The Internet has become a new medium, and educational activities have also undergone changes due to the development of new technologies. In the past, teaching activities that required students to teach in a specific time and space have changed to less time and space constraints, which have also made the educational process pay more attention to the university teaching mode under the Internet situation, which makes the teaching process more comfortable and intelligent. In this paper, we propose an English interactive teaching system based on the association rules algorithm. This method can make full use of the relevance between data to improve the efficiency of English teaching. According to the division of UNESCO, education informatization is divided into four stages: start, application, integration, and innovation. With the initial development of network hardware technology construction in recent years, it has gradually entered the integration and innovation stage of education and information technology. The important task at this stage is to carry out innovations that are different from traditional teaching concepts, innovations that are different from traditional talent training methods, and innovations that are different from traditional education methods and evaluation methods. From the perspective of dialectical materialism, different angles of a certain issue can be expressed differently. Educational activities are based on Huluo’s technology to a certain extent, and the closedness of traditional education methods has been changed. In order to verify the performance of the method proposed in this paper, we test the proposed algorithm as well as compare it with the other two strategies. The experimental results show that the proposed has a better performance.

1. Introduction

The Internet is another new media after radio and television, newspapers, books, and periodicals. In recent years, with the advancement of social technology, computers, PCs, and smart terminals have become more and more popular, and the Internet has become more widely used in people’s daily production and life. The take-off of China’s economy and the revitalization of the Chinese nation began with the reform and opening up after the Third Plenary Session of the Eleventh Central Committee of the Communist Party of China. Internet technology has developed in this trend. It can be said that it has fulfilled the requirements of history and promoted the process of reform. For now, the newly proposed “Internet +” is still in its infancy, and it is still in the theoretical stage, that is, there are many ideas but not implemented, and various fields will do some research and discussion on it.

The interactive teaching model of college English is based on various pedagogy theories and adopts the eclecticism teaching method in foreign language teaching [1]. Students are the center of the interactive teaching model, and teachers are the dominant of the interactive teaching model. The interactive teaching model pays more attention to the development of students’ personality and emphasizes students’ cooperative learning spirit [2, 3]. The teaching goal is not only to get rid of the “dumb English” phenomenon which has long existed in college English teaching but also to avoid overemphasizing students’ oral practice and English learning with light language ability and to improve students’ English listening, speaking, reading, and writing ability in an all-round way. (1) Integrity of characteristics of the
interactive college English teaching mode: in the interactive theory of this teaching mode of college English, teaching elements are not isolated. In the implementation process of the mode, teachers, students, courses, and other elements in the teaching activities are made observation and positioning, teaching material conditions, teaching time, and space to explain and restrict so that the teaching objectives and means in the teaching model are more clear, to ensure the integrity and system of the model. Operability: the interactive teaching mode of college English is technically realizable [2]. It is not only a theoretical basis but also combines the cognitive emotions and learning conditions of students in English learning to investigate the relevant factors. The interactive measures implemented, such as the seven principles of classroom teaching and oral communication between English-speaking countries and students, are easy to operate. Optimal effect: the college interactive teaching mode combines the natural law of language learning with the characteristics of foreign English teaching [4]. In the principle of practical effect, it not only exercises students’ systematic language knowledge but also gets strong practicality. Secondly, the interactive teaching mode drives multiple elements to produce positive interaction, enhances the effectiveness of each teaching link, and makes the thinking training more profound and the learning effect more extensive.

Huang et al. proposed a teaching tactics training system combined with multimedia interactive model and virtual reality technology [5]. In this paper, a new teaching and tactical training system of sports basketball is constructed by combining multimedia interactive model and virtual reality technology. Firstly, the basketball movement model and elastic deformation model are constructed for basketball by the mathematical model. Then, the basketball players are modeled geometrically and kinematically by the virtual reality model, and the information generated in basketball tactical training is captured. Finally, information is processed by the multimedia signal processing method, and the observation and feedback of basketball based on multimedia interaction model and virtual reality technology are constructed. Wang and Gao proposed a parallelization of the Apriori algorithm in the association rule mining method [6]. This paper adopts the idea of parallelization and improves the Apriori algorithm based on the MapReduce model. Firstly, the local frequent itemsets on each subnode in the cluster are calculated; then, all the local frequent itemsets are merged into the global candidate itemsets, and finally, the frequent itemsets that meet the conditions are filtered according to the minimum support threshold. The advantage of the improved algorithm is that it only needs to scan the transaction database twice and calculate the frequent itemset in parallel, which improves the efficiency of the algorithm. Singh proposed an improved Apriori algorithm [7]. In this paper, the authors proposed improved MapReduce-based Apriori algorithms VFPC (Variable size-based Fixed Passes Combined-counting) and ETDP (Elapsed Time-based Dynamic Passes Combined-counting) over FPC and DPC. Further, we optimize the multipass phases of these algorithms by skipping the pruning step in some passes and propose optimized-VFPC and optimized-ETDPC algorithms. Quantitative analysis reveals that counting cost of additional unpruned candidates produced due to skipped-pruning is less significant than reduction in computation cost due to the same. In [8], the authors agreed that association rules mining (ARM) is a fundamental and widely used data mining technique to achieve useful information about data. The traditional ARM algorithms are degrading computation efficiency by mining too many association rules which are not appropriate for a given user. Recent research in ARM is investigating the use of meta-heuristic algorithms which are looking for only a subset of high-quality rules. In this paper, a modified discrete cuckoo search algorithm for association rules mining DCS-ARM is proposed for this purpose. The effectiveness of the proposed algorithm is tested against a set of well-known transactional databases. Results indicate that the proposed algorithm outperforms the existing metaheuristic methods.

For now, the Internet has become a new medium, and educational activities have also undergone changes due to the development of new technologies [9–11]. The previous requirement that students must teach in a specific time and space has changed to less restricted by time and space. To make the education process more focused on interaction, the teaching mode that exists on the Internet makes the teaching process more comfortable and intelligent. As far as subjective logic is concerned, people use Internet technology for teaching activities, technology is the medium, and the subject of interaction is still the personnel themselves. According to the division of UNESCO [12–14], education informatization is divided into four stages: start, application, integration, and innovation. With the initial development of network hardware technology construction in recent years [15–18], it has gradually entered the integration and innovation stage of education and information technology. The important task at this stage is to carry out innovations that are different from traditional teaching concepts, innovations that are different from traditional talent training methods, and innovations that are different from traditional education methods and evaluation methods. Based on the above background, this article has launched the research and design of the system. This article uses the association rules algorithm to design the current English teaching interaction. According to the association rules algorithm proposed in this paper, it is a data mining method which can reflect the relationship between two objectives [19–21]. In this paper, we can make the English teaching process comfortable and intelligent with the help of the association rules algorithm. Because of the relationship between the radio and television, newspapers, books, and Internet, so we can use the dependency of these objectives to realize the English teaching. According to the association rules algorithm, it actually is a data mining method.

The contributions of this paper can be described as follows:

1. This paper studied the characteristic of the traditional teaching activities and the new teaching activities. In the past, teaching activities that required
students to teach in a specific time and space have changed to less time and space constraints, which have also made the educational process more pay attention to that the university teaching mode under the Internet situation, which makes the teaching process more comfortable and intelligent.

(2) This article has launched the research and design of the system, which use the associated algorithm to design and research the current English teaching interactive system. In this paper, we analyse the current implementation of the school English interactive teaching system and propose the use of association rule algorithms in data mining technology to apply to English teaching.

The rest of this paper is organized as follows:

Section 2 gives the detail of the association rule mining. Section 3 gives the experiment setting. Empirical results and analysis are given in Section 4. Then, Section 5 is the conclusion.

2. Association Rule Mining

ARM can be defined formally as follows: let us assume a set of objects $X = \{x_1, x_2, \ldots, x_n\}$ and transaction dataset $T_D = T$ are given, where each transaction $T$ is a subset of objects $T \subseteq X$. Then, an association rule is defined as follows [22–24]:

$$X_o \rightarrow X_p,$$

where $X_o \subseteq X$ and $X_o \cap X = \emptyset$. In order to estimate the quality of the mined association rule, two measures are defined: confidence and support. The confidence is defined as

$$C(X_o \rightarrow X_p) = \frac{n(X_o \cup X_p)}{n(X_o)},$$

whereas support is

$$S(X_o \rightarrow X_p) = \frac{n(X_o \cup X_p)}{|T|},$$

where the function $n(.)$ calculates the number of repetitions of a particular rule within $T_D$ and $|T|$ is the total number of transactions in $T_D$. Let us emphasize that two additional variables are defined. These variables denote a threshold value limiting the particular association rule with lower confidence and support from being taken into consideration.

For the special case $I = \{1, 2, 3, 4\}$, we visualize the search space that forms a lattice in Figure 1.

Let map $I \rightarrow \{1, \ldots, |I|\}$ be a mapping that maps all items $x \notin I$ one-to-one onto natural numbers. Now, the items can be seen as totally ordered by the relation “<” between natural numbers. In addition, for $X \subseteq I$, let $X$ items: $\{1, \ldots, |X|\} \rightarrow I$: $n \rightarrow X$ and item $n$ be a mapping with $X$ item $n$ denoting the $n$-th item of the items $x \in X$ increasingly sorted by “<.” The $n$ prefix of an itemset $X$ with $n \leq |X|$ is then defined by $P = |X \cdot \cdot \cdot \cdot \cdot \cdot m|1 \leq m \leq n|$, c.f. [11]. Let the classes $E(P), P \subseteq I$, with $E(P) = |X \subseteq I||X| = |P| + 1$ and $P$ is a prefix of $X$ be the nodes of a tree. Two nodes are connected by an edge, if all itemsets of a class $E$ can be generated by joining two itemsets of the parent class $E^*$, e.g., Figure 2. In this figure, we give the tree of $\{1, 2, 3, 4\}$, and there are three layers.

2.1. Three Conceptual Analysis. The three concept lattices are the main content of the three concept analysis [25–28]. The three concept lattices include $OE$ concept lattice and $AE$ concept lattice. This article mainly conducts research on $OE$ concept lattice, so only the related theories of $OE$ concept lattice are introduced.

The formal background is a triplet $(G, M, I)$, where $G = [x_1, x_2, \ldots, x_n]$ and each $x_i (i < n)$ is regarded as a object and $M = [a_1, a_2, \ldots, a_m]$ and each $a_j (j < m)$ is regarded as an attribute; for $x \in G$ and $a \in M$, if $x a$, let $(x, a) \in I$, and it is also called the object $x$ which owns attributes $a$ or the attribute $a$ is owned by the object $x$.

Let $(G, M)$ be a formal background; for any object subset $X \subseteq G$ and attribute subset $A \subseteq M$, a pair of operators is defined as

$$*: P(G) \rightarrow P(M), X^* = \{a \in M | \forall x \in X, (x, a) \in I\},$$

$$*: P(M) \rightarrow P(G), A^* = \{x \in G | \forall a \in A, (x, a) \in I\},$$

where $P(\ast)$ represents the power set.

Suppose $(G, M)$ is a formal background, $X \subseteq G$, and $A \subseteq M$, and if the two-tuple $(X, A)$ satisfies $X^* = A$ and $A^* = L$, it is called $(G, M)$ A formal concept, a concept for short. $X$ is called the extension of $(X, A)$, and $A$ is called the connotation of $(X, A)$. In the analysis of the three-branch concept, the operator given in above is called a positive operator, and the following definition of a negative operator is given.

Let $(G, M)$ be a formal background, and for any object subset $X \subseteq G$ and attribute subset $A \subseteq M$, a pair of negative operators is defined as

$$\overline{x}: P(G) \rightarrow P(M), X \overline{x} = \{a \in M | \forall x \in X, x \overline{f a}\},$$

$$\overline{x}: P(M) \rightarrow P(G), A \overline{x} = \{x \in G | \forall a \in A, x \overline{f a}\}.$$
Use OEL \((G, M, I)\) to represent the collection of all \(OE\) concepts generated by the formal background \((G, M, I)\); then, \(OEL\ (G, EL (G, M))\) is a partial-order relationship as defined above, \(I\) a complete lattice, and the object called \((G, M, I)\) derives three conceptual lattices, abbreviated as \(OE\) conceptual lattice. Among them, the supremum and infimum are

\[
(X, (A, B)) \lor (Y, (C, D)) = ((X \cup Y) \setminus (A, B) \cap (C, D)),
\]

\[
(X, (A, B)) \lor (Y, (C, D)) = ((X \cap Y), (A, B) \cup (C, D))^c.
\]

(6)

Use \((X, (A, B)) < (Y, (C, D))\) to represent \((X, (A, B)) \subseteq (Y, (C, D))\) and \((X, (A, B)), (Y, (C, D))\). If \((X, (A, B)) < (Y, (C, D))\) is true and there is no such that \((X, (A, B)) < (Z, (E, F)) < (Y, (C, D))\) established \((Z, (E, F))\), then \((X, (A, B))\) is a sub-concept of \((Y, (C, D))\) and \((Y, (C, D))\) is the parent concept of \((X, (A, B))\), denoted as \((X, (A, B)) < (Y, (C, D))\).

Use \((X, (A, B)) < (Y, (C, D))\) to represent \((X, (A, B)) \subseteq (Y, (C, D))\). If \((X, (A, B)) < (Y, (C, D))\) is true and there is no such that \((X, (A, B)) < (Z, (E, F)) < (Y, (C, D))\) established \((Z, (E, F))\), then \((X, (A, B))\) is a sub-concept of \((Y, (C, D))\) and \((Y, (C, D))\) is the parent concept of \((X, (A, B))\), denoted as \((X, (A, B)) < (Y, (C, D))\).

Table 1 represents the formal background \((G, M)\), where \(G = \{1, 2, 3, 4\} \cup^* a, b, c, d, e +\). Formal context is shown in Table 1.

In \((G, M)\), any two concepts that are directly connected with each other are a pair of father and son concepts. Two child concepts of the same parent concept are a pair of brother concepts.

2.2. The Extraction of Association Rules in Three Concept Lattices. Association rules are rules in the form \(A \Rightarrow B\), where \(A\) and \(B\) are a collection of items. The support of any itemset \(X\) is the percentage of transactions that include \(X\) in the transaction set \(D\), where \(t = |D\) transaction \(t|t contains \(X\)\). The itemsets whose support degree is greater than the given minimum support degree are called frequent itemsets. Association rules \(A \Rightarrow B\) support \((A \Rightarrow B) = (A \cup B)\), that is, the proportion of affairs that includes \(A \cup B\) in the \(B\). The confidence level of the rules of association \((A \Rightarrow B)\) is defined as \(\supp(A \cup B)\), that is, the percentage of transactions included in the same set. The goal of mining association rules is to generate all association rules with support greater than the given minimum support \(\text{minsupp}\) and confidence greater than the minimum confidence \(\text{minconf}\). It generally includes two steps: (1) calculate all frequent itemsets and

\[
\text{Table 1: Formal context } (G, M, I).
\]

| G | a | b | c | d | e |
|---|---|---|---|---|---|
| 1 | × | x | c | d | e |
| 2 | x | × | × | × | x |
| 3 | × | × | × | × | x |
| 4 | × | × | × | × | × |

(2) generate association rules with confidence greater than the minimum confidence from the frequent itemsets. Based on the above ideas, this paper prunes the three concept lattices, selects candidate concepts, and then extracts qualified association rules based on the parent-child relationship and sibling relationship between the candidate concepts.

In the formal concept analysis, the formal background \((G, M)\) can be understood as the transaction database \(TD\), where \(G\) is the collection of transactions in the database \(TD\) and \(M\) is the collection of all possible items in the database. For \(x \in G\) and \(a \in M\), \(x A\) means that \(a\) belongs to the itemset of the transaction \(x\), then, the relationship between the itemsets is fully reflected in the concept lattice, and each concept is a maximum frequent itemset. In the concept \((X, A), X\) is a subset of all transaction sets, and \(A\) is a closed itemset shared by these transactions. An association rule \(A \Rightarrow B\) is established, and the concept corresponding to the connotation containing \(A\) also contains \(B\). The three-branch conceptual analysis can simultaneously express the semantics of “commonly possessing” and “commonly not possessing.” For \(x \in G\) and \(a \in M\), \(x A\) means that \(a\) does not belong to the itemset of the transaction \(x\). In the concept lattice of \(OE\), \((X, (A, B))\) means that the transactions in the transaction set \(X\) have an itemset \(A\) in common and do not have an itemset \(B\) in common. In the two semantics of the three concept lattices, in addition to the association rules of the form \(A \Rightarrow B\), the rules of the form \(\neg C \Rightarrow \neg D\), \(\neg C \Rightarrow D\), and \(C \Rightarrow \neg D\) can also be obtained. Concepts with \(C\) also have no \(D\) in common, concepts that do not have \(C\) in common have \(D\), and concepts that have \(C\) in common do not have \(D\), which are called negative association rules, or negative rules for short. Correspondingly, \(A \Rightarrow B\) is called the positive association rule, or positive rule for short. This article mainly discusses the extraction of association rules in the concept lattice.

The definitions of the confidence and support of the positive and negative association rules in the three concept lattices are given below.

Let \((G, M)\) be a form of background and \(A, B, C \subseteq M\), and the support of the positive rule \(A \Rightarrow B\) is defined as the proportion of the object with \(A \cup B\) in \(B\):

\[
\text{supp}(A \Rightarrow B) = \frac{|(A \cup B)^+|}{|G|}. \tag{7}
\]

The support of the negative rule \(\neg C \Rightarrow \neg D\) is defined as the proportion of objects that do not have \(C \cup D\) in \(G\), denoted as

\[
\text{supp}(\neg C \Rightarrow \neg D) = \frac{|(C \cup D)^-|}{|G|}. \tag{8}
\]
Let \((G, M)\) be a formal background and \(A, B,\) and \(C \subseteq M,\) and the positive rule \(A \Rightarrow B\)'s confidence is defined as the proportion of objects with \(A \cup B\) in the record for
\[
\text{conf (} A \Rightarrow B \text{)} = \frac{|(A \cup B)|^*}{|A|^*} 
\] (9)

The confidence of the negative rule \(\neg C \Rightarrow \neg D\) is defined as the proportion of objects without \(C \cup D\) in objects without \(C,\) denoted as
\[
\text{conf (} \neg C \Rightarrow \neg D \text{)} = \frac{|(C \cup D)|^*}{|C|^*} 
\] (10)

2.3. The Extraction of Association Rules in Three Concept Lattices

for \((X_1, (A_1, B_1))\) in \(OEL (G, M, I)\):
if \(|X_1| < \text{Minsup}|G|\) then
continue
put \(\neg B_1 \Rightarrow A_1, A_1 \Rightarrow \neg B_1\) into
put \text{supp (} \neg 1 \Rightarrow A_1 \text{) into supp}
put \text{supp (} A_1 \Rightarrow \neg B_1 \text{) into supp}
put \text{conf (} \neg B_1 \Rightarrow A_1 \text{) into Conf}
put \text{conf (} A_1 \Rightarrow \neg B_1 \text{) into Conf}
for \((X_2, (A_2, B_2))\) in \((X_1, (A_1, B_1)))\). Parent-concepts:
if \text{supp (} A_2 \Rightarrow A_1 - A_2 \text{) > minsup and conf}
(A_2 \Rightarrow A_1 - A_2) \text{ > minconf then}
put \text{A_2} \Rightarrow \text{A_1 - A_2} \text{ into R+}
put \text{supp (} A_2 \Rightarrow A_1 - A_2 \text{) into supp}
put \text{conf (} A_2 \Rightarrow A_1 - A_2 \text{) into Conf}
if \text{supp (} \neg B_2 \Rightarrow \neg (B_1 - B_2) \text{) > minsup and conf}
(\neg B_2 \Rightarrow \neg (B_1 - B_2)) \text{ > minconf then}
put \text{\neg B_2} \Rightarrow \text{\neg (B_1 - B_2)} \text{ into R+}
put \text{supp (} \neg B_2 \Rightarrow \neg (B_1 - B_2) \text{) into supp}
put \text{conf (} \neg B_2 \Rightarrow \neg (B_1 - B_2) \text{) into Conf}
for \((X_3, (A_3, B_3))\) in \((X_2, (A_2, B_2)))\). Child-concepts:
if \((X_3, (A_3, B_3)) \neq (X_1, (A_1, B_1))\) then
if \text{supp (} A_1 \Rightarrow A_3 - A_1 \cap A_3 \text{) > minsup and conf}
(A_1 \Rightarrow A_3 - A_1 \cap A_3) \text{ > minconf then}
put \text{A_1} \Rightarrow \text{A_3 - A_1 \cap A_3} \text{ into R+}
push \text{supp (} A_1 \Rightarrow A_3 - A_1 \cap A_3 \text{) into supp}
push \text{conf (} A_1 \Rightarrow A_3 - A_1 \cap A_3 \text{) into Conf}
if \text{supp (} \neg B_1 \Rightarrow \neg (B_3 - B_1 \cap B_3) \text{) > minsup and conf}
(\neg B_1 \Rightarrow \neg (B_3 - B_1 \cap B_3)) \text{ > minconf then}
put \text{\neg B_1} \Rightarrow \text{\neg (B_3 - B_1 \cap B_3)} \text{ into R+}
push \text{supp (} \neg B_1 \Rightarrow \neg (B_3 - B_1 \cap B_3) \text{) into supp}
push \text{conf (} \neg B_1 \Rightarrow \neg (B_3 - B_1 \cap B_3) \text{) into Conf}
return, supp, Conf, R+, supp, Conf

According to the above algorithm, when \(\text{minsupp} = \text{minconf} = 0.4,\) in Example 1, \((G,\) as shown in \(M)\) in Table 2. Among them, rules 1–5 are derived from the parent-child relationship between concepts, and negative rules 6–9 are derived from a single concept. In particular, rules where the antecedent is an empty set, such as rules 1, 2, 4, and 5, can be retained or deleted according to actual applications. For example, in a recommendation system, these rules can be used as a basis for new users to provide recommendations, and the latter rules that are empty sets are generally ignored. Association rules and support and confidence are shown in Table 2.

2.4. Design of the Overall Architecture of the System. Figure 3 shows the structure and working principle of an interactive teaching system based on association rules. First, use various sensor equipment to extract the teacher’s image and voice information, and then transmit it to the PC. The input information is analyzed and processed through the LAN of the control center. In the same way, we have established another similar information processing system with similar functions. Finally, the information of these two systems is fused, and the method we propose is used to extract information from it.

2.4.1. Design of the Listening Module. The teaching of the listening module can be based on the course unit according to the teaching requirements. The main listening materials are daily English conversations, lectures on general topics, and English radio and TV programs with a slow speaking rate (130–150 words per minute). List all kinds of key words for listening content of different subjects are used to prepare for listening comprehension. In the listening skills training, guide students to master the typical expressions and key expression elements of different topics and content, train students to master the general idea, grasp the main points, add special listening skills training projects in single or several modules, and then use listening special test questions be trained. Construction and principle of the interaction teaching system are shown in Figure 3.

2.4.2. Design of the Conversation Module. The conversation module is in the form of spoken language and has a strong practicality. The teaching of the conversation module should be based on vocabulary and sentence patterns and extended to job abilities and career development abilities. Vocabulary and sentence patterns constitute the basic ability module, which is connected to the specific topic and content of each unit. Its teaching focuses on enabling students to master the common vocabulary, fixed usage, and sentence structure of a specific topic. Regarding the job ability and career development ability modules, the teaching is based on the students’ majors, closely focusing on the content and characteristics of their professional subjects and giving students the ability to develop themselves. The conversation module of the interaction teaching system is shown in Figure 4.
### Design of the Reading Module

Reading module teaching can be classified according to the content and subject of reading, or it can be based on the evaluation of the teacher, but also the evaluation of the coursework and the study group. The purpose of constructing this evaluation system is to improve teaching quality, promote learning,
make up for deficiencies, and stimulate students’ interest in learning English. Therefore, the evaluation of higher vocational English teaching should follow the principle of openness. Everyone should find, raise, and solve problems in the process of English teaching, so as to work together and make progress. In addition, teachers can comprehensively evaluate students’ learning attitude and performance through the evaluation platform in the MOOC for students’ evaluation, so as to help students correct their own shortcomings and play a role in urging students to actively learn English. At the same time, it is necessary to encourage mutual evaluation between students and students, using bilingual evaluation methods to check students’ grammar and vocabulary, so as to play a role in mutual supervision and overall development. The reading module of the interaction teaching system is shown in Figure 5. In this figure, we can see that the intrinsic motivation and extrinsic motivation can influence the reading anxiety and the reading fluency, separately. Reading anxiety can give a negative impact to the reading comprehension, while reading fluency can give a positive impact to the reading comprehension.

2.4.4. Design of the Teaching System Module. In this paper, we can design a teaching system module which can realize the listening, conversation, and reading, simultaneously. In this system, there is a teaching center, some listening teaching terminals, conversation teaching terminals, and reading teaching terminals. These objectives form a communication system. The principle of this communication system can be found in Figure 6.

3. Experiment Setting

Since the data is classified according to the modules of the learning platform, the learners are mapped according to the given modules during processing, and the activities of the learners in the platform are obtained, as shown in Figure 4. According to the duration of the course, it can be divided into early, mid, and late [29, 30]. T0 in the figure represents the number of learning behaviors of the learner in the entire course, T1 represents the early period, T2 represents the midterm, and T3 represents the later period. In the whole process, the learning behavior generated is divided into seven modules, namely, Problem (doing homework), Video (watching video), Access (reading objects other than homework and video), Wiki (reading the wiki of the course Encyclopedia), Discussion (forum discussion), Navigate (browse other parts of the course), and Page_close (close web page) [31–34] [36], these data attributes are divided into preperiod, midterm, and postperiod according to the same method, and then, calculate the average value of each column of data, and then, calculate the average of the data greater than and less than the average to obtain the average value of the high segment and the average of the low segment. Finally, the value of each column is divided into four levels based on this, and they are represented by Very High, High, Median, and Low, respectively. At this point, the final data to be analyzed is obtained, as shown in Figure 3.

Finally, use the WEKA data mining platform for rule mining. WEKA is a free, noncommercial data mining software that runs based on the JAVA environment. The main interface of WEKA is the WEKA GUI selector, which provides four main applications, namely, Explorer (Explorer), KnowledgeFlow (Knowledge Flow), Experimenter (Experimenter), and Simple CLI (Simple Command Line). This article mainly uses Explorer (Explorer) interface. The Explorer interface provides a friendly graphical interface. All data mining functions of WEKA can be invoked by selecting the menu and filling in the form. Data obtained after processing the original data is shown in Table 3.

4. Empirical Results and Analysis

In order to verify the performance of the proposed method, we give the comparision of the efficiency of the algorithm proposed in this paper, the Apriori algorithm proposed in [6], and the pApriori algorithm proposed in [7]. The test environment of this experiment is as follows: Intel Core i7-2350M 2.30 GHz CPU, 8 GB internal memory, Windows 10.1 professional operating system, Python programming language, and Spyder as the programming tool. The dataset used in the experiment is a retail text file downloaded from the GitHub community. The file has a total of 88,162 transaction records.

Experiment 1. This experiment compares the time efficiency of the Apriori algorithm, pApriori algorithm, and the proposed algorithm that creates a thread. The given support
values are 2%, 4%, 6%, 8%, and 10%. Select the first 10,000 records from the dataset file retail to test the running time of the two algorithms. The results of its execution time (unit: ms) are shown in Table 4.

It can be seen from the above table that the proposed method has a significant improvement in time performance compared with the classic algorithm Apriori. The execution time of the Apriori algorithm is concentrated in about 12,000 ms, and the improved algorithm is mostly concentrated in about 3,000 ms. In addition, the overall time spent on running the two algorithms decreases with the increase in support. This is because the increase in support will reduce the number of frequent itemsets to a certain extent, thereby improving the efficiency of the algorithm. It can be seen from the first half of the curve that when the support is increased from 2% to 4%, the execution time of the two algorithms has dropped significantly, especially the improved algorithm. The reason for this phenomenon may be related to the dataset itself. When the support of the dataset used in this experiment is set to 2% to 4%, the scale of frequent itemsets will be greatly reduced. Looking at the second half of the curve again, when the support is 10%, the execution time of the improved algorithm increases. The main consideration in this situation is the existence of errors. Since the support is set to 8% and 10%, there is not much difference in the execution time of the algorithm, which may cause slight errors. On the whole, the mining efficiency of the improved algorithm has a significant advantage over the classic algorithm.

Experiment 2. This experiment continues to compare the execution time of the Apriori algorithm and the proposed algorithm that creates a thread. Assuming the given support value is 10%, 1,000, 5,000, 10,000, 50,000, and 80,000 transaction records are taken from the dataset file retail to test the running time of the two algorithms. The test result (unit: ms) is shown in Table 5. In this figure, we can see that the execution time of three algorithms increases with the increase of the items, but the method proposed in this paper has the lowest execution time.

Then, we convert the table to a graph which is shown in Figure 7. It can be seen from Figure 7 that the execution time of the improved algorithm is generally shorter than that of the Apriori algorithm, especially when the amount of data is large, the performance of the improved algorithm is more significant. With the increase in the number of records, we can see that the execution time of the classic algorithm increases rapidly, almost exponentially, while the increase of the improved algorithm is slower and has a slowing trend. This shows that compared with the classic Apriori algorithm, the improved algorithm is more suitable for processing 100,000 or even larger data volumes and has certain practical value. In addition, when the number of records is only 1,000, we find that the execution time of the Apriori algorithm is shorter than that of the improved algorithm. This is because when the improved algorithm reads the transaction dataset to form a candidate 1-itemset, the candidate itemset needs to be sorted in lexicographic order, and this process will take

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### Table 3: Data obtained after processing the original data.

| Course_id | Enrollment | T0 | T1 | T2 | T3 | Problem0 | Video0 | Access0 | Wiki0 | Discussion | Navigate | Page |
|-----------|------------|----|----|----|----|----------|-------|--------|------|------------|----------|------|
| Bwdj2GDcJ | 4219       | 119| 115| 4  | 0  | 46       | 2     | 30     | 0    | 14         | 12       | 15   |
| Bwdj2GDcJ | 4290       | 55 | 38 | 17 | 0  | 0        | 5     | 15     | 3    | 2          | 20       | 10   |
| Bwdj2GDcJ | 4364       | 6  | 0  | 6  | 0  | 0        | 1     | 2      | 0    | 0          | 2        | 1    |
| Bwdj2GDcJ | 4430       | 28 | 0  | 28 | 0  | 0        | 1     | 6      | 0    | 8          | 10       | 3    |
| Bwdj2GDcJ | 4435       | 421| 214| 178| 29 | 113      | 15    | 168    | 1    | 38         | 38       | 48   |
| Bwdj2GDcJ | 4440       | 28 | 0  | 28 | 0  | 0        | 1     | 6      | 0    | 8          | 10       | 66   |
| Bwdj2GDcJ | 4454       | 310| 233| 53 | 24 | 120      | 8     | 95     | 1    | 28         | 52       | 15   |
| Bwdj2GDcJ | 4524       | 527| 390| 78 | 59 | 198      | 8     | 150    | 3    | 68         | 71       | 29   |
| Bwdj2GDcJ | 4571       | 803| 666| 74 | 63 | 142      | 8     | 122    | 7    | 424        | 83       | 17   |
| Bwdj2GDcJ | 4697       | 15 | 0  | 15 | 0  | 0        | 1     | 6      | 1    | 0          | 7        | 0    |
| Bwdj2GDcJ | 4743       | 6  | 0  | 6  | 0  | 0        | 1     | 2      | 0    | 0          | 2        | 1    |
| Bwdj2GDcJ | 4773       | 48 | 11 | 37 | 0  | 14       | 1     | 26     | 0    | 0          | 6        | 1    |
| Bwdj2GDcJ | 4813       | 7  | 0  | 7  | 0  | 0        | 1     | 3      | 0    | 0          | 2        | 1    |
| Bwdj2GDcJ | 4919       | 104| 2  | 102| 0  | 44       | 3     | 31     | 0    | 14         | 9        | 3    |
| Bwdj2GDcJ | 4954       | 103| 0  | 90 | 13 | 56       | 4     | 34     | 0    | 1          | 7        | 1    |
| Bwdj2GDcJ | 4979       | 25 | 12 | 13 | 0  | 0        | 4     | 12     | 0    | 0          | 5        | 4    |
| Bwdj2GDcJ | 5084       | 669| 377| 135| 157| 243      | 71    | 143    | 2    | 47         | 62       | 101  |

### Table 4: Comparison of the execution time of three algorithms with different support degrees.

| Items | 2%     | 4%     | 6%     | 8%     | 10%    |
|-------|--------|--------|--------|--------|--------|
| Apriori | 12944  | 12129  | 12085  | 12052  | 12026  |
| pApriori | 10456  | 9889   | 10345  | 9345   | 11345  |
| The proposed method | 8968   | 3567   | 3298   | 3107   | 3243   |

### Table 5: Comparison of the execution time of three algorithms with different numbers of records.

| Items | 1000   | 5000   | 10000  | 50000  | 80000  |
|-------|--------|--------|--------|--------|--------|
| Apriori | 339    | 4185   | 12263  | 94186  | 174463 |
| pApriori | 367    | 3744   | 10522  | 72890  | 153689 |
| The proposed method | 266    | 1828   | 3173   | 12767  | 16055  |
some time. In general, although the improved algorithm has spent some time sorting, in the face of a rapidly increasing amount of data, the time efficiency of the improved algorithm is superior to the classic algorithm Apriori.

**Experiment 3.** This experiment compares the operating efficiency of the Apriori algorithm with different thread versions. Set the given support value to 10%, and select the first 50,000 records from the dataset file retail to test the running time of the improved algorithm with different thread numbers. The experimental results (unit: ms) are shown in Table 6. In this table, we can see that the execution time of the improved algorithm with different number of threads decreases as the number of threads increases.

It can be seen from Table 5 that, as the number of threads increases, the overall execution time of the improved algorithm decreases. This is because the CPU used in the experiment is dual-core four-threaded and the operating system is based on thread scheduling, so multiple threads will be scheduled to run on multiple cores, allowing threads to execute in parallel, thereby reducing the execution time of the algorithm. Especially, when the number of threads created changes from 1 to twice its 2, the algorithm execution time drops significantly. When the number of threads increases from 4 to 5, the algorithm execution time increases. This is because there are more threads than cores, and thread context switching takes time. In general, the improved algorithm makes full use of the advantages of multicore CPUs, and its efficiency is significantly improved compared to the classic algorithm.

### Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

### Conflicts of Interest

The author declares that there are no conflicts of interest.

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