United International University (UIU)

Dept. of Computer Science & Engineering (CSE)

Mid Exam: Spring 2024
Course Code: CSE 3811, Course Title: Artificial Intelligence
Total Marks: 30 Duration: 1 hour 30 minutes

Answer all questions. Marks are indicated in the right side of each question.

[Any examinee found adopting unfair means will be expelled from the trimester/program as per UIU disciplinary rules.]

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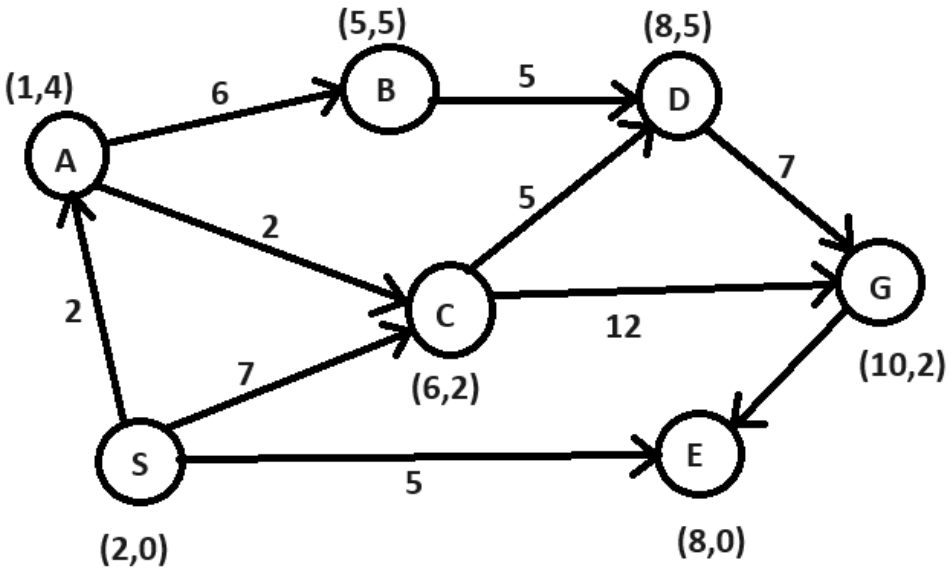
1. There are around 4.3 x 10^{19} possible configurations of a 3 x 3 Rubik's cube. However, if played optimally, any configuration can be solved in 20 moves or less. Here, one single move consists of a rotation of one of the faces of the cube. There are 27 possible rotations from a single configuration.
   - **a.** Suppose that you are building a robot that will solve this Rubik's cube in the fastest way possible. Write down the PEAS description for it. **[2]**
   - **b.** Formulate this as a search problem. Your formulation must contain the state representation, total possible number of states, actions, successor function, start state, and goal test. **[2]**

2. Consider the following directed search space. S is the initial state. G is a state that satisfies the goal test. Find out the solution paths and costs returned by the following search algorithms: **[3+3]**

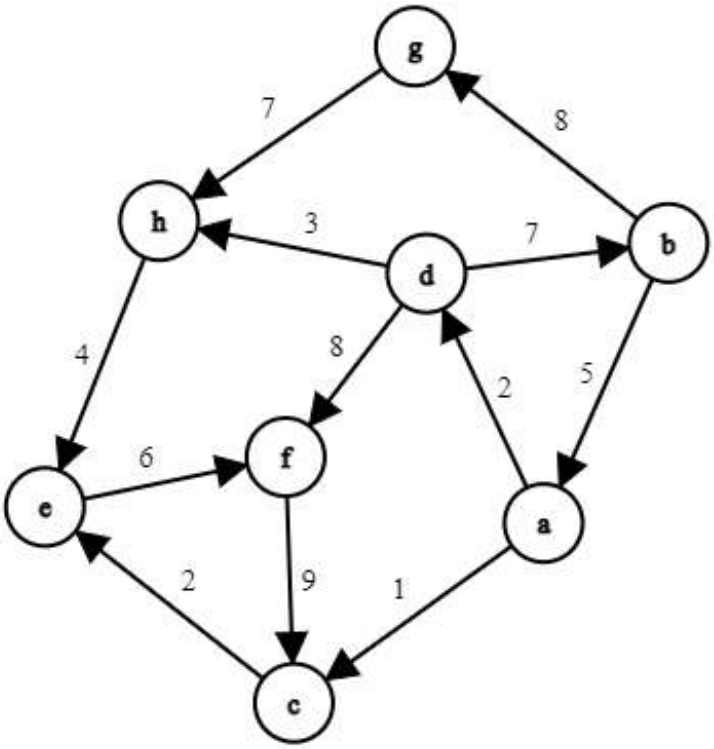
   (The values next to the nodes denote their co-ordinate values. Use **Euclidean Distance** as the Heuristic Value for the nodes. In the case of floating point numbers, use the **ceiling value.**

   Euclidean Distance: $\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$
   - **a.** Uniform Cost Search
   - **b.** A* Tree Search



3. **a**. Consider the state-space graph in the following figure and the heuristic values given in the table. Consider **d** as the start node and **c** as the goal node. The heuristic values for node **a** and **b** are missing. Set values for **a** and **b** so that the function is

   i. Admissible and consistent
   ii. Admissible but inconsistent
   iii. Inadmissible **[3]**



n	d	a	b	e	f	g	h	c
h(n)	12	?	?	10	8	24	11	0

b. Suppose that for some specific problem, heuristic function h is admissible. Is h^3 admissible? How about $\frac{h}{2}$? If your answer is yes for any of these two functions, would you prefer them over h? Explain your answer. **[2]**

4. **a**. For what types of problems the local search strategies are usually inapplicable? Why so? Elaborate with an example. **[2]**

b. Suppose you have six blocks marked A, B, C, D, E which are unsorted and you want them to line up in sequence.

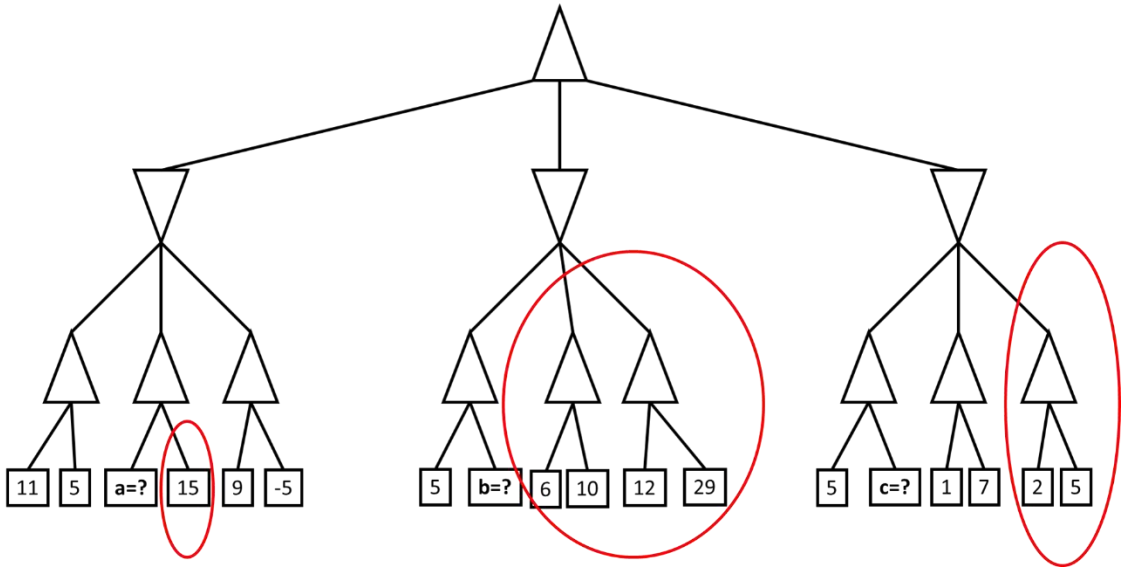
Initial state : | B | D | A | E | C |

Goal state: | A | B | C | D | E |

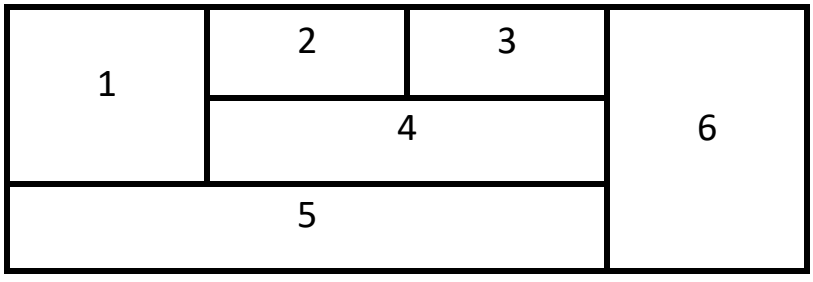
You want to solve this problem using hill climbing search. Now answer the following: **[4]**

i. Define the states with appropriate variables.
ii. What can be used as a heuristic function?
iii. Will it be a maximization or a minimization problem?
iv. Is the algorithm guaranteed to find the optimal solution? Explain.

5. Find the values of **a**, **b**, **c** so that only the marked branches are pruned when the minimax algorithm with **alpha-beta pruning** is applied on this search tree. Show the steps including utility values at each node. **[4]**



6. Consider the following 6 tiles. You need to fill each tile with one of the four colors: Red, Green, Blue, White in such a way that all the 6 tiles are distinguishable after assigning the colors. However, there are **some additional constraints**:
Tile 1 must be colored with Red and Tile 5 **cannot** be colored with White
(Hint: Do not assign same color to adjacent tiles).



Now formulate the problem as CSP, Show the Constraint Graph, and solve the problem must applying both Minimum Remaining Values(MRV) and Least Constraining Value(LCV) heuristics. **[2.5+2.5]**