INDIAN INSTITUTE OF ENGINEERING SCIENCE AND TECHNOLOGY, SHIBPUR

B.Tech. (IT) 8th Semester Final Examination, 2023

Subject : Artificial Intelligence (IT-4201)

Full marks : 50 **Time : 3 Hours**

Answer any five Questions

1. Describe different types of agent with example. Why is tabular representation of agent function not considered? Are there agent functions that can not be implemented by any agent program? What is state space of a problem? How can we measure the performance of problem solving approaches?

   4+2+1+1+2

2. Compare the number of nodes expanded by breadth first search and iterative-deepening search for searching a tree. Consider a path search problem with a very large branching factor, but the goal node involves a relative short sequence of actions. These actions have varying costs. Which search algorithm would you use to find the best solution? Consider a heuristic such that $h(n) = h^*(n)$ for any node n. What is the impact of this heuristic on A* algorithm? Prove that when a node n is expanded by A* algorithm then every path with lower f-value has already been expanded. Explain the role of relaxed problem for inventing heuristic. Discuss the potential drawbacks of hill climbing search.

   2+1+1+2+2+2

3. " If A_2* is more informed than A_1*, then at the termination of their searches on any graph having a path from start to a goal node, every node expanded by A_2* is also expanded by A_1*" ---- prove the statement. Define a 'game' formally. How does heuristic affect a game playing program that uses the Minimax algorithm? What is the best case scenario of Minimax algorithm with Alpha-beta pruning? Consider a binary tree as game tree. The root node is the MAX node. The utility values of the leaf nodes from left to right of the tree are 5,3,2,1,4,6,7,2,2,3,5,4,5,6,3,1. Find out the minimax value, alpha and beta cut off points with proper explanation.

   3+1+1+1+4

4. Why is logic considered for knowledge representation? Two clauses are semantically distinct if they are not logically equivalent. How many semantically distinct 2-CNF clauses can be constructed from N proposition symbols? What are the disadvantages of propositional calculus (logic) in knowledge representation? Consider the following knowledge base (KB): "If I eat spicy foods, then I have strange dreams." "I have strange dreams if there is thunder while I sleep." "I did not have strange dreams." From the KB find out the relevant conclusion(s) and prove the conclusion(s) using propositional logic rules of inference. Translate the following axioms into predicate calculus wff: *"In every city there is a thief who is beaten by every policeman in the city"*.

   1+2+2+3+2

5. Explain alphabetic variant and ground instance in the context of substitution. Convert the following expression to clause (CNF) form: $(\forall x)[P(x) \rightarrow (\forall y)[(\forall z)[Q(x,z)] \rightarrow \sim(\forall z) [R(x,y)]]]$ (Assume that the lower case letters are variables and ~ is NOT operator). What is the need of most general unifier (mgu) in the context of unification? Consider that a knowledge base contains following sentences: Marcus was a man. Marcus was a Roman. All men are people. Caesar was a ruler. All Romans were either loyal to Caesar or hated him (or both). Everyone is loyal to someone. People only try to assassinate rulers they are not loyal to. Marcus tried to assassinate Caesar.

   Represent the above information by predicate calculus sentences in such a way that you can represent the question "Who hated Caesar?" as a predicate calculus expression. Use resolution refutation with answer extraction to answer it.

   2+3+1+4

6. Why is semantic net used for knowledge representation? Construct semantic net representation for the following information: Alex is a Quaker and a Republican. Quakers and Republicans are Persons. All Quakers are pacifists. All Republicans are not pacifists.

   Is there any problem with this semantic net? Explain the differences between semantic net and frame. What is demon? With a block diagram describe the different parts of expert system.

   1+2+2+1+4

7.

   a) Explain with an example how 'cut' is used to prevent backtracking in Prolog.

   b) Write Prolog program for the following:

   i) Split a list of numbers into two lists: positive ones(including zero) and negative ones.

   ii) Sort a given list of numbers using quick sort.

   iii) Copy numbers of a list which is greater than 50 to another list.

   iv) Insert an element in the last position of a list. Also double the element that is inserted.

   3+7