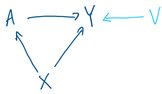
Intro to instrumental variables (IV)

12.07.21 10:28

Classic confounding setup: X affects treatment A & affects outcome Y

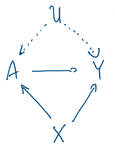


→ as long as we observe X, we can analyze causal effects using methods s.a.: Matching, PS matching, IPTW

→ even if there are risk factors, that only affect Y, it's valid to simply control for X

Reality: Unmeasured confounding:

→ there will be unmeasured/unobserved variables, U, that affect A and Y.
↳ in this case we have unmeasured confounding.



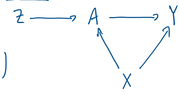
here: the ignorability assumption ($Y^{a=1} \perp A \mid X$) is violated !!!

Problems caused in DAG above: (1) biased estimates of causal effects.
(11) we cannot control for confounders and average over the dist. if we do not observe the confounders at all.

Instrumental variables (IV):

- Instrumental Variables (IV) is an alternative causal inference (CI) method that does not rely on the ignorability assumption.
- Z is the instrumental variable (IV) which affects treatment assignment A. Z doesn't directly affect the outcome Y.
- think of Z as "encouragement"
(e.g. higher Z, more encouragement for treatment)
lower Z, less encouragement for treatment))

DAG:



- Z is randomized; thus some part of the treatment is being explained by sth. that is random.

Example for an IV Z:

A: Smoking during pregnancy (yes/no)
Y: birth weight X: (parity, weight of mother, age of mother)

Concern: Could be unmeasured confounding still present despite observing X.

Challenge: Unethical to randomly assign smoking to pregnant women.

Encouragement Design:

A: smoking / Y: birthweight / X: (parity, mother age, weight, etc.)
new: Z: randomize to either receive "encouragement" to stop smoking (Z=1) or receive usual care (Z=0)

↳ Idea: Enrol only women who are smokers and randomize them into 2 groups.

group 1: ⊗ usual care (Z=0).

group 2: ⊕ care with extra encouragement to stop smoking (some active intervention, aimed at preventing smoking (Z=1).

Encouragement design:

- intention-to-treat analysis would focus on the causal effect of encouragement:

$E(Y^{Z=1}) - E(Y^{Z=0})$

this however would only be the causal effect of encouragement, NOT of the "treatment" smoking itself.

$E(Y^{Z=1})$: the avg. birthweight we would expect if the whole population was encouraged (Z=1) to eg. quit smoking.

$E(Y^{Z=0})$: the avg. birthweight if whole population had been given the usual care (Z=0).

- intention-to-treat effect: $E(Y^{Z=1}) - E(Y^{Z=0})$.

⇒ BUT what can we say about the causal effect of smoking?
↳ this is the focus of IV methods.

IVs:

- Sometimes: IV is randomly assigned as part of the study → randomized on purpose.
- other times: IV is randomized in nature (natural experiment)

- Mendelian randomization
- quarter of birth
- geographic distance to specialty care provider
encourages visit to healthcare/medicine providers.