Vehicle Routing Problem

1- Team members info

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2- Problem definition

The classical vehicle routing problem (VRP) aims to find a set of routes at a minimal cost (finding the shortest path, minimizing the number of vehicles, etc) beginning and ending the route at the depot, so that the known demand of all nodes are fulfilled. Each node is visited only once, by only one vehicle, and each vehicle has a limited capacity. Some formulations also present constraints on the maximum traveling time. The VRPSD is a variation of the classical VRP, where each customer can be served by more than one vehicle. Thus, for the VRPSD, besides the delivery routes, the amount to be delivered to each customer in each vehicle must also be determined. The option of splitting a demand makes it possible to service a customer whose demand exceeds the vehicle capacity. Splitting may also allow decreasing costs.

3- Algorithm Used

Ant Colony Optimization History

ACO studies artificial systems that take inspiration from behavior of real ant colonies.

Natural behavior of ants have inspired scientists to mimic insect operational methods to solve real life complex optimization problems.

It constitutes some metaheuristic optimizations.

The inventors are Frans Moyson and Bernard Manderick. Initially proposed by Marco Dorigo in 1992 in his PhD thesis, the first ACO algorithm was called the Ant system and it was aimed to solve the travelling salesman problem, in which the goal is to find the shortest round trip to link a series of cities. At each stage, the ant chooses to move from one city to another according to some rules.

Ant Colony Optimization Concept

THE WHOLE CONCEPT OF ANT COLONY OPTIMIZATION IS TO MINIMIZE THE PATH AND POWER CONSUMPTION

What is ACO?

Artificial Ants stand for multi-agent methods inspired by the behavior of real ants.

Combinations of Artificial Ants and local search algorithms have become a method of choice for numerous optimization tasks involving some sort of graph, e.g., vehicle routing and internet routing.

A colony is a population of simple, independent, and asynchronous agents that cooperate to find a good solution to the problem.

Best route must be:

1- minimum cost
2- minimum distance
3- minimum time

4- Input explanation

- **Input explanation:**

1- Number of Customers (Demand)
2- Set of vehicles
3- One or more depots
4- Optimal value is the best cost

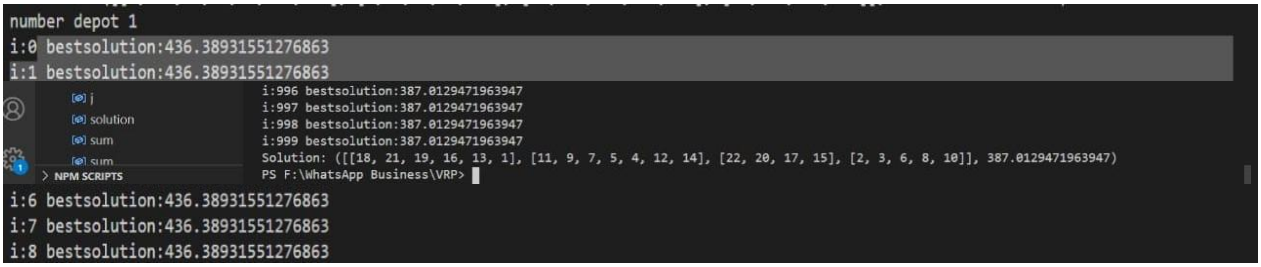
Dataset from file:

```
depotcustomer=[2,1]
vertices = [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22]
capacityLimit = 6000
optimalValue=375

demand = {1: 0, 2: 1100, 3: 700, 4: 800, 5: 1400, 6: 2100, 7: 400, 8: 800, 9: 100, 10: 500, 11: 600, 12: 1200,
          13: 1300, 14: 1300, 15: 300, 16: 900, 17: 2100, 18: 1000, 19: 900, 20: 2500, 21: 1800, 22: 700}

graph = {1: (145, 215), 2: (151, 264), 3: (159, 261), 4: (130, 254),
         5: (128, 252), 6: (163, 247), 7: (146, 246), 8: (161, 242),
         9: (142, 239), 10: (163, 236),
         11: (148, 232), 12: (128, 231), 13: (156, 217), 14: (129, 214),
         15: (146, 208), 16: (164, 208), 17: (141, 206), 18: (147, 193),
         19: (164, 193), 20: (129, 189), 21: (155, 185), 22: (139, 182)}
```

- **Screen Shot of output**

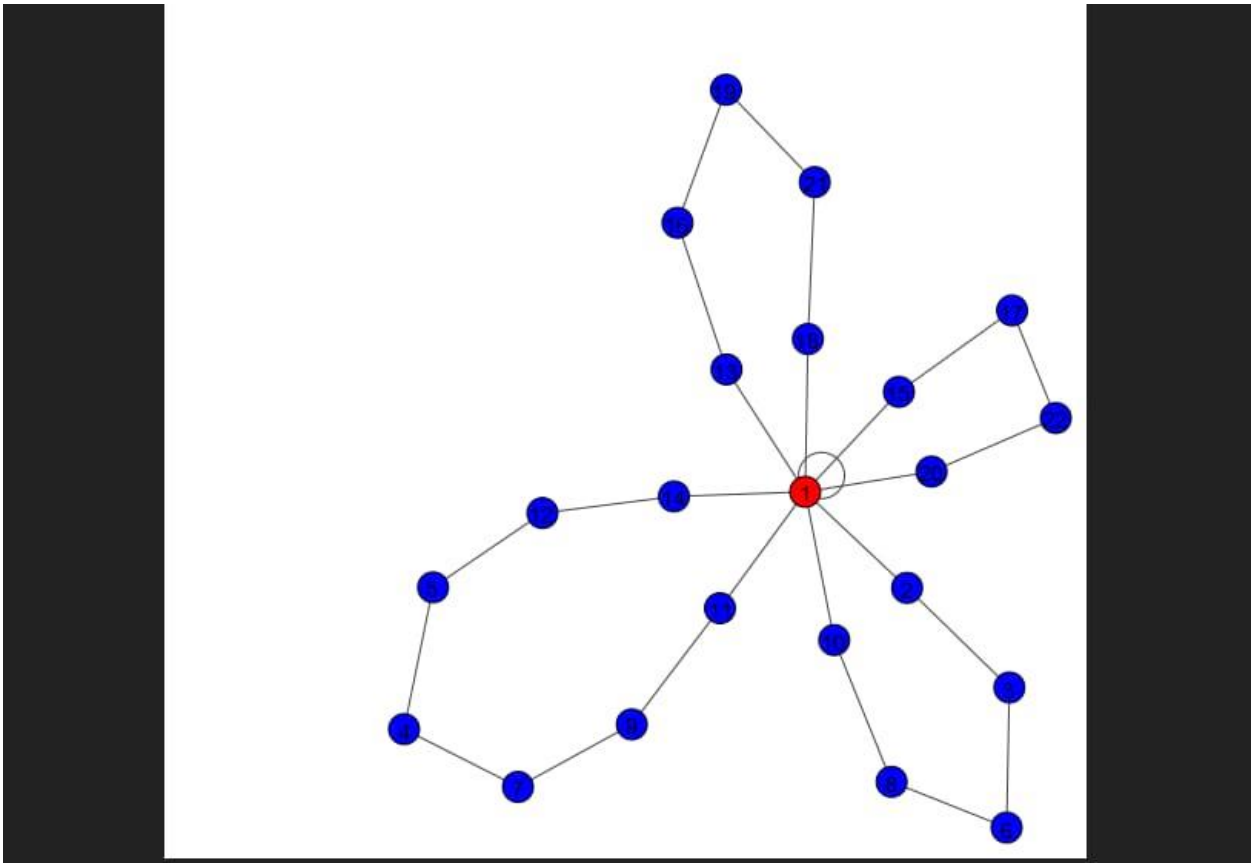
Number 1 Depot

All Cost:



Best Solutions:

Graph:



Number 2 Depot

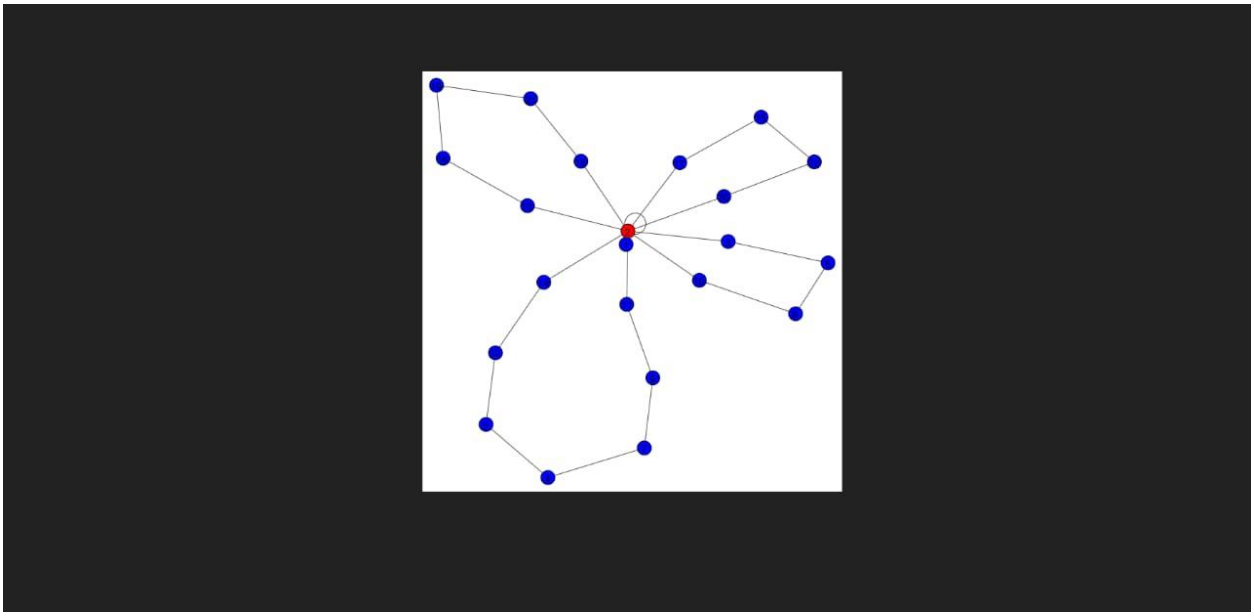
All Cost:

```
number depot 2
i:0 bestsolution:454.5997504611731
i:1 bestsolution:454.5997504611731
i:2 bestsolution:454.5997504611731
i:3 bestsolution:454.5997504611731
i:4 bestsolution:454.5997504611731
```

Best Solutions:

```
edges
i
j
solution
i:995 bestsolution:396.84500691284836
i:996 bestsolution:396.84500691284836
i:997 bestsolution:396.84500691284836
i:998 bestsolution:396.84500691284836
i:999 bestsolution:396.84500691284836
Solution: ([[9, 11, 7, 4, 5, 12, 14], [2, 3, 6, 8, 10], [13, 16, 19, 21, 18], [22, 20, 17, 15]], 396.84500691284836)
```

Graph:



Source Code URL

https://github.com/AhmedOmara14/vehicle-routing-problem

References

https://developers.google.com/optimization/routing/vrp?fbclid=IwAR35dtpIwKsXqEwaR9coNmf_Ie2JZT2eZJAVk1nRrCnsA-8ObawnOxy7C4w

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https://docs.microsoft.com/en-us/archive/msdn-magazine/2012/february/test-run-ant-colony-optimization?fbclid=IwAR35dtpIwKsXqEwaR9coNmf_Ie2JZT2eZJAVk1nRrCnsA-8ObawnOxy7C4w