Oxygen Delivery System: An Example of Travelling Salesman Algorithm

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***Abstract*—The Travelling Salesman Problem (often called TSP) is a classic algorithmic problem in the field of computer science and operations research. It is focused on optimization. In this context better solution often means a solution that is cheaper. TSP is a mathematical problem. It is most easily expressed as a graph describing the locations of a set of nodes.**

In Operations Research, the Travelling Salesman Problem (TSP) lies at the heart of several distribution management problems and has thus received much attention in the last thirty years. The fact that the TSP and many of its extensions are NP-hard means that in practice, exact solutions will be obtained for only modest problem sizes. Much effort has been devoted recently to the derivation of optimal solutions for problems of realistic dimensions and characteristics. There have been many algorithms introduced to grant time competent solutions for the problem, both exact and approximate.

The objective of this project is to optimize delivering of oxygen cylinder at n randomly chosen hospitals in the city of Chennai. This problem is otherwise called the Travelling Salesman Problem(TSP). The Traveling Salesman Problem includes a salesman who must make a tour through various points utilizing the briefest way possible. In this problem the total travelling distance of few hospitals is minimized. The distance matrix of *n* hospitals is taken as input and dynamic algorithms are applied to find optimal solutions. The tour is to be begun from a given point and after completing the tour the Travelling Salesman has to return to the starting point.

***Index Terms*—Travelling Salesman, Oxygen Delivery**

I. INTRODUCTION

The idea of the traveling salesman problem (TSP) is to find a tour of a given number of cities, visiting each city exactly once and returning to the starting city where the length of this tour is minimized.

The first instance of the traveling salesman problem was from Euler in 1759 whose problem was to move a knight to every position on a chess board exactly once. The traveling salesman first gained fame in a book written by German salesman BF Voigt in 1832 on how to be a successful traveling salesman. He mentions the TSP, although not by that name, by suggesting that to cover as many locations as possible without visiting any location twice is the most important aspect of the scheduling of a tour.

The origins of the TSP in mathematics are not really known all we know for certain is that it happened around 1931. The standard or symmetric traveling salesman problem can be stated mathematically as follows:

Given a weighted graph G = (V, E) where the weight cij on the edge between nodes i and j is a nonnegative value, find the tour of all nodes having minimum distance.

Currently the only known method guaranteed to optimally solve the traveling salesman problem of any size, is by enumerating each possible tour and searching for the tour with small. Each possible tour is a permutation of 123 . . . n, where n is the number of cities, so therefore the number of tours is n!There are many algorithms which can be used for this problem

In our paper we have used two algorithms namely dynamic programming and Belford algorithm to solve this problem.

The TSP has several applications even in its purest formulation, such as planning, logistics, and the manufacture of microchips. Slightly modified, it appears as a sub-problem in many areas, such as DNA sequencing. In these applications, the concept city represents, for example, customers, soldering points, or DNA fragments, and the concept distance represents travelling times or cost, or a similarity measure between DNA fragments. The TSP also appears in astronomy, as astronomers observing many sources will want to minimize the time spent moving the telescope between the sources. In many applications, additional constraints such as limited resources or time windows may be imposed.

II. LITERATURE SURVEY

Traveling salesman problem (TSP) is a well-known, popular and extensively studied problem in the field of combinatorial optimization and attracts computer scientists, mathematicians and others. Its statement is deceptively simple, but yet it remains one of the most challenging problems in operational research. It also an optimization problem of finding a shortest closed tour that visits all the given cities. It is known as a classical NP-complete problem, which has extremely large search spaces and is very difficult to solve.

The definition of a TSP is: given N cities, if a salesman starting from his home city is to visit each city exactly once and then return home, find the order of a tour such that the total distances (cost) traveled is minimum. Cost can be distance, time, money, energy, etc. TSP is an NP-hard problem and researchers especially mathematicians and scientists have been studying to develop efficient solving methods since 1950's. Because it is so easy to describe and so difficult to solve. Graph theory defines the problem as finding the Hamiltonian cycle with the least weight for a given complete weighted graph. The traveling salesman problem is widespread in engineering applications. It has been employed in designing hardware devices and radio electronic devices, in communications, in the architecture of computational networks, etc. In addition, some industrial problems such as machine scheduling, cellular manufacturing and frequency assignment problems can be formulated as a TSP.

There are several reasons for the choice of the TSP as the problem to explain the working of ACO algorithms it is easily understandable, so that the algorithm behavior is not obscured by too many technicalities; and it is a standard test bed for new algorithmic ideas as a good performance on the TSP is often taken as a proof of their usefulness. They presented an approach for solving traveling salesman problem based on improved ant colony algorithm. In 2013, Saloni Gupta and Poonam Panwar has Proposed Genetic algorithms appear to find good solutions for the traveling salesman problem, however it depends very much on the way the problem is encoded and which crossover and mutation methods are used. A number of genetic algorithm techniques have been analyzed and surveyed for solving TSP. The research can be extended for different hybrid selection, crossover and mutation operators. The proposed approach can be applied for various advanced network models like logistic network, task scheduling models, vehicle navigation routing models etc. The same approach can also be used for allocation of frequencies in cells of cellular network. In 2014, Sonam Khattar and Dr. Puneet Gosawmi has concluded in their paper how Genetic Algorithm can be used for solving the Traveling Salesman Problem Genetic Algorithm finds the good solution for the TSP, depend upon the way how the problem is encoded and which types of crossover and mutation methods are used. A number of genetic algorithm techniques have been analyzed and surveyed for solving TSP

III. PROBLEM FORMULALTION

Consider a travelling salesman wishes to deliver oxygen at n number of hospitals in Chennai. He wants to travel to each destination exactly once and return home taking the shortest total route. Each trip can be represented as a n number of vertices where each each vertex is a destination, including the starting point. A edge exists between one vertex to any other vertex. The traveling salesman problem is solved if there exists a shortest route that visits each destination once and permits the salesman to return home after visiting all hospitals. Though this may not seem like a real life scenario, where there is only one salesman, this problem interests those who want to optimize their routes, either by considering distance, cost, or time.

If one has four people in their car to drop off at their respective homes, then one automatically tries to think about the shortest distance possible. In this case, distance is minimized. If one is traveling to different parts of the city using the public transportation system, then minimizing distance might not be the goal, but rather minimizing cost.

IV. PROPOSED METHODOLOGY

The methodology which was used was using two different algorithms. One being a latest dynamic algorithm and the other being the initial and old nearest neighbor algorithm. We have the distances from each point to one another . These values are taken as an input from a text file into the code and the algorithm tries to give the best route possible to visit all the points and return back to the starting point. The places include various hospitals in Chennai and hence the path suggested by the two algorithm will not repeat the same destination more than once. In the algorithm the places are referred to as node and the distance between them is referred to as an edge and the distance is mentioned as the weight. The pseudo code following is of modified nearest neighbor algorithm.

1. Start on an arbitrary vertex as current vertex.
2. Visit a node with higher priority
3. If no nodes with higher priority is left,find out the shortest edge connecting current vertex and an unvisited vertex V.
4. set current vertex to V.
5. mark V as visited.
6. if all the vertices in domain are visited, then terminate.
7. Go to step 2.

	Apollo Hospitals	Dr. Kamakshi Memorial Hospital	Dr. Mehta's Hospital	Fortis Malar Hospital	Frontier Lifeline Hospital ontier Lifeline Hospital	SIMS Hospital	Sri Ramachandra Medical Centre	The Madras Medical Mission	Vijaya Group of Hospitals	Cloudnine Hospital	Rajiv Gandhi Government General Hospital	Mount Multispeciality Hospitals
Apollo Hospitals	0	20.2	5.5	14.8	4.5	6.1	15.2	4.8	6.6	9.6	8.4	15
Dr. Kamakshi Memorial Hospital	20.2	0	14.8	10.7	20.4	14.8	17.5	20.7	15.4	7.6	11.8	9.2
Dr. Mehta's Hospital	5.5	14.8	0	11.1	7.6	7.1	14.4	5.5	7.7	5	5.1	16.9
Fortis Malar Hospital	14.8	10.7	11.1	0	16	11	18.7	10.6	11.5	6	10.2	14.4
Frontier Lifeline Hospital	4.5	20.4	7.6	16	0	6.5	10.9	11.1	7.1	11.8	11.7	15.4
SIMS Hospital	6.1	14.8	7.1	11	6.5	0	9.1	10.1	1.5	6.9	10.7	10
Sri Ramachandra Medical Centre	15.2	17.5	14.4	18.7	10.9	9.1	0	18.6	7.6	14.8	18.2	12.5
The Madras Medical Mission	4.8	20.7	5.5	10.6	11.1	10.1	18.6	0	11.6	6.3	2.4	18.2
Vijaya Group of Hospitals	6.6	15.4	7.7	11.5	7.1	1.5	7.6	11.6	0	6.4	10.2	9.6
Cloudnine Hospital	9.6	7.6	5	6	11.8	6.9	14.8	6.3	6.4	0	6.9	12.4
Rajiv Gandhi Government General Hospital	8.4	11.8	5.1	10.2	11.7	10.7	18.2	2.4	10.2	6.9	0	18.9
Mount Multispeciality Hospitals	15	9.2	16.9	14.4	15.4	10	12.5	18.2	9.6	12.4	18.9	0

The other algorithm used to find the optimal path is:

```
int[][] dp = new int[1 << n][n];

// Some initialization of dp, possibly.

for (int mask = 1; mask <= (1<<n); mask++) {

 for (int last = 0; last<n; last++) {

 if (((mask >> last) & 1) == 0) continue;

 int prev = mask – (1 << last);

 dp[mask][last] = Integer.MAX_VALUE;

 // v is the last item visited in prev.

 for (int v=0; v<n; v++) {

 if (((prev >> v) & 1) == 0) continue;

 int curScore = dp[prev][v] + cost(v, last);

 dp[mask][last] = Math.min(dp[mask][last], curScore);}}}
```

These algorithms are used by writing the code and taking the input from a text file which are the distances of the places and their distances from each other and the first vertex is taken as the initial and final position.

V. CONCLUSION

The main conclusions can be stated as follows:

1) The proposed system solves largescale problems in a plane (with up to several hundreds of nodes)with respectively modest computer resources, and can be recommended for the solution of real-life problems;
2) The application of interactive procedures increases the accuracy of the solution and reduces the computer resources;

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