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Genetic Algorithm and its Application in Scheduling System

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Abstract

With the development of education and college expansion and consolidation in the Educational Management System Course Scheduling System has become more complex, and therefore necessary to design one for development, and reuse. Given this situation, this paper proposes a solution based on genetic algorithm. The results show that genetic algorithms can effectively solve the course timetabling problem. This method is easy to learn and apply, and do not rely on a special mode.

Keywords*: timetable, genetic algorithms, genetic factors, fitness function*

1. The Background, Current Situation and Significance Of The Research

The 21st century, the world will enter a high-tech industrial pillars of the knowledge economy era. The emergence of a knowledge-based economy indicates that human society is entering the era of relying mainly on economic and intellectual resources. Colleges and universities as the positions of senior personnel training will usher in a new challenge. Only by understanding and mastering the forefront of science and technology, and cultural knowledge colleges and universities as the dissemination of scientific knowledge, to train qualified professionals, but also to an invincible position in the fierce competition. The major institutions train students through teaching. Teaching activities, there is a series of management. The implementation of the teaching plan is an important part. Timetable schedule of college teaching programs, it maintains a teaching order, to ensure the quality of teaching has a very important role. Arranging Timetable occupies an important position in the Senate work, but because of its large scale, involving many factors, it is a fairly complex task. Timetable problem has great complexity and intractability [1].

Course timetabling problem is also called the timetable (Timetable Problems, TTP), it is a matter of multiple factors (such as teachers, classrooms, classes, courses, time, etc.), the multi-constrained combinatorial optimization problems. 1963 CCGotlieb to raise the issue in his article attracted attention [2]; 1975, S Even et al demonstrated Timetable problem is NP-complete class of problems, announced the academic status of this space-time combination problem and the difficulty [3]. Ferland takes Timetable problem into an integer programming to solve [4], but a lot of calculation only applies to a very small Arranging Timetable for large-scale complex Timetable, there has been no practical algorithm; Hu Shunren proposed the Timetable Problem tried coloring problem in graph theory to solve et al Unfortunately graph coloring problem is NP-complete problem [5].

Since 1999, with China's implementation of university enrollment policy, almost all universities were the different levels of enrollment, major colleges and universities also greatly increase the number of students in the school. Thus, arranging work for the university academic departments, more difficult, often arranging conflict, such as: teachers at the same time to go to two or more different courses in a classroom, a teacher at the same time two course, some teachers may not attend class at a specific time.

University class schedule organized not only the number of large-scale, involving many factors, restrictions, and complex structure, in order to compile a reasonable the science curriculum bound to consume a large amount of time and effort, its complexity because Timetable in resource constraints and special requirements limit the limited time and space targets. Various colleges and universities in recent years, successive years of enrollment,

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making the workload increased every year curriculum, the school's own problems gradually exposed to the curriculum, which also adds a lot of difficulty, these problems include: lack of classroom resources, faculty deficiencies, lack of multimedia teaching equipment, these problems arranging work demanding higher [6].

Computer Timetable operation, with users able to clearly see the teaching of a variety of information, can be efficient, fast work, which will not only reduce Timetable of work of the teaching staff of the hand, but also greatly improve the management of efficiency can be rational and efficient allocation of teaching resources, and indirectly improve the teaching quality, promote the teaching activities virtuous circle. Therefore, the study and improvement of a Course Scheduling System has a very important practical significance.

If it is not a good solution to these conflicts will be teaching confusion. Therefore, arranging the correctness of the algorithm, the efficiency is very important [7]. In view of the complexity of the course timetabling problem, many articles heuristic function to solve course scheduling problems, most methods to achieve through analog handmade Timetable process. Due to the actual Timetable problems with a variety of constraints and special requirements, the ability to properly deal with these issues is very important [8].

The Liao YuLi [9] solves the Timetable Problem critical fitness function of genetic algorithm design, arranging goals can be better achieved;

This paper focuses on the application of genetic algorithms in the Timetable, Intelligent Course Scheduling algorithm based on genetic algorithm to solve the schedule conflicts, rational and efficient allocation and use of teaching resources, and indirectly improve the quality of teaching, advanced teaching the virtuous circle of activities.

2. Introduction of Genetic Algorithms

The emergence and development of the genetic algorithm, according to Darwin's theory of evolution, the various biological worlds have been able to adapt to the environment and to survive the evolutionary and biological heredity and variation are inseparable. Based on of modern cytology and genetics research that the material basis of heredity and variation of organisms is the chromosome, chromosomal DNA and protein, and prove Avery 1944, chromosome DNA is the primary genetic material. Modern molecular biology, DNA is the genetic effects of gene fragments; genetic information is stored in the genes, which control protein synthesis and control of biological traits. Organism itself operating through gene duplication and cross its trait selection and control; through recombinant genetic variation at the same time make it a wide variety of traits change. Genetic characteristics of the organisms, the biological species able to maintain relatively stable, the biological variability of the Health Fair.

The genetic algorithm research began in the late 1960s to the early 1970s, early by Professor John Holland of the University of Michigan and his colleagues, students create a theory and method. Then, after more than 20 years of development, has achieved fruitful results and theoretical research progress, especially evolutionary computation boom in recent years formed the world, computational intelligence as an important direction of artificial intelligence research. From the First International Conference on Genetic Algorithms, held at Carnegie Mellon in 1985, May 1997, IEEE Transactions on Evolutionary Computation Founded genetic algorithm as the high-performance computing system optimization, adaptation and learning modeling method matures.

Genetic algorithm [10] is based on natural selection and genetic mechanism of search optimization algorithm. The basic principle is: the entire evolutionary process from generating the initial population, fitness function is determined in accordance with the characteristics of the program under test, perform procedures to assess the fitness of each test data, the higher the fitness test data and the expected effect of the more close, then use selection, crossover, and mutation are three basic genetic operators to modify the test data, and evaluation of the fitness function, until the nearest optimal expectations. Genetic algorithm has been used in many aspects of the study [11, 12].

Genetic algorithms to generate test data, follow these steps:

Step 1) Initialization individual: according to the given path to identify To generate test data variables, and a random string of 0,1 conferred for each variable, in accordance with the coding principles, composed of individuals.

Step 2) Calculated value of the fitness function: the fitness function value for each set of variables were calculated according to the structure of the fitness function. If the termination condition is met, the transfer step 4.

Step 3) Improve individual: if the individual does not meet the conditions of using the selection, crossover, variation of three basic operators for the following operations:

Solution options: the next generation of the better individual fitness function value;

Solution of the cross: from individuals generated randomly select two individuals cross, new individuals, repeat this step until all individuals are selected so far;

Variation solution: adding some variation in cross individual randomly generate new individuals;

Go to Step2;

Step 4) Split individual satisfy a condition: 0,1 string corresponding to each variable is converted into a decimal number, the data is generated test data.

Step 5) Algorithm ends.

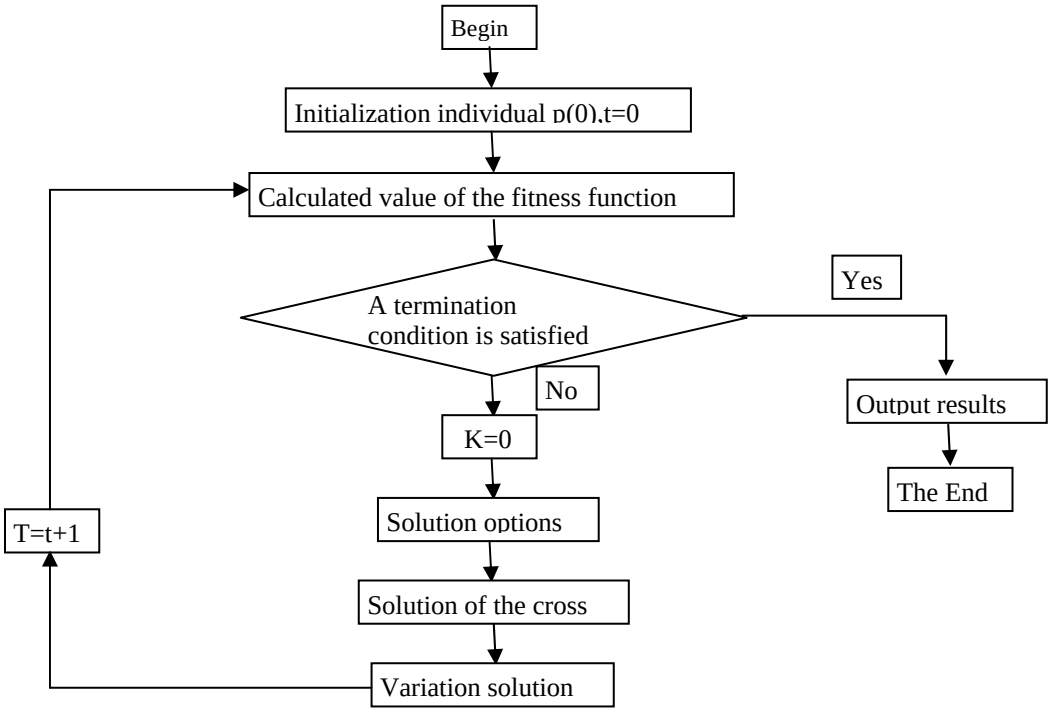

Figure 1. Genetic Algorithm Flow Chart

3. The Application of Genetic Algorithm In The Timetable

3.1. Course Scheduling Algorithm of constraints

Hard constraints arranging process, due to the limited resources of all kinds, it must satisfy the constraints that can not be changed, usually as long as the following hard constraints to ensure that such conflicts do not occur in the process of Timetable.

The genetic algorithm lies in the design of genetic factors, but arranging system is an optimization problem with constraints.

Timetable algorithm the common constraint conditions are as follows:

(1) Hard constraints:

Constraint 1:

The same time in the same classroom can only arrange a course.

Constraint 2:

Same time same teachers can only arrange a course.

Constraints3:

A course can only be arranged in the same time in the same class.

Constraint 4:

Type in the classroom to meet the curriculum needs.

Constraint 5:

Classroom capacity must be greater than the sum of the class student class size.

(2) Soft constraints:

Soft constraints in arranging process to meet but can not fully meet the constraints, the arranging process as much as possible to meet the hard constraints on the basis of the requirements to meet the constraints, soft constraints due to the different teaching circumstances vary. The soft constraints usually changed by adjusting the satisfaction of soft constraints Timetable effect, you can be sure to meet "hard constraints".

The following is the arranging process used soft constraints, but also consider soft constraints.

Constraint 1:

The same course several courses within a week is best separated arranged. The singular lesson need to pay attention to the row of odd and even weeks. Single-class problem can be temporarily not considered as long as the odd and even weeks with one week can be removed.

Constraint 2:

The total number of school classes preferably close to the classroom capacity for rational use of teaching resources.

Constraint 3:

More difficult courses should be ranked in the energetic, such as the high number of arrangements in the morning 1-2 section. Physical education as far as possible be ranked 3-4 in the morning or afternoon.

Constraint 4:

Best for the students between two consecutive lectures change classrooms, teachers and students in different campus classes to stay some time for rushed.

Constraint 5:

The same class in the same classroom courses as far as possible in the same classroom.

Constraint 6:

A teacher in the same classroom type of course as far as possible in the same classroom.

Constraint 7:

Classroom curriculum daily lessons should be as uniform as possible.

The Timetable results requirements have to meet the hard constraints, as much as possible to meet the soft constraints. At the same time, meet the conditions more reasonable degree the higher class schedule.

3.2. The Genetic Algorithm Timetable Process

Timetable Problem encoded according to the general process of the genetic algorithm, the following work: to produce the genetic factor, to the gene and chromosomal way to various factors in the Timetable Problem. Then selection, crossover, variation of genetic operators subdesign. Second, the calculation of the fitness function. Fitness function is to determine the merits of the curriculum program, so that convergence to a global optimal solution.

3.2.1. Selection, Crossover and Mutation Genetic Manipulation

Timetable process, produce a time, classrooms, courses, classes, teachers as the base factor of course, as with the string represents a set of initial factor 0000 0000 0000 0000 0000 chromosome, it said 0segment in the classroom 0 on 0 curriculum, students of class 0 has class, No. 0 teachers teaching. Said another group with 1111 1,111,111,111,111,111 chromosome initial factor that represents the time period in the n-n No. classrooms, No. n courses, school classes n number of classes, teachers teaching for n number of teachers. Use of these two initial course factor, to start the cross, and then generates a series of new courses factor. Curriculum factor screening according to the fitness function, then the variation until satisfactory results are obtained.

Conducting genetic operators operation, the master to determine the course factor whether optimal solution is the key. We can take advantage of a decision function to be

determined. First of all, will have a new curriculum factor with the previous generation of curriculum factor than the factor already exists, then discard. Secondly, in the comparison process, if found between the factors contrary to the conditions of hard constraint must also be discarded, in order to maintain the feasibility of arranging factor. All courses will have a factor seen as a two-dimensional array, and then using discriminate function to determine if the same teachers exists on course.

The specific determination process is as follows:

(1) Remove the time of each row, teacher's factor, the combination of a new array of the time-teacher;

(2) All the elements of the string and the rear of the first row of the comparison. If there are the same elements, and then abandoned. Back to the cross-process, re-produce the new factor;

(3) If there is the same element is compared next line element and all subsequent elements, if there are the same elements, then abandoned, to return to the cross-process, re-produce the new factor;

(4) Repeat steps (2)/(3) until all the elements do not exist to the end of the same element.

Whether the judge finished the same teachers after the course conditions, but also to distinguish whether the same classroom at the same time whether on a multi-course, and in the same class at the same time on doors courses. Process and to determine whether the same teacher at the same time on a multi-course similar to the process, not repeat them here.

3.2.2. Fitness Function

The fitness function is divided into two parts, one for teachers, students satisfaction F1 Timetable program. Preferences of classroom teachers and students of the class period prior to the survey. The period can be set to three alternative answers: like, it does not matter the time period and do not like period, then were given different weights. Instructor of the Timetable program preferences can be determined in advance, then an instructor, the satisfaction of arranging programs can be expressed as follows:

F1 = The value of the preference * corresponding weights.

Another part of a course in the degree of dispersion of the week F2, that a course twice within a week of class time interval as long as possible, so as to facilitate students to the digestion and absorption of knowledge, but also easy for teachers to prepare lessons, correcting homework. The degree of dispersion can be expressed as:

F2 = the number of hours a week for a course * this course in the time period the number of intervals in the Timetable program.

Fitness function is denoted by F, F = satisfaction F1 + degree of dispersion F2.

Finally, of course factor independence fitness testing, such as some of the special requirements of the course meets the conditions (such as a high number of generally better student effort am 1-2 section). If not, you need to regroup. After this operation repeated several times, the courses factor is relatively stable, the last factor in the conversion of these courses to real Timetable information. 0010 0,010,000,101,011,001 converted into the time period of the No. 2 in the 2nd classroom courses, the school is the 5th class teaching is the 9th teachers. After the conversion is completed, you will get what we want Timetable combination.

As demonstrated intelligence, parallel and robustness of genetic algorithm in solving combinatorial optimization problems, and genetic manipulation is used to solve constrained fuzzy multi-objective course scheduling problems is more appropriate.

4. Conclusion

College courses arranging to solve the problem, the actual efficiency of the Timetable Course Scheduling algorithm using genetic algorithm optimization have been greatly improved. Therefore the optimal solution to the use of genetic algorithms to achieve a similar course timetabling problem is a relatively simple and practical way, the convergence speed quickly, the distribution of the time period is relatively uniform. Course timetabling problem is a combination of a multi-objective optimization problem, too many uncertainties, using genetic algorithm to its optimized technology means continued development and need further research.

May not be in the actual process of arranging the termination condition or feasible solution of some practical problems may be the only, such as teaching resources or teachers resource shortage is more serious if the constraint conditions are too harsh. There is no feasible solution may, in such cases the need for manual intervention.

Timetable Problem intractable problems of an interdisciplinary the Timetable Problem in the basis of this article, there are many: First, effective organization in the course timetabling problem constraints, to further improve the Course Scheduling algorithms versatility. Second, the determination of various control parameters of the genetic algorithm is how to set the respective control parameters in the algorithm, to study the influence of each parameter variation on solving algorithm, and to the design parameters of the dynamic changes in the evolution of the iterative process. Third, the course timetabling problem as a starting point, to continue to study the problem of this related fields.

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