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A Comparative Analysis of Genetic Algorithm Selection Techniques

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Abstract - *The focus of this paper is towards analyzing the performance of various selection methods in Genetic algorithm. There exist different selection methods that play a significant role in genetic algorithm performance. Some selection methods are taken into consideration. Objective of this paper is to extracting a comparative analysis of the different selection methods.*

Key Words: **Fitness number, Genetic Algorithm, GA operators, Selection Techniques**.

1.INTRODUCTION

Now a days, Genetic algorithms are broadly used in optimisation problems. With the help of these algorithms a good alternative can be found in such problem areas where the number of constraints is too large for humans to evaluate efficiently. Genetic algorithms (GAs) were invented by John Holland in the 1960s and colleagues at the University of Michigan in the 1960s and the 1970s. His actual aim is to study the phenomenon adapted by the nature for further reproduction system not to design the Genetic algorithms. So that, nature adaption method can be used in computer system to find their offspring. [4]

2. GA OPERATORS

A genetic algorithm involves three types of operators: selection, crossover (single point), and mutation.

2.1 Selection

This operator selects chromosomes in the population for reproduction. The better the chromosome means with more fitness number, having more chances to be selected to reproduce.

2.2 Crossover

This operator randomly chooses a locus and exchanges the sub sequences before and after that locus between two chromosomes to create two offspring. For example, the strings 10000100 and 11111111 could be crossed over after the third locus in each to produce the two offspring 10011111 and 11100100. Mostly the crossover is same as biological recombination between two single–chromosome (haploid) organisms.

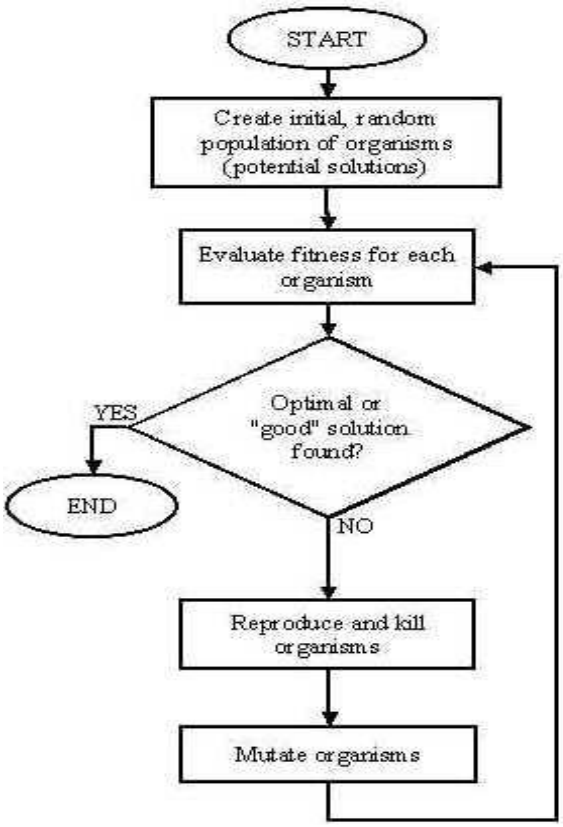


Fig.1.1

2.3 Mutation

This operator randomly flips some of the bits in a chromosome. For example, the string 0000 might be mutated in its first position to yield 1000.

3. SELECTION

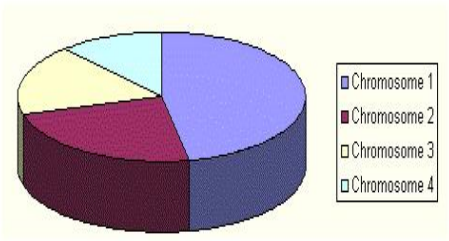
The operation selection is used to choose a list of individuals for reproduction, the so-called mating pool from a list of solution candidates. Selection may behave in a deterministic or in a randomized manner, according to its application- dependent implémentation.

There exist two classes of selection algorithms: with replacement and without replacement. In a selection algorithm without replacement, each individual from the

input list is taken into consideration for reproduction at most once.

3.1 Roulette Wheel Selection

In this selection method, parents are selected according to their fitness number. The better the chromosomes are, the more chances to be selected. The chromosomes in the population are placed in a roulette wheel; every chromosome has its place as large according to their fitness number, as shown in the Fig 3.1



Then a marble is thrown there and selects the chromosome. Chromosome with bigger fitness will be selected more times.

Fig: 3.1 Roulette Wheel Selection [5]

Then a marble is thrown on the Roulette wheel and selects the chromosome. There are more chances of chromosome with bigger fitness will be selected more times as they have larger space. This can be simulated by following algorithm.

1. [Sum] Calculate sum of all chromosome fitness in population - sum S.
2. [Select] Generate random number from interval (0, S) - r.
3. [Loop] Go through the population and sum fitness from 0 - sum s. When the sum s is greater than r, stop and return the chromosome where you are.

Step 1 is performed only once for each population.
This selection will have problems when the fitness differs very much. For example, if the best chromosome fitness is 90% of the entire roulette wheel then the other chromosomes will have very few chances to be selected.

Advantage:
The chromosome having more fitness number have more chance to become as parent, because it occupies the more space. Always better chromosome will become the parent.

Disadvantage:
But it is not fair because worst will never become the parent.

3.2 Rank Selection

In Rank selection first ranking are given to the population and then every chromosome receives fitness from this ranking. The worst will have fitness 1, second worst 2 etc. and the best will have fitness N (number of chromosomes in population). Following picture shows how the situation changes after changing fitness to order number. [5]

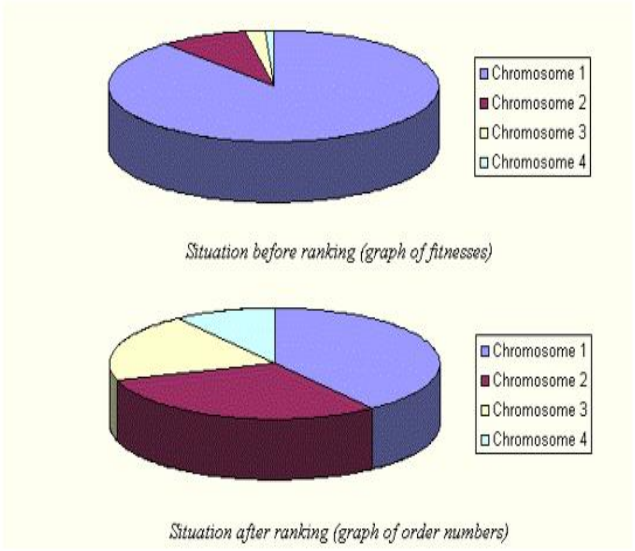


Fig: 3.2 Situation before ranking (graph of fitness)
Situation after ranking (graph of order numbers) [5]

Advantage:

In this selection method, all the chromosomes have a chance to be selected. It preserves the diversity also.

Disadvantage:

This method can lead to slower convergence, because the best chromosomes do not differ so much from others. Computationally expensive as a sorting is also required.

3.3 Tournament Selection

The fitness–proportionate methods described above require two passes through the population at each Generation -one pass to compute the mean fitness (and, for sigma scaling, the standard deviation) and one pass to compute the expected value of each individual. Rank scaling requires sorting the entire population by rank—a potentially time–consuming procedure. Tournament selection is similar to rank selection in terms of selection pressure, but it is computationally more efficient and more amenable to parallel implementation. [4]

Two individuals are chosen at random from the population. A random number r is then chosen between 0 and 1. If r < k (where k is a parameter, for example 0.75), the fitter of the two individuals is selected to be a parent; otherwise the less fit individual is selected. The two are then returned to the original population and can be selected again. An analysis of this method was presented by Goldberg and Deb (1991).

Binary Tournament:

It will take two chromosomes and according to their fitness function it will choose the best of them, and ignore the second one.

Triple Tournament:

It will replace the worst two chromosomes between three chromosomes by the chromosome with the highest fitness value.[3]

Advantage:
It can be implemented efficiently as no sorting of the population is not required.

Disadvantage:
Weak individuals have a smaller chance to be selected if tournament size is large. [1]

3.4 Elitism

In this method, each individual is assigned a fitness value via the fitness function. Using these scores, a percentage of the best, most fit individuals are used as parents. To start, the first numParents numbers of individuals from the population are chosen as the parents. Then, each member of the population after that is compared one by one to each of the parents. If a member of the population is found to be more fit than an existing parent, that parent is swapped out with that member. This continues until all the members have been compared against the existing parents. Then the original members of the population that were initially selected as parents are compared to the current set of parents to ensure that the fittest individuals are chosen as parents and a more fit individual was not replaced prematurely. [2]

3.5 Steady-State Selection

This is not particular method of selecting parents. Main idea of this selection is that big part of chromosomes should survive to next generation. GA then works in a following way. In every generation 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.

4. COMPARATIVE ANALYSIS

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.

5. CONCLUSION

The present paper was directed towards analyzing the pros and cons of various selection methods for Genetic algorithm. Observations provided an analytic insight of the algorithm

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