

# **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**

SUSAN CRAWFORD IDEAS 08.22.18 07:00 AM

# 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

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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 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									<input type="button" value="+ Add"/>												94%		
2	Las Vegas, NV						<input type="button" value="+ Add"/>												<input type="button" value="+ Add"/>			89%		
3	San Francisco, CA															<input type="button" value="+ Add"/>							85%	
4	Virginia Beach, VA						<input type="button" value="+ Add"/>									<input type="button" value="+ Add"/>								79%
5	Baton Rouge/E.B.R. Parish, LA							<input type="button" value="+ Add"/>			<input type="button" value="+ Add"/>									<input type="button" value="+ Add"/>		<input type="button" value="+ Add"/>	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

**S** 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](#))

**H** 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

**U** 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**

**Cloud computing**

**Neural  
networks**

**Artificial  
intelligence**

**PR-speak for  
“statistics”**

# What is “data science”?

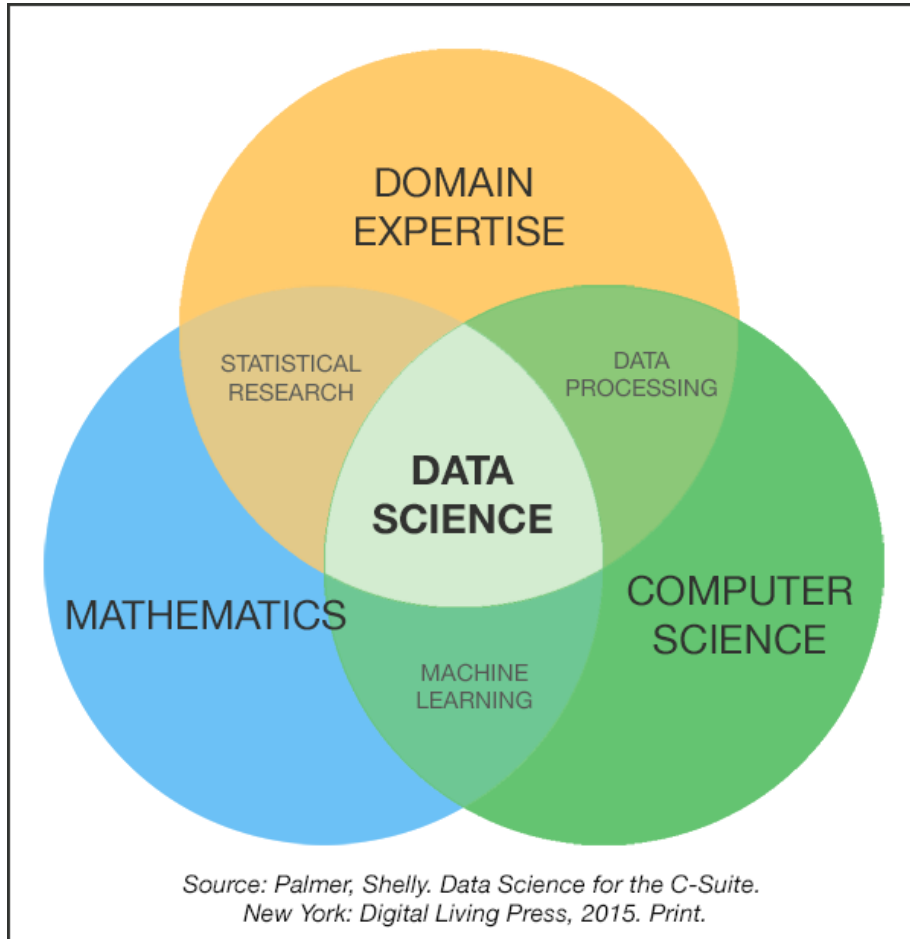
**Turning raw data into  
understanding, insight,  
and knowledge**

**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



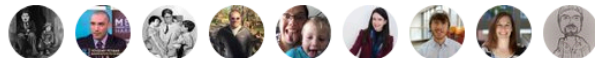
IF U DONT SMOKE,  
U ALREADY  
BELIEVE IN  
CAUSAL INFERENCE  
WITHOUT  
RANDOMIZED TRIALS



[#HistorianSignBunny](#) [#Epidemiology](#)

10:13 PM - 12 Jul 2018

200 Retweets 612 Likes



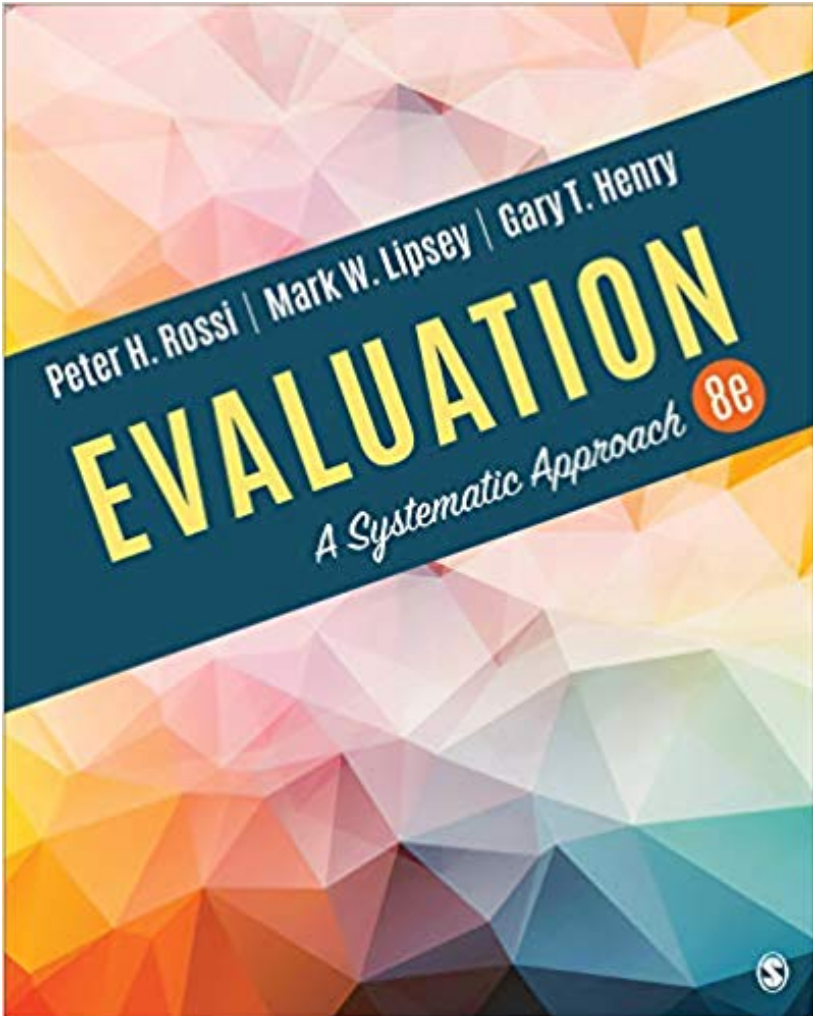
29 200 612



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

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

# Types of evaluation



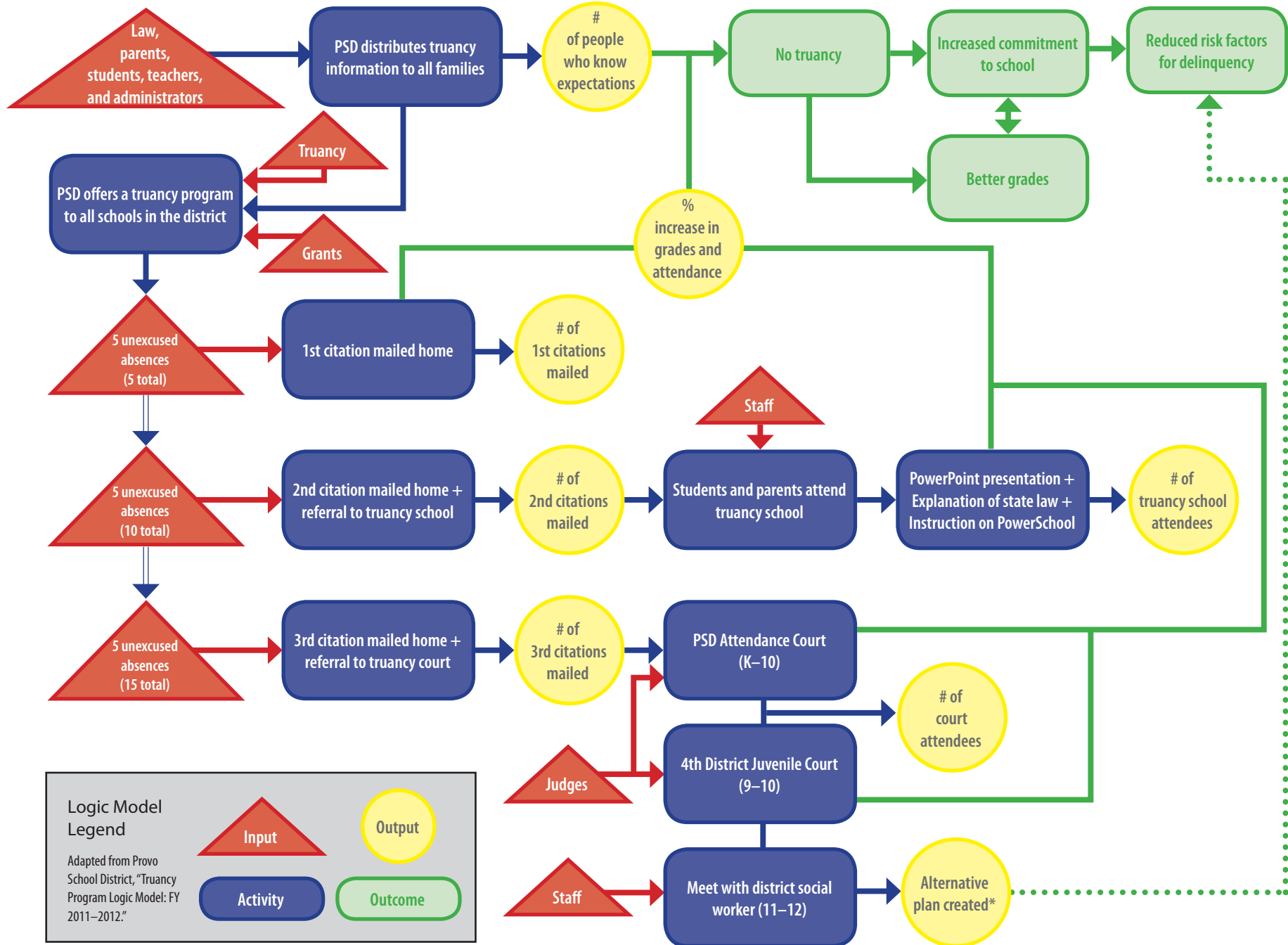
**Needs assessment**

**Design and theory assessment**

**Process evaluation  
and monitoring**

**Impact evaluation**

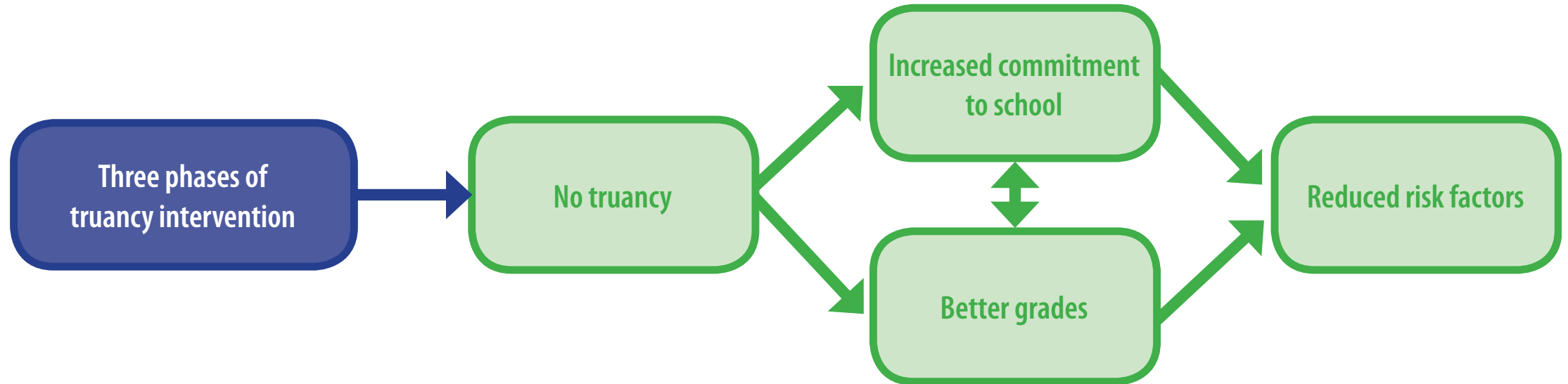
**Efficiency evaluation (CBA)**



\* 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!**

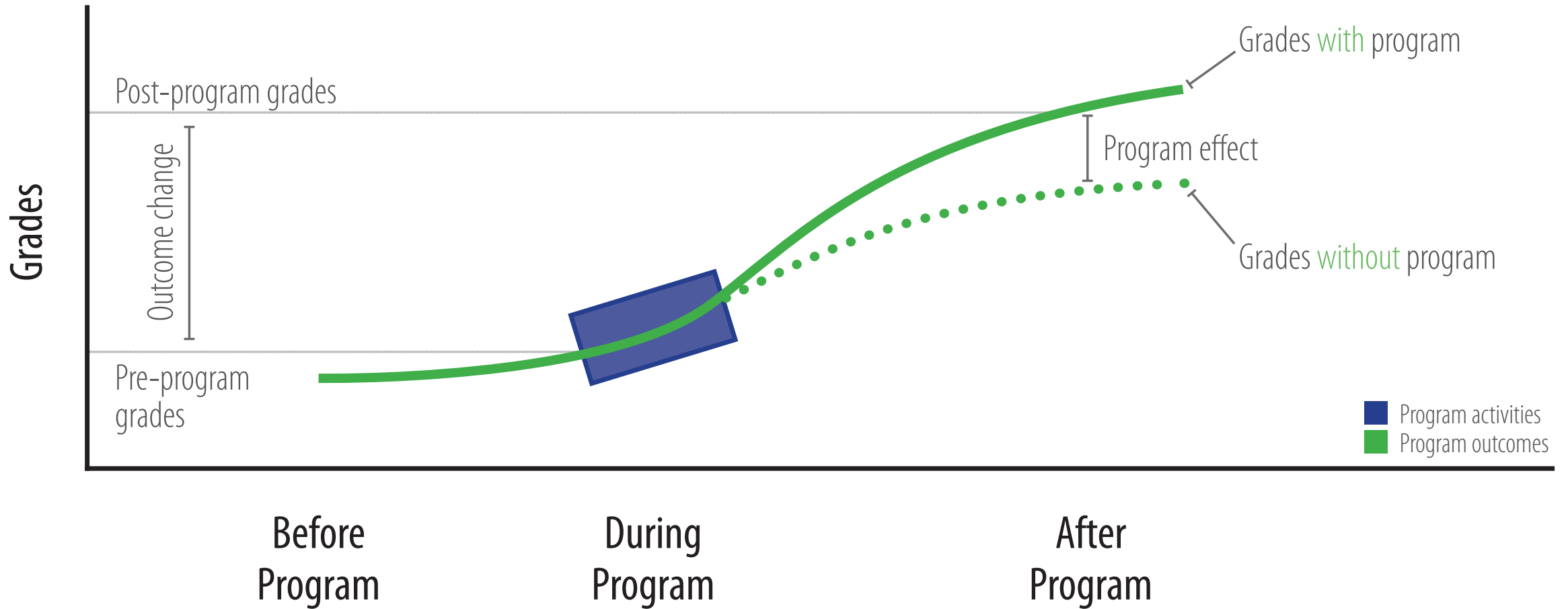
# Impact Evaluation in Practice

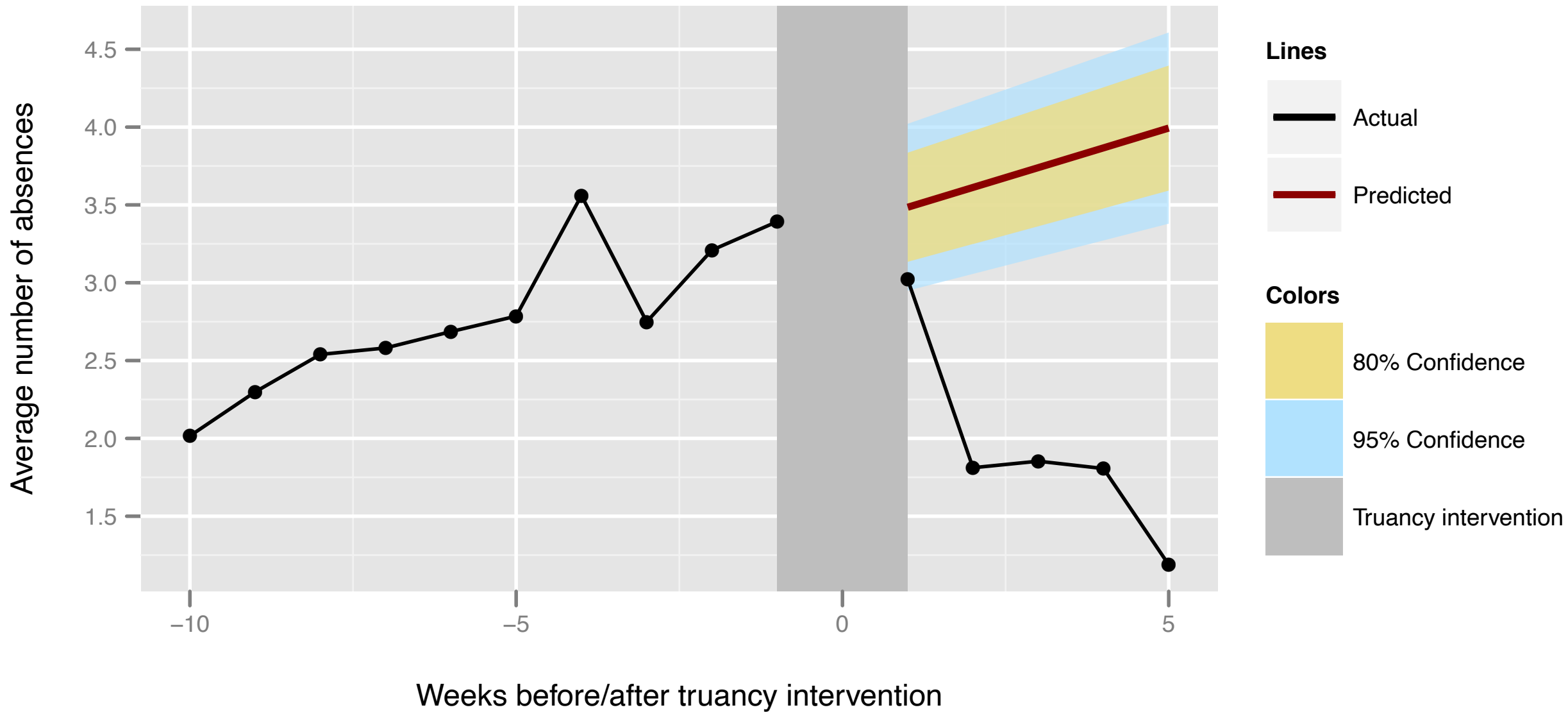
SECOND EDITION

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

# 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.



[Show this thread](#)



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

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



[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

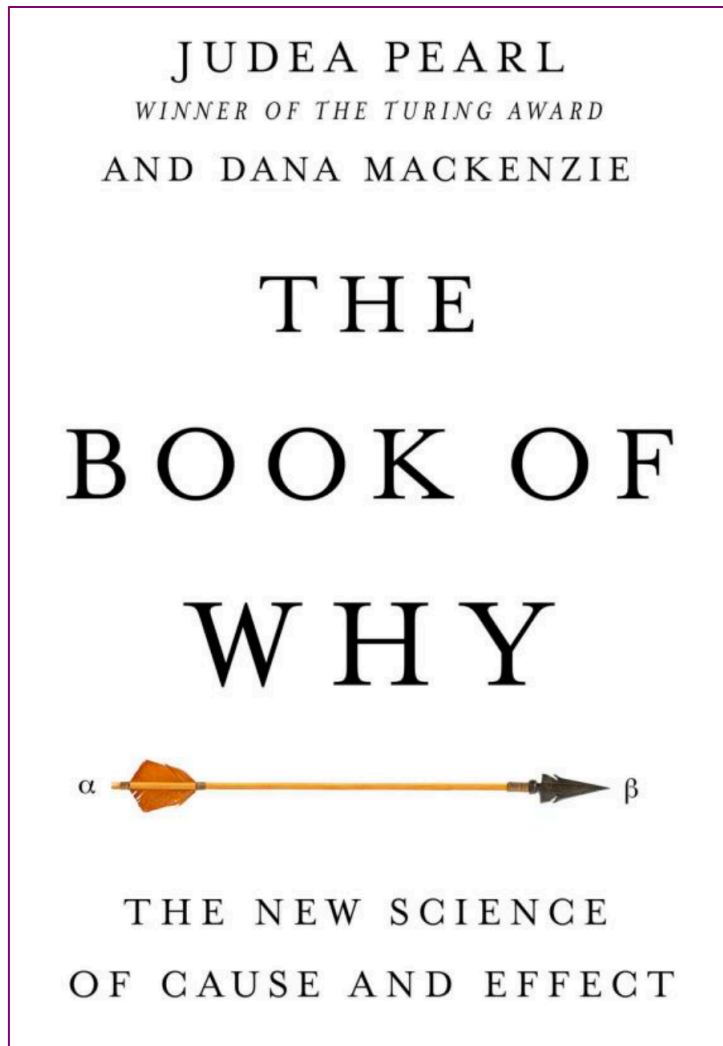
**Causation =  
Correlation + time order +  
all other factors ruled out**

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

**You need a philosophical model**

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

# The causal revolution



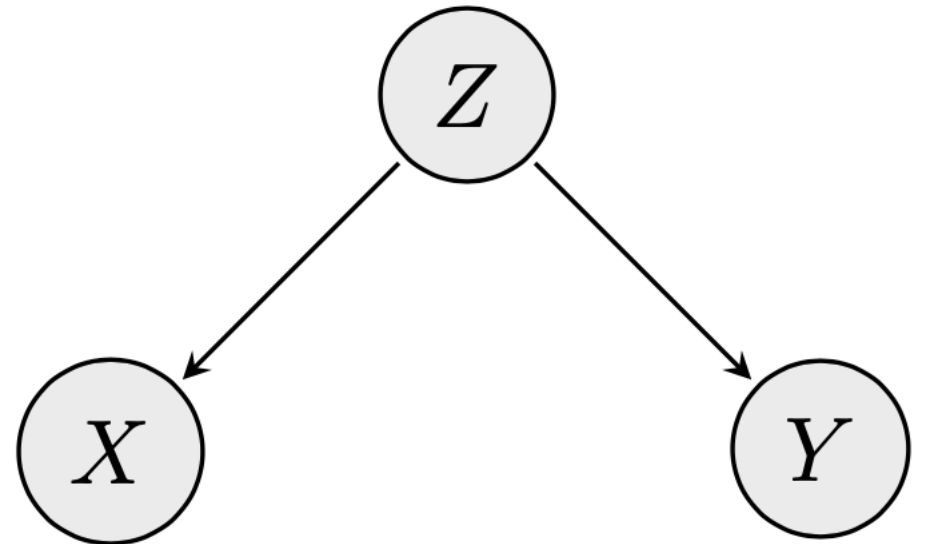
# Causal diagrams

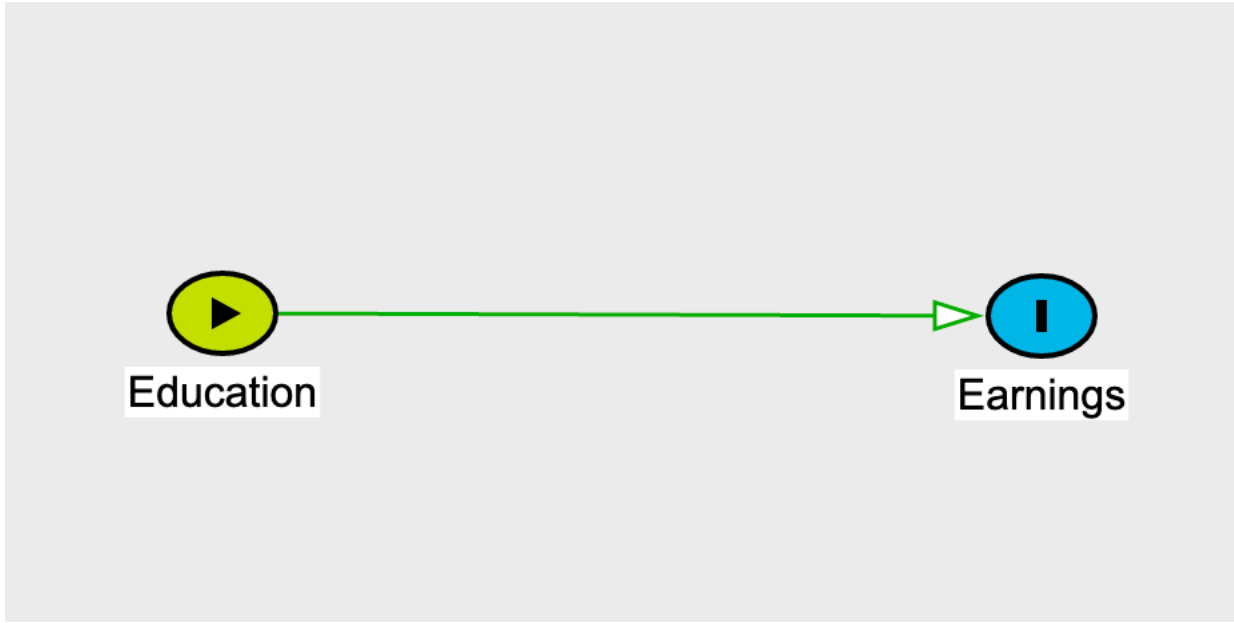
## Directed acyclic graphs (DAGs)

Graphical model of the process that generates the data

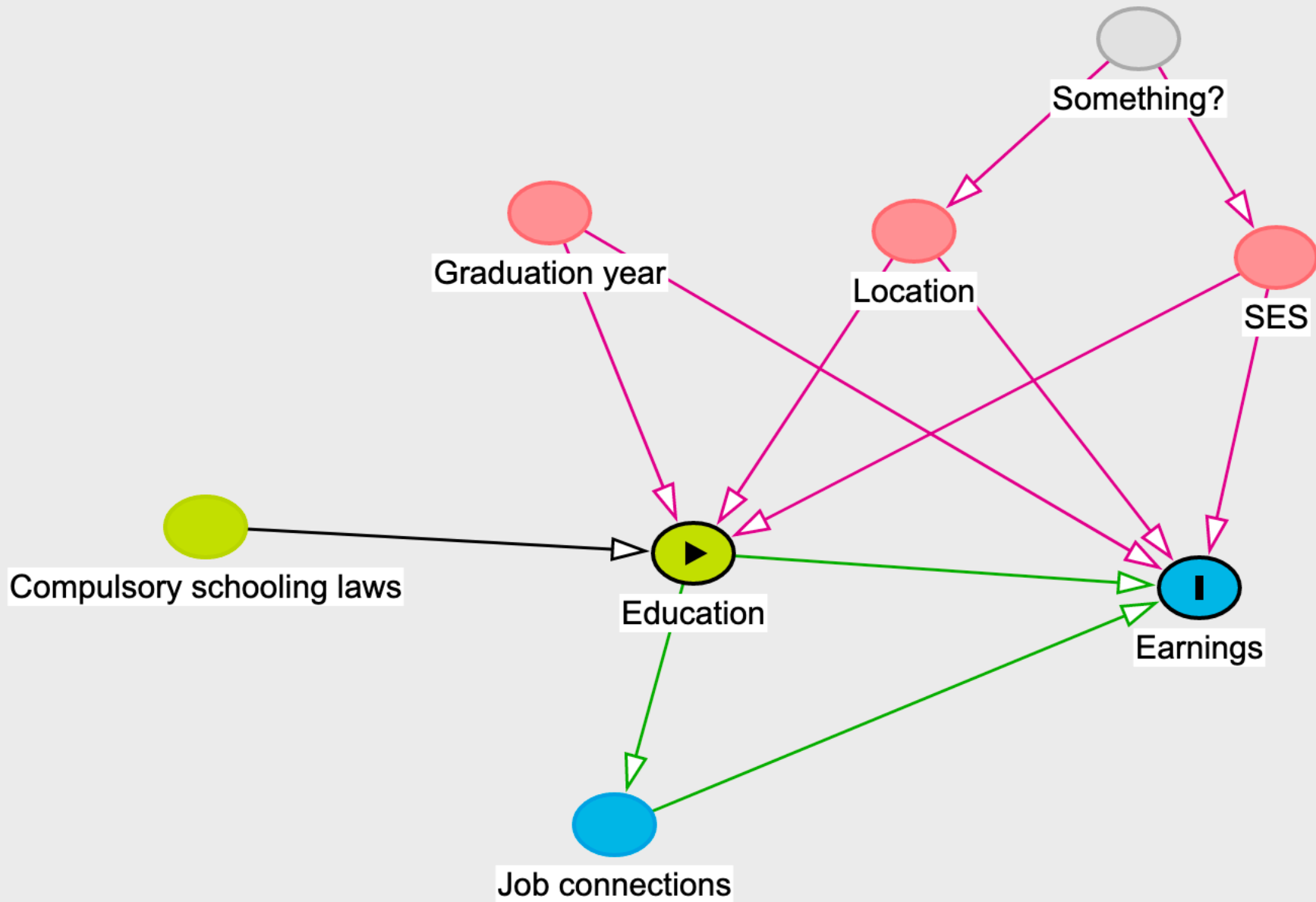
Maps your philosophical model

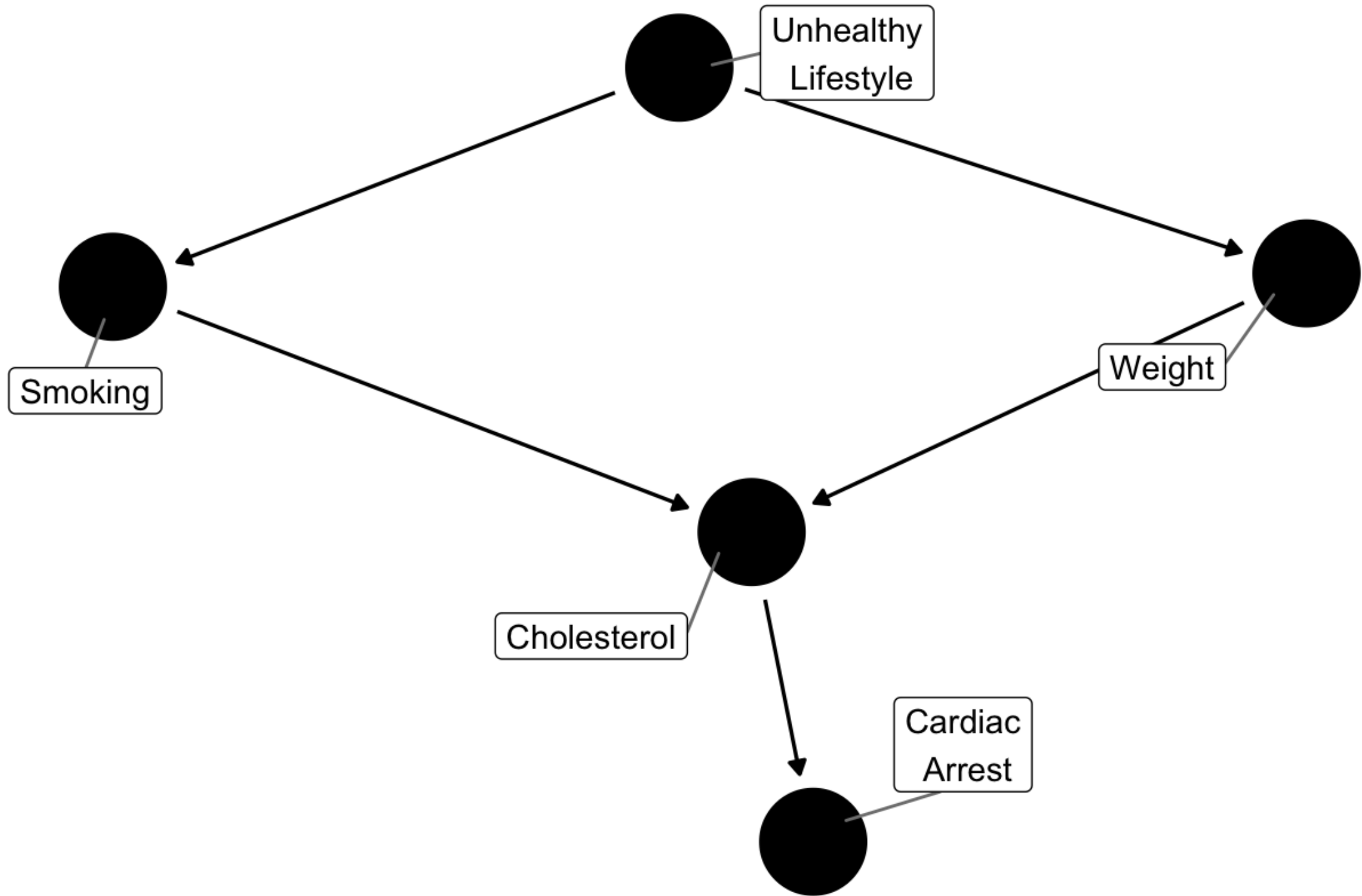
Fancy math (“do-calculus”) tells you what to control for to find causation

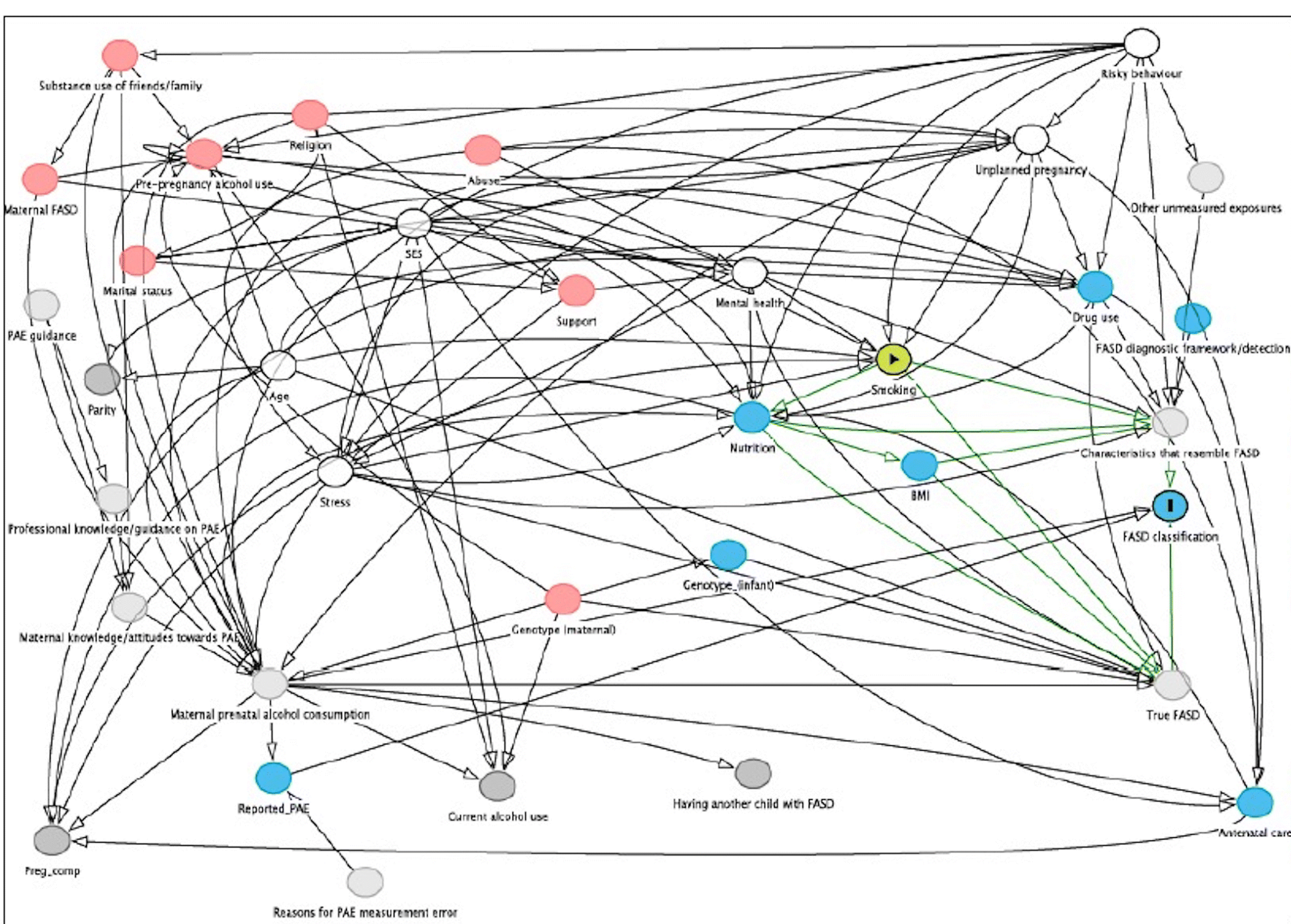












☑ Causal effect identification

Adjustment (total effect) ▾

Minimal sufficient adjustment sets containing Age, Mental health, Risky behaviour, SES, Stress, Unplanned pregnancy for estimating the total effect of Smoking on FASD classification:

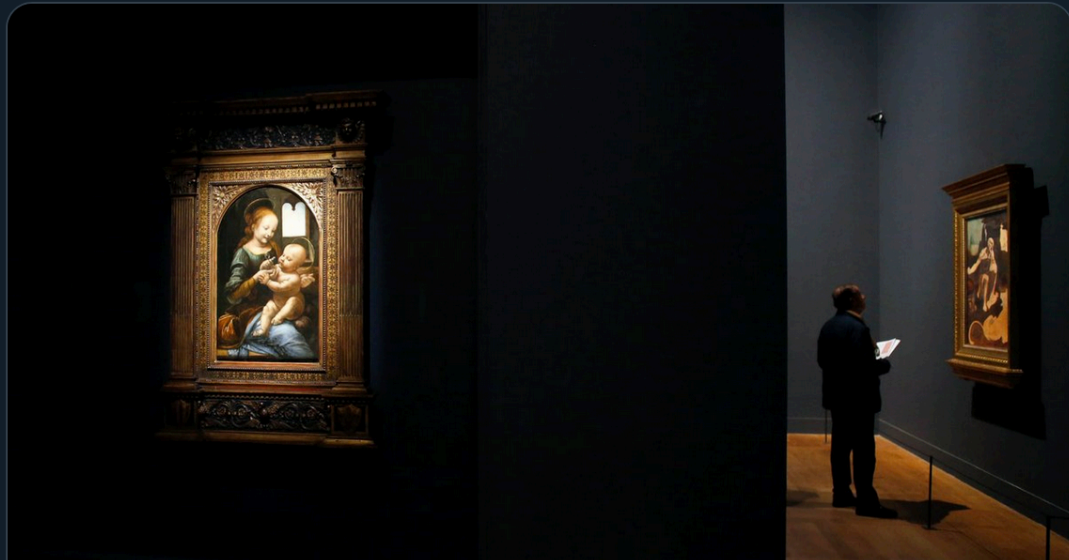
- Age, Mental health, Risky behaviour, SES, Stress, Unplanned pregnancy

☑ Legend

- 🟡 exposure
- 🟢 outcome
- 🟠 ancestor of exposure
- 🟡 ancestor of outcome
- 🟠 ancestor of exposure and outcome
- ⊖ adjusted variable
- ⊖ unobserved (latent)
- ⊖ other variable
- 🟢 causal path
- 🔴 biasing path



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.



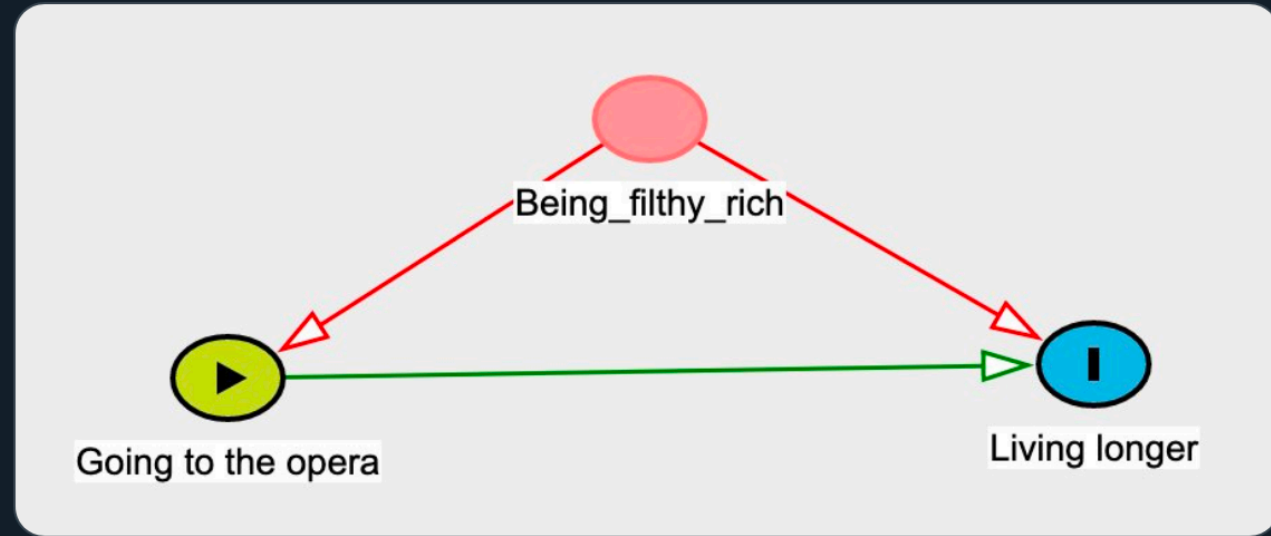
Another Benefit to Going to Museums? You May Live Longer  
Researchers in Britain found that people who go to museums, the theater and the opera were less likely to die in the study period than those who didn't.  
[nytimes.com](https://www.nytimes.com)

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

336 Retweets 1.3K Likes



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

# 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!**

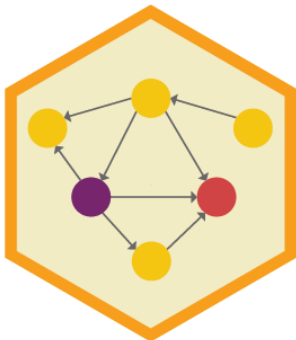
# Class details

**Evaluation and causation**  
Program theories  
Logic models Measurement  
DAGs Potential outcomes

**R and the tidyverse**  
Data manipulation Modeling  
R Markdown Visualization

**Tools and methods**  
Randomization Matching  
Difference-in-differences  
Regression discontinuity  
Instrumental variables

**Applied evaluation**  
Preregistration Ethics  
Communication  
Other evaluations



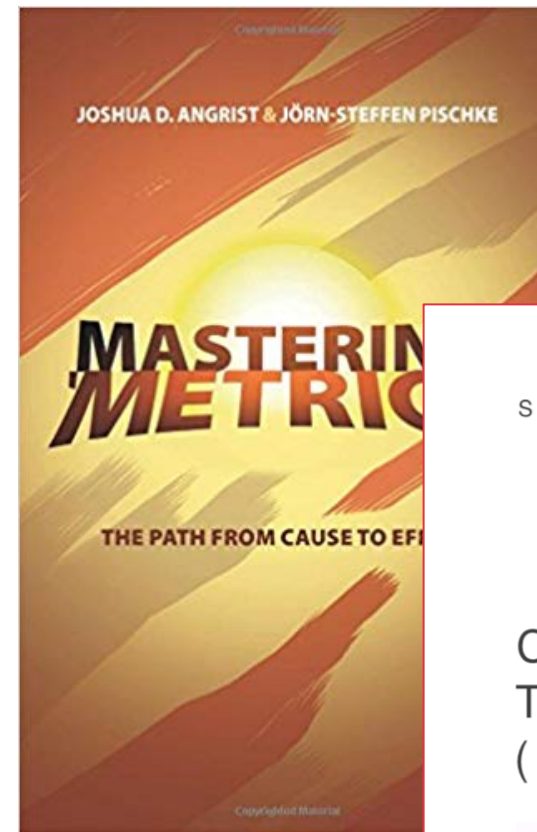
# Program Evaluation for Public Service



# Impact Evaluation in Practice

SECOND EDITION

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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:

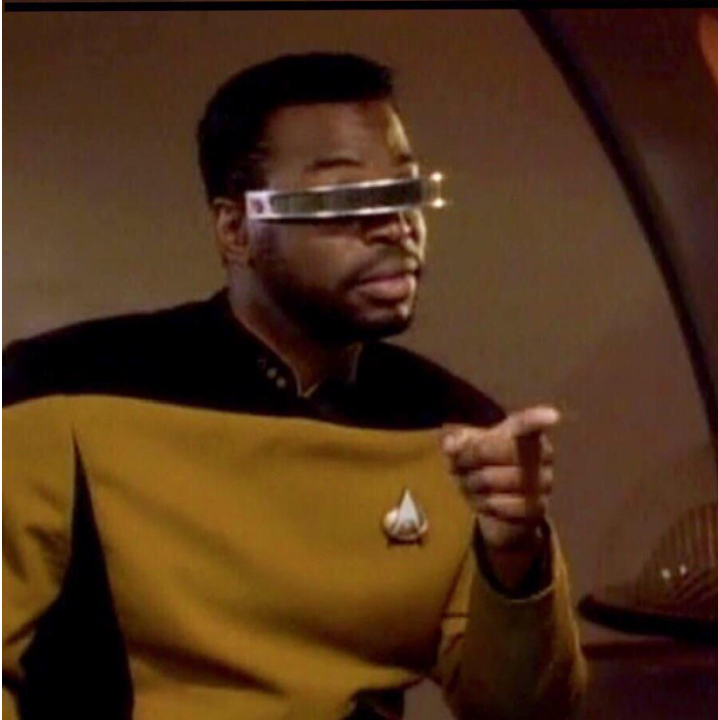
$$\widehat{X} = Z\hat{\delta} = Z(Z^T Z)^{-1} Z^T X = P_Z X.$$

**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)
```

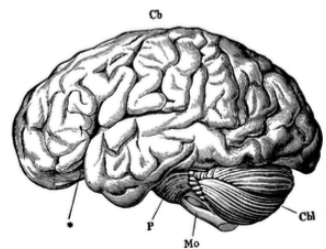
# Class technology



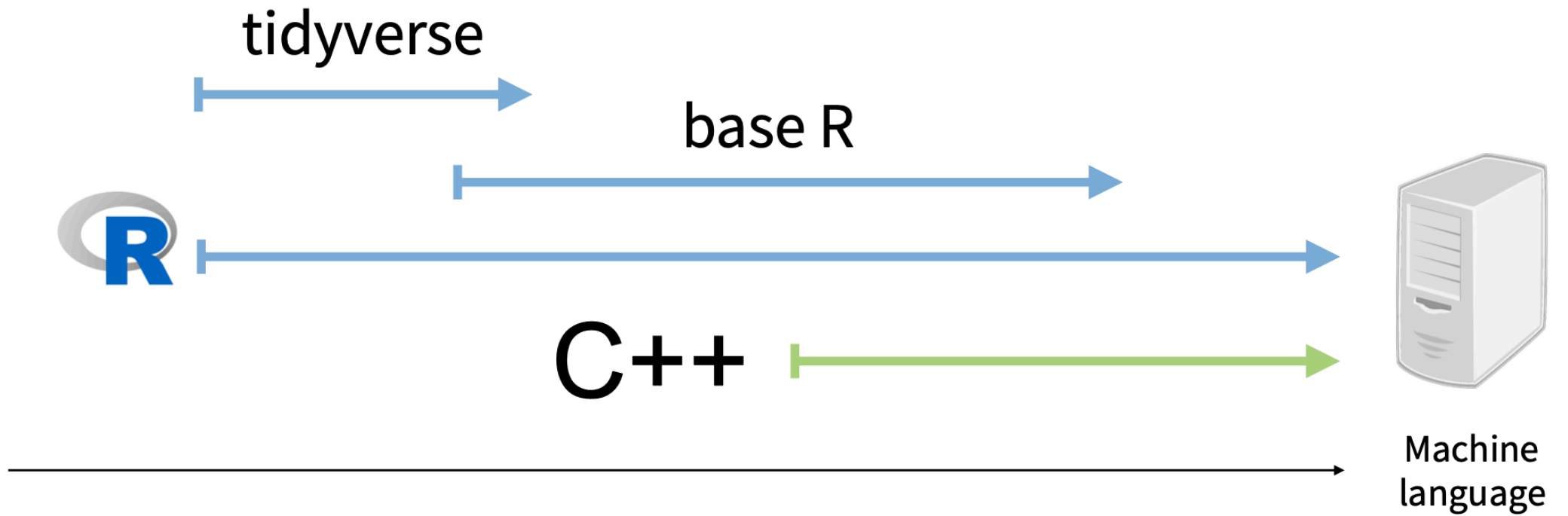
# The tidyverse



# The tidyverse



Human language



Machine language

# 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



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](https://andhs.co/survey)