

## ANALYSIS OF GENETIC OPERATORS

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**Abstract :** Genetic algorithm is used to provide optimal solution by providing best combinations of the things in the large search space. Genetic algorithm uses selection, crossover and mutation as its operators to provide solution. The aim of this paper is to give light on the working of these operators. Each genetic operator performs different function and is interdependent on each other. The basis of this algorithm is based on Charles Darwin theory "Survival of the fittest". Crossover and mutation are the two important operator and part of genetic algorithm and affect the performance of genetic algorithm. The main aim of genetic operator is to maintain genetic diversity of the genetic algorithm and this variation is the basis of evolution.

### Keywords

Genetic algorithm, selection, crossover, mutation.

## 1. INTRODUCTION

Genetic algorithm is widely is used for solving search space problem. Genetic algorithm is a type of algorithm that follows adjusted heuristic search technique. It is one of the fast developing areas of Artificial Intelligence. Genetic algorithm uses past information and Utilize that data to optimize the search into particular area in the search space. It is part of evolutionary computing.

## 2. LITERATURE SURVEY

In the paper "Genetic Algorithm for the Traveling Salesman Problem using Sequential Constructive Crossover Operator", by Zakir H. Ahmed a new crossover operator, Sequential Constructive crossover (SCX), has been used that generates good quality solutions to the Traveling Salesman Problem (TSP) using genetic algorithm. The sequential constructive crossover operator selects better edges on the basis of parent individuals that build an offspring that can manage sequence of nodes in the parent individuals. The efficiency of the SCX is compared as against some existing crossover operators; namely, edge recombination crossover (ERX)

and generalized N-point crossover (GNX) for some benchmark TSPLIB instances. Experimental have proved that sequential constructive crossover operator shows better results than the ERX and GNX.

In another paper, "Evaluating the Effectiveness of Mutation Operators on the Behavior of Genetic Algorithms Applied to Non-deterministic Polynomial" by Basima Hani F. Hasan and Moutaz Saleh M. Saleh Genetic Algorithms (GAs) are powerful general-purpose optimization search algorithms based upon the principles of evolution observed in nature. Mutation operator is one of the GA operators which is used to preserve genetic diversity and is based on evolution. It is used to produce new chromosomes or modify some features of them depending on some small probability value and helps in better solution by inheriting some characteristics from parent chromosomes. The objective of this operator is to prevent falling of all solutions in population into a local optimum of solved problem by applying mutation operators. This paper tries to solve the problem of selected non-deterministic polynomial (NP) hard problems and compares the results. The problems that will be introduced in this paper are: traveling salesman problem (TSP), 0/1 Knapsack problem, Shubert function, and system of linear equations.

In another paper "A Comparative Study of Crossover Operators for Genetic Algorithms to Solve the Job Shop Scheduling Problem" by JORGE MAGALHÃES-MENDES "Genetic algorithms (GA) includes wide class of global optimization methods. Many genetic algorithms have been applied to solve complex combinatorial optimization problems. The choice of crossover operator is considered a major problem in genetic algorithm. The aim of this paper is to present that how the selection of correct of genetic crossover operators affects the performance of a genetic algorithm. The GA is applied to the job shop scheduling problem (JSSP). To achieve this aim an experimental study of a set of crossover operators is presented. The experimental study is based on a decision support system (DSS); the DSS was designed to examine the potentiality of all the operators giving them the same opportunities. The genetic crossover operators are tested on

a set of standard instances taken from the literature. To evaluate the genetic crossover operators the make span is measured. The main conclusion is that there is a crossover operator having the best average performance on a specific set of solved instances.

In another paper “New Operators of Genetic Algorithms for Traveling Salesman Problem” by Shubhra Sankar Ray, Sanghamitra Bandyopadhyay and Sankar K. Pal the paper describes that how genetic algorithm can be applied to solve travelling salesmen problem. New knowledge based multiple inversion operators and a neighborhood swapping operator is proposed. To provide superior results have been provided on different benchmarks using the experimental data as compared to some other existing methods. The keywords that have been used are knowledge based multiple inversion, order crossover, knowledge based neighborhood swapping.

### 3. SELECTION

Selection is as stage where in individual genomes are selected from present generation for insertion in the coming generation’s population. In this, each individual genome is computed. Selection is also termed as reproduction. Each individual is classified on the basis of fitness function and the population is sorted by descending fitness value. Basically selection extracts subset of genomes from the available population on the basis of quality constraints. Chosen chromosomes are may proceeded for crossover and mutation in which the off springs are the one that created in next generation. Selection include following technique:

#### 3.1 Roulette Wheel Selection

In this type of selection technique individual are selected on the basis their fitness value. Each individual fitness values are compared with its competitor’s fitness values in the population and the individual having high fitness values are selected. It is also called fitness proportionate selection. It simulates wheel type shape in which individual fitness value are marked on the circumference of the wheel. When the selection process is duplicated again and again for each chromosome until we get the fittest value, the process is called Roulette values.

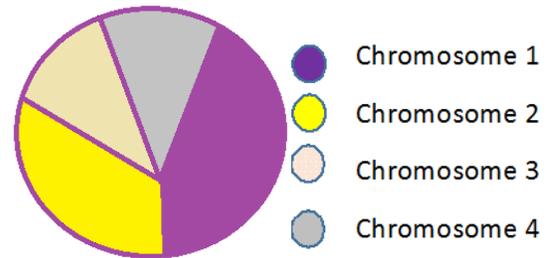
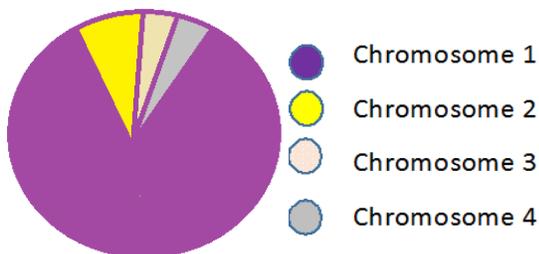


Fig. 1: Roulette wheel selection

#### 3.2 Boltzmann Selection

Boltzmann selection is used to select individual on the basis of maximum or minimum fitness value depending on the given problem. Boltzmann selection is based on following equation to solve selection problem.

$$P(E) = \exp(-E/kT)$$

k is Boltzmann Constant . T is temperature.

Controlling the temperature T, it is supposed that search process follow Boltzmann probability distribution.

#### 3.3 Tournament Selection

In this, selecting of the ace chromosomes out of randomly chosen subset is done. It uses roulette selection n times to produce a subset of tournament. The best chromosomes amongst these are the selected chromosomes. It provides extra selective pressure over roulette selection.

#### 3.4 Truncation

In this selection, from the selected best chromosomes, one fourth or half or more proportions is taken.

#### 3.5 Top Percent

Random Selection of chromosomes from top n percent as per specified by the user.

#### 3.6 Best

Best chromosomes chosen on the basis of their fitness value. If two chromosomes have same fitness value one is taken randomly.

#### 3.7 Random

It is based on random selection of chromosomes from a population.

### 4. CROSSOVER

Crossover is the process of integration of the parents. The idea behind crossover is that the newly generated off springs are better than their parents and inherit some characteristics of their parents. In this process the programming of individuals varies from one generation to

the other. it is based on user definable crossover probability. In crossover binary encoding is done. Its types are:-

#### 4.1 Single Point Crossover

In single point crossover a random point is selected and parents starts combining these individuals to produce new offspring. It is a process in which binary string is duplicated till the random point and the rest is copied from the other parent.

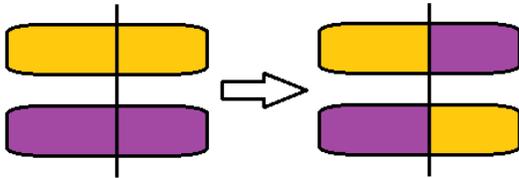


Fig. 2: Single point crossover

#### 4.2 Two Point Crossover

In two points crossover two points are selected within the parent individuals and swapping of individuals between the parents generates the offsprings. Interchanging of binary strings between the parents takes place at two random points for generation of child chromosomes.

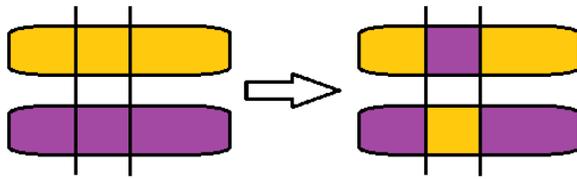


Fig. 3: Two point crossover

#### 4.3 Uniform Crossover

Uniform crossover enables fixed ratio of interchanging of individuals between the parents. Chromosome combination occurs at gene level rather than segment level. In this process strings are copied in a fixed manner to generate better chromosomes.

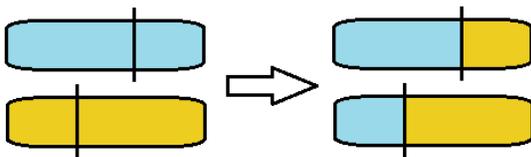


Fig. 4: Uniform crossover

### 5. MUTATION

Mutation is a genetic operator in which switching of genes takes place in the chromosomes. It is similar to biological mutation. Mutation is carried out to generally maintain the natural diversity of a population. The solution generated

after mutation may change the previous solution. Hence mutation helps in generating better solutions for genetic algorithms. Mutation occurs during evolution based on user definable mutation probability. Its type are-

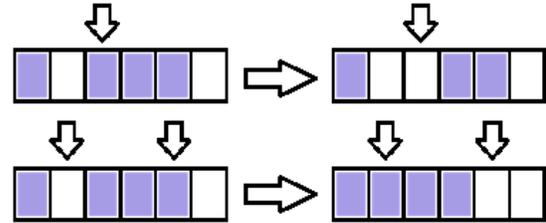


Fig. 5: Mutation

#### 5.1 Bit String Mutation

Bit strings are flipped randomly at random positions.

Example- 100100



#### 5.2 Flip Bit

The mutation operators takes the chosen individuals and reverses the bits is that is if genome bit is 0 it reverses it to 1. It can be used for only for binary genes.

#### 5.3 Boundary

The mutation operators replace the chosen genome with an upper or lower bound for genes. This operator can be applied only to float and integer genes.

#### 5.4 Non-Uniform

In this mutation as the number of generation of genes increase the probability that the mutation will reach near to 0 also increase. It protects the population from deteriorating in the early stages of evolution and allows measuring the solution at later stages. This operator is applicable to float genes and mutation genes only.

#### 5.5 Uniform

A mutation operator substitutes the value of selected gene with a uniform selected gene according to user specified lower and upper bounds of genes. This operator is valid only for float and integer genes.

#### 5.6 Gaussian

A unit Gaussian distributed value is added to selected genome. If the new value of genome comes outside user defined upper and lower bounds then it is cropped. The mutation operator is valid only to float genes and integer genes.

## 6. CONCLUSION

The paper gives complete description about what a genetic operator is and how it works in genetic algorithm. Genetic operators are used for maintain genetic diversity in the algorithm. . Genetic operators like selection, select individuals from the population according to fitness criteria. The selected individual then is processed by another genetic operator that is crossover. Crossover operator is used to select best characteristics from the parents and form new off springs. Last one is mutation, in this the one or more genes of the chromosomes is changed from its previous state so that variation can be maintained. Thus genetic operator's works and new population is created.

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