6a (1)
6b (2)

Mid 1 Exam for Artificial Intelligence Course (CSE 371)

Question	Value	Marks
1	15	a)0 b)3 c)2 e)4 d)2.5
2	5	5
3	12	7.5
4	15	15
5	11	6
6	7	3
Total	65	

Roll Number: 20161103

Seat Number: A10

Invigilator's Signature:

Date of Exam: 06/02/2018

Max Time: 90 minutes

General Instructions:

- Please print on both sides
- No calculators are allowed
- This is a closed book exam
- In case of doubt, please make reasonable assumptions and specify the assumptions clearly. If there was no need to make those assumptions your assumptions may be considered invalid
- If you think a problem is wrong or cannot be answered please state so and move on. If it is discovered to be solvable or correct you will be assigned 0 points
- Clarifications may not be provided during exam
- If space is not enough, please provide answers in the Additional Space towards the end. Please mention clearly -- continued on page number **
- Please do not waste time on any single question

1. Please answer the following questions:

a) What is the algorithm used for robot navigation in the Shakey robotics project and describe how it is related to the A* algorithm ? -- 3 points

The algorithm used by shakey robot is similar to A* search. It uses an informed search algorithm with a special heuristic function. ✗

Moreover it uses hough Transform & visibility graph method to supplement the A* search.

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b) What is an expert system? Name an expert system that was introduced in the class and briefly explain its purpose? -- (1 + 1 + 1) points

An expert system is basically an AI system that specializes on a given domain using domain specific knowledge & rules.

DENDRAL & MYCIN are examples of expert system.

The MYCIN expert system is used for diagnosing bacterial infection & then suggesting antibiotics. It is based on an inference engine & about 600 rules.

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c) What is the ARMOR system -- please describe in 3-4 sentences ? -- 2 points

ARMOR is a security system used in several airports like LAX in USA.

It is an agent program/system that uses game Theoritic concepts & randomization to provide security in uncertain environment.

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Based on the decision taken by the system, checking by officials & sniffing dogs is done at the chosen random locations.

The system is now being incorporated in marine installation as well.

d) Who is Herbert Simon ? Please name two contributions of his with a 1-2 sentence description to the field of AI. -- (1 + 2) points

Herbert Simon is one of the founding fathers of AI. He introduced the logic theorist in the first AI conference at dartmouth. This was considered as a seminal work in the field of AI. Moreover he also introduced the GPS ie General Problem solver that solves a problem in a way a human does. One more contribution of his was in SOAR Architecture.

2.5

e) What is PEAS description for an agent ? Please explain using an example. -- (2 + 2) points

The task environment as well as agent functionalities are described using PEAS. PEAS is an acronym for i) Performance ii) Environment iii) Actuators iv) Sensors

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i) Performance: Basically what are the goals / tasks of AI agent

ii) Environment: The various outside agent elements that it interacts with

iii) Actuators: How the agent brings change to the environment

iv) Sensors: The way an agent percieves its environment.

eg. Taxi Driving

Performance	Environment	Actuators	Sensors
Reach destination, safety, speed, fuel consumption	road, other vehicles, environment	Gears, steering wheel, wipers	camera's, infrared, GPS

2. Please provide the proof of optimality for A* graph search. -- 5 points

We prove the optimality of A* search in the following manner : ||

A* search is optimal (Graph search variant) if h(n) is consistent

i) The ~~path~~ goal path consists of nodes with non-decreasing f values.

We have : $f(n) = h(n) + g(n)$ & $h(n) \leq h(n') + c(g, n, n')$

* n' is the successor node of n in the given path

$$f(n) = h(n) + g(n) \leq h(n') + c(g, n, n') + g(n) \leq h(n') + g(n') \leq f(n')$$

ii) If a node is expanded at any given point of time, then it is ~~has~~ the optimal path from initial state to current node.

If this is not the case, then there exists another node n' in the frontier st, by the graph separation property it would be in the optimal path from initial state to goal state & thus, would be expanded before n.

Using these 2 we ~~can~~ prove the optimality of A* search.

Also, it checks all nodes with $f(n) < C^*$ & any other algo. must also check these nodes else it might not be optimal.

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3. Please answer **True** or **False** for each of the questions below. Each question is worth 1 point. Leaving a question blank is worth 0 points and answering incorrectly is worth -1/2 point.

9 - 1.5

a) Agent should be able to sense is a necessary attribute for (definition of) an agent. True

b) Agent should be able to explore is a necessary attribute for (definition of) an agent. False

c) Agent function maps an action to a percept sequence. True

d) A task environment is considered dynamic if the environment changes as the agent deliberates about action to take. True

e) A search algorithm is complete if it always finds the optimal solution whenever a solution exists. False (Need not find optimal soln., any soln can do)

f) For tree search, depth-first search always expands at least as many nodes as A* search with an admissible heuristic. False

g) For graph search, depth-first search always expands at least as many nodes as A* search with a consistent heuristic. False

h) For a binary tree with unit step cost, algorithm A will perform a depth-first search if f(n) = - g(n). True

i) Space complexity of depth first graph search is lower than that of breadth first tree search. True

j) Time complexity of depth first tree search is higher than that of breadth first graph search. True (If $b^m \geq b^d$, m is max length path)

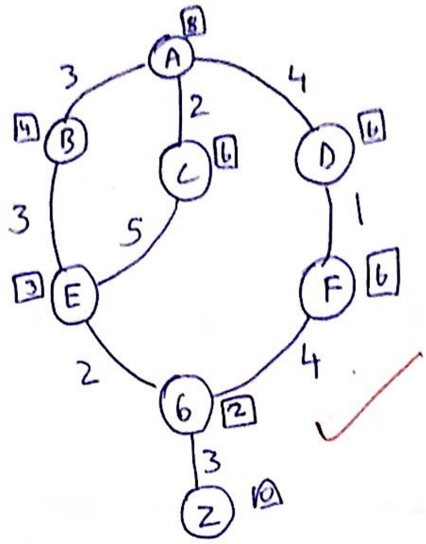
k) Depth limited graph search is optimal if depth limit l > depth of optimal node d. True

l) Bi-directional graph search is always more time efficient than (uninformed) uni-directional graph search. True

4. Consider a search space defined by the following table, which gives the cost of arcs between pairs of nodes. Node A is the start state and node Z the goal.

From	A	A	A	B	C	D	E	F	G
To	B	C	D	E	E	F	G	G	Z
Cost	3	2	4	3	5	1	2	4	3

a) Draw the complete graph of the state space. -- (3) points



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* $\boxed{x}$ → Heuristic cost

b) Using graph search with a selection function of **f(n) = g(n)**, in what order would the nodes in the graph be expanded. Expanding a node means computing its successors and adding links to them. Note that g(n) is the cost of the cheapest known path from the start node to node n. -- (4) points

f(n) = g(n) ⇒ We are using uniform cost search. Pick the nearest node with lowest cost that belongs to explored set & add it to this set.

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Order of expansion :

A → C → B → D → F → E (B-E) → G → Z ← Goal

Thus the min cost to reach Z is A → B → E → G → Z

ie 11.

c) Repeat this exercise using the selection function **f(n) = -g(n)**. -- (4) points

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If f(n) = -g(n) then the algorithm becomes similar to dfs algorithm.

Order in which nodes are expanded :

A → D → F → G → Z ← Goal

Initially D has min value of −4. Then after D is expanded, F has min. value of all nodes (−5). Similarily G has minimum value after F & Z after G at which point the algorithm stops.

d) Assuming the following values for the heuristic function h(n), show the order in which nodes would be expanded if the selection function is **f(n) = g(n) + h(n)**. -- (4) points

node	A	B	C	D	E	F	G	Z
h(node)	8	4	6	6	3	6	2	0

4

The algorithm to be used is A* search.

The nodes are selected one by one in increasing order of f values:

The order of expansion is as follows:

A → B (7) → C (8) → E (9) → D (10)

D ↓ G (10)

Z (11) ← F (11) ← G (10)

5. Consider a sliding tile puzzle with six tiles (three black and three white) in a linear tray which can hold seven tiles. The following depicts the initial configuration: [B][B][B][W][W][W][E] where [B] represents a black tile, [W] a white one and [E] the empty cell. The puzzle has the following two moves: (1) A tile may move into an adjacent empty cell with unit cost; and (2) A tile may hop over one or two tiles into the empty cell with cost equal to the number of tiles hopped over. Thus, the initial configuration has the following three immediate successors:

[B][B][B][W][W][E][W] (cost = 1)

[B][B][B][W][E][W][W] (cost = 1)

[B][B][B][E][W][W][W] (cost = 2)

The goal is to have all of the white tiles to the left of all of the black ones. It is unimportant where the empty cell is.

a) What is the maximum number of successors that a state can have? What is the minimum? -- (1.5 + 1.5) points

i) The maximum no. of successors a state can have is 6. BBBEWWW ... ie. E should be at centre

3

ii) The minimum no. of ~~state~~ successors a state can have is 3. The state is when empty tile is at either ends. eg. BBBWWWE, EBBBWWW ...

b) How many states are goal states ? Please list them. -- (3) points

The no. of goal states are 7 & they are given as :

3

i) WWWBBB_   ii) WWW_BBB   iii) WWWB_BB

iv) WWWBB_B   v) WW_WBBB   vi) W_WWBBB

vii) _WWWBBB

Find no. of tiles that are not in correct position in a given state

0

h(wwBwEBB) = 2 > 1

c) Please present an admissible heuristic function (h) for this problem. -- (2) points

An admissible heuristic is :

~~For all white tiles find the no. of black tiles to their right. The sum of the values for all white tiles is the heuristic function.~~

It is admissible as it is optimistic & does not overestimate.

d) Please present an admissible but not consistent heuristic for this problem ?

-- (3) points

0

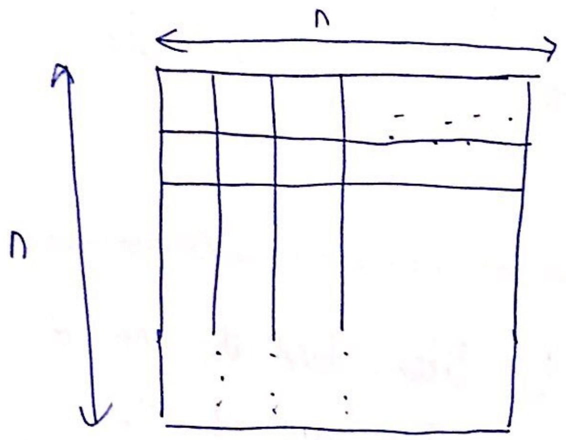
~~not admissible~~ It is consistent

For all white tiles, find the no. of black tiles to their right. The sum of the values for all the white tiles is the heuristic function.

It is not consistent as it does not satisfy the triangle / consistency property.

6. You and your friend got separated at an exhibition. Both of you start searching for each other simultaneously and you don't know each other's starting location. Both of you will take one action per time step where the possible actions are North, West, South and East. You can assume that the search area is a grid with rows numbered 1 to n (top to bottom) and columns numbered 1 to n (left to right). Actions that lead out of the grid from a state are not valid actions for that state. You can see your friend if both of you are at the same state. Please make reasonable assumptions to answer the following questions and state the assumptions and reasoning:

a) Among the breadth first, depth first, bi-directional, A* and SMA* search, which algorithm would you prefer to use if you know your friend's favorite algorithm is depth first search and would use it with actions selected in the following order: North, West, South, East ? Please explain your reasons ? You can pick actions in a different order (and state the order). -- (3) points



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bfs

I would prefer to use ~~dfs~~ in the order North, West, South & East as slowly I will cover more area while ~~my~~ the friend would reach the final/solution state.

b) If the distance between you and your friend needs 8 valid steps to be taken and your friend is using SMA* algorithm with a memory size of 6, would you be able to meet your friend if you were also using SMA* algorithm but with a memory of 4. Assume actions are selected by your friend in following order: North, West, South, East. Please explain reasons for your answer ? You can pick actions in a different order (and state the order). -- (4) points

2

Yes, we would be able to meet the friend using SMA* as max depth by friend is 6 & max depth by me is 4. Also distance = 8 is less than sum of the two max depths (i.e 10). The order would be North, West, South & East.

Additional Space