

- (1) What is a causal state? What does it mean for a causal state to be finely articulated?
- (2) Why can't we measure individual level treatment effects,  $Y^1 - Y^0$ , in practice?
- (3) Do you think the SUTVA might be violated (why? Why not? ) for the causal effect of X on Y when
- (a) X = "Having a college degree" and Y = "Future earnings"
  - (b) X = "Vaccinating individual i in a local population" and Y = "person i's chances of getting sick abroad"
- (4) Use the notebook posted for this assignment from class to measure the ATE, ATC and ATT in the population when the naive estimator is unbiased.
- (5) Let's explore bias with simulated data:
- (a) Copy and modify the data generating process to introduce bias in the ATT and ATE, but leave the ATC unbiased (hint: define the [usually unmeasured]  $Y^0$  and  $Y^1$  for each unit, then examine the assumptions A1 and A2).
  - (b) Use naive estimators to measure the (potentially biased) ATE, ATC and ATT.
  - (c) Which estimates are biased? Is the bias baseline bias, differential treatment effect bias, or both?