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Retraction

Retracted: Design of Experiential Teaching System for Solfeggio in Normal Universities Based on Machine Learning Algorithm

Mobile Information Systems

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] K. Liu and J. Awang bin Othman, "Design of Experiential Teaching System for Solfeggio in Normal Universities Based on Machine Learning Algorithm," *Mobile Information Systems*, vol. 2022, Article ID 3622567, 14 pages, 2022.

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Research Article

Design of Experiential Teaching System for Solfeggio in Normal Universities Based on Machine Learning Algorithm

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At present, with the rapid development of the Internet and its close connection with our life, more and more educators apply the Internet to teaching. However, there is little research on the application of the Internet in solfeggio teaching, and there are some problems in the teaching process, such as nonstandard use methods, inability to highlight teaching objectives, and mismatch with students' professional level. On the premise of fully understanding the teaching objectives of solfeggio in China, this paper designs an experiential teaching system of solfeggio in normal universities based on machine learning algorithm, studies the application of digital technology in solfeggio, including Internet technology, multimedia digital technology, and the use of music software, and analyzes the auxiliary role of digital technology in solfeggio teaching by combining the specific teaching contents of online solfeggio teaching during the epidemic period. In this experiment, the average classification accuracy of WNB algorithm is 0.767, while that of BP algorithm is 0.683. Experimental results show that WNB algorithm outperforms BP algorithm in classification. At the same time, in terms of time efficiency, the average time consumption of WNB algorithm in this experiment is about 0.026 s, while that of BP algorithm is about 0.45 s. Compared with WNB algorithm, the time consumption of WNB algorithm is less. Through concrete practice, it is proved that the combination of solfeggio teaching and digital technology is of great significance to both teachers' teaching and students' learning.

1. Introduction

With the progress of the times, digital technology based on computer has been widely used in all fields of society, and digital music teaching has made considerable progress in China in recent years. As a basic subject in the field of music education, many teachers have realized the importance of digital technology in solfeggio teaching and need to make use of the development of digital technology to improve the quality of solfeggio teaching. This is a problem that solfeggio teachers should consider. In 2020, due to the epidemic situation, each school adopted the online teaching method to complete the teaching plan. Although various problems were encountered in this process, it also fully proved the superiority of digital technology in the development of Chinese education. Combining solfeggio teaching with digital technology, through research, making full use of the development of digital technology, aiming at improving the teaching quality and progress of solfeggio, this paper solves the problems of listening, solfeggio, flipping classroom, and online teaching in solfeggio course, analyzes the advantages and disadvantages of the influence of music software development on solfeggio, and puts forward some teaching suggestions related to the combination of traditional solfeggio teaching and digital technology. We summarize the specific links and problems in online solfeggio teaching and, through practice, analyze how to combine traditional solfeggio teaching with digital technology, so as to make the solfeggio teaching process more complete and more conducive to the improvement of students' solfeggio level.

Solfeggio teaching is becoming more and more important. Aycan K. observed that, without pronouncing syllables in roll-call sounds, there would be no rhythm structure. The vocal music practice in class suitable for Bona found that Solmization syllables can alleviate solfeggio [1]. Zhou and Yan developed a music solfeggio teaching system to serve the curriculum study of music majors, which has important practical significance and application value for promoting the development of information technology in music education [2]. In order to teach traditional songs in solfeggio and music education courses, Kodela has explored and studied the traditional music heritage by using the methodology of ethnomusicology, which is helpful to better understand, preserve, and transfer the music practice of traditional local music expressions that are gradually disappearing [3]. In order to better carry out music learning, Qiao and Yan have completed the design and implementation of music solfeggio teaching system in combination with the actual teaching situation of Conservatory of Music. The platform design provides an effective learning and testing means for the implementation of solfeggio teaching [4]. Traditional solfeggio (music theory) learning methods usually do not use computer-based support. The purpose of Debevc et al. research is to test the effectiveness of interactive mobile application mySolfeggio in learning solfeggio [5]. Folk-oriented music education has a long history in Russia. Pivnitskaya research shows that there are two trends in ethnomusicology, among which the consistent logic system is related to the unique characteristics of different regions [6]. However, the above solfeggio teaching research has not been combined with machine learning.

The use of CAI to assist teaching did not play its due role. Quan research applied artificial intelligence and intelligent prediction to teaching and collected different students' teaching portraits to differentiate their behaviors [7]. Christiane et al. research supports the development of machine learning models and their deployment and how tools are developed and evaluated [8]. Huang studies how to use machine learning to provide more accurate teaching for teaching. By combining improved algorithms to improve related models, it provides a reference for the integration of the two [9]. Liu et al. research is based on machine learning algorithms, combined with intelligent image recognition technology to improve machine learning algorithms, so as to achieve automatic essay scoring [10]. Using effective evaluation to evaluate the quality of English online teaching, Fang used machine learning to evaluate the quality of teaching and built an SVM model to improve it [11]. The application of computer-assisted instruction or computer learning system is conducive to improving the quality of English teaching. Wen is committed to the design of intelligent teaching system based on computer-assisted instruction research. According to modern educational theories and policies, it makes use of computer network collaborative learning mode and network teaching function to conduct research [12]. But the above machine learning research is only combined with teaching research.

At the same time, the cross-validation experiments of BP network and WNB algorithm are compared. The novelty of this paper lies in the use of basic theoretical knowledge of musicology in the design, which is conducive to the construction of digital music resource database and the realization of music resource visualization technology through learning and comparison.

2. Experiential Teaching Method of Solfeggio in Normal Universities Based on Machine Learning Algorithm

2.1. Features of Solfeggio. Solfeggio has both theoretical and technical characteristics. The theory means that, in the process of learning solfeggio, it is necessary to systematically learn basic music theory knowledge, harmony, musical form, etc., so as to assist listening and solfeggio practice, and apply theoretical knowledge to practice [13]. That is, when technology involves solfeggio and listening, students need to gradually master the technical characteristics of solfeggio in the learning process and improve students' solfeggio listening ability from the auditory training of single tone, interval, chord, and melody [14]. Especially in the context of the gradual enrichment of the teaching content of solfeggio in recent years, the emergence of various multipart solfeggio repertoire and atonal solfeggio exercises put forward new requirements for students' solfeggio ability. At the same time, digital technology, that is, the emergence of various computer music software tools, in the process of students using computer music software to assist solfeggio teaching, also fully reflects the theoretical and technical characteristics of solfeggio [15].

Solfeggio, as a basic subject in the field of music education, has a direct impact on the improvement of students' own level [16]. The recipients are students of different majors and levels, which requires teachers to be targeted in teaching, and to choose teaching methods suitable for students.

2.2. Solfeggio Diversified Teaching Problems. In recent years, solfeggio teaching methods have gradually diversified, such as flip classroom, online teaching, and music software application, all of which put forward new requirements for teachers' classroom teaching ability. Faced with many freshmen's teaching methods, we should avoid problems in teaching, clarify the advantages and disadvantages of a certain teaching method, and choose a teaching method suitable for students. Diversification is not a blind choice. We should carefully choose teaching methods according to the training objectives of students at different stages, so as to improve the course quality of solfeggio and avoid teaching mistakes [17].

Due to the characteristics of high accuracy, various forms, and high efficiency of multimedia, in building a modern multimedia solfeggio classroom, we need not only the stacking of software, but also the maximization of the practicality of multimedia teaching [18]. We will integrate and adjust the software and hardware with the traditional solfeggio course, trying to absorb the "essence" of the two models and eliminate the "dross" of the two models. In order to better meet the application of software in solfeggio course, some adjustments should be made in the curriculum arrangement of colleges and universities, so that students can learn more operational skills in other classes [19].

The hardware configuration of multimedia solfeggio classroom can be arranged according to the expected funds of the school. Firstly, the hardware configuration is relatively

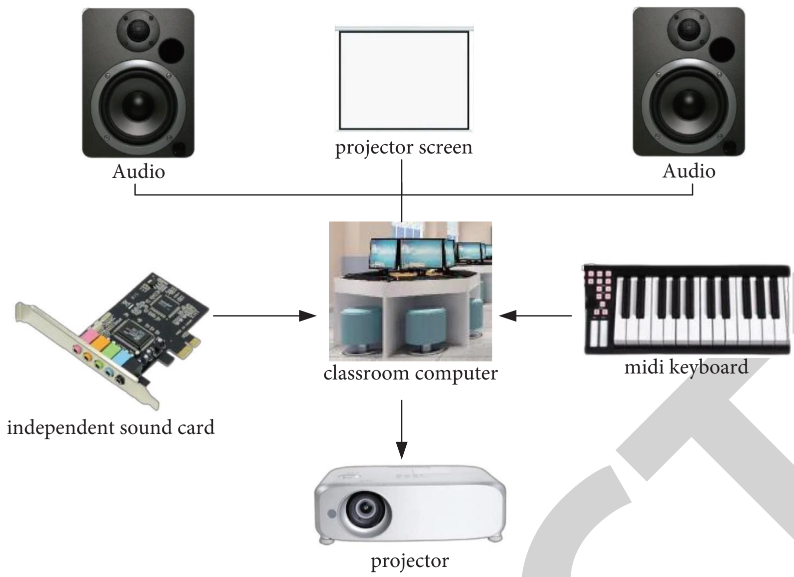


Figure 1: "Lecture-style" multimedia teaching platform.

simple with little capital investment. The venue can choose the existing conventional classroom. The "lecture-style" multimedia teaching platform is shown in Figure 1.

As shown in Figure 1, the configuration of this hardware facility can improve the traditional classroom platform or configure a modern telescopic platform, which we can call "lecture-style" multimedia teaching platform. Preclass preparation and after-class homework formulation of solfeggio play an extremely important role in improving students' solfeggio level [20]. In the traditional solfeggio teaching, the preview before class only allows students to understand some basic music knowledge from words, and the content is rather boring. Homework is mainly to arrange solfeggio and exercises for students after class, and the completion of students' solfeggio homework cannot be guaranteed. In the face of the rapid development of digital technology, whether teachers can make use of the convenient conditions brought by digital technology to improve the quality of preclass preview and after-class homework formulation of solfeggio and improve students' ability to understand and think about problems, if the quality of these two links can be improved, it will also mean that teachers' teaching quality and efficiency of problem solving in class will be improved [21].

The second multimedia technology configuration, which we can call "all-round" multimedia solfeggio classroom, is shown in Figure 2.

As shown in Figure 2, the final running environment of this system is the Solfeggio Professional Training Room of Conservatory of Music. In the teaching of solfeggio, students have professional teaching laboratories, and the corresponding supporting facilities include input and output devices such as computers, midi electronic organ, headphones, and microphones. The examinations are conducted in different batches in the same place under the organization of teachers [22]. At the same time, it is hoped that the solfeggio teaching system developed does not depend on the external network environment and requires strong data processing ability, high security performance, and fast response speed. Considering the above factors, through the analysis of the advantages and disadvantages of C/S and B/S structures, the architecture of this system decided to adopt C/S mode. At the same time, C/S mode can flexibly process audio files and realize audio processing in this machine. At the same time, this system is a student-oriented learning and examination module of teaching resources, which has strong interactivity, large amount of audio information, and high requirements for system stability. Using C/S gives full play to its strengths.

2.3. Bayesian Knowledge Tracking Model. The original knowledge tracking model is constructed according to the structure of HMM model. Each hidden state node in the HMM model is defined as the knowledge node of the knowledge tracking model, and each visible state node is defined as the performance node of the model. It is assumed that the states among the learners' nodes are irreversible.

Through BKT model, this paper analyzes the process of learners' mastery of knowledge nodes, observes the relationship between the states of each node, and trains model parameters for a series of data series with correct or false answers. By referring to the conditional probability table CPT, the Bayesian formula of current learners' learning performance can be obtained, and the learners' learning situation at the next knowledge node can be inferred.

When the learner's current answer is correct, consider two situations in which the learner answers correctly: if the knowledge points have been mastered, the error of the learner's answer will have a greater impact on the correct answer than the probability of guessing. At this time, it is not necessary to consider the guessing of the learner's answer,

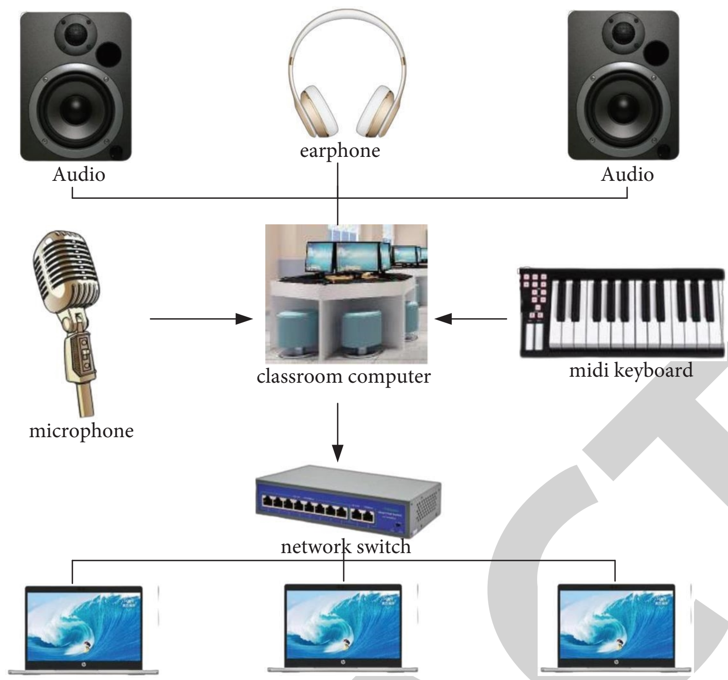


Figure 2: “All-round” multimedia solfeggio classroom.

but only consider the correct answer when the learner answers with small errors [23]. If the knowledge points are not mastered, the influence of learners' mistakes in answering questions on the correctness of answers is smaller than that of guesses. At this time, consider the influence of learners' guesses on the answers. Therefore, the probability of learners' correct answers can be expressed by the following formula:

$$P(\alpha) = P(\chi_n)(1 - P(H)) + (1 - P(\chi_n))P(G). \tag{1}$$

When the learner's current answer is wrong, consider two situations of the learner's wrong answer: when the knowledge points have been mastered, the guessing of the learner's answer is also not considered, but when the probability of the learner's wrong answer is high, the answer will be wrong. When the knowledge points are not mastered, there is no need to consider the error probability in the process of answering questions. Only when learners guess wrong, the probability of $P(m)$ can be expressed by the following formula:

$$P(m) = P(\chi_n)P(H) + (1 - P(\chi_n))(1 - P(G)). \tag{2}$$

If the learner's answering performance is known, the learning prior probability of the current knowledge node can be derived: according to the correct and wrong sequence of the learner's answering result, the learner's learning prior probability is obtained. If the learner's current knowledge answering situation is correct, then the learned correct prior probability $P(\chi_n|\alpha)$ is obtained, which can be expressed by the following formula:

$$P(\chi_n|\alpha) = \frac{P(\chi_n)1 - P(H)}{P(\chi_n)(1 - P(H)) + (1 - P(\chi_n))P(G)}. \tag{3}$$

If the current answering situation is wrong, the prior probability $P(\chi_n|m)$ of the learner's learning error is obtained, which can be expressed by the following formula:

$$P(\chi_n|m) = \frac{P(\chi_n)P(H)}{P(\chi_n)P(H) + (1 - P(\chi_n))(1 - P(G))}. \tag{4}$$

If the current answering situation is wrong, the prior probability $P(\chi_n)$ of the learner's learning error is obtained, which can be expressed by the following formula:

$$P(\chi_n) = P(\chi_n|\alpha) + P(\chi_n|m). \tag{5}$$

The model is processed according to a series of right and wrong sequences of learners' each answer, and the Bayesian formula is used to update learners' learning of the next knowledge point. When the forgetting factor is not considered in the model, the posterior learning knowledge probability of the future knowledge node state is updated only by the learning transition probability $P(T)$; that is, the learner's mastery probability of the next knowledge point can be expressed by the following formula:

$$P(\chi_{n+1}) = P(\chi_n) + (1 - P(\chi_n))P(T). \tag{6}$$

2.4. Bayesian Knowledge Tracking Model Based on Learning Behavior. This section mainly studies the influence of learners' online learning behavior on the prediction results of the model, analyzes and uses learners' rich behavior characteristics to track the changes of learners' learning state, and uses deep learning technology to optimize the data set used in BKT.

By improving the model structure of Bayesian knowledge tracking, in the B-BKT model, no matter whether learners have mastered the knowledge points or not, learners' behaviors will have certain positive or negative effects on guessing or making mistakes in answering questions, which will affect the judgment in the final answer, resulting in certain differences in the final performance state. Therefore, we will consider the influence of different knowledge states and behavior states in the process of answering questions on the correct or wrong answer results.

Therefore, according to the four situations when learners answer questions, updating the probability formula that learners answer questions correctly is simplified from formulas (7) to (8).

$$P(\alpha) = P(\chi_n)(1-P(H)) + P(\chi_n)P(G)(1-P(H)) + (1-P(\chi_n))P(G) + (1-P(\chi_n))P(G)(1-P(H)), \tag{7}$$

$$\Rightarrow P(\alpha) = P(\chi_n)(1-P(H)) + (1-P(\chi_n)) + P(G)(1-P(H)). \tag{8}$$

When the answer is wrong, consider four situations in which the learner answers incorrectly:

In the B-BKT model, the phenomenon of learning forgetting is not considered. When learners have mastered the state of knowledge points and behave positively, learners may make mistakes when they make mistakes.

When learners have mastered the knowledge points, and their behavior state is relatively negative, it may lead to mistakes in the process of answering questions. At this time, learners may guess wrong when answering questions.

When the learner has not mastered the knowledge points, and his behavior state is positive, it is assumed that, in the ideal state, after learning for a period of time, the learner will have a little understanding of the knowledge points, but in the final answer, there will still be a probability of guessing wrong in the case of mistakes, resulting in wrong answers.

When the learner's knowledge state is not mastered, and the state of learning behavior is relatively negative, there are guesses in the process of answering questions, which lead to wrong answers.

At this time, updating the probability that the learner's answer is wrong can be simplified by formula (9) to obtain formula (10).

$$P(m) = P(\chi_n)P(H) + P(\chi_n)(1-P(G)) + (1-P(\chi_n))(1-P(G))P(H) + (1-P(\chi_n))(1-P(G)), \tag{9}$$

$$\Rightarrow P(m) = P(\chi_n)P(H) + (1-P(\chi_n))(1-P(G)) + (1-P(G))P(H). \tag{10}$$

According to the correct and incorrect sequence of the learner's answering results, the learner's learning prior probability is updated. When the learner's current knowledge answering situation is correct, the probability of $P(\chi_n|\alpha)$ is updated, which can be expressed by the following formula:

$$P(\chi_n|\alpha) = \frac{P(\chi_n)(1-P(H)) + P(\chi_n)P(G)(1-P(H))}{P(\chi_n)(1-P(H)) + (1-P(\chi_n))P(G) + P(G)(1-P(H))}. \tag{11}$$

When the answer is wrong, the probability of updating $P(\chi_n|m)$ can be expressed by the following formula:

$$P(\chi_n|m) = \frac{P(\chi_n)P(H) + P(\chi_n)(1-P(G))P(H)}{P(\chi_n)P(H) + (1-P(\chi_n))(1-P(G)) + (1-P(G))P(H)}. \tag{12}$$

After all answers are completed, the updated probability of $P(\chi_n)$ can be expressed by the following formula:

$$P(\chi_n) = P(\chi_n|\alpha) + P(\chi_n|m). \tag{13}$$

Predicting the learner's mastery probability at the next knowledge node can be expressed by the following formula:

$$P(\chi_{n+1}) = P(\chi_n) + (1-P(\chi_n))P(T). \tag{14}$$

2.5. Algorithm for Determining the Weights of Evaluation Attributes Based on Weighted Naive Bayes. In order to reduce the computational cost, the naive Bayesian algorithm assumes that the conditional attributes are independent of each other, and another implicit assumption is that the importance of each conditional attribute to decision classification is the same; that is, the weights are all set to 1. In practical application, the importance of each conditional attribute to classification is different, so when all weights are set to 1 by default, the accuracy of classification will be reduced.

In this paper, Weighted Naive Bayes (WNB) classification algorithm is used to assign a reasonable weight to attributes according to their contribution to classification, which not only keeps the high speed of WNB algorithm, but also reduces the influence of conditional independence assumption of attributes on classifier performance. The calculation formula is as follows:

$$P(A_i|\beta) = \arg\max_{A_i} P(A_i) \prod_{j=1}^{n} P\left(C_j|A_i\right)^{wj}. \tag{15}$$

Among them, w_j represents the weight of the attribute C_j, which determines the importance of different attributes in the classification process. The larger the w_j value, the more important the corresponding attribute C_j for the classification. In the specific application, how to determine the specific weight for each attribute is the key issue of the weighted naive Bayesian model.

According to the correlation between the evaluation attributes of the teaching evaluation data and the comprehensive evaluation value, it can be seen that the value of each index has different degrees of influence on the evaluation results. Therefore, this paper proposes a method to determine the weight of each evaluation attribute by using the correlation probability of the class attributes. Each attribute A may have K different values, which are represented by k_a, where $a \in K$. Assuming a specific instance β, when the attribute C_j of β takes the value of k_a, for the category A_i, the calculation formulas of the correlation probability C_j and the irrelevant probability A_i of the attribute $P(C_j|\text{rel})$ about $P(C_j|\text{norel})$ are as follows:

$$\begin{aligned} P\left(C_j|\text{rel}\right) &= \frac{\text{count}\left(C_j = k_a \wedge A_i\right)}{\text{count}\left(C_j = k_a\right)}, \\ P\left(C_j|\text{norel}\right) &= 1 - P\left(C_j|\text{rel}\right), \end{aligned} \tag{16}$$

where count represents the number of statistics. When the value of the attribute C_j is A_i and belongs to the k_a class, the attribute weight calculation formula is as follows:

$$w\left(C_j, k_a, i\right) = \frac{P\left(C_j|\text{rel}\right)}{P\left(C_j|\text{norel}\right)}. \tag{17}$$

Therefore, the specific calculation formula of weighted naive Bayes classification algorithm is as follows:

$$P(A_i|\beta) = \arg\max_{A_i} P(A_i) \prod_{j=1}^{n} P\left(C_j|A_i\right)^{w\left(C_j, k_a, i\right)}. \tag{18}$$

In dataset D, if there are M class labels, N attributes, and K possible values for each attribute, the total weight of all attributes is $m * n * k * N * K$. If the specific values of the same attribute are different, the weights are different. When the same attribute has the same value, the weights are different in different categories. Finally, according to the specific value of each attribute, the weight of the probability related to the current category label is selected for calculation, and the result values of each category are compared, and the category corresponding to the maximum value is the classification result.

3. The Realization of Music Solfeggio Teaching System

Based on the overall structure design and module function design of the system, this paper further expounds the concrete realization of the main functional modules of the system, that is, teaching knowledge resource bank, examination question bank, knowledge learning and testing, and the function of selecting topics and generating test papers, and gives the realization method, system user interface, and program analysis of other main functional modules in the system. Finally, it analyzes the considerations of system security.

3.1. System Logic Structure Design. The system adopts the C/S structure development mode of combining foreground application with background SQL server database and adopts C# as the development language. According to the requirements of the music solfeggio teaching system, this project needs a large number of user interfaces. Because it is used in the local area network, the WinForm interface application program, which is familiar under the NET platform, is first selected to be responsible for interacting with operators, receiving input and displaying output. In this system, the core technologies that need to be solved are how to access data in the most reasonable way and which data components should be selected to achieve specific purposes according to different needs. The logical structure diagram of the system is shown in Figure 3.

As shown in Figure 3, under normal circumstances, SqlCommand control can be used to execute SQL statements without returned record sets, such as adding, modifying, and deleting user information, or SQL statements with returned sets, such as query and statistics of students' grades. With the data read by the SqlDataReader object, the Fill method can be used to call the Select command in the SQL statement, or the Update method can be used to Update the changes recorded every day to automatically call the implicit Insert, Update, and Delete commands.

3.2. Implementation of Key Technical Modules

3.2.1. Management of Teaching Resource Bank. The management function of the teaching resource database of the system is similar to that of the question bank. It mainly realizes the management of adding, deleting, and modifying the basic knowledge points of solfeggio, and its realization principle is basically the same. The difference is that the management of knowledge points needs to be presented in the form of a tree diagram directory in the student login interface.

Set the system knowledge point resource management function in the "Knowledge Point Management" module of "System." In the system, the parameter information of knowledge points in different chapters is different. Here, take the "scale" knowledge point as an example, and design the interface display. The management information of knowledge points in this module directly controls the display catalogue and detailed contents of knowledge points of students' clients. In the knowledge point resource management, information such as resource ID number, parent knowledge point ID, resource description, level, mid-audio resource location, and URL address of music score stored in the server is set for each music resource field.

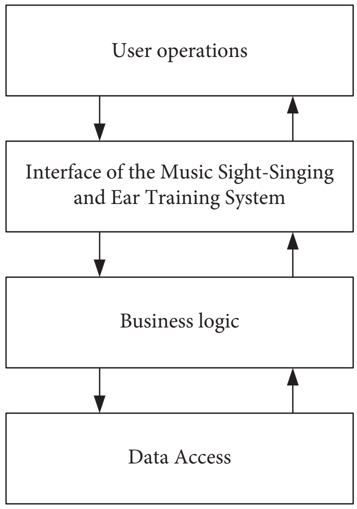


Figure 3: System logic structure diagram.

3.2.2. The Design of Question Template. The examination questions involved in the system are mainly divided into five types: syllable recognition, interval comparison, music reading and pronunciation recognition, sound bundle dictation, and rhythm style. In the question bank management system, the questions corresponding to various questions are added, deleted, modified, and queried. The system needs to design the management interfaces of various questions respectively. For the attribute information of various questions is different, in order to facilitate the management of the questions, according to the main attributes in the solfeggio knowledge database, such as the content of the questions, midi audio files, music score pictures, knowledge chapters, and difficulty levels, according to the requirements of different questions, different management templates are designed for each question. The following are brief introductions to each question:

(1) Scale recognition

The question of scale identification is to examine students' cognition and proficiency in scale of mode and tonality system by listening and distinguishing various scales.

(2) Interval comparison

The interval comparison test is to play two midi single notes, respectively, compare their sizes, and mainly examine students' ability to perceive the distance between the two notes.

(3) Reading music and recognizing sounds

The score reading test is to give the musical scores in different modes and tonality systems. Students are required to identify the clef information of their musical scores, fill in their answers, and submit the answer results. This type of question examines the students' mastery of basic notes and clefs by viewing music scores.

(4) Bundle chords

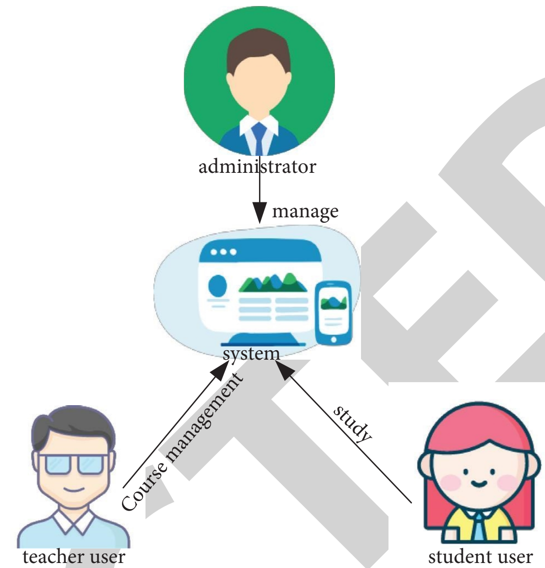


Figure 4: System role assignment structure diagram.

Bundle and chord test questions cover the investigation of knowledge points of chord composing, chord listening, and bundle and chord discrimination. By playing a piece of music information, we can identify its bundle and chord content and select the correct answer from the alternative answers and save it.

(5) Rhythm style

The style test is to identify the style type by playing an audio rhythm segment, select the correct item from the alternative answers, and press OK to answer. This type of question examines students' mastery of rhythm types and sound, and at the same time, through grasping different beat numbers and rhythm styles, they can understand the music background embodied in different rhythm styles and improve students' ability to appreciate music.

According to the software development process in this chapter, the requirements analysis and general framework outline design before development are completed, in which the requirements analysis includes functional requirements and nonfunctional requirements. There are three types of users in this system, namely, administrators, students, and teachers. The distribution structure of roles is shown in Figure 4.

As shown in Figure 4, the overall architecture system of online teaching system based on personalized recommendation and the overall architecture design of the system help developers control the general level development structure of the whole system, so that each module of the system development is independent and highly aggregated within blocks, and the division of labor is clear.

3.2.3. System Architecture. By analyzing the system architecture diagram, we can easily understand the system structure information and the data interaction process

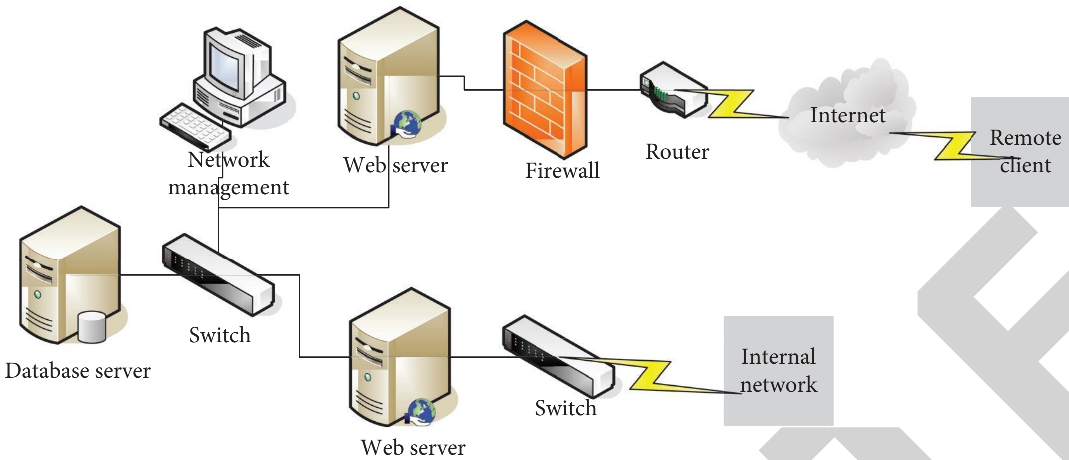


FIGURE 5: Topology diagram of solfeggio experiential teaching network in normal universities.

between each functional module and other layers. The overall system architecture design is shown in Figure 5.

As shown in Figure 5, the internal network can be directly connected to the internal network of the local server, which is located in the same domain as the server, thus facilitating various operations. The server mainly includes Web server, firewall, database server, switch, and router. The remote client uses the Internet to log into the server, which is convenient for all operations.

3.3. Design of Logical Structure of Database. The function of database logic design is to finally determine all kinds of information tables needed in the system database and the fields contained in each table. The structure of the table in the main part is introduced below.

(1) The fields contained in the user login information table are shown in Table 1.

(2) Student information table, which is used to store the detailed information of students, is shown in Table 2.

(3) Teacher information table is shown in Table 3.

TABLE 1: UserInfo table.

Field name	Type of data	Length	Illustrate
ID	Int	Four	System number
UserFlag	Int	Four	User type
UserCh	Varchar	40	Username
UserName	Varchar	40	Username
UserPwd	Varchar	40	User password
IsTest	Int	Four	Whether to take the exam

TABLE 2: StudentInfo table.

Field name	Type of data	Length	Illustrate
SNO	Varchar	45	Student ID
SName	Varchar	45	Name
ClassID	Int	Eight	Class number
Grade	Varchar	40	Grade
EmailInfo	Varchar	40	E-mail address

TABLE 3: TeacherInfo table.

Field name	Type of data	Length	Illustrate
TeacherID	Varchar	20	Teacher username
Password	Varchar	15	Password
Name	Varchar	20	Teacher name
Class	Varchar	10	Class

4. Experimental Analysis of Music Solfeggio Teaching System under Machine Learning

4.1. Experimental Analysis of Audio Feature Extraction and Matching. Through audio input devices such as microphone, the system inputs the user's sight-singing signal according to the Atlas into the computer, which is basically stored in binary or compressed data stream in PCM format. As far as the original data is concerned, on the surface, we cannot see the intrinsic characteristics of music. When compared with the Atlas, we cannot directly use the original data, and the accuracy of solfeggio of users of the system cannot be completely tested. In the solfeggio teaching system, the most important step is to extract the features of audio signals. After feature extraction, all kinds of signal features can be extracted from audio data, and the extracted features can fully reflect the basic features of the original data, and the original data's own signals or its own music meanings can be represented, which is quite beneficial to the evaluation of solfeggio results. The short-time random original signal and autocorrelation function are shown in Figure 6.

Figure 6(a) shows a randomly selected frame of speech signal, and the autocorrelation function of this frame of speech signal after autocorrelation processing is shown in Figure 6(b). It can be seen from the figure that the peak value of autocorrelation function is reflected in the pitch period, and the average value of pitch period is the distance between these peak points. The short-time original signal and autocorrelation function are shown in Figure 7.

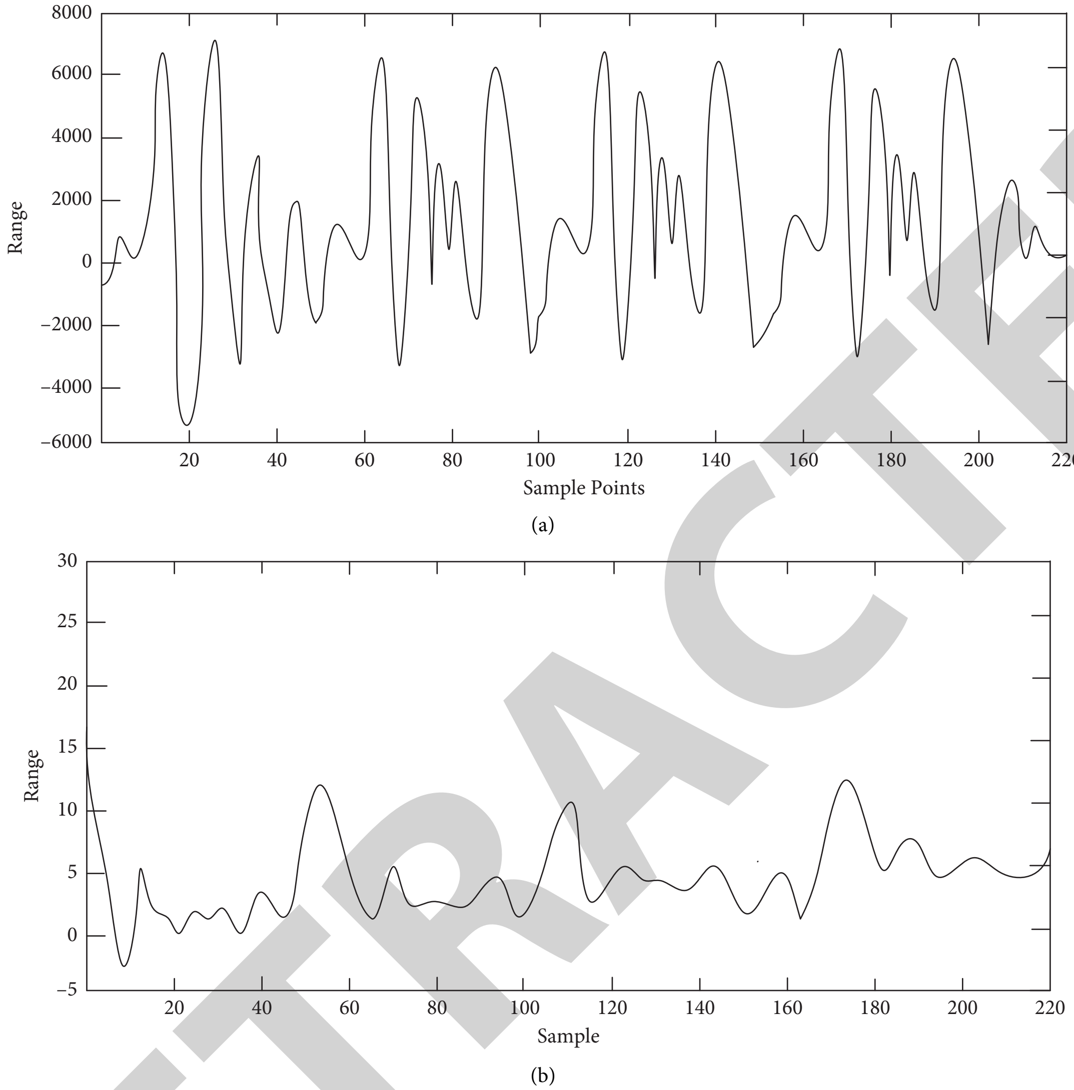
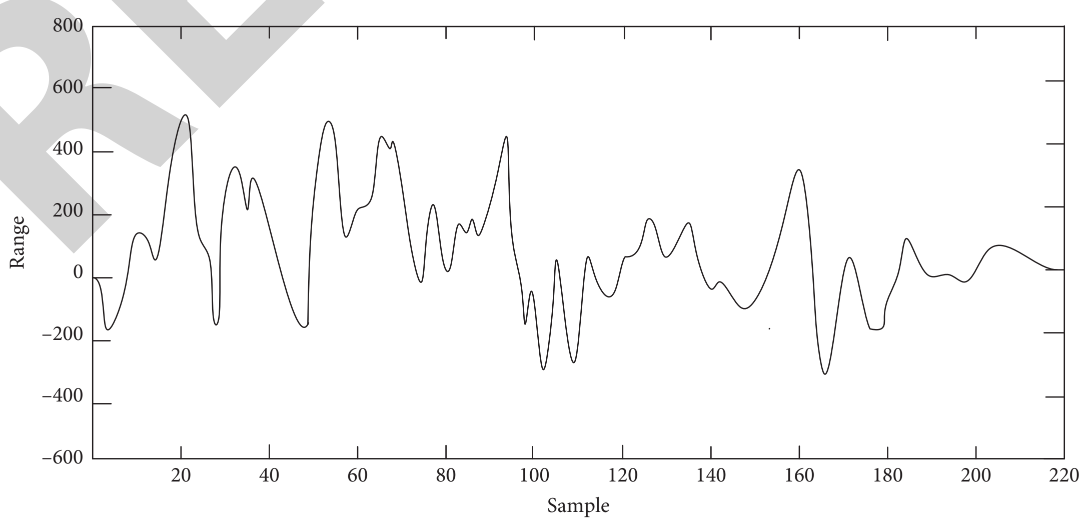
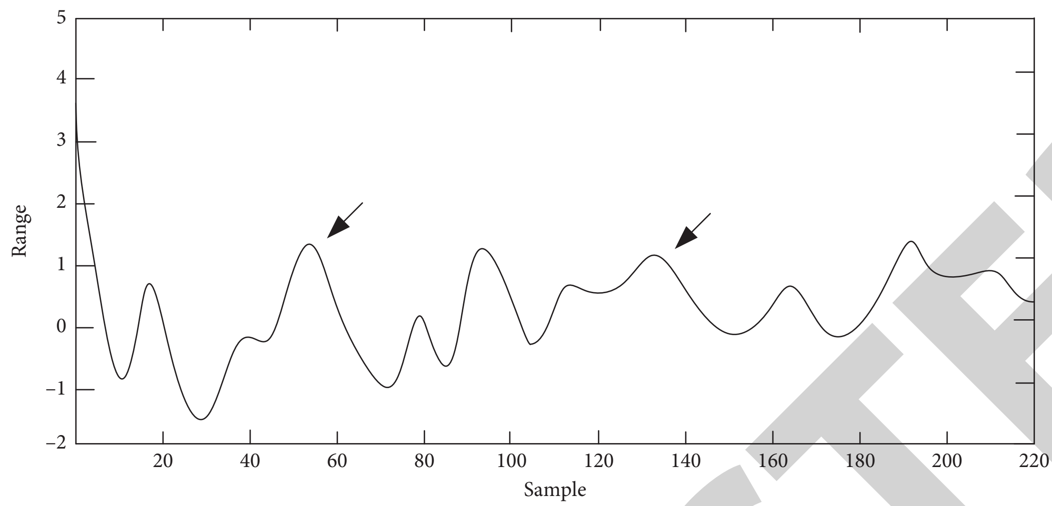


Figure 6: Short-time random original signal and autocorrelation function. (a) Random original signal. (b) Random autocorrelation function.



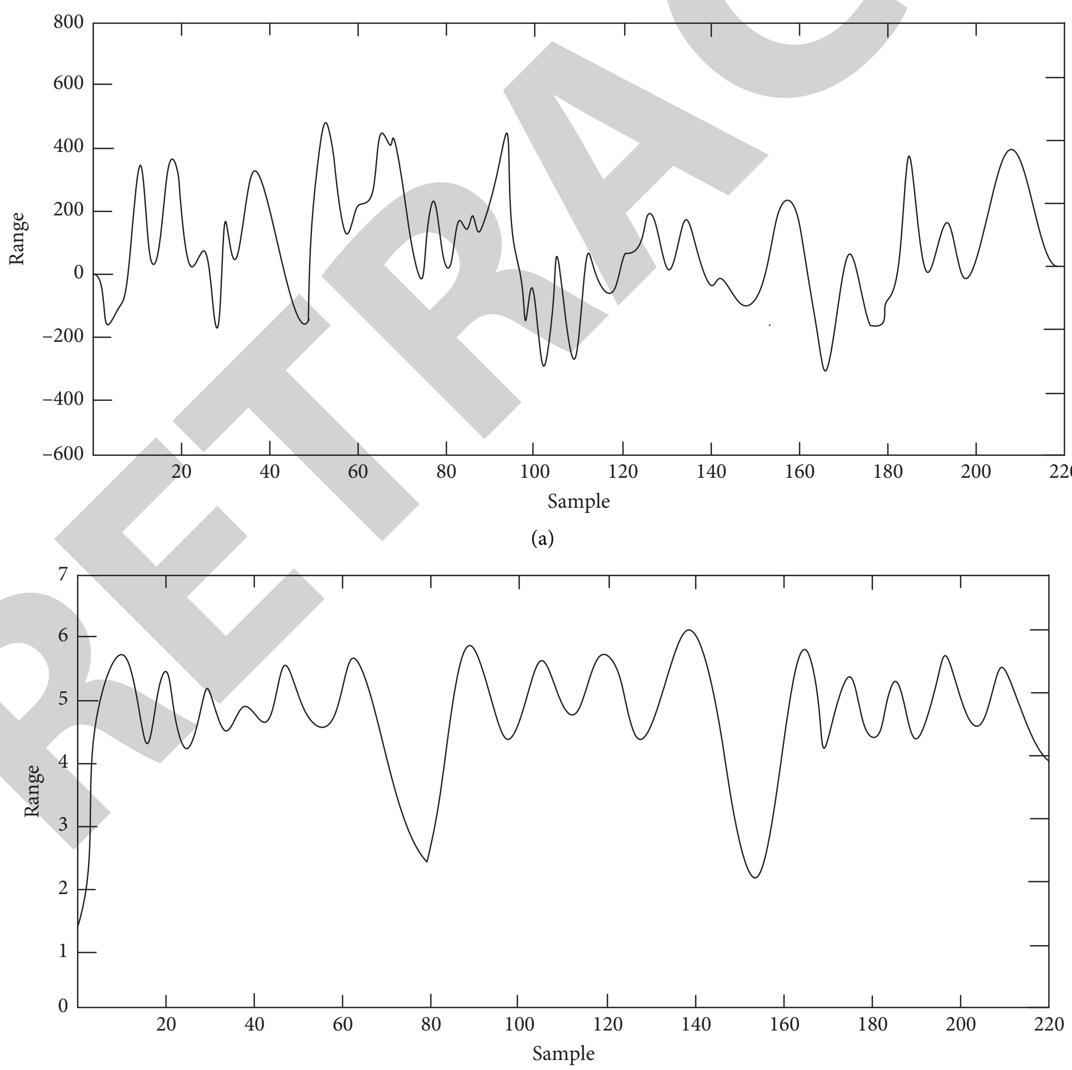
(a)

Figure 7: Continued.



(b)

Figure 7: Short-time original signal and autocorrelation function. (a) Original signal. (b) Autocorrelation function.



(b)

Figure 8: Random original signal and average amplitude difference function. (a) Random original signal. (b) Random average amplitude difference function.

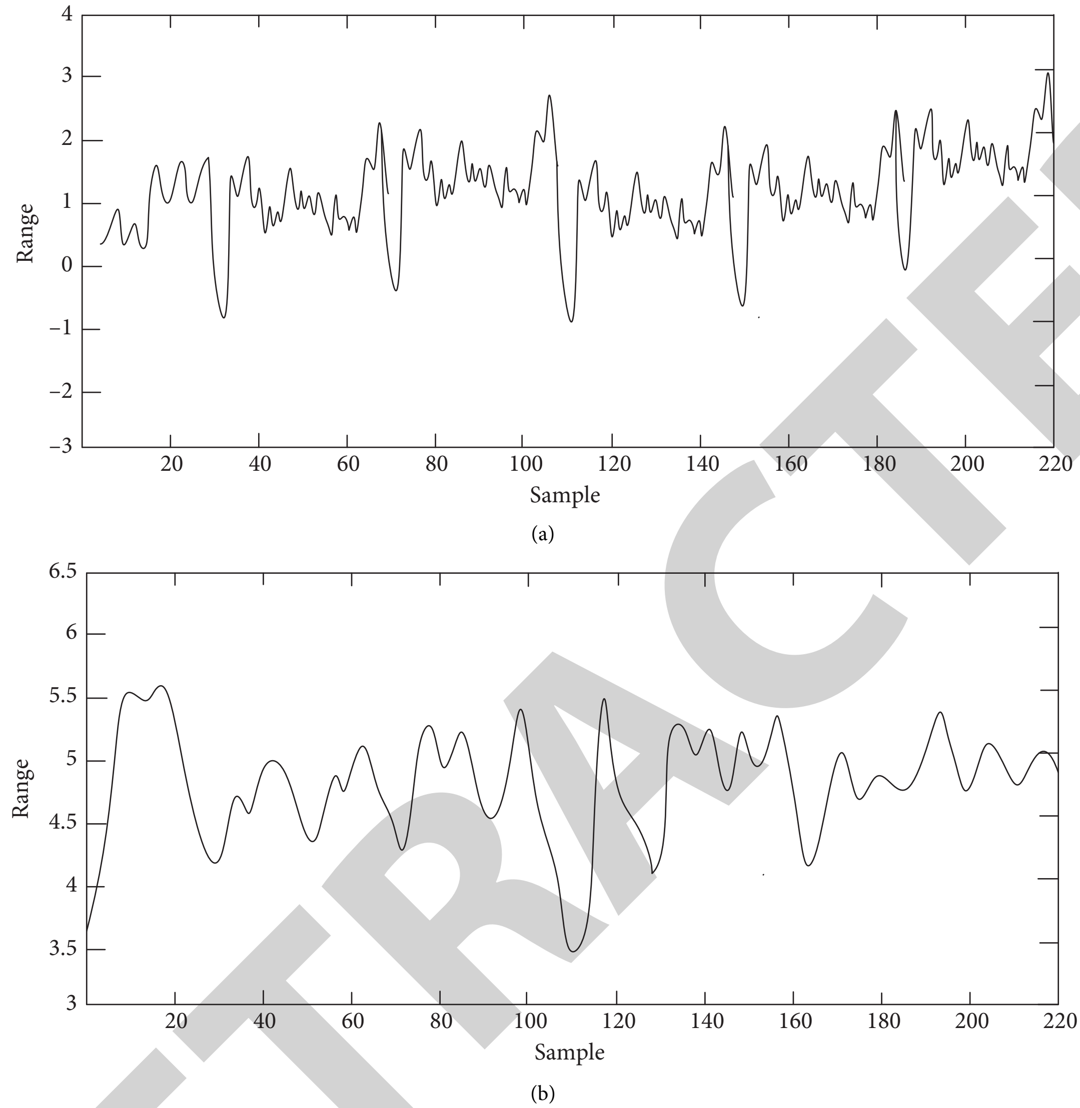


Figure 9: Noise signal and average amplitude difference function. (a) Noise signal. (b) Average amplitude difference function.

As shown in Figure 7, it can be seen that the pitch period detected by the autocorrelation function is not deeper than that of the original signal, but only half of it. The reason for this situation is the harmonic peak point indicated by the arrow in the figure, which is the frequency doubling phenomenon we mentioned earlier. Although AMDF method is extremely effective in extracting the base period, when the speech environment is harsh and noisy, and the signal-to-noise ratio is low, the detection effect is not ideal, and other methods must be used to deal with it. The original signal and the average amplitude difference function are shown in Figure 8.

As shown in Figure 8, the average amplitude difference function is calculated using frames randomly selected from the speech signal. It can be seen that the average amplitude difference function of the base period shows the number of holes, and the base period is the distance between these holes. If noise with a signal-to-noise ratio of 2 dB is added to this speech signal frame, the result is shown in Figure 9.

As shown in Figure 9, when calculating the average amplitude difference function of frames with noise in the speech signal, it can be seen that many harmonic components are added to the average amplitude difference function, and the basic sound waves are not found in these harmonic components at all. The basic cycle cannot be determined at all.

4.2. Comparison and Analysis of Classification Accuracy of NB Algorithm and WNB Algorithm. The data of the experiment comes from the database of teaching evaluation, and 220 data records are randomly selected as the training set and 70 data as the test set, and the cross-validation experiment is carried out. Through 10 cross-validation experiments, the classification accuracy of NB algorithm and WNB algorithm is measured. The specific experimental results are shown in Figure 10.

As shown in Figure 10, it can be seen from the experimental results that the average classification accuracy of Naive Bayes algorithm is 0.713 on this data set, while that of

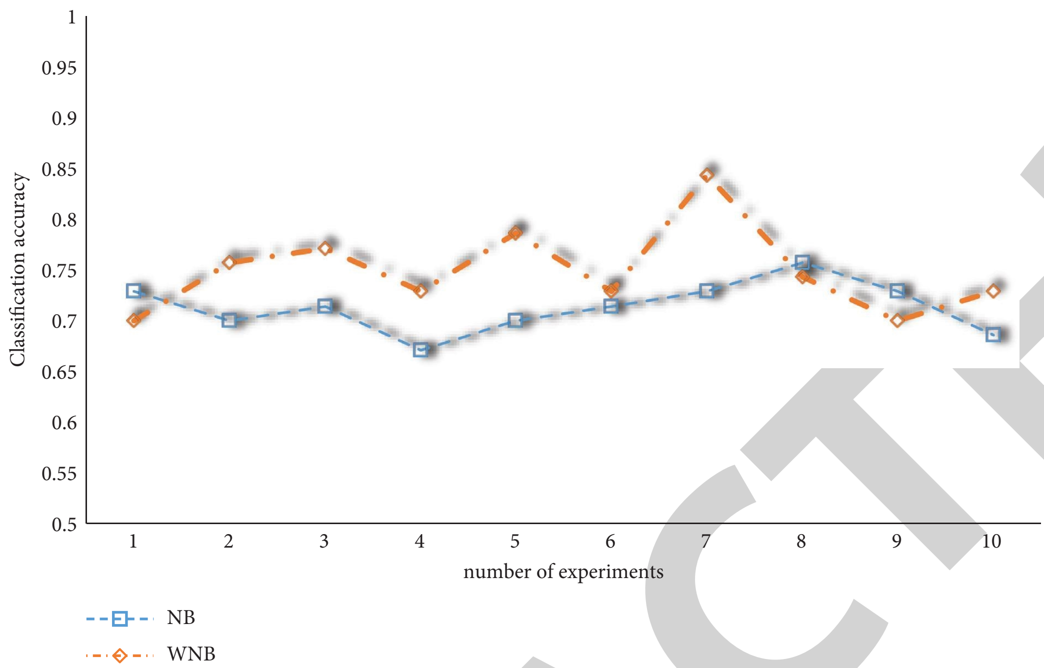


Figure 10: Comparison of classification accuracy between NB algorithm and WNB algorithm.

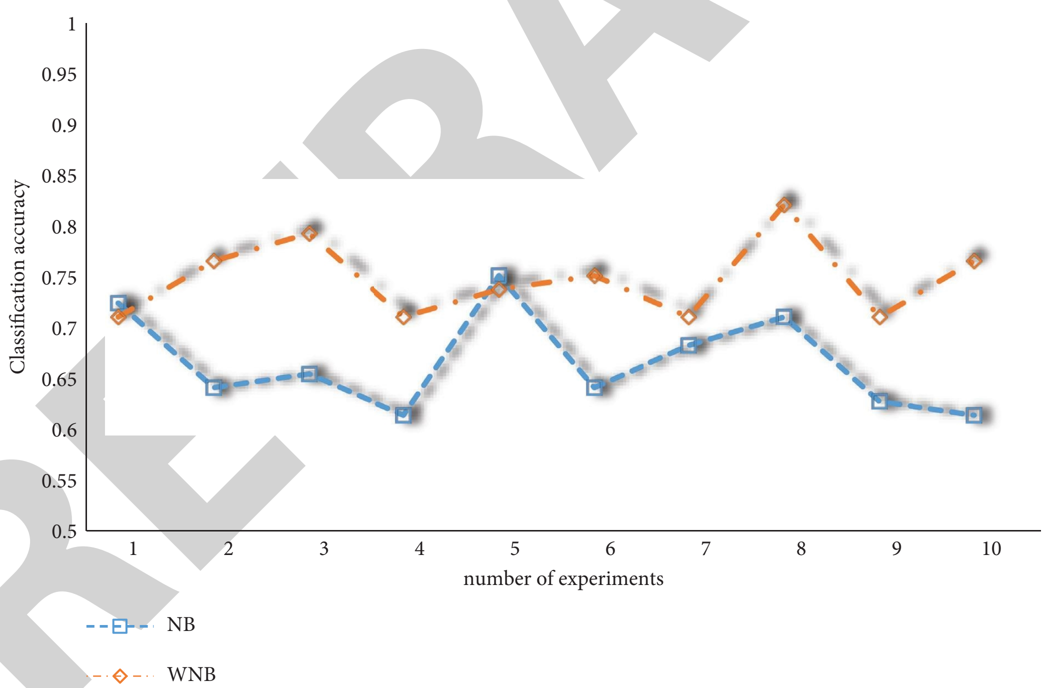


Figure 11: Comparison of classification accuracy between BP algorithm and WNB algorithm.

weighted Naive Bayes algorithm is 0.75. Generally speaking, the classification accuracy of weighted Naive Bayes algorithm is better than that of traditional Naive Bayes algorithm on teaching evaluation data set.

4.3. Comparative Analysis of Classification Accuracy between BP Algorithm and WNB Algorithm. From the data analysis of all experimental results, it is found that, in the actual evaluation process, the 100-point evaluation value given by students is generally very high, so in the process of model training, it is easy to overfit, which leads to a generally high prediction level. Therefore, after preprocessing, the score value of 100-point system is discretized into the evaluation value of five-level system, and the data of different levels are randomly selected and mixed into training data sets, among which there are 220 data sets in the training set and 70 data sets in the testing set, and the cross-experiment comparison between BP network and WNB algorithm is conducted. The experimental results are shown in Figure 11.

As shown in Figure 11, in the actual teaching evaluation data set, there are many excellent grades and relatively few other grades in the evaluation grades. Therefore, when the hierarchical data is used to train the classification model, different training data sets will have a certain degree of influence on the experimental results. In this experiment, the average classification accuracy of WNB algorithm is 0.767, while that of BP algorithm is 0.683. Experimental results show that WNB algorithm outperforms BP algorithm in classification. At the same time, in terms of time efficiency, the average time consumption of WNB algorithm in this experiment is about 0.026 s, while that of BP algorithm is about 0.45 s. Compared with WNB algorithm, WNB algorithm has less time consumption and higher classification accuracy, so WNB algorithm has greater advantages in teaching evaluation.

5. Conclusions

Combined with the development trend of solfeggio teaching in China, this paper thinks about the development of digital technology in the field of music, the influence of computer music software on solfeggio training, the specific application of digital technology in discipline training, the auxiliary role of digital technology in solfeggio teaching, etc. and puts forward targeted suggestions for solfeggio teaching under the background of digital technology. In this paper, a musical solfeggio teaching system has been preliminarily established, which integrates the functions of knowledge management, examination questions management, online examination, after-class practice, assessment and scoring, performance management, and statistical analysis. The system adopts three-tier C/S mode and is used in LAN. Teachers and students use the system by installing client programs. Combining digital technology with solfeggio teaching can enrich teachers' teaching content, make up for students' lack of hardware facilities in after-class practice and formulate reasonable after-class homework for students at different levels, so that digital technology can become a good tool to assist solfeggio teaching and improve students' comprehensive ability of solfeggio. In the future research, we can introduce the current popular smart client architecture combining B/S and C/S, which makes the system easier to deploy and manage and brings fast response speed and rich user experience to users.

Data Availability

No data were used to support this study.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this article.

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