

## ESTIMATING THE NUMBER OF GENERATIONS IN A HUMAN GENETIC PROCESS

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### ABSTRACT

The article discusses about the idea to estimate the number of generations of offspring in a human genetic process on the basis of its computational analysis. As per analysis carried out and presented in this short communication, It is estimated from the result that the maximum numbers of successive offspring generation is 60 while 8 codes were considered for each parent therefore if the maximum human age is considered to be 100 years then the maximum genetic termination age after 60 generations is 3000 years, here the offspring generation is considered during the mid age of a parent to estimate the maximum age for 60 generations during the successive generation processes.

**KEYWORDS:** Genetic Theory, Evolution Process and Genetic Algorithm

### INTRODUCTION

The Genetic Algorithm (GA) was invented by Prof. John Holland at the University of Michigan in 1975 and it has been made widely popular by Prof. David Goldberg at the University of Illinois [1-2]. GA is a class of evolutionary algorithms that typically use fixed-length character strings to represent their genetic information, together with a population of individuals that undergo crossover and mutation in order to find interesting regions of the search space. GA work on the principle of “survival of the fittest”, where the less fit members of a particular generation are replaced by new members formed by combining parts of highly fit members. The objective of the GA is to find an optimal solution to a problem. It does not depend on the specific areas of the problem belongs to, and has been widely used in function optimization, automatic control, image processing, machine learning and other technology areas [3-5].

### GA BASICS

Genetic Algorithms work by evolving a population of members over a number of generations. First, the initial population of members is generated. After this, the fitness of each member is evaluated, where the fitness is a function of the application. Two members or individuals are then selected simultaneously. The selection is usually proportional to the fitness value, i.e., the members with higher fitness have a greater probability of being selected. These members are then crossed to form new individuals and these new members are mutated to avoid convergence to local optima. The resulting members replace the less fit members of the old population. Thus, the fitness value of the population is improved with every new generation. The different operations of genetic algorithm are described here [2], and it has been presented in a process flowchart in figure 1. The operations are as follows.

**Initial Population:** All genetic algorithms work on a population or a collection of several alternative solutions to the given problem. Each individual in the population is called a string or chromosome. These individuals are coded as binary strings, and the individual characters or symbols in the strings are referred to as genes.

**Fitness Function:** The fitness function is an important component of the GA and has an important role in directing the search toward high-quality solutions. An individual's fitness reflects its quality as a solution to the problem, relative to the other individuals. If, we consider the square function,  $f(x) = x^2$ , where  $x$  is the input string value, known as a chromosome.

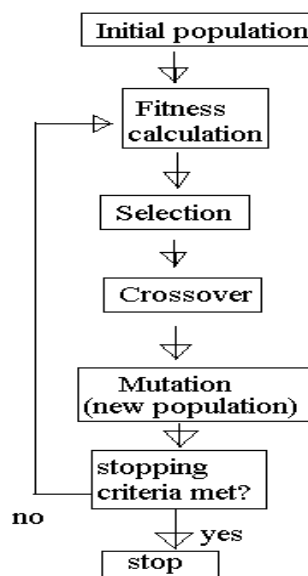
**Crossover:** Crossover is the main operator used for reproduction. It combines portions of two parents to create two new individuals, called offspring, which inherit a combination of the features of the parents.

**Mutation:** Mutation is an incremental change made to each member of the population. Mutation enables new features to be introduced into a population. Mutation can be done by flipping a bit. The GA operation invokes the mutation operation on the new bit strings very rarely, that is with a low probability, generating a random number for each bit and flipping this bit only if the random number is less than or equal to the mutation probability.

**Termination:** The termination condition determines stopping criteria after the maximum number of generations.

**Generation:** The process of creating a new population from an existing population through reproduction is called generation.

**Function optimization:** For an  $n$ -input, single-output function, function optimization is technique to find the set of input parameters that maximize the output function.



**Figure 1: Process Flowchart of Genetic Algorithm**

The following tables 1 to 6 shows how the genetic algorithm code works to optimize the function  $f(x) = x^2$  where the range of  $x$  is taken from 0 to 27, and simulation result generated by the GA code written in Verilog. Initial population of four strings is taken where each string is of 5-bit. For the fitness function  $f(x) = x^2$  where  $0 \leq x \leq 27$ , the maximum fitness value that can be attained is 729.

**Table 1**

Initial population		Fitness function
Chromosome		$f(x) = x^2$
(1)	01101	0010101001
(2)	11000	1001000000
(3)	01000	0000010000
(4)	10011	0101101001

Since 3rd chromosome is less fit member, it is replaced by most fit member that is 2nd chromosome for crossover and mutation in the next evolution process.

**Table 2: Mating Chromosomes for Crossover**

(1)	01101
(2)	11000
(3)	11000
(4)	10011

Single point crossover is considered in this case.

**Table 3**

Chromosome 1	01   101
Chromosome 2	11   000
Offspring 1	01   000
Offspring 2	11   101

**Table 4**

Chromosome 3	11   000
Chromosome 4	10   011
Offspring 3	11   011
Offspring 4	10   000

The offspring then undergoes mutation operation. Mutation occurred on offspring 3 and mutation point is at bit-1, this mutation point is generated randomly.

**Table 5**

Original Offspring 3	11011
Mutated Offspring 3	11001

After crossover and mutation operation the new population is generated and it increases the fitness function.

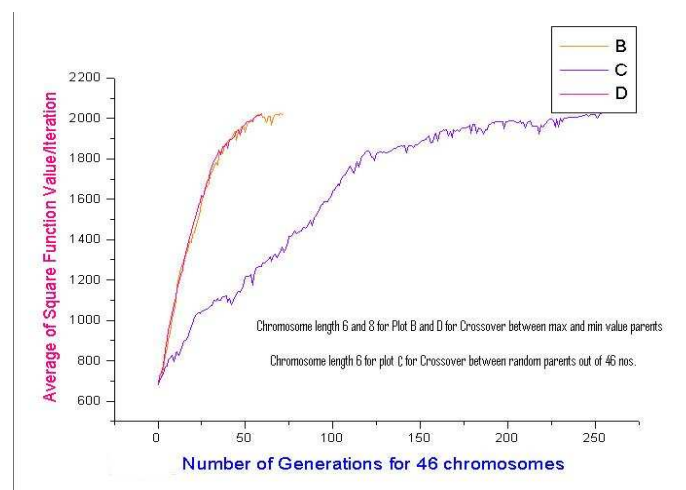
**Table 6: New population**

(1)	01000
(2)	11101
(3)	11001
(4)	10000

The process is repeated until function is optimized. The function is optimized at generation number 6. The output of the simulation result gives  $f(x) = 729$  at  $x=27$ , which gives the maximum value of the function.

## DESCRIPTION OF WORK

The genetic algorithm, explained in previous paragraphs, is used in the case of human genetic process. Since, it is known that 23 chromosomes of each parent share to form human cell's nucleus of a baby therefore total 46 chromosomes involves to produce an offspring. A genetic process [1-2] & [6], consists of selection of chromosomes, crossover and mutation for the generation of offspring including copying operation. In this study, it has been considered that the genetic generation process is functional, a square fitness function is used, its simulation and analysis work is carried out and presented here. It has been observed that maximum number of generations for a human genetic process is 60 generations while considering 8 codes per chromosome, it means that after 60 generation it terminates the further generation process, it has been presented in plot D of Figure 2, in the case of 6 codes per chromosome the maximum generation processes will be 72, after that no further generation happens as shown in plot B. Plot B and D has been generated while considering the parents having maximum and minimum functional value participated in their crossover selection process for parents to produce offspring and only lower 6 codes were involved in the genetic process in both cases, while in plot C the crossover happens between the two parents randomly selected for their 6 codes per chromosome per parent. Maximum number of generations is 254 for randomly selected parents in their crossover process to produce offspring. The data has been presented in Figure 2, each graph's peak represents the termination of a generation process after certain generations.



**Figure 2: Plot for the Termination of Successive offspring Evolution Process (Y-Axis) after Certain Generations (X-Axis) in Human from an Initial Parent with 46 Chromosome**

## CONCLUSIONS

On the basis of above study, it is observed that the maximum offspring generation in a human genetic process is deterministic and limited for its initial parents, as shown in figure 2, the maximum numbers of successive offspring generation is 60, when 8 codes per chromosomes were considered for each parent and the total estimated age is 3000 years, if average generation age of each parent is assumed to be 50 years.

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