Computer Science Department, University of Bonn

Knowledge Graph Analysis

Solutions to Exercise Sheet 8

Dr. Hamed Shariat Yazdi, Prof. Jens Lehmann

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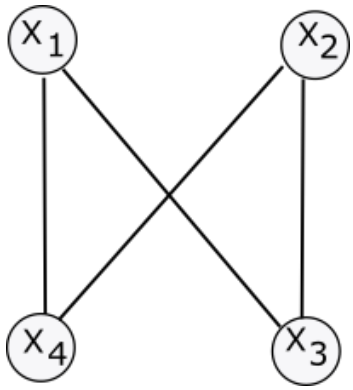
1 In Class

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.

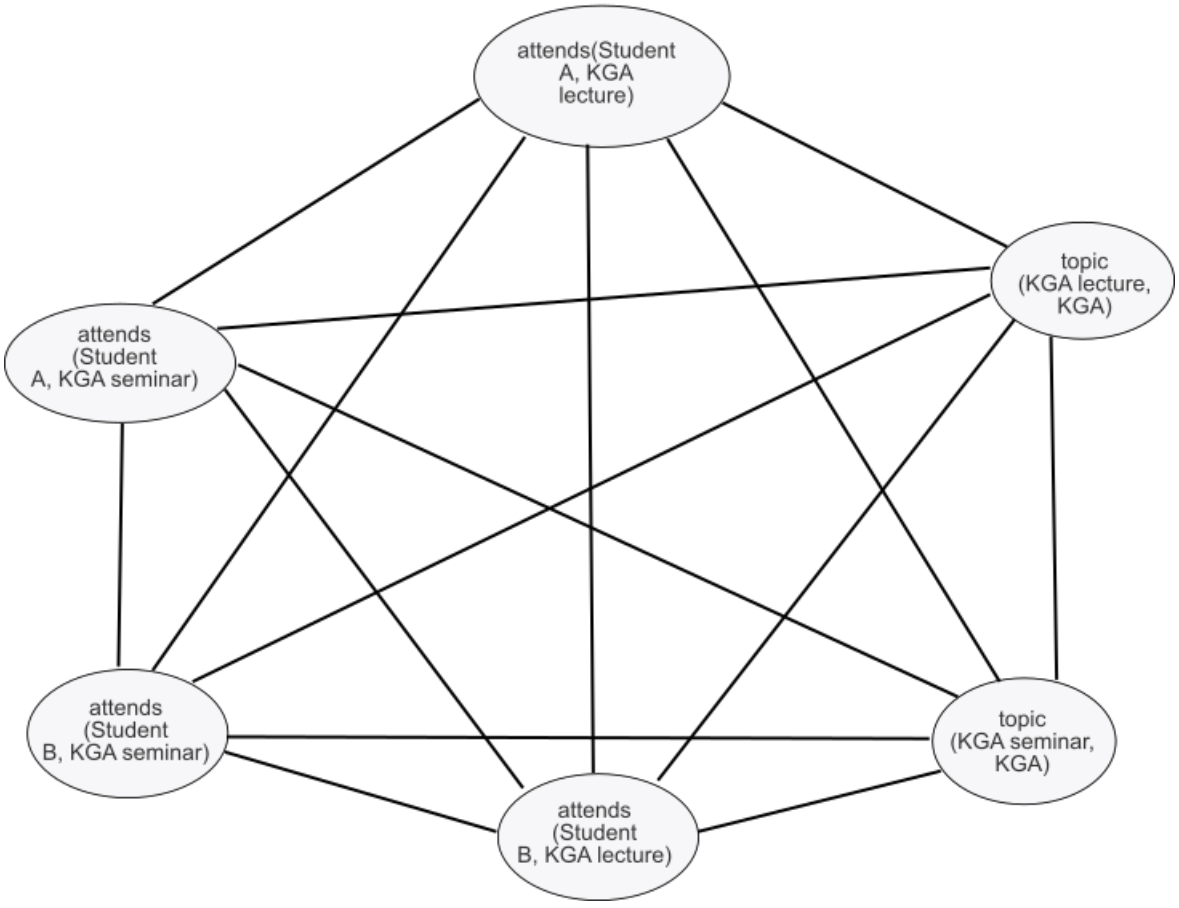
2. Factor Potentials

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
						$\sum = 16$

▷

$$P(w) = \frac{1}{Z}\phi(X1 = true, X2 = false)\phi(X1 = false, X2 = false, X3 = true)$$
$$= \frac{(0.5 \times 2)}{16}$$

3.



4. Groundings / MLNs

▷ Formula 1 True grounding:

$$attends(\text{Student A}, \text{KGA lecture}), friendOf(\text{Student A}, \text{Student B}) \implies attends(\text{Student B}, \text{KGA lecture})$$

▷ 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 $attends(P_1, E), friendOf(P_1, P_2)$ need to be true. The only possible true grounding of $friendOf(P1_2, P_2)$ wrt. the knowledge graph is $friendOf(StudentA, StudentB)$. However, since $StudentB$ 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:

$$attends(\text{Student B}, \text{KGA lecture}), topic(\text{KGA lecture}, KGA), topic(\text{KGA seminar}, KGA) \implies attends(\text{Student B}, \text{KGA seminar})$$

▷ Formula 2 False grounding:

$$attends(\text{Student A}, \text{KGA lecture}), topic(\text{KGA lecture}, KGA), topic(\text{KGA seminar}, KGA) \implies attends(\text{Student A}, \text{KGA seminar})$$

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.