Segment 1: Fundamentals of Causal Inference

Section 07: Stable Unit Treatment Value Assumption (SUTVA)

Key Assumption: SUTVA

Stable **U**nit **T**reatment **V**alue **A**ssumption

(has actually been implicit thus far)

1. No "Interference"
2. No "multiple versions of treatment"

$$Y_i^z = Y_i^{z'} \text{ if } Z_i = Z_i'$$

Note: SUTVA is discussed in Ch 18.6 in Gelman, Hill, and Vehtari

SUTVA Part I: No Interference

Potential outcomes for the i^{th} unit do not depend on the treatments assigned to *other* units.

Let $\mathbf{Z} = (Z_1, Z_2, \ldots, Z_N)$

Assumption:

$$Y_i^{\mathbf{Z}} = Y_i^{Z_i}$$

This is precisely the assumption that gives us (with a binary treatment) only 2 potential outcomes for each unit

Example: Two Units, No SUTVA

$Z = (0, 1)$ for (taking, not taking) an aspirin when one has a headache. For $N = 2$ units, $\mathbf{Z} = (Z_1, Z_2)$

$\mathbf{Z}$ takes 2^N values: $(0,0), (1,0), (0,1), (1,1)$

Unit	Potential Outcomes			
1	$Y_1^{(0,0)}$	$Y_1^{(1,0)}$	$Y_1^{(0,1)}$	$Y_1^{(1,1)}$
2	$Y_2^{(0,0)}$	$Y_2^{(1,0)}$	$Y_2^{(0,1)}$	$Y_2^{(1,1)}$

Can you think of any examples of when this might happen?

Settings Where SUTVA May Not Hold

- Infections Diseases
  - *My wife's* infection outcome will depend on whether *I* get treated with vaccine
- Social Networks
  - If an intervention gets *me* to quit smoking, it may induce my *friends* to quit too
- Consumer goods
  - Treating a *new product* with a price reduction might make customers less likely to buy *other* products

Think of treatment effects that "spill over" across units

SUTVA Part II: No "Multiple Versions" of Treatment

- No matter how i received treatment t, the outcome would be Y_i^t
  - Analogously for Y_i^c
- Need clear definition and understanding of actions performed on the treated units
- AKA, "consistency"

$$Y_i^{obs} = Y_i^t \quad \text{whenever} \quad Z_i = t$$

Examples of "Multiple Versions of Treatment

SUTVA/consistency violations

- $Z \equiv$ "heart transplant," but different units receive different surgical procedures or some transplants performed by more skilled doctors
- $Z \equiv$ "reduction in ambient particulate pollution" but this reduction is achieved by different actions (regulating cars, closing power plants, planting trees)
- $Z \equiv$ "being obese", but there are many different reasons someone might be obese

Multiple versions of treatment $\rightarrow$ poorly defined potential outcomes $\rightarrow$ vague causal questions