COMP6925: Applied Operations Research
The University of the West Indies
Sept 2021

Assignment 3

Due Date: 6th November 2021 @ 11:59 PM (AoE)

Instructions:

- Create **.zip** folder with code and write-up to inzamam.rahaman@outlook.com. Your folder should be named using your UWI ID number
- Document code with comments. Your code should be in **.jl** or **.py** files as appropriate named without spaces.
- All non-code documents are to be submitted as **.pdf** files.
- All submission components should be submitted together as a **.zip** folder named using your student id number.
- Submissions that violate the above will be considered as not submitted and will not be considered.

1. A cellular provider is currently in the process of expanding into a new city. The city comprises 15 neighbourhoods, and based on their geographic placement, a single cell tower can serve multiple neighbourhoods. The potential placement sites are labeled 1 through 7, and the communities served by each site is provided below:

Site	Communities served
1	1, 2
2	2, 3, 5
3	1, 7, 9, 10
4	4, 6, 8, 9
5	6, 7, 9, 11
6	5, 7, 10, 12, 14
7	12, 13, 14, 15

Table 1: Sites and Communities they can serve

The cellular provider would like to minimize the number of towers they need to construct while ensuring that each neighbourhood is served

   (a) Represent the above problem as optimization problem. [5 marks]

   (b) Write Julia code to solve the above problem, and state the obtained output. [5 marks]

2. A combination of environmental factors and regulatory requirements can lead to different cell towers incurring different costs. These costs are summarized in the table below:

Site	1	2	3	4	5	6	7	8
Cost (millions)	4	3.60	2.30	4.10	3.15	2.80	2.65	3.10

Table 2: Cost of construction of cell towers on different sites

The populations of different neighbourhoods are described in Table 3.

The cellular provider has a budget of $11 million dollars, and wants to maximize the number of people served while still staying within budget - even if they must neglect one or more neighbourhoods. Using the information in Tables 1, 2, and 3, answer the following:

   (a) Formulate the above as an optimization problem. [10 marks]

   (b) Solve the above formulation using Julia and output the towers that should be constructed. [5 marks]

   (c) Suppose that two additional constraints are added due to environmental regulations:

      i. The construction of site 2 mandates the construction of site 6

      ii. Either site 1 or site 3 can be built but not both

      Modify your formulation of 2a. to accommodate the above requirements, and write Julia code to solve this mode [10 marks]

Neighbourhood	Population (1000s)
1	4
2	3
3	10
4	14
5	6
6	7
7	9
8	11
9	15
10	11
11	6
12	12
13	7
14	5
15	16

Table 3: Population in 1000s of different neighbourhoods

3. Consider the below telecommunication network.

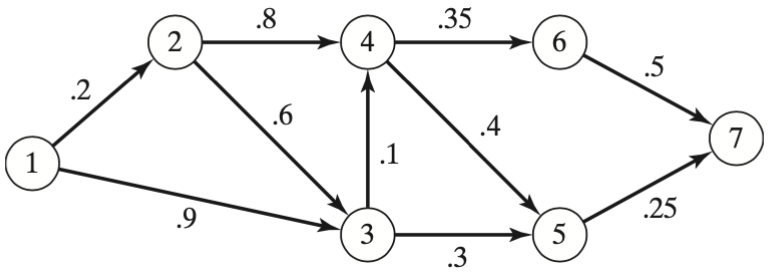

Figure 1: Telecommunications Network

The weights on the edges denote the probability of a packet being sent correctly across said edge. All probabilities are independent of one another. For example, the probability that a packet traveling from 2 to 8 would remain intact is 0.8. Furthermore, a node traveling from 1 to 4 through 3 would arrive intact with probability 0.9×0.1. Suppose that we want to transport a packet from 1 to 7 and we care about the choosing the route that maximizes the probability of a packet remaining intact.

- Frame this problem and as shortest-path problem, explaining any transformations if any. [10 marks]
- Using NetworkX and Python, find the best route to travel from 1 t0 7. [5 marks]