A Novel Approach for Solving TSP Problem Using Genetic Algorithm Problem

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Abstract
TSP is a well-known optimization problem. It comes in the category of NP-Hard problems. The solution of TSP problem is not possible using traditional algorithms. It is having many application areas in science and engineering. Genetic algorithm is a well-known AI technique which performs well to solve optimization problems. The performance of genetic algorithm depends upon its operators. In this paper a novel genetic cross over is proposed to solve TSP problem. The performance of proposed algorithm is better as compared to other techniques to solve TSP.

Keywords: Genetic Algorithm, Travelling Salesman Problem, Mutation, Cross Over

1. Introduction
In the field of computer science, Travelling Salesman problem is the most popular algorithm. It is declared as NP-hard problem by operation research domain. The application of this problem is widely applied in various areas such as logistics industries, Transportation and semiconductor manufacturing. Some promising application of TSP are parcels collection and dispatching, optimal path discovers in integrated chips etc. The solution of these entire problems provided the assurance that the works are performed in a well effective and organized manner. It helps to improve the work rate. That is the reason; many researchers of different areas are working on TSP for the problem of many industries.

One of the most important and famous problem in the field of computer science is Traveling Salesman Problem. This problem can be represented in the form of Complete graph in such a manner where G= (V, E) is a complete graph with V vertices and E Edges.

Here V ={0,…, n} represent a deterministic vertex set and E={(i, j)|i, jϵV} is an edge set.

Now we can consider that V is a set of cities which are to be traversed at once and every edge from one vertex Vi to another vertex Vj.e E={(vi,vj)} represent the distance from city vi to vj. The goal of TSP is to find out the minimum distance of a tour in which each city is to be traversed exactly once and then return back to the origin city.

This problem is already approved as NP hard combinatorial Optimization problem. Various algorithms which claim to solve TSP are further divided into two categories: First Exact Algorithms and second heuristic algorithms. As we are aware that mathematical methods to be used for a very limited problem domain so lot of the researchers now a days rely on heuristic methods to solve TSP Problem. Genetic Algorithm inspired by principle of natural selection is meta-heuristic technique. This algorithm is comprising of three main operators: selection, crossover and mutation. Crossover and mutation operators are used to reproduction of individuals. Selection operator is vital operator which is responsible to select best individuals from the population.

Figure 1 is showing the flowchart of genetic algorithm. GA starts from initial population and then form selection, crossover and mutation to solve problems. The next section illustrates the recent work done in this area by other researchers.
Fig 1. Flowchart of genetic algorithm

2. Literature Survey
This section presents the progress to find optimal tour of TSP. In recent days, various researchers presented their approaches to solve the problem of TSP by considering it as NP complete with their algorithms. Paper [1] [2] proposed the genetic algorithm to find out the solution of TSP solution, however, the test results shows the acceptable time to reach the solution. The authors in Paper [3] proposed a novel hybrid adaptation combined PeSOA and HS, in this paper the population of PeSOA is increased after each iteration of HS. The Experiment result of PeSOA provides its efficiency to determine some case of TSP according PeSOA and HS. Paper [4] applied clustering technique to solve TSP. Paper [5] presented a PNP (Pick near point) algorithm which is able to work efficiently. It is better than others because other algorithms solution is dependent on comparison with all points. This approach saved the execution time to make it efficient using PNP algorithm which finds the path on fraction points.

In paper [6], author focused on symmetric TSP problem solution. In paper [7], author proposed a method which uses initialization process at initial for an initial population for GA on TSP excepting random initializing method. This method is better than a method NF. It makes GA faster than randomly initializing methods. In paper [9], Meta-heuristic methods are applied as a good choice for finding solution of NP complete problems. However, finding the good parameter setting is the major drawback. In paper [11], author presented an ABC&VNS algorithm. ABC refers to artificial bee colony method which has been improved. It consists of the process of solution construction of the artificial bee colony using the VNS algorithm. A method of VNS has been introduced into ABC to balance the local exploitation and global exploration. This has been measured on the benchmark instances and presented that work is efficient to solve the TSP problem.

After going through this literature it is concluded that there is a scope of further research to improve the performance of genetic algorithm for finding better solution of TSP problem. The next section discussed the proposed work.

3. Proposed Work
In this work, a new genetic algorithm is proposed that solves the TSP problem. The genetic algorithm solves a problem by applying its genetic operators. In this work, a new genetic algorithm is proposed by applying the modified cross over operation. The cross over operation is applied using greedy approach. Figure 2(a) and figure 2(b) are showing two chromosomes of a TSP problem with 10 cities.
Modified Cross Over Operation – When these two chromosomes perform cross over with each other then the selection of cities will be performed on greedy nearest neighbor approach. Table 1 is showing the distance matrix of the TSP of 10 cities.

Table 1 Distance matrix of the TSP problem.

| City No. | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 |
|---------|----|----|----|----|----|----|----|----|----|----|
| 1       | 0  | -  | -  | -  | -  | -  | -  | -  | -  | -  |
| 2       | 15 | 0  | -  | -  | -  | -  | -  | -  | -  | -  |
| 3       | 10 | 32 | 0  | -  | -  | -  | -  | -  | -  | -  |
| 4       | 23 | 18 | 27 | 0  | -  | -  | -  | -  | -  | -  |
| 5       | 50 | 14 | 20 | 25 | 0  | -  | -  | -  | -  | -  |
| 6       | 21 | 26 | 33 | 40 | 50 | 0  | -  | -  | -  | -  |
| 7       | 44 | 21 | 20 | 32 | 30 | 39 | 0  | -  | -  | -  |
| 8       | 38 | 17 | 26 | 24 | 39 | 33 | 28 | 0  | -  | -  |
| 9       | 17 | 16 | 40 | 10 | 35 | 12 | 22 | 46 | 0  | -  |
| 10      | 34 | 39 | 38 | 49 | 35 | 18 | 46 | 31 | 31 | 0  |

While performing modified cross over operation, let city 5 is the cross over point. With one-point cross over, the cities of parent 1 is copied into child1 and cities of parent 2 are copied into child1, from starting point to cross over point. After city 5, the remaining cities are selected with nearest neighbor approach. So using proposed approach, the new children by modified cross over are shown in figure 3(a) and 3(b).

Fig. 3(a) Child 1 generated by proposed cross over operator

Fig. 3(b) Child2 generated by proposed cross over operator
In child 1, cities are copied from city 1 to city 3. After that a city nearest to city 3 among the remaining cities is found. City 7 is having minimum distance equal to 20 among the remaining cities i.e. 6,7,8,9,10. So city 7 is selected as next city to 3. After that a nearest city to city 7 is selected among the remaining cities i.e. 6,8,9,10. City 9 was found nearest at distance 22 from city 7. So next city after 7 is city 9. The remaining cities are also selected in the same fashion and the whole child is generated. The same procedure is followed to generate child2 also which is shown in figure 3(b).

This proposed algorithm is applied and results are discussed in the next section.

4. Result Analysis

The proposed genetic algorithm is implemented in JAVA programming language using JDK1.8 and NetBeans 8.0.2 software. The proposed algorithm is applied on some instances of TSP algorithm taken from TSPLIB data set. Table 2 is showing the results obtained from the experiments.

From table 2 it is analyzed that the proposed algorithm performs better than the results obtained by Hao Qian et al [13]. The proposed algorithm works better for Att48 and Eil51 TSP instances for both SA and DFOA algorithms. But for the Eil76 TSP instance the proposed algorithm works better than the SA but not DFOA. Figure 4 is showing the graph of the results for Att48 problem. Figure 5 is showing the graph of the results for Eil51 problem. Figure 6 is showing the graph of the results for Eil76 problem.

| TSP Problem | SA  | DFOA | Results of proposed GA |
|-------------|-----|------|------------------------|
| Att48       | 39671 | 37645 | 32393                 |
| Eil51       | 498  | 465  | 448                    |
| Eil76       | 696  | 486  | 566                    |

**Fig. 4 Results of Att48 TSP Instance**
5. Conclusion and Future Scope

This paper proposed a solution of the TSP problem using improved genetic algorithm. The greedy approach is used while performing ross over operation in the genetic algorithm. The results are compared with other state of art in this area. It is concluded that the proposed algorithm works better for two TSP instances out of three. However, there is need of improvement in other genetic operators to improve the performance further. The limitations of this work is that the proposed algorithm should be applied on other instances of TSP problem. In future the algorithm can be tested on other instances of TSP problem having thousands of nodes.

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