CSCE420: Introduction to Artificial Intelligence
Prior Final Exam Questions

The following questions are all questions from prior examinations (finals and midterms).

Important: Your exam assumes that you will have prepared **6 pages** of notes. These can be US-letter, double-sided, typeset or written—to be brought with you on Mar 6th. These practice questions can give you a sense of what it might be useful to include in your notes.

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Question 1. Classical Planning: Execution

The following is PDDL description of a blocks-world problem.

$Init(On(A, Table) \land On(B, Table) \land On(C, A)$
$\quad \land Block(A) \land Block(B) \land Block(C) \land Clear(B) \land Clear(C)$
$Goal(On(A, B) \land On(B, C))$
$Action(Move(b, x, y),$
$\quad$ PRECOND: $On(b, x) \land Clear(b) \land Clear(y) \land Block(b) \land Block(y)$
$\quad \land (b \neq x) \land (b \neq y) \land (x \neq y),$
$\quad$ EFFECT: $On(b, y) \land Clear(x) \land \neg On(b, x) \land \neg Clear(y))$
$Action(MoveToTable(b, x),$
$\quad$ PRECOND: $On(b, x) \land Clear(b) \land Block(b) \land (b \neq x),$
$\quad$ EFFECT: $On(b, Table) \land Clear(x) \land \neg On(b, x))$

1.1 Write down all the actions that are applicable from the initial state. (2 pts)

1.2 Show all the steps involved in updating the state when action $Move(C, A, B)$ is executed from the initial state. Show the delete list and add list operations separately. (6 pts)

Question 2. Classical Planning: Definitions

1. Describe the relationship between planning and search by completing the following description:

(2 pts)

Complete final the sentence are completely and informatively as you can:

Like search, planning involves problem-solving. Planning can be implemented with search-based methods, but planning systems utilize explicit propositional or relational representations of states and actions. In constrast, search typically considers ________________________________

2. Russell & Norvig state (second paragraph on page 367) that $\neg Poor$ is not permitted as a fluent in a state because it is a negation. But several places (bottom of page 367, several in Figure 10.1) we see negations. Explain.

(2 pts)

3. How do propositional logical inference-based agents and PDDL planning-based agents compare? Describe their differences in terms of: level of expressiveness (first-order logic vs. PDDL) , theoretical worst-case performance, and practical performance.

(5 pts)

Question 3: Wolf, goat, and cabbage in PDDL

Old MacDonald—the very same one who had a farm—went to market and bought a wolf, a goat, and a cabbage. On his way home, he came to the bank of a river and found a boat. It was a small rowing boat, so he could cross carrying only himself and a single one of his purchases: either the wolf, the goat, or the cabbage.

The trouble is that wolves devour goats, if left together unattended. Similarly, the goat would eat the cabbage, if left together unattended. Yet, MacDonald managed to carry himself and his purchases to the far bank of the river, without the loss of any purchases.

Write down a PDDL description of MacDonald's conundrum, so that a planner could find a solution. You may use either the abstract style of description used in the textbook, or the more concrete form in your programming assignment.

Question 4: First-Order Logic Modeling (9 points)

Here is a scenario we studied in class, when discussing propositional logic:

"Jack is looking at Anne, but Anne is looking at George.
Jack is married, but George is not."

We then asked the following question:

"Is a married person looking at an unmarried person?"

1) Using the predicates **Person**, **Married**, **LookingAt**, express the facts in the domain as a single sentence in first-order logic.

2) Express the question in first-order logic.

3) If the correct answer to the first part of the question is A_1 and the second part is A_2, then does $A_1 \models A_2$?

Question 4: Proof in Propositional Logic (9 points)

On the Isle of Knights and Knaves: Knights always tell the truth, and Knaves always lie. However, it is not immediately obvious who is a Knight and who is a Knave.

You encounter Albert, Betty, and Carla, who are each either Knights or Knaves.

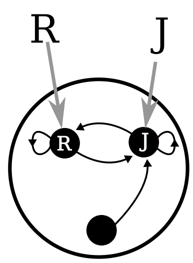
Albert says: *"Betty is a Knight, but Carla is a Knave."*
Betty says: *"Two of us are Knights."*
Carla says: *"Albert and I are both Knights."*

Prove that Carla is a Knave.
(Ensure that you describe each step and clearly label the rules you applied.)

Question 5: Short Questions (9 points)

5.1 True or False: "It is always possible to prove that a sentence in propositional logic is entailed or not entailed by a knowledge base." Give a brief justification. (2 pts)

5.2 Someone was asked to draw a diagram showing some member of the set of all models for a language with two constant symbols, R and J, and one binary relation, under database semantics. If the diagram below is the result, their depiction is not a correct interpretation. Explain why not. (2 pts)



5.3 True or False: The expression "$\neg P \vee \neg Q$" is a Horn clause. Briefly explain why. (2 pts)

5.4 Explain the intuition behind the minimum-remaining-values heuristic in a CSP search. (3 pts)

Question 6. True or False

Answer True or False <u>and</u> provide an illustratory example or explanation.

1. Backus-Naur Form (BNF) is commonly used to describe the semantics of a formal language. (2 pts)

2. Abduction is a form of deductive inference. (2 pts)

3. First-order logic and propositional logic are primarily distinguished by their epistemological commitments. (2 pts)

4. "There is a tree which is taller than any human" is a good translation of
$\exists t\, Tree(t) \Rightarrow [\exists h\, Human(h) \wedge Height(t) > Height(h)]$ (2 pts)

5. Clause $(A \Leftrightarrow B) \wedge (\neg A \vee B)$ is valid. (2 pts)

6. The Peano axioms define the positive integers. (2 pts)

7. The statement of the contrapositive can be expressed in first-order logic, i.e., "For all predicates, $P(x) \Rightarrow Q(x)$, is equivalent to $\neg Q(x) \Rightarrow \neg P(x)$." (2 pts)

In addition to these questions, we have worked two detailed examples in class. The first is resolution-based proof in FOL, the second is ID3 for decision tree induction. Though no prior questions appear for these, both will have questions on the final exam. Practice those!