Reduce Total Distance and Time Using Genetic Algorithm in Traveling Salesman Problem

A.Aranganayaki(Research Scholar)
School of Computer Science and Engineering
Bharathidasan University
Tamil Nadu, India
aaranganayakimsc@gmail.com

Abstract: Traveling salesman problem is quite known in the field of combinatorial optimization. Through this research describe how the traveling salesman problem is solved by the heuristic method of genetic algorithms. This research to find the most approximate solution that gives us the least distance, which is the shortest route for traverse the cities given in the data set such that each city is passed through just once and the traveling salesman comes back to the initial city from where he started. I accomplish this by carrying out the algorithm through generating a fitness formula and with the help of genetic operators like selection, crossover and mutation. The main purpose of this study is to propose a new representation method of chromosomes using binary matrix and new fittest criteria to be used as method for finding the optimal solution for TSP. The proposed method is taken from genetic algorithm of artificial inelegance as a basic ingredient which has been used as search algorithm to find the near-optimal solutions. This research introducing the new fittest criteria for crossover, and also applying the algorithm on symmetric as well as asymmetric TSP.

Keywords: Traveling salesman problem (TSP); Genetic Algorithm (GA);Selection, Crossover, Twopoint crossover; Mutation.

I. INTRODUCTION

Traveling salesman problem is quite known in the field of combinatorial optimization. Through this research describe how the traveling salesman problem is solved by the heuristic method of genetic algorithms This paper develops a new crossover operator, Sequential Constructive crossover (SCX), for a genetic algorithm that generates high quality solutions to the Traveling Salesman Problem (TSP). The Travelling Salesman Problem (TSP) is a classic combinatorial optimization problem, which is simple to state but very difficult t o solve. Tsp is special case of the traveling purchaser problem. This problem is known to be NP-hard, and cannot be solved exactly in polynomial time. Many exact and heuristic algorithms have been developed in the field of operations research (OR) to solve this problem. The problem is to find the shortest possible tour through a set of n vertices so that each vertex is visited exactly once. 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. Even though the problem is computationally difficult, a large number of heuristics and exact methods are known, so that some instances with tens of thousands of cities can be solved completely and even problems with millions of cities can be approximated with in a small fraction **.** This research work proposes a new crossover operator for solving the traveling salesman problem.

II. RELATED WORK

ChetanChudasama, S. M. Shah and Mahesh Panchal, "**Comparison of Parents Selection Methods of Genetic Algorithm for TSP**"[1].

In this paper proposed, Artificial Intelligence is used to optimize combinatorial problem. Many combinatorial problems like Travelling Salesman, Network Graph problem are optimize by Artificial Intelligence (AI) Searching Methods. One of Searching method of AI is Genetic Algorithm. In Genetic Algorithm parent selection for next generation is very important because solution of problem depends on how much optimized solution derives. In this paper, I have proposed comparative performance of roulette wheel, Elitism and tournament selection method for Travelling Salesman problem. And we found that elitism method is best in all these methods.

Dwivedi, TarunaChauhan,SanuSaxena and PrincieAgrawal, "**Travelling Salesman Problem using Genetic Algorithm**",[2].

In This paper proposed, offers a solution which includes a genetic algorithm implementation in order to give a maximal approximation of the problem with the reduction of cost. In genetic algorithm crossover is as a main operator for TSP. There were lot of attempts to discover an appropriate crossover operator. This paper presents a strategy to find the nearly optimized solution to these type of problems, using new crossover technique for genetic algorithm that generates high quality solution to the TSP. The work proposed here intends to compare the efficiency of the new crossover operator with some existing crossover operators.

Abdoun Otman , Abouchabaka Jaafar," **A Comparative Study of Adaptive Crossover Operators for Genetic Algorithms to Resolve the Traveling Salesman Problem**"[3].

In this paper proposed, the basic conceptual features and specific characteristics of various crossover operators in the context of the Traveling Salesman Problem (TSP) are discussed. The results of experimental comparison of more than six different crossover operators for the TSP are presented. The experiment results show that OX operator enables to achieve a better solutions than other operators tested.

Ivan Brezina Jr.,ZuzanaCickova, "**Solving the Travelling Salesman Problem using the Ant colony Optimization**", Management Information Systems, 2011, Vol. (6), No. (4).[4].

In this paper proposed, study a possibility of solving the well-known Travelling Salesman Problem (TSP), which ranges among NP-hard problems, and offer a theoretical overview of some methods used for solving this problem. in discuss the Ant ColonyOptimization (ACO), which belongs to the group of evolutionary techniques andpresents the approach used in the application of ACO to the TSP. in this study the impactof some control parameters by implementing this algorithm. The quality of the solutionis compared with the optimal solution.

Shalini Singh1, Md. Ejaz Asl " **Comparison Study of Multiple Traveling Salesmen Problem using Genetic Algorithm**", [5].

In this paper proposed makes the attempt to show how Genetic Algorithm (GA) can be applied to the MTSP with ability constraint. In this paper, this compare MTSP in term of distance and iteration by considering several set of cities. The computational results show that the proposed algorithm can find competitive solutions within rational time, especially for large scale problems.

Poonam Panwar1, Saloni Gupta2 "**Brief Survey of Soft Computing Techniques Used for Optimization of TSP**"[6].

In this paper proposed, there are a number of approximation algorithms an heuristics proposed in the literature which can yield to good solutions. But with the increase in the number of cities, the complexity of the problem goes on increasing. There are a number of soft computing techniques that can be used to solve extremely large sized problems with millions of cities. In this paper discussed the use of various soft computing techniques like Genetic Algorithm etc.

Harun Raşit Er Prof. Dr. Nadia Erdoğan ,"**parallel Genetic Algorithm to solve Traveling Salesman Problem on Map Reduce using Hadoop Cluster**"[7].

In this paper proposed , Given the list of cities and distances between them, the problem is to find the shortest tour possible which visits all the cities in list exactly once and ends in the city where it starts. Despite the Traveling Salesman Problem is NP-Hard, a lot of methods and solutions are proposed to the problem. One of them is Genetic Algorithm (GA). GA is a simple but an efficient heuristic method that can be used to solve Traveling Salesman Problem. In this paper, we will show a parallel genetic algorithm implementation on MapReduce framework in order to solve Traveling Salesman Problem. Map Reduce is a framework used to support distributed computation on clusters of computers. In this used free licensed Hadoop implementation as Map Reduce framework.

III. EXISTING PROBLEMS

The traveling salesman problem (TSP) is perhaps the most well known combinatorial optimization problem. TSP is to find a routing of a sales man who starts from a home location,

visits a prescribed set of cities and returns to the original location in such a way that the total distance travelled is minimum and each city is visited exactly once. Although a business tour of a modern day traveling salesman may not seem to be too complex in terms of route planning, the TSP in its generality represents a typical hard combinatorial optimization problem.

This paper develops a new crossover operator, Sequential Constructive crossover (SCX), for a genetic algorithm that generates high quality solutions to the Traveling Salesman Problem (TSP). The sequential constructive crossover operator constructs an offspring from a pair of parents using better edges on the basis of their values that may be present in the parents' structure maintaining the sequence of nodes in the parent chromosomes. The efficiency of the SCX is compared as against some existing crossover operators; namely, edge recombination crossover (ERX) and generalized N-point crossover (GNX) for some benchmark TSPLIB instances. Experimental results show that the new crossover operator is better than the ERX and GNX.

A. Disadvantage

- Increase time,
- High path choose
- To make high distance.

IV. PROPOSED WORK

Traveling Salesman Problem (TSP) Genetic Algorithm (GA) Finds a (near) optimal solution to the TSP by setting up a GA to search for the shortest route (least distance for the salesman to travel to each city exactly once and return to the starting city) .TSP is combinatorial problem. So, if we taken large set of cities than search space becomes large. So, in early transition steps finding optimize solution from number of feasible solutions we have to select best fittest path for next generation. It is done by fitness function and selection method for selecting fittest path.

1. A single salesman travels to each of the cities and completes the route by returning to the city.

2. Each city is visited by the salesman exactly once.

A. Advantages

- choose best path.
- To take minimum time.
- The genetic algorithm produce better solution in tsp problem.

V. IMPLEMENTATION WORK

The different forms of encoding, crossover and mutation that we have seen so far can be combined to give various genetic algorithms that can be used to solve the traveling salesman problem. Obviously some crossover routines can only be used with a certain form of encoding so we do not have too many different genetic algorithms to explore. Also, only certain methods have been attempted, so we will only look at these. Finally, we will keep in mind that these programs have been tested on different problems and it will therefore be difficult to compare them to each other.

- First we will note the best known solutions for particular problems. For the 25 city problem the best known solution is 1,711, the 30 city problem is 420,the 42 city problem is 699, the 50 city problem is 425, the 75 city problem is 535, the100 city problem is 627, the 105 city problem is 14,383 and the 318 city problem is 41,345. These problems are standard problems with set edge costs that can be used to test new algorithm. We will now consider pure genetic algorithms with no heuristic information used.
- The algorithm is applied to a set of total five problems taken from the literature. We have explained the working of the algorithm on a problem of 15 cities in the following section. The coordinates of 15 cities.
- Consider the partially modified crossover (PMX) with the tour notation and no mutation operator. Jog ([4]) found that this algorithm gave a tour who's length was ten percent larger than the known optimum for the 33 city problem. For the 100 city problem, the result was 210 percent larger than the known optimum. states that the best tour length of this same algorithm is 498 for the 30 city problem. The algorithm using order crossover gives a better performance, giving a result of length 425 for the 30 city problem, while cycle crossover only gives a tour of length 517 for the same problem. The best known solution for the 30 city problem is 420 so order crossover seems to be the best.
- Integer representation and basic crossovers. Homaifar also tested an algorithm that uses only the 2-opt mutation operator and no crossover. This also performed decently, however not as well as the previous case where we used matrix crossover. In particular, it performed worse
- With problems where the number of cities is large. Jog's heuristic algorithms also performed well. The heuristic crossover, when combined with the 2-opt and Or-opt mutation operators sometimes gives the best known solution for that particular problem, and otherwise returns a solution very close to that value. Heuristic algorithms also take up more space.

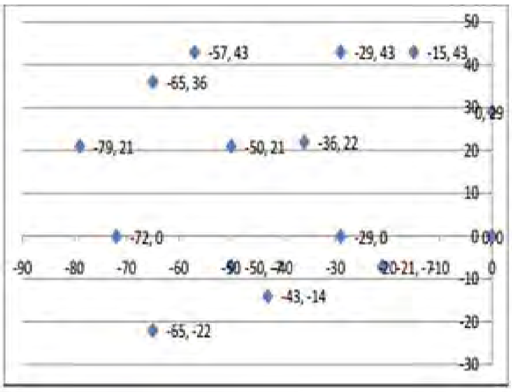

Fig. 1 Distance matrix for 15 cities

- The distance matrix of the problem is given in above figure. We have assumed the distance-matrix to be symmetric; therefore, the part above the main diagonal contains all necessary information. The distance between the cities is considered to be symmetric i.e. if the salesman moves from city 1 to city 5 than the distance is same if he moves from city 5 to city 1. Due to this half of the matrix is empty. The information above the diagonal is enough to find the distance between different cities. The first row and column denotes the city.

Initial population of chromosomes is created randomly by using unique random number generator function in Matlab. The initial population created is shown in following section. The population consist of ten chromosomes, where each chromosome denotes the sequence in which cities have to be traversed and each gene represent the number assigned to a city. Section A to E describes the various genetic operators applied to the initial population to obtain the optimal results.

Chromosome1 1 4 13 3 8 2 5 15 7 10 14 12 6 9 11

Chromosome 2 3 14 13 2 9 10 5 7 1 15 6 12 8 11 4

Chromosome 3 1 15 3 7 14 11 9 2 13 5 12 4 8 10 6

Chromosome 4 4 12 14 13 5 9 11 8 1 3 10 2 6 7 15

Chromosome 5 11 2 9 5 13 14 3 12 8 1 15 6 4 10 7

Chromosome 6 3 10 7 13 11 2 9 4 15 12 6 5 14 1 8

Chromosome 7 11 5 2 9 15 13 7 8 4 1 3 12 6 10 14

Chromosome 8 3 4 13 14 11 7 10 2 8 15 1 5 9 12 6

Chromosome 9 10 11 7 8 15 1 5 9 12 4 14 6 2 13 3

Chromosome 10 10 11 4 7 12 1 6 3 9 5 15 14 13 8 2

The Purpose of the fitness function is to decide if a chromosome is good then how good it is? In the travelling salesman problem the criteria for good chromosome is its length. Calculation takes place during the creation of the chromosomes as given in equation . Each chromosome is created and then its fitness function is calculated. The length of the chromosome is measured in pixels by the scheme of the tour.

L= sqrt (diff(x).^2 + diff (y).^2)

L- Distance

Sqrt – Over all distance

X,Y- city point outs

A. Selection

Selection is used to select the chromosome whose fitness value is small. We have used the tournament selection by using Sorting method.

B. Crossover

2-point crossover is applied to the pair of chromosomes so that new chromosomes will be generated which might have better fitness value. In 2-point crossover, randomly two positions in the chromosomes are chosen and then replace the gene with each other in both chromosomes.

C. Mutation

Mutation is applied to form a new generation. We apply interchange mutation. In interchange mutation, randomly select two genes from a chromosome and then swap them.

VI. RESULT ANALYSIS

The data result and analysis for Existing method and proposed method.

S.no	City Point	Existing Total Distance	Proposed Total Distance	Existing Total Time	Proposed Total Time
1	57	60.9401	61.0743	12.3761	0.30427
2	68	78.8600	76.2247	13.8028	0.3535
3	104	93.8486	90.6825	15.8787	0.91467
4	78	74.8539	73.5663	13.727	0.38791
5	86	85.1860	82.5188	14.7066	0.47174
6	99	90.6602	88.5846	15.1031	0.6089
7	106	87..4754	85.3518	15.6992	0.70349

VII. CONCLUSION

In this paper, Combining the knowledge from heuristic methods and genetic algorithms is a promising Approach for solving the TSP. Genetic algorithms appear to find good solutions for the travelling 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 work can be extended for different hybrid selection, crossover and mutation operators. The proposed approach can be determine the short path and to take minimum time.

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