Homework 3
Submission by: Mohammad Mirza (mmmirza); Collaborators: rsafiull, anumm, jricoari

Question 1

Decision Variables:

x_j = 1, if shelter j is built, 0 otherwise
y_{ij} = 1, if residential area i is assigned to shelter j, 0 otherwise

Sets:

i = 1, …, n: residential areas, where n = 200th residential area
j = 1, …, m: shelter sites, where m = 40th site

Parameters:

d_{ij}: distance from residential area i to shelter site j
r_i: number of residents in residential area i
c_j: capacity of shelter site j

Objective Function:

$$\text{Min} \sum_{j=1}^{m} \sum_{i=1}^{n} (r_i * d_{ij} * y_{ij})$$

Constraints:

- Resource constraint to build shelters

  $$\sum_{j=1}^{m} x_j \leq 10 \text{ shelters}$$

- Each potential site receives residents within its capacity, given a shelter is built at the site

  $$\sum_{i=1}^{n} r_i * y_{ij} \leq c_j * x_j, \forall j = 1, \dots, m$$

- Each residential area is assigned to the same (one) shelter built

  $$\sum_{j=1}^{m} y_{ij} = 1, \forall i = 1, \dots, n$$

- Binary

  x_j, y_{ij}

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Question 2

190586.47 miles is the total distance across all residents. The optimization takes place in 4.67 seconds.

Question 3

Decision Variables:

x_j = 1, if shelter j is built, 0 otherwise
y_{ij} = 1, if residential area i is assigned to shelter j, 0 otherwise
D: Maximum distance between a shelter and a residential area.

Sets:

i = 1, …, n: residential areas, where n = 200th residential area
j = 1, …, m: shelter sites, where m = 40th site

Parameters:

d_{ij}: distance from residential area i to shelter site j
r_i: number of residents in residential area i
c_j: capacity of shelter site j

Objective Function:

Min D

Constraints:

- Resource constraint to build shelters

$$\sum_{j=1}^{m} x_j \leq 10 \text{ shelters}$$

- Each potential site receives residents within its capacity, given a shelter is built at the site

$$\sum_{i=1}^{n} r_i * y_{ij} \leq c_j * x_j, \forall j = 1, \dots, m$$

- Each residential area is assigned to the same (one) shelter built

$$\sum_{j=1}^{m} y_{ij} = 1, \forall i = 1, \dots, n$$

- Each area has distance to the assigned shelter which is less than the objective

$$\sum_{j=1}^{m} d_{ij} * y_{ij} \leq D, \forall i = 1, \dots, m$$

- Binary: x_j, y_{ij}

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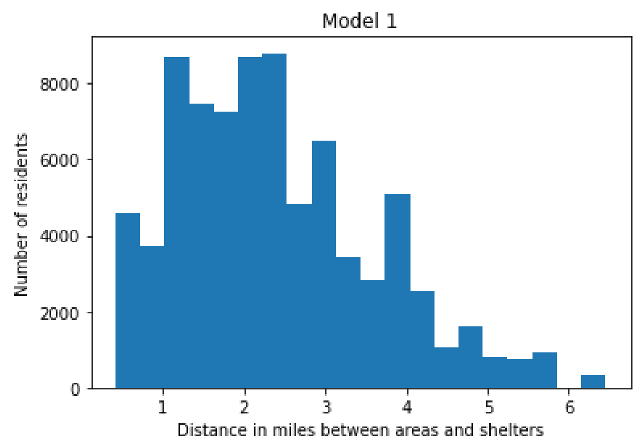
Question 4

5.34 is the maximum distance between a shelter and a residential area. The optimization takes place in 0.58 seconds.

Question 5

In model 1, the objective is to minimize the total distance across all residents required to access their assigned shelter. Therefore, this graph is relatively right skewed since the model aims to work on ensuring as many individuals have lower distances as possible, in order to drive down the total distance across all residents. Consequently, as we move to higher distances, the frequency of residents declines.



On the contrary, the objective for model 2 is to minimize the largest distance required by any resident to access a shelter. Therefore, this graph is relatively left skewed since the model no longer aims to minimize the total distance across all residents, due to which the frequency is high even for higher distances e.g. ~ 5 miles, which still leaves the objective i.e. maximum access distance unchanged.