Application of slack variable-optimized SVM on piano teaching reform

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Abstract. The data mining task of the classification algorithm is mainly to classify the data and classify them into each known category. As a classification algorithm, SVM has many unique advantages in solving small sample, nonlinear and high-dimensional pattern recognition. Based on the advantages of the SVM algorithm, this paper optimizes the slack variables, establishes a teaching quality evaluation model, and takes 500 subjects of the questionnaire survey as data samples by comparing with a variety of classification methods to evaluate, and the results show that the accuracy of the SVM model is 92.70%, which proves the effectiveness of the research model.

1. Introduction
Music is an art form that can reflect life and convey emotions. Music can help people express their emotions, release emotions, and improve people's aesthetic ability. It is one of the eight major arts in the world. Nowadays, most colleges and universities have opened music majors in order to meet the needs of talents, and piano lessons are one of the important courses of music majors. In order to promote the development of piano teaching, in 2019, Fu Long explored the methods and paths of piano teaching reform in colleges and universities, and briefly analyzed and discussed the reform of piano teaching in college music majors [1]. In addition to the task of improving the professional quality of college students, teaching reform also needs to keep up with the pace of quality education. In 2020, based on actual research, Wang Xia analyzed the current situation of piano teaching in colleges and universities, and proposed strengthening curriculum design, strengthening students' own capacity building, and strengthening the construction of teaching staff [2]. With the help of new Internet technology, these teaching reform ideas can be better realized. Lu Wei et al. [3] intend to build a diversified teaching platform to enrich the teaching content and improve the teaching effect with new teaching models, so that high-quality piano teaching can be more inclusive. Piano learner. As teaching forms become more and more diversified, teaching content needs to be improved accordingly. In 2021, Xu Mengchen put forward the strategy of innovating teaching methods, enriching teaching content, and combining theory and practice in response to the problems of single content, lack of innovation, and insufficient combination of theory and practice in piano teaching in colleges and universities [4]. The above-mentioned discussion and research on teaching reforms still remain at the level of theoretical analysis, and there are still greater difficulties when colleges and universities implement specific implementations. This article will use the SVM model optimized by slack variables to quantitatively analyze the teaching reform work to obtain more objective and effective reform methods.
2. Principle

2.1. Principle of svm algorithm
SVM is a two-class model. But after modification, it can also be used to classify multi-category problems, which is a common method of discrimination. In the field of machine learning, it is a supervised learning model, usually used for pattern recognition, classification and regression analysis. Support vector machines can be divided into two categories: linear and nonlinear. The main idea is to find a hyperplane in space that can divide all data samples, and make the distance between all data in the sample set and this hyperplane the shortest. The original SVM optimization problem can be expressed as:

\[
\min \frac{1}{2} \| \omega \|^2
\]

Subject to \( y_i (\omega \cdot z_i - b) \geq 1, \forall i = 1,\ldots,n \). Need to maximize the distance \( \| \omega \| \) of the hyperplane, Equivalent to minimizing \( \frac{1}{2} \| \omega \|^2 \), \( y_i \in \{-1,1\} \) indicates which side of the hyperplane is point \( z_i \), As shown in Figure 1.

Figure 1. Schematic diagram of support vector machine algorithm.

2.2. Slack variable optimization
In many cases, it is impossible to construct a hyperplane that can divide the data. In actual problems, in order to obtain better results for the sample as a whole, points that belong to the same feature do not need to be strictly on the same side of the hyperplane. At this time, it is necessary to introduce the slack variable \( \xi_i (\geq 0) \), which corresponds to the allowable deviation of the function value interval of the data point \( z_i \). If \( \xi_i \) can be arbitrarily large, then any hyperplane will meet the condition. Therefore, \( \xi_i \) needs to be added to the objective function (2).

\[
\min \frac{1}{2} \| \omega \|^2 + C \sum_{i=1}^{n} \xi_i
\]
2.3. Algorithm flow
The algorithm operation flow chart is shown as in Figure 2.

![Algorithm flow chart](image)

**Figure 2.** SVM algorithm flow chart.

3. Experimental design and result analysis

3.1. Experimental design
The teaching process is a complex system composed of teachers, students, teaching environment, teaching resources and other factors. Each influencing factor affects the quality of teaching together through interaction and their respective effects. Therefore, teaching quality evaluation is a complex nonlinear system fitting problem under the influence of multiple factors, and it is a comprehensive result of multiple evaluation indicators. This study refers to the results of existing teaching quality evaluation related literature, combined with the existing teaching quality evaluation index system, and regards teaching discipline, teaching attitude, teaching content, teaching method and teaching effect as the index layer of teaching quality evaluation. After further analysis, 18 evaluation indicators are obtained. The quality evaluation is divided into five grades: very satisfied, satisfied, general, dissatisfied, and very dissatisfied, corresponding to 5-1 points. See Table 1 for details. This survey is mainly for college students in school. In the form of a questionnaire survey, a questionnaire is designed for college students in combination with the actual situation, and a self-filled anonymous survey is conducted. The number of questionnaires issued is 500, and 500 are actually received.
Table 1. Comprehensive evaluation system of teaching quality.

| Index layer       | Evaluation standard                                                                 | variable | Points |
|-------------------|--------------------------------------------------------------------------------------|----------|--------|
| Teaching attitude | Lesson preparation and teaching documents;                                           | X11      | 5      |
|                   | Use Mandarin throughout the process, with articulation and moderate speaking speed;  | X12      | 5      |
|                   | Serious in teaching and rigorous academic research;                                  | X13      | 5      |
|                   | Dignified appearance and generous teaching attitude;                                 | X14      | 5      |
|                   | Comply with school rules and disciplines;                                            | X21      | 5      |
|                   | Respect and care for students, treat students equally and fairly;                    | X22      | 5      |
| Teaching discipline| Clear goals and substantial content;                                                 | X31      | 5      |
|                   | Meet the requirements of the syllabus;                                              | X32      | 5      |
|                   | The layout of the writing on the blackboard is reasonable, and the handwriting is    | X33      | 5      |
|                   | neat and clear;                                                                      | X34      | 5      |
|                   | The teaching courseware is beautifully designed with both pictures and texts;        | X35      | 5      |
|                   | Lectures are refined, organized, and important and difficult points are prominent;   | X36      | 5      |
|                   | Use professional foreign languages reasonably;                                       | X37      | 5      |
|                   | Respond to the frontiers of disciplines and integrate theory with practice;          |          |        |
| Teaching content  | The teaching method is flexible and diverse, focusing on the cultivation of ability  | X41      | 5      |
|                   | and literacy;                                                                        | X42      | 5      |
|                   | Reasonably use traditional teaching methods and modern teaching techniques;          |          |        |
| Teaching effect   | Give full play to the leading role of teachers, have an active classroom atmosphere  | X51      | 5      |
|                   | and good interaction;                                                               | X52      | 5      |
|                   | Have corresponding classroom management measures;                                    | X53      | 5      |
|                   | Students have strong interest and can master the corresponding knowledge and skills; |          |        |

3.2. Result analysis
The performance of SVM is closely related to the choice of kernel function, and the support vector machines constructed by different types of kernel functions are also different. In the current related research, the choice of kernel function type is usually based on the experience of the experimenter. The commonly used kernel functions of SVM include Linear, Polynomial, Radial Basis Function, RBF and Sigmoid.

The evaluation accuracy and AUC value of SVM corresponding to different kernel functions are shown in Table 2. The results show that the evaluation performance of SVM with RBF as the kernel function is the best, better than the other three kernel functions, and its evaluation accuracy and AUC value are 92.7% and 0.974, respectively.
Table 2. SVM evaluation performance corresponding to different kernel functions.

| Kernel function | Accuracy (%) | AUC value |
|-----------------|--------------|-----------|
| Liner           | 83.77        | 0.850     |
| Polynomial      | 91.97        | 0.970     |
| RBF             | 92.70        | 0.974     |
| Sigmoid         | 87.73        | 0.890     |

In order to verify the evaluation performance of the SVM model, Bayes, KNN and decision tree C4.5 are used as comparison models to perform evaluation and verification respectively. The evaluation results of the four models are shown in Table 3. It can be seen from the results that the evaluation accuracy and AUC values of Bayes, KNN and decision tree C4.5 are 90.11% and 0.93, 93.77% and 0.960, 86.08% and 0.900, which are all smaller than SVM.

Table 3. Evaluation performance of different models.

| Evaluation model | Accuracy (%) | AUC value |
|------------------|--------------|-----------|
| Bayes            | 90.11        | 0.930     |
| KNN              | 91.77        | 0.960     |
| C4.5             | 86.08        | 0.900     |
| SVM              | 92.70        | 0.974     |

Before evaluating the sample instances, in order to verify the correctness of the model, the survey results of 500 survey subjects were brought into the model, and the satisfaction of piano teaching work was judged again, as shown in Figure 3. The average of the satisfaction degree test results was obtained after inspection. The accuracy rate is 92.70%, and the accuracy is high, indicating that this model has a high reference value for college piano teaching.

![Figure 3. Comparison of actual values of piano teaching evaluation results and SVM predicted values.](image-url)
Based on the simulation results, this article puts forward the following suggestions for piano teaching reform:

1. Teaching content is the foundation of students' learning, and has a direct relationship with students' knowledge and understanding of music and piano. Therefore, the teaching content should be reformed when the piano lessons of college music majors are reformed.

2. In addition to teaching content, teaching methods are also an important part of teaching reform. Novel and interesting teaching methods can effectively stimulate students' interest in piano learning. Therefore, piano teachers should reform the teaching methods to make students prefer piano lessons.

3. There is a teaching method course for English majors in colleges and universities, but it is not in piano teaching, so the piano teaching method course can be added to the piano teaching reform of college music majors. Mainly for the explanation of piano theory knowledge, which is not the same as the general piano course knowledge explanation. The theoretical knowledge explained in the piano teaching method course is more comprehensive and systematic, and the analysis of piano learning rules is more thorough, so schools and teachers should pay attention to this course.

4. Conclusions
This article uses SVM as the teaching quality evaluation model to provide a reference for teaching reform. SVM has great advantages in solving problems of non-linearity, small samples, high dimensionality, and local minima. SVM has shown excellent performance in the evaluation of teaching quality. The addition of slack variables is of great help to the improvement of SVM evaluation performance. Therefore, the SVM piano teaching quality evaluation system based on the optimization of slack variables constructed in this study is of great significance for improving the teaching quality of universities and promoting professional construction and teaching reform.

References
[1] Fu Long. Based on the method and path analysis of college piano teaching reform [J]. Art Criticism, 2019(23): 109-110+125.
[2] Wang Xia. The method and path analysis of piano teaching reform in colleges and universities[J]. Art Criticism, 2020(23): 74-77.
[3] Lu Wei, Zhou Ziwen, Pu Junhong. Reform of piano teaching mode led by new Internet technology[J]. Sichuan Drama, 2020(06): 168-170+177.
[4] Xu Mengchen. Thoughts on the reform of piano teaching in colleges and universities[J]. Decision Exploration (Part 2), 2021(02): 61-62.