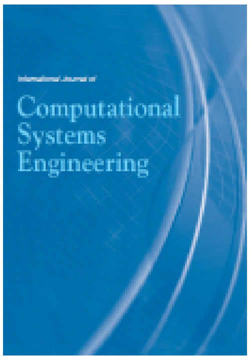

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Research on an online teaching system for ethnic music courses incorporating fuzzy control and CRP algorithms

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Abstract: With the continuous development of intelligent teaching, ethnic music teaching in colleges and universities began to try to use the online and offline teaching mode. However, with the continuous improvement of teaching requirements, the traditional teaching system gradually appeared an unsatisfactory state in the use of resources. Therefore, how to effectively improve the use of online teaching resources is the key to improve teaching quality. The emergence of cloud computing has solved the current problem of wasted network resources. In order to achieve resource optimisation and stability for online teaching of ethnic music courses, the study proposes a design scheme for an online teaching system incorporating fuzzy control and CRP algorithms. Firstly, the CRP algorithm is used to achieve resource scheduling, secondly, adaptive fuzzy control is used to enhance computational stability by, and finally, the two algorithms are combined to build an online teaching platform for ethnic music courses.

Keywords: adaptive fuzzy control; CRP; ethnic music; online teaching.

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1 Introduction

With the continuous development of information technology, the emergence of cloud computing has provided the direction of development for a number of fields. In the current education model, offline teaching courses are no longer able to meet the learning needs of students, so the design of an online teaching platform based on cloud computing is gradually appearing in people's view (Kiili et al., 2021). The design of the teaching platform is an important result of the application of cloud computing technology, which enables the use of cloud computing technology to realise cloud services for teaching resources, helping teachers and students to achieve close contact with each other through the online environment, which on the one hand can enhance students' interest in learning, and on the other hand can help teachers better understand students' learning situation (Hussain et al., 2018; Wei et al., 2018). At present, the CRP algorithm is often used in the design of online teaching platforms to achieve optimal scheduling of teaching resources, but the instability of the CRP algorithm has hindered the development of online teaching platforms to a certain extent. In response to the instability of the algorithm, some studies have proposed that fuzzy control can be used to solve the problem, using the dynamic adjustment of the fuzzy control algorithm to improve the stability of the algorithm calculation (Ha et al., 2021). This study takes folk music teaching as the research object, and constructs an online teaching system that integrates fuzzy control and CRP algorithm for folk music courses. The fuzzy control algorithm is used to improve the ability of CRP algorithm in resource acquisition, including improving the load balancing ability in CRP resource acquisition, as well as the scheduling ability of the algorithm in resource allocation. Aiming at the relatively large music teaching resources, using fuzzy algorithm to optimise the CRP algorithm can more effectively improve the online teaching system. On the one hand, it can improve the national music teaching ability of colleges and universities, on the other hand, it can provide theoretical support for the development of online teaching and cloud computing technology, and at the same time, it can also provide ideas for the inheritance of China's traditional culture.

There are two innovations in the research. The first is to propose an online teaching system design scheme combining intelligent algorithms for ethnic music teaching. The second point is to improve the teaching stability of online teaching platform by introducing CRP algorithm to obtain teaching resources, and using fuzzy control to improve the stability of CRP algorithm.

2 Related works

With the continuous development of information technology, in the field of education, course teaching has gradually started to develop from offline teaching to online and offline collaborative education, and in online education, the establishment of a teaching system is the key to ensure that teaching is carried out properly. Xiao et al. (2020) established a web-based teaching platform by combining DingTalk, WeChat and the Learning@ZJUWeb website, and through the established web-based teaching platform. In order to improve the quality of teaching in the nursing profession, Smith and Kennedy (2020) proposed a redesign of an online course on evidence-based practice, combining online virtual clinical scenarios and analysing data on students' use of information and learning processes, individual assignments and reduced psychological stress. Wang et al. (2020) proposed a laboratory manipulation platform that supports learning behaviour analysis, which enables rapid feedback through a smooth learning curve to quickly capture students' manipulation skills based on their learning behaviour. In the tests, the platform was shown to be effective in scaling to a large number of students and improving teaching effectiveness based on student behaviour. Sinitò et al. (2020) proposed a virtual learning platform for understanding and learning about mineralogy and petrography based on pedagogical ideas, in which users can observe rocks and minerals through online virtual exploration, in a museum knowledge dissemination application, the research proposed the platform can effectively help in the dissemination of scientific knowledge. Lebdai et al. (2020) proposed an immersive virtual patient simulation based on the MedicActiv platform in order to improve the academic performance of medical students by simulating virtual cases through the platform to fill in the practical operations in traditional university education. The results show that students who participated in the platform had more significant gains in performance.

With the development of information technology, the emergence of cloud computing has provided technical support in several social fields. Due to the importance of cloud computing in social development, a large number of scholars have conducted in-depth discussions. Sreenu and Malempati (2019) believe that the optimisation of computing resources in cloud computing needs to be reasonably scheduled, so they proposed a multi-objective task scheduling method based on the fractional grey wolf optimisation algorithm, which can effectively reduce energy consumption as well as improving resource utilisation. In comparison experiments, it is shown that the proposed algorithm is more practical compared to other scheduling algorithms. Shu et al. (2021) argue that virtualisation technology is highly utilised in resources while its randomness and load imbalance hinders the optimisation of relevant cloud computing technologies, so an optimisation algorithm based on peak energy consumption task scheduling is proposed, which can study the strong agile corresponding optimisation model, and the results show that the algorithm can improve the throughput of cloud computing systems. Li et al. (2014) address the problems in big data scheduling, introduce customisable services, divide resource scheduling into macro workflow scheduling and micro workflow scheduling for cloud users, and customise service policies for different types of workflows, and it is shown in the results that the method proposed in the study has a high execution success rate. Delling et al. (2019) analyse the road network customisable path planning, arguing that routing engines in road networks should provide performance guarantees for users in cloud services, and that resource scheduling and path planning need to show a fast enough response when users access data. Djellali et al. (2021) propose a comparative experiment to address the problem of data clustering in cloud computing, analysing the differences between fuzzy clustering and adaptive resonance, and use this to propose an initialisation-based fuzzy adaptive resonance theory with high accuracy in clustering cloud computing datasets.

In summary, under the influence of the new epidemic, online teaching is gaining more and more attention in the education sector, and research on online teaching platforms is increasing. In the design of teaching platforms, cloud computing is one of the technical priorities, but it can be seen from current research that there is still relatively little technical research on teaching platforms and cloud computing, and that the existing resource scheduling problem has not been significantly improved for cloud computing. This research incorporates fuzzy control and CRP algorithms to achieve teaching resource scheduling and validates its effectiveness with online teaching of ethnic music.

3 Design of a teaching platform incorporating adaptive fuzzy control and CRP algorithms

3.1 Strategies for providing teaching resources based on the CRP algorithm

The core idea of building an online teaching system is the rational use of cloud computing, which provides services to users by virtualising computing resources in data centres (Sydow et al., 2019). In order to design an online teaching system for ethnic music courses, the study first proposes a teaching resource provisioning strategy based on the CRP algorithm. The framework diagram of the teaching resource provisioning strategy under cloud computing is shown in Figure 1.

Figure 1 Strategic framework for teaching resource provision (see online version for colours)

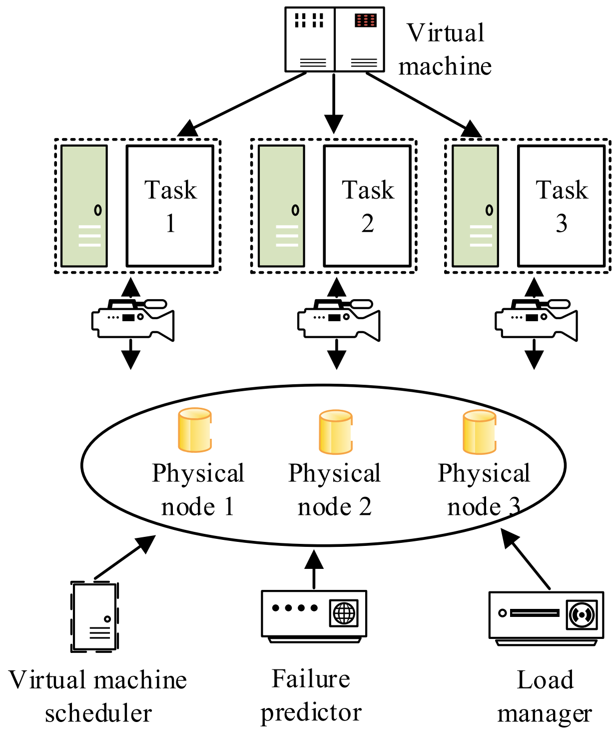


Figure 1 shows that in the resource provisioning strategy under cloud computing, a virtual machine is used to split the work task into multiple executable subtasks. The split subtasks are then assigned to the client operating system, where they are analysed by the virtual machine monitor, which is also used to select the appropriate computing resources. In addition to monitoring the subtasks, the VM monitor also monitors and manages the physical resources to ensure that the tasks to be executed are well encapsulated.

Existing resource provisioning strategies include random selection strategy, first matching selection strategy and reliability-based best selection strategy, all three strategies have shown more significant resource provisioning effects in applications (Jahantigh et al., 2020). However, the three policies do not take into account the cost factor when calculating resources, so a resource provisioning policy based on the CRP algorithm is proposed. The core idea of the CPR algorithm is to ensure load balancing of resources in resource provisioning, so that the appropriate physical node is selected at the time of execution of each character, and the current performance state of the selected physical node needs to be taken into account (Singhal and Singhal, 2021). The physical nodes are classified into nodes that can complete the task and nodes that cannot complete the task according to the deadline of the task as it proceeds, and the physical nodes that can complete the task can be expressed as shown in equation (1).

$$c_j(t_0) \bullet (d_0 - t_0) \geq w_i(t_0), \quad d_i \leq t_0 + \delta_j(t_0) \tag{1}$$

In equation (1), $c_j(t_0)$ represents the computational capacity of the physical node at the time of t_0; d_0 represents the cut-off time; $w_i(t_0)$ represents the remaining load after completing the task at the time of t_0; and $\delta_j(t_0)$ represents the failure prediction time after the time of t_0 under the failure predictor. The nodes that are unable to complete the task can be represented as shown in equation (2).

$$\begin{aligned} & c_j(t_0) \bullet \delta_j + c_k(t_0 + \delta_j + \tau) \bullet (d_0 - t_0 - \delta_j) \geq w_i(t_0), \\ & d_i \geq t_0 + \delta_j(t_0) \end{aligned} \tag{2}$$

In equation (2), τ denotes the migration overhead incurred by the virtual machine in the migration computation; $c_k(t_0 + \delta_j + \tau)$ denotes the computational capacity of physical node k considering t_0 time, failure prediction time and migration overhead. In the process of resource provisioning according to the CRP algorithm, it is first necessary to calculate the reliability of physical nodes according to the failure predictor, and determine whether they can participate in the resource provisioning process by reliability prediction, grouped according to the reliability status of task nodes, as shown in equation (3).

$$\begin{cases} G_1 = \{ n_j \, | t_0 + \delta_j(t_0) | \geq d_i \} \\ G_1 = \{ n_j \, | t_0 + \delta_j(t_0) | < d_i \} \end{cases} \tag{3}$$

In equation (3), G_1 indicates the reliability physical node grouping; G_1 indicates the unreliability physical node grouping; and n indicates the number of physical nodes. When the reliability grouping is completed, the appropriate physical nodes are selected based on the reliability of the physical nodes as well as the unit cost, and when the reliable physical nodes are those that can complete the task, equation (4) is used to select the physical nodes.

$$\begin{aligned} CRP = {} & \alpha \frac{c_j(t_0) - \dfrac{w_i(t_0)}{d_i - t_0}}{\dfrac{w_i(t_0)}{d_i - t_0}} + \beta \frac{\delta_j(t_0) - d_i(t_0) + t_0}{d_i(t_0) - t_0} \\ & + \gamma \bullet c_i(t_0) \bullet p_i(t_0) \end{aligned} \tag{4}$$

In equation (4), α, β and γ all represent weights and the sum of the three is 1. In equation (4), the first term of the sum of the three represents the computing power, the second term represents the reliability of the physical node and the third term represents the unit cost in performing the task. The overall benefit of the policy in resource provision is then calculated, as shown in equation (5).

$$rb = \frac{1}{CRP} \tag{5}$$

Equation (5) shows that as the CRP factor increases, the gain value of the algorithm decreases. For unreliable physical nodes, equation (6) is satisfied when they are unable to complete their tasks.

$$CRP_1 = \lambda \frac{c_j(t_0) - \frac{w_i(t_0)}{d_i - t_0}}{\frac{w_i(t_0)}{d_i - t_0}} + (1-\lambda) \bullet c_j(t_0) \bullet p_j(t_0) \tag{6}$$

In equation (6), $p_j(t_0)$ denotes the price of the resource provision in the cloud at the moment of t_0, and the policy decision is made under equation (6), along with the selection of a migration node at the next moment of t_0, which is based on the selection shown in equation (7).

$$\begin{aligned} CRP_2 = {} & \alpha \frac{c_j(t_0) - \frac{w_i(t_0) - c_j(t_0) \bullet \delta_j}{d_i(t_0) - t_0 - \delta_j - \tau}}{\frac{w_i(t_0) - c_j(t_0) \bullet \delta_j}{d_i(t_0) - t_0 - \delta_j - \tau}} \\ & + \frac{\delta_k(t_1) - d_i(t_0) + t_0 + \delta_j + \tau}{d_i(t_0) - t_0 - \delta_j - \tau} + \gamma \bullet c_k(t_1) \bullet p_k(t_1) \end{aligned} \tag{7}$$

Finally, the value of the combined policy benefit resulting from the selection of the appropriate task node in the resource provisioning policy can be derived, as shown in equation (8).

$$rb = \frac{1}{CRP_1 + CRP_2} \tag{8}$$

The CRP algorithm is used to implement computational resource provisioning, taking into account the computational capacity and reliability of the resource department, and the policy benefits generated by the task nodes are analysed according to their reliability, as a way of reducing the task costs incurred in user requests.

3.2 Design of CRP algorithm based on fuzzy control

Computing resource provisioning based on CRP algorithm can effectively handle load balancing of virtualised resources, however, the traditional CRP algorithm generates the possibility of overflow of user cloud requests during the working process, which also leads to the degradation of the quality of some user cloud requests in acquiring cloud resources (Ai et al., 2021; Macias-Bobadilla et al., 2020). Therefore, in order to solve the above problems, fuzzification of cloud computing service resource provisioning is proposed in the study, i.e., fuzzy control is introduced to optimise the CRP algorithm. In order to ensure that the cloud computing service resources have a high fuzzification effect, the study uses indirect-type adaptive fuzzy control as the algorithm basis for the CRP algorithm optimisation. The indirect type fuzzy control contains several fuzzy systems, among which the expression of the nonlinear controllable canonical system is shown in equation (9).

$$\begin{cases} x^{(n)} = f\left(x, x^1, \ldots, x^{(n-1)}\right) + g\left(x, x^1, \ldots, x^{(n-1)}\right)u \\ y = x \end{cases} \tag{9}$$

In equation (9), $f(x)$ and $g(x)$ both represent unknown continuous functions; x represents the input to the fuzzy system; y represents the output of the fuzzy system; u represents the current operating condition of the system; and n represents the amount of data in the system. The ideal fuzzy controller is used so that the output can always track the desired trajectory, as shown in equation (10).

$$u(t) = \frac{1}{\hat{g}(x)}\left(-\hat{f}(x) + y_m^n\right) \tag{10}$$

In equation (10), y_m represents the desired trajectory; $\hat{g}(x)$ and $\hat{f}(x)$ both represent the fuzzy system interest. Since $\hat{g}(x)$ is a fuzzy system, its value will change continuously throughout the online operation and gradually close to the actual value. The Lyapunov function is then defined to determine the stability of the fuzzy control system, as shown in equation (11).

$$\begin{aligned} V = {} & \frac{1}{2}e^T Pe + \frac{1}{2\gamma_1}\left(\theta_f - \theta_f^*\right)^T \left(\theta_f - \theta_f^*\right) \\ & + \frac{1}{2\gamma_1}\left(\theta_g - \theta_g^*\right)^T \left(\theta_g - \theta_g^*\right) \end{aligned} \tag{11}$$

In equation (11), θ_f denotes the variable parameters in the fuzzy system $\hat{f}(x)$; θ_g denotes the variable parameters in the fuzzy system $\hat{g}(x)$; γ denotes the constant; e denotes the tracking error; and P denotes the positive definite matrix, which is $n * n$.

$$-Q = \Lambda_e^T S + S\Lambda_e \tag{12}$$

In equation (12), Q denotes any $n \times n$ positive definite matrix. Equation (13) is obtained by derivation.

$$\dot{V} = -\frac{1}{2}e^T Qe + e^T Pb\omega \tag{13}$$

In equation (13), b represents the minimum approximation error. When the minimum approximation error is sufficiently small, $\dot{V} \leq 0$ can be achieved.

The main way of fuzzing is by collecting the performance metrics of the computing resources in the cloud platform at regular intervals and quantifying the performance metrics one by one, as shown in equation (14).

$$per = 1 - \left(I_i W_i + CW_c + MW_m\right) \tag{14}$$

In equation (14), i denotes the number of parameters; W_c denotes the CPU underutilisation; W_m denotes the memory underutilisation; W_i denotes the other metrics underutilisation in the cloud platform; I_i denotes the quantified parameters of other metrics underutilisation, whose values vary with the number of parameters; C and M denote the quantified metrics, whose values belong to [0, 1], and in the cloud computing, the quantified metrics are assigned with different values for different nodes' demands. There is a certain connection between CPU unutilisation, memory unutilisation and other metrics unutilisation, which can be expressed as equation (15).

$$W_i + W_c + W_m = 1 \tag{15}$$

Equation (15) shows that the sum between the three unutilised rates is 1, indicating that the study uses the three unutilised rates in the ideal state for the experimental analysis. The CRP algorithm under fuzzy control is not only capable of optimising the scheduling of cloud computing resources, it is also capable of ensuring its computational stability under fuzzy control, and its algorithmic flow is shown in Figure 2.

Figure 2 CRP algorithm flow under fuzzy control

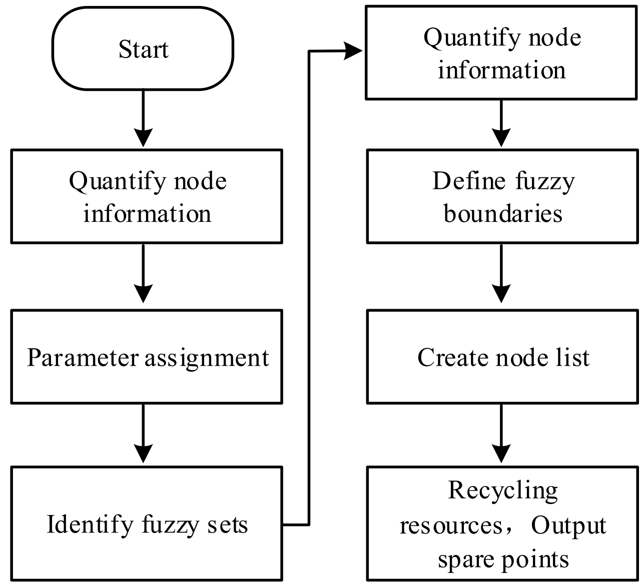


Figure 2 shows that the adaptive fuzzy controller is used to firstly quantify the node information and secondly to assign parameters based on the quantisation criteria required for the node. After the parameters have been assigned, the node performance is identified as a fuzzy set and the boundary conditions for fuzzy control are defined, thus creating a list of nodes. Finally, the CRP algorithm is used to recover resources, optimise the scheduling of resources and remove vacant nodes.

3.3 Design of an ethnic music teaching platform with fusion algorithms

The teaching of folk music courses is a key subject currently offered in China in order to promote cultural heritage. With the rapid development of information technology, the emergence of online teaching mode provides new ideas for the teaching and heritage of folk music (Wu et al., 2020). The design of the platform is based on cloud computing. In the design of the platform, a virtual machine is used as the basis for building the network environment, and the overall architecture of the virtual platform is shown in Figure 3.

Figure 3 Overall architecture of virtual platform (see online version for colours)

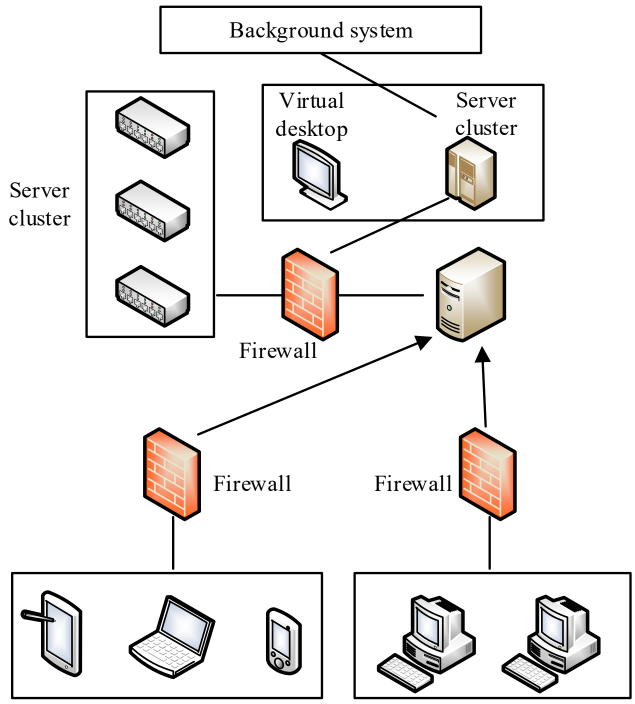


Figure 3 shows that the overall architecture of the virtual desktop platform consists of four structures: the backend application layer, the virtual desktop layer, the firewall and the terminal layer. The backend application layer consists of the backend system, whose main role is to ensure the normal operation of the platform. In the virtual desktop layer, there are virtual desktops, virtual desktop inspiration clusters, infrastructure server clusters and a firewall to ensure the normal operation of the virtual machines. In the firewall layer, there is an external firewall and a user-segment firewall. The different firewalls target different endpoint devices, with the external firewall protecting mobile devices and laptops, and the user segment firewall protecting PCs and thin clients. The overall architecture of the virtual teaching platform is used to design the system functions of the online teaching platform for ethnic music courses, as shown in Figure 4.

Figure 4 Online teaching platform system function (see online version for colours)

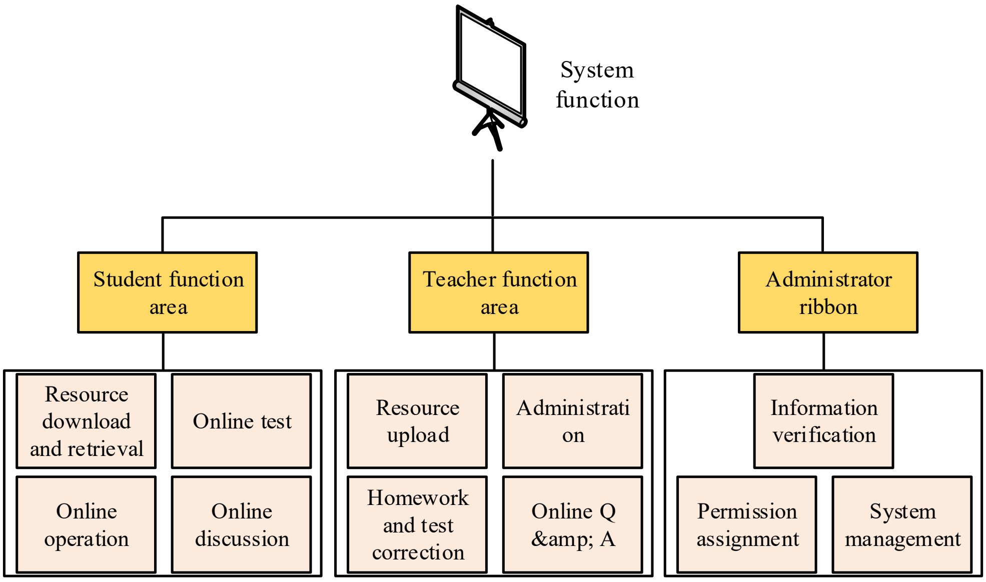


Figure 4 shows that the functions of the ethnomusicology teaching platform include student learning functions, teacher teaching functions, and administrator system management functions. In the student learning function, there are functions for students to search and download teaching resources, online homework and quizzes, and interactive discussions, all of which are interrelated to facilitate students to choose suitable teaching resources according to their own needs in ethnic music learning. The teacher teaching function includes resource creation and uploading, student management, homework and test correction, and online question and answer functions. The teacher teaching function enables teachers to keep track of students' progress in folk music learning in real time, and assess students' learning ability through their exam results, so as to develop a reasonable online teaching plan. The administrator management function includes user information audit function, user rights allocation function and system management function. The administrator management function is the key to ensure the normal operation of the teaching platform.

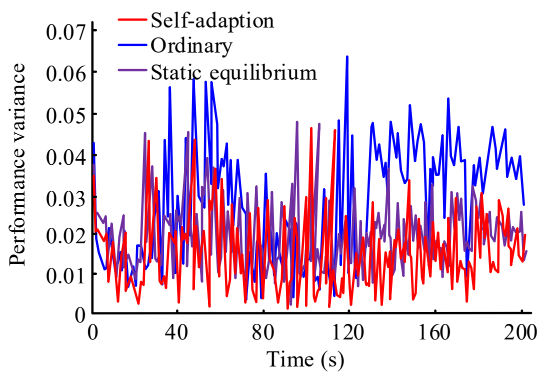
The study uses the CRP algorithm under fuzzy control to build a resource pool for teaching ethnic music online courses, and the resource pool is created in six steps. Firstly, the virtual platform sends a request to the virtual management centre to obtain virtual information, secondly the desktop information is generated according to the data from the virtual management centre, then the virtual management centre responds to the request from the virtual platform by sending relevant information to it. Thereafter the request to create a resource pool is sent to the virtual management centre, then the virtual platform sends the created virtual machine information to the management centre, and finally the virtual machine management platform returns to the management centre.

4 Data analysis

4.1 Algorithm performance testing and analysis

The adaptive fuzzy control algorithm was used in the study to optimise the CRP algorithm, so in order to understand the stability of the adaptive fuzzy control algorithm in optimisation, a comparison experiment was first set up to analyse the performance variance of the adaptive algorithm during operation. Three web servers were selected for the experiment and the performance variance of the servers was calculated as shown in Figure 5.

Figure 5 Server performance variance (see online version for colours)



As can be seen in Figure 5, the ordinary fuzzy control algorithm, the static load balancing algorithm and the adaptive fuzzy control algorithm were chosen for the performance variance comparison of the fuzzy algorithms. The results show that the server performance variance under ordinary fuzzy control is stable at around 0.03 after 100 s of experimentation, and the performance variance of the service fluctuates more steadily. The variance of the curve for the normal control algorithm shows that although the algorithm is more stable, the variance value after stabilisation is significantly higher than the variance value

100 s before the test, indicating that the normal fuzzy control algorithm has a deviation condition. The variance of the server performance under the adaptive fuzzy control algorithm is known to stabilise at around 0.015 as the experiment progresses, and it can be seen that with adaptive control, the variance of the fuzzy control algorithm is less variable and has a more balanced performance variance in the long-term test. Comparing the performance variance of the adaptive fuzzy control algorithm with that of the static load balancing algorithm, it can be seen that the difference in performance variance between the two is not significant. The adaptive fuzzy control algorithm is therefore more stable and has lower performance variance than the normal fuzzy control algorithm, and also shows more stable operation than the static load balancing algorithm. The adaptive control algorithm was used to optimise the performance of the CRP algorithm, and the effectiveness of the algorithm was reflected by evaluating the operating state of the algorithm, as shown in Figure 6.

Figure 6(a) shows a comparison of the computing times of different algorithms, with the traditional CRP algorithm, Rand algorithm and BF algorithm as the comparison algorithms for testing and comparison. From Figure 6(a), it can be seen that as the number of concurrent users continues to increase, several algorithms exhibit increasing computing times. Figure 6(b) shows the change in the number of nodes allocated to each algorithm. The number also increases continuously. The number of nodes allocated by the optimised CRP algorithm proposed in the study reaches 221 after the number of concurrent users reaches 100, while the final number of nodes allocated by the better CRP algorithm among the other three algorithms is only 134. The above results show that the optimised CRP algorithm proposed by the research has a lower operation time compared with the algorithm proposed by the existing research, so it can obtain the calculation results in a shorter time and improve the convergence speed of the algorithm. In addition, the results show that the number of nodes allocated by the optimised CRP algorithm is more, because the fuzzy control algorithm is used in the study to improve its stability. Therefore, the optimised CRP algorithm can keep stable when a large number of nodes are allocated. Finally, the reliability gains of multiple algorithms in the computation process were analysed. To ensure the accuracy of the experiments, the study conducted ten experiments and the results are shown in Figure 7.

As can be seen in Figure 7, after ten sets of experiments, there is a significant difference in the strategy gains obtained during the calculation of the different algorithms. However, from the comparison of several algorithms it can still be learned that the optimised CRP algorithm proposed in the study has the highest gain value, with the highest gain value of 587 over ten experiments. The lowest gain value is the Rand algorithm, with the highest gain value of only 462 over ten experiments. The above results show that the CRP algorithm optimised by the fuzzy control algorithm not only has high stability, but also can significantly improve the income of the algorithm under the influence of high stability.

4.2 Ethnic music teaching practice in school

The learning of folk music included both folk music singing and folk instrument playing. In folk music singing, both traditional folk repertoire and modern folk songs were included, and folk instrument playing, only suona, erhu, pipa and flute were included in the study for teaching experimental analysis. The teaching platform was set to teach online for 12 months, and the changes in the number of teaching resources downloaded for different subjects and the changes in students' performance in the quizzes over the 12-month period were analysed, as shown in Figure 8.

Figure 6 Comparative analysis of the running state of the algorithm, (a) comparison of operation time (b) node allocation comparison (see online version for colours)

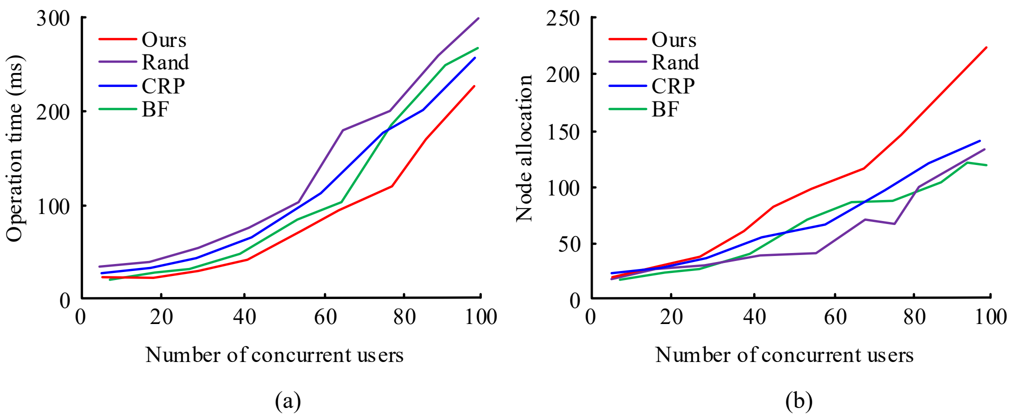


Figure 7 Algorithm reliability benefit (see online version for colours)

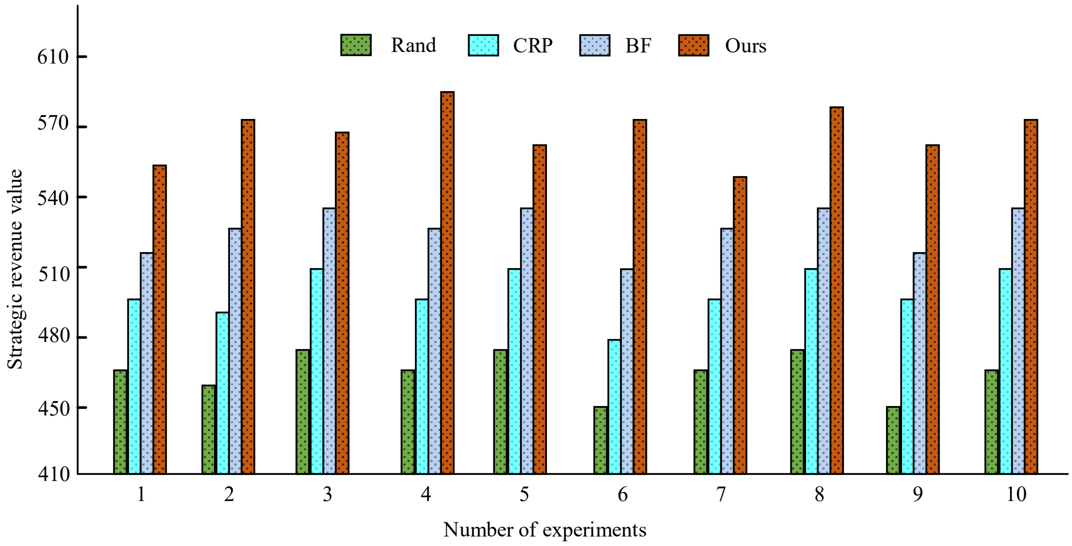
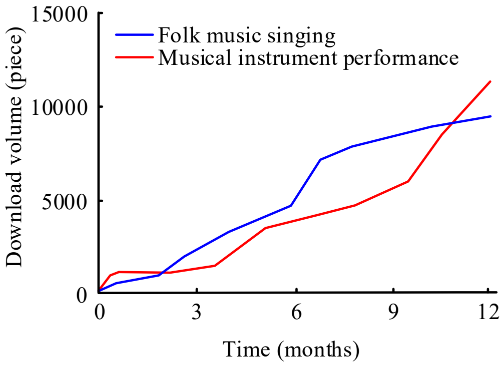
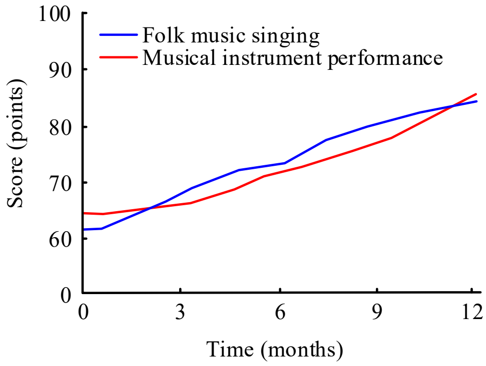


Figure 8 Students' online learning, (a) download volume change (b) score change (see online version for colours)

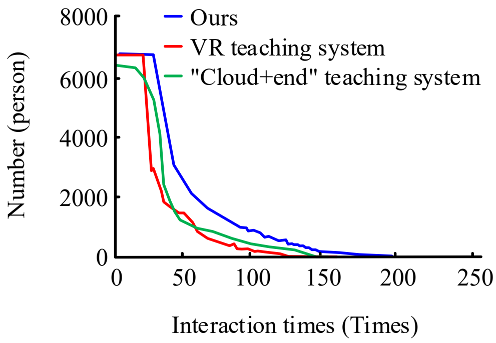


(a)

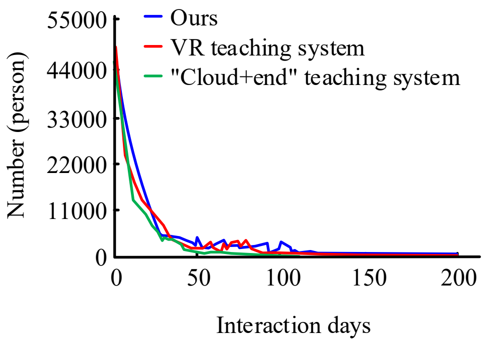


(b)

Figure 9 Online teaching interaction, (a) interaction times (b) interaction days (see online version for colours)



(a)

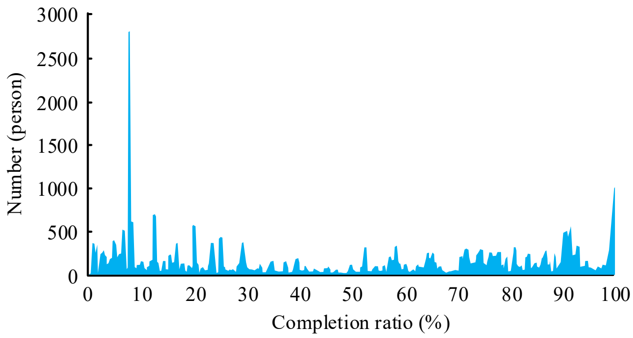


(b)

As can be seen in Figure 8, the change in the number of downloads of teaching resources can be found in the teaching platform, which shows an increasing trend for all ethnic teaching resources. From the combined changes in the curves, it can be found that in the online teaching of ethnic music courses, significantly more teaching resources were downloaded for ethnic instrument playing than for ethnic music singing. Figure 8(b) shows the change in average student performance over the 12 months of instruction, and the change in students' ethnic music online learning ability is assessed overall by analysing their ratings for ethnic music singing and their ratings for ethnic instrument playing. From the changes in the curves in Figure 8(b), it can be seen that the average student score in ethnic music singing eventually reached 87.64 and the average student score in ethnic instrument playing eventually reached 86.92. Secondly, it analyses the interactive changes between students and teachers in the online course teaching of different ethnic music, as shown in Figure 9.

Figure 9(a) shows the change in the number of interactions under the change in the number of interactions, and it can be seen that the number of interactions decreases as the number of interactions increases over the 12-month long online teaching practice. It can also be seen that compared with VR teaching and 'cloud + end' online teaching system, the number of student visits to the national music online teaching system proposed by the research has decreased more slowly. Therefore, it can be seen that the online teaching platform proposed by the research can attract more students' attention in application. Figure 9(b) shows the change in the number of interactions under the change in the number of interaction days. From the figure, it can be seen that as the number of interaction days keeps increasing, the number of interactions gradually decreases from 50,629 at the beginning to 1. Finally, the completion of assignments after browsing teaching resources in online learning was counted as a way to analyse the learning status of students in online learning. The 14,826 student users over the 12 months of online learning were used in the study and the differences in completion rates were calculated as shown in Figure 10.

Figure 10 Student learning and homework completion rate (see online version for colours)



As can be seen in Figure 10, the highest number of all students with a completion rate of 7.1% after studying the teaching resources was 2,759 students. The change in the completion rate of students' assignments shows that the number of students with a completion rate above 50% is high and the number of students with a 100% completion rate among all students reached 1,000. The above results show that after learning online teaching resources, most of the students were able to complete the online teaching resources, as well as completing the relevant assignments after class to consolidate their learning results.

5 Conclusions

The inheritance of national music is an important part of the current cultural development in China. Under the current social situation, it is worth thinking about how to use online teaching mode to improve the quality of national music teaching. Based on the online teaching of folk music courses, this paper proposes the optimisation of CRP algorithm based on fuzzy control to build an online teaching platform with high stability and efficient resource scheduling. The algorithm test shows that the adaptive fuzzy control algorithm selected in the study is more stable than the ordinary fuzzy algorithm, and its performance variance is only 0.015. The CRP algorithm optimised by adaptive fuzzy control shows better performance in the test. Its operation time finally reaches 237.63 ms, which is significantly lower than other comparison algorithms. At the same time, the number of nodes allocated to optimise CRP algorithm can finally reach 221, which is higher than other algorithms. This paper analyses the application effect of the folk music online teaching platform under the CRP algorithm of fuzzy control. The results show that the download amount of teaching resources in the platform is increasing, indicating that the learning interest of online learning students is increasing. At the same time, in the long-term online teaching, most students can participate in the homework function of the teaching platform. The above results show that the ethnic music online teaching platform proposed by the research has good operational stability and application effectiveness, and is of great significance to the inheritance of ethnic music and the development of cloud computing.

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