Hindawi
Wireless Communications and Mobile Computing
Volume 2021, Article ID 8576534, 14 pages
https://doi.org/10.1155/2021/8576534

Research Article

Construction of a Nonlinear Model of Tourism Economy Forecast Based on Wireless Sensor Network from the Perspective of Digital Economy

Jun Liu[1] and Faxian Jia[2,3]

[1]*School of Management, Northwest University of Political Science and Law, Xi'an, 710122 Shaanxi, China*
[2]*School of Management and Economics, North China University of Water Resources and Electric Power, Zhengzhou, Henan 450046, China*
[3]*School of Management, Henan Institute of Urban Construction, Pingdingshan, Henan 467000, China*

Correspondence should be addressed to Faxian Jia; jiafaxian@hncj.edu.cn

Received 4 August 2021; Revised 22 September 2021; Accepted 29 September 2021; Published 14 October 2021

Academic Editor: Zhihan Lv

With the outbreak of the new crown epidemic, the world economy has been severely tested, making predictions more difficult. Wireless sensors have the advantages of low cost, ease of use, high reliability, and high safety and have been widely used in the tourism economy. In order to understand the ability of wireless sensors to predict the regional economy, this article uses an example to construct a nonlinear model of wireless sensors to predict the regional economy. With the continuous development of the concept of circular economy, circular economy has gradually been recognized by Chinese scholars and practitioners. After domestic scholars continue to study the theory of circular economy, practicing the concept of circular economy and taking the road of sustainable development have become one of the important directions of the development of industrial theory. Literature analysis and other methods were used to conduct research on databases such as CNKI, Wan fang Database, and SSCI. Literature was collected, and GIS spatial analysis technology was used to analyze different areas and finally get a prediction model. The phenomenon is nonlinearity (such as saturation nonlinearity in the magnetic circuit), and some are caused by the nonlinear relationship between system variables (such as linear resistance and squared nonlinearity between current and power) and some artificially introduced nonlinear links (such as the hysteresis nonlinearity of relays). Experiments have proved that there is a certain error between the prediction model and the actual result; the error value is about 9%, which is less than the value of other prediction models. This shows that the output results of the nonlinear model of wireless sensor regional economic prediction should be processed reasonably. This result has a certain reference value, and its output should be combined with the actual situation. Related research found that under the nonlinear model, the more accurate and comprehensive the input value is, the closer the output result is to the actual value.

1. Introduction

The spatial structure of regional tourism mainly studies the spatial distribution of tourism economic activities in the region, reveals the spatial agglomeration degree and agglomeration forms formed by the interaction of the system and tourism activities in space, and reflects the spatial attributes and interrelationships of the regional tourism system and tourism activities. With the continuous development of local tourism and the acceleration of the process of regional economic integration, the research on the spatial structure of regional tourism has received more and more attention. At the end of the last century, the application and popularization of computer technology, especially database technology, made it possible to obtain a large amount of data [1]. Then, how to effectively process data information, find laws, and use these laws to predict future data or unobservable data becomes particularly important. The rapid development of

Internet technology makes the network present a variety of data information resources However, the rapidly increasing amount of data has not been able to develop corresponding data processing and analysis methods at the same time, and the contradictions between them have become more and more prominent. People hope to conduct scientific research, commercial decision management, or business decision-making on existing data. For business management, traditional data analysis methods can no longer meet the requirements of gradual data generation and update, and data mining technology has emerged. With the rapid development of Internet technology today, data mining technology not only promotes the development of technology and economy but also brings great convenience to people's living standards. With the development of data mining technology, more and more industries will also use this technology to process massive data sets [2, 3]. In recent years, wireless sensor networks have become more and more widely used and have been fully integrated into our lives and become an important part of the "Internet +." Wireless sensor networks and mobile ad hoc networks (MANET) are both IoT, in the perception layer of the three-tier framework of the IoT, responsible for signal collection and transmission.

The network topology of wireless sensor networks will dynamically change with unstable environmental factors, and network propagation can only be done in the form of broadcasting. These two characteristics make the security of wireless sensor networks challenged. Among the many security problems of wireless sensor networks, the most serious threat is the networking and transmission parts, which are vulnerable to man-in-the-middle attacks, flooding attacks, and selective forwarding attacks. It may cause serious national property losses and people's safety threats, such as electricity leakage in the transmission network, failure of forest fire alarms, and privacy leakage of smart homes. With the development and popularization of the Internet of Things (IoT), as an important supporting technology of the Internet of Things, WSNs have received more and more attention from researchers. WSNs are the products of the continuous development and maturity of wireless communication, sensor technology, and microelectronics technology. Their appearance directly promotes the development of the Internet of Things, so they have huge development potential and application prospects. In the era of data explosion, the development of wireless sensor networks from the perspective of the digital economy has also promoted the development of learning based on wireless sensor networks in big data classification. In the classic wireless sensor network, all sample sets are trained in the initial training process to obtain a classification model, and then, new samples are added to the initial sample set for training to obtain a new classification model. This method usually leads to a longer training time. If the relevant useful information of the SVM classification model obtained after the initial training can be effectively used in the learning process [4], the time required for relearning can be reduced to a certain extent, and there is no need to change the initial value, retrain, and learn wireless samples of sensor networks. Today, with the rapid development of information technology and Internet technology, new data for information updates are constantly being produced, and basic data processing methods can no longer be synchronized with data updates [5]. Therefore, in order to effectively solve the problem that wireless sensor networks cannot meet the classification requirements when generating new data, the application of incremental learning to wireless sensor networks has become an important area of wireless sensor network method research [6].

For the role of wireless sensor networks in prediction, scholars at home and abroad have conducted a lot of research. Xingjie et al. studied the research on classification algorithms of wireless sensor networks; proposed the application of wireless sensor networks in generalized learning, face recognition, and automatic encoders; and verified the role of wireless sensor networks through experiments [7]; Ying and Naiqiu discussed the basis of wireless sensor networks, conducted theoretical research on the advantages of wireless sensor networks, and classified them based on the application of wireless sensor networks [8]; Yuanhang et al. used wireless sensor networks to establish training models and input stock-related data, get experimental results and errors, and verify the prediction function of wireless sensor networks [9]; Hongshuang and Lu introduced linearity based on the characteristics of wireless sensor networks, the difference between nonlinear wireless sensor networks, and large-scale algorithm research of nonlinear wireless sensor networks [10]. In order to improve the quality of image segmentation, Wu et al. adopt the kernel function algorithm of wireless sensor networks, use wireless sensor networks to input related functions, and get the best segmentation line for prediction; after testing and verification, the prediction error is very small [11]; Zhang et al. integrated machine learning theory into wireless sensor networks and introduced the effect of machine learning theory on wireless sensor networks. It is proved through experiments that the algorithm after machine learning theory fusion is more balanced [12]; Wang et al. use the prediction function of wireless sensor networks to establish an economic development level model and use the strong promotion ability and overall optimization characteristics of wireless sensor networks. The related model was verified [13]. Generally speaking, domestic and foreign experts have conducted in-depth and comprehensive research on the application and classification of wireless sensor networks, but there are few related researches on the nonlinear models of wireless sensor networks which build provide the foundation [14].

This article introduces some basic concepts and principles of wireless sensor networks and statistical learning theory, provides necessary background support for nonlinear modeling based on wireless sensor networks, and then specifically introduces the basic ideas, specific theories, and theories of wireless sensor network system architecture. For the algorithm, a direct wireless sensor network regional economic forecasting nonlinear model was established, and case analysis was used to analyze the economic conditions of Beijing, Hangzhou, Wuhan, Xi'an, Guangzhou, and other places to predict economic development trends, which is the role of theoretical research.

2. Nonlinear Modeling Method Based on Wireless Sensor Network

2.1. Wireless Sensor Network

2.1.1. Wireless Sensor Network System Architecture. The collection method means that the detection node can be the sensor node itself or an independent collection node deployed separately, and even in some hop networks, the collection node can be the base station itself. The processing location is divided into distributed and centralized types. The distributed type requires relatively small bandwidth and higher hardware requirements for the detection unit; the centralized type consumes more bandwidth and needs to send information to the base station or cluster head node, which has a greater impact on the power consumption which is large and may have a large impact on the performance of the application itself.

As shown in Figure 1, after deployment, a large number of sensor nodes form a network through self-organization. After the sensor nodes collect the sensing information of the monitoring area [15, 16], the signal processing in the node will process the sensing signals and convert analog signals into digital signals. The signal is transmitted to the sink node or base station in a hop mode, and the base station sends these data to the task management center through communication satellites, wireless networks, or the Internet. Managers send monitoring tasks to the base station through communication satellites or the Internet. The nodes in wireless sensor networks are generally divided into two types: sensor nodes and aggregation nodes. The sensor node has the functions of physical information collection, processing, and wireless communication, and the energy it carries is small. The aggregation node has a gateway and data forwarding function, is responsible for the information interaction between the sensor network and the Internet, can convert different communication protocols, has complex functions, is not limited by energy, and generally has a small amount of data.

The apostasy caused by a node being captured is an internal attack. Insider attacks are the main problem faced by security detection. How to prevent apostasy nodes, namely, attackers, from causing greater damage to the network, how to detect attacks more quickly, and how to detect attacks with low cost and low consumption are the main difficulty of wireless sensor networks. Wireless sensor network security detection is divided into two major research areas. One is the system framework of security detection, including how to collect data, where to analyze the data, and the frequency and period of data collection. The second is the security detection method. The main research content is which data to collect, how to analyze the data, what model to use, and how to deal with errors.

The nodes in the wireless sensor network have certain information collection, processing, storage, and wireless communication functions. The working environment of the node requires the node to have the characteristics of small size and low energy consumption. As shown in Figure 2, the node structure is divided into four parts according to its function: sensor, data processing part, wireless communication part, and power supply [17]. The transmitter is composed of various physical sensing devices, which sense various physical signals, generate analog signals, and convert the analog signals into digital signals through digital-to-analog conversion equipment. The processor part has simple data preprocessing and storage capabilities. The communication part can send and receive data through a wireless communication transceiver. The main function of the power supply is to provide power to the node to ensure the normal operation of the node.

The wireless sensor network technology has just started, and the wireless sensor network protocol has not yet formed a unified standard. The protocols between manufacturers are different. There is currently no stable wireless sensor network security protocol, and there is no mature attack type analysis. Researchers can only construct attackers based on their own understanding, and their detection capabilities cannot be tested and guaranteed. Therefore, a more comprehensive and reliable security detection mechanism is needed, which is also the goal of establishing a wireless sensor network security detection platform. The wireless sensor network architecture is based on the TCP/IP network protocol, which is the distribution and description of each layer of the network and its functions. Although the architecture of the wireless sensor network is similar to the existing computer network architecture, it is different. As shown in Figure 3, from top to bottom, the wireless sensor network layer protocol includes the physical layer, data link layer, network layer [18, 19], transmission layer, and application layer. These protocols, together with power management, security management, and task management, have realized the functions of network time synchronization, node location, transmission control, routing, channel access, and topology generation.

2.2. Tourism Trend Prediction Method Based on Wireless Sensor Network. In reality, part of the problem is a nonlinear problem. Corresponding rules need to be established to transform the training data; that is, nonlinear problems in low-dimensional space are transformed into high-dimensional linear problems for solving. Nonlinearity is a common phenomenon in actual control systems. Some are caused by the inherent characteristics of the system (such as saturation nonlinearity in the magnetic circuit), and some are caused by the nonlinear relationship between system variables (such as linear resistance and squared nonlinearity between current and power), and some are caused by artificially introduced nonlinear links (such as the hysteresis nonlinearity of relays) [20]. Therefore, nonlinear systems are general systems. In recent decades, the theory and application of nonlinear systems have also developed greatly. However, the research and development of nonlinear systems still lack a complete, systematic system and effective analysis tools. This part briefly introduces some specific types of control problems, as well as some important and representative theories and methods.

Nonlinear systems may have richer and more complex characteristics than linear systems, and their theoretical research models and methods also have their own scope of

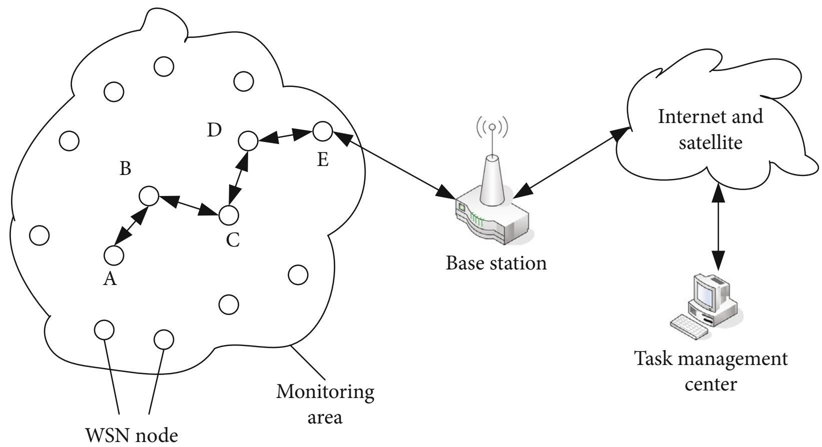

Figure 1: Wireless sensor network structure.

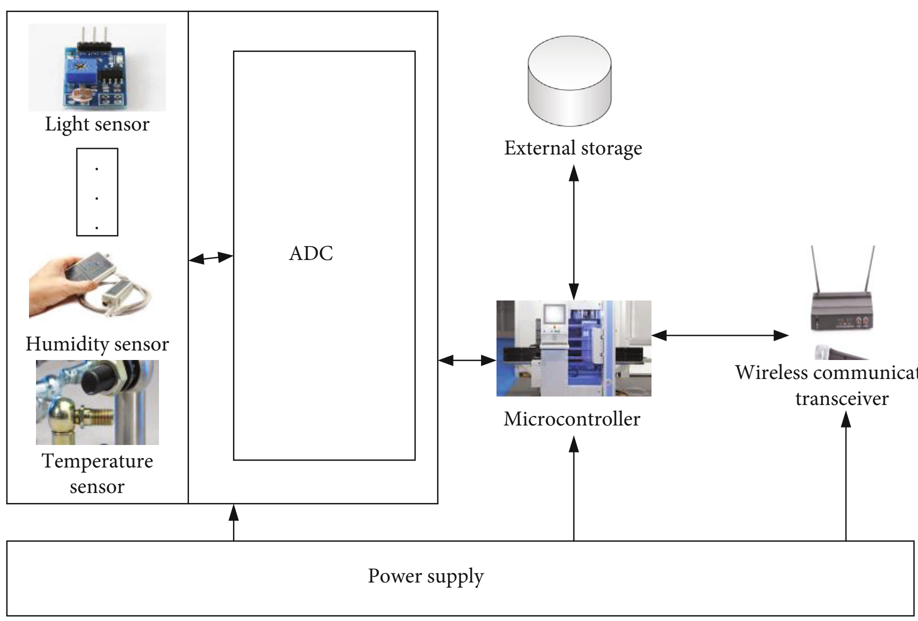

Figure 2: Wireless sensor node structure.

application. The part and the whole are no longer unified, nor do they satisfy the superposition principle of linear systems [21]. Even if it is a known nonlinear dynamic system, it is difficult to model and control it. When the structure of the controlled object is completely unknown, the research of the system will become more complicated. This also makes the model identification and control of nonlinear systems a research hotspot in the current control field. In recent years, artificial intelligence technology has been widely used in the identification of black box systems. Among them, the regional economy has attracted much attention. Its unique nonlinear approximation ability brings vitality to the modeling of nonlinear systems, but the selection of network structure and parameter optimization, model verification, and generalization capabilities are involved in the modeling process [22]. The dynamic behavior of a nonlinear system is not like a linear system that can be represented by a general model structure, which makes the choice of the network structure directly affect the correctness and effectiveness of the modeling [23].

2.2.1. Calculation Method of Standard Deviation Ellipse. This article first introduces the research status of regional tourism spatial structure and spatial economics. The analysis points out that tourism economy has the main characteristics of spatial economic research objects. First, tourism market competition belongs to the type of monopolistic competition, so the monopolistic competition is generally adopted by the theory of spatial economics; the equilibrium analysis method is also applicable to the tourism market. The standard deviation ellipse is a tool that can reflect the center, distribution, and direction of spatial elements, by calculating the$x$and$y$directions, the standard distance to define the axis of an ellipse that contains the distribution of all the elements [24]. Standards are build based on the calculation of spatial objects after the difference ellipse; the basic elements of the

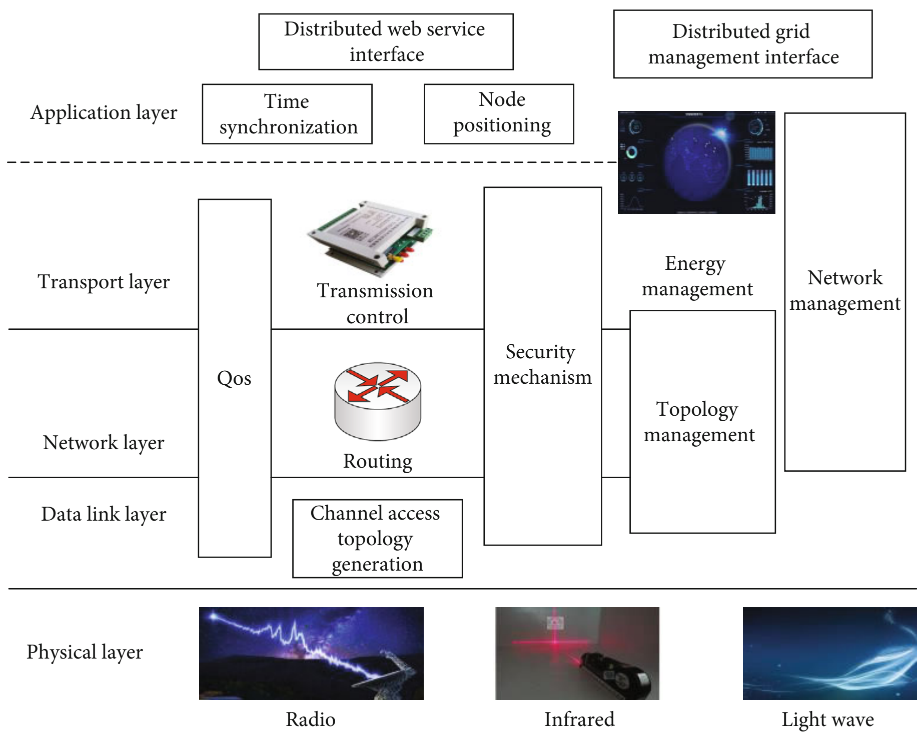

Figure 3: Protocol stack structure of wireless sensor network.

standard deviation ellipse (center point, semimajor axis, semiminor axis, spread range, and azimuth angle) analysis can identify the spatial differentiation characteristics of spatial objects. The center point represents the relative position of the spatial distribution of spatial objects, and the difference between the center point and the center of the space object reflects the degree of data variation of the space object; the semimajor axis reflects the void of the degree of dispersion of space objects in the main trend direction [25]. The short semiaxis reflects the degree of dispersion of space objects in the secondary direction. The difference between the short semiaxes is the embodiment of the centripetal force of the space object; the spread range is determined by the standard deviation taken by the standard deviation ellipse; the value is from 1 to 3, indicating that the standard deviation ellipse contains 68%, 95%, and 99% of the centroid of the space object; the azimuth angle is the performance of the main trend direction and is used to analyze the spatial distribution direction of spatial objects. The table of standard deviation ellipse format is as follows:

$$\mathrm{SDE}_x = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n}}, \qquad \mathrm{SDE}_y = \sqrt{\frac{\sum_{i=1}^{n} (y_i - \bar{Y})^2}{n}}. \tag{1}$$

In the formula, x_i and y_i are the coordinates of the element i, $\bar{x}$, $\bar{Y}$ represent the average center of the element, and n is the amount of the element.

The calculation process of the standard deviation ellipse azimuth is as follows:

$$\begin{aligned} \tan\theta &= \frac{A+B}{C}, \\ A &= \left(\sum_{i=1}^{n} \tilde{x}_i^2 - \sum_{i=1}^{n} \tilde{y}_i^2 \right), \\ B &= \sqrt{\left(\sum_{i=1}^{n} \tilde{x}_i^2 - \sum_{i=1}^{n} \tilde{y}_i^2 \right)^2 + 4\left(\sum_{i=1}^{n} \tilde{x}_i \tilde{y}_i \right)^2}, \\ C &= 2\sum_{i=1}^{n} \tilde{x}_i \tilde{y}_i. \end{aligned} \tag{2}$$

Spatial economics is based on economies of scale and increasing returns to scale, and the related theories of economies of scale are also applicable to the tourism industry. Spatial economic models assume that consumers have diverse preferences and analyze product consumption through the maximization of consumer utility. In the regional tourism market, tourists also take utility maximization as the code of conduct and have diverse preferences and characteristics. Therefore, the theory of the spatial economic model is applicable to the study of the tourism spatial structure. In the formula, $x^{\sim}_i$ and $y^{\sim}_i$ are the difference between the average center and the xy coordinates.

2.2.2. Nonlinear Regression Method. While drawing on the theory of spatial economics to study the spatial structure of regional tourism, it is also necessary to fully consider the characteristics of the tourism industry itself. The spatial economics of the composition of the tourist source area analyzes the trade exchanges within the region through the transportation of products between different regions, and tourism products cannot be transported. The nonlinear method studies the nonlinear interaction relationship between variables [26], and the nonlinear regression is the regression function about the unknown; the regression coefficient has a nonlinear structure of regression. When the explained variable of the regression model is more than one function of the explanatory variable formula, the regression law will be shown as a curve of volatility on the graph [27]. Nonlinear regression algorithms usually use mathematical means to convert the nonlinear regression into a linear regression problem and then solve the problem according to the linear regression method; when the nonlinear regression cannot be solved when regression is transformed into linear regression, methods such as decision tree and ANN are often used to solve nonlinear problems. Decision tree and other parties are compared with the method; it has the characteristics of fast execution speed and strong interpretability. At the same time, it can build multiple decision trees for integrated learning. It has a big advantage, so this article adopts the decision tree as a nonlinear forecasting method [28].

Regression decision trees rely on classification and regression trees (CART) to solve regression problems to output continuous variables. CART [29] uses binary recursive segmentation technology to construct a binary tree, selects the feature according to the Gini index estimation function of the minimum distance, and determines the optimal binary cut point of the feature, making the decision tree highly interpretable, and when the data complexity is higher when the number of variables increases, the regression decision tree based on CART can usually obtain more accurate results than other methods.

With the development of artificial intelligence technology, researchers gradually tend to use artificial intelligence technology to solve nonlinear problems.

Extreme gradient boosting (XGBoost) is a machine learning algorithm implemented under the gradient boosting framework. XGBoost uses the regression tree in CART as the base classifier but adopts the concept of integrated learning to combine multiple learning models to obtain better results. The specific implementation process of XGBoost is the following: by constructing multiple interrelated decision trees, the error between the output result of the previous decision tree and the true value is input to the next decision tree, and finally, all the output results of the decision tree are accumulated and combined. The cumulative sum is output as the result. The prediction model of XGBoost can be expressed as

$$\hat{y}_i = \sum_{k=1}^{k} f(x_i). \tag{3}$$

In the formula, $\hat{y}_i$ represents the prediction result of sample x_i, k is the tree of the decision tree, and f_k represents the k th tree.

In order to make the predicted value of the decision tree closer to the true value, XGBoost solves and evaluates the model by minimizing the loss function. The expression of the loss function is

$$\mathrm{Obj}(\theta) = \sum_{i=1}^{n} l(y_i, \hat{y}_l) + \sum_{k=1}^{k} \Omega(f_k). \tag{4}$$

In the formula, $l(y_i, \hat{y}_l)$ represents the error between the true value of the ith sample and the predicted value; $\Omega(f_k)$ represents the complexity of the decision tree, and the complexity is inversely proportional to the generalization ability of the prediction model. The expression $\Omega(f_k)$ is

$$\Omega(f_k) = \gamma T + \frac{1}{2}\gamma \sum_{j=1}^{T} w_j^2. \tag{5}$$

In the formula, γ is the number of leaves, T is the number of leaf nodes, and w is the score value of the leaf nodes.

2.3. Time Series Research. If a certain variable $x(t)$, at time point: $t_1, t_2, \cdots, t_N (t_1 < t_2 < \cdots < t_N)$, there is a series of data $x(t_1), x(t_2), \cdots, x(t_N)$ in a certain order, then this column of data is called discrete time sequence; the sample sequence of daily visitors to Jiuzhaigou analyzed here is a discrete time sequence. In practical applications, the most widely used time series model is the ARMA model. There are mainly three basic ARMA models, autoregressive models, moving average models, and autoregressive moving average models, which combine autoregressive models and moving average models.

2.3.1. Autoregressive Model AR(p). If the generation of random process X_t satisfies

$$X_t = c + \phi_1 X_{t-1} + \phi_2 X_{t-2} + \cdots + \phi_p X_{t-p} + \varepsilon_t. \tag{6}$$

The stochastic process X is called the P-order autoregressive process, abbreviated as AR(p).

2.3.2. Moving Average Model MA(q). If the generation of random process X_t satisfies

$$X_t = \varepsilon_t + \theta_t \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \cdots + \theta_q \varepsilon_{t-q}. \tag{7}$$

The stochastic process X is called the q-order moving average process, abbreviated as MA(q).

2.3.3. Autoregressive Moving Average Model ARMA(p, q). For the random process X, the generation satisfies

$$\begin{aligned} X_t = c &+ \phi_1 X_{t-1} + \phi_2 X_{t-2} + \cdots + \phi_p X_{t-p} + \varepsilon_t + \phi_1 \varepsilon_{t-1} \\ &+ \phi_2 \varepsilon_{t-2} + \cdots + \phi_q \varepsilon_{t-q}. \end{aligned} \tag{8}$$

It is called the stochastic process X_t, which is the autoregressive moving average process, abbreviated as ARMA (p, q).

Sequence autocorrelation refers to the correlation between all observations $X_t, X_{t-1}, X_{t-2}, \cdots, X_{t-r}$ in the time series X_t, and the autocorrelation function is to measure the autocorrelation relationship between observations. Define the autocorrelation function as

$$\rho_\tau = \frac{\gamma_\tau}{\gamma_0} = \frac{\mathrm{Cov}(X_t, X_{t-\tau})}{\sqrt{DX_t \cdot DX_{t-\tau}}}. \tag{9}$$

ρ_τ is a measure of the degree of correlation between the random variable X_t and $X_{t-\tau}$, but it may be affected by the random variable $X_{t-1}, X_{t-2}, \cdots, X_{t-\tau+1}$. In order to eliminate the influence of random variables, calculate the correlation coefficient to get the partial correlation function, recorded as ρ_τ-partial autocorrelation, which refers to the time series X_t, under the condition of a fixed $X_{t-1}, X_{t-2}, \cdots, X_{t-\tau+1}$. The conditional correlation between X_t and $X_{t-\tau}$, the partial autocorrelation coefficient, is an index to measure the degree of partial autocorrelation definition. The partial autocorrelation function is

$$\rho_\tau = \begin{cases} \rho_1, & \tau = 1, \\ \dfrac{\rho_\tau - \sum_{j=1}^{\tau-1} \phi_{\tau-1} \rho_{\tau-j}}{1 - \sum_{j=1}^{\tau-1} \phi_{\tau-1} \rho_{\tau-j}}, & \tau = 2, 3, \cdots. \end{cases} \tag{10}$$

2.4. Kernel Function and Generalization Ability

2.4.1. Kernel Function. The kernel function is one of the key factors that determine the performance of the support vector machine. The kernel representation method is to map the data to a high-dimensional space to change the separation status. When the space dimension increases, only the inner product algorithm is changed. It does not become complicated with the increase of dimensionality, nor does it affect the promotion ability in high-dimensional space. The learning method is based on the kernel function. An important building block in the support vector machine is provided by the kernel function. Support vector machines use different kernel functions to construct learning machines with different types of nonlinear decision surfaces in the input space.

In order to solve the two-category classification, the support vector machine classification method was proposed. However, the regional economy of this system is a multiclassification problem, so the next difficulty lies in how to apply the two-category classification method to the multiclass problem. The support vector machine method cannot be directly applied to the multicategory classification problem. To solve the multicategory recognition problem, the two-category classification problem in the support vector machine can be combined to achieve. Generally speaking, the processing strategy is divided. For "one-on-one" and "one-on-one," each classifier needs to choose one of two each time, so the training data of type a needs to be divided into two. Finally, the total number of support vector machines is constructed, and then, the "voting" method is adopted for identification during classification $N_a^2 = a(a-1)/2$. This is the calculation process of the "one-to-one" method. A classifier needs to separate each category from all other categories. When dealing with N classification problems, it is necessary to construct a support vector machine. It is the task of each vector machine to distinguish this type of data from the rest of the data. The support vector machine with the farthest distance from the interface plays a decisive role in the final classification result. This is the recognition process of the "one-to-the-rest" method. Since the regional economy of this system is a multicategory pattern recognition problem, we choose to adopt the "one-to-one" method.

The kernel function is the most important part of SVM. The kernel function directly affects the classification efficiency of SVM. SVM's nonlinear classification processing method is to map the input vector of each sample to a high-dimensional feature space with a nonlinear function and then linear regression to obtain the effect of nonlinear regression on the original space.

2.4.2. Generalization Ability. Generalization ability is a very important problem in support vector machines. The generalization ability of the learning model is its generalization ability. In the prediction regression problem, it means that the data not in the training sample can also produce more reasonable prediction results. In the past learning and training, the training error is often minimized. During training, sometimes overfitting the training data can minimize the training error, but sometimes the trained learning model is used for a certain point in the future. When making predictions, the phenomenon of overlearning will inevitably occur, thus reducing the generalization ability of the learning model. Therefore, only relying on the minimization of prediction errors cannot achieve satisfactory results.

In the case of limited samples, the training error and the generalization ability of the model are mutually restricted. Generally speaking, the smaller the training error, the weaker the generalization ability. When all the sample data is trained, the training error is zero, or when the situation is too small, the phenomenon of overlearning occurs. Therefore, in the actual application process, under the condition of ensuring enough training samples, reasonable selection of prediction models and algorithms can avoid the generation of learning to a certain extent. It can be obtained that under the limited number of samples, the experience risk minimization does not necessarily meet the desired risk minimization.

Theoretical and experimental studies show that the generalization performance of regional economy greatly depends on the accuracy and difference of individual regional economy in the integration. In order to obtain highly differentiated individual networks, researchers use different training sets, different network structures, different network types, different initial conditions, and different training algorithms to improve the differences between networks. Usually from the following aspects:

Changing the initial random weight set. Each time the network is trained, the same training data is used, but different random initial weights are used. This method can generate a set of different networks.

Changing the topology structure. Before each training, by changing the topology of the network and then using the same data set for training on the changed network, a group of different networks can be generated.

Changing the network type. Changing the network type can use different network types to generate integrated members. For example, you can use multilayer perceptrons [30], radial basis function regional economy, and probability regional economy to generate a group of different regional economies.

Changing the algorithm used. When predicting the regional economy, use the same data set but use different learning algorithms for training, and a set of networks can be obtained through this method.

Changing the training data. Changing the training data is a method often used in regional economy, including data sampling, the use of disjoint training sets, and adaptive resampling, different data sources, and preprocessing methods. A group of different regional economies can be obtained through these methods.

3. Support Vector Machine Experiment

3.1. Experimental Analysis Object. This article uses the case investigation method to make statistics on Beijing, Hangzhou, Wuhan, Xi'an, and Guangzhou. Through relevant literature, statistics on economic development and changes in the five places are used to study the impact of relevant variables on economic changes and construct a regional economic development model.

3.2. Establish a Model Evaluation Index System. The evaluation index is a specific evaluation item determined according to some evaluation goals, which can reflect some basic characteristics of the evaluation object. The index is specific and measurable, and it is the observation point of the goal. Definite conclusions can be drawn through actual observation of objects. Generally speaking, the evaluation index system includes three levels of evaluation indexes: they are the relationship between gradual decomposition and refinement. Among them, the first-level evaluation indicators and the second-level evaluation indicators are relatively abstract and cannot be used as a direct basis for evaluation. The third-level evaluation indicators should be specific, measurable, and behavior-oriented and can be used as a direct basis for teaching evaluation.

3.3. Determine the Evaluation Weight. The index weight is a numerical index indicating the importance and function of the index. In the indicator system of the evaluation plan, the weight of each indicator is different. Even if the indicator level is the same, the weight is different. Index weight is also called weight and is usually represented by a. It is a number greater than zero but less than 1, and the sum of the weights of all first-level indicators must be equal to 1, that is, satisfy the conditions $0 < a < 1$ and $\sum a - 1$.

3.4. Comprehensive Evaluation Model. Currently, there are two main evaluation models: one is the main factor highlight model, and the other is the weighted average model. If the weight of a single factor is significant and there are dominant factors in the evaluation factors, you can choose the prominent main factor model; if the weight of the evaluation factors is relatively average, you can choose the weighted average model. These two models have their own characteristics. In the specific implementation process, the two methods can be implemented separately. Finally, the results of the two models are compared.

4. Nonlinear Regional Economic Forecasting Model Analysis

4.1. Statistics of Economic Development in Five Places in the Past Five Years. This article uses China's economic development white paper and local economic development reports to collect statistics on the economic development of Beijing, Hangzhou, Wuhan, Xi'an, and Guangzhou from 2015 to 2019, as shown in Table 1.

According to Table 1, Beijing's economic situation is the best, with an average annual growth rate of about 12%. The average annual growth rate of other cities ranges from 9% to 11%. The growth rate is the fastest in 2019. The growth rate is about 18%, and the growth rate of the rest is about 13%.

According to the survey of the economies of various regions in the past five years, we have obtained the changes in the five regions in recent years, and input their variables into a nonlinear model, as shown in Figure 4.

As shown in Figure 4, in the past five years, economic changes in various regions have been steadily increasing. Among them, Beijing has the fastest change, followed by Guangzhou. Among the five regions, Xi'an has the slowest change. This is mainly due to different economic foundations, different local policies, development levels, and attractiveness to talents caused by differences in the current uneven development, and the power of science and technology must be fully utilized.

Science and technology are the primary productive forces, and the implementation of circular economy theory and the path of sustainable development provide motivation support for science and technology. In practicing the production process of circular economy, on the one hand, we must rely on the company's own long-term scientific research experience and at the same time actively draw on and learn from the advanced research results of other research units to build a technical foundation for our own units to practice the theory of circular economy. In the process of knowledge absorption, the government should issue a series of support policies to build communication bridges between technology-controlled scientific research departments and companies that need technology.

4.2. Descriptive Statistics of Visitor Volume and Internet Search Data in City m. The following will perform descriptive statistics on the daily visitor volume data and Baidu search data of p scenic spots in the corresponding time period, and the analysis results are shown in Figures 5 and 6.

The above all reflect the abnormal search phenomenon of each keyword. It can be found that the search changes of each keyword are not the same, and there will be a

Table 1: Five-year economy in five provinces.

	Beijing	Hangzhou	Wuhan	Xi'an	Guangzhou
2015	23685.7	9206.1	10069.5	5801.2	18334.5
2016	25669.1	10050.2	10905.6	6282.6	19805.3
2017	28014.9	11313.1	11912.6	7471.9	21503.1
2018	30320.0	12603.3	13410.1	8349.8	22859.3
2019	35371.3	13509.1	14301.3	9321.2	25306.7

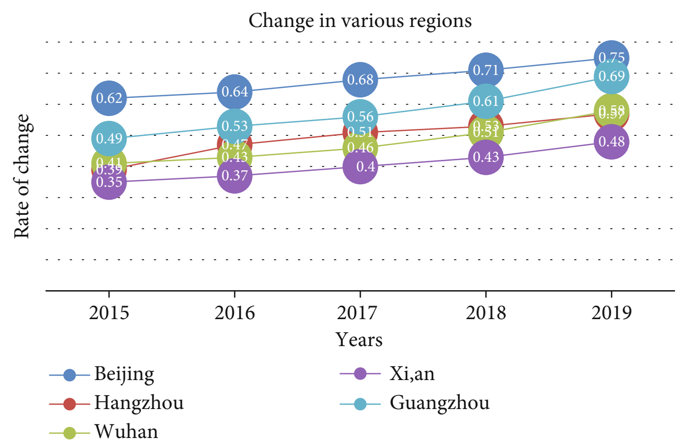

Figure 4: Changes in various regions in the past five years.

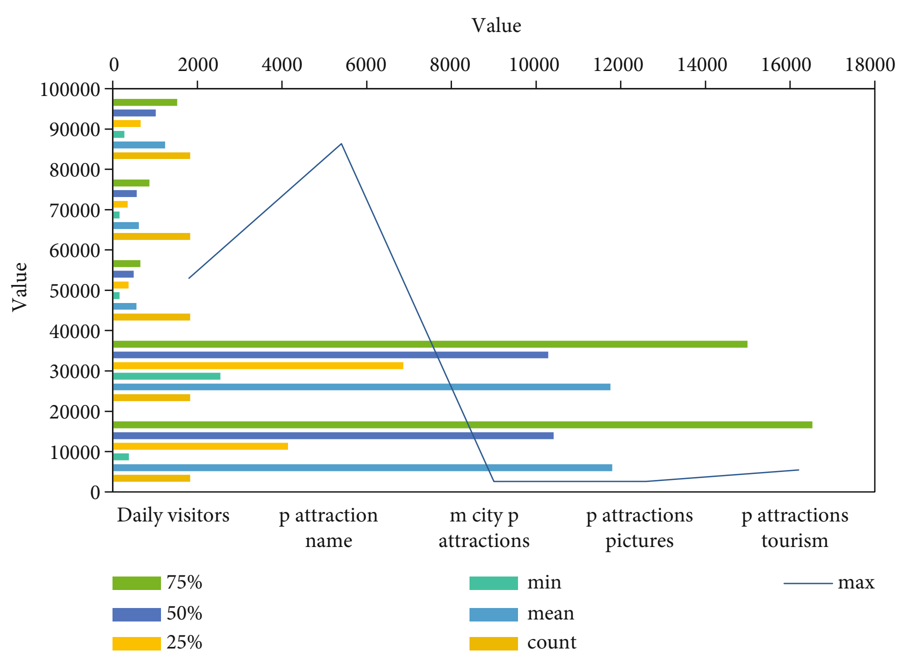

Figure 5: Daily visitor volume data of p tourist attractions and Baidu search data.

phenomenon that the search volume is particularly high in some years and holidays, and the trend of the change in the number of visitors to the p scenic spot every year. They all present a similar situation, which is different from the change trend of the eight keywords. Therefore, it is meaningful to study the impact of the search data of the eight keywords on the daily visitor volume of p scenic spots.

From the Baidu search statistics of eight keywords, people searched the Internet the most for "p scenic spot." Its six-year average search value was 11,755.5, the highest value was 86347, and the lowest value was 2542, always maintaining a high level. Search volume and the average search value of "p scenic spot" are also very close to the average daily visitor volume of p scenic spot. Secondly,

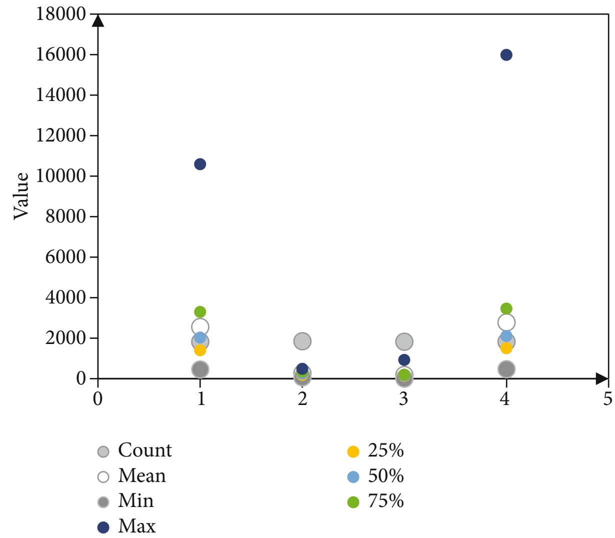

Figure 6: Daily visitor data of p scenic spots and Baidu search data.

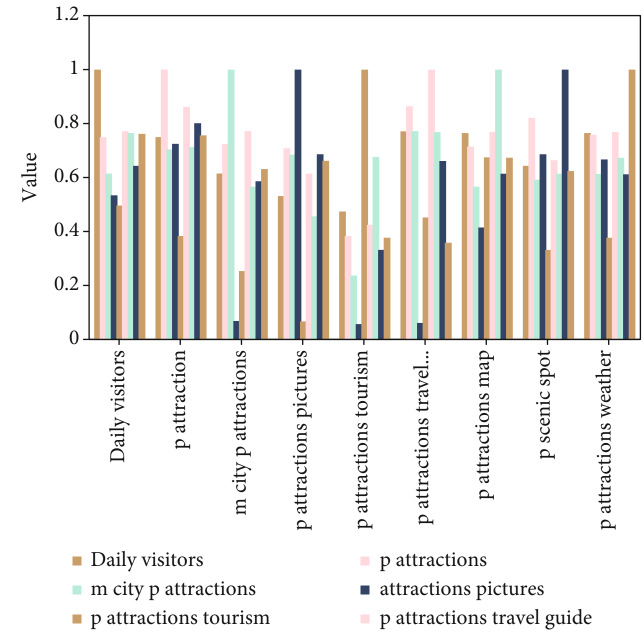

Figure 7: p analysis of the relationship between the number of tourists at scenic spots and the eight keywords.

the most searched ones are "p scenic spot weather," "p scenic spot travel guide," and "p scenic spot travel." The search volume of these three keywords has exceeded 1000, and they have a certain degree of attention, and these three keywords are related to p spot tourism, showing the behavioral characteristics of people searching on the Internet before traveling. Finally, the search volume of the four keywords of "p scenic spot picture," "m city p scenic spot," "p scenic spot map," and "p scenic spot scenic spot" is relatively low, which is related to keyword refinement and overlap.

4.2.1. Analysis of the Influence of Internet Search Data on Tourist Flow. The correlation analysis of the nine variables is shown in Figure 7. According to the analysis, it can be found that the daily visitor volume of p scenic spot is significantly correlated with the keywords "p scenic spot travel guide," "p scenic spot map," and "p scenic spot." There is a greater chance that the crowd will visit the p attractions. Among the eight keywords of Internet search data, the keywords "p scenic spots," "m city p scenic spots," "p scenic spots map," and "p scenic spots weather" are all related to the keyword "p scenic spots travel guide." This shows that while doing travel guides for p scenic spots, most people will choose to inquire about the situation of p scenic spots and the weather of p scenic spots. In addition, the keyword "p scenic spot picture" has the strongest correlation with the keyword "p scenic spot," the keyword "p scenic spot tourism" has the strongest correlation with the keyword "p scenic spot map," and the keyword "p scenic spot scenic spot" has the strongest correlation with the keyword "p scenic spots" which are the most relevant. One of the interesting phenomena is that the keyword "p scenic spot travel" has a particularly weak correlation with all keywords except "p scenic spot map," and the correlation with the daily visitor volume of p scenic spot is also the weakest of all keywords. Yes, the correlation with "p scenic spot pictures" is even only 0.06. But on the contrary, the keyword "p scenic spot travel guide" has a strong correlation with most keywords and the daily visitor volume of p scenic spots, which may have a certain relationship with the overlap of the two keywords.

4.2.2. Granger Causality Analysis. Since one of the research focuses of this article is whether network search data can be used to predict the economic development of scenic spots, the Granger causality test is carried out on the number of visitors to p scenic spots and eight keywords. The Granger causality test is a hypothesis testing method based on the autoregressive model. The premise is that the time series must be stationary. Therefore, the stationarity test is performed on the time series of p scenic spots and the time series of eight Baidu search keywords. In Eviews8.0, the ADF unit root test was performed on 9 sequences. Through the test, it was found that the five sequences of p scenic spots daily visitor volume and keywords p scenic spots, p scenic spots pictures, p scenic spots travel guides, p scenic spots, and scenic spots are 0-order. The single integral stationary series meets the preconditions of cointegration analysis. The ADF test results are shown in Table 2. Next, the Granger causality test was performed. If a random variable K is helpful for predicting another random variable, then the variable is said to be the Granger cause of the variable.

4.2.3. Research on the Timeliness of Network Search Data. As shown in Table 3, the Baidu index can reflect the "user attention" and "media attention" of different keywords in the past period of time. Therefore, the Baidu index has certain timeliness. For tourism, consumers mainly, the main network searches are conducted in two time periods. One is to explore tourist destinations before preparing to travel, mainly from the aspects of clothing, food, housing, transportation, and play. The other is to search for the purpose of

Table 2: Time series ADF inspection table.

Variable	ADF value	1% level	5% level	10% level	In conclusion
Daily visitors to *p* attractions	-4.097907	-3.433747	-2.862927	-2.567555	Steady
p attractions	-5.118466	-3.433737	-2.862923	-2.567553	Steady
m city *p* attractions	-2.974895	-3.963106	3.412286	-3.128076	Unstable
p attractions pictures	-4.373545	-3.963087	-3.412277	-3.128071	Steady
p attractions tourism	-3.044682	3.963121	3.412293	-3.12808	Unstable
p attractions travel guide	3.457893	3.963118	-3.412292	-3.12808	Steady
p attractions map	-2.84491	-3.433761	-2.862933	-2.567559	Unstable
p scenic spot	-4.807605	-3.96309	-3.412278	-3.128071	Steady
p attractions weather	3.159483	-3.963109	-3.412288	-3.128077	Unstable

Table 3: Comprehensive table of various regression indicators.

	MAE	MSE	*R* squared	RMSE
Test0	0.154231	0.042469	0.957531	0.206080
Test1	0.157729	0.045666	0.954334	0.213696
Test2	0.139859	0.03724	0.96276	0.192976
Test3	0.140824	0.038114	0.961886	0.195228
Test4	0.144836	0.040422	0.959578	0.201052
Test5	0.152621	0.045427	0.954573	0.213136
Test6	0.159382	0.04862	0.95138	0.220499
Test7	0.168946	0.052882	0.947118	0.229960

Table 4: Comparison table of advance accuracy of web search.

	MSE	*R* squared	RMSE	RMSE changes
Original GBRT	0.042469	0.95753 *I*	0.206080	
GBRT two days in advance	0.03724	0.962760	0.192976	6.36%

travel during the travel period, searching locally, such as surrounding attractions, traffic, etc. Therefore, there may be a time difference in the prediction of tourist flow from the Internet search data, so the sample is processed again. Keep the daily visitor volume of *p* scenic spots unchanged, and move forward the Baidu search data of eight keywords, that is, study the advancement of online search.

This article will study the impact of Baidu search data from one day in advance to seven days in advance on the forecast of *p* scenic spots and use the gradient boosting regression (GBRT) with the best prediction effect in Section 5 for fitting. The regression evaluation indicators are shown in Table 4. Using RMSE as the main evaluation index, it can be found that Baidu search data two days in advance, three days in advance, and four days in advance can effectively improve the accuracy of the model. Among them, the accuracy of Baidu search data two days in advance is the best. In the GBRT regression model, using Baidu search data two days in advance can reduce RMSE by 6.36%. The RMSE changes are shown in Figure 8. The changes in RMSE reflect the decision-making process of tourists from the side. Most people will conduct corresponding online searches for destinations before they travel, mainly in the two or three days before travel, with more searches conducted two days in advance.

In order to study the number of visitors to *p* scenic spots based on web search data, the SVR algorithm model and GBRT algorithm model are used to fit and predict the number of visitors to *p* scenic spots, combined with web search data. In the SVR study, the linear kernel function, polynomial kernel function, and Gaussian kernel function were selected to fit and predict the samples. It can be found that the performance of support vector regression is related to the choice of kernel function. Among them, the Gaussian kernel function reaches 74%, and the RMSE is 0. 506183, the goodness of fit is the best, and the prediction effect is the best among the three kernel functions. The overall prediction trend is close to the true value, but even if it is the Gaussian kernel function with the best fit among the three kernel functions, it is in the fitting. It is not as good as the AR model. In the GBRT study, the gradient boosting regression algorithm was used to predict the fitting of samples, and the goodness of fit R^2 reached 95%, and the RMSE was 0.211645, the overall trend is similar to the true value, it has better performance at each volatility turning point, and accurate predictions are made at the two peaks. Comparing

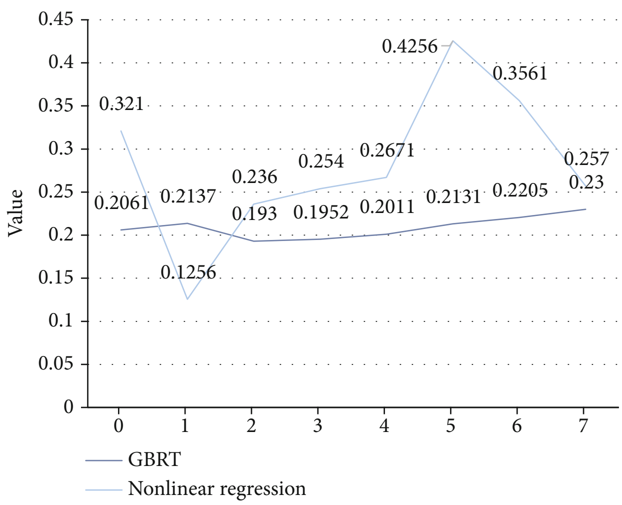

FIGURE 8: RMSE change chart.

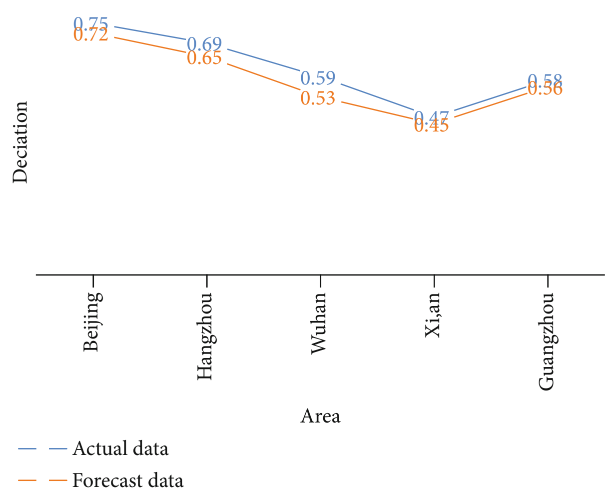

FIGURE 9: 2019 reality and forecast.

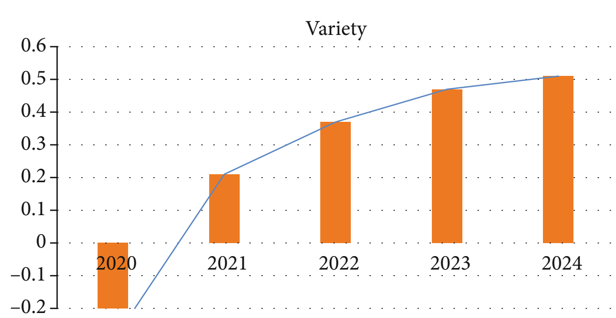

FIGURE 10: East Asian economic changes in the next four years.

the three prediction methods, the GBRT model added to the network search data has the best goodness of fit and the best prediction performance.

4.3. Data Comparison Deviation and Prediction of Wireless Sensor Network. In this paper, the comparison is obvious. The actual data in 2019 and the output data of the nonlinear support vector machine are selected for comparison. The results are shown in Figure 9.

It can be seen from Figure 9 that there is an error between the predicted result of the nonlinear model of the wireless sensor network and the actual result. The error value is about 8%-9%. This is because there are too many factors affecting the economy, even nonlinear. The wireless sensor network of this model does not need too much data in the calculation, and it will also cause certain errors. However, from the results, the error value is within an acceptable range. It can be seen that the prediction results of this model can be used as a relevant reference.

This paper uses the nonlinear model of wireless sensor networks to predict the economic changes in East Asia in the next four years. The specific results are shown in Figure 10.

As can be seen from Figure 10, through the prediction of the nonlinear model, the overall economy of East Asia will shrink in 2020 due to the epidemic and other reasons but will begin to show a steady growth trend in 2021, which shows that the overall forecasting model is about the future development situation. Optimistically, although the forecast model still has shortcomings and errors, the forecast results still have a certain reference value.

5. Conclusions

The dimensions of the indicators in the sample data may be inconsistent. If the data is not normalized, the influence of the smaller data value on the result will be affected by the larger data value, so the calculated result may be realistic; there is a certain deviation in the situation. The normalization of data is a basic work of data mining. After the raw data is processed through data standardization, the indicators are at the same level, so that the results obtained by comparative evaluation are more in line with the objective reality.

As an important component and technical support of the Internet of Things, wireless sensor networks have attracted more and more attention to their security issues. The wireless sensor network is different from the wired network; because of its protocol diversity and network dynamics, network security is greatly threatened. The existing wireless sensor network security detection system has neither formalized analysis of protocols nor in-depth research on attack types. This makes the types of attacks detected not comprehensive enough, and the reliability of the detection effect is poor. For an innovative nonlinear research method of evaluation results, future research can consider using other calculation methods and models to analyze indicator data, which will help to understand the level of regional economic development more deeply and accurately and help analyze the impact and contribution of a specific single indicator to the overall result, so as to make the evaluation results more effective and accurate and improve the value of research and application.

The nonlinear model based on wireless sensor networks is used to predict the overall economy, and the results have a certain value, but the relevant data still needs to be strictly screened to ensure data quality, so that the results can more restore the actual situation. In the future, wireless sensor networks will have more and more applications in economic forecasting and will play a greater role.

Data Availability

No data were used to support this study.

Conflicts of Interest

The authors declare that there is no conflict of interest with any financial organizations regarding the material reported in this manuscript.

References

[1] F. Lu, L. Hua, L. Yanzhong, and L. Lingyan, "Research on fault diagnosis method based on support vector machine," *New Industrialization*, vol. 3, no. 4, pp. 34–39, 2015.

[2] W. Ning, X. Min, D. Jialiang et al., "Mid- and long-term cooling load forecasting based on support vector machine regression combined model," *Power System Protection and Control*, vol. 44, no. 3, pp. 92–97, 2016.

[3] X. Bai, N. Peng, M. Gang, W. Ji, and T. Li, "Spatial load forecasting method based on multi-level cluster analysis and support vector machine," *Automation of Electric Power Systems*, vol. 39, no. 12, pp. 56–61, 2015.

[4] L. Xiao, X. Wang, and Y. Zheng, "Short-term wind power load forecasting based on improved least squares support vector machine and forecast error correction," *Power System Protection and Control*, vol. 21, no. 11, pp. 69–75, 2015.

[5] M. Xie, J. Deng, X. Ji, and M. Liu, "Support vector machine cooling load forecasting method based on information entropy and variable precision rough set optimization," *Power System Technology*, vol. 41, no. 1, pp. 210–214, 2017.

[6] F. Xiao, "Multi-sensor data fusion based on the belief divergence measure of evidences and the belief entropy," *Information Fusion*, vol. 46, pp. 23–32, 2019.

[7] F. Xingjie, Z. Zhiwei, and S. Jinchuan, "Text sentiment analysis based on convolutional neural network and attention model," *Application Research of Computers*, vol. 35, no. 5, pp. 1434–1436, 2018.

[8] L. Ying and S. Naiqiu, "Transformer fault diagnosis based on fuzzy clustering and complete binary tree support vector machine," *Transactions of the China Electrotechnical Society*, vol. 31, no. 4, pp. 64–70, 2016.

[9] D. Yuanhang, C. Lei, Z. Weiling, M. Yong, and L. Wenfeng, "Power system transient stability assessment based on multi-support vector machine synthesis," *Proceedings of the CSEE*, vol. 36, no. 5, pp. 1173–1180, 2016.

[10] L. Hongshuang and Z. Lu, "Support vector machine response surface method for structural reliability analysis," *Railway Technical Supervision*, vol. 26, no. 2, pp. 199–203, 2016.

[11] Y. Wu, Z. Yang, and L. Yunlin, "Small target detection in hyperspectral remote sensing image based on adaptive parameter support vector machine," *Acta Optica Sinica*, vol. 21, no. 9, pp. 330–339, 2015.

[12] Y. Zhang, Z. Cheng, Z. Xu, and J. Bai, "Application of parameter optimization support vector machine in transformer fault diagnosis based on photoacoustic spectroscopy," *Spectroscopy and Spectral Analysis*, vol. 35, no. 1, pp. 10–13, 2015.

[13] K. Wang, G. Shaoqing, and L. Wang, "Wind power joint forecast modeling based on fuzzy information granulation and least square support vector machine," *Power System Protection and Control*, vol. 3, no. 2, pp. 26–32, 2015.

[14] M. Zhou, Y. Wang, Z. Tian, Y. Lian, Y. Wang, and B. Wang, "Calibrated data simplification for energy-efficient location sensing in Internet of Things," *IEEE Internet of Things Journal.*, vol. 6, no. 4, pp. 6125–6133, 2019.

[15] Z. Wang, S. Jiajun, Z. Yu, and Y. Bu, "Overview of remote sensing image classification research based on support vector machines," *Computer Science*, vol. 43, no. 9, pp. 11–17, 2016, 31.

[16] Z. Weizheng, L. Yongli, and Y. Chuang, "Fault diagnosis of high voltage circuit breaker based on least squares support vector machine," *High Voltage Apparatus*, vol. 13, no. 12, pp. 79–83, 2015.

[17] D. Yang and C. Guowei, "Wind farm short-term wind speed prediction based on discrete empirical mode decomposition and least square support vector machine," *Journal of Northeast Electric Power University*, vol. 21, no. 3, pp. 44–49, 2015.

[18] L. Qiong and C. Li, "An improved support vector machine text classification method," *Computer Technology and Development*, vol. 36, no. 5, pp. 78–82, 2015.

[19] Y. Wang, Y. Weiping, Y. Zhu et al., "Multi-objective combustion optimization of 300 MW unit boilers based on support vector machine theory and genetic algorithm," *Thermal Power Generation*, vol. 21, no. 10, pp. 91–96, 2015.

[20] D. Wang, S. Xiaoxia, and Y. Jiaoying, "A comparative study of support vector machines with different kernel functions for air conditioning load forecasting," *Transactions of the China Electrotechnical Society*, vol. 32, no. 5, pp. 531–535, 2015.

[21] N. Zhang, N. Cheng, A. T. Gamage, K. Zhang, J. W. Mark, and X. Shen, "Cloud assisted HetNets toward 5G wireless networks," *in IEEE Communications Magazine*, vol. 53, no. 6, pp. 59–65, 2015.

[22] C. Wang and L. Zhiwei, "Using support vector machine model combining height and monocular image features to identify weeds," *Transactions of the Chinese Society of Agricultural Engineering*, vol. 47, no. 15, pp. 165–174, 2016.

[23] W. Li, M. Gong, J. Li, Y. Wang, and S. Lu, "2016-2017 China's macroeconomic forecast and analysis," *Journal of Xiamen University*, vol. 235, no. 3, pp. 5–13, 2016.

[24] S. Zhi and Z. Qi, "Overview of socio-economic forecast based on internet big data," *Information Magazine*, vol. 2, no. 7, pp. 18–21, 2015.

[25] Y. Yang and L. Shaoyuan, "Economical predictive control of global optimal operation of switched nonlinear systems," *Acta Automatica Sinica*, vol. 43, no. 6, pp. 1017–1027, 2017.

[26] J. Dong, "Based on the analysis of economic forecasts and financial statistics of the People's Bank of China in the "big data" era," *Digital User*, vol. 25, no. 14, pp. 60–62, 2019.

[27] S. Namasudra and P. Roy, "Ppbac: popularity based access control model for cloud computing," *Journal of Organizational and End User Computing*, vol. 30, no. 4, pp. 14–31, 2018.

[28] H. Zhao, J. Shen, and Y. Li, "Research on robust stability of multi-objective economic predictive control algorithm for uncertain nonlinear systems," vol. 3, no. 6, pp. 101–103, 2017.

[29] P. Wu and H. Hu, “The construction of China's financial risk index FRI and the test of economic forecasts,” *Statistics and Decision*, vol. 13, no. 2, pp. 120–123, 2016.

[30] W. Wang, “Fuzzy statistical theory and its application in economic forecasting and decision-making,” *Global Markets*, vol. 13, no. 14, pp. 24–24, 2015.