IN-CLASS EXERCISE (I2)

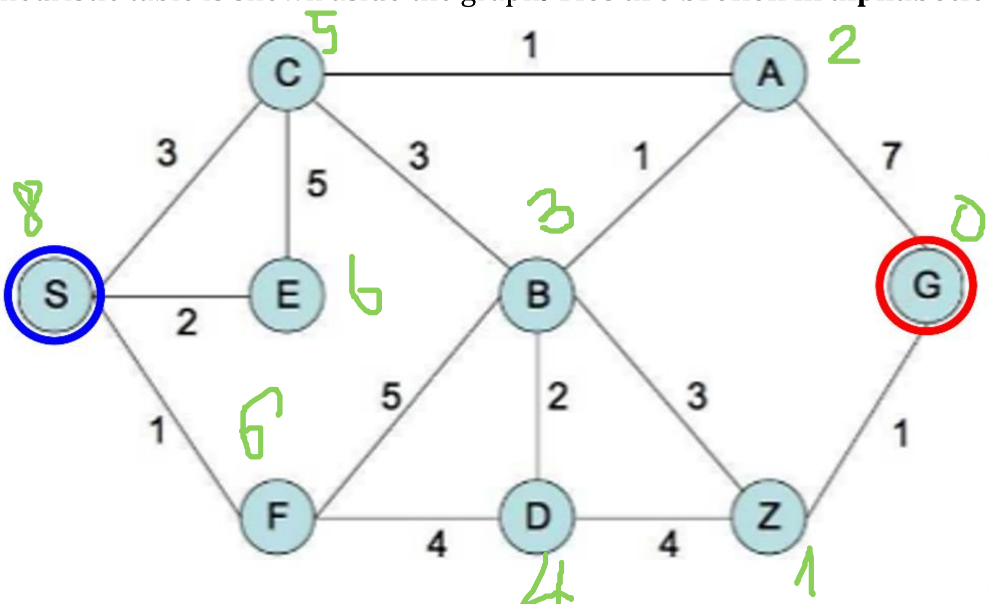
Duration: 15 mins

Date: 28/02/2023

Score: ..../ 3

Student ID:............................Student name: ....

Question 1 (2pts) Consider the following graph. The initial state is **vertex S**, and the goal state is **vertex G**. The heuristic table is shown aside the graph. **Ties are broken in alphabetical order**.



Vertex	Heuristic
S	8
A	2
B	3
C	5
D	4
E	6
F	6
Z	1
G	0

For each of the following search strategies, state the order in which states are expanded and the path returned. Vertices should be presented in their exact order without spaces in between, e.g., SABC)
Note that the path returned will not be accepted if the list of expanded states is wrong.

Algorithm	**List of expanded states in exact order**	**Path returned**
Uniform cost search (1pt)		
Iterative deepening search (0.5pt)	Level 0: Level 1: Level 2:	
Graph-search GBFS (0.5pt)		

Question 2 (1pt) Explain why the following statement is TRUE (or FALSE).
If $h_1(s)$ is a consistent heuristic and $h_2(s)$ is an admissible heuristic, $h_3(s) = \min(h_1(s), h_2(s))$ must be consistent.

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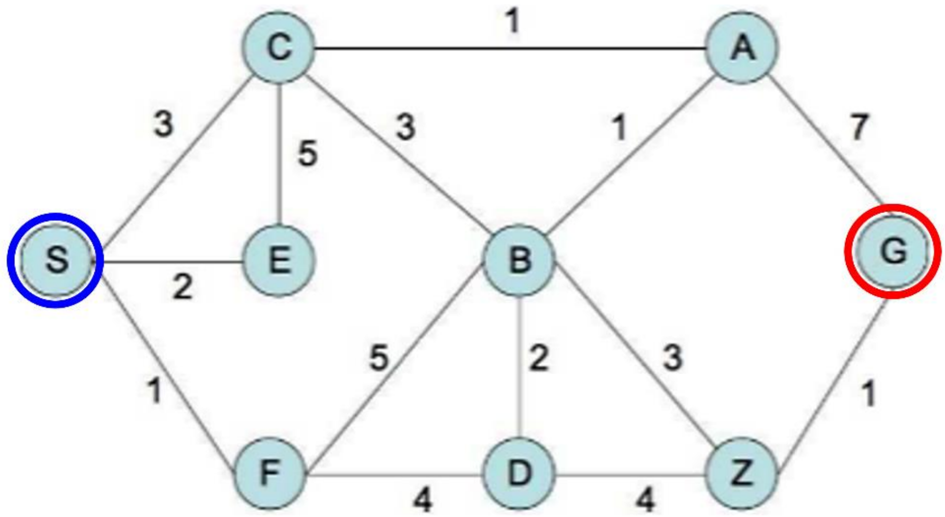

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Algorithm	**List of expanded states in exact order**	**Path returned**
Graph-search A* (1pt)		
Depth-first search (0.5pt) avoid repeating any state on the current path		
Breadth-first search (0.5pt)		

Question 2 (1pt) Explain why the following statement is TRUE (or FALSE).
If g(s) and h(s) are two admissible heuristics, then their average f(s) = 0.5g(s) + 0.5h(s) must also be admissible.

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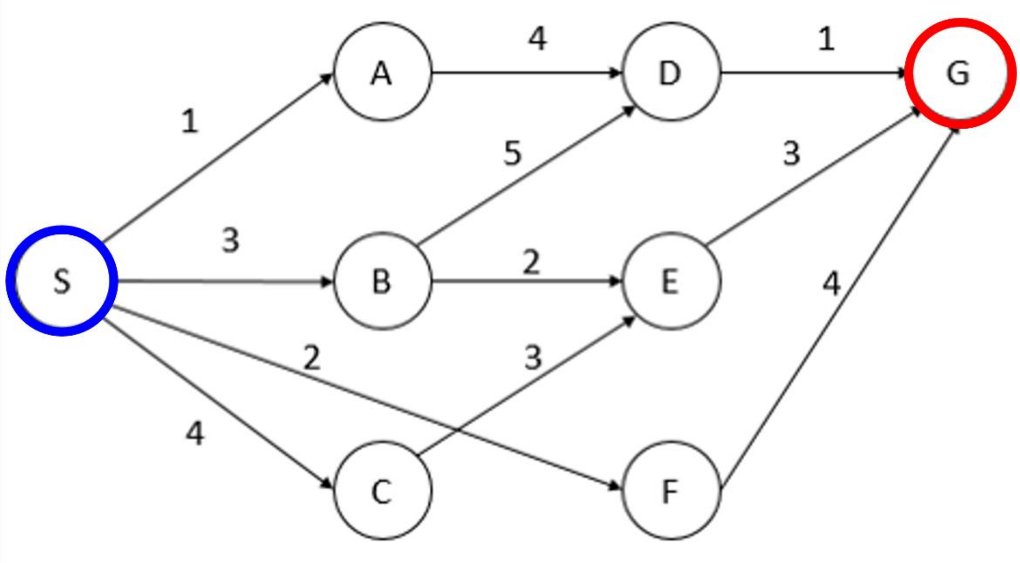

Vertex	Heuristic
S	6
A	5
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C	5
D	1
E	2
F	3
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Graph-search GBFS (0.5pt)		

Question 2 (1pt) Is tree-search A* guaranteed to be optimal with a consistent heuristic function? Justify your answer.

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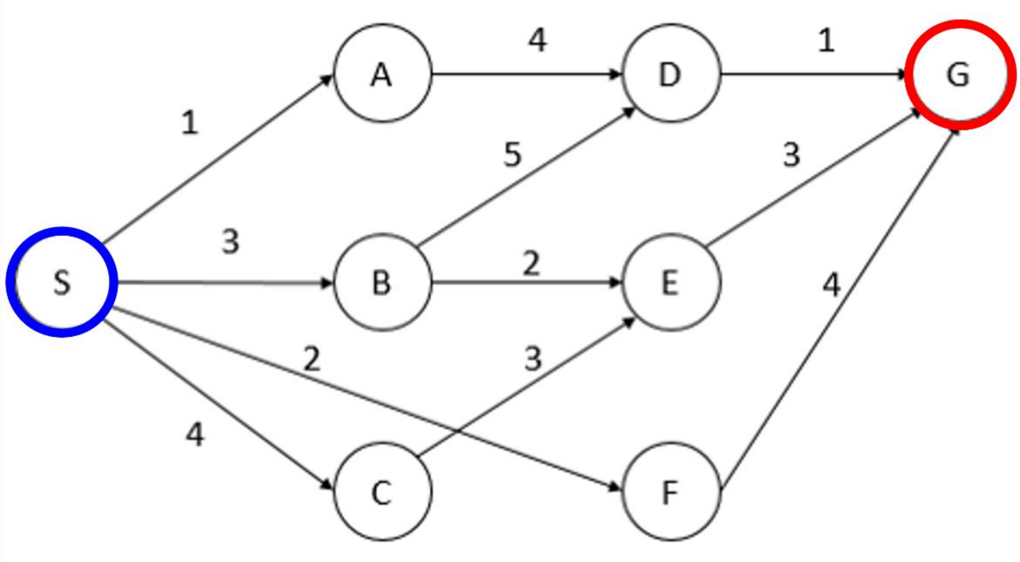

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Question 2 (1pt) Is graph-search A* guaranteed to be optimal with an admissible heuristic function? Justify your answer.

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SOLUTION

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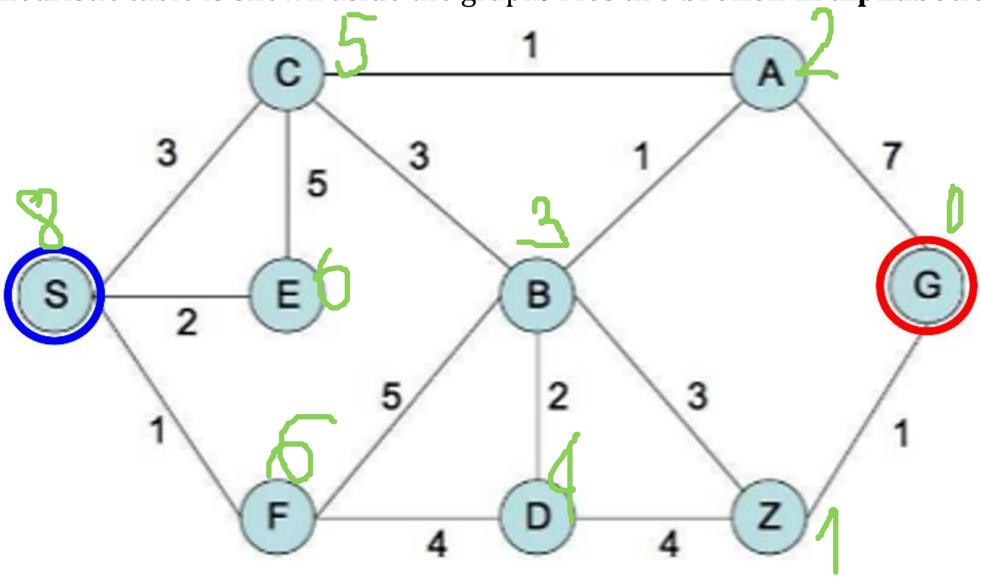

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Note that the path returned will not be accepted if the list of expanded states is wrong.

Algorithm	**List of expanded states in exact order**	**Path returned**
Uniform cost search (1pt)	S F E C A B D Z **G**	S C A B Z G
Iterative deepening search (0.5pt)	Level 0: S Level 1: S C E F Level 2: S C A B E E C F B D	S C A G
Graph-search GBFS (0.5pt)	S C A	S C A G

Question 2 (1pt) Explain why the following statement is TRUE (or FALSE).
If $h_1(s)$ is a consistent heuristic and $h_2(s)$ is an admissible heuristic, $h_3(s) = \min(h_1(s), h_2(s))$ must be consistent.

FALSE. $h_2(s)$ may be smaller than $h_1(s)$, and thus $h3(s) = \min(h_1(s), h_2(s)) = h_2(s)$ is only admissible.

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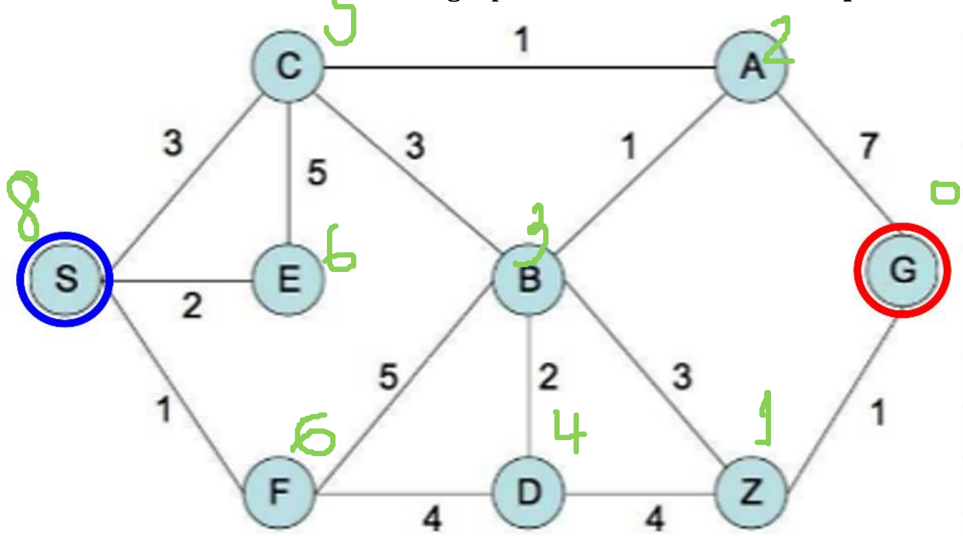

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Note that the path returned will not be accepted if the list of expanded states is wrong.

Algorithm	**List of expanded states in exact order**	**Path returned**
Graph-search A* (1pt)	S F C A B E D Z **G**	S C A B Z G
Depth-first search (0.5pt) avoid repeating any state on the current path	S C A	S C A G
Breadth-first search (0.5pt)	S C E F A	S C A G

Question 2 (1pt) Explain why the following statement is TRUE (or FALSE).
If g(s) and h(s) are two admissible heuristics, then their average f(s) = 0.5g(s) + 0.5h(s) must also be admissible.

TRUE. Let C*(s) be the optimal path from s to goal. Since g(s) and h(s) are admissible, g(s) <= C*(s) and h(s) <= f*(s). Thus, f(s) = 0.5g(s) + 0.5h(s) <= 0.5C*(s) + 0.5C*(s) <= C*(s). Therefore, f(s) is admissible

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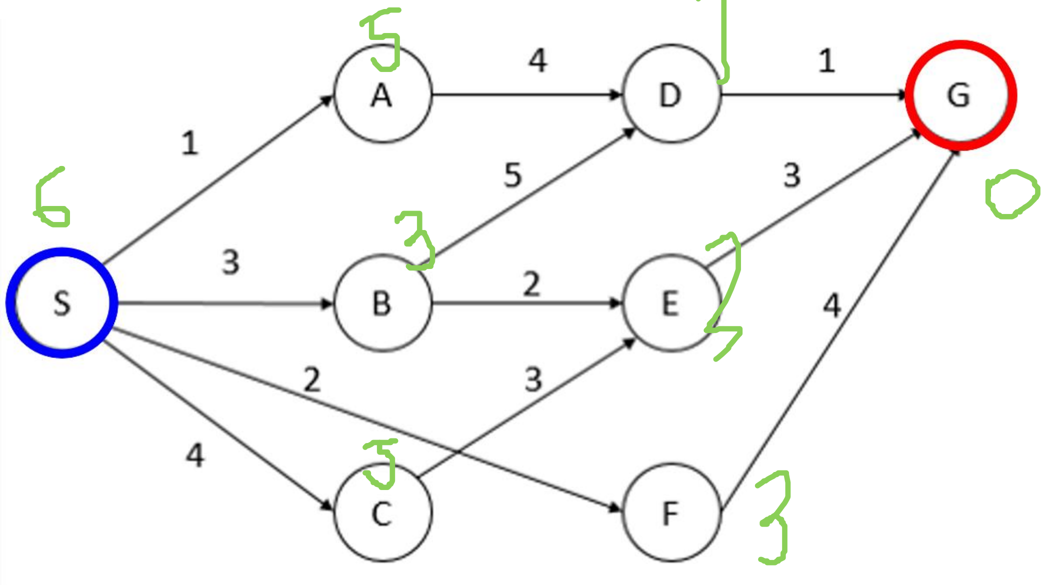

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Note that the path returned will not be accepted if the list of expanded states is wrong.

Algorithm	**List of expanded states in exact order**	**Path returned**
Uniform cost search (1pt)	S A F B C D E **G**	S F G (S A D G acceptable)
Iterative deepening search (0.5pt)	Level 0: S Level 1: S A B C F Level 2: S A D B D E C E F	S F G
Graph-search GBFS (0.5pt)	S B D	S B D G

Question 2 (1pt) Is tree-search A* guaranteed to be optimal with a consistent heuristic function? Justify your answer.
YES. Tree-search A* is optimal with an admissible heuristic. Furthermore, a consistent heuristic is definitely an admissible heuristic. Thus, tree-search A* is optimal with a consistent heuristic.

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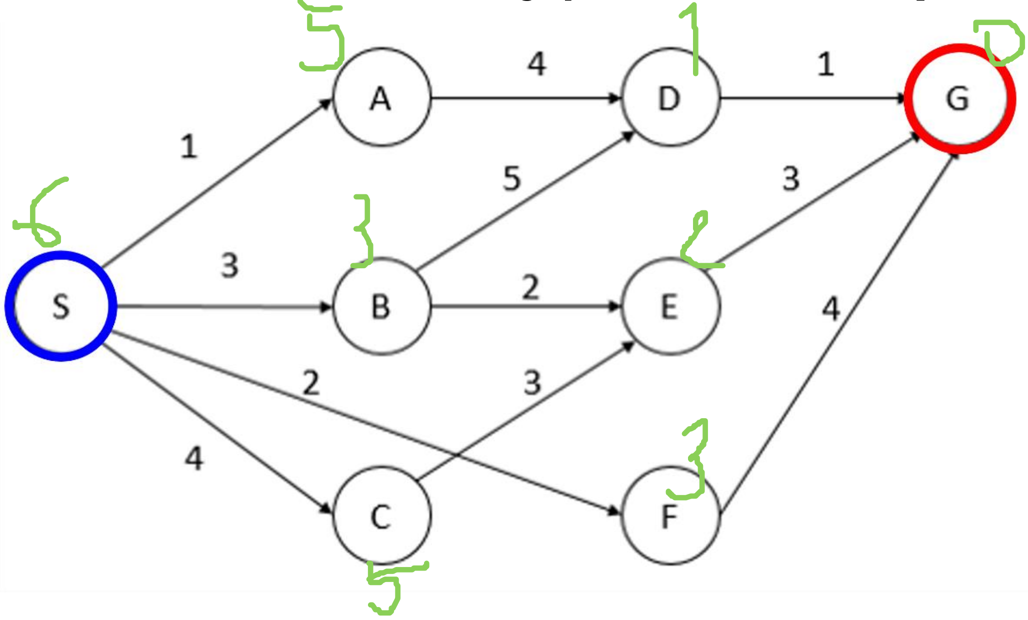

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For each of the following search strategies, state the order in which states are expanded and the path returned. Vertices should be presented in their exact order without spaces in between, e.g., SABC)
Note that the path returned will not be accepted if the list of expanded states is wrong.

Algorithm	**List of expanded states in exact order**	**Path returned**
Graph-search A* (1pt)	S F A B D **G**	S F G (S A D G acceptable)
Depth-first search (0.5pt) avoid repeating any state on the current path	S A D	S A D G
Breadth-first search (0.5pt)	S A B C F	S F G

Question 2 (1pt) Is graph-search A* guaranteed to be optimal with an admissible heuristic function? Justify your answer.

NO. Graph-search A* is optimal with a consistent heuristic. Furthermore, an admissible heuristic is not always a consistent heuristic. Thus, graph-search A* is not guaranteed to optimal with an admissible heuristic.