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ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

MID SEMESTER EXAMINATION **SUMMER SEMESTER, 2021-2022**

DURATION: 1 HOUR 30 MINUTES **FULL MARKS: 75**

CSE 4617: Artificial Intelligence

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer **all 3 (three)** questions. Figures in the right margin indicate full marks of questions whereas corresponding CO and PO are written within parentheses.

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1. You have been assigned the task of scheduling 5 different courses among 3 different professors. You must produce a complete and consistent schedule based on the following constraints:
   - Each professor only teaches one course at a time
   - Each course is taught by only one professor
   - Some professors can only teach some of the courses

   You decide to formulate this task as a CSP in which courses are the variables (named C1 through C5) and professors are the domain values (named A, B, and C). After you have solved the CSP, each course (variable) will be assigned one professor (value) and all constraints will be satisfied.

   The courses (variables) are:
   - C1, Course 1 - Structured Programming I: meets from 8:00-8:50am
   - C2, Course 2 - Introduction to Software Engineering: meets from 8:30-9:20am
   - C3, Course 3 - Discrete Mathematics: meets from 9:00-9:50am
   - C4, Course 4 - Digital Logic Design: meets from 9:00-9:50am
   - C5, Course 5 - Artificial Intelligence: meets from 9:30-10:20am

   The professors (domain values) are:
   - A, Professor A, who is available to teach Courses C3 and C4.
   - B, Professor B, who is available to teach Courses C2, C3, C4, and C5.
   - C, Professor C, who is available to teach Courses C1, C2, C3, C4, C5.

   a) For each variable C1-C5, identify its domain as a subset of the values {A, B, C}. Enforce unary constraints as a preprocessing step, i.e., delete from the domain of each course variable any professor who is not available to teach that course. 5 (CO1) (PO1)

   b) Write all the constraints that are associated with this CSP implicitly as $Ci \neq Cj$ for all courses Ci and Cj that overlap in time and therefore cannot be taught by the same professor. Use these constraints to draw the constraint graph. 6+4 (CO1) (PO1)

   c) Run Arc Consistency (AC-3) on the domains in 1.a) and the constraints and the constraint graph in 1.b). Write down the reduced domains that result when all inconsistent domain values are removed by AC-3. Use this arc consistent domain to give one solution to this CSP. 7+3 (CO1) (PO1)

2. Consider the state space graph in Figure 1. The values within each node represent the heuristic cost while the numbers on the edges denote the cost of executing the action for going to a successor state. Assume that S is the start state and G_1, G_2, and G_3 are goal states. We will run **graph search variants** of different search algorithms to find a path from the start state to any of the goal states. When expanding the successors of a state, we will break ties in alphabetic order.

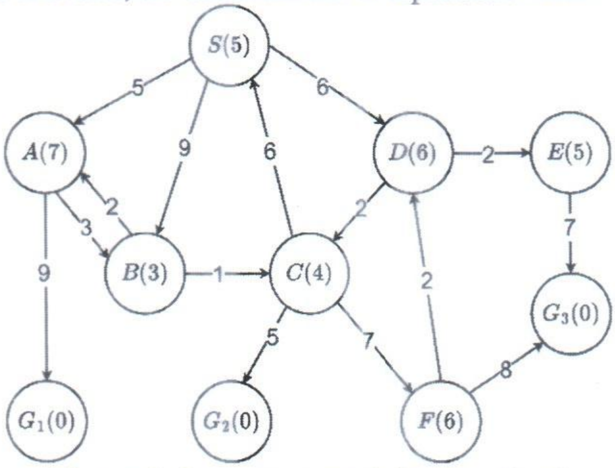

Figure 1: State space graph for Question 2

Compare between the following algorithms by determining the order in which the states are expanded and the path returned. 12+13 (CO1) (PO1)

i. Breadth-First Search and Depth-First Search

ii. Greedy Search and A* Search

Identify which on performs better and the reason behind it

3. Consider a Pacman game where there are two kinds of food pellets, R and B. Pacman is interested in tasting the two different kinds of food at least once: the game ends when he has eaten 1 R pellet and 1 B pellet (though Pacman may eat more than one of each pellet). Pacman has four actions: moving up, down, left, or right. There are K different R pellets and K different B pellets, and the dimensions of the board are N by M. A sample board of the game is shown in Figure 2. In this board $K = 3$, $N = 4$, and $M = 4$.

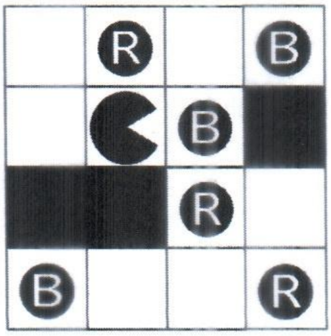

Figure 2: Sample Pacman game for Question 3

a) Model the state space graph for this problem. Your model should describe the states, actions available, successor function, start state, and goal test. 10 (CO2) (PO2)

b) Give a tight upper bound for the following two terms with proper justification: 6 (CO1) (PO1)

i. The size of the state space

ii. Branching factor of the search problem

c) With proper justification, determine whether each of the following heuristics is admissible or not: 3 × 3 (CO1) (PO1)

i. The number of pellets remaining.

ii. The smallest Manhattan distance to any remaining pellet.

iii. The minimum Manhattan distance between any two remaining pellets of opposite colors.