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Innovative Research on Undergraduate Education Models Driven by Industry-Education Integration under the Framework of New Quality Productivity

Ying Qi[1], Wei Feng[2,✉]

[1] College of Business, Quzhou University, Quzhou, Zhejiang, 324000, China

[2] College of Education, Zhongyuan Institute of Science and Technology, Zhengzhou, Henan, 450000, China

ABSTRACT
As the key driving force to promote the development of new quality productivity, the internal logic of the integration of production and education is to provide core support for the development of new quality productivity by training high-quality workers, providing high-quality labor elements and creating an efficient innovation platform. However, at present, the integration of middle and teaching in undergraduate education faces challenges such as "school hot and enterprise cold", school-enterprise cooperation obstacles, and imperfect mechanism. This paper analyzes the current situation of the integration of production and education in undergraduate education, constructs the corresponding mathematical model. And uses genetic algorithm to solve the optimization objectives of curriculum design and teaching resource allocation under the integration of production and education, include the incorporation of enterprise elements, such as the proportion of enterprise practice courses, enterprise mentors, joint research and development data. Based on the above, the feasibility of GA optimization algorithm is tested from three perspectives: comparison of the same kind, practical application and student satisfaction. In order to effectively enable the development of new quality productivity, it is necessary to optimize the education major setting in accordance with industrial changes, deepen the learning situation and customize practical courses, deepen the school-enterprise cooperation and development platform, strengthen collaborative innovation, and improve the incentive mechanism, so as to form an effective connection between the education chain, the talent chain, the industrial chain and the innovation chain, and jointly promote the high-quality development of undergraduate education.

Keywords: New quality productivity, Integration of industry and education, Undergraduate, Genetic algorithm, Resource allocation

✉ Corresponding author.
E-mail address: fw6155@163.com (W. Feng).
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1. Introduction

The Ministry of Education has issued the guiding opinions on deepening the integration of industry and education to promote the connotative development of higher vocational education, proposing a series of policy measures such as strengthening school-enterprise cooperation, implementing professional construction, and advancing teaching reforms, encouraging undergraduate colleges and universities to adjust their professional settings in accordance with industrial demand, promoting curriculum reform, and improving the quality of teaching [1-4].

Technological change and industrial upgrading are increasing the demand for technical and skilled talents, and undergraduate education, as an important part of vocational education, has problems such as lagging content and insufficient practice in its curriculum system, which makes it difficult to meet the requirements of industry and enterprises for high-quality talents [5-8]. The proposal of industry-teaching integration provides a new perspective for the optimization of the curriculum system of undergraduate colleges and universities. Through the school-enterprise collaborative education model, the industry demand can be accurately transformed into teaching content, so that students can master the core skills required by the real production environment in their learning [9-11]. The key to the optimization of the curriculum system lies in the in-depth combination of theory and practice, which not only highlights the cultivation of vocational ability, but also integrates cutting-edge technology and industrial cases to enhance the practicality and innovation of the curriculum content [12-14]. Efficient curriculum system reform is an important guarantee to enhance the competitiveness of students' employment and promote the development of regional economy, and it is also an inevitable choice for undergraduate colleges and universities to serve the industrial chain and help the technological progress [15-16].

The community of industry-teaching integration is a collaborative education mechanism that connects the education chain with the industrial chain in depth, and its essence is that schools and enterprises can realize common development around the goal of skill-based talent cultivation by sharing resources and complementing each other's strengths [17-18]. The construction of the community is based on the relevance of interests, emphasizes the balance and interaction of the roles of schools and enterprises in the process of talent cultivation, and is committed to breaking down the barrier between traditional education and production [19-20].

Literature [21] describes students' satisfaction with the design of the current vocational education curriculum system, and believes that a good and perfect vocational curriculum system design is an important foundation for vocational talent training. Literature [22] proposes that the introduction of industrial education in college education to bridge the gap between students' theoretical knowledge and practice promotes the quality and efficiency of industrial talent cultivation to a certain extent. Literature [23] reveals the urgency and necessity of fully integrating enterprise production and vocational education in “research”, “technology” and enterprise “production”, which can create a real additive manufacturing integrated operation for students. This can create a real additive manufacturing integrated operation background and business process for students, and strengthen students' knowledge theory and practice.

The research on curriculum design related to factory vocational learning is as follows. Literature [24] systematically reviews the research literature related to production education in the 4.0 industrial context, in order to reform and optimize the curriculum design of production education, and then adapt it to the 4.0 industrial production context. Literature [25] introduces the concept of learning factory and analyzes the path of Industry 4.0 lean management and employee quality improvement, which provides a reference for Industry 4.0 lean curriculum design. Literature [26] elucidates that learning factories provide a scientific and efficient platform for education, training, and research, and highlights the logic and potential for learning engineering course design and course content to work.

In this paper, by summarizing the current status of talent cultivation work in undergraduate colleges and universities and analyzing its deficiencies, we construct the mathematical model and optimization objective of the current status of undergraduate colleges and universities' education work, and transform the actual problem into a combinatorial optimization problem under multiple constraints. Then the traditional genetic algorithm is introduced, the fitness function is designed with reference to the optimization objective, and the GA optimization algorithm is obtained by improving the traditional genetic algorithm with the adaptive method and simulated annealing idea. Finally, this paper's algorithm is compared with similar algorithms to analyze the performance of this paper's algorithm in scheduling work and the students' recognition of this paper's algorithm curriculum in practical applications.

2. Mathematical model construction and optimization objectives

2.1. The current situation of talent cultivation work of industry-teaching integration in undergraduate colleges and universities

1) Curriculum system construction needs to be deepened. Undergraduate colleges and universities in the course of the curriculum, although the relevant enterprises on the ability of college students demand, skills demand into the curriculum content, but has not yet fully grasp the employment needs of enterprises, not according to the professional needs of the talent market, talent demand, the main business of the relevant enterprises, effectively adjust the professional settings, optimize the professional curriculum, is not conducive to the human resources market to screen the useful talents, but also is not conducive to the undergraduate colleges and universities in the long term. Development.
2) Subjects involved in cultivation need to be enriched. At present, undergraduate colleges and universities have fewer participating subjects in the process of formulating talent cultivation programs under the background of industry-teaching integration, and the participation of each subject needs to be enlarged. Local government departments are relatively less involved in the university-enterprise cooperation between undergraduate colleges and local enterprises. The enterprises concerned in the work of industry-teaching integration only provide universities with basic information such as job duties and employment standards in the process of production and operation, while the universities only determine the cultivation objectives according to the relevant documents of government departments and employment standards of the enterprises, lacking certain informatization methods and equipment, and failing to understand the current trend of employment changes in the market of human resources.
3) Educational resource construction needs to be strengthened. Undergraduate colleges and universities outside the tutor hiring system is not yet perfect, enterprise-related excellent technical backbone is difficult to enter the classroom as a lecturer to teach students professional knowledge, teaching front-line production experience, resulting in a disconnect between students' professional knowledge and practice.
4) Teaching mode to be changed. Generative Artificial Intelligence (AIGC) refers to a technology based on artificial intelligence and other related technologies, which creatively describes the generated content according to instructions through massive corpus learning and training. Based on the characteristics of AIGC, such as large model, strong computing power and multiple algorithms, it can realize the rapid acquisition and cross-domain transfer of knowledge in undergraduate education, and sort out the potential innovation of AIGC education mode from three stages: before, during and after class.
5) Teaching evaluation methods need to be innovative. Due to the lack of digital talent training resources, teachers evaluate students' learning results mainly through observation of students' daily performance, which is subjective and difficult to provide accurate guidance for students' learning.

Therefore, the current problems of university industry-teaching integration teaching work can be summarized as unreasonable teaching design and shortage of teaching resources. In the actual teaching work of colleges and universities, whether it is the teaching plan or the allocation of teaching resources, all through the scheduling board coordinated deployment. That is, the rational arrangement of teaching plan and teaching resources allocation focuses on the scheduling work.

2.2. Mathematical model and optimization objective

Based on the above analysis, this section constructs the teaching resource allocation problem in the current university industry-teaching integration work as a mathematical model, and at the same time puts forward the optimization goal.

2.2.1. Mathematical models. Teaching resource allocation is a common task in the teaching and learning process is to schedule classes, and the teaching resources involved in scheduling are mainly teachers, classrooms, courses, classes and class periods. Under this setting, the problem of optimizing the allocation of teaching resources in the process of scheduling can be described as solving the quintuple of the solution space (C, O, T, R, S), where C denotes the class, O denotes the course, T denotes the teacher, R denotes the classroom, and S denotes the class period.

For the above problem of temporary increase of teaching schedule after the beginning of the school year, due to the limited nature of teaching resources, there is bound to be resource constraints when optimizing the allocation of teaching resources for the new teaching classes. These constraints include enterprise practice, enterprise tutor, virtual laboratory and other elements of production-education integration. In which there are constraints in terms of class periods and classroom use with the existing scheduling data. The two quintuples $\left(C_i, O_i, T_i, R_i, S_i\right)$ and $\left(C_j, O_j, T_j, R_j, S_j\right)$ corresponding to the existing scheduling data and the arrangement of new teaching classes must satisfy the following relations (1) and (2):

$$S_i = S_j \to T_i \neq T_j \tag{1}$$

$$S_i = S_j \to R_i \neq R_j \tag{2}$$

In the above two equations, equation (1) indicates that different teaching classes should not have the same teachers in the same time slot, otherwise it will cause conflicts, and similarly, equation (2) indicates that the classrooms arranged for different teaching classes in the same time slot should belong to different classrooms. In the actual teaching resource allocation process, for this kind of new teaching classes, usually through the coordination of the teacher's class time or outside teachers and other methods to do a good job in the classroom time and the arrangement of teachers, then the above constraint relationship (1) can not be considered, while the constraint relationship (2) must be satisfied, otherwise it will cause conflicts in the use of classrooms.

2.2.2. Optimization objectives. For this kind of new teaching classes, since the contents of the lectures and the participants have been determined for a long time, which corresponds to the values of course O and class C in the quintuple group (C, O, T, R, S), and from the above discussion, it can be seen that the class periods and class teachers for the new teaching classes have already been arranged, i.e., the values of class period S and teacher T in the quintuple group (C, O, T, R, S) have already been determined, it is necessary to make a combination of classrooms in the quintuple group that have not been determined yet. Configuration.

For this kind of classroom configuration of new teaching classes, the solution that satisfies the hard constraint of Eq. (2) above is a feasible solution, and the goal of the solution is to find out a more optimized solution from the feasible solutions, and the optimization goal is to try to configure the classrooms as the same classroom or similar classrooms, i.e., the classrooms as the teaching resources should be allocated as the same classroom, in order to avoid the inconvenience of the classroom changes to the participating teachers and students, and also to minimize the classroom arrangement. The goal is to minimize the inconvenience of classroom changes to teachers and students, as well as to minimize other aspects of classroom arrangement, such as reducing the workload of property management. In the case of classroom resource constraints, it is difficult to configure the classroom as the same classroom, so as to minimize the change of the classroom in different time periods, so that teachers and students can participate in the teaching task more conveniently and efficiently, which is the goal of optimization using genetic algorithms in this paper, and is also the reference basis for the design of the fitness function in the genetic algorithms.

3. Construction of GA optimization algorithm

From the above analysis, it can be seen that in the mathematical model, the current problem faced by universities is a combinatorial optimization problem under multiple constraints. The traditional genetic algorithm, as a classical method to solve this type of problem, is easy to fall into local problems as well as slow convergence during the operation. In this regard, this chapter designs the fitness function according to the optimization objective, and also performs crossover and mutation operations using adaptive strategies to construct the GA optimization algorithm.

3.1. Genetic algorithms

Genetic Algorithm (GA), as an evolutionary algorithm, originates from the genetics theory of the evolutionary process of natural selection. It adopts a probabilistic approach to optimization, which automatically acquires and optimizes the search space and adaptively adjusts the direction of optimization without determining detailed and specific rules.

1) The operation mechanism of genetic algorithm is carried out on the basis of heredity and evolution, so it involves the following genetics and other related concepts:

(1) Coding: the form of the problem to be solved is transformed into the recognized form of the genetic algorithm gene.

(2) Chromosome: the solution of the problem after optimization is presented by the chromosome.

(3) Individual: corresponds to the solution vector of a problem.

(4) Population: composed of multiple individuals, equivalent to a set of solution vectors.

(5) Population size: the number of chromosomes in a population.

(6) Genes: determine the expression of an organism

(7) Adaptation: a quantification of how well an individual adapts to the environment as a whole.

2) Genetic algorithm is an adaptive search algorithm based on the knowledge of biology and genetics, fused with computer coding, generally has the following five operational steps:

(1) Select the coding method. The layout of the production plant needs to be brought into the algorithm for solving by coding. Coding is the operation of the variables in the model by coding to present them in the algorithm in the form of genome, mapping the individual performance to the genetic form. Decoding operation, in contrast, is to take the optimized individuals solved through the algorithm and map their genetic form to the manifestation.

(2) Initialize the population. Define the objective function of the algorithm and formulate the corresponding constraints according to the actual situation, determine the number of populations, which can be randomly generated or manually added to generate the initial multiple individuals, to ensure that the genetic diversity of individuals.

(3) Calculation of fitness. The calculation of the fitness function follows the principle of “survival of the fittest”, calculating the fitness value of each individual, automatically eliminating individuals with small fitness, and individuals with high fitness will enter the next round of calculation.

(4) Genetic operator optimization. Individuals selected through the operation in step (3) are subject to crossover and mutation operations, and on the basis of retaining the good genes in a wider

range, the mutation will continue to increase the diversity of the population, and the above operations are carried out continuously, and the optimal solution is selected through iteration after iteration.

(5) Termination algorithm. According to whether the individuals selected in step four meet the conditions, if so, output the individual with the highest fitness and end the program. If not satisfied, return to step three to continue the operation.

The operation flow of the genetic algorithm is shown in Figure 1.

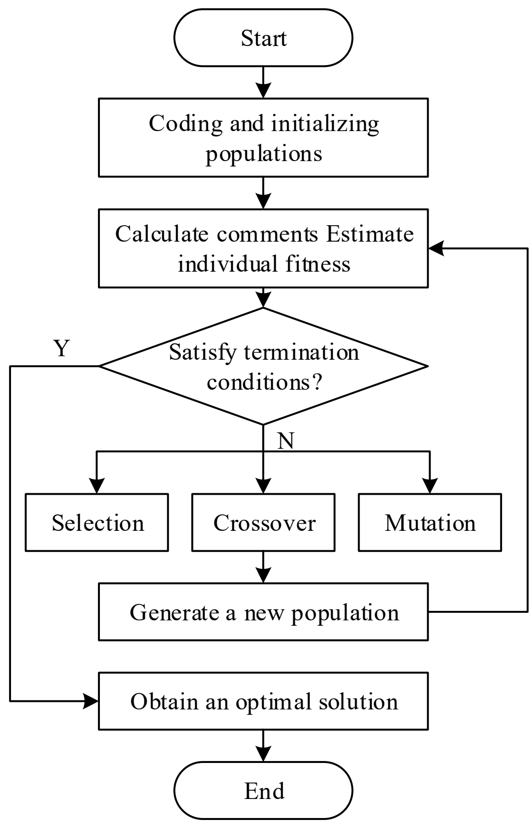

Fig. 1. Genetic algorithm flow

3.2. Design of the fitness function

The design of the fitness function not only affects the convergence speed of the algorithm, but also affects whether the algorithm can find the optimal solution in a short time. Therefore, the design of the fitness function should not only ensure that the operation is as simple as possible, but also ensure that the fitness value is in a stable and non-negative interval. In order to carry out the integration of production and education more effectively, the course arrangement of college students involves many practical factors, such as the teaching arrangement of "double teacher type", the arrangement between enterprise practice courses and professional courses in colleges and universities. Therefore, this paper selects the optimal value of course segmentation, the discrete value of course time, the expected value of "double teachers" and the utilization rate of course resources to form the fitness function under the environment of integration of production and teaching, and measures the quality of course scheduling by the fitness value.

3.2.1. Optimized values for course sections. Under the background of the integration of industry and education, students' skill level mainly comes from the accumulation of practical courses in enterprises. However, as a major, practical course chapters also need to form a specific system. The course section optimization value reflects faculty and student satisfaction with the section and class time of a course and classroom efficiency. The larger the value, the better the class time and the more efficient the class is. A teaching working day has five days, in which there are 25 time units, and the section weight value is set as t_i. The course section optimization objective is shown in equation (3):

$$f_1 = \sum_{i=1}^{n} t_i \tag{3}$$

Where n is the total number of courses offered.

3.2.2. Course time discrete values. The integration of industry and education requires enterprises and schools to communicate frequently on people and equipment. Ideally, it is best for schools and enterprises to be adjacent to each other, but in fact, it is difficult to achieve. Therefore, it is necessary to accurately arrange the course time. If a course is taught 2 periods a week, then the course time schedule should not be too concentrated. In order to avoid over-concentration of courses, ensure teaching effectiveness, and improve teacher and student satisfaction, the course time discrete value is used to measure the reasonableness of the class schedule. Using the same course time difference indicates the size of the discrete value, for example, a time difference of 3 means that the difference between the course is 3 sessions. The course time discrete value optimization objective is shown in equation (4):

$$f_2 = \sum_{i=1}^{n} d_i \tag{4}$$

Where d_i denotes the course time discrete value. n denotes the total number of courses that need to be scheduled for 2 periods per week.

3.2.3. Teacher expectations. The premise of the integration of production and education is to meet the expectations of both schools and enterprises, followed by the establishment of a reasonable talent training plan, and finally to create conditions to ensure the implementation of the plan. Therefore, the expectation of teachers here refers to the expectation of teachers in enterprises and universities. Before scheduling a lesson, it is necessary to know the teacher's expectation of the lesson time, and the teacher's expectation is generally categorized as wanting to have a lesson at a certain time or not wanting to have a lesson at a certain time. In this paper, we use c_i to denote the teacher expectation of course 1, and the optimization objective of teacher expectation is shown in equation (5):

$$f_3 = \sum_{i=1}^{n} c_i \tag{5}$$

Where n is the total number of courses offered.
where there is equation (6):

$$c_i = \begin{cases} 1 & \text{Scheduling is in line with expected timing} \\ 0 & \text{Otherwise} \end{cases} \tag{6}$$

3.2.4. Utilization of classroom resources. The classroom resources here include enterprise practice resources, virtual laboratories and so on, which have a certain number of constrained course resources. Therefore, each classroom has a limited capacity, and scheduling takes into account the ability of the classroom to accommodate the number of students in the course being taught. The higher the percentage of instructional course class size to classroom capacity, the higher the classroom resource utilization rate. The classroom resource utilization rate is shown in equation (7):

$$f_4 = \sum_{i=1}^{n} \frac{k_c}{R_n} \tag{7}$$

Where n is the total number of courses offered, k_c refers to the number of students in the course, R_n refers to the number of classroom capacity.

Designed by the above optimization objectives of each formula f_1, f_2, f_3 and f_4 for the composition of this paper adaptation function, adaptation function as in equation (8):

$$F = f_1 + f_2 + f_3 + f_4 \tag{8}$$

3.3. Design of genetic operators

3.3.1. Selection operations. The selection operation reproduces by screening individuals with high fitness values as parents for genetic derivation. In this paper, the selection operation is a generalized roulette wheel selection method in which a roulette wheel is divided proportionally to obtain different regions, which are randomly selected. The probability of selection of individuals in a population is proportional to their fitness value. In roulette operations, the selection of individuals is achieved by dividing the roulette wheel into regions based on "cumulative probability".

Assuming that the population size is N, the operation steps are as follows:

1) Calculate the individual fitness based on the fitness function formula $f(i = 1, 2, 3, 4, \ldots, N)$

2) Calculate the ratio of the individual fitness value to the sum of all individual fitnesses as in equation (9):

$$P(x_i) = \frac{f(x_i)}{\sum_{j=1}^{N} f(x_j)} \tag{9}$$

Where $f(x_i)$ is the current individual fitness value, $\sum_{j=1}^{N} f(x_j)$ is the sum of fitness values of all individuals in the population, and $P(x_i)$ is the individual selection probability.

3) Calculate the cumulative probability of each individual in the population as in equation (10):

$$q(i) = \sum_{j=1}^{i} p(x_i) \tag{10}$$

where $P(x_i)$ is the individual selection probability and $q(x_i)$ is the sum of the cumulative probabilities of all individuals in the population.

4) Use a random function to generate a number r in the range of $[0,1]$ intervals.

5) According to the value of r to determine the interval segment, if $q_{i-1} < r \le q_i$, then select the individual i.

6) Repeat 4) and 5) until a new population of size N is generated.

Affected by factors such as the large number of teachers in colleges and enterprises and the large number of class hours, not any two individuals can complete the selection operation, and there is a situation that each node of the two individuals cannot complete the crossover, which may lead to the loss of excellent individuals. The roulette selection strategy commonly used in the selection operation, each time selecting the best individual directly promoted, to a certain extent, to ensure the optimal learning path under the background of the integration of production and education.

3.3.2. Adaptive crossover and mutation. Crossover probability P_c and mutation probability P_m are important parameters that affect the performance of the algorithm. If P_c is set large, the structure of the parent chromosome is destroyed and the algorithm's ability to search for optimization is reduced. If P_m is set large, the algorithm may become a random search algorithm. In this regard, adaptive genetic algorithm is introduced, which dynamically adjusts P_c and P_m

according to the value of individual fitness in the population, and when a certain generation is in the process of genetic evolution, the population dynamically adjusts P_c and P_m for crossover and mutation to enhance the algorithm's ability to search for excellence, as shown in equations (11) and (12):

$$p_c = \begin{cases} k_1 - \dfrac{(k_1 - k_2)(f_c - f_{avg})}{(f_{\max} - f_{avg})} & f_c \geq f_{avg} \\ k_1 & f_c < f_{avg} \end{cases} \tag{11}$$

$$p_m = \begin{cases} k_3 - \dfrac{(k_3 - k_4)(f_{\max} - f')}{(f_{\max} - f_{avg})} & f \geq f_{avg} \\ k_3 & f < f_{avg} \end{cases} \tag{12}$$

Where f_{avg} is the average fitness value of the population, $f_{\max}$ is the maximum fitness value in the population, f_c is the larger fitness value in the crossover individuals, and f' is the fitness value of the parent chromosome where the mutation operation was performed. Where k_1, $k_2 \in (0,1)$ and $k_1 > k_2$, k_3, $k_4 \in (0,1)$ and $k_3 > k_4$.

Crossover operation means that two parent chromosomes decide whether to exchange partial gene segments based on the crossover probability P_c. Before crossover according to the random function to generate the number $r \in (0,1)$, if $r < P_c$, perform the operation to exchange the partial gene fragments to get a new offspring chromosome individual.

To ensure that the course information is not damaged, this paper adopts the single-point crossover method for crossover. That is, a point on the paternal chromosome is selected as the crossover point, the paternal chromosome is divided into left and right segments, and the two paternal chromosomes change gene sequences by exchanging the left and right parts with each other.

Mutation operation refers to the process of genetic evolution, according to the probability of mutation P_m to decide whether the genetic information of the paternal chromosome is mutated, so that the chromosomes of the offspring exhibit new traits. Before performing the mutation operation, the number $r \in (0,1)$ is generated according to a random function, and if $r < P_m$, the operation is performed on a certain gene on the chromosome of the parent to obtain a new zygote chromosome.

In this paper, the basic position method is utilized to perform the mutation operation. The mutation is performed only on the “time period” code in the “classroom-time period” gene sequence of the chromosome, which changes the structure of the parent chromosome and thus changes the individual fitness value. Mutation manipulation is similar to genetic mutation in an organism, where one or more genes are altered to produce new traits. Because of the particularity of course scheduling in the mode of integration of production and education, it is necessary to ensure that the number of class hours in enterprises and universities remains unchanged, so after a mutation, the corresponding region should be adjusted to rationalize its mutation. In this paper, an adaptive crossover scheme is proposed, in which random flipping points are selected to carry out the whole gene flipping. Since this operation is to flip all the class schedules in a single individual (course scheduling scheme), this operation does not affect the correctness of the course scheduling scheme under the integration mode of production and education, and will not cause any conflict.

3.3.3. Individual population optimization. In this paper, the Metropolis acceptance criterion of the simulated annealing algorithm is used to implement annealing operation on the individuals of the new population after crossover and mutation, and to decide with a certain probability whether the poorer individuals in the old population are inherited to the next generation or not, so as to improve the convergence of the algorithm.The Metropolis acceptance criterion is specified as in Equation (13):

$$p=\begin{cases}\exp\left(-\dfrac{f(x_{new})-f(x_{old})}{T_t}\right) & f(x_{new})\le f(x_{old})\\ 1 & f(x_{new})>f(x_{old})\end{cases} \tag{13}$$

Where $f(x_{new})$ refers to the adaptation value of the individual whose state is NEW, $f(x_{old})$ refers to the adaptation value of the individual whose state is OLD, T_t is the temperature value at the moment of algorithm t, and the updated temperature value is as in equation (14):

$$T_{t+1}=\alpha T_t \tag{14}$$

Where α is the decay parameter of temperature, which controls the annealing speed and takes the value range of $\alpha\in(0,1)$.

By establishing a mapping relationship between the operations in the improved genetic algorithm and the mathematical model of the undergraduate scheduling problem, the method of course design and teaching resource allocation based on the GA optimization algorithm is constructed and obtained. Applying this algorithm to the teaching mode of the integration of production and education, it can solve the difficult problem of course scheduling in the integration mode of production and education, and can give an optimized course scheduling scheme in a short time.

4. Performance test of GA optimization algorithm

In this chapter, the performance of this paper's algorithm is examined from three dimensions: comparison of similar algorithms, scheduling experiments, and students' recognition, so as to verify the excellence of this paper's algorithm in the field of specialization, scheduling applications, and users' recognition.

4.1. Comparison with similar algorithms

Using the GA optimization algorithm proposed in this paper and the classical spatial coding and sinusoidal selection operator (SCSS) algorithm, the experimental effect of the value of the fitness function and the time consumed by the algorithm is compared. In this section, the scheduling data of a university for the second semester of the 2023-2024 academic year is used as a training sample for the algorithm to solve the scheduling problem, and the dataset is shown in Table 1.

Table 1. Training data set

Scheduling factor	Quantity
Teacher	130
Classroom	70
Student	1685
Course	271
Class	59
Teaching scheme	107

In order to ensure the scientific and representative of the experimental effect, this paper combines the basic situation of the university and the special characteristics of the implementation process of college education and teaching, in the process of data collection and analysis, some redundant data and invalid data pre-processing, and ultimately the formation of sample data as shown in Table 1. For example, the course name “Computer Application Fundamentals” should be the same course as “Computer Fundamentals” and “University Computer Fundamentals”.

4.1.1. Adaptation function value effects. Due to the small volume of experimental data, the experiment still adopts the strategy of multiple testing in order to ensure that the experimental results have a high degree of confidence. During the experiment, the best fitness function value of the population was recorded once every 100 generations of evolution, and the average of the best fitness values recorded in 15 experiments was taken as the observation point, and the results of the fitness function values of the SCCS algorithm and GA optimization algorithm scheduling experiments are shown in Fig. 2.

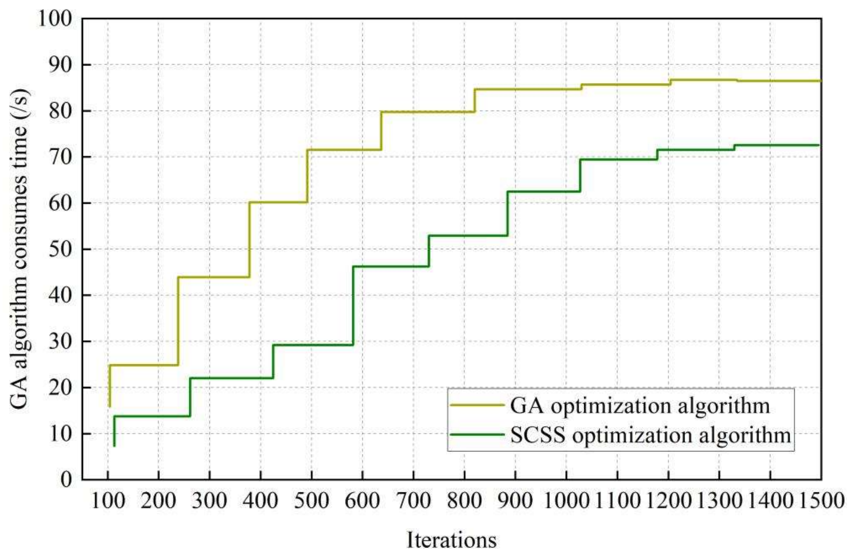

Fig. 2. Fitness function values comparison of SCSS and GA

The two lines in Fig. 2 have a more obvious display pattern, the GA optimization algorithm line has a better fitness function value than the SCSS algorithm at the initial point (the number of iterations is 100).The GA optimization algorithm has a fitness function value that will gradually remain smooth with the increase of the number of iterations as the number of iterations approaches 800. SCSS algorithm in the number of iterations close to 1200, the fitness function value only appeared relatively smooth state. Compared with the SCSS algorithm, the GA optimization algorithm is relatively fast to obtain the global optimal solution, which can be seen that the GA optimization algorithm scheduling effect performance is relatively good.

This paper analyzes the production-education integration practical training projects, and identifies the problems of production-education integration practical training projects, such as resources failing to meet the requirements of course construction, deficiencies in traditional teaching management methods, unreasonable curriculum planning arrangements, and many unstable factors in the implementation process, which lays a foundation for the optimization of production-education integration.

4.1.2. Comparison of Algorithm Consumption Time Effectiveness. Due to the guidance of both school and enterprise tutors, the teachers in the school participate in the whole process of enterprise projects and are exposed to new equipment, new technology and new design concepts, and the theoretical level and practical ability of teachers have been greatly improved. Algorithm consumption time is a measure of algorithm quality from the dimension of CPU resource (Teaching Resources) usage. In this paper, 100 generations of each evolution of the population are recorded as the key point, and the average of the algorithm consumption time recorded in 15 experiments is taken as the reference point, and the consumption time of the SCCS algorithm and GA optimization algorithm scheduling experiments is shown in Fig. 3.

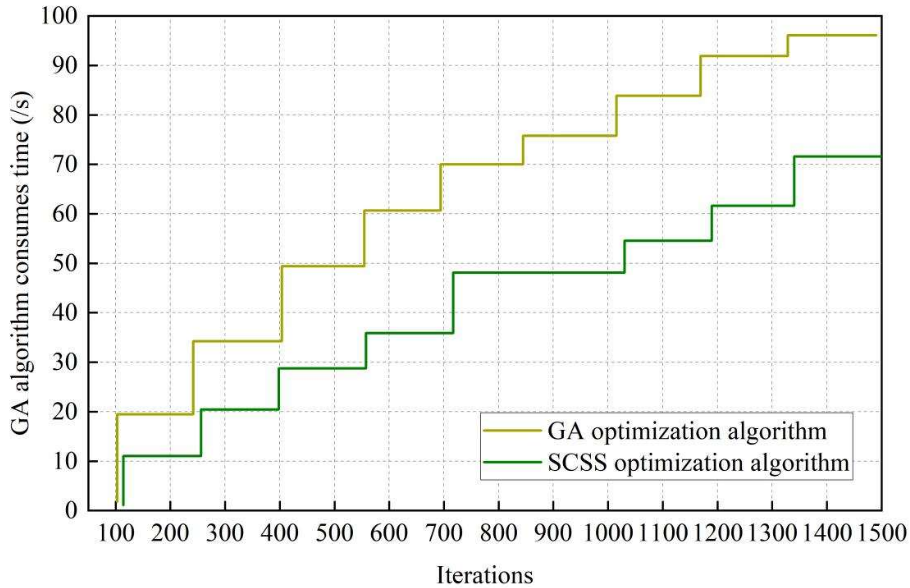

Fig. 3. Algorithm consuming time comparison of SCSS and G

In terms of algorithm consumption time, the GA optimization algorithm proposed in this paper consumes significantly less time than the SCSS algorithm.The GA optimization algorithm carries out a single-point crossover of the two parent chromosomes, performs the mutation operation by using the basic bit method, and then carries out the annealing operation on all the individuals of the new population, which enables the GA optimization algorithm to escape from the locally optimal solution, and the searching effect is further improved. It is due to the design and improvement of the algorithm using the above algorithm that the time consumed by the GA optimization algorithm shown in Fig. 2 is significantly reduced compared to the time consumed by the SCSS algorithm, which shows that the GA optimization algorithm performs better than the SCSS algorithm. Therefore, in order to carry out the integration of production and education more effectively, the course scheduling system based on GA algorithm should have the authority of independent course scheduling and concentrate the teaching of specialized courses.

4.2. *Scheduling experiments*

In this section, the teaching plan course scheduling of undergraduate students in the second semester of the 2023-2024 academic year and the first semester of the 2023-2024 academic year of the sophomore year of a university is taken as an example, and the GA optimization algorithm proposed in this paper is used to solve the problem.

In the actual course scheduling process, the values of α, β, and γ in the objective function can be set on demand so that the scheduling result focuses on teacher satisfaction or focuses on course interval uniformity. When α=β=0.5 and γ=0, the results of the scheduling experiment are shown in Table 2.From Table 2, it can be seen that the uniformity of course spacing in the second semester of the 2023-2024 academic year is 72.8%, and the uniformity of course spacing of all undergraduates in the first semester of the 2024-2025 academic year is 79.2%, and the calculation of the teacher's satisfaction in the second semester of the 2023-2024 academic year is 81.06%. Faculty satisfaction for the first semester of the 2024-2025 academic year was 82.96%.

Table 2. Computational results of proposed method when α=β=0.5

Semester	The second semester of the 2023-2024 school year	The first semester of the 2024-2025 school year

α value and β value	α=β=0.5	α=β=0.5
Teacher satisfaction	89.3%	86.9%
Meet evenly spaced class hours	4107	5848
The number of evenly spaced classes is not satisfied	1528	1549
Evenness of course spacing	72.8%	79.2%
Objective function value	81.06%	82.96%
Run time(s)	17	27

The results of the scheduling experiment when α = β = γ = 0.3 are shown in Table 3. The value of the objective function for the second semester of the 2023-2024 academic year was calculated to be 86.42% and for the first semester of the 2024-2025 academic year to be 87.34%.

Table 3. Computational results of proposed method when α=β=γ=0.3

Semester	The second semester of the 2023-2024 school year	The first semester of the 2024-2025 school year
α value,β value,γ value	α=β=γ=0.3	α=β=γ=0.3
Teacher satisfaction	87.5%	82.4%
Evenness of course spacing	72.6%	77.8%
Students walk distance countdown	1/503827	1/491148
Objective function value	86.42%	87.34%
Run time(s)	23	32

Some of the scheduling results of the GA optimization algorithm are shown in Table 4. The scheduling results have been applied to the teaching process of all categories of undergraduate students in the second semester of the 2023-2024 academic year in the experimental university, and the actual testing is without any abnormality. The personalized demand for individual teachers' class time is satisfied by the manual adjustment function of the system. As a result of the comprehensive consideration of teacher satisfaction, even spacing of courses and students' walking distance between classes, the scheduling of courses maximizes the possibility of meeting the needs of teachers and students in classes.

Table 4. The results of part of the course arranging

Course number	Course name	Credit hours/credits	Selected number	schooltime	Place of class
20242002	civil law	52/3.0	37	Tuesdays 1-2	301,the first teaching building
20242002	civil law	52/3.0	37	Tuesdays 3-4	301,the first teaching building
20242146	Marketing management	34/2.0	40	Thursdays 3-4	708,the second teaching building
20242098	College English	68/3.0	53	Monday 1-2	511,the second teaching building
20242156	Mathematical equation	34/2.0	35	Friday 7-8	405,the fifth teaching building
20242110	Engineering optics	36/2.0	42	Wednesday 11-13	401,the third teaching building
20242169	Science of investment	56/3.0	33	Monday 5-6	109,the third teaching building
20242186	Operations	42/3.0	38	Thursdays	203,the fourth

	research			1-2	teaching building
20242132	System modeling	40/3.0	40	Wednesday 9-10	506,the fifth teaching building
20242123	European history	36/2.0	45	Friday 5-6	306,the fourth teaching building

4.3. Student buy-in to the curriculum

In this section, a total of 80 students in the second year of business administration major in the university launched a questionnaire survey, the questionnaire covers the annual study plan arrangement of the sophomore academic year curriculum, the overall curriculum and satisfaction with the preset employment goals of the three major aspects, a total of 80 questionnaires were issued, 78 questionnaires were retrieved, and 3 invalid questionnaires were removed, the questionnaire validity rate of 93.75%.

4.3.1. Descriptive Frequency Statistical Analysis of Curriculum Identity. Table 5 shows the results of the frequency statistical analysis of the 75 students in the program with regard to their satisfaction with the schedule of study and the overall course offerings during the sophomore year.

Table 5. Annual learning plan arrangement, overall curriculum setting satisfaction

degree of satisfaction		Annual study plan arrangement	Holistic curriculum
be very dissatisfied	Frequency (order)	3	0
	percentage(%)	3.75	0
dissatisfaction	Frequency (order)	8	2
	percentage(%)	10	2.5
indeterminacy	Frequency (order)	10	10
	percentage(%)	12.5	12.5
satisfaction	Frequency (order)	25	43
	percentage(%)	31.25	53.75
great satisfaction	Frequency (order)	34	25
	percentage(%)	42.5	31.25

In terms of the annual study program arrangement, 3 people indicated that they were very dissatisfied, 8 people indicated that they were dissatisfied, 31.25% indicated that they were satisfied, and 42.5% indicated that they were very satisfied, which is a good level of satisfaction. In terms of the overall curriculum, 2 indicated that they were dissatisfied, 53.75% indicated that they were satisfied, and 31.25% indicated that they were very satisfied, which is a good level of satisfaction.

Table 6 shows the results of the frequency statistical analysis of the 75 students in the program on the approval of the scheduling order and the criteria for the development of study plans for the sophomore academic year.

Table 6. Class order, study plan formulation standard recognition

degree of satisfaction		Course arrangement sequence	Study plan setting standards
be very dissatisfied	Frequency (order)	3	2
	percentage(%)	3.75	2.5
dissatisfaction	Frequency (order)	6	8
	percentage(%)	7.5	10
indeterminacy	Frequency (order)	14	5
	percentage(%)	17.5	6.25
satisfaction	Frequency (order)	21	25
	percentage(%)	26.25	31.25
great satisfaction	Frequency (order)	36	40
	percentage(%)	45	50

As can be seen from Table 6, the question "Do you agree that the order of each course in this major can help you better grasp the knowledge of each subject?" On the first question, 3 people said they strongly disagreed, and 6 people said they did not agree, indicating that the order of the major did not meet the learning situation of these people. 26.25% of the respondents said they agreed, and 45% of them said they strongly agreed with the order of the major. It can be seen that the order of the course of this major is recognized by more than half of the people, and it is helpful for them to better grasp the knowledge of each subject. Regarding "Do you agree that the professional study program is developed according to the standard from easy to difficult?" On the first question, 2 people said they strongly disagreed, and 8 people said they disagreed, and these people did not agree that the professional learning plan was formulated according to the standard from easy to difficult based on their personal learning situation. However, 31.25% of them agreed, 50% of them agreed very much, and more than half of them agreed that it was easy to make a study plan.

4.3.2. Gender Differences in the Identity of Curriculums. This subsection explores the gender differences in curriculum identity through the analysis of questionnaire survey data, and the specific analysis results are shown in Table 7. It can be seen that the p-value of the mean equivalence t-test is 0.024<0.05 in the "annual study plan", so there are significant differences between genders in the "annual study plan". In the "Overall Curriculum" item, the p-value of the mean equivalence t-test was 0.135>0.05, so there was no significant difference. In the "Scheduling Order" item, the p-value of the mean equivalence t-test was 0.17>0.05, so there was no significant difference. In the "Criteria for Setting Learning Plans" item, the p-value of the mean equivalence t-test was 0.404>0.05, so there was no significant difference.

In summary, there was no significant difference between gender in the recognition of the curriculum of business administration major, in the "annual study plan", and in the "overall curriculum" and "meeting the preset employment goals".

Table 7. Sex-factor independent sample t test

	Levin's test for variance equality		Mean equivalence t test		
	F	significance	t	degree of freedom	sig.(Double tail)
Annual study plan arrangement	1.127	0.293	-2.293	80	0.024*
Holistic curriculum	0.07	0.778	-1.517	80	0.135
Meet preset employment targets	1.243	0.268	1.213	80	0.23
Course arrangement sequence	0.038	0.849	-1.418	80	0.17
Study plan setting standards	0.718	0.398	-0.842	80	0.404

(Note: The p value≦0.05, with significant difference)

4.4. *The internal logic of production-education integration enabling the development of new quality productivity*

From the above research, the constraint of using genetic algorithm to solve the course scheduling problem in the mode of integration of production and education is mainly to avoid conflicts among course scheduling elements such as virtual laboratories, courses, and internship places in enterprises, effectively utilize various resources, and make the education mode of integration of production and education more humanized. Indirectly, from the above results, we can summarize the internal logic of the production-education integration model to promote the development of new quality productivity. The details are as follows:

1) The integration of production and education provides high-quality workers for the development of new quality productivity. First, at the level of personnel training mode, the integration of production and education realizes the docking of curriculum content and professional standards, and the docking of teaching process and production process by deepening the cooperation between schools and enterprises. Second, at the level of practical teaching system, the integration of production and education allows students to exercise their professional skills and comprehensive quality in a real or simulated working environment through practical training and project-driven methods. Third, at the level of teacher team construction, the integration of production and education promotes the mutual employment and use of teachers between universities and enterprises, and realizes the two-way flow of teachers and enterprise technical personnel. This not only enriches the teaching resources of colleges and universities, improves the teaching quality, but also enables teachers to keep abreast of industry trends and technological development trends, so as to guide students to study and practice more pertinently.

2) The integration of production and education provides high-quality labor elements for the development of new quality productivity. At the level of technological innovation, the integration of production and education promotes the transformation and application of scientific and

technological achievements. Through in-depth cooperation with enterprises, universities can timely understand the market demand and technology trends, and transform scientific research achievements into actual productivity. This close cooperation mechanism not only accelerates the research and development and promotion of new technologies, but also provides enterprises with a steady stream of high-quality technical elements, and injected a strong impetus for the development of new quality productivity.

3) The integration of production and education creates an efficient innovation platform for the development of new quality productivity. The integration of production and education promotes the deep integration of theoretical knowledge and practical skills by building a bridge of school-enterprise cooperation. The actual demand of enterprises feeds back the educational content, and the educational innovation results directly serve the industrial upgrading, forming a virtuous circle. This close cooperation model can quickly transform cutting-edge technologies into productive forces and provide a steady stream of innovation impetus for the development of new quality productive forces. At the same time, the industry-education integration platform brings together talents and technical resources of colleges and universities and market demand and capital advantages of enterprises. The two sides share resources, jointly undertake scientific research projects, overcome technical problems and promote interdisciplinary and cross-field collaborative innovation. This efficient allocation of resources has greatly improved the innovation efficiency of the development of new quality productivity.

5. Conclusion

This paper conforms to the development trend of education digitization, proposes to improve the curriculum design and teaching resource allocation in the current education work of colleges and universities by genetic algorithm, and proves through experiments that the algorithm in this paper can reasonably carry out the undergraduate teaching plan and course arrangement, which provides an effective reference for the research on the integration of education and production under the framework of the new qualitative productivity. The specific findings of this paper are as follows:

1) The current problems of undergraduate talent cultivation in colleges and universities are attributed to teaching design and teaching resource allocation, and a mathematical model and optimization goal are constructed accordingly. For the goal of solving the teaching problems in colleges and universities, the traditional genetic algorithm is introduced and combined with the characteristics of undergraduate teaching scheduling using adaptive methods to perform crossover and mutation operations, simulated annealing ideas to jump out of the local optimal solution, to construct the GA optimization algorithm in this paper.

2) Firstly, comparing the fitness function values of similar algorithms, this paper's algorithm has tended to be smooth when the number of iterations is close to 800, while the SCSS algorithm needs to be close to smooth when the number of iterations is close to 1200. Then use this paper's algorithm to start a college scheduling experiments, the application process of the actual detection of no anomalies. Finally, the survey analyzes the students of a major in this university on the curriculum of this paper's algorithm, the students of the annual study plan arrangement, the overall curriculum and with the preset employment goals of the three aspects of satisfaction are 50.00% and above. The result shows that the integration of curriculum production and teaching not only significantly changes the team of double-qualified teachers, but also enriche professional teaching resources, greatly improves students' skills, and brings more space for professional development.

To sum up, the integration of industry and education, as an important driving force for economic development in the new era, has a profound impact on the shaping and promotion of new quality productivity. By optimizing the docking of education supply and industrial demand, the integration of industry and education not only provides high-quality talents and high-quality labor elements for economic development, but also builds an efficient innovation platform. Looking forward to the future, deepening the integration of production and education, optimizing professional Settings, customizing practical courses, and strengthening school-enterprise cooperation and collaborative innovation are important ways to enable new high-quality productivity and promote high-quality economic and social development.

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