Course Code: AI2002	Course Name: Artificial Intelligence
Instructor Name: Mir Murtaza	
Student Roll No:	Section No:

Instructions:

- Return the question paper and make sure to keep it inside your answer sheet.
- Read questions completely before answering. There are **6 questions.**
- In case of any ambiguity, you may make assumptions. But your assumption should not contradict any statement in the question paper.

Time: 60 minutes. **Max Marks**: 50 Marks

Question No. 1: [10 Marks][CLO1]

Read the following description of an environment involving decision making of rational agents and answer the given questions about properties of the environment:

There are two prisoners whose aim is to minimize the years of imprisonment. They have committed a crime together. Each prisoner is interviewed separately, and there are not any contacts between them. They decide individually to confess or to deny the crime taking into account possible decisions of the prisoner. Each prisoner chooses his dominant strategy, that is behaviour giving the best result regardless of the decision taken by the other prisoner. This environment is tabulated as:

		Prisoner B			
		confess		deny	
Prisoner A	confess	3	3	1	4
	deny	4	1	2	2

The first number shows the years of imprisonment of A, the second number of B. If for example, A confesses and B denies, A gets 1 year of imprisonment and B 4 years(field at the top right)

Identify the nature of the above decision making environment according to the following dimensions with a suitable reasoning:

a. Fully observable or Partially Observable

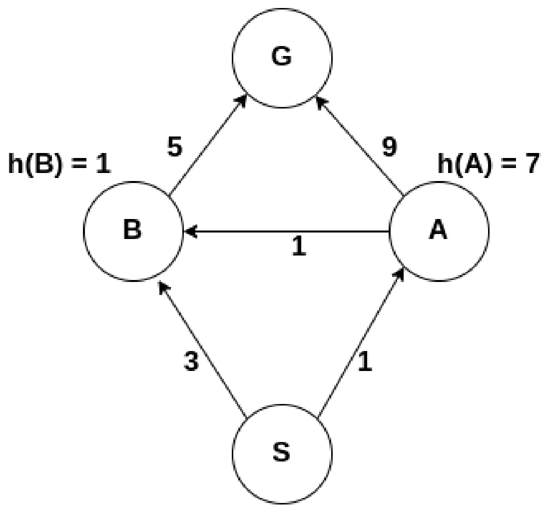
b. Deterministic or Nondeterministic
c. Single-agent or Multiagent
d. Discrete or Continuous
e. Known or Unknown

Answer:

a. The environment is fully observable. Both the agents (prisoners) have complete observations of all the configurations of the environment
b. Nondeterministic environment. The decisions of each of the prisoners can not be determined with complete certainty
c. Multiagent environment. There are two agents (prisoner A and prisoner B) participating in the environment
d. The environment is discrete in nature, the prisoners' decisions constitute categorical values: confess or deny.
e. Unknown in the perspective of prisoners' knowledge. Each of the respective prisoners is unaware of the decision making process of the other prisoner.

Question No. 2: [10 Marks][CLO2]

For an informed search algorithm such as A* search to return optimal results, we need admissible and consistent heuristics. For the given search graph, heuristic values for the node A and the node B are provided. a) Prove whether the given heuristic values h(n) are admissible. b) And prove whether the given heuristic values h(n) are consistent. Use the respective mathematical equations for the proof.

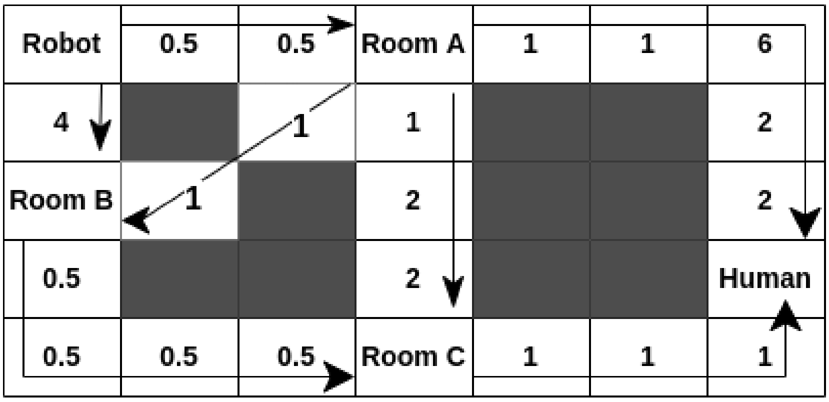


Answer:

a) The heuristic values are admissible: h(A) <= h*(A) and h(B)<=h*(B)
b) The heuristic values are not consistent: |h(A)-h(B)| ≤ cost(A,B) is not satisfied

Question No. 3: [10 Marks][CLO2]

An autonomous Robot(Start-State) needs to search for the optimal path to reach and rescue the Human(Goal-State) as represented in the following environment. There are three rooms: Room A, Room B, and Room C. The Robot can move about this environment in the direction of arrows. The values in each square show the difficulty(for e.g heat intensity) in moving in that particular square. The distances for each directed path can be computed by summing up all the values in the path. Additionally, the Robot has been given the following heuristic function values in order to perform an informed search:



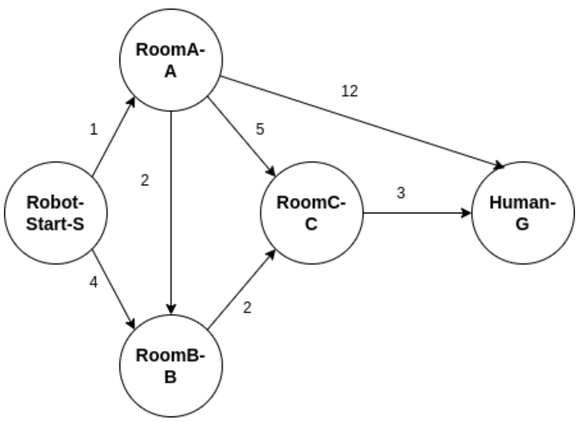
h(Starting State) = 7
h(Room A) = 6
h(Room B) = 4
h(Room C) = 2
h(Human) = 0

Perform the following:

1. Convert the above environment into a graph data structure
2. Perform A* search on the graph and provide the output-path with the total cost.

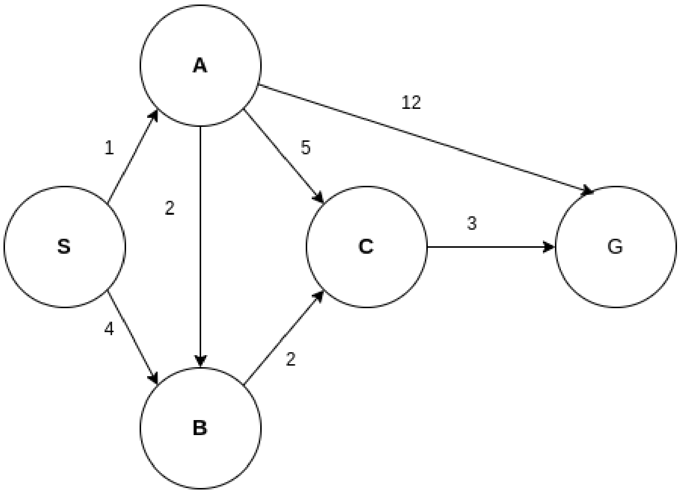
Answer:

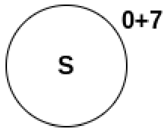
1.



2.

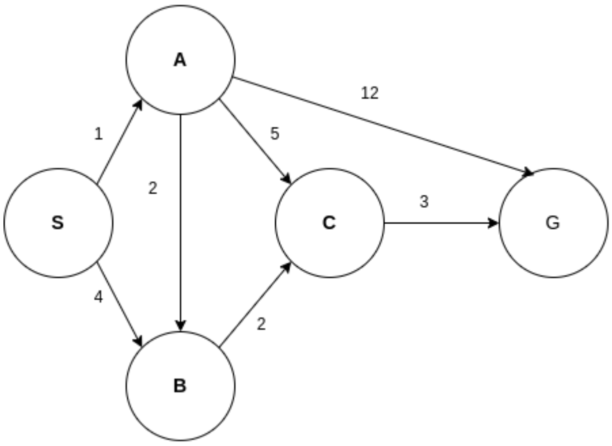
List = {}

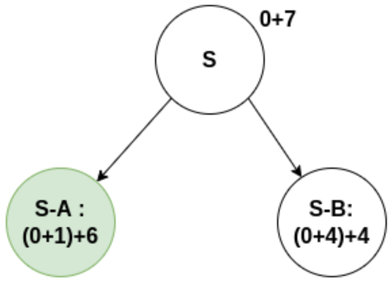




Heuristic function - h
h(S) = 7 **hA) = 6** **h(B) = 4** **h(C) = 2** **h(G) = 0**

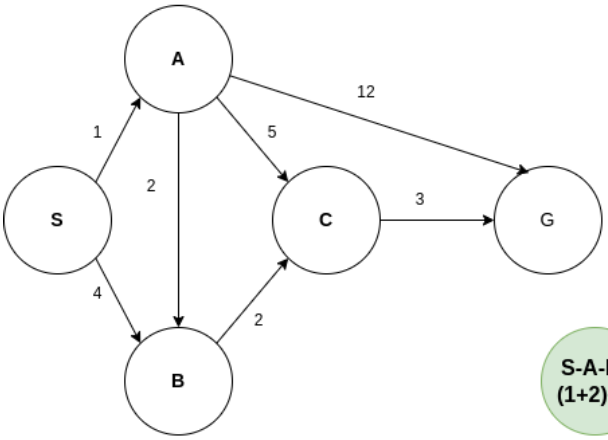
List = {S}

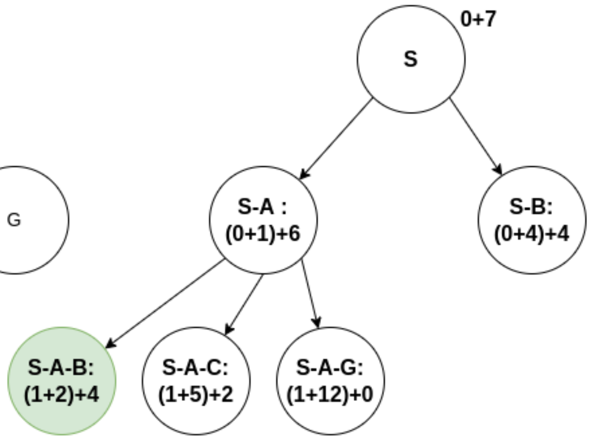




Heuristic function - h
h(S) = 7 **hA) = 6** **h(B) = 4** **h(C) = 2** **h(G) = 0**

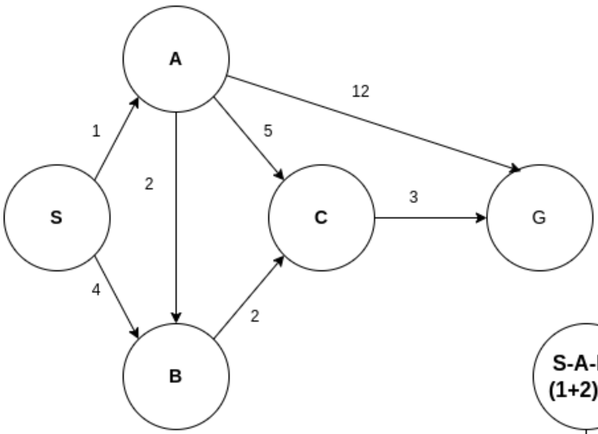
List = {S, A}

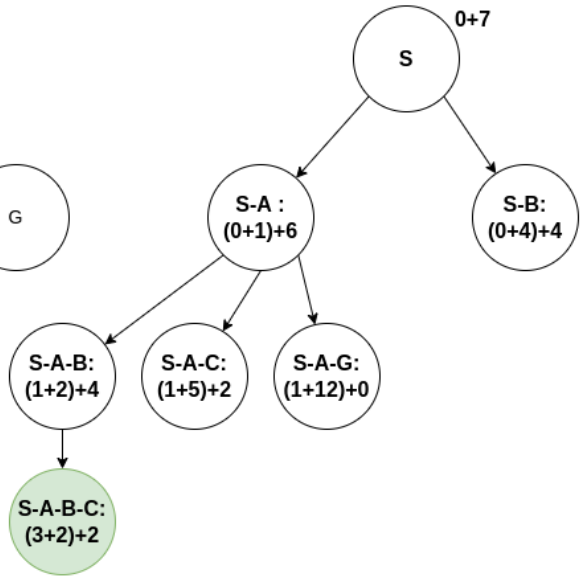




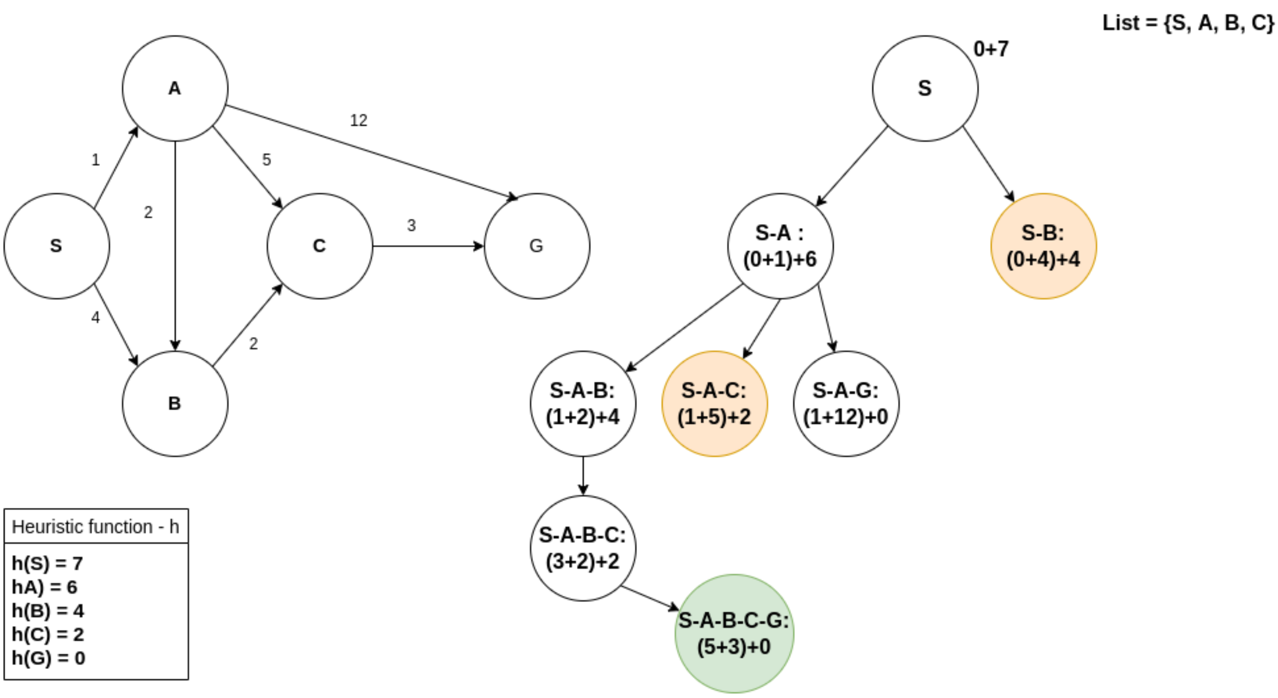
Heuristic function - h
h(S) = 7 **hA) = 6** **h(B) = 4** **h(C) = 2** **h(G) = 0**

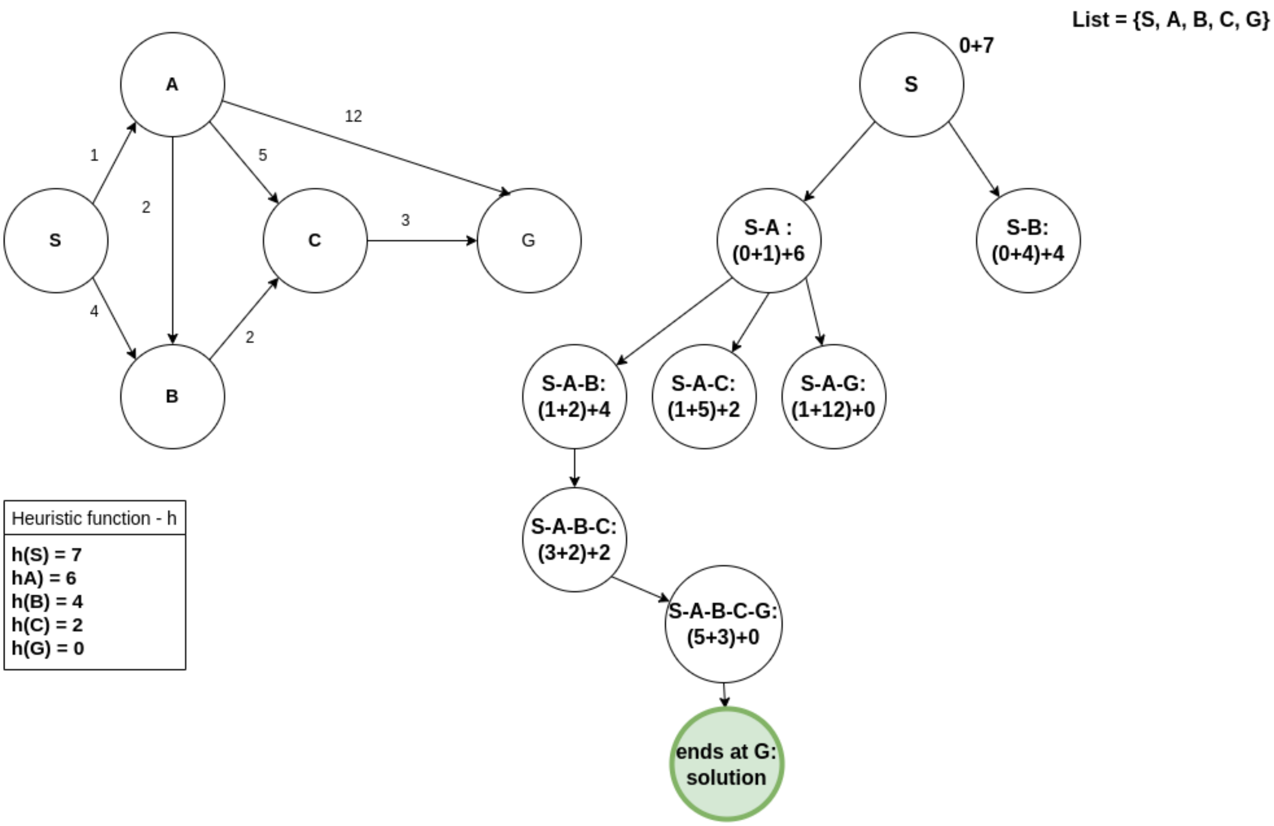
List = {S, A, B}





Heuristic function - h
h(S) = 7 **hA) = 6** **h(B) = 4** **h(C) = 2** **h(G) = 0**





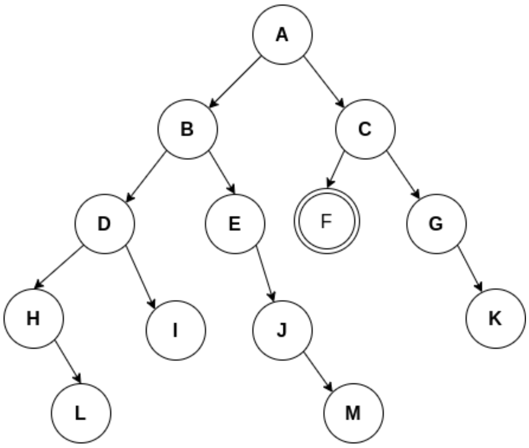
Output-path: S-A-B-C-G

cost: 8

Question No. 4: [5 Marks][CLO2]

The position of the goal state in a search tree specifies the performance of breadth-first search(BFS) and depth-first search(DFS) algorithms. For the given search tree, in which the node F is the goal state. Perform the following in order to know which algorithm is suitable for this particular positioning of the goal state.

1. Apply both the algorithms; BFS and DFS.
2. Determine the number of visited nodes for both BFS and DFS before reaching the goal node of F.

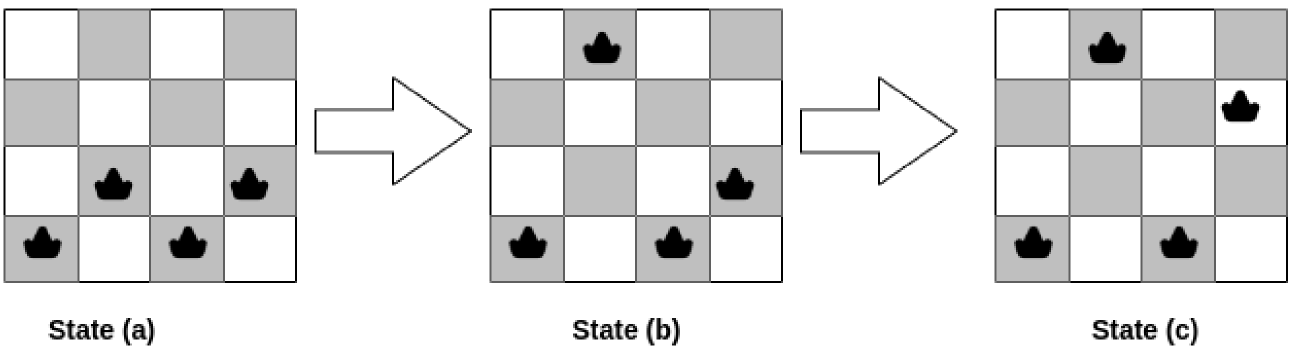


Answer:

1. BFS visit order: ABCDEF (using queue) and DFS visit order: ABDHLIEJMCF (using stack)
2. BFS reached node F after visiting 5 nodes whereas DFS reached node F after visiting 10 nodes.

Question No. 5: [10 Marks][CLO2]

Answer the given questions based on the following 4-Queens local search problem. Two local search moves are applied to the initial state (a)



Q. 5 a: Calculate the heuristic cost function values of the three states (a,b, and c) of the above 4-Queens problem.

Q. 5 b: What does the computed heuristic cost function value of the state (c) denote. Is the state the global maxima or local maxima of the objective function of this problem? Answer with reasoning.
Q. 5 c: What is the total number of configurations possible for this 4-Queens problem?

Answer:

a. Heuristic cost function of n-Queens problems is the number of attacks directly or indirectly.
   h(State-a) = 5
   h(State-b) = 3
   h(State-c) = 1
b. The heuristic cost function value for State (c) is 1. So, this is a local maxima of the objective function.
c. Total number of configurations: Queen 1 can move 4 positions along its respective column, similarly the other 3 queens, therefore 4*4*4*4 = 256 configurations possible of this problem.

Question No. 6: [5 Marks][CLO1]

Answer the following questions with reasoning.

A. Is machine learning synonymous with artificial intelligence? What is the difference and connection between the two domains?

B. Is the breadth-first search or the depth-first search an AI based algorithm? Answer with a reasoning.

C. The hill climbing algorithm usually gets stuck in the local minima (cost function) or in the local maxima (objective function) of the solution space. How can this problem of the hill climbing algorithm be mitigated?

D. What is the main characteristic difference between the hill climbing algorithm and the simulated annealing algorithm?

Answer:

A. Machine learning which learns intelligent models from the data is generally considered a branch of artificial intelligence. With the availability of large datasets and state-of-the-art results in many problems, machine learning has become the dominant branch of artificial intelligence. There are other branches of artificial intelligence which function differently from the machine learning paradigm such as expert systems.
B. Both the search algorithms are uninformed and do not use any kind of information in form of heuristics, prior data, or knowledge base. The two algorithms could not be considered to utilize AI techniques.

C. One solution can be the random-restart hill climbing, which conducts a series of hill-climbing searches from randomly generated initial states, until a goal is found.
D. A hill-climbing algorithm that never makes “downhill” moves toward states with lower value (or higher cost) is always vulnerable to getting stuck in a local maximum. In contrast, simulated annealing can move downhill toward states with lower value (or higher cost) with a certain probability which changes with the changing time, temperature values of the algorithm.