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Effect of Fitness Scaling Functions on Simple Genetic Algorithm

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Abstract: ***Today the most commonly used heuristic method of searching and optimization is the GENETIC ALGORITHM. Optimization is used to solve the problem of minimizing and maximizing the function using equality or inequality constraints. Fitness scaling function is used for getting more generalized results in GENETIC ALGORITHM. In this paper we compare many kinds of fitness scaling functions and try to get the suitable one.***
Keywords: Genetic algorithm, Cross over, Mutation, Optimization, Heuristic

I. INTRODUCTION

Genetic Algorithm (GA) is a optimization technique used for searching purpose based on the principles of Genetics and Natural Selection. These types of techniques are used frequently to find optimal or near-optimal solutions to difficult problems present and spoiling our working which otherwise would take a lifetime to solve. It can provide the most nearby result or we can say the correct solution in the field of computation and search problems in our work area. That's why; it is categorized in global optimization technique. It is a kind of evolutionary algorithm which can use inheritance, mutation, crossover, selection etc. for searching purpose. this technique is most commonly used to solve optimization problems, , in machine learning and , in research.

A. Optimization

Optimization is the process of making something better. In any process, we have a set of inputs and a set of outputs as shown in the following figure.

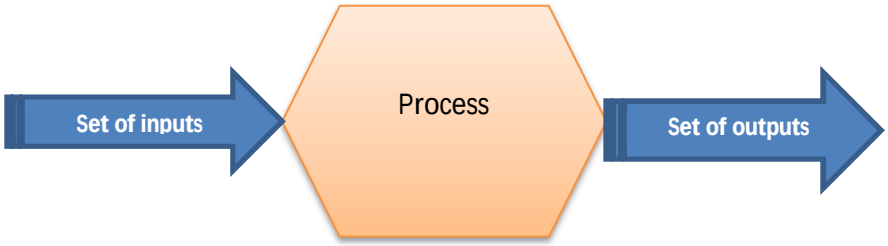

Fig. 1 Diagram of Optimization process

It refers to getting accurate values of inputs in a way that we gain the "best" output values. The meaning of "best" varies from problem to problem, in mathematical form , it reflects the maximizing or minimizing one or more objective functions, by changing the input parameters. The set of all possible solutions or values which the inputs can take make up the search space is called "Population".

In each iteration, new population is used and same process is repeated until the maximum generation is achieved or the fitness value is derived. In this paper we just focus on fitness scaling functions, how they affect the searching of GA and how much extent they affect the output. There are so many kinds of fitness scaling functions is there like linear scaling, sigma truncation scaling, power scaling, exponential scaling. Here we first check that where to apply fitness scaling and then check and compare output produced by using each type of fitness scaling and their accuracy.

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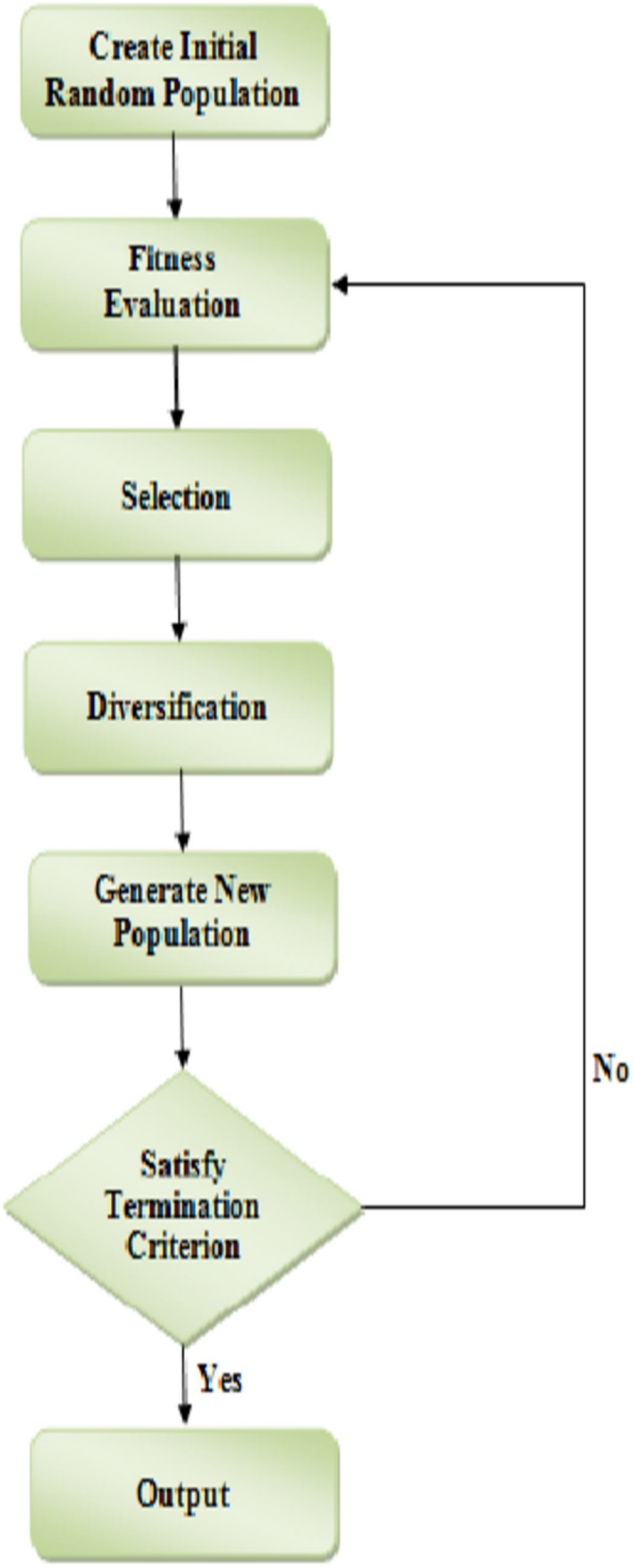

Fig.2 Genetic Algorithm With Scaling Flowchart

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B. Advantages of Genetic Algorithm

Genetic Algorithms have various advantages:-

1) It normally not needs any derivative information (which may or may not be available for many types of real-world problems).
2) Is faster and more efficient as compared to the traditional methods.
3) Has very good parallel capabilities.
4) It is used to optimizes both continuous and discrete functions and also optimize multi-objective problems.
5) It can provides a list of so many "good" solutions, not just only a single solution.
6) Try always to gets an answer for the problem, which gets modifies over the time.
7) It proves useful when the search space is very large/big and there is a large number of parameters involved in it.

C. Basic Terminology

It is essential to be familiar with some basic terminology

1) *Chromosomes:* A chromosome act as one such solution for any kinf of given problem.
2) *Gene:* A gene act as one element position of any chromosome.
3) *Allele:* It is the particular value a gene used for a particular given chromosome.
4) *Population:* It is a subset or sub part of all the possible solutions to the given problem. The population for a Genetic algorithm is analogous to the given population for human beings except that other than human beings, we have Candidate Solutions or alternative solutions representing human beings.
5) *Encoding and Decoding:* For any kind of simple problems, the genotype and phenotype spaces are same. However, in many of the cases, the genotype and phenotype spaces are different. Decoding is the process of converting a solution from the genotype space to the phenotype space, while encoding is the process of transforming from the phenotype space to genotype space. Decoding must be fast because it is carried out repeatedly in a GA during the intermediate fitness value calculation.

II. FITNESS SCALING FUNCTIONS

The results between good result and best result. There are numerous fitness scaling methods. Various kind of obstacle that are faces during deriving the fittest output. To overcome these problems we can scale the value provided by fitness function and after scaling apply that value gently to the fitness function using algorithm. Some of the fitness scaling functions are –

1) *Transform Rank Scaling*-The outputs of this type of scaling progress from linear to nonlinear. The output results of this fitness scaling can totally enhance the quality of search of linear Griewank function and also probability nonlinear function of Schwefel function.
2) *Top Scaling*- It is the most simplest type of scaling method. In this method, many of the top best individuals have set their fitness to the same value, while others having set their fitness values to zero. So this method gives several individuals an identical fitness levels, the diversity of the succeeding generations is increased.
3) *Sigma Scaling*-Sigma scaling is a variant of linear scaling method where a single fitness is scaled according to its variation from the mean fitness of the whole population, measured in standard deviations.
4) *Nonlinear Rank Scaling*-This is a nonlinear type of rank scaling that helps in increases the chances of fittest population selection pressure.
5) *Boltzmann Scaling*-Boltzmann scaling is also a nonlinear scaling that uses the idea of a ―temperature (T) that drops slowly from one generation to next generation.
6) *Linear Scaling*-This is one of very simple linear relationship between the scaled fitness (sf) and raw fitness (ff). Kreinovich et al [1] have demonstrated that linear scaling is the most optimal type of scaling, but if and only if optimal scaling parameters are well known.

III. RELATED WORK

There is a huge amount of research work carried out in the context of fitness scaling function. Some of them are worth discussed here- Vladik kreinovich[1], Chris Quintana from university of Texas, can conclude that the performance of the genetic algorithm can be very effected by applying scaling function on it. Paper presented by him can formulate that the problem of choosing any function as a mathematical optimization problem under the various criterion. He can conclude that the different function proves to be best for different criterion [4].

Yan Yi concluded in the fitness scaling genetic algorithm (FSGA) functioning as one of a heuristic search as the parameterof optimization for rule-based classifier. This algorithm i.e. (FSGA) was compared with genetic algorithm(GA),simulated annealing

(SA), and ant colony algorithm(ACA), and the results concluded that the proposed FSGA rule-based classifier was the most robust and rapid[3].

Farzad A Sadjadi, conclude that the dynamic optimization can be used by applying it on compacted genetic algorithm (CGA). CGA needs for the fitness scaling. CGA can be used/applies on the optimized variable controls the fitness scaling in simple GA. By this the fullest realization can be achieved [4].

HAO Guo-Sheng et al. Concluded in there paper that several kind of problems occur during finding the fitness scaling. They discover two new kind of scaling techniques during selecting the parameters of the fitness scaling with roulette wheel selection in their research. These two new scaling techniques are logarithm and trigonometric scaling.

Anamika taya also concluded that GA's are well suited for optimization tasks even when the fitness or scaling functions which they map are fairly complicated. The Surrounding points are of very close the same fitness. This type of algorithm will not efficiently perform "hopping" from one point to the other point, if there are multiple peaks available in close proximity.

Hopgood, A. et al. has discoverd a new type of scaling which is transform rank scaling[5]. The resulting outputs of transform rank scaling goes from linear scaling to nonlinear scaling which is highly influence the previous scaling to great extent .

IV. CONCLUSION

After reading various studies it can be concluded that there is no doubt that fitness scaling plays an essential role in the genetic algorithm optimization. GA's are well suited for optimization tasks even when the fitness or scaling functions which they map are fairly complicated. The comparison of various types of fitness scaling by applying complex function will be done and it will lead to enhancement in the searching which is more optimized than simple scaling functions. Also, the best suitable in given condition and parameters can be find out. The major motive of this paper is to apply same complex function on different kind of scaling and try to get best minimum and maximum output values which are more optimized. By this we will also try to reduce the limitation of simple genetic algorithm which is premature convergence.

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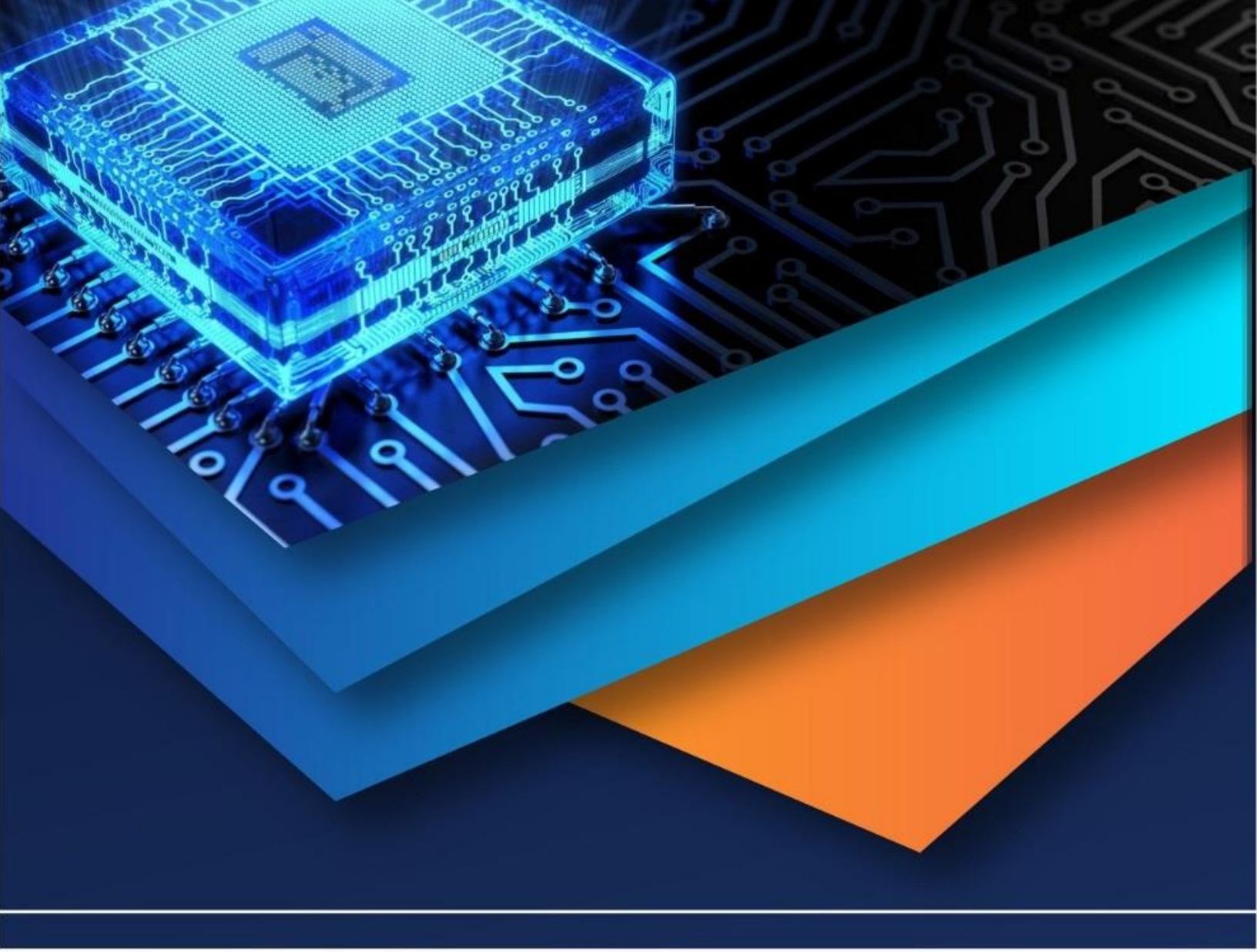

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