BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
CSF 407 (ARTIFICIAL INTELLIGENCE), Second Semester 2022 - 2023
Mid Semester Exam [CLOSED BOOK]

March 16, 2023 **MM: 27 [90 Mins]**

Answer all parts of a question together. There are five questions in all.

Q1 [4M]. With respect to uninformed search strategies, answer the following:

- **a)** Out all uninformed search strategies covered during the lectures, which one is better to use if the search space is large and the depth of the solution is not known. Justify your answer.
- **b)** What is the time-complexity and space-complexity of Iterative Deepening DFS? Prove your answer. Answer your question in terms of b (branching factor), d, and m.
- **c)** Is Iterative Deepening DFS complete? Is it optimal? Justify.

Q2 [4M]. What is the difference between heuristic function of greedy search and A* search? Which one is better? Also, how can we characterize the quality of a heuristic?

Q3 [6M]. Suppose two friends live in different cities on a map, such as the Romania map. On every turn, we can simultaneously move each friend to a neighbouring city on the map. The amount of time needed to move from city i to neighbour 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.

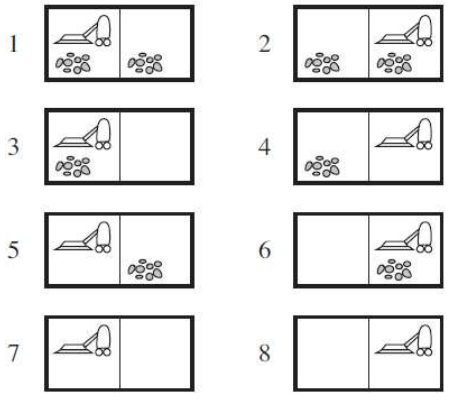
- **a)** Write a detailed formulation for this search problem.
- **b)** Let D (i, j) be the straight-line distance between cities i and j. Which of the following heuristic functions are admissible? (i) D(i,j); (ii) 2 x D(i, j); (iii) D(i,j)/2.
- **c)** Are there completely connected maps for which no solution exists?
- **d)** Are there maps in which all solutions require one friend to visit the same city twice?

Q4 [4M]. A hill-climbing algorithm that never makes "downhill" moves toward states with lower value (or higher cost) is guaranteed to be incomplete, because it can get stuck on a local maximum. In contrast, a purely random walk—that is, moving to a successor chosen uniformly at random from the set of successors—is complete but extremely inefficient. How to reasonably combine hill climbing with a random walk in some way that yields both efficiency and completeness.

Q5 [4M]. Recall that the vacuum cleaning world state space has eight states, as shown in the given Figure. There are three actions—Left, Right, and Suck—and the goal is to clean up all the dirt (states 7 and 8). In the erratic vacuum world, the Suck action works as follows:

- When applied to a dirty square the action cleans the square and sometimes cleans up dirt in an adjacent square, too.
- When applied to a clean square the action sometimes deposits dirt on the carpet.

Now consider the sensorless version of the erratic vacuum world. Draw the belief-state space reachable from the initial belief state {1, 2, 3, 4, 5, 6, 7, 8} and comment about its solvability.



Q6 [5M]. Consider the given dataset. Given that Outlook attribute forms the root node of the decision tree (because it has best information gain), make the complete tree. Show the calculations.

Outlook	Temperature	Humidity	Wind	Played football(yes/no)
Sunny	Hot	High	Weak	No
Sunny	Hot	High	Strong	No
Overcast	Hot	High	Weak	Yes
Rain	Mild	High	Weak	Yes
Rain	Cool	Normal	Weak	Yes
Rain	Cool	Normal	Strong	No
Overcast	Cool	Normal	Strong	Yes
Sunny	Mild	High	Weak	No
Sunny	Cool	Normal	Weak	Yes
Rain	Mild	Normal	Weak	Yes
Sunny	Mild	Normal	Strong	Yes
Overcast	Mild	High	Strong	Yes
Overcast	Hot	Normal	Weak	Yes
Rain	Mild	High	Strong	No