The Operator of Genetic Algorithms to Improve its Properties

Aijun Li

Information and Technology College, Tianjin University of Technology and Education

He Xi Qu Liu Lin Dong, Tianjin 300222, China

E-mail:aij_li@126.com

Abstract

Based on the traditional genetic algorithm, proposed an improved adaptive genetic algorithm, the experimental results show that the improved adaptive genetic algorithm results than standard genetic algorithm much better and effective to improve the convergence of genetic algorithm optimization of speed and efficiency.

Keywords: Genetic algorithm, Adaptive, Crossover, Mutation

1. Introduction

Genetic algorithm is a kind of bionic algorithm that simulates natural process of biological evolution developed problem-solving strategies and approaches. It has a variety of coding techniques to represent the complex structure, and through a set of codes that a simple genetic operation and survival of the fittest in natural selection to guide the study and determine the search direction. It is starting from an initial population, constantly repeat the selection, crossover and mutation process, so that more and more closer to a target population evolution.

2. Basic genetic algorithm

Basic genetic algorithm is summarized by Goldberg as a basic genetic algorithm, the genetic evolution operation formed the basis of the genetic algorithm.

3. Improved Adaptive Genetic Algorithm

Constraints in the genetic algorithm runs through the genetic operations has always been, this will certainly affect the efficiency of operations. Because as the evolution progresses, the lower the fitness of some individuals have been gradually eliminated, while the higher fitness individuals more and more, and are concentrated in the vicinity of the most advantages. The main idea of this method is the evolution of several generations in a group, it will remove the weak solution space, in the future evolution of the process with the same group size only in the strong solution space groups, breeding. You can increase the strong solution space of the individual density to improve the accuracy of solution, which helps produce excellent performance of individuals and groups likely to shorten the evolutionary process. Such adaptive genetic algorithm for optimization of complex functions; numerical results show that the method is effective and reliable.

Compared with the general genetic algorithm, adaptive genetic algorithm crossover probability and mutation probability is not a fixed value, but by groups, fitness adaptive adjustment, adaptive genetic algorithm steps:

(1) Using randomly generated N (N is even) the initial group of candidates, such as the method of solution to form the initial population.

(2) The definition of fitness function to calculate each individual's fitness f_i.

(3) In accordance with rules of roulette selection method select N individuals from the calculation, the average population fitness f_{avg} and the largest fitness f_{max}.

(4) For each individual, according to formula (1) calculate the probability of adaptive crossover P c. With Pc as the probability of crossover, that is randomly generated R (0, 1), if R < P c Then the operation of the individual cross.

$$pc = \begin{cases} \dfrac{k_1(f_{max} - f')}{f_{max} - f_{avg}}, & f \geq f_{avg} \\ \\ k_2, & f < f_{avg} \end{cases}$$

(5) For the group of all N individuals of, in accordance with formula (2) Calculate the probability of adaptive mutation

Pm. With mutation probability Pm is the mutation operation, that is randomly generated R (0, 1).if R< Pm Then the mutation operation on the chromosome.

$$pm = \begin{cases} \dfrac{k_3(f_{max} - f')}{f_{max} - f_{avg}}, & f \geq f_{avg} \\[2em] k_4, & f < f_{avg} \end{cases}$$

(6) Calculated from the crossover and mutation generate a new individual's fitness, the new individual and parent groups together constitute a new generation.

(7) To determine the number of iterations to run, to meet the requirements then the optimization process is complete; otherwise transfer step (4). In equation (1), (2), f_{max} every group of individuals on behalf of the largest fitness value; f_{avg} the average population per generation fitness value; f' is the cross of the two individuals was chosen larger fitness value; f was chosen the fitness value of individual variation. As long as the set k_2, k_4 take (0, 1) interval values, you can self-adaptive adjustment. And usually take $k_1 = 0.9, k_2 = 0.6$.

4. Analysis of experimental results

Improved adaptive genetic algorithm optimization of the maximum demand function:

$$f(x) = 10 * \sin(5 * x) + 7 * \cos(4 * x) - (x - 7)^2 + 62 \qquad x \in [0, 12]$$

Set population size set to 40, respectively, the proportion of genetic operators selection, single-point crossover and single-point mutation, mutation probability of dynamic adjustment, that is, the late iterations in the algorithm increases the probability of mutation, this method can greatly to avoid early algorithm converge to a local optimal solution, the largest 300-generation evolution of algebra. The results are shown:

Standard genetic algorithm for solving the optimal value is 77.2446, run time of 5s.

Improved genetic algorithm for solving the optimal value is 78.5736, run time is 2s.

References

Hyun-ray and South Chengrun Wei, (2004). *Genetic Algorithm and Engineering Optimization*, Tsinghua University Press, Beijing.

Wang Xiaoping, Cao Liming. (2002). *"genetic algorithms - theory, application and software implementation"*, Xi'an Jiao tong University Press, 2002, P98.

Yang Ping, ZHENG Jin-hua. (2007). *Comparison of genetic operators and research*. Computer Engineering and Applications, 2007, 43 (15):59-65.

Zhang Xiaoqin, HUANG Yu-qing. (2005). Heuristic based on tabu search algorithm for solving knapsack problem the University of *Electronic Science and Technology Journal*, 2005(3):359-362.
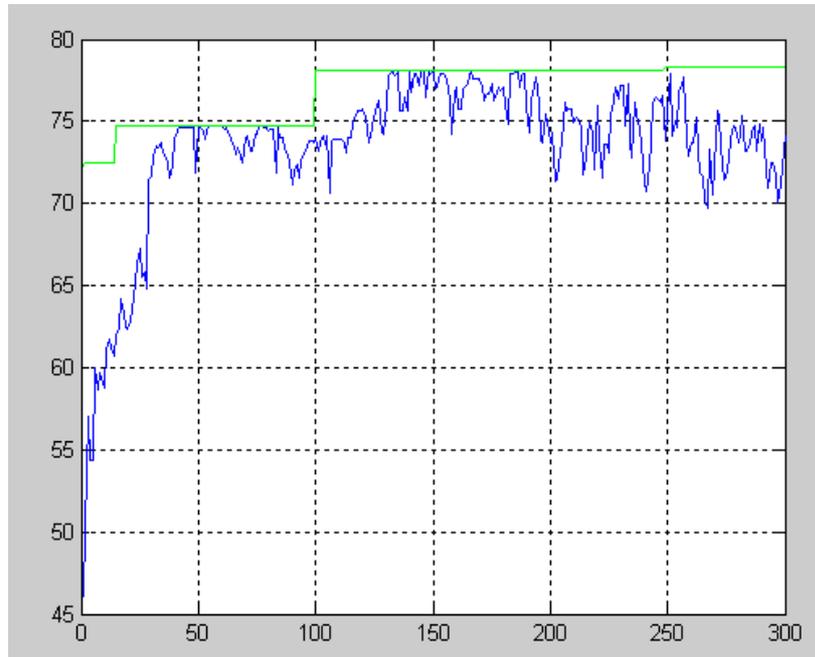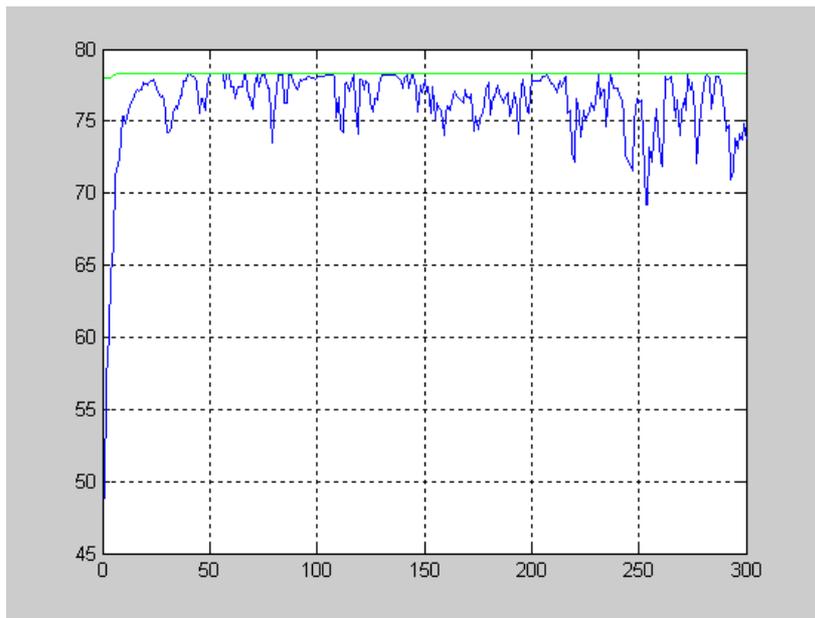
Figure 1. Adaptive Genetic Algorithm for the Traditional Result

Figure 2. Improved Adaptive Genetic Algorithm Results