Practice Question 2

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 x3`

We are interested in the causal relationship between `x1` (exposure) and `x3` (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. Identify the number of backdoor path(s)

How many backdoor path(s) are there?

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

D. What is the valid adjustment set?

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

A) $\emptyset$
B) $\{X_2\}$
C) $\{X_1, X_2\}$
D) $\{X_2, X_3\}$

E. Simulate the Data

Simulate the data ($n = 1000$ with `set.seed(1)`) from the structural equations:

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

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

F. Test the Correlations

Test the correlations between the variables use $\alpha = 0.05$. Tip: You can use `cor.test` from (`stats`) to test marginal dependencies and `pcor.test` from (`ppcor`) to test conditional dependencies.

G. Recover the DAG

Which correlation(s) are (in)significant from part C? What structure can you infer from the results?

A) Mediator
B) Collider
C) Confounder

H. Recovered DAG from PC Algoritm

Figure 1 (next page) shows that the `PC-algoritm` did not recover the DAG. Which model assumption is not met?

A) Positivity
B) Exchangeability
C) Faithfulness
D) Sufficiency
E) Strong ignorability

I. Why does the algoritm require this assumption?

J. In general, we do not worry about violation of this assumption, why?

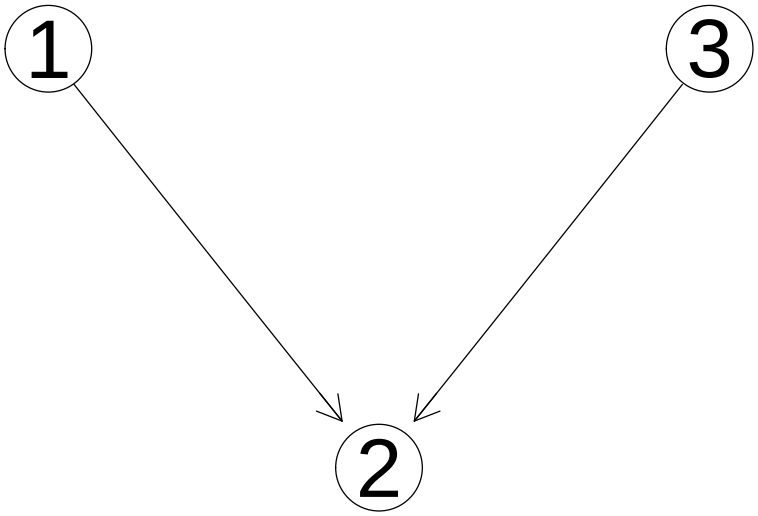

Figure 1: DAG Recovered by PC Algoritm