International Journal of Engineering Sciences & Emerging Technologies, Nov., 2015.
ISSN: 22316604 Volume 8, Issue 3, pp: 96-103 ©IJESET

COMPARATIVE STUDY ON VARIOUS SELECTION METHODS IN GENETIC ALGORITHM

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ABSTRACT

In the field of artificial intelligence, a genetic algorithm (GA) is a search heuristic. Genetic algorithm mimics the process of natural selection. This heuristic (also sometimes called a metaheuristic) is routinely used to generate useful solutions to optimization and also used for search problems. Genetic algorithms belong to the larger class of evolutionary algorithms (EA). Genetic algorithm generate solutions to optimization problems using techniques inspired by natural evolution, such as inheritance, mutation, selection, and crossover. In this paper various selection methods has been described like roulette wheel selection, rank selection, tournament selection, steady state selection, Boltzmann selection and elitism selection. So in this paper comprehensive overview of research in various selection methods in genetic algorithm is presented.

KEYWORDS: *Genetic Algorithm, Selection Method*

I. INTRODUCTION

Basic genetic algorithm (GA) is generally composed of two processes. The first process is selection of individuals for the production of the next generation and the second process is manipulation of the selected individuals to form the next generation by crossover and mutation techniques. The selection mechanism determines which individuals are chosen for mating (reproduction) and how many offspring each selected individual produces. The main principle of selection strategy is "the better is an individual; the higher is its chance of being parent." Generally, crossover and mutation explore the search space, whereas selection reduces the search area within the population by discarding poor solutions.

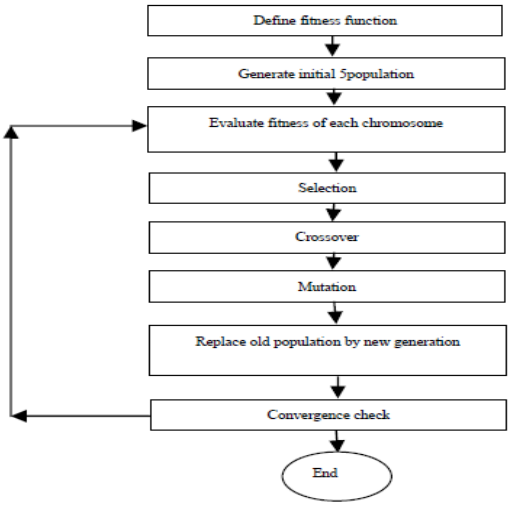


Figure 1. Basic Flowchart of genetic algorithm

However, worst individuals should not be discarded and they have some chances to be selected because it may lead to useful genetic material. A good search technique must find a good trade-off between exploration and exploitation in order to find a global optimum [13]. Hence, it is important to find a balance between exploration (i.e. poor solutions must have chance to go to the next generation) and exploitation (i.e. good solutions go to the next generation more frequently than poor solutions) within the mechanism of the selection. The different selection strategy used in the GA process will significantly affect the performance of the algorithm differently. This study is intended to examine the performance of GA when using different selection strategy.
In this paper, the other sections are organized as follows. Section II described related work. Section III explains different methods. Section IV contains results.

II. RELATED WORK

Anshul Sharma, Anuj Mehta [3], proposed a number of selection method of genetic algorithm and described various selection methods. Poonam Sharma, Amit Wadhwa, Komal [4], proposed comparative analysis of selection schemes for solving an optimization problem in genetic algorithm and evaluates their performance.
Omar Al Jadaan, Lakishmi Rajamani, C. R. Rao [5], proposed modification of roulette wheel selection method to increase the gain of resources, reliability and diversity and decrease the uncertainty in selection process. Shalini Singh, Ejaz Aslam lodhi [8], proposed variation in travelling salesmen problem using genetic algorithm technique and compare the operator of pursued approach which give the best result for finding the shortest path in a shortest time for moving toward the goal. They obtained the optimal distance with the tour length in a more effective way.
Rakesh kumar, jyotishree [10], proposed compared two selection method blending roulette wheel selection and rank selection with different problem size. Xunbo shuai, Xiangguang Zhou [11], proposed two genetic operators dual operator and inverse operator for nonlinear optimization problems.

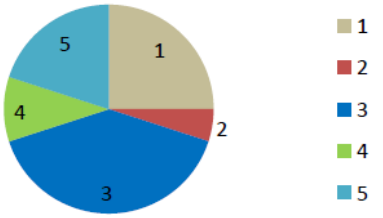
III. METHODOLOGY

The objective of GA is to find an optimal solution to a problem. Since GA is heuristic procedures, they are not guaranteed to find the optimum, but experience has shown that they are able to find very good solutions for a wide range of problems. In this paper focus is given on selection phase of GA. In selection operator individual are selected according to their fitness and chooses those chromosomes in the population that will be allowed to reproduce, and on average the fitter chromosomes produce more offspring than the less fit ones. A number of selection method has been described like roulette wheel selection, rank selection, tournament selection, steady state selection, Boltzmann selection. Types of selection method are:

a. Roulette Wheel Selection
b. Rank Selection
c. Tournament Selection
d. Steady State Selection
e. Boltzmann Selection
f. Elitism Selection

3.1 Roulette Wheel Selection:

In roulette wheel, individuals are selected with a probability that is directly proportional to their fitness values i.e. an individual's selection corresponds to a portion of a roulette wheel. The probabilities of selecting a parent can be seen as spinning a roulette wheel with the size of the segment for each parent being proportional to its fitness.



Population	Fitness
1	25.0
2	5.0
3	40.0
4	10.0
5	20.0

Fig 2 - Roulette Wheel Selection

3.2 Rank Selection:

In Linear Rank selection, individuals are assigned subjective fitness based on the rank within the population. The individuals in the population are sorted from best to worst according to their fitness values. Each individual in the population is assigned a numerical rank based on fitness, and selection is based on this ranking rather than differences in fitness.

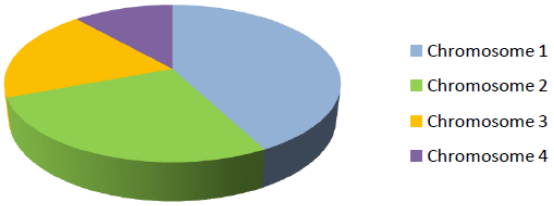


Fig 3 - Rank Selection

3.3 Tournament Selection:

Tournament selection provides selection pressure by holding a tournament among s competitors, with s being the tournament size. The winner of the tournament is the individual with the highest fitness of the s tournament competitors. The winner is then inserted into the mating pool. The mating pool, being comprised of tournament winners, has a higher average fitness than the average population fitness. This fitness difference provides the selection pressure, which drives the GA to improve the fitness of each succeeding generation. Increased selection pressure can be provided by simply increasing the tournament size s, as the winner from a larger tournament will, on average, have a higher fitness than the winner of a smaller tournament.

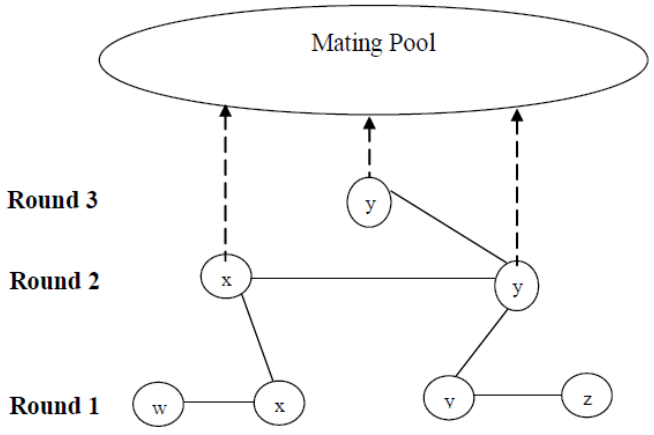


Fig 4 - Tournament Selection

3.4 Steady State Selection:

Main idea of steady state selection is that big part of chromosomes should survive to next generation. In every generations are selected a few (good - with high fitness) chromosomes for creating a new

offspring. Then some (bad - with low fitness) chromosomes are removed and the new offspring is placed in their place. The rest of population survives to new generation.

3.5 Boltzmann selection:

In Boltzmann selection a continuously varying temperature controls the rate of selection according to a preset schedule. The temperature starts out high, which means the selection pressure is low. The temperature is gradually lowered, which gradually increases the selection pressure, thereby allowing the GA to narrow in more closely to the best part of the search space while maintaining the appropriate degree of diversity.

3.6 Elitism Selection:

Elitism is a kind of selection in which the best individual passed to the next generation as such without any modification. Elitism prevents the best individual to undergo the reproduction process so as to pass them without any modification into next generation. [3]

Genetic algorithm is a population based an adaptive search and optimizations techniques and genetic mimic the natural evolution process. The Genetic operators include selection, crossover and mutation. The aim to present this paper is it gives comparative selection strategies for solving an optimization problem in genetic algorithm and evaluates their performance. A number of selection method has been used like roulette wheel selection, rank selection, tournament selection, Elitism selection. [4]

Selection operator is one of the important aspects in the GA process. There are several ways for selection. Some of them are Tournament selection, Ranking selection, and Proportional selection. There are many ways for proportional selection. The most popular are Roulette Wheel Selection (RWS), Stochastic Reminder Roulette Wheel Selection (SRRWS), and Stochastic Universal Sampling (SUS). In this paper a modified RWS method is proposed to increase the gain of resources, reliability and diversity; and decrease the uncertainty in selection process. [5]

The Purpose of this Paper is to give near optimal solution in terms of quality and computation time. By implementing Genetic Optimization Technique, the effectiveness of the path has been evaluated in terms of fitness function with the parameter such as tour length. Different variation in traveling salesmen problem using Genetic Algorithm Technique. Considering the Limitation of Nearest Neighbor we find that the number of iteration and resulting time complexity can be minimized by using Genetic approach. Also compare the operator of pursued approach which give the best result for finding the shortest path in a shortest time for moving toward the goal. Thus the optimal distance with the tour length is obtained in a more effective way. [8]

Both exploration and exploitation are the techniques employed normally by all the optimization techniques. In genetic algorithms, the roulette wheel selection operator has essence of exploitation while rank selection is influenced by exploration. In this paper, a blend of these two selection operators is proposed that is a perfect mix of both i.e. exploration and exploitation. The blended selection operator is more exploratory in nature in initial iterations and with the passage of time, it gradually shifts towards exploitation. The proposed solution is implemented in MATLAB using travelling salesman problem and the results were compared with roulette wheel selection and rank selection with different problem sizes. [10]

Dual operator and inverse operator are defined as two new genetic operators respectively in this paper. Then a genetic algorithm based on inverse and dual combination operator was designed to overcome the defect of genetic algorithm in local searching, which combined with uniform crossover. The genetic algorithm is proved to be convergent. [11]

IV. RESULT

In Roulette wheel, all the chromosomes in the population are placed on the roulette wheel according to their fitness value. The virtual roulette wheel is spinned. The process is repeated until the desired number of individuals is selected. Individuals with higher fitness have more probability of selection. Rank selection ranks the population and every chromosome receives fitness from the ranking. It results in slow convergence but prevents too quick convergence. In tournament selection winner of the tournament is the individual with the highest fitness of the s tournament competitors. The winner is then inserted into the mating pool. In steady state selection some good chromosomes are selected

and bad chromosomes are removed. Boltzmann selection controls the rate of selection by varying temperature. The result shows that the genetic algorithm with elitism provides more optimal solution and has better convergence speed than the simple genetic algorithm. All of these selection mechanisms have the same purpose of creating more copies of the individuals with higher fitness than those with lower fitness. However the selection mechanisms differ in the manner in which they allocate copies to the fittest individuals. A selection method has the higher selection measure than the other if it makes more copies of the best individuals thereby eliminating low fit individuals rapidly. A strong selection mechanism reaches equilibrium faster than a weaker method. [3]

Poonam Sharma, Amit Wadhwa, Koma[4] proposed Analysis of schemes for solving an optimization problem in genetic algorithm. Experimental result shown in The table 1 shows the chromosome id and their fitness value(x) and after that it shows the graph for chromosome .After applying 10 generation the table 2 show the best result for selection.[4]

Table 1. Chromosome id & fitness value

Chromosome id	Fitness Value
1	1.210
2	0.360
3	3.610
4	2.560
5	0.250
6	5.760
7	4.410
8	2.890
9	5.289
10	0.640
11	1.690

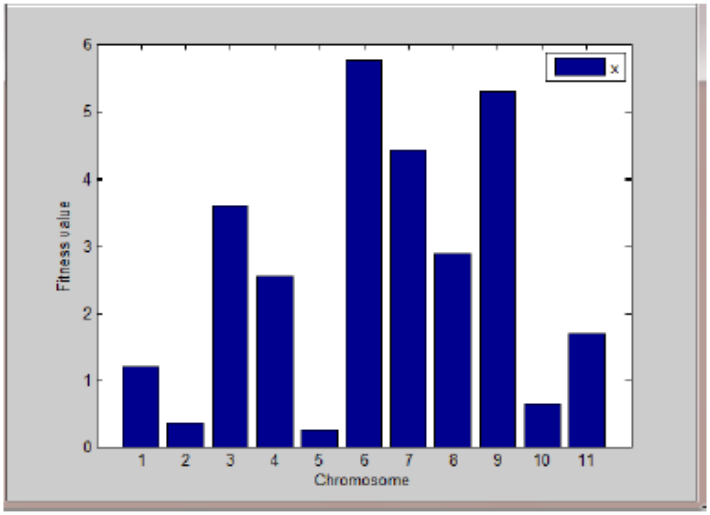


Fig 5: Graph for chromosome

Table 2. After applying 10 generation

Selection	Crossover	After 10 generation
Roulette wheel	One point	1.702
Roulette wheel	Two point	2.077
Tournament	One point	1.820
Tournament	Two point	1.860
Stochastic Uniform	One point	1.467
Stochastic Uniform	Two point	1.867

In Roulette wheel selection the area covered by the entire chromosome in a population as per the fitness value. Now this process is repeated until the desired number of individual is selected. In rank selection first of all rank the population and after that from the ranking every genes receives the fitness. In Tournament Selection We select best fitness values with winner of each tournament. When the tournament size is changed we can easily adjusted selection pressure. In elitism selection we can copy the first best chromosomes or the few best chromosomes to the new population. Hence we achieve best result when applying roulette wheel selection with two point crossover and tournament selection with one point crossover. [4]

Roulette wheel selection is easy to implement and mimics nature more faithfully and therefore is much more appealing. But it is slower than the ranked based roulette wheel selection in convergence to near the optimum solution. If good solution is discovered early, its fitness value dominates other fitness values. Then it will occupy majority portions of the mating pool. This will reduce the diversity in the mating pool and cause the GAs to converge to wrong solutions. Ranked roulette wheel selection overcomes this problem and increases the diversity. By using RRWS the GA becomes steadier and faster towards the optimum solutions than RWS. RRWS is outperforming the conventional RWS in convergence, time, reliability, certainty, and more robustness. GA can help find very good solutions to difficult real-world problems. [5]

The Purpose of this Paper is to give near optimal solution in terms of quality and computation time. By implementing Genetic Optimization Technique, the effectiveness of the path has been evaluated in terms of fitness function with the parameter such as tour length. In this research work, we see different variation in travelling salesmen problem using Genetic Algorithm Technique. Considering the Limitation of Nearest Neighbour we find that the number of iteration and resulting time complexity can be minimized by using Genetic approach. We also compare the operator of pursued approach which give the best result for finding the shortest path in a shortest time for moving toward the goal. Thus the optimal distance with the tour length is obtained in a more effective way[8].

A blended selection operator - PBS is proposed having balanced trade-off between exploration and exploitation. The performance of PBS selection operator is compared with RS and RWS technique on standard TSP problem. RWS performed like nature selecting the most fit individuals. RS did more of exploration and maintained diversity in population. PBS had both the features and outperformed the other two techniques. Its performance was dependent on the current number of generation. In early generations, there is less pressure on selection, so it had exploratory nature. As the number of generation increased, selection pressure also increased and exploratory nature gradually turned into exploiting nature. It is evident from above results that performance of PBS is superior over than that of RS and RWS. [10]

The dual and inverse combination operator can effectively improve local searching performance of genetic algorithm. Combined with uniform crossover operator with greater probability can solve the conflict between global searching and local searching. The RAGA has strong local searching performance and better searching performance. However, compared with standard genetic algorithm, the algorithm's running time is slightly longer, which is the spirit of "no free lunch" theorem [12].
Simulation results show that the algorithm can be applied in the nonlinear complex optimization problems whose genome can reverse. The probability of uniform crossover operator can dynamically adjust based on specific questions and the intensity of local searching. [11]

V. CONCLUSION

According to study, we find out that combination of good selection operator and crossover operator provides best solution.

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