AI-Powered Genetic Algorithm for Optimal Scheduling in Medical Research and Educational Management

Rui Chen [1], Lili Su[2*] and Jingjing Guan[3]

[1] School of Education Science, Baise University, Baise 533000, Guangxi, China, chery602362497@163.com
[2] Institute of Life Science, Youjiang Medical University For Nationalities, Baise 533000, Guangxi, China, Su_6187@163.com
[3] School of Education Science, Hanshan Normal University, Chaozhou, 521041, Guangdong, China Hi_Jingjing123 @163.com

Corresponding Author: Lili Su, Su_6187@163.com

Abstract. The course scheduling problem is a typical combinatorial optimization problem. It involves many factors, such as the school management department, teachers, students, and classrooms. It is a mixed integer nonlinear programming problem with multiple constraints. The traditional course scheduling algorithm has many defects. For example, the conventional genetic algorithm is only suitable for solving continuous function course scheduling problems and cannot be used for discrete and constant course scheduling problems. The improved genetic algorithm has unique advantages in solving discrete and continuous combinatorial optimization problems. This paper combines the traditional and improved genetic algorithms to solve the course scheduling problem. It applies the combination of the two to optimize intelligent course scheduling. The experimental results show that the improved genetic algorithm can improve course scheduling to a certain extent, including efficiency and scheduling quality.

Keywords: Improved genetic algorithms; educational management; intelligent course Arrangement; AI-powered Genetics.
DOI: https://doi.org/10.14733/cadaps.2024.S24.17-34

1 INTRODUCTION

Scheduling is a critical task in educational management. However, due to the large number of courses and the strong correlation between them, traditional manual scheduling methods could be more efficient and prone to conflicts and contradictions. To solve this problem, in recent years, scholars have begun to use genetic algorithms for intelligent scheduling optimization. Genetic algorithms have global optimization capabilities and can significantly improve scheduling efficiency while ensuring scheduling quality. However, the existing genetic algorithms still need some help in

their application in educational management. This article aims to enhance the application of genetic algorithms in educational management to improve the effectiveness and accuracy of intelligent scheduling [12].

Scheduling is a typical combinatorial optimization problem involving various factors such as school management, teachers, students, and classrooms, making it a mixed integer nonlinear programming problem with multiple constraints. Therefore, analyzing and comparing various factors and comprehensively considering the constraints is necessary for the best and optimal solution. A genetic algorithm is a global optimization method that simulates the process of biological evolution, which consists of basic operations such as chromosome generation, selection, crossover, and mutation to produce excellent genes. Genetic algorithms have two prominent characteristics: one is to search for the optimal solution by simulating the process of biological evolution, and the other is to continuously generate new excellent genes through genetic operations [9].

With the rapid development of information technology, education management increasingly needs artificial intelligence technology to improve efficiency and optimize results. In education management, scheduling has always been time-consuming and complex, requiring consideration of various factors such as teacher's time arrangements, student course demands, classroom utilization, and so on. Traditional manual scheduling methods can no longer meet the needs of modern education management. Therefore, how to use artificial intelligence technology for intelligent scheduling optimization has become one of the hotspots in the current research field of education management.

With the arrival of the intelligence era, the education management field has also ushered in a significant transformation. In education management, scheduling is a critical task related to the teaching quality of schools, students' learning effectiveness, and teachers' work quality. However, traditional scheduling methods have many problems, such as low scheduling efficiency and unsatisfactory scheduling results. To solve these problems, genetic algorithms have been introduced into scheduling as an effective optimization method [13].

As an optimization algorithm, a genetic algorithm has a strong advantage in solving complex problems. Therefore, the application of genetic algorithms to the optimization of intelligent course scheduling in education management has become a research direction that has attracted much attention. This article will discuss how to improve the application of genetic algorithms in education management, improve the efficiency and accuracy of intelligent course scheduling, and provide strong support for modern education management.

2 ANALYSIS ON THE PROBLEM OF INTELLIGENT CLASS ARRANGEMENT

As an advanced education management method, intelligent course scheduling has significant advantages but also encounters some problems. First, smart course scheduling requires much course data and teacher support. Suppose the school curriculum could be better or the number of teachers needs to be increased. In that case, intelligent course scheduling will require more data, affecting the accuracy and efficiency of course scheduling. Secondly, intelligent course scheduling must consider each student's course needs and personal circumstances, which requires the school to have sufficient student information and data processing capabilities. The wise course arrangement will be wrong or unreasonable if the student's information or data processing ability is insufficient [7]. Finally, intelligent course scheduling needs to be organically combined with the school's teaching management system, which requires highly skilled IT personnel to complete. If the school lacks such IT personnel, the development and application of intelligent class scheduling will be affected. Therefore, while promoting intelligent class scheduling, schools must also pay attention to solving the above problems better to promote innovative education management applications [14].

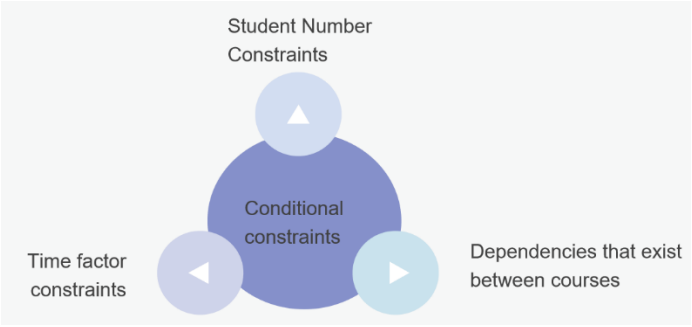

Figure 1: Course selection constraints diagram.

First, the system's operation will be constrained by the number of students because the courses offered by different majors will be affected by the teaching methods (multimedia, blackboard writing, etc.), the classroom's capacity for the number of students, etc. There is a maximum number of people, so in selecting and arranging courses, it is necessary to control the classroom model of the class according to the number of people who choose courses and promptly adjust the resource information of the courses [11].

Secondly, the opening of courses will also be limited by time factors, mainly reflected in three aspects: classroom vacancy time, student class time, and teacher teaching time. In the same period, only one teacher can be assigned to teach one course in one classroom, and one student can only complete the study of one course. Therefore, in the course selection system, it is necessary to make timely adjustments to the conflicts between the above three factors to eliminate the time conflicts in different courses.

Finally, there are dependencies between different courses because there are multiple courses in the same major; some are professional introductory courses, and some are professional advanced courses. The introductory courses need to be started and completed before the advanced courses. In the course scheduling process, it is also necessary to consider the dependency relationship between different classes. If these factors are not considered, the course scheduling information will be unreasonable[4].

Mathematical permutation and combination problems will be involved in the course scheduling process, and the content included in the course scheduling process mainly includes restrictive conditions and optimal solutions to nonlinear problems. Simply put, it is necessary to solve the conflicts between different resources in scheduling courses and arranging courses within a specific limit to avoid conflicts between other factors. Therefore, the principles that need to be followed in the course scheduling process are:

1. Strictly follow the teaching plan principles

The teaching plan must be strictly followed in course arrangement management because it is the core program of the school's teaching work and provides programmatic guidance for the development of the entire teaching work.

2. In the course scheduling process, the summary needs to follow the constraint principle

In today's information age, education management needs more advanced technical means to improve efficiency and quality. Among them, class scheduling, as an essential part of teaching management, has always been a complex problem in education. The traditional manual course scheduling method has complicated, time-consuming, and error-prone issues, and it is challenging

to meet the rapidly changing needs of students and teaching models. Therefore, introducing an intelligent course scheduling system has become one of the crucial ways to solve the course scheduling problem [19].

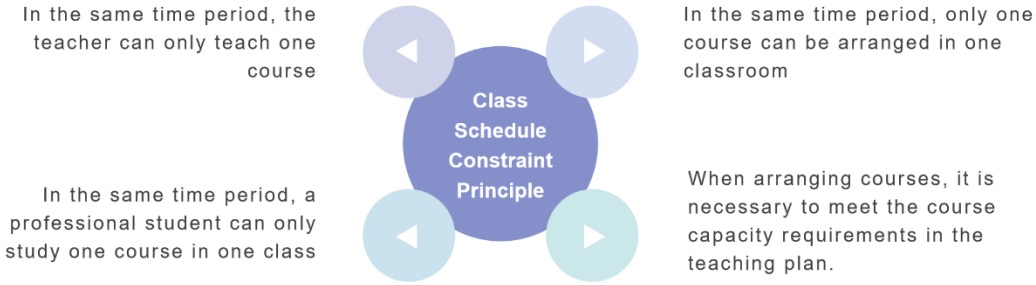

Figure 2: Class schedule constraint principle.

After the above constraints are completed, the initial stage of course selection is entered. In the initial stage of course selection, the educational administrators and teachers need to learn the specific situation of the student's course selection. In this case, the course selection without constraints can be implemented. The natural course selection stage provides a more accurate and practical reference. After obtaining these data, the administrators of the Academic Affairs Office can set some course selection rules during the course scheduling process. In the actual course selection stage, students must select courses according to these rules, such as how many credits they need to complete this semester, Which courses are compulsory, etc. Students can submit course selection applications on the system after following these course selection constraint rules [10].

Finally, it enters the stage of course arrangement and management. After the students complete the online course selection application, the administrative staff of the Academic Affairs Office can extract and organize the course selection information data in the system's background and the teaching resources according to the student's course selection. Optimal distribution [18].

3 IMPORTANCE OF IMPROVED GENETIC ALGORITHMS IN INTELLIGENT COURSE ARRANGEMENT SYSTEM

In education management, class scheduling is a critical task. The traditional way of arranging courses usually takes a lot of time and workforce, and meeting the needs of all teachers and students is often challenging. Therefore, it is becoming more and more urgent to develop an intelligent course scheduling system. The traditional genetic algorithm has good robustness and searchability but can only be used in continuous functions, not discrete and ongoing ones. Moreover, the algorithmic complexity of the traditional genetic algorithm is very high, and the amount of calculation is also significant, leading to large errors in the course scheduling system during operation [2].

Compared with the traditional genetic algorithm, the improved genetic algorithm can overcome the defects of the conventional genetic algorithm to a certain extent. For example, the improved genetic algorithm has a robust global search ability and a better local search ability. In addition, the improved genetic algorithm can solve many problems only by modifying some basic parameters. Therefore, introducing the improved genetic algorithm into the course scheduling system can effectively enhance the course scheduling system's course scheduling quality and reduce the course scheduling system's calculation amount to a certain extent so that its operation speed is greatly accelerated, thereby improving the course scheduling system. Work efficiency [2].

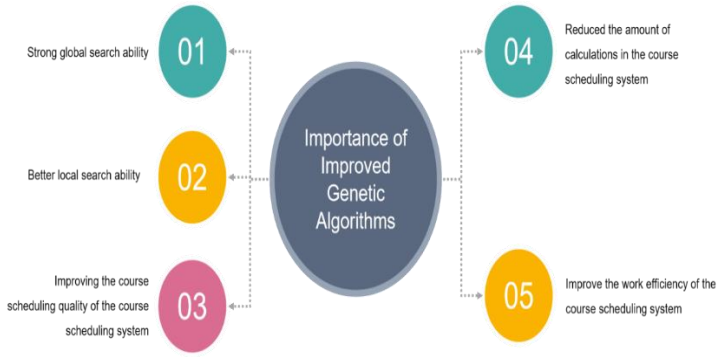

Figure 3: Importance of improved genetic algorithms.

Improving the application of genetic algorithms can optimize the utilization of teaching resources, reduce teaching conflicts and waste of teaching resources, and enhance the quality of teaching and efficiency. At the same time, it can meet the needs of students, teachers, and schools and realize the intelligence and informatization of education management. In practical application, improving the genetic algorithm can further improve the performance and function of the intelligent course scheduling system. For example, enhancing the genetic algorithm coding method, selection operator, and crossover operator can optimize the quality and feasibility of course scheduling results. In addition, techniques such as multi-objective and constrained optimization can also be introduced to meet different requirements and constraints [3].

The genetic algorithm is an optimization algorithm that can provide efficient solutions when solving complex problems. The genetic algorithm can generate the optimal course scheduling scheme through continuous evolution and selection in an intelligent course scheduling system. However, the traditional genetic algorithm has some problems in the smart course scheduling system, such as the selection operator, crossover operator, mutation operator, etc.

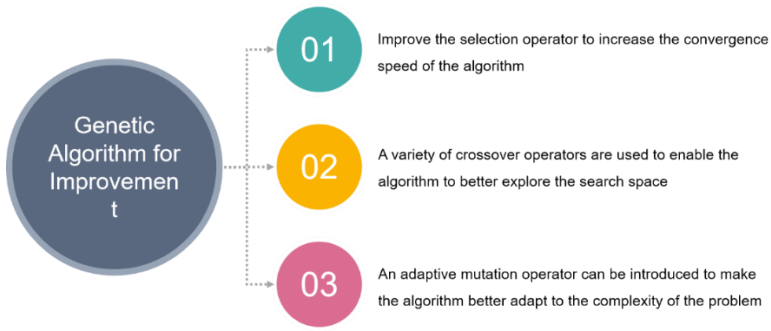

Figure 4: Genetic algorithm for improving strategies.

To solve these problems, the genetic algorithm needs to be improved. First, the convergence speed of the algorithm can be enhanced by improving the selection operator. Second, various crossover operators can enable the algorithm to explore the search space better. Finally, an adaptive mutation operator can be introduced so that the algorithm can better adapt to the complexity of the problem.

By improving the genetic algorithm, the intelligent course scheduling system can generate the optimal course scheduling plan more efficiently to meet various needs in education management. It

can reduce class scheduling conflicts, improve the satisfaction of teachers and students, optimize the utilization efficiency of educational resources, and thus promote education development. Therefore, the improved genetic algorithm is significant in the intelligent course scheduling system [26].

In short, applying an improved genetic algorithm in an intelligent course scheduling system has essential significance and value. It can improve the efficiency and accuracy of class scheduling, optimize the use of teaching resources, improve teaching quality and efficiency, and realize the intelligence and informatization of education management.

4 IMPROVED GENETIC ALGORITHM

The course scheduling problem is a typical combinatorial optimization problem with two cases of discrete and continuous functions. For the discrete course scheduling problem, the genetic algorithm is used to solve the problem, and its running time and resource utilization rate are high, while for the continuous course scheduling problem, the genetic algorithm is used to solve the problem slowly. To improve the algorithm's efficiency, this paper adopts the improved genetic algorithm to solve the course scheduling problem.

A traditional genetic algorithm can solve the class scheduling problem of continuous function. In practical application, if the conventional genetic algorithm cannot decrypt the constant function, then the method combining the genetic algorithm and simulated annealing algorithm can be used to solve it. However, it should be noted that when applying the improved genetic algorithm, it should be noted that the improved genetic algorithm is only suitable for discrete class scheduling problems [26].

4.1 Traditional Genetic Algorithm

The traditional genetic algorithm is an optimization algorithm based on evolutionary thinking. It continuously iterates out the optimal solution by operating and mutating the population's genetic information. Genetic algorithms are widely used in education management to optimize intelligent course scheduling. The traditional genetic algorithm achieves the purpose of optimal course scheduling by adjusting the parameters of course time and place. However, the conventional genetic algorithm also needs some help.

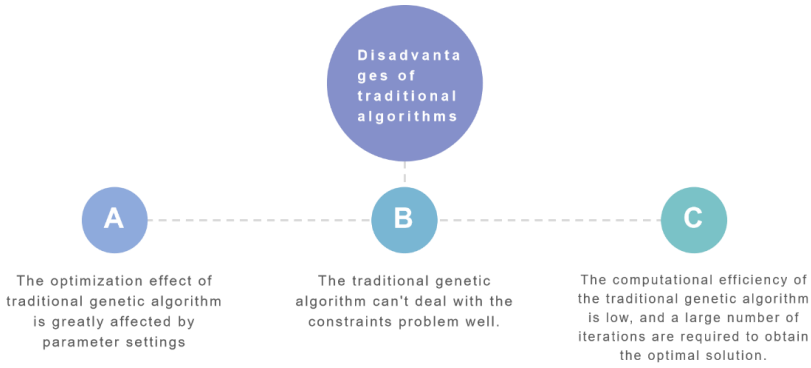

Figure 5: Disadvantages of traditional genetic algorithm.

First, parameter settings significantly affect the optimization effect of traditional genetic algorithms. If the parameters are not appropriately set, the algorithm may fall into a local optimal solution, and the optimal solution cannot be obtained. Second, the traditional genetic algorithm cannot deal with

the constraints problem well. In education management, there are some constraints on course scheduling, such as only one course can be arranged in a classroom at a time. It is difficult for the traditional genetic algorithm to deal with these constraints well, and it can easily lead to insufficient optimization of the course scheduling results. Finally, the computational efficiency of the traditional genetic algorithm could be higher, and many iterations are required to obtain the optimal solution, which is unacceptable for educational management [16].

The main characteristics of traditional genetic algorithms. First, a genetic algorithm is a global search algorithm that can search for the optimal global solution to a problem. The genetic algorithm has broader applicability and better searchability than other optimization algorithms. Secondly, the genetic algorithm can continuously optimize the quality of the solution through the selection, crossover, and mutation operations of the population. In this way, the genetic algorithm can balance diversity and convergence in the solution space and prevent the algorithm from falling into a local optimal solution. In addition, the genetic algorithm is robust and adaptable. Since the genetic algorithm is based on population evolution, it can adaptively adjust the search strategy of the algorithm by selecting individuals with high fitness and random mutation to adapt to different optimization problems. Finally, the genetic algorithm has better interpretability. Since the operation process of the genetic algorithm is similar to the process of natural evolution, it can help people understand the principle of the algorithm and the optimization process by visualizing and explaining the process of population evolution. These characteristics give genetic algorithms broad application prospects in intelligent course scheduling optimization in education management. By designing an appropriate genetic algorithm model and optimizing the objective function, the rational allocation and optimal utilization of educational resources can be realized, and the quality and efficiency of education can be further improved [17].

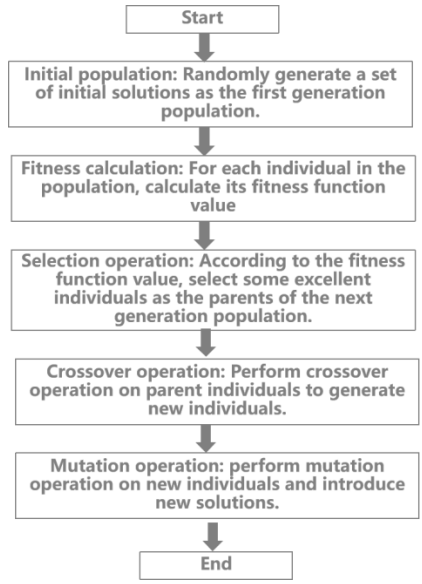

Figure 6: Flowchart of genetic algorithm.

A genetic algorithm is an optimization algorithm based on natural selection and natural genetic mechanisms. In education management, genetic algorithms can be applied to course scheduling optimization. The following is a flow chart of the genetic algorithm:

1. Initial population: Randomly generate a set of initial solutions as the first-generation population.

2. Fitness calculation: Calculate each individual in the population's fitness function value.

3. Selection operation: According to the fitness function value, select some excellent individuals as the parents of the next generation population.

4. Crossover operation: Perform crossover operation on parent individuals to generate new individuals.

5. Mutation operation: perform mutation operation on new individuals and introduce new solutions.

6. Repeat steps 2-5 until the preset stop condition is reached.

Insufficiency of traditional genetic algorithm. Applying conventional genetic algorithms in education management has achieved specific results, but some things could be improved. First, the conventional genetic algorithm may have limitations on the problem's search space, which means that the algorithm may fall into a local optimal solution and need help finding a globally optimal solution. Secondly, the traditional genetic algorithm has the problem of slow convergence speed; because of the high randomness, it requires a lot of iterations to get better results. In addition, the traditional genetic algorithm cannot deal with multi-objective problems, and the optimization effect of the conventional genetic algorithm is also limited to some complex issues in education management. Some improved genetic algorithms have emerged in recent years to solve these problems. Among them, the multi-objective genetic algorithm (MOGA) is a commonly used improved algorithm, which can effectively avoid the limitations of traditional genetic algorithms when dealing with multi-objective problems. In addition, the improved genetic algorithm also includes some new operation methods, such as crossover operator, mutation operator, etc. These operation methods can help the algorithm explore the search space better, thereby accelerating the convergence speed of the algorithm. At the same time, the improved genetic algorithm also applies some heuristic algorithm ideas, such as particle swarm algorithm, ant colony algorithm, etc [8-24]. These heuristic algorithms can explore the search space more intelligently, thereby improving the algorithm's optimization effect. In short, the improved genetic algorithm has broad application prospects in education management. It can effectively help education managers solve complex problems such as class scheduling problems and improve the efficiency and quality of class scheduling.

4.1 Improved Genetic Algorithm

The genetic algorithm is applied to the problem of intelligent course arrangement in colleges and universities, and an innovative course arrangement system is realized. Combining the soft and hard constraints that the wise course scheduling system needs to design and the characteristics of "walking" students' hierarchical course selection, the shortcomings of the traditional course scheduling algorithm are analyzed, and the constraints and related factors of the college course scheduling problem are combined with the adaptive genetic algorithm. Correspondingly, optimize and adjust the initial population homogenization, fitness function, genetic operators, etc., establish a corresponding mathematical model of the intelligent course scheduling system, and apply it to the actual education and teaching environment to meet the requirements of administrative class scheduling. The demand for class and class scheduling provides a new idea and new method for the development of today's education in the issue of course scheduling, making the course scheduling system of colleges and universities tend to be intelligent and improving the completion of college education and teaching plans [1].

The genetic algorithm draws on the random search algorithm evolved from the biological evolution law 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 performs genetic crossover and genetic mutation operations to obtain A new generation of individuals, which are the current population for the next iteration of evolution. In real-life applications, the genetic algorithm provides optimization ideas for solving complex problems and many constraints. It does not need to consider the target problem itself. It only needs to encode and analyze the situation and set an appropriate objective function to calculate and determine each. The size of the encoded individual fitness and the evaluation of the individual fitness must be determined by the operation of the fitness function. The initial population of the genetic algorithm is generated by randomly searching individuals in the problem. Each individual is regarded as a possible or approximate optimal solution to the problem. After genetic encoding, each needs to be compared with the fitness function. The algorithm protects individuals with high fitness values for evaluation and judgment, so individuals with large fitness values will be selected first.

In contrast, individuals with small fitness values will be eliminated and discarded, leaving only fitness values in the population. For high chromosomes, the selected individuals directly perform genetic crossover and genetic mutation operations, and a new generation of individuals forms offspring populations. In this cyclic iterative operation, the good chromosomes left in the final population can get the optimal solution to the problem. As mentioned above, the whole evolutionary process embodies the basic genetic algorithm principle. The algorithm is very efficient in the application process, and the global search function can be realized by using this algorithm. In the process of rapid development in recent years, it has been widely used in many fields.

The application of a genetic algorithm mainly starts from a specific feasible solution set of the problem to be solved. This set can be regarded as a population composed of a specified number of individuals, and the individuals in the population are collected of genes through coding. In the specific solution, the biological evolution process is simulated so that the probability selection of some individuals in the population can be realized, and the optimal solution can be obtained at the end through gradual evolution. Before each iterative operation, it is necessary to calculate and solve the fitness value of the individual in the population, select some individuals based on the probability value, and then continue to perform operations, such as crossover and mutation, to form a new population. In specific applications, inferior individuals in the entire population can be eliminated through multiple iterative calculations to generate better individuals through genetics, and the optimal solution can be obtained after calculation. Figure 7 below shows the algorithm's calculation process [5].

Improved genetic algorithm coding method. The improved genetic algorithm coding method optimizes the traditional genetic algorithm coding method. The conventional genetic algorithm coding method adopts binary coding. When this coding method deals with complex problems, the chromosome length is too long, and the search space is too large, leading to the algorithm's low efficiency. The coding method of the improved genetic algorithm adopts accurate number coding, and expressing genes as real numbers solves the problem of excessive length of chromosomes. At the same time, the actual number code can also tell the gene's value range more intuitively, improving the algorithm's search accuracy. Intelligent course scheduling optimization in education management must consider multiple factors, such as students' course selection, teachers' teaching conditions, and class scheduling conditions. The traditional genetic algorithm makes it difficult to deal with these complex constraints, and the improved genetic algorithm coding method can solve this problem by introducing additional constraints. For example, the teacher's teaching time arrangement can be a further constraint to optimize teaching time [25].

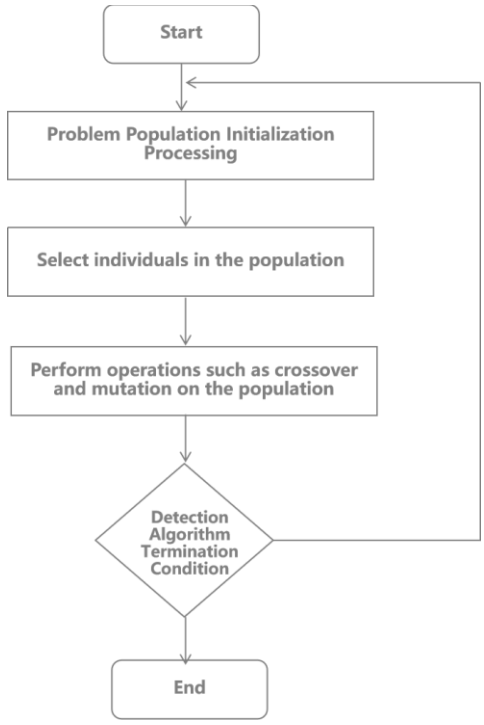

Figure. 7: Genetic algorithm flowchart.

The flow chart of the improved genetic algorithm. The application of the improved genetic algorithm in education management can be used for intelligent course scheduling optimization. In practical application, the improved genetic algorithm must complete the whole optimization process through a series of steps. Below, we will introduce the flow chart of the improved genetic algorithm:

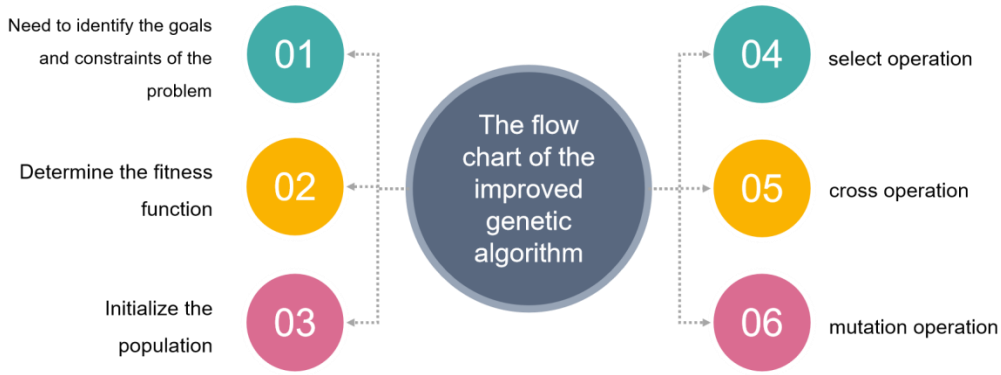

Figure 8: The flow chart of the improved genetic algorithm.

In the first step, the goals and constraints of the problem need to be determined. In educational management, the goal is usually to maximize students' learning effect, and the constraints include teachers' working hours, classroom capacity, etc.

In the first step, the goals and constraints of the problem need to be determined. In educational management, the goal is usually to maximize students' learning effect, and the constraints include teachers' working hours, classroom capacity, etc.

The third step is to initialize the population. A population is a collection of individuals with the same genetic characteristics. In the course scheduling problem, the population can be composed of different course scheduling schemes.

The fourth step is to select an operation. The selection operation refers to selecting excellent individuals from the population for crossover and mutation. The improved genetic algorithm can use roulette and tournament selection [6].

The fifth step is cross-operation. In the genetic algorithm, the crossover operation generates a new individual by exchanging the chromosomes of two individuals. In the course scheduling problem, two different course scheduling schemes can be cross-operated to create a unique course scheduling scheme.

The sixth step is mutation operation. Mutation operation refers to randomly changing a gene in an individual's chromosome to generate a new individual. In the course scheduling problem, a course's scheduling time or location can be randomly changed.

The above is the flow chart of the improved genetic algorithm. Through these steps, we can continuously optimize the course arrangement plan, improve students' learning effect, and realize the optimization of intelligent course arrangement.

4.1 Application of Genetic Algorithm in Course Arrangement

In the course scheduling process design, it can be abstracted as calculating the optimal solution for a 5-element array, which mainly includes courses, classes, teachers, classrooms, and time, which can be expressed as follows:

$$\mathrm{TP} = (\mathrm{KC}, \mathrm{BJ}, \mathrm{SJ}, \mathrm{JS}, \mathrm{CR}) \tag{1}$$

In the 5-tuple above, where

A collection of courses is represented by： KC={KC1, KC2, KC3…KCn}

A class collection is defined as BJ={BJ1, BJ2, BJ3…BJn}

The collection of times is defined as SJ={SJ1, SJ2, SJ3…SJn}

The teacher set is as follows： JS={JS1, JS2, JS3…JSn}

The classroom set is as follows： CR={CR1, CR2, CR3…CRn}

During the actual scheduling process, Durin the actual scheduling process, $\mathrm{TP} = (\mathrm{KC}, \mathrm{BJ}, \mathrm{SJ}, \mathrm{JS}, \mathrm{CR})$. This set is combined according to the constraints. We combine the time factor and the classroom factor, and G can be expressed as：

$$\mathrm{G} = \mathrm{SJ} \bullet \mathrm{CR}\{(\mathrm{SJ1}, \mathrm{cr1}), (\mathrm{sj2}, \mathrm{cr2}), \ldots (\mathrm{sjm}, \mathrm{crn})\} \tag{2}$$

In the above collection, the relevant elements in the G collection mainly represent the combination of classrooms and time. The problem of class scheduling can be abstracted according to the arrangement of teaching tasks. According to the corresponding matching relationship, it can be expressed in the following calculation formula：

$$\mathrm{T} = \&(SJ, CR) \tag{3}$$

In problem conversion, the set G generated by time and classroom is called the resource set. In setting up the course arrangement, the three factors of course, class, and teacher constitute a set of necessary factors. Combining these three constraints, the class scheduling event E can be recorded as：

$$E = \{e1, e2, e3, \dots em\} \tag{4}$$

By analyzing the above, we can get the constraints between the scheduling event E and the obtained set G, get： E—>G

Due to time conflicts between different courses in the course scheduling process, only one teacher can be arranged to teach one course in one classroom simultaneously. To effectively judge these conflicts, it is necessary to design a method for evaluating conflicts in algorithm design. Let's illustrate the conflict of time factor as an example [20].

1. Through the above analysis and design, two-time factors are coded SJAi in the process of conflict variable detection;

2. Perform an AND operation on the two coding factors to solve;

3. If the AND operation result is not equal to 0, it means that there is a conflict and needs to be rearranged;

4. The two codes are used to obtain a new code.

By adopting this method, the conflict of different teaching resources in the course scheduling process can be effectively avoided, thereby ensuring the orderly development of teaching planning tasks.

5 EXPERIMENTAL RESULTS AND ANALYSIS

To verify the effectiveness and feasibility of the course scheduling algorithm in this paper, we designed two sets of experiments for testing. The first group of experiments used the traditional genetic algorithm, and the second group used the improved genetic algorithm.

5.1 Build a Mathematical Model

The previous analysis taught us that the course scheduling process will be subject to various artistic restrictions. Hence, optimizing the course scheduling plan is necessary when dealing with the course scheduling problem. In the course scheduling function module, it is essential to establish a problem optimization processing model, and at the same time, it is necessary to develop multiple constraints. Under the typical restrictions and limitations of various constraints, the calculation and processing of the mathematical model can be realized, and finally, the optimal mathematical model can be obtained. Excellent solution [23].

In dealing with the course arrangement problem, the mathematical model is mainly constructed according to the teaching plan arranged by the teacher. Suppose the teaching plan is: $P = \{p_1, p_2, p_3, \dots, p_n\}$； Class hours for each semester are: $T = \{t_1, t_2, t_3, \dots, t_n\}$； The classroom resources that the school has in teaching are $S = \{s_1, s_2, s_3, \dots, s_n\}$； The information of the classes involved in teaching in each semester is： $C = \{c_1, c_2, c_3, \dots, c_n\}$, The limiting factor for the scheduling problem caused by some other factors is： $G = \{g_1, g_2, g_3, \dots, g_n\}$.

By analyzing the above mathematical model, we can get the constraints of different aspects of the course arrangement. In problem-solving, we can explore and calculate the relationship between other elements., An incidence matrix will be introduced in the calculation process R_e； to represent

the relationship between different constraints. r_{ij} Calculate the optimal solution according to the corresponding constraints set, t_i, and class c_j . The relationship between the two elements is shown in the formula below.

$$R_{e_{gt}} = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1g} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ r_{t1} & r_{t2} & \cdots & r_{tg} \end{bmatrix} \tag{5}$$

From the above discussion, we know that by constructing the corresponding matrix equations, the relationship between different elements related to course scheduling can be established, and the constraints can be calculated and solved by combining the corresponding equations. In a specific period, t_c, fixed classroom s_k,t can only be used to teach one course, and the following constraints can be obtained according to the correlation matrix relationship.

$$\begin{cases} r_{i,j=1,i=k\&\neq c} \\ r_{i,j=1,i\neq k\&=c} \end{cases} \tag{6}$$

5.2 Algorithm Design Ideas

1. The goal of the course scheduling problem must be clarified, and a mathematical model of course scheduling must be built according to the problem.

2. In the course scheduling problem, the elements involved, such as teachers, classrooms, classes, and courses, are converted by coding.

3. Construct the genetic factor of the course scheduling problem according to the actual situation and apply the genetic factor to the chromosome-corresponding operation.

4. Construct the corresponding fitness function according to the problem's constraints and the objective function, then iteratively calculate and solve based on the constructed mathematical model. The individual with the best fitness can be obtained.

5. The decoding operation is performed on the individuals obtained by iterative calculation so that the actual problem can be restored and, finally, the curriculum that satisfies the constraints can be introduced.

5.3 Chromosome Code

The genetic algorithm's basic information and parameters must be processed to a certain extent, affecting its computational efficiency and closely related to the coding scheme. Real-number coding is the most common, and it is also used in this study [21].

Chromosome coding mainly encodes various factors that affect the class arrangement, including the class number, period code, and classroom number, which are recombined and then used as gene fragments. Table 1 follows the encoding format table.

Period D（2 bit）	*Classroom D（4 bit）*	*Classroom ID（8 bit ）*

Table 1: Encoding format table.

Based on this encoding format, classroom, classroom number, and period are processed. For example, 20200618-22-1006 represents that the school with the number 20200618 will have class in classroom 1006 on Thursday's third period.

5.4 Fitness Function Design

The key to designing based on a genetic algorithm is to complete the design of the fitness function, which is influenced by various factors. This article discusses only three dimensions of combinatorial optimization: class hour distribution and the optimization degree of class periods in the design of the scheduling algorithm.

After analyzing the relevant influencing factors, the various influencing factors must be comprehensively analyzed in the design of the fitness function. At the same time, it is also essential to determine the proportional weight of the different factors influencing the fitness function. The weight values of other factors reflect this in the algorithm. Based on the above analysis, the design of the fitness function can be implemented, as shown in the specific formula below.

$$\mathrm{F} = \frac{1}{3}(p_1 l + p_2 C + p_3 D)e \tag{7}$$

In the fitness function designed above,$\mathrm{p_1 p_2 p_3}$, The weight values of different influencing factors in the algorithm summary are represented separately. Due to the multiple factors affecting automatic class scheduling in practice, numerous constraint conditions and factors must be checked during the algorithm design process.

If there is a resource conflict in scheduling, the value of e will be set to 0. This indicates that this scheduling plan is not feasible. If there is no resource conflict, the parameter e will be set to 1. l indicates the section priority, C indicates the classroom priority, and D indicates the resource priority [22].

5.5 Genetic Operator Design

After the comprehensive analysis above, the problems related to gene coding and chromosome composition in the genetic algorithm processing were designed and completed. Finally, it realized the design of the fitness function. The processing of genetic algorithms mainly includes the following processes.

Assuming Crossover Probability in Solving Practical Problems Based on Genetic Algorithms $\mathrm{p_c}$, The probability of variation that may occur in the actual calculation process is $\mathrm{p_m}$; in the processing of the problem, it is assumed that the population size of the genetic algorithm is M, The maximum number of runs that need to be run in an iterative calculation of the algorithm is G, The final termination condition of the algorithm in the iterative calculation process is to find a specific solution for fitness.

The probability of generating a new generation of population after population initialization and iterative calculation is P. Through a detailed analysis of the steps in the calculation process of the algorithm, the initial population of the algorithm can be generated using random generation to ensure that the randomly generated values have balanced distribution characteristics in the application, and through the characteristics of the population, it can be determined that the initial population has a uniform distribution. Distribution characteristics [15].

The selection operator is needed in the calculation based on the genetic algorithm. Based on the selection operator, the selection of different populations in the iterative calculation process of the population can be completed so that local optimal solutions can be avoided in the calculation process. The probability of an individual being selected during the solution process is:

$$\mathrm{Q_i} = \frac{F_i}{\sum F_i} \tag{8}$$

The crossover operator mainly completes the selection of individuals in the calculation. In an iterative solution, not all the selected individuals need to perform crossover operations and other processing, but only the selected individuals have a higher crossover probability than others. Individual: At the same time, in the crossover calculation, it is necessary to follow the crossover probability of p_c conduct. Usually, the corresponding cross operator and cross point are selected during the cross calculation.

The mutation operator mainly sets the corresponding calculation in the algorithm's iterative process. The algorithm also needs to use the mutation operator to process the chromosome. In the specific implementation, the probability of occurrence will be controlled using random numbers. In this paper's course scheduling algorithm design, mutation operators are mainly used to realize the selection of classes and the processing of mutation genes.

5.6 The Experimental Results of the Improved Genetic Algorithm

After completing the design of the genetic algorithm, it is necessary to verify its operation effect. In this paper, the single-objective optimization problem is mainly confirmed. Respectively selected Schwefel, Griewank, Sphere, Rosenbrock, and Rastrigin functions to verify the algorithm's operation effect. Keep one running scenario for the five algorithms, and calculate the average running time for five single-objective optimization problems after 15 consecutive calculations(unit： ms); according to the analysis of running results, the algorithm can meet the requirements. Figure 9 below shows the running results.

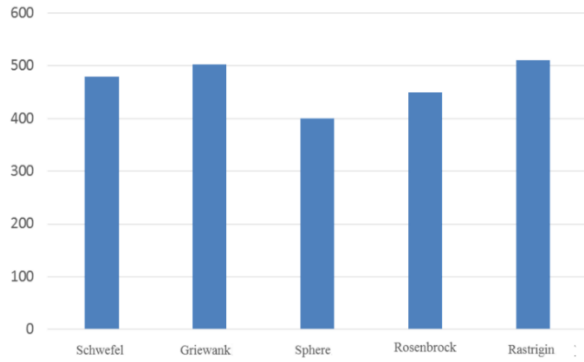

Figure 9: Algorithm running result.

The experimental results of the improved genetic algorithm scheduling conflict problem. The improved genetic algorithm has been widely used in optimizing intelligent course arrangements in education management. In the experiment, we applied the improved genetic algorithm to the curriculum scheduling of a middle school and compared it with the traditional scheduling method. The experimental results show that the improved genetic algorithm can more accurately deal with the conflicts in course scheduling and effectively enhance its efficiency and accuracy. In the experiment, we used the improved genetic algorithm to arrange courses, which adopted a new crossover and mutation strategy and added a fitness function and penalty function so that the algorithm could better deal with the conflicts in the course arrangement question. We also set up multiple experimental groups in the experiment, using different parameters to schedule lessons and compare them. The experimental results show that using the improved genetic algorithm to arrange courses can better solve the conflict problem in course arrangement and can better meet the needs of students and teachers. Compared with the traditional course scheduling method, the improved

genetic algorithm can save more time and energy and better ensure the accuracy and fairness of course scheduling. The improved genetic algorithm has a broad application prospect in optimizing intelligent course arrangement in education management. This algorithm will shortly become integral to education management, providing students and teachers more efficient services.

6 CONCLUSIONS

Due to its slow convergence speed and premature convergence, the traditional genetic algorithm is limited mainly when applied to the course scheduling problem. This paper proposes an improved genetic algorithm and uses the enhanced genetic algorithm for course scheduling optimization. The algorithm speeds up the evolution of the population by introducing crossover operators and improves the population evolution rate by setting the genetic mutation rate and operation operators. Diversity effectively avoids the problem of premature convergence. Experimental results show that the algorithm is feasible in solving the class scheduling problem.

The improved genetic algorithm is vital in optimizing intelligent course arrangements in education management. By enhancing the genetic coding method, the algorithm can better adapt to different course scheduling needs while ensuring the feasibility and rationality of the course scheduling results. Further experimental results show that the improved genetic algorithm has significantly improved the efficiency and accuracy of the optimized course scheduling scheme.

In addition, the improved genetic algorithm is also highly robust and adaptable. In the face of complex course scheduling scenarios, the algorithm can quickly converge and find the optimal solution while avoiding the trap of locally optimal solutions. These characteristics make the improved genetic algorithm widely used in education management and provide a better course arrangement plan for the education management department.

In short, the improved genetic algorithm significantly optimizes intelligent course scheduling in education management. With the continuous progress and development of related technologies, this algorithm will play an increasingly important role in future education management and provide strong support for developing and improving education. Incorporating AI-driven genetic algorithms for scheduling in medical research and educational management promises to significantly improve productivity, efficiency, and overall outcomes in these critical domains, benefiting both research endeavors and academic experiences within the medical field.

Rui Chen, https://orcid.org/0009-0008-9256-7907
Lili Su, https://orcid.org/0009-0004-9009-9426
Jingjing Guan, https://orcid.org/0009-0000-3411-8806

ACKNOWLEDGEMENTS

The reform of educational evaluation in 2022 in Guangxi's "Fourteenth Five-Year Plan" for academic science： Research on the construction of teacher's ethics evaluation index system in Guangxi universities under the background of "double first-class"（2022ZJY460）.

Open Project of Guangxi University Teacher Ethics Construction Research Center： A Study on the Long-term Mechanism of Teacher Ethics and Professional Conduct Construction in Local Universities in Guangxi under the Background of the New Era（SD2022YB08）.

Guangxi University Young and Middle-aged Teachers' Basic Research Ability Improvement Project： An Empirical Study on the Willingness and Influencing Factors of Targeted Medical Graduates to Stay on Duty upon Expiration of Contract Performance（2023KY0543）.

Hanshan Normal University's educational reform project is "Research on the contextualized teaching of teachers' professional courses in the context of new normal construction" (521072)

The Doctoral Fund of Hanshan Normal University "Research on Multi-agent Interaction and Personalized Learning Management" (E22038).

REFERENCES

[1] Alkhatib, F.; Kasim, N.; Qaidi, S.; Najm, Hadee M.; Sabri, SabriMohanad M.: Wind-Resistant Structural Optimization of Irregular Tall Building Using CFD and Improved Genetic Algorithm for Sustainable and Cost-Effective Design, Frontiers in Energy Research, 2022. https://doi.org/10.3389/fenrg.2022.1017813

[2] Aote, Shailendra S.; Pimpalshende A.; Potnurwar, A.; Lohi, S.: Binary Particle Swarm Optimization with an Improved Genetic Algorithm to Solve Multi-Document Text Summarization Problem of Hindi documents, Engineering Applications of Artificial Intelligence, 2023, 117(PA). https://doi.org/10.1016/j.engappai.2022.105575

[3] Bo, C.; Wei, C.; Bao, Xiang W.; Ying, C.; Peng, fei W.; Yan, T.: Intelligent Optimization System of Burden Structure in Sintering and Blast Furnace Ironmaking Process Based on Improved Genetic Algorithm Ironmaking & Steelmaking, 2022, 49(10). https://doi.org/10.1080/03019233.2022.2075690

[4] Chang, Y.; Hamedi, M.; Haghani, A.: Solving Integrated Problem of Stowage Planning with Crane Split by an Improved Genetic Algorithm Based on Novel Encoding Mode, Measurement and Control, 2023, 56(1-2). https://doi.org/10.1177/00202940221097981

[5] Chen, Q.; Hu, X.: Design of Intelligent Control System for Agricultural Greenhouses Based on Adaptive Improved Genetic Algorithm for Multi-Energy Supply System, Energy Reports, 2022, 8. https://doi.org/10.1016/j.egyr.2022.09.018

[6] Chen, S.; Yue, Y.; Liu, J.: Constrained Optimization of Transition Metal Dichalcogenide-Based Bloch Surface Wave Sensor Using Improved Genetic Algorithm, Applied Physics A, 2022, 128(10). https://doi.org/10.1007/s00339-022-06091-x

[7] Feng, Z.; Wang, R.; Xie, D.; Liao, M.; DuanXiongying, Ma H.: Research on Efficiency of New Self-driven Fault Current Limiter Based on the Improved Genetic Algorithm, Journal of Physics: Conference Series, 2023, 2419(1). https://doi.org/10.1088/1742-6596/2419/1/012089

[8] Guo, X.; Ma, Y.: Social Work Management Intelligent System Based on Improved Genetic Algorithm, Mobile Information Systems, 2022, 2022. https://doi.org/10.1155/2022/8615251

[9] Hassan Aakash.; Bass Octavian.; Masoum Mohammad, A.S.: An Improved Genetic Algorithm Based Fractional Open Circuit Voltage MPPT for Solar PV Systems, Energy Reports, 2023, 9. https://doi.org/10.1016/j.egyr.2022.12.088

[10] Li, Z.; Wang, D.; Wei, M.; Li, Y.: Study on Scheduling of Metro Construction Muck Transport Vehicles during Restricted Hours Based on Improved Genetic Algorithm, Academic Journal of Engineering and Technology Science, 2022, 5(12). https://doi.org/10.25236/AJETS.2022.051201

[11] Liu, Q.; Peng, L.; Liu, W.; Zhang, B.: Optimization of Coal Procurement and Transportation Decisions Based on Improved Genetic Algorithm, Journal of Physics: Conference Series, 2023, 2422(1). https://doi.org/10.1088/1742-6596/2422/1/012015

[12] Long, Q.; Shi, W.: Research on Fault Reconstruction of Ship Regional Distribution System Based on Improved Genetic Algorithm, Journal of Physics: Conference Series, 2023, 2418(1). https://doi.org/10.1088/1742-6596/2418/1/012101

[13] Lu, Y.; Teng, Y.; Zhang, Q.; Dai, J.: Prediction Model for the Chemical Futures Price Using Improved Genetic Algorithm Based Long Short-Term Memory, Processes, 2023, 11(1). https://doi.org/10.3390/pr11010238

[14] Ma, H.; Sun, F.; Fan, B.; Liu, G.: Research on Online Monitoring Method of Arrester Deterioration Based on Improved Genetic Algorithm, Journal of Physics: Conference Series,

2023, 2422(1). https://doi.org/10.1088/1742-6596/2422/1/012008
[15] Qi, J.; Wang, Q.: Tourism Route Selection Model for Tourism Sustainable Development Based on Improved Genetic Algorithm, International Transactions on Electrical Energy Systems, 2022, 2022. https://doi.org/10.1155/2022/4287011
[16] Shang, Z.; Zhao, C.: The Mobile Edge Computing Task Offloading in Wireless Networks Based on Improved Genetic Algorithm, Web Intelligence, 2022, 20(4). https://doi.org/10.3233/WEB-220019
[17] Wei, Y.; Feng, J.; Huang, Y.; Liu, K.; Ren, B.: Path Planning of Mobile Robot Based on Improved Genetic Algorithm, Journal of Physics: Conference Series, 2022, 2365(1). https://doi.org/10.1088/1742-6596/2365/1/012053
[18] Wu, J.; Song, B.; Zhang, G.; Ou, J.; Chen, Y.; Yao, F.; He, L.; Xing Lining.: A Data-Driven Improved Genetic Algorithm for Agile Earth Observation Satellite Scheduling With Time-Dependent Transition Time, Computers & Industrial Engineering, 2022, 174. https://doi.org/10.1016/j.cie.2022.108823
[19] Xia, J.; Yan, Y.; Ji, L.: Retraction Note: Research on Control Strategy and Policy Optimal Scheduling Based on an Improved Genetic Algorithm, Neural Computing, and Applications, 2022, 35(6). https://doi.org/10.1007/s00521-022-08191-4
[20] Xu, Q.; Xu, C.; Wang, J.: Forecasting the Yield of Wafer by Using Improved Genetic Algorithm, High Dimensional Alternating Feature Selection, and SVM with Uneven Distribution and High-Dimensional Data, Autonomous Intelligent Systems, 2022, 2(1). https://doi.org/10.1007/s43684-022-00041-3
[21] Yujie, S.: Application of Improved Genetic Algorithm in FJSP, Academic Journal of Computing & Information Science,2022,5(11). https://doi.org/10.25236/AJCIS.2022.051101
[22] Zhang, Q.: An Optimized Solution to the Course Scheduling Problem in Universities Under an Improved Genetic Algorithm, Journal of Intelligent Systems, 2022, 31(1). https://doi.org/10.1515/jisys-2022-0114
[23] Zhang, W.: Artificial Intelligence-Based Soccer Sports Training Function Extraction: Application of Improved Genetic Algorithm to Soccer Training Path Planning, Journal of Sensors, 2022, 2022. https://doi.org/10.1155/2022/8375916
[24] Zhang, Y.; Deng, N.; Zhang, S.; Liu, P.; Chen, C.; Cui, Z.; Chen, B.; Tan, T.: Prediction of Plasticizer Property Based on an Improved Genetic Algorithm, Polymers, 2022, 14(20). https://doi.org/10.3390/polym14204284
[25] Zhang, Z.; Pan, K.: Analysis of Transportation Network Scheduling of Maritime Silk Road and International Digital Trade Potential Based on Improved Genetic Algorithm Under Digital Trade Barriers, Wireless Communications and Mobile Computing, 2022, 2022. https://doi.org/10.1155/2022/7903376
[26] Zhen, L.; Lu, T.; Xu, Sun C.; Mei, Wu Y.; Sheng, Wang D.; Hong, M.: A Systematic Research on System Recovery Based on Improved Genetic Algorithm and Quotient Resilience Model Under Attack and Damage, International Journal of Computational Intelligence Systems, 2022, 15(1). https://doi.org/10.1007/s44196-022-00158-6