MATH3202/7232 Operations Research & Mathematical Planning 2016

Practical Exam

Do not open this exam paper until instructed to do so.

Time allowed: **90** minutes

There are **2** questions on this exam for a total of **15** marks

You may access any material during the exam including material on paper, in your electronic files or online. However you may not communicate with other people during the exam.

Submit your Python files for each question through Blackboard (under Assessment) before the end of the exam.

Please fill in your details below.

Student number: .....

Name: .....

Signature: .....

Question 1 *(9 marks)*

After a major earthquake, a city is being rebuilt. The city planners wish to decide where to position the new hospitals so as to minimise the overall cost of building the hospitals plus the cost of transporting patients to and from hospitals. They have the following information:

- The construction cost of each candidate hospital
- The population of each suburb
- The travel time from each suburb to each hospital

The units have already been standardised so that multiplying the populations of suburbs by the travel time gives a cost that can be used together with construction costs to estimate the total cost.

Furthermore, the city planners have decreed that no hospital can serve more than 7 suburbs or more than 500,000 people. Each suburb must be assigned to exactly one hospital.

Formulate the problem of selecting where to build the hospitals and how to assign suburbs to hospitals as an integer programming problem. Write the formulation in the space below.

Implement your solution in Python and use it to find the optimal solution. You will need to download the stub file **Question1.py**. Write down the optimal objective value and the list of candidate hospitals to be built in the space below.

Question 2 *(6 marks)*

In this question you will need to demonstrate your understanding of the Simulated Annealing algorithm by using it to solve the Assignment Problem.

Given a cost matrix for assigning objects to locations, we wish to assign exactly one object to each location, and each object to exactly one location, so that the total cost of assigning objects to locations is minimized.

The solution will be represented as a single vector, corresponding to the object stored in each location. You will need to define a "neighbourhood" and a means of selecting a random "neighbouring" solution. Write down a description of this below.

Starting with the stub file **Question2.py**, implement a simulated annealing algorithm to solve this problem. The stub includes the generic code for simulated annealing and shows the functions you need to define for this problem. (You might find the examples from class useful in seeing what needs to be completed.) You will then need to experiment to find suitable parameters for the number of iterations and the cooling factor.

When the code you submit to Blackboard is executed it should run the Simulated Annealing procedure with the final parameters you have selected and display the total cost of the solution found. Your code should not take more than 30 seconds to run.