Practice Question 3

Causal Inference

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A. Sketch the Directed Acyclic Graph (DAG)

Sketch (on paper or in `R`) the following DAG, representing our beliefs that:

- `x1 causes x2`
- `x1 causes x3`
- `x2 causes x4`
- `x4 causes x3`

We are interested in the causal relationship between `x1` (exposure) and `x4` (outcome).

B. Identify the number of open path(s)

How many open path(s) are there?

A) 0
B) 1
C) 2
D) 3

C. What is the valid adjustment set?

What are the valid adjustment set(s)? (Multiple solutions are possible)

A) $\emptyset$
B) $\{X_2\}$
C) $\{X_3\}$
D) $\{X_2, X_3\}$

D. Simulate the Data

Simulate the data ($n = 10000$ with `set.seed(1)`) from the structural equations:

$$X_1 \sim \epsilon_1$$
$$X_2 \sim -2X_1 + \epsilon_2$$
$$X_3 \sim 0.5X_1 + 0.5X_4 + \epsilon_3$$
$$X_4 \sim -0.25X_2 + \epsilon_4$$

where $\epsilon_1, \epsilon_2, \epsilon_3, \epsilon_4 \sim \mathcal{N}(0, 1)$ (i.i.d.)

E. Prima Facie Effect

Provide the *prima facie effect*.

F. Prima Facie Effect

The *prima facie effect* shows unbiased effect of `x1` on `x4`, because:

1. There are no blocked paths
2. There are no backdoor paths

A) No statements are true
B) Statements 1 is true and statements 2 is false
C) Statements 1 is false and statements 2 is true
D) Both statements are true

G. Simpsons Paradox

Show an example of a Simpsons Paradox with the use of the `lm` function. Discuss the result.

H. Berksons Bias

Show an example of a Berksons Bias with the use of the `lm` function. Discuss the result.

I. The True Average Causal Effect

Calculate the true causal effect by mimicking an intervention.