



Implementation of Modified Genetic Algorithm Based on the Sub Graph Formation of Travelling Salesman Problem

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Abstract -- The Solution of Travelling Salesman Problem (TSP) is tough task to execute, because it cannot be solve by conventional mathematical approach. Different approaches are performing on it as a general test bench to find solution. In this paper we are applying approaches like the combination of Simulated annealing and Tabu search with genetic algorithm based on the frequency sub graph of travelling salesman problem to find a solution which is optimal. Our main objective is to reduce time complexity of Travelling Salesman problem by making the sub graph implementation and here we will also give the solution to get best route in this problem without repeating nodes.

Keywords – Genetic algorithm, Travelling Salesman Problem, Tabu Search, Frequency Sub Graph.

I. INTRODUCTION

Generally in Travelling Salesman Problem, a map of cities is given to the salesman and he has to visit all the cities only once to complete a tour such that the tour length is the shortest among all possible tours for this map of city. The weights assigned to the edges of a finite complete graph and the objective is to find the best route to get time efficient result. Travelling salesman problem need an efficient solution procedure to get optimized solution. One can either use heuristic, meta-heuristic or natural inspired algorithm[1] to solve this problem with no any knowledge that particular solution given by algorithm is require result or not. In this research paper Genetic algorithm, Simulated annealing, Tabu search algorithm is used to solve travelling salesman problem and comparison among all above is done with graph representation in terms of time.

In general TSP shown as a complete graph $G(V, E)$, where V represents cities and E represents different Path between cities respectively. Each edge has some values we call them, cost on the Edges for a graph G including n vertices. We have total of $n \times (n-1)/2$ edges in this travelling Salesman Problem. WE use frequency graph method to reduce the travelling salesman graph into sub graph by using optimal Hamiltonian circuit. A Hamiltonian circuit (HC) according to standard definition including n vertices once and exactly once is represented as $HC = (v_1, v_2, v_3, \dots, v_i, \dots, v_n, v_1)$ and the two end vertices are identical.

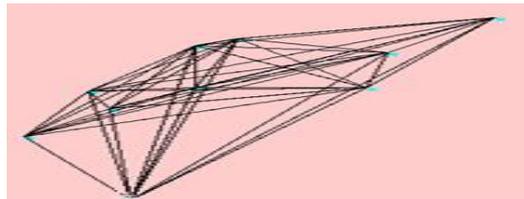


Fig 1 - complete graph of travelling salesman problem with n vertices.

According to definition of complete graph, as we take the TSP in this paper as a complete graph So if Vertices $n=10$, Edges are $n \times (n-1)/2$ i.e 45 edges Than Its sub graph can be as following



Fig 1 - sub graph of complete graph of travelling salesman problem with n vertices.

II. PROBLEM STATEMENT

The travelling salesman problem consists of a salesman and a set of cities. The salesman has to visit each one of the cities starting from a certain one (e.g. the hometown) and returning to the same city. List of cities and their pair wise distances present with us, the only task is to find a shortest possible route and Make sure that each city visited once and left once. This statement is easy to State but difficult to Solve.

III. LITERATURE SURVEY

Background: - The background study is provided so as to get familiar with the basic concepts related with Techniques of travelling salesman problem solution.

A .Genetic Algorithm

Genetic algorithm is different than conventional algorithm. It is heuristic search method. It is proposed in 1960 by John Holland [2]. This algorithm is start with initial solution by selecting population randomly. Each element of population is called chromosome. Chromosome is a string of symbol. Genes which are atomic entity composed inside chromosomes and allite are the real values of a control parameter, encoded in gene.

Working of Genetic algorithm:

An initial random population of chromosomes is used and evaluated, genetic algorithm execution takes place using following basic genetic operators:

- 1) Parent selection;
- 2) Crossover;
- 3) Mutation.
- 4) Termination

The search starts with a randomly generated population that goes to successive generations that is iterations of the solutions. Fitness function based selection process is use to choose two solution which are parents solution for further iterations.

The crossover operator inherits features of good surviving designs from the parent population into the future population, which will have better fitness value on average. The third operation is “Mutation” which causes diversity in population characteristics. It causes local modifications to the new generation randomly. The new generation is identical to the parent except one or more changes made by mutation process. Repeat selection, crossover and mutation operations to produce more new solutions until the population size of the new generation is the same as that of the old one. The iteration then starts from the new population.

The procedure continues until the number of generations is reached to the solution quality cannot be easily improved.

Table 1- Genetic Algorithm pseudo code

Genetic algorithm()
Begin
1. Choose initial population
2. Evaluate the fitness of each individual in the population
3. Repeat until termination: (time limit or sufficient fitness achieved)
a. Select best individuals to reproduce
b. Get new generation through crossover and mutation operations
c. Evaluate the individual fitness of the new generation
d. Replace old solution by new one if not new one is not worst
End

Genetic algorithm which is the Evolutionary Algorithm and it is behaves as a base of most of algorithm so solve such type of problem. It is easily mix with other algorithms to get better solution. When we have poor or no mathematical analysis is available it is more useful. It is having poor search capability for both discrete and continuous variables [4]. But with these good qualities it also having limitation because it converges at local minima and dynamic change in particular problem is not accepts by this algorithm [7].

B. Simulate Annealing Algorithm

Simulated Annealing (SA) is the oldest probabilistic meta-heuristic algorithm and one of the first algorithms having ability to avoid being trapped in local minima [9]. It was first presented by Kirkpatrick, Gelatt and Vecchi in 1983.

- *Inspiration*

Simulated Annealing is inspired by the process of annealing in metallurgy. In this process a material is heated and slowly cooled into solid crystal state with minimum energy and larger crystal size to reduce defects in metallic structures. The heat increases the energy of the atoms allowing them to move freely, and the slow cooling schedule allows a new low energy level to be discovered. This annealing process requires the careful control of temperature and cooling rate.

- *Metaphor*

Each set of a solution represents a different internal energy of the system. Heating the system, results in a relaxation of the acceptance criteria of the samples taken from the search space. As the system is cooled, the acceptance criteria of samples are narrowed to focus on improving movements. Once the system has cooled, the configuration will represent a sample at or close to a global optimum.

Simulated Annealing is one of the oldest algorithms [12] which are not trapped at local minima. It is statically in nature. It is easy to code complex problem. Non linear ability of global optimality makes it versatile in nature.

It is easy to code complex problem. Non linear ability of global optimality makes it versatile in nature. But it is time consuming algorithm. To get cost for particular problem it needs more computation [11]. Unlike above algorithm it is not easily accumulate with other algorithms. Time need to execute this algorithm is inversely proportional quality of solution.

Table 2- Simulated annealing pseudo code

Simulated annealing()
Begin
1. Choose initial population
(A) Select a starting solution and assign it as best.
(B) Evaluate it if it best solution use it as a best
(C) And make history empty
2. If not then find the new solution to get new solution Termination by a chosen iteration cut off condition
3. Update recent solution with new one
If new solution is worst than previous ,perform step 1(B)
Update history record
End

C. Tabu Search

Tabu search (TS) is a neighborhood search method which employs "intelligent" search [8] and flexible memory technique to avoid being trapped at local optimum. Speed up the search process. Moves are selected intelligently and Use tabus to restrict the search space and avoid cyclic behavior. Glover (1986) introduces tabu search as a "meta heuristic" superimposed on another heuristic. Glover (1989) provides a full description of the method [8].

Table 3- Tabu search pseudo code

Tabu search()
Begin
1. Randomly create an initial solution, call it current solution.
2. Find the best neighbor of current solution, by certain moves.
3. If the best neighbor is reached by performing the non tabu search, accept as a new current solution, else find another neighbor (by no tabu search)
4. If stopping condition reached, then go to step 5 else on step 2.
5. Globally best solution is the best solution we found throughout he iterations
End

Tabu search algorithm is stochastic in nature, guaranteed to give optimal result always but it takes time that is time complexity is high [11]. This algorithm is act like ant cycling mechanism.

IV. DESCRIPTION OF PROPOSED ALGORITHM

In proposed method we developed an algorithm which is based on modified Genetic algorithm. In this paper we uses combination of two algorithms Simulated annealing and Tabu search with Genetic algorithm to make new approach to solve the problem in efficient time with less number of iterations and give the best result. The main objective is on reducing the problem of repetition of node in route finding for travelling salesman problem which is fulfills in this paper.

Outline of proposed Approach:

- IN beginning we take number of cities, routes and costs assign to each edge joining nodes.
- Make the graph representation of travelling salesman problem.
- Find the sub graph of travelling salesman problem by frequency graph approach[12].
- After that we apply genetic algorithm on sub graph with the help of tabu search algorithm to find the best route.

Proposed algorithm consist of two algorithms

A. Sub Graph Formation

After making graph $G (V, E)$ of TSP problem in proposed algorithm we make the sub graph $G' (V, E')$ of graph of travelling salesman problem by performing following algorithms

Table 4- Sub graph Formation algorithm pseudo code

Sub graph Formation()
$G (V,E), V= (v_0, v_1, v_2, v_3, \dots, v_i, \dots, v_n),$ frequency f parameter Number of vertices n. Begin While($f \leq (n-2) \times (n-3)/2$) { Iteration $i=v_0$ to v_n { 1. Generate adjacent vertex from v_0 and which frequency between n and $(n-2) \times (n-3)/2$ 2. Simply select the candidate vertices as well as replace the particular surrounding vertices with the recent vertex inside next to OHC 3. Compute along the modern next to OHC and observe after the particular next } } End

C. Genetic Algorithm +Tabu Search

After getting sub graph $G' (V,E')$ of TSP problem, we are applying approaches like the combination of Simulated annealing and Tabu search with genetic algorithm to find solution. Very first we apply Genetic algorithm to get the solution and these solutions use by tabu search to get our objective that is getting best solution from them.

Table 5- genetic algorithm with tabu search pseudo code

Genetic Algo+Tabu Search()
1. Central node generates n initial solutions using GA. It runs GA for fixed number of iterations, t. a. Choose initial population of fixed size and set $j=1$ b. While($j \leq t$) Begin i. Apply the operator on the two parent schedules chosen randomly to produce two offspring and replace the parents by the best two the four Schedules. ii. $j=j+1$ End 2. Central node sends m best solutions chosen to the m remote worker nodes 3. Each worker node runs the TS algorithm by Using the initial state received. 4. Upon receiving a converged result from one of the worker nodes, the central node stops Execution.

V. IMPLEMENTATION OF PROPOSED ALGORITHM

We implement this modified algorithm in Net beans IDE (Java).

- **Technique 1:-** In this method we generate the frequency sub graph solution [12] of travelling salesman problem graph.
- **Technique 2:-** This technique is the original Genetic algorithm is implementing in java. In this method we generate the initial solution from population.
- **Technique 3:-** This is the enhanced form of genetic algorithm based on combination of tabu search [18].

Through this method we minimize the iterations of travelling sales man problem as compare to previous solutions.

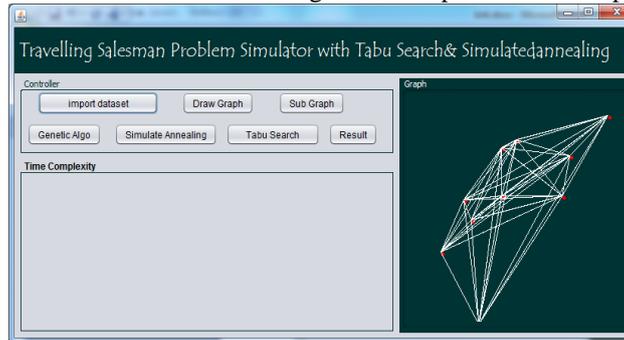


Fig 3- Graph representation of travelling salesman problem.

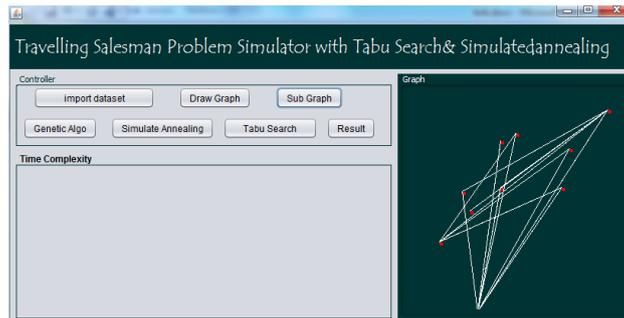


Fig 4- Sub Graph representation of travelling salesman problem.

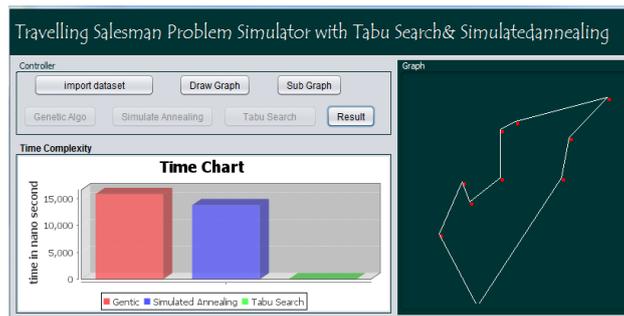


Fig 5- Result with time complexity representation of travelling salesman problem.

And comparison of new method that is the “combination of genetic algorithm and tabu search applied on sub graph” with previously studied Genetic algorithm with simulated annealing is shown in it with respect to time.

VI. RESULT ANALYSIS

With using this algorithm for travelling salesman problem we calculate the time of proposed method for different values of cities by choosing datasets and also compare this new method with the original genetic algorithm and hybrid algorithm containing genetic and simulated annealing algorithms. We use three dimensional bar chart to represent comparison of different algorithms solution. Following graph shows the time of execution of TSP problem with different s in which X-AXIS:- Different algorithms and Y-AXIS:- Execution time (In nano seconds)

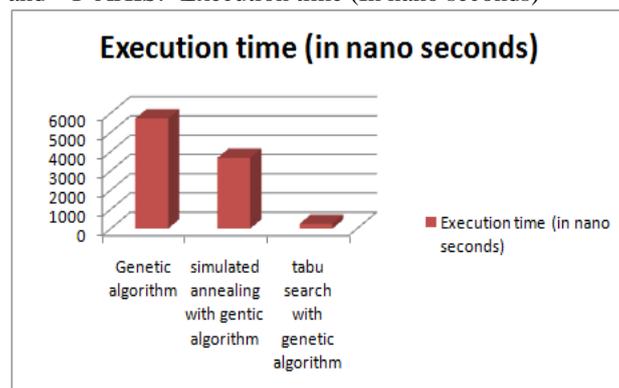


Fig 6- chart shows the comparison of genetic, genetic with simulated annealing and genetic algorithm with tabu search on sub graph of travelling salesman algorithms with respect to time.

This chart shows that this new algorithm which is combination of genetic algorithm and tabu search applied on sub graph of travelling salesman problem gives less execution time as compare to Conventional Genetic Algorithm and hybrid Genetic and Simulated Annealing Algorithm. Clearly it is explain ,according to this above chart that Genetic Algorithm solve the TSP problem in thousand nanoseconds , Genetic Algorithm with simulated Annealing solve in half time as compare to Genetic Algorithm and this new approach solve the TSP in hundreds nano seconds.

VII. CONCLUSION

In this paper, we improve the speed through the modification of an existing genetic algorithm called modified form of genetic algorithm based on the sub graph formation of Travelling Salesman Problem. This paper contains the practical implementation of the proposed algorithm using Netbeans7.3 software of java technology. In this method we have used sub graph implementation of travelling salesman problem. Genetic algorithm with the help tabu searching method applied on sub graph to give the best route without repetition of node and reduces the time complexity of finding the solution, thus it is more time efficient as compare to an existing genetic method. In future number of cities can be increases for this algorithm with reduction of time and addition of some another method can be possible

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