

Knowledge Graph Analysis

Solutions to Exercise Sheet 8

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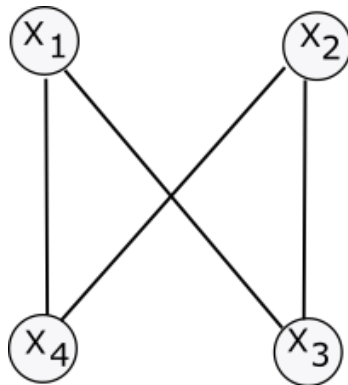
January 30, 2018

1 IN CLASS

1. Graphical Models

▷ Example Markov Network:

- Yes, because they are connected.
- No, because there is a path from X_1 to X_3 .
- No, because there is a path from X_1 to X_3 not going through X_4 .
- Yes, because every path from X_1 to X_3 does through $\{X_2, X_4\}$.



▷ Markov Network:

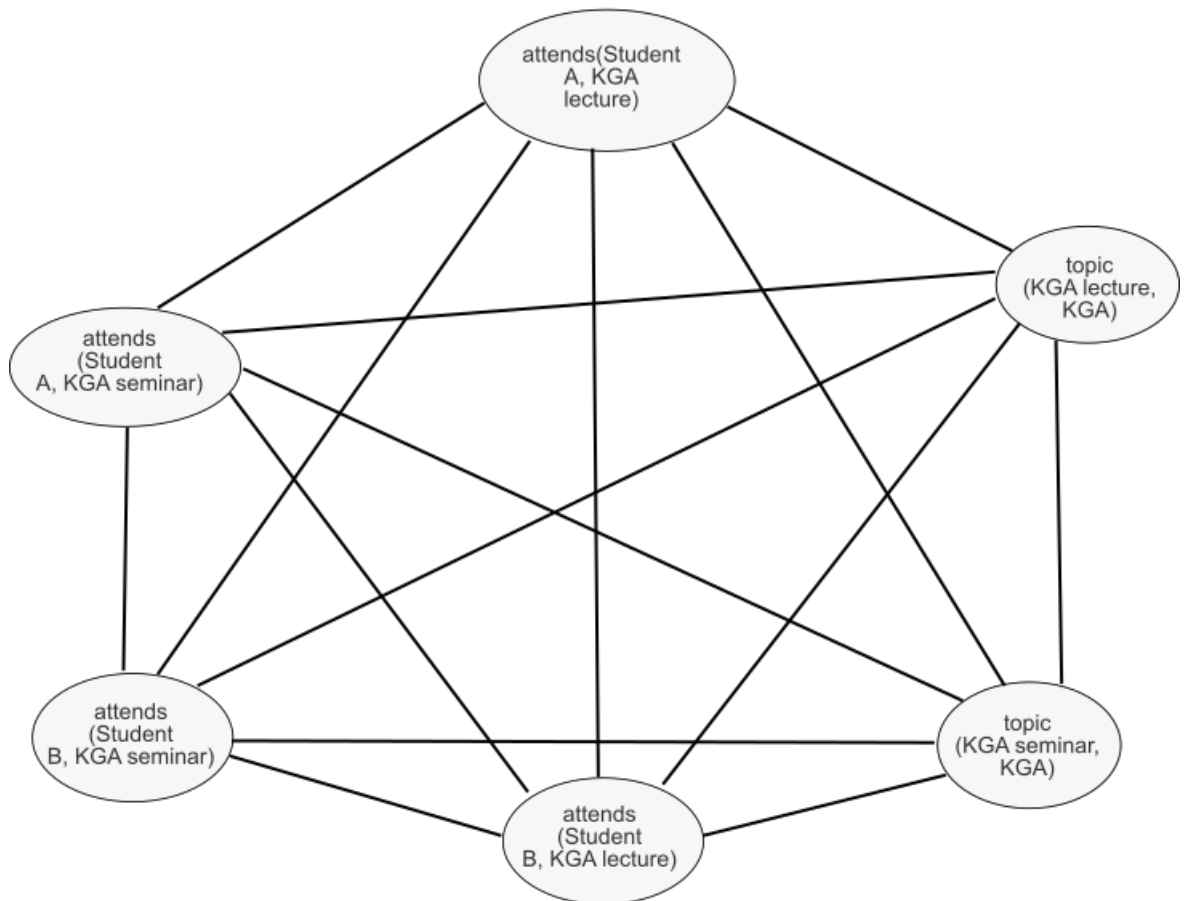
▷ Yes.

2. Factor Potentials

	X_1	X_2	X_3	X_4	$\phi(X_1, X_2)$	$\phi(X_2, X_3, X_4)$	$\phi(X_1, X_2) \times \phi(X_2, X_3, X_4)$
	false	false	false	false	0.5	1	0.5
▷	...						
	true	true	true	true	1	2	2
							$\Sigma = 16$

▷

$$\begin{aligned}
 P(w) &= \frac{1}{Z} \phi(X_1 = \text{true}, X_2 = \text{false}) \phi(X_1 = \text{false}, X_2 = \text{false}, X_3 = \text{true}) \\
 &= \frac{(0.5 \times 2)}{16}
 \end{aligned}$$



3.

4. Groundings / MLNs

- ▷ Formula 1 True grounding:

$$\begin{aligned} & \textit{attends}(\textit{Student A}, \textit{KGA lecture}), \textit{friendOf}(\textit{Student A}, \textit{Student B}) \\ \implies & \textit{attends}(\textit{Student B}, \textit{KGA lecture}) \end{aligned}$$

- ▷ Formula 1 False grounding: In order for the grounding to be false, the premise of the implication needs to be true and its conclusion false. For the premise to be true, both literals $\textit{attends}(P_1, E)$, $\textit{friendOf}(P_1, P_2)$ need to be true. The only possible true grounding of $\textit{friendOf}(P_1, P_2)$ wrt. the knowledge graph is $\textit{friendOf}(\textit{StudentA}, \textit{StudentB})$. However, since $\textit{StudentB}$ attends all known events, the conclusion is always true in that case. Hence, there is no false grounding of that formula.
- ▷ Formula 2 True grounding:

$$\begin{aligned} & \textit{attends}(\textit{Student B}, \textit{KGA lecture}), \textit{topic}(\textit{KGA lecture}, \textit{KGA}), \textit{topic}(\textit{KGA seminar}, \textit{KGA}) \\ \implies & \textit{attends}(\textit{Student B}, \textit{KGA seminar}) \end{aligned}$$

- ▷ Formula 2 False grounding:

$$\begin{aligned} & \textit{attends}(\textit{Student A}, \textit{KGA lecture}), \textit{topic}(\textit{KGA lecture}, \textit{KGA}), \textit{topic}(\textit{KGA seminar}, \textit{KGA}) \\ \implies & \textit{attends}(\textit{Student A}, \textit{KGA seminar}) \end{aligned}$$

5. ▷ No assumptions. (Markov Logic Networks are applied on knowledge graphs, given the assumption that all random variables for triples can be potentially statistically dependent on each other.)
 - ▷ 1 (hard constraint).
 - ▷ Weight learning in MLNs means to estimate the weights of formula given data. It is useful, if the structure of a problem is already known but the exact weight parameters are not (which is frequently the case) and should be estimated from data.
 - ▷ Learning the structure of Markov Logic Networks involves discovering rules capturing relationships found in data. It involves learning both formulas and their weights.