# Physical Training in Higher Vocational Colleges Based on Sequencing Adaptive Genetic Algorithm

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***Abstract*—This study is based on the sequencing adaptive genetic algorithm and conducts an in-depth discussion on optimization issues in the field of higher vocational sports training. By analyzing the shortcomings of traditional genetic algorithms in optimizing training plans, a new sequencing adaptive genetic algorithm is proposed to improve the optimization effect and adaptability of training plans. First, the optimization goals and constraints in higher vocational sports training were studied, including the diversity of training content and the rationality of training intensity. Secondly, based on the sequencing adaptive genetic algorithm, an optimization algorithm framework suitable for higher vocational sports training was designed, including key steps such as individual coding, fitness evaluation, and crossover mutation. Then, the proposed algorithm was verified and analyzed using experimental data. The results showed that the algorithm can effectively improve the optimization effect of the training plan and has strong adaptability and generalization capabilities. Finally, through comparison with traditional genetic algorithms and other optimization algorithms, the superiority and practicability of sequencing adaptive genetic algorithms in higher vocational sports training are further verified.**

***Keywords*—Sequencing adaptive genetic algorithm; higher vocational colleges; sports training; convergence speed**

## I. INTRODUCTION

With the continuous optimization and improvement of vocational education, higher vocational academic education has received more and more attention [1]. On the one hand, the cultural education of higher vocational colleges is further enriched. Still, on the other hand, the lack of physical education and training in HVC is relatively weak. For high-quality students, it is the embodiment of cultural ability and the improvement of physical quality [2], [3]. From the perspective of practicality, the physical training and education of HVC can be carried out to cultivate students' physical fitness, exercise their will, improve students' abilities from many aspects, and give play to the multiple effects of higher vocational education, the characteristic training advantages of HVC [4].

However, it is worth noting that, how to set up physical education classes in HVC and arrange them to combine work and rest, which can exercise physical fitness and relax better. In response to this problem, scholars have proposed many methods, such as introducing basic genetic algorithms, trying to change the problems of slow convergence and poor stability, and avoiding the two-level differentiation [5]. Still, the basic genetic algorithm has certain application limitations. Therefore, some scholars further optimize, introduce the genetic algorithm's incorporation of co-evolution, conduct competition among multiple courses to improve global convergence, and achieve the optimization balance of multiple courses. However, this is prone to weakening and degradation [6], [7]. Physical training in higher vocational colleges is one of the important ways to improve students' physical quality and sports skills, its purpose is to cultivate students' physical quality, improve athletes' competitive level, and promote the overall development of students' physical and mental health. The traditional training methods of higher vocational sports are often subject to the design and implementation of training plans, and there are problems such as unstable training effect and low degree of individuation, so it is necessary to introduce more scientific and effective optimization methods to improve training effect. Genetic algorithm is a common heuristic optimization algorithm in the research field of optimization problems, which has strong global search ability and adaptability. In recent years, with the continuous development and improvement of genetic algorithm, sequencing adaptive genetic algorithm, as a variant of genetic algorithm, has been widely concerned and has achieved some successful applications in many fields. Sequencing adaptive genetic algorithm is an optimization method based on population evolution. Its basic idea is to continuously select individuals with higher fitness from the initial population to solve the optimization problem by simulating the selection, crossover and mutation operations in the process of biological evolution. Compared with traditional genetic algorithms, sequencing adaptive genetic algorithm has stronger adaptability and flexibility in individual evaluation and selection, crossover and variation, and can better cope with the solving needs of different problems. In the field of higher vocational sports training, optimizing the training plan is the key to improve the training effect and individuation degree. The traditional training plan design usually relies on experience and professional knowledge, and it is difficult to fully take into account the characteristics and needs of different athletes, so it is necessary to introduce more scientific and effective optimization methods to improve the design of training plans. As a new optimization method, sequencing adaptive genetic algorithm has good application potential and development prospect, and can provide new ideas and methods for the improvement and promotion of physical training in higher vocational colleges.

In summary, as a new optimization method, sequencing adaptive genetic algorithm has the potential and prospect of application in the field of higher vocational sports training, but the relevant research is still relatively limited, and its specific application and effect in this field need to be further discussed.

The field of higher vocational sports training has made some progress in recent years, including the improvement and innovation of training methods, the improvement of athletes' technical level, and the quantitative evaluation of training effects. With the development of sports science and the advancement of technology, more and more scientific methods and technologies are introduced into higher vocational sports training, making the training process more scientific and personalized. However, the field of higher vocational sports training still faces some challenges. This includes the optimization of training plans, the satisfaction of athletes' personalized training needs, and the quantitative evaluation methods of training effects. Traditional training methods may not fully take into account the characteristics and needs of different athletes, resulting in unsatisfactory training results. There are still some unresolved issues in the field of higher vocational sports training, such as how to better realize the personalization and differentiation of training plans, how to improve the accuracy and scientificity of evaluation of training effects, how to effectively adjust and Optimize training plan, etc. Solving these problems will help improve athletes' training effects and competitive levels. This study is based on the sequencing adaptive genetic algorithm and focuses on the optimization problems in higher vocational sports training. Compared with traditional training methods, sequencing adaptive genetic algorithms are more personalized and adaptable and can better meet the training needs of different athletes. The importance of this study is that by introducing new algorithmic methods, it improves the optimization effect and degree of personalization of the training plan, and provides new ideas and methods for the improvement and improvement of higher vocational sports training. At the same time, this research also fills the gap in optimization methods in the field of higher vocational sports training, and is innovative and advanced to a certain extent.

Based on this, the article relies on the sorting adaptive genetic algorithm through the introduction of adaptive genetic operators so that each course has its cross arrangement, and it is gradually tried and automatically changed, aiming to adjust the optimal sports training in HVC.

Section I briefly introduces the background and significance of physical training in higher vocational colleges, discusses the problems and challenges existing in physical training in higher vocational colleges, and puts forward the purpose and significance of this research; Section II analyzes the present situation of PE teaching in higher vocational colleges; Section III discusses the relationship between higher vocational education and physical training. Section IV proposes the exercise training based on adaptive genetic algorithm; Section V determines the research object and data source of the experiment, and describes the experimental design and setting, including participant selection, experimental conditions, evaluation indicators, etc. Discussion is given in Section VI. Finally, the main findings and contributions of this study are summarized, the direction and suggestions for further research are put forward, and the application prospect of sequencing adaptive genetic algorithm in higher vocational sports training is prospected in Section VII.

## II. An Analysis of the Current Situation of Physical Education in Higher Vocational Colleges

### A. Physical Education Teaching Goal

The so-called PE is not only simple sports such as long-distance running and hurdles, but also actively guides students, such as adding group gymnastics, Tai Chi, and other sports, integrating traditional culture and sports, and guiding students in team spirit, Physical and mental health, and other aspects have been fully displayed and embodied.

### B. Physical Education Teaching Methods

Concerning the approach of physical education, the traditional methods are led by teachers, imparting the corresponding knowledge to students, and it is difficult for students to choose according to their interests. The consequence is that the development of all students cannot be satisfied, making physical education teaching quality cannot be significantly improved [8], [9].

### C. Physical Education Content

At present, physical education courses and physical training are mostly based on exercise methods. On the one hand, physical training with a large amount of exercise may only suit some students. On the other hand, repeated courses will be produced, which are only continuously strengthened. Over a long period, students will become tired of learning, leading to a continuous decrease in the quality of teaching.

### D. The Need for Constructing Special Sports Courses in Higher Vocational Colleges in the New Era

Different HVCs have different school-running ideas and concepts, and their characteristics are also different. Therefore, higher vocational physical education curricula and physical training should also be their focus [10]–[13]. Quality education can be introduced and integrated with the physical education courses of HVC, guide students to conduct comprehensive development training, comprehensively cultivate all aspects of quality, complement cultural courses, and finally realize the high-quality sports training and cultivation of HVC.

### E. The Need of Physical Education Reform in Higher Vocational Colleges

Given the traditional teaching methods, teaching goals, and teaching content, traditional methods need to be reformed, which is mainly reflected in (1) ideological reforms to guide students' independence and innovation, comprehensively considering students' intelligence and other factors to develop and integrate Quality education is expanded to cultivate students with good habits and good ideas; (2) Reform of the model, change the traditional teacher teaching, students passively accept teaching, guide the gradual participation of academics, full participation, from the beginning of the physical training design and implementation, Give full play to individual initiative and creativity, assisted by teachers, and cooperate; (3) Reform in methods. From the perspectives of thinking mode and physical instinct, carry out effective sports training guidance, complete the concept change and plan formation, and raise the standard of instruction; (4) Reform in evaluation. Transform from traditional evaluation indicators to comprehensive evaluations of students' progress, physical

fitness, sports skills, and learning attitudes to guide students' physical and mental health.

## III. Higher Vocational Education and Sports Training

### A. The Content of Physical Education in HVC aiming at Quality Education

For physical education and training in HVC, it is necessary to fully consider the feasibility and integration of quality education in teaching content, fully integrate market needs and teaching, and arrange the content and training of teaching scientifically, effectively, and reasonably [13], [14]. The goal of its teaching is to enhance the physical fitness of students and cultivate comprehensive graduates. Therefore, in addition to traditional sports, it is necessary to add or set up some new sports training content according to the local characteristics of the advantages of the school, such as Tai Chi, Boxing, group gymnastics, swimming, etc.

### B. Carry out Physical Education Based on Students' Professional Characteristics

The PETs and resources of higher vocational colleges are different. Therefore, in addition to traditional physical training, it is necessary to design the division of labor according to the existing profession. Teaching physical education requires a thorough understanding of the factors that affect the students, designing teaching content that aligns with students' interests and sports, and conducting practical sports training to improve students' physical fitness and effectively give full play to physical education in HVC. The role of quality education in students' life is very important.

At the same time, different sports training courses and contents are set up for the student subjects of different majors in HVC. It is optional for all students to make a unified selection. According to the characteristics of different majors and occupations when selecting courses, they are classified and pushed and selected separately to ensure that there are Course selection is required to ensure that the selection is more scientific, reasonable, and effective.

To continue the physical education process of higher vocational colleges from inside to outside, HVC should investigate the combination of extracurricular physical activity and intramural physical education to form a unity of teaching and practice to ensure the unity of students inside and outside the campus to the greatest extent and completeness, but also to ensure the connection between HVC and enterprises.

### C. Physical Education Teaching Form That Highlights Practical Ability

The higher vocational college's PE should highlight students' practical abilities. Simulating professional scenes and social situations, physical training, and future work abilities should conduct comprehensive training. According to different majors, different genders, and different interests, they are separately cultivated. Design different physical education or physical training content to reserve enough knowledge of physical education for students. At the same time, students experience different roles in sports training, such as referees, athletes, captains, etc., to fully exercise their resilience and unity ability, and they can also exercise other abilities while exercising. At the same time, by simulating the requirements of the enterprise, it is required not to be late or leave early and to attend sports training fully.

## IV. Sports Training Based on Adaptive Genetic Algorithm

In adaptive Genetic Algorithms Based on Co-evolution (SAGA) based on co-evolution, in each iteration of the algorithm, the evolution process and the collaborative process are carried out in sequence [15], in which the evolution process uses adaptive genetics. With a strong global search capability and a good convergence speed, the SAGA algorithm's genetic operation seeks to improve the genetic algorithm from both local and global perspectives.

The objective function is the core indicator in the genetic algorithm (GA) optimization process. It defines the goals or performance evaluation criteria that need to be optimized. In the scenario of higher vocational sports training, the objective function may be diverse, such as the overall performance index of the training plan, the athlete's training effect evaluation index, etc., which are determined according to the specific content and purpose of the research. Generally speaking, genetic algorithms can be used for optimization problems as well as search problems. In optimization problems, genetic algorithms find optimal solutions or near-optimal solutions through iterative evolution; while in search problems, genetic algorithms are used to find solutions that meet specific conditions in a large-scale search space. In the scenario of higher vocational sports training, if it is a training plan optimization problem, the genetic algorithm is used to optimize the objective function, that is, to find the best training plan; if it is a training plan design problem, the genetic algorithm is used Search for the optimal training plan.

### A. Framework Description of Co-Evolution

The two-layer co-evolutionary framework is shown in Fig. 1. The population is separated into n sub-populations. Enhanced co-evolution is employed to prevent early maturation within the populations. The phenomenon continues to uphold the global search capability. The local population forms the lower layer, and a neighborhood-based local adaptive evolution algorithm is applied for conducting the local lookup. Enhancing convergence speed and promptly locating the best local solution are the goals. The local population is promoted to the top performers in the global group through the promotion operation association between the two layers. Subsequently, the local adaptive algorithm converges to the local optimum quickly.

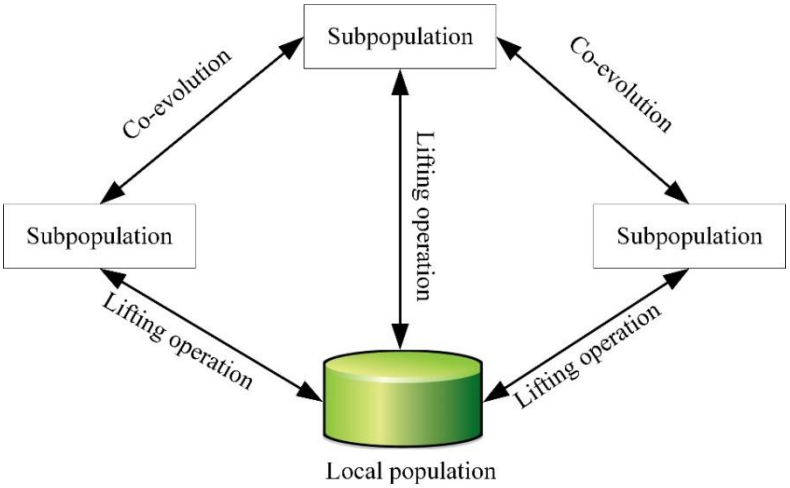


Fig. 1. Two-layer framework model diagram of co-evolution.

### B. Adaptive Mutation Strategy of Local Evolution

The lifting operation concentrates the better individuals between the n subpopulations of the world and local populations. The local evolution uses a neighborhood-based local adaptive evolution algorithm to rapidly allow the local population to converge to the ideal solution. In this algorithm, selection and crossover operations are not used; only mutation operations are used, and the mutation rate that adapts is employed. The mutation is restricted to the individual's $\Delta$ neighborhood, and the purpose is to accelerate the convergence speed of the local population. The adaptive mutation rate among them is described as follows:

$$P_m(t) = 0.01 + NG \times cof \quad (1)$$

Of them, t denotes the algebra of the current iteration, and NG denotes the algebra for which there hasn't been a better solution since the last generation, at which point an excellent solution first surfaced. Typically, a small value, like 0.01, is used to determine the threshold for a coefficient called cof, which increases the mutation rate.

Formula (2) illustrates that if the evolution process is smooth—if a better solution emerges in every generation—then NG=0. In this case, it can be concluded that the current mutation operation effect is preferable, and raising the mutation probability is unnecessary. If it has not evolved, the longer the time will be. The greater the NG, the higher the mutation probability $P_m$, and the need to expand the search range, but once a particular threshold for the number of non-evolved generations is reached (if cof=0.01, the threshold is 100 generations), then $P_m = 1$ can be considered as the population at this time There is no better solution in the 4-neighborhood, and the evolution process is terminated.

### C. SAGA Algorithm Description

Through the analysis of the above two-layer framework and operation strategy, the steps of the adaptive algorithm based on co-evolution (SAGA) are described as follows:

*1)* Perform a random initialization on the global population and set the population to n;

*2)* Improve the algorithm of the sub-population and form the coverage of the global population;

*3)* For the local adaptive evolution, the formation of a new population is optimized;

*4)* Cooperate based on the new population to achieve continuous improvement;

*5)* If the termination conditions are met, then end. Otherwise, go to (2).

Chromosomes are usually represented by bit strings, where each bit represents the value of a gene or variable on the chromosome. The following is a simple example. Suppose there is a chromosome containing 5 genes, and each gene has 2 possible values (0 or 1). The chromosome can be represented as a 5-digit bit string, for example: 10110.

In genetic algorithms, crossover and mutation are two common genetic operations used to generate new individuals. Their probabilities are usually specified by the user during algorithm design.

The crossover operation partially exchanges the chromosomes of two parent individuals to produce new offspring individuals. For example, for chromosomes represented by bit strings, crossover can cut the two chromosomes at random positions and swap the parts after the cut point. Suppose there are two parent individuals A and B, respectively 10110 and 01101, then the possible offspring individuals are 10101 and 01110. The probability of the crossover operation is usually specified by the user and is generally set between 0.6 and 0.9; the mutation operation randomly changes the values of some genes in the individual chromosomes to introduce new changes and diversity. For example, for a chromosome represented by a bit string, a mutation could randomly invert certain bits in the chromosome. Suppose there is a chromosome 10110, which may become 10100 after mutation. The probability of mutation operations is usually low and is generally set between 0.001 and 0.01. It should be noted that the probability of crossover and mutation can be adjusted according to specific problems and experimental experience. Certain experiments and tuning are usually required to determine the best parameter settings.

## V. EXPERIMENTAL VERIFICATIONS

According to the dual consideration of the majors studied by the students of HVC and their future occupations, the student's physical fitness requirements are integrated, and the focus is on selecting courses to improve their physical fitness and, at the same time, related skills. The specific physical education training is shown in Fig. 2.

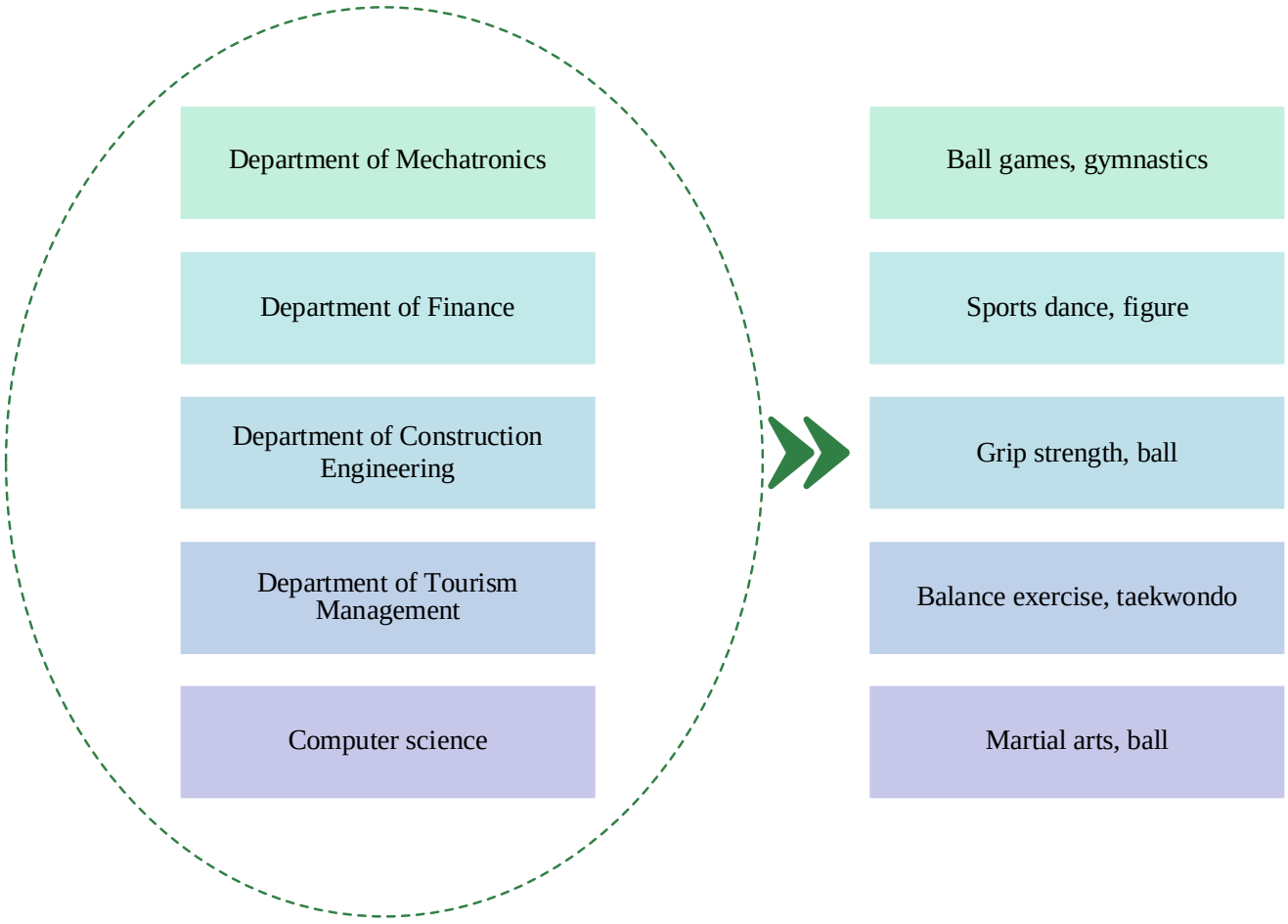


Fig. 2. Practical physical education curriculum in higher vocational education.

To further clarify the effectiveness of the SAGA algorithm, this paper uses this method, the ECCGA algorithm, and the FLAGA algorithm to optimize the performance of the physical education curriculum setting. The relevant parameters are set as follows: the physical education class hours are set to 240, divided into three sample groups, respectively 90, 80, and 70. The probability of coordination is set to 0.42. m is set to 4, the environmental load K is set to [80, 80, and 20], and the probability of promotion is set to 0.4, so the selected test function is as in Formula (2), Formula (3), Formula (4) as shown in:

$$f_1 = \left|\frac{\sum_{i=1}^{n} cos^4(x_i) - 2\prod_{i=1}^{n} cos^2(x_i)}{\sqrt{\sum_{i=1}^{n} x_i}}\right|, 0 \le x_i \le 10, 1 \le i \le n, \prod_{i=1}^{n} x_i = 0.75 \quad (2)$$

$$f_2 = \sum_{i=1}^{n}\{x_i^2 - 10\,cos(2\pi x_i) + 10\}, -5.12 < x_i < 5.12 \quad (3)$$

$$f_3 = -20\,exp\left\{-0.2\sqrt{\frac{1}{N}\sum_{i=1}^{n} x_i^2}\right\} - exp\left\{\frac{1}{N}\sum_{i=1}^{n} cos(2\pi x_i^2)\right\} + 20 + exp(1), -32 < x_i < 32 \quad (4)$$

F1 is a non-linear function, and f2 and f3 are multi-dimensional and multi-modal. It is simple to become mired in a locally optimal solution when solving. Set n to 30, then the results of a certain iterative optimization process can be obtained, as shown in Fig. 3, Fig. 4, and Fig. 5.

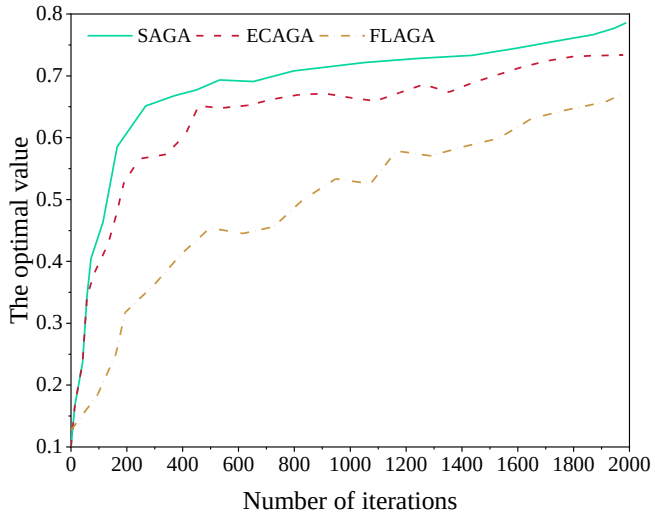


Fig. 3. Iterative process of function f1.

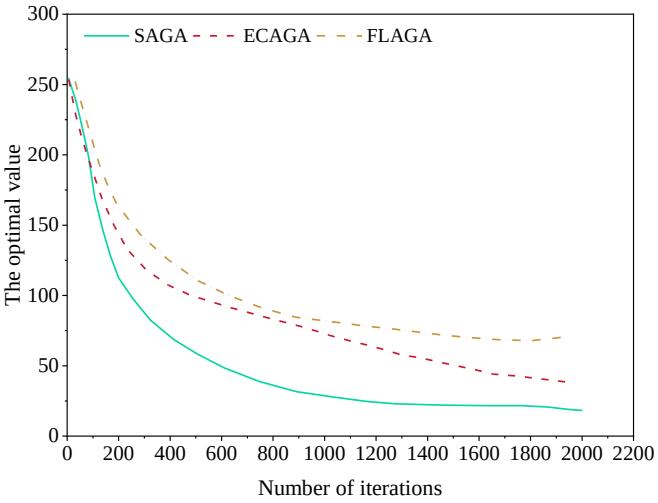


Fig. 4. Iterative process of function f2.

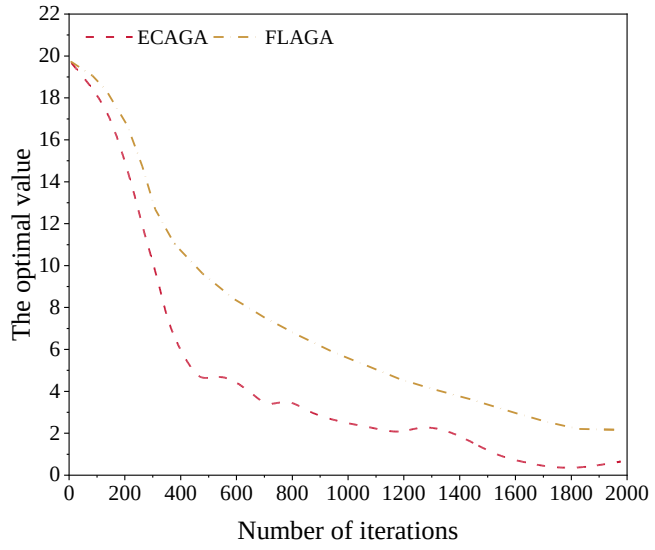


Fig. 5. Iterative process of function f3.

It can be seen from the results in Fig. 3 that it is the iterative process of the function. Compared with the other two functions, the convergence speed of the SAGA algorithm is faster and closer to the optimal value of 0.81; from the two calculation results in Fig. 4 and Fig. 5, you can see the convergence process of the SAGA algorithm has fewer fluctuations, so it can be obtained that compared to the other two algorithms, the SAGA algorithm not only has a faster convergence speed but also has a higher accuracy. Similarly, when solving the maximum value of the function value, when the SAGA algorithm is iterated 8000 times, the optimal function value 0.81 is obtained. Still, the traditional method is iterated 40,000 times more than the SAGA algorithm. Therefore, the SAGA algorithm has more obvious advantages.

## VI. Discussion

The traditional training plan design is often based on expert experience and general rules; it is difficult to fully consider the individual differences and training needs of different athletes. The sequencing adaptive genetic algorithm can automatically adjust the training plan according to the characteristics and goals of each athlete to achieve personalized and differentiated training, so as to better meet the needs of athletes. Through the comparison of experimental results, it is found that the training plan optimized by sequencing adaptive genetic algorithm has certain improvement in training effect. Compared with the traditional training plan, the optimized training plan is more scientific and reasonable, and can better improve the training effect and competitive level of athletes. In this study, we adjusted and optimized the parameters of the sequencing adaptive genetic algorithm in a certain range, and compared the optimization effects under different parameter settings. The results show that the algorithm parameters have a certain influence on the optimization results, and reasonable setting of algorithm parameters can improve the optimization effect and convergence speed. Although the experimental results of this study show that the personalized training plan based on sequencing adaptive genetic algorithm has certain advantages, its feasibility and stability in practical applications still need to be further verified. Future studies can further expand the sample size and experimental scope to explore the applicability of the algorithm in different scenarios and sports. There are still some limitations in this study, such as small sample size and insufficient control of experimental environment. Future studies can further improve the experimental design, strengthen the evaluation of algorithm performance and stability, and explore more effective and reliable methods for optimizing personalized training plans.

In summary, the optimization method of higher vocational physical training based on sequencing adaptive genetic algorithm has certain potential and application prospect, but it needs further verification and improvement in practical application. We believe that with the progress of technology and in-depth research, this method will bring more innovations and breakthroughs in the field of higher vocational sports training.

## VII. Conclusions

As a group of important academic institutions for cultivating skilled students, vocational colleges are receiving

more and more attention. The students who are trained should also integrate academic and practical skills to improve the physical fitness of students. This article uses a ranking adaptive genetic algorithm. As a basis, it has absorbed the advantages of strong convergence and put forward an adaptive genetic algorithm to protect sports training and the algorithm's stability on time, which is advantageous to setting sports courses in HVC and has obvious effects.

## DATA AVAILABILITY

The data used to support the findings of this study are available from the corresponding author upon request.

## CONFLICTS OF INTEREST

The authors declare no conflicts of interest

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Not applicable.

## AUTHORSHIP CONTRIBUTION STATEMENT

Quanzhong Gao: Writing-Original draft preparation, Conceptualization, Supervision, Project administration.

## DECLARATIONS

Not applicable

## REFERENCES

[1] J. W. L. Keogh and P. W. Winwood, “The epidemiology of injuries across the weight-training sports,” Sports medicine, vol. 47, no. 3, pp. 479–501, 2017.

[2] G. Diaz Babio et al., “Atrial size and sports. A great training for a greater left atrium: how much is too much?” Int J Cardiovasc Imaging, vol. 37, no. 3, pp. 981–988, 2021.

[3] C. A. Emery et al., “Implementing a junior high school-based programme to reduce sports injuries through neuromuscular training (iSPRINT): a cluster randomised controlled trial (RCT),” Br J Sports Med, vol. 54, no. 15, pp. 913–919, 2020.

[4] D. J. Paul, “Agility in team sports: Testing, training and fact...,” 2016.

[5] W. C.-C. Chu, C. Shih, W.-Y. Chou, S. I. Ahamed, and P.-A. Hsiung, “Artificial intelligence of things in sports science: weight training as an example,” Computer (Long Beach Calif), vol. 52, no. 11, pp. 52–61, 2019.

[6] Y. Zhou, C.-T. Chen, and N. G. Muggleton, “The effects of visual training on sports skill in volleyball players,” Prog Brain Res, vol. 253, pp. 201–227, 2020.

[7] A. D. Rogol, S. P. Cumming, and R. M. Malina, “Biobanding: a new paradigm for youth sports and training,” Pediatrics, vol. 142, no. 5, 2018.

[8] N. B. Jain, J. Borg-Stein, G. Miranda-Comas, W. Micheo, C. Visco, and M. Fredericson, “Recommendations for enhancing sports medicine fellowship training,” Am J Phys Med Rehabil, vol. 99, no. 4, pp. 348–352, 2020.

[9] Z. Luan, “The effect of beach sports power training on ankle joint injury,” J Coast Res, vol. 93, no. SI, pp. 530–535, 2019.

[10] D. Simon et al., “Biomechanical stress in the context of competitive sports training triggers enthesitis,” Arthritis Res Ther, vol. 23, pp. 1–6, 2021.

[11] D. E. Rae, K. J. Stephenson, and L. C. Roden, “Factors to consider when assessing diurnal variation in sports performance: the influence of chronotype and habitual training time-of-day,” Eur J Appl Physiol, vol. 115, pp. 1339–1349, 2015.

[12] J. Moran, G. Sandercock, M. C. Rumpf, and D. A. Parry, “Variation in responses to sprint training in male youth athletes: a meta-analysis,” Int J Sports Med, vol. 38, no. 01, pp. 1–11, 2017.

[13] G. Nambi, W. K. Abdelbasset, B. A. Alqahtani, S. M. Alrawaili, A. M. Abodonya, and A. K. Saleh, “Isokinetic back training is more effective than core stabilization training on pain intensity and sports performances in football players with chronic low back pain: A randomized controlled trial,” Medicine, vol. 99, no. 21, 2020.

[14] K. A. Stokes et al., “Returning to play after prolonged training restrictions in professional collision sports,” Int J Sports Med, vol. 41, no. 13, pp. 895–911, 2020.

[15] S. Thng, S. Pearson, and J. W. L. Keogh, “Relationships between dry-land resistance training and swim start performance and effects of such training on the swim start: a systematic review,” Sports Medicine, vol. 49, pp. 1957–1973, 2019.