

Introduction to Causal Inference

Academia Sinica ISSM — Day 1, Worksheet 2: Experiments and Ignorability

Name: _____

(short — finish with your neighbor if we run out of time)

1. Selection bias and randomization

The difference in means decomposes as

$$\begin{aligned}\mathbb{E}[Y_i \mid D_i = 1] - \mathbb{E}[Y_i \mid D_i = 0] &= \underbrace{\mathbb{E}[Y_i(1) - Y_i(0) \mid D_i = 1]}_{\text{ATT}} \\ &\quad + \underbrace{\mathbb{E}[Y_i(0) \mid D_i = 1] - \mathbb{E}[Y_i(0) \mid D_i = 0]}_{\text{Selection Bias}}\end{aligned}$$

- (a) In words, what does the selection-bias term measure?
- (b) Why does random assignment of D_i make it zero?
- (c) Bonus: With the bias term gone, the DIM equals the ATT. Why does it also equal the ATE here?

2. Arguing for CI — and why the estimator can't rescue you

A team estimates the effect of attending a cram school (D) on exam scores (Y), comparing attendees to non-attendees while conditioning on parental income and prior grades (X).

- (a) Write conditional ignorability for this study, then read it “backwards”: in one sentence, what does it assume about *who* attends a cram school, within a given level of X ?

$$\{Y_i(1), Y_i(0)\} \perp\!\!\!\perp ______ \mid ______$$

- (b) Name one thing they did *not* measure that plausibly affects both attendance and scores. Which way would it bias the naive comparison?

- (c) They report that subclassification, matching, and regression (all conditioning on the same X) give nearly identical estimates. Does this agreement make the causal claim more credible? Why or why not?