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**PRINCIPLES OF FORMATION OF GENERATIONS IN GENETIC ALGORITHMS**

The problem of finding suboptimal solutions in simulation models of "large systems", such as a system for managing technological modes of complex production, a system for optimal management of financial, logistic and material flows of a large corporation, an investment portfolio management system, etc. [1]. The search for optimal solutions in such systems should be carried out according to a set, as a rule, competitive and different-scale criteria with complex constraints. The problem is that optimization by multiple criteria at once requires significant time and computational resources. At the same time, since the objective functions of many variables (more than 10) generate a multidimensional space for finding solutions, the computational complexity of the optimization problem, as a rule, becomes an obstacle to its solution in an admissible time. An analytical description and a rigorous solution of such a problem in practice, as a rule, is not feasible. When solving this class of problems, algorithms of the metaheuristic class have proven themselves well, which allow, without fully examining the region of feasible solutions, with a certain probability to find the global extremum in single-criterion problems and the Pareto front in multi-criteria. One of the widespread classes of metaheuristic algorithms is genetic algorithms (GA), the theory of which was developed by J. H. Holland in 1975 [2]. It has been proven that GAs have significantly less computational capacity than a simple enumeration method, and a number of advantages compared to other methods for solving optimization problems, but they always have the risk of converging to a local optimum instead of a global one [3].

The strategies for the formation of new generation populations are based on two main directions:

1. New persons (descendants) take the place of their parents. Then comes the next stage, in which the offspring are evaluated, selected, give offspring and give way to their "children".

2. An intermediate population is created, which includes both parents and their offspring. Members of this population are evaluated, and then the best N are selected from them, which will enter the next generation.

Which of these two options is better - it is difficult to answer unequivocally. Obviously, the second option is more practical (as it does not allow to replace adapted parents with "unknown who"), but there may be more problems with premature convergence than in the first option. In addition, it requires sorting an array of size (at least) 2 \* N.

The principle of "elitism" is that the best parents are included in the new generation. Their number can be from 1 and more. The use of "elitism" allows not to lose a good intermediate solution, but, at the same time, because of this, the algorithm can "get stuck" in the local extremum. However, the experience of using the principle of "elitism" allows us to conclude that in most cases, "elitism" does not harm search solutions, and most importantly - to give the algorithm the ability to analyze different lines from the search space.

The classical description of the genetic algorithm implies the creation of a population of offspring and the replacement of parental persons by their "children". This approach is quite good, but not particularly effective, because the offspring obtained by genetic transformation may be worse than the parents. As a result, there are several approaches that correct this phenomenon, which can be combined using the concept of "elitism" (sometimes) "elitism strategy" (elitist strategy) .The following is a brief description of these approaches.

### Conditionally elitism can be divided into two classes-approaches, we will call them competitive and non-competitive:

### 1. Competitive approach. Parents "compete" with the offspring and the winners (or winners) pass on to the next generation.

### 2. Non-competitive approach. In this case, part of the parent subpopulation (random or determined by a given rule) passes into a new generation without any objections from the electorate.

### In other words, in the first grade, the descendants after creation have, in general, equal rights with their parents to pass to the new generation, and the decisive factor here is the adaptation of the person, not his position on the family tree. In the second grade, older individuals have a certain priority, and even if all offspring are better than any parent, some part of the parental subpopulation will inevitably be present in the new generation.

### Consider each class in more detail. In this case, we will, if possible, take into account developments in the field of evolutionary strategies (evolutionary strategies). Evolutionary strategies have a history dating back to at least the mid-1960s, and the symbols used in them are quite convenient for showing different approaches to elitism.

***Competitive approach***. We distinguish in the class of competitive approaches 2 subclasses:

* global competition
* local competition

In a global competition, all the offspring are created first, who then compete on a common basis with all the parents, and those who turn out to be the best, regardless of age, pass into a new generation. That is, after the creation of offspring, their adaptation is determined and, knowing the adaptation in the current population (ie in the population from which the parents were selected), you can sort people from the current population and offspring to form a population for the next generation. Descendants do not necessarily compete with all individuals from the current population, you can arrange a championship by taking only parents and their descendants. The main thing in global competitions is for individuals to compete together.

A slightly different approach is used in local competitions. Consider a fairly common case where two parents are used to create two offspring. Then, immediately after creation, the offspring are evaluated, and then the offspring compete only with their parents. Here the problems of the family are solved within the family. In this way, the population of the new generation is formed from the winners of numerous local competitions.

In terms of evolutionary strategies, the competitive approach corresponds to a (mu + lambda) strategy (called a "plus strategy"), where mu is the number of parent individuals and lambda is the number of offspring created.

***Non-competitive approach***. In a non-competitive approach, everything is much easier. After estimating the current population, some of the best individuals are selected, and they "automatically" fall into the next generation. In this case, elite individuals can participate in crossbreeding on an equal footing with other individuals. Due to the fact that, thus, parents do not compete in one form or another with the offspring, this approach is called non-competitive. In evolutionary strategies, the non-competitive approach corresponds to the (mu, lambda) strategy (the literal translation looks like a "comma strategy"), the content of the variables mu and lambda remains the same.

In any case, we should not forget about the "formula for success" in genetic algorithms, which can be formulated as follows: "It is necessary to strike a balance between the study of search space (exploration) and the use of good solutions (exploitation)." That is, if elitism is used, in other words, the already found good people are used more actively, then measures are needed to compensate for the influence of elitism, such as increasing the likelihood of mutation, or increasing population size, or banning the existence of "twins" in the population. Otherwise, the risk of premature convergence increases significantly. The use of elitism, in general, can significantly improve the performance of the GA. However, elitism must be used with some caution to avoid premature convergence. As a result of classification of known methods of elitism it is offered to allocate the following approaches:

* Competitive approach with local competition.
* Competitive approach with global competition.
* Non-competitive approach.

**References**

1. Akopov A.S., Hevencev M.A. (2013) A Multi-agent Genetic Algorithm for Multi-objective Optimization. Proceedings of *2013 IEEE International Conference on Systems, Man and Cybernetics. Manchester, UK, October 13-16, 2013*. IEEE,pp. 1391-1396.
2. Holland J.H. Adaptation in natural and artificial systems. – Ann Arbor: University of Michigan Press, 1975.
3. T. Yu, L. Davis, An Introduction to Evolutionary Computation in Practice, in: T. Yu, L. Davis, C. M. Baydar, R. Roy (Eds.), Evolutionary Computation in Practice, vol. SCI 88, Springer, 1–8, 2008.