Research on Online Autonomous Learning Support System of Advanced Mathematics Based on Feature Extraction Algorithm

Li Su*
Advanced Mathematics and Trade in Jilin International Studies University,
Changchun, Jilin 130117, China

*Corresponding author: 2980674751@qq.com

Abstract. One of the key problems in researching and developing online autonomous learning support system of advanced mathematics which adapts to learners' personality characteristics is to acquire learners' characteristics. According to the theory of teaching structure and network teaching mode, based on analyzing the syllabus and teaching materials of higher mathematics, this paper puts forward the overall goal and design principle of the system, redesigns the teaching expression form, and designs an online autonomous learning support system of higher mathematics based on feature extraction algorithm. In the design of the system, the teaching idea of taking teachers as the leading factor and students as the main body runs through, so that students can arrange their own study plans, actively explore knowledge, actively participate in interaction and get feedback in time, thus improving the learning effect.

Keywords: Feature extraction algorithm; Advanced mathematics; Online autonomous learning support system

1. Introduction

With the continuous development of science and technology, the position and role of computers and computer networks are becoming increasingly prominent. Especially in the fields of correspondence education, vocational education and continuing education, distance teaching has become a very important teaching mode [1]. Due to the large number of students studying advanced mathematics, and the limited faculty of the school, many teachers can only concentrate on teaching the course content, but students can only do their own homework and exercises [2]. The rapid development and popularization of the Internet has provided a broader space for modern education. How to better adapt the traditional teaching methods to the development of the network era is a great opportunity and challenge in the field of education.

It is the key to improve the quality of distance teaching to research and develop an intelligent distance teaching system which can provide learning content according to learners' personality characteristics and realize the teaching strategy of "vary from person to person" [3]. Personalized feature extraction of learners' behavior is the key of online autonomous learning support system for advanced mathematics. Once the personalized features of learners are determined, it can provide important basis for the recommendation of corresponding teaching strategies and teaching methods.
On-line autonomous learning support system for advanced mathematics based on feature extraction algorithm is attracting increasing attention at home and abroad. According to the characteristics of the course "Advanced Mathematics", we carefully analyzed the teaching content, redesigned the teaching expression form, and designed and developed an online autonomous learning support system of Advanced Mathematics based on feature extraction algorithm.

2. Learner feature extraction algorithm

2.1. Structure of online autonomous learning support system for advanced mathematics

The teaching website system of higher mathematics education with online communication function mainly includes two parts: the foreground system of the website and the background system of the website. The foreground system of the website is that users can browse and learn the content they are interested in online; When you encounter problems you don't understand, you can discuss them with your online classmates or teachers in time. Online learning system breaks through the limitations of traditional teaching methods. The structure of the system platform is open, easy to operate and practical, and stimulates the creativity of both teaching and learning sides. According to the analysis results, the exercises that are most suitable for students' practice are automatically selected, and the weak links of students' knowledge are strengthened by practicing similar exercises repeatedly [4].

The online autonomous learning support system for advanced mathematics consists of six parts, including information collection, learning feature database, decision inference engine, resource library, knowledge base and personalized courseware generation module, as shown in Figure 1:

![Figure 1](image.png)

**Figure 1** Online autonomous learning support system for advanced mathematics

Teaching mode is a set of plans or models to carry out teaching activities, which is a relatively stable framework and procedure of teaching activities based on certain teaching theories, that is, a dynamic process composed of various teaching activities organically connected together. In the system design, we should always follow the strategy of cultivating autonomous learning ability under the network environment, so that we can combine these strategies to teach students online which is suitable for autonomous learning. For users, it is convenient to use, easy to get started, easy to switch between modules, and convenient and timely online communication.

2.2. Basic thought

Learners' media preference is a dimension of learning characteristics. Because different learners have different preferences for different sensory organs and sensory channels, some learners like to receive information through visual channels, while others like to obtain information through hearing [5-6]. By retaining the similarity between the vertex pairs of the graph and representing each vertex corresponding to the data as a low-dimensional vector, the specific statistical or geometric distribution characteristics of the data set can be well represented. Some attributes play a key role in decision-making, which are important attributes, while the existence of some attributes has little influence on
decision-making. If the association rules are applied to the learner model of online autonomous learning support system for advanced mathematics, the potential personality characteristics of learners can be mined through their learning behaviors, and targeted recommended learning can be realized.

Apriori algorithm was proposed by R. Agrawal and R. Srikant in 1994, which is a typical algorithm in association rules algorithm [7]. This algorithm can mine all frequent itemsets, using the width-first iterative search method. First, find the frequent 1-itemset $F_1$, find the frequent itemset 2-itemset $F_2$ with $F_1$, find $F_3$ with $F_2$, and cycle in turn until the frequent $k$-itemset cannot be found. Finding each $F_k$ requires a database scan. The specific algorithm is as follows:

```java
//Transaction database D; Minimum support threshold minsup
F_1 = find_frequent_1_itemsets(D, minsup) //Find out the frequent 1-itemsets F_1
for (k = 2; F_{k-1} != null; k++) {
  C_k = apriori_gen(F_{k-1}) //Generating candidate k-itemsets according to frequent (k-1)-itemsets
  //Scan D to count items
  for (Every transaction t ∈ D) {
    //Get a subset of t, which is a candidate itemset
    C_k = subset(C_k, t);
    for (Every candidate c ∈ C_k) c.count ++;
  }
  F_k = \{ c ∈ C_k | c.count ≥ minsup \};
  return F = F_1 ∪ F_2 ∪⋯∪ F_k;
}
```

The simplification of conditional attributes is to delete irrelevant or unimportant attributes while keeping the classification or decision-making ability of decision table unchanged. However, its effect will be greatly reduced in the face of nonlinear problems, so we can choose to embed linear graph for kernel, and then get kernel graph embedding. Psychologists' research shows that learners with different perceptual types have different performances in learning [8]. The online learning management system has the functions of checking and passing the registration information of teachers and students, and maintaining the course materials, test questions, forums and system security.

3. Modular structural design method

Considering the characteristics of B/S mode, according to the system construction goal, the system is divided into administrator subsystem, autonomous learning subsystem, counseling and answering subsystem, open question bank management subsystem and other functional modules. The functional module diagram is shown in Figure 2.
3.1. Administrator subsystem

The main function of the administrator subsystem is to manage users and clean and maintain system data. It includes the following sub-functional modules: user management, system maintenance, media materials and courseware required by the system, and input of test questions. On this basis, the program design is divided into independent and interrelated modules, which we call modularization [9]. Modularization is beneficial to divide huge program engineering into relatively simple modules for processing, so as to complete larger-scale program design. The system should take strict security measures in identity authentication, resource management, database, etc. to ensure the safety and correctness of data and the system platform is not infringed. Figure 3 below shows the structure diagram of administrator management module.

![Figure 3 Structure diagram of administrator management function module](image)

The control of user access is mainly through the control and management of user authority, which is the right for users to perform certain operations on an object. In this system, this right refers to the right of users to view pages or modify data through pages. It can be used as a general system platform for online learning of advanced mathematics and other professional courses. Including random test paper and manual test paper. Random test papers only need to specify the test questions, scores, difficulty, related chapters, etc., and the system automatically extracts the questions from the question bank. The relationships between users and roles, roles and permissions, and roles and access objects are all many-to-many.
3.2. Student module
The student learning system constructs the student space, and users with student status can enter the student space. The student space provides students with a variety of functional modules, forming a systematic network learning support environment. Teachers can query and analyze the students' examination situation by selecting the grades and majors to query, and master the students' learning situation. Figure 4 below shows the structure diagram of students' online discussion module.

![Figure 4 Discuss the structure diagram of AC function module](image)

If the student's test result falls outside the confidence interval and belongs to the extreme preference situation, it needs to be further judged. If the student's test result is less than the lower limit of the confidence interval, the student prefers audio; If it is greater than the upper limit of the confidence interval, it shows that the student prefers video; First, the system queries whether the user exists and is valid from the user table. If it exists and is valid, the user's authority is assigned to the object, so that the system can judge the authority in the future pages.

3.3. Teacher module
Teachers' teaching system constructs teachers' space. Users with teacher status can enter the teacher space, which provides teachers with various functional modules and forms a systematic network teaching support environment. Of course, on the premise of ensuring the functions to be completed by the whole program, the degree of interconnection between modules is as small as possible. The database needs to be stored in binary format, so the data input of the system can't be processed like the general text information input. Therefore, this system designs an independent module, which is specially used for inputting and modifying data such as media materials, test questions and courseware. Figure 5 shows the structure of the teacher's Q&A forum module.

![Figure 5 Module structure diagram of teacher answering forum](image)

4. Database design
The design of database plays an important role in a website system with online communication function. It can be said that the design of database directly affects the convenience of using this system and the efficiency of system operation [10]. The system platform should adopt an open architecture and loose coupling mode to provide an advanced and open space for users, and provide great support for the expansion and technical upgrade of the system platform. The system identifies the students of corresponding majors or classes according to the corresponding positions of student numbers in the student achievement view, and then makes classification statistics. On this basis, other two-level data warehouses are realized step by step. First, take the middle and upper levels of each dimension to form entities of each level, and form the star model of bureau-level data warehouse. The business flow chart of online autonomous learning support system for advanced mathematics is shown in Figure 6.
5. Detailed design and implementation of the system

5.1. Code identification design
Code design plays an important role in the program development of a system. A good code design scheme can not only facilitate the work of program development, but also provide the running efficiency of the program, and also provide great convenience for the management and maintenance of the software after use. In the learning process, use the system platform to communicate with teachers, keep abreast of the learning progress, accept the learning suggestions from teachers and answer difficult questions. The system can automatically select the appropriate dish according to the students' intestinal preparation. To reduce the burden of the data warehouse, a transit storage space is set up between the basic data layer and the well site data warehouse for storing the changed data. The explanation process of examples should have strong interactivity, which can not be displayed all at once like books, but should conform to the characteristics of mathematics teaching and be displayed step by step.

5.2. Design of homepage module of website
Because of the characteristics of higher mathematics itself, there is some internal connection or correlation between knowledge points and knowledge units, especially the relationship between knowledge points, which must be mastered by people studying higher mathematics and is difficult for ordinary learners to master. The modules and functions of this website are listed in detail in the form of menus and submenus. A list of commonly used functional modules, which is on the right side of the website; Examine each level and category of dimension entities. If the information contained in a dimension is too complex and needs to be analyzed by level or category, these dimension entities will be extended to generate level entities and detailed information entities. Transforming unstructured log data into accurate data for data mining mainly includes data cleaning, user identification, session identification, path supplement and transaction identification.

5.3. User identification
Because of the special network, for example, the page caching technology caches the pages visited by the user in the client, and the next request of the user does not need to get the return from the server, but directly reads from the cached page, which is why the user accesses the page slowly for the first time and quickly for the second time. Purify, transform and integrate the data in transit storage space according to metadata, that is, eliminate all inconsistencies among data and prepare for loading data
into data warehouse. With this method, users can select mathematical formulas from the web page only by familiarizing themselves with the basic methods of mathematical formulas, and the use process is simple and quick. It not only provides convenient conditions for teachers to prepare lessons and teach, but also provides test and evaluation for students' autonomous learning. Students can learn interactively on the Internet at any time, so that students can test the learning effect and master the learning skills in time.

Nowadays, the system is generally designed that users can browse website resources without logging in. Only some special pages such as downloading, testing and forum exchange in this system must be logged in. If learners just enter the system to browse teaching resources, they do not need to log in. In the decision table, the determination of the final classification of each object is determined by its various conditional attribute values, while some attribute values may be redundant attribute values which have no decisive effect on the classification of the object. As the data of the system comes from the operation database of each drilling crew, on the one hand, these data are application-oriented and cannot completely describe the subject field in drilling engineering; on the other hand, there are many inconsistencies in the data of multiple data sources, such as the inconsistency of naming, data structure and unit, etc. Therefore, the data extracted from each data source needs to be transformed or purified before it can be loaded into the warehouse.

5.4. Design of administrator management module
The administrator management interface of this system is mainly divided into two tabs: "Administrator Management Home Page" and "Add Administrator". In Add Administrator, you can fill in the user name, real name, initial password and confirmation password, and then click Add to add an administrator. You can also delete the administrator and set permissions on the "Administrator Management Home Page".

6. System test
The formulation of the system test plan should first be based on the design goal in the website design. Secondly, we should consider the goals to be verified and the purpose of the system test. Finally, the test of the system should consider whether the designed test scheme can be realized. In this testing stage, we can take the method of virtualizing users with different identities, such as virtualizing a website viewer and an administrator, and then performing related operations as a certain user and covering the tests one by one, and testing the correctness of the pages to be linked or jumped one by one as different users. According to the functions of this website, the system function test methods, test results and screenshots of test results are designed, as shown in Table 1.

| Serial number | User identity | Test method | Test result |
|---------------|---------------|-------------|-------------|
| 1             | User          | Post in the forum area | Success     |
| 2             | User          | Reply to posts in the forum area | Success     |
| 3             | User          | Have a discussion in the discussion area | Success     |
| 4             | Administrator | Log in on the login screen | Success     |
| 5             | Administrator | Add administrator | Success     |
| 6             | Administrator | Delete administrator | Success     |

7. Conclusions
The online autonomous learning support system of advanced mathematics has changed the traditional practice and examination mode of mathematics, which provides convenience for students' autonomous
learning and lightens the work of teachers. On the basis of the school's existing informatization construction, it has realized the online teaching and efficient and orderly digital management functions with the characteristics of students' autonomous learning, strong interactivity, individualized teaching, sharing of teaching resources and multimedia teaching. Basically, it has realized most of the functions of browsing websites and topic discussion websites, which are popular on the Internet at present, and has organically combined their functions and interfaces. The feature extraction algorithm is applied to the online autonomous learning support system of advanced mathematics. The system log is preprocessed, the learner's learning feature data is read for algorithm analysis, and the learner's browsing strong association rules are obtained. According to these rules, personalized recommendation can be realized.

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