Optimization of Management System of Independent Enrollment Based on Quantum Evolutionary Algorithm

Yanqin Wang
School of Education, Yunnan University of Business Management, Kunming, Yunnan 650104, China
E-mail: 317792126@qq.com

Abstract. The independent enrollment of colleges and universities is a heavy task for colleges and universities. With the development of information technology, when colleges and universities conduct independent enrollment, many data hit in a flash. The statistical analysis of data brings difficulties to the general independent enrollment management system. This paper relies on quantum evolution algorithm to optimize the independent enrollment system, aiming to sort out and optimize the enrollment, the work flow of student management provides real-time data query and analysis services for relevant functional departments and individuals, realizes the linkage between the enrollment system and other systems of the school, improves the efficiency and management level of enrollment management, effectively improves the efficiency of independent enrollment, opens data interface for the access of other systems, and provides new work, student information management and financial management in the later stage work provides convenient and efficient information support.

1. Introduction
In recent years, based on the country's requirements for education information construction, the campus information system of each school has made great development, basically realizing fast and accurate access to the information of people, finance, materials, learning, research and management business process in the campus [1], providing data support for business process and management improvement through comprehensive data analysis, and promoting the school's teaching innovation and system innovation, management innovation, scientific decision-making and standardized management.

In the research of the enrollment management system, the main ideas and methods of the development of the enrollment management system at home and abroad are the overall planning and design of the independent enrollment management system to achieve online enrollment, online management and online services [2]. The unified identity authentication service design is adopted, which focuses on the centralized storage and management of user information, centralized authentication of user identity, centralized control and management of access rights [3]. The system design follows the principles of comprehensive planning, unified design and step-by-step implementation; the design is comprehensive and thoughtful, and attention is paid to reserve margin to meet the needs of future development.

Based on the operation status of the independent enrollment management system, this paper optimizes the enrollment management information system in order to improve the work efficiency of enrollment, deal with the problems of slow speed and low accuracy of enrollment information summary, and the data of enrollment, enrollment, payment and enrollment management cannot be shared. In this paper, the optimization application of quantum evolution algorithm in autonomous enrollment
management system is proposed. The algorithm adopts quantum bit coding scheme, which has strong parallel search ability. In the selection strategy, the probability characteristic of qubit is considered, and the probability consistency of quantum individual and binary individual is considered, which makes the algorithm effectively overcome the common premature phenomenon in swarm intelligence algorithm and improve the global optimization ability.

2. Quantum evolutionary algorithm

2.1 The concept of quantum evolutionary algorithm

Quantum evolutionary algorithm is based on the concept and theory of quantum computing. It introduces quantum theory into the field of evolutionary computing [4]. It uses quantum bits to encode individuals, and uses unitary transformation of quantum space and other evolutionary operators to realize the evolution of system state. In the quantum evolutionary algorithm, the additive qubit is used to encode, that is, a pair of complex numbers is used to define a qubit. A system with m-bit qubits can be described as follows:

\[
\begin{bmatrix}
\alpha_1 & \alpha_2 & \cdots & \alpha_m \\
\beta_1 & \beta_2 & \cdots & \beta_m
\end{bmatrix}
\]

In the determinant, \( |\alpha_i|^2 + |\beta_i|^2 = 1 \), \( i = 1, 2, \ldots, m \), satisfies the normalization condition.

In quantum algorithm, the information processing is realized by unitary transformation of quantum state, which is introduced into classical evolutionary algorithm. The evolution of system is realized by individual quantum mutation, which can effectively overcome the blindness of mutation operation in standard evolutionary algorithm, avoid the random disturbance of evolution process, and accelerate the convergence speed [5].

The unitary transformation of quantum state is usually realized by quantum gate. Quantum mutation is guided by the information of the optimal individual, through the role of quantum gate to update the quantum individual, so that the whole population evolves to a higher adaptive direction. For an individual with m-bit quantum bits described above, the updating formula of each quantum bit \((\alpha_i, \beta_i)\) is as follows:

\[
\begin{bmatrix}
\alpha_i(t+1) \\
\beta_i(t+1)
\end{bmatrix} = U(\theta) \begin{bmatrix}
\alpha_i(t) \\
\beta_i(t)
\end{bmatrix}
\]

In the formula: \( t \) represents the evolutionary algebra; \( U(\theta) \) is the quantum revolving gate.

The quantum transform gates are all set according to the actual situation of the problem. This paper uses the following phase rotation operator.

\[
U(\theta) = \begin{bmatrix}
\cos(\theta) & -\sin(\theta) \\
\sin(\theta) & \cos(\theta)
\end{bmatrix}
\]

In the formula: \( U(\theta) \) is a first-order positive matrix; \( \theta \) is a variation rotation angle, \( \theta = s(\alpha, \beta_i) \cdot \Delta \theta_i \), which can be obtained by checking Table 1.

| \( x_i \) | \( b_i \) | \( f(x) \geq f(b) \) | \( \Delta \theta \) | \( s(\alpha, \beta_i) \) |
|---|---|---|---|---|
| 0 | 0 | False | 0 | \( \alpha, \beta \geq 0 \) |
| 0 | 1 | True | 0 | 0 |
| 0 | 1 | False | \( \delta \) | +1 |
| 0 | 1 | True | \( \delta \) | -1 |
| 0 | 1 | False | \( \delta \) | -1 |
| 0 | 1 | True | \( \delta \) | +1 |
| 0 | 1 | False | \( \delta \) | +1 |
| 0 | 1 | True | \( \delta \) | -1 |
| 0 | 1 | False | \( \delta \) | -1 |
| 0 | 1 | True | \( \delta \) | +1 |
In Table 1, $x_i$ and $b_i$ are the binary values of the $i$ bit of the current individual and the historical optimal individual; $f(x)$ is the fitness function; $s(\alpha, \beta)$ is the direction of the rotation angle, which determines the search direction to the global optimal solution; $\delta$ is the rotation angle value, which controls the convergence speed of the algorithm, $\delta \in (0, 0.025\pi)$.

In the quantum evolutionary algorithm, the quantum measurement collapse principle can be used to achieve the conversion from the quantum superposition state to the binary evolutionary state of the traditional evolutionary algorithm [6]. For the $m$-bit quantum individual described in equation (3), the corresponding binary code is also $m$-bit, bits take 0 or 1 with probability $|\alpha|^2$ or $|\beta|^2$. The specific conversion method is as follows: generate a uniformly distributed random number $R_{\text{randi}}$ that belongs to $[0, 1]$, if $R_{\text{randi}} \leq |\alpha|^2$, then take 0, otherwise take 1. For the $k$-th generation quantum population $Q(k) = \{q_1, q_2, \ldots, q_n\}$, after measuring the collapse, a binary solution group, $p(k) = \{p_1(k), p_2(k), \ldots, p_n(k)\}$ is generated, where each bit of the binary solution $p_j(k) (j=1, 2, \ldots, n)$ is obtained by using the probability of the qubit, that is, $|\alpha_{ji}(k)|^2$ or $|\beta_{ji}(k)|^2$ in $q_j(k)$.

2.2 Advantages of quantum evolutionary algorithms
Compared with the traditional evolutionary algorithm, the population size of quantum evolutionary algorithm can be very small, and it can even run on a single person, and still maintain the diversity of the population. In quantum evolutionary algorithm, a quantum chromosome can represent the superposition of multiple states by using the coding method of qubit [7]. Therefore, compared with the traditional evolutionary algorithm, it has better population diversity. Quantum evolutionary algorithm has high search efficiency, wide adaptability and fast convergence. Quantum evolutionary algorithm has a good global search ability. At the same time, because of the probability representation of qubit, it can express all the linear superposition states with one qubit at the same time, which greatly reduces the number of chromosomes, and each qubit is determined by the observed problem solution individual and the previous optimal solution individual. In this way, the horizontal connection between each individual in the same group is relatively weak [8]. Therefore, it is more suitable for the realization of parallel structure than the traditional evolutionary algorithm, and has the ability of data exploration and data development. Structure chart of quantum evolutionary algorithms is shown in Figure 1.

1) Through many experiments, a more universal mechanism of quantum rotation angle is summarized.
2) Individuals in a population no longer evolve to only one goal, but everyone can evolve to different goals.
3) When the optimal solution is saved, the $N$ optimal solutions that have been searched by the algorithm so far are saved instead of one of the optimal solutions in the latest generation of population. $N$ is the population size.
3. Design and application of management system of independent enrollment based on quantum evolutionary algorithm

3.1 Overall functional design
Through the demand analysis of enrollment work, we can understand the business process of enrollment work in detail, and carry out feasibility study and analysis [9]. The main business of management includes announcement management, system management, enrollment setting, examination and enrollment, query statistics and other five modules. The system function structure of the software is shown in Figure 2.

![Figure 2. Functional structure of independent enrollment management system](image)

According to the different user roles of the system, analyze the system functional requirements, and obtain the system application diagram as shown in Figure 3.
According to the requirements of the system, the tables of the database mainly include 20 tables, such as school information table, school enrollment table, student information table, user information table, professional information table, enrollment type table, menu and authority table used by the system. Enrollment management information system should generally include three basic links: information collection, information processing and information transmission [10]. The system software is mainly composed of five management modules: notice announcement, system management, enrollment setting, enrollment review and enrollment inquiry system, some of which are small modules operated independently.

The main function of notice and announcement module is to issue all kinds of notices and announcements to each enrollment college, which are maintained by the system administrator. The system administrator can issue announcements and manage the announcements. The system management module mainly manages the system information, including six sub modules: role management, user management, school management, professional database management, enrollment control and enrollment instructions [11]. The main function of the role management module is to set different user roles according to different needs, maintained by the system administrator, set different roles according to the system needs, and give corresponding system management rights. The main function of the user management module is to set up and manage the users of the system, which is maintained by the system administrator. Users can be added, modified, deleted and viewed; each user should select the corresponding role to obtain certain system management authority [12]. The main function of the school management module is to manage the enrollment institutions managed by the system, which can be added, modified, deleted and viewed by the system administrator. The main function of the specialty library management module is to manage the enrollment specialty of the system, which is mainly maintained by the administrators of various colleges and universities. You can view the specialty and export it to excel file. The main function of the enrollment control module is to realize the initialization of enrollment data, the node control of specialty setting and student enrollment. It is maintained by the system administrator, it can update the specialty database and place name database, set the year of enrollment, and control specialty setting and student enrollment. The main function of the registration notice management module is to input and release the registration notice.
3.3 Optimization result of algorithm function
On the 50-dimensional function optimization, the test results are shown in Figure 4 (a). When the optimization function is 100 dimensions, the test results are shown in Figure 4 (b).

![Figure 4. Optimization result of algorithm function](image)

Taking the relative potential energy of an individual as the height of a rectangular region, the higher the fitness, the higher the relative potential energy, and the greater the probability of the optimal solution appearing in the region. When the quantum chromosome performs mutation operation, the information of contemporary excellent individuals is added to guide the mutation process, which can avoid falling into local optimal solution. The self-learning operator uses a small-scale quantum evolutionary algorithm to realize the self-learning process of the individual, learning the contemporary excellent individual within a given search radius, in order to obtain a better solution. Experimental results show that quantum evolution has superior performance in function optimization.

4. Conclusion
The system construction method of entity framework set, work unit mode, resource base mode and hierarchical architecture of the independent enrollment management system based on quantum evolution algorithm is proposed in this paper. The test results show that the method ensures the efficiency of system development, system quality and code readability. At the same time, the system online reduces the work pressure of the staff, it avoids the mistakes caused by manual operation, and the system has the characteristics of easy to use, powerful function, strong expansibility, etc. it meets the needs of independent enrollment and management, and has a certain universality and good practical value.

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