

Causal Inference - Homework 3

Introduction to Causal Inference -
a Machine Learning Perspective 0365-4094-01
Winter 2019/2020

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Question 1

Consider the DAG in Figure 1. For each of the following pairs of nodes, list: (1) all possible paths between them (2) what set of nodes is required (in a d-separation sense) to block all of their paths:

- (1) $W \rightarrow S$.
- (2) $X \rightarrow T$.
- (3) $Y \rightarrow H$.

Question 2

Consider the casual graph in Figure 2.

- (i) List all of the sets of variables that satisfy the backdoor criterion to determine the causal effect of T on Y .
- (ii) List all of the minimal sets of variables that satisfy the backdoor criterion to determine the casual effect of T on Y (i.e., any set of variables such that, if you removed any one of the variables from the set, it would no longer meet the criterion).
- (iii) Give a minimal set of variables that need to be measured in order to identify the effect of D on Y .

Question 3

Consider the following scenario, which is loose adaptation of the LaLonde experiment (as described in the tutorial).

You received data collected from an experiment run in a 3 years (2024-2026) span in Gotham City, USA, trying to estimate the effect of job training on real income a year following the training. In

the data (See Table 1), you have binary indicators for: prior education (Z), whether the annual real income in 2024 is higher than 50K\$ (X), had job training (T), whether the annual real income in 2026 is higher than 100K\$ (Y), and whether the citizen bought a house in 2026 (W).

We know the following:

- (i) The income in 2024 depends solely on the prior education.
- (ii) A person is selected to the job training program based on her prior education, and income in 2024.
- (iii) The income in 2026 depends on the job training, prior education and income in 2024.
- (iv) Whether a citizen purchased a house is directly based on her income in 2024 and 2026.

Your task is as follows:

1. Draw the causal graph that describe the above experiment.
2. Calculate the ATE of the experiment (derive the necessary probabilities from Table 1)

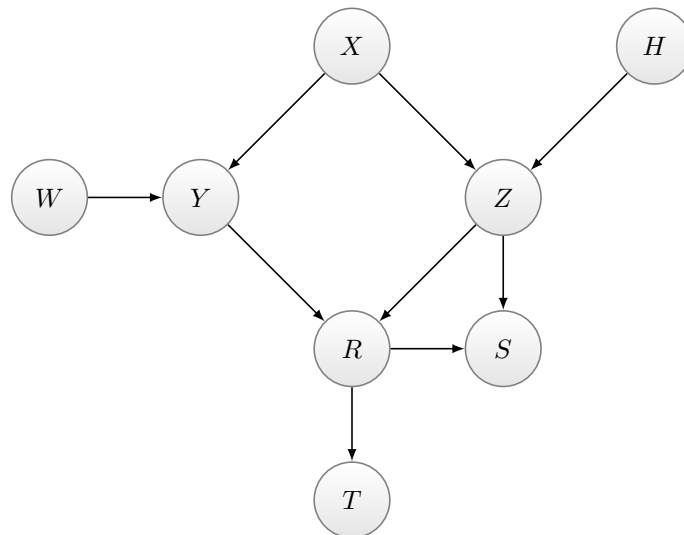


Figure 1

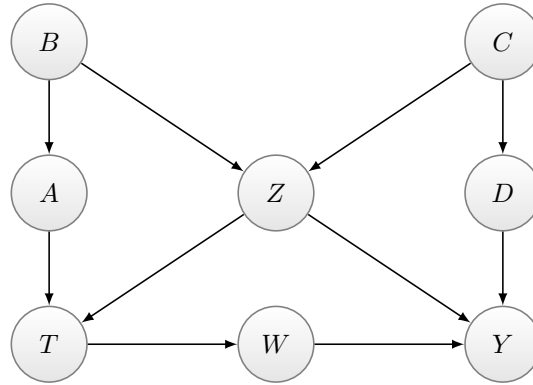


Figure 2

Z	X	T	Y	W
0	1	1	1	0
0	0	1	1	0
0	0	1	1	0
1	1	1	1	1
1	0	1	1	1
1	0	1	1	1
1	1	0	0	0
1	0	0	0	0
0	0	0	0	0
1	1	1	1	1
1	0	0	1	0
1	0	1	0	0
1	1	0	1	1
1	1	0	0	1
0	1	0	0	0
1	0	0	0	0
0	0	0	0	0
0	0	1	0	0
1	0	1	0	1
0	0	1	0	1

Table 1: Table1