Assignment-1

IEOR in Healthcare (IE709)

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- **Ans of Ques-1(a)**:-
  - **Assumption**:-

1. All demand location are equally important.
2. No traffic in this model.
3. No call when ambulance is busy.
4. We want to serve with in 10 minutes.
5. t_{ij} measured in units of time.
6. Here we put at most 1 ambulance on 1 location.

$$\begin{aligned} \text{minimize} \quad & \sum_{j=1}^{40} x_j \\ \text{subject to} \quad & \sum_{j \in w} a_{ij} * (x_j) \geq 1, i \in v \\ & \forall x_j \in 0, 1 \end{aligned}$$

  - **Where**

x_j is a decision variables as follows.

$$x_j = \begin{cases} 1, & if\ ambulance\ put\ on\ location\ j. \\ 0, & else. \end{cases}$$

v - set of demand location and $v \in \{1, 2, 3, 4, ..., 85\}$.
w - set of ambulance location (where we can put ambulance) and $w \in \{1, 2, 3, ..., 40\}$.
t_{ij} - given travel time from j to i and $i \in v$, $j \in w$.
Here, we have changed given travel time matrix t_{ij} in binary matrix as follows.

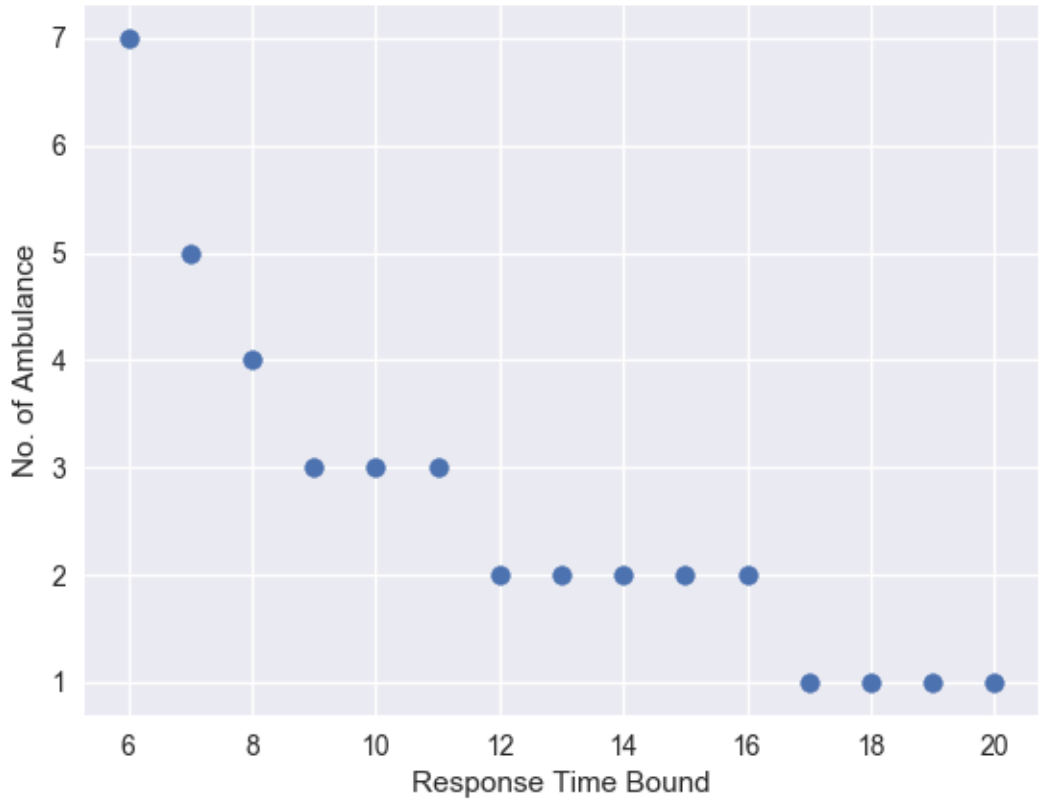
$$a_{ij} = \begin{cases} 1, & 0 \leq t_{ij} \leq 10 \\ 0, & t_{ij} > 10 \end{cases}$$

  - **S**olution of Qus.1(a):- solve in python software, coding file is **Qus1(a).py**.
    minimum number of ambulance required = 3.
    location of ambulances are 24, 29 and 38.

- **Ans of Qus-1(b)**:-Coding file is **Qus1(b).py**

  Assumption:- Here assumption same as Ques.1(a). and find out minimum no. of ambulance require for Threshold time range [4,20].

1. when threshold response time 4 and 5 both of time solution is infeasible because some demand location never satisfy with 4 and 5 threshold value of time , from any ambulance location.
2. threshold value for 6, minimum number of ambulance requirement is 7(max) and for time 17 to 20 minimum no. of ambulance require 1(min.).
3. this is clear, if we increase threshold response time then number of ambulance requirement is decrease.
4. for threshold value 17 number of ambulance require is 1. this is minimum as given bellow graph.



- **Ans of Qus-1(c)**:-

  Assumption:- same as **Ques.1(a)** and here number of ambulance is fixed.

  Qus.1(c) is solve in AMPL software and coding files **Qus1(c).mod,Qus1(c).dat , Qus1(c).run**.

1. from ques.1(a) minimum number of ambulance(p) = 3 and threshold value of response time = 10. and a_{ij} is binary matrix which is taken from python (Qus1(a)).
2. d_i = population of demand location point i.

3. For this problem, we have taken model from survey research paper, **BACOP1** model. variable u_i 1, if any node demand location point cover atleast twice and 0 otherwise.

$$\begin{aligned} \underset{x}{\text{maximize}} \quad & \sum_{i \in v} d_i u_i \\ \text{subject to} \quad & \sum_{j \in w} a_{ij} * x_j - u_i \geq 1, i \in v. \\ & \sum_{j \in w} x_j = p. \\ & \forall x_j \in 0, 1 \end{aligned}$$

4. By using this model, we get batter redistribution of ambulance location. and for this model we maximize the population that is covered twice, thus we have batter location for ambulance as compare to Qus1(a).
5. after the relocation of ambulance location are 19, 28 and 35. Objective value is (population that atleast cover twice) 405396.

- **Ans of Ques-1(d)**:-

  Assumption:-

1. No traffic in this model.
2. Number of ambulance is fixed (we have P=8 ambulance to allocated).
3. We want to serve with in 10 minutes.
4. t_{ij} measured in units of time.
6. we try to cover every location with more no. of ambulance

We use model maximum covering location problem (MCLP) with modification. all y_i can take integer value instead of 0, 1 only. The value of y_i show, how much no. of time Ambulance cover location i. By making y_i integer (instead of binary) we force solution to be more distributed where we can cover each location with multiple ambulances. so we cover maximum population with frequency.

$$\begin{aligned} & \text{maximize} \sum_{i \in v} d_i y_i \\ \text{subject to} \quad & \sum_{j \in w_i} x_j \leq y_i, i \in v. \\ & \sum_{j \in w} x_j = p, j \in w \\ & y_i \geq 1, i \in v. \quad \forall y_i \ \ integer \end{aligned}$$

  - **Solution of Qus1(d)**:-

    Ambulance location are 7,8,16,18,19,20,35,39.

    All demand location coverage can be check to run Qus1(a).run in AMPL. most of location cover multiple time(maximum 8).

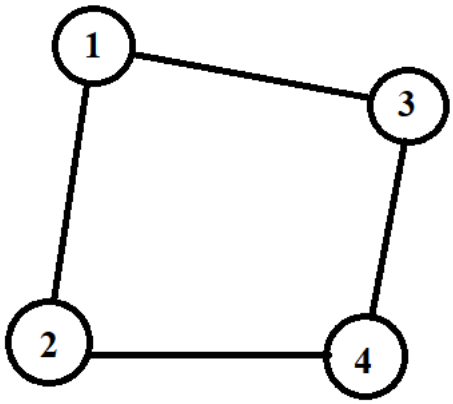
    For this Solution we can release our assumption in 1st exercise "no call when ambulance busy", Now we cover certain demand location with other ambulance too.

- **Ans. of Ques.2**:-

  Model Assumption:- There are n demand location and similar number of (n) ambulance location and assume if i=j than j always cover i. Time matrix is binary(0,1), where $T\{i,j\} = 1$ indicate demand point i cover by location j within threshold limit. and 0 indicate not cover.

  Model Example

-	A-1	A-2	A-3	A-4
L-1	1	1	1	0
L-2	1	1	0	1
L-3	1	0	1	1
L-4	0	1	1	1



$$
\begin{aligned}
\text{minimize} \quad & x_1 + x_2 + x_3 + x_4 \\
\text{subject to} \quad & \\
& x_1 + x_2 + x_3 \geq 1 \\
& x_1 + x_2 + x_4 \geq 1 \\
& x_1 + x_3 + x_4 \geq 1 \\
& x_2 + x_3 + x_4 \geq 1 \\
& 0 \leq x_j \leq 1, \quad j \in 1 \; to \; 4
\end{aligned}
$$

Solution for given example:- all x_1, x_2, x_3, x_4 equal to 0.333 and optimal value equal to 1.3333 .

this example can be generalized, when n is even (say 4) with all main diagonal elements (i.e. from top right to bottom left diagonal) value 0 (Zero).for this case each variable take same value($\frac{1}{n-1}$) and objective value($\frac{n}{n-1}$).

In this model our assumption has Demand location always satisfy by itself (i.e. i=j), thus when n is odd (say 5) this example not valid because diagonal entry of [3,3] become 0, that Violet our assumption.

For n equal to odd condition, all elements just above and below the diagonal from main diagonal (that is from top right to bottom left diagonal) should be 0 (Zero) in order to get solution which will not give integer value to all variables.

for 5x5 case:-

-	A-1	A-2	A-3	A-4	A-5
L-1	1	1	1	0	1
L-2	1	1	0	1	0
L-3	1	0	1	0	1
L-4	0	1	0	1	1
L-5	1	0	1	1	1

Ans. of Question.3

Let us consider as

- **P-1**:- Emergency Medical Services in India: The Present and Future (2013).
- **p-2**:- Public - private implementation of integrated emergency response services: Case study of GVK Emergency Management and Research Institute in Karnataka, India (2017).

Similarities in both Paper:

- **Discuss type of Emergencies**:- In both paper discussed type of Emergencies, some of given in blow table In our country maximum number of emergency cases related to pregnancy.

Name of EMS	p-1 (in %)	p-2 (in %)
Pregnancy	47	40
Troma	19	9
Cardiac vascular	3	4.4
diabetic	1	0.4
other	30	26.2

- discuss about of lack of the ambulance and lack of early transportation
- **Reason of Decreasing EMS.**:- In our country, Population increasing rate is very high and we are unable to increase EMS services rate same as population rate. for example, (In 2001 to 2011) The population grew up 37.1% in bangalore (IInd largest increase in India) and highest growth in Dehli.
- **Public and private Partnership**:- Here discuss about public - private implementation of integrated EMS. in paper-1 took a case study GVK Emergency Management and Research institue in karnataka.GVK EMRI is a major EMS provider in India that covers 15 states and 2 union territories. An evaluation of GVK EMRI in 3 states Andhra Pradesh, Gujarat,and Rajasthan provided key recommendations for improving financing, effectiveness, efficiency, and governance structures.11 Other studies have analyzed the case profiles of GVK EMRI users in states such as Assam, Andhra Pradesh, and Goa.

Different in both Paper

- **EMS Training standards**:- In p-1 discussed about the EMS training, No standardise EMS training course exist in India when some government recognize training course provide training similar to EMS or paramedical in the US(United State).
  In Govt India also recognize those with GNM(General Nursing Home) and midwifery certified as perahospital care provides 2670 GNM program in all country 100,000 students graduate in 3 year and 6 month internship. In p-2 , discuss about the prize and promotion, if any employ is doing good job then give promotion and prize. so people will be doing work.
- **Type of collection data**:- In p-2, Call data are routed immediately through a software program, and key information about the call appears on a computer screen. Officers use software developed by the Indian information technology firm of TechMahindra to complete the dispatch. In p-1, did not discuss how to collect data.
- **About ALS and BLS**:- In p-1, In delhi, 10% ALS and 90% BLS . In p-2, Karnataka, 25% are considered advanced life support (ALS) and 75% basic life support (BLS).ALS ambulances have been used occasionally in interhospital transfers, cardiac cases, and road traffic incidents. Select, experienced EMTs (Emergency Medical technician) undergo 2-week training programs in ALS techniques at the state headquarters.

Key points and Suggestion

- **Working progress**:- Here working progress is very slow. for example, Centralized Accident and Trauma Services (CATS) is funded by the Delhi government and was conceived in 1984 with plans of expansion throughout the country. Pilot operations were started in 1991 but the services have not yet become fully operational.
- **Basic Training**:- In our country, It should be noted that these courses should be accredited by a national authority. Moreover, training programs in first aid and resuscitation should be initiated for police officials,college students, taxi drivers, working adults, or any interested citizen so that any trained member of the public who is present at the site of an emergency can initiate some form of first aid before an ambulance arrives at the scene.

- **Financial Condition**:- In India, should be increase the money , spend on health. The total expenditure on health in India as a percentage of GDP is four percent, compared with 18 % in the US.Now, In Karnataka, the state government provides 100% of funding for direct operations through the National Rural Health Mission, a scheme launched by the Government of India in 2005 to strengthen health systems and improve reproductive and child health outcomes.spend 97% of funds were for operational expenditures and 3% for ambulance refurbishment, medical equipment, replacement, and so on.
- **Increase Awareness**:- only 27% of the patients presenting for stroke services at a tertiary level hospital in India were aware they had had a stroke, and most of them did not know the importance. Higher levels of public awareness might be a difficult task to achieve because of IndiaâĂŹs literacy rate of 74%, but efforts should be made by involving social welfare societies who work at the village level.
- there should be centralized body For EMS service and unique contact number throughout the country.