CS401 Artificial Intelligence

Thursday, 21 March, 2019

Course Instructor

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Serial No:
Mid Term Exam
Total Time:120 Min
Total Marks:

_____
Signature of Invigilator

_____	_____	_____
Roll No	Section	Signature

DO NOT OPEN THE QUESTION BOOK OR START UNTIL INSTRUCTED.

Instructions:

1. Verify at the start of the exam that you have a total of Five (5) questions printed on Eight (8) pages including this title page.
2. Attempt all questions on the question-book and in the given order.
3. The exam is closed books, closed notes. Please see that the area in your threshold is free of any material classified as 'useful in the paper' or else there may a charge of cheating.
4. Read the questions carefully for clarity of context and understanding of meaning and make assumptions wherever required, for neither the invigilator will address your queries, nor the teacher/examiner will come to the examination hall for any assistance.
5. Fit in all your answers in the provided space. You may use extra space on the last page if required. If you do so, clearly mark question/part number on that page to avoid confusion.
6. Use only your own stationery and calculator. If you do not have your own calculator, use manual calculations.
7. Use only permanent ink-pens. Only the questions attempted with permanent ink-pens will be considered. Any part of paper done in lead pencil cannot be claimed for checking/rechecking

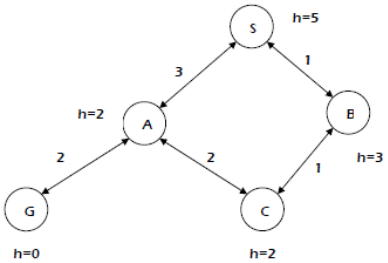
PART B
(SUBJECTIVE)

Question	**<Objective>**	**1**	**2**	**3**	**4**	**5**			**Total**
Points		17	05	08	10				
Score									

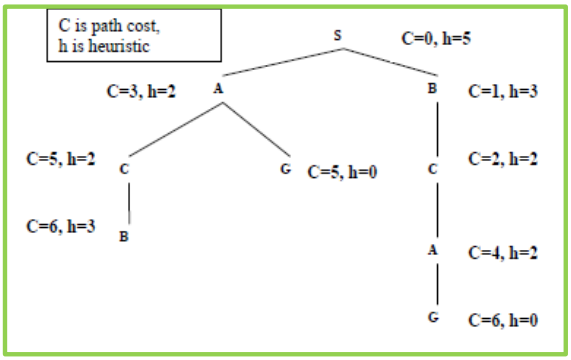
Vetted By: _____Vetter Signature: _____
University Answer Sheet Required: No ☐ Yes ☐

Question:1	Marks 5+3x4=17

Consider the search graph given below with S as the start state and G as the goal state.



a. Draw the complete search tree for this graph. Label each node in the tree with the cost of the path to that node and the heuristic cost at that node. Be very careful as your answers to the following questions will be incorrect if you made a mistake in the tree.



b. For each of the searches below, just give a list of node names (state name, length of path) drawn from the tree above. Break ties using alphabetical order. **Refer to the states with their names and the cost of the path to that node.** Trace algorithms very carefully, no partial credit will be given for any of these.

NOTE: we used the following two terms: visited list and expanded list which refers to open and closed list respectively.

i. Perform a depth-first search **using** a visited list. Assume children of a state are ordered in alphabetical order. Show the sequence of nodes that are expanded by the search.

S0, A3, C5, G5

ii. Perform a best-first (greedy search) **without** a visited or expanded list. Show the sequence of nodes that are expanded by the search.

S0 (h=5), A3(h=2), G5(h=0)

iii. Perform a Uniform Cost Search **without** a visited or expanded list. Show the sequence of nodes that are expanded by the search.

S0, B1, C2, A3, A4, C5, G5

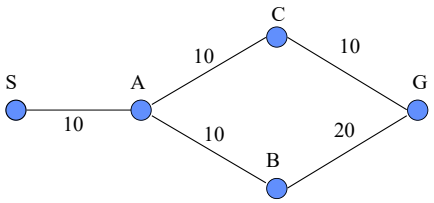
iv. Perform an A* search **without** an expanded list. Show the sequence of nodes that are expanded by the search.

S0(0+5), B1(1+3), C2(2+2), A3(3+2), G5(5+0)

Question 2:	**Marks 2.5+2.5 = 05**

Consider the state-space given below, where the arc costs are shown for each pair of states, which are connected. Define an admissible heuristic for each of S, A, B, C, and G, such that no two values that H takes coincide (gives us a tie) and:

- **Heuristic H1:** greedy best-first search **will** find the optimal path using this heuristic
- **Heuristic H2:** greedy best-first search doesn't find the optimal path using this heuristic



Fill in the following table to with your answers. Make sure that each of your heuristic is admissible and satisfies the above condition. No partial credit will be given.

	S	**A**	**B**	**C**	**G**
Heuristic H1	*25*	*20*	*15*	*10*	*0*
Heuristic H2	*25*	*20*	*3*	*10*	*0*

There could be multiple possible solutions to this question. Best-first search will find sub-optimal path using H2.

Question 3:	**Marks 2.5+2.5+3=08**

a) Let h1 and h2 be two admissible heuristic functions (assuming both are non-negative). Then, max(h1, h2/2) is also admissible. State whether this statement is TRUE or FALSE and provide valid reasoning to justify your answer to get any credit.

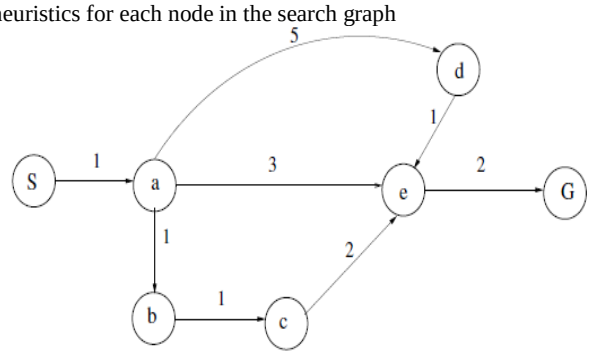
Answer: True. Since $h1 \leq h^*$, and $h2 / 2 \leq h2 \leq h^*$, hence in any case $\max(h1, h2 / 2) \leq h^*$, and it is admissible.

b) Let h1 is an admissible search heuristic while h2 be an inadmissible heuristic function. Then h3=min(h1, h2) is also admissible. State whether this statement is TRUE or FALSE and provide valid reasoning to justify your answer to get any credit.

Answer: True. Since $h1 \leq h^*$, and $h2 \leq h^*$, hence in any case $\min(h1, h2) \leq h^*$, and it is admissible

c) Consider three heuristics h1, h2, h3. The table below indicates the estimated cost to goal (h value) for each of the heuristics for each node in the search graph

node	h_1	h_2	h_3
S	6	6	6
a	5	5	6
b	5	4	5
c	4	2	3
d	2	1	2
e	2	1	1
G	0	0	0



For each heuristic function, circle whether it is admissible and whether it is consistent with respect to the search problem given above.

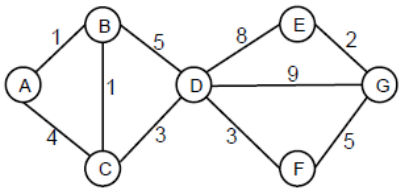
	Admissible?		Consistent?	
h1	**Yes**	**No**	**Yes**	**No**
h2	**Yes**	**No**	**Yes**	**No**
h3	**Yes**	**No**	**Yes**	**No**

Commented [ZI1]: H2 fail at c 6-2<3

Commented [ZI2]: H3 e fail 6-1<=4

Question 4:	**Marks 06+04 =10**

Consider the following state space graph shown above. A is the start state and G is the goal state. The costs for each edge are shown on the graph. Each edge can be traversed in both directions. Note that the heuristic h1 is consistent but the heuristic h2 is not consistent.



Node	h_1	h_2
A	9.5	10
B	9	12
C	8	10
D	7	8
E	1.5	1
F	4	4.5
G	0	0

a) For each of the following graph search strategies (do not answer for tree search), mark which, if any, of the listed paths it could return. Note that for some search strategies the specific path returned might depend on tie-breaking behaviour. In any such cases, make sure to mark all paths that could be returned under some tie-breaking scheme.

Search Algorithm	**A-B-D-G**	**A-C-D-G**	**A-B-C-D-F-G**
Breadth first search	X	X	
A* search with heuristic h1			X
A* search with heuristic h2			X

b) Suppose you are completing the new heuristic function h3 shown below. All the values are fixed except h3(B).

Node	A	B	C	D	E	F	G
h_3	10	?	9	7	1.5	4.5	0

For each of the following conditions, write the set of values that are possible for h3(B). For example, to denote all non-negative numbers, write [0, ∞]. Or null for empty set.

i. What values of h3(B) make h3 admissible?

To make h_3 admissible, $h_3(B)$ has to be less than or equal to the actual optimal cost from B to goal G, which is the cost of path B-C-D-F-G, i.e. 12. The answer is $0 \leq h_3(B) \leq 12$

ii. What values of h3(B) make h3 consistent?

All the other nodes except node B satisfy the consistency conditions. The consistency conditions that do involve the state B are:

$$h(A) \leq c(A,B) + h(B) \qquad h(B) \leq c(B,A) + h(A)$$
$$h(C) \leq c(C,B) + h(B) \qquad h(B) \leq c(B,C) + h(C)$$
$$h(D) \leq c(D,B) + h(B) \qquad h(B) \leq c(B,D) + h(D)$$