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Design of Intelligent Education Decision Support System Based on Big Data Analysis

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This paper uses cloud services to design an intelligent education decision support system (DSS) based on big data analysis. This system utilizes computer technology and takes knowledge, data and model as its basis. This paper explains association rule mining in detail. The proposed intelligent education DSS based on cloud services system is tested in order to ensure that its design and development enables it to perform its various functions as expected.

Keywords: Big data; Cloud computing; Decision support system; Intelligent education

1. INTRODUCTION

Education is the top priority of a country. The development of education needs the support of people from all walks of life. Today, many sectors of society and industry, as well as governments, are embracing the era of cloud computing and big data, and education is also undergoing modernization as a result of technological developments. In education, it is necessary to effectively use technological skills and data-driven learning methods in teaching and learning in order to achieve better academic outcomes [1]. The process of extracting and refining education big data stored on the data platform to find useful information and internal laws through visual analysis, data mining algorithms, predictive analysis, semantic engine and data quality management. Scattered and non-uniform data structure, education data information is visually analyzed and communicated by simple, clear and intuitive graphical means on the visual data analysis platform, which is easier for learners to accept [2]. Statistics of various types of data, data can be in-depth mining, different algorithms according to different data sources to extract data values. Firstly, the design and algorithm evaluate the data provided by users, identify patterns in the data, and conduct design analysis. According to the analysis results, the best patterns are identified and used for the development of mining models and the provision of feasible models [3]. In terms of students' academic data and graduation prospects, a systematic decision-making data warehouse is constructed, which is processed and analyzed by using computer networking technology. While making full use of and studying data mining algorithms, historical data is deeply mined by association rules to explore the close relationship between these data. Figure 1 shows the construction of a DSS [4].

2. LITERATURE REVIEW

To solve this research problem, Sivamani et al. (2018) constructed the initial clustering center of the corresponding original data layer by using data mining technology and K-means clustering algorithm, and used the analytic hierarchy process to meet the quantitative analysis needs of decision makers [5]. Santoso and Redmond (2015) achieved the

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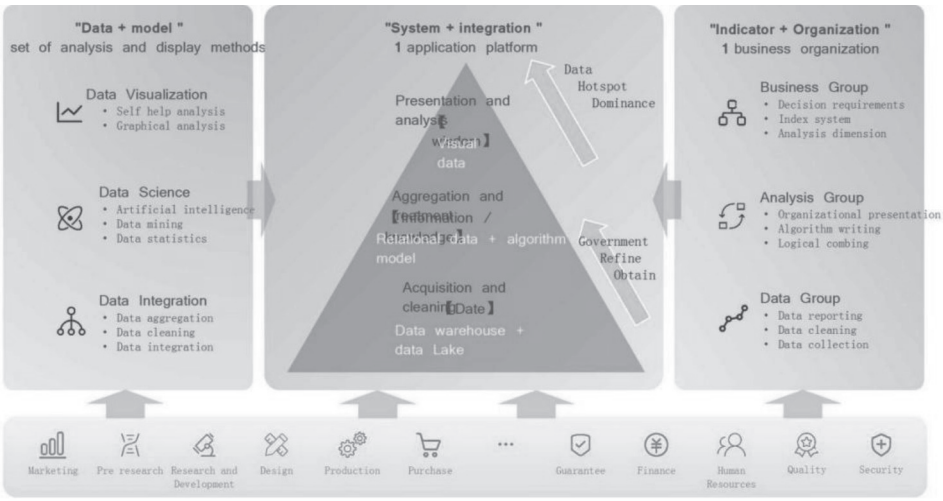

Figure 1 General construction of big data decision support system.

coding, data, encapsulation and server requirements of the standardized model by analyzing the model problems in the decision support system in detail and taking the expression mode, category and traditional modeling scheme as the key entry point. Based on the model class selection method of ontology and natural language understanding, the automatic selection of model classes was completed, which makes the model selection more intelligent, flexible and provides excellent human-computer interaction [6]. Niskar et al. (2015) emphasize that knowledge is the basis, decision-making is the purpose, evaluation is the auxiliary, and semantics runs through the whole knowledge-based decision support system. They constructed a decision support system from the technical perspective. Based on the theory of whole life cycle product analysis, the concept of product knowledge is defined in a broad sense, and the ontology-based knowledge modeling principle and product design construction method are created, which defines the unified standard for describing product knowledge resources to a certain extent [7]. Gao et al. (2018) used service-oriented architecture and composite computing model to build a decision support system for enterprises, implementing an open environment. While greatly improving the integrated, intelligent and networked performance of the system application, it also gives full play to the loose coupling and good distributed advantages of the decision support system. In the open environment, they encapsulate the enterprise business flow and database access in the web service, so as to achieve efficient integration and interoperability between the application layers of enterprise information systems [8]. Ma et al. (2015) exploited the advantages of a decision support system when building cloud platform computing, so as to greatly improve the application scale, computation and operation efficiency of the whole system [9]. In the context of educational informatization, Agrawal et al. (2017) posited that intelligent classrooms and smart learning systems should be constructed and supported through computer software technology, big data analysis technology, computer network communication technology and artificial intelligence technology [10]. Wang et al. (2019) studied the interactive teaching of mathematics in rural primary schools under the condition of a smart classroom system, and proposed that the student-student interaction and teacher-student interaction in rural primary school classroom should integrate the teaching resources of smart classroom system to ensure the improvement of the quality of mathematics teaching [11]. In terms of the application of an intelligent teaching system, Pathak and Yadov (2019) studied the constituent elements of intelligent teaching and pointed out that each component of intelligent teaching needs a comprehensive system platform as support [12]. Adnan et al. (2015) proposed a modern distance education architecture based on cloud computing, emphasized the important position of computer technology in distance education, and made a prospect for the deployment of Distance Education [13]. Ellis et al. (2020) pointed out the advantages of education combined with advanced computer technologies such as cloud computing; these include: efficient utilization of infrastructure, sharing of educational resources, and saving of operational costs, to name just a few [14]. Based on the previous research, this current work uses cloud services to analyze the model of cognitive decision support learning. It is a computer that supports decision making based on knowledge, data and models. This article provides an overview of the structure of data warehouses and the relationship between data mining and data warehousing.

3. METHOD

3.1 Cloud Computing Application of Information System in Big Data Information Resources

Cloud computing is an important part of data transfer. Cloud computing and cloud storage [15] enable big data to be shared and scheduled. In the cloud platform, sensor networks are connected to other networks to create a large group of data. By means of cloud computing, large network data can be centralized into multiple data centers to achieve real-time, fast and accurate data calculation and scheduling. Due to the great differences in data and data services, the big data in cloud

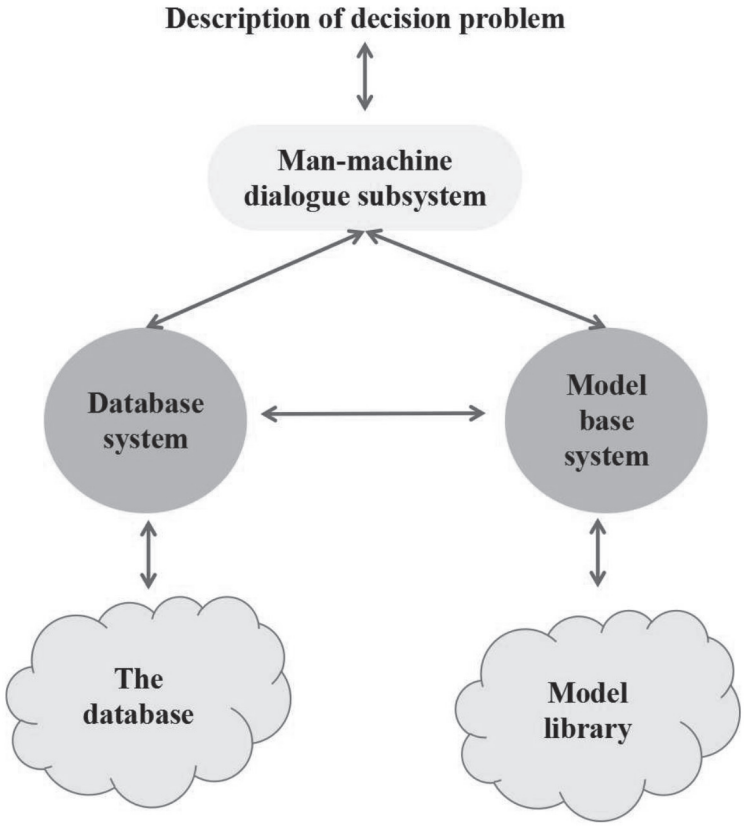

Figure 2 DSS structure.

computing has different characteristics, and the interface and communication channel of cloud computing are also very different. Therefore, this paper uses cloud services to develop an intelligent learning decision [16].

3.2 Concept of Decision Support System

A decision support system (DSS), which uses computer technology and takes knowledge, data and model as the basic basis, uses human-computer interaction to assist decision makers to solve unstructured or semi-structured decision-making problems. Figure 2 shows its specific structure.

Its high-level analysis tools and information resources can create an environment for problem analysis, model construction, decision-making process simulation and solutions, which can effectively help any decision-maker make informed decisions.

(1) Basic functions of a decision support system

Decision support integrates theories from cybernetics, operations research, management theory, and behavioral science to ensure accurate decision making. It can support and improve the skill level involved in solving multiple semi-decision problems [17]. When faced with decision problems, decision makers can use technology to collect quantitative data and information, understand and analyze decision problems, and develop models suitable for decision making, problem solving, and then comparison. Evaluate, select, make decisions, and refer to the actions of advocates to provide optimal decisions to users.

(2) Description of a typical decision support system

With the continuous expansion of the research field of decision support systems, various technologies are also emerging, such as online analytical processing, data mining and data warehousing, artificial intelligence, etc. The group decision support system (GDSS), which is an extension of the decision support system (DDS) has strong regional dispersion among members. GDSS relies on the capabilities of distributed artificial intelligence, because the computer distributed network it relies on makes it easy for members dispersed throughout various regions to collaborate in group decision-making. GDSS can be applied in a variety of contexts, one of which is remote conferencing [18].

These computer networks are spread over many objects and can carry out information processing operations simultaneously. Therefore, the hardware and software components of DDSS are connected as a whole, not just limited to a small software system [19]. Intelligent decision support systems (IDSS) make full use of uncertain reasoning, qualitative analysis of artificial intelligence technology, and comprehensive application of DSS quantitative model solution and analysis technology. Integrated and interactive IDSS are being widely used by decision makers in their decision-making processes. Although the traditional DSS has been used on a large scale, its problems are also very obvious. It does not form a unified theory and product, which needs to be developed and designed by the R & D personnel; also, there is insufficient data source support, resulting in numerous inconsistencies in the method base, database and model base. This is not conducive to the further development of traditional DSS [20].

3.3 Composition of Data Warehouse

A data warehouse includes data, metadata, data extraction tools, access tools, etc., which are described in detail below.

(1) Data warehouse database

The most important component of a data warehouse is its database where a large amount of data is stored. Compared with the ordinary operational database, its most obvious advantage is that the amount of stored data is relatively large. At the same time, because its design is based on the inverse paradigm, it has faster query and search speed and stronger system function.

(2) Data extraction tool

This tool enables data to be read quickly in various storage media, and then processed accordingly. The processing operation is carried out according to unified standards, and then the processed data is stored in the data warehouse. The most important performance of this tool is to realize extraction through corresponding storage methods. Its data conversion process consists of: converting the original data to ensure that the names and definitions of each data are unified. Also, specified default values are used for missing data, as well as dirty data being deleted.

(3) Metadata

Metadata itself is data related to the data source. It can describe the data of the data warehouse and the method of establishing data, such as the description information of the storage business. This information can enable users to obtain a more comprehensive description of business storage functions. In addition, metadata can also support data management and data maintenance, so as to make the storage of data items more convenient and data access more efficient. Business metadata describes data warehouse data from the business perspective, and includes data information, business intelligence report, business intelligence query, etc. the metadata of data warehouse can be accessed by using the information directory, which describes the types of data stored in the entire data warehouse. At the same time, it can also describe the storage mode, access mode and source of data.

(4) Access tools

Access tools enable users to access the data warehouse. They comprise online analytical processing, application development, report and data query, data mining and other tools.

3.4 Relationship Between Data Mining and Data Warehouse

Data mining is very important for the extraction of knowledge from databases. By finding valuable and useful information hidden in large-scale data, we can mine its value and the significance of information. Data mining is usually associated with computer science. With the help of pattern recognition, learning and retrieval, statistics, online analysis and other means, the above objectives can be successfully achieved. The data warehouse extracts the stored data in various ways, and then carries out unified processing. After processing, it is integrated and stored. This requires a large storage capacity and belongs to a relational database. The data stored in the warehouse can find the required data in the transaction processing system, integrate and process it to obtain more standardized data, and then store it in the data warehouse, so as to provide a basis for informed decision-making and enable decision-makers to find relevant information.

3.5 Association Rules

At present, association rule mining is the method most commonly studied in related fields. It is mainly used to determine (mine) the relationship between entities. Initially, it was applied to determine the relationship between commodities in supermarkets' transaction databases, and discern purchasing patterns.

(1) Basic concepts of association rules

The first definition: if $I = \{i1, i2, \ldots, im\}$, it belongs to m item sets, and each item is different.

The second definition: if a transaction t belongs to a subset of item set I, the relevant transactions will have the corresponding identification transaction number, which is unique and recorded as TID.

The third definition: for itemset X, if count($X \subseteq T$) belongs to the number of X transactions covered in transaction set D, the support of itemset X is expressed as:

$$support(X) = count(X \subseteq T)/|D| \tag{1}$$

The fourth definition: the minimum support threshold of an itemset is actually the minimum support, which is SUP min, which represents

The association rules in which the user is located have the lowest importance, and the item set with support exceeding SUP min belongs to frequent set.

The fifth definition: association rules are actually expressed as:

$$R{:}X \Rightarrow Y \tag{2}$$

In this equation, $X \subset I$, $Y \subset I$, meanwhile

$$X \cap Y = \phi \tag{3}$$

That is, if item set X is generated in a transaction, Y will appear according to the corresponding frequency, and the association rules valued by users are measured by support and reliability.

The sixth definition: association rule R support actually belongs to the transaction set and covers the ratio between X, Y transactions and $|D|$. That is:

$$support(X \Rightarrow Y) = count(X \cup Y)/|D| \tag{4}$$

A stimulus can show the probability that X and Y will form together. Support for Union policies is support for permanent packages. Seven points: For the organization R, its reliability consists of the number of changes X and Y, and the ratio of changes X. It is:

$$confidence(X \Rightarrow Y) = support(X \Rightarrow Y)/support(X) \tag{5}$$

The confidence can show that if X is covered in the transaction, the probability that the transaction will produce Y.

Usually, for users, the association rules for support and execution are the most critical.

The eighth definition: if the minimum support of association rules is SUP min, the minimum confidence is CONF min. Rule R has greater support than SUP min and higher confidence than CONF min, so it belongs to a strong association rule. Association rule mining is mainly used to find strong association rules in order to help decision-making.

(2) Nature of association rules

There are three common forms in association rule mining:

The first property: if X is an itemset, X support is higher than U support:

$$support(X) \geq support(Y) \tag{6}$$

The second property: if C is an itemset, the explicit data transaction set D and the minimum support min sup are: if itemset C belongs to an infrequent itemset, then Y is consistent with it. That is, there is no non-frequent itemset superset, which belongs to a non-frequent itemset.

$$support(X) = support(Y) \tag{7}$$

The third property: if C is an itemset, for a given data transaction set, D and minimum support min sup are: if itemset C belongs to a frequent itemset, correspondingly, y also belongs to a frequent itemset. That is, any subset of frequent itemsets must be frequent itemsets.

(3) Representation of association rules

The probability that itemset A and itemset B appear together is called the support of association rules, also known as relative support:

$$Support(A \Rightarrow B) = P(A \cap B) \tag{8}$$

When itemset A appears, the probability that itemset B will also appear is the confidence of the association rule:

$$Confidence(A \Rightarrow B) = P(B|A) \tag{9}$$

(4) Minimum support and minimum confidence

The threshold used to test support is often called the minimum support, which refers to the minimum standard of significance for statistical data. The threshold often used to define and measure trustworthiness is called the minimum trustworthiness threshold, which is the minimum trustworthiness standard of federal law.

(5) Itemset

An itemset is a collection of multiple items. A K itemset consists of K itemsets. The frequency of itemset occurrence (also known as support count) is the number of transactions within all itemsets. If the relative occurrence frequency of itemset I meets the preset minimum support threshold, itemset I is a frequent itemset.

(6) Support count

If the support count of an itemset is known, the support and confidence of rule $A \Rightarrow B$ can be calculated from the support counts of all transactions, itemset A and itemset $A \cap B$:

$$Support(A \Rightarrow B) = \frac{\text{Number of simultaneous transactions of } A \text{ and } B}{\text{Number of all transactions}} \tag{10}$$

$$\frac{\text{Number of simultaneous transactions of } A \text{ and } B}{\text{Number of all transactions}} = \frac{Support\_count(A \cap B)}{total\_count(A)} \tag{11}$$

$$support(A \Rightarrow B) = \frac{Support\_count(A \cap B)}{total\_count(A)} \tag{12}$$

$$Confidence(A \Rightarrow B) = P(B|A) \tag{13}$$

$$P(B|A) = \frac{Support(A \cap B)}{Support(A)} \tag{14}$$

$$\frac{Support(A \cap B)}{Support(A)} = \frac{Support\_count(A \cap B)}{Support\_count(A)} \tag{15}$$

$$Confidence(A \Rightarrow B) = \frac{Support\_count(A \cap B)}{Support\_count(A)} \tag{16}$$

As long as the number of all transactions and the support counts of three itemsets a, B and $A \cap B$ are obtained, the corresponding association rules $A \Rightarrow B$ and $B \Rightarrow A$ can be generated and, finally, whether it is a strong association rule can be determined.

3.6 Advantages of Intelligent Education Decision Support System Based on Cloud Services

Online teaching and obtaining learning resources from the Internet have become increasingly common, giving rise to innovative and more effective teaching methods. Compared with other areas of education, the main benefits of climate science education mentioned in this paper are:

(1) The most advanced computer technology is applied

This paper introduces artificial intelligence-based cloud services. It combines cloud computing and SOA architecture with various network technologies. This system can manage the integration and use of educational resources and services, and can meet the real needs of schools, students, teachers, and administrators.

(2) The teaching environment is improved

By implementing an intelligent decision support system in the education sector, we can create a mobile and intelligent environment for classroom teaching, and also facilitate online education under the "Internet plus" mode, and transfer traditional teaching from online to online. In traditional classrooms, blackboards and podiums are two of the main features of the teaching environment. After the application of an intelligent education decision support system, the information and intelligence of the teaching environment are realized based on intelligent voice.

Table 1 User table.

Field name	Describe	Data type	Is it empty?	Key
user_id	User number	int	N	Primary key
username	Title of account	Var char(20)	N	/
password	Password	Var char(20)	N	/
permission_id	Authority number	int	N	/
role_id	Role number	int	N	/

Table 2 Role table.

Field name	Describe	Data type	Whether	Key
role_id	Number	int	N	Primary key
role_name	Role name	Var char(20)	N	/

Table 3 Curriculum.

Field name	Describe	Data type	Is it empty?	Key
course_id	Number	int	N	Primary key
course_name	Course name	Var char(20)	N	/
date	Opening time	date	N	/

Table 4 Permission table.

Field name	Describe	Data type	Is it empty?	Key
role_id	Number	int	N	Primary key
role_name	Role name	Var char(20)	N	/

4. RESULTS AND ANALYSIS

4.1 Frame Design

The intelligent education decision support system based on cloud services has a browser / server structure. The MVC mode used by the system is comprised of the model layer (M), control layer (C) and view layer (V), which represent the separation of business logic, data and interface display. The view layer is the interface layer enabling user interaction with the system. It uses front-end technologies such as CSS, Ajax, HTML and JavaScript to display the intelligent teaching content. This part comprises a logical compilation of course upload, course selection, homework and other electronic resources for the sharing of intelligent teaching content. The model layer is the core of the whole intelligent education decision support system. It involves the design of cloud computing and SOA layer. The control layer is the middle part of the interaction between request and data, that is, the middle layer of the data request and result display of the whole system.

4.2 Database Design

The intelligent education decision support system based on cloud services is a teaching system for cloud courses. It targets cloud service users, cloud service providers and cloud platform managers. At the same time, cloud services users need to learn, cloud service providers need to provide corresponding services, and managers manage these users. In order to meet these needs, the intelligent education decision support system based on cloud services includes five tables: user table, role table, curriculum table, permission table, homework table and user homework table. The data storage of the system described in this paper uses a MySQL data table.

(1) User table

User table is mainly used to record user information, including user number, user name and password, user permission number and user role number. Table 1 shows the specific information.

(2) Role table

The role table is used to record user role information, including role number. Table 2 shows the specific role information.

(3) Curriculum

The course schedule is used to record course information, mainly including course number, course information and class opening time. Table 3 shows the specific curriculum information.

(4) Permission table

A permission table is used to provide user permission information, including permission number and permission name. Table 4 shows the specific permission table information.

(5) Job table

The assignment table is used for the information of course assignments, including assignment number, assignment name, assignment description and assignment time. Table 5 shows the specific operation information.

Table 5 Job table.

Field name	Describe	Data type	Is it empty?	Key
job_ id	Number	int	N	Primary key
job_name	Job name	Var char(20)	N	/
description	Describe	Var char(20)	N	/
date	Job time	date	N	/

Table 6 User job table.

Field name	Describe	Data type	Is it empty?	Key
user_id	User number	int	N	/
job_id	Job number	int	N	/

Table 7 System development environment.

Software name	Description/Function
Windows7	Operating system of the system development environment
JDK	Java is a necessary component of the development kit
Eclipse	Development platform for code writing and debugging
Nginx	Provides load balancing service
Tomcat	Provides web server
Hadoop	Provides distributed computing and storage environment
H base	Basic database
MySQL	Extended database
VM ware	Provides virtual machine environment
V Sphere SDK	Virtual environment management tools

Table 8 Function test.

Test Case ID	Test item	Test content
1	User registration	Go to the registration page, select a user role, enter user information, set a password, and complete the registration form.
2	User login	Go to the login page of the system, select the user role, enter the account and password, and check whether the product role can be accessed.
3	Service management	Access the system administration area to ensure that the registration service, configuration file service, advertising service and other functions are working properly.
4	Resource storage	Log into the system as a teacher or student to download and upload educational resources such as videos, documents and audio materials.
5	Distance classroom	Log into the system as a teacher or student to complete online classes, quizzes, exams, etc.
6	Educational Administration	Log into the system as a learning administrator to conduct user management, learning resource audits, and learning audits.

(6) User job table

User job table is mainly used to the information of user job, including job number and user number. Table 6 shows the specific user job table information.

4.3 System Development Environment

The creation of a system has four components: core environment, data center, server and client. Therefore, it is necessary to develop the following methods to meet the needs of intelligent decision support based on cloud services. Table 7 shows the system development environment.

4.4 System Test

(1) Function test

The functionality of the system must be checked. The current update is only for the PC side, so this side is used to access the page for testing. When testing performance, the aesthetics of the page should be considered together with the responsiveness of the page to the current device. Table 8 shows the detailed analysis of the coarse-grained tests for the main functions.

(2) Database pressure test

To test the load capacity, sequential writing, random reading and random writing are carried out using the test tool provided by H base. Table 9 shows the test results.

Table 9 Database pressure test.

Test index	Sequential reading	Sequential write	Random block read	Random write
Total time	779	349	967	238
Rate	1221	3224	1021	4702

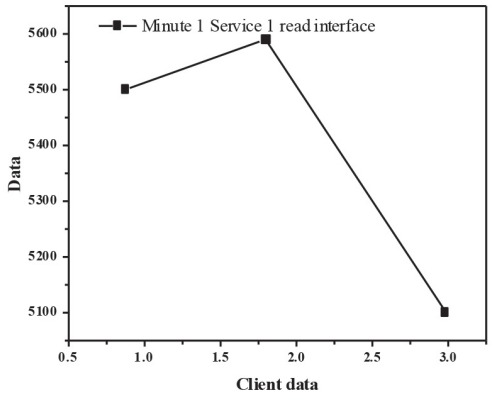

Figure 3 Pressure test of service 1 read interface in the first minute.

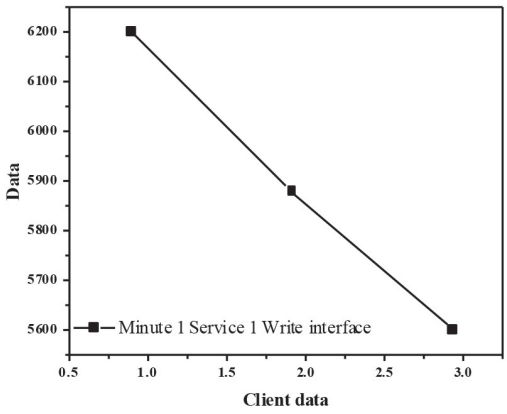

Figure 4 Pressure test of service 2 write interface in the first minute.

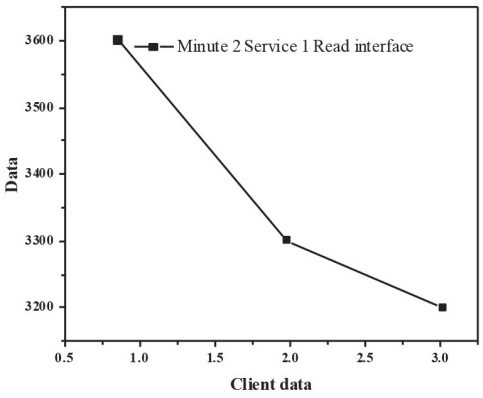

Figure 5 Pressure test of service 1 read interface in the second minute.

The service must be tested. Here, two services, management services and distance learning, are selected for stress testing. Figures 3, 4, 5 and 6 show the experimental results.

By analyzing the data in the above table, it can be seen that the system can still operate stably under the condition of high concurrency of services, meeting the basic requirements of the design.

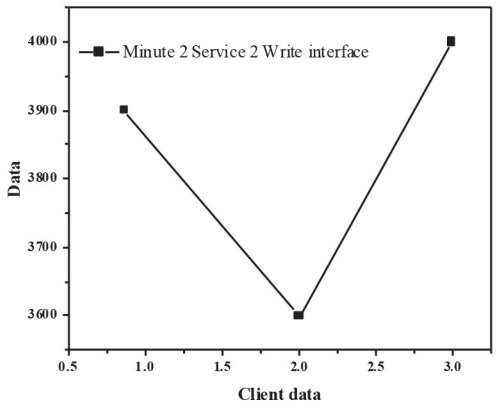

Figure 6 Pressure test of service 2 write interface in the second minute.

5. CONCLUSION

This paper presents the development of an intelligent decision support system based on big data analysis. In the cloud computing environment, computing resources, storage resources, and software resources have many features facilitating the effective use of cloud computing and cloud storage of various data. In order to improve the accuracy of the data group and create a basis for pattern recognition, it is necessary to integrate the large data into a cloud environment. Therefore, in this work, the creation of smart decisions using cloud services is studied. First, this paper briefly introduces the requirements analysis and design of an intelligent decision support learning system, and then describes the special development environment and the key points of using the service. Then, it shows how to utilize the intelligent learning decision results supported by the three functions of cloud service center, learning resource management and remote classroom to conduct test operations, view capacity data and function data, and determine the quality of related services and planning processes.

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