

# Evaluation and the causal revolution

## Session 1

PMP 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

POWERED BY OPEN DATA CENSUS																						
Rank	Place	Budget	Crime Reports	Parcels	Construction Permits	Zoning	Service Requests	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><div></div></div>	<div><div></div></div>	<div><div></div><div>1</div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div>+ Add</div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	94%
2	Las Vegas, NV	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div>+ Add</div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div>+ Add</div></div>	<div><div></div></div>	<div><div></div></div>	89%
3	San Francisco, CA	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div><div>1</div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div><div></div></div>	<div><div>+ Add</div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div><div></div></div>	<div><div></div><div></div></div>	<div><div></div></div>	85%
4	Virginia Beach, VA	<div><div></div></div>	<div><div></div></div>	<div><div></div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div>+ Add</div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div><div></div></div>	<div><div></div></div>	<div><div></div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div>+ Add</div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div><div></div></div>	<div><div></div><div></div></div>	<div><div></div></div>	79%
5	Baton Rouge/E.B.R. Parish, LA	<div><div></div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div>+ Add</div></div>	<div><div></div></div>	<div><div></div></div>	<div><div>+ Add</div></div>	<div><div></div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div><div></div></div>	<div><div></div></div>	<div><div>+ Add</div></div>	78%

0%  
Open

0%  
Score

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

Q salt lake city



Salt Lake City Police  
Department

[moto.data.socrata.com](http://moto.data.socrata.com)

Updated Aug 26, 2018

Salt Lake City Police Department

[moto.data.socrata.com](http://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](http://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](http://www.icpsr.umich.edu)  
[datamed.org](http://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?**

**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"?

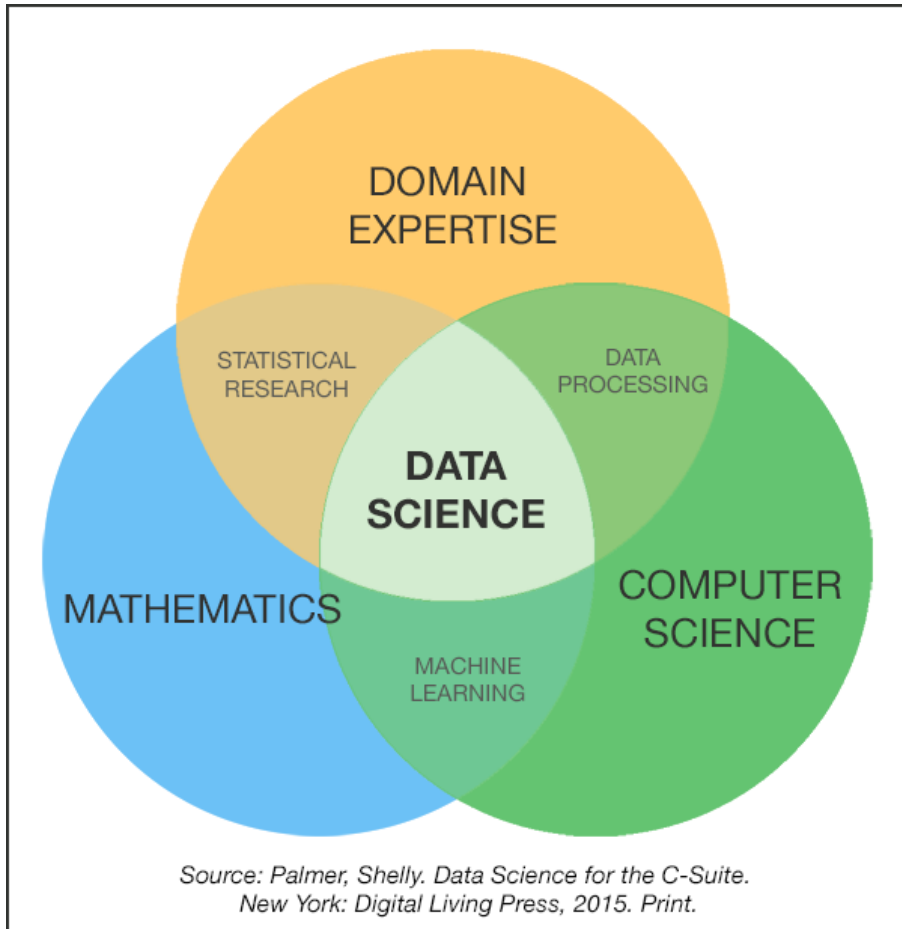
**Turning raw data into  
understanding, insight,  
and knowledge**

**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



#HistorianSignBunny #Epidemiology

10:13 PM - 12 Jul 2018

200 Retweets 612 Likes



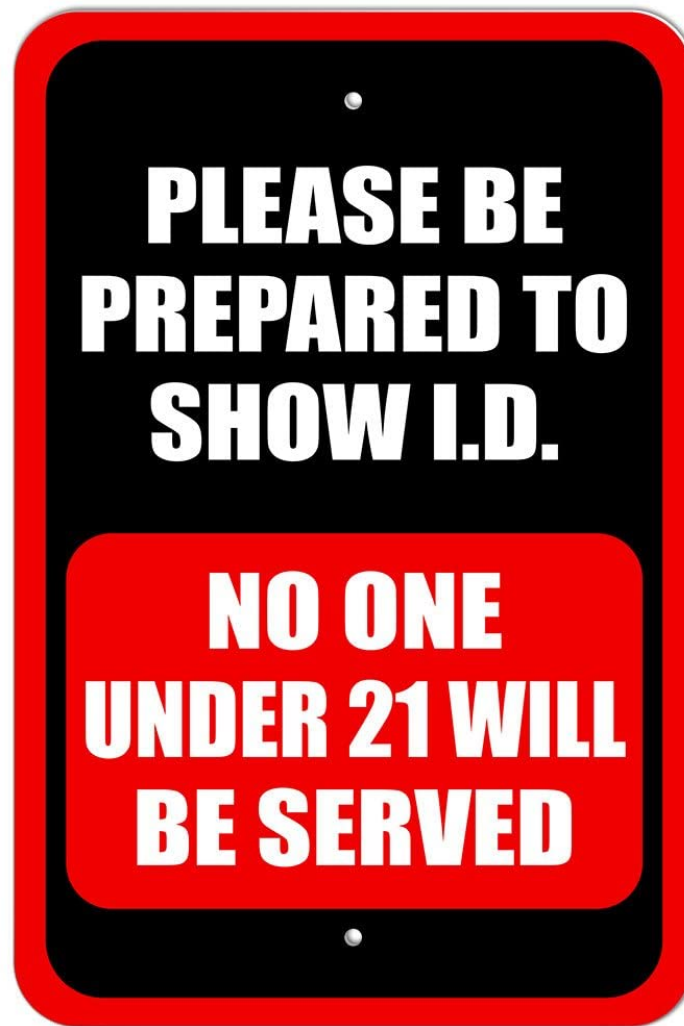
29



200



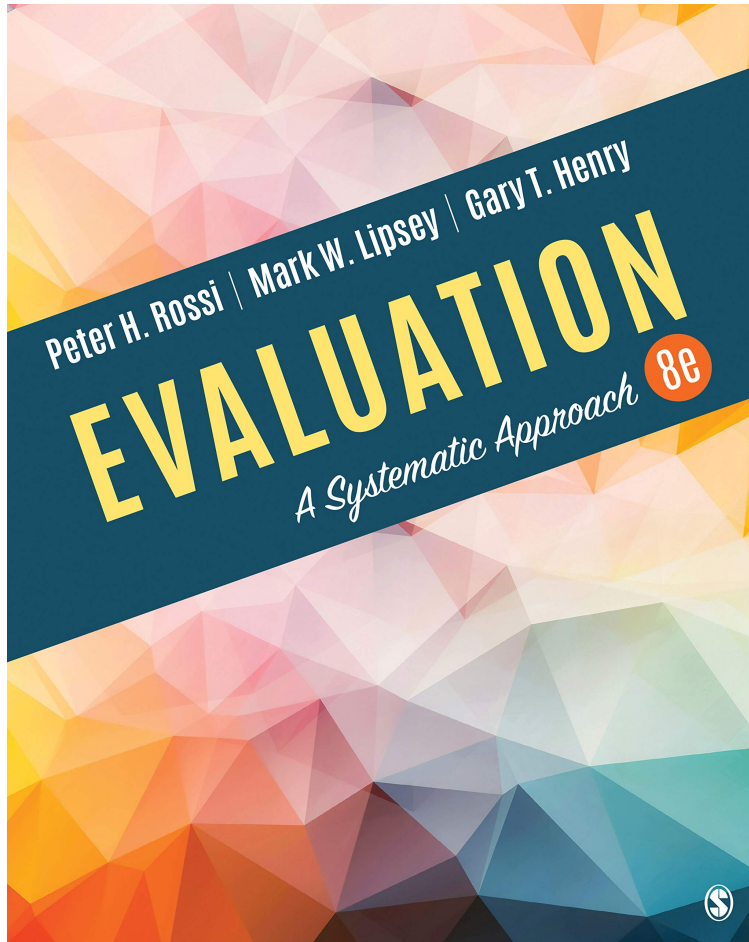
612



# Where does program evaluation fit with all this?

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

# Types of evaluation



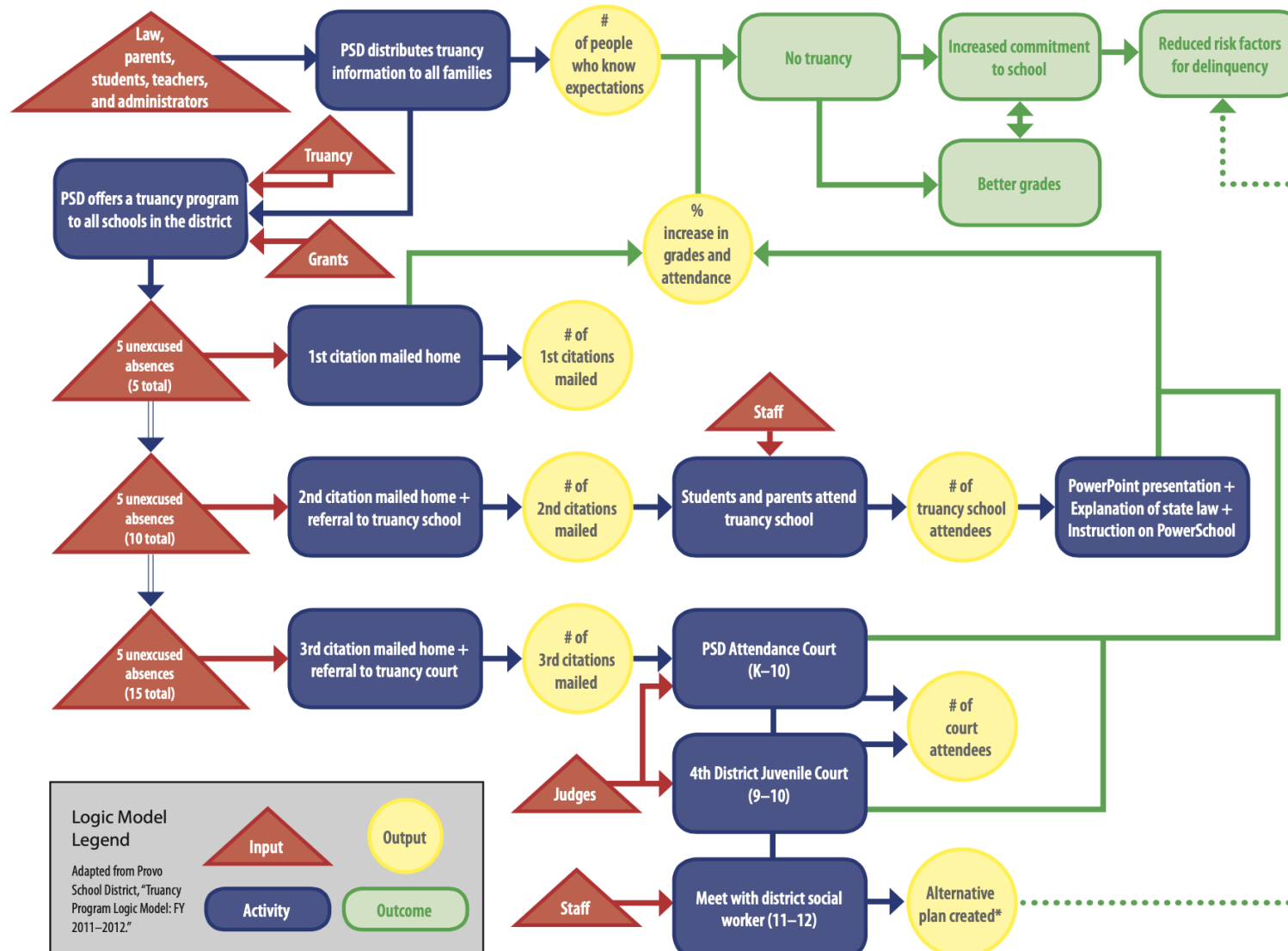
Needs assessment

Design and  
theory assessment

Process evaluation  
and monitoring

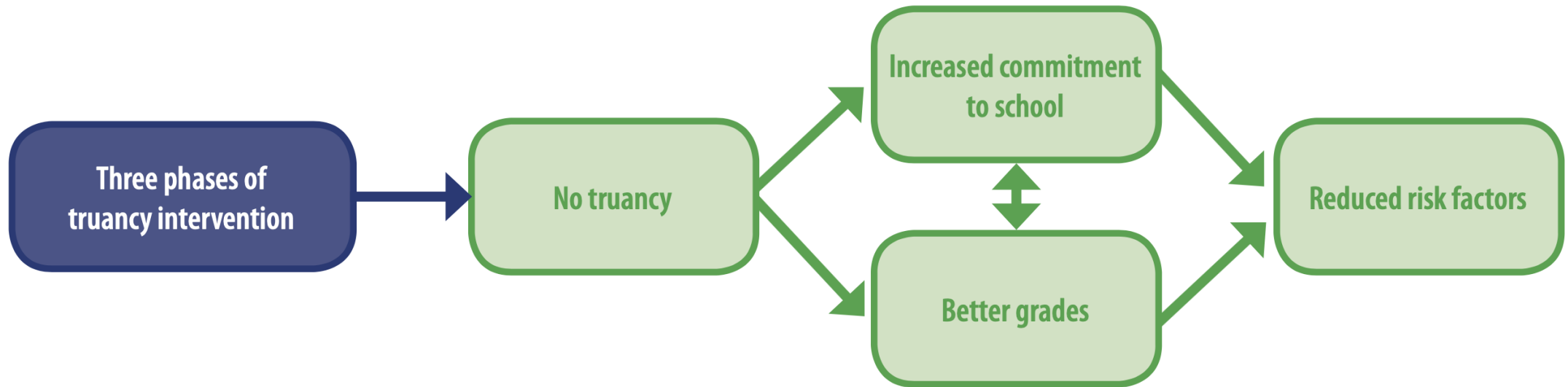
Impact evaluation

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!**

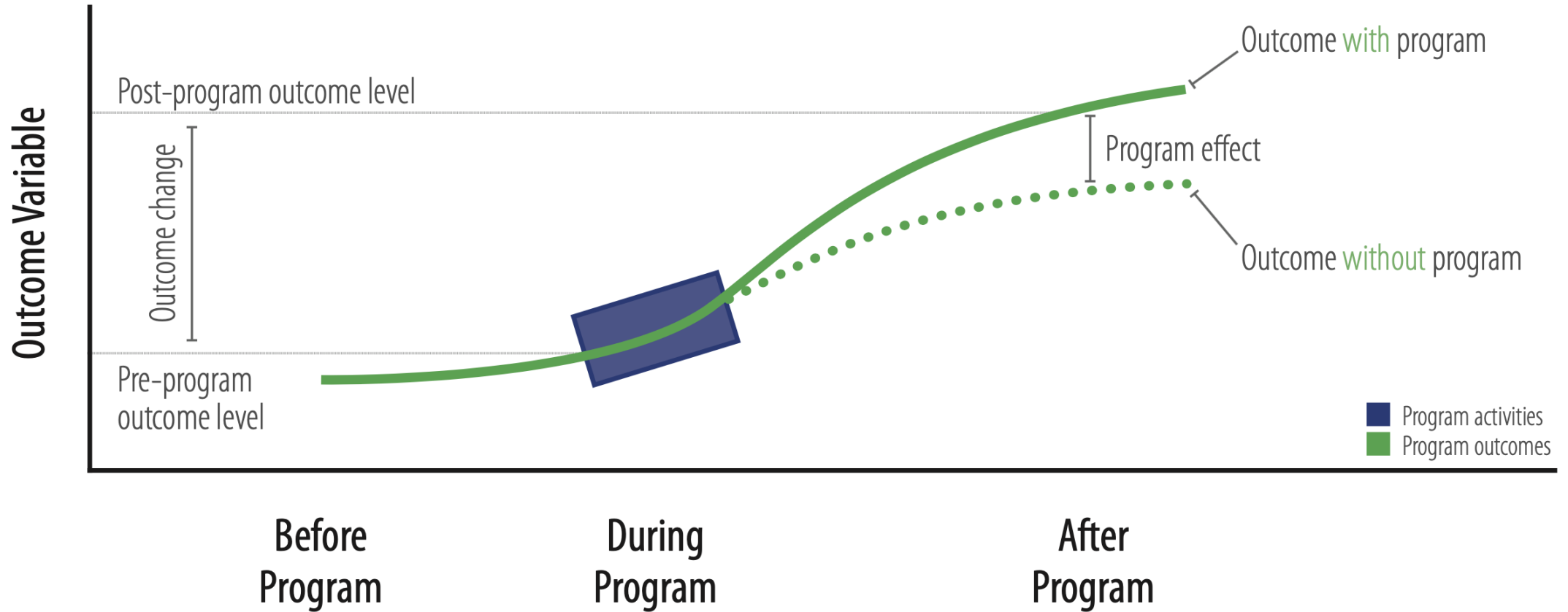
# Impact Evaluation in Practice

SECOND EDITION

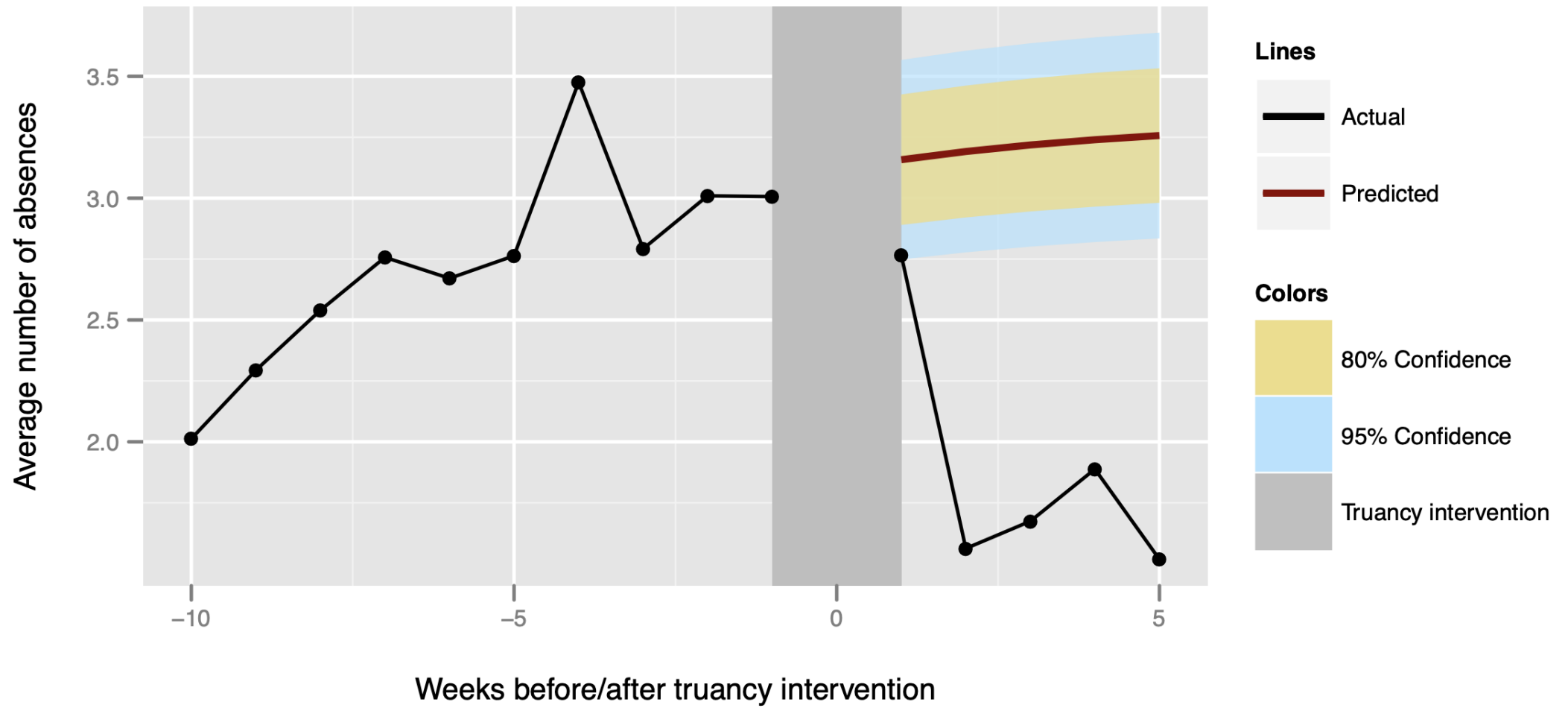
Paul J. Gertler, Sebastian Martinez,  
Patrick Premand, Laura B. Rawlings,  
and Christel M. J. Vermeersch



# 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**



SCIENCE

# 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

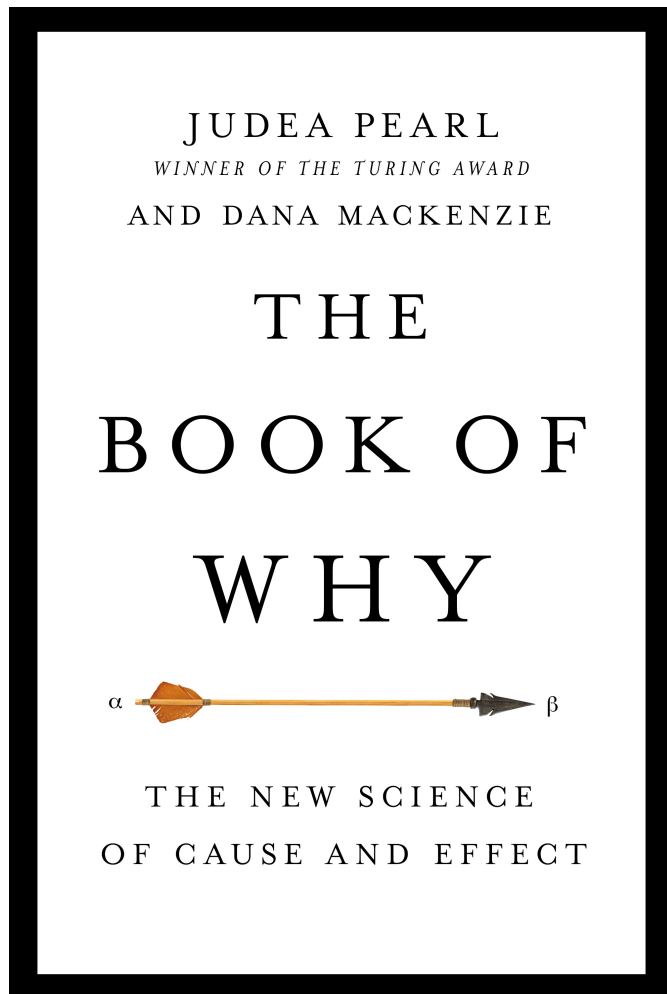
**Causation =  
Correlation + time order +  
nonspuriousness**

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

**You need a philosophical model**

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

# The causal revolution



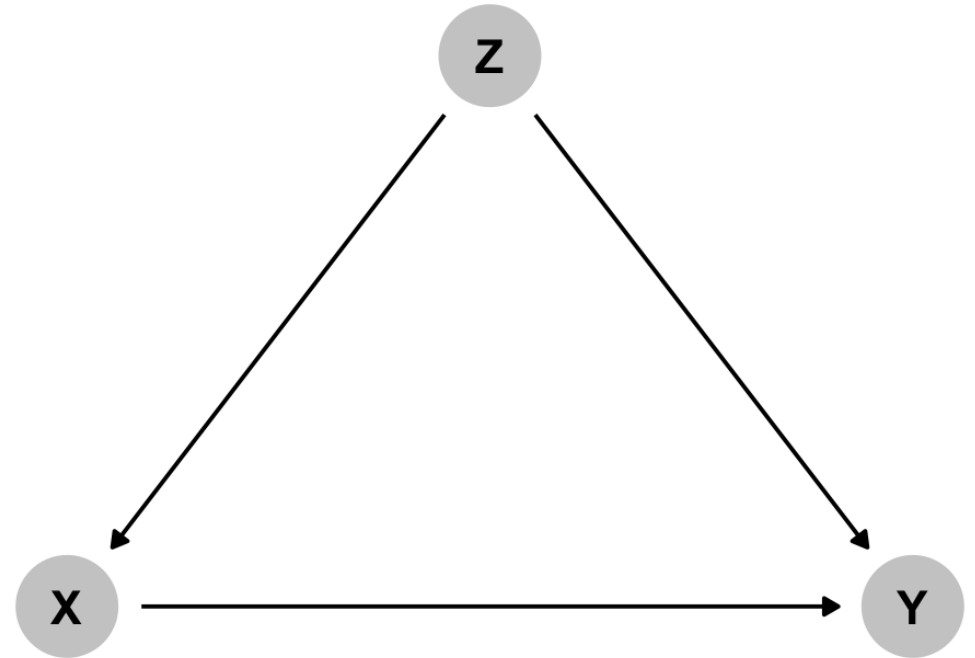
# Causal diagrams

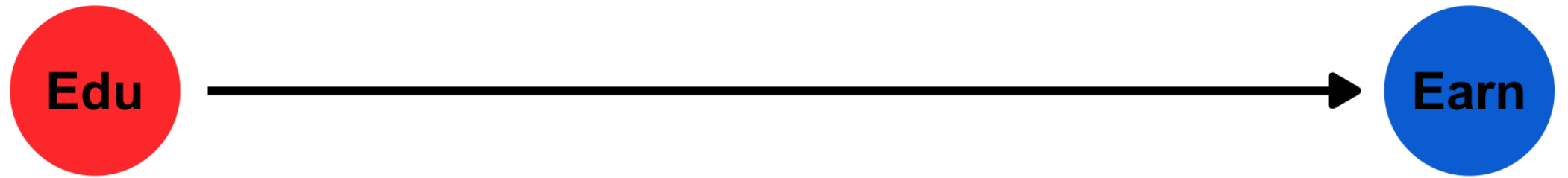
## Directed acyclic graphs (DAGs)

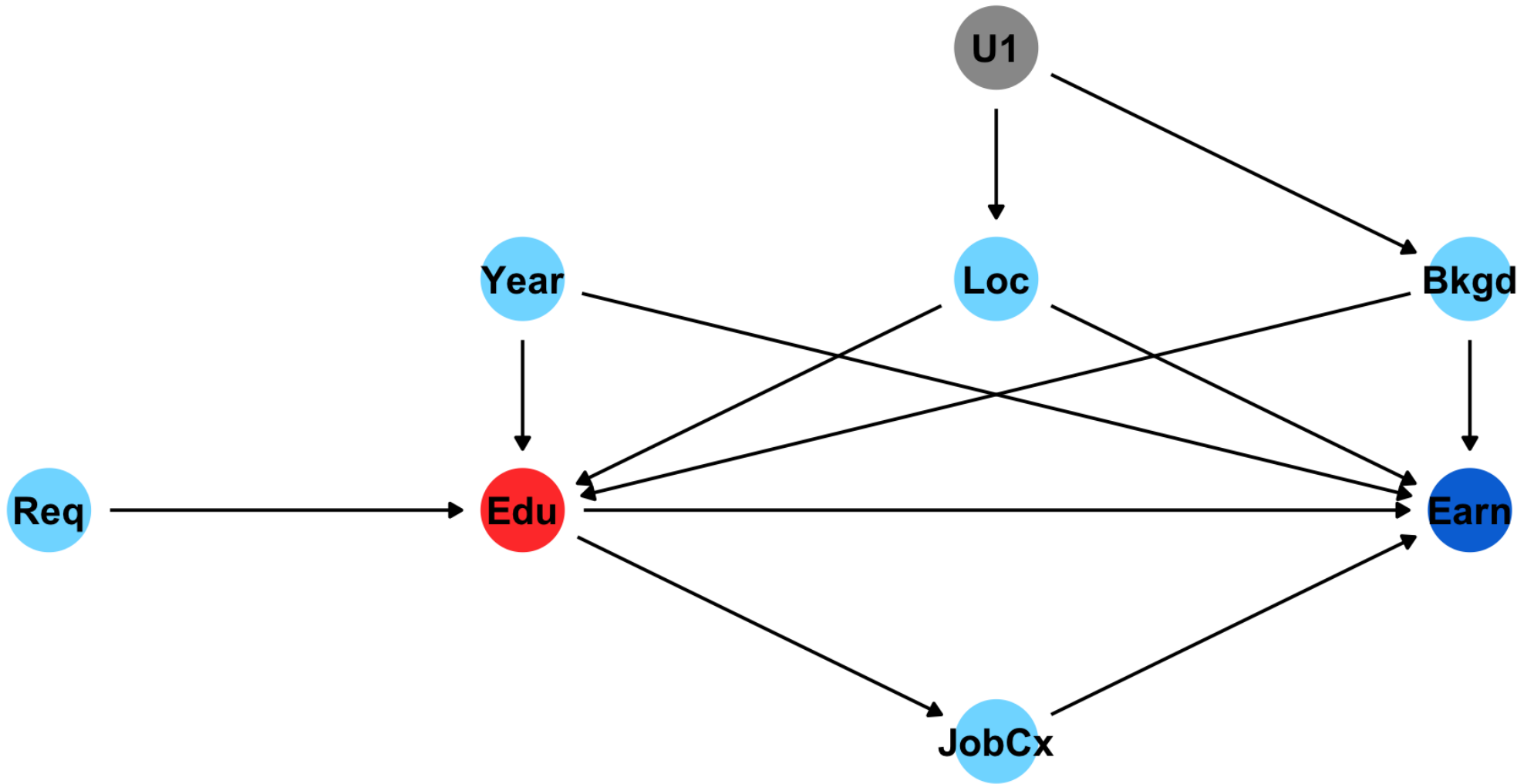
Graphical model of the process  
that generates the data

Maps your philosophical model

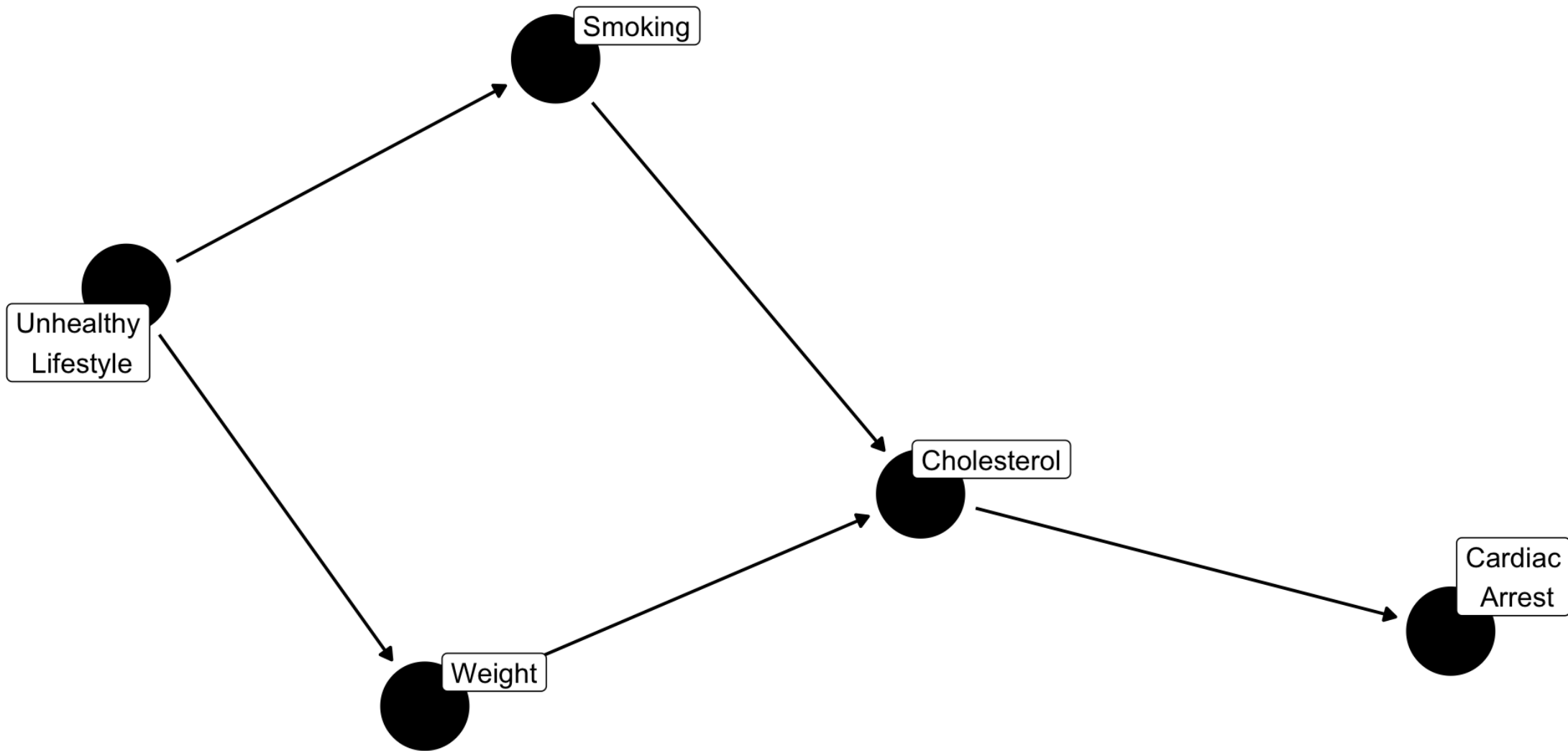
Fancy math ("*do*-calculus") tells  
you what to control for to isolate  
and identify causation

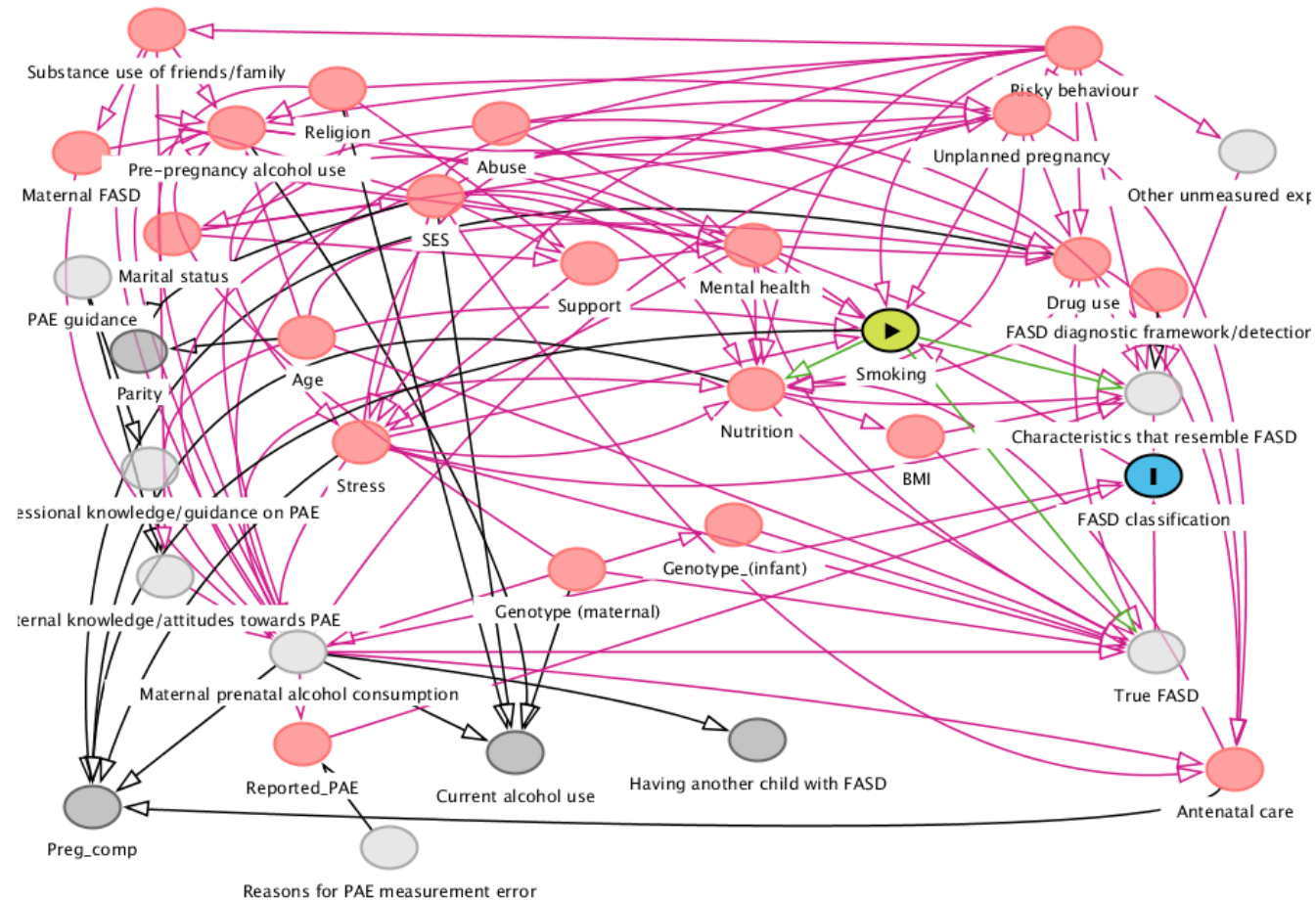










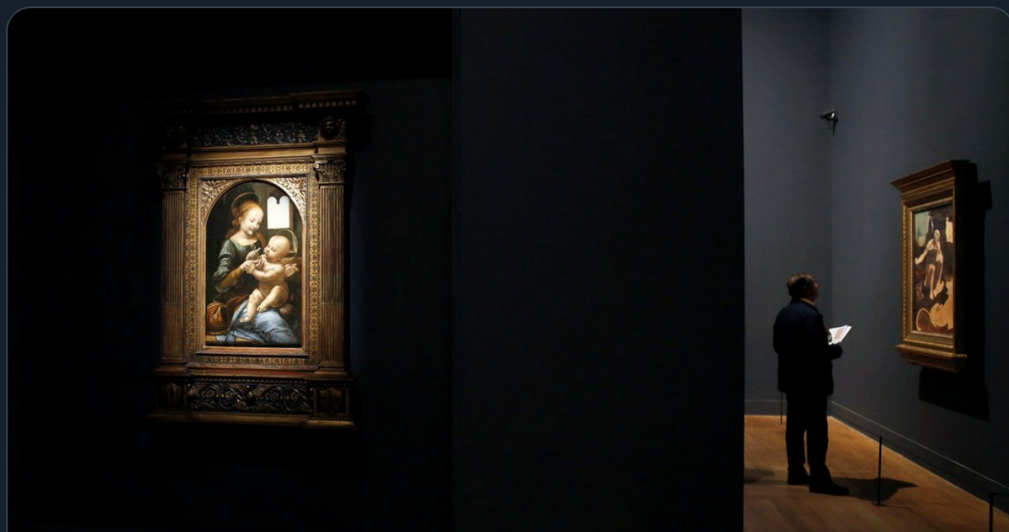


Effect of smoking on fetal alcohol syndrome



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.

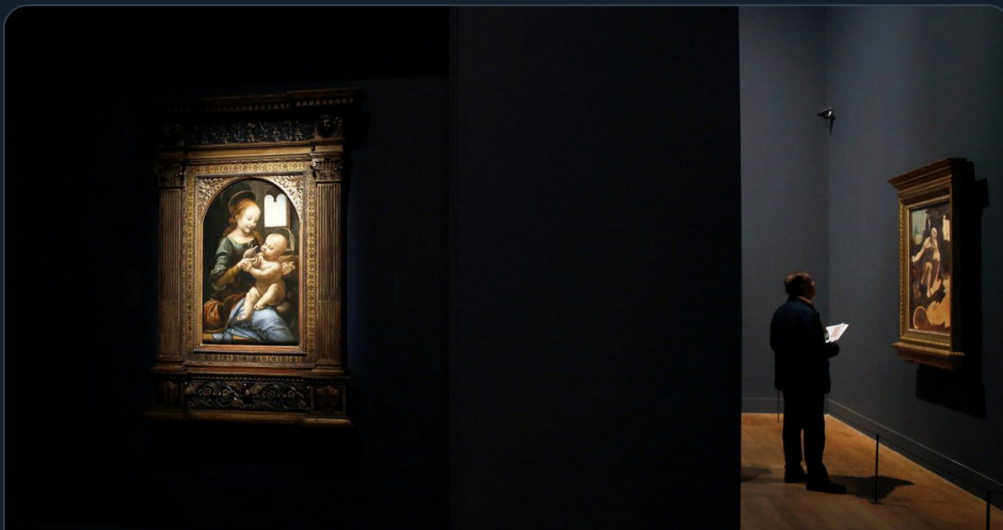
[nytimes.com](https://www.nytimes.com)

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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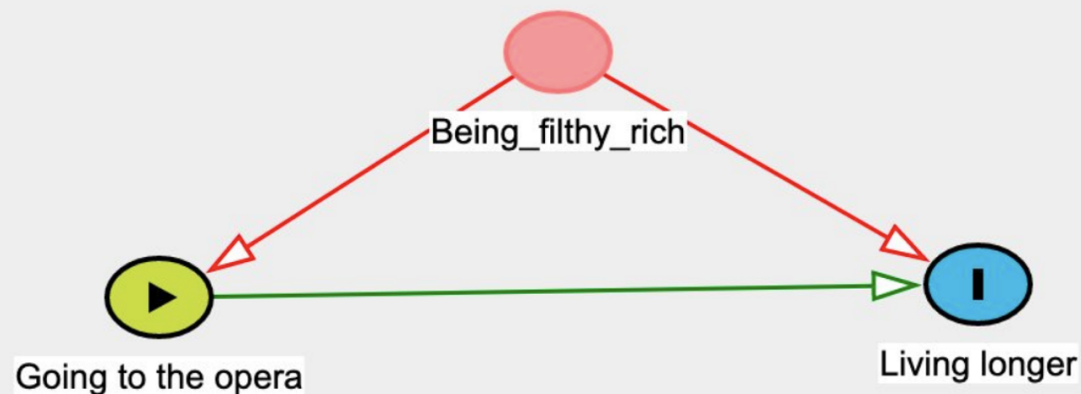
[nytimes.com](https://www.nytimes.com)

9:19 AM · Dec 22, 2019 · [SocialFlow](#)

336 Retweets 1.3K Likes



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](https://nyti.ms/2Q9AmZV)

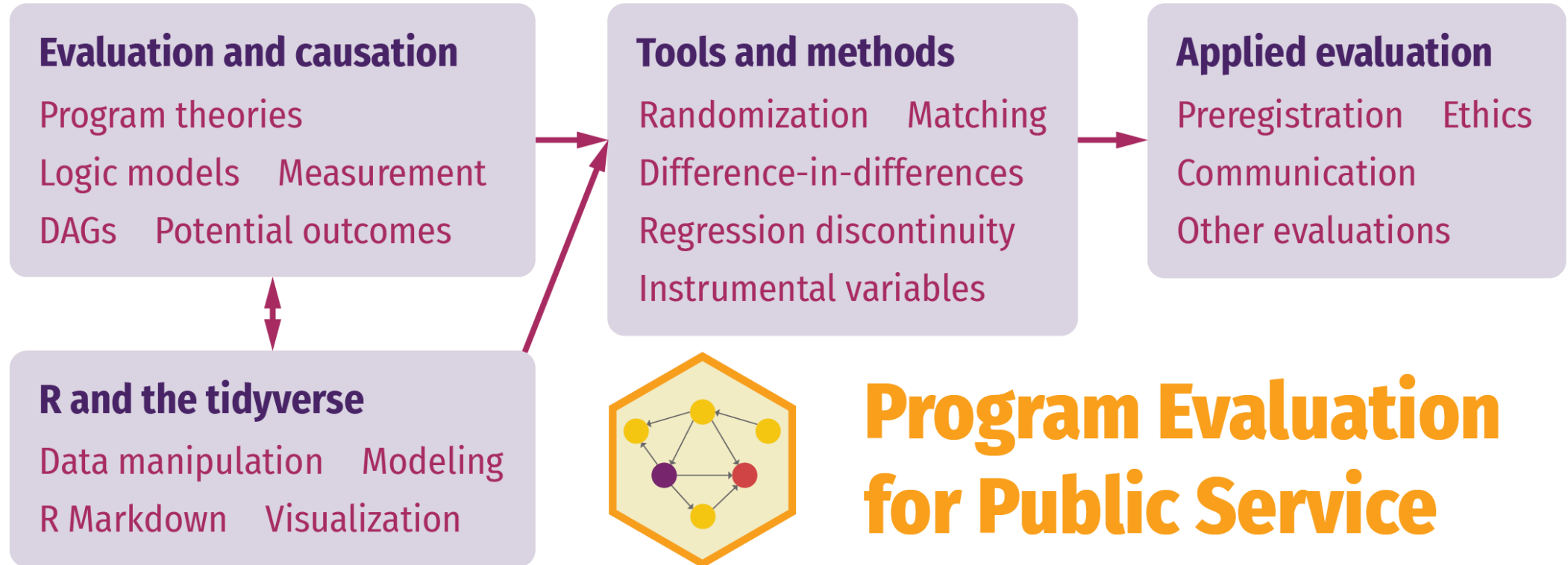
2:47 PM · Dec 22, 2019 · [Twitter Web App](#)

[View Tweet activity](#)

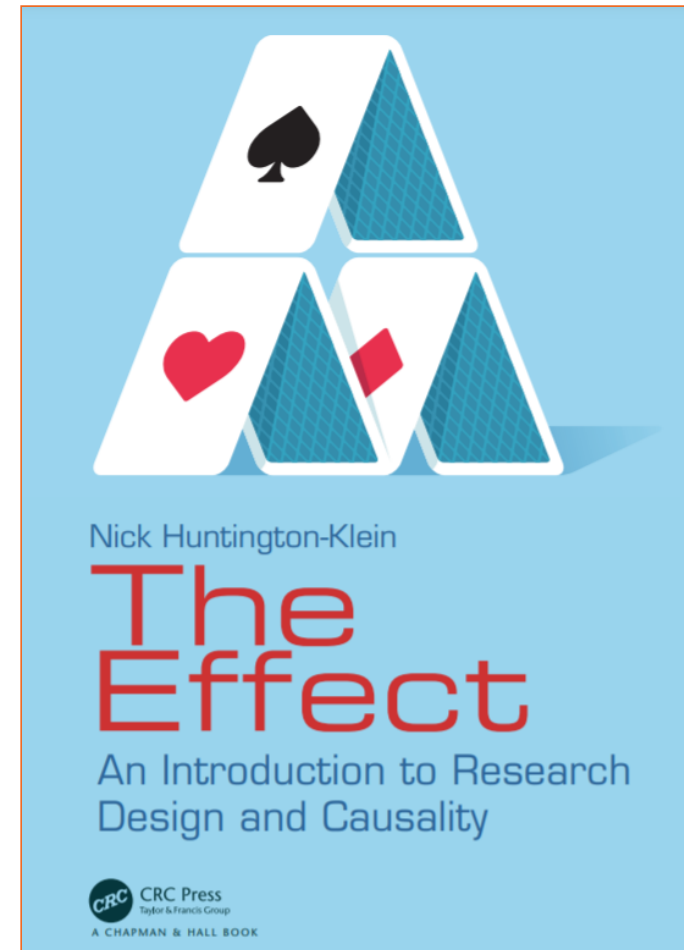
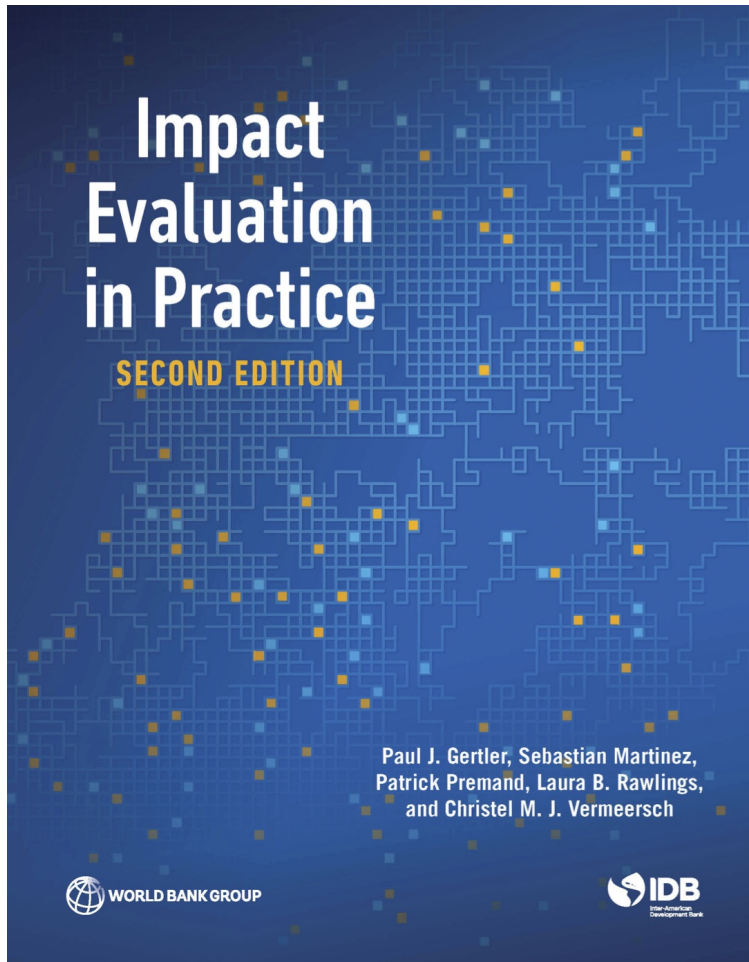
837 Retweets 3.9K Likes

# 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:

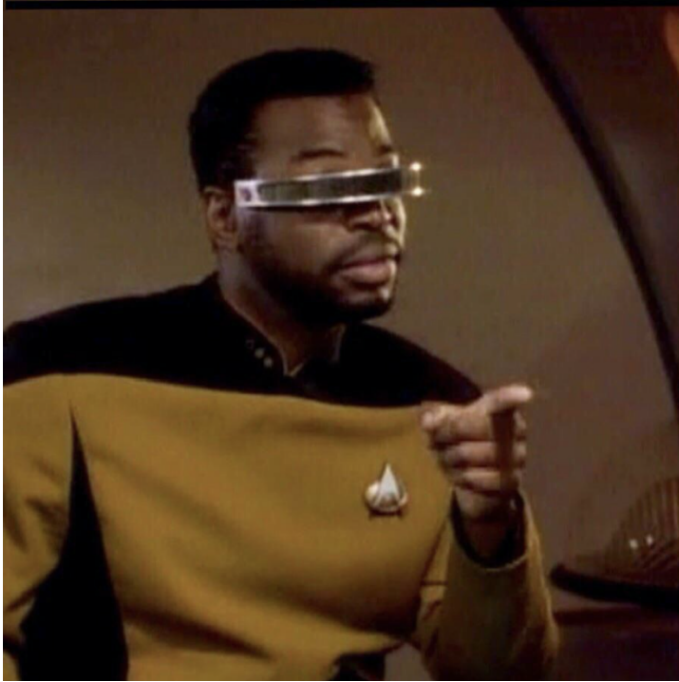
$$\widehat{X} = Z\hat{\delta} = Z(Z^T Z)^{-1} Z^T X = P_Z X.$$

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

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

which gives

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



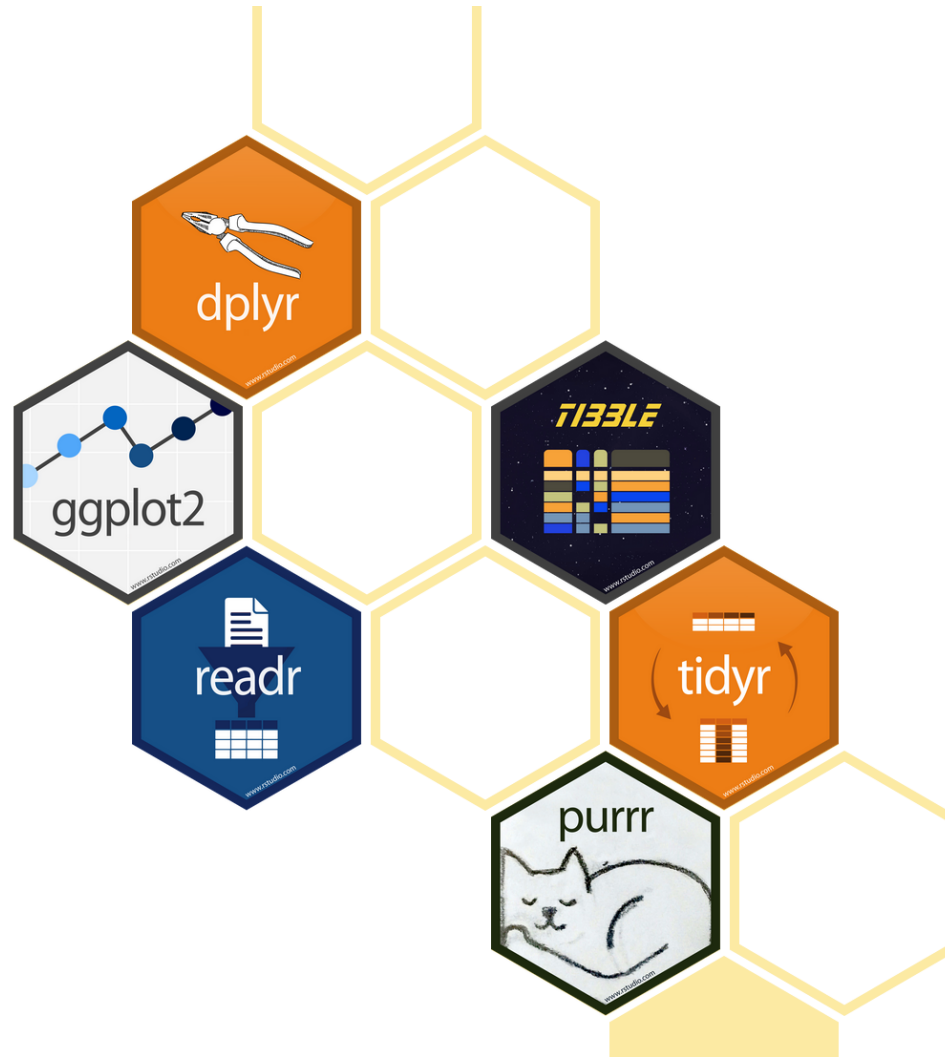
```
model_2sls <- iv_robust(  
  health ~ bed_net | treatment,  
  data = bed_nets)
```



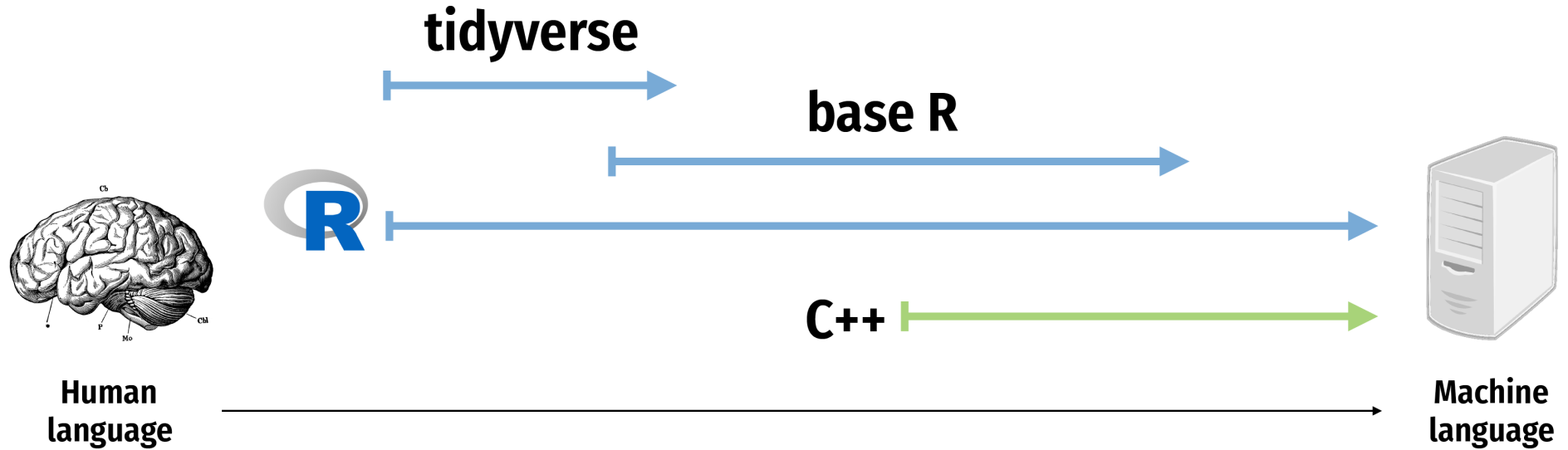
# Class technology



# 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?",  
       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



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