0109

National University of Computer and Emerging Sciences

Artificial Intelligence (AI 2002)

Sessional-I Exam

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Total Time: 1 Hours
Total Marks: 25
Total Questions: 02

Semester: SP-2025
Campus: Lahore
Dept: Computer Science
Data Science

Student Name ______ Roll No ______ Section ______ Student Signature ______

Vetted by ______ Vetter Signature ______

WRITE THE FINAL ANSWER IN THE SPACE PROVIDED ON THE QUESTION PAPER
CLEARLY STATE ASSUMPTIONS IN CASE OF ANY MISSING INFORMATION
USE ROUGH SHEET TO PLAN YOUR ANSWER BEFORE WRITING IT

CLO 1: **Demonstrate** understanding of **basic** AI strategies for searching a large solution space

Q 1: Minimax Search **[5 + 5 marks]**

A program uses minimax search without pruning to play a simple game with the following rules

1. The game starts with a variable N set to an initial random value (e.g. 5).
2. Two players take turns picking a number from the set {1, 2, 3} such that the picked number must never be greater than N.
3. The chosen number is subtracted from the N.
4. The player who picks the last number (reducing N to 0) loses the game.

Assume that the initial value of N is 5 and it is programs turn to make a move.

ON THE NEXT PAGE, Draw the complete game tree used by the program to decide the move in this state and determine the move selected by the program by computing value of all nodes in the game tree.

Remember that the value of leaf nodes in this game tree will be +1 if program is winning, -1 if it is losing and 0 in case of a draw.

0109

CLO 1: **Demonstrate** understanding of **basic** AI strategies for searching a large solution space

Q 2: State-Space-Search **[4 + 2 + 7 + 2 marks]**

A computer program uses state-space-search methods to solve the following class of problems.

Given two variables, X and Y, which can hold integer values. The maximum value X can store is 4, and the maximum value Y can store is 3. Initially, both variables are set to 0.

At any step, one of the following operations can be applied on these integers:

1. **S_1:** Set X to 4 { After this operation X becomes 4}.
2. **S_2:** Set Y to 3 { After this operation Y becomes 3}.
3. **Z_1:** Set X to 0 if it is not already 0.
4. **Z_2:** Set Y to 0 if it is not already 0.
5. **T_1:** Transfer as much value as possible from X to Y without exceeding the limit of Y i.e. 3. For example if in state (3, 2) operation T_1 is applied then the new state will be (2, 3) i.e. value of X reduces by 1 and that of Y increases by 1. Similarly if T_1 is applied in state (2, 0) then the new state becomes (0, 2)
6. **T_2:** Transfer as much value as possible from Y to X without exceeding the limit of X i.e. 4. T_2 is similar to T_1 with vale transferred from Y to X.

The goal is to reach a specific target state (X, Y) using the allowed operations.

Part a. Assume that initially the variables (X, Y) are set to (0, 0) and the problem at hand is to set the values to (2, 3) i.e. X = 2 and that of Y = 3 and that the repeated states are avoided during the state-space-search

ON THE NEXT PAGE, Draw the state-space-search tree used by the program to find the solution if it used BFS to find it. Also determine the minimum and maximum numbers of states expanded by the program during the BFS search to solve this problem.

Remember we say that a state has been expanded when it comes out of the queue and its successors are inserted into the queue

Part b. What will be the minimum number of states expanded/processed by the program if it used DFS instead of BFS? Justify.

SPACE FOR TREE IN PART a

Part c. Next assume that the initial state is (4, 3) and the goal state is (2, 0). Further assume that A* search is used by the program to find the solution using the following heuristic

h(n) = Sum of Absolute Differences from the goal state,

For example, the difference of the initial state (0, 0) from the goal state (2, 0) is 2 = abs (0-2) + abs(0-0), and for a state (4,1) to the goal state (2, 0) is 3 = abs (4-2) + abs(1-0).

Draw the complete state-space-search tree used by the program to find the solution if it used A* to find it. Also write the solution found by A* and specify the states in the queue when the solution is found?

0105

Part d. Is the heuristic function, given above admissible? Justify