

Causal Inference: Course Recap

Cornell STSCI / INFO / ILRST 3900

Fall 2024

causal3900.github.io

5 Dec 2024

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
Person 2	missing	lifespan
Person 3	lifespan	missing
Person 4	missing	lifespan
Person 5	lifespan	missing
Person 6	lifespan	missing
Person 7	missing	lifespan
Person 8	lifespan	missing

Outcome
under
Mediterranean
diet

Outcome
under
standard
diet

lifespan	lifespan
lifespan	lifespan
lifespan	lifespan
lifespan	lifespan
lifespan	lifespan
lifespan	lifespan
lifespan	lifespan
lifespan	lifespan

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

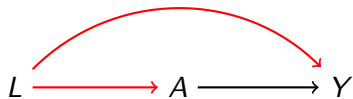


Potential outcomes

$$Y_i^{a_i, a_j}$$

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!

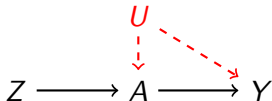
Estimation

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

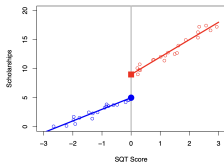
- ▶ regression
- ▶ inverse probability weighting
- ▶ matching

Identification without exchangeability

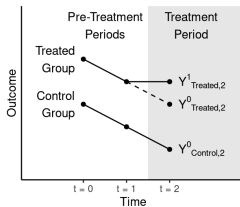
Instrumental Variables



Regression Discontinuity



Difference in Difference



Synthetic Control

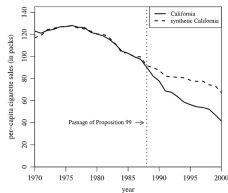


Figure 2. Trends in per-capita cigarette sales: California vs. synthetic California.

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!

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