CSCE420: Artificial Intelligence

Practice Questions for Midterm 2

Question 1: Propositional Logic

1) Given the following rules:

1. $P \wedge Q \Rightarrow R$
2. $\neg X \vee \neg Y \vee R$
3. $Q \wedge Y \Rightarrow W$
4. Q
5. $\neg(\neg X)$
6. Y

Prove using natural deduction $R \wedge W$. Describe each step and which labeled rules have been applied.

2) Express the following sentence in proposition logic.

"I must take at least two of cs320, cs420, and cs520."

3) Is the following in Clausal form?

$(P \Rightarrow Q) \wedge (X \Rightarrow Y)$

Question 2: Constraint Satisfaction Problem Formulations

You are trying to schedule observations on the space telescope. We have m scientists who have each submitted a list of n telescope observations they would like to make. An observation is specified by a target, a telescope instrument, and a time slot. Each scientist is working on a different project so the targets in each scientist's observations are different from those of other scientists. There are k total time slots, and the telescope has three instruments, but all must be aimed at the same target at the same time.

The greedy scientists cannot all be satisfied, so we will try to find a schedule that satisfies the following constraints:

C1. Exactly two observations from each scientist's list will be made (the choice of the two will be part of the solution).

C2. At most one observation per instrument per time slot is scheduled.

C3. The observations scheduled for a single time slot must have the same target.

Note that for some set of requested observations, there may not be any consistent schedule, but that's fine.

Consider the following three formulations of the problem.

A. The variables are the $3k$ instrument/time slots.

B. The variables are the m scientists.

C. The variables are the mn scientists' requests.

For each formulation, specify

i The value domain for the variables.

ii The size of the domain for the variables (in terms of k, m, and n).

iii Which of the constraints are necessarily satisfied because of the formulation.

iv Whether the constraints can be specified as binary constraints in this formulation. If they can, explain how. If not, provide a counterexample.

Formulation A: The variables are the $3k$ instrument/time slots.

i Domain:

ii Size of domain:

iii Satisfied constraints:

iv Binary constraints?:

Formulation B: The variables are the m scientists.

i Domain:

ii Size of domain:

iii Satisfied constraints:

iv Binary constraints?:

Formulation C: The variables are the mn scientists' requests.

i Domain:

ii Size of domain:

iii Satisfied constraints:

iv Binary constraints?:

Question 3: True or False (FOL)

Answer True or False and provide an illustratory example or explanation.

1.1 Backus-Naur Form (BNF) is often used to describe the semantics of a formal language.

1.2 First-order logic and propositional logic are primarily distinguished by their epistemological commitments.

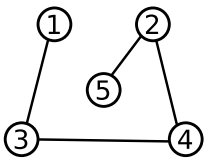
1.3 For a given Knowledge Base (KB), suppose S_S is the set of all possible models under standard semantics, and S_{DB} is the set of all possible models under database semantics. Not only is $S_{DB} \subseteq S_S$, but $S_{DB} \subset S_S$.

1.4 Prolog is complete as a theorem prover for definite clauses.

Question 4: Constraint Satisfaction

Consider the constraint graph that appears below. Assume each variable has the same domain $D_i = \{A, B, C\}, i \in \{1, 2, 3, 4, 5\}$. The only valid assignments to pairs of constrained variables are given in the table below.

Constraint (V_i — V_j)	**Valid assignments** (V_i — V_j)
1 — 3	A — C B – A
2 — 4	A — A B – B
3 — 4	A — B C – A
2 — 5	B — A A – C



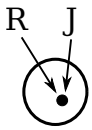
For example, the first row of the table should be interpreted as "Variables 1 and 3 can take either values A and C, respectively, or B and A, respectively."

2.1 Do constraint propagation repeatedly until you achieve arc consistency and show the legal domain values for each variable after the constraint propagation.

Variable	**Legal Values**
V_1	
V_2	
V_3	
V_4	
V_5	

Question 5: First Order Logic

Label each of the following diagrams with respect to the unique-names assumption, and the domain-closure property.



Question 6: Temporal Logic

1. Give some sequences that show that $\Box q \Rightarrow \Diamond q$ means. Include some that match, and some that do not and indicate which is which.
2. Explain why $\Box p \Rightarrow \Box\Box p$.
3. Express the following: "after a message is sent, it will arrive, though not immediately, since it takes three or more time ticks in order to be received."

Other preparation

Useful exercises from Russell & Norvig. (These may be more than you realistically have time to tackle. Read each of them, make sure you know what is being asked, and pick some—or form a study group.)

Chapter 6: 6.3, 6.5

Chapter 7: 7.1, 7.2, 7.4, 7.6, 7.10

Chapter 8: 8.2, 8.3, 8.6, 8.7, 8.8, 8.12, 8.24

Chapter 9: 9.4, 9.20, 9.21, 9.22, 9.23