An Exploration to Challenges and Scope of Travelling Salesman Problem

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Abstract: Travelling salesman problem is the complex and traditional algorithmic problem to provide aggregative route formation. To provide the solution of the problem in optimized time is always a challenge. In this paper, a study on the different application areas and challenges is provided. The challenges are here based on the algorithmic formulation as well as under different complexities. Different constraints that affect the algorithmic model are also discussed in this paper.

Keywords: Travelling Salesman Problem, Complex Problem, Optimization Method.

I. INTRODUCTION

Travelling Salesman problem is one of the common as well complex problems which is considered as the benchmark for research. The problem is identified by different communication methods to provide the real time solution so that the problem can be identified at the early stage. The problem solution can be identified effectively so that the travelling problem can be identified effectively. In this problem, the city network is defined with n number of cities represented by individual nodes. The problem is about to generate the effective shortest path so that visit will be started from a city and move to all the cities. For n number of cities there are about 2^n possible paths. The analysis on these possible cities comes under NP-Hard problem. To provide the solution of this problem in effective time is always a challenge for the researcher.

The optimized problem solution can be identified so that all the feasible solution can be processed. The time and space optimization is here provided to generate the optimized problem solution. In this basic path transformation, the term specific analysis is defined with specification of N number of cities. The edges between the cities represent the shortest direct path to visit between the cities. The work is here defined to provide the ordered solution to identify the effective travelling path between all the cities. The solution is here provided to generate the optimized problem solution from the ordered processing list. The connected edges and the order of connectivity is provided to generate the optimized work solution. The city network for travelling salesman problem is shown here in figure 1.
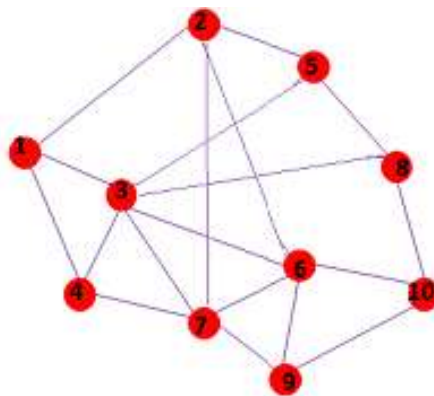

Figure 1: City Network for TSP

To generate the distance vector between the cities, different distance measures can be applied. These measures are divided in two main categories called Euclidean distance specific measure and non-Euclidean distance measure. The Euclidean distance measure is the direct distance map over the surface defined on flat piece of paper. The drawing specific analysis with chart formation can be defined for each of the city. Some other distance measures can be applied for distance evaluation including the cosine distance, degree of the connectivity, minimum coverage etc. Based on these measures, the distance analysis can be done between the cities.

A)   Requirement of Travelling Salesman Problem

The problem is basically defined to generate the effective shortest tour for a salesman to visit all the cities. The problem requires some sample space specific search method to identify the optimized solution in effective time. The problem come comes under the algorithmic formulation and having associated sub problems including shortest path, Hamiltonian Cycle Problem etc. Different optimization methods including genetic, differential evolution and the swarm based approach can be applied to generate the optimized work solution. The algorithmic model uses tour distance as the fitness rule respective to which the optimized solution will be obtained.

B)   Applications

The problem can be identified in different forms and effective work solution can be obtained. Some of common applications of travelling salesman problem are listed hereunder

1)   One of the core problem is the vehicle routing problem. The route taken by a vehicle to move particular destination is defined by travelling salesman problem. The problem can be identified by the number of customers and the vehicles. The number of cities visited by the vehicle is also analyzed. Different parameters can be setup to formulate the problem in real time. The cost of the overall visit can be reduced by applying the travelling salesman problem.

2)   Another application area of travelling salesman is to identify the wiring length while setting up a network. The wires are applied to connect two computers or the devices. To generate the complete network, the required wirelength can be estimated from this method.

3)   Another application requirement of travelling salesman is to provide the overhauling of gas turbine engine. The assembly level analysis and the stage specific observation with different parameters including gas flow, minimization of fuel consumption can be defined to provide the optimized work solution.

4)   Job scheduling is another method defined to provide the effective work solution for setting up the processing sequence of allocated tasks. Work duration, sequence and the environmental constraints can be defined to provide the effective work solution.

II.   RELATED WORK

Different researchers provided the work on travelling salesman problem using different optimization methods. In this section some of the work provided by earlier researchers is presented and discussed. Author[1] has provided a genetic based heuristic solution to provide the travelling salesman problem. Author applied the m-crossover method and defined a valid offspring method so that the optimized work solution will be obtained. The comparative analysis can be applied to generate the optimized work solution and to provide the shortest travelling path. Author[2] has defined a PSO based approach to generate the optimized work solution for travelling saleman problem. Author has defined the adaptive work solution for generating the solution path. The work method is effective to provide the route solution with minimum time and space complexity. Author combined the heuristic search method with harmony search to generate the cost optimized work solution. Author[3] has investigated the travelling salesman problem with mathematical formulation. Author included the soft computing method and linear programming integration for generating the optimized parameter specific solution. The uncertain aspect based solution in imprecise and vague framed specification was provided. Author discussed the multi objective analysis with linear programming integration to generate the flexible work solution. The fuzzy constraint method was integrated with linear programming formulation as well as with the specification of imprecise parameter specific integration. The constraint specific analysis was applied to generate the effective work solution. Author[4] has defined genetic based solution to generate the effective routing path between the cities. Author has provided the optimized worksolution for the larger work dimension and efined the fast computing method to improve the search technique. A larger dimension specific specific search method was provided by the author. Author[5] has generated a new work solution to divide the problem in sub segments and to generate the optimized solution tour with local search technique. Author has provided the significant work solution to generate the optimized and feasible solution. The specific design based work method was provided to improve the ability of the solution in relative measures. The mutation operator based significant work method was provided to improve the effectiveness of work. A tour specific problem specification and the ability driven computation was provided. A relative computation measure was provided to generate the optimized work solution. Author[6] has defined a cloning based search method to generate the optimize route for travelling salesman problem. The experimental setup was defined with comparative observation was provided to generate the solution. A convergence specific method using

ANT approach was provided to improve the selective feature based solution. The experimental work based comparative analysis was defined to improve the convergence and to improve the relative work solution.

Author[7] has defined a work solution to resolve the classic travelling salesman problem. Author used the multiple neurons in the recurrent network and with specification of linear threshold. The classical feature based method was provided under the constraint specification so that the optimized route will be formed. A direct dynamic based difference measure was defined with Hopfield network to provide the optimized work solution. Author[8] has defined a genetic based solution using DPX crossover approach. Author used the assignment problem solution along with hybrid GA method to extend the solution. The feature specific measure with optimized complexity was provided. Author has defined the hybrid method to generate the quality solution so that the low complexity solution is obtained. Author[9] has defined a multi agent based optimized solution for cooperative method so that the compact agent based method to provide optimized solution. A certain sharing based route formation method was provided with optimized utilization of memory.

III.   PROBLEM AND CHALLENGES OF TRAVELLING SALESMAN PROBLEM

Travelling salesman is a complex problem defined in real time with specification of a city network. The network is here defined with N number of cities and there is the requirement to generate the optimized routing path over the cities. This problem is also defined in different forms with specification of different variations to the path problem. Some of such path associated problems with variations are defined in this section:

A)   Hamiltonian Path Problem

It is another complex problem with specification of weight at node level or the edge level. In this problem, the source and destination nodes are defined with specification of objective function. The work is to visit all the nodes and move back to the initial city. The Hamiltonian path identification with weight formation is here defined. The path will be effective where weight is higher as well as the positive. The cost adaptive route formation was provided to generate the optimized travelling path. The optimization is here provided to achieve the maximize weight and to provide cost effective solution.

B)   Asymmetric Traveling Salesman

The problem is here defined with a variation to generate the optimized path between a node pair with specification of two cities. The path is to generate between these two cities without visiting all the cities of the network. The problem can be solved in different forms with specification of edge weights and the cycle formation. The Hamiltonian cycle can be formed over the graph to generate the weight specific solution. The distance between the cities is considered as the weight so that the optimized route solution will be generated.

C)   Multisalesmen Problem

In this problem variation, the city network is defined with M number of salesman defined randomly over the network. The work is here defined to generate the optimized solution. The problem is here defined to identify the region covered by each salesman and to provide the minimum distance visit over the region. The connectivity between the cities is also required to define to generate the optimized solution.

D)   Bottleneck Traveling Salesman

The travelling salesman problem is here defined to provide the minimum distance solution for route formation. In this problem, the constraints are changed and instead of cost optimization, the largest cost edge is defined to generate the optimized path solution. The adjacent city specific solution was provided to generate the solution relative to the problem domain.

E)   Time Dependent Traveling Salesman

Standard salesman problem is defined with specification of different time periods and relatively time and cost adaptive solution. The time period specific estimation is provided to generate the optimized solution. The method has covered the time, speed and distance parameters to generate the route solution.

F)   Complexity Challenges

Travelling salesman problem is the complex problem defined without specification of polynomial time interval and provided the discovery to the solution without specification of considerable factors. The problem specific estimation and the relative optimized work solution was provided to generate the solution in memory and time effective measures. This problem comes under NP Complete problem so that the optimized solution will be obtained.

For a graph defined $G=(V,E)$ here V is the cities network and the E is the distance matrix between the cities. The weights can be positive or negative assigned to the path. The complexity of the solution is given by $O(VE)$.

IV. CONCLUSION

Travelling salesman problem is here identified as the challenging problem which requires the efforts to generate the optimized solution. The paper has formulated the problem under different variations. The problem formulation and the relative characterization is also provided in this paper.

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