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Research Article

Landscape Planning and Management Methods of Beautiful Rural Pastoral Complexes under the Background of Big Data

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With the continuous acceleration of the urbanization process, rural areas have gradually put forward construction plans for new rural forms. Pastoral complex is a construction mode of characteristic townships and rural complexes, which has become a new form of social development today. Pastoral complexes provide a new model of new rural construction, and its development is still in the preliminary stage for China. The construction of pastoral complexes involves rural landscape planning, economic management, etc. It is difficult for rural managers to process these complex data characteristics. Big data technology is affecting people's lives, and the discipline of landscape architecture is also deeply affected by big data. This paper mainly uses data mining technology and neural network method to carry out feature mining and prediction on the landscape planning and management methods of beautiful rural pastoral complexes. In this paper, a data mining algorithm is used to classify the landscape types and locations of rural complex, and the neural network method is used to predict the landscape characteristics. The results show that the methods of data mining and neural network are feasible and reliable both in the proportion of classification and in the prediction of landscape planning. The maximum error of the prediction of landscape design is 2.87%, and the minimum error is only 0.79% using the neural network method, which is an acceptable error range.

1. Introduction

With the continuous progress and rapid development of Chinese economy, the speed of urbanization is getting faster and faster. The pace of new rural construction has also developed rapidly. Pastoral complex is a new type of rural economic comprehensive model discovered in the process of new rural construction, and it is still in the initial stage of development [1, 2]. Pastoral complex is a characteristic township model that integrates new rural economy, leisure tourism, and pastoral communities. The development of Chinese rural areas has experienced the development of new countryside construction, beautiful countryside construction, and pastoral complexes [3]. The development of the pastoral complex is not only to improve the development of rural economic level or only to improve the level of rural tourism development. The pastoral complex is a comprehensive development model that maximizes the economic development of rural areas by giving full play to the local economic development model based on local customs and geographical tourism advantages [4]. In general, the beautiful rural pastoral complex is a development model that fully utilizes the combination of local tourism and other rural economies. This development model can not only improve the living happiness index of residents but also improve the local living environment and economic level [5]. However, there are many factors that restrict the development of beautiful rural pastoral complexes, such as policy support, management level restrictions, tourism development planning level restrictions, etc., which require reasonable planning according to the actual rural economy and tourism mode.

The development of the pastoral complex involves many aspects. This research mainly studies the landscape planning and management methods [6]. However, the process of rural landscape planning involves the consideration of the landscape type, scale, location, etc., which requires comprehensive consideration of the economic level of the countryside, the type of tourism development and the economic development status of local farmers to make a reasonable plan [7]. With the continuous development of domestic pastoral complexes, we can learn from successful cases about the construction of pastoral complexes, not only local managers make plans according to local conditions [8]. It can also absorb the reasons for the failure of pastoral complexes in other places at home and abroad, and then avoid these problems. However, the construction of the pastoral complex is not only limited to many factors in the comprehensive development of local rural areas, but also involves reference and reference construction factors [9]. The processing of these data and plans is difficult for managers to make decisions, and some correlations between these comprehensive data are difficult for builders to discover only by relying on their professional level. It requires that rural managers not only need to improve their own professional level but also need to use computer-aided technology to carry out landscape planning and management of pastoral complexes [10]. This method can not only improve management efficiency but also discover more data related to landscape planning as much as possible. This study combines big data technology to study and analyze the landscape planning and management of pastoral complexes.

Big data technology is a data processing method that has developed rapidly in recent years, thanks to the rapid development of computers and hardware [11, 12]. Statisticians have developed many mature big data methods and successfully applied them to human life. With the development of economic globalization, countries in the world are more closely connected, and a large amount of data will be generated in both life and production activities, and there are complex data correlations between these data [13]. The development of the pastoral complex will also generate a large amount of data with strong correlation. It only relies on professionals to process these data will not only increase the error rate but also utilize a lot of human and material resources, and its efficiency is low. Big data technology can provide classification and prediction methods such as data mining and neural networks. It can not only effectively classify these complex data but also discover more correlations and inevitable connections between data through these data [14]. Data mining techniques include efficient classification and regression methods such as decision trees, random forests, and support vector machines. Neural networks include convolutional neural networks and fully connected neural networks. It can do good classification based on distance or density between data [15–17]. The neural network method can learn the correlation and mapping relationship between input and output based on more historical data. If big data technology can be applied to the planning of pastoral complexes, it will be beneficial to improve the efficiency and level of managers.

The combination of big data and pastoral complexes will not only improve the decision-making level of rural managers but also find more suitable landscape projects and location information according to the actual situation in rural areas, which will maximize the overall economic level of rural areas [18]. Data mining technology can effectively classify these data and fully mine the links between the data according to the development goals of the local pastoral complex, the local economic level, tourism projects, etc. Neural network technology can make effective predictions based on the development of pastoral complexes and landscape layouts in other parts of the country.

Based on the abovementioned introduction to the pastoral complex and big data technology, this paper will effectively classify the landscape prediction and management of the pastoral complex and use data mining technology and neural network methods for prediction. This research is mainly divided into five parts: The first part mainly introduces the development significance of the pastoral complex and the significance of big data to the development of the pastoral complex. The second part mainly describes the development status and research methods of the pastoral complex. The third part is the data mining method and neural network method adopted in this paper. The fourth part mainly analyzes and discusses the feasibility and accuracy of big data technology in rural landscape classification and prediction from the perspective of statistical participation. It uses statistical parameters such as linear correlation distribution, hot spot distribution map, and mean error to study landscape design. The fifth part is the summary of the study.

2. Related Work

Researchers have done a lot of research on the design and management of pastoral complexes and landscapes using different methods, and these research studies have achieved good results and utilization values. Du and Long [19] believed that big data technology brings new opportunities for the layout optimization of landscape architecture, which also promotes the mutual development of discipline integration and big data technology. He built a simulation program for landscape architecture layout optimization, which was also used in the trend prediction of three-dimensional pastoral complexes, and it predicted the fragmentation and heterogeneity of pastoral complexes. The results showed that the degree of fragmentation was reduced by 6.7%. Liao [20] proposed a method for assessing the mobility of multi-scale pastoral complexes in response to the difficulty of measuring mobility in animal husbandry. Moreover, he used GPS and big data technology to study the mobility of pastoral complexes in Ethiopia. The findings suggest that pastoral mobility tends to be highly heterogeneous, and that sedentary pastoralists engage in finer scale movements. This method has an important reference value for the management of pastoral complexes. Shibia et al. [21] charted an extensive grazing pastoral management approach to pastoral complexes in southern Ethiopia. Expensive remote sensing data constrain ecological features and adaptive mobile life of pastoralists. He combined topographic descriptions with indicators such as pasture greenness and phenology derived from remote sensing data images, and then studied the relationship between these data and plant types. He obtained a p-index of 0.00001 through the chi-square test method, which has important guiding significance for the pastoral complex of herdsmen. Yang et al. [22] believed that the land use patterns of pastoral complexes are severely affected by climate and that interventions have jeopardized the value of the ecosystem. He used Landsat TM/ETM data to quantitatively evaluate the ecological service value (ESV) of agricultural pastoral complexes. This research is of great significance for humans to fully understand the land use of agricultural pastoral complexes and the impact on the ecological environment. Li [23] believed that big data technology is conducive to the full scale, refinement, and humanization of landscape planning, but the current landscape architecture field rarely uses big data technology to carry out related research studies, based on big data and the PERSONA method in Internet products. Landscape design has been studied and it has been found that voluntary geographic information (VGI) is beneficial for small-scale landscape analysis. Xu et al. [24] found that traditional urban planning methods and landscape management models can no longer meet the requirements of today's people's living standards, and his basic intelligent design concept analyzed the significance and practical characteristics of the application of big data intelligent methods in urban planning and landscape planning. Cui and Wang [25] applied virtual reality technology to landscape planning, SPASS, and Sketch software and big data technology were used by him to study the rationality of location, design mode, and rendering technology in landscape design. Jaworek et al. [26] used the Polish Basin as a research object to analyze the relationship between landscape features and land cover data. Aerial photos and land cover data were used by him to analyze the spatiotemporal and transitional changes of forest trajectories. At the same time, he used the ArcGIS method research and big data technology to study the changes of landscape cover types. These research conclusions have a reference value for the management of forest landscape. The range of pastoral complexes and landscape design is relatively wide, and many researchers have used various traditional means to carry out related research and predictions. The planning of big data and pastoral complexes is a future development trend. This study mainly uses the method of decision tree and neural network to predict the influencing factors related to landscape design, which is helpful for the management and decision-making of landscape designers of pastoral complexes.

3. Research Algorithms and Big Data Technologies

3.1. Review of Application of Big Data in Landscape Design. Big data technology is a method to discover the correlation between data from numerous data, and the amount of data it allows to process is huge. In today's society and in the production and life of human beings, there will be many and a wide variety of data, which is difficult to solve only by manpower. The integration of big data technology with pastoral complexes and landscape design planning is relatively small, but it can process a large amount of data generated in the process of landscape planning and management. The large amount of data generated in landscape planning is of a wide variety and not of the same order of magnitude, which is difficult for the designers of landscape management [27–29]. Big data technology can process these data efficiently and accurately, and it can output the information the designer needs according to its data.

3.2. Application of the Data Mining Algorithm in a Landscape Design of the Pastoral Complex. A data mining method is a method of finding correlations from a large amount of data by using methods such as distance or density between data. Data mining has been widely used in the fields of economy and e-commerce, etc. It can not only help financial personnel to discover financial development trends and future changes but also help e-commerce practitioners to discover potential customers and their preferences for products. Similarly, data mining methods have also been applied in other fields, but it is less used in landscape planning of pastoral complexes. Data mining methods include decision trees, support vector machines, random forests, neural networks, and other methods [30–32]. These data mining methods are selected according to the different types of data and the needs of the task. In recent years, the performance of computers has grown rapidly and the associated hardware processing capabilities and speeds have grown, allowing computers and intelligent algorithms to process larger amounts of data. The magnitude of data is more and more able to ensure the accuracy of data mining technology. The basis of data mining is data. The larger the data magnitude, the more potential correlations the intelligent algorithm can find from the data.

This research mainly includes two processes of classification and prediction of landscape planning and management of pastoral complexes. Figure 1 shows these two processes used in landscape planning. From Figure 1, it can be seen that the landscape location and landscape type information generated by data mining are used as the forecast data for landscape planning. First, we need to collect data from successful pastoral complex landscape planning schemes. There are large differences in magnitude and variety between these data, and these data need to be preprocessed. The preprocessed data are then classified by data mining methods. These classified data can be used by landscape planning designers for management and use, and at the same time, these data can be used as prediction data for landscape planning. The number of branches of the decision tree 4 was adopted in this study, and the learning rate was set to 0.001. The number of nodes in each branch is set to 4.

The classification method of landscape planning data of the pastoral complex will use the method of decision tree to fully mine the landscape planning data. There are many evaluation indexes in the decision tree, which will decide the classification effect of the decision tree. Entropy is one of the most important evaluation indexes of decision tree. The

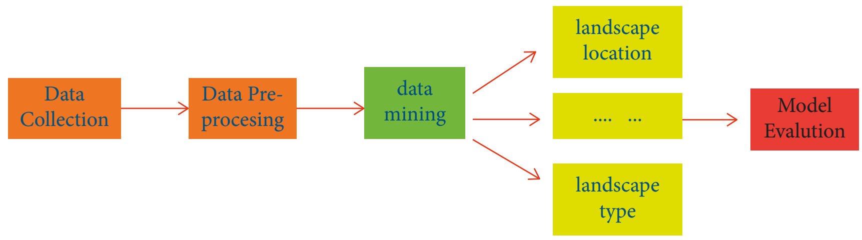

FIGURE 1: Landscape planning classification and forecasting process of pastoral complexes.

equation (1) shows the expression of entropy. The smaller the entropy value, the better the data classification effect of landscape planning.

$$H(D) = -\sum_{l=1}^{L} \frac{|C_l|}{|D|}\log_2\frac{|C_l|}{|D|}. \tag{1}$$

Conditional entropy is also one of the evaluation criteria for decision trees, which is a conditional probability distribution, and this conditional entropy is often used in more tasks. Equation (2) shows the expression of conditional entropy, which represents the uncertainty of D under condition A, which can often reflect the uncertainty distribution of the effect after classification.

$$H\left(\frac{D}{A}\right) = \sum_{j=1}^{n} \frac{|C_j|}{|D|}H\left(D_j\right). \tag{2}$$

In the decision tree classification method, information gain is an important part. Equation (3) shows the operation process of information gain. Information gain describes the degree to which feature A reduces the uncertainty of the total data set D, which can reflect the influence of a feature on the overall classification effect, and the factors that affect the poor classification effect can be quickly found through information gain. For landscape planning tasks, datasets contain many types of data, where information gain is particularly important.

$$g_r(D, A) = \frac{g(D, A)}{H_A(D)}. \tag{3}$$

The equation (4) shows the expression of the Gini index. In the landscape planning task of the pastoral complex, the Gini index is also used in the classification task, which is beneficial to the designer to judge the classification effect more intuitively.

$$\text{Gini}(D) = 1 - \sum_{l=1}^{L}\left(\frac{|C_k|}{|D|}\right)^2. \tag{4}$$

The Gini index is also of the conditional probability type, and equation (5) presents the conditional probability form of the Gini index, which allows for classification tasks with multiple types of data through decision tree methods, which is beneficial for landscape planning tasks. It can be related to classification of landscape location and landscape type.

$$\text{Gini}(D, A) = \frac{|D_1|}{|D|}\text{Gini}(D_1) + \frac{|D_2|}{|D|}\text{Gini}(D_2). \tag{5}$$

3.3. Neural Network Methods for Landscape Planning Tasks. The neural network method has obvious advantages in dealing with high-dimensional data with a nonlinear relationship. It maps the relationship between input and output through continuous optimization of weights and biases. Whether in the form of a convolutional neural network or a generative adversarial neural network, it is part of a perceptron. Figure 2 shows the basic flow and composition of the perceptron. The neural network mainly includes two processes: forward propagation and back propagation. Forward propagation is used to continuously fit the real relationship between the input and output of the learning data set. This process is completed by the gradient descent method. This process is a process of constantly finding the optimal value of weights and biases. Backpropagation is a process of minimization through a loss function. The perceptron is the basis of the neural network approach, and CNN is also a variant of the perceptron. All the parameters of the perceptron need to be calculated, which results in a sharp increase in the amount of calculation. CNN can solve the problem of parameter quantity very well.

There will be two important functions in the operation of the neural network: the loss function and the activation function. The loss function is the driving force for the continuous iterative decline of the neural network algorithm. Through the continuous decline of this loss function, the neural network will find the optimal weight and bias. Equation (6) shows the operation process of the neural network loss function. Equation (6) is calculated according to the mean square error. The type of this loss function can also be other types.

$$E = \frac{1}{2}\left(d_{\text{out}} - O_{\text{real}}\right)^2 = \frac{1}{2}\sum_{\kappa=1}^{t}\left(d_\kappa - O_\kappa\right)^2. \tag{6}$$

The neural network is composed of many hidden layers, and the weights and biases of these hidden layers are constantly performing nonlinear operations. Equation (7) shows the weight calculation process between each hidden layer.

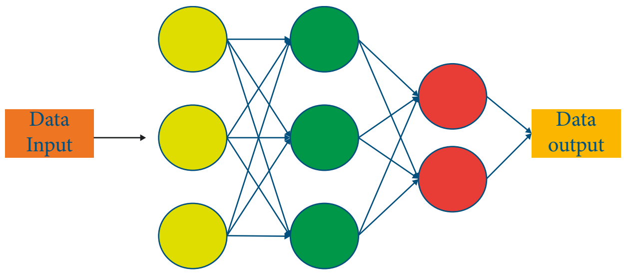

FIGURE 2: Operation flow of the neural network.

$$E = \frac{1}{2}\sum_{k=1}^{m}\left[d_k - f\left(\text{net}\omega_k\right)\right]^2 = \frac{1}{2}\sum_{k=1}^{m}\left[d_k - f\left(\sum_{j=0}^{n}\omega_{jk}y_j\right)\right]^2. \quad (7)$$

In the forward propagation and back propagation of neural networks, the main form of operation is the derivation operation, because both processes involve gradient descent methods. Equations (8) and (9) show the derivation of weights and biases, which are two critical operations for neural networks.

$$\Delta\omega_{ji} = -\eta\frac{\partial E}{\partial\omega_{ji}}, \quad (8)$$

$$\Delta u_{ij} = -\eta\frac{\partial E\,\partial}{\partial u_{ij}}. \quad (9)$$

Convolutional neural network is a special form of neural network. In general, the weight of each layer of neural network will perform nonlinear operations, which results in a huge amount of computation, which requires high-performance computers and hardware devices. As the amount of data increases, the number of layers of the neural network is required to be deeper, and the advantages of convolutional neural networks lie in weight sharing and a small amount of computation. Figure 3 shows the computational flow of the convolutional neural network in the landscape rule task of the pastoral complex. First, the input of the convolutional neural network comes from data information such as landscape types and landscape locations classified by data mining technology. These data will be proposed through the convolution layer and the pooling layer to characterize the landscape information, and finally the relevant variables in the landscape planning task will be output. The number of filters of CNN is chosen to be 32, and the learning rate is chosen to be 0.001. The number of convolutional layers of CNN is set to 3.

It is similar to the fully connected neural network, the convolutional neural network is also composed of two processes, and it also requires nonlinear operations of weights and biases. Equation (10) shows the propagation calculation method of the convolutional neural network.

$$x_j = f\left(\sum_{i\in M_j} x_i^{\zeta-1} * k_{ij}^{\zeta} + b_j^{\zeta}\right). \quad (10)$$

What is special about convolutional neural networks is the operation of the convolutional layer, which is the source of the reduction in computation. Equation (11) shows the operation of the convolutional layer. Equation (12) shows that the pooling layer uses downsampling to further reduce the amount of computation. This process assigns a larger weight to the main features in the landscape planning task, which ensures that the main features are proposed and the amount of computation is reduced.

$$\delta_j^{\zeta} = \beta_j^{\zeta+1}\left(f'(u)_l^{\zeta} \circ \text{up}\left(\delta_j^{\zeta+1}\right)\right), \quad (11)$$

$$x_j = f\left(\sum_{u,v}\beta_j^{\zeta}\text{down}\left(x_i^{\zeta-1}\right) + b_j^{\zeta}\right). \quad (12)$$

3.4. Preprocessing of Landscape Planning Data for the Pastoral Complex. The data collected in the pastoral complex landscape planning task includes other types of data such as landscape type, landscape location, and economic development. It can be seen that there are large differences between these data, both in magnitude and characteristics. If these data are directly input into the data mining algorithm or neural network algorithm, this will cause uneven distribution of weights, which will eventually lead to inaccuracy of classification and prediction effects. Therefore, the preprocessing process of landscape planning data is particularly important. According to the requirements of data mining algorithms and neural network algorithms, these data need to be processed into data that conform to the same distribution and are in the same interval. In this study, a standardized data preprocessing method was used, and the data-set of landscape design factors was processed with data between the interval −1 and 1.

4. Result Analysis and Discussion

This study mainly classifies and predicts the landscape planning of pastoral complexes in the background of beautiful countryside, which facilitates the management of landscapes. Data mining methods are used for the classification task of landscape planning data, and neural network algorithms are used for the prediction task of landscape planning. Figure 4 shows the error of data mining on the landscape planning classification task. In general, the decision tree method is relatively accurate in the classification task of pastoral complex landscape planning, and all errors are within 3%. The largest error is 2.93%, which mainly comes from other factors that affect landscape planning because the data characteristics of other factors are changeable. The smallest error is only 0.88%. This error comes from the number of landscapes. It can be seen that the number of landscapes in a pastoral complex area is relatively easy to classify, which also shows that the number of landscapes in the landscape planning task is relatively easy to design. The classification errors of landscape type and landscape location are only 2.13% and 1.74%, which are also relatively small. This will benefit neural networks for prediction tasks. Figure 5 shows the prediction accuracy of the neural network method in the landscape planning task, it

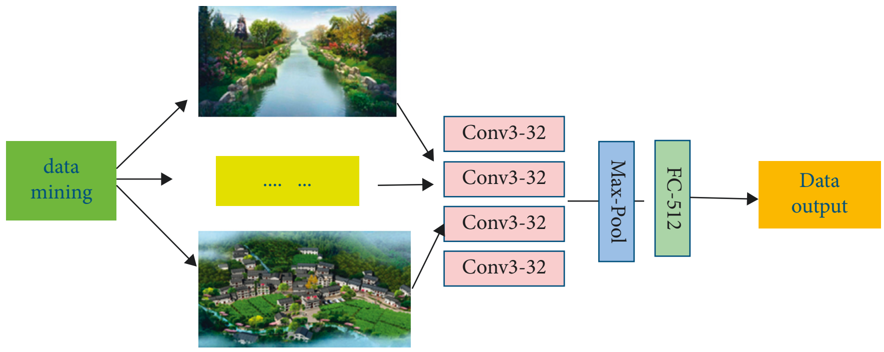

Figure 3: Workflow of convolutional neural networks in landscape planning tasks.

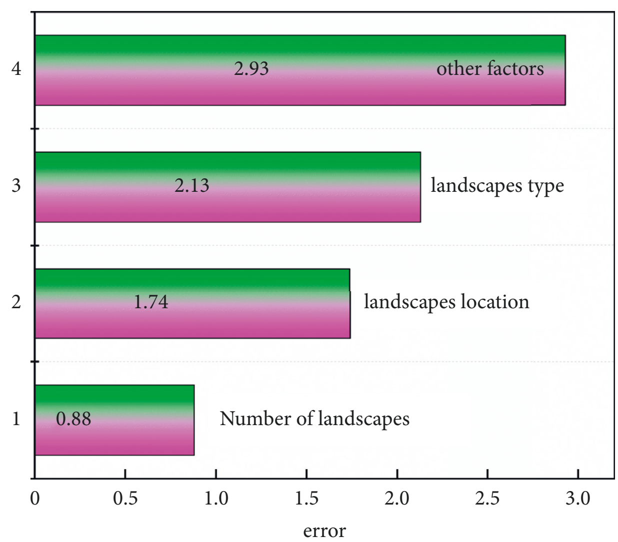

Figure 4: Classification errors of data mining in landscape planning tasks.

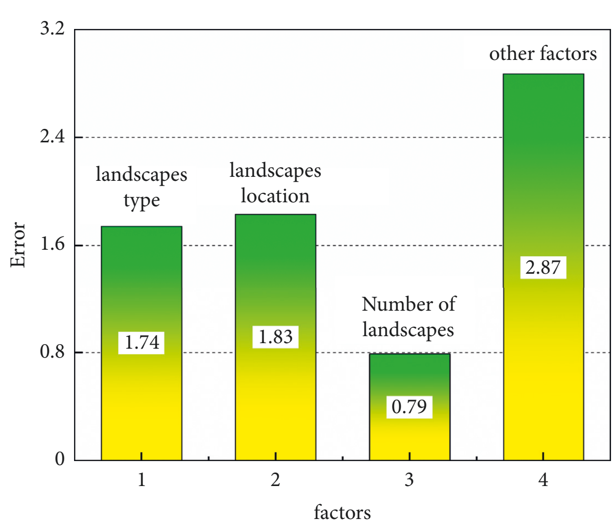

Figure 5: Prediction errors of neural networks in landscape planning tasks.

can be intuitively seen that the neural network method is reliable in the landscape planning prediction, because the maximum error is only 2.87%. The main source of error for neural network prediction tasks is the same as for data mining in landscape planning classification tasks. The prediction errors of landscape type and landscape location are 1.74% and 1.83% respectively. This relatively small error is helpful for landscape designers to make corresponding decisions based on the prediction results.

In the test set of the landscape planning prediction task for pastoral complexes, it contains many sets of landscape data types. In order to more intuitively demonstrate the accuracy of the neural network method in predicting landscape planning, 10 sets of data were selected for each landscape data set, totaling 40 data sets. Figure 6 shows the predictions of the four data sets in the pastoral complex landscape planning prediction. In general, it can be seen from the prediction curve that the predicted values of landscape type, landscape location, economic development level, etc. are in good agreement with the actual data, which shows that the neural network method is feasible in landscape prediction tasks. It can also be seen that the prediction errors for landscape location and type are larger compared to the other two data sets. This is mainly because the location of the landscape and the choice of the type will develop and change over time, which leads to large errors. Accuracy can be improved by adding more data from successful pastoral complex landscape plans.

In this study, in order to more intuitively demonstrate the feasibility of neural networks in landscape planning tasks, a heat map of predicted values was selected for analysis. In Figure 7, the upper part is the distribution of the predicted numerical values of the landscape design, and the lower part of the figure is the distribution of the actual value of the landscape design. Figure 7 shows the distribution of hotspots between predicted data and actual data for the landscape prediction task. From the heat map, it can be clearly seen that the differences between the four influencing factors in landscape planning and the actual values selected in this paper are relatively small. For the top ten data sets of landscape planning, the color and data differences between them are small, which is derived from the number of landscapes. The largest difference between color and data value comes from the third set of data, which is derived from other factors of the landscape, such as local policies and economic factors. This part of the landscape impact characteristics has variability, and all predicted values have large differences.

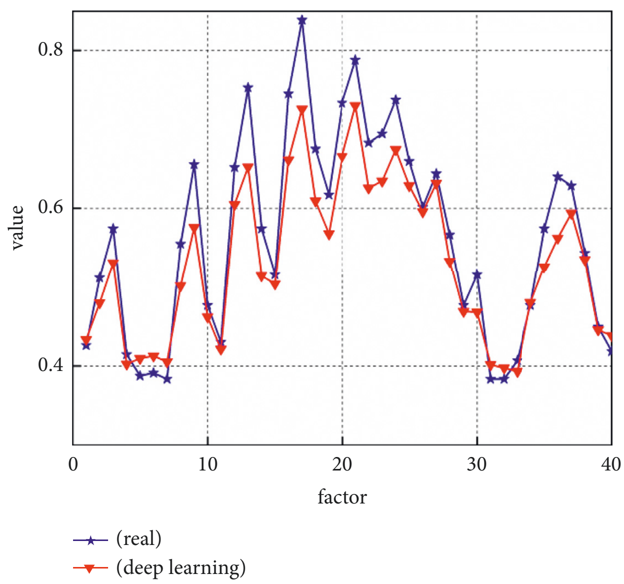

Figure 6: Predicted data and actual data curve of pastoral complex landscape planning.

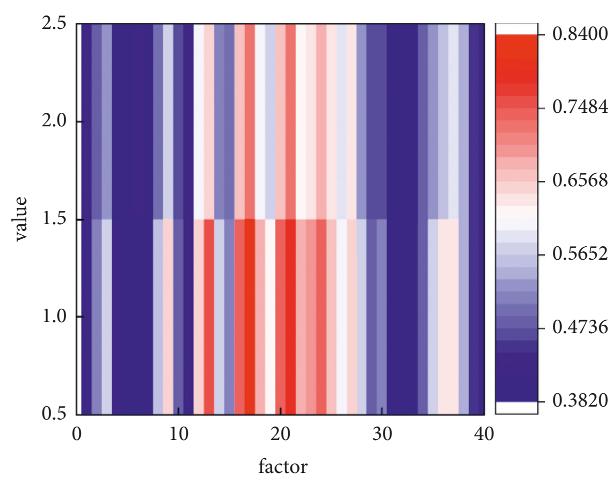

Figure 7: Hot spot distribution map of landscape prediction value of pastoral complex.

In order to further demonstrate the feasibility of the neural network method in landscape planning prediction of pastoral complexes, Figure 8 shows the distribution difference between the predicted and actual values of landscape planning. In Figure 8, the blue scatter points represent the actual landscape design factor data values, and the red scatter points represent the predicted landscape design factor data values. The predicted differences between the four sets of data are small because this part of the landscape planning features has the least fluidity and variability compared to other types of landscape planning features. Figure 9 shows the linear correlation diagram of landscape planning feature prediction. It can be seen that the data points of the linear correlation diagram are basically distributed on both sides of the $y = x$ line, which indicates that the predicted value of the landscape planning feature has a strong relationship with the actual landscape feature value. Moreover, the distances of

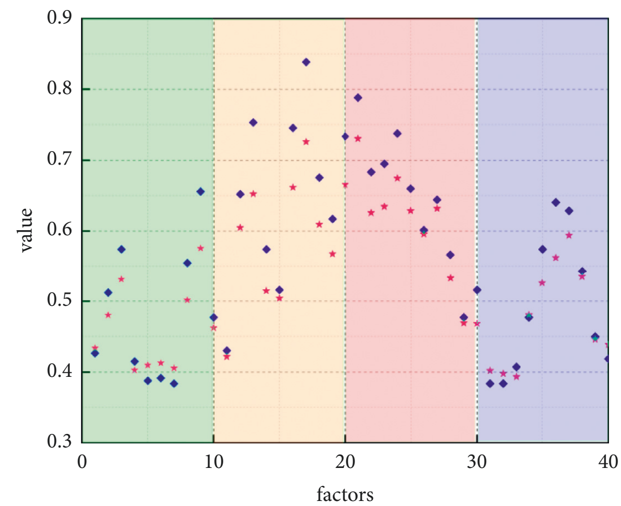

Figure 8: Distribution of predicted and actual values of landscape.

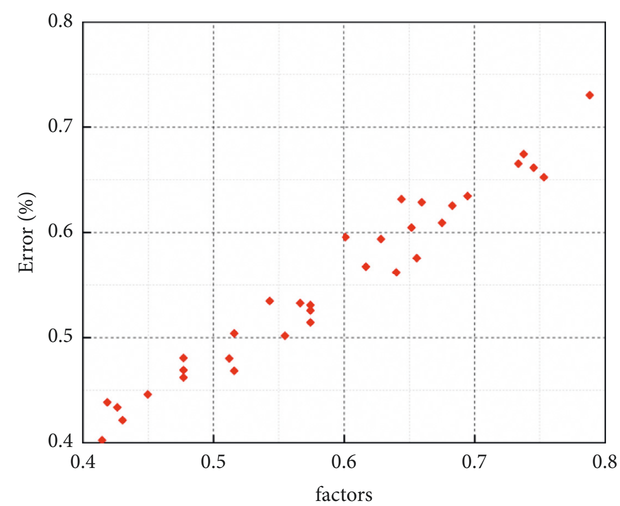

Figure 9: Linear correlation plot of predicted values for landscape planning.

the data points of the linear correlation map from the $y = x$ line are relatively small, which further proves the accuracy of the neural network method in the prediction of the landscape planning of the pastoral complex.

5. Conclusions

With the continuous advancement of urbanization, the construction of rural areas has also undergone great changes. Rural construction has successively experienced the development stages of new rural construction and pastoral complex. The pastoral complex is still in the initial stage of development. It not only requires the development of rural tourism but also requires the comprehensive development of rural economy to utilize landscape tourism. However, for local managers, the job is difficult to rely solely on human expertise. Big data technology has been widely and successfully applied in many fields in recent years, and it can effectively and efficiently mine the connections between data. Similarly, a lot of relevant data for reference will be generated in the process of landscape planning and design. This study combines big data technology to classify and predict the landscape planning aspects of pastoral complexes using data mining technology and neural network methods. For the classification task of data mining in the landscape planning of pastoral complexes, the classification results of the four landscape features such as landscape location and landscape type are relatively good, the errors are all within 3%, and the largest error is only 2.93%. For the prediction of landscape planning features, the neural network method is also more reliable, with a maximum error of only 2.87%. Moreover, the linear correlation of landscape planning features is relatively strong, and the data values are basically distributed on both sides of the $y=x$ function, and the distance is relatively close. Likewise, the largest differences in the predicted values of landscape planning features come from other factors that affect landscape planning, such as economic level, local policies, etc., and these features are variable. Improving the accuracy of this section requires more data on successful landscape planning cases. In general, data mining technology and neural network method are feasible and reliable in landscape planning and management tasks of pastoral complexes.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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