Design of Networked and Digital Teaching Platform based on Big Data

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Abstract. In the traditional network-learning, we have produced the massive data, but they do not play a corresponding role in the actual teaching, therefore, large data technology is used for improving the existing teaching platform, so that it can dig the hidden knowledge in teaching, this issue has become a hot topic that many educators continue to explore. We deeply study the big data technology, take MapReduce as the data analysis model, introduce clustering technology and association rule as the main models of data analysis, which are used for building the teaching platform based on big data. In the process of designing the large data teaching platform, we have built the digital teaching platform and the networked teaching platform respectively, the emphasis of the two platforms is different, among them, the networked teaching platform is used to analyze the students' academic performance, that is, we take a certain student as the research object, analyze the students' different academic achievements, adopt association rules technology, analyze the relationship of different disciplines, to develop a set of knowledge points to improve the performance of students' weak disciplines, and generate a networked large data teaching platform; digital teaching platform can be used for the recommendation of students' suitable curriculum combination, clustering technology will be introduced, analyze the effective combination of disciplines, which can help students improve academic performance, at the same time, students are willing to spend more time on learning, and take the subject combination module as a main function to generate digital large data teaching platform. By the design of digital and network large data teaching platform, they help educators make personalized learning plans for students, therefore, it help more students to achieve their learning goals.

1. Introduction
With the continuous development of information technology[1], information-based teaching platform[2] is also increasing, however, the current information-based teaching platform has homogeneity problems, lack of learning records for individual students, and lack of developing personalized learning plans for corresponding students. Information platform is used in contemporary teaching, students and teachers will get the data they need by this platform, students can inquire about their own learning curriculum information, teachers can inquire about students' performance information, but these information are static, lack of effective analysis of information[3]; at the same time, people can get the resource of education by mobile phones, PAD and other devices, the capacity of educational resource is increasing, however, for different students, it is difficult to obtain the learning resources they need, which result in a lot of waste of resources.

The current information-based teaching platform is difficult to make a reasonable judgment for different learners, that is, what kind of teaching methods can be adopted for different learners, what kind of teaching content can be made, so we can achieve the teaching strategy of differentiation[4]. Information-based teaching platform helps teachers and students obtain more information, but it is
difficult for teachers to deeply understand the students' learning circumstances, lack of in-depth analysis for students' learning circumstances. When students put the information-based teaching platform into learning, they will produce a large number of network data[5], which include the registration information of students, students' curriculum plan, students' academic performance, students' discussion of learning knowledge and other data, these data have not been effectively analyzed. Web-based learning platform only saves students' learning data, and does not analyze students' learning data, which include students' interest, students' weak disciplines, students' learning problems, the analysis of these data is conducive to teachers to improve their teaching quality. Adopting large data technology[6] and applying it to teaching process can solve the problem of lack of reasonable data analysis.

The United States has created big data technology, they adopted data mining technology and in-depth learning technology to reform the teaching mode in the United States. In view of the problems of students' lack of interest in learning, slow rise of students' academic performance, and lack of in-depth understanding of students' learning circumstances among teachers, data mining technology is adopted to do deep analysis for teaching data, they introduced deep learning model to generate students' personalized learning model[7]; some scholars studied the bayesian probability distribution model[8] and put it into establishing the learning analysis model, students generated the problems of learning by this model, which can be feed back to the system, the system can analyze the students' next step of learning behavior based on bayesian probability; some scholars studied the network teaching system[9], optimized the students' learning model, took the students' learning data and the teachers' teaching strategies as the data source, and made an interactive analysis model, students' learning data includes the students' learning log and the students' discussion of knowledge; some scholars put data mining technology[10] into design of teaching navigation system, which adopts an adaptive teaching model, this model can adjust itself adaptively according to the students' learning feedback; some scholars combined cloud model with data mining technology[11], and the students' learning data will get a big increasing, adopting cloudy model can store data by the technology of cloud storage, data scatter to different servers, at the same time, teachers can remotely visit serers, which can be helpful to teaching planning; some scholars introduced the support vector machine algorithm[12], and the student data can be used for designing analysis model, which includes student's academic performance, student's learning behavior, student's curriculum plan, therefore, the model can analyze students' characteristics of learning and make individualized learning plans; some scholars regarded students and learning system as two objects, learning system includes teaching system, hypertext connection, knowledge model of students-learning system can be built, learning system can change its knowledge structure interactively and guide learning direction of learners by the way of hypertext link[13]; some researchers combined web technology with data mining technology, among them, data mining technology can analyze learners' learning behavior, extract their characteristics of learning, and web technology can be used for generating individualized web management system[14]; some researchers introduced association rules[15], students' learning behavior and students' habits are regarded as a kind of correlative rule, so it can analyze different students' learning habits and provide personalized learning services.

In this paper, large data technology is deeply studied, and MapReduce is used as data analysis model, clustering technology and association rule are introduced as the main data analysis model, which is used for building teaching platform based on large data. In the process of designing the big-data teaching platform, we design the digital teaching platform and the networked teaching platform respectively, the emphasis of the two platforms is different, among them, the networked teaching platform is used for analyzing the students' academic achievements, and each student is regarded as an individual, different students involve many disciplines, analyze the relationship of disciplines and disciplines, make a personal learning plan for each student and a large network data teaching platform is generated; the digital teaching platform can recommend suitable curriculum combination for students, and cluster technology is introduced to analyze the effective combination of disciplines, that is, students' learning preferences and students' academic achievements can be done some analysis of clustering, so as to recommend a personalized discipline collection-student teaching plan.
2. Big Data Technology

In the face of massive data processing, we adopt large data technology, in which we adopt distributed computing framework MapReduce, which scatters the data to many PCs, each PC processes a part of the data, while each PC runs a function, different PCs perform the same task; we adopt clustering technology, the technique can make abstract objects into multiple classes according to certain constraints; association rules are needed to dig the potential relationships between objects, that is, an object can contain multiple attributes, their relationship can be inferred from each other, and an attribute or several attributes are related to another attribute.

2.1. Classical Distributed Computing Framework Mapreduce

It is a computational model that can search and process data quickly in massive data sets, in this model, the problem to be executed is split into Map and Reduce to achieve the effect of decentralized operation, the user specifies a Map function to handle the Key/Value pairs, and generates a series of intermediate Key/Value pairs, and then adopt the Reduce function to merge all intermediate key-value pairs with the same key and put the result as input in the next round of MapReduce model. Programs written by MapReduce function are automatically distributed in a larger cluster of ordinary machines and run, resolve the distributed details of input data during run time. The structure of the algorithm is as follows:

```plaintext
1 Map(String key, String value)
2 initialize: key -> document name;
3 initialize: value -> document contents for each word W in value;
4 EmitIntermediate(W, "1"); reduce(String key, Iterator values);

1 Reduce(String key, int[] values)
2 initialize: key: a word
3 initialize: values: a list of counts
4 int result = 0;
5 for each v in values:
6     Result += ParseInt(v);
7     Emit (as String(result));
8 end for
```

2.2. Clustering Technique

The function of clustering is to divide scattered individuals into a group according to the characteristics of the data and the similarity of the features, therefore, they can form a number of groups. In clustering algorithm, the K-means clustering algorithm is the most common clustering algorithm, this method divides the data object into several clusters by the idea of repeated iteration, each cluster sets the corresponding objective function, the shorter the distance between the nodes of the cluster and the central point, the closer the relationship between the elements in the cluster. The distance is calculated as, the difference of distance between each element of cluster and the center point can be taken as a value $f_k$, getting multiple values {$f_{k1}$, $f_{k2}$, $f_{k3}$.....$f_{kn}$} by calculation, which is calculated the sum of squares, the purpose of iteration is to ensure that the sum of these values is the minimum. The implementation process of K means clustering algorithm is as follows:
1 Initializing K cluster centers;
2 for (i = 0; i < Intermax; i++)
3   for (j = 0; j < Num(samples); j++)
4     samples in the dataset are allocated to the nearest central point \( k_j \);
5   endfor
6  for (p = 0; p < K; p++)
7     recalculate central points in clusters, get \( \{ k_c_p \} \);
8     if (\( k_c_p < k_i \))
9       back to step 3;
10    endif
11  endfor
12 endfor
13 output the final central points.

2.3. Association Rule Technology
In association rules, a core concept is minimum support. Minimum support denotes the minimum
occurring frequency of different commodity combinations that needs to be reached in different
transactions, or it can also be described that the subset of the K-dimensional item needs to be set the
lowest frequency to meet the minimum support. Based on item set and item subset, the item subset
that reaches minimum support is also called frequent item set. According to the idea of association
rules, the following definitions are satisfied: (1) The necessary condition for k-dimensional data
itemset \( L_k \) being a frequent itemset is that all \( k-1 \)-dimensional sub-itemsets are also frequent itemsets,
which are recorded as \( L_{k-1} \). (2) If any subset \( L_{k-1} \) of k-dimensional data item set \( L_k \) does not satisfy the
condition, then k-dimensional data item set \( L_k \) is not a frequent item set; (3) In k-dimensional itemsets,
if the number of v-dimensional itemsets in all \( (v < k-1) \) subsets is less than k, then \( L_k \) can not be the
most frequent data itemsets.

1 Initialize the collection of data items, and each data item collection gives a ID
2 for (int i = 0; i < num of data items; i++)
3   splitting data items into a collection of individual data;
4   form can be denoted as \([\text{data items, ID of data item sets}]\);
5 endfor;
6 for (j = 0; j < num(data items); j++)
7   calculate the frequency of data items;
8   form can be denoted as \([\text{data item, frequency}]\);
9 endfor
10 for (i = 0; i < num of data items; i++)
11   if (frequency > 2 && elements have the same ID of dataitems)
12     output the group of dataitems;
13   endif
14 endfor

In the above algorithm, we need to split the data items into a set of individual data, each sample output
in the form of \([\text{data items, ID}]\) (lines 1-5); calculate the frequency of each data item (lines 6-9); if the
frequency of the data items is greater than 2 and they exist in a set, the subset of the data items is taken
as a set of frequent items, output the results (line 10-14).

3. Design of Networked Teaching Platform Based on Big Data Technology
We collect academic achievement, introduce association rules’ information, and dig the internal links
between different disciplines, for the weaker disciplines, we regard the links between disciplines as a
solution. As a module, the relationship between disciplines is used for building a network teaching
platform based on large data technology, we put forward the general framework of the platform, and
analyze the structure of the platform.
3.1. Student Achievement Acquisition and Preprocessing

We conduct a subject analysis of student performance, subject performance can be seen as data, data needs to be collected, pre-processing, this is a very important step. In the distributed computing model, the data need to be set to the corresponding format, so they can be processed, further analysis of reasons can be made, which include: (1) data types need to be converted, the lack of format data will appear mismatch problem of the algorithm; (2) data needs to be pre-processed, data processing needs many stages, not a step to be achieved. The preprocessing effect of data directly determines the effect of data analysis. According to the running time distribution of MapReduce, the time of data preparation accounts for about 70% of the whole running process, therefore, data preprocessing plays an important role in the results of data analysis.

We collect data from student achievement and get the data format as shown in Table 1:

| Name   | Student ID  | Curriculum                  | Class period | Type               | Score |
|--------|-------------|------------------------------|--------------|--------------------|-------|
| Xiefang| 181506315   | college english             | 60           | required course    | 83.7  |
| Xiefang| 181506315   | computer basis              | 60           | required course    | 92.5  |
| Xiefang| 181506315   | graphic design information  | 60           | required course    | 86.7  |
|        |              | theory and coding           |              |                    |       |
| Xiefang| 181506315   | system design and analysis  | 35           | elective course    | 87.7  |
|        |              |                              |              |                    |       |
| Xiefang| 181506315   | matrix analysis              | 60           | required course    | 80    |
|        |              |                              |              |                    |       |
| Xiefang| 181506315   | practical writing            | 35           | elective course    | 88    |
|        |              |                              |              |                    |       |
| Xiefang| 181506315   | cloud computing              | 60           | required course    | 86.5  |
|        |              |                              |              |                    |       |
| Xiefang| 181506315   | advanced architecture        | 60           | required course    | 87    |
|        |              | computer mathematics         |              |                    |       |

In Table 1, we can see that the results of each subject are listed, at the same time, each column includes the name of the student, the ID of the student, the course chosen by the student, the class hour, the type of the course, and the grade of the course. In the step of data preprocessing, we set the attributes of student and extract the achievement field in the form of name + student ID, so that we can express the collected data format as [Name_StudentID_Score].

In the MapReduce computing model, we can split the generated data into format [Name_StudentID, Score], where Name_StudentID is the key, and Score is the Value, which helps with the subsequent calculations. The MapReduce model takes the displacement of data as Key, we needs to modify the function in this way. In Table 1, we see that each data has multiple data attributes, but in the process of calculation, we only need to extract a few data attributes.

3.2. Implementation of Association Rules in Analysis Module of Academic Achievements

For each student, they have their own learning habits, they have their own advantages in disciplines, they also have their own weak disciplines. At the same time, it should be noted that there is a certain link between different disciplines, that is, one discipline may be the basis of another discipline, and
some disciplines may be the basis of another discipline. We can take computer programming as an
example, writing functions or achieving the corresponding functions require learners to have a certain
mathematical basis. Based on this, we need to analyze different students’ academic achievements and
analyze the internal links of different disciplines.

Association rules put related data items as a record, store all the records, each record has its own ID,
at the same time, each record may contain the same set of sub-items. We put the principle of
association rules into analyzing the relationship between disciplines, some of the results are shown in
Table 2:

| Support degree | Number of data items | Association rule |
|----------------|----------------------|------------------|
| 257            | 2                    | (data structure>8) => (cloud computing>7) |
|                |                      | (advanced mathematics>8 ; data structure>8) => (algorithm design>7) |
| 96             | 3                    | (computer basis>7) => (information theory and coding>7) |
| 127            | 2                    | (computer basis>7) => (information theory and coding>7) |
| 340            | 2                    | (computer basis>7) => (information theory and coding>7) |
|                |                      | (computational framework>8 ; advanced mathematics>8 ; program programming>9) => (cloud computing>7) |
| 27             | 4                    | (computer basis>7) => (information theory and coding>7) |
| 104            | 2                    | (computer basis>7) => (data structure>5) |

In Table 2, we can see that there are 6 relationships: (1) the achievement of data structure directly
affect the performance of cloud computing; (2) the achievements of higher mathematics and data
structure, and the achievements of two disciplines directly affect the performance of algorithm design;
(3) the achievement of computer foundation directly determine the performance of information theory
and the performance of coding disciplines; (4) achievement of computational frameworks, achievement of advanced mathematics, and achievement of programming directly affect the
performance of cloud computing; (5) achievement of computer foundation directly determine the
performance of graphic design; (6) achievement of computer foundation directly determine the
performance of data structure.

We can further find that the degree of connection between different disciplines is different, we take
level 1-level 10 to express the degree of association, the higher the level, the greater the correlation
between disciplines. We can see that the influence’s degree of computer foundation on data structure is
grade 5, and the influence’s degree of computer foundation on graphic design is grade 9, it shows that
the knowledge of computer foundation is very useful to the study of graphic design.

A discipline can have an impact on many disciplines, at the same time, many disciplines can work
together and have a great impact on a discipline, we can express the relationship between disciplines
as follows:
Figure 1. Relationships among different courses

As can be seen from Figure 1, we can further reduce the result of Table 2 to 4 E-R diagrams. In Figure 1, we can see that computer foundation is related to many disciplines, it can affect cloud computing, data structure, information theory and coding, and graphic design disciplines, among them, the degree of its impact on data structure is level 5, and its impact on information theory and coding is level 7, it can explain that, compare with data structure, information theory and coding discipline are more dependent on computer foundation discipline. Different disciplines can be taken as a set, they have a great impact on another discipline, at the same time, as the basis of a number of disciplines, they need to master the corresponding degree, so as to have an impact on another discipline, that is, as the basis of a number of disciplines, if the students' mastering is not good, it is difficult for having an impact on another discipline.

3.3. The Overall Design of Networked Teaching Platform

We design a networked teaching platform to provide students with a mobile learning platform, that is, students can learn at any time, anywhere. Students and teachers can get the information they need by this platform, students can know their weak subjects, the platform can help students design learning plans, which can improve student performance; teachers can get students' learning circumstances by this platform, it includes student performance, the mastering of students' knowledge, students’ opinion for teaching, teachers take these data as a basis for improving their teaching methods and their teaching plans.

We design the platform, consider 3 conditions: (1) the platform can run on any mobile device, it should have a certain compatibility; (2) the platform needs to be set as a set of multiple modules, modular design facilitates maintain the platform, and reduces design cycle of the platform; (3) the platform adopts large data technology, can do corresponding analysis according to the needs of students, help students develop personalized learning programs. Based on this, the overall design of the networked teaching platform is shown in Figure 2:
As can be seen from Figure 2, students’ achievements in different disciplines can be taken as a lot of data, transferred to the big-data computing center; association rules algorithm is used for data analysis, according to the analysis results, the system collects the knowledge points of students’ weak disciplines; in the unified management interface, the collected knowledge points are displayed in an interface; the unified management interface can download data, distribute it to different students and teachers, who can view it on their mobile devices.

4. Design of Digital Teaching Platform Based on Big Data Technology

We collect students’ learning data, different students need to learn a lot of subjects, and adjust the time, so that students adjust the time of learning different subjects in the limited time. We put clustering technology into designing a digital teaching platform, analyze the data of students’ courses, help students classify their own subjects, so that students can be strengthened the study of required courses, they can make a reasonable learning plan for their own.

4.1. Data Table’s Design Based on Student Discipline

We make statistical analysis on different subjects of students, and adopt clustering technology to screen out the required subjects of students. When choosing a subject, we need to consider students' professional and course credits. First, we need to define the data format of course, as shown in Table 3 and Table 4:

| Table 3. Table structure of required curriculum |
|-----------------------------------------------|
| Column name     | Data type | Length | Primary key |
| CourseID        | char      | 10     | Yes         |
| CourseName      | Varchar   | 30     |             |
| ScoreL          | int       | 16     |             |
| AcadeID         | char      | 4      |             |
| MajID           | char      | 8      |             |
Table 4. Table structure of elective curriculum

| Column name | Data type | Length | Primary key |
|-------------|-----------|--------|-------------|
| CourseID    | char      | 6      | Yes         |
| CourseDate  | char      | 8      | Yes         |
| CourseTime  | time      | 24     | Yes         |
| Teacher     | Varchar   | 30     |             |
| IfChoose    | char      | 2      |             |

In Table 3, there are 5 fields for required courses, which include course ID, course name, course credit, professional ID and college ID; in Table 4, there are five fields for elective courses, which include course ID, course date, course time, course’s teacher and elective function. We can find that the data format of the elective course is different from that of the required course, because the elective course is temporary, at the same time, the elective course has a change in the class time and the class date, and the class time and the class date of the required course are fixed. The digital teaching platform needs to adjust the arrangement of courses to ensure the time of required courses, at the same time, we need avoid the conflict of class time between required courses and elective courses.

In the MapReduce model, we define the data format for class time, class date, subject, and subject type, which can be expressed as (subject_subject type_class date_class time). In the field of subject types, we set "1" to indicate required courses, and "2" means elective courses. In the process of data comparison, we find that the subjects of the two data are different, then we compare the dates of class, if the dates are different, there is no conflict of time between the required course and the elective course, if the dates are the same, we further compare the class time, if the class time exist intersection, we need to adjust the class time.

System select courses based on students' credit, clustering technology take different disciplines as a whole, so as to ensure that the completion of these subjects can help students get enough credit. In the design process of digital teaching platform, credit is taken as a constraint condition to cluster the disciplines of students, and then adjust the class time.

4.2. Implementation of Clustering Technology in Students' Curriculum Selection

Clustering technology takes some variables as constraints, it divide objects within a certain range, objects can be divided into K groups. According to the degree of compactness, each group chooses variables \(\{a_1, a_2, a_3, \ldots, a_n\}\) as constraints, and re-selects the center point in the group, so as to exclude unqualified objects from the group.
Select k samples as a set, and divide the whole data set into M sets.

Evaluate each set, calculate its fitness, arrange the fitness of different sets, and select the number of sets with minimum fitness as the optimal number of individuals.

By using mutation and crossover operation, and taking scale factor and crossover probability as constraints, the partitioned set is re-partitioned to obtain the number of intermediate individuals.

Fitness evaluation is made on the set of intermediate individuals, and new partition results of data sets are obtained by certain formulas, new optimal individuals are created to replace the results of the worst individuals.

Number of iterations $< \text{iter}_{\text{max}}$ or Improved value of objective function $> \theta$

Output optimal number of set and fitness

**Figure 3.** Implementation process of clustering technology

In the course of choosing courses, we ensure that the students’ credits cannot be lower than the minimum requirement, at the same time, the required credits need to meet the requirement of graduation, therefore, we apply clustering technology to the digital teaching platform. Among them, the implementation steps of clustering technology are as shown in Figure 3.

As can be seen from Figure 3, the implementation of clustering is an iterative process, the central nodes in the cluster are constantly changing, while the nodes in the cluster are constantly updated. According to the constraint conditions, we iterate out the qualified K clusters and output K central points.

**4.3. The Overall Design of Digital Teaching Platform**

Credit-based course arrangement module is the core part of the digital teaching platform, at the same time, the results of the platform can be queried by mobile devices, the overall design of the platform is shown in Figure 4:
Figure 4. The overall design of digital teaching platform

As can be seen from Figure 4, we can see that the platform has collected the curriculum data of many students, and different students' courses can be clustered according to credit. For each student, the selected courses will be designed to ensure that students complete the learning of required courses, at the same time, be designed to obtain sufficient credit. Credit-based curriculum results are displayed on the unified management interface and distributed to students and teachers on mobile devices.

5. Conclusion
We deeply study the big data technology, take MapReduce as the data analysis model, introduce clustering technology and association rule as the main model of data analysis, and adopt them to build the teaching platform based on big data. In the process of designing big data teaching platform, we set up digital teaching platform and networked teaching platform respectively, the emphasis of two platforms is different, among them, in the network teaching platform, association rule is put into analyzing the students' academic performance, so as to put forward the learning plan for improving the students' weak subjects; clustering technology is put into clustering the subjects of students in the teaching platform, credit and class time are taken as constraints, platform can provide students with a reasonable curriculum learning plan.

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