IE501 Assignment 2

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1 Problem 1

Motivation

At IITB, students residing in the hostels often walk to various academic buildings for lectures, labs, and other activities. During rains, the paths become inconvenient due to lack of proper shedding. So, our motivation is to make some corridor like infinity corridor that is beneficial to most number of residents and has minimum length so as to minimize investment in this project.

Description

Students usually take different ways to reach Lecture hall complex. The problem is to minimize the cost to make a corridor in the campus subject to:

1. total utility of the hostel residents is maximum
2. consider the effect of pedestrian traffic on each way

Tentative Solution Idea

We will collect path length and traffic data from Google map for simplification. We will assume some key routes for the purpose of this problem like from Hostels to Lecture Hall Complex.
To optimize, we will map Traffic data to paths and then use algorithms to minimize the cost and maximize the utility for maximum number of students in the campus.

Deliverables

1. Campus map with traffic data
2. Optimized shed placement lan

3. Simulution and final report

Distribution of Tasks among Team members

Member 1: Responsible for collecting GPS data of traffic from hostels to Lecture Hall Complex

Member 2: Develop the optimization algorithm to maximize the utility of shed placements

Member 3 and Member 4: Code the algorithm and simulate the results to find optima.

2 Problem 2

Observation:
IIT Bombay map is a **connected graph**.
For each edge (i, j) in the map there exists an edge (j, i) in the map i.e. both the directional movements are possible on the given pair (i, j) or the edges are not directed in nature.
Parameters:
Let the map of IIT Bombay be a graph **G(V,E)**. Here **V** is the set of vertices and **E** is the set of edges.
Let d_{ij} be the distance between vertices **i** and **j**.
Decision Variables:
Let x_{ij} be defined as:

$$x_{ij} = \begin{cases} 1 & \text{if } (i, j) \in E \text{ is in the cycle} \\ 0 & \text{otherwise} \end{cases}$$

Let y_i be defined as:

$$y_i = \begin{cases} 1 & \text{if } i \in V \text{ is in the cycle} \\ 0 & \text{otherwise} \end{cases}$$

Objective Function:

$$max \sum_{(i,j)\in E} d_{ij}.x_{ij}$$

Constraints:
If a vertex i is part of the cycle(i.e. $y_i = 1$) then exactly two edges are incident on the vertex i and if it isn't a part of the cycle(i.e. $y_i = 0$) then none of the edges incident on i will be a part of the cycle .

$$\sum_{\substack{(i,j)\in E \\ (j,i)\in E}} x_{ij} + x_{ji} = 2y_i \quad \forall i \in V$$

We can traverse any given road in the closed path only once therefore,

$$(x_{ij} + x_{ji}) < 2 \quad \forall (i, j) \ \& \ (j, i) \in E$$

If edge (i, j) is a part of the cycle then both the vertices i and j will be a part of the cycle therefore,

$$y_i \geq x_{ij} \;\; \forall \ (i, j) \in E$$

$$y_j \geq x_{ij} \;\; \forall \ (i, j) \in E$$

This constraint is added to make the output a single closed cycle rather than disjoint small cycles. Here, the u_i variable is interpreted as the order of vertices in the tour which prevents presence of any small disjoint cycles and n is the number of vertices in the graph.

$$u_i - u_j + n.x_{ij} \leq n - 1 \quad u_i \in \{0, 1, 2 \ldots, n - 1\}$$

The decision variables chosen here are binary decision variables

$$y_i \in \{0, 1\}; x_{ij} \in \{0, 1\}$$

Applying all these constraints on the given map we are getting the length of the longest closed path equal to **8564** meters