17s2: COMP9418 Advanced Machine Learning

Lectures: Statistical Relational Learning – A Probabilistic Logic Approach
Topic: Questions from lecture topics
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Introduction

Some questions and exercises from the course lectures focusing on aspects of first-order logic for statistical relational learning. Please refer to the latest version of the lecture slides to answer the questions.

Question 1 Review the presentation of parameterized random variables (PRVs) and logical variables in the lecture slides. For the following, say whether you think each expression is a PRV or an RV, and give a reason.

1. *alarm*
2. *john_calls*
3. *calls(john)*
4. *calls(X)*
5. *noun_phrase([the,cat,sat,on,the,mat])*
6. *noun_phrase([the,X,sat,on,the,Y])*
7. *likes(scott,Zelda)*

Question 2 Thinking about the fact that the problem of determing whether a given formula in propositional is satisfiable (has a model, or a "possible world" which has value "true") is NP-complete, give an intuitive argument based on inference with factors to show that the problem of determining the probability of such a formula (such as computing the posterior probability of some query) is $\#P$-complete.

Question 3 When grounding out the following PRVs, will the size of the grounding be finite or infinite ? Give an explanation, with any assumptions that you made that could be used in applying lifted graphical modelling.

1. *calls(X)*, where X is the name of a person living in Los Angeles
2. *even(X)*, where X is an integer
3. *board_position(P)*, where P is a board position in chess

4. *recommend(I,U)*, where I is an item and U is a user on Amazon

5. *do(move(robot(X_t, Y_t),robot(X_{t+1}, Y_{t+1})))*, where the variables are coordinates of a robot position

Question 4 Give an explanation for the numbers obtained for the grounding in the "student modelling" example on slide 28, where the size of the grounding is $nm + n + m$.

Question 5 What, if any, statements can we make about conditional independencies in the "student modelling" example grounded model on slide 28? If so, why is this possible ?

Question 6 A key idea in lifted variable elimination that exploits repeated structure in the grounded factors enables a single instance of a repeated factor to be evaluated, then the exact value is inferred based on a *count* of the number of times the factor is repeated.

With reference to the relational inference example on slides 35–37 using lifted variable elimination, explain (i) why there are n^2 occurrences of the same factors (RVs) when summing out $s(X, Y)$ for parfactor ϕ_3, and (ii) why do we have the sum over products $\phi_2\phi_3$ raised to the power n ?