National University of Computer and Emerging Sciences

Artificial Intelligence (AI 2002)

Sessional-I Exam

Date: Feb 29th 2024

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Total Time: 1 Hours
Total Marks: 35
Total Questions: **02**

Semester: SP-2024
Campus: Lahore
Dept: Computer Science
Data Science

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Student Name Roll No Section Student Signature

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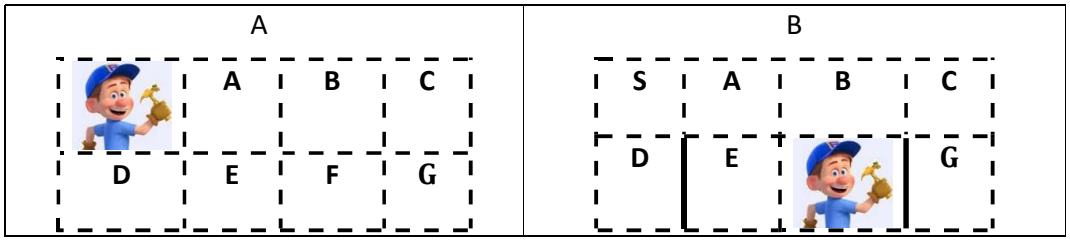
Vetted by Vetter Signature

CAREFULLY PLAN YOUR ANSWER ON A ROUGH SHEET AND WRITE THE FINALIZED ANSWER IN THE SPACE PROVIDED ON THIS QUESTION PAPER

CLO 1: Understand principles and techniques of artificial intelligence

Q1: Search Techniques **[3 + 10 + 4 + 3 marks]**

"Solve-It Felix" is a puzzle based game played on an N x N grid of cells. An agent, **Felix**, starts from a given location on the grid and need to reach the exit cell (i.e. cell containing key). In a single move, the agent is allowed to move into either a horizontally (i.e. L, R) or vertically (i.e. U, D) adjacent cell. Some of the cell sides are permanently locked and hence cannot be used to enter into that cell. For example, in the figure (a) Felix is allowed to enter into both cells A and D whereas in figure (b) **Felix is not** allowed to enter into cell G, as that side is blocked (**SHOWN WITH SOLID LINE**) but he can enter into any other neighboring cell including cell E which also has one of its sides blocked.



For creating an auto-player for this puzzle, a teacher at NUCES-FAST proposed to use some search strategies for solving this puzzle and she needs your help in implementing the auto-player.

a) How would you represent the state of the puzzle at any instance so that it is used by the search algorithm for finding a solution?

HINT: Think about the minimum necessary information needed at any point during the execution of search algorithm for making a decision.

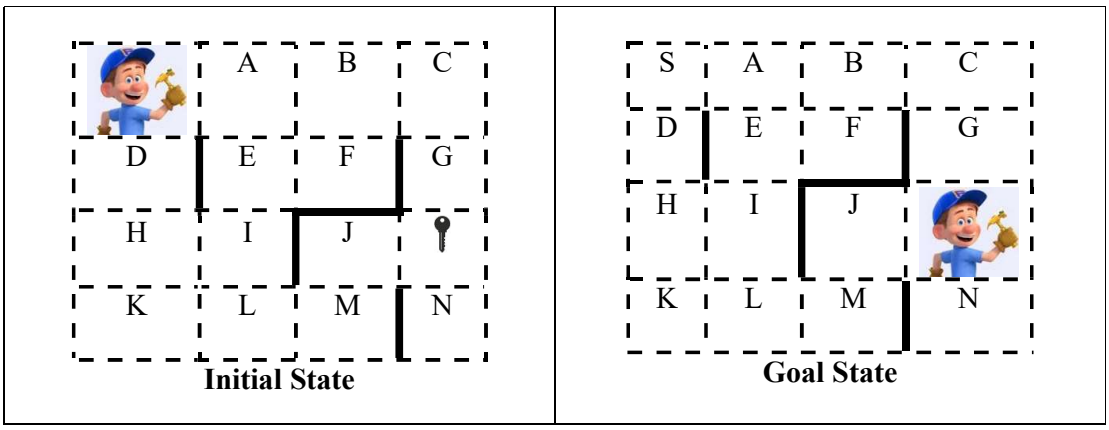
AT MINIMUM WE NEED TO KEEP TRACK OF FELIX POSITION (R, C) ON THE M X N GRID

Plus

State of the grid including position of key, sate of blocked sides might be included as these will be used to generate successors and test for the Goal state

b) Draw a complete state space search tree that will be used by the agent to plan a path from the start to the goal state assuming that implementation of the agent uses A* algorithm with the heuristic function

h(n) = Horizontal Distance of cell n from key cell + 5 * Vertical Distance of n from key cell (ignoring the blocked walls). For example the heuristic value of cell B is 1 + 5 * 2 = 11 and heuristic value of cell K is 3 + 5 * 1 = 8



On the tree, you must clearly mark

i. The **order** in which each node of the tree is visited/processed/expanded by A*

ii. The **value** of each node that is used by A* during processing

Also list/write the solution found by A*

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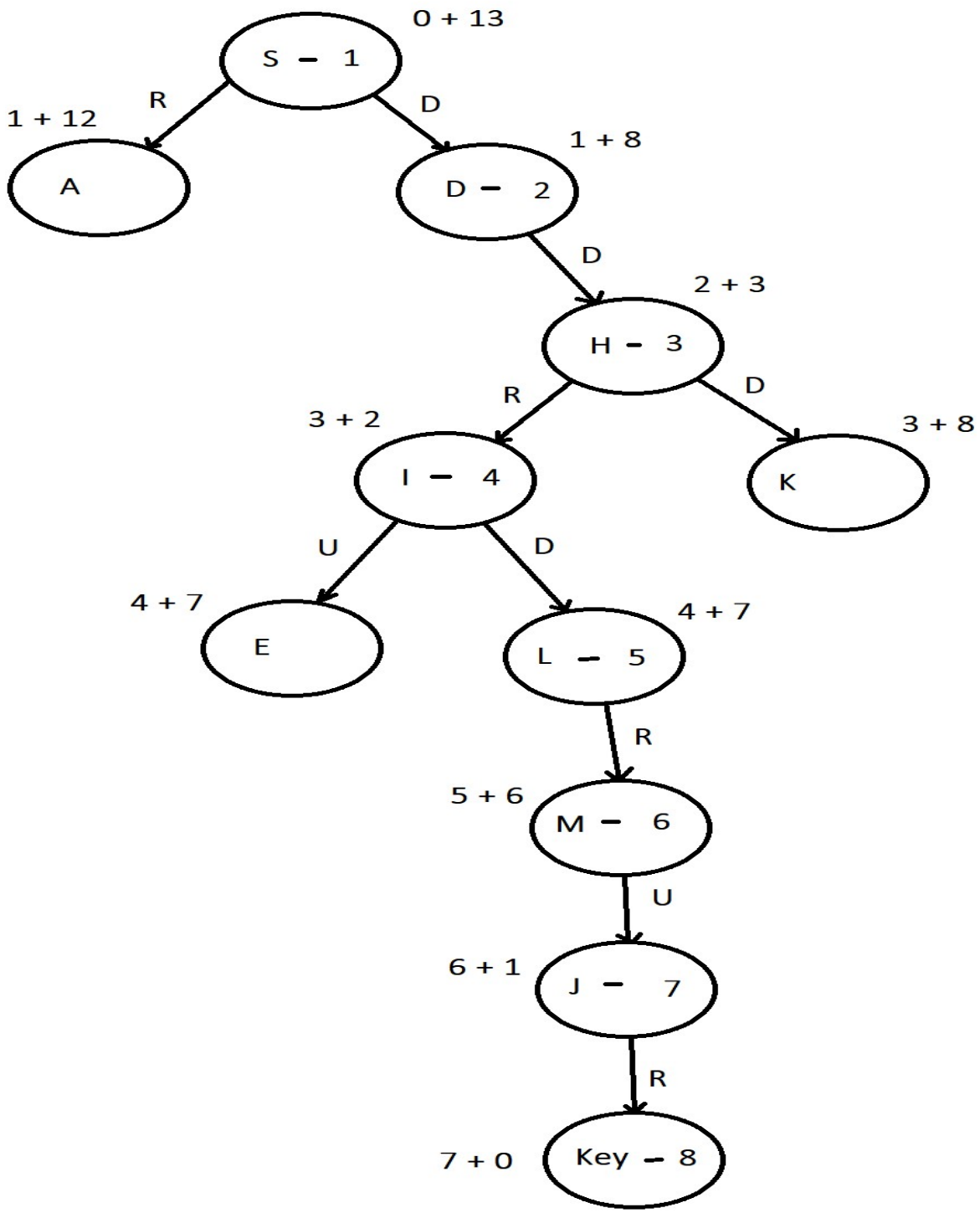
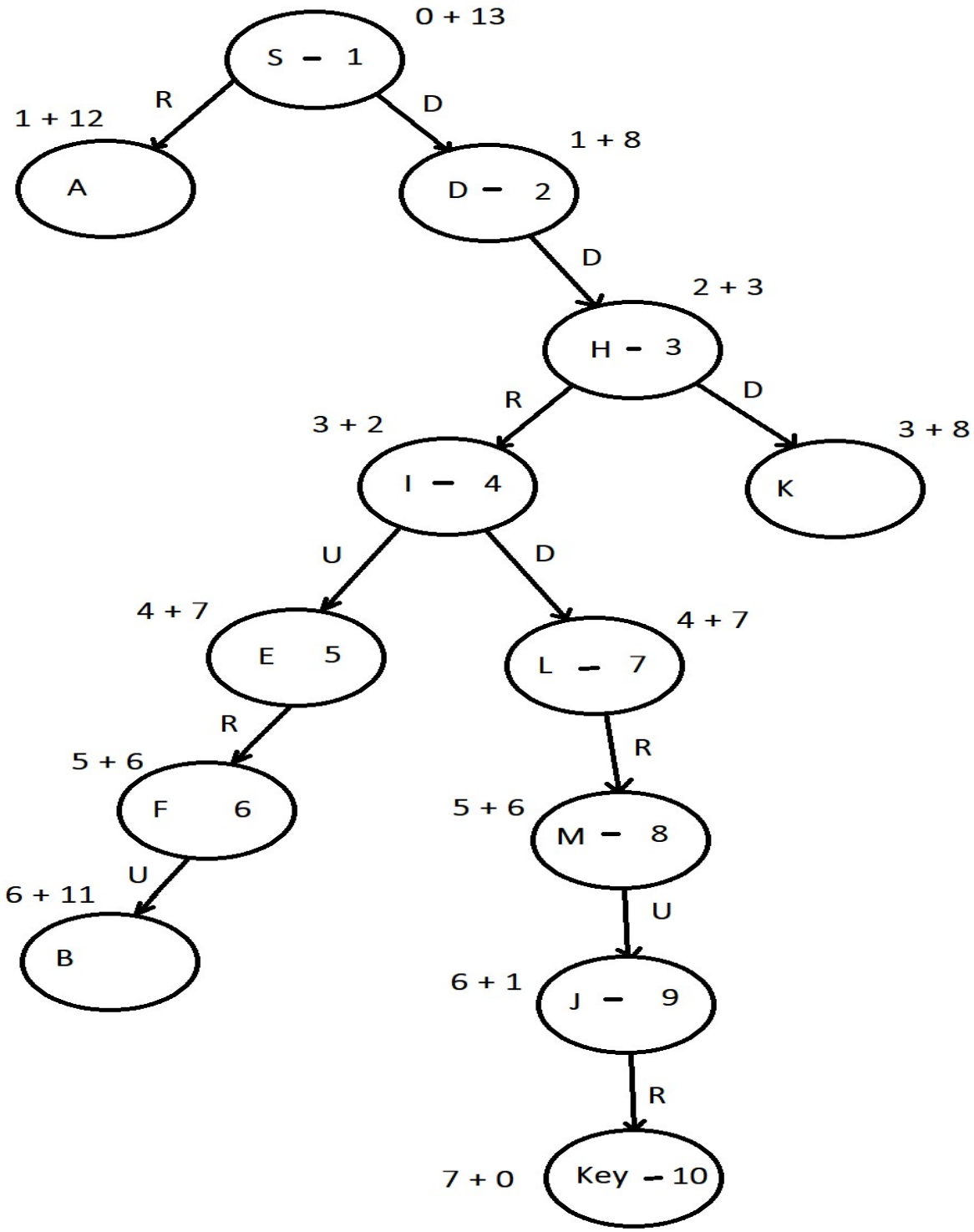
i and ii) Order of nodes expanded is given within the nodes while the cost Path + Heuristic is given outside the node. The Move is given along the arrow connecting states

The solution found will be D-D-R-D-R-U-R i.e. a total of 7 moves



A second possible tree that is a possible answer because of ties broken in slightly different way and some similar other trees with nodes expanded in a slightly different order are possible answers. However the solution found will be same if repeated nodes are avoided



c) Specify the longest (maximum number of moves) and shortest (minimum number of moves) solutions that will be generated by each of the following search strategies for the search problem of part b.

HINT: YOU DON'T NEED TO RUN ANY OF THE ALGORITHMS TO ANSWER

Search Strategy	Longest Solution	Shortest Solution
BFS	**R-R-R-D-D**	**R-R-R-D-D**
Uniform Cost Search	**R-R-R-D-D**	**R-R-R-D-D**
Iterative Deepening	**R-R-R-D-D**	**R-R-R-D-D**
A* with some admissible heuristic	**R-R-R-D-D**	**R-R-R-D-D**

All the search strategies given above give optimal solution

d)

i. Is the Heuristic function of part b admissible? Justify

THE HEURISTIC FUNCTION IS NOT ADMISSIBLE AS IT OVER ESTIMATES THE DISTANCE/MOVES FROM MANY CELLS. FOR EXAMPLE THE HEURISTIC VALUE OF G IS 5 WHEREAS THE MINIMUM COST OF G FROM KEY IS ONLY 1

CLO 1: Understand principles and techniques of artificial intelligence

Q 2: Game Playing using Minimax **[3 + 10 + 2 marks]**

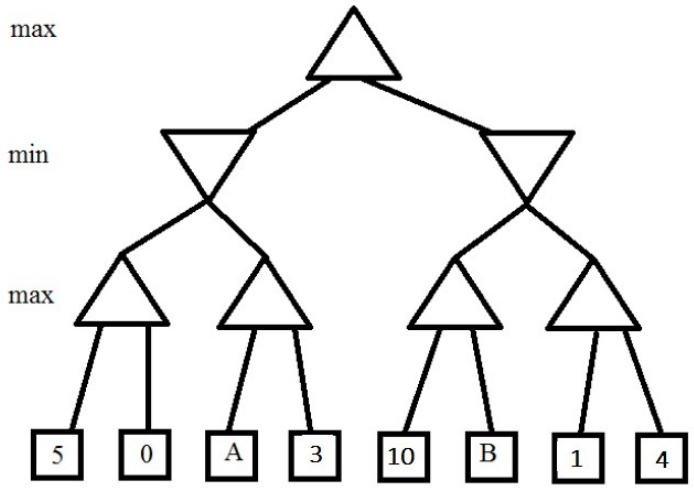
a)

For a hypothetical game tree shown on the right specify the values of A, B such that the RIGHT-SIDE move will be selected by the minimax based player

RIGHT-SIDE MOVE WILL BE SELECTED IF
MIN(5 , MAX(A,3)) < MIN (4, MAX(10, B))
i.e.
MIN(5 , MAX(A,3)) < 4

CLEARLY THE RIGHT-SIDE MOVE WILL BE SELECTED IF VALUE OF **A** IS LESS THAN 4 NO MATTER WHAT THE VALUE OF **B** IS.

Any Answer less than 4 is acceptable

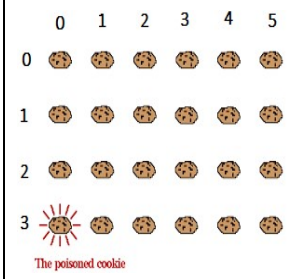


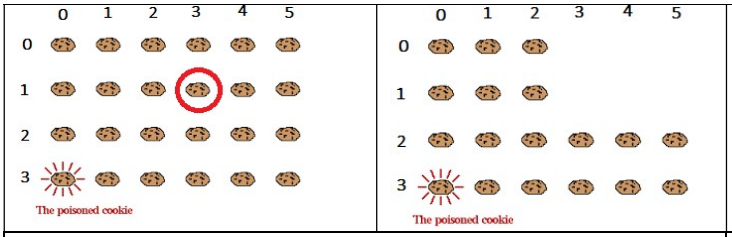
b)

Chomp is a two-player game played on a rectangular M x N grid of chocolate squares with the bottom-left square containing a poisoned bar. The figure on the right shows a 4 x 6 instance of the game

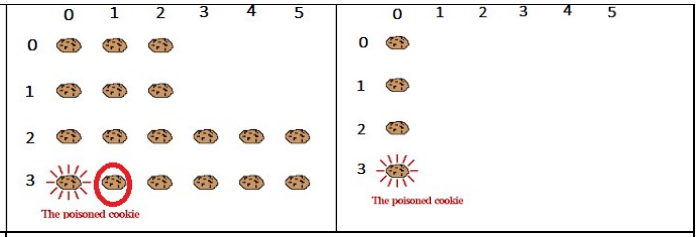
Players take turns and in each turn a player must choose a chocolate bar to eat along with all squares to the right and above it. The player who eats the poisoned square loses.

Two such possible moves along with the resulting state are shown below for the 4 x 6 grid. The encircled chocolate is selected by the player





First Move

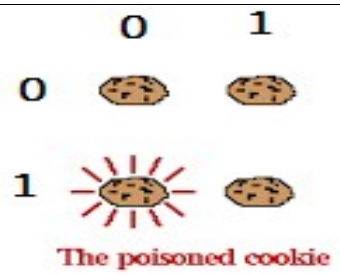


Second Move

For the 2 x 2 grid game state shown on the right

a) Built the complete game tree that will be traversed by the minimax algorithm for deciding a move at this state.

b) Compute value of each node in the game tree and hence find the move that will be selected by the player



The game tree is shown on the next page
BOX means it is a end state and hence the value of such state is either +1 or -1
Each move is shown using a tic mark
All other values can be computed using minimax with selected move shown

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