

Causal Inference: Course Recap

Cornell STSCI / INFO / ILRST 3900

Fall 2023

causal3900.github.io

30 Nov 2023

Learning goals for the course

As a result of participating in this course, students will be able to

- ▶ define counterfactuals as the outcomes of hypothetical interventions
- ▶ identify counterfactuals by causal assumptions presented in graphs
- ▶ estimate counterfactual outcomes by pairing those assumptions with statistical evidence



Fundamental problem of causal inference

Holland 1986

Descriptive evidence



Causal claim



Causal inference is a **missing data** problem

Person 1	lifespan	missing	lifespan	lifespan
Person 2	missing	lifespan	lifespan	lifespan
Person 3	lifespan	missing	lifespan	lifespan
Person 4	missing	lifespan	lifespan	lifespan
Person 5	lifespan	missing	lifespan	lifespan
Person 6	lifespan	missing	lifespan	lifespan
Person 7	missing	lifespan	lifespan	lifespan
Person 8	lifespan	missing	lifespan	lifespan
	Outcome under Mediterranean diet	Outcome under standard diet	Outcome under Mediterranean diet	Outcome under standard diet

Potential outcomes

$$Y_i^a$$

the outcome Y
of person i
if exposed to treatment $A = a$

Potential outcomes

The screenshot shows the Nike website interface for the Nike ZoomX Vaporfly Next% 2. At the top left is the Nike logo. Navigation links include "New & Featured", "Men", "Women", "Kids", "Sale", and "Back to School". A search bar and icons for heart and cart are on the right. The product is displayed in two images: a side view of the shoe and a close-up of hands tying the laces. A "★ Highly Rated" badge is present. The product title is "Nike ZoomX Vaporfly Next% 2" with the subtitle "Men's Road Racing Shoes". The price is listed as \$179.97, with a crossed-out price of \$250 and a "28% off" discount. A color selection grid shows various colorways, with the current selection highlighted. Below the grid is a "Select Size" section with a "Size Guide" link and a grid of size options from 6 to 13.

★ Highly Rated

New & Featured Men Women Kids Sale Back to School

Search

Nike ZoomX Vaporfly Next% 2
Men's Road Racing Shoes

\$179.97 ~~\$250~~ 28% off

Select Size

Size Guide

6	6.5	7	7.5	8
8.5	9	9.5	10	10.5
11	11.5	12	12.5	13

1

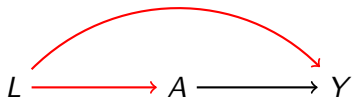
¹Image source: Nike

Potential outcomes

$$Y_i^{a_i, a_j}$$

the outcome Y
of person i
if exposed to treatment a_i
and their friend exposed to a_j

Causal identification by the backdoor criterion



Backdoor path starts with an edge pointing in to A and ends at Y

A set of variables satisfies the backdoor criterion if

1. Blocks all backdoor paths
2. Does not contain any descendant of A

β Sufficient adjustment sets satisfy the backdoor criterion!

Estimation

If conditional exchangeability holds given \vec{L} ,
then we need an estimator that statistically adjusts for \vec{L}

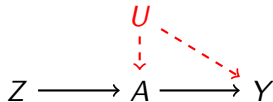
- ▶ regression
- ▶ inverse probability weighting
- ▶ matching

Identification without exchangeability

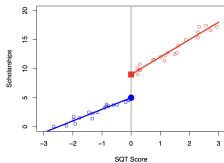
Front Door



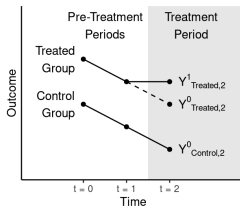
Instrumental Variables



Regression Discontinuity



Difference in Difference



Synthetic Control

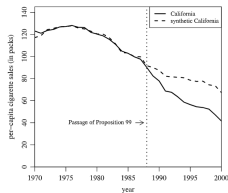


Figure 2. Trends in per-capita cigarette sales: California vs. synthetic California.

Course structure

- ▶ concepts introduced in lecture
- ▶ hands-on practice in discussion
- ▶ reinforced with problem sets
- ▶ project to independently apply what you learned

Causal Inference Course

Table of contents

Welcome

1 Defining counterfactuals

Welcome

Cornell [STSCI](#) / [INFO](#) / [ILRST 3900](#). Causal Inference. Fall 2023.

Welcome! Together, we will learn to make causal claims by combining data with arguments.

Your thoughts

- ▶ What could we do to make this course better?
- ▶ What is your favorite thing you learned?
- ▶ What parts do you anticipate being most useful for your future work?

Evaluations

We want to hear from you!

We encourage **specific examples** for your TAs

- ▶ Recitation or discussion
 - ▶ Comments on the recitation or discussion section (include day and time of section or TA name)
- ▶ Comparison to other courses
 - ▶ If you would like to nominate a TA from this course for a teaching award, please identify the TA and explain briefly why.

Drop us a line!

In the future, if you are using any of the material from class, we'd love to know!

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