The Application of Genetic Algorithm in the Course Scheduling System

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Abstract—**Because of the expansion of colleges and universities, the traditional manual scheduling is unable to meet the needs of education in Colleges and universities, so many scholars have begun to look for the method of arranging courses that can meet the requirements of the present situation. Genetic algorithm is a search algorithm for solving optimization problems in computational mathematics. It is a kind of evolutionary algorithm, drawing on the natural selection mechanism of natural selection in biological world. Aiming at the problem of arranging course in University, this paper uses the idea of genetic algorithm, and puts forward an effective and reliable method of applying genetic algorithm to the course scheduling system by using genetic algorithm in the university course scheduling system.**

Index Terms—**genetic algorithm, fitness function, timetabling system**

I. INTRODUCTION

Since 1999, in order to adapt to the large demand for talent and technology in Chinese society, Chinese institutions of higher learning have implemented the policy of expanding enrollment. The number of enrollment has increased rapidly every year, and the enrollment scale has expanded over a year. Although this policy has a great help to the development of Chinese society,and it also has its drawbacks. The sudden increase of students' scale has brought many problems to the school. It has brought great challenges to the educational work from the lack of school buildings to the tension of teaching equipment and the shortage of teachers' resources, especially the problem of arranging courses.

In the case of a small number of students, school scheduling can be arranged manually by educational staff, and personnel are organized to check and correct curriculum schedules. The efficiency of this method is very low, and the method can't meet the requirements in the face of the reality of enrollment expansion. In order to solve the problem of scheduling, some commercial course scheduling software has begun to be adopted, but there are still a lot of shortcomings, which can not meet the requirements of the rationalization of the curriculum. The course scheduling system needs to consider the quantity and time of the course, the number and capacity of the classroom, the resources of teachers, and the teaching plan. In recent years, many scholars have put forward some effective timetabling methods to solve the difficulty of arranging courses in Colleges and universities, [1, 2]. Among them, genetic algorithm is an effective algorithm for solving optimization problems in computational mathematics, and also an evolutionary algorithm. Its principle is to adopt the stochastic algorithm of the essence of Darwin's natural selection theory in biology, and It is a mathematical bionic [3-5] for biological evolution process.

In order to solve the problem of arranging course in University, this paper uses genetic algorithm, and puts forward an effective and reliable method to apply genetic algorithm to the course scheduling system in the University scheduling system, and realizes the optimization design of the course arrangement, which is simple and efficient.

II. THE ANALYSIS OF THE PROBLEM OF CURRICULUM

There are many factors influencing the effect of arranging courses, and the joint action of various factors makes the course scheduling problem a big problem for university educational administration. Some schools even waste a lot of manpower and financial resources on the problem of arranging courses, even after investing a lot of resources, they still can not solve the problem effectively, so that students can not better choose courses to study. The main influencing factors are students, teachers, classrooms, courses and time. By optimizing and arranging the combinations according to different constraints, the teaching work can be carried out smoothly and orderly, and the quality of teaching is expected to improve. The genetic algorithm principle of timetabling problem is shown in Figure 1.

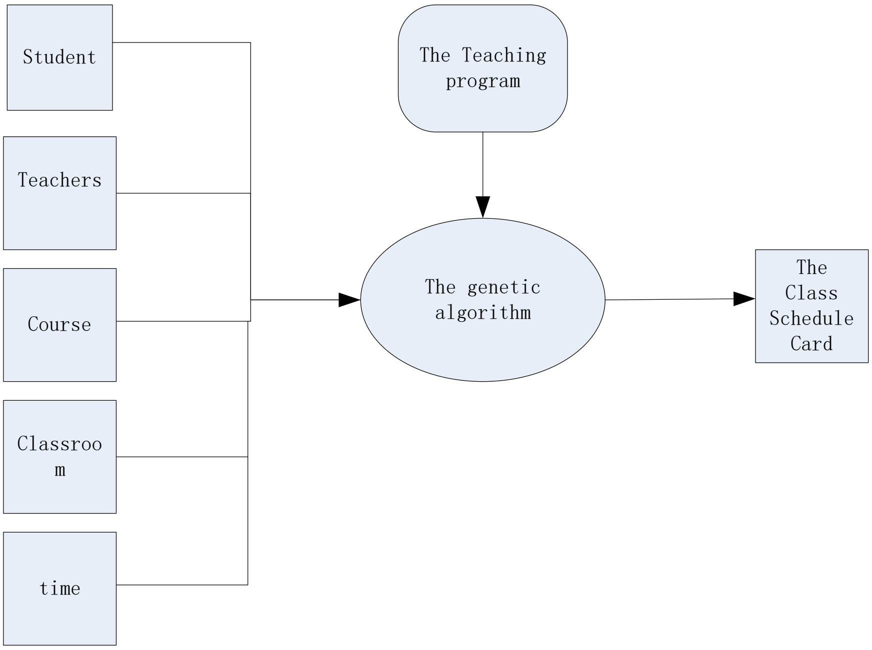

Figure 1. The Genetic algorithm schematic of scheduling problem

In order to get the optimal solution of the combination, enough constraints can bring better solutions. However, the more constraints are required for the solution process, the solution process is difficult to achieve, which brings great computing time and waste calculation resources, so it is very important to select the appropriate constraints. In view of the factors that affect the effect of scheduling, we can choose the following constraints, which can be divided into two categories: important constraints and secondary constraints. Among them, the important constraints are the constraints that have great and direct impact on the scheduling system. The secondary constraint is a type of constraint that has little effect on the timetabling problem but can not be ignored. The types of constraints are complex and large. Considering the degree of individual acceptance by the students and teachers, this paper mainly considers several typical constraints. There are several important constraints and minor constraints.

TABLE I.
THE CONSTRAINT CONDITION TABLE

The Important constraint conditions	
1	At the same time, the same teacher can only be responsible for explaining a course.
2	At the same time, only one course can be seen at the same place.
3	At the same time, only one course can be taught in the same class.
Secondary constraint conditions	
1	Meeting the special teaching needs of individual teachers as much as possible
2	The two adjacent courses of students and teachers should be close to each other to prevent students from catching up with the next course.
3	The distribution of courses for each day should be more uniform and avoid focusing on one day or a few days.
4	The duration of each course should be evenly distributed so that students can have time to prepare and review.

III. THE DESIGN OF GENETIC ALGORITHM

The principle of genetic algorithm is to correspond to the coding space in the way of coding, each encoding corresponds to a specific solution and uses the computer language to describe the problem object. The initial population is generally determined by random methods, and then the individuals in the population are selected according to the fitness value or other mechanisms. Finally, different genetic operators are used to get the next generation of population and iteratively iterate until the desired value is obtained, thus producing the optimal solution needed. The steps of genetic algorithm are divided into three steps: chromosome coding, fitness function design and genetic operator selection. Figure 2 is a flow chart of the genetic algorithm.

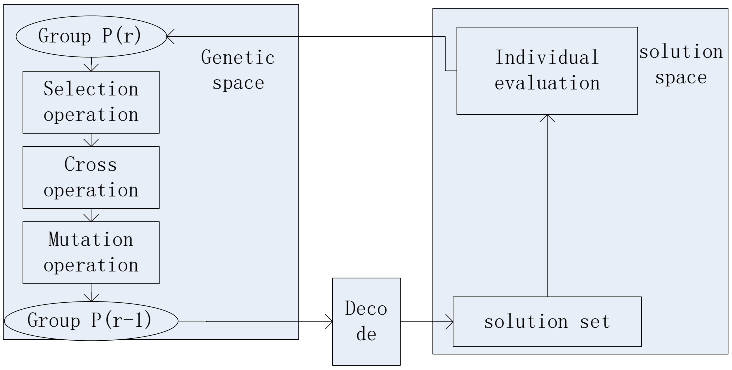

Figure 2. The Genetic algorithm flowchart

A. The coding

In this paper, the traditional binary coding length of 20 is used as a substitute for the curriculum variables in the computer program. The main consideration is that the class time of the general college is 5 days from Monday to Friday, with about 8 classes per day, of which 1 are 1 courses, one course is 2, and 0 shows no courses. This allows you to record the number of teachers at different times, so as to connect teachers, classes and courses.

B. The fitness function

It is very complicated and difficult to determine a timetable plan, so a variety of constraint rules should be considered. Fitness function is the key to solve this problem. The fitness function of timetabling problem is not single and simple. In the process of genetic manipulation, the genetic algorithm needs to be attached to a reasonable adaptive function, and the fitness function can fully and accurately represent the advantages and disadvantages of each individual variable of the subject, so as to achieve the rapid acquisition of the optimal solution. There are three main fitness functions for the direct evolution of the objective function: (1) replace the objective function directly to the fitness function; (2) if the problem object is minimized, the fitness function can be set the Formula (1); (3) if the problem object is the maximization problem, the fitness function can be set as the Formula (2). In the above two formulas,the C is a conservative estimate of the fitness function.

$$Fit\left(f\left(\mathrm{x}\right)\right)=1/\left(1+c+f\left(\mathrm{x}\right)\right) \tag{1}$$

$$Fit\left(f\left(\mathrm{x}\right)\right)=1/\left(1+c-f\left(\mathrm{x}\right)\right) \tag{2}$$

C. The Selection of operators

The most critical step in genetic algorithm is the design process of genetic operators. The operation of genetic algorithm includes three kinds of genetic operators: selection operator, crossover operator and mutation operator. These three operators correspond to the phenomenon of survival of the fittest, gene recombination and gene mutation. This is the coding form of the three genetic operators, the size of the population, the initial population, the operation probability, and the fitness function, which all seriously affect the validity and correctness of the genetic operation [6-8].

In the population of the subject, because the individual will have a certain gap, there are better individuals, and there are inferior individuals, so we need to eliminate the bad individuals, so that the population is more rational optimization. The selection operator, also called the regeneration operator, is to select the excellent individuals in the population, similar to the survival mechanism of the survival of the fittest, so that the excellent features can be inherited and retained to the next generation of [9]. We divide the solution space into n small spaces and randomly select 1 individuals in each small space. The initial population is composed of these n individuals, which makes the distribution of the initial population evenly and can cover the whole solution space, avoiding the problem that the distribution of individual characteristics of the initial population is too concentrated.

The crossover operator refers to the regular interconversion of the parts of the two pairs of individuals through the cross probability, and in the end produce two new individuals, also known as the gene recombination operator [10]. Because crossover operators are prone to conflict, for example, a teacher may be assigned to several classes at the same time, so we need to conduct conflict tests.

Another operator is the mutation operator. The mutation operator is an exchange operation for two genes of the same individual, which can guarantee the diversity of the population and can inhibit the precocious phenomenon. Mutation operation first determines whether the mutation is changed, and then selects the mutation position randomly to perform mutation operation.

IV. THE REALIZATION OF THE COURSE ARRANGING SYSTEM

The main functions of the course scheduling system in universities are: curriculum plan, course setting, manual or automatic course arrangement, inquiry and printing of timetable, and maintenance of course arrangement system. The basic steps of the course scheduling system are as follows:

(1) process the course data according to the curriculum plan;

(2) the operation of genetic algorithm is used to code the course scheduling system.

(3) the optimal solution is obtained by the operation of the genetic operator.

(4) translate and decode the optimal solution and get

effective result of arranging courses, thus forming a timetable.

V. CONCLUSION

The focus of university management is educational administration. The core of educational administration is to arrange courses. The influencing factors of arranging courses are various and complex, which is the key and difficult point of educational administration. Therefore, it is necessary to solve this problem through simple and effective methods.The Studies at home and abroad show that genetic algorithm is a mathematical bionic method, and it is the most effective way to get the optimal solution. In this paper, the problem of arranging course and the genetic algorithm to solve the problem are analyzed in this paper. In view of the actual arrangement of the course, the idea of using genetic algorithm is used, and the design steps of genetic algorithm in the university course scheduling system are put forward, and an effective and reliable method of applying the genetic algorithm to the course scheduling system is put forward. The optimization design of the course arrangement is realized. Using chromosome coding and adaptive function to avoid the conflict of the timetable, realize the rationalization and humanization of the scheduling system, so that the educational administration of the school is more scientific and intelligent.

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