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A Review: Optimized Solutions for Travelling Sales Person Problem

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ABSTRACT

Travelling sales person or simply **TSP** problem is one of the most common problems related to many research areas to find out direct route. The main aim of this problem is to search the shortest tour for a salesman to visit all cities exactly once and return back to the starting city. This paper presents review of different algorithms used to solve travelling salesmen problem previously discussed.There are different algorithms reviewed in this paper like Genetic algorithm, Ant Colony algorithm, Bee colony algorithm, Neural networks based Genetic algorithm, Particle Swarm Optimization Technique and M-crossover operator etc.

Keywords: -Travelling Salesman Problem, Genetic Algorithm, Ant Colony Algorithm, Bee Colony Algorithm, Lin–Kernighan algorithm.

I. INTRODUCTION

Traveling Salesman Problem

The traveling salesman problem was studied in the 18th century by a mathematician from Ireland named Sir William Rowam Hamilton and by the British mathematician named Thomas PenyngtonKirkman. The traveling salesman problem is one which has commanded much attention of mathematicians and computer scientists specifically because it is very much easy to describe the problem but much more difficult to solve this problem.The problem can be stated as:

"If a traveling salesman wishes to visit exactly once each of a list of **m** cities andthen return to the home city, what should be the least costly and smallest route the traveling salesman can take."

There are many researchers who solved TSP with different algorithms is discussed below:

R. Baragliaet al (2001), Weimin Liu et al (2009) and Yu Yang et al (2010).

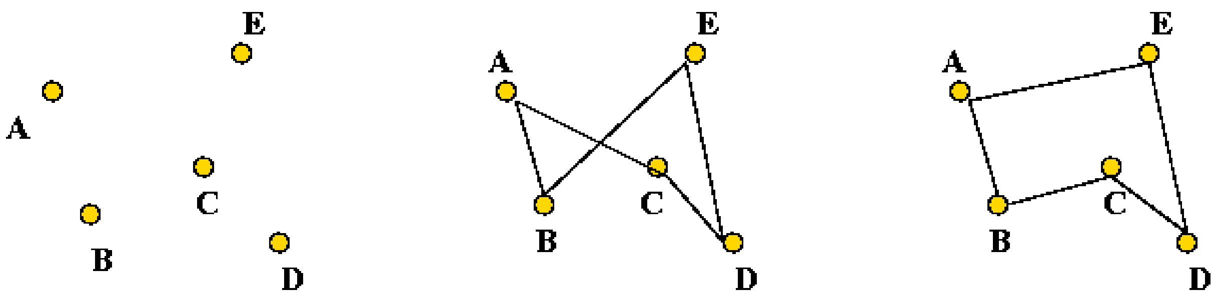

Figure 1: Input nodes, Non optimized tour and Optimized tour.

II. ALGORITHMS

1. **Ant Colony Algorithm:** Real ants are capable of finding the shortestpath from a food source to the nest without using visual cues. Also, theyare capable of adapting tochanges in the environment, e.g. finding a new shortest path once the oldone is no longer feasible due to a new obstacle. ConsiderFig. 2A: ants are moving on a straight line thatconnects a food source to their nest.This elementary behavior of real ants can be used toexplain how theycan find the shortest path thatreconnects a broken line after the sudden appearance of an unexpected obstacle has interrupted the initial path (Fig. 2B). In fact, once the obstacle as appeared, those ants which are just infront of the obstacle cannot continue to followthe pheromone trail and therefore they have to choose between turning right or left. In thissituation it can be expected that half the ants to choose to turnright and the other half to turn left.A very similarsituation can be found on the other side of theobstacle (Fig. 2C). It is interesting to note thatthose ants which choose, by chance, the shorterpath around the obstacle will more rapidly reconstitute the interruptedpheromone

trail comparedto those who choose the longer path. Thus, theshorter path will receive a greater amount ofpheromone per time unit and in turn a largernumber of ants will choose the shorter path (Fig. 2D).For more analysis on the Ant Colony Algorithm, see*Marco Dorigo et al* (1997), *Weimin Liu et al* (2009) and *Sudip Kumar et alSahana* (2011).

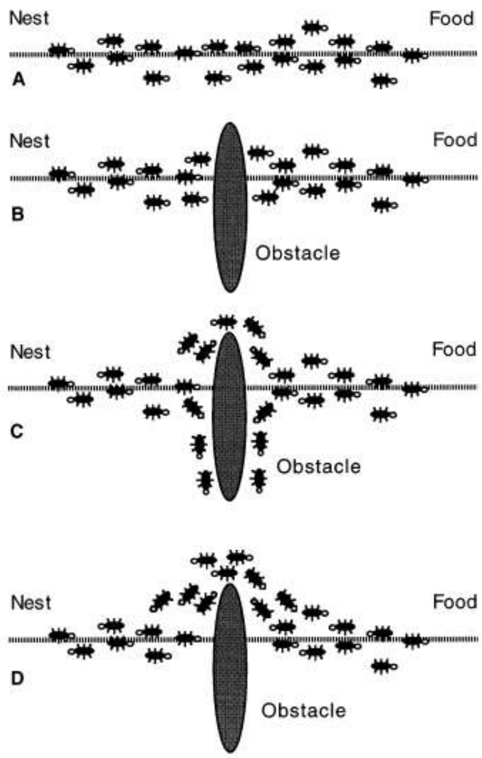

Figure 2: Ant Colony Algorithm

2. **Lin–Kernighan algorithm:**The Lin-Kernighan heuristic is generally considered to be one of the most effective methods for generating optimal or near-optimal solutions for the symmetric traveling salesman problem. However, the design and implementation of an algorithm based on this heuristic is not trivial. For more analysis on the Lin-Kernighan heuristic, refer *R. Baraglia et al* (2001).

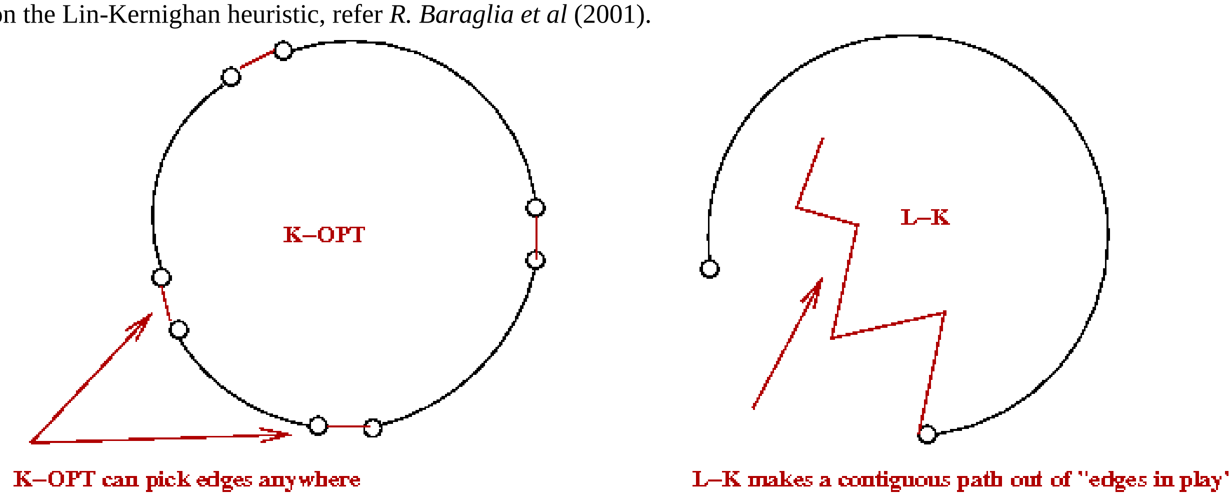

Figure 3: Lin-Kernighan Algorithm

3. **Discrete Optimization:**Discrete optimization or combinatorial optimization means searching for an optimal solution in a finite or countable infinite set of potential solutions. Optimality is defined with respect to some criterion function, which is to be minimized or maximized. The solutions may be combinatorial structures like

arrangements, sequences, combinations, choices of objects, sequences, subsets, sub graphs, chains, routes in a network, assignments, schedules of jobs, packing schemes, etc.

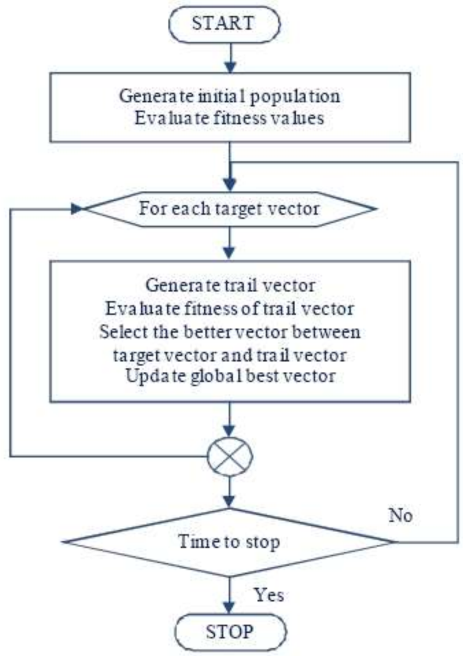

Figure 4: Discrete Optimization

4. **Genetic algorithm:**In the field of artificial intelligence, a genetic algorithm is a search heuristic that mimics the process of natural selection. This heuristic is routinely used to generate useful solutions to optimization and search problems. Genetic algorithms belong to the larger class of evolutionary algorithms, which generate solutions to optimization problems using techniques inspired by natural evolution, such as inheritance, mutation, selection, and crossover.For further details for Genetic Algorithm, refer*Yu Yang et al* (2010),*Peng Chen* (2013) and *Shiwei Zhang et al* (2014).

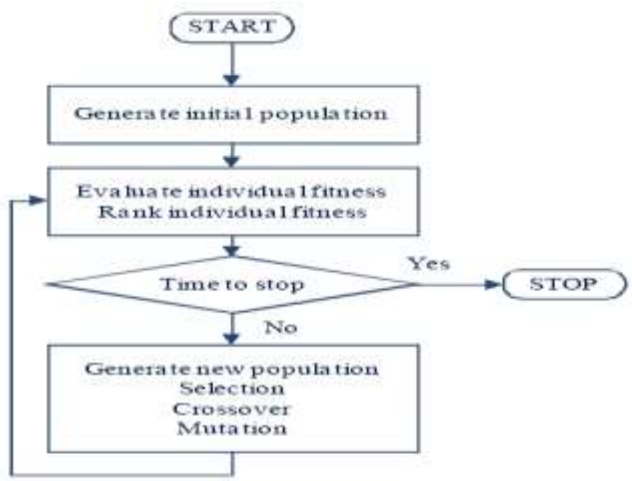

Figure 5: Genetic Algorithm

5. **Artificial Bee colony:** In the ABC model, the colony consists of three groups of bees: employed bees, onlookers and scouts. It is assumed that there is only one artificial employed bee for each food source. In other words, the number of employed bees in the colony is equal to the number of food sources around the hive. Employed bees go to their food source and come back to hive and dance on this area. The employed bee whose food source has been abandoned becomes a scout and starts to search for finding a new food source. Onlookers watch the dances of employed bees and choose food sources depending on dances. The main steps of the algorithm are given below:

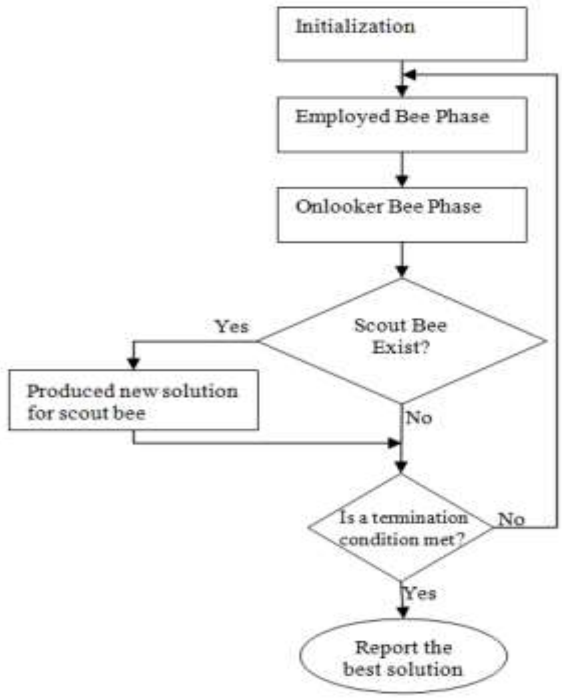

Figure 6: Bee Colony Algorithm

III. RELATED WORK

The author describes an artificial ant colony capable of solving the travelling salesman problem (TSP). Ants of the artificial colony are able to generate successively shorter feasible tours by using information accumulated in the form of a pheromone trail deposited on the edges of the TSP graph, *Marco Dorigoet al* (1997). The combination of genetic and local search heuristics has been shown to be an effective solve approach to solving the method of traveling salesman problem (TSP). This research work describes a new hybrid algorithm that exploits a compact genetic algorithm in order to generate high-quality tours, which are then refined by means of the Lin–Kernighan (LK) local search. Local optima found by the LK local search are in turn exploited by the evolutionary part of the algorithm in order to improve the quality of its simulated population, *R. Baraglia et al* (2001). Traveling salesman problem using combined approach of Ant Colony Optimization and Genetic Algorithm is implemented in this research work. Several solutions exist for the TSPusing ACO or GA and even using a hybrid approach of ACO and GA. This framework gives an optimal solution for the above problem by using the modular hybrid approach of ACO and GA along with heuristic approaches, *PengChen*(2013). This research presented a Discrete Particle Swarm Optimization (DPSO) technique to solve Graph based Travelling Salesman Problem (TSP). TSP can be represented as a graph where nodes represent cities and edges represent paths between them. A partially connected graph addresses a more realistic problem than a completely connected graph since in real life paths may not exist between certain cities. A novel approach to DPSO was used to obtain results in this situation. Convergence of DPSO to the optimal solution for such a Graph based TSP is tasted,*H. Afaq et al* (2011).Artificial Bee Colony Algorithm (ABC) is an optimization algorithm used to find out the global optima. In ABC, each bee stores the information of feasible solution or candidate solution and stochastically modifies this over time, based on the information provided by neighboring bees, it speculative modifies over time and based on the best solution found by the bee itself. In this proposed work, the swarms of bees are dynamically divided into smaller groups and search process is performed by independent smaller group of bees, *Poorti Sharma et al* (2015).

Results

40 city coordinates were randomly selected. 703generations were calculated applying the original algorithmand the best path long about 1997.67 was found shown in figure 7(a) and algorithm was employed to calculate thebest path after 900 generationsand found the shortest pathabout 1976.44 shown in figure 7(b).*Peng Chen* (1013).

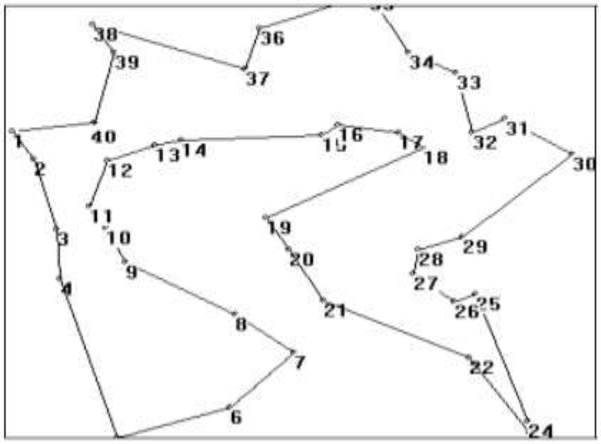

Figure 7(a)

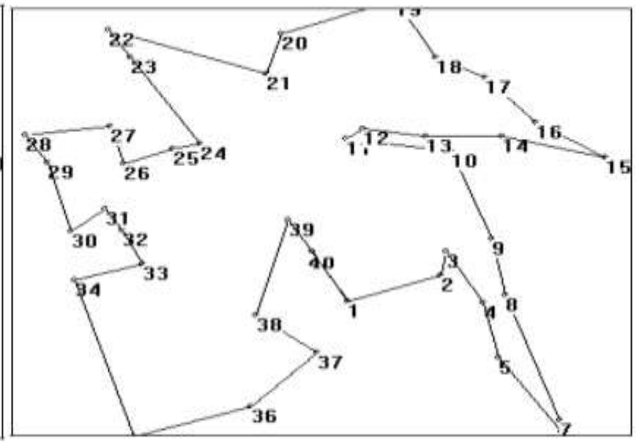

Figure 7(b)

Cities	Generation	Shortest route length	Time
40	649	2280.45	3.5
40	520	2476.18	4
40	353	2336.74	3.5
100	1026	5298.57	20
100	978	5543.98	17
100	985	5375.73	19

Table 1: Results obtained by Genetic Algorithm

IV. CONCLUSION

In this article, a number of algorithms developed by researchers are explained. Performance evaluation and practical implementation shows that all the algorithms can be optimal problem useful for the optimization. Travelling salesmen problem can be solved by using anyone of these algorithms, but Genetic Algorithm is best suited algorithm for optimization and for best route with lowest cost. Genetic algorithm is also used to combine with many different approached.

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