Intelligent Learning Evaluation Method Based on Data Mining

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Abstract. With the development of artificial intelligence technology, the field of education has also begun to use artificial intelligence technology, and the intelligent learning system with intelligent assessment as the core has gradually become a research hotspot. Compared with traditional rule-based evaluation methods, intelligent evaluation methods comprehensively evaluate learners from multiple aspects, which can effectively improve the comprehensiveness and objectivity of learning evaluation. The article first introduces the relevant concepts in the intelligent learning system, and then introduces the data mining technology used in the intelligent learning system based on data mining. Then this paper analyzes the learner feature extraction method, knowledge system construction method and evaluation strategy design method used in the intelligent learning system, finally, based on this, expounds an evaluation method of intelligent learning system based on data mining and knowledge system construction. The experimental results show that the reliability of the evaluation method based on data mining can reach 9.5 points at the highest.

Keywords: Data Mining; Intelligent Learning; Learning Assessment; Knowledge System

1 Introduction

With the rapid development of artificial intelligence technology, more and more intelligent learning systems are applied in the field of education. Compared with traditional rule-based evaluation methods, the intelligent learning system can comprehensively evaluate learners from multiple perspectives through learning data collection and analysis. This evaluation method can reflect the learner's learning situation more comprehensively, and can effectively improve the comprehensiveness and objectivity of the evaluation.

In recent years, many outstanding scholars have carried out relevant research on intelligent learning. Among them, Agbo, Friday Joseph focused on research trends in the field of intelligent learning environments, academic productivity and thematic focus of scientific publications, and the analysis of the results showed that "digital storytelling" and its related components, such as "virtual reality", "critical thinking", and "serious games" are emerging themes for intelligent learning environments [1].

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Shah, Sayed Kifayat provided a theoretical framework based on a technology acceptance model, incorporating elements of social practice theory. The results show that these are the factors influencing students' intention to adopt 5G smart learning technology. These results are intended to help service providers and policymakers develop effective methods to increase the use of intelligent learning [2]. García-Tudela, Pedro Antonio proposed a qualitative approach implemented in two stages. The main results show that the method provides a framework for the design and analysis of instructional proposals based on the model [3]. The above content is helpful to intelligent learning, but there are few studies on design evaluation methods.

The article first introduces the relevant concepts used in the intelligent learning system, and then aims at the deficiencies in the current intelligent learning system, and expounds an intelligent learning evaluation method based on data mining and knowledge system construction. This method combines data mining technology and knowledge system construction method, can comprehensively evaluate learners from multiple aspects, and provide learners with more comprehensive and accurate personalized information. Finally, the article takes the commonly used knowledge system construction method in the field of education as an example, expounds an intelligent learning evaluation method based on the knowledge system construction, and illustrates the method with specific examples, further verifying the effectiveness and feasibility of the method.

2 Intelligent Learning System

The intelligent learning system is developed on the basis of computer network technology, multimedia technology and other related technologies, is an artificial intelligence system that can comprehensively evaluate learners. The intelligent learning system can use the learning data stored in the system to intelligently evaluate the learners according to the learning situation of the learners, so as to provide the learners with personalized learning suggestions [4].

In the intelligent learning system, the most important ones are learner feature extraction technology and knowledge system construction technology. Through these two technologies, various characteristic information of learners can be transformed into a valuable knowledge system, and a knowledge base with strong semantic understanding ability and reasoning ability can be established. In the knowledge base, a large number of learning resources and knowledge can be stored, which is crucial for an intelligent learning system. Therefore, in the intelligent learning system, the knowledge system is a very critical core content [5].

2.1 Learner Feature Extraction Technology

The main task of the learner feature extraction technology is to extract the learning rules of the learners by mining the behavior data of the learners, and intelligently evaluate the learners through these rules. Learner feature extraction technology includes the following aspects: learning habit feature extraction, cognitive process fea-

ture extraction and learning attitude feature extraction [6]. The characteristics of learning habits include cognitive style, cognitive process, and learning habits; the characteristics of cognitive process include language ability, calculation ability, and analytical ability; the characteristics of learning attitude include emotional attitude and goal achievement. Among them, the characteristics of cognitive style and cognitive process are abstract concepts and cannot be directly used to reflect the actual situation of learners. Therefore, in an intelligent learning system, in order to realize the intelligent evaluation of learners, it is necessary to accurately analyze the characteristics of the learner's cognitive process, and then use these analysis results to realize the intelligent evaluation of learners [7].

2.2 Knowledge System Construction Technology

The knowledge system construction technology is mainly to organize the learning resources and information obtained by the learner feature extraction technology, and use certain methods and means to build these contents into a knowledge base with strong semantic understanding ability and reasoning ability, so as to provide learners with the knowledge needed for intelligent evaluation. Knowledge system construction technology mainly includes three aspects: data collection, knowledge collation and knowledge storage. In terms of data collection, it is necessary to collect learner characteristic information through various channels and establish a relevant database. In terms of knowledge collation, it is necessary to organize and merge various information to make it a knowledge base with a certain structure [8].

3 Data Mining Technology

Data mining is to extract information from a large amount of data and discover unknown patterns. It is a new data analysis method developed on the basis of data warehouse, database or data analysis technology. Data mining mainly includes data preprocessing, feature selection and classification [9]. It can be used to discover knowledge, support decision-making, discover new patterns, and update information systems. The prototype of the data mining system is shown in Figure 1.

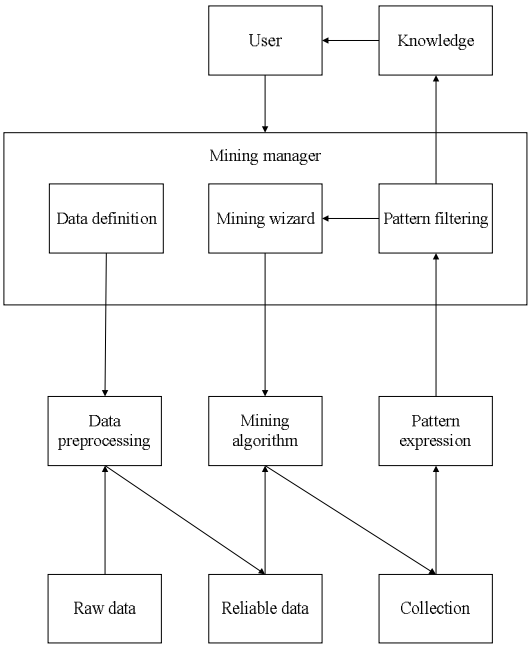

Fig. 1. Data mining system prototype

Data mining algorithms can be divided into Min-max standardization, Z-score standardization, and modified standard Z-score [10]. The Min-max standardized calculation method is shown in formula (1).

$$\hat{a} = \frac{a - \min}{\max - \min} \tag{1}$$

In formula (1), max is the maximum value of the sample, and min is the minimum value of the sample. The Z-score standardized calculation method is shown in formula (2).

$$z = \frac{a - \delta}{\mu} \tag{2}$$

In formula (2), δ represents the mean value and μ represents the standard deviation. The modified standard Z-score calculation method is shown in formula (3).

$$z = \frac{a - \delta}{asd} \tag{3}$$

In formula (3), *asd* is the absolute deviation.

Data mining can be divided into three levels: ① the preparation stage of data mining, including data collection, data cleaning, feature selection, and model building; ② the

process stage of data mining, including data conversion, classification, and prediction; ③ the result stage of data mining, including feature extraction, association analysis, classification prediction, etc. [11].

In the field of education, data mining technology is mainly used in the analysis of individual characteristics of students, curriculum and teaching design, learning behavior analysis, and curriculum evaluation. In addition, data mining technology is also widely used in network information management, teaching quality assessment, and learning resource design [12].

Data mining technology is mainly used in the analysis of individual characteristics of learners and the design of curriculum system in the intelligent learning system. It can help learners understand their own learning situation, and formulate corresponding learning plans according to their actual situation, so as to achieve better learning effect [13].

4 Construction of Knowledge System

The construction of the knowledge system is an important link in the intelligent learning system. After comprehensive analysis of the characteristics and behavior characteristics of the learners, the personalized learning content, learning activities and learning strategies for the learners are constructed to provide knowledge support for the intelligent learning system. The knowledge system is a knowledge structure system formed by organically combining, reorganizing, and integrating various learning resources in the intelligent learning system, including knowledge points, the relationship between knowledge points, and the relationship between knowledge points and situations. An intelligent learning system based on data mining needs to analyze the characteristics and behaviors of learners from multiple perspectives. These analysis results are used as the data basis for building a knowledge system, and an evaluation strategy is designed based on this [14]. Therefore, the construction of knowledge system is an important basis for evaluating learners in intelligent learning systems. Ontology technology, concept map technology and information extraction technology are used in the construction of knowledge system.

4.1 Ontology Technology

Ontology technology is a language to express the relationship between concepts in the computer field, and it is also a knowledge organization method, which can establish the relationship between concepts in the field through the form of knowledge elements. It uniformly encodes concepts, rules, facts, etc. in the domain to form a knowledge base that can describe all concepts and rules in the domain. Through the learning of ontology technology, the relationship between concepts in the field can be obtained, and on this basis, the knowledge system can be constructed. When ontology technology is applied to the intelligent learning system, its main function is to use ontology to manage and maintain knowledge, so that learners can easily obtain the knowledge they need, thereby improving the efficiency of knowledge acquisition [15]. Therefore, ontology

technology is used in the article to construct the knowledge system. For learners, they can obtain the knowledge points they need by searching and selecting resources.

4.2 Concept MAP Technology

A concept map is a graphical framework used to represent the relationship between concepts, which can clearly express the hierarchical relationship between concepts and is easy for learners to understand. The concept map is used to describe the concept of the knowledge field, based on the hierarchical relationship between concepts, using the graph structure to organize and store data to form a knowledge network. The concept map technology utilizes the basic concepts (nodes and edges) and their attributes in graph theory, as well as symbols, identifiers, etc., to organize domain knowledge in a hierarchical form, and realize the abstraction and modeling of domain knowledge. The concept map technology makes the knowledge structure clear and intuitive, which is beneficial for learners to understand, master and apply knowledge. Concept map technology can be applied in many fields, such as education, computer science, etc. [16]. In the field of education, concept map technology can be used to organically combine, reorganize, and integrate knowledge points in different fields. The process of building a knowledge system based on concept map technology can be divided into three steps: the first step is to model the relationship between concepts in the ontology; the second step is to organize the extracted learning resources, learning activities, learning strategies and other knowledge information; the third step is to construct the concept map.

4.3 Information Extraction Technology

Information extraction technology is a combination of natural language processing technology and artificial intelligence technology to extract factual information in text. Information extraction technology is one of the key technologies in the construction of knowledge system, which can extract information entities containing factual information from text, and then construct a complete knowledge system [17]. Information extraction technology is widely used in knowledge system construction. For example, rule-based methods can extract factual entities in text, and then classify and cluster these factual entities. According to classification and clustering results, relevant knowledge about factual entities can be obtained. This method is straightforward and easy to understand, but requires a lot of labeled data to get the desired results. With the increase in the number and size of the corpus, there will be more and more labeled data [18]. Therefore, how to extract useful information from massive data has become a difficult problem for intelligent learning systems.

5 Evaluation Strategy Design

In an intelligent learning system, in order to improve the comprehensiveness and objectivity of evaluation, multiple evaluation strategies need to be used. Therefore, the

evaluation strategy of intelligent learning system is constructed from two aspects of knowledge system and learning behavior [19].

(1) Evaluation strategy of knowledge system: establishing the corresponding knowledge system by classifying learners' knowledge. In the intelligent learning system, the knowledge system is organized on the basis of knowledge points. When a learner learns a certain knowledge point, the system will classify it into four levels: mastery, better, general and poor according to their mastery. On this basis, it can be evaluated according to the mastery of the knowledge points by the learners, so as to identify the deficiencies of the learners in the learning process.

(2) Behavior assessment strategy: analyzing the behaviors exhibited by learners during the learning process, including reading speed, writing speed, thinking time, etc. On this basis, a preliminary assessment can be made to the learners, thus providing a reference for the next step of learning.

(3) Feedback evaluation strategy: in the intelligent learning system, students can give feedback to the system at any time about their own learning situation. When the learner's feedback and evaluation information is fed back by the system, the system will guide the learner to the next step of learning according to the feedback information. On this basis, it can be reassessed and guided according to the information fed back by the learners.

Through the evaluation strategy design of the above three aspects, a complete set of intelligent learning system evaluation system can be established. This system can not only effectively help students find their own deficiencies, but also find and help students solve problems in a timely manner through the intelligent system. This evaluation method can not only conduct a comprehensive evaluation of learners from multiple aspects, but also effectively improve the objectivity and comprehensiveness of the evaluation [20].

6 Test Experiment of Intelligent Learning Evaluation Method

The article then carried out the test experiment of the intelligent learning evaluation method. First, the learning records were saved, and the learning situation of the students was analyzed through data mining technology. When the students' learning situation is systematically evaluated, the system will guide the students accordingly according to the evaluation results. On this basis, it is re-evaluated according to the feedback and evaluation information of the students. Finally, the article tests the evaluation strategy used in the intelligent learning system through a simulation experiment. The experimental process is as follows: (1) saving the learning records; (2) analyzing the learners' learning situation; (3) saving the students' feedback and evaluation information; (4) using data mining technology to analyze the learning situation of students, and return the analysis results to the intelligent system. Finally, the article compares the results with the analysis results of general evaluation methods, and compares the credibility and reliability. The results are shown in Figure 2 and Figure 3.

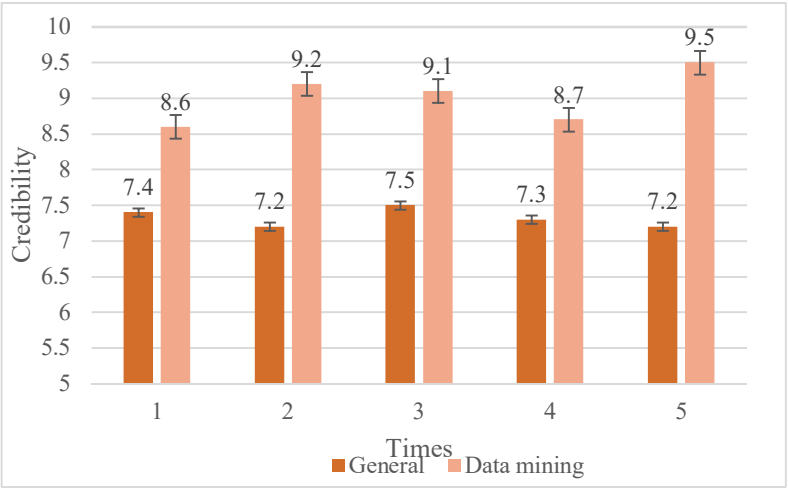

Fig. 2. Confidence

It can be seen from Figure 2 that the highest reliability of the general evaluation method is 7.5 points, the lowest is 7.2 points, and the calculated average score is 7.32 points; the credibility of the evaluation method based on data mining reached 9.5 points at the highest point and 8.6 points at the lowest point, and the calculated average score was 9.02 points. It can be seen that the intelligent learning evaluation method based on data mining has high credibility.

Fig. 3. Reliability

It can be seen from Figure 3 that the reliability of the general evaluation method is the highest at 8.5 points, the lowest at 7.6 points, and the calculated average score is

7.96 points; the reliability of the evaluation method based on data mining can reach up to 9.6 points, the lowest point is 8.6 points, and the calculated average score is 9.16 points. It can be seen that the intelligent learning evaluation method based on data mining has high reliability.

To sum up, the intelligent learning evaluation method based on data mining has high credibility and reliability, and is a relatively effective evaluation method. When assessing learners' learning, it can effectively discover the problems existing in the learning process of learners, and can provide corresponding learning guidance in a timely manner, and can effectively help learners find their own problems. Finally, the article conducted a satisfaction survey questionnaire on the intelligent learning evaluation method based on data mining, and the results are shown in Table 1.

Table 1. Satisfaction Survey

	Very good	Good	General	Poor	Very poor
Credibility	20%	28%	39%	7%	6%
Reliability	24%	28%	36%	6%	6%

It is not difficult to see from Table 1 that in the actual application of the intelligent learning evaluation method based on data mining, the number of favorable reviews far exceeds that of negative reviews, the credibility of "good" and above accounted for 48%, the evaluation of "poor" and below accounted for 13%, the reliability of "good" and above evaluation reached 52%, and the evaluation of "poor" and below accounted for 12%. It can be seen that this evaluation method not only has a good effect in the experiment, but also receives rave reviews in practical application.

7 Conclusions

As intelligent learning systems continue to develop, evaluating them becomes increasingly important. The article first analyzes the relevant concepts in the intelligent learning system, and then introduces the feature extraction method, knowledge system construction method and evaluation strategy design method used in the intelligent learning system based on data mining, and on this basis, elaborates an evaluation method of intelligent learning system based on data mining and knowledge system construction. The shortcoming of the article is that when the existing research analyzes the characteristics of the learners used in the intelligent learning system, it mostly starts from a macro perspective and lacks a detailed description of the analysis of the characteristics of the specific learners. Secondly, due to the relatively complex design methods of evaluation strategies used in intelligent learning systems, multiple strategies need to be used to achieve the best results when evaluating intelligent learning systems, which also makes existing research more inclined to study different evaluation strategies. For example, the process of learner feature extraction does not take into account the influence of factors such as differences between learners and learning styles on the evaluation effect. These issues need to be addressed in future research.

The future research direction should be to continue to improve the evaluation effect and efficiency of the existing methods, and to reduce the time and energy required for the learner feature extraction process.

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