Scalable Computer Interactive Teaching System Based on Large Scale Multimedia Data Analysis

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Abstract

The emergence of computer interactive teaching system greatly facilitates the needs of students to learn anytime and anywhere at this stage. At the same time, the increase of online course video, voice, files and other teaching resources also puts forward higher requirements for the operation of the teaching system. Based on the actual needs of online teaching, this paper designs an extensible computer interactive teaching system with the aid of large-scale multimedia data analysis algorithm. Because of the complexity and large volume of the data in the teaching system, this paper uses the linear data feature extraction algorithm of principal component analysis to extract the most basic low dimensional features of the data, and reconstructs the data through the linear transformation method to achieve data prediction. Most online course resources are displayed in the form of multimedia. Therefore, this paper uses robust component analysis to process multimedia data, especially for some problems such as data missing and multimedia data interference. This paper uses RC ranking related evaluation method and R-value evaluation method to evaluate the prediction data, which proves that parameter selection plays an important role in controlling sparse regression. And the actual teaching system resources related video and picture data were tested, and the results showed that the algorithm used in this paper had the best data recognition performance when the number of theme models was 100, which provided an important reference for the design of the system. Finally, this paper designs a computer interactive teaching system which includes three modules: administrator, student and teacher, and tests the system, which proves the practical operation possibility and application value of the system.

1 Introduction

Network education and teaching, which are not limited by time and region, provide different and diverse courses for each Internet user. Therefore, more and more teachers and students use network teaching, and give network education a lot of praise. In the context of the rapid upgrading of network and computer technology, the platform has begun to improve its beautiful interface and customized autonomous learning environment, and its operation has become easier to use and its functions have become more perfect. Based on the continuous development of multimedia, artificial intelligence and human-computer science, current online education research mainly focuses on the intelligent interactive education system that places students in the learning center, and focuses on improving teachers' experience and wisdom when using computers. By using computers to simulate the thinking process and change the traditional learning mode, students can voluntarily retrieve the knowledge in the system or carry out customized learning according to their personal characteristics. Therefore, it can promote students' understanding and acquisition of knowledge, stimulate students' learning motivation and fun. The interactive teaching system based on multimedia data mining is an interactive teaching system that uses data extraction technology to analyze students' learning characteristics. The importance of studying interactive teaching system lies in improving the quality of online education, ensuring that the intelligent system can complete the work of some teachers and reduce their workload. So as to realize the individuation of educational methods and the diversification of educational content.

The interactive teaching system uses technologies related to data development to identify and analyze learning characteristics and effect characteristics, educational strategies and effects, rational use of educational resources, and optimization of educational models and strategies. Not only can we use technology to extract and analyze the information about the students' education process and learning content stored in the site, but also we can redesign it according to the textbooks in the textbook library, making the curriculum closer to the educational rules and students' personal needs. Recommend appropriate training resources according to potential needs, analyze student behavior through Internet search technology, modify the website structure according to the found student access mode, and approach the mode that students are used to. The unprecedented online multimedia data source is one of the most typical data sources in the education system. In addition, the configuration of multimedia data is gradually changing from a single media to a form of interactive use of multiple media. The interactive teaching system uses data mining technology to analyze the educational strategies and learning processes of teachers and students. The results can be used for the customization of educational strategies, the simplification of courses and personalized learning.

2 Related Work

It is mentioned in the literature that with the wide popularization of mobile terminals and the development and application of information technology, multimedia technology has gradually developed and expanded [1]. To some extent, it has affected the mode of traditional teaching methods. In view of the drawbacks of the traditional teaching mode, the literature expounds that all students focus on learning, which is difficult to be taken care of in the traditional comprehensive teaching [2]. Therefore, in most cases, students do not seem to be able to fully teach the results of skill tests, which brings a great burden to teachers after class. In addition, it is inconvenient for students to communicate with teachers, which seriously affects teachers' burden after school, and students' learning effect is also poor. The literature describes that the online information interactive learning system has the characteristics of real-time interaction, which enhances the communication between teachers and students, and promotes the sharing of educational resources to a certain extent [3]. The literature emphasizes that through this way, resources can be integrated and communication can be extended to the greatest extent [4]. Teachers and students can communicate in this way. Students and students can feedback information about learning, develop the situation of joint learning, and reduce the burden on students and teachers. According to the literature, online teaching interaction can improve students' learning ability of skills, enable students to develop the habit of independent learning, and become more efficient in learning the teaching content [5]. According to the literature, online teaching interactive system enables students to quickly and timely feed back to teachers when they encounter problems in the learning process [6]. The teacher can check and answer this question in the background. At the same time, when encountering the same questions of students, you can first browse the answers to relevant questions to avoid repeating the same questions, which saves time and improves efficiency to a certain extent. It is mentioned in the literature that the implementation of interactive learning information system can change the traditional teacher centered education form and form a new student centered education mode [7]. It is mentioned in the literature that

the intelligent teaching system is integrated with the methods and technologies of artificial intelligence to simulate human teachers' teaching, stimulate students' learning initiative, improve students' learning quality, and improve teachers' teaching quality [8]. It is an interactive and adaptive learning system. At the same time, the intelligent teaching system is not perfect. For example, it is mentioned in the literature that under the online teaching form, students cannot communicate with teachers face to face, students' learning state is difficult to grasp systematically, and it is difficult to measure the learning effect [9]. After observing the learning state of learners in the literature, it is found that learners often do other things while watching video courses. Online courses become the background music of other activities [10]. In response to this problem, the literature introduces the basic characteristics of the online teaching system at this stage, which will use the Internet teaching means carrier to add more teaching interaction on some teaching nodes of online videos, such as click operation, exercise questions, staged summary tests, etc [11]. At the same time, through the front camera of the mobile phone, we can identify learners in a targeted way, obtain the actual learning status data of learners, evaluate the learning effect of learners on a basis, and conduct a more comprehensive analysis of the reasons for their failure.

According to the literature, student information management system, educational administration management system and teacher management system can be continuously used in the interactive learning system [12]. They tend to coexist, each containing a lot of valuable data. Literature uses data collection technology to manage student information, evaluate higher education, analyze student achievements and test systems, which become a good driving force to improve the level of school education [13]. The literature emphasizes that multimedia has become the carrier of education system since it emerged as the main means of information resources [14]. More effective use of such information resources is the goal that the academic community has been committed to. With the arrival of big data, this demand is more urgent. It is mentioned in the literature that multimedia data analysis technology, as an important field of multimedia content analysis, is widely used in financial, biological information, security, medical and other fields [15]. In the literature, multimedia data prediction is an analysis method based on existing data information to predict changes and trends [16]. Different research objects can be divided into different topics for research. For example, a timeline of prediction data, represented as an output signal from a multimedia sensor, prediction of single media data represented by images/videos, and cross media data displayed on a social network, etc. The literature explains that cross media information has the characteristics of huge data volume, rapid updating, diversification and variability [17]. It emerged as a new type of data source. Compared with traditional multimedia information, it has many differences. For example, their information sources are often not single, but diversified. Information sources are more collections of information flows with different structures. In addition, these different kinds of data may be related to some extent.

3 Basic Knowledge Of Large-scale Multimedia Data Analysis

3.1 Multimedia data feature extraction algorithm

The minimum reconstruction error principal component analysis has smaller error compared with the original data, and its objective function is:

$$\mathrm{W}_{opt} = \underset{\mathrm{W}, \mathrm{W}^T\mathrm{W} = \mathrm{I}}{\operatorname{argmin}} \|\mathrm{X} - \mathrm{W}\mathrm{W}^T\mathrm{X}\|_F^2$$

1

On this basis, we can obtain:

$$\mathrm{W}_{opt} = \underset{\mathrm{W}, \mathrm{W}^T\mathrm{W} = \mathrm{I}}{\operatorname{argmin}} Tr\left(\mathrm{X}^T\mathrm{X} - \mathrm{X}^T\mathrm{W}\mathrm{W}^T\mathrm{X}\right)$$

2

Formula (2) is equivalent to:

$$\mathrm{W}_{opt} = \underset{\mathrm{W}, \mathrm{W}^T\mathrm{W} = \mathrm{I}}{\operatorname{argmax}} Tr\left(\mathrm{X}^T\mathrm{W}\mathrm{W}^T\mathrm{X}\right)$$

3

Based on the characteristics of matrix trace, formula (3) can be transformed into

$$\mathrm{W}_{opt} = \underset{\mathrm{W}, \mathrm{W}^T\mathrm{W} = \mathrm{I}}{\operatorname{argmax}} Tr\left(\mathrm{W}^T\mathrm{X}\mathrm{X}^T\mathrm{W}\right)$$

4

Using the Lagrangian multiplier method, the constrained problem is transformed into an unconstrained problem with the following formula (5):

$$\mathrm{W}_{opt} = \underset{\mathrm{W}}{\operatorname{argmax}} Tr\left(\mathrm{W}^T\mathrm{X}\mathrm{X}^T\mathrm{W}\right) \text{-} Tr\left(\bigwedge\left(\mathrm{W}^T\mathrm{W} - \mathrm{I}\right)\right) \text{(5)}$$

At the same time:

$$\mathrm{W}_{opt} = \underset{\mathrm{W}^T\mathrm{W} = \mathrm{I}}{\operatorname{argmax}} \sum_{i=1}^{N} \|\mathrm{f}_i\|_2^2$$

6

Finally:

$$\mathrm{W}_{opt} = \underset{\mathrm{W}^T\mathrm{W} = \mathrm{I}}{\operatorname{argmax}} Tr\left[\mathrm{W}^T\left(\sum_{i=1}^{N}\mathrm{X}_i\mathrm{X}_i^T\right)\mathrm{W}\right]$$

7

Short time energy refers to all energy gathered by a sampling point signal in a short time audio frame, and its calculation formula is:

$$E_n = \sum_m \left[x\left(n\right)w\left(n-m\right)\right]^2$$

8

The amplitude of audio signal will change with time, and its audio loudness is calculated as follows:

$$v\left(n\right) = \sqrt{\frac{1}{N}\sum_{n=1}^{N-1}x^2\left(n\right)}$$

9

In a short time frame, the short-time zero crossing rate of the sampled signal value reflects the evaluation rate of the audio signal in a short time. The calculation formula is:

$$sgn\left(x\left(n\right)\right) = \begin{cases} 1, x\left(n\right) \geq 0 \\ -1, x\left(n\right) < 0 \end{cases}$$

10

The frequency domain energy is defined as follows:

$$FE = \int_0^{\omega 0}\left|F\left(\omega\right)\right|^2 d\omega$$

11

The index for measuring audio brightness is called the center frequency. In general, the center frequency of music is higher than that of speech. The calculation formula is as follows:

$$FC = \frac{\int_0^{\omega 0}\left|F\left(\omega\right)\right|^2 d\omega}{FE}$$

12

The index measuring the frequency domain range of audio is called broadband. Generally, the bandwidth range of voice is between 300-3400Hz. In comparison, the bandwidth range of music is wider than that of voice. The calculation formula is as follows:

$$BW = \frac{\int_0^{\omega 0} (\omega - FC) \left| F(\omega) \right|^2 d\omega}{E}$$

13

3.2 Research on multimedia data processing function

Given a data matrix X, first, the Lagrange multiplier Y is introduced to calculate the augmented Lagrange function of the objective function:

$$L(\mathrm{A}, \mathrm{E}, \mathrm{Y}, \mu) = \|\mathrm{A}\|_* + \lambda \|\mathrm{E}\|_1 + \frac{\mu}{2} \|\mathrm{X} - \mathrm{A} - \mathrm{E} + \frac{\mathrm{Y}}{\mu}\|_F^2$$

14

Secondly, A is fixed and E is calculated. The above problem is converted to the standard Lasso form, as shown in the following formula (17):

$$\mathrm{E}^* = \underset{\mathrm{E}}{argmin} \frac{\lambda}{\mu} \|\mathrm{E}\|_1 + \frac{1}{2} \|\mathrm{E} - \left(\mathrm{X} - \mathrm{A} + \frac{\mathrm{Y}}{\mu} \right)\|_F^2$$

15

Thirdly, E is fixed to find A, and the above optimization problem is converted into the following formula (18):

$$\mathrm{A}^* = \underset{\mathrm{A}}{argmin} \frac{1}{\mu} \|\mathrm{A}\|_* + \frac{1}{2} \|\mathrm{A} - \left(\mathrm{X} - \mathrm{E} + \frac{\mathrm{Y}}{\mu} \right)\|_F^2$$

16

In order to more easily grasp the prediction of image memory, image attributes need to be well characterized. When evaluating the prediction results, it is often necessary to adopt two methods: RC ranking correlation evaluation method and R-value evaluation method. The calculation formula of RC sorting method is:

$$RC(r_1, r_2) = 1 - \frac{6 \times \sum_{i=1}^{N} (r_{1i} - r_{2i})^2}{N \times \left(N^2 - 1 \right)}$$

17

To test the convergence performance of the proposed algorithm, we randomly select one time and report the results. Since matrix A can be directly used to map the original characteristic matrix into a low rank subspace, we measure the perturbation of matrix A during iteration by the following measures:

$$D\left(t+1\right)=\left\|\mathrm{A}_{t+1}-\mathrm{A}_{t}\right\|_{F}^{2}$$

18

In all parameters, λ The choice of is essential to predict the performance impact. Parameters used to control the influence of sparse regression λ To express. Table 1 shows the λ Value to predict performance. In the following table, we selected the images in the top 20 and top 100, and the images in the bottom 20 and bottom 100 respectively according to the true popularity scores, and calculated the average of the predicted memory scores.

Table 1
Different λ Predictive performance of algorithm with value

	0.01	**0.1**	**1**	**10**	**100**
Top 20	0.6627	0.8562	0.8675	0.8688	0.8687
Top 100	0.6892	0.8020	0.8297	0.8291	0.8288
Bottom 20	0.6241	0.5603	0.5354	0.5359	0.5361
Bottom100	0.6167	0.4840	0.4562	0.4594	0.4671
RC	0.0996	0.5361	0.6422	0.6419	0.6414
R-value	0.0907	0.5366	0.6350	0.6348	0.6343

It can be seen from Table 2 that when the supervised regression information is discarded, noSR achieves the worst prediction effect. This shows that effective supervised learning is very important to improve the prediction accuracy of the prediction model. In addition, because the noSR model divides the whole learning process into two stages, it makes it impossible to learn the two processes of mutual monitoring and guidance, which leads to poor prediction. It shows that it is necessary to introduce low rank constraint and graph regularizer, and the influence of graph regularizer on the prediction of image memory is weaker than that of low rank constraint.

Table 2
Prediction performance of algorithm under different components

	noSR	noLR	noGraph	All
Top 20	0.7638	0.8372	0.8704	0.8648
Top 100	0.6997	0.8289	0.8279	0.8271
Bottom 20	0.6570	0.5362	0.5360	0.5337
Bottom100	0.6470	0.4786	0.5112	0.4548
RC	0.0953	0.6174	0.6262	0.6383
R-value	0.0987	0.6032	0.6160	0.6331

During the analysis of multimedia data by the algorithm, each video is first displayed in a unified manner of 6 frames, and then each frame is divided into 10 × 13. Then each frame is converted into a vector, and a new vector is formed to represent a gesture video.

In the whole process, there are two very important parameters, namely the number of topic models K and the number of words in each text topic N. The similarity between images is calculated by using Euclidean distance and texture features of images.

4 Application Design Of Extensible Computer Interactive Teaching System

4.1 Analysis of overall system model design

According to the requirements of the system, the overall design architecture of the whole auxiliary teaching system is shown in Fig. 3.

In the use of computer course teaching system, the users are mainly administrators, students and teachers. These three types of subject objects constitute the most important users of the system.

4.2 Analysis process of system multimedia data

Multimedia data mining mainly includes a series of basic steps described in Fig. 4. The data acquisition module is the intelligent core of the intelligent learning system based on data extraction, which is mainly composed of relevant supervision sub modules and classification sub modules. The key features extracted from each part can be analyzed by using data collection techniques such as relevant rules and classification to determine the temporal and spatial relationships between features. The whole process includes data selection and collection, data preprocessing, data cleaning and analysis, data exchange and tool selection, and finally generates data analysis results.

4.3 Systematic test results and analysis

The classification algorithm of data collection includes analyzing these classification rules according to the accumulation of training data, and then classifying other types of data in the same form, and providing effective guidance for the business system. To more clearly describe the ID3 algorithm, we set A as the training data set and m as the number of categories in the training data set. The entropy of A, that is, the expected value formula, can be expressed as:

$$\text{entropy}\,(\mathrm{A}) = -\sum_{i=0}^{m} p_i \log_2 p_i$$

19

If attribute E divides training data set A into n parts, the entropy of these divided subsets, that is, the expected value formula, can be expressed as:

$$\text{entropy}\,(\mathrm{A}) = -\sum_{i=0}^{m} p_i \log_2 p_i$$

20

Considering the combination of association rules r1 and r2, it is possible that the left and right parts of the two rules are the same or similar, or the left or right sides of the two rules can be combined. In the case that the attributes of the left and right sides of the two rules are equal and similar, the formula for calculating the confidence level of the new rule r according to rules r1 and r2 is:

$$\text{confidence}\,(\mathrm{r}) = \mathrm{s}\,(\mathrm{r})\,/\mathrm{s\_lhs}\,(\mathrm{r}_1)$$

21

In order to compare the efficiency of approximate association algorithm and Apriori algorithm. The data used in the experiment provides students with a set of historical data, which are collected and accumulated in the forefront of the learning system. Figure 5 shows the difference between the optimized association approximation algorithm and the traditional relational analysis algorithm. If the operation records in the database are not executed at the same time, the algorithm optimized in this paper is considered to be more effective than the classical Apriori algorithm when the minimum support is used, which shows the efficiency and availability of the algorithm optimized in this paper.

We set the simulated threads to 1, 10, 20, and 100 for multiple groups of performance tests. The capacity of the message queue in each group of performance tests is set to 1000. The results of HBase based performance tests are shown in Table 3.

Table 3
Upload performance test results based on HBase data

Number of impersonation threads	Number of user threads	Run time (seconds)	Upload request/sec	Data loss rate
1	30	17.3	611.4	0%
10	30	68.4	1521.3	0%
20	30	75.2	2762.6	0%
100	30	653.8	1552.8	0%
100	50	584.8	1742.9	0%
100	100	446.2	2345.7	0%

The image reading and writing performance test includes the performance test of two operations, namely, image import and image reading. Image import includes two steps: image segmentation and image block writing; Image reading is also divided into two steps: reading image blocks and image block splicing. We have prepared four sets of performance tests. In the test, the size of the image data set is 100MB, 515MB, 1.1GB and 5.1GB respectively. As shown in Fig. 6, in the four groups of performance tests, the interface throughput in the HBase environment is better, which proves that HBase can also provide storage and access services for real-time applications through secondary indexing.

5 Conclusion

Different from classroom learning, the interactive teaching system has incomparable advantages over traditional school education. In addition to avoiding the time and space limitations of traditional education models, it can also save learning data and learning resources to achieve more detailed and intuitive analysis of learning conditions and sharing of teaching resources. The free learning environment of online teaching system helps students to use existing knowledge and skills to inspire each other, and realizes more extensive interaction in learning activities. As an information exchange activity of online learning, students are more flexible in resource acquisition, and can successfully understand the knowledge resources obtained through various learning, understand knowledge and construct the meaning of new knowledge. In this paper, the large-scale multimedia data analysis is introduced into the teaching system, and the operation data mining technology is used to develop a set of online learning system for courses in line with the teaching reality, and the system administrator, teachers and students' respective permissions are specified according to the needs. The reliable large-scale multimedia data analysis technology is used for the analysis of learning resources in the interactive teaching system. Finally, the system is tested and analyzed. The system achieves its goal by realizing the basic online management of student information and teacher courses, as well as the functions of course video data analysis, upload, modification and update. In the whole process of learning, through data mining, we analyze and formulate appropriate and targeted learning suggestions.

Declarations

Compliance with Ethical Standards

Conflict of interest

The authors declare that they have no conflict of interests

Ethical approval

This article does not contain any studies with human participants performed by any of the authors.

Data Availability

Data will be made available on request.

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Figures

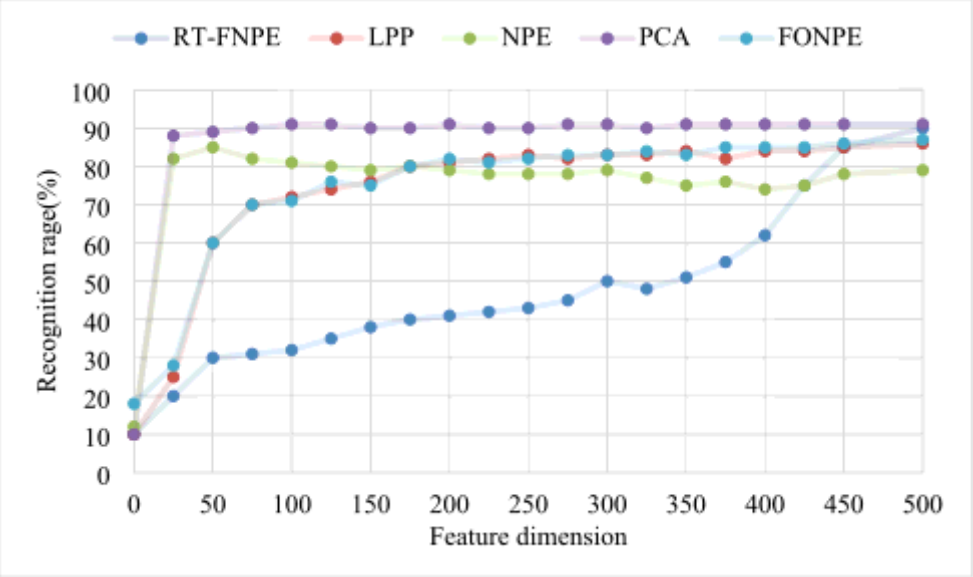

Figure 1

Curve of recognition rate changing with the number of projection vectors on database

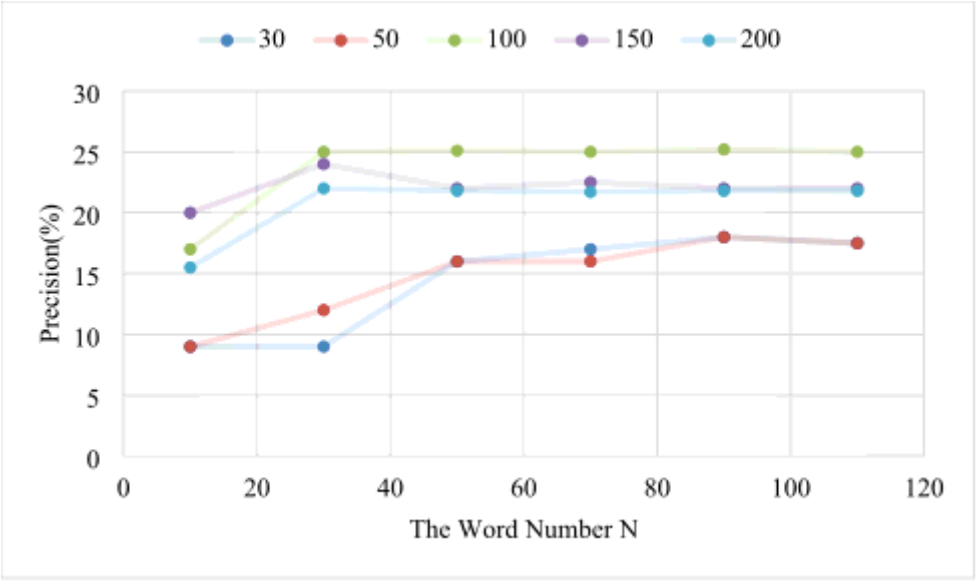

Figure 2

The Influence of the Number of Words on the Prediction of Picture Location

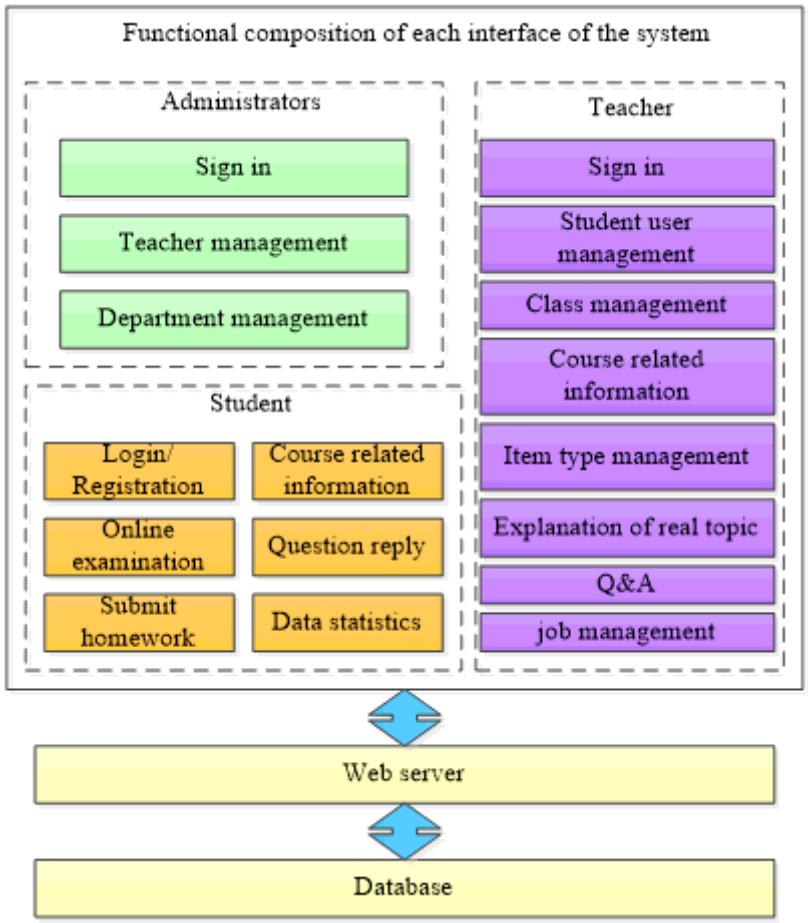

Figure 3

System overall design architecture diagram

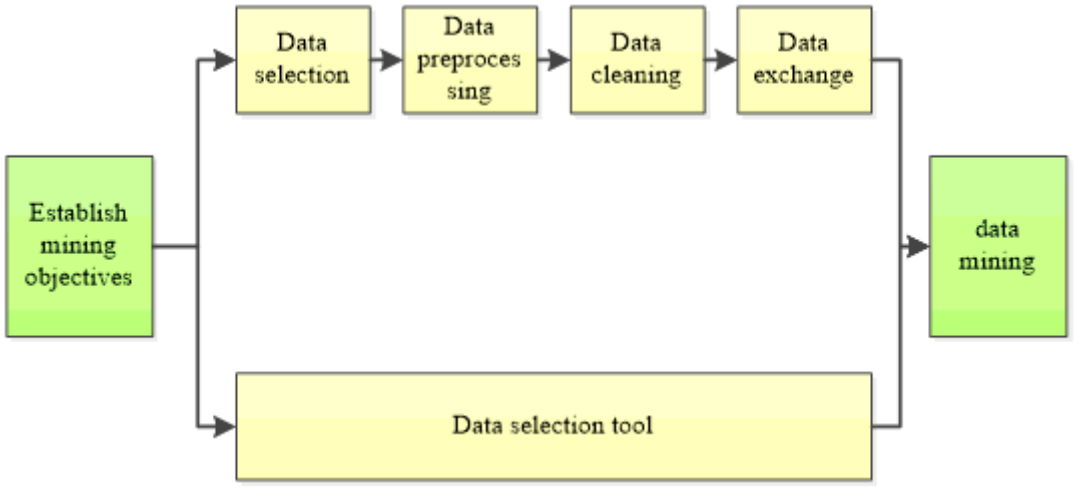

Figure 4

Data analysis process

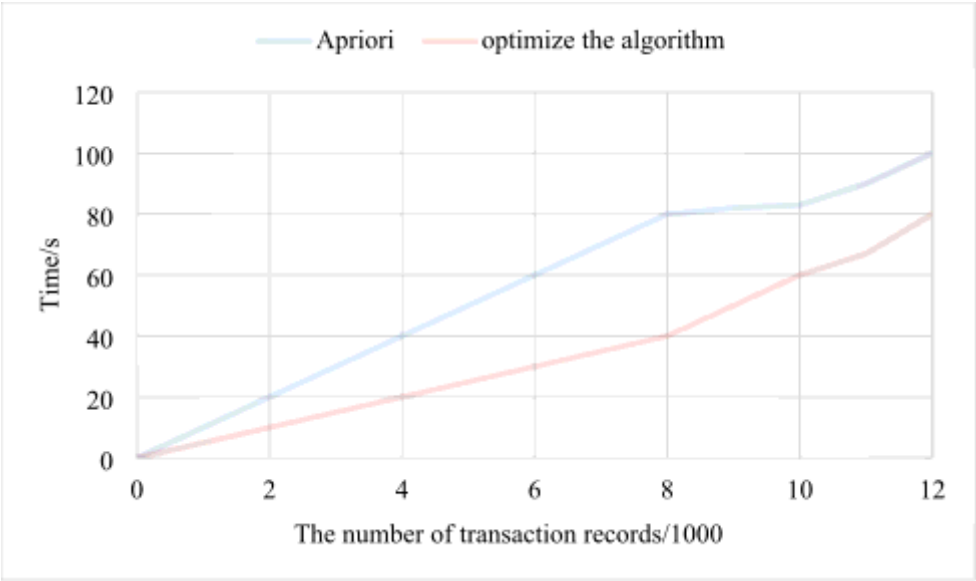

Figure 5

Comparison of execution time under different transaction records

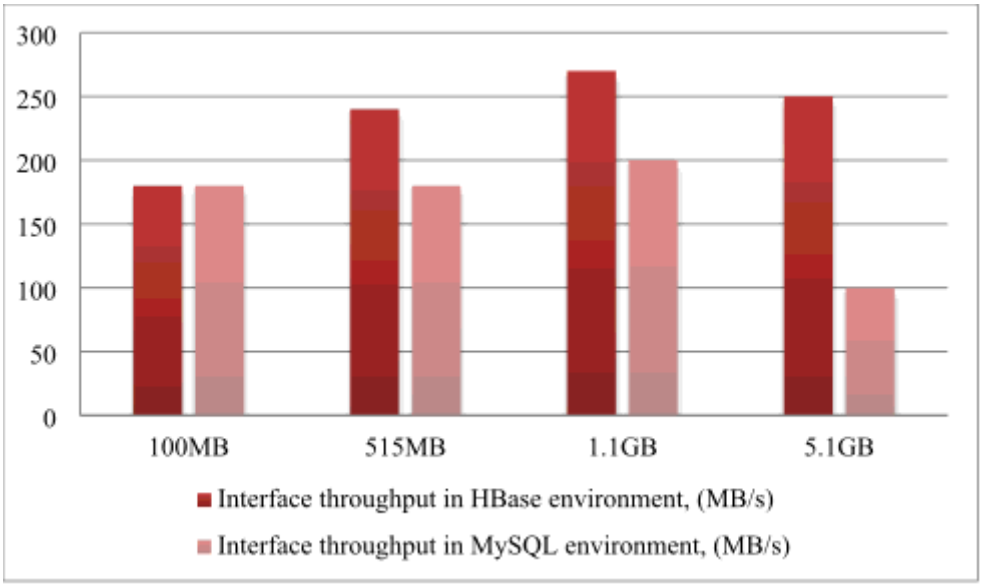

Figure 6

Throughput results of interface performance test