§5.4 Assumptions

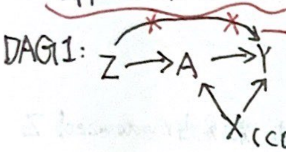
Important assumptions that are necessary for identifying causal effect.

§5.4.1 Assumptions about IVs.

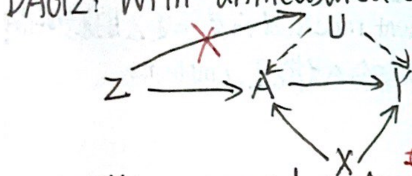
(1) It associated with treatment
(2) It affects the outcome only through its effect on treatment. Exclusion restriction.

重点1: Must not directly affect Y

DAG1:



DAG2: With unmeasured confounding U



重点2: Z must not affect unmeasured confounding, ~~directly or indirectly~~

- U作为unmeasured confounding, affects Y.
- 如果 $Z \to U$ 成立, 那么Z就可以通过U affects Y.
  $Z \to U \to Y$

也就是说Z可以不通过treatment A来影响Y, 违反了Exclusion restriction: Z can not affect Y through its impact on some unmeasured confounders. 如果Z对Y有影响, 也只能通过A.

(假设的实际性 realistic) If Z is randomized treatment assignment, are IV assumptions met?

1st. Z affects A ⟹ check this through data.
2nd. Z: coin flip ⟹ not affect the outcome or unmeasured confounders.

☆ subject: knowledge of treatment assignment.

§5.4.2

Recall the identification of causal effect is ... we don't know who the compliers are.! 必须作额外的假设.

(Monotonicity assumption) There are no defiers.

? Q: 为什么称为Monotonicity (单调性)?

因为随着encouragement程度的增大, take ~~treatment~~ treatment的程度也增大. The assumption is that probability of treatment should increase with more encouragement.

With monotonicity assumption:

Z	A	A^0	A^1	class
0	0	0	?	Complier or Never
0	1	1	1	Always taker
1	0	0	0	Never taker
1	1	?	1	Complier or Always

对于某部分subjects来说, 我们可以确定他们属于哪一个subpopulation, 于是问题就简化了很多. we can actually identify the causal effect among compliers. (monotonicity assumption的作用)

§5.5 Causal Effect Identification and Estimation

- How to estimate complier average causal effect use observational data?
- How the CACE relates to intention-to-treat-effect.

Recall: Our goal is to estimate

$$CACE = E(Y^{A=1} - Y^{A=0} \mid complier)$$

⟹ Begin with sth. that we can identify: ITT

$$E(Y^{Z=1} - Y^{Z=0}) = E(Y \mid Z=1) - E(Y \mid Z=0) \quad (5\text{-}1)$$

Intention-to-treat-effect

Q: 为什么 $E(Y^0) = E(Y \mid Z=0)$

因为Z是randomization 所以在Y的条件分布和potential Y的分布存在一一对应.

(1) $E(Y \mid Z=1) = E(Y \mid Z=1, \text{always takers}) P(at)$
$+ E(Y \mid Z=1, \text{never takers}) P(nt)$
$+ E(Y \mid Z=1, \text{compliers}) P(\text{compliers})$

a weighted average of the expected value of Y given Z=1 in 3 subpopulations

$= E(Y \mid \text{always takers}) P(\text{always takers})$
$+ E(Y \mid \text{never takers}) P(\text{never takers})$
$+ E(Y \mid Z=1, \text{compliers}) P(\text{compliers}) \quad (5\text{-}2)$

相等

(2) $E(Y \mid Z=0) = E(Y \mid \text{always takers}) P(\text{always takers})$
$+ E(Y \mid \text{never takers}) P(\text{never takers})$
$+ E(Y \mid Z=0, \text{compliers}) P(\text{compliers}) \quad (5\text{-}3)$

(3) $E(Y^{Z=1} - Y^{Z=0}) = E(Y \mid Z=1) - E(Y \mid Z=0)$
$= E(Y \mid Z=1, \text{compliers}) P(\text{compliers})$
$- E(Y \mid Z=0, \text{compliers}) P(\text{compliers}) \quad (5\text{-}4)$