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Computer-Aided Design AND APPLICATIONS

Tutoring Innovation of Educational Informatization Transformation Path Based on Intelligent CAD and Trusted Neural Network

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Abstract. Only by mining the correlation of data from the teaching management data can we better serve the university teaching management, motivate teachers to participate in teaching, improve the university's teaching quality and teaching effect, and cultivate qualified talents needed by society. With the application of BD (big data) technology, the application innovation of the whole information education management system is realized. This paper studies the path innovation of educational informatization transformation based on BD technology and TNN (Trusted Neural Network). The educational information architecture is constructed, and the features of users and projects are extracted from the basic information of users and projects by using the cascade sparse noise reduction self-encoder, which is integrated into the model to complete the integration with the scoring information and the top-ranked resources in the resource list are recommended to students and users, to achieve personalized recommendation. The results show that the accuracy of the recommendation algorithm based on the TNN model for processing project information is 12.19% higher than that of the traditional algorithm. The recommendation quality of the new algorithm is the highest due to the addition of user classification, which effectively alleviates the problem of users' cold start and the excellent project feature learning ability of the self-encoder DL (Deep learning) model.

Keywords: Intelligent CAD; Trusted neural network; Educational informatization; Recommendation algorithm
DOI: https://doi.org/10.14733/cadaps.2025.S8.274-286

1 INTRODUCTION

With the development of information technology to a certain extent, digital technology has brought about comprehensive changes in universities, followed by the birth of the BD (Big Data) era, a highly developed product of information technology. The huge data resources and the application of cutting-edge technology make every field of society begin the process of "BD," which impels social change penetratingly. As far as higher education is concerned, it is in the midst of this

transformation, being changed and affected and being directly and indirectly promoted by the wave of BD. The information-based education method not only brings convenience to teachers and students but also stores a large amount of information generated when teachers and students apply the platform, which is also the biggest feature of the information-based teaching method itself. Personalized recommendation service for educational resources makes the system change from a simple mode of "people looking for resources" to an intelligent mode of "people looking for resources and resources looking for people."

Many of these technologies are also applied in the process of information and informatization in higher education [1]. Therefore, by using the BD information system to accurately locate different university education management problems and analyzing the trend of education management according to the university education environment, the formulation of education management norms can be effectively implemented. The development of the BD era has become the main topic of many conferences in China in recent years, and its core content is campus information management in the BD era [2]. Only by mining the correlation of the data from the teaching management data can we better serve the university teaching management, motivate teachers to engage in teaching better, improve the teaching quality and teaching effect of the university, and cultivate qualified talents needed by society. Information centers, network centers, data centers, and other new business functional organizations have emerged and will develop into professional organizations of digital education management and teaching activities. How can we make use of this advantage to make up for the deficiency in traditional education so that students' learning content after class is more suitable for themselves and teachers' lectures are more suitable for classes [3]? This paper uses a data mining algorithm to study this problem.

People's exploration and application of massive data indicate the growth of a new generation of productivity and the arrival of consumer surplus. With the popularization of modern information education, the implementation of traditional university education management appears to be the problem of curve fluctuation. The intensity of one education management is too high, while the content design of the other education management is slightly slack, which fails to form a complete education management, and it can't be applied to the diversified education development environment at the practical level of education management. In the classroom teaching of the new teaching mode, teachers and students can have effective dialogue and communication, and students can give full play to their advantage and stimulate their enthusiasm. The application research of data mining in educational informatization has a far-reaching influence and important significance for enhancing the application of educational informatization in daily teaching and improving the teaching level and quality.

Research innovation:

(1) Through an example simulation, the effectiveness of data mining technology in the application of educational informatization is verified, which provides a scientific decision-making basis for the development of educational informatization.

(2) The feedback alignment mechanism is applied to the recommendation algorithm, and the personalized recommendation algorithm of educational information resources based on TNN is derived. Finally, the performance of the algorithm is evaluated under different learning parameters.

The paper is divided into five chapters, and the main contents of each chapter are as follows:

The first chapter introduces the background work of the research. The second chapter mainly introduces the present situation of this research. The third chapter puts forward an algorithm model of personalized recommendation of educational information resources based on TNN. The fourth chapter verifies the performance of the model studied in this paper. The fifth chapter is the conclusion.

2 RELATED WORK

2.1. Research on Education Informatization

Limited by the traditional educational management mode, the efficiency of educational management in contemporary universities is generally low, and the educational management cycle is delayed for a long time, which makes it difficult to guarantee the efficiency and timeliness of educational management. Through the investigation of the current situation of information development in university education management in China, it was found that BD technology has been applied and integrated into many universities. We can better establish the information organizational structure of universities, improve the teaching quality, and play a great role in promoting the development and innovation of education and teaching.

Chai believes that the fundamental reason for the formation of BD is that it has such important features as scale, diversity, and high speed, but the descriptions of each feature are not completely consistent [4]; Lu et al. think that BD is just massive data and that the value of BD is the value embodied by massive data [5]. Cao et al. discussed the functions and influences of BD in many industries and fields, such as automobile insurance, retail manufacturing, the electric power industry, gambling, telecommunications, etc., through the analysis of typical BD sources and their values [6].

By analyzing the demand of enterprises for information systems and the positioning of information system talents in the BD era, Shao et al. discussed the transformation of university information system talent training and, by extension, predicted the influence of the BD era on university talent education [7]. Syambas et al. found the factors that influence students' choice of learning methods by analyzing the different preferences of more than 2,000 students in nearly 30 schools in online learning platforms [8]. Hussein et al. put forward that BD has become an important technical force in promoting the development of higher education and expounded how BD can promote the development of higher education from four aspects: talent cultivation, scientific research, serving society, cultural inheritance, and innovation [9]. Gao et al. think that BD should be combined with cloud computing to greatly increase the opportunities for using educational resources, analyze how BD combines cloud computing to process data and provide services, and predict the development trend of higher education in the BD era [10].

2.2. Research on Neural Network Technology

DL (Deep Learning) realizes the extraction of the deep features of the input signal, breaking the limitation of the shallow layer model on the number of network layers. The encoding process is to expand the information code word, that is, add a number of redundant bits to the original code word to form a new input code word so that the added redundant code word has a constraint relationship with the information bit code word. Therefore, when the model parameters of the network are trained well, the decoding delay of the deep neural network is shorter, and the decoding performance can be improved to some extent.

In their research, Chen et al. put forward multi-scaling BP decoding, which is a deep neural network based on polarization. The application of this network in the decoding of polarized codes reduces the delay and complexity of the decoder [11]. Shin et al. put forward a recursive neural network decoder model, which has fewer network parameters and fast running speed, but it has been proved that the network can only have good performance in high-density codes with short length and short length [12]. Taghizadeh et al. think that DBN (Deep Belief Networks), like squeezing information out of the bottleneck in the learning process, removes noise input and only retains the features most related to general concepts [13].

Liu et al. applied a cyclic redundancy check to the decoding algorithm of a continuous deletion list to reduce the bit error rate and improve the performance by 0.5dB, which is the best decoding algorithm among the most widely used decoding algorithms at present [14]. Yu et al. proposed an algorithm combining CNN (Convective Neural Network) with BP to improve the decoding ability of

LDPC (Low-Density Parity Check Codes) codes in a colored noise environment [15] and achieved good performance because the correlation of noise is used as a feature to train and learn. Kiliarslan et al. converted the depth CNN into the depth pulse neural network without reducing the learning accuracy and realized the fast and effective calculation of pattern recognition problems on the pulse-based neural morphology computing platform [16].

3 METHODOLOGY

3.1. Innovation Scheme of Educational Informatization Transformation Path Based on BD Technology

The establishment of the BD information system is based on the application design of the Internet information platform. The use of BD resources in universities is bound to be realized through BD summarization, screening, and analysis [17-18]. At this time, using the way of increasing students' learning costs to improve the ability of education management will make the difficulty of university education management suddenly increase, and at the same time, it will also lose educational fairness for students. However, suppose the details of education management can't be solved in the framework of education management. In that case, the practical application of BD education management innovation will naturally be bound by the actual conditions, which in turn will affect the effectiveness of BD information education management practice.

A decision tree algorithm is a common classification method in data mining, which is a hierarchical structure composed of nodes and directed edges. It can classify data by dividing the source database [19]. The process of establishing a decision tree is to continuously segment the data, form paths from the root to the leaf nodes, and form different rule sets [20]. ID3 is the most basic decision tree classification method.

When classifying a data set with N samples, assume that the category number has k different values, classify the sample set according to the category and let $s_1,\cdots,s_k$ and $n_i \ \ i=1,\cdots,k$ be the number of samples corresponding to each category $s_1,\cdots,s_k$, then the probability value of occurrence of s_i for each category is:

$$p\ \ s_i\ \ =\frac{n_i}{N} \tag{1}$$

After that, if the sample data set is divided by attribute a, the expected information of the division of attribute is:

$$h_a\ \ s\ \ =\sum_{i=1}^{t}\frac{n_{ai}}{N}h\ \ n_{ai}\ \ \tag{2}$$

The information gain rate is defined as the ratio of average mutual information to the cost of obtaining a information, namely:

$$E\ \ X,a\ \ =\frac{I\ \ X,a}{H\ \ X,a} \tag{3}$$

Taking the information gain rate as the selection criterion of the test attribute is to choose the $E\ \ X,a\ \ $-maximum attribute as the test attribute.

Defined as follows:

$$D\ \ x,y\ \ =\sqrt{\sum\nolimits_{i=1}\ \ x_i\text{-}y_i\ \ ^2} \tag{4}$$

x_i is the i th variable value of point x , and y_i is the i th variable value of point y .

The birth of technology has made different computers connect with each other, and it has become the primary channel for people to store and obtain all kinds of data. The emergence of cloud computing technology has once again changed the way data is stored and accessed. With the development of artificial intelligence, machine learning, statistics, pattern recognition, and other emerging technologies, it is possible to extract useful knowledge from massive data and guide decision-making. Data will become a strategic asset, and the more data you control, the more likely you are to get the potential value of data.

Cloud computing is an Internet-based computing mode. Through this computing mode, shared information and software and hardware resources can be allocated to computers and other devices according to needs. Cloud computing has the advantages of integrating resources, reducing costs, and creating new profits. From the perspective of creating profits, cloud computing has the characteristics of integration and openness, which can adapt to various needs of enterprises and create new profits.

The educational information architecture introduced in this paper is based on the educational information network, taking the sharing of basic information, teaching resources, and other data resources as the research object, taking the application support platform as the core, and taking e-government, teaching management, education management and other system contents as the main applications. Combine the most advanced information service support technology and application software to realize the education cloud. The educational information architecture is shown in Figure 1.

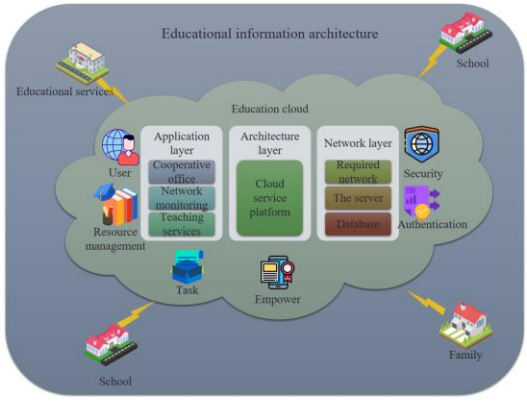

Figure 1: Educational information architecture.

Let BD environmental university education management always be carried out scientifically within the standard framework so as to avoid the problems of nonstandard education management and disunity of education management content caused by the diversified advancement of university information education management, fundamentally put an end to the practical risks of university education management in the information age, and create a new opportunity for future university information education management to use the education development environment further.

3.2. Design of Personalized Recommendation Algorithm for Educational Information Resources Based on TNN

Facing the storage problem of BD, the education management system established a data center server. Combined with the campus information management construction, the existing software and hardware management resources of the campus were used to a great extent, and the BD in

the management system was stored in the application server system. The original, innovative, closed classroom teaching organization mode is semi-open, completely open, cooperative, informational, socialized, and digital learning organization mode. On the basis of modern digital information technology, we should not only use the network platform but also actively use all kinds of information media so as to realize the management mode of two-way communication, release, and transmission of information, in essence, by which managers and managed persons can enjoy the resources and information of common concern.

In today's information age, the influence of information technology on all aspects of society is beyond doubt. Informatization has become an important means to improve the quality and reform of higher education. For higher education, the substantial improvement of computing power means the possibility of analyzing more data, and more and more comprehensive data information of teaching, scientific research, and management processes has been included in the scope that can be analyzed and studied. The changing role of information technology in society and science has changed the teaching content. The new knowledge structure, including information technology, maintains the coupling between knowledge skills and social needs so as to ensure that students can learn something useful.

At present, the popular personalized recommendation algorithms are user-based and resource-based collaborative filtering algorithms. These algorithms analyze users' query behavior of resources, determine the set of unused users by the clustering algorithm, and recommend the resources that different users may need according to their set pairs so as to realize personalized push. For online learning platforms, learners can view the general situation of a course through information such as a catalog and course introduction, but it is difficult to have a clear understanding of the specific content setting of the course and the teaching situation of teachers. There are also some problems in online learning platforms, such as lack of emotion, information overload, and deviation of discussion content. It is one of the means to solve the above problems by recommending learning resources for learners based on their discussion topics and emotional tendencies.

The error of TNN at a time t can be defined as the square of the difference between the actual output pulse sequence s_o^a of the output layer and the corresponding function $\tilde{s}\ t$ of the expected output pulse sequence s_o^d:

$$E\ t\ = \frac{1}{2}\sum_{o=1}^{N_o}\left[\tilde{s}_o^a\ t\ - \tilde{s}_o^d\ t\ \right]^2 \tag{5}$$

Where N_o represents the number of neurons in the output layer.

η_i represents the kernel function, which is the response of post-synaptic neuron i to its own output pulse and is simulated according to formula (6).

$$\eta_i\ s\ = -\ell \exp\left(-\frac{s}{\tau}\right) H\ s \tag{6}$$

Calculate the density function value $f_{ij}\ x_i$ of the i-th point in the j-th independent distribution and normalize it by formula (7) to obtain the posterior probability p_{ij} that the i-th point belongs to the j-th independent distribution:

$$p_{ij} = \frac{f_{ij}\ x_i}{\sum_{j=1}^{n} f_{ij}\ x_i} \tag{7}$$

In any field, in order to recommend appropriate resources to the corresponding users, the selection of recommendation algorithm and the support of recommendation system are essential. Collect user preference information and recommend users using appropriate recommendation algorithms. The recommendation system processes and analyzes the collected user data and then uses different recommendation strategies to recommend items to users. Form a resource list according to the degree of similarity. At the same time, the current students' learning behavior will be analyzed, and the concept tree of learning characteristics in the student learning database will be matched with the required resource type corresponding to the current student's learning behavior. Finally, the resource list should be reordered to be highly similar to the resources, and the top-ranked resource list should be recommended to student users so as to achieve personalized recommendations.

Figure 2 shows the framework of a personalized recommendation algorithm for educational information resources based on TNN. The features of users and projects are extracted from the basic information of users and projects by using the cascade sparse noise reduction self-encoder and then integrated into the model to complete the integration with scoring information. Then, the loss function is calculated by multiplying the two matrices with the user-item score, and the final user-preference and item-feature matrices are obtained by adding the penalty function iteration. The predicted score of the user-item is obtained by multiplying the two matrices.

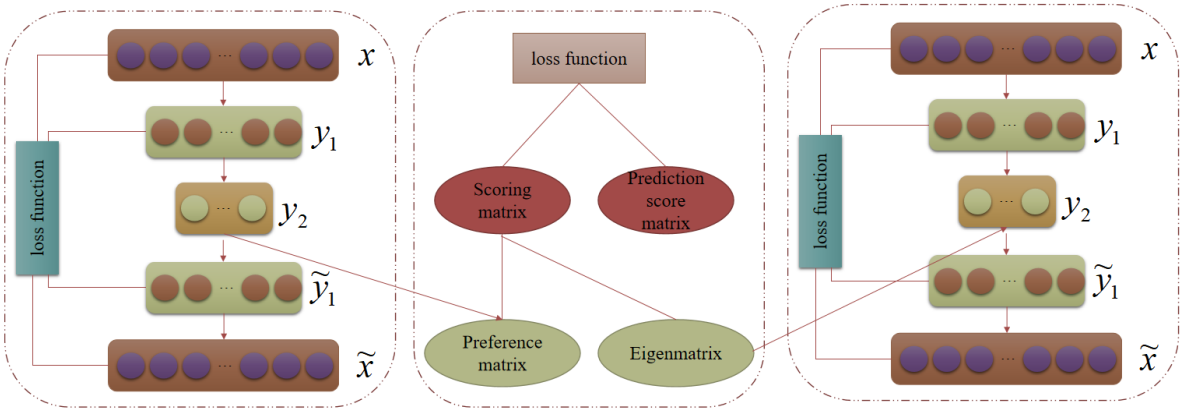

Figure 2: TNN-based personalized recommendation algorithm framework for educational information resources.

In this paper, it is used to indicate learners' mastery of different knowledge points, as shown in the following formula:

$$Z_{n,k} = \sum_{m=1}^{M} S_{n,m} * C_{m,k} \tag{8}$$

In which $S_{n,m}$ represents the emotional value of learner n on topic m, and $C_{m,k}$ represents the corresponding relationship between topic m and knowledge point k.

In order to obtain domain-invariant features, this paper hopes that the parameter θ_m of feature mapping network can maximize the loss of comment building network and minimize the loss of rating prediction network, the parameter θ_r of rating prediction network can minimize the loss of rating prediction network, and the parameter θ_d of comment building network can minimize the loss of comment building network.

See formula (9) for the definition of loss function of the model:

$$E\ \theta_m,\theta_d,\theta_r\ =\ \sum_{i=1,\cdots,N} L_r\ \varphi^r\ \varphi^m\ I_0^m\ ;\theta_m\ ;\theta_r\ -\lambda \sum_{i=1,\cdots,N} L_d\ \varphi^d\ \varphi^m\ I_0^m\ ;\theta_m\ ;\theta_d \tag{9}$$

Here, L_r is the score to predict the loss of the network. L_d is the loss of commenting on building a network.

In this paper, min-max standardization method is used to normalize the user classification matrix, and it is improved to make it suitable for 1-5 scoring data sets. The formula of the improved min-max standardization method is shown in formula (10):

$$c'_{m,n} = \frac{c_{m,n} - \min C_{M,N}\ \times 5}{\max C_{M,N} - \min C_{M,N}} \tag{10}$$

$\min C_{M,N}$ is the lowest score in the classification score matrix, and $\max C_{M,N}$ is the highest score.

4 EXPERIMENT AND RESULTS

In this paper, 180 students in an innovative experimental class of a school and 5000 learning resources in the database are selected. In order to simplify the node of the ontology tree of students' learning behavior concept, the following nodes are selected: students' learning place, learning time, and learning resource type. The ontology tree of the resource concept is determined as the resource node of all disciplines in the university. First, 100 students were selected to test 2,000 university learning resources to generate a test model, and then the remaining 80 students were used to train the remaining 3,000.

When a is 0.5, in the similarity matching of educational resources ontology tree, α represents knowledge points, β represents resource difficulty, and γ represents the weight of learning resource types. The test results are shown in Table 1.

Table 1: α , β The effect of α , β and γ on similarity match of ontology tree of educational resources.

α	β	γ	Similarity
1.206	1.106	1.123	0.531
1.361	1.127	1.119	0.507
1.105	1.121	1.14	0.565
1.394	1.118	1.135	0.308

Table 1: Test results.

It can be seen that when the weight of the knowledge point is 1.105, the weight of resource difficulty is 1.121, and the weight of the learning resource type is 1.14, the similarity matching of the educational resource ontology tree is the highest.

Summarize the prediction results five times and compare them with the expected output to get the probability of correct prediction of each topic. The results are shown in Figure 3. It can be seen that among the 50 questions in the five predictions, 85% of the questions between the actual output and the expected output are consistent with the expected output in the five predictions. The results of five predictions of the test sample set are counted. Among them, 85% of the test questions are in the five predictions.

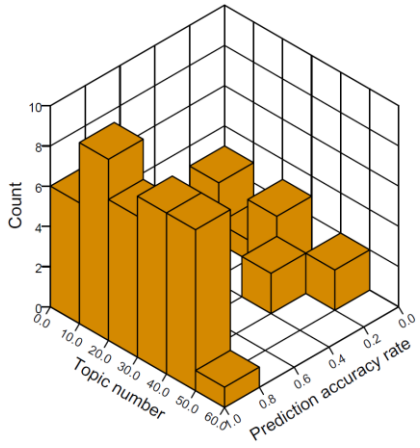

Figure 3: Check the prediction accuracy of 50 questions in the sample set.

Table 2 shows the accuracy before and after pruning output by the model. Noise data is eliminated in the pruning process.

Pruning operation	*Correct number*	*Error number*	*Accuracy (%)*
Before pruning	78	3	96.3
After pruning	73	8	90.1

Table 2: Accuracy of model beach before and after pruning.

In this algorithm model, the main parameters that affect the experimental results are the dimension of the embedding matrix, learning rate, etc. The control variable method commonly used in scientific experiments is adopted. The experiment is conducted by adjusting the model parameters. Figure 4 shows the experimental results obtained when the embedding matrix increases from small to large, keeping the same training times, learning rate, and convolution kernel number unchanged.

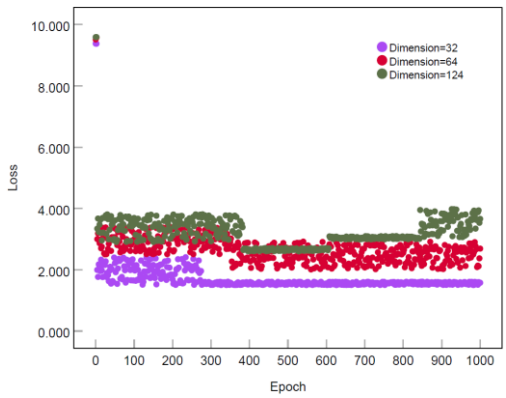

Figure 4: Experimental diagram of TNN recommendation algorithm under different dimensions of the embedded matrix.

As the dimension of the embedding matrix increases, the stability of the algorithm will gradually decrease. Therefore, in this algorithm, the value of the dimension parameter should be as small as possible. However, when the value of the dimension parameter is too small, the amount of extracted raw data will be too small, which will not represent the raw data well.

Figure 5 shows the results of experimental simulation under different learning rates while ensuring the same training times, embedding matrix dimension, and convolution kernel number.

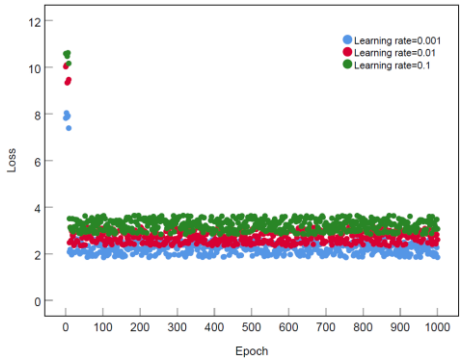

Figure 5: Experimental diagram of TNN recommendation algorithm under different learning rate.

It can be seen that with the change of training error when the learning rate gradually changes from 0.1 to 0.001, it is more appropriate to choose the learning rate of 0.001 in this experiment.

Topic sentiment analysis based on the discussion text of individual learners. Starting from three aspects: topic mining, topic-emotion analysis, and learner's emotional support rate, this paper presents the results of topic-emotion information recognition for learners.

In this paper, two learners who participated in this course were randomly selected as experimental objects, and they were named "Learner A" and "Learner B" in consideration of ethical privacy. The probability distribution of topics that two learners can pay attention to after topic mining of their discussion texts by the TNN model is shown in Figure 6 below.

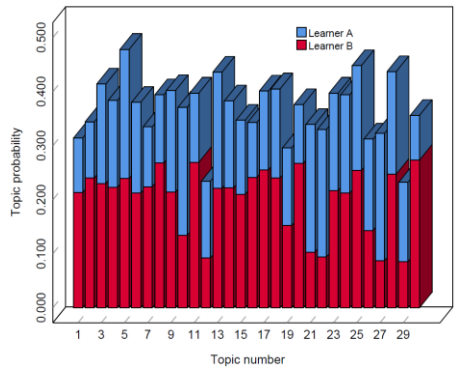

Figure 6: Probability distribution diagram of learners' attention to topics.

It can be seen that, for learner A, topic 6, topic 10, and topic 21 are the first few topics that the learner is most concerned about; For learner 9, topic 11, topic 20, and topic 29 are the topics that the learner is most concerned about.

Figure 7 shows RMSE (root-mean-square error) values of the three recommendation methods on the data set, among which the recommendation algorithm based on the TNN model for processing project information is 12.19% more accurate than the traditional algorithm. It shows that using the DL model to fuse basic project information and scoring information has a high-quality effect.

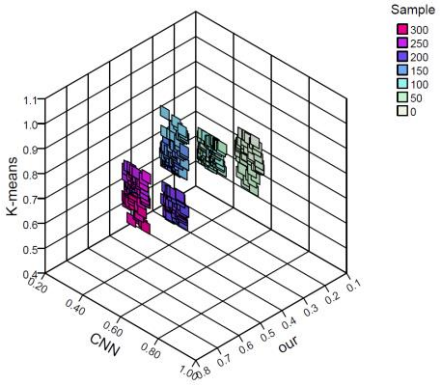

Figure 7: Comparison of RMSE values of different recommended models.

That is, the smallest average absolute error and root mean square error, which indicates that the recommendation quality of this new algorithm is the highest among the three algorithms, which is due to the addition of user classification, which effectively alleviates the problem of cold start of users and the excellent learning ability of self-encoder DL model.

The original information system lacks the ability to process unstructured data and complex data, and the original hardware equipment of the university also needs to be upgraded and planned to meet the needs of the BD era. Therefore, it is necessary to integrate data resources, optimize the configuration of university hardware and software, establish a good platform for the acquisition, integration, and analysis of university BD, and build a collusive connection path with the cloud, the Internet, and the Internet of Things. It mainly includes upgrading and constructing data acquisition, data storage, data transmission networks, and data analysis systems. The information processing platform, which can realize the high integration of university information equipment and information systems, can give full play to BD's powerful data mining and data analysis capabilities, effectively improve the efficiency of data management, and make effective use of data value. All these strategies can be used to clarify the rights of data producers to protect, develop, and utilize their own data, and finally establish BD protection and use norms based on security and privacy.

As far as BD is concerned, the basic premise and purpose of university resource integration is to change the local maladjustment of higher education to BD and to promote the innovation and reform of higher education through the effective application of BD. For universities, as the undertakers of cultural inheritance and innovation, it is the general trend to construct a data culture based on value rationality and instrumental rationality, fully and reasonably applying BD technology so as to solve the problem of lack of rationality in our education system.

5 CONCLUSIONS

Information centers, network centers, data centers, and other new business functional organizations have emerged and will develop into professional organizations of digital education management and teaching activities. This paper studies the path innovation of educational informatization transformation based on BD technology and TNN. The educational informatization architecture introduced in this paper combines the most advanced information service support

technology and application software to realize the educational cloud. Integrate into the model to complete the integration with the scoring information. RMSE values of three recommendation methods on data sets. Among them, the recommendation algorithm based on the TNN model to process project information has an accuracy rate of 12.19% higher than that of the traditional algorithm. It shows that using the DL model to fuse basic project information and scoring information has a high-quality effect.

6 ACKNOWLEDGEMENT

Engineering Research Center of Integration and Application of Digital Learning Technology, Ministry of Education：Research on undergraduate course comprehensive evaluation system based on multi-source big data analysis (1221021).

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