METHODS FOR CAUSAL INFERENCE: TUTORIAL 4

1. [*Causal Inference in statistics: A primer*, Chapter 3]

   (a) List all of the sets of variables that satisfy the backdoor criterions, to identify the causal effect of T on Y.

   (b) List all of the *minimal* sets of variables that satisfy the backdoor criterion, to identify the causal effect of T on Y. A *minimal* sets of variables, refers to variables which if removed, the backdoor criterion is no longer satisfied.

   (c) List all minimal sets of variable that need to be measured in order to indetify the effect of D on Y. Repeat for the effect of $\{W, D\}$ on Y.

   (d) Assume only one variable, apart from T and Y, can be measure for the above graph. Explain which variable would allow the identification of the causal effect of T on Y and write down the identification formula.

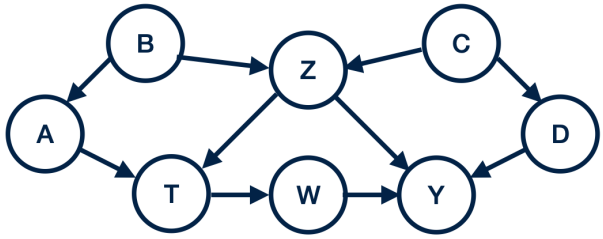

FIG. 1: The causal graph (Lecture 14)

2. Create a simulation similar to Lecture 13 and convince yourself of the optimal adjustment rule using numerical examples and causal graphs.

3. Using the lecture notes convince yourself that

$$p(Y_x = y) = p(Y = y|do(T = t)), \tag{1}$$

   by considering the set Z which satisfies the backdoor criterion.

4. [*Causal Inference in statistics: A primer*, Chapter 3] Prove that if T is binary, the effect of treatment on the treated can be estimated from a mix of observational and experimental data.

   Hint: Decompose $\mathbb{E}[Y_t] = \mathbb{E}[Y_t|T = t']p(T = t') + \mathbb{E}[Y_t|T = t]p(T = t)$ and use the observation in the previous question.