Section 1

Introduction and Potential Outcomes

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GOV 2003

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Overview

- Logistics:
  - Section: Thur 3:00 - 4:15 pm @ K262
  - TF Office Hours: Mon 1:30 - 2:30/Thur 4:30 - 5:30 pm @ TBD
  - **Pset 1 released!** Due at 11:59 pm (ET) on Sept 15
  - We encourage you to share your questions on Ed.
  - By September 17: Find a collaborator for the project (check the open thread for finding partners on Ed).

- Today's topics:
  1. Identification and estimation
  2. Example: Political canvassing

Identification and Estimation

- The fundamental problem of causal inference (Holland 1986)
  - We only observe one potential outcome per unit
    $\rightsquigarrow$ How do we infer the missing potential outcomes (= counterfactual)?
- Identification (*definition* of causal effects)
  - Assumptions for defining effects: e.g., SUTVA
  - Estimands (= Quantity of Interest): e.g., Sample Average Treatment Effect (SATE)
- Estimation (*learning* from observed outcomes)

Example: Political canvassing[1]

- Study of n voters
  - n_1 are canvassed
  - $n_0 = n - n_1$ are not canvassed
- For each voter $i \in \{1, 2, \ldots, n\}$, observe:
  - Vote choice (observed outcome): $Y_i = 1$ if voter i cast ballot for candidate A, and 0 if the voter cast ballot for candidate B.
  - Turnout (observed selection): $S_i = 1$ if voter i turned out, and 0 otherwise.
  - Canvassing (treatment): $D_i = 1$ if canvassed, and 0 otherwise.
- Causal question: does canvassing (D_i) affect vote choice (Y_i)?
- Selection on samples:
  1. canvassing may affect turnout (S_i), and
  2. we only observe the vote choices of the voters who turned out $\rightsquigarrow$ post-treatment bias

[1] Example adapted from 2021S STAT286/GOV2003 Review Question 1

Potential Outcomes and Principal Stratification

1. $D_i \to S_i$

- S_i: **Observed** turnout
- $S_i(d)$ for $d \in \{0, 1\}$: **Potential** turnout
  - Recall the "consistency" assumption: $S_i = S_i(d)$ if $D_i = d$ (no hidden versions of treatment)
  - If canvassed $[D_i = d]$, the potential turnout when the voter is canvassed $[S_i(d)]$ is the observed turnout $[S_i]$
- We have four principal strata defined by $(S_i(0), S_i(1))$
  - $(1, 1)$: turning out regardless of the canvassing
  - $(0, 1)$: turning out only when being canvassed
  - $(1, 0)$: turning out only when not being canvassed
  - $(0, 0)$: never turning out

Potential Outcomes and Principal Stratification

2. Vote choice does not exist if a voter i does not turn out

- Y_i: **Observed** vote choice
- $Y_i(d, s)$ for $d, s \in \{0, 1\}$: **Potential** vote choice
- $Y_i(1, 0)$ and $Y_i(0, 0)$ are not well defined
  - $Y_i(1, 0)$: Potential vote choice if the voter is canvassed and didn't turn out $\rightsquigarrow$ does not exist
  - $Y_i(0, 0)$: Potential vote choice if the voter is not canvassed and didn't turn out $\rightsquigarrow$ does not exist

Estimands

- Suppose effect of interest is the effect among those who turn out regardless of the treatment.
- What is the individual causal effect of canvassing on voting for candidate A among always turnout?

$$Y_i(1,1) - Y_i(0,1)$$

- What is the **population average treatment effect** of canvassing on voting for candidate A among always turnout?

$$\mathbb{E}[Y_i(1,1) - Y_i(0,1) \mid (S_i(0), S_i(1)) = (1,1)]$$

Estimands

- Vote share for candidate A = $\frac{\text{Number of votes for A}}{\text{Number of those who turn out}}$
- What is the group-level causal effect of canvassing on candidate A's vote share (among n voters in the study)?

$$Z(1) - Z(0) \text{ where } Z(t) = \frac{\sum_{i=1}^{n} Y_i(t) S_i(t)}{\sum_{i=1}^{n} S_i(t)} \text{ for } t \in \{0, 1\}$$