A Comparative Study of Several Evolutionary Algorithms

Busheng Li and Jingfang Hu

ABSTRACT

Evolutionary algorithm is a search and optimization method that is evolved from the laws of biological evolution. It includes four kinds of genetic algorithms, genetic programming, evolutionary strategies and evolutionary programming. This paper briefly introduces the concept of evolutionary algorithm and the relationship and difference between the four schemes.¹

KEYWORDS

Genetic Algorithm, Genetic Programming, Evolutionary Strategy, Evolutionary Programming

INTRODUCTION

Evolutionary algorithm is a method of searching and optimizing, which is evolved from the law of biological evolution. It includes four typical methods: genetic algorithm, genetic programming, evolutionary strategy and evolutionary programming. Evolutionary algorithms are mainly used to solve complex problems such as structural optimization, nonlinear optimization and parallel computation. When solving the problem, the basic objective is to pursue the convergence of groups, and ensure that the algorithm tends to the global optimum.

¹Busheng Li, Jingfang Hu. School of Information Engineering, Jingdezhen Ceramic Institute, Jiangxi, P.R. China.
DETAILED ANALYSIS OF EVOLUTIONARY ALGORITHMS

Evolutionary algorithm is composed of four typical schemes: genetic algorithm, genetic programming, evolutionary strategy and evolutionary programming. There is no essential difference between the four methods. The difference is only in the continuous improvement and improvement of the operator, and the emphasis of solving the problem is different. Specific expressions, initial population generation methods, fitness calculation, genetic manipulation and other aspects of the differences and relations are shown in table 1.

|                          | Genetic Algorithm | Genetic Programming | Evolution Strategy | Evolutionary Programming |
|--------------------------|-------------------|---------------------|--------------------|-------------------------|
| Exchange operator        | Exchange between characters | Interchange between subgenes | Exchange between components | |
| Mutation Operator        | Character inversion | Node mutations | Variance variations | Variance variations |
| Replication (selection) operator | The choice of randomness is limited to the selection of the parent group | The deterministic selection is often selected from the offspring group and also includes the parent group | Random selection is selected from the parent and offspring groups |
| Genetic manipulation     | Replication, exchange, mutations | Replication, exchange, fewer mutations | Variance mutation, recombination, deterministic selection | Random selection of variance mutation |
| Fitness                  | Individual performance indicators are often appropriately transformed to adjust selection | Regular fitness, fitness, standard fitness, adjustment fitness | Individual performance indicators | Individual performance indicators |
| Method of generating initial population | Randomly selects characters from 0 to 1 to form strings | Then the nodes are selected from the function set and terminator set to form hierarchical expressions | Starting from a feasible real number vector, the initial population is generated by mutation | Starting from a feasible real number vector, the initial population is generated by mutation |
| Ways of expression       | Fixed length 0/1 strings and decimal strings are also available | In a hierarchical computer program format, represented by functions and terminators | Real number vector of decimal representation | Real number vector of decimal representation |
COMPARISON BETWEEN FOUR SCHEMES OF EVOLUTIONARY ALGORITHMS

Limitations of Comparison Between Genetic Algorithm And Genetic Programming

Genetic algorithm is the operation of string, and gradually realize the evolution of genetic, can solve many complex problems. However, due to the commonly used string representation problem of fixed length genetic algorithm, its application range is limited. The main disadvantage of genetic algorithm is that:

(1) Can't describe hierarchy problem. Polynomial f (x) = A0 + A1x + A2x2 + A3x3, it is difficult to use fixed length string expression, it can essentially be represented by a graph.

(2) Computer programs cannot be described. In the field of artificial function, computer automatic programming is a hot topic, but genetic algorithm can only change the form of string, cannot form a hierarchical computer program.

(3) Lack of dynamic variability. Because string is fixed length, it is difficult to express dynamically the change of behavior or state.

Comparison of Evolutionary Strategies And Genetic Algorithms

SAME POINT

(1) "Survival of the fittest in natural selection, survival of the fittest" principle, from the initial random feasible solution of evolution through merit, gradually approach the optimal solution.

(2) Progressive search optimization, after many iterations, to expand the search scope, find the global optimal solution.

(3) All use the concept of group. At the same time, multiple search points are driven to reflect the characteristics of the parallel algorithm (adaptive search, guided search, global optimization, black box structure, etc.).

DIFFERENCE

(1) Difference of expression. Evolutionary strategy (decimal) is used to deal with continuous optimization problems. Genetic algorithm (binary coding) is used to deal with discrete problems.

(2) Difference of operators. The recombination operator of evolutionary strategy can not only replicate the parent factor, but also generate new information. The mutation of evolutionary strategy is to add a normal distribution of random numbers on the basis of old individuals, thus producing new individuals. The genetic algorithm is a complement to a character of an old individual. In evolution strategy, mutation is necessary for every individual, and it is the most important evolutionary method. The selection of evolutionary strategy is to select a group of individuals
from a lambda individual or a lambda + lambda individual, and the selection method is determined.

(3) Differences in execution sequence. The evolutionary strategy is to perform the reorganization first, then the mutation, and finally the choice. Genetic algorithm first performs selection and replication, followed by exchange, and finally mutation. The recombination and mutation of the evolutionary strategy are carried out in the same old order, and the exchange and mutation of the genetic algorithm do not necessarily occur on the same old individual.

CONCLUSIONS

Evolutionary algorithm as a search algorithm, although there are a lot of changes, but they are the basic calculation model based on the natural evolutionary process, with the traditional calculus method and exhaustive method optimization algorithm based on evolutionary algorithm is compared to a mature and has high robustness and applicability of the method for global optimization. It has the characteristics of self-organization, self-adaptation and self-learning, and can effectively deal with complex problems which are difficult to solve by traditional optimization algorithms without the limitation of the problem.

REFERENCES

1. Yang Yingqing, Zhao Feng. Semi supervised multi objective evolutionary clustering algorithm applied to color image segmentation [J/OL]. computer application research, 2017, (10): 1-2
2. Wang Ling, Zhou Dongfang, Bai Rong. Fault tolerant diagnosis of analog circuits based on differential evolution weed algorithm [J/OL]. computer application research, 2017, (09): 1-4
3. Wang Qinghe, Chai Wan Gang, Zheng, Li Dengfeng. Study on the multi objective [J/OL]. allocation method for cooperative multi machine computer application based on improved genetic algorithm 2017, (09): 1-2