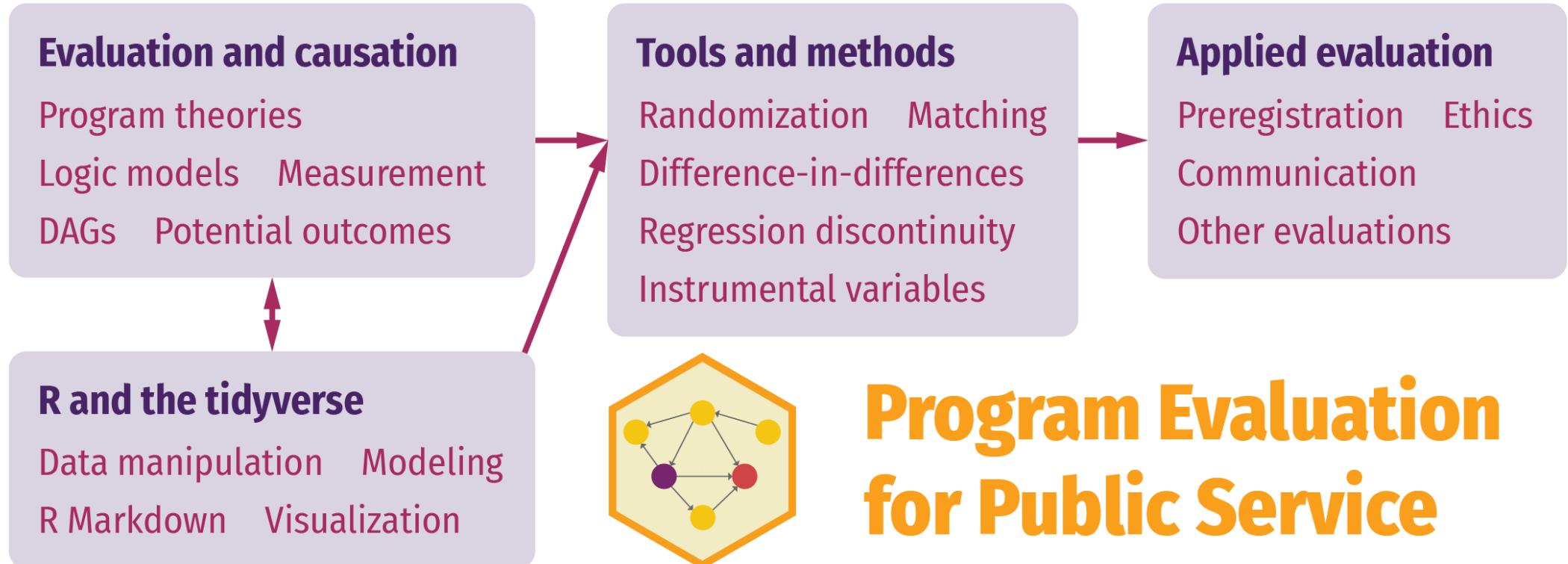
2:47 PM · Dec 22, 2019 · Twitter Web App

View Tweet activity

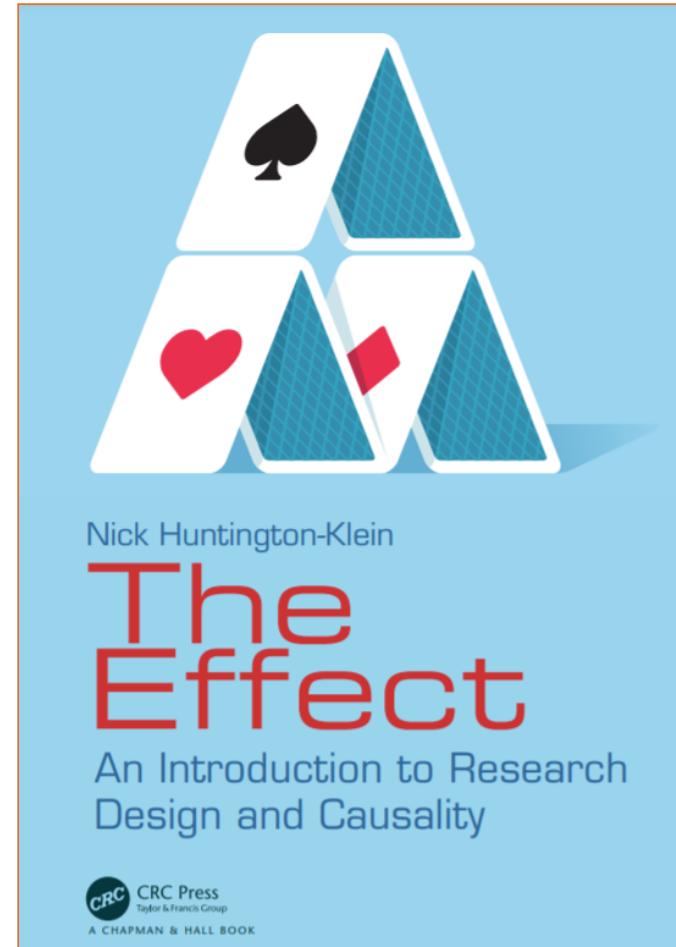
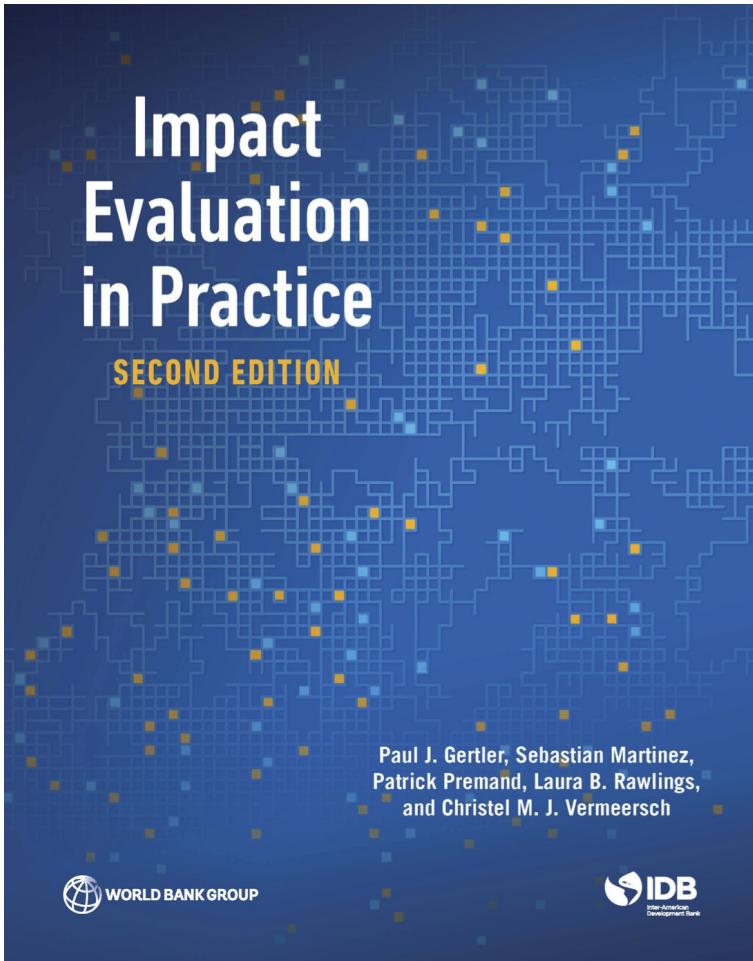
837 Retweets 3.9K Likes

# Class details

# Plan for the class



# Textbooks





**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:

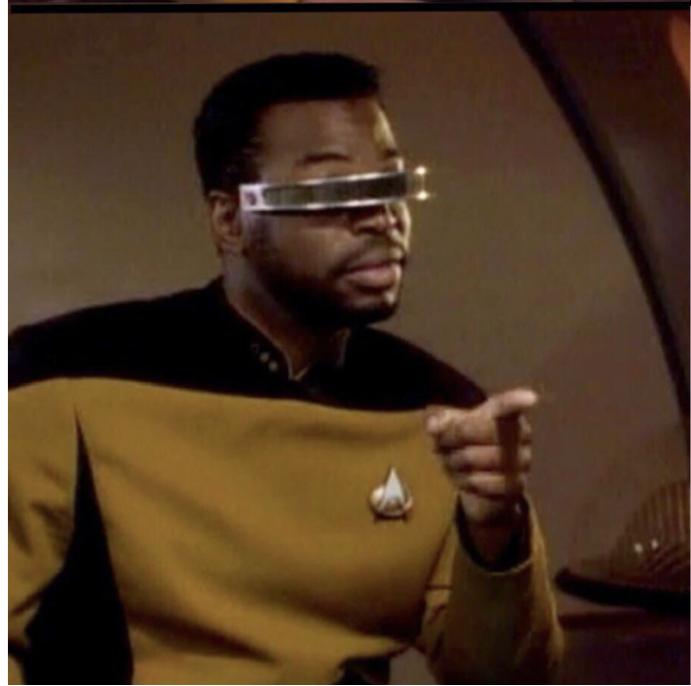
$$\widehat{X} = Z\hat{\delta} = \mathbf{Z}(Z^T Z)^{-1} Z^T X = \mathbf{P}_Z X.$$

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

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

which gives

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

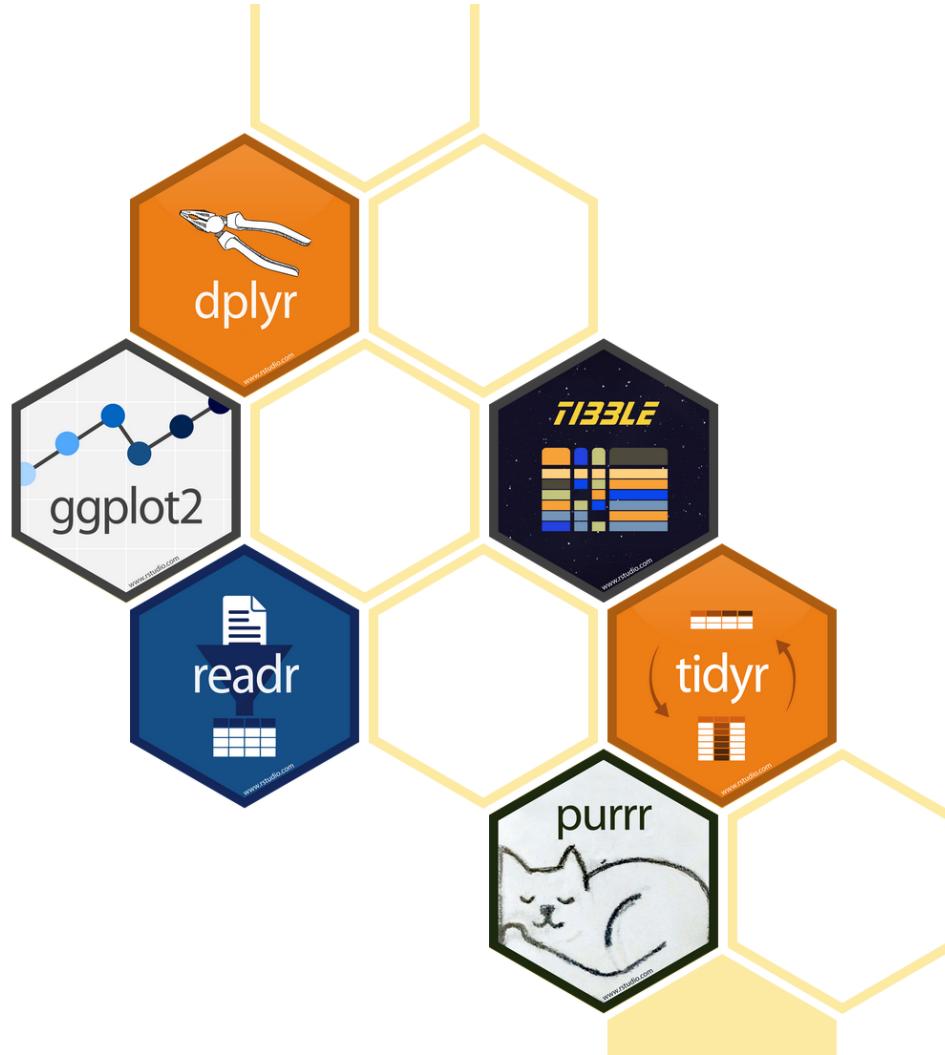


```
model_2sls <- iv_robust(  
  health ~ bed_net | treatment,  
  data = bed_nets)
```

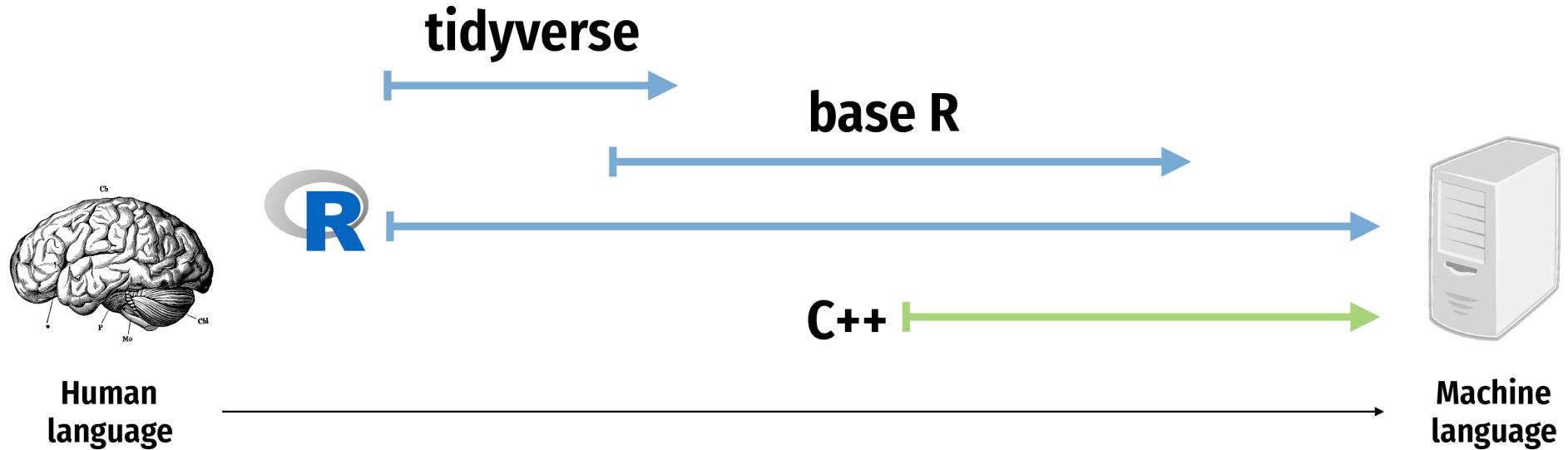
# Class technology



# 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?",
       caption = "Source: FAA Wildlife Strike Database")
```

# Sucking

**“There is no way of 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`

# Sucking



The New York Times

Opinion

SPORTING

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

By Karen Rinaldi

April 28, 2017



225

Karen Rinaldi, "(It's Great to) Suck at Something"

# 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, differences in means, and statistical significance