LNMIIT
The LNM Institute of Information Technology

LNMIIT/B.Tech./CSE/CORE/2018-19/ODD/AI/MT

Artificial Intelligence (AI)

Mid Term

Time: 90 minutes | Date: October 04, 2018 | Max. Marks: 60

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Please read the following instructions carefully.

- There are 4 questions printed on both sides.
- **No marks** for providing just expressions/answers unless accompanied with correct justification and/or derivation.
- In case of any doubt, make your assumption, write it clearly and continue.
- Be precise and to the point in your answers.

======XXXXXX======

1. Provide justifications to make the following statements hold.
   (a) DFS is *always* complete except under one condition. (Basically provide that condition with example.)
   (b) BFS provides the shortest path to the goal provided one condition is met. (Again provide that condition with a suitable example.)
   (c) DFS with fringe is computationally more robust than hill climbing.
   (d) For a two player zero sum game, minimax tree provides the optimal play against a perfect adversary.

3+4+4+4 Marks

2. Consider the Tiles problem as shown in Fig. 1.

initial state

1	8	2
	4	3
7	6	5

→

goal state

1	2	3
4	5	6
7	8	

Figure 1: Tiles problem.

   (a) Design an A* algorithm for solving the above tiles problem.
   (b) Design two heuristics and compare them in terms of performance (measured with respect to the number of steps taken to reach the goal state).
   (c) Design a heuristic that is not admissible for the above problem.
   (d) Design a consistent heuristic for the above problem. Prove that it is admissible too.

5+3+2+(4+1) Marks

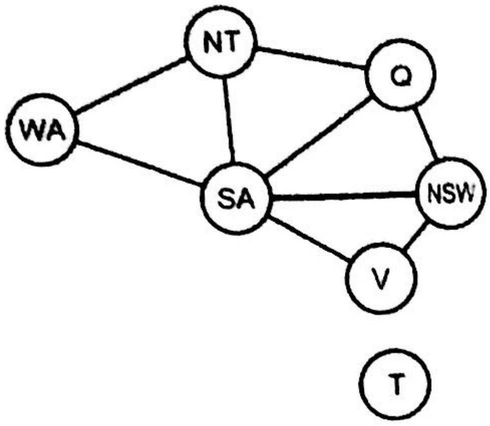

Figure 2: Graph for CSP for coloring Australia

3. Consider the coloring problem that we had discussed in the lectures on CSPs (Fig. 2). We are given that we can choose from a set of {blue, green, red} to color each node such that no two neighbours get the same color. We discussed many strategies in the class. Answer the following questions.

(a) Write the variables, domain and constraints for the problem.

(b) Explain how the Minimum Remaining Values and Least Constraining Value heuristics help in improving the time complexity for DFS with backtracking.

(c) In a quest to further improve backtracking, we introduced the notion of arc consistency. Discuss a scenario in which arc-consistency fails, i.e., even though the arcs are consistent, yet no valid assignment of the colors exist.
Hint: Think of 3-consistency.

(d) Show how the problem can be converted to tree structure to solve the prolbem efficiently. Can we efficiently find tree structures for all CSPs in general?

(e) Recall iterative improvement. In this algorithm, instead of starting from an empty assignment, we start from a random complete assignment. Solve the coloring problem using iterative improvement.

3+3+3+(2+1)+3 Marks

4. Define X_n as the number of rows, columns, or diagonals with exactly n X's and no O's. Similarly, O_n is the number of rows, columns or diagonals with just n O's. Assuming $n = 3$, the utility function assigns $+1$ to any position with $X_3 = 1$ and -1 to any posiition with $O_3 = 1$. All other terminal positions have utility 0. For nonterminal positions, we use a linear evaluation function defined as $Eval(s) = 3X_2(s) + X_1(s) - 3(O_2(s) + O_1(s))$.

(a) *Approximately* how many possible games of tic-tac-toe are there?

(b) Show the whole game tree starting from an empty board down to depth 2 (i.e., one X and one O on the board), taking symmetry into account.

(c) Mark on your tree the evaluations of all the positions at depth 2.

(d) Using the minimax algorithm, mark on your tree the backed-up values for the positions at depths 1 and 0, and use those values to choose the best starting move.

(e) Circle the nodes at depth 2 that would not be evaluated if alpha-beta pruning were applied, assuming the nodes are generated in the optimal order for alpha-beta pruning.

3+3+3+3+3 Marks