

COMP3211 Final Exam

Dec 19, 2011

INSTRUCTIONS:

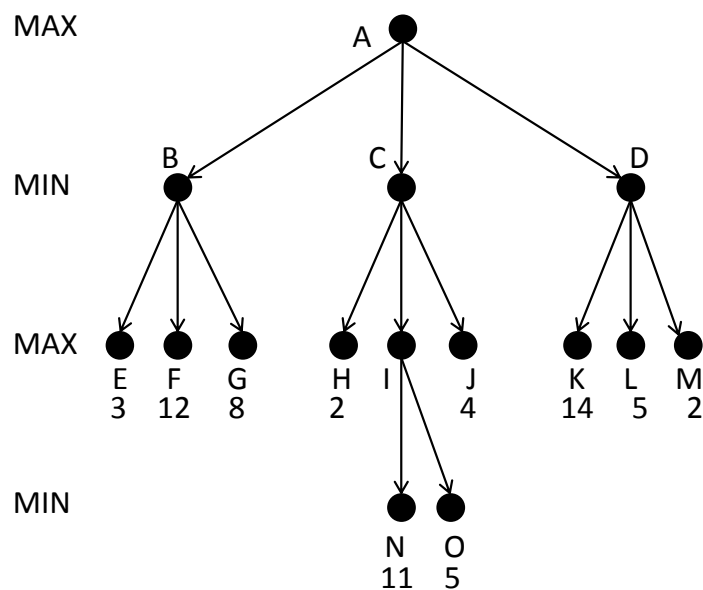
- **This is a closed book exam.**
- **There are total six questions.**
- **You have two and a half hours to complete it.**
- **Do not write your answers in any other space except the ones given.**
- **You can use back pages and the last blank page as your scrap paper.**
- **Use pen only. No pencils, please!**
- **Take out your student ID card and put it at the top left corner of your desk.**

Your student ID number:

Your name:

1. (14pts) Alpha-Beta Pruning

- Perform minimax with perfect decision on the tree given in the following figure (the leaves are terminal nodes, and the numbers next to them are their utility values).
- Perform a left-to-right alpha-beta prune on the tree and list the nodes pruned.
- Perform a right-to-left alpha-beta prune on the tree and list the nodes pruned.



2. (16pts) Convert the following sentences into CNF. Notice that negation has the highest precedence, followed by conjunction and disjunction, then implication, and then equivalence. Notice also that the conjunction and disjunction operators are left associative, but implication and equivalence are right associative.

A. $(p \supset q) \supset r \vee \neg(s \supset q).$

B. $[(p \equiv q) \supset s \supset \neg q] \supset p \supset q \supset p.$

$$\text{C. } \forall x[\forall y(P(x) \supset Q(x, y)) \supset \exists y, z(P(y) \wedge Q(y, z))]$$

$$\text{D. } \exists x F(x) \wedge \forall x G(x) \supset \neg[\forall x F(x) \vee \exists x \neg G(x)]$$

3. (15pts) Rule Learning with GSCA

Consider a soccer team that decides whether to hire someone as a Goal Keeper based on the following features:

- HS: high speed, true if the applicant has a top speed of 10m/s.
- LT: long throw, true if the applicant has a large range on long throws.
- PS: penalty saver, true if the applicant saves penalties very well.
- QL: quick launch, true if the applicant can reach his top speed quickly.
- FA: frequent attack, true if the applicant comes out to attack frequently.

Use GSCA to learn a set of rules from these examples about when to hire an applicant based on the values of the given attributes.

Please use the heuristic in the lecture notes: it selects a feature p that will yield the highest ratio n_+/n , where n is the number of instances covered, and n_+ the number of positive instances covered when p is added to the condition of the new rule.

FA	LT	PS	QL	HS	Hire
0	1	1	0	1	0
0	0	0	1	1	1
1	1	0	1	0	0
1	0	1	0	0	1
1	0	1	0	0	1
1	1	0	0	1	0
0	0	0	1	1	1
0	0	0	1	1	1
1	1	1	0	0	1
0	0	0	0	1	0
1	0	1	0	0	1

4. (15pts) Knowledge Representation and reasoning

Consider the following English sentences:

All people who are rich and smart are happy.

All people who read are smart.

John reads and is rich.

David is rich but does not read.

Jack is smart but is not rich.

Happy people have exciting lives.

- A. Express the statements above as first-order sentences using the following predicates (assuming all individuals are people):
rich(x), smart(x), happy(x), read(x), exciting-live(x)

B. Convert each sentence in your answers to part A into CNF.

C. Use resolution with refutation to show that there exists someone whose life is exciting. Note that you need to represent the query in first-order logic.

5. (20pts) Uncertainty

An admissions committee for a college is trying to determine the probability that an admitted candidate is really qualified. The relevant probabilities are given in the Bayes network shown here. Calculate $p(A|D)$.

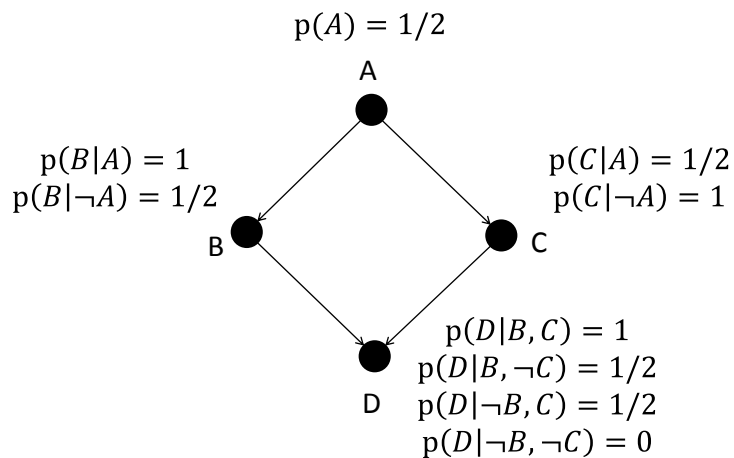
A = applicant is qualified

B = applicant has high GPA

C = applicant has excellent recommendations

D = applicant is admitted

Calculate $p(A|D)$.



6. (20pts) Answer the questions below

A. Indicate which of the following Boolean functions of three input variables can be realized by a TLU. You do not need to give the TLUs.

1. x_1
2. $x_1x_2x_3$
3. $x_1 + x_2 + x_3$
4. $x_1x_2x_3 + \overline{x_1x_2x_3}$
5. 1

B. Formalize the 4-queen problem into an assignment problem (constraint satisfying problem). You need to define the variables, domain and constraints. You do not need to solve it.

C. Prove that the two equations below are equivalent.

$$P(A|B,C) = P(A|C) \text{ and } P(B|A,C) = P(B|C)$$

D. Given n variables, how many non-equivalent Boolean formulas are there?
Your answer should be a formula of n .

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