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An Improved Adaptive Genetic Algorithm and its Application in Intelligent Course Scheduling System

Xiaofeng Wu, Lu Zhang*

College of Electrical and Information Engineering, Quzhou University, Quzhou Zhejiang 324000, China

Abstract

In this paper, the initial population, coding design, adaptive crossover and mutation operators and conflict detection methods of traditional genetic algorithm are studied. Using the operator operation with better performance, the crossover rate and mutation rate are adjusted nonlinearly according to the individual fitness between average fitness and maximum fitness, and an improved new adaptive genetic operator is constructed, An improved new adaptive genetic algorithm is designed, which makes the algorithm jump out of the local optimal solution and improves the accuracy. On this basis, the elements and constraints of college course scheduling are analyzed, the mathematical model of College intelligent course scheduling system is established, and the improved adaptive genetic algorithm is applied to college intelligent course scheduling system.

Keywords

Adaptive Genetic Algorithm; Conflict Detection Mechanism; Intelligent Class Scheduling; Class Scheduling Model.

1. Introduction

In the course scheduling problem, teachers, classes, courses, classrooms and other factors and related constraints are taken into account. The allocation between different factors will have a certain impact on the efficiency of the course scheduling system. The improved adaptive genetic algorithm is applied to optimize the candidate solution. Through the optimization of population size and genetic operator, the coding evolution strategy and fitness function are improved to detect and eliminate the conflict in the course scheduling process. After several iterative genetic operations, the optimal solution of the algorithm is obtained, that is, the best course scheduling scheme of the intelligent course scheduling system is obtained, With the continuous progress and development of information technology, course scheduling system has gradually formed an intelligent information management system based on campus network. Therefore, among all the current methods to solve the intelligent course scheduling problem, the most feasible is to adopt self-organizing and adaptive, and select the improved adaptive genetic algorithm to solve it, so as to provide a new idea and method for the intelligent course scheduling problem, make the course scheduling management system of colleges and universities more intelligent, and improve the rational allocation of teaching resources and the completion of education plan.

2. Theoretical Basis of Genetic Algorithm

In 1975, John Professor Holland first put forward the theory of genetic algorithm. He took Darwin's biological evolution theory as the prototype, combined with Mendel's genetic theory, and followed the principle of survival of the fittest to carry out iterative genetic operation. Later, after the continuous development of genetic algorithm, Mendel and Morgan put forward "the

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law of separation, the law of free combination and the law of linkage and exchange have become the three laws of genetics".

2.1. Basic Principles

Genetic algorithm refers to the random search algorithm evolved from the law of biological evolution in nature. According to the evolutionary principle of "survival of the fittest and survival of the fittest", it finds high-quality genes, selects chromosomes with high fitness, and then carries out genetic crossover and genetic variation operations to obtain a new generation of individuals, which are the current population for the next iterative evolution. In real life applications, genetic algorithm provides optimization ideas for solving problems with high complexity and many constraints. Without considering the target problem itself, it only needs to code and analyze the problem and set an appropriate objective function to calculate and determine the individual fitness of each code. The evaluation of individual fitness needs to be determined by the operation of fitness function. The initial population of genetic algorithm is generated by solving individuals in the problem through random search. Each individual is regarded as a possible solution or approximate optimal solution of the problem. Each individual after gene coding needs to be evaluated and determined by fitness function. Individuals with high fitness value are protected in the algorithm. Therefore, individuals with large fitness value will be preferred, The individuals with small fitness value will be eliminated and abandoned, and the chromosomes with high fitness value will be left in the population. The selected individuals will directly carry out genetic crossover and genetic variation operation, and the new generation of individuals will form the offspring population. In this cyclic iterative operation, the good chromosomes left in the population can get the optimal solution to the problem. The above whole evolution process is the embodiment of the basic principle of genetic algorithm.

2.2. Basic Features

When using genetic algorithm to solve the optimal solution of the objective problem, it will simulate the genetic process of biological evolution in nature, and the biological characteristics of organisms will be inherited from future generations by genetic genes. According to the similar principle, a random function is determined in the genetic algorithm to obtain and solve the problem, randomly generate a series of genetic code DNA chromosomes, randomly form these individuals into a set, that is, the generation of the initial population, and set up several indexes for the individuals in the population to facilitate the acquisition of the global optimal solution of the target problem, The fitness function is used to evaluate and judge these individual indicators, and the obtained index data is the individual fitness value, that is, the possible contribution value of these individual fitness estimates to solving the target problem. The individual with small fitness value will be discarded. On the contrary, the excellent individual with large fitness value will be selected for the next genetic operation. After the execution of the whole algorithm, the optimal individual will be left in the solution space of the problem, which is a solution to the target problem. The process of genetic algorithm embodies the global optimization strategy. Compared with the traditional search algorithm, genetic algorithm embodies the following characteristics:

(1) In solving the objective problem, we only need to set the objective function and use the fitness function to evaluate and judge each individual;

(2) The parallel mechanism processing of the group in the solution space has strong parallel ability, high efficiency and good expansion performance Combination of other algorithms;

(3) The research subject of the algorithm is the encoded individual, and does not consider solving the problem or subproblem itself;

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(4) The more genetic iterations, the greater the coverage, and the more obvious the concentration of genes of high-quality individuals, which is conducive to obtaining the global optimization of the target problem.

The search direction is determined by the probability law, with the ability of self-organization, self-adaptive and self-study habits, fast convergence speed and less time consumption.

2.3. Realization Elements

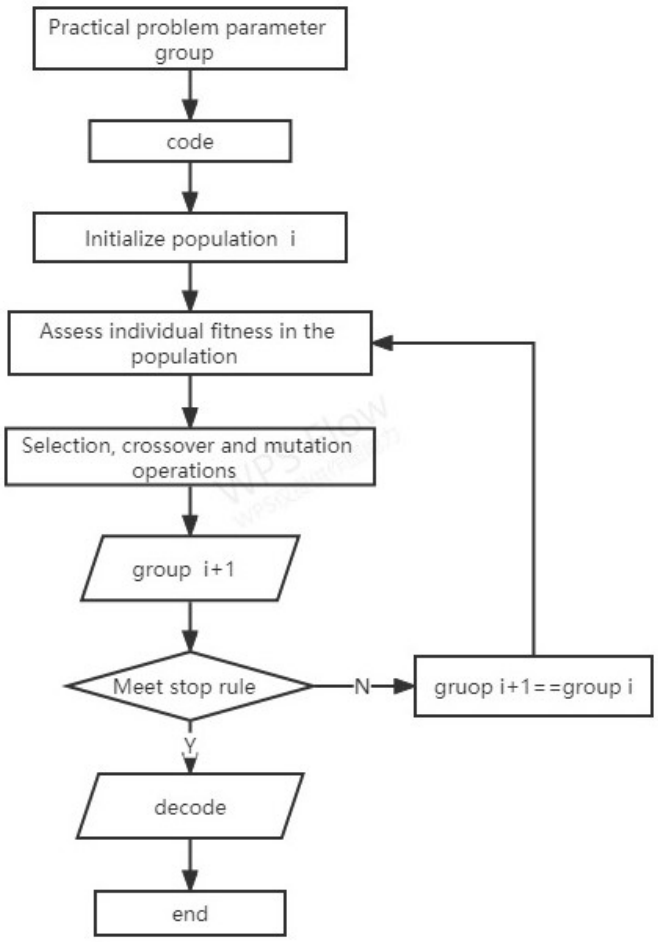

Figure 1. algorithm implementation flow chart

In the process of using genetic algorithm to solve problems, the following key elements are mainly included:

(1) Code. Because the genetic algorithm itself has good robustness, the standardized coding method will have a positive impact on the realization of genetic operation, and map the phenotype to the individual genotype. The common coding methods include binary, decimal real number coding, gray coding and so on.

(2) Initialize the population and calculate the fitness. The objective function is used to describe the functional relationship between the concerned target (a variable) and related factors (multiple variables). The fitness value determines the selection probability. The fitness function is obtained through the objective function, and the fitness is generally positive.

(3) Determine the fitness function. The general fitness function is derived from the derivative of the objective function, so as to carry out the subsequent continuous genetic operation. In genetic algorithm, adaptability is a measure of the efficiency of chromosome crossover and mutation. It is used to assign reproductive characteristics to individuals in the population. It is

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a measure of the advantages and disadvantages of individuals. In short, the fitness function takes the solution as the input and the adaptability measure of the solution as the output.

(4) Determine the parameters of genetic operator. Genetic operators are divided into three genetic operation operations: genetic selection, genetic crossover and genetic variation. The operation parameters include genetic crossover probability, mutation probability and population number. The coding of chromosome and the problem to be solved are closely related to the design of genetic operators to a certain extent.

(5) Fitness assessment. It is mainly to select the chromosomes of high-quality individuals in the population. The quality of chromosomes is evaluated by fitness value. Due to different chromosomes, there is a large difference in corresponding solution space, so the appropriate fitness is selected for screening individuals in the population.

(6) Judge the stop rule of the algorithm, that is, whether the convergence stop condition of the algorithm is satisfied. If it is satisfied, the decoding can be ended to obtain the result. If it is not satisfied, it will continue the next cycle for genetic operation until the end of the stop cycle algorithm.

The basic process of general GA implementation is shown in the figure 1 below.

3. Improved Adaptive Genetic Algorithm

This chapter mainly completes the research on the improvement of traditional genetic algorithm. Starting from the overall optimization design of genetic algorithm, it optimizes and improves the coding design and its chromosome representation, initialized population, conflict detection and elimination mechanism, the construction of fitness function, genetic operator, control parameter setting and so on, An improved new adaptive genetic operator is constructed and an improved new adaptive genetic algorithm is designed.

3.1. Improved AGA Optimization Design

3.1.1. Process Design

Simple genetic algorithm is a standard genetic algorithm. After that, various forms of genetic algorithms have evolved from the basic genetic algorithm. The basic mathematical model of the basic genetic algorithm can be expressed in an octet mathematical way:

$$\mathrm{SGA} = (\mathrm{C}, \mathrm{E}, \mathrm{P0}, \mathrm{M}, S, \Gamma, \Psi, T) \quad (1)$$

Where, C represents the coding mode; E represents individual fitness evaluation function; P0 represents the initial population; M is the size of the initial population; S is genetic selection operator; Γ Genetic crossover operator; ψ Genetic mutation operator; T is used to represent the termination condition of genetic algorithm.

3.1.2. Coding and Chromosome Representation

The common gene coding method of genetic algorithm is binary or decimal or gray coding. In the improved adaptive genetic algorithm, the gene coding method adopts natural real number coding, and the class schedule is regarded as chromosome (coding 29 bits), including 6 teachers, 7 classes, 7 courses, 5 classrooms and 4 class hours. For example, Professor Chen of the Institute of telecommunications takes the course of Java programming in class 1 of communication of grade 17 three times a week. The place of class 2 teaches classroom 101. The time is two, three and four classes every Monday morning. The chromosome code is 001001-1200011-22101-0113. The teacher code 001001, 00 represents the Institute of telecommunications, 1 is the teacher title, and 001 is the teacher number. The following is the detailed coding method:

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Teacher's code: a total of 6, including the teacher's college, the teacher's professional title level and the teacher's number. The college is represented by two 0-9 decimal digits, the professional title level of teachers is represented by one decimal digit, and the teacher number is represented by three decimal digits.

3.1.3. Initialize Population

In the basic genetic algorithm, the initial population is generated by random search. The initial solution is obtained through genetic operation, and the effect of individual fitness is not very good. The size of the initial population will have a certain impact on the efficiency of genetic algorithm. If the initial population is too large, it will reduce the efficiency of the algorithm and increase the overall calculation time of large algorithm execution; On the contrary, if the initial population is too small, the diversity of the population will be reduced, the sample size will be reduced, and the overall performance of the algorithm is poor, which is easy to make the whole algorithm end prematurely and converge prematurely. In the process of initializing the population, if the value of individual fitness is too small, all solution spaces will be reduced accordingly, and the final result is not the global optimal solution, but the local optimal solution.

In order to avoid the above problems, accelerate the convergence of the algorithm and prevent deceptive problems, we must pay attention to the population initialization of chromosomes in the new improved adaptive genetic algorithm. In this paper, teachers are sorted according to the weight Ci of the course, and teachers are sorted according to the weight Ti of the professional title, so as to avoid extracting repeated sequences each time. The sorted population is extracted by quasi random Halton sequence. The initial population generated by this method has low difference, high uniformity among individuals, expanded search range and easy to obtain the global optimal solution, At the same time, avoid premature convergence in the solution space, quickly produce feasible solutions, and obtain the best course scheduling scheme.

4. Conclusion

At present, scholars at home and abroad have extensive and in-depth research on genetic algorithm, but there are few studies on Personalized Intelligent course scheduling system, and there are few cases of intelligent Course Scheduling System under the new college entrance examination mode. Facing the further construction of national education informatization, it is of great significance to apply the new improved adaptive genetic algorithm to realize the intelligent course scheduling system.

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