PRIFYSGOL ABERYSTWYTH UNIVERSITY

SEMESTER ONE 2026

COMPUTER SCIENCE

CSM6120 : FUNDAMENTALS OF INTELLIGENT SYSTEMS

Time allowed: **3 HOURS**

Answer **BOTH** questions.

YOU MAY BRING THE FOLLOWING INTO THE EXAMINATION:
UP TO 3 SHEETS OF NOTES ON A4 PAPER (WHICH MAY BE DOUBLE-SIDED). THERE ARE NO ADDITIONAL RESTRICTIONS ON CONTENT OR FORMATTING OF THESE NOTES.
NO ELECTRONIC DEVICES.

CALCULATORS ARE NOT PERMITTED.

STUDENTS MAY SUBMIT ANSWERS TO THIS PAPER IN EITHER WELSH OR ENGLISH

Once seated, students may complete the front cover of the answer book(s) and the attendance slip ONLY.

DO NOT TURN THE EXAMINATION QUESTION PAPER OVER UNTIL INSTRUCTED TO DO SO.

1. The following figure illustrates a collection of 9 member planets within an imaginary galaxy and approved flight routes between them, i.e., it is not feasible to travel between specific pairs of them due to active magnetic storms in those areas. Two travelling salesmen, Tom and Jerry, try to find their paths from planet A to planet G. Note that names of these planets are represented by capital letters and marked in the given figure. In addition, each of the non-restricted links is marked with a flight time in light years (assuming that a standard spacecraft can travel 1 light year in space using the time of 1 hour on earth).

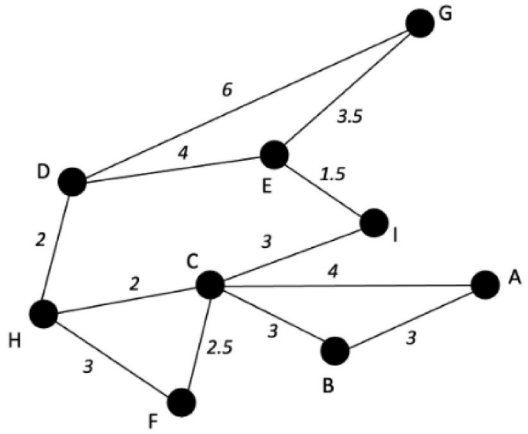


Figure 1: Planets and approved flight routes for Questions 1 and 2

a) If Tom makes use of the depth-first search technique or DFS, which of the following two preferences to order children of a non-leaf node in the search tree makes the search process more efficient: i) alphabet order from A to Z, or ii) alphabet order from Z to A. Explain the reason and draw a diagram to support it. Do the two approaches lead to different solutions and costs (in light years) to travel? [15 marks]

b) After Tom arrives at his destination, the approved flight routes are updated, such that direct travel between Planet C and Planet I is no longer allowed. Given this change, Jerry decides to exploit the breadth-first search technique or BFS using the preference of alphabet order from A to Z. What is the path found and how long does it take? With the current choice of order preference, which of the BFS or DFS techniques is more efficient? Explain the reason and draw a diagram to support it. [15 marks]

c) Make use of the original approved flight routes to answer this question. If the spacecraft used by Tom can fly up to 12 light years without refueling, there is only one refueling station and it is on planet D, how do these factors impact the way UCS (Uniform Cost Search) works, provided that the preference of alphabet order is from Z to A?

Explain the modification made to standard UCS in order to factor in this additional information and draw a diagram to support it. [10 marks]

d) Instead of solving this problem using a search technique, logical inferences with forward and backward chaining methods are exploited with the knowledge base of 8 rules presented below. This has been acquired from an expert and might not cover all possible series of connecting routes. The capital letters denote logical prepositions, which can be evaluated as either True or False. For instance, A represents the logical preposition 'A salesman visits planet A'. This inference task is to prove that there is an approved path from planet A to planet G, provided that only A is in the working memory initially. Which of the forward and backward chaining methods can prove this, assuming that the strategy of 'fire all applicable rules' is used for any conflicts? [10 marks]

Knowledge Base (different feasible series of connecting routes stated by an expert).

R1: If E Then G

R2: If D Then E

R3: If C and I Then E

R4: If A and C Then I

R5: If B and C Then H

R6: If B and C Then F

R7: If A Then C

R8: If A Then B

2. Based on the approved flight routes given in Figure 1, Jerry aims to solve the travelling salesman problem (TSP) such that he can find a valid solution or a tour, i.e., one with each of all the 9 planets visited only once.

a) If this is treated as a constraint-satisfaction problem or CSP (i.e., the length or cost of each valid tour is not relevant to this problem), explain in detail how to define the three major components of this CSP. [15 marks]

b) If this TSP is to be solved as an optimisation problem with the goal to minimise the tour length (in term of light hours), describe how to design a state, one example of a possible operation (to generate a new state) and the objective function to be exploited by a local search approach. Those constraints specified in the previous question are required for the validation of new states. Draw a diagram to support the explanation regarding state, operation and constraint-based validation. [15 marks]

c) With the definition of the state you specified in the previous question, a genetic algorithm or GA (with a population size of 4 and the maximum number of iterations set to 50) will be used to solve this optimisation problem. With an example set of states, discuss how this problem can be solved using a GA, including the representation of those states, choice of operators, and the results of applying those operators to your example. Draw a diagram to support the explanation regarding the population, operations and the overall optimisation process. [20 marks]

END OF PAPER