K. Kalenik, Master student
O. Grabar, PhD., As. Prof., research advisor
L. Mohelnytska, PhD in Phil., As. Prof., language advisor
Zhytomyr State Technological University

THE GENETIC ALGORITHM. THE ISLAND MODEL OF GENETIC ALGORITHM

The genetic algorithm (GA) is an evolutionary search algorithm which is used for solving optimization problems. GA is based on Ch. Darwin's principles of natural selection. GA is a stochastic method. These algorithms are successfully applied in various fields (economics, physics, engineering sciences, etc.). Different versions of GA are created and a number of test functions are developed.

The idea of using analogue of evolution mechanisms lies in the basis of genetic algorithms for finding solutions. As it is known, the basic concepts of the evolution theory are heredity and natural selection. The same mechanisms are used in GA for finding the solution.

The work of GA can be described in such stages. At the beginning the population is initialized in a random way. The population has such characteristics as quantity, number of genes in every individual and their category. Individuals of a population are estimated according to the selected criterion and the result of the estimation determines their fitness. The higher the fitness of an individual is the greater the chance is that it will participate in the crossing. When crossing two individuals "the exchange of genetic information" takes place. This means that relevant genes exchange their bits. This operation is called crossingover. Mutation is all the same as reproduction. There is some a part of mutants m, which is a parameter of genetic algorithm and at the stage of mutations pm individuals should be selected, and then they should be changed according to predetermined operations of mutation. The descendents received as a result of crossing make the next generation instead of the previous one, and everything is repeated from the very beginning, but this time for the newly created generation.

Basic principles of GA are enclosed in the following chart (Fig. 1)

1. Generate initial population of n chromosomes.
2. Calculate suitability of each chromosome.
3. Choose a pair of parent chromosome using one of the selection methods.
4. Cross over two parents with probability of pc, producing two offspring.
5. Conduct the mutation of descendants with probability pm.
6. Repeat steps 3-5 until a new generation of a new population containing n chromosomes is generated.
7. Repeat steps 2-6 until the criterion of the process completion is reached.

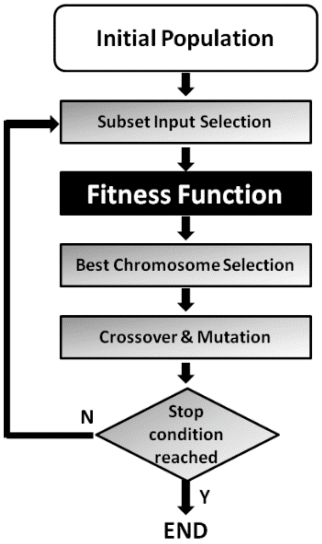

Fig. 1. Scheme of a simple genetic algorithm

At the end of the work the best adapted individual in a population, or rather its genes will represent the solution of the problem, found with GA. Mechanisms underlying the GA can not guarantee finding the best solution, but they are likely to find one of the best decisions.

The island model is the most common model of parallel GA. Its essence is that the population composed of a very large number of individuals is divided into subpopulations of the same size. Each subpopulation is processed with a separate processor with the help of one of the varieties of GA nonparallelism. Sometimes, for example, in five generations the subpopulations will exchange a few individuals. Such migration allows subpopulations to share genetic material.

Introducing migration into the island model allows us to find various dominant individuals in subpopulations. It helps maintain diversity in the population. Each subpopulation can be regarded as an island. During migration subpopulations share their dominant genetic material. Under intensive migration of a large number of individuals mixing of genetic material takes place. Thus local differences between the islands are eliminated. Very rare migrations do not allow us to prevent premature algorithm convergence in small subpopulations.

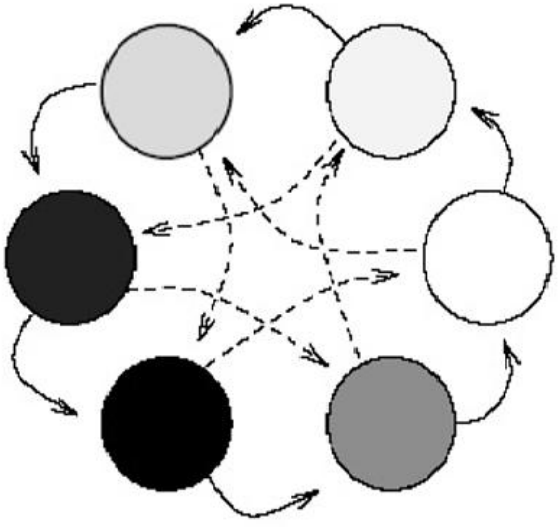

Fig. 2. Island model

In the model migration from each island can occur only at a certain distance, i.e. 2-5 islands depending on the amount of subpopulations. Thus, each island is almost isolated. The number of islands, to which individuals of every subpopulation can migrate, is called isolation distance. It should be noted that mutual migrations are impossible (Fig. 2).

In the island GA model various combinations of the ways of selection and formation of the next generation can be simulated. It also enables the use of different GA operators combinations in different populations.

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