System for emergency centers for optimized service and routing.

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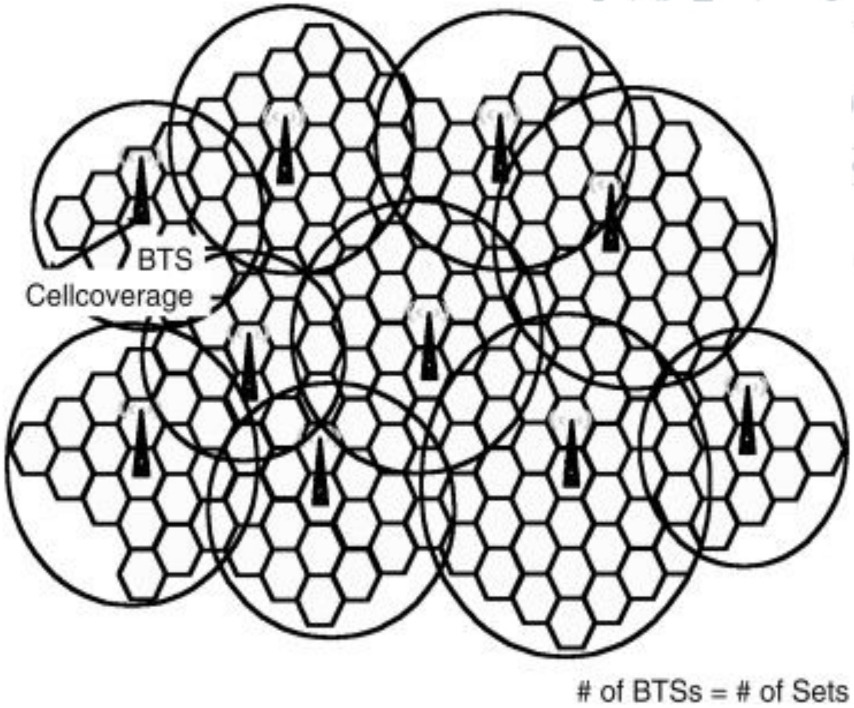
Introduction

- In a world of on-demand everything, it’s never been more important to make sure your business is ready to deliver.
- In large or medium retail enterprises, the downstream of the supply chain is usually composed of distribution centers or various warehouses.
- Since the distance of each distribution route is large, so the optimization of the path is essential for the cost control and profit maximization of the enterprise.
- In our project, we focus on minimizing distribution centers and reducing paths for each demand point such that the overall covered path is minimum and optimized in terms of cost and profit.

First Half of project

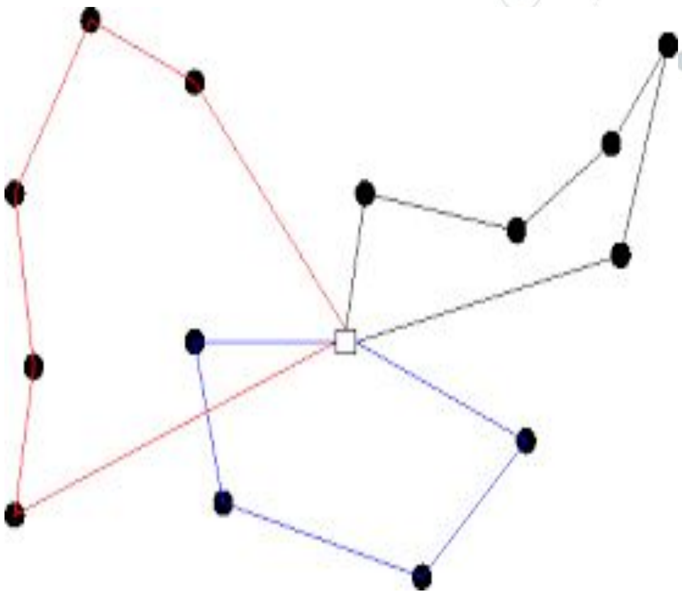
- It is a classic problem in combinatorial mathematics known as a p-center problem.
- The p-center problem seeks the location of p facilities. Each demand point receives its service from the closest facility.
- The objective is to minimize the maximal distance for all demand points.
- This is equivalent to covering every point in the area with p circles with the smallest possible radius.



P-center problem

Second Half of Project (TSP)

- It is about routing a path to cover demand points deliveries in minimum time and cost.
- This is similar to the traveling salesman problem.
- The traveling Salesman Problem is an optimization problem and has a vast search space and is said to be NP-hard, which means it cannot be solved in polynomial time.
- In the second part, the distance between the facility and demand points is euclidean considering the delivery will be through the drone.



Travelling salesman problem with service point at center.

Motivation

The pandemic has created fear in people's mind to go and collect their prescriptions physically and demand for on-time delivery has multiplied overnight.

In post pandemic world , Google searches have evolved to "Can I get my medicine on same day?" or "Fast delivery for my prescriptions".

This is where our motivation lie.But, we are not limiting our project to just pharmacies.
We are trying to develop a generalised system for emergency centres for optimized service and routing.

"

In a world of on-demand everything, it's never been more important to make sure your required items are ready to deliver.

"

Challenges

1. To find the minimum number of facilities so that the whole area is covered.

2. To find the nearest facility for a given demand point.

3. To to find the shortest way of visiting all of the demand points and returning to the facility.

Literature Survey

1) The p-centre location problem in an area

https://www.sciencedirect.com/science/article/pii/S0966834996000125

- The p-center location problem over a continuous area of demand is an interesting practical problem with various applications.
- The problem is equivalent to covering a given area in the plane with p identical circles which have the smallest possible radius (the facilities are located at the centers of these circles).
- It is usually assumed that demand for the required service originates from a finite set of “demand points”. In many cases, assuming that an area represents the set of demand points is more realistic. Demand originating in an area rather than in a finite set of demand points applies to location of mobile demand.

2) Optimal delivery routing with wider drone-delivery areas along a shorter truck-route

https://www.sciencedirect.com/science/article/pii/S0957417418301775

- In the COVID-19 pandemic, it was essential to transport medical supplies to specific locations accurately, safely, and promptly on time.
- The application of drones for medical supplies delivery can break ground traffic restrictions, shorten delivery time, and achieve the goal of contactless delivery to reduce the likelihood of contacting COVID-19 patients.
- However, the existing optimization model for drone delivery is cannot meet the requirements of medical supplies delivery in public health emergencies.
- In this paper, they propose yet a newer approach to the nonlinear programming model that can further shorten the total delivery time by shifting the centers of clusters after applying a K-means clustering algorithm and TSP modeling.

Methodology

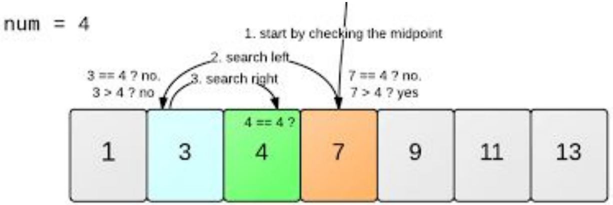
Algorithm Application (First Part)

1. Our area is considered as a rectangular matrix (vector of vector of sets) where each block is vector of sets.
2. By applying BFS on service points considered as nodes with level as r = initial value , for each block we get which service points can work there.
3. The next stage is to check if whole area is getting covered or not (sets.size() > 1).
4. If not, we increase the radius or decrease it. (Binary Search Algorithm) Go to step 2 again.

1,5	1,5	5	2,5	2,5	2	2
1	1,5	1,5	1,2	2	2	2
1	1	1,5	1,2	2	2	2
1	1	1	2,4	2,4	2,4	2,4
1,3	1,3	1,3	4	4	4	4
3	3	3	4	4	4	4

With r=2 and this red dot signifies all pharmacy and blue dot signifies redundant pharmacy

Binary Search

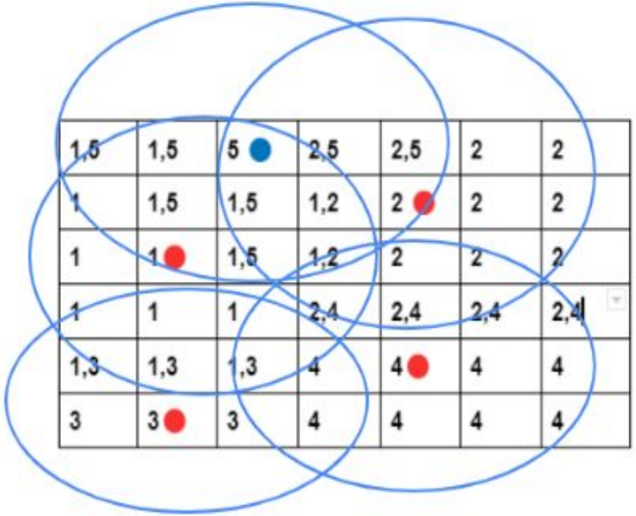


5.If yes, for each block we check if it have service providers > 1 , check if any service point is redundant or not.

6.Remove that service point if redundant. Go to step 5.

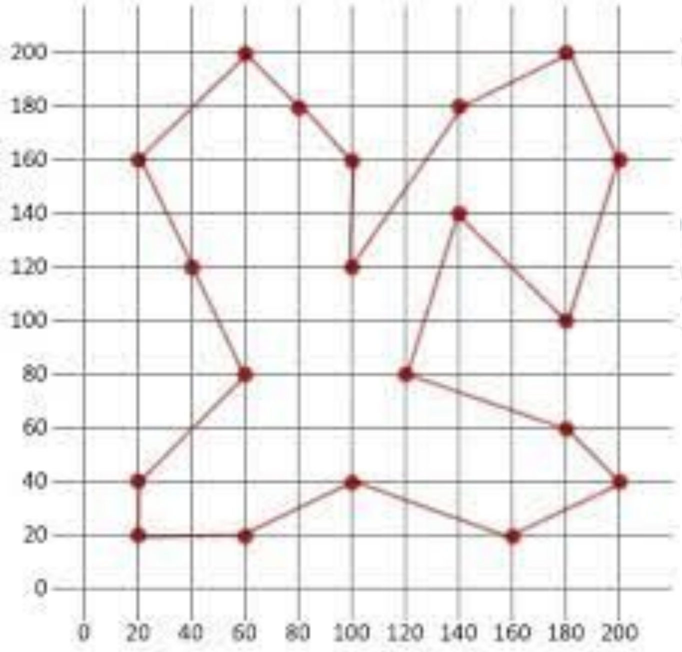
7. At last we have , minimum radius and minimum no. of points which can cover whole area.

8. The service points are given input to next part i.e., routing problem.



Algorithm Application (Second Part)

1. Consider service point as the starting and ending point.
2. Calculate the euclidean distance for each pair of point.
3. Generate all (n-1)! permutations of demand and service points.
4. Calculate the cost of every permutation and keep track of the minimum cost permutation.
5. Return the permutation with minimum cost.
6. We get our desired minimum path for delivery.



$$d(\mathbf{p}, \mathbf{q}) = \sqrt{\sum_{i=1}^{n} (q_i - p_i)^2}$$

Input/Output

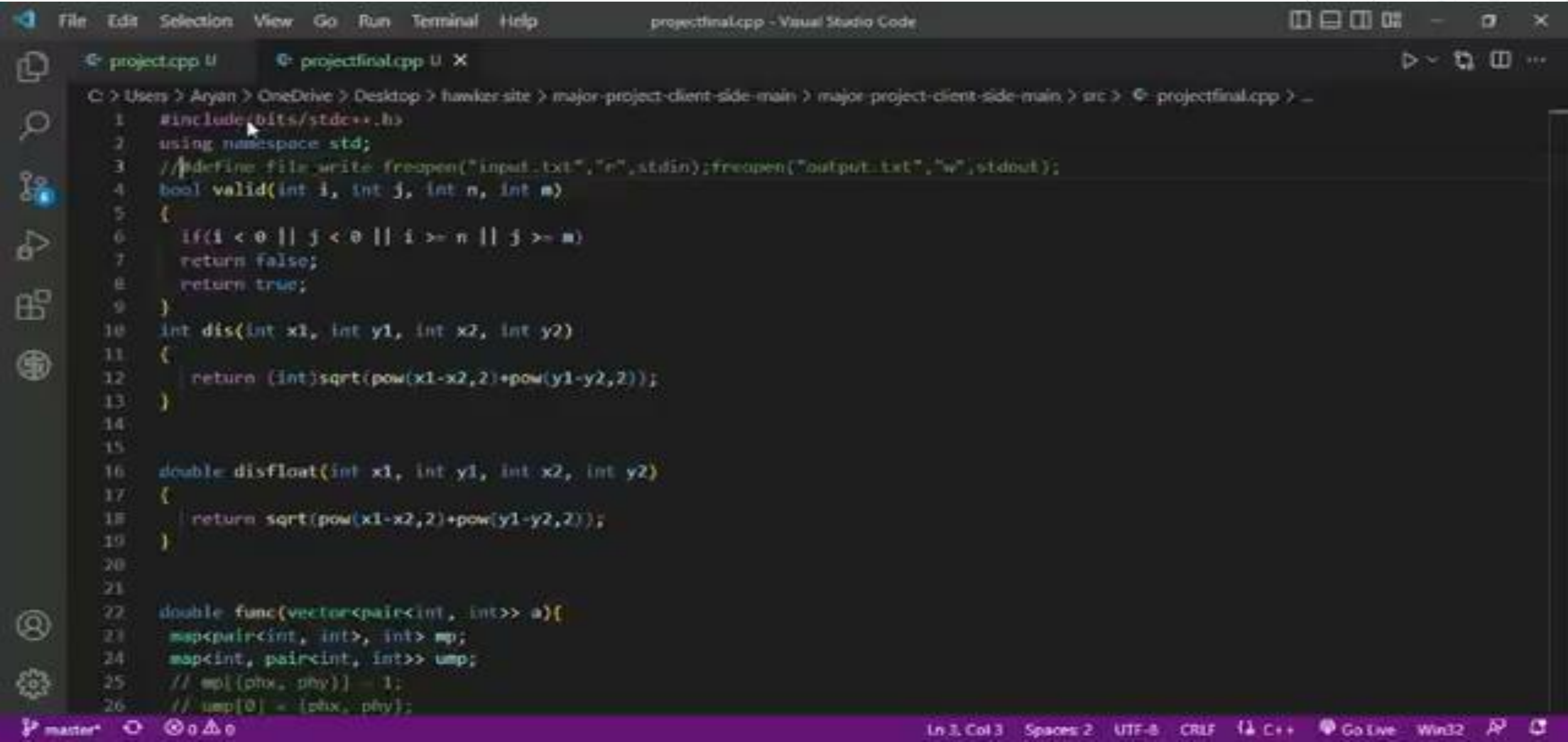
```
Enter the size of City :
8 8
Enter number of Pharmacy :
4
Enter the coordinates of each Pharmacy :
0 7
7 0
0 0
7 7
Min coverage radius: 4
Min number of shops: 4
Requried shops after removing redundant pharmacy :
0 0
0 7
7 0
7 7
List of shops that cover a part of city :
1 1 1 2 2 2 2 2
1 1 1 2 2 2 2 2
1 1 1 2 2 2 2 2
3 3 3 1 2 4 4 4
3 3 3 3 4 4 4 4
3 3 3 4 4 4 4 4
3 3 3 4 4 4 4 4
```

```
Enter number of Customers :
2 1
clustering pharmacy with customers
0 0            1 1            1 2            2 1
0 7            1 6
7 0            6 1
7 7            6 6
P1 ( 0 0) - Total Cost is :6.0645
P2 ( 0 7) - Total Cost is :2.82843
P3 ( 7 0) - Total Cost is :2.82843
P4 ( 7 7) - Total Cost is :2.82843
```

Output -

- Required facilities after removing redundant facilities will be printed.
- Which area of city will be covered by which facility will also get printed.
- Which demand point will get served by which facility will also get printed along with the minimum cost of delivery.

Demonstration



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THANK YOU