International Journal of Advanced Technology in Engineering and Science
Vol. No.4, Issue No. 07, July 2016
www.ijates.com
ijates
ISSN 2348 - 7550

A SURVEY ON DIFFERENT METHODS TO SOLVE TRAVELLING SALESMAN PROBLEM

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ABSTRACT

Travelling salesman problem acts as an eminent combinatorial optimization problem .It belongs to the class of NP-Hard complexity problem and becomes an notable method of validating the correctness and feasibility of new algorithms.TSP finds its application in many areas like VLSI chip design, vehicle routing problem, gene sequencing, etc. Many algorithms have developed to solve the TSP. This paper presents the survey about the different approaches to solve TSP with an optimized cost value. With the survey, We find Branch and bound approach facilitates for solving TSP with the parallel computing mechanism and will give the results within a reasonable amount of time for large scale problem.

Keywords**: **Branch and bound, Travelling Salesman Problem, Parallel Computing

I. INTRODUCTION

Travelling Salesman Problem (TSP), in which salesman wants to find a shortest possible tour by visiting every city exactly once and returns back to the city from where he started. [1].Travelling salesman problem (TSP) finds its application in the areas like logistics, transportation, and semiconductor industries. few prospective applications of TSP includes finding an optimized scan chains route in integrated chip design and testing, transportation routing problem[2].TSP first expressed as a mathematical problem in 1930 and most aggravatingly studied problem in combinatorial optimization [3].It belongs to the class of NP-hard problem, which can't be solved by deterministic algorithm in polynomial time but can be verified in exponential time[4].Travelling salesman problem has different solution but requires to find the best optimal solution from available solution space search tree.

Two methods for solving TSP: *exact algorithm* and *approximate algorithm. Exact algorithms* fully search the complete solution space tree and obtain the global optimal solution i.e. it solves the problem towards optimality. E.g. branch-and-bound method, linear programming method, and dynamic programming method. Algorithm based on this approach has the exponential running time. *Approximate algorithm* provides solution as close as possible to the optimum value in a reasonable amount of time but it does not assure the optimal solution. E.g. greedy algorithm, genetic algorithms, simulated annealing algorithm, neural network algorithm and ant colony algorithm [5].

With the comparison of these two methods, exact algorithms have difficulty to transform for large scale problem because of exponential time complexity. Whereas approximate algorithms have advantages as simple methods,

small amount of calculation required .It opportune for medium scale problem but with the increased number of nodes it does not give the optimal solution in polynomial time.

To solve TSP in an acceptable time, it has the ways as to optimize the existing algorithm or to propose new algorithm and to improve hardware computing performance. But these are improbable to get qualitative innovation in a short time so it requires to find the other ways to solve TSP .The emergence of parallel computing mechanism brings hope to solve TSP in an acceptable amount of time.

This paper is organized as follows: In section II, We present overview of TSP. Section III, Literature survey of different methods to solve TSP. Section IV proposed work and last section presents the summary.

II. OVERVIEW OF TSP

Operations research and theoretical computer science addresses the TSP as a combinatorial optimization problem, used to find optimum route to travel through the given number of cities. It classified as Symmetric TSP (STSP), asymmetric TSP (ATSP). In STSP, the distance between cities same in both the direction this means it results in undirected graph. As in ATSP, the directed graph where distance between two cities differ in both the direction.

The notation of the TSP is as follows:

Complete graph G=(V,E) that has positive integer cost c(u,v) Where cities are represented as vertices and the distance (u,v) ϵ E , a set of undirected edges, **V**={u}($1 \leq u \leq n$) , a vertex set and to find a Hamiltonian cycle (a tour) of G with minimum cost [6].

Fig. 1 shows the complete graph of four nodes. Assume edges assigns with different x values. Fig 2 shows the graph as a Hamiltonian cycle, that cycle indicates the optimized cost(tour) which obtained by calculating the minimum cost required to visit all the vertex.

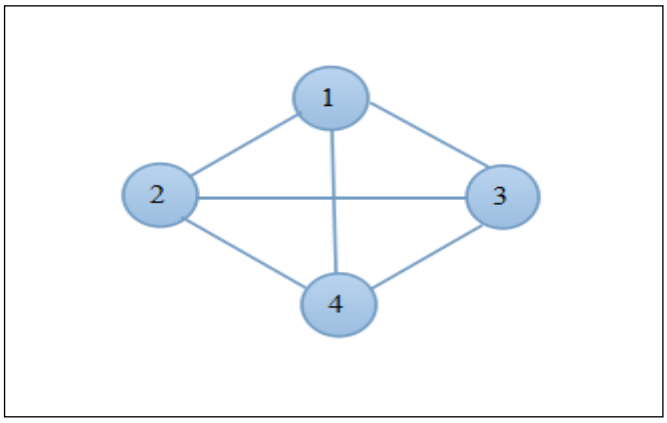

Fig. 1. A Complete Graph

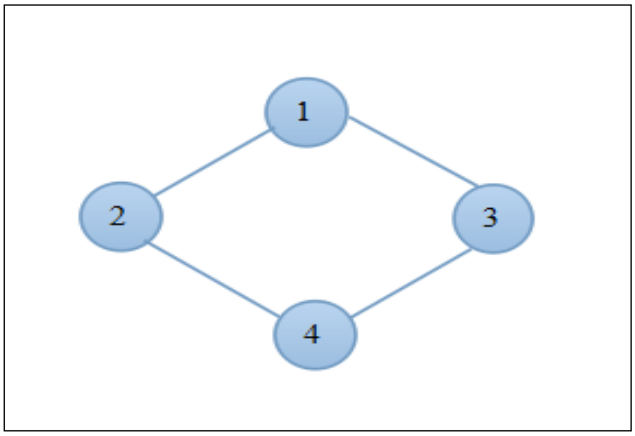

Fig. 2. Hamiltonian Cycle (Optimized Tour)

III. LITERATURE SURVEY

[7] The proposed work in this project uses branch and bound approach where code matrix to calculate the low bound value. In this method, each branch needs a matrix and the child nodes will use code matrix of its parents. These methods can improve the traditional algorithm and improve the speed of cutting branch. But these types of algorithms are more complexity and get affected by the performance of the hardware. If the hardware configuration is not high, algorithm speed up effect is not evident or the results cannot be obtained. On single core, it can improve the performance but as the number of nodes increases, the improved results are not obvious. The proposed work [8] introduces genetic algorithm which is created with the help of a neighborhood creation scheme for flowshop scheduling.

[9] In this paper an improved genetic algorithm is proposed where the new crossover operation, population reformulation operation, multi-mutation operation, partial local optimal mutation operation, and rearrangement operations are used to solve the Travelling Salesman Problem.

The work proposed in [10] and [11] paper solves the problem using parallel genetic algorithm. In [10] TSP is solved using genetic algorithm and it is parallelized using Hadoop Map/Reduce framework. Here three crossover methods are used such as Order Crossover, Two Point Crossover and Partially Matched Crossover.[11] The parallel genetic algorithm process the fitness evaluation phase in parallel so that time consumption is reduced and hence execution speed is increased. The Map/Reduce framework is also used to run the genetic algorithm in parallel so that it can handle the large scale data.

[3] In this paper the combination of genetic algorithm with dynamic programming uses for solving travelling salesman problem. In *CGADP*, the solutions obtained by genetic algorithm will be selected for applying a local search based on *DP*. The convergence rate of the solution found by *CGADP* is faster than that of *GA*. But with larger size problem, the running time is also increasing.

[12] This paper proposed to solve the problem of excessive memory usage, calculates the bound by simple estimation method. This method reduces the complexity of boundary calculation algorithm and it also saves memory space. But this algorithm just solves the time and space-consuming problem and it does not consider time increased exponentially due to the increasing scale of TSP.

With the survey of methods [13] in this, TSP solves using dynamic programming method found its correct and gives optimal solution with complexity O(n22n) ,but optimal solution obtained is not exact optimal solution, the use of heuristic as intermediate step to get the optimal solution using dynamic programming approach.

[14]Using approximation algorithm to solve large scale TSP generally includes the eliminating cross path improves the quality of solution. In this proposed work, develop a method to detect and dismantle cross paths, and thus propose a novel greedy algorithm-based approach to the TSP. The experimental result compared with other optimization algorithm shows the approximate solution to high quality and less computational cost.

A simulated annealing algorithm provably works better than the metropolis algorithm for any fixed temperature [15].Although the use of parallel computing approach can improve the efficiency of algorithm on dealing with large-scale TSP problem, these papers both refers to local optimal solution algorithm, e.g. genetic algorithms, simulated annealing algorithms. Even they can calculate the results quickly; the results are not globally optimal solution.

[1]In this proposed work TSP solved using Parallel branch and bound algorithm at multi-core platform Beehive. It finds the bound by limit method according to greedy algorithm and minimum of distance matrix. And on each core the algorithm eliminates the sub loop to avoid repetitive calculations, and reduce the time required to get the optimize solution. But due to limitation of timer in beehive multi-core platform, result cant shows the accurate search time for more than 15 cities. Due the small memory space of Beehive it solves for small scale problem.

IV. PROPOSED WORK

In the proposed work we will try to use parallel computing approach to realize branch and bound algorithm to solve the travelling salesman problem. Our main aim is to solve large scale Travelling Salesman Problem in polynomial time with optimized cost. Parallel computing mechanism will provide the result in polynomial time as TSP is NP-Hard problem. Branch and bound algorithm is suitable for distributed and parallel computing as it can be divided into independent sub-problems and can run that sub-problem parallel to get global optimal solution as it is an exact algorithm.

V. CONCLUSIONS

In this paper an overview of travelling salesman problem is discussed .The paper presents a glance of different approaches to solve TSP. With the survey of different methods for solving TSP problem, parallel branch and bound method of exact algorithm is found better workable to get accurate and efficient results.

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