MODERATED COPY
End-Semester Examination November 2021

CSL 412- ARTIFICIAL INTELLIGENCE (SLOT D)

Time: 1 Hr 30 Min **Max. Marks: 35**

Instruction to the candidates

Use suitable assumptions wherever necessary and state them in the answer script.

Q1. (a) With an example show that entailment in First Order Logic is semi-decidable. (CO3) (2)

(b) What is the complexity of the unification algorithm? Why? (CO3) (2)

(c) Which issues need to be taken into account for making the forward chaining algorithm efficient? How does the conjunct ordering problem impact the efficiency of the forward chaining algorithm? (CO3) (3)

(d) Why is the backward chaining algorithm more efficient than the forward chaining algorithm? What is the memory complexity of the backward chaining algorithm? (CO3) (2)

(e) With an example, explain how existential quantifier from a sentence given in first order logic is removed using Skolemization. Why is this necessary? (CO3) (3)

Q2. Consider that the knowledge base (KB) has been converted into the CNF and the ten clauses (C1-C10) with 13 variables (x1-x13) are as follows. (¬ refers to NOT and ∨ refers to OR)

C1: ¬ x1 ∨ x2 C2: ¬ x1 ∨ x3 ∨ x9 C3: ¬ x2 ∨ ¬ x3 ∨ x4 C4: x1 ∨ x8
C5: ¬ x4 ∨ x5 ∨ x10 C6: ¬ x4 ∨ x6 ∨ x11 C7: ¬ x5 ∨ ¬ x6
C8: x1 ∨ x7 ∨ ¬ x12 C9: ¬x7 ∨ ¬x8 ∨ ¬ x13 C10: x9 ∨ x10 ∨ x11 ∨ ¬ x1

Using the DPLL algorithm, find a model (if one exists) for the KB. At each step of choosing an assignment, mention which heuristic is being used. (CO3) (3)

Q3. (a) Solve the following cryptarithmetic problem using the heuristics for solving a constraint satisfaction problem and also using constraint propagation.

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   T W O
 + T W O
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 F O U R
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Each letter stands for a distinct digit and no leading zeroes are allowed. (CO1, CO2) (8)

(b) Why do we need to cut-off search in implementing realistic games? Which criteria need to be considered while deciding the cut-off point? (CO2) (2)

Q4. (a) What is the stopping criterion for any search algorithm for problem solving? (CO1) (1)

(b) Prove that the uniform cost search is an optimal search technique. (CO2) (2)

(c) In what situation can the bi-directional search algorithm be used? Give a problem in which it can be used and a problem in which it can not be used. (CO1) (2)

(d) What do we mean by the phrase that the 'A* search is optimally efficient'? Prove the optimality of the A* search technique. (CO1) (2)

(e) In the worst case, how many nodes will be generated by each of the following algorithms for the 8-tile puzzle if the depth of the shallowest goal node is at depth 8? The shallowest goal node occurs as the right most node at depth 8.

i) breadth first search
ii) depth limited search with limit of 8
iii) iterative deepening search (CO2) (3)