MGMTMSA 408 – Operations Analytics – Spring 2024

Final Exam – Answer Sheet - Q1

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Please follow all instructions on the Final Exam question sheet.

Q1 - Medical waste disposal

Part 1: Understanding the data

a)

The hospital farthest from the depot is Antelope Valley Hospital with a distance of 90167.00 units.

b)

The hospital farthest from the depot is Mission Community Hospital with a distance of 2141.00 units.

c)

The cost of the route produced by this heuristic is $94553.9.

d)

The average cost of this heuristic over the 100 simulations is $488934.474
The best (= lowest) cost that this heuristic attains over the 100 simulations is $438397.5

Part 2a

$$
\begin{aligned}
\underset{\mathbf{x}}{\text{minimize}} \quad & \sum_{i=1}^{n} \sum_{\substack{j=1 \\ j \neq i}}^{n} d_{i,j} x_{i,j} \quad \text{[Objective Function]} \\
\text{subject to} \quad & \sum_{\substack{j=1 \\ j \neq i}}^{n} x_{i,j} = 1, \quad \forall\, i \ \in \{1, \ldots, n\} \quad \text{[Each hospital has exactly one outgoing path]} \\
& \sum_{\substack{j=1 \\ j \neq i}}^{n} x_{j,i} = 1, \quad \forall\, i \ \in \{1, \ldots, n\} \quad \text{[Each hospital has exactly one incoming path]} \\
& \sum_{i \in S} \sum_{\substack{j \in S \\ j \neq i}} x_{i,j} \leq |S| - 1, \quad \forall\, S \subsetneq \{1, \ldots, n\}, \quad \text{[Subtour Elimination Constraint]} \\
& x_{i,j} \in \{0, 1\}, \quad \forall\, i, j \in \{1, \ldots, n\},\ i \neq j. \quad \text{[Binary Constraint]}
\end{aligned}
$$

where decision variables are given as follows:

d_{ij} is the travel distance from hospital i to hospital j.

$x_{ij} = 1$ if if the path from hospital i to hospital j is included in the tour

$x_{ij} = 0$ otherwise

to minimize total distance travelled.

Part 2: An optimization formulation

a)

b) The optimal cost is $77578.9

c) The first five hospitals that are visited in the optimal route are (depot), Mission Community Hospital, Mission City Community Network Inc, Northridge Hospital Medical Center, West Hills Hospital and Medical Center, Kaiser Permanente - Woodland Hills Medical Center