Learning Behavior Analysis and Prediction of Teaching System Based on Neural Network Algorithm

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Abstract: The current teaching system relies on students' behavior and interaction data in the system. This article proposes a teaching system based on recurrent neural networks to solve the above problems. This article collects learners' behavioral data and applies appropriate neural network models for training and analysis. Teaching systems based on neural networks can accurately capture learners' behavioral patterns and trends, and gain an in-depth understanding of their learning characteristics and behavioral preferences. Experimental results show that the accuracy of this system is 83%-94%. By analyzing learning behavior, we are able to predict learners' future learning needs and performance and provide personalized learning support. This personalized recommendation and suggestion function can help educators provide accurate learning resources and guidance, and improve learners' learning effects and satisfaction. The research also points out the need to further improve the accuracy and interpretability of the algorithm and apply these research results to actual educational environments to achieve better teaching results. This study provides useful guidance and research basis for teaching systems based on neural network algorithms.

Keywords: Neural Network Algorithm, Teaching System, Learning Behavior Analysis, Behavior Prediction

1. Introduction

The field of education faces important challenges of personalized instruction and learner support. Every learner has unique learning characteristics and learning needs, and traditional one-size-fits-all teaching methods are no longer able to meet the diverse needs of different learners. Therefore, research on the teaching systems based on neural network algorithms has become particularly important. This research method can provide personalized learning support and precise learning suggestions by analyzing learners' behavior patterns and trends, thereby helping learners achieve more efficient learning outcomes.

A large amount of research has been conducted on learning behavior analysis, Li X believed that the causes of students' false learning in physical education teaching were

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mainly affected by both students and teachers. Among them, unreasonable teachers' explanation, organization, evaluation and content arrangement were the main reasons for students' false learning [1]. Wang J collected and analyzed data in the learning process and found that learners' course visits were positively correlated with course grades, and there were large differences in course visits in different time periods [2]. Zhang Z believed that collecting and analyzing learning behavior data could more accurately describe students' learning habits, and then improve the quality of teaching by taking targeted incentive measures [3]. However, current research on the analysis and prediction of learning behavior in teaching systems based on neural network algorithms is relatively limited.

In order to achieve this goal, this study will collect learners' behavioral data, including learning records, interactive behaviors, etc. We will then apply appropriate neural network algorithms to train the model and analyze and predict learning behavior. At the same time, we will also explore how to apply these research results into the teaching system to provide educators with personalized learning recommendations and suggestions. This will help improve learners' learning effectiveness and satisfaction, and promote their independent learning and personalized development.

2. Introduction to Teaching System

Teaching system refers to a computer software or platform used in the teaching process, designed to support the various needs of teachers and students in learning and teaching activities. It combines educational theory, technology tools and learning resources to provide an interactive and personalized learning environment. The system can manage students' personal information, course registration, learning progress and performance records. Through the learning management function, teachers can track students' learning, evaluate their academic performance, and provide personalized guidance and feedback. The system provides learning content in various forms, such as text, images, audio and video. Students can interact with learning content through the teaching system, read online, watch teaching videos, participate in discussions, etc. It can also provide personalized learning paths and resource recommendations based on students' learning needs and ability levels. By analyzing students' learning behavior and performance, the teaching system can provide intelligent learning guidance and content recommendations based on the characteristics and needs of each student. The system provides various forms of student assessment and feedback mechanisms [4-5]. It automatically assesses student assignments and quizzes and provides instant feedback. The teaching system can also generate learning reports and analysis to help teachers understand students' learning progress and difficulties and adopt corresponding teaching strategies.

2.1 Learning Behavior Analysis

In teaching systems, learning behavior analysis refers to the process of collecting, analyzing, and interpreting students' behaviors and interactions during the learning process. Through learning behavior analysis, teachers and teaching systems can understand students' learning status, behavior patterns and difficulties, thereby providing personalized learning support and guidance. Learning behavior analysis can apply various analysis techniques and methods. Through these methods, students' learning patterns can be extracted, learning difficulties identified, learning performance and personalized learning needs predicted, etc. [6-7]. By analyzing learning behaviors, helping students better understand and master knowledge. Teachers can understand students' learning behaviors and reactions through learning behavior analysis, and adjust and improve teaching strategies to improve teaching effectiveness and student participation. Learning behavior analysis can help evaluate students' learning progress and performance, providing teachers with data support to provide accurate learning feedback and assessment. Learning behavior analysis is an important link in the teaching system. By analyzing students' learning behavior, it can provide personalized learning support, improve teaching strategies, and provide accurate learning assessment and feedback. It helps teachers and teaching systems better understand and meet students' learning needs [8-9].

2.2 Learning Behavior Prediction

Learning behavior prediction refers to the use of statistical models, machine learning or artificial intelligence technology to predict students' future learning behavior and performance through the analysis of students' historical learning behavior and related data. Through learning behavior prediction, teachers and teaching systems can better understand students' learning needs, provide personalized learning support and guidance, and optimize teaching strategies [10-11].

Learning behavior prediction can be used to predict students' future academic performance. By analyzing students' historical learning behavior, homework completion, test scores and other data, prediction models can be established to predict students' performance in future exams or homework, and help predict students' learning progress. Based on students' learning activities, course progress, and past learning performance, it can predict students' future learning progress and completion, and whether they need additional learning support or intervention. It can be used to detect learning difficulties that students may encounter. By analyzing students' learning behavior patterns, response times, error patterns, etc., it can predict that students may encounter difficulties in specific topics or concepts, and provide corresponding help and support as early as possible [12-13]. Behavior prediction can also be used to plan students' personalized learning paths. By analyzing students' learning goals, prerequisite knowledge, learning progress and learning styles, it can predict the most suitable learning paths and course arrangements for students to achieve the best learning results. Learning behavior prediction relies on the analysis of large amounts of student data and related characteristics. Commonly used prediction methods can be selected and adjusted for specific prediction tasks and data features.

2.3 Limitations of the Current System

Current teaching systems rely on student behavior and interaction data in the system, but not all learning behaviors can be recorded and collected in the system. For example, students may conduct learning activities outside the classroom, such as group discussions, field trips, etc., and these behaviors cannot be captured by the system. Therefore, the system cannot fully understand students' learning behavior. There may be quality and accuracy issues with the learning behavior data it collects. Errors, omissions, or false positives may occur during the data collection process, affecting the reliability of the data. Inaccurate or incomplete data may lead to errors in learning behavior analysis and prediction [14-15]. Learning behavior analysis and prediction involves students' personal data and privacy and requires reasonable data collection and processing mechanisms. Protecting the privacy and security of student data is an important issue, and teaching systems must comply with relevant privacy regulations and ethical guidelines to ensure the legal use and protection of student data. Learning behavior is a complex process that is affected by many factors, including students' cognitive ability, learning motivation, social interaction, etc. This makes learning behavior analysis and prediction somewhat uncertain and challenging [16-17]. The accuracy of predicting learning behaviors and results may be interfered by many factors, and there is a certain range of error.

3. Teaching System Based on Neural Network Algorithm

3.1 Neural Network Algorithm

Neural network algorithms are a type of machine learning algorithm inspired by the human brain nervous system. They perform learning and prediction tasks by simulating the connections and information transfer between brain neurons. Neural network algorithms utilize a series of artificial neurons and the connection weights between them to process input data and generate output results. The core idea of the algorithm is to enable the network to extract useful features from the input data and perform prediction or classification by adjusting the connection weights between neurons. This adjustment process is usually implemented through the backpropagation algorithm, which uses the gradient descent optimization method to minimize the prediction error of the network [18-19]. Algorithms usually consist of multiple layers of neurons, including input, hidden, and output layers. The input layer receives raw data input, and the hidden layer and output layer calculate and transfer information based on connection weights. Each neuron performs a nonlinear transformation on the input signal through an activation function and passes the result to the neuron of the next layer. During training, the algorithm adjusts connection weights by providing known inputs and corresponding desired outputs. Through multiple iterations of training, the neural network algorithm gradually adjusts the connection weights, allowing the network to better adapt to the training data and produce accurate prediction results. It is widely used in various tasks in the field of machine learning. Different types of neural network algorithms are suitable for different data types and task requirements [20]. The development and improvement of these algorithms have promoted the rapid development of the field of deep learning and achieved important breakthroughs and applications in many fields. This article uses recurrent network neural to improve and optimize the system. Its common structure is shown in Figure 1.

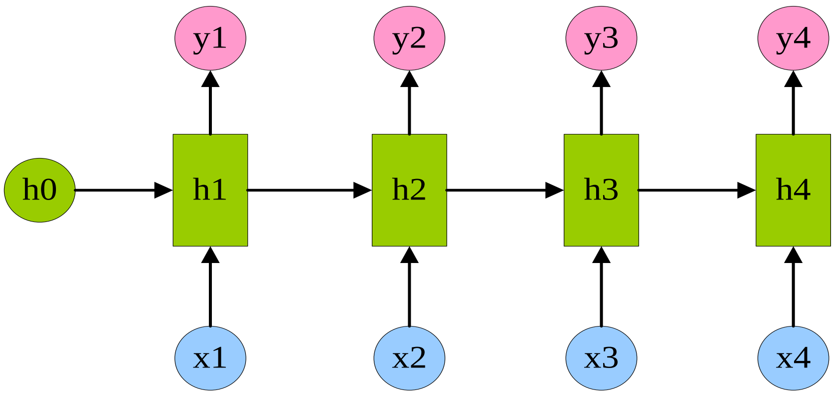

Fig 1. Common RNN structural models

3.2 System Framework

When designing a teaching system based on neural network algorithms, the system framework is first established. When componentizing the system framework, the system framework is divided into modules such as data processing and feature extraction, neural network model design, model training and optimization, and learning behavior analysis and prediction. Data processing and feature extraction are performed by collecting students' usage of learning materials, answer records, study time and other learning behavior and interaction data, and the data is cleaned, converted and standardized to facilitate subsequent analysis and modeling. Learning behavior data is transformed into feature representations that can be processed by neural networks. This involves extracting useful features from raw data, such as sliding window processing of time series data and word embedding representation of text data. The quality of feature extraction and representation will directly affect the performance of subsequent learning behavior analysis and prediction. Determining the neural network model suitable for learning behavior analysis and prediction, and select the recurrent neural network as the algorithm model based on the characteristics of the task and the type of data. At the same time, the model parameters were also determined, as shown in Table 1.

Table 1. Recurrent neural network parameters

Parameter	**Recommended Range**
Number of Layers	2
Number of Neurons	100
Activation Function	Tanh
Learning Rate	0.001
Optimization Algorithm	Adam
Regularization	Dropout

Setting the number of network layers to 2, the number of neurons to 100, and use Tanh as the activation function. The output range of the Tanh function is between [-1, 1] and has the characteristics of an S-shaped curve. It can introduce nonlinear transformation and help the neural network deal with nonlinear relationships. The initial value of the learning rate is set to 0.001, and then the learning rate is adjusted based on the performance during training. Using Adam as the optimization algorithm to optimize the model, and use Dropout regularization to reduce overfitting.

3.3 System Optimization and Improvement

Ensuring the quality and consistency of the input data, and perform pre-processing operations such as cleaning, standardization and normalization of the data to improve the stability and accuracy of the model. Optimizing the expression ability of the model by adjusting the number of layers, number of neurons, and connection methods of the neural network. The main direction of this improvement is feature extraction. The main purpose of feature extraction is to improve the expressive ability and discrimination of features, thereby improving the performance of machine learning and pattern recognition tasks. In high-dimensional data sets, feature extraction can reduce the number of features by reducing the dimensionality, thereby reducing computing and storage overhead and reducing the risk of model overfitting. The calculation formula is as follows:

$$J(w) = \frac{w^\wedge T * S\_B * w}{w^\wedge T * S\_W * w} \tag{1}$$

$$X\_lda = X.dot(w) \tag{2}$$

$J(w)$ is the objective function of LDA, w is the optimal projection vector, S_B is the scatter matrix between categories, S_W is the scatter matrix within the category, and X_lda is the data matrix after dimensionality reduction. By improving the feature extraction algorithm, more distinguishable and discriminative feature representations can be extracted, which helps to enhance the model's ability to perceive differences between different categories, thereby improving classification accuracy. After improving the system model, training and optimizing the system.

4. Experimental Effect Test

4.1. Test Methods

In order to verify the accuracy and efficiency of the learning behavior analysis and prediction of the teaching system based on the neural network algorithm, the neural network is used to train the learning behavior prediction model, and the model performance is evaluated through cross-validation. In the experimental test, the system studied in this article was used as the experimental group, and the traditional system was used as the control group. The experimental environment of this article is a computer device with sufficient memory and computing power and a win7 system or above with GPU acceleration. The neural network algorithm uses Python's deep learning library and uses MOOCs data sets containing student learning behavior data. The data includes students' learning behaviors (such as the number of video views, discussion forum participation, etc.) and learning results (such as test scores, exam scores, etc.). Parts of the dataset are subjected to a cleaning step, after which the data is divided into different datasets. The experimental group and the control group conducted experiments on different data sets respectively, and the evaluation indicators were accuracy and recall. Its calculation is as follows:

$$A = \frac{TP + TN}{TP + TN + FP + FN} \tag{3}$$

$$R = \frac{TP}{TP + FN} \tag{4}$$

4.2. Test Results and Analysis

According to the above experimental steps and requirements, the system model is experimentally tested, Matlab is used to statistically summarize the data, and the results are made into images. Figure 2 shows the accuracy data, Figure 3 shows the recall data, and Figure 4 shows the F1 value data.

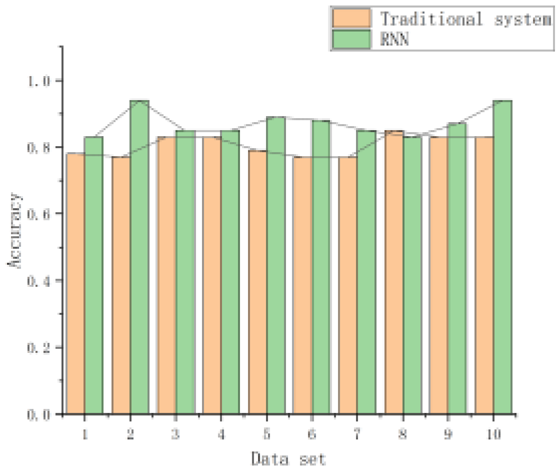

Fig 2. Comparison of accuracy data

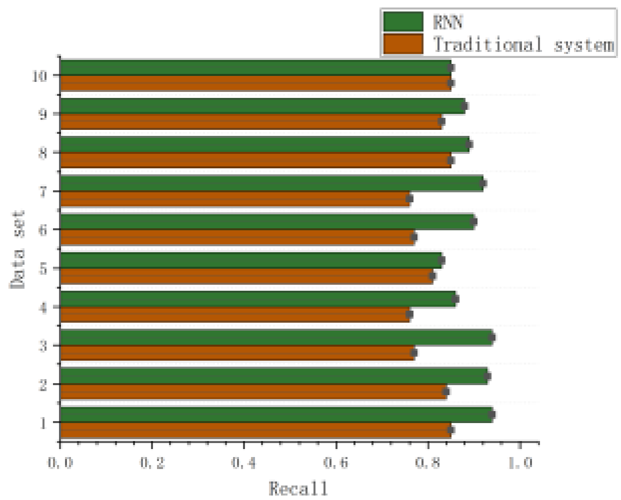

Fig 3. Comparison of recall data

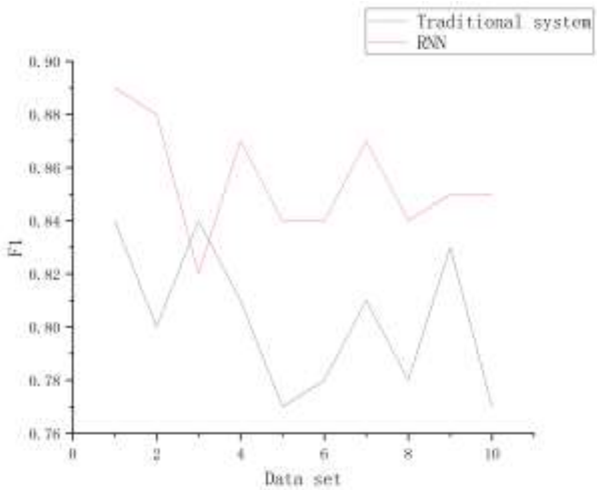

Fig 4. Comparison of F1 value data

In the accuracy experiment, the accuracy of the traditional system ranged from 77% to 85%, while the accuracy of this system ranged from 83% to 94%. The experimental results in Figure 3 show that the recall rate of the traditional system is 76%-85%, and the recall rate of this system is 83%-94%. According to Figure 4, in terms of F1 value data, the F1 value of the traditional system is between 77% and 84%, while the F1 value of this system is between 82% and 88%. The system in this article has been improved in terms of accuracy, recall rate, and F1 value. The higher accuracy means that the model is more accurate in overall classification and can correctly predict more samples. The higher recall rate means that the model is better able to capture positive samples and reduce false negatives. The F1 value takes precision and recall into account and is their weighted harmonic mean. The higher F1 value indicates that the model performs well in both precision and recall, and is able to strike a balance between accuracy and coverage.

5. Conclusion

Neural network algorithms have shown excellent performance in learning behavior analysis. By modeling and training on learner behavioral data, neural networks are able to accurately capture learner patterns and trends, providing deep insights. Through learning behavior analysis, we can better understand learners' learning characteristics and behavior patterns. This includes their learning preferences, learning progress, knowledge mastery, and potential difficulties. These insights are critical for personalized instruction and learner support, helping educators better tailor teaching strategies and provide adaptive learning resources and guidance. Predictive capabilities based on learning behavior allow us to predict the future behavior and performance of learners. By analyzing learners' historical behavioral patterns, we can infer their future learning needs, possible learning outcomes, and challenges they face. Such predictions provide valuable information to educators, allowing them to take steps ahead of time to meet learners' needs and help them achieve better learning outcomes. The personalized recommendation and suggestion functions of teaching systems can be improved through learning behavior analysis and prediction. By accurately predicting learners' behaviors and needs, teaching systems can provide more personalized and accurate learning resources, activities and suggestions to help learners better achieve their learning goals.

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