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Optimization of TSP Using Genetic Algorithm

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Abstract

The traveling salesman problem is a permutation problem in which the goal is to find the shortest path between N different cities that the salesman takes is called the TOUR. In other words, the problem deals with finding a route covering all cities so that the total distance traveled is minimal. This paper gives a solution to find an optimum route for traveling salesman problem using Genetic algorithm technique, in which cities are selected randomly as initial population. The new generations are then created repeatedly until the proper path is reached upon reaching the stopping criteria. The genetic generated path is more optimized and gives better results in terms of distance travelled and route followed as compared with the previous approach. The work is implemented using MATLAB environment.

Keywords

TSP (Travelling Sales Problem), GA (Genetic Algorithm), Route, MATLAB etc.

I. Introduction

It is a permutation problem with the objective of finding the path of the shortest length (or the minimum cost) on an undirected graph that represents cities or node to be visited. The traveling salesman starts at one node, visits all other nodes successively only one time each, and finally returns to the starting node. i.e., given n cities, named {c1, c2, ……., cn}, and permutations, σ1, ..., σn!, the objective is to choose σi such that the sum of all Euclidean distances between each node and its successor is minimized. The successor of the last node in the permutation is the first one. The Euclidean distance d, between any two cities with coordinate (x1, y1) and (x2, y2) is calculated by simple distance formula given by:

d=sqrt $((x_1-x_2)$^2 $+(y_1-y_2)^{\wedge 2})$

There are mainly three reasons why TSP has been attracted the attention of many researcher's and remains an active research area. First, a large number of real-world problems can be modeled by TSP. Second, it was proved to be NP-Complete problem. Third, NP-Complete problems are intractable in the sense that no one has found any really efficient way of solving them for large problem size. Also, NP-complete problems are known to be more or less equivalent to each other; if one knew how to solve one of them one could solve the lot. The methods that provide the exact optimal solution to the problem are called exact methods. An implicit way of solving the TSP is simply to list all the feasible solutions, evaluate their objective function values and pick out the best. However it is obvious that this "exhaustive search" is grossly inefficient and impracticable because of vast number of possible solutions to the TSP even for problem of moderate size. Since practical applications require solving larger problems, hence emphasis has shifted from the aim of finding exactly optimal solutions to TSP, to the aim of getting, heuristically, good solutions in reasonable time and establishing the degree of goodness. Genetic algorithm (GA) is one of the best heuristic algorithms that have been used widely to solve the TSP instances.

II. Literature Work

A. Yaowei Yan (2011)

Introduced a mixed algorithm to solve the Travelling Salesman Problem (TSP). In the algorithm he mixes the two heuristic algorithms to get a better performance and validated the feasibility and efficiency of the mixed algorithm by simulating it with classic instances of TSP. According to the simulating results the algorithm can get the optimal solution and the performance is significantly improved

B. Taesu Cheong And Chelsea (2012)

Investigated the value of choosing the next stop to visit in a multistop trip based on current traffic conditions to minimize the expected total travel time of the tour. We model this problem as a Markov decision process. Numerical examples are presented that indicate that the value of using current traffic information for dynamic tour determination can be significant.

C. Hongwei Dai, Yu Yang, Cunhua Li (2012)

Proposed a novel quantum Clonal Selection Algorithm (NQCSA) which combines the traditional Clonal Selection Algorithm (CSA) and the improved quantum crossover for Traveling Salesman Problems (TSP). The NQCSA integrates the characteristics of both CSA and quantum mechanics. By using CSA which is derived from clonal selection theory, the solution space can be exploited and further explored parallel with more efficiency. Furthermore, the probability of local minimum can be reduced because of the quantum interference mechanics.

III. Problem Statement

The TSP is the NP complete problem and our objective is to find the solution of the problem in a definite and optimized time. NP hard problems can be solved by number of exact algorithms with guaranteed optimal solution but the major drawbacks to take very large computational time. So for this, various approximate algorithms like GA has been developed to find near to optimal solution in very small computational time. A hybrid version of SGA has been proposed in which we are combining the Fuzzy Logic along with Genetic Algorithm. In DPX cross-over operator, all the edges which are not common in the other parents are then removed.

A GA Relating Our Problem Domain

The steps of applying GA relating our problem at hand are:
1. Choosing an Encoding scheme.
2. Fitness function.
3. Choosing Operators.

4. Choosing Parameters.
5. Choosing an Initialization method and Stopping criteria.

There are various different types of crossover methods/techniques available such as:

1. One point crossover.
2. Two point crossover.
3. Uniform crossover.
4. Ordered crossover.
5. PMX (Partially matched crossover) &
6. Arithmetic crossover

We have considered in our proposed work one point crossover which is explained below

The traditional genetic algorithm uses one point crossover, where the two mating chromosomes are cut at some random points once and the sections after the cuts exchanged i.e. a crossover point is selected randomly along the length of the mated strings and bits next to the cross-sites are exchanged. Figure 4.4 illustrates one point crossover and it can be observed that the bits next to the crossover point are exchanged to produce the children.

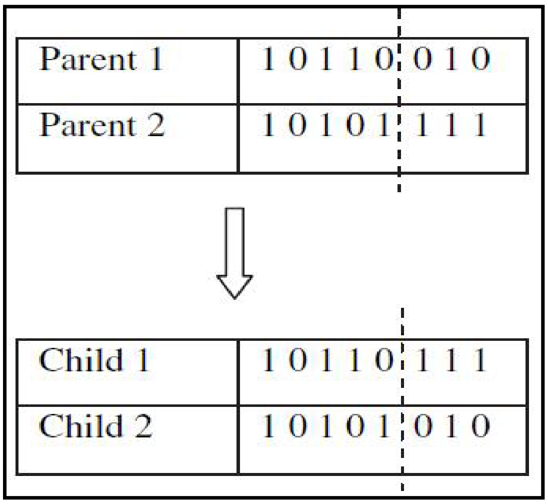
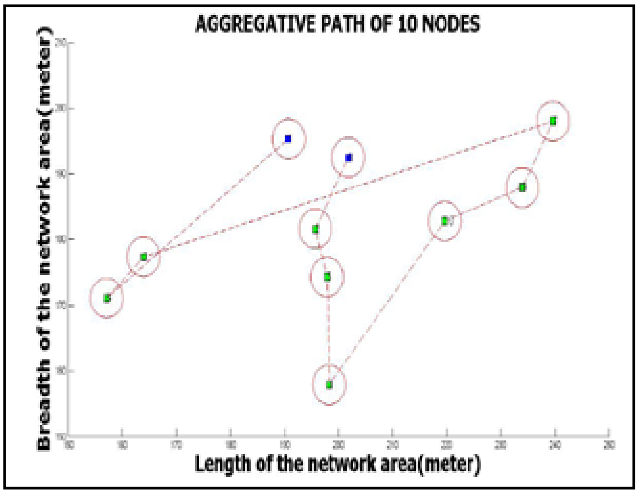


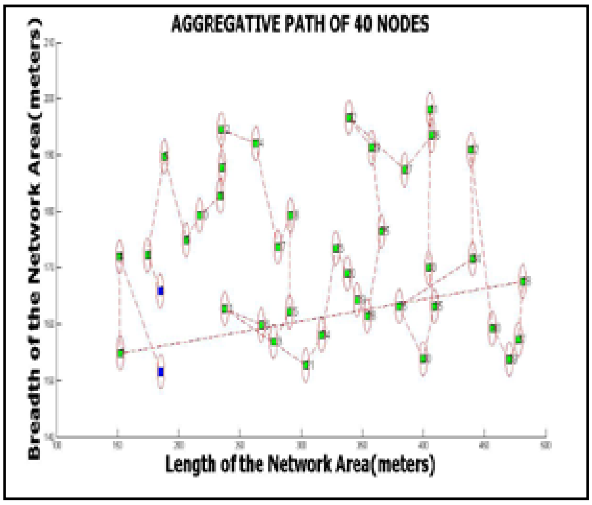
Fig.1: One point crossover

IV. Simulation Results

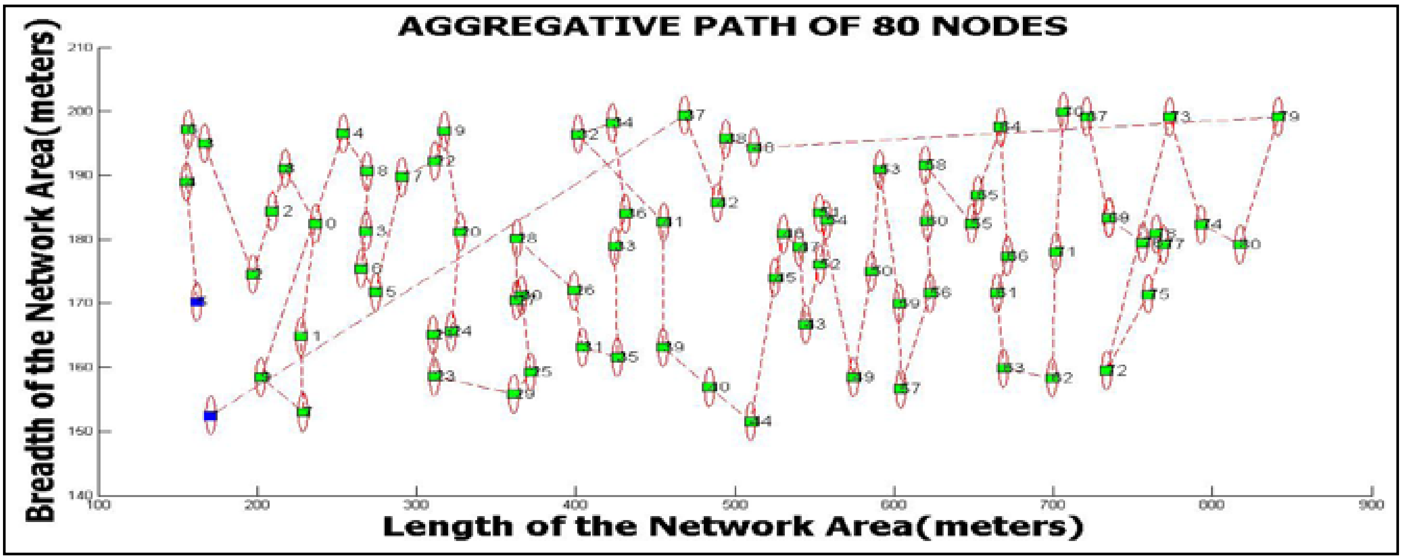
A. Aggregative Path of Existing Work:



1. Path of 10 nodes



2. Path of 30 nodes



Path of 80 nodes

Here in this algorithm the aggregative path is chosen from the source to the destination. The graphs analysis shows the different path for the different number of cities. Here in this method the path generated is less energy efficient because the sum of distances obtained has a large value.

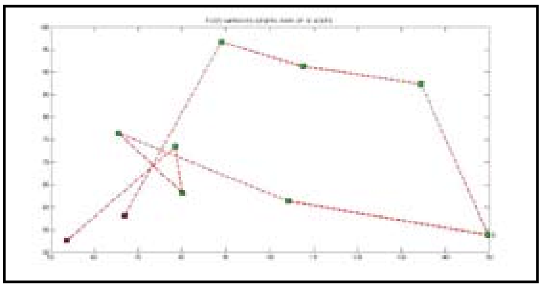
V. Proposed Method

The proposed work is a genetic based approach to build the network path for the route construction in an optimize way. As the selection process is done we will perform the crossover to select the most promising nodes. Finally mutation will be performed. In this work, the selection of the next cross over child path will be identified based on one point crossover operator. The simulation will be implemented under the parameters of path and the distance specification. In this work, the improved Genetic algorithm will be implemented for the route generation.

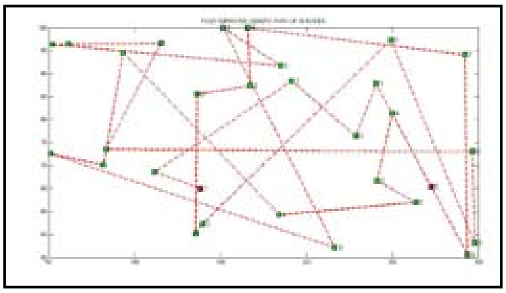
A. Proposed Approach Flow chart

1. Start GA
2. Step1. Initialize NOP and POPULATIONSIZE [input no. of processes and population size from the user].
3. Step 2. Initialize population randomly [using using rand function].
4. Step 3. Evaluate the fitness of each individual [using fitness function].
5. Step 4. for no. of iterations do
6. Step 5. select two parents from the randomly generated population [perform roulette wheel selection using wheel function].
7. Step 6. Crossover two parents [perform one pont,ordered and cyclic crossover].
8. Step 7. if i/5==0, mutate two offspring produced. [perform mutation at every fifth iteration using mutation_interchanging function].
9. Step 8. Evaluate fitness and return the two best fitted individual to the population [perform weakparent replacement using replace_weak function].
10. Step 9. Is done=optimization criteria met?
11. Step 10. if (not) then, i=i+1. [increase iteration number].
12. end for [if optimization criteria met, stop the algorithm].
13. Step 11. output the best solution
14. end GA

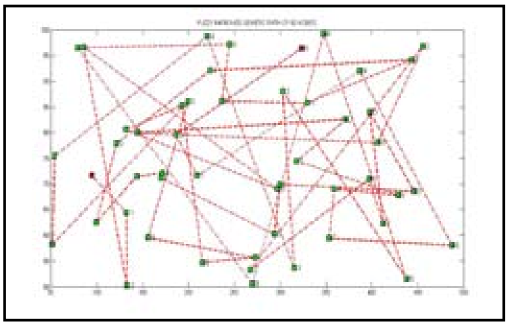
B. Graphs Of Proposed Work



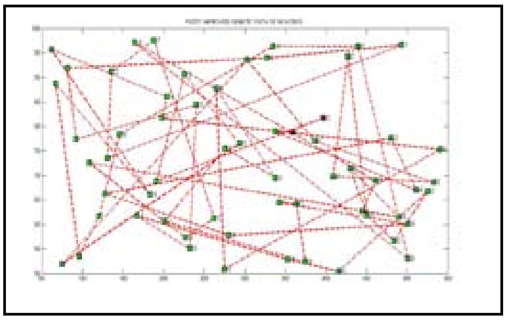
1. Path for no of nodes=10



2. Path for no of nodes=30



3. Path for no of nodes=50



4. Path for no of nodes=60

C. Optimizzed results

Iterative History

Generation	f(x)
1	225.398
2	225.398
3	225.398
4	225.398
5	225.398
6	225.398
7	225.398
8	225.398
9	225.398
10	225.398
11	225.398
12	225.398
13	225.398
14	225.398
15	225.398
16	225.398
17	225.398
18	225.398
19	225.398
20	225.398

Optimization terminated.

Iterative History

Generation	f(x)
1	861.334
2	861.334
3	861.334
4	861.334
5	861.334
6	861.334
7	861.334
8	861.334
9	861.334
10	861.334
11	861.334
12	861.334
13	861.334
14	861.334
15	861.334
16	861.334
17	861.334
18	861.334
19	861.334
20	861.334

Optimization terminated.

The graphs analysis in section 5.2 shows the genetic inspired path for different number of cities which is based on improved genetic algorithm. For the same number of cities the sum of distance using the proposed approach is less as compared to the previous method, which indicates the optimization level achieved using the two techniques. It is clearly estimated that the proposed work has better prosperity for the route optimization. Hence we have solved the Travelling Salesman problem using Genetic Algorithm.

VI. Conclusion and Future Work

Distance optimization/minimization is the main point of discussion in this dissertation. Actually this dissertation is based on implementing the GA based on the total distance of these algorithms at different number of iterations. Basically GA is one of the better function optimization methods generally employed now days. Population is randomly generated. The encoding scheme for this problem of function maximization is value/real encoding. And so a different type of crossover method is applied for crossing the chromosomes in the population for producing better offspring's. And finally interchanging mutation is used while implementing this algorithm.

In future, further this work may be enhanced to incorporate more advanced operators to further improve the minimum distance.

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