Artificial Intelligence

Mid-I Exam, Spring 2016

Date: February 16, 2016 **Marks: 50** **Time: 60 min.**

Name: ---

Registration No: -------------------------

Section: -------------

Question 1. [Short Questions] (12 minutes) **[2 x 5 Points]**

Provide short answers (1-3 sentences) for each of the following questions.

1) In what way is iterative deepening is better than depth-first search? Use the four criteria typically used to compare the search algorithms.

2) Under what minimal conditions on the heuristic function the A* algorithm with graph-search is guaranteed to return an optimal solution?

3) Under what minimal conditions on the heuristic function the A* algorithm with Tree-Search is guaranteed to return an optimal solution?

4) State two major difference between Hill-climbing search and Best-first search.

5) If H1 and H2 both be admissible heuristics Then which of the following must be true
   i) max(H1;H2) is necessarily admissible
   ii) min(H1;H2) is necessarily admissible
   iii) (H1 + H2)/2 is necessarily admissible
   iv) max(H1;H2) is necessarily consistent

Question 2. [Iterative Deepening + A*] (15 minutes)

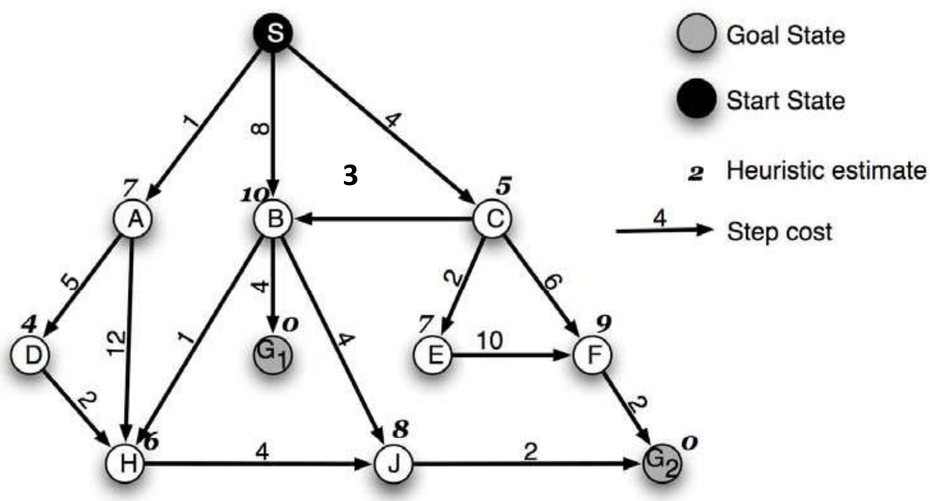
Consider the search space below, where **S** is the start node and $\mathbf{G_1}$ and $\mathbf{G_2}$ are goal nodes.

Arcs are labeled with the value of a cost function; the number gives the cost of traversing the arc.

Along each node is the value of a heuristic function; the number gives the estimate of the distance to the goal.

Assume that uninformed search algorithms always choose the left branch first when there is a choice.

Also assume that the algorithms do not keep track of and recognize repeated states.



For each of the following search strategies:

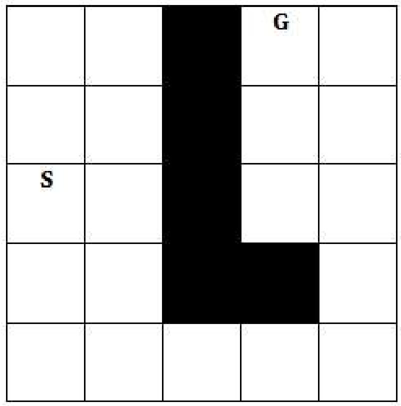
- Indicate which goal state is reached first (if any) and
- List in order, all the states that are popped off the OPEN list. (Sequence of path)

(a) Iterative Deepening [2 + 3 Points]

(b)A* [2 + 3 Points]

Question 3. [DFS] (10 minutes) **[8 Points]**

Given the following maze with S marking the start state cell and G marking the goal cell. An intelligent agent can move in this maze either horizontally or vertically while moving along a diagonal is not allowed. Black Cells are blocked and hence an agent cannot move into these cells.



Show the order of cells expanded by DFS algorithm. Mark the start cell as 1 and the next cells as 2, 3, ...

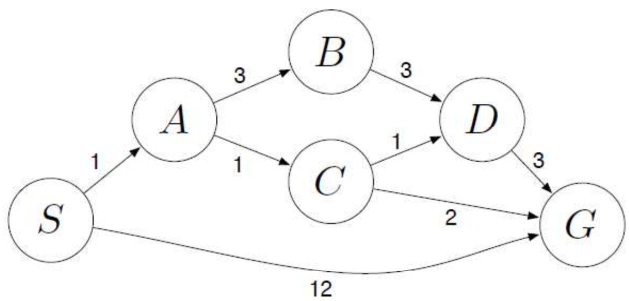
Assume that **DFS** is implemented such that it inserts the cells in the **stack** in **UP-LEFT-DOWN-RIGHT** order and cells already visited are not re-visited (Graph Search Implementation).

Question 4. [BFS, UCS, A*, Heuristics] (24 minutes)

Answer the following questions about the search space shown in the figure below. The arrows indicate the moves and the numbers by the arrows give the step-cost associated with a move. Assume that any ties are settled alphabetically.

For the questions that ask for a path, please give your answers in the form 'S – A – D – G.' for path.

Note: Nodes in the fringe **(i.e. Open List)** are mentioned in the order they are pushed in the fringe.



a) What path would breadth-first graph search return for this search problem and also mention the nodes in the fringe **(i.e. Open List)** after the goal is found? **[3 Points]**

b) What path would uniform cost graph search return for this search problem and also mention the nodes in the fringe after the path found? **[4 Points]**

c) Consider the heuristics for this problem shown in the table below **[3 Points]**

i. Is h_1 admissible? Also give reason for your answer.

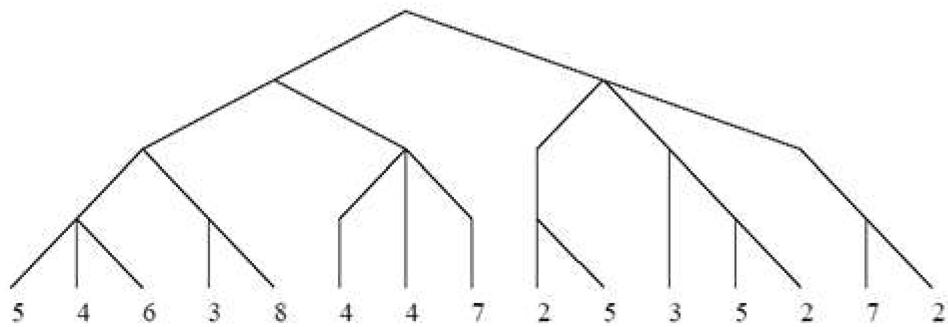
ii. Is h_2 admissible? Also give reason for your answer.

State	$\mathbf{h_1}$	$\mathbf{h_2}$
S	5	4
A	3	2
B	6	6
C	2	1
D	3	3
G	0	0

d) What path would A* graph search return if $\mathbf{h_1}$ is used as the heuristic. Also mention the nodes in the fringe after the path found? **[5 Points]**

Question 5. [MINIMAX, Pruning] (12 minutes) **[3 + 5 + 2 Points]**

In an adversary game, like the game of CHESS, **MAX** is playing against **MIN.** It is MAXs turn to make a move and he has constructed the following game tree down to 3-levels. **MAX** uses the **MINIMAX** algorithm to decide his move.



a) Simulate the MINIMAX algorithm to figure out the move of MAX by using his game tree.
b) Which parts of the tree will be pruned if MAX uses the MINIMAX algorithm with **α-β** pruning procedure while the nodes are always explored/processed from left to right? To get full marks you must clearly indicate the values of **α** and **β** used by MAX at the of pruning.
c) We know that MINIMAX is optimal against an OPTIMAL opponent but non-optimal against a non-optimal opponent. Justify this statement by arguing that the move chosen by MAX in part a is not optimal against a non-optimal **MIN.**

Question 6 [BONUS PART]

We need to create an intelligent shopping Robot which will operate in large single-story shopping mall to facilitate the customers.

The shopping mall is divided into a number of regions and each region contains a range of products. Some of the regions are adjacent to each other and the Robot can directly go to any of the neighboring/adjacent region of a given region.

The whole map of the shopping mall can be represented as a graph with the nodes as regions and there is an undirected edge between neighboring regions.

As programmer of the shopping robot we can use a simple command MOVE_To(R_ID) move to region R_ID that is adjacent to the present region and the Command PICK_UP(ITEM_ID) to pick the item using the ITEM_ID.

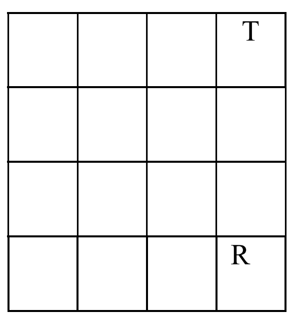
The user of our Robot will provide it the ITEM_ID of a single item to be purchased and the main job of our shopping Robot will be to identify the target region that contains the item by using a database and then go to the appropriate part of the store and bring the requested item by using minimum number of steps. You can assume that we can query the database by using the interface function R_ID = QUERY(ITEM_ID); It has been decided to formulate the problem of finding the shortest path from the Robots initial position to the destination region and hence your first job is to formulate this problem as a search problem.

Part a) **[3 + 2 Points]**

- Completely specifying a minimal set of items needed to keep the state of the problem.
- Which algorithm(s) could be used to find a shortest path from the starting position to goal region if each **MOVE-TO** command has a constant cost.

Part b) **[3 + 2 Points]**

Now assume that each floor of the mall is divided into n x n square regions. The robot is in the right-bottom corner and the target region is in the upper-right corner where the Robot can only move either horizontally or vertically. Such a floor is shown in the figure below.



- How many regions would be expanded, in the best and worst case, by BFS algorithms. (Assume Graph Search Versions)
- How many regions would be expanded by the A* search algorithms if the City-block-Distance is used as a heuristic function. (Assume Graph Search Versions). The City-Block-Distance is defined as the sum of horizontal and vertical distances.

Good Luck!