THE UNIVERSITY of ADELAIDE

Optimisation & Operations Research

Haide College, Spring Semester

Assignment 3 (5%)

Due: 30 April, 23:59

Instructions:

- Answer the below questions and submit via Cloudcampus as a single PDF file.
- It is strongly recommended that you type your assignment (for example with LaTeX/Overleaf, as a MATLAB Live Script). A handwritten/scanned submission is acceptable provided it is neat and legible.
- Show all your working. Marks will be deducted if your answers do not include sufficient explanation, are illegible or are otherwise difficult to understand.
- In submitting this assignment you agree to have abided by the principles of academic integrity. You may discuss your assignment with other students but the written submission must be your own work and reflect your own understanding of the material.
- You must submit your assignment by the due date. Late assignments will incur a 50% penalty up to 48 hours after the due date, and a 100% penalty after that. You may request an extension, but please do this at least 24 hours before the due date.

This assignment covers Topic 4 (Integer Programming Problems).

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10 marks

1. Recall from the course notes that the knapsack problem involves choosing which items to put in a knapsack (or backpack). Each item has value, but you have a limited volume in the pack.

   Consider the following linear program representing a knapsack problem for six items with total value z and maximum volume 35.

$$\begin{array}{llcrcrcrcrcrcrcl} \text{max.} & z & = & 19x_1 & + & 22x_2 & + & 30x_3 & + & 37x_4 & + & 11x_5 & + & 42x_6, & & \\ \text{s.t.} & & & 7x_1 & + & 6x_2 & + & 11x_3 & + & 13x_4 & + & 4x_5 & + & 13x_6 & \leq & 35, \end{array}$$

   with $x_i = 0, 1$, for $i = 1, \ldots, 6$.

   2 a) Relax the integral constraint to $x_i \geq 0$ (and real). Solve the relaxed version of the linear program either by inspection or with MATLAB.

   1 b) Relax the integral constraint to $0 \leq x_i \leq 1$ (and real). Solve the relaxed problem with MATLAB and submit via MATLAB Grader. You do **not** need to include your code.

   1 c) Now solve the true binary integer linear program with MATLAB and submit via MATLAB Grader. You do **not** need to include your code.

   2 d) State the solutions (variables and objectives) you found in 1(b) and 1(c).
   Comment on the relative size of the objective function for each solution from 1(a)–(c), and discuss why you would expect the value of the objective to change as it does.

   4 e) Now apply the greedy algorithm from the course notes to the problem. You should do this by hand, rather than in MATLAB, and include all working in your submission.
   How does the greedy solution compare to the optimal solution?

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10 marks

2. In this question you will explore how mapping apps (Baidu or Gaode, for example) find the shortest routes between locations. Consider the below map of the OUC campus.

Eleven locations have been labelled with numbers, for instance the Haide College (Xingzhi) Building is labelled "1".

A visitor would like to find the shortest routes from the Haide College building to the other locations marked on the map (location 2 to 11). Assume they will only walk between these locations via the footpaths and roads marked in green.

The distances between the locations (along the green footpaths/roads) are given in the table below:

From	To	Distance (m)	From	To	Distance (m)
1	2	160	6	7	40
1	6	590	7	8	150
2	3	400	7	11	290
2	5	350	8	9	170
3	4	280	8	10	260
4	5	120	9	10	220
4	8	190	9	11	110
5	6	70	10	11	350

Apply a greedy heuristic from the course notes to find the shortest routes from the Haide College building (location 1) to the other 10 marked locations.

Include all working in your submission.

As part of your submission include a table showing the shortest route to each destination and the length of the route. (**Hint:** A similar table is given in the solution for Tutorial 4, Question 3).