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

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Fundamental problem of causal inference

Holland 1986

Descriptive evidence

average lifespan − average lifespan

Causal claim

average lifespan − average lifespan

Causal inference is a **missing data** problem

	Outcome under Mediterranean diet	Outcome under standard diet
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

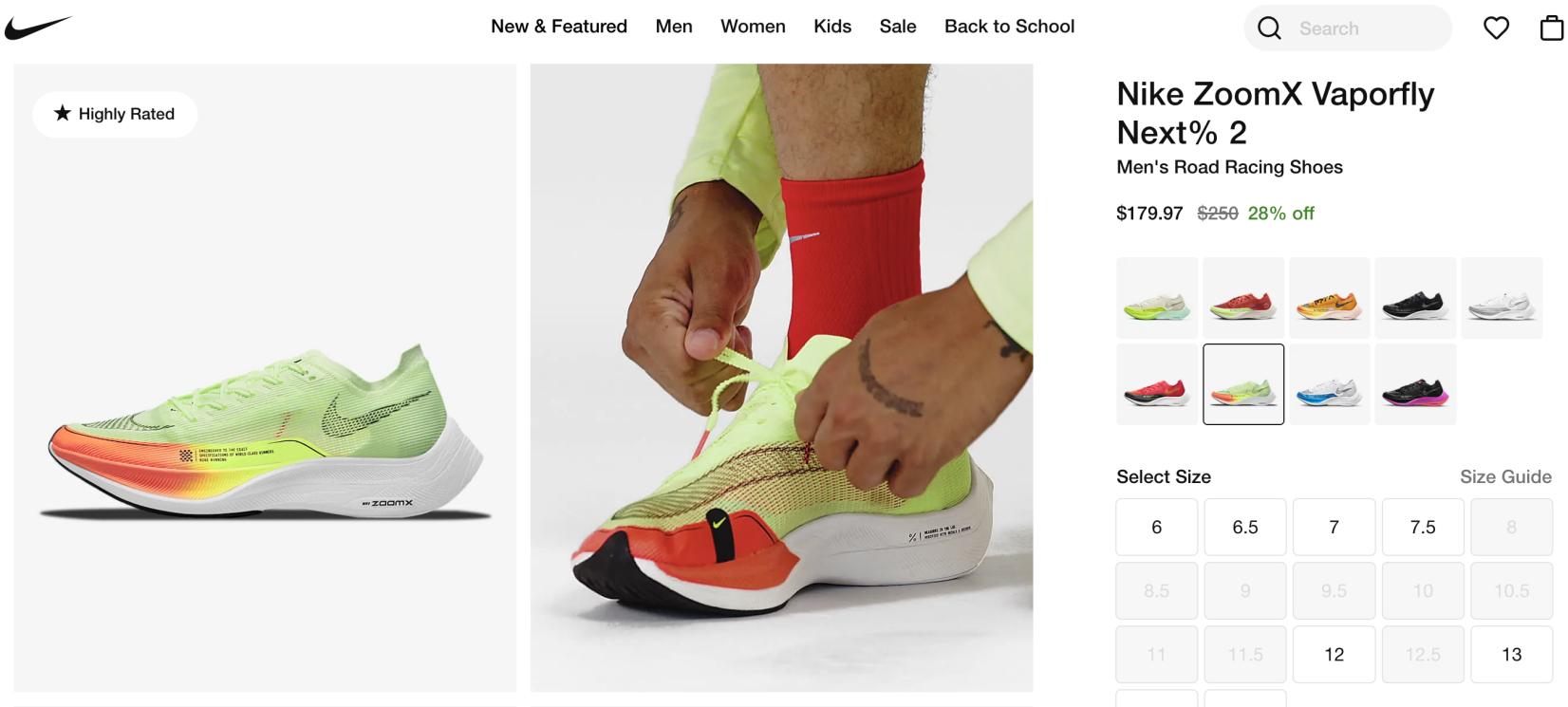
Outcome under Mediterranean diet	Outcome under standard diet
lifespan	lifespan
lifespan	lifespan
lifespan	lifespan
lifespan	lifespan
lifespan	lifespan
lifespan	lifespan
lifespan	lifespan
lifespan	lifespan

Potential outcomes

$$Y_i^a$$

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

Potential outcomes



[1]

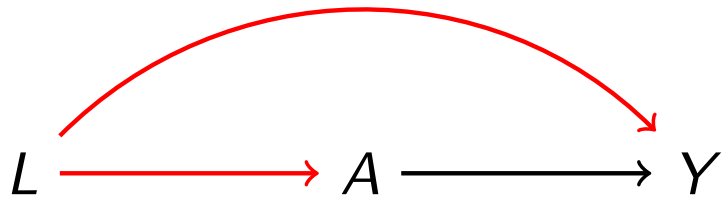
[1] Image source: Nike

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

ß Sufficient adjustment sets satisfy the backdoor criterion!

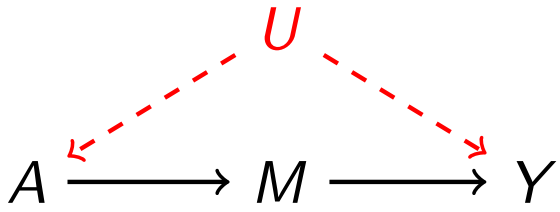
Estimation

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

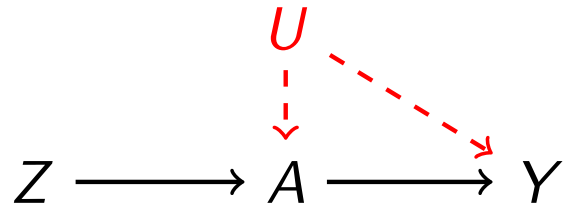
- regression
- inverse probability weighting
- matching

Identification without exchangeability

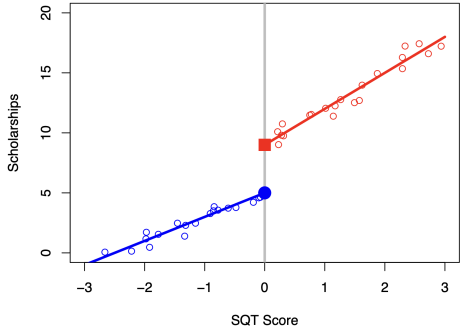
Front Door



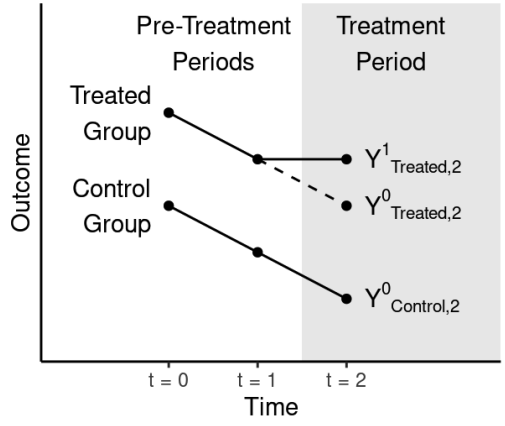
Instrumental Variables



Regression Discontinuity



Difference in Difference



Synthetic Control

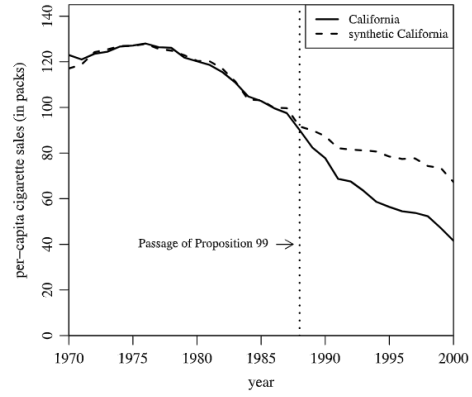
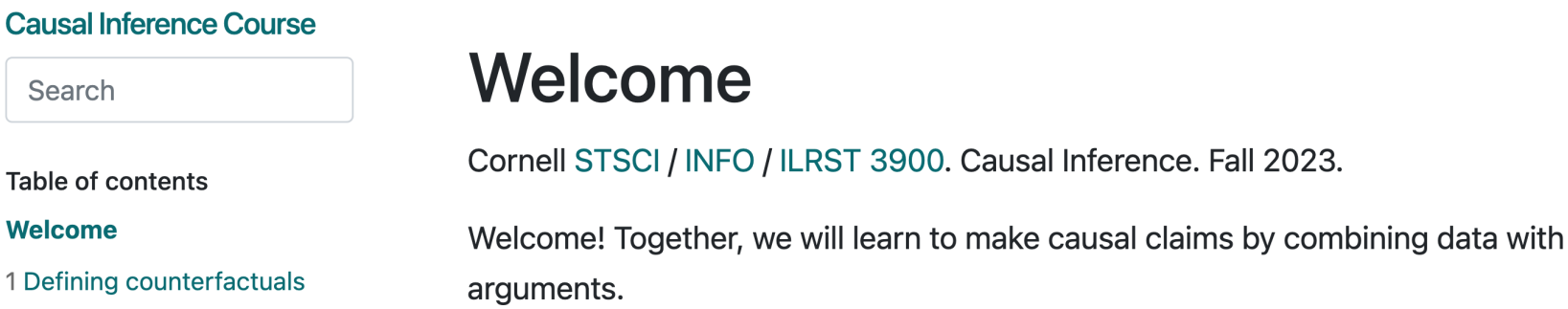


Figure 2. Trends in per-capita cigarette sales: California vs. synthetic California.

Course structure

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



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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