

MiniProject 3: Emergency Service Location

IP Model and Python Implementation

- Written description and python implementation due **Friday 10 Dec at 2359**

Ground Rules:

- Can work alone or in groups of 2.
 - If you work in a group email me the members of your group!
- You may ask me for help, your textbook/notes, or Google but cite your sources.

1 The Problem

A county is deciding where to place police precincts in order to respond to potential emergencies. The county has divided its land area into 40 locations which need police protection. Moreover, they decided that, out of these 40 locations, 20 of them are candidates to place a police station. The county has a budget of \$2,500,000 to place police stations. Each location has a projected demand for police protection. Lastly, each potential candidate locations for a police station has a capacity and fixed cost to open. They hired an OR contractor who hastily gave them the following model.

Sets:

Let C be the set of customer locations $C = \{1, 2, 3, \dots, 40\}$

Let S be the set of potential locations to place a police station

Parameters:

Let h_c be the demand of customer location c for all $c \in C$

Let $d_{s,c}$ be the distance between station s and customer c for all $s \in S$ and $c \in C$

Let u_s be the capacity of each police station for all $s \in S$

Let f_s be the fixed cost of opening police station s for all $s \in S$

Let B be the total budget

Decision Variables:

Let $x_s = 1$ if a police station is placed at location s for all $s \in S$

Let $y_{s,c} = 1$ if customer location c is assigned to police station s for all $c \in C$ and $s \in S$

Objective Function:

$$\text{minimize: } \sum_{c \in C} \sum_{s \in S} h_c d_{s,c} y_{s,c}$$

Constraints:

$$\sum_{s \in S} f_s x_s \leq B \quad (1)$$

$$\sum_{s \in S} y_{s,c} = 1 \quad \text{for all } c \in C \quad (2)$$

$$\sum_{c \in C} h_c y_{s,c} \leq u_s x_s \quad \text{for all } s \in S \quad (3)$$

$$x_s \in \{0, 1\} \quad \text{for all } s \in S \quad (4)$$

$$y_{s,c} \in \{0, 1\} \quad \text{for all } s \in S, c \in C \quad (5)$$

Part 1: Model Description. Explain the provided model. Explain what the objective function does and the purpose of each numbered constraint. This description should be understandable by someone who is not an OR expert. There is no page requirement, but should be long enough to explain the model.

Part 2: Python implementation.

- a. Using the provided project 3 starter file, complete the Jupyter notebook to implement this model. Report which locations should have a police station opened and which location is assigned to each station.
- b. After you have determined the initial set of police stations to open with the \$2,500,000 budget; assume that they are gifted the funds to open 2 more police stations. Determine which additional 2 police stations should be opened based on your solution to part (a). This means they are in addition to the police stations opened in part (a), e.g., you can assume that the stations from part (a) will be built.

Grading: For grading, submit both your model description and Jupyter notebook. The description will count as 20% of your project 2 grade while the python code will count for 80% of your project 2 grade.