National Institute of Technology, Tiruchirappalli – 15
Department of Computer Science and Engineering
End Semester Examination
CSPC54 – Introduction to Artificial Intelligence and Machine learning

Course/Department : B.Tech./CSE
Semester/Section : V A
Date and Time : 22-11-2024 & 02.00 PM – 05.00 PM

Batch : 2022-2026
Session : July/2024
Marks : 40

Answer ALL Questions with proper steps and justification
Draw diagrams wherever necessary.

1. a) Using the PEAS framework, describe the task environment of an autonomous drone designed to deliver medical supplies in urban areas during emergencies. Identify the performance measures, the characteristics of its environment, the actuators it uses for navigation and delivery, and the sensors it relies on for obstacle detection and route planning. How do these components ensure timely and safe delivery? **(2)** CO:

   b) Suppose two friends live in different cities on a map. On every turn, we can simultaneously move each friend to a neighboring city on the map. The amount of time needed to move from city i to neighbor j is equal to the road distance $D(i, j)$ between the cities, but on each turn the friend that arrives first must wait until the other one arrives (and calls the first on his/her cell phone) before the next turn can begin. We want the two friends to meet as quickly as possible. Write a detailed formulation for this search problem. (You will find it helpful to define some formal notation here. Write the states, initial state, goal test, actions, cost function.) Let $D(i, j)$ be the straight-line distance between cities i and j. Which of the following heuristic functions are admissible? (i) $D(i, j)$; (ii) $2*D(i, j)$; (iii) $D(i, j)/2$. **(4)** CO1 CO:

   c) Compare uninformed search strategies such as breadth-first and uniform-cost in terms of Completeness, Optimality, Time and Space complexity. **(2)** CO1

   d) Consider a two-player zero-sum game represented by the game tree given below, where Player 1 (Maximizer) and Player 2 (Minimizer) alternate turns. Each terminal node contains an evaluation score representing the utility for Player 1. Perform alpha-beta pruning method on this tree. Update and record the α, β and node values at each internal node during traversal. Determine the optimal path that Player 1 would take under perfect play. **(3)** CO1
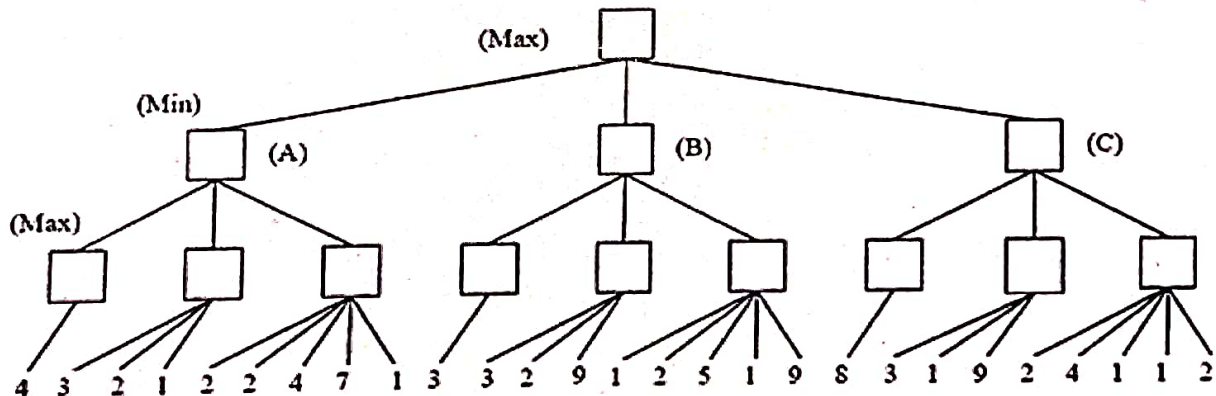
2. a) Formalize the following sentences using First order Logic.
   There exists a city where every resident loves pizza. **(1)** CO3

   b) Consider the following sentence:
   $[(A \Rightarrow C) \vee (B \Rightarrow C)] \Rightarrow [(A \wedge B) \Rightarrow C]$
   Determine, using enumeration (truth table), whether this sentence is valid, satisfiable, or unsatisfiable. **(2)** CO3

Q. In the Wumpus World, consider the following scenario:

The agent starts in square [1,1], which is safe. The Wumpus is located in [2,3], and there is a single pit located in [3,2]. The agent perceives the following sensory information as it moves:

At [1,1]: No percepts.
At [1,2]: No percepts.
At [2,2]: Stench and Breeze.
At [2,1]: No percepts
At [3,1]: Breeze.
At [1,3]: Stench.

The agent is tasked with determining the safe path to retrieve the gold, which is located at [2,4], and return to [1,1] without falling into a pit or being killed by the Wumpus.

(6) CO1 CO2

Construct the logical knowledge base for the agent in First order Logic or Proposition Logic, incorporating its percepts and reasoning about the Wumpus's and pit's locations. Using any inference methods (deduction/ forward chaining/ resolution), determine the safe squares the agent can move to at each step by inferring the pit's location and the Wumpus's location.

3. a) Discuss on successor-state axiom. Write a successor-state axiom for the Locked predicate, which applies to doors, assuming the only actions available are Lock and Unlock. **(2) CO3**

b) Draw a semantic network that represents the following data. **(2) CO2**
All dragons are living beings. There are two types of dragons: Fire Dragons and Ice Dragons. Fire Dragons breathe fire, and Ice Dragons breathe ice. Drogon is a Fire Dragon, while Viserion is an Ice Dragon. All dragons can fly, but only Fire Dragons can withstand high temperatures. There is a magical kingdom called Valyria, ruled by dragons, where Drogon is the king. Living beings in Valyria include humans, elves, and dragons. Humans worship dragons, and elves work for them.

4. a) Explain learning in multi-layer feed forward networks. Derive the equations. **(4) CO4**

b) Construct a Bayesian Network to model the factors influencing student performance (grade) in an exam. **(2) CO4**
Intelligence influences study hours and exam performance.
Study hours affect exam performance.
Exam difficulty affects the grade.

c) Discuss on the advantages and disadvantages of SVM. **(2) CO4**

5. a) Perform Hierarchical Agglomerative clustering on the following data points: A (10,5), B (15,10), C **(3) CO5**
(14,20), D (21,30), and E (24,22). Use Manhattan distance as the distance function (i.e, Dist (P1, P2) = |x1 - x2| + |y1 - y2|). Merge the clusters using single linkage and update the proximity matrix accordingly.

b) Explain fuzzy clustering in detail. **(3) CO5**

c) Discuss on the applicability of using silhouette score in finding the optimal number of clusters in k-means clustering. **(2) CO5**