Ant Colony Optimization Based Simulation Analysis of Sports Course Achievement Management System

Mingli Chi, M.Sc
Mingli Chi, Lecturer, Northeast Agricultural University, Harbin, Heilongjiang, 150030, China.
Correspondence Lec Chi; glslob8863778938@163.com

Objectives: With the rapid development of computer technology and network technology, school teaching and management also need to keep pace with the development of the times, and information construction is needed in teaching and management. In the process of campus informationization construction, it is required that all links can be developed in a balanced way, and the school should be built into a scientific platform of information education and teaching from both hardware and software aspects. **Methods:** Sports achievement management system is based on reducing the workload of physical education teachers, improving teaching efficiency, optimizing the process of students' class selection, enhancing the identification of students taking part in examinations, saving manpower, financial resources and time compared with the traditional registration model. **Results:** The ant colony optimization algorithm has achieved encouraging results in solving the combinatorial optimization problem that the traditional optimization method is difficult to work. Therefore, using this algorithm to optimize the simulation analysis of the physical education curriculum management system has better matching characteristics. **Conclusion:** The system has the characteristics of friendly man-machine interface, easy operation, strong compatibility, fast running speed, etc. It has rich reports and powerful query statistics.

Key words: Ant colony optimization algorithm; Physical education curriculum; Achievement management system
Tob Regul Sci.™ 2021;7(5): 1978-1990
DOI: doi.org/10.18001/TRS.7.5.118

With the invention and popularization of computers, optimization theory and method have been widely used in economic planning, engineering design, production management, transportation and other fields, making it a very active subject [1]. In the past 30 years, great changes have taken place in the field of optimization. Artificial intelligence and artificial life technology have injected new vitality into the field of optimization. A series of modern heuristic optimization methods based on bionic principles and simulating natural phenomena or processes have been proposed successively. The simulation of group behavior of simple organisms has led to the emergence of swarm intelligence optimization algorithm [2]. The birth of ant colony algorithm is observed from the foraging behavior of real ant colony in nature. When ants crawl between food sources and nests, they release a substance called pheromone on the ground and form a pheromone trajectory [3]. Ant colony optimization algorithm is first used to solve the traveling salesman problem. The experimental results show that the ant system has strong robustness and the ability to search for a better solution, but it also has some defects, such as slow convergence and easy stagnation [4]. The emergence of ant system has attracted the attention of many scholars. In view of the shortcomings of the algorithm, many new ant algorithms have been proposed, such as the maximum-minimum ant system of ant colony system and the sorting based ant system [5]. These algorithms have greatly improved the performance and eliminated the stagnation phenomenon in search to a large extent, which is more suitable for solving high-dimensional np-hard problems [6].

In recent years, the construction and development of social sports major has been concerned by all sides, and the comprehensive assessment of students' PE performance is an important link in the physical education teaching in colleges and universities [7]. The results of education must pass, and only through the appropriate performance management system can be reflected. Achievement evaluation is an important means to promote the realization of curriculum objectives and curriculum construction. Achievement management embodies the basic idea and value orientation of curriculum, and influences and determines the direction of curriculum development [8]. In the evaluation of physical education performance, the method of comprehensive scoring is adopted according to the proportion of the scores of each item in terms of semester or academic year. Its contents include: the usual scores, i.e. attendance rate and learning attitude of physical education class (10%), theoretical scores of physical education (20%), physical health test (30%) and technical scores (40%). Among them, Physical Fitness Standard Test scores are included in the evaluation of physical education results. Six items of test data need to be completed: height, weight, vital capacity, standing long jump, sitting forward bend, 800 m (female) and 1 000 m (male) table-looking score and statistical conversion. Teachers use calculators to operate manually, which is heavy workload, inefficient and error-prone [9]. Therefore, it is necessary to use ant colony optimization algorithm to develop the integrated management system of physical education achievements, to realize the comprehensive evaluation of physical education achievements and the standardization, automation and networking of physical education teaching management, so as to improve work efficiency and quality [10]. The integrated management system of physical education achievement adopts modular and structured design, which has good expansibility and can expand or improve the system function at any time according to the needs of physical education teaching management [11].

Traditional ant colony system will stagnate prematurely when solving complex problems. Stasis can occur when ants search too little and rapidly develop pathways with high pheromone concentrations [12]. The biggest difference between the maximum-minimum ant colony system and the ant colony system is that its pheromone concentration is limited within a given range. The research field of ant algorithm is to observe the behavior of real ants, establish corresponding behavior models, and then use these models to design new algorithms to solve the corresponding problems of optimization, discrete control and clustering [13]. Different ant algorithms can be derived by observing different behavioral aspects of ant colony [14]. A group of optimization algorithms can be used to solve some complex combinatorial optimization problems. According to the provincial education department assessment requirements for the work of higher vocational college sports, school sports should work as an important breakthrough of the implementation of student literacy cultivation, cultivating students' personality, improving and partial physical health level of the teachers and students, and promote a harmonious, efficient and vibrant campus sports culture construction, to better reflect scientific management and effective organization, scientific evaluation, the active intervention of sports education idea [15.] We need to establish a comprehensive management system of students' sports selection courses, students' physical condition and students' participation in sunshine sports activities according to the latest college physical education policy [16]. Because the composition of sports scores is complex, management projects are large, and the workload is large, manual entry and calculation are easy to make mistakes. Management is not convenient for statistics and query. Ant colony optimization algorithm is used to optimize the performance management system of physical education. Simulation is the best way to solve such problems.

In this article we propose an ant colony optimization algorithm, which is a new algorithm for the optimization and simulation of the performance management system of physical education curriculum.

In summary, our contributions are as follow:

1. Ant colony algorithm (ACO) is a probabilistic algorithm to find the optimal path for the optimization and Simulation of the performance management system of physical education courses. This algorithm has the characteristics of distributed computing, positive feedback of information and heuristic search. It is essentially a heuristic global optimization algorithm in evolutionary algorithm.

2. This technology is widely used in the optimization mode of imitating natural biological system, and it has high applicability for the performance management of physical education courses according to optimization and simulation problems.

3. Parallel distributed computing; Strong optimization capability; Strong adaptability

Ant colony optimization (ACO) is a kind of swarm intelligence optimization method developed by Dorigo et al. in the 1990s based on the biological behavior of ants traveling along the shortest path in the process of foraging. The algorithm achieves encouraging results in solving combinatorial optimization problems with characteristics which are difficult to be effectively solved by traditional optimization methods, so it has attracted wide attention from academia and industry [17]. In 2014, some scholars introduced finite state machine (FSM) from training samples by ant colony optimization (ACO). It was proved that the algorithm could converge to the global optimal solution by adaptively adjusting volatilization coefficient or pheromone lower bound value [18]. In 2014, some scholars proposed a simplified ant colony algorithm based on the link quality of ant-optimized impromptu on-demand distance vector and a minimization problem with combinatorial optimization properties. It is pointed out that when the number of iterations tends to infinity, the algorithm The global optimal solution can always be found [19]. In 2016, some scholars proposed an encounter algorithm based on the ant colony algorithm based on the event management and ant colony optimization project management system, which improved the quality of the ant's travel, and then the encounter algorithm and the segmentation using parallel strategy. Combining the algorithms, a problem segmentation algorithm based on ant colony algorithm is proposed [20].

Student achievement management is an important part of day-to-day management for each college and involves many aspects of the various departments within the college. With the continuous deepening of the reform of the teaching system, especially since the implementation of the credit system in colleges, the management of student achievement has become more complicated and arduous, and it is urgent to introduce modern information technology for management [21]. Many colleges and universities have been using computer system software to achieve the management of information, data processing automation. The problem: these commercial software systems are generally expensive and require annual maintenance. Therefore, it is necessary to use the ant colony optimization algorithm to hang your ladder for optimization and simulation of PE grades [22]. In 2014, some scholars based on teachers' self-efficacy in physical education teaching and students' motivation, atmosphere, the relationship between satisfaction that sports achievement management system, system Settings and basic Settings section, close to our students learn professional knowledge, and therefore, the project can be used as the subject, students "work-integrated learning" under the guidance of the teacher to finish [23].

METHODS

The ant colony optimization algorithm is derived from the biological phenomenon that the ant colony can find the shortest path between the nest and the food source in the real world. The real ant system can also realize many other complicated functions. The ant colony optimization algorithm is only for ants. The abstraction and improvement of group foraging behavior, so the two are related and different. The construction process of the ant colony optimization algorithm is gradually completed, and the prior knowledge of the field can be conveniently combined in this process. The solution mechanism of the ant colony optimization algorithm also has a very good advantage, that is, the constraint condition can be conveniently handled, and the ant can dynamically adjust the next accessible node in the process of the solution to ensure the feasibility of the solution, and the processing is complicated. Constraints are a weak link in genetic algorithms. Evolutionary computation is a heuristic random search optimization method developed by modern genetics with reference to the idea of biological evolution. Starting from the randomly generated initial group, after the continuous action of the evolutionary operator, the fitness value of the individual in the current group is gradually improved in the iterative process until the algorithm obtains the optimal solution or satisfactory solution of the problem. The parameters of ant colony optimization (aco) have great influence on the performance of the algorithm. Due to the large number of parameters of ant colony optimization algorithm and the strong coupling between the parameters, how to determine a better parameter combination is still lack of strict mathematical basis. The initial value of pheromone also influences the performance of the algorithm.

Ant colony algorithm is to inspire a group of artificial ants to seek a good solution through cooperation in the optimization of difficult discrete problems. Collaboration is at the heart of one of ACO' s designs to design computational resources to a group of relatively simple artificial ants that communicate indirectly with each other through stigmergy. Therefore, a good solution to specific problems is logical. The application of the comprehensive management system of university physical education achievements has greatly improved the quality and efficiency of the management of physical education teaching in Colleges and universities. Teachers are not limited by time and space, and can easily enter online. This system not only facilitates teachers to quickly and accurately count and analyze students'physical education achievements, but also reduces the work intensity of teaching managers.

In the ant colony optimization algorithm, the parameter E is set to adjust the pheromone concentration in the process of optimizing the performance management system of physical education curriculum. The performance of E is as follows:

$$E_{total} = kE_{cluster} = l(E_{elec}N + E_{DA}N + k\zeta_{amp}d^{4}_{toBS} + E_{elec}N + \zeta_{fs}\frac{1}{2\pi}\frac{M_1M_2}{k}N) \quad (1)$$

Where k is the maximum pheromone concentration of the adjacent path of the node, and N is the minimum pheromone concentration of the adjacent path of the node.

In the process of using the ant colony optimization algorithm for system optimization simulation, the progressive limit adjustment is performed. When the formula 2 is 0, the search is determined to be stagnant.

$$E_{total-\min} = l(E_{elec}N + E_{DA}N + d^{2}_{toBS}\sqrt{\frac{2M_1M_2N\xi_{fs}\xi_{amp}}{\pi}}) \quad (2)$$

The upper limit of pheromone can avoid stagnation behavior, and the excessive increase of pheromone concentration will limit the fast convergence of the algorithm to a single path. The pheromone lower bound increases the probability that more edges will be included in the solution. For any L, the following formula is true:

$$S = 2L + W = \frac{c}{2f\sqrt{\varepsilon_{eu}}} \quad (3)$$

In the formula, C represents the overhead of the theoretical optimal solution. The pheromone table of weights is shown in Table 1.

Table 1
Pheromone Tables of Weights

Grade	1	2
Scale division	a1	a2
Pheromone value	θ1	θ2

Combinatorial optimization minimization problem is to find an optimal solution in a feasible solution set, which has the minimum objective function value. Then the combinatorial optimization problem can be mapped to a problem with the following characteristics:

$$ES_i = \sum_j (1 - \sum_q p_{iq} m_{jq}), q \neq i, j \tag{4}$$

For each step after the construction sequence, randomly select elements according to the following formula:

$$T(n) = \begin{cases} \dfrac{W * P}{1 - P * [r \bmod (1/P)]}, & n \in G \\ 0, & others \end{cases} \tag{5}$$

Where p is a pheromone increment with the following properties:

$$P = P(Y = 1) = F(\beta_i X_i) \tag{6}$$

Where b is controlled by parameter A, the weight of heuristic information e is controlled by W, and F is a random variable selected according to the probability distribution calculated by the function of heuristic information. For the choice of F, rely on the following probability formula:

$$F_r = (A_c + Wtan\varphi)\left[1 - \frac{K}{iK}\left(1 - e^{\frac{iL}{k}}\right)\right] \tag{7}$$

$$F_c = \frac{2b}{(n+l)K^{\frac{1}{n}}}\left(\frac{W}{A}\right)^{\frac{n+1}{n}} \tag{8}$$

The influence of parameters on the performance of the solution is shown in Figure 1. The coordinates of parameters are shown in Table 2.

Figure 1
Effect of Parameters on Solution Performance

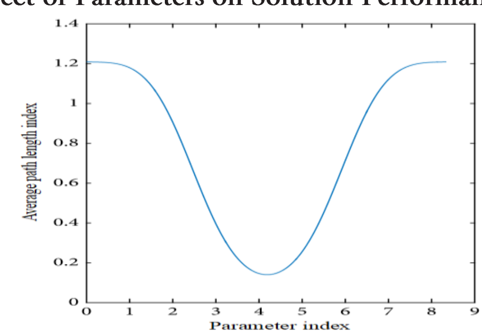


Table 2
Parameter Coordinates

X	38.23	37.64	39.55	34.71
Y	20.58	25.16	26.24	11.28

For k, its updating rules can be obtained by learning:

$$K_{s,d}=\frac{1}{MN}\sum_{m=1}^{M}\sum_{n=1}^{N}\frac{\left|\left|W_{s,d}(m,n)\right|-\mu_{s,d}\right|^{4}}{\sigma_{s,d}{}^{4}} \qquad (9)$$

In the formula, m is the forgetting factor, similar to the volatile factor, and N is the learning step.

Ant Colony Optimization (ACO) based optimization simulation of sports curriculum performance management system updates pheromone concentration on the best path found, which is called global pheromone updating.

$$\log\Gamma(x)=-\gamma x-\log(x)+\sum_{k=1}^{\infty}\left[\frac{x}{k}-\log\left(1+\frac{x}{k}\right)\right] \qquad (10)$$

Select the probability of Equation 11 below. The parameters z and x are used to adjust the model, which means that the data requirements of the simulation system are met.

$$x_{ij}^{A}=x_{ij}+\left[\max_i\left\{z_i,\tilde{\beta}\right\}-z_i\tilde{\beta}\right]+\left[\max_i\left\{\tilde{v}_{ij}\right\}-\tilde{v}_{ij}\right] \qquad (11)$$

Through the above formula, based on the ant colony optimization algorithm, the optimization results of the performance evaluation system of the physical education curriculum can finally obtain the data results as follows:

$$\tilde{E}(v_{ij}\left|\varepsilon_{ij}\right.)=S_{ij}^{+}-f^{j}(z_i;\beta^{j})-\tilde{E}(u_{ij}\left|\varepsilon_{ij}\right.),i=1,2,\ldots,m;j=1,2,\ldots,n. \qquad (12)$$

From the update process of pheromone, it can be seen that on the one hand, the current ants jointly develop new solutions based on the release of pheromones from the previous generation of ants. On the other hand, the same generation of ants are competing with each other when pheromone is updated. That is, "eliminate" the inferior solution, only the optimal path in this iteration can be updated. The number of iterations of the ant colony algorithm has not been a clear rule, usually based on experience, or the online and offline performance requirements of the algorithm to give a general number of iterations. The pheromone value on the path where the optimal solution is located is higher than any other path, and the optimal solution will be "highlighted out", and more and more ants will gather around the optimal path for searching. Ant colony optimization algorithm is a simulated evolutionary algorithm which is inspired by the foraging process of ant colony. In the process of foraging, the ant colony can always find an optimal path from the nest to the food source. Although the behavior of a single ant is extremely simple, when multiple ants form an ant colony, they exhibit very complex behavior characteristics. In addition, ant colonies also have a strong ability to adapt to the environment. For example, when there is an obstacle in the path of the ant colony, the ant colony can always quickly find an optimal path again. Therefore, this algorithm is suitable for the analysis of physical education curriculum management system optimization simulation.

RESULTS

The examination of students' achievement is an effective way to examine students' comprehensive quality. The results of physical education mainly consist of three parts: the usual results, the examination results of physical education teaching content and the physical health test results. Physical test scores not only need to have the test data, also need to convert the test data into the corresponding scores, but also to the data uploaded to the national center for the cervix, although there is a corresponding national center for the cervix for typing statistics software can operate, but it need to input additional categories is too much, when brought us a lot of unnecessary work. In view of the above confusion, in order to better meet the needs of college development, reduce the work pressure of teachers; It is extremely urgent to develop a sports score management system that is suitable for the actual situation of colleges and universities. The optimized simulation system of PE course performance management based on the swarm optimization algorithm can store the evaluation information of each student's PE class and extracurricular sports activities in the database at any time; complete the statistical analysis of students' PE class performance in each grade and class; and the stored data can be used to study and analyze various factors affecting students' physical condition, and guide students to exercise scientifically. To provide help in improving students' nutrition and hygiene conditions, so as to facilitate the relevant departments to understand, master the situation of school physical education teaching and take corresponding improvement measures based on the information provided.

System requirement analysis is an important part and content of software development. From the demand analysis, we can get that the college sports achievement management system mainly consists of the following parts: student information, class information, teacher information, physical fitness test results, peacetime results, sports results and so on. In order to make the design of sports performance management system more reasonable, enable managers to carry out efficient management, improve the efficiency of use of the system and the stability of operation, the system needs to ensure the following performance in design: The users of the system need to enter the system. To log in, you can enter the system only through background database authentication. We have set different usage rights for different types of users, which is convenient for management. In the realization of the function interface operation, it is necessary to respond in time to input and update data, and accurately process each instruction issued by the system to meet the needs of system design. When designing the system, we need to leave room for the function of the module to be more perfect, especially for the design of the data table, to be more scientific and to provide maximum scalability for the system. Develop a set of sports performance management software, which can register sports scores; handle the health data; enable teachers and students to check in time; finally, the sports performance data can be seamlessly connected with the educational system.

The management of students' physical education results and physical health standard test results is divided into three modules: score sheet management, physical education score input and physical health standard test score input. Teachers can input student numbers or enroll students in male and female classes separately. The system manages students' transcripts according to the joint class, which not only facilitates teachers' operation, but also improves the efficiency of enrollment. The operation flow chart of the system is shown in Figure 2. The overall data flow chart of the system is shown in Figure 3.

Figure 2
System Operation Flow Chart

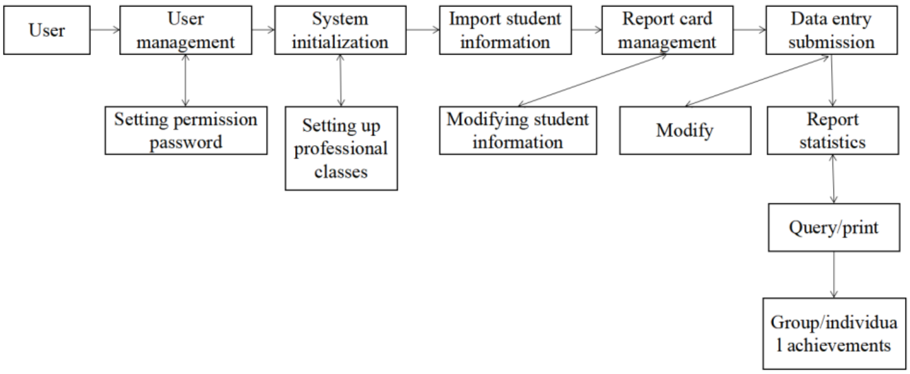
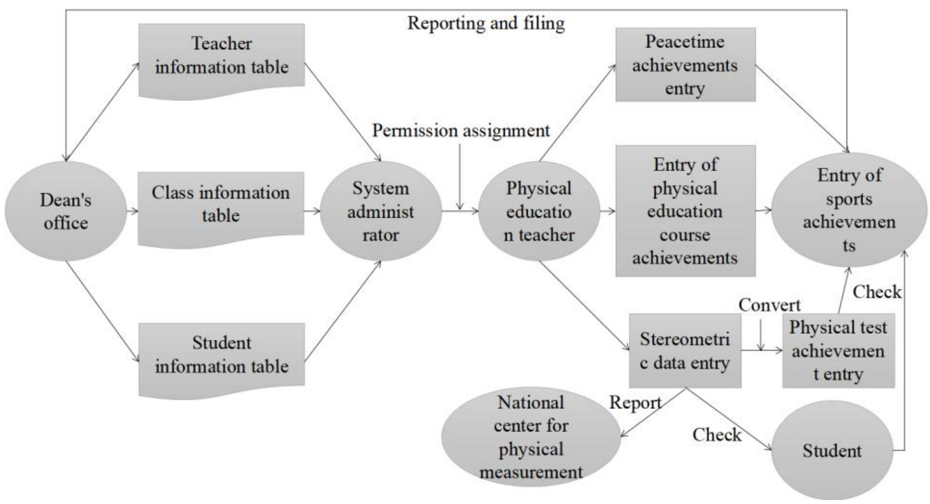


Figure 3
The Overall Data Flow Chart of the System



Ant Colony Optimization (ACO) algorithm is used to create alternative paths from source nodes to destination nodes. The mathematical model of multicast routing is transformed into a non-linear integer programming model, and then the model is solved by using neural networks and other algorithms. Figure 4 shows the performance impact of ant colony optimization algorithm. The pheromone tables of nodes are shown in Table 3.

Figure 4
The Performance Impact of Ant Colony Optimization Algorithm

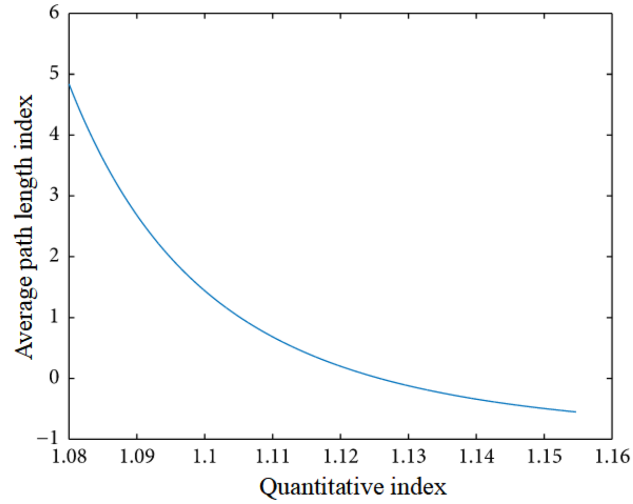


Table 3
Pheromone Table of Nodes

Target node	Neighbor node		
	a1	b1	c1
1	a11	b11	c11
2	a21	b21	c21
3	a31	b31	c31

Compared with the traditional general algorithm, the algorithm has the characteristics of information distribution, dynamics, randomness and asynchrony in the optimization simulation of the performance management system of physical education curriculum, and these characteristics can meet the optimization simulation of the performance management system of physical education curriculum. need. Table 4 and Table 5 show the experimental results of using the ant colony optimization algorithm to optimize the performance management system of the simulated physical education curriculum. Figure 5 shows a line graph showing the results of this experiment.

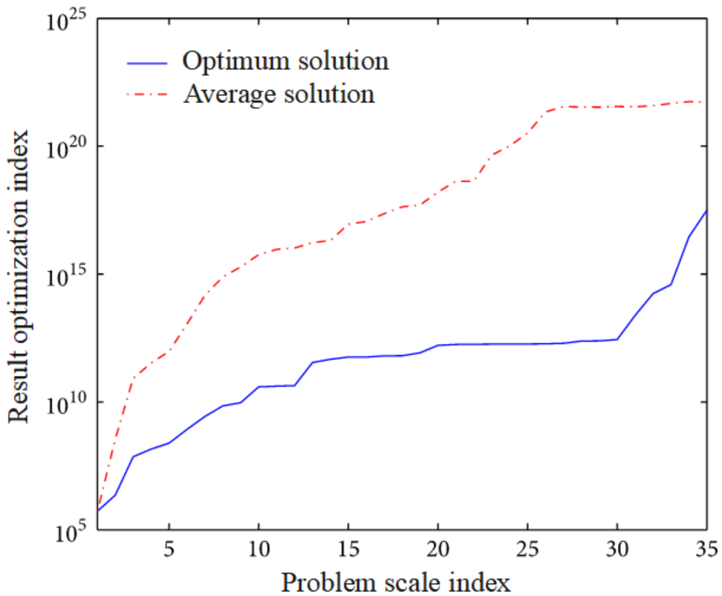
Table 4
Experimental Results

Problem size	Ant colony optimization algorithm	
	Average solution	The optimal solution found
3*3	93.6	92.1
4*4	149.7	140
5*5	255.2	250.7

Table 5
Problem Experiment Results

Algorithm name	solution	Group 1	Group 2	Group 3	Total average
Ant colony optimization algorithm	Average solution	4.25	4.23	4.22	4.23
	Optimal solution	4.13	4.14	4.13	4.13

Figure 5
Experimental Results



Ensure the confidentiality and security of your data. Both the program and the database are placed on the system server, and this server is powered by an uninterrupted UPS and has a power-on password. Teachers and students operate on any client terminal computer connected to the Internet, and log in with the user account password. Automatically save one data per operation, and back up the database regularly, and rebuild and recover in time when the database is destroyed. At this time, the pheromone volatilizes quickly, and the initial solution has a great influence on the subsequent optimization behavior. The optimization behavior has great influence, and the better solution found in the initial stage will be highlighted by the pheromone update. The effect of pheromone volatilization coefficient on the performance of the solution is shown in Figure 6. The effect of pheromone volatilization coefficient on the number of iterations is shown in Figure 7.

Figure 6
Effect of Pheromone Volatilization Coefficient on Solution Performance

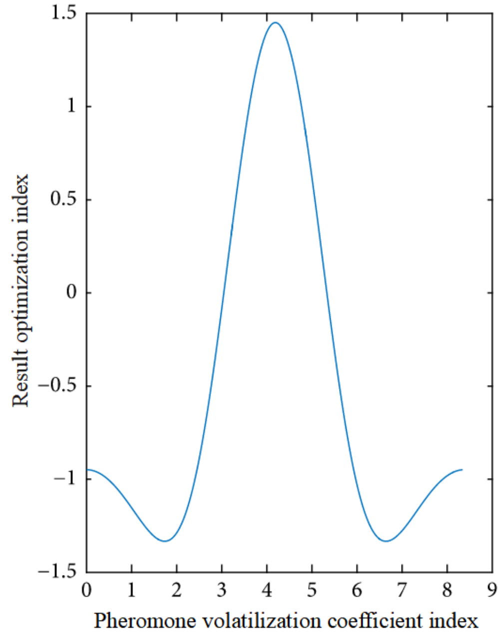
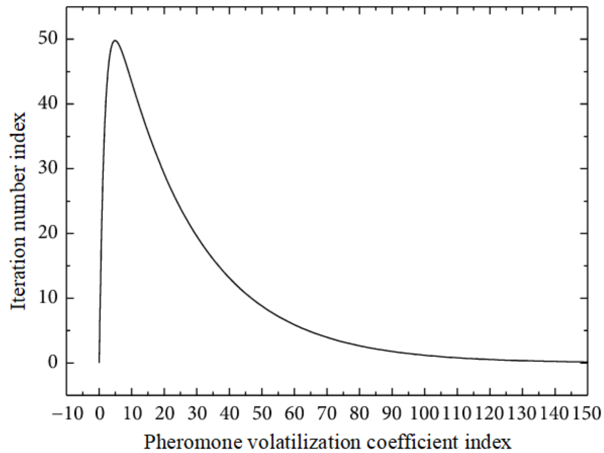


Figure 7
Effect of Pheromone Volatilization Coefficient on the Number of Iterations



With the development of network technology and database technology, the use of computers for modern management has become an inevitable trend. The development of the comprehensive management system of physical education achievements has provided strong support for the scientific, standardized and networked implementation of the management of physical education in Colleges and universities. After using, the system is stable, functional, easy to operate and practical. It is suitable for popularization in Colleges and universities.

DISCUSSION

Ant Colony Optimization (ACO) algorithm is applied to the optimization and Simulation of the performance management system of physical education courses. It is planned and designed step by step. It breaks away from the traditional way of manual operation and greatly improves the efficiency and accuracy of department work. The system basically realizes the needs of the use department, the registration and maintenance management of students' physical performance, the online management of students' physical performance and the online inquiry of physical performance, the digitization of students' physical performance and data reporting, and the seamless integration with the national students' physical health data reporting software. In particular, students' physical fitness test scores and student sports scores are organically combined through data import and export processing, which can be manually input and modified, and can be processed through the system data, greatly facilitating the use of users. System analysis and design is an essential step of system development, in order to develop a good sports performance management system, it is necessary to further elaborate the function design and implementation on the basis of this paper, and choose the appropriate development environment and language.

Human Subjects Approval Statement

This paper did not include human subjects.

Conflict of Interest Disclosure Statement

None declared.

Acknowledgement

Heilongjiang Provincial Higher Education and Teaching Reform Project.

Sports soul: the penetration research of ideological and political education in college physical education courses

Subject number: SJGY20200093

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