Research on Course Arrangement System of Private Colleges Based on Improved Genetic Algorithm

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Abstract: Based on the original genetic algorithm, this paper adopts the innovative initial population construction method and the optimized population evolution strategy, combined with the corresponding coding, and proposes a college scheduling program suitable for dealing with multiple constraints. In this course arrangement method, a lot of optimizations are made for the shortcomings of the genetic algorithm itself, the initial population is strengthened, the speed of the course result is accelerated, and the evaluation method of the near optimal solution is optimized. By applying the genetic algorithm of the variant to the specific scheduling tasks of colleges and universities, the results are tested and evaluated, and the superiority of the method compared with the traditional genetic algorithm is verified.

1. Introduction

In recent years, the genetic algorithm is a computational model that simulates the genetic selection of Darwin [1] and the biological evolution process of natural elimination. Genetic algorithm [2] is a brand-new global optimization search algorithm. It has an important position in the field of intelligent computing through simple operation [3], strong robustness, and wide adaptability [4]. Therefore, this paper uses genetic algorithm as a tool to carry out in-depth research on the scheduling problem, and designs the crossover operator, which has certain significance in practical application. In practical applications, we can regard the scheduling problem [5-6] as a constrained, multi-objective, and difficult combination of optimization problems. It is very difficult to solve the scheduling problem by simply using mathematical algorithms or a single algorithm. The problem. Its essence is the timetable issue, which has been confirmed as a complete NP problem. As a random search algorithm, genetic algorithm is very effective for solving NP problems by using group search technology.

In this paper, we describe how to solve these problems in a mechanism through an evolutionary algorithm: genetic algorithm and heuristic features: greedy algorithms alternate. First, we introduced the problem and then proposed genetic and greedy algorithms. After that, we conducted a detailed analysis of the given process and proposed a timetable for improvement. Finally, we present interpretative results that are related to the convergence of the methods used in real school schedules. Comparing and evaluating classical genetic algorithms and alternating genetic algorithms in the specific case of timetable problems, we clearly show that this approach can yield very beneficial improvements in terms of time processing and fitness value.

2. Introduction to improved genetic algorithm

In the early stage of genetic evolution, some extraordinary individuals are usually produced. If the proportional selection method is used, these abnormal individuals control the selection process because of their outstanding competitiveness, which can lead to immature convergence and affect the

global optimization performance of the algorithm. In the process of evolution, the average fitness of the group is close to the optimal individual fitness, which weakens the competitiveness of individuals, so that the optimization process of the target tends to a random roaming process without targets. In order to avoid the first situation, it is necessary to avoid the adaptability of one individual too much; for the random roaming phenomenon, it is necessary to enlarge the corresponding fitness value to improve the individual competitiveness. Therefore, the scale transformation of fitness is proposed. The commonly used scale transformation methods include linear transformation method, power function transformation method and exponential transformation method.

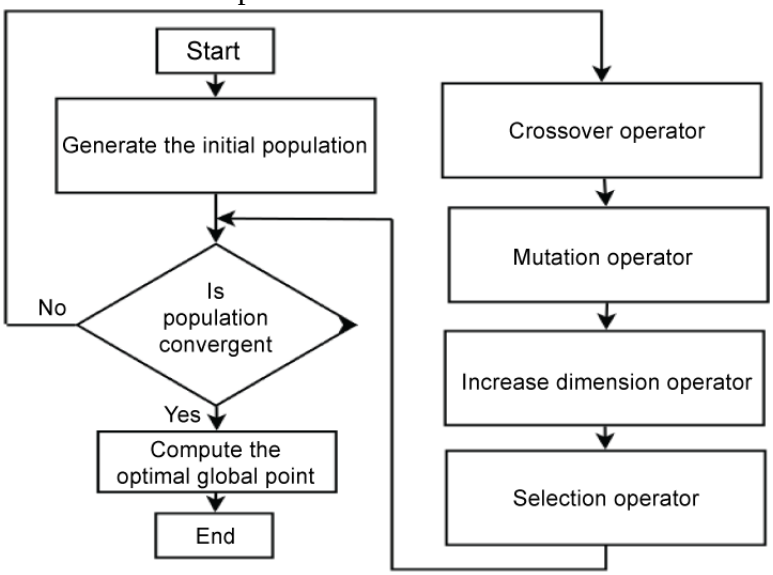

Figure 1. Basic steps to improve the genetic algorithm

The following is an introduction to the exponential transformation method:

$$F^*(X) = e^{-aF(X)} \tag{1}$$

Where: $F^*(X)$ is the new fitness obtained after exponential transformation; $F(X)$ is the original fitness, and the objective function can be directly taken, or the objective function can be performed according to the requirements of the problem itself and the range of variation of the objective function value range.

Linear transformation; a is the coefficient of the exponent, taking a positive number. It can be seen that the change of controls the change of the value of the exponential function, that is, the mandatory of the selection. If the individual fitness value or the change of the objective function value can be well grasped during the genetic operation process, the artificial control of the size of a can be achieved in the iterative process of the genetic operation. According to this idea, this paper proposes a fitness function based on the exponential transformation and the exponential coefficient increasing with the increase of evolutionary algebra:

$$\begin{cases} F^*(X) = e^{-aF(X)} \\ a = \sqrt[m]{t} / \left(F_{avg} + \varepsilon\right), \quad m = 1 + \lg(T) \end{cases} \tag{2}$$

$F^*(X)$ is the new fitness obtained after exponential transformation; $F(X)$ is the original fitness. If the problem itself is minimized, the objective function can be directly taken. If the problem is maximized, the problem must be linearly transformed and transformed. In order to find the minimum problem, the purpose of linear transformation is to make the change of the original fitness value of the individual in the evolution process population similar to the change of the objective function value of the individual, that is to say, when the individual population is dispersed, the original fitness

value is also dispersed. Similarly, the exponential coefficient a is no longer a constant, but a positive number of dynamic changes that gradually increase with increasing evolutionary algebra; t is the current evolutionary algebra, T is the maximum genetic algebra; and the average fitness F_{avg} is the current population $F(X)$. Average, since a is a positive number, F_{avg} must be non-negative, so when the population

When the value of the objective function has a negative number, $F(X)$ can be taken as the objective function plus a sufficiently large positive number, usually taking the maximum estimate of the objective function; ε is a sufficiently small positive number to prevent the denominator of the formula from zero when F_{avg} is 0. It is also known that $F(X)$ is also a non-negative number.

From the above analysis, since $F(X)$ is non-negative, in the process of minimization, F_{avg} is large in the initial stage of evolution, and generally can reach the maximum, then a is smaller. As evolution progresses, F_{avg} gradually decreases, and the current evolutionary algebra t is also gradually increasing, according to this trend we can make a gradually increase. Therefore, the fitness function proposed in this paper is an adaptive dynamic adjustment function.

3. Research on College Course Scheduling System Based on Improved Genetic Algorithm

In the actual course scheduling problem, the main problem to be solved is how to prevent classroom conflicts in the class, classroom and course during a specific time period of the week. Therefore, in order to ensure that the curriculum is not conflicted, not only the various parts of the course arrangement are arranged to be optimal on each goal, but also the utilization rate of the existing teaching resources can be maximized. According to the actual situation of colleges and universities, this paper stipulates the conditions of hard constraints and soft constraints. From the perspective of hard constraints, it is mainly required that each class corresponding to the same time period can only choose the last class; the same time period Only one class can be arranged in each classroom; the same teacher can only take one class at a time; the capacity of the classroom must be no less than or equal to the number of students in the actual class; the type of classroom assigned must be the same as the type of classroom required by the course; Courses must be arranged on the campus as defined in the teaching assignments. From the point of view of soft constraints, it is mainly required that the number of courses arranged in each time period should be as uniform as possible; each class time in the weekly schedule has a certain degree of merit, and the course should be arranged in a time period with high degree of merit; The time of multiple classes of the course should be as evenly spaced and evenly distributed; the classroom capacity should be moderate to make full use of the classroom; the two class hours should not be arranged in the afternoon or evening, so as not to waste a class. Through the research on genetic algorithm and the above-mentioned scheduling requirements, this paper analyzes the three aspects of classroom scheduling, conflict detection and time planning, and describes and designs the corresponding algorithm flow in detail.

3.1 Improved genetic algorithm selection strategy

In the initial stages of the evolution of genetic algorithms, we still adopt the traditional roulette strategy. Because the population has not been finalized at this time, the fitness is uneven. Individuals with relatively good fitness are likely to have large defects. At this time, the roulette strategy only uses "larger probability" rather than "inevitable selection" as the overall selection scheme; individuals with lower fitness are not completely useless. It is very likely that there is potential to develop an optimal solution. At this time, the roulette strategy will preserve these individuals with a certain probability, increasing the search space of the optimal solution, thus providing a diversified sample for the evolution of subsequent populations. In summary, we still use the roulette strategy in the initial stage of the algorithm. In the middle and late stages of the evolution of genetic algorithms, the quality of individuals with high population fitness is generally good, and the defects are few. At

this time, it is particularly important to effectively retain the optimal solution. At this stage, individuals with poor fitness often do not have the potential to develop into high-quality solutions, and can be eliminated with confidence. At this point, we use the tournament selection method, which randomly groups the individual individuals and ranks according to the degree of fitness. The individuals ranked in each group will directly enter the next round of operations. The tournament selection method is easier to select high-quality individuals than the roulette selection method, and it is easier to eliminate inferior individuals. Therefore, this selection method is applicable to the middle and late stages of genetic algorithms.

3.2 Improvement of crossover and mutation operations

In the initial stage of genetic algorithm deduction, because the population quality is generally not high, at this time, because the crossover operation is convenient to fuse the high-quality characteristics of different individuals, the frequency of cross-operation should be strengthened; in contrast, the mutation operation will cause the population to lose. Certain stability, which is a disaster for the genetic algorithm in the initial iteration phase, should therefore weaken the mutation operation. In the middle and late stages of genetic algorithm deduction, since the individual quality is generally superior at this time, the crossover operation cannot greatly improve the quality of the individual at this time, so the crossover operation should be diluted at this time; and in contrast, the mutation operation will have a chance to play. The chaotic algorithm gradually converges on the situation, thereby increasing the search space, so that the optimal solution has a wider range of search, so the mutation operation should be appropriately strengthened. In addition, in the middle and late stages of genetic algorithm, the individual quality is generally superior, and the new individual generated by each cross or mutation operation has a lower risk than the father, which will make the population unstable or even degenerate, which wastes the previous Iterative steps, so we will add an immune mechanism to calculate the fitness of the parent and the offspring separately. If the offspring are inferior to the parent, the offspring will be eliminated, otherwise the genetic algorithm will continue to evolve according to the normal steps.

3.3 Optimization of coding methods

Traditional genetic algorithms often use binary coding methods. A long series of 01 sequences represents the schedule of each class break. This coding method is not easy for programmers to understand, and the curriculum is not very intuitive. Therefore, in this paper, we use a two-dimensional Boolean matrix to indicate the arrangement of a course, 1 to arrange the course at a certain time, 0 to not arrange the course at a certain time:

Table.1. Binary code table

Is there a course?	Monday	Tuesday	Wednesday	Thursday	Friday
Time slot					
T1	0	1	0	0	0
T2	0	0	0	1	0
T3	0	0	0	0	0
T4	0	0	0	0	0
T5	0	0	0	0	0

The two-dimensional matrix arrangement table of all courses will be connected in sequence using a linked list, and the order is the order of each course, that is, the multi-course path representation.

3.4 Construction of heuristic functions

According to the actual situation of each university, the criteria for judging the quality of the curriculum are also inconsistent. This is because the individualized needs of each school lead to personalized evaluation criteria. According to the extensive experience of scheduling in previous years, in addition to the hard rules cannot be violated, the audience evaluation of the curriculum is the embodiment of the merits of the curriculum. Therefore, this paper focuses on the design of

personalized fitness function. First of all, since the class schedule problem is a complete NP problem, there may be no solution. We need to find a near optimal solution rather than an absolute optimal solution. Therefore, unlike the traditional design that relies on only one fitness function to control the design, this paper designs two fitness functions, namely "just need fitness function" and "soft demand fitness function". Firstly, the two fitness for each individual are set to 0, and the corresponding scores are satisfied by different criteria. Finally, the total score is calculated separately. The higher the score, the stronger the fitness. For the "just needed fitness function", we stipulate the following: at the same time, there is no curriculum conflict in the same classroom, the individual scores +20, otherwise +0; at the same time, the same teacher has no conflict course arrangement, the individual scores +20, otherwise +0 If the public lesson\basic lesson is arranged in the first section of the morning, the individual score is +10, and the second grade is +8; if the multi-class public lesson\basic lesson is staggered (the interval is 1 day), then The individual score is +6; for the "soft demand fitness function", it is summarized as follows: If there is a teacher with special preference, one is satisfied, then +5; for the students generally reflect the need for class scheduling, satisfying one, then +3. When making fitness judgments, it is preferred to judge the "just-in-time fitness function" because it is just the basic requirement for schedule preparation. However, in the immunization strategy described in 4.3.2 of this paper, we are based on the sum of the "just-needed fitness function" and the "soft-demand fitness function" to determine whether the progeny is degraded. In doing so, it not only ensures that the rigid demand is satisfied as much as possible, but also takes into account the humanistic care. The final solution will fully take into account the "just need" and "soft need".

4. Experimental conclusion and analysis

In the above content, the problem of scheduling is briefly explained. On the basis of the traditional genetic algorithm, a lot of bold improvement is made item by item and point by point, and compared with the traditional genetic algorithm, the advantage analysis is carried out. The legend shows the explanation.

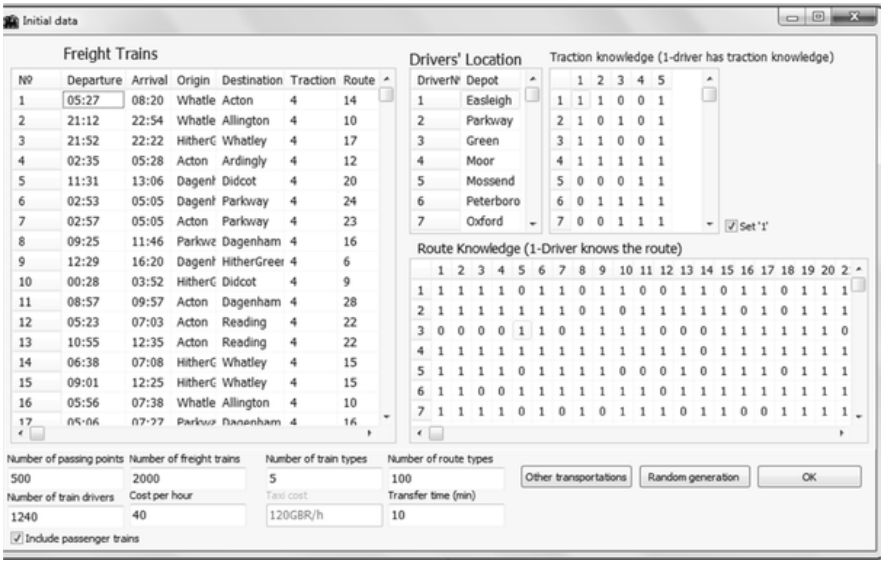

Figure 2. Shows the scheduling system of improved genetic algorithm

On the algorithm platform we built, we will introduce the courses to be arranged in the teaching plan of the past several years, first use the traditional genetic algorithm to perform iterations, record the number of iterations and iteration time, and calculate the fitness of the final solution; then, the data will be Bring into our improved algorithm, build a knowledge base, optimize the initial population, dynamic probability genetic manipulation, dual fitness calculation, immune strategy application... Finally record the same test data. The improved genetic algorithm shows a clear advantage in the total time of the course and the quality of the final solution.

5. Conclusion

Based on the school in which it is located, this paper first analyzes the complexity of the scheduling problem, and then briefly analyzes the genetic algorithm and the feasibility of solving the problem of scheduling optimization. The calculation steps of general genetic algorithm, the mandatory conditions and optimization conditions of scheduling problems are given, and then the method of using genetic algorithm to solve the problem of scheduling optimization is analyzed. The whole course scheduling process was verified according to the situation of the school, which confirmed the scientific and rationality of this course optimization algorithm. This method can significantly reduce the workload of the teaching staff and improve work efficiency. Although this intelligent course scheduling algorithm can realize intelligent class scheduling optimization, but the scope of use is limited, it can only be used for the class scheduling problem of public classes. At present, many colleges and universities have opened different elective courses, the class is no longer fixed, and the intelligent class scheduling system is proposed. Higher requirements, this is also the direction of the follow-up study of this topic.

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