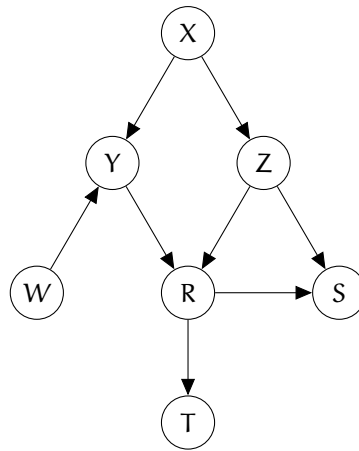


COMP3224: Homework 2

1. For the following graphical model, verify which of the claims below are correct.



- (a) $W \perp\!\!\!\perp S \mid \{Y, X\}$
- (b) $W \perp\!\!\!\perp S \mid \{Y, Z\}$
- (c) $W \perp\!\!\!\perp S \mid \{R, X\}$
- (d) $\{W, X\} \perp\!\!\!\perp \{S, T\} \mid \{R, Z\}$
- (e) $\{Y, Z\} \perp\!\!\!\perp T \mid \{R, S\}$
- (f) $\{X, S\} \perp\!\!\!\perp \{W, T\} \mid \{R, Z\}$
- (g) $\{X, S, Z\} \perp\!\!\!\perp \{W, T\} \mid R$
- (h) $\{X, Z\} \perp\!\!\!\perp W$
- (i) $\{X, S, Z\} \perp\!\!\!\perp W$
- (j) Can $\{X, S, Z\}$ be d-separated from W by conditioning on any set in the DAG above?

Recall, the semantics of the graphical relations are conditional probabilities:

$$\{\alpha, \beta\} \perp\!\!\!\perp \{\gamma, \delta\} \mid \{\epsilon, \phi\} \Leftrightarrow P(\{\gamma, \delta\} \mid \{\alpha, \beta\}, \{\epsilon, \phi\}) = P(\{\gamma, \delta\} \mid \{\epsilon, \phi\}).$$

2. The kidney stone data is reproduced below.

recovery rate	surgical treatment	
	T = 1 open	T = 0 needle
small stones	(81/87) = 93%	(234/270) = 87%
large stones	(192/263) = 73%	(55/80) = 69%
all	(273/350) = 78%	(289/350) = 83%

- Define what the average treatment effect (ATE), making sure you explain what each of the symbols you introduce means.
- Following the steps for the calculation of $\mathbb{E}[Y^1]$ as shown in the lecture, calculate $\mathbb{E}[Y^0]$ and find the ATE.
- Explain the relationship between do-calculus as employed in this example and the quantities Y^1 and Y^0 .
- Calculate $\mathbb{E}[Y = 1 \mid T = 1] - \mathbb{E}[Y = 1 \mid T = 0]$ (where $[\cdot]$ denotes ordinary conditioning).
- Of the two computed differences above between effects of treatment on recovery, why is the ATE considered the truer measure of the causal effect?

Submission

Submit a clearly written document explaining all the necessary steps.

Marks Q1 10, Q2 15.