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Study of various selection operators in Genetic Algorithm

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ABSTRACT

Genetic Algorithm is the best search and optimization technique which is based on Darwin's principle which focuses on Survival of the Fittest. It is a nature inspired algorithm. There are various methods used in Genetic process. The objective of this paper is to focus on only the selection method of Genetic Algorithm. This paper focuses on the benefits in terms of the quality of the solution and its accurate response towards the problem. The strength and quality of the solution always depends on the choice of the selection process. The main purpose of this study is to compare the different selection processes to balance the genetic diversity and the selective pressure.

Keywords: Genetic Algorithm, Selection, Roulette wheel, Tournament selection, Selection pressure, Genetic Diversity

I. INTRODUCTION

The Genetic Algorithm (GA) was developed by John Holland in 1960 and published a book called, "Adaptation in Natural and Artificial Systems ", in 1975.Initially, his objective was to model the adaptation process and to define how those processes are used in computing systems [1]. The GAs are stochastic search methods using the concepts of Mendelian genetics and Darwinian evolution. This method solves a variety of problems in many application domains such as economics, engineering, manufacturing, medicine, bio-informatics, computational sciences etc. In Genetic Algorithm, solving problems mean looking for solutions, which is best among others. Optimization is a process that finds a best solution for a problem [2]. There are three main centered factors for optimization problem are,

1) Objective Function: Which is either minimize or maximize,

2) Set of Unknowns or variables that affects the objective functions and

3) Set of Constrains that allows the unknowns to take on certain values but exclude others .

In principle, a population of individuals selected from the search space, often in a random manner, serves as candidate solutions to optimize the problem. The individuals in this population are evaluated through a fitness

function [3]. A selection mechanism is then used to select individuals to be used as parents to those of the next generation. These individuals will then be crossed and mutated to form the new offspring. The next generation is finally formed by an alternative mechanism between parents and their offspring. This process is repeated until it achieves to a best optimal solution.

II. SELECTION OPERATOR

The process that determines which solutions are to be preserved and allowed to reproduce and which ones deserve to die out [4]. The primary objective of the selection operator is to emphasize the good solutions and eliminate the bad solutions in a population while keeping the population size constant. "Selects the best, discards the rest".The functions of Selection operator are,

1. Identify the good solutions in a population
2. Make multiple copies of the good solutions
3. Eliminate bad solutions from the population so that multiple copies of good solutions can be placed in the population [5].

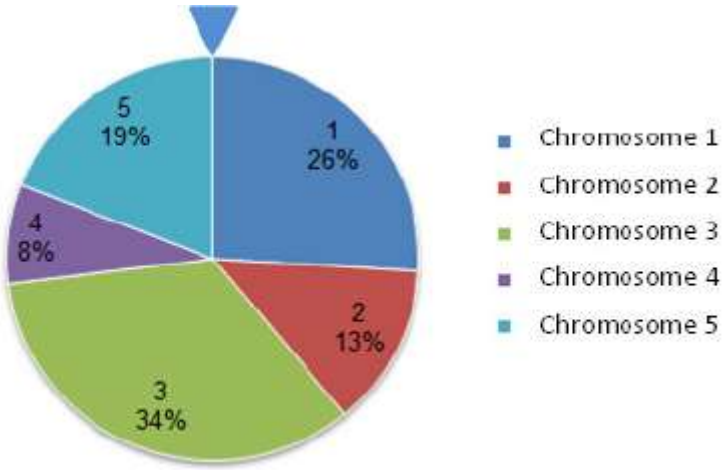
To identify the good solution, fitness function should be found. A fitness value can be assigned to evaluate the solutions. A fitness function value quantifies the optimality of a solution. The value is used to rank a particular solution against all the other solutions. A fitness value is assigned to each solution depending on how close it is actually to the optimal solution of the problem [6].

There are different techniques to implement selection in Genetic Algorithms [7]. They are:

1. Roulette wheel selection
2. Tournament selection
3. Rank selection
4. Proportionate selection
5. Steady State Selection
6. Boltzmann Selection
7. Stochastic Universal Sampling
8. Linear Rank Selection
9. Exponential Rank Selection
10. Truncation Selection.

III. ROULETTE WHEEL SELECTION

Roulette wheel is the simplest selection approach. In this method all the chromosomes or the individuals in the population are placed on the roulette wheel according to their fitness value [8]. Each individual is assigned a segment of roulette wheel. The size of each segment in the roulette wheel is proportional to the value of the fitness of the individual - the bigger the value is, the larger the segment is. Then, the virtual roulette wheel is spinned. The individual corresponding to the segment on which roulette wheel stops are then selected. The process is repeated until the desired number of individuals is selected [9]. Individuals with higher fitness have more probability of selection. This may lead to biased selection towards high fitness individuals. It can also possibly miss the best individuals of a population. There is no guarantee that good individuals will find their way into next generation. Roulette wheel selection uses exploitation technique in its approach. Roulette Wheel Selection is the easiest and simplest method to implement and consumes the least amount of time. However it suffers from problem of premature convergence which results in finding a solution which is locally optimum [10].

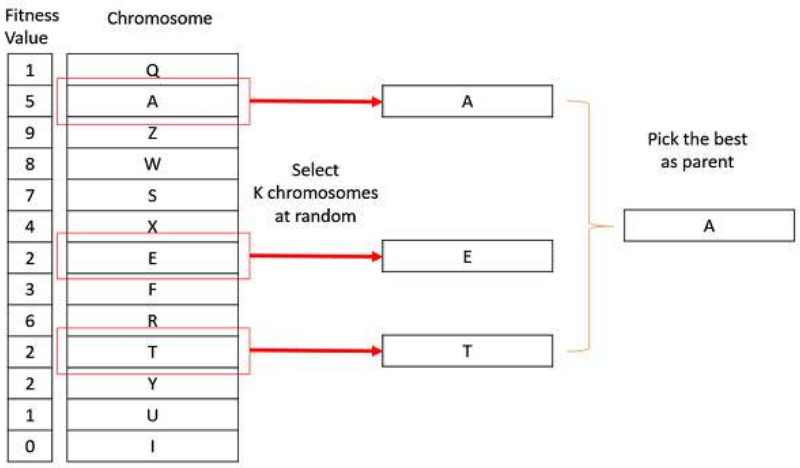


It is clear that a fitter individual has a greater pie on the wheel and therefore a greater chance of landing in front of the fixed point when the wheel is rotated. Therefore, the probability of choosing an individual depends directly on its fitness [11].

IV.TOURNAMENT SELECTION

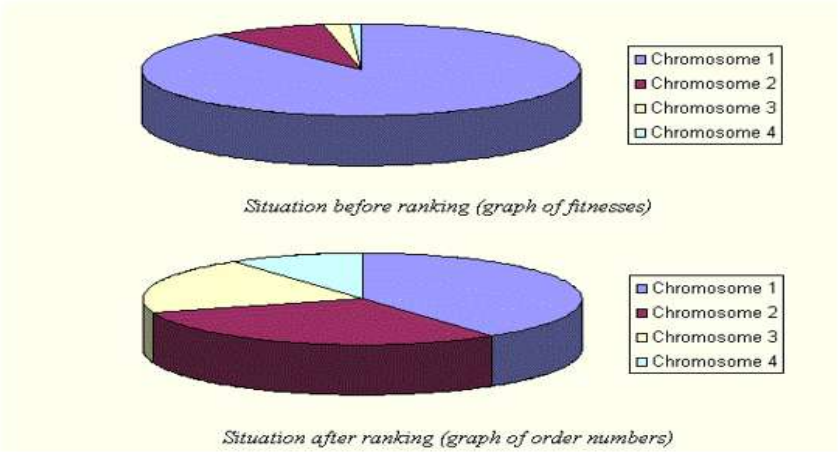
Tournament selection is probably the most popular selection method in genetic algorithm due to its efficiency and simple implementation which was stated by Goldberg, Korb and Deb [12]. In tournament selection, n individuals are

selected randomly from the larger population, and the selected individuals compete against each other [13]. The individual with the highest fitness wins and will be included as one of the next generation population [14]. The number of individuals competing in each tournament is referred to as tournament size, commonly set to 2 (also called binary tournament) [15]. Tournament selection also gives a chance to all individuals to be selected and thus it preserves diversity, although keeping diversity may degrade the convergence speed [16].The tournament selection has several advantages which include efficient time complexity, especially if implemented in parallel, low susceptibility to takeover by dominant individuals, and no requirementfor fitness scaling or sorting [17].



V.RANK SELECTION

Rank Selection sorts the population first according to fitness value and ranks them. Rank N is assigned to the best individual and rank 1 to the worst individual [18]. Then every chromosome is allocated selection probability with respect to its rank. Individuals are selected as per their selection probability [19]. Rank selection is an explorative technique of selection. Rank selection prevents too quick convergence and differs from roulette wheel selection in terms of selection pressure. Rank selection overcomes the scaling problems like stagnation or premature convergence [20]. Ranking controls selective pressure by uniform method of scaling across the population.Rank Selection maintains a consistent selection pressure and the selection strategy is robust. However it leads to slower convergence as fitness of individuals participating in reproduction is almost similar [21].



VI.CONCLUSION

Genetic Algorithms are straightforward to apply in wide range of problems, from optimization issues to inductive idea learning, scheduling, and layout problems. The results will be very good on some problems, and rather reduced on others. This paper clearly explains about three different selection operators which are Roulette wheel selection, Tournament selection and Rank selection. Each of these three selection operators differs in their selection method by its own nature. Each shows its uniqueness while performing the selection criteria. The same idea can be applied to cross over and Mutation techniques.

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