This question paper consists of 3 printed pages each of which is identified by the Code Number (COMP5920M01)

This is a closed book examination. No material is permitted.

School of Computing

May/June 2018

COMP5920M01

Scheduling

Answer all THREE questions

Time allowed: 2 hours

Question 1

A computer scientist has been successful in train crew scheduling research and now has attracted interest from a supermarket chain to develop algorithms for scheduling their staff.

(a) The train crew scheduling problem has some special characteristics in terms of the rail network covered, the timing of individual crew shifts and the inter-relationship between crew shifts. With reference to these special characteristics, discuss how the supermarket staff scheduling problem would differ.

[6 marks]

(b) After some initial study of the supermarket staff scheduling problem, the computer scientist proceeds to collect data. Outline four main categories of data for train crew scheduling that the computer scientist would be familiar with, and comment on the suitability of such categorisation of data for the supermarket staff scheduling problem.

[6 marks]

(c) The project went well and the supermarket chain commissioned a pilot trial of the newly developed algorithms. The company assigned a senior manager to assist in this pilot trial project, who was able to provide any data required and answer queries from the computer scientist. At the end of the first phase of the trial, the computer scientist delivered their initial results and was jubilant that a saving of about 10% was achieved. Unfortunately, the manager rejected the results because some duties in the schedule broke the rules and some duties could not be implemented 'in practice'. It turned out that the computer scientist misinterpreted one labour rule and that the manager had not described all the local practices. It was difficult to blame the manager, to whom staff scheduling was a totally intuitive process.

Analyse and comment on the difficulty in setting up the input data correctly in an industrial pilot trial of scheduling optimisation research. Suggest to the computer scientist three actions by which the difficulty might have been avoided.

[8 marks]

[question 1 total: 20 marks]

Question 2

(a) For the Selection Phase of the Generate and Select approach for train crew scheduling, an ILP method was discussed in lectures and the design and implementation of greedy heuristics were the focus in coursework 2. In terms of the problem model, practicality for real life problem instances, computational performance and optimality of solutions, compare and contrast the ILP method and the greedy heuristics.

[8 marks]

(b) The cost of a train crew shift is expressed in terms of the duration (in minutes) from the time the crew is required to sign on to the time the crew signs off. With reference to the second coursework assignment, one student has designed a greedy heuristics for train crew scheduling which has yielded a solution schedule with 191 shifts at a total cost of 62494 minutes for one of the given datasets. The train company concerned expects a schedule of around 70 shifts. A normal full-time train crew shift would be around 9 hours long. The student is going to analyse their solution for clues to improve their heuristics. Discuss and suggest two areas for the student to consider in relation to the quality of the crew schedule they have obtained above.

[4 marks]

(c) A research student is investigating the graph colouring approach for train crew scheduling. They have set up a graph in which each vertex represents a train trip in the given timetable to be scheduled. Graph edges have been inserted such that any pair of train trips (graph vertices) joined by an edge will have at least part of their journeys running at the same time. A graph colouring solution is computed and each set of trips of the same colour label are arranged into a chronological sequence. A train crew is assigned to cover from the beginning of the trip sequence until it reaches the maximum length allowed. The sequence of trips is then split for more crews to cover the remaining work. Explain four reasons why the solutions obtained would likely be infeasible.

[8 marks]

[question 2 total: 20 marks]

Question 3

(a) Outline how an initial matrix would be constructed for Floyd's shortest path algorithm to be applied to compute the empty running times between any pair of locations, including the terminals, intermediate stops and depots, in a bus network.

[5 marks]

(b) Explain the key differences between bus vehicle scheduling and train unit scheduling.

[8 marks]

(c) Although the Size Limited Iterative Method (SLIM) algorithm discussed in this module is a heuristics, it has a close working relationship with an exact integer linear programming solver; describe this relationship.

[7 marks]

[question 3 total: 20 marks]

END