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# Fibonacci Sequence in Genetic Algorithm

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**Abstract.** This paper presents an application of Fibonacci Sequence (FS) in determining the population of Genetic Algorithm (GA) called Fibonacci Sequence in Genetic Algorithm (FSGA). The objective is to develop GA to be able to find better results. We have tested with one-max problem that is suitable for evaluating algorithm. We have configured of GA parameters is the same except for the size of population. From the experiment with one max problem in different length shows that FSGA better than Simple Genetic Algorithm (SGA).

**Keywords:** genetic algorithm, fibonacci sequence, size of population

## 1. Introduction

Genetic Algorithm (GA) is one of machine learning method that uses to find the optimal solution of problem that apply from the concept of natural selection. GA starts with initialization of population, then use fitness function to evaluate fitness of all populations, after that will bring the population into genetic operator which contains crossover, mutation and selection. GA will do this in a loop until the end of the last generation.

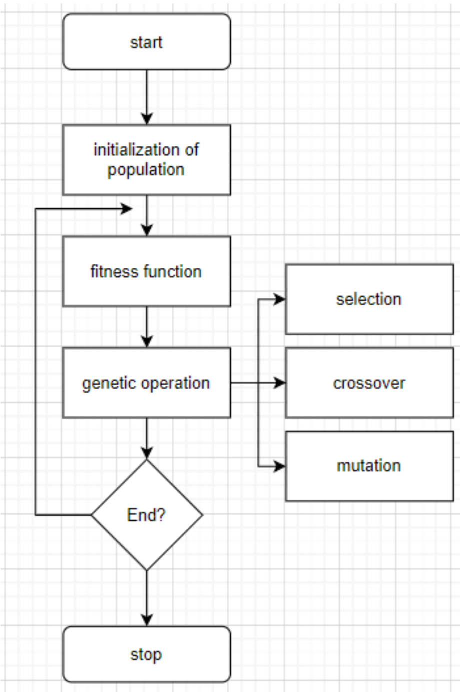


Fig. 1: Genetic algorithm flowchart.

Normally, GA has parameters that must be setting before running such as number of generation, size of population, crossover rate or mutation rate. In this paper we are interested in size of population.

We think if continuing to increase the population size in each generation, GA will be able to find better solution, so we found that Fibonacci Sequence is suitable to use. Fibonacci Sequence (FS) is a sequence in which number is the sum of the 2 numbers preceding it, defined by the equations Fn = Fn-1 + Fn-2 for all

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n>= 3 where F1 = 2 and F2 = 1and Fn represents the nth Fibonacci number. FS can written as {1,1,2,3,5,8,13,21,34,….}

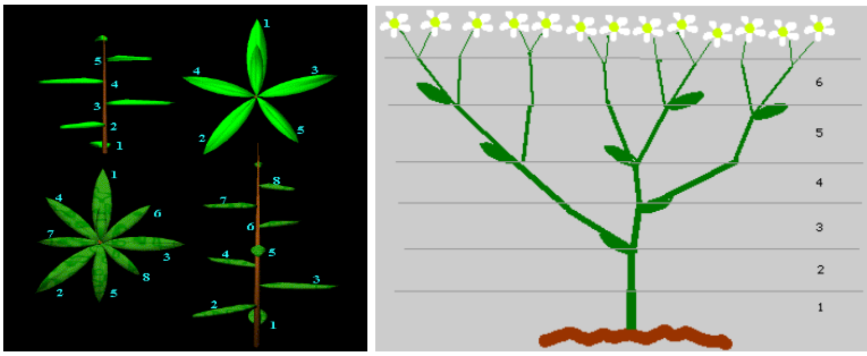

Fig. 2: Fibonacci sequence in nature

For test reliability, we tested with one-max problem that is a suitable problem for evaluating algorithm performance, especially GA. The one max problem is a problem to maximize the number of one of a bitstring. For example in Fig. 2, the last chromosome string is the best of answer because it has 1 more than any chromosome strings.

| CHROMOSOME STRING | FITNESS |
|---|---|
| 111000000 | 3.00 |
| 000111110 | 5.00 |
| 101101101 | 6.00 |
| 111110000 | 6.00 |
| 110111111 | 8.00 |

Fig. 3: Example of one max problem.

We are interested in experimentally applying FS to determine the population size of GA with the expectation that it can increase the efficiency of GA than Simple GA.

## 2. Simple Genetic Algorithm

In the experiment, we tested with one max problem by the steps of Fig. 1. This is a problem commonly used to measure the efficiency of algorithms. The goal of this problem is that the answer has the largest number of 1. From the tested with SGA, we set the population size to be 100, number of generations is 10, crossover rate is 0.7 and mutation rate is 0.01 and tested in at length 100 to 1000.

| Generation | Size of population |
|---|---|
| 1 | 100 |
| 2 | 100 |
| 3 | 100 |
| 4 | 100 |
| 5 | 100 |
| 6 | 100 |
| 7 | 100 |
| 8 | 100 |
| 9 | 100 |
| 10 | 100 |

Fig. 4: Size of population of SGA

The results are shown in Fig. 5

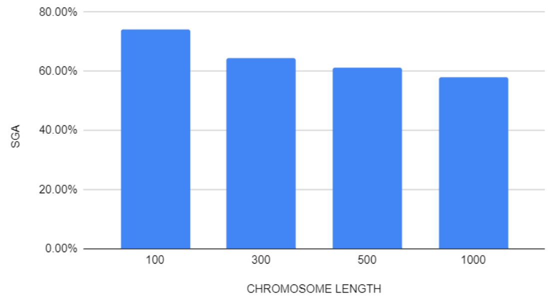


Fig. 5: Results from simple genetic algorithm.

From the experiment results in Fig. 4, at length 100 had average fitness 74.20, at length 300 had average fitness 193.70, at length 500 had average fitness 306.70 and at length 1000 had average fitness 580.40. In term of percentages from Fig. 3, it is quite clear that the percentage of answer decreases when length of population increases.

## 3. Fibonacci Sequence in Genetic Algorithm

We applied FS to determine the population size of GA, which is generally set at 100. For FS in GA, we defined by the equations Fn = Fn-1 + Fn-2 for all n>= 3 where F1 = 100 and F2 = 100 and Fn represents the nth Fibonacci number that mean size of population of GA will increases in every generation of GA,not fixed at 100 like SGA, which can be written as {100,100,200,300,500,800,1300,2100,3400,….}.

| Generation | Size of population |
|---|---|
| 1 | 100 |
| 2 | 100 |
| 3 | 200 |
| 4 | 300 |
| 5 | 500 |
| 6 | 800 |
| 7 | 1300 |
| 8 | 2100 |
| 9 | 3400 |
| 10 | 5500 |

Fig. 6: Size of population of FSGA

The size of GA's population continued to increase until reached 5500 in the last generation which means FSGA has 5500 choices while SGA has only 100 choices. The flowchart of FSGA is shown in fig.7.

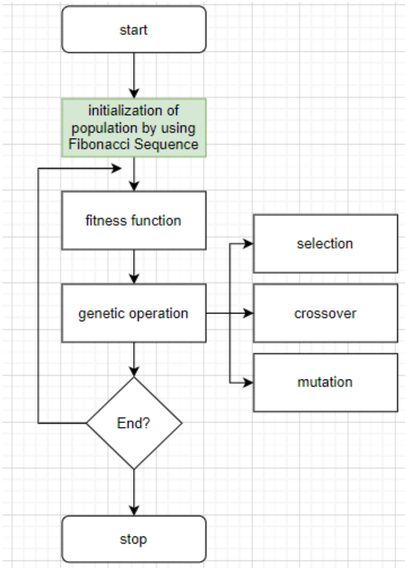


Fig. 7: Fibonacci sequence genetic algorithm flowchart.

The results are shown in Fig. 8

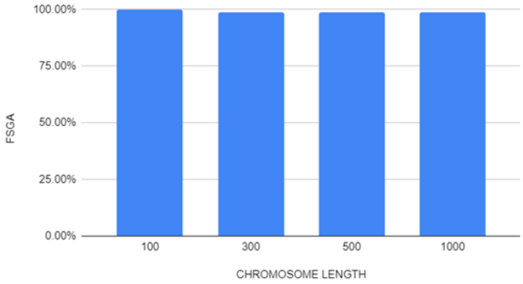


Fig. 8: Results from Fibonacci Sequence Genetic Algorithm.

From the experiment results in fig.6, at length 100 had average fitness 99.90, at length 300 had average fitness 296.79 at length 500 had average fitness 493.10 and at length 1000 had average fitness 987.00. In term of percentages, that it is clearly higher than SGA and stable. Next, we will compare the results between SGA and FSGA to evaluate and summarise the experiment.

## 4. Experiment Results

When comparing the results between SGA and FSGA, we found that FSAG had better average fitness than SGA at all test lengths, shown in Fig. 7

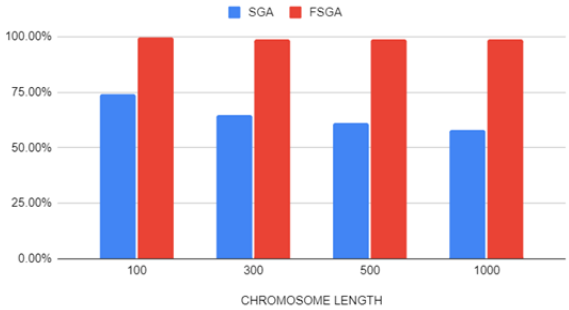


Fig. 9: Comparing results between SGA and FSGA

At length 100, percentage of answer SGA 74.20 vs FSGA 99.90.

At length 300, percentage of answer SGA 64.57 vs FSGA 98.93.

At length 500, percentage of answer SGA 61.34 vs FSGA 98.62.

At length 1000, percentage of answer SGA 58.04 vs FSGA 98.70.

From the above results, it is clear that FSGA is better than SGA and FS can be applied to determine the population size of GA.

## 5. Summary

This paper presents an approach to improve Genetic Algorithm (GA) efficiency by applying the concept of Fibonacci Sequence to determine population size in GA called Fibonacci Sequence in Genetic Algorithm (FSGA).

The goal of this paper is to try and find ways to optimize GA to find better solutions and we expect that by increasing the number of alternatives to GA can enable GA to find better solutions.

From the results of experiment with one max problem at different chromosome length, we found that the results from FSGA had average fitness better than Simple Genetic Algorithm (SGA) in all length tested.

We can conclude from the experiment results that Fibonacci Sequence can greatly increase the performance of Genetic Algorithm which we will use in the real world problem in the real world next.

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