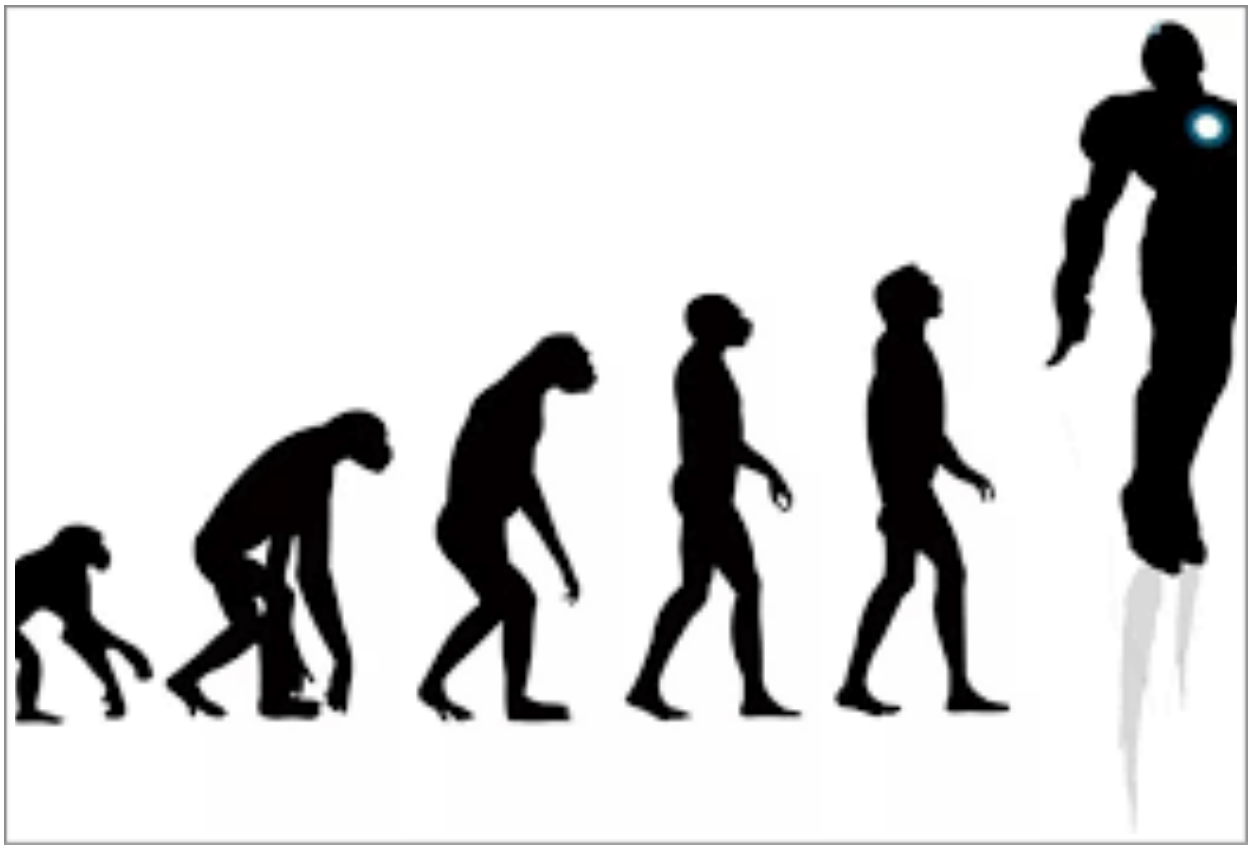
Evolution



INFO6205-110

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Content

1.Introduction

1.1Genetic Algorithm

In computer science and operations research, a genetic algorithm (GA) is a meta-heuristic inspired by the process of natural selection that belongs to the larger class of evolutionary algorithms (EA). Genetic algorithms are commonly used to generate high-quality solutions to optimization and search problems by relying on bio-inspired operators such as mutation, crossover and selection. The goal of the project is to find the best solution to the Genetic problem.

1.2 Project Goal

In this project, we need to apply Genetic algorithm to find the best pattern.

In the processing of constructing “Evolution” model, we build the starting pattern and offspring, genotypes, expressions, and environment in the genetic algorithm. Then, we design the fitness calculation algorithm, the selection algorithm, the and the mutation algorithm Finally, we can get the best pattern.

2.Problem Statements

2.1Overview

The problem is that starting patterns are generated randomly and set the maximum the number of generation.We can apply fitness function and calculate the fitness of each individual in the population.So we can through the fitness calculation algorithm, the selection algorithm, the and the mutation algorithm and terminate algorithm to find the optimal solution.That is to say we can generate different number of generation and find the best pattern.

2.2 Concepts

2.2.1 Individuals

Individuals are a candidate 2-Dimensional graphic and its location. And the individuals' shape are determined by its chromosome that is a point of 2-dimensional rectangular coordinate system

2.2.2 Genotype

we present the format of genotype as decimal numbers within 20 bits (it should be no less than 2 and no more than 20). The length of genotype should be divided by 2. The bits of the genotype would be in the domain of [-10, 10].

2.2.3 Expression

The expression is reflection relationship, a two-to-one correspondence between genotypes and phenotypes. Specifically, we use two-bits genotype to present a point of 2-dimensional rectangular coordinate system that is phenotype.And the shape is constructed by these points.

2.2.4 Phenotype

The format of phenotype is a 2-Dimensional graphic that constructed by 2-17 points. X coordinate and Y coordinate of these points belong to (-10,10).And the phenotype is different from the genotype because of it has fitness.

2.2.5 Fitness

The number of generation that an initial individual graphic can mutate and evolve is presented by our system fitness. If the number of generation is larger, it means the corresponding initial graphic fits the environment better.

3.Parameter Settings

3.1 Group Size

We generate the group size randomly, but we set the original number of individuals is 10,50,100

3.2 Chromosome Length

We generate Chromosome length randomly and the scope is between 4 to 34.

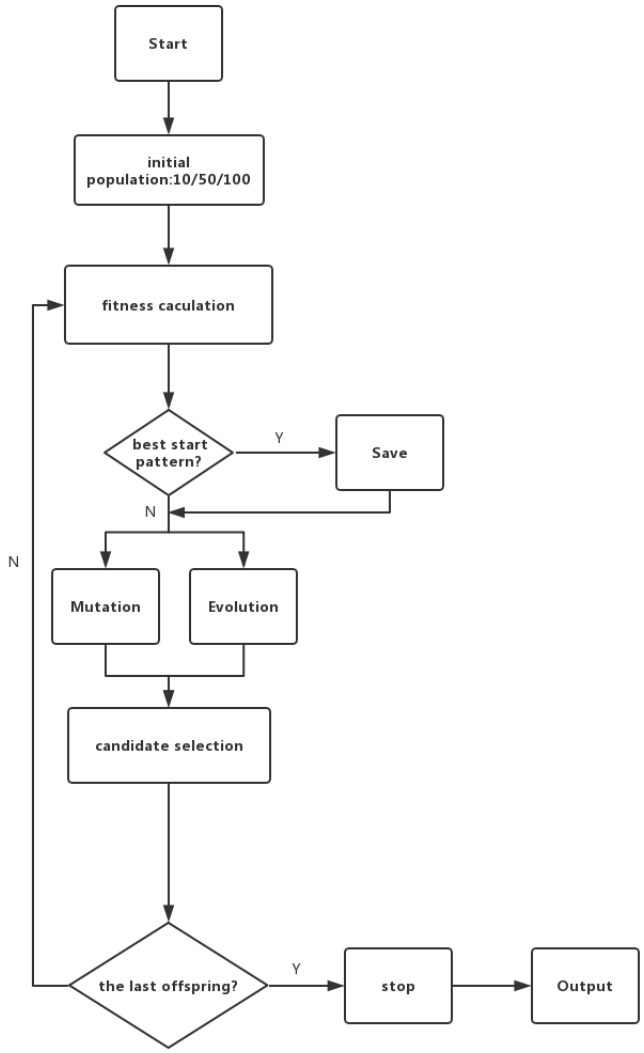
3.3 Mutation Probability

We set mutation probability is 10%,50% or 90%.And its scope is 0%-100%.

3.4 Evolution Probability

We set evolution probability is 90%,50% or 10%.And its scope is 0%-100%,so we can use (1- mutation probability) to get the evolution probability.

4.Program Structure



5.Algorithm Design

5.1 Calculation Algorithm of Fitness

The fitness function simply defined is a function which takes a candidate solution to the problem as input and produces as output how "fit" our how "good" the solution is with respect to the problem in consideration. We use the same fitness to find the different generation of the genotypes.

5.2 Terminate Algorithm

Under three different conditions, individuals will terminate;

1) Individuals whose generation is over 1000;
2) The number of points in current individuals is 0.
3) If the shape of individuals already exist, it would terminate.

5.3 Start Pattern Algorithm

1)Random process: we set the number of initial individuals are 10,50,100.We use two-bits and the range is between -10-10 to construct a point of 2-dimensional rectangular coordinate system randomly.The number of points of the shape won't over 17 and under 2.And we can use data generation to generate 50 subsequents.

2)We set one hash map to save our original data, it includes initial start pattern and the number of satisfied pattern which generation can be 1000 at last.

5.4 Mutation Algorithm

Mutation is genetic level variation ,so it not for the individual level.And the individual's genetic sequence would mutate over time in the population.But in mutation algorithm, replacing the whole genetic sequence by the new whole genetic sequence is wrong.So in our mutation algorithm, we can choose the random number of points from the group, and exchange x, y coordinates to get new points.If the new point existed in the original list ,we would remove this point.

Step 1:we choose the random number of points from the group.

Step 2: we can change the coordinate of points , execute avoiding same operation.

Step 3: we save the mutation points in the list.

5.5 Evolution algorithm

Evolution is genetic level variation ,that is to say we need to change genotype.In our evolution algorithm, we choose the one point from individuals randomly.So we add two point around this point.If two points are both existed, we need to choose

new points randomly again .Once one of two adding points does not exist at last ,we add point and finish the process of evolution.

5.6 Selection algorithm

At first ,through the number of generation(the larger number means better), we can choose the best first generation.Then we execute reproduction operation, we can get different subsequents.Then we can get the best subsequent.So through selection operation, we can return the best one.

6.Data Analysis and Result

6.1 Overview

1)We set the number of initial pattern is 10, the mutation probability is 10%,50% and 90%,and evolution probability is 90%,50% and 10%.And each condition would be executed 5 times.So we can get the best individual and its number of generation.

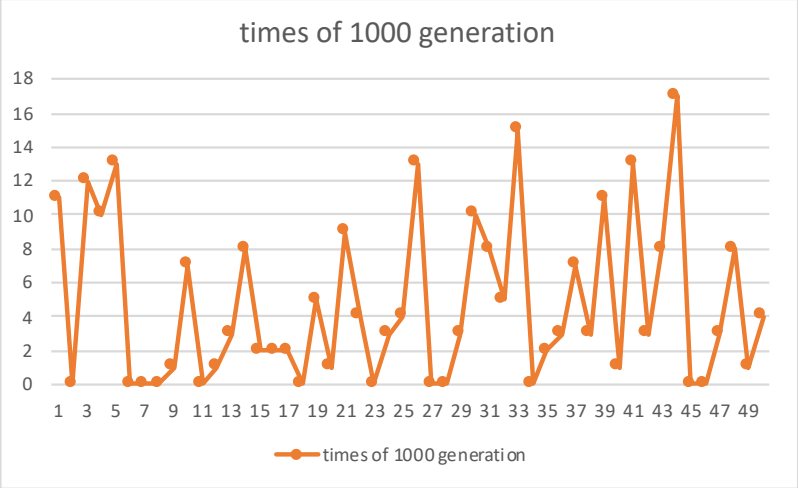
2)We set the number of initial pattern is 10,50 or 100, the mutation probability is 50%and evolution probability is 50%.And each condition would be executed 3 times.So we can get the best individual and its number of generation.

6.2 Result

The result of data are the following:

1.We change the mutation probability and evolution probability.

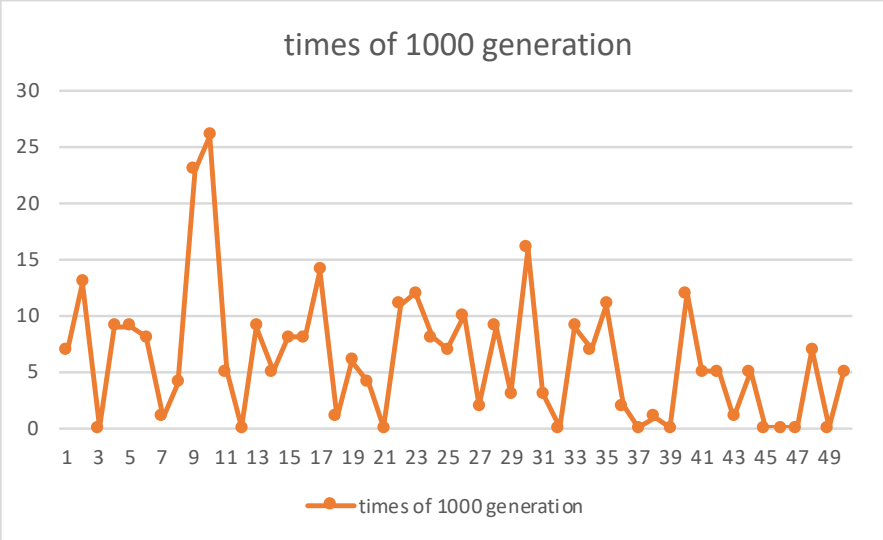
1)Individual： 10 generation： 10 mutation probability： 50%/evolution probability:50%



Data Analysis: Under this condition , we run the program 5 times, and each time we found the best start patterns and the best start pattern's ancestor.From this chart, we can get the number that is generation of subsequent can be 1000 at least. The maximum number is 17 and its string is 10 5 ,-5 -3 ,5 -6 ,4 -3 ,-9 -10 ,-9 9 ,6 -5 ,8 1 ,8 -1 ,-3 1 ,5 1 ,4 -7 ,-5 9 ,2 7 .Therefore this start pattern can generate the best group.
The first time :

Best start pattern is 4 10, 7 -4, -2 7, 10 8, 10 11, -9 -3, -7 7, 3 2, -6 8, 5 4, -2 0, -4 -9, 1 2, -10 0, 2 -8, 1 7, -5 -8, 10 9, 6 -8, 5 -9, 0 1, 3 4, 9 8, 9 -5, 9 10, 0 -10, -8 6, -8 -5, 2 1, 4 3, 7 1, 8 -3, 6 -5, 8 7, 4 5, 2 3, 8 2, 6 0, -1 1, -3 -1, 5 -6, 2 8, 0 6, 5 11, 3 9, 9 -2, -1 8, -3 6, -7 -4, -9 -6, 6 12, 4 -7, 11 12, -5 9, 3 -7, 1 -9, -1 -11->1000
Best start pattern's ancestor is 10 4 ,-4 -9 ,1 2 ,-10 0 ,0 -2 ,2 -8 ,-4 7 ,1 7 ,-5 -8 ,-3 -9 ,7 -7 ,8 10 ,7 -2 ,10 9 ,2 3
The second time:
Best start pattern is 10 -6, -7 -7, 1 0, -8 6, 0 4, -5 1, 6 8, -7 -2, -6 4, 10 -4, -5 -6, 2 2, 5 1, -4 2, -6 0, -6 -6, -8 -8, -7 -1, -5 5, -7 3, -8 -2, -9 -3, -10 -4, -4 -5, -6 -7, 11 -5, 9 -7, -6 -1, -8 -3->1000
Best start pattern's ancestor is 10 -6 ,-7 -7 ,1 0 ,-8 6 ,0 4 ,-5 1 ,6 8 ,-7 -2 ,-6 4 ,10 -4 ,-5 -6 ,2 2 ,5 1
The third time:
Best start pattern is 6 8, 10 1, 4 -9, 1 -8, -1 7, -8 -1, 6 4, 0 8, 3 -5, -1 3, 7 -7, 9 0, -8 -9, 9 -7, 10 -7, 0 -10, -7 6, -3 5, -2 6, -4 4, 1 -9, -1 -11, -5 3, 5 -8, 3 -10, 7 5, 5 3, 4 -4, 2 -6, 11 -6, 9 -8, -6 2, 6 -7, 0 9, -8 5, -9 -8, -9 1, -1 -8, 5 7, 3 -1, -8 1, 5 -3, 7 -1, -7 9, 1 10, 3 5, 6 -2, -11 -1, -7 10, 8 0, -8 9, -10 0, 4 6->1000
Best start pattern's ancestor is 10 1 ,4 -9 ,1 -8 ,-1 7 ,-8 -1 ,6 4 ,0 8 ,3 -5 ,-1 3 ,7 -7 ,9 0 ,-8 -9 ,9 -7 ,10 -7 ,0 -10 ,-7 6 ,-3 5
The fourth time:
Best start pattern is 4 -9, -9 4, -9 0, -3 7, 1 0, 6 8, -1 2, 4 9, 5 -3, -5 -3, -5 10, 9 10, 9 6, -4 1, 0 -10, 2 1, -2 0, 0 -2, -10 0, 1 2, 0 1, 10 9, 8 6, 7 -3, 9 4, -3 5, 6 9, 2 -1, 10 -5, -3 -5, 10 7, 8 5, 10 11, 8 9, 0 3, -2 1, 8 -2, 6 -4, 7 8, 6 7, 3 2->1000
Best start pattern's ancestor is 10 -5 ,-3 5 ,0 -10 ,9 4 ,0 -9 ,10 9 ,6 9 ,-3 -5 ,1 -4 ,4 -9 ,0 1 ,2 1 ,7 -3 ,8 6 ,4 -9 ,-2 0 ,2 -1
The fifth time:
Best start pattern is 10 5, -9 9, -1 0, 7 -6, 2 1, -10 9, 6 -7, 2 10, 3 11, 1 9, 0 8, 5 -8, -8 10, -10 8, 4 -9, -9 10, -11 8, 4 12, -12 7, 5 13, -13 6->1000
Best start pattern's ancestor is 10 5 ,-9 9 ,-1 0 ,7 -6 ,2 1 ,-10 9 ,6 -7 ,2 10

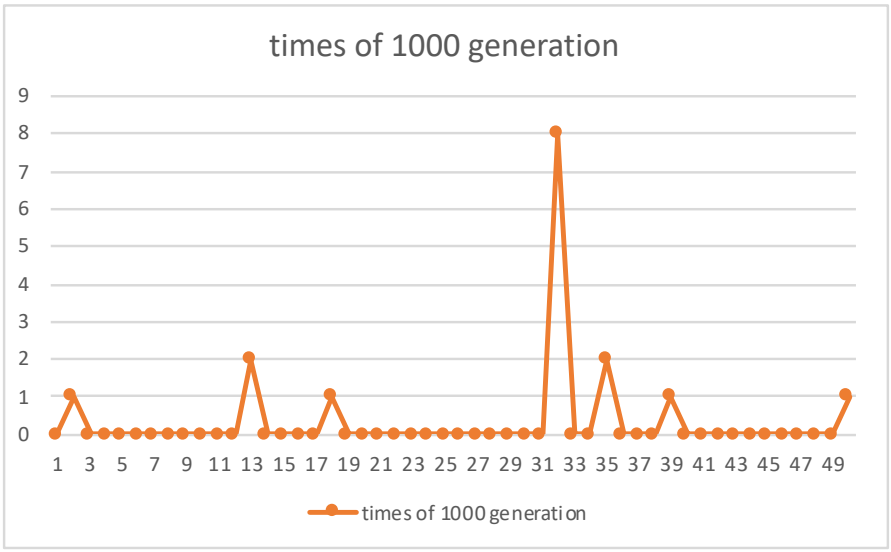
2)Individual：10 generation：10 mutation probability：10% evolution probability:90%



Data Analysis: Under this condition , we run the program 5 times, and each time we found the best start patterns and the best start pattern's ancestor.From this chart, we can get the number that is generation of subsequent can be 1000 at least. The maximum number is 26 and its string is 10 10 ,-3 -4 ,0 -8 ,-5 0 ,9 -4 ,0 -2 ,-10 0 ,9 4 ,-4 -10 ,10 -8 ,4 9 ,-10 6 .Therefore this start pattern can generate the best group.
The first time:
Best start pattern is 10 -5, 3 4, 6 -8, -1 -1, 10 -8, -6 3, -1 -9, -5 -8, 6 1, -5 -5, 9 -8, -9 8, -8 -5, 6 9, 3 7, -9 6, -5 4, -7 2, 7 2, 5 0, -4 -7, -6 -9, -7 -10, -3 -6, 4 -1, -8 7, -10 5, 0 0, -2 -2, 4 8, 2 6, -8 -11, 4 5, 2 3, 11 -4, 9 -6, 8 3, -3 -3, 11 -7, 9 -9, -4 -4, -6 -6, -7 -7->1000
Best start pattern's ancestor is 10 -5 ,3 4 ,6 -8 ,-1 -1 ,10 -8 ,-6 3 ,-1 -9 ,-5 -8 ,6 1 ,-5 -5 ,9 -8 ,-9 8 ,-8 -5 ,6 9 ,3 7 ,-9 6
The second time:
Best start pattern is 10 0, 10 1, 5 -7, -6 -8, -5 -6, -2 10, -7 0, 4 0, 9 -2, -4 -5, -6 -7, -1 11, -3 9, -3 -4, 11 1, 9 -1, -4 8, -5 7, -6 1, -8 -1, 8 -2, 0 12, -5 -7, -7 -9, -7 -8->1000
Best start pattern's ancestor is 10 0 ,10 1 ,5 -7 ,-6 -8 ,-5 -6 ,-2 10 ,-7 0 ,4 0 ,9 -2
The third time:
Best start pattern is 10 3, 2 7, -5 2, 8 -7, 7 -10, -7 -4, -7 10, 8 -9, 6 -11, -6 11, -8 9, 9 -8, -4 3, -6 1, 9 -6, 7 -8, -7 0, -3 4, 11 4, 9 2, 10 -5, 11 -4, 6 -9, 5 -10->1000
Best start pattern's ancestor is 10 3 ,2 7 ,-5 2 ,8 -7 ,7 -10 ,-7 -4 ,-7 10
The fourth time:
Best start pattern is 10 -1, -3 4, 4 -5, 10 9, -7 -9, -6 -8, -8 -10, -9 -11, 11 10, 9 8, 12 11, 8 7, 7 6, -10 -12, 13 12, -5 -7, -11 -13, -4 -6, 14 13, -3 -5, 5 -4, 3 -6, 6 -3, -12

-14, 6 5, 11 0, 9 -2, 15 14, 5 4, 2 -7, 4 3, -2 -4, 12 1, -2 5, -4 3, 16 15, -13 -15, 8 -3, -1 -3, 0 -2, 1 -1, 7 -2, 1 -8->1000
Best start pattern's ancestor is 10 -1 ,-3 4 ,4 -5 ,10 9 ,-7 -9
10 7 ,9 8 ,10 -1 ,-8 3 ,10 -4 ,5 6 ,-3 -8
The fifth time:
Best start pattern is -7 -1, 7 -6, 4 9, -5 5, 10 0, 1 10, -5 8, 0 -6, 2 5, -10 5, -2 -6, -10 1, -7 -8, -3 10, 2 4, -8 -6, 10 5, 11 1, 9 -1, -2 11, -4 9, 3 5, 1 3, 11 6, 12 2, 1 -5, 13 3, 12 7, 2 11, 0 9, -1 -5, -3 -7, -2 -8, -1 12, 6 -4, 4 -6, 14 4, 2 -4, 4 6, -7 -5, -9 -7, 8 -2, 8 3, -9 6, -11 4, 3 12, -8 7, 3 -7, 3 -3, 7 12, 3 13, 4 14, 6 11, 12 3, 4 2, -4 6, -5 -7, -6 -2, 11 2, 9 -4, -5 1, 1 -10, -6 4, 8 -5, 2 12, 0 10, -8 -2, -1 9, 12 -1, -5 -1, 6 4, 5 3, 10 1, 6 -9, 7 -8, 4 -11, 3 1, 3 8, 9 0, 1 11, -8 -7, 5 -10, -4 2, -6 -8, -7 -9, -7 -3, -2 8, 5 10->1000
Best start pattern's ancestor is 10 0 ,1 10 ,-5 8 ,0 -6 ,2 5 ,-10 5 ,5 -5 ,-2 -6 ,-10 1 ,-7 -8 ,-3 10 ,2 4 ,-8 -6 ,10 5

3)Individual： 10 generation： 10 mutation probability： 90% evolution probability:10%



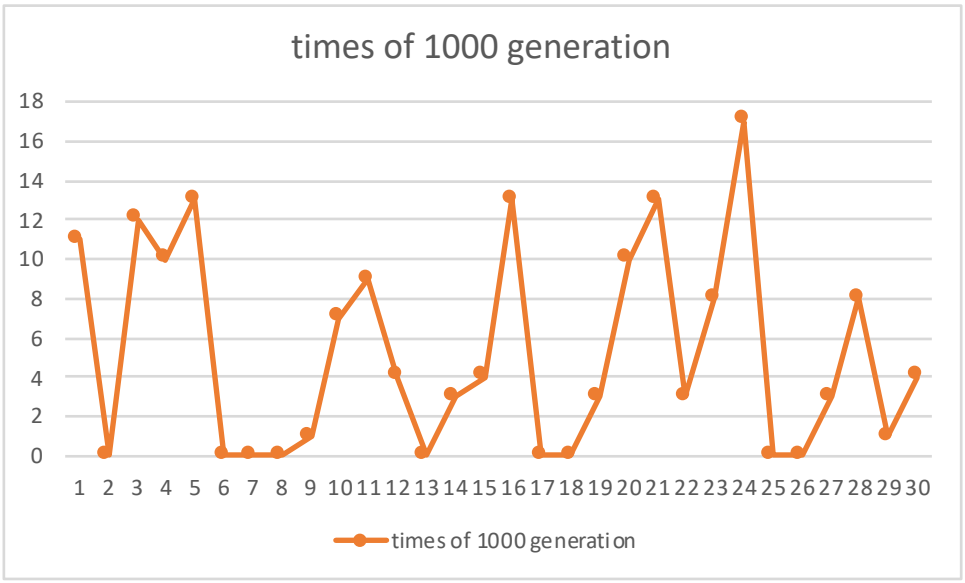
Data Analysis: Under this condition , we run the program 5 times, and each time we found the best start patterns and the best start pattern's ancestor.From this chart, we can get the number that is generation of subsequent can be 1000 at least. The maximum number is 8 and its string is 10 -3 ,7 3 ,9 -8 ,8 8 ,3 6 ,-7 9 ,6 -1 ,7 2 .Therefore this start pattern can generate the best group.

The first time:

Best start pattern is 3 8, -10 -7, -4 -4, 5 9, 2 10, -1 -4, -8 6, 3 11, 1 9, 6 10, 4 8, 4 9, 2 7, 3 7, 1 6, -3 -3, -5 -5, -9 -6, -11 -8, 4 12, 5 10->1000

Best start pattern's ancestor is 10 2 ,-4 -4 ,2 10 ,-1 -4 ,3 8 ,-7 -10 ,-8 6 ,5 9 ,3 8
The second time:
Best start pattern is -1 9, -7 -3, -3 10, 7 3, -8 0, 3 1, 3 7, -10 -2, 1 -1, 6 2, 10 -10, 9 10, 9 5, -7 1, -2 8, -9 -1, -6 2, 7 8, 4 8, 1 6, -8 10, 0 2, 11 10, 9 8, -2 -6, -4 -8, 7 -3, 8 4, -8 -4, 10 -8, -6 -2, -3 7, 10 11, 2 0, 6 1, -9 -5, -11 -3, 2 6, 8 9, 6 7, 10 6, -7 11, -9 9, 1 5, 11 -7, 9 -9, 11 -9, 9 -11, -3 -7, -5 -9, -5 -1, 8 -10, 11 12, 11 7->1000
Best start pattern's ancestor is 10 -3 ,4 8 ,-10 10 ,-3 -7 ,1 3 ,8 -2 ,1 6 ,1 -7 ,-8 10 ,7 3 ,10 9 ,0 2
The third time:
Best start pattern is 10 10, 3 -9, 1 6, -2 -1, 10 1, 6 1, 1 3, -7 -3, -2 -3, -1 -3, -7 2, 3 -1, -8 7, -1 -8, -1 0, 11 11, 9 9, -1 -2, -3 -4, 0 -7, -2 -9, -6 -2, -8 -4, 0 -2, -2 -4->1000
Best start pattern's ancestor is 10 10 ,3 -9 ,1 6 ,-2 -1 ,10 1 ,6 1 ,1 3 ,-7 -3 ,-2 -3 ,-1 -3 ,-7 2 ,3 -1 ,-8 7 ,-1 -8 ,-1 0
The fourth time:
Best start pattern is -6 9, 0 -3, -7 -3, 3 -7, 2 9, 5 -3, -1 -2, -5 5, 4 5, -6 5, 5 4, -7 3, 8 -1, -2 -1, -8 2, 2 4, 4 10, 10 4, -6 4, 9 0, 7 -2, 3 10, 1 8, 11 5, 9 3, 5 6, 3 4, 4 11, -5 6, -7 4, -9 1->1000
Best start pattern's ancestor is 10 4 ,5 -5 ,-7 -3 ,2 9 ,-6 9 ,4 5 ,-1 8 ,-3 5 ,-6 5 ,2 -8 ,-7 3 ,-3 0 ,4 2 ,-1 -2
The fifth time:
Best start pattern is 11 12, 9 5, -10 0, 1 -5, 4 -6, 5 -5, 10 9, -9 1, -11 -1, -8 2, 0 -6, -3 -1, -6 0, -7 3, 2 -8, -6 -1, -2 0, -4 -2, 11 10, 9 8, 8 7, -4 6, 6 10, 4 8, -7 -1, 10 6, 8 4, 10 11, 6 -4, -2 -4, 3 -7, 1 -9, -1 -11->1000
Best start pattern's ancestor is 10 9 ,5 9 ,-3 -1 ,-7 3 ,0 -6 ,-10 0 ,-6 -1

2.We change the number of initial pattern.



1)Individual： 10 generation： 10 mutation probability： 50% evolution probability:50%

Data Analysis: Under this condition , we run the program 3 times, and each time we found the best start patterns and the best start pattern's ancestor.From this chart, we can get the number that is generation of subsequent can be 1000 at least. The maximum number is 17 and its string is 10 5 ,-5 -3 ,5 -6 ,4 -3 ,-9 -10 ,-9 9 ,6 -5 ,8 1 ,8 -1 ,-3 1 ,5 1 ,4 -7 ,-5 9 ,2 7 .Therefore this start pattern can generate the best group.

The first time :

Best start pattern is 4 10, 7 -4, -2 7, 10 8, 10 11, -9 -3, -7 7, 3 2, -6 8, 5 4, -2 0, -4 -9, 1 2, -10 0, 2 -8, 1 7, -5 -8, 10 9, 6 -8, 5 -9, 0 1, 3 4, 9 8, 9 -5, 9 10, 0 -10, -8 6, -8 -5, 2 1, 4 3, 7 1, 8 -3, 6 -5, 8 7, 4 5, 2 3, 8 2, 6 0, -1 1, -3 -1, 5 -6, 2 8, 0 6, 5 11, 3 9, 9 -2, -1 8, -3 6, -7 -4, -9 -6, 6 12, 4 -7, 11 12, -5 9, 3 -7, 1 -9, -1 -11->1000

Best start pattern's ancestor is 10 4 ,-4 -9 ,1 2 ,-10 0 ,0 -2 ,2 -8 ,-4 7 ,1 7 ,-5 -8 ,-3 -9 ,7 -7 ,8 10 ,7 -2 ,10 9 ,2 3

The second time:

Best start pattern is 6 8, 10 1, 4 -9, 1 -8, -1 7, -8 -1, 6 4, 0 8, 3 -5, -1 3, 7 -7, 9 0, -8 -9, 9 -7, 10 -7, 0 -10, -7 6, -3 5, -2 6, -4 4, 1 -9, -1 -11, -5 3, 5 -8, 3 -10, 7 5, 5 3, 4 -4, 2 -6, 11 -6, 9 -8, -6 2, 6 -7, 0 9, -8 5, -9 -8, -9 1, -1 -8, 5 7, 3 -1, -8 1, 5 -3, 7 -1, -7 9, 1 10, 3 5, 6 -2, -11 -1, -7 10, 8 0, -8 9, -10 0, 4 6->1000

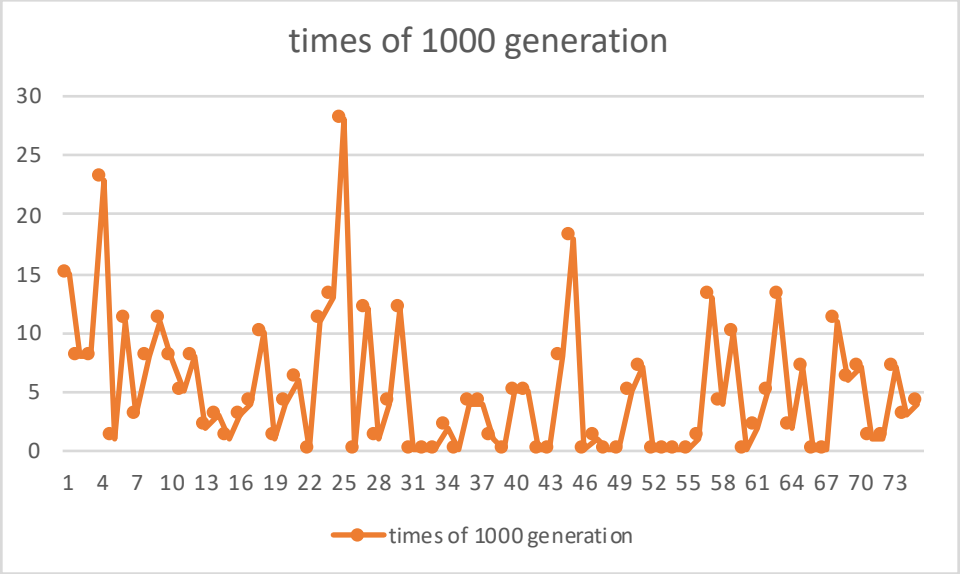
Best start pattern's ancestor is 10 1 ,4 -9 ,1 -8 ,-1 7 ,-8 -1 ,6 4 ,0 8 ,3 -5 ,-1 3 ,7 -7 ,9 0 ,-8 -9 ,9 -7 ,10 -7 ,0 -10 ,-7 6 ,-3 5

The third time:

Best start pattern is 10 5, -9 9, -1 0, 7 -6, 2 1, -10 9, 6 -7, 2 10, 3 11, 1 9, 0 8, 5 -8, -8 10, -10 8, 4 -9, -9 10, -11 8, 4 12, -12 7, 5 13, -13 6->1000

Best start pattern's ancestor is 10 5 ,-9 9 ,-1 0 ,7 -6 ,2 1 ,-10 9 ,6 -7 ,2 10

2)Individual：25 generation：10 mutation probability：50% evolution probability:50%



Data Analysis: Under this condition , we run the program 3 times, and each time we found the best start patterns and the best start pattern's ancestor.From this chart, we can get the number that is generation of subsequent can be 1000 at least. The maximum number is 28 and its string is 10 -2 ,-1 -9 ,1 8 ,-3 5 ,-10 10 ,2 -8 ,-3 8 .Therefore this start pattern can generate the best group.

The first time:

Best start pattern is 6 -7, 4 -9, -8 3, 2 -5, 4 1, -7 2, 1 -6, -8 -1, -7 0, -8 5, 3 6, 2 -9, -2 -10, 0 -9, -10 1, 10 -2, -4 -3, 7 4, -8 1, 8 5, 5 2, -6 3, -3 -2, -5 -4, 6 3, 11 -1, 9 -3, 1 -8, -1 -10, 4 7, 2 5, 0 -7, -9 2, -11 0, 7 -6, 5 -8, -1 -8->1000

Best start pattern's ancestor is 10 -2 ,1 -8 ,2 -9 ,-4 -3 ,-6 1 ,-8 5 ,-2 -10 ,4 7

The second time:

Best start pattern is 1 -1, -1 1, -6 -2, -5 4, -9 10, 10 3, 3 -8, -1 7, -3 -7, 4 -5, 2 -3, 4 5, 4 1, -5 -6, -8 10, -3 -8, 0 0, 1 5, 5 1, -8 -3, -6 -5, 10 -8, 1 4, -3 2, -2 -6, 5 4, -1 -5, 5 2, 3 0, -5 -4, -7 -6, -4 -5, -6 -7, 0 -4, 2 -1, -2 3, -4 1, -3 -4, 6 2, 4 0->1000

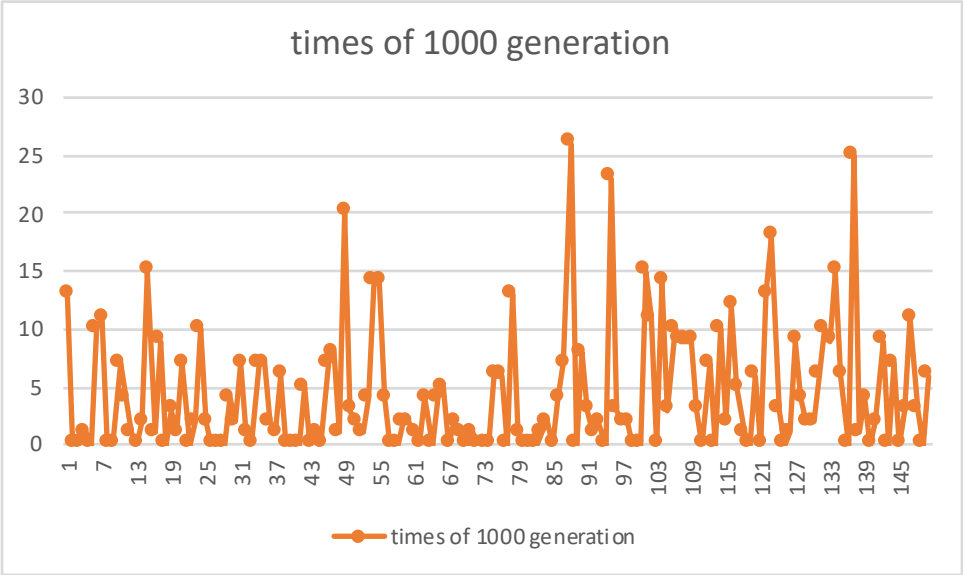
Best start pattern's ancestor is 10 3 ,10 -8 ,0 0 ,-8 -3 ,7 -1 ,1 5 ,-3 2 ,-6 -5 ,3 -8 ,-7 -3 ,4 5 ,-1 1 ,10 -9 ,4 -5 ,-6 -2 ,1 4 ,-3 -7

The third time:

Best start pattern is 0 -2, -2 -6, 8 -6, 10 -5, 7 2, 3 8, -5 1, 10 7, 5 -6, 5 -2, 7 -10, -4 2, -6 0, -1 -5, -3 -7, 4 9, 2 7, 11 -4, 9 -6, -7 -1, 8 -9, 6 -11, 9 -8, 1 -1, -1 -3, 8 -7, 6 -5, 4 -7->1000

Best start pattern's ancestor is 10 -5 ,7 2 ,3 8 ,-5 1 ,-6 8 ,10 7 ,5 -6 ,-6 -2 ,-2 0 ,5 -2 , 7 -10

3)Individual： 50 generation： 10 mutation probability： 50% evolution probability:50%



Data Analysis: Under this condition , we run the program 3 times, and each time we found the best start patterns and the best start pattern's ancestor.From this chart, we can get the number that is generation of subsequent can be 1000 at least. The maximum number is 26 and its string is 10 -2 ,5 9 ,-5 9 ,7 0 ,-5 -8 ,6 -2 ,1 -2 ,8 -1 , 5 -3 ,9 -4 .Therefore this start pattern can generate the best group.

The first time:

Best start pattern is 8 -2, 4 -1, 4 -8, 8 1, 9 12, 2 -1, 6 9, 9 -1, 7 -3, -2 -1, 10 0, 5 0, -4 -3, 3 4, 8 11, 10 7, 0 3, 0 5, 0 7, 1 9, -2 -3, -4 -5, -1 6, -2 5, 1 11, 1 6, 8 5, 2 9, 3 10, 1 4, 7 0, 5 8, 6 1, 9 2, 11 1, 7 10, 10 3, 3 0, -5 -4, 4 1, 5 -2, -3 -2, 9 1->1000

Best start pattern's ancestor is 10 7 ,-8 4 ,-3 -4 ,0 3 ,0 5 ,0 5 ,0 7 ,1 9 ,4 3 ,0 10

The second time:

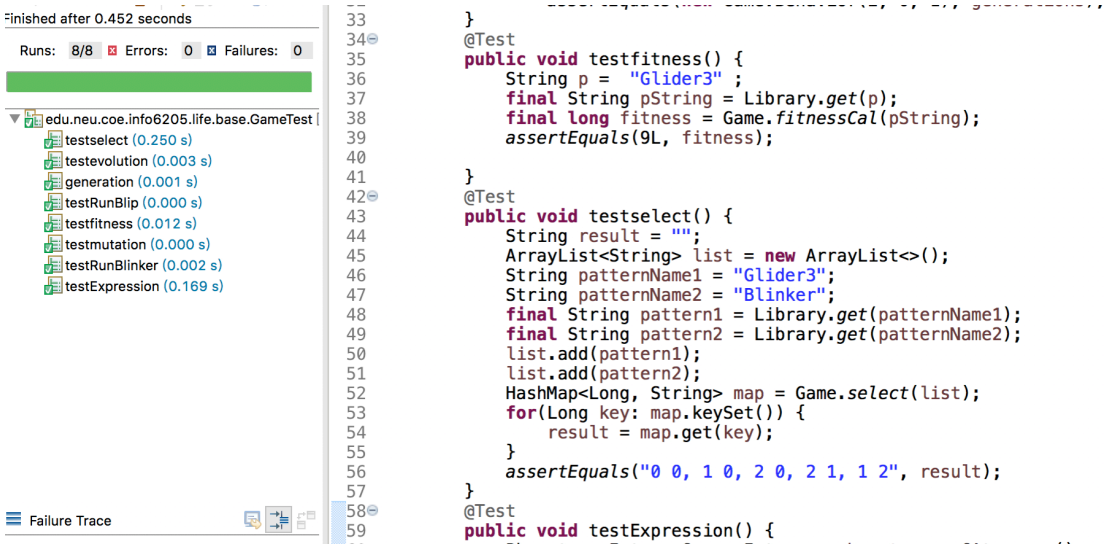
Best start pattern is -3 2, 8 -1, 7 -2, 1 0, 0 1, -11 4, 8 2, 8 5, 3 9, 3 6, -1 8, -7 -8, -2 3, 4 10, -10 5, -14 -13, -8 1, 10 6, -13 -12, -2 -1, -8 -7, -2 -3, -1 0, -7 9, -9 -8, -6 3, 6 1, 2 -7, 7 4, 9 0, -8 7, -1 4, -9 6, -9 -10, 10 1, 11 5, -10 -11, 0 5, 2 1, -11 -12, 6 -3, -12 -11, -10 -9, 1 10, 5 11, -11 -10, 0 9, 7 -8, 4 -1, -3 6, 5 0, 1 2, 3 -2, 4 7, 1 6, -7 2, 6 3, 6 10, 1 -8, -12 -13, 5 8, 6 -9, 0 -1, -4 1, 7 2, -13 -14, -3 -2, 12 6, 10 4, -4 -3, 2 7->1000

Best start pattern's ancestor is 10 6 ,2 -7 ,7 4 ,10 4 ,9 -7 ,8 -1 ,-2 3 ,-8 -9 ,9 0 ,0 -1 ,-2 3 ,-8 7 ,-10 5

The third time:

Best start pattern is -2 7, 3 -2, 1 9, 3 11, -5 7, -1 8, 0 9, -7 -6, -7 -8, -6 -5, 2 10, -7 10, 0 8, -6 11, -8 9, -4 8, -6 6, -7 5, 1 10, -3 6, -1 7->1000
Best start pattern's ancestor is 10 2 ,7 -5 ,-7 -6 ,8 -1 ,-2 3 ,10 -7

7.Test



Our program includes following test case:
The t*estfitness* tested fitness function;

The *testMutation* tested mutation function.

The testExpression tested expression function *(Genotype!= Phenotype)*.

The testselect tested candidate selection function.

The testevolution tested evolution function.

8.Conclusion

We apply the method of control variables:

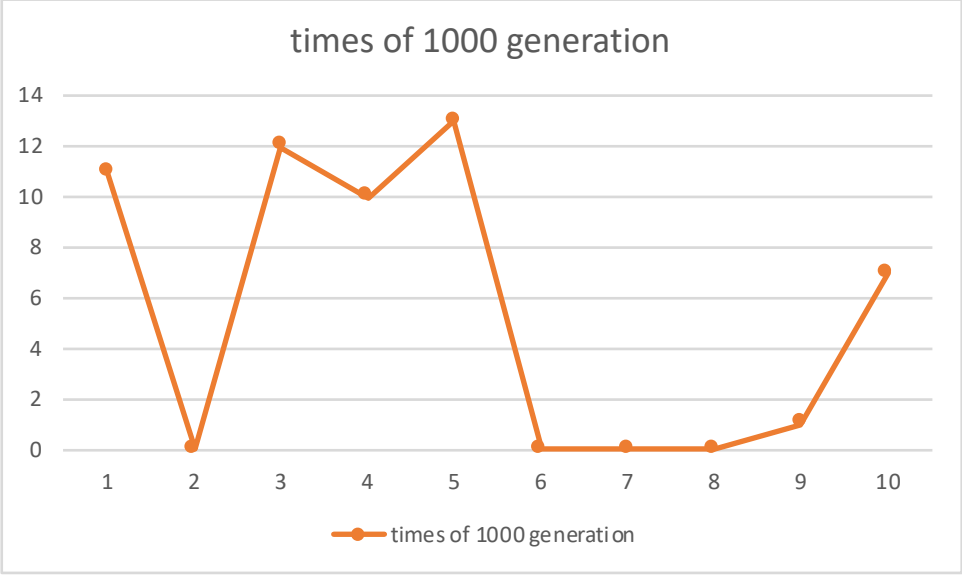
Under the first condition, we change the mutation probability and evolution probability and the number of individual is constant.

Under the second condition, we change the number of individual and the mutation probability and evolution probability is constant.

Through running program each time we can get satisfactory pattern and its ancestor.But we set the maximum fitness of this project is 1000, so this satisfactory pattern is one of the best pattern.

But we think it is not enough. So we also count the number that is generation of subsequent can be 1000 at least and so we can know that this initial pattern can generate the best group very likely.For example, if we set the number of initial individual is 10 ,its generation is 10 and mutation probability ,evolution probability are 50%. Like the following chart, we can get the maximum number is 13 and its string is 10 -4 ,0 3 ,4 -6 ,10 7 ,-10 6 ,-4 8 ,-9 -6 ,1 -6 ,-3 -7 ,-3 10 ,-8 9 ,10 10 ,-8 10 ,-5 -6 ,4 1 ,-10 -2 ,4 9.So running this program ,we can also find the best individual.

Therefore, we think it is a meaningful research.



Also we also found that it maybe the points of shape are more tight, it maybe can generate more offsprings and survive more generations.