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Retraction

Retracted: Research on Prediction Model of Hotels' Development Scale Based on BP Artificial Neural Network Algorithm

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] N. Zhao and S. Tsai, "Research on Prediction Model of Hotels' Development Scale Based on BP Artificial Neural Network Algorithm," *Mathematical Problems in Engineering*, vol. 2021, Article ID 6595783, 12 pages, 2021.

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Research Article

Research on Prediction Model of Hotels' Development Scale Based on BP Artificial Neural Network Algorithm

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Due to the lack of macro and systematic data, the target cost of high-star hotel project cannot meet the characteristics and needs of the hotel project itself. Therefore, the establishment of star hotel development scale prediction is urgent. In the scale development strategy, based on the previous studies, combined with the development characteristics of regional high-star hotels in a city, this paper constructs the index system of influencing factors of the development scale of high-star hotels and extracts the main influencing factors of hotel development scale by principal component analysis and partial relationship analysis, which are mainly urban development, economic development, tourism development, tourism development exhibition industry development, business development, and transportation development. The BP artificial neural network prediction method is used to establish a prediction model for the development scale of high-star hotels, by adopting the above key extraction factors as input of BP neural network. Through the input and output of the scale influence index data, the development scale of star hotels is accurately predicted. The simulation results verify the effectiveness and reliability of the star hotel development scale prediction strategy based on BP neural network, in terms of accuracy and model superiority.

1. Introduction

With the development of China's economy and tourism, as the three pillar industries of tourism, the hotel industry is also developing rapidly, and the star hotels are also developing rapidly [1, 2]. Affected by the differences of location, economic development level, and tourism development, the scale and spatial distribution of hotels in a certain region are also different [3]. With the development of China's tourism industry, the hotel industry, as the three pillars of the tourism industry, has developed rapidly [4]. According to the data released by the China Hotel Association in January 2018, the overall average annual growth rate of the number of star hotels in the past three years is 6%, while the average annual growth rate of the number of five-star hotels is more than 15%. Among the three-star hotels (including three-star hotels) opened in the fourth quarter of 2012, the number of five-star hotels accounts for nearly 80% of the total number of opened hotels, occupying a dominant position, which also reflects that high-star hotels have become the focus of the development of the hotel industry and the hot spot of investment [5, 6]. With the development of Hefei's economy and frequent business activities, high-star hotels have a huge market [7]. However, with the entry of international hotel brands, such as Hilton, Westin, Howard Johnson, and Crowne Plaza, and domestic hotel brands, such as century Jinyuan, Kaiyuan, Jinling, and Kelley, the competition among hotels is becoming increasingly fierce. Therefore, how to improve their competitiveness and gain more market share are the problems that many high-star hotels should be considered [8]. There are many theories about enterprise competitiveness at home and abroad, such as value chain management and enterprise culture. However, these theories explore enterprise competitiveness from the internal perspective [9]. With the change of market environment, scholars and enterprises begin to focus on customers.

Therefore, customer value has become the common focus of theoretical and business circles; as a new source of competitive advantage, how to evaluate the development scale of star hotels reasonably is of great significance to enhance the competitiveness of high-star hotels [10].

Many scholars at home and abroad have put forward their own views on the research of influencing the development scale of star hotels [11]. Foreign scholars Li et al. believe that the country's GDP, population, nationalization rate (export/GDP), business environment, tourism income, and other factors have an impact on the hotel development [12]. Ritter studies the hotels in Nuremberg, Germany, and thinks that urban roads and other modes of transportation are the influencing factors of hotel development, so he puts forward a traffic-oriented development mode of urban hotels [13]. When Kmeci and Balta studied hotels in Istanbul, Turkey, they found that there was a close interaction between hotel development and urban development. There are also a lot of domestic literatures on this aspect [14]. Literature [15] considers that location, economic and commercial development, urban planning, tourist market, and natural and traffic conditions are the main factors affecting the hotel development in Zhuhai. In literature [16], the factors that affect the development of star hotels in China are summarized as seven dynamic factors: consumption power, tourism power, commercial power, investment power, opening power, traffic power, and city power. Literature [17] selects four evaluation indexes as the factors influencing the spatial distribution of hotels, including economic development index (GDP, per capita GDP), tourism development index (number of inbound tourists, tourism foreign exchange income, number of domestic tourists, domestic tourism income, business development index (total retail sales of social consumer goods and total import and export) and transportation development index (turnover of goods, total foreign exchange income, and total domestic tourism income) and passenger turnover [18]. The factors related to the development scale of high-star hotels in the above literatures are total import and export, actually utilized foreign capital, number of foreign-funded enterprises, total retail sales of social consumer goods, total tourism income, total number of tourists, number of travel agencies, number of tourist attractions, number of international tourists, per capita public green space area, population (10000), urbanization level, GDP Per capita disposable income of urban residents, investment in fixed assets, per capita GDP, leading role of tertiary industry, passenger volume, transaction volume of exhibitions, and number of exhibitions [19].

Literature [20] innovatively studies the relationship between national culture and hotel management and demonstrates the role of national culture in hotel management. Literature [21] uses a large number of research methods to evaluate the efficiency of hotel management. Literature [22] established a comprehensive evaluation model of service quality by using five dimensions of service quality PZB and expert questionnaire survey and evaluated the service quality expected by Taiwan hot spring hotel customers. Literature [23] evaluates the service quality of hotels in Scotland. Literature [24] uses quantitative fuzzy mathematics method to measure the service quality of hotel industry. Literature [25] studies how to remedy the complaints of hotel customers. This paper studies the relationship between human resource management, employees themselves, and the comfort of working environment in Hong Kong and points out the reasons for the high turnover rate of employees. By comparing the human resource management of hotels in Singapore and Australia, literature [26] analyzes their advantages and disadvantages. However, the above literature does not objectively give the factors that affect the development scale of star hotels [27].

Referring to the index system of hotel development scale influence factors established in the article in literature [28], this paper constructs the index system of high-star hotel development scale influence factors from six aspects and uses partial correlation coefficient and principal component analysis to objectively evaluate the factors influencing hotel development scale. The main factors that affect the development scale of star hotels are urban development, economic development, tourism development, exhibition industry development, business development, and transportation development. According to the above factors, the development scale prediction model of star hotels based on BP neural network is constructed, and the simulation verifies the effectiveness and accuracy of the model. The main contributions are as follows. (1) The prediction structure of star hotels based on the Internet of things system is designed to collect and preprocess the prediction data (principal component analysis and data cleaning) to improve the storage utilization. (2) The partial relation coefficient is used to analyze the influencing factors of the recruitment scale of star hotels, so as to improve the prediction efficiency and accuracy of BP neural network. (3) Six factors affecting the scale of development are fed into BP neural network, and high prediction accuracy is achieved.

In Section 2 of this paper, architecture design of star hotel data mining and data dimension reduction is introduced. Section 3 introduces research on the prediction model of star hotel development scale based on BP neural network algorithm. Section 4 is the simulation and analysis of the simulations. Section 5 is the conclusion.

2. Architecture Design of Star Hotel Data Mining and Data Dimension Reduction

2.1. Architecture Design of Star Hotel Data Mining. High-star hotels are often used to represent the social and economic development level of a region or city. The reason is that high-star hotels are highly correlated with the market environment of the local region, the overall local economic development level, and the comprehensive development level of related industries. In some areas with a large number of high-star hotels, the local social and economic development level has already exceeded the average level of society. At present, the spatial distribution of high-star hotels in China directly shows the close relationship between high-star hotels and the level of social and economic development in the region. In order to objectively realize the accurate

prediction of the development scale of star hotels, this paper designs a data acquisition framework as shown in Figure 1.

As shown in Figure 1, the intelligent data mining system based on the Internet of things is composed of data collection layer, data dimension reduction layer, data storage layer, and data visualization layer.

In the data collection layer, the hotel financial data, urban development data, tourism development data, GDP data, regional development level, social consumption level, business power, investment power, opening power, traffic power, and other data are collected. Data collection is the basis for the development scale prediction of star hotels.

Regarding data dimension reduction layer, when the amount of data in the dataset is large, it will bring two problems.

(1) There will be dimension disaster. In order to learn the rule of each dimension, the number of samples in that dimension cannot be too small, and the number of samples increases exponentially with the increase of feature dimension.

(2) The resource cost is large. We extract too many features, and these features may have correlation and redundancy, which bring burden to data storage, learning, and optimization. Therefore, principal component analysis is used to reduce the data dimension effectively, and a variety of factors that affect the prediction results are compared and analysed. Data cleaning is the process of reexamining and verifying data to remove duplicate information, correct existing errors, and provide data consistency. This paper mainly uses consistency check method to clean a large number of data to improve the availability of data.

Data prediction layer is a kind of technology that fully excavates and analyses each data and finds its rules through principal component analysis and partial relation analysis from many data. It is a bridge of information and service. Common data mining technologies include BP neural network, SVM, KCM clustering algorithm, and machine learning method.

The data visualization layer mainly uses graphical means to convey and communicate information clearly and effectively, present the data results to users, and help users make better use of data analysis and decision-making. Each data item in the database is represented as a single element in visualization. A large number of datasets constitute data images. At the same time, each attribute value of data is represented in the form of multidimensional data. Data can be observed from different dimensions, so as to conduct more in-depth observation and analysis of data (see Figure 1).

2.2. The Data Dimension Reduction Based on the PCA Method. Principal component analysis (PCA) is a typical method to reduce the dimension of data by transforming the dataset into a new set of variables. For example, one component is required to represent the information of the whole system, but most of the information can be explained only by a few principal components. When this happens, the principal component contains almost as much information as the original variable. So, the principal component can be used to replace the initial variables, and the original dataset composed of the secondary measurements of the variables is compressed into the original dataset composed of the secondary measurements of the principal component. So, the new dataset has less redundant information.

Let $x(1), \ldots, x(T)$ be a simple random sample of capacity from the random vector $X = [X_1, X_2, \ldots, X_T]$ with T elements. In principal component analysis, it is not necessary to assume the probability density function and the generating model of random vectors but only to estimate the first- and second-order statistics through random samples. In principal component analysis, X is usually centered first; that is, X subtracts its mean value:

$$X \leftarrow X - \varepsilon\{T\}. \tag{1}$$

The mean value can be estimated by the sample, that is, the sample mean value:

$$\mu = \frac{1}{T}\sum_{j=1}^{T} x(j). \tag{2}$$

The linear transformation from X to another vector y with k elements is solved so that the elements of Y are uncorrelated and have less redundancy than X. We find an orthogonal coordinate system, make the elements of X uncorrelated in the new coordinate system, and maximize the variance of X projection on the new coordinate axis. The first axis corresponds to the maximum variance, and the second axis corresponds to the maximum variance in the direction orthogonal to the first axis. Suppose X is n random variables $X_1, X_2, \ldots, X_n$, in which each random variable X_i has p samples to form a data matrix of $p \times n$ order; then, we can have

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{p1} & x_{p2} & \cdots & x_{pn} \end{bmatrix}. \tag{3}$$

Suppose $X_1, X_2, \ldots, X_n$ are the original variable indexes $Y_1, Y_2, \ldots, Y_m$, where $m \le n$ is the new variable index; then, we can have

$$\begin{cases} Y_1 = l_{11}X_1 + l_{12}X_2 + \cdots + l_{1n}X_n, \\ Y_2 = l_{21}X_1 + l_{22}X_2 + \cdots + l_{2n}X_n, \\ \vdots \\ Y_m = l_{m1}X_1 + l_{m2}X_2 + \cdots + l_{mn}X_n, \end{cases} \tag{4}$$

where $Y_1, Y_2, \ldots, Y_m$ is the principal part of $X_1, X_2, \ldots, X_n$ and $Y_1, Y_2, \ldots, Y_m$ are uncorrelated matrices.

The main idea of principal component analysis is to remove correlation and reduce dimension. In all kinds of signal processing, because there is a certain correlation between the decomposition coefficients, this method can achieve the purpose of removing redundancy. In addition, it

can effectively measure and choose all the parameters that affect the results. Let us only consider the limited important parameters and ignore the parameters that have less impact on the results. The principal component analysis method is applied to the urban development data in the dataset, and the results are shown in Figure 2. It can be seen from the figure that after PCA algorithm, data dimension reduction is realized, redundant data is eliminated, and it is more convenient for data storage and data analysis (see Figure 2).

3. Research on Prediction Model of Star Hotel Development Scale Based on BP Neural Network Algorithm

3.1. The Structure Design of Prediction Model for Star Hotel Development Scale. The development scale of regional high-star hotels can be used to reflect the tourism reception capacity of a region in a certain period of time. Therefore, the prediction of the development scale of high-star hotels plays a very important role in regional economic development planning and tourism planning. According to the dynamic factor index system of high-star hotels, this paper makes a quantitative prediction of the future development scale of high-star hotels by using the complex relationship between them and the development scale of high-star hotels.

The commonly used prediction methods of star hotel development scale include time series method, moving smoothing method, exponential smoothing method, random time series method, correlation and regression analysis method, grey prediction method, and combination prediction method of various methods. Because these methods are simply based on regression and time series analysis, the amount of information is missing and cannot be fully captured, so they cannot scientifically reflect the complex relationship between dependent variables and independent variables. Because of the complexity of the system state equation, it is difficult to model accurately with simple and familiar methods. Therefore, we can use the relationship established by BP neural network to reflect the system with complex nonlinear relationship. BP neural network regards the unknown system as a black box. In the process of prediction, some training samples in the system are selected first, and the input and output data are input to train BP neural network so that it can successfully memorize and have the ability to reserve specific mapping to reflect the function. Finally, the data of test samples are output according to the trained system, so as to get their own prediction results. Therefore, BP neural network will be used to predict the development scale of high-star hotels in this paper. The structure design of prediction model of star hotel development scale is shown as follows (see Figure 3).

The factors related to the development scale of high-star hotels include total import and export volume, actual utilization of foreign capital, number of foreign-funded enterprises, total retail sales of social consumer goods, total tourism income, total number of tourists, number of travel agencies, number of tourist attractions, number of international tourists, per capita public green area, population (10000), urbanization level, GDP, per capita disposable income of urban residents, fixed assets investment, per capita GDP, the leading role of the tertiary industry, passenger volume, exhibition turnover, the number of exhibitions, and other factors. Therefore, before using BP neural network prediction, this paper first uses partial relationship analysis method to process the data and extract more relevant factors. The main influencing factors of urban development, economic development, tourism development, exhibition industry development, business development, and transportation development are extracted, and then the above factors are sent to BP neural network for prediction.

3.2. The Factors Influencing the Development Scale of High-Star Hotels Based on Partial Relationship Analysis. Correlation coefficient is used to describe the correlation between variables x and y. It represents the degree of correlation between x and y. Its calculation formula is

$$r_{xy} = \frac{\sum (x_i - \overline{x})(y_i - \overline{y})}{\sqrt{\sum (x_i - \overline{x})^2 (y_i - \overline{y})^2}}. \tag{5}$$

When we study the linear correlation between two variables, we can examine the simple correlation coefficient of the two variables. However, in the study of linear correlation between multiple variables, it is often false to use the correlation coefficient of two variables only. In the multiple linear regression problem, the interaction between independent variables and dependent variables is mixed with the interaction between each independent variable at the same time. Due to the interaction between independent variables and between independent variables and dependent variables, the relationship between independent variables and dependent variables is no longer completely consistent with the situation reflected by simple correlation coefficient. In order to accurately and truly reflect the correlation between variables, partial correlation coefficient is defined in statistics.

Given a set of independent variables $x_1, x_2, \ldots, x_n$, the partial correlation coefficient between x_i and x_j is calculated as follows. The correlation matrix is composed of simple correlation coefficient r_{ij}:

$$R = \left(r_{ij}\right)_{n\times n} = \begin{bmatrix} r_{11} & r_{12} & \ldots & r_{1n} \\ r_{21} & r_{22} & \ldots & r_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{m1} & r_{m2} & \ldots & r_{nn} \end{bmatrix}. \tag{6}$$

We find the inverse matrix of R:

$$R^{-1} = \begin{bmatrix} \lambda_{11} & \lambda_{12} & \ldots & \lambda_{1n} \\ \lambda_{21} & \lambda_{22} & \ldots & \lambda_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \lambda_{m1} & \lambda_{m2} & \ldots & \lambda_{nn} \end{bmatrix}. \tag{7}$$

The partial correlation coefficient c_{ij} indicates the degree of correlation between the two variables when other elements already exist in the model:

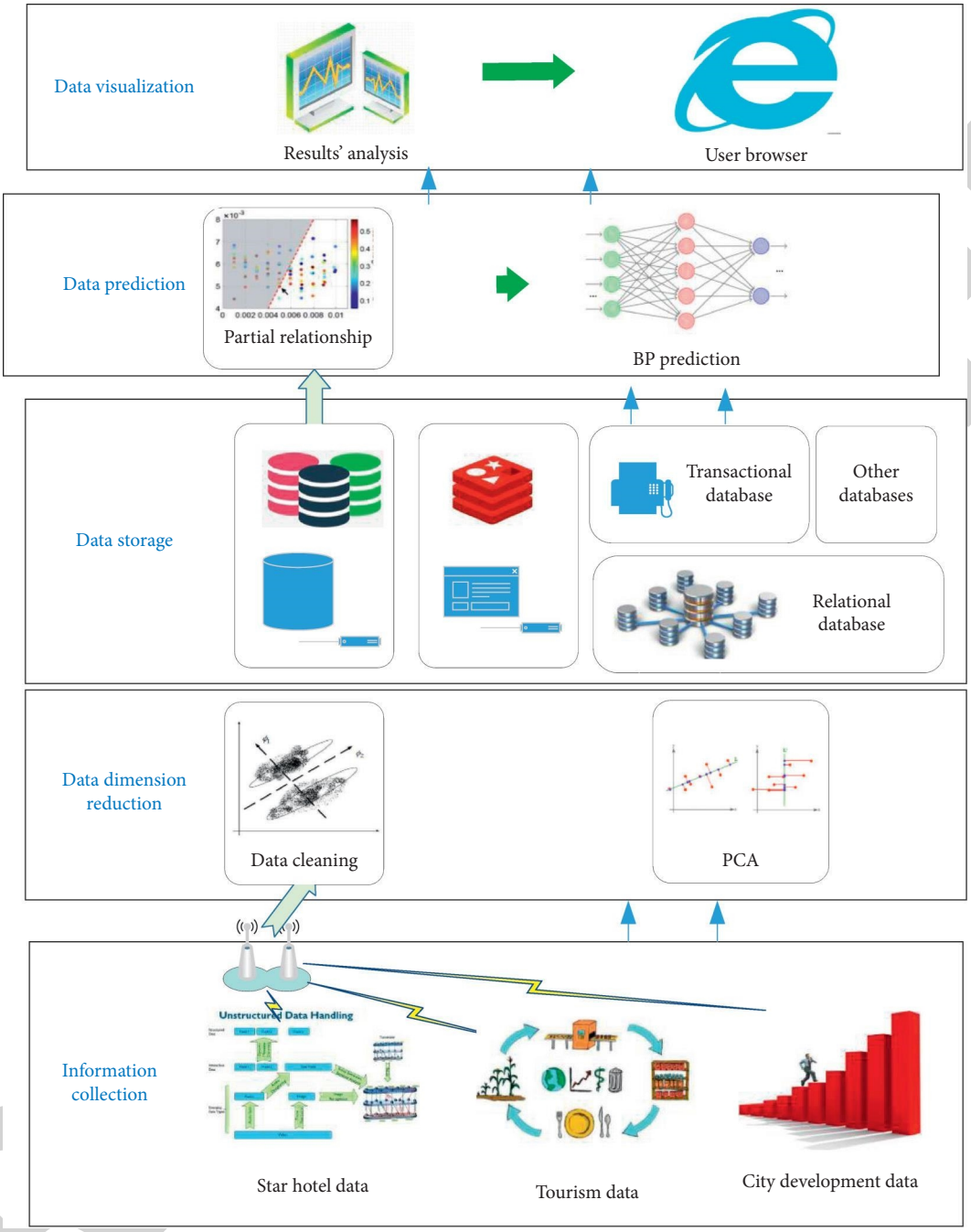

Figure 1: The structure design of star hotel prediction based on the IoT system.

$$c_{ij} = \frac{-\lambda_{ij}}{\sqrt{\lambda_{ii}\lambda_{ij}}}. \tag{8}$$

Partial correlation analysis is a better modeling optimization method. Through partial correlation optimization modeling, the influencing factors and influencing factors of star hotel prediction model are greatly reduced, and the training efficiency of BP neural network is improved.

3.3. Star Hotel Development Scale Prediction Model Based on BP Neural Network. BP (backpropagation networks, BPNN) neural network is one of many neural network methods. It is an intelligent nonlinear learning system that simulates human brain processing information. According to a multilayer feedforward network of error back propagation, gradient descent method is used in calculation, and the weights and thresholds of the network are continuously adjusted through error backpropagation, to ensure that the square sum of the error between the expected output and the actual output of the neural network is minimum so that the actual network output value is as close to the expected value as possible, so as to improve the adaptability of network learning. BP neural network is composed of many layers.

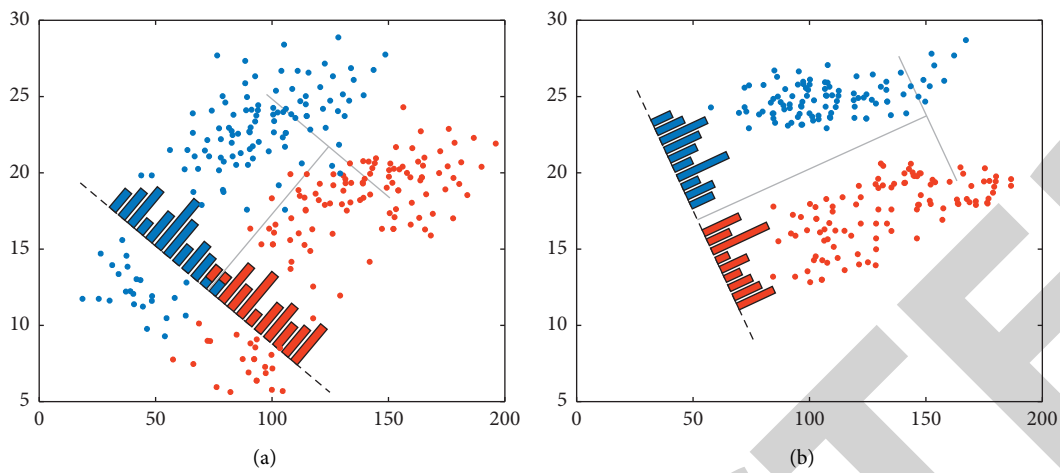

Figure 2: The data reduction figure based on PCA methods. (a) Original data before PCA processing. (b) Data after PCA processing.

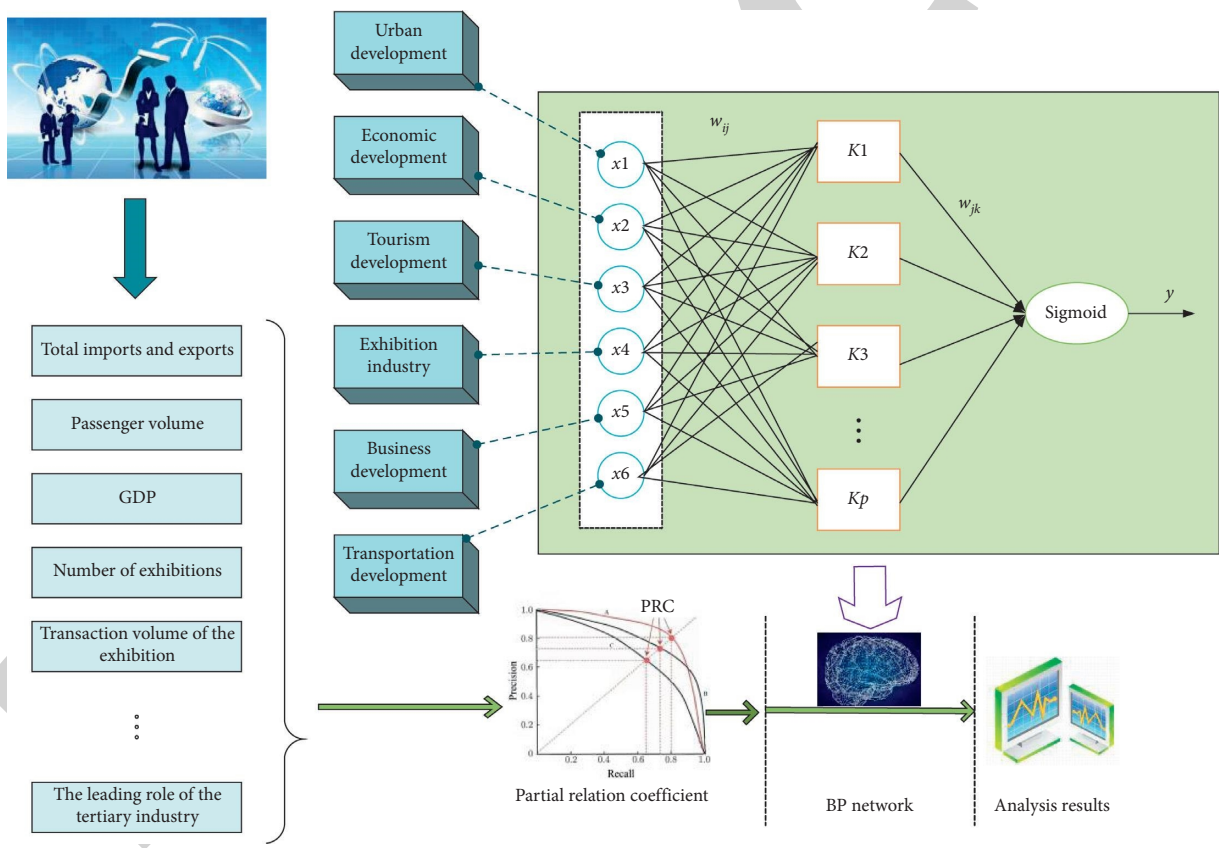

Figure 3: The structure of the prediction model of star hotel development scale.

The more the layers are, the more the information each layer contains and the more complex the problems it can deal with. The simple structure of BPNN is designed as in Figure 4.

In Figure 4, $X_1, X_2, \ldots, X_n$ are the input data of the system and $Y_1, Y_2, \ldots, Y_n$ are the output data of the system, that is, the predicted value. ω_{ij} and ω_{jk} are the weights adjusted by the system. In fact, the input value of BP neural network model is the independent variable, and the predicted value we want to get is the dependent variable. When the number of input nodes is n and the number of output nodes is m, the function mapping relationship from n independent variables to m dependent variables is established from BP network.

BPNN should be trained before prediction. Through repeated training, the network can reach the ability

standard of associative memory and prediction. Generally speaking, the training process of BP neural network can be completed in seven steps, which is shown in Figure 5.

(1) The first step is to initialize the BPNN. According to the purpose of using neural network and according to the variables (x, y) formed by your input data and output data, we determine the connection weights ω_{ik} and ω_{jk} initialization input layer, output layer threshold b, and given learning rate η. And the neuron excitation function $f(x).f(x)$ is also called sigmoid function, which is a transfer function in BP network.

(2) The second step is to calculate the output value of hidden layer. According to the data X of the input variable, we determine the weight ω_{ij} between the two and the threshold of the hidden layer and get the final value of the hidden layer output H.

(3) The third step is to calculate the output of the output layer. According to the corresponding hidden layer output result H, we determine the good connection weight value ω_{ij} and connection threshold value b and output the prediction result O.

(4) The fourth step is the error calculation. According to the network prediction output O and the expected output Y, the network prediction is calculated error e.

(5) The fifth step is updating weight. Weights ω_{ik} and ω_{jk} are updated according to the prediction error e.

(6) The sixth step is the threshold update. Node thresholds a and b are updated according to the prediction error e.

(7) The seventh step is iterative update.

4. Simulation Results and Performance Analysis

4.1. Data Sources and Simulation Setting. It mainly uses PCA and data cleaning method to preprocess data, reduce data dimension, and improve data utilization. Secondly, the partial relation coefficient is used to solve the main influencing factors of the development scale of star hotels, and then the above factors are used as the input of BPNN to predict the scale. This paper takes the number of high-star hotels as the research index and takes 11 eastern provinces as the research samples, mainly including Hainan, Guangdong, Fujian, Zhejiang, Jiangsu, Shanghai, Shandong, Beijing, Tianjin, Hebei, and Liaoning. The number of high-star hotels is the weighted average of four-star and five-star hotels, and the data is from China Tourism Statistical Yearbook (2001–2018). The data of tourism resources, freight turnover, passenger turnover, telecommunications business volume, postal business volume, per capita GDP, openness, tourism income, etc., are from China Tourism Development Report 2018, China Statistical Yearbook 2018, China Urban Statistical Yearbook 2018, and China Tourism Statistical Yearbook 2018. As far as regional choice is concerned, the eastern region is the most developed area in China, with the most densely populated, highly open to the outside world and the most developed inbound tourism, and it consumes a large amount of high-star hotels. At the same time, the East is also the most concentrated place of high-star hotels. According to the data calculation, the number of high-star hotels in the East accounted for 62.5% of the country from 2000 to 2018 (taking the average proportion of 17 years). In terms of time series, from 2000 to 2017, China's inbound tourism experienced a process from high-speed development to low-speed development. During this period, the performance of high-star hotels is worth studying. Therefore, it has a certain typicality and practical significance to select 11 eastern provinces from 2000 to 2017 as research samples.

We use VC + + 6.0 to implement BPNN prediction model on a machine with 512 M memory, 866 mhz CPU, and Windows 10 operating system. The simulation parameters are as follows. The principal components are 17, and in our study, there are six input parameters and one output parameter, so the structure of BP neural network is 6-70-1.

4.2. The Results' Analysis of Data Dimension Reduction. In order to make the relationship between population factor and the number of high-star hotels in urban development, this paper uses PCA analysis method to reduce the dimension of data. The dimension reduction results are shown in Figure 6. This is mainly because the population includes rural population and urban population, whose caliber is too wide, and a large number of rural population will not generate consumption demand for high-star hotels, while the opposite urbanization level is positively related to the number of high-star hotels in urban and rural areas. The reason is that the number of urban populations in the total population reflects the range of potential customers of high-star hotels. Therefore, we eliminate the population and keep the urbanization level, and the per capita public green space area reflects the status of urban construction facilities, which directly affects the degree of attraction of the city to the population, and therefore it also shows strong correlation (see Figure 6).

Figure 6(b) shows the data dimension reduction results of urban development population, urban greening rate, and GDP. It can be seen from the figure that the influence of the three presents obvious aggregation effect, which indicates that this method can extract the influencing factors and improve the data storage efficiency.

4.3. The Influence Factor Results' Analysis Based on Partial Relation Coefficient. According to the influencing factors, the total import and export volume, the actual use of foreign capital, the number of foreign-funded enterprises, the total retail sales of social consumer goods, the total tourism income, the total number of tourists, the number of travel agencies, the number of tourist attractions, the number of international tourists, the per capita public green space area, the number of population (10,000), the level of urbanization, GDP, the per capita disposable income of urban residents, fixed asset investment, per capita GDP The third industry dominance, passenger volume, exhibition turnover,

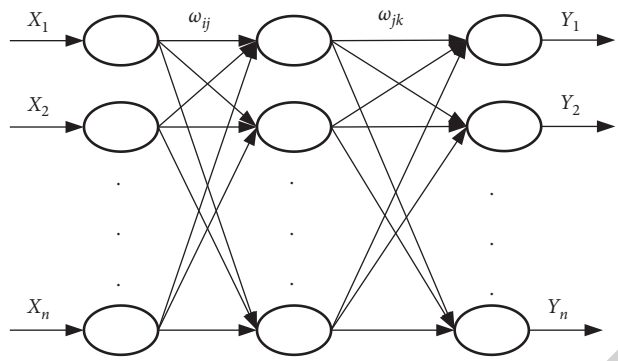

Figure 4: The simple structure BPNN.

exhibition number. Using partial relationship coefficient to study its impact factor evaluation system, the partial relationship coefficient is shown in Figure 7.

Through the partial relationship coefficient, we can see that there is a strong correlation between the number of high-star hotels and the factors of business development, urban development, tourism development, exhibition development, transportation exhibition, and economic development.

4.4. The Prediction Results Based on the BPNN Model. The data of influencing factors of the development scale of star hotels in 2018 are preliminarily obtained, and the ways to obtain the data are explained as follows. ① We first have the total tourism income, the total number of tourists, the level of urbanization, the gross national product (GDP), the per capita disposable income of cities and towns, the investment in fixed assets, and the number of the leading role of the tertiary industry. According to the "strategic plan for the development of international metropolis" (2000–2018), the outline puts forward the target value of 2020 for the above data in "Column 3 main indicators of economic and social development during 2009–2018." ② The data sources of total import and export volume and foreign capital actually utilized are defined according to the annual average growth rate of 22% and 18%, respectively, according to the current development form on the basis of referring to the completion of the main development goals of "Column 2 11th Five Year Plan" in the Twelfth Five Year Plan outline of national economic and social development. ③ The per capita public green space mainly comes from the forest construction master plan, which is based on its previous development trend. ④ The total retail sales of social consumer goods are based on 161.131 billion yuan in 2010. According to the average annual growth rate of the total retail sales of social consumer goods in Xi'an from 1996 to 2000, the average annual growth rate is 12.3%, and the average annual growth rate is 13.01% from 2001 to 2005. From 2006 to 2010, the average annual growth rate of total retail sales of social consumer goods from 2011 to 2020 is estimated to be 18%–21%. It is estimated that the total retail sales of social consumer goods will reach 478.5–507.5 billion yuan in 2018. The data of passenger volume and the number of exhibition industry are obtained according to the same method. After determining the number of nodes, the BP network is trained. When the trained network can achieve better nonlinear output, it can be used to calculate the predicted value of the research object. In our study, there are six input parameters and one output parameter, so the structure of BP neural network is 6-70-1. The prediction results are shown in Figure 7.

It can be seen from Figure 8 that the BPNN prediction model can accurately predict the main influencing factors of star hotels and smooth the influencing factors. It plays a great role in the prediction of the development scale of star hotels (see Figure 8).

In order to compare and verify the effectiveness and reliability of the proposed method, this paper selects entropy weight method [29] and grey correlation method [30] to compare and verify. The simulation results are shown in Figure 9.

Figure 9 shows the prediction results of the scale of star hotels in a city from 2003 to 2018 by using three different methods: entropy weight method, BPNN, and grey correlation method. The evaluation results show different degrees of differences. The green dotted line represents the result of grey correlation analysis, the yellow solid line represents the result of TOPSIS evaluation, the blue solid line represents the result of entropy weight evaluation, and the brown solid line represents the result of GRA-BPNN evaluation. In fact, the stability and smoothness of the line are relatively more stable than the other three methods, and the evaluation results are more reasonable than the other three methods, which well proves the feasibility and scientificity of the evaluation method in this paper for the prediction of the development scale of star hotels.

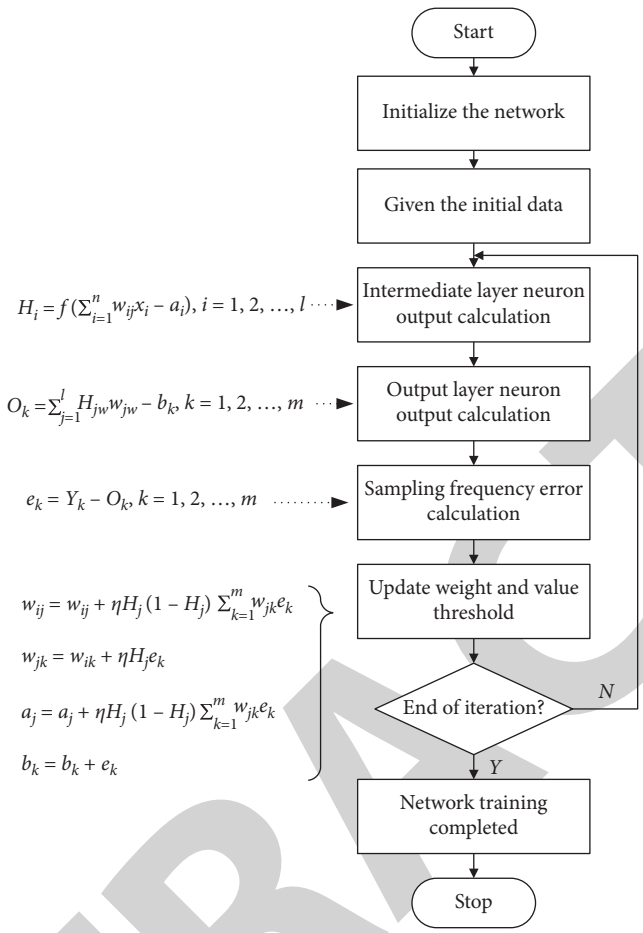

Figure 5: The flowchart of training process for BP neural network.

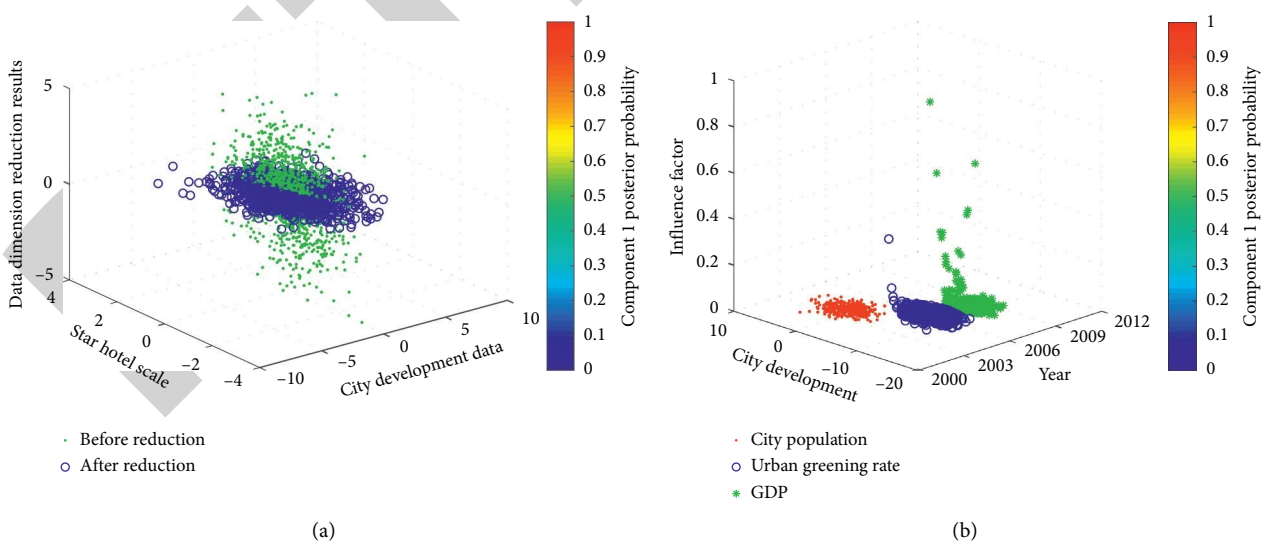

Figure 6: The data reduction results based on PCA methods. (a) Data reduction results. (b) City development factor analysis.

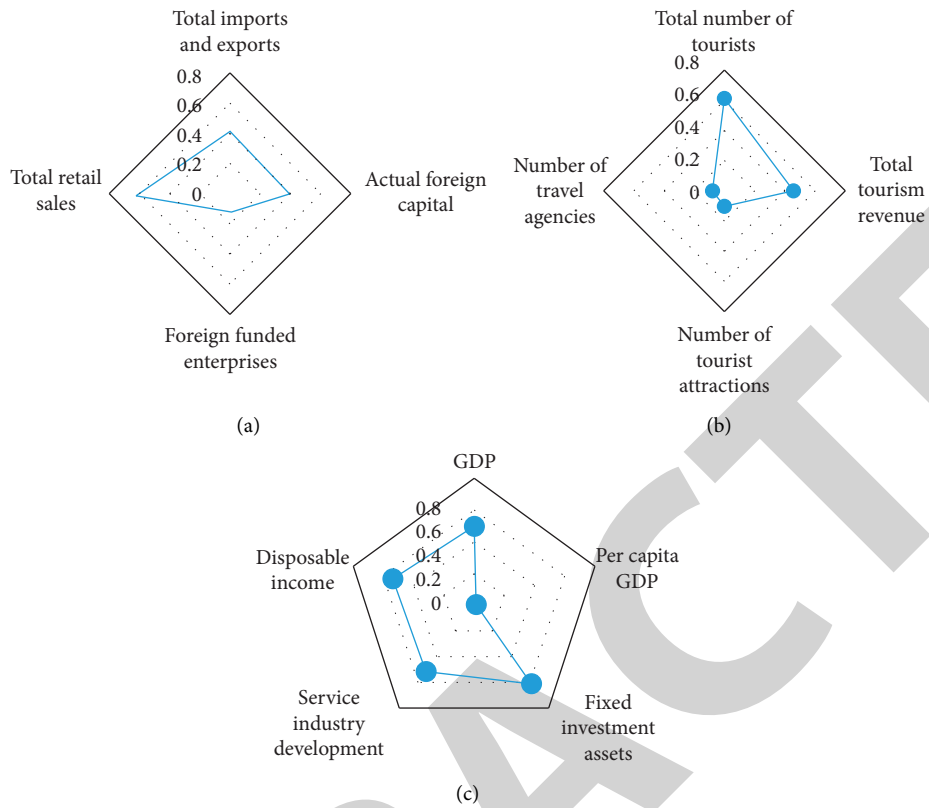

Figure 7: The factor analysis results of hotel scale based on partial relation coefficient. (a) Business impact factors. (b) Tourism factors. (c) City development factor.

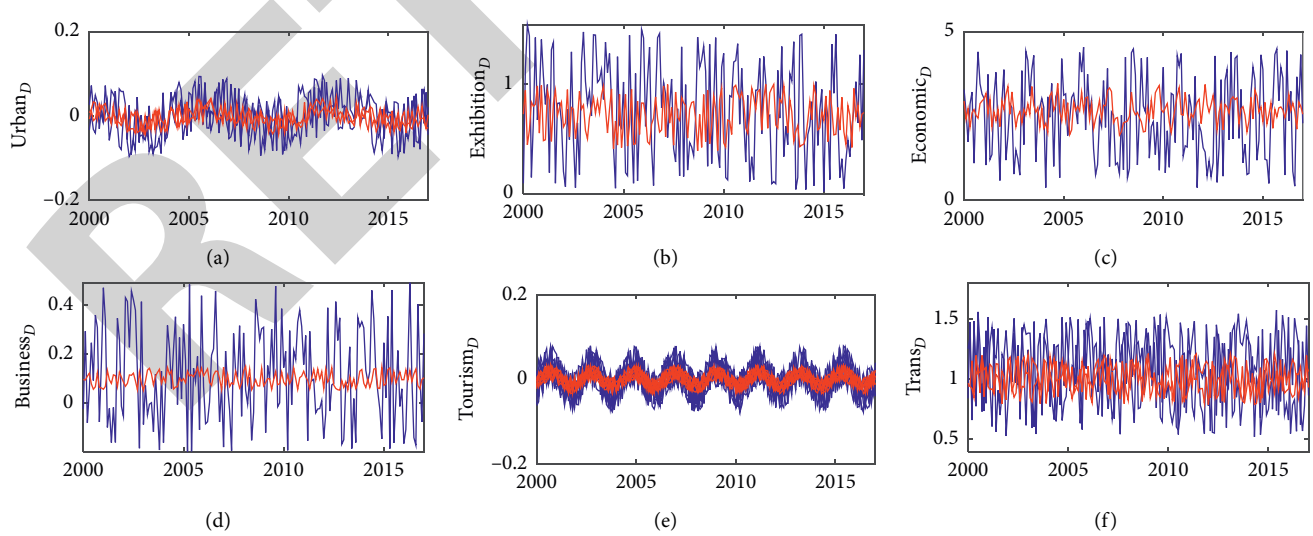

Figure 8: The factor analysis results of hotel scale based on partial relation coefficient.

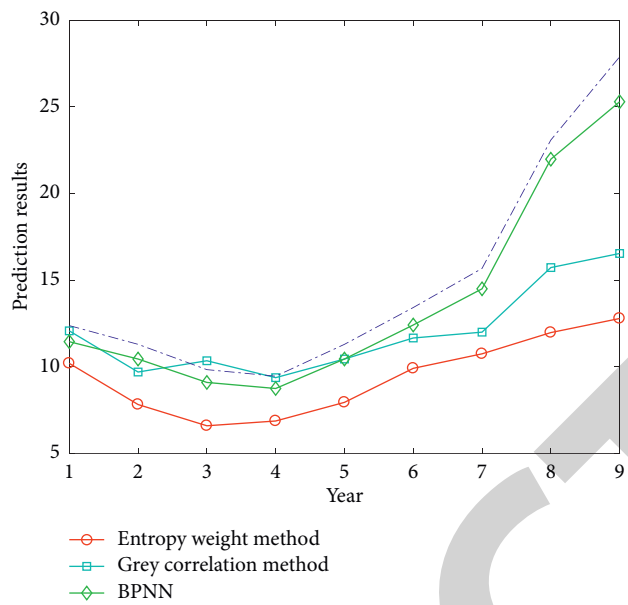

Figure 9: The superiority comparison compared with other prediction models.

5. Conclusion

In order to study the scale development strategy of high-star hotels, this paper constructs the scale impact index system of high-star hotels, mainly from six aspects of urban development, economic development, tourism development, exhibition industry development, business development, and transportation development, selects 14 scale impact factors to measure, and uses partial relationship to analyse the correlation between hotel scale and each impact factor. Through the partial relationship coefficient, the six dynamic factors have a strong correlation with the number of high-star hotels. Then, the constructed index system of high-star hotel development scale factor is combined with BP artificial neural network prediction model to predict, and the simulation verifies the effectiveness and reliability of the algorithm. In addition, the superiority of the model is verified by comparing with entropy weight method and grey correlation method. This method can be applied to the prediction of large-scale data, such as the number of scenic spots and population.

Data Availability

The data used to support the findings of the study are included within the article.

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] D. Xu and H. Ma, "Degradation of rhodamine B in water by ultrasound-assisted TiO_2 photocatalysis," *Journal of Cleaner Production*, vol. 313, Article ID 127758, 2021.

[2] S. Chen, G. Fang, X. Huang, and Y. Zhang, "Water quality prediction model of a water diversion project based on the improved artificial bee colony-backpropagation neural network," *Water*, vol. 10, no. 6, pp. 806–816, 2018.

[3] Y. Deng, X. Zhou, J. Shen et al., "New methods based on back propagation (BP) and radial basis function (RBF) artificial neural networks (ANNs) for predicting the occurrence of haloketones in tap water," *Science of The Total Environment*, vol. 772, no. 6, Article ID 145534, 2021.

[4] J. Liu, L. Liu, W. Guo et al., "A new methodology for sensory quality assessment of garlic based on metabolomics and an artificial neural network," *RSC Advances*, vol. 9, no. 31, pp. 17754–17765, 2019.

[5] Q. Tian, S. Liu, Y. Mao et al., "PSO-based BP-ANN predictive model of S. Typhimurium in processing of surimi with citric acid," *Journal of Food Safety*, vol. 38, no. 1, Article ID e12420, 2018.

[6] H. Ji, F. Xue, Z. Zhang et al., "Microstructure quantification of Cu–4.7Sn alloys prepared by two-phase zone continuous casting and a BP artificial neural network model for microstructure prediction," *Rare Metals*, vol. 38, no. 12, pp. 1124–1130, 2019.

[7] W. Liu, H. Ma, and A. Walsh, "Advance in photonic crystal solar cells," *Renewable and Sustainable Energy Reviews*, vol. 116, Article ID 109436, 2019.

[8] X. Zhang, C. Zang, H. Ma, and Z. Wang, "Study on removing calcium carbonate plug from near wellbore by high-power ultrasonic treatment," *Ultrasonics Sonochemistry*, vol. 62, Article ID 104515, 2020.

[9] H. Ma, X. Zhang, F. Ju, and S.-B. Tsai, "A study on curing kinetics of nano-phase modified epoxy resin," *Scientific Reports*, vol. 8, no. 1, p. 3045, 2018.

[10] Y. J. Liang, R. Chao, H. Y. Wang et al., "Research on soil moisture inversion method based on GA-BP neural network model," *Journal of Applied Remote Sensing*, vol. 12, no. 4, pp. 1–17, 2018.

[11] L. Garg, S. Mcclean, B. Meenan et al., "Non-homogeneous Markov models for sequential pattern mining of healthcare

data," *IMA Journal of Management Mathematics*, vol. 20, no. 4, pp. 327–344, 2018.

[12] H. Li, M. Luo, J. Zheng et al., "An artificial neural network prediction model of congenital heart disease based on risk factors," *Medicine*, vol. 96, no. 6, Article ID e6090, 2017.

[13] N. Yang, "Construction of artificial translation grading model based on BP neural network in college students' translation grading system," *Journal of Intelligent and Fuzzy Systems*, vol. 37, no. 2, pp. 1–8, 2019.

[14] Y. Xu and M. He, "Improved artificial neural network based on intelligent optimization algorithm," *Neural Network World*, vol. 28, no. 4, pp. 345–360, 2018.

[15] M. Ling, M. J. Esfahani, H. Akbari, and A. Foroughi, "Effects of residence time and heating rate on gasification of petroleum residue," *Petroleum Science and Technology*, vol. 34, no. 22, pp. 1837–1840, 2016.

[16] H. Ma and S.-B. Tsai, "Design of research on performance of a new iridium coordination compound for the detection of Hg^{2+}," *International Journal of Environmental Research and Public Health*, vol. 14, no. 10, p. 1232, 2017.

[17] L. Mo, W. Sun, S. Jiang et al., "Removal of colloidal precipitation plugging with high-power ultrasound," *Ultrasonics Sonochemistry*, vol. 69, Article ID 105259, 2020.

[18] A. Zhu, "Spatiotemporal feature mining algorithm based on multiple minimum supports of pattern growth in internet of things," *The Journal of Supercomputing*, vol. 76, no. 12, pp. 9755–9771, 2020.

[19] H. Wang, L. Xu, and X. Wang, "Outage probability performance prediction for mobile cooperative communication networks based on artificial neural network," *Sensors*, vol. 19, no. 21, pp. 4789–4796, 2019.

[20] Y. Wang and D. Qing, "Model predictive control of nonlinear system based on GA-RBP neural network and improved gradient descent method," *Complexity*, vol. 2021, no. 3, 14 pages, Article ID 6622149, 2021.

[21] W. Kuai, "Prediction method for energy consumption of high-rise buildings based on artificial neural network and big data analysis," *NeuroQuantology*, vol. 16, no. 6, pp. 524–530, 2018.

[22] J.-J. Jiang, L.-R. Bu, X.-Q. Wang et al., "Clicks classification of sperm whale and long-finned pilot whale based on continuous wavelet transform and artificial neural network," *Applied Acoustics*, vol. 141, no. 3, pp. 26–34, 2018.

[23] D. Gao, Y. Liu, Z. Guo et al., "A study on optimization of CBM water drainage by well-test deconvolution in the early development stage," *Water*, vol. 10, no. 7, 2018.

[24] S. B. Tsai and H. Ma, "A research on preparation and application of the monolithic catalyst with interconnecting pore structure," *Scientific Reports*, vol. 8, no. 1, 2018.

[25] J. Xie and H. Ma, "Application of improved APO algorithm in vulnerability assessment and reconstruction of microgrid," *IOP Conference Series: Earth and Environmental Science*, vol. 108, no. 5, Article ID 052109, 2018.

[26] J. Wang, L. Zhang, L. Duan, and R. X. Gao, "A new paradigm of cloud-based predictive maintenance for intelligent manufacturing," *Journal of Intelligent Manufacturing*, vol. 28, no. 5, pp. 1125–1137, 2017.

[27] F. Sun, G. Xie, and S. Li, "An artificial-neural-network based prediction of heat transfer behaviors for in-tube supercritical CO_2 flow," *Applied Soft Computing*, vol. 102, Article ID 107110, 2021.

[28] S. Ghosh, B. P. Chattopadhyay, R. M. Roy, J. Mukherjee, and M. Mahadevappa, "Estimation of echocardiogram parameters with the aid of impedance cardiography and artificial neural networks," *Artificial Intelligence in Medicine*, vol. 96, no. 5, pp. 45–58, 2019.

[29] A. Delgado and I. Romero, "Environmental conflict analysis using an integrated grey clustering and entropy-weight method: a case study of a mining project in Peru," *Environmental Modelling & Software*, vol. 77, no. 5, pp. 108–121, 2016.

[30] C. Hou, H. Chen, R. Long et al., "Construction and empirical research on evaluation system of green productivity indicators: analysis based on the correlation-fuzzy rough set method," *Journal of Cleaner Production*, vol. 279, no. 1, Article ID 123638, 2020.