भारतीय प्रौद्योगिकी संस्थान जम्मू
INDIAN INSTITUTE OF TECHNOLOGY JAMMU
Discipline of
Computer Science & Engineering

End-Semester Examination - Executive M.Tech(AI)
Course: Artificial and Computational Intelligence **Date: 16 April 2023**
Total Points: 50 **Time:2Hrs**

`Instructions:`

1. Write your name, enrollment number, and page number (in sequence) on each page of your answer sheet.
2. Write the full solution of each question with steps. No marks for direct answers. **PLAGIARISM is strictly prohibited**.
3. It is acceptable to make assumptions in exam questions with insufficient information, as long as you clearly state those assumptions in your answer.

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1. **[5 Marks]** Consider a scenario where you are designing an autonomous delivery robot to deliver packages to different Geo locations in a city. The robot needs to be able to navigate through different types of terrain, interact with humans in a socially acceptable manner, and safely deliver packages to the required locations. Design a basic agent-based AI system that can control the robot's behavior, taking into account its sensors and actuators. Include a discussion of the different components of the AI system. Also, specify the environment, actuators and performance metric. (Maximum word limit - 100 words, Preferably a Pictorial Representation of your proposed approach)

2. **[4 + 4 + 2 Marks]** Consider a robot that needs to navigate through a maze to reach a target location. The maze shown in Figure 1 represented by a 5×5 grid, where each cell can either be empty or blocked. The robot can move up, down, left, or right, but cannot move diagonally. The robot starts at position (0, 0) and the target location is at position (4, 4).

   (a) Use uniform cost search (UCS) and Best First Search (BFS) to find the shortest path from the robot's starting position to the target location. Assume that the cost of moving from one cell to an adjacent cell is 1, and the cost of moving to a blocked cell is infinite.

   (b) Use A* search with the Manhattan distance heuristic to find the shortest path from the robot's starting position to the target location. The Manhattan distance heuristic is defined as the sum of the absolute differences between the current position and the target position along each dimension.

   (c) Compare UCS, BFS and A* search in terms of the number of nodes expanded and the number of steps taken to find the solution. Explain your results.

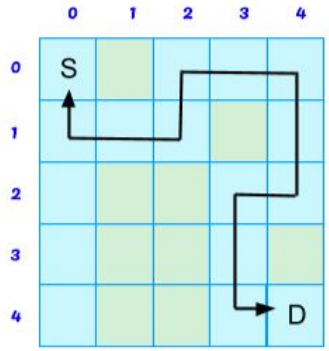

Figure 1: 5*5 maze

3. **[5+5+5 Marks]** Consider the two-player (Max player and Min Player) zero-sum game. The game begins with a set of eleven coins. On any player's move, the player must split the set of coins into two subsets. Max-player is not allowed to split a set/subset of coins into two equal sizes. If it is max player turn and all the sets/subsets of coins have either one or two coins, max player will lose the game. Propose an appropriate utility function for playing the game.

   (a)Apply the minimax algorithm for finding the best action for the max player at the root.

   (b)Apply the minimax algorithm with alpha-beta pruning for finding the best action for the max player at the root.

4. **[5+5+5 Marks]** Suppose that you are in the process of organizing a seating arrangement for a dinner party with six attendees: Alice, Bob, Charlie, David, Emily, and Fiona. Your objective is to seat them around a circular table that has six seats, but there are following limitations that you must consider.

   1. Alice and Bob are a couple and must sit next to each other.
   2. Charlie and David had a recent argument and must sit at opposite ends of the table.
   3. Emily is allergic to cats and must not sit next to Fiona, who has a cat.

   Write the mathematical formulation for the above constraint satisfaction problem (CSP). Find the step by step solution using

   - backtracking and
   - forward propagation
   - Genetic Algorithm with single point cross-over

5. **[5 Marks]** Write the brief problem statement mentioned by you in 0^{th} class assignment and propose the solution with respect to your learning in this ACI course. (Maximum word limit - 100 words, Preferably a Pictorial Representation of your proposed approach).