International University – VNUHCM
School/Department Name

Student Name:.....
Student ID:.....

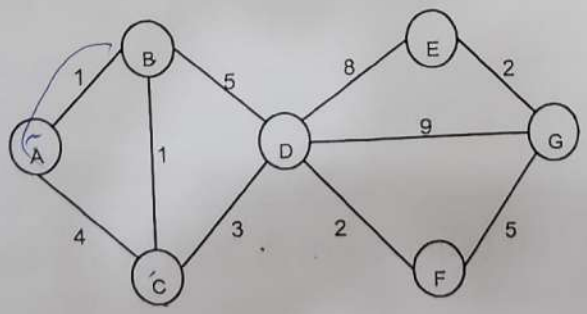
Q1. [10 pts] Intelligent Agents

Please enumerate basic agent types? What is the agent type of solving problem by searching?

Q2. [50 pts] Search

1. Consider the water jug problem: there are two jugs, a 4-gallon one and a 3-gallon one. Neither has any measuring markers on it and they are initially empty. There is a pump that can be used to fill the jugs with water. The goal is to have exactly 2 gallons of water in the 4-gallon jug and 3-gallon jug empty. A state space description of this problem can be a set of ordered pairs of integers (X,Y), such that X= 0,1,2,3, or 4 and Y= 0,1,2, or 3; X and Y represent the number of gallons of water in the 4-gallon jug, and the 3-gallon jug respectively.
   a. [10 pts] Is it appropriate to formulate this problem as a search problem? If so, give some description of how. If not, justify why not. If yes, construct the search tree to obtain the goal state, using the following search methods:
   b. [10 pts] Breadth-first search (BFS). Which solution would BFS find to move from initial state to goal state if run on this search tree?

2. Consider the state space graph shown below. 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 h_1 is consistent but the heuristic h_2 is not consistent.



Node	h_1	h_2
A	9.5	10
B	9	12
C	8	10
D	6	8
E	1.5	1
F	4	4.5
G	0	0

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Heuristic function properties

Suppose you are completing the new heuristic function h_3 shown below. All the values are fixed except $h_3(B)$.

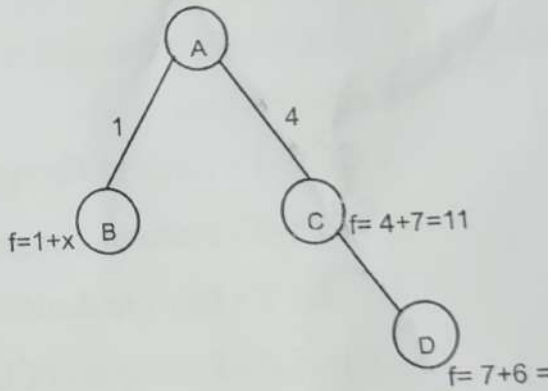
Node	A	B	C	D	E	F	G
h_3	7	?	7	6	1.5	4.5	0

For each of the following conditions, write the set of values that are possible for $h_3(B)$. For example, to denote all non-negative numbers, write $[0, \infty]$, to denote the empty set, write $\emptyset$, and so on.

(i) [10 pts] What values of $h_3(B)$ make h_3 admissible?

(ii) [10 pts] What values of $h_3(B)$ make h_3 consistent?

(iii) [10 pts] What values of $h_3(B)$ will cause A* graph search to expand node A, then node C, then node B, then node D in order?



Q3. [40 pts] CSPs

1. A constraint satisfaction problem (CSP) is defined by three components <X, D, C>, where X is a set of variables, D is a set of their respective domains of values and C is a set of constraints.
   a. [5 pts] Please describe what is consistent assignment in CSP? What is complete assignment? Please describe what is a solution to a CSP?
   b. [5 pts] Explain why it is a good heuristic to choose the variable that is *most* constrained but the value that is *least* constraining in a CSP search.
   c. [5 pts] Explain what are node and arc consistency in CSP?
2. Class Scheduling

   You are in charge of scheduling for computer science classes that meet Mondays, Wednesdays and Fridays. There are five classes that meet on these days and three professors who will be teaching these classes. You are constrained by the fact that each professor can only teach one class at a time.

The classes are:

- Class 1 - Intro to Computing: meets from 13:00 - 14:00 pm
- Class 2 - Natural Language Processing: meets from 13:30 - 14:30 pm
- Class 3 - Intro to Artificial Intelligence: meets from 14:00 - 15:00 pm
- Class 4 - Principles of Database Management: meets from 14:00 - 15:00 pm
- Class 5 - Deep Learning: meets from 14:30 - 15:30 pm

The professors are:

- Professor A, who is available to teach Classes 3 and 4.
- Professor B, who is available to teach Classes 2, 3, 4, and 5.
- Professor C, who is available to teach Classes 1, 2, 3, 4, 5.

a. [10 pts] Formulate this problem as a CSP problem in which there is one variable per class, stating the domains, and constraints. Constraints should be specified formally and precisely, but may be implicit rather than explicit.

b. [5 pts] Draw the constraint graph associated with your CSP.

c. [5 pts] Show the domains of the variables after running arc-consistency on this initial graph (after having already enforced any unary constraints).

d. [5 pts] Give one solution to this CSP.

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