Research on Music Assisted Teaching System Based on Artificial Intelligence Technology

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Abstract. With the advent of the information age, computer technology has been greatly developed, especially the development of Artificial Intelligence (AI). And with the passage of time, AI began to involve various fields, music education is no exception. In this paper, after a detailed understanding of some research results of AI on music assisted instruction system, we mainly analyze the students’ video, audio and other related information, and save it in the database. This paper first introduces the evaluation process by using AI technology. In fact, it is necessary to find out the relationship between the influencing factors and evaluation of music assisted teaching system. Neural network (NN) is actually a model proposed by simulating the way people think in the brain. It has no strict requirements for data distribution. In terms of nonlinear data processing method, robustness and dynamics, it is very suitable to be used as a model for evaluating music assisted instruction system. Then each factor is taken as the input parameter of the NN. According to the evaluation index of music teaching, a special modeling system is designed. With the help of technical personnel, we obtained the sample data of music performance and completed the neural training. The experimental results show that the development of AI technology has broken the original situation of traditional teaching, especially the application of music system and intelligent music software based on AI in music teaching.

Keywords: AI technology, music assisted teaching, assisted system, NN

1. Introduction
At the beginning, people just applied intelligent technology to music and formed a new kind of intelligent musical instrument [1]. This kind of teaching system can relearn the learning methods of various musical instruments, and can output the learning methods that people want and need anytime and anywhere [2]. In the process of using, teaching methods will change constantly. In addition, this
new technology is introduced into music teaching because of its small size and easy transplantation, and we call these instruments intelligent instruments. This kind of intelligent instrument can not only store more instrument timbres and how to use them, but also arrange various timbres and execute them in order according to some teaching instructions. This function is incomparable to other teaching methods [3-4].

Using AI technology to develop new teaching methods is the requirement of the times. The Ministry of education proposes that we should use modern educational technology to improve the current teaching level, require schools to strengthen the construction of intelligent teaching environment, and gradually increase the proportion of class hours through multimedia teaching methods [5]. In the current music teaching in Colleges and universities, we think about many ways to improve the quality of teaching, and finally we think that we can use AI to teach synchronously, because this method is simple and convenient, and AI can better solve the shortcomings of traditional teaching in the reform of music assisted teaching system and the development of the existing teaching mode, update the harmonious teaching concept, adjust the teaching content and methods, and gradually form The new music assisted teaching mode, in line with the development of the times to meet the needs of the contemporary [6-7].

Because of the unique advantages of AI, it has gradually penetrated into teaching. In the traditional education mode, there are many problems to be solved[8]. Based on the traditional music recording and analysis of timbre, we have developed a unique digital music teaching system by using modern AI based music skill training elements[9]. Because music teaching is not materialized, it is generally expressed in the form of singing, so the past teaching is very difficult, but the development of AI makes music teaching more convenient and intuitive. Therefore, in modern teaching, we can use AI and various digital signal converters on the computer to comprehensively process the audio information, and then carry out targeted teaching [10].

2. The establishment of NN algorithm and its optimization analysis

2.1 BP NN algorithm

The artificial NN system came out in the 1840s. In particular, the error back propagation training (BP network) can be close to any continuous function, and has strong nonlinear mapping capabilities. Moreover, network parameters can be set according to specific conditions, such as the number of intermediate layers, the number of processing units in each layer, and the learning coefficient of the network.

As mentioned above, because of the limited number of samples in the training set, this article only fine-tunes on the basis of the training set, so the correction rate cannot be too large. In this article, the initial correction rate of the model is 30%, and the correction rate increases by 80% every 2 cycles of training.

\[ I_t = I_{t0} \alpha^{\left\lfloor \frac{t}{2} \right\rfloor} \]  
(1)

In the formula: \( I_{t0} = 30\% \), \( \alpha = 0.2 \), \( t \) is the current number of training cycles; rounded down. The loss function is defined as cross entropy, and the formula is as follows

\[ L = \sum_{i=1}^{K} y_i \log y'_i \]  
(2)

Where: \( y \) and \( y' \)are the true label and predicted input of the picture, respectively; \( K = 6 \) is the number of categories. This paper uses the stochastic gradient descent algorithm with momentum as the optimizer, and each parameter update is

\[ \omega_{t+1} = \omega_t - I_t \nabla L(\omega_t) + \gamma (\omega_t - \omega_{t-1}) \]  
(3)
In the formula: $\gamma = 0.9$ is the momentum; $\nabla L(wl)$ is the loss function to derive the parameter $wl$. This is the result we finally got.

2.2 BP neuron

Like biological neurons, BP neurons also have the functions of weighting, summing, and transfer. Therefore, according to the analysis of the formula, the value of $S_j$ of the $i$-th neuron can be obtained:

$$S_j = \sum_{i=1}^{x} W_{ji} \cdot x_i + b_j = W_jX + b_k$$

Then the net input $S_j$ of node $j$ can be expressed as

$$S_j = \sum_{i=1}^{x} W_{ji} \cdot x_i = W_jX$$

After the static input $S_j$ passes through the transfer function $f(x)$, the output $y_j$ of the $j$th neuron can be obtained:

$$y_j = f(S_j) = f(\sum_{i=1}^{x} W_{ji} \cdot x_i) = F(W_jX)$$

In the formula, $f(x)$ is a monotonous ascending function, and it must be a bounded function, because the signal transmitted by the $s$ neuron cannot increase infinitely, and there must be a maximum value.

2.3 Construction of improved BP NN model

The BP model is divided into input, implicit and output layers, and data analysis is completed through forward and reverse signal propagation. In the back-propagation process, the weight and threshold adjustment of each neuron in the hidden layer directly affects whether the feedback error meets the requirements, so dynamic adjustment is required, that is, multiple iterations.

$EM$ is the difference between the estimated value and the measured value, reflecting the overall error of the result; the error percentage of a single sample of EC is shown in the following formula:

$$E_m = \frac{\sum_{i=1}^{N-1} (d_i - o_i)^2}{N - 1}$$

$$E_e = \frac{O_i - d_i}{d_i} \times 100\%$$

Normalization:

$$d_i = \alpha \frac{d_i - d_{min} + \beta}{d_{max} - d_{min} + \beta}$$

$$u(k + 1) = \omega(k) - [J^T + \mu I]^{-1}J^Te$$

$$b(k + 1) = b(k) - [J^T + \mu I]^{-1}J^Te$$

The improved BP NN model first determines the value through the coefficients, arranges the performance indicators in ascending order, and then divides them into different clusters. The LM method normalizes the input variables of the BP model and maps them to $(0, 1)$ to improve the calculation speed.

3. Modelling method

3.1 Combined modeling of music teaching rating index and tone correction rate

The model implementation steps are as follows:

1) First preprocess the tone signal. Use wavelet transform to normalize the pitch and denoise, the wavelet mother function is sym5, and the number of decomposition layers is 5.

2) Perform feature extraction and dimensionality reduction on the tone signal. When the tone signal is not dimensional zed, the sample dimension is 4900. First, the sample is de-averaged, and then the
covariance function is calculated, and the covariance function is solved. The eigenvalues and eigenvectors are selected, and the dimensions of the principal components are according to the cumulative contribution rate, and the contribution rate calculation formula is:

\[
1 - \frac{\sum_{i=1}^{k} D_{i1}}{\sum_{i=1}^{k} D_{i1}} \leq t
\]

Among them: \(D\) represents a 112×1 dimensional feature vector; \(n\) represents the number of rows of \(D\); \(k\) is the dimension of the final selected principal component; \(t\) is the error that can be set by yourself. The results of multiple experiments show that when \(t = 0.1\), the cumulative contribution rate when the principal component is selected as 36, the tone recognition rate is the highest. Therefore, this paper finally selects the principal component dimension as 36.

3) Normalize the piano tone signal after dimensionality reduction, and the normalization method is:

\[
X = \frac{D - \bar{D}}{D_{\text{MAX}} - D_{\text{MIN}}}
\]

Among them: \(X\) is the normalized signal; \(D\) is the feature vector extracted from the timbre signal after dimensionality reduction; \(\bar{D}\) is the mean value of \(D\), and \(D_{\text{MAX}}\) and \(D_{\text{MIN}}\) are the maximum and minimum values of \(D\), respectively.

4) Initialize the relevant parameters of the BP model. The model uses a three-layer structure to compare the effects of multiple experiments. Set the number of neurons in the input layer to 30, the number of neurons in the hidden layer to 40, and the number of neurons in the output layer to 3.

5) After the size reduction and normal, 810 voice samples are input from the training set, and the BP model improved by SSE algorithm is input. The BP model is optimized and the results of weight updating are as follows: ① According to the uniform distribution According to the law, \(m\) particles are randomly initialized and placed in the domain of the objective function; ②Find a new position on each particle in the search space according to the simplex neighborhood and multi-role search strategy; ③Update the four of each particle The position of the central role; ④Center according to status, and determine the three action states of the particles: the central state, the mining state and the action state; ⑤Record the best position of the particle, when the convergence position of the particle is at the required Stop the search when the accuracy is within the range; ⑥Set the weight of the BP model to the best position of the particle, and update the deviation and weight in parallel. ⑦Input the tone cycle of 198 test samples into the training network.

AI technology stores music teaching rating index and timbre correction rate, modeling prediction model judgment is a typical two class model in the system rating process, and logist model is the most widely used model, according to which the experimental results can be determined.

\[
\rho(Y = 1|X) = \frac{1}{1 + e^{-(\beta_0+\beta_1x_1+\ldots+\beta_nx_n)}}
\]

We can get:

\[
R^2 = \frac{\text{Cox&Snell} - R^2}{1 + \text{Cox&Snell} - R^2}
\]

\[
\text{R}^2 = \frac{1}{1 - \frac{\left(\text{Cox&Snell} - R^2\right)}{1}}
\]

The final model is as follows:

\[
\text{RESF} = \frac{\text{TA}}{\text{TA} + \text{FA}}
\]

3.2 Experimental research investigation and design

In order to better carry out the experiment, we selected 70 students from the Conservatory of music as the research object, divided into experimental class and ordinary class. The two classes are equally divided into 35 students. We understand their learning situation through different experimental forms, and then get the experimental results to make this analysis.
4. Evaluation results and research

4.1 Experimental investigation report statistics

Table 1. Statistics of your satisfaction with using the intelligent online network assisted teaching system

| Course information | Very satisfied | Quite satisfied | General | Less satisfied | Very dissatisfied |
|--------------------|----------------|-----------------|---------|----------------|------------------|
| Percentage         | 63             | 2               | 3       | 1              | 1                |
| Percentage         | 90%            | 2.8%            | 4.2%    | 1.5%           | 1.5%             |
| Operating Area     | 65             | 4               | 0       | 1              | 0                |
| Percentage         | 92.8%          | 5.7%            | 0%      | 1.5%           | 0%               |

We get the data through the experiment and after fine processing, extract the data we need to make table 1, as shown in the table above. Through comparison and analysis in many aspects, we can know from the data in the table: 65 students are very satisfied with the choice, accounting for about 93% of the total number of students, which shows that our experiment is more successful, and that this system is more effective.

Table 2. Accuracy analysis table of convolutional NN algorithm

| Sample | Observed | 0 | Predicted | Correct rate |
|--------|----------|---|-----------|--------------|
| Training | 0 | 85 | 20 | 85.50% |
|          | 1 | 25 | 90 | 72.15% |
|          | Total proportion | 59.25% | 40.75% | 79.10% |
| Test    | 0 | 9  | 3  | 86.72% |
|          | 1 | 5  | 6  | 64.43% |
|          | Total proportion | 70% | 30% | 72.09% |

From the data in Table 1, it can be found that the classification accuracy of convolution NN algorithm accuracy model is 72.09%, and the prediction accuracy is 85.50%. Among them, the first kind of error (abnormal data is regarded as abnormal data) of training set and test set is 24.21% and 35.30% respectively, and the second kind of error (normal data is regarded as abnormal data) is 11.97% and 13.21% respectively, which shows that the authenticity of the model can be guaranteed to a certain extent.
Figure 1. Distribution diagram of the subsequent state of the processing of AI on music-assisted teaching

The data in Figure 1 is still abnormal after intelligent correction, which is a bad information. Because there are not too many problems after the correct information is processed, and the data samples that cannot be processed show that there are problems, so in the future design, we mainly consider the information that cannot be analyzed, process them to explore the difficult points in the experiment, and analyze and process them to improve the model.

5. Conclusion

In summary, AI has been widely used in our music education, and music-assisted education has also increased the use of AI technology, especially the current widespread application of AI technology in modern music-assisted teaching, not only can break the traditional music-assisted teaching model, but also provide learners with a new music teaching model that is more suitable for their own learning. In the process of music learning, learners can better learn music knowledge and understand the characteristics and functions of each music feature and element. The application of modern information technology and AI system teaching methods can integrate various educational information with the teaching of teachers and the learning of students to achieve the best teaching effect.

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