MIE1623: Assignment 1

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Excel workbook for MIE1623-Assignment1(File name)

1. Data for the Model

Table 1: Costs and limits

Item	**Cost/Limit**
Maximum number of exams per year per CT machine	19,743
Annual cost to operate a CT machine	$1,700,000
Cost install a new CT machine	$1,250,000
Cost per exam	$62.26

Table 2: CT location.xlsx data description

Worksheet	**Column name**	**Information**
Demand	CID	Census tract ID
	Demand	Average annual unmet demand for CT scans
Travel Time	First column (CID)	Census tract ID
	Remaining columns (CT loc)	Travel time (minutes) from each census tract to each CT location site (hospital)

2. Model Data

Parameter	**Variable Notation**
Census Tracts set Track	T= {1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19} t
Hospital /CT machine Locations set	L= {1,2,3,4,5,6,7,8} l
Demand at tracts	D Demand

Number of locations where machines to be installed	P=8

3. **Questions**

1. **Describe the Model**

a. What did you use for your objective function?

Ans. Maximize the demand coverage for CT scans from locations L(Maximal set covering problem)

$$Maximize \sum_{t \in T} Demand_t \; Z_t \quad \forall\, t \in T$$

b. What are your variables?
Indicator Variables:

$a_{tl} = \begin{cases} 1 \\ 0 \end{cases}$ if demand at t is covered by location l within travel time 45minutes

(Calculated using Travel time data given in sheet1 using logical conditions)

Decision variables:
$X_l = \begin{cases} 1 \\ 0 \end{cases}$ *if a CT machine is to be installed at location l*

$Z_t = \begin{cases} 1 \\ 0 \end{cases}$ if a demand at tract t is covered

c. What are your constraints?

Constraint 1: states that demand tract cannot be counted as covered unless we locate at least one facility that is able to cover the demand node.

$$Z_t - \sum_{l \in L} a_{tl} X_l \;\leq\; 0 \qquad \forall t \in T$$

Constraint 2: At most P locations machines can be installed (P is increased incrementally until the desired (maximum) coverage level is achieved) (P=8)

$$\sum_{l \in L} X_l \leq P$$

Constraint 3: Binary constraints:

$$X_l \in \{1, 0\} \quad \forall\, l \in L$$

Constraint 4: Binary constraints

$$Z_t \in \{1, 0\} \; \forall\, t \in T$$

d. How many binary and continuous variables and constraints does your model have?
Indicator variable=1(a_{ij}) $\forall\, t \in T, l \in L$
Binary variables =2(X_l,Z_t)$\forall\, l \in L, t \in T$

Total constraints=Constraints1 &2 (20) + Integer constraint (27) = 47

2. Describe the solution

a. Does your solution meet the target that 90% of the population is within 45 minutes of a CT machine? If not, how close did you get?

No, my solution did not meet the target to make 90% of the population within the reach of 45 minutes. The model and solution did make 88.98% of the population within the reach of 45 minutes.

b. What is the 90th-percentile travel time?
90[th] percentile travel time is 40minutes.

c. What percent of the population is within 45 minutes of a CT machine?
Percent of population that is within 45 minutes of CT machine 88.89%

d. What is the total cost?

The total cost = $28720639.28

e. How many new CTs should be built at each hospital?

The optimal number of CT machines to be installed at each hospital
Hospital1=1
Hospital2=0
Hospital3=2
Hospital4=0

Hospital5=1
Hospital6=1
Hospital7=1
Hospital8=1

f. What is the utilization of each CT machine?

Utilization of each machine location wise

0.016816%	0	100%	0	100%	100%	100%	44.29418%

3. **Is the RHA's goal realistically achievable?**

The RHA’s goal is not realistically achievable because there are 3 census tracts which cannot be reached within 45 minutes and those 3 tracts contribute to about 11.10% of population.