

PSC4375: Introduction to Causality

Week 1: Lecture 1

Prof. Weldzius

Villanova University

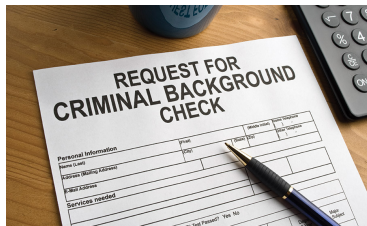
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What is a causal effect?

Factual vs. Counterfactual

- Does the minimum wage increase the unemployment rate?
 - Unemployment rate went up after the minimum wage increased
 - Would it have gone up if the minimum wage increase not occurred?
- Does having girls affect a judge's rulings in court?
 - A judge with a daughter gave a pro-choice ruling.
 - Would they have done that if had a son instead?
- **Fundamental problem of causal inference:**
 - Can never observe counterfactuals, must be inferred.

Criminal record experiment



- Does having a criminal record affect job prospects?
- Experimental setting:
 - Randomly assign 4 hired “confederates” (2 White, 2 Black) to apply to different jobs in Milwaukee.
 - Men were matched on physical appearance, self-presentation, age, etc.
 - Confederates would alternate indicating they had a criminal record.
- Outcome of interest: receiving a callback from a potential employer.

A tale of two applications

	Criminal Record	Callback?
Applicant 1		
Applicant 2		

- Did the first applicant not callback the applicant **because** they had a criminal record?

Notation and Jargon

- **Unit** (indexed by i): job application for employer
- **Treatment variable** T_i : criminal record or not
- **Treatment group** (treated units): applications with criminal record
- **Control group** (untreated units): applications without criminal record
- **Outcome variable** Y_i : callback

	T_i (ex-felon)	Y_i (callback)
Ex-felon applicant	1	0
Non-ex-felon applicant	0	1

Causal effects and counterfactuals

- What does “ T_i causes Y_i ” mean? \rightsquigarrow **counterfactuals**, “what if”
- Would an employer treat criminal & noncriminal applicants differently?
- Two **potential outcomes**:
 - $Y_i(1)$: would applicant i get a callback if applied as an ex-felon?
 - $Y_i(0)$: would applicant i get a callback if applied not as an ex-felon?
- **Causal effect**: $Y_i(1) - Y_i(0)$
 - $Y_i(1) - Y_i(0) = 0 \rightsquigarrow$ criminal record has no impact on callback
 - $Y_i(1) - Y_i(0) = -1 \rightsquigarrow$ criminal record prevents callback
 - $Y_i(1) - Y_i(0) = +1 \rightsquigarrow$ criminal record leads to callback

Potential Outcomes

	T_i (ex-felon)	Y_i (callback)	$Y_i(1)$	$Y_i(0)$
Ex-felon applicant	1	0	0	???
Non-ex-felon applicant	0	1	???	1

- **Fundamental problem of causal inference:**

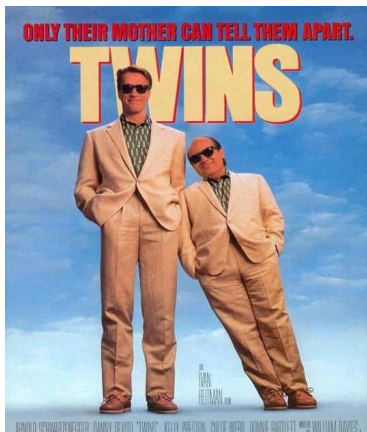
- We only observe one of the two potential outcomes.
- Observe $Y_i = Y_i(1)$ if $T_i = 1$ or $Y_i = Y_i(0)$ if $T_i = 0$
- To infer causal effect, we need to infer the missing counterfactuals!

How can we figure out counterfactuals?



- Find a similar unit! \rightsquigarrow **matching**
 - Mill's method of difference
- Did applicant fail to get a job offer because of his criminal record?
 - \rightsquigarrow find a non-ex-felon who is just like ex-felon applicant.
- NJ increased the minimum wage. Causal effect on unemployment?
 - \rightsquigarrow find a state similar to NJ that didn't increase minimum wage.

Imperfect matches



- The problem: imperfect matches!
- Say we match i (treated) and j (control)
- **Selection Bias:** $Y_i(1) \neq Y_j(1)$
- Those who take treatment may be different than those who take control.
- How can we correct for that?