G53KRR

Revision

Plan of the lecture

- exam format
- common mistakes
- Bayesian networks
- description logic

Exam format

- same as before, 4 questions out of 6
- previous papers and answers on the web

Common mistakes 1

First order logic question: show that S1, S2 do not logically entail S3

- Correct answer: describe an interpretation which makes S1 and S2 true and S3 false
- Don't:
  - use truth tables for first order sentences
  - attempt a resolution derivation of [] from S1, S2 and ¬S3, and then stop and say 'see, it does not work, so S3 is not entailed'

Common mistakes 2

Resolution

- don't apply resolution to two literals at the same time:

$$MISTAKE: \quad \frac{[A, B],\ [\neg A, \neg B]}{[\,]}$$

  it is not sound! $A \vee B$ and $\neg A \vee \neg B$ should not derive false.

- only substitute for variables (not constants or functional terms) Don't do $f(x)/a$ or $a/f(x)$.

$$MISTAKE: \frac{[(P(f(x))],\ [\neg P(a)]}{[\,]}$$

Bayesian networks

- Directed acyclic graph
- Nodes: propositional variables; a directed edge from p_i to p_j if the truth of p_i affects the truth of p_j. p_i parent of p_j.
- $$J(\langle P_1, \ldots, P_n \rangle) = Pr(P_1 \wedge \ldots \wedge P_n)$$
- Chain rule

$$Pr(P_1 \wedge \ldots \wedge P_n) = Pr(P_1) \cdot Pr(P_2|P_1) \cdots Pr(P_n|P_1 \wedge \ldots \wedge P_{n-1})$$

- Independence assumption *Each propositional variable in the belief network is conditionally independent from non-parent variables given its parent variables:*

$$Pr(P_i \mid P_1 \wedge \ldots \wedge P_{i-1}) = Pr(P_i \mid parents(P_i))$$

where $parents(P_i)$ is the conjunction of literals which correspond to parents of p_i in the network.

Mistake 3

- Mistake: suppose a network consists of two variables, p_1 and p_2, such that there is an edge from p_1 to p_2. The mistake is to say that $Pr(p_1 \mid p_2) = Pr(p_1)$ because p_2 is not a parent of p_1 (so apply the independence assumption 'in reverse order of indices')
- This is a much more subtle (and understandable given the way the independence assumption is stated) mistake. I actually did not penalise the students who made it in the last year exam.
- The independence assumption statement on the previous slide is a bit sweeping
- In reality we assume that in the state description, the variables are listed in topological sort order (if there is an edge from p_i to p_j, then p_i appears before p_j in the order). This is always possible since the graph is acyclic.
- Independence assumption only applies to this order of indices. It does not apply to the probability of a parent conditioned on a child or a set of descendants.