
# Convolutional Neural Network based Recommendation Algorithm of Instructional Resources Mechanism for Online Music Education

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**Abstract.** The forms of music curriculum resources are very diverse, and the broad Internet platform provides many valuable materials for the integration of music curriculum resources. As an important part of tertiary education informatization, online instructional resources play an increasingly important role in promoting learners and educators' knowledge construction, improving their practical ability and developing their advanced thinking ability. In this article, a recommendation algorithm of instructional resources in universities based on computer-aided technology and deep learning (DL) is proposed. Convolutional neural network (CNN) is integrated into the joint probability matrix decomposition model to fully mine the hidden information in existing instructional resources and instructional resources. The results show that after continuous training, the accuracy of proposed algorithm is significantly higher than that of the other two algorithms, reaching over 95%. Compared with information retrieval technology, the recommendation of instructional resources can better meet the individual needs of students. Therefore, it is feasible to apply the model to the recommendation of instructional resources mechanism, which can provide modern theoretical and technical support for the reform of music education mechanism.

**Keywords:** Music Education; Instructional Resources; Deep Learning; Computer Aided.
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## 1 INTRODUCTION

Adhering to the road of whole-person education in higher music education has a turning point, which not only deepens the though, but also explores the significant progress of music education practice [1]. The growth and integration of school-based music textbook resources has become an important method for schools to develop music education [2]. With the growth of IT, online learning has also undergone profound changes. The original knowledge presentation method, and

the digital resources are becoming more and more abundant, which also makes learners waste a lot of time in searching and selecting resources [3]. The forms of music curriculum resources are very diverse, and the broad Internet platform provides many valuable materials for the integration of music curriculum resources [4]. The changing process of textbooks from a single paper textbook to a new media textbook of "textbooks+digital resources" is also a process of constantly improving the degree of informatization of learning [5]. With the continuous improvement of informatization, the learning style has gradually changed from the traditional learning style to the informational and digital learning style.

It is difficult for learners to find suitable instructional resources among the massive instructional resources, which leads to problems such as learning lost and information overload. Composite textbooks add information technology means to the original paper textbooks, so that the paper textbooks are connected with instructional resources, and the paper and digital instructional resources are all presented in the hands of students. In this way, teachers can embed various forms of brackets such as situational brackets, explanatory brackets, example brackets and guide brackets into paper textbooks. Users type keywords into the search engine to query resources, and the search engine will return all the resources related to keywords, but it can't screen out the resources that meet users' needs. It takes users a long time to screen out resources. In this article, a recommendation algorithm of university instructional resources based on computer-aided technology and DL is proposed. CNN is integrated into the joint probability matrix decomposition model, and the implicit information in existing instructional resources is fully mined existing recommendation algorithm of instructional resources.

To select resources suitable for learners from massive data to realize personalized learning, traditional search engines can't meet the personalized requirements. The emergence of recommendation system provides an effective solution for personalization. Recommendation system doesn't need users to provide explicit needs, and it can mine users' potential interests through their historical behaviors. In this article, big data and IT are better applied to music education in universities, and the database of instructional resources is constructed to realize the effective integration and resource sharing of network resources. The research mainly includes the following innovations:

(1) This article combines computer-aided technology and DL to model and analyze user preferences, and constructs a personalized recommendation model for music education.

(2) This study designed and implemented the research experiment based on the knowledge base system of instructional resources and the prototype model of personalized resource recommendation, including the comparison experiment with the traditional recommendation algorithm. The results show that the instructional resource recommendation model in this article has higher recommendation accuracy and obviously improves the recommendation quality.

## 2 RELATED WORK

The use of computer assisted music practice can make up for the technical advantages that traditional teaching cannot achieve. This paper mainly discusses the computer aided piano teaching, harmony teaching and solfeggio teaching, and explores the practical value of practical software in the process of music practice. It can help teachers and students to engage in theoretical research, music classroom reform, music creation, integrate teaching resources through modern technical means, and redistribute and effectively use music teaching resources. Li [6] uses computer-assisted instruction to provide students with practical functions such as music score input, harmony analysis and music production. It is enough to meet the needs of music classroom teaching and music production. The following introduces the integration methods commonly used in our school's music classroom teaching software. In the past, colleges and universities used traditional teaching models to teach music courses with low efficiency. This has seriously stifled college students' interest and enthusiasm in music courses. Especially for students majored in music arrangement, it is undoubtedly an erasure of creative imagination. The integration of

computer music technology into modern music teaching mode is very helpful to stimulate students' creativity and enthusiasm for music. Mavromihales et al. [7] has improved students' understanding, memory and judgment of music theory, solfeggio and notation. The computer is powerful. From basic music theory, solfeggio, ear training to harmony, composition, musical form, orchestration, from vocal music to instrumental music and even dance, computer-assisted instruction can be used. Nam et al. [8] believes that it has the function of man-machine dialogue and two-way communication, which can help students concentrate. Learn music knowledge easily in the game, improve the aesthetic ability of music, and mobilize students' initiative and enthusiasm in the learning process. In order to meet the challenges of the era of knowledge economy, Su et al. [9] believes that we must focus on studying and solving the problem of how to cultivate students' innovative consciousness, innovative thinking and innovative ability. Zhang et al. [10] discusses the principle of processing MIDI data with CAL language, designs its application in teaching, and develops corresponding teaching programs. The application and effect of computer audio software in teaching are studied. The experimental design, experimental process and fuzzy evaluation of experimental data are introduced in detail. Compared with the traditional music teaching, the application effect of computer music software assisted teaching is studied.

Artificial intelligence technology can effectively help the construction and integration of instructional resources. As an outstanding tool, the recommendation system based on personalized recommendation technology recommends the most suitable and useful instructional resources for learners. After identifying learners' interests and preferences, the system intelligently recommends the required resources for learners, solving the problem of overload of digital resources, thus avoiding the trouble caused by selecting resources. In this article, the learner portrait model and instructional resource portrait model are established by combining computer-aided technology and DL. Based on the modeling of individual learners, the instructional resources are divided by knowledge points, so as to realize the personalized recommendation of instructional resources in universities.

## 3 METHODOLOGY

In the internet age, the network provides endless information. Students no longer only rely on teachers' explanations to obtain information, and teachers' traditional function of imparting knowledge is getting weaker and weaker. Therefore, it is need to change the image of information disseminators and presenters of good knowledge structure in the past. In the network education, students' dominant position is further strengthened. Under the network condition, students' learning is usually based on self-study, and this self-study is completed with the help of teachers, so learning guidance becomes an important work of teachers under the network condition. Individualized learning refers to finding and solving students' learning problems through comprehensive evaluation of specific students, customizing for learners, and helping them to learn effectively. The personalized recommendation module of instructional resources is mainly for student users. When the student users browse the homepage of personalized recommendation of instructional resources and the page of instructional resources respectively, the recommendation system will make different recommendations. Constructing an appropriate recognition model is the key to realize the learning mode based on CNN. On the premise that the general direction of overall student training remains the same, music teachers can formulate learning content that meets students' needs according to their actual situation and interest orientation, and learners can customize learning content that can promote their progress and growth according to their own learning goals. The model of instructional resources and the access process are shown in Figure 1.

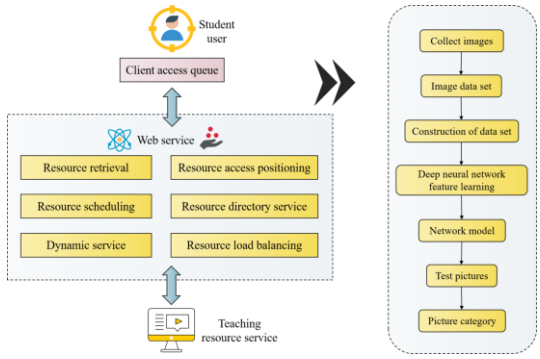



**Figure 1:** Music instructional resource model and access process.

In the internet age, the network provides endless information. Students no longer only rely on teachers' explanations to obtain information, and teachers' traditional function of imparting knowledge is getting weaker and weaker. Therefore, it is need to change the image of information disseminators and presenters of good knowledge structure in the past. In the network education, students' dominant position is further strengthened. Under the network condition, students' learning is usually based on self-study, and this self-study is completed with the help of teachers, so learning guidance becomes an important work of teachers under the network condition. The interest preference document of students' learning can be expressed as:

$$D=\{M,N\} \tag{1}$$

Where: $M$ represents short-term learning interest, and $N$ represents long-term learning interest. Due to the variety of learning interests, $M$ and $N$ are respectively represented as:

$$M=\{S_1,S_2,\ldots,S_n\} \tag{2}$$

$$N=\{L_1,L_2,\ldots,L_n\} \tag{3}$$

Students' interest preferences are expressed as follows:

$$U=\{S_1,S_2,\ldots,S_n,L_1,L_2,\ldots,L_n\} \tag{4}$$

For each $S_i$ and $L_j$, the category attribute variables $E_i$ and $E_j$ and the weight attribute variables $F_i$ and $F_j$ are introduced. Therefore, $S_i$, $L_j$ are expressed as:

$$S_i=\langle S_i,F_i,E_i\rangle, i=1,2,\ldots,m \tag{5}$$

$$L_i=\langle L_j,F_j,E_j\rangle, i=1,2,\ldots,n \tag{6}$$

Students' learning interest preference documents can be expressed in the form of a two-dimensional table:

$$D=\begin{Bmatrix} S_1 & S_2 & \ldots S_m & L_1 & L_2 & L_n \\ F_1 & F_2 & \ldots F_m & F_{m+1} & L_{m+2} & L_{m+n} \\ E_1 & E_2 & \ldots E_m & E_{m+1} & E_{m+2} & E_{m+n} \end{Bmatrix} \tag{7}$$

$S_m$ and $L_m$ are some attribute values of short-term learning interest and long-term learning interest, respectively; $E_{m+n}$ represents the resource category of track and field instructional resources corresponding to students' learning interest; Learning interest weight of vocabulary representing $F_{m+n}$ attribute value.

When the user browses the homepage, the recommendation system will make recommendations according to the user's browsing habits and the attributes of instructional resources. Compared with traditional learning methods, personalized learning pays more attention to student-centered, with a wider learning range, and encourages students to develop in a variety of ways. The logical structure of the instructional resource system with personalized recommendation function is shown in Figure 2.

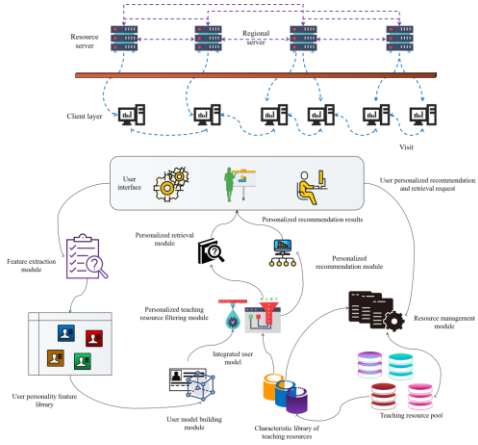



**Figure 2:** Logical structure of instructional resource system with personalized recommendation function.

Entering the internet age, students' access to information resources has become more and more diversified, and the massive study resources on the Internet almost provide vocational students with any resources they need. However, in the online world, many music study resources are repetitive and ineffective. Therefore, it is need for universities to lay emphasis on the effective screening of massive information resources on the network, and to build a specialized instructional resource bank.

The selection of network layers and the setting of network parameters are the key issues to be studied in the design process. Whether these two values are appropriate or not will have a direct impact on the accuracy of model testing. The model uses the $p$ -dimensional max-pooling operation to aggregate the local important information in the convolutional hidden layer sequence $h^c$ , thereby obtaining a global-level hidden layer sequence:

$$h^{cp} = \left\{h_1^{cp}, \ldots, h_{\lfloor (N+k-1)/p \rfloor}^{cp}\right\} \tag{8}$$

Among them, each hidden layer element is:

$$h_i^{cp} = \left[ \max \begin{bmatrix} h_{i-p+1,1}^c \\ \dots \\ h_{i,1}^c \end{bmatrix}, \dots, \max \begin{bmatrix} h_{i-p+1,d}^c \\ \dots \\ h_{i,d}^c \end{bmatrix} \right] \tag{9}$$

The model alternately uses multi-layer similar convolution-pooling operations, gradually learns the global semantic information at the sentence level, and finally obtains the sentence embedding vector.

Constructing characteristic difference evaluation function according to recommendation model:

$$\min F(x) = \sum_{i=1}^{3} W_i F_i \tag{10}$$

$$F_1 = \frac{\sum_{n=1}^{n} x_{mn} \left| S_{mn} - DI_{mn} \right|}{\sum_{n=1}^{N} x_{mn}} \tag{11}$$

$$F_2 = \frac{\sum_{k=1}^{k} \left| MF_{mk} - M_{mk} \right|}{k} \tag{12}$$

$$M_{mk} = \frac{Num2_{mk}}{\sum_{k=2}^{k} Num2_{mk}} \tag{13}$$

$$Q2 = X_{mn} MT_{mn} \tag{14}$$

$$F_3 = \frac{\sum_{k=1}^{k} \left| CF_{mk} - C_{mk} \right|}{k} \tag{15}$$

$$C_{mk} = \frac{Num3_{mk}}{\sum_{k=1}^{k} Num3_{mk}} \tag{16}$$

$$Q3_{mn} = X_{mn} CT_{mn} \tag{17}$$

The construction of university music study resource platform can effectively use information-based instructional methods to improve teachers' instructional efficiency, help students break through learning disorder, effectively improve learning efficiency, and finally improve the quality of education. For personalized instructional resource recommendation, it is essentially a process of matching learners' characteristics and instructional resource characteristics to find the minimum difference solution and then output the instructional resource sequence. In the process of image classification, the verification image is used to test the network model obtained in the training process. First, the picture should be converted into format, and then the model generated by training should be called to classify and recognize the picture, and the recognition effect should be tested.

## 4 RESULT ANALYSIS AND DISCUSSION

In the training process of the whole model, firstly, the formatted image data set is input into the network as the bottom data, verification data and test data according to the set proportion. The input image is convolved in the convolution layer to extract image features and generate multiple

feature maps. The human nervous system is very complex. In order to simulate the working process of neurons in the human visual nervous system, CNN model makes each output feature undergo the calculation of activation function and add an offset value before outputting the features of the image. For the construction method of instructional resource recommendation model based on computer-aided technology and DL in this article, results are shown in Table 1 and Figure 3.

| *Iterations* | *Improve CNN* | *Traditional CNN* | *CF* |
|---|---|---|---|
| 50 | 0.651 | 0.634 | 0.617 |
| 100 | 0.679 | 0.645 | 0.619 |
| 150 | 0.808 | 0.729 | 0.716 |
| 200 | 0.912 | 0.721 | 0.705 |
| 250 | 0.977 | 0.782 | 0.693 |
| 300 | 0.969 | 0.787 | 0.719 |

**Table 1:** Accuracy comparison of algorithms.

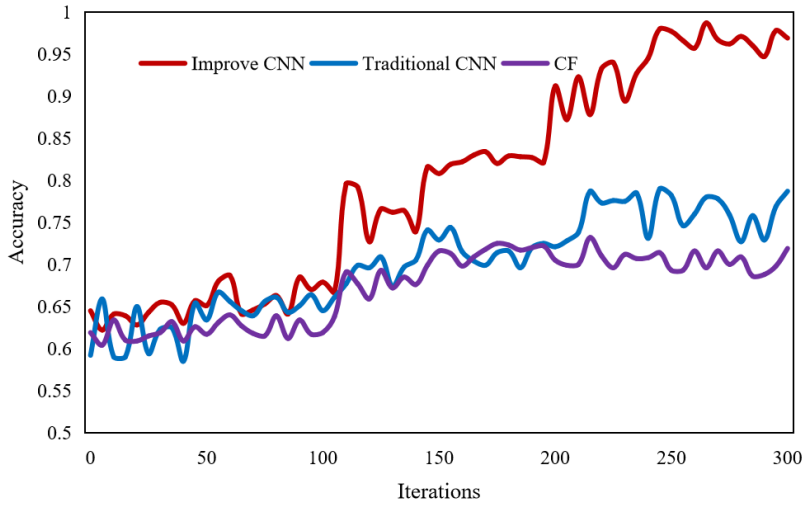



**Figure 3:** Comparison of algorithm accuracy.

As can be seen from Figure 3, although the instructional resource recommendation algorithm in this article has no obvious advantages operation, when the algorithm keeps running, the accuracy of proposed algorithm is significantly higher than that of the other two algorithms, reaching over 95%.

If the learning rate is too small, although the network can converge, it will greatly reduce the optimization speed and spend a lot of time. Therefore, it is very important to find a suitable time factor for training the model. Figure 4 shows the change of accuracy when the time factor is between 0 and 1.

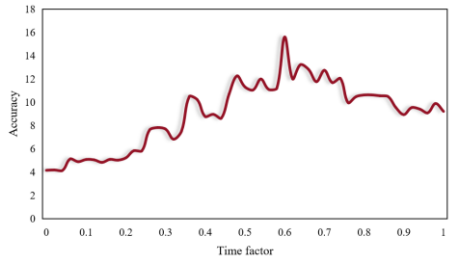



**Figure 4:** Relationship between time factor and accuracy.

It is not difficult to find that the accuracy time factor. When the time factor is 0.7, the accuracy reaches the peak, so the best time factor is 0.7.

Table 2 and Figure 5 show the comparison of recommendation recall between the proposed algorithm and the traditional algorithm.

| Iterations | Improve CNN | Traditional CNN | CF |
|---|---|---|---|
| 50 | 0.612 | 0.601 | 0.621 |
| 100 | 0.673 | 0.684 | 0.644 |
| 150 | 0.67 | 0.706 | 0.633 |
| 200 | 0.775 | 0.785 | 0.7 |
| 250 | 0.768 | 0.735 | 0.702 |
| 300 | 0.859 | 0.783 | 0.732 |

**Table 2:** Recall comparison of algorithms.

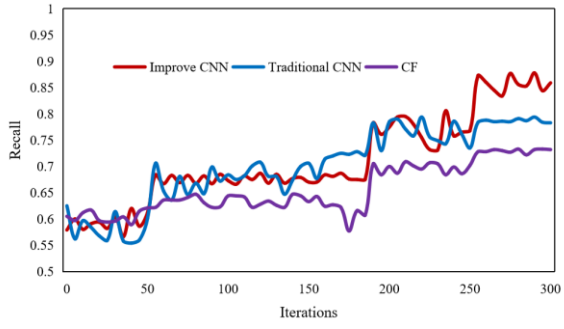



**Figure 5:** Comparison of recall of algorithms.

It can be seen that the recall on the whole increases with the continuous iteration of the algorithm, and the recommendation effect of proposed algorithm is better than that of the other two traditional recommendation algorithms. Compare MAE algorithm with traditional algorithm, as shown in Table 3 and Figure 6.

| Iterations | Improve CNN | Traditional CNN | CF |
|---|---|---|---|
| 50 | 0.59 | 0.82 | 0.74 |
| 100 | 0.54 | 0.8 | 0.78 |
| 150 | 0.49 | 0.68 | 0.64 |
| 200 | 0.38 | 0.68 | 0.71 |
| 250 | 0.27 | 0.7 | 0.65 |
| 300 | 0.52 | 0.65 | 0.59 |

**Table 3:** MAE comparison of algorithms.

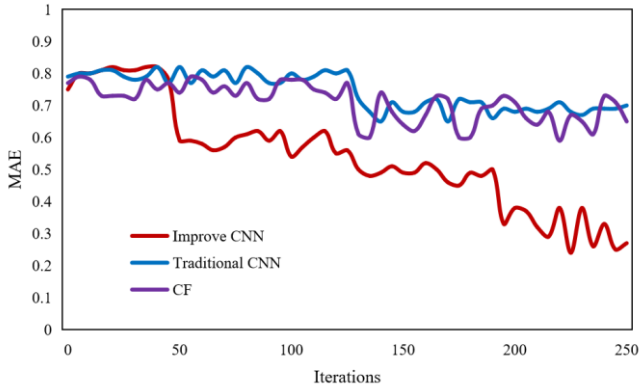
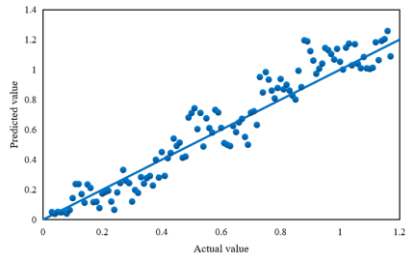



**Figure 6:** MAE comparison of algorithms.

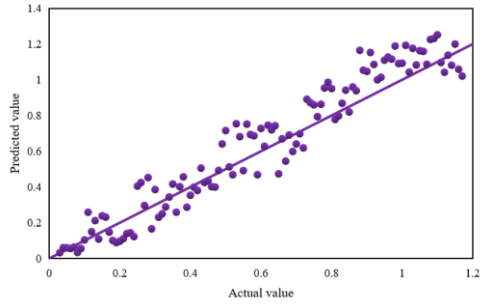
Overall, with the increasing quantity of users, the instructional resources recommendation algorithm proposed in this article has smaller error and more accurate recommendation results than the traditional CF.

CNN model uses loss function to describe the parameters to be optimized and the effect of the model. Through the loss function, the gap between the actual output result and the expected result is determined, and then through the back propagation algorithm, the parameters of the network are constantly adjusted. When the value of the loss function is large, it means that the network parameters have not reached the optimum yet, and training is needed again. Then, go back to the beginning of training and learn the features of the input picture again. When the value of the loss function is small and the network reaches the convergence state, it can be considered that the current state of the network parameters is the optimal state, and then it is decided whether to end the model training process. Scatter charts of predicted values and actual values tested by different algorithms are shown in Figure 7.

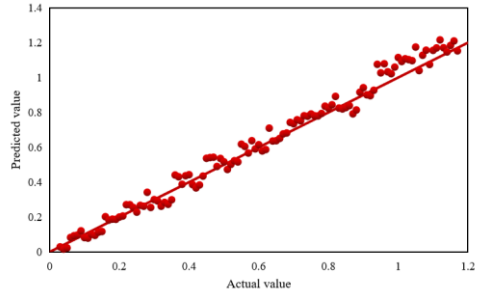
The personalized recommendation model of instructional resources based on computer-aided technology and DL is superior to the traditional CF in both accuracy and efficiency. The forward propagation of information and the backward propagation of errors are two parts of the training process of CNN. It is the main work of the training process to constantly optimize the parameters of the network model through iterative operation. When there are too many layers in the network, because the quantity of pictures is limited, and the parameters of the network with too many layers are more than the quantity of picture data, there will be over-fitting. At this time, the loss function is negative, which indicates that the network structure design is wrong.




(a) Traditional CNN.




(b) CF.




(c) Improve CNN.

**Figure 7:** Scatter diagram of predicted value and actual value of different algorithms.

With the popularization of network resources, learners can be provided with rich instructional contents, and then their learning thinking can jump out of the limitations of the traditional instructional system, so as to provide a platform for practical teaching and improve the instructional efficiency of music courses. In terms of educational decision-making, educational big data helps decision-makers to have a clearer understanding of the current situation and timely grasp more comprehensive and valuable information, so as to formulate, implement and adjust specific educational policies.

## 5 CONCLUSIONS

Wisdom education and online teaching can conveniently provide instructional resources for learners and help them learn and master knowledge points effectively. However, a large quantity of instructional resources is published on the Internet, and the quantity of instructional resources is increasing rapidly. It is difficult for learners to find suitable instructional resources among the massive instructional resources, which leads to problems such as learning lost and information overload. In this article, a recommendation algorithm of university instructional resources based on computer-aided technology and DL is proposed. CNN is integrated into the joint probability matrix decomposition model, and the implicit information in existing instructional resources is fully mined to improve the accuracy of the existing recommendation algorithm of instructional resources. After continuous training, the accuracy of proposed algorithm is significantly higher than that of the other two algorithms, reaching over 95%. The forms of music curriculum resources are very diverse, and the broad Internet platform provides many valuable materials for the integration of music curriculum resources.

The experiment in this study uses test data, and the amount of data is not very large. If it is subsequently applied to the real teaching environment, the user scale and the quantity of instructional resources will be uncontrollable. How to make the recommendation system seamlessly connect to the real use environment is the focus of the next research.

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