Ref. No. : Ex/PG/CSE/T/114A/8/2017

MASTER OF COMPUTER SCIENCE AND ENGINEERING 1ST SEMESTER EXAMINATION 2017

Advances in Artificial Intelligence

Time: Three hours **Full Marks: 100**

Answer any*five* questions

1. John is a researcher at an elite computer science research facility working on developing an efficient Graph-Search strategy. You are a junior researcher working with John on the problem. Together, you have designed a heuristic function,

$$f(n) = g(n) + h(n)$$

Where g(n) = the cost of the least costly path out of all the paths so far explored from start node **'s'** to node **'n'** and h(n) = approximate cost of the least costly path from node **'n'** to a goal node.
The strategy would explore the nodes at each iteration for which the value of the function f(n) is the least.

Suppose you have now introduced a condition $h(n) \leq h^*(n)$ *on every node n, where* $h^*(n)$*=actual cost of the least costly path from node 'n' to a goal node.The condition opens up a possibility that the algorithm will always terminate with optimal solution. John is however unimpressed. He states that then a node* n'*, which is on an optimal path from start node to a goal node, would need to be present in the OPEN list just before algorithm termination, which according to him cannot always be a certainty.*

a. To convince John,write a detailed proof illustrating that the node n' would indeed always be present on the OPEN list just before algorithm termination.
b. Additionally, John has also stated that if a goal node is to exist in the OPEN list along with the node n' just before termination, the algorithm would select the goal node thus ending in a non-optimal path. Contradict his statement with proper proof.

After convincing John, you have decided to publish your results in a reputed journal. However, your research was rejected by the reviewer and the following cause was given. ***"Although an innovative approach, however, the number of states generated by the algorithm is not much different from existing methods, i.e., the search is not much focused yet. Also, the pointer redirection problem still exists which is a large overhead."***

c. John has now suggested that if you can prove that your algorithm will only expand nodes through an optimal path from the start node, then the cause of rejection of the paper would cease to exist. Can you introduce any additional condition to your existing algorithm to better focus the search? If yes, then explain.
The research paper would only be accepted if it can be proven that by adding an additional condition, your algorithm will always expand nodes through an optimal path from the start node. How can you prove this?

6 + 6 + 8 marks

2. a.)Define an optimal policy π^* in terms of the reward based value $V^{\pi^*}(n)$ of a node n in the state space. Define the learning procedure Value Iteration that will converge to the optimal values.
   b.) Give a scheme for learning heuristic functions where the state space cannot be represented by an explicit graph and no model of the effects of the agent's actions is known.

   10 + 10 marks

3. What are the problems that may arise if State space search is applied for generating plans in real world? How can Sense/Plan/Act architecture developed by Nilsson be of help in such situations? Suggest methods to reduce computational cost for search under Sense/Plan/Act architecture with special reference to Limited Horizon Search.

   20 marks

4. a. State whether the following set of literals is unifiable and if yes, then find the most general unifier (mgu) for it.

   {P(y,y,B) ,P(z,x,z)}

   b. Convert the following well-formed formula to Clausal Form:

   $$\sim(\forall x)\{P(x) \Rightarrow \{(\forall y)[P(y) \Rightarrow P(f(x,y))] \wedge \sim (\forall y)[Q(x,y) \Rightarrow P(y)]\}\}$$

   c.Convert the following sentences into well-formed formulas using First Order Predicate logic.

   i. Every student, who walks, talks.

   ii. Everyone, whom Mary loves, loves someone who is happy.

   iii. Everyone loves everyone except himself.

   iv.Every city has a dog-catcher who has been bitten by every dog in town.

   4 + 8 + 8 marks

5. An author is creating a collection, titled "***Frontiers of AI***", comprising of research papers, for publication in a reputed journal. His objective is to collect all latest, standard research papers in the domain of AI. For selecting only the top research papers, he has decided that if the number of citations of the paper is greater than some integer ***C*** only then should the paper be selected for inclusion in his collection.
   He has now asked one of his students to compile the collection based on the given criterion. The author did not specify the value for ***C***. However, to give the student a head start, the author has stated that a paper ***AI_1*** is to be included in the collection. Now, a paper ***AI_2*** has a citation value greater than ***AI_1***. The student can prove that the paper ***AI_2*** should be included in the collection as well based on the domain rules:

   $\forall(x,y,z)$ [Greater(*citation(x)*,*citation(y)*)$\wedge$ Greater(*citation(y)*,*citation(z)*)$\Rightarrow$ Greater(*citation(x)*,*citation(z)*)]
   $\forall$(x)[Accept(x)$\Rightarrow$ Greater(*citation(x)*,C)]
   $\forall$(x)[Greater(*citation(x)*,C)$\Rightarrow$Accept(x)]
   And the data:
   Accept(***AI_1***)
   Greater(Citation(***AI_2***),Citation(***AI_1***))

a. Using these axioms, prove that ***AI_2*** should be included in the collection.

b. Using explanation-based generalization techniques on your proof, establish the rule $[\forall(x,y)\{[Greater(Citation(x), Citation(y)) \wedge Accept(y)] \Rightarrow Accept(x)\}$

c. Explain the goal of Inductive Logic Programming (ILP). Discuss about some standard procedures for selecting literals that might be added to the *body* of a Horn Clause.

6. Consider the following sentences. 14 + 6 marks

Tony, Mike and John belong to the Alpine Club. Every member of the Alpine Club is either a skier or a mountain climber or both. No mountain climber likes rain and all skiers like snow. Mike dislikes whatever Tony likes and likes whatever Tony dislikes. Tony likes rain and snow.

Use Resolution Refutation to prove that **"There exists someone who is a member of the Alpine Club and who is a mountain climber but not a skier"**

b. Discuss about the feasibility of resolution refutation system in realistic applications. Suggest the ways to make reasoning efficient at the cost of foregoing certain important properties of inference rules and limiting its applications.

15 + 5 marks