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Analysis of Available Selection Techniques and Recommendation for Memetic Algorithm and its Application to TSP

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ABSTRACT: In this article, different types of selection techniques have considered for the study. The method of selecting the appropriate chromosome in the genetic algorithm is called selection operation. So, it can be a part of the matting cycle. The genetic and memetic algorithm is probabilistic and randomized. Both of these algorithms fall into the evolutionary algorithm group. These algorithms work on the principle of natural selection used by Charles Darwin. This algorithm can be applied to various problems of optimization, such as scheduling, routing, Travelling salesman problems, and combinatorial problems. Such two algorithms performance depends on their operators, such as selection techniques, crossover operators, mutation operators, and their probability rates. This research mainly focuses on studying and evaluating the selection techniques. Genetic algorithm is implemented for the combinatorial problem i.e process scheduling problem. In the extend research memetic algorithm can be implemented for other combinatorial problem i.e TSP. The computation time of the algorithm with respect to the selection techniques are analyzed. Compared to the existing selection operator, steady state selection technique shows better results.

Keywords: Genetic algorithm, Memetic algorithm, Crossover, Mutation, Selection operator, NP-Hard.

I. INTRODUCTION

Many combinatorial optimization problems are being studied over the past two decades, which include real - world manufacturing problem or market environment issues. Exact algorithms are available for some problems to get the optimum solution. But many problemscome in the category of NP-Hard [7]. Exact algorithm approach takes a huge amount of computation cost to obtain the optimal solution [36]. It is impractical to get solution by spending large computational time. When problem size increase then exact algorithm's time complexity increases in exponential order. To tackle this type of problem stochastic or heuristic algorithm comes into the practice with compromise on solution optimality Heuristic algorithms are normally applied to the problem when exact algorithm is computationally expensive to provide the optimal solution in polynomial time. Stochastic (approximation) and Heuristic algorithms are problem specific; they have less robustness with respect to the combinatorial problem such as travelling salesman problem (TSP). So to tackle this type of problem meta-heuristic approach is best option. A metaheuristic is guided heuristic algorithm which intelligently use the concept of exploitation and exploration to search the large space and learning adaptability guide the heuristic to find the near optimal solution [13].

Genetic Algorithm: Genetic algorithm (GA) is metaheuristic global search algorithm .GA is inspired by Darwin's theory of survival of fittest and natural selection. It was first invented by Prof. Holland [16] and its students in 1975. GA is a deal with the population individual in the evolution process. In the iterative evolution process new population of individual is generated by the application of selection, crossover and mutation operators. The GA flowchart is shown at Fig. 1. GA has been used broadly in combinatorial problem optimization such as travelling salesman problem.

Following are the steps used in the Genetic Algorithm
Step 1: Generate an initial population of individual
Step2: While stopping criteria not met repeat the following steps
Step 3: Select the best individuals for making matting pool
Step6: Appling crossover operation with a certain crossover probability P_c to create offspring.
Step7: Appling mutation operation certain crossover probability P_m. **Step9:** Replacement **Stop10:** End

Memetic Algorithm: Memetic algorithms are also population-based metaheuristic search algorithm. This algorithm is a combination of evolutionary algorithm and local search algorithm. Basically, MA is advance version of Genetic algorithms (GA). The concept of meme is borrowed from the philosophy and is expressed as cultural transmission unit [30]. The name Memetic Algorithm (MA) is devised by Pablo Moscato [27] but as always, the same idea was also given under the name of Baldwinian GA [20] , local searchers [24] , Hybrid GA [15], Lamarckian GA [31], others MAs consist of the concept of combining global and local search algorithms [30, 42, 45]. Memetic Algorithm can be used to solve combinatorial problem (Such as TSP , Scheduling problem etc.) The working of the memetic algorithm is same as in genetic algorithm except local search, which help the algorithm to converge toward global maxima. The MA flowchart is shown at Fig. 2.

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Step8: Perform local search Step9: Replacement Stop10: End

II. LITERATURESURVEY

The researcher presents the result in the paper and explains that MA can be successfully applied to the combinatorial optimization problem. i.e TSP. There is a need for an empirical study to optimize the local search used in the memetic algorithm for the TSP problem. How we can reduce the computation time in the local search [35].
The author provides the details knowledge of metaheuristics and their application to combinatorial problems. Metaheuristics are robust powerful approaches that have been applied to difficult combinatorial problems. Before applying to any 5problem its characteristic must be known[13].
The Researcher illustrates the theoretical and practical relevance of Memetic algorithm and their design issue. Different design issues are present when we implement the Memetic algorithm [19].
Metaheuristic with hybridizing approach is the best way to improve the method which is applying to solve the problem. The optimal parameter setting of the hybridization is not known. When hybridization techniques are applied. So the data mining techniques help to set the parameters. Further improvement is required [17].
The researcher in the present paper combines the evolutionary algorithm with local search and clustering process. The proposed algorithm shows better results. The computational time can be reduced by applying the clustering technique [23].
The researcher presents Two-Level Genetic Algorithm for Clustered Traveling Salesman. Which favors neither intra-cluster paths nor inter-cluster paths. The experimental results show that clustering TLGA for the large scale TSPs is more effective and efficient than that of traditional classic genetic algorithm [11].
Author present the Road transport travelling salesman problem. He solve the problem by using the bacterial evolutionary algorithm. In the present paper researcher explain with road transport travelling salesman problem that it has practical application. A novel construction and formulation of the problem is presented. Simulation result shows better results. Further the results can be improved by apply the hybrid evolutionary algorithm [12].
In the present paper Intelligent Transportation Systems, Traveling Salesman Problem (ITS-TSP) is described. The proposed algorithm is to deal with transportation problems. The proposed heuristic algorithm provides the best solution. Further, this algorithm can be improved for the route prediction[25].
The author presents the survey report of Machine learning and its applicability to the Evolutionary algorithm. This report provides the research direction that how to improve the evolutionary algorithm and its different elements, such as initialization of population, evaluation of the fitness of solution, selection operation, local search, and reproduction process.
The funding of the researcher of this paper shows that the Memetic algorithm is developed by using tabu search techniques. It shows better results with respect to the TSPHS. The gap that we found in this paper is that we can use other local search techniques which may give better results. The present research use 1000 customer. We do not know what will be the result of n number of customers with respect to the tabu search [8].
The researcher works on the 11 different TSP problems and concludes that the component property of the local search techniques change with respect to the problem under consideration. The results of the present paper show that the properties of the local search change with respect to the problem. So there is scope to design a new local search technique that will adapt itself [38].
The researcher in the paper present uses two different local search techniques that are applied together. The new techniques better results with respect to the traditional GA. The computational complexity of the proposed algorithm increases with the increase in problem size. There is scope to work in this area to reduce the computation complexity of the algorithm [40].
The researcher uses new techniques to apply the different operators. Also, the result shows that multiple uses of the operators are better as compared to the single operator. The researcher applies the different operators, but the probability crossover i.e. Pc and Mutation i.e Pm is not clear [10].
The researcher uses new techniques of self-adaptive multi-mems. Hybridize the algorithm with a hill-climbing technique. The result shows that self-adaptive self-configuration is better than a static memetic algorithm. The Computational Complexity of the existing algorithm is high [33].
The author implements the improved genetic algorithm with a local search technique on the android platform. The result shows that the improved algorithm show better results as compared to the simple GA. The researcher use a very small instance of 20 cites. It is not clear when the size of the problem increases, what we will be the performance of the algorithm [29].
The experimental results show in this paper is better. Researchers only use mutation operators to get the best results. Only mutation operator is used to get the high-quality solution for the TSP. The crossover probability is 0%. Which means, it is not applied? [4].
The researcher in the paper applies the evolutionary algorithm i.e GA for finding the shortest optimal route for Istanbul Electricity Team. The proposed algorithm provide the optimal route for the IETT audit Team. The result can further improve by applying local search techniques[14].
The researcher uses a variable population-based algorithm. It uses 13 instances an out of which 42 popular problems. The exploration power of the algorithm increase with an increase in the population size. After analyzing the results of this paper. It has a scope to apply to TSP. Which is a combinatorial problem? [43].

In the present paper, new permutation rules and GA is proposed to solve the TSP. The proposed algorithm shows better results with respect to the TSP. Improved in the present algorithm can be made by apply local search approach [18, 6]

The researcher of this paper uses the route based crossover operator, random greedy, and variable neighborhood technique. The results are better. The researcher uses six different operators. This research can be extended by using more operators with different ways of applicability [2, 22].

III. RESULTS AND DISCUSSION

Experimental Study has been carried out in the simulation environment. Six selection techniques have been implemented for the combinatorial problem. i.e. process scheduling problem. The parameter setting is considered for the experiment is given in Table 1. We have taken the crossover rate as 1 and the mutation rate as 0.5. Population type is generational. The results are displayed in Table 2 and are compared. The graphic representation of the analysis appears in Figs. 1, 2, 3. Which shows SSS is better with respect to the available selection techniques.

Table 1: Parameter Setting of Genetic Algorithm with Execution Time as a Fitness Functions for all Selection techniques.

Parameter/Strategy	Setting
Population Size	100
Population Type	Generational
Initialization	Random
Selection techniques	RLWS , TMS , SSS , RS , RWS , MRS
Mutation operator	Inversion Mutation
Crossover Operator	Order Crossover
Crossover Probability Pc	1.0
Mutation Probability Pm	0.5
Replacement strategy	Keep 85 % Best
Stopping Strategy	85 % Population convergence
No. of process to be Schedule	15
Fitness Function	Execution Time

Table 2: Comparison of RLWS, TMS, SSS,RS, RWS and MRS Selection techniques w.r.t. Execution time.

Data set No.	RLWS	TMS	SSS	RS	RWS	MRS
1	5	5	5	5	8	5
2	5	5	4	5	8	5
3	4	5	5	5	8	5
4	5	5	4	4	7	5
5	5	5	4	5	18	5
6	4	5	5	5	29	5
7	5	5	4	5	13	5
8	5	5	5	5	13	4
9	5	5	4	5	13	5
10	4	5	5	4	11	5
Sum	47	50	45	48	128	49
Mean	4.7	5	**4.5**	4.8	12.8	4.9

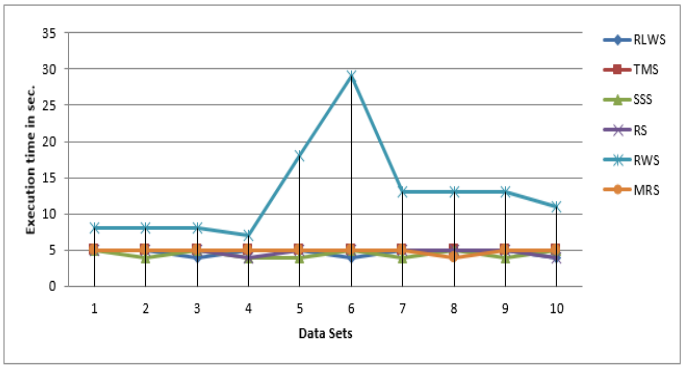

Fig. 1. Comparison of Proposed Selection techniques with the Traditional Selection operators with Execution time as a Fitness Function.

Fig. 2. Comparison of Proposed Selection techniques with the Traditional Selection operators with Total Fitness values.

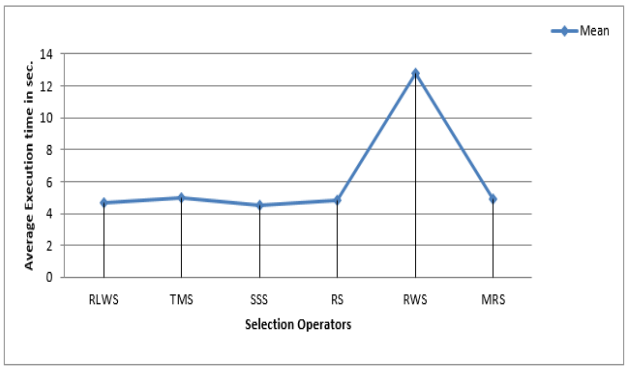

Fig. 3. Comparison of Proposed Selection techniques with the Traditional Selection operators with Average fitness values.

IV. CONCLUSION

The selection techniques are the first operation applied to start the evolution process of the genetic and memetic algorithm. When we implement evolutionary algorithm, ie. GA and MA, to choose the right selection technique is the main issue. Because the convergence time of the algorithm directly depends upon the selection techniques. In the present research, we have compared the available selection techniques. The experimental results show that the steady-state selection technique shows better results for the scheduling problem. Under the given parameter setting SSS techniques bases, GA takes minimum computation time i.e 4.5s to provide the best results.

V. FUTURE SCOPE

GA has been implemented with the available selection techniques. Further, this work can be extended by apply selection techniques in memetic algorithm under TSP. It is a matter of research on which selection techniques are better for the memetic algorithm and how it affects the performance of the algorithm. When it applied to the combinatorial problems i.e Travelling salesman problems.

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Conflict of Interest. There is no conflict of interest, according to the authors. This work is being done at Uttaranchal University, Dehradun, India.

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