

Research Article

A New Model of Environmental-Economic Coordination Prediction Using Credible Neural Network Integration and Big Data Analysis

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Currently, a significant portion of sustained economic growth still depends on a high input of resources. We must fully understand the significance, difficulty, and long-term nature of resource conservation and environmental protection. We must also intensify our efforts to protect the ecological environment. We must gradually form a production mode, lifestyle, and consumption mode conducive to environmental protection. We must also establish a benign interactive relationship with the environment. This study offers a big data analysis and neural network integration optimization design strategy for a new kind of environmental and economic coordination prediction model. The data of the new type of environmental and economic impact with numerous parameters are preprocessed using big data analysis and principal component analysis. A neural network integration system is used to create the prediction model, and prediction research and error analysis are conducted to enhance the new kind of environmental and economic model. The simulation test analysis is completed lastly. According to the simulation findings, the proposed arithmetic has an accuracy that is 8.56% higher than that of the conventional arithmetic. A sustainable improvement management system with environmental objectives, environmental management planning plans, and environmental monitoring systems can be established with help from the new environmental and economic coordination prediction model, which can also assist in predicting the potential environmental impact caused by economic development activities. This will ensure sustainable development as a result of the mechanism.

1. Introduction

With the development of social productivity, while human's ability to use and transform nature to obtain material means of life has increased significantly, the pollution and damage to the ecological environment are also increasing, and the coordination between environment and economy is decreasing [1]. Economic growth and environmental protection are consistent in objectives and interact with each other. Therefore, while economic growth is required, attention should also be paid to the coordination of environmental protection. Environment, an economic system, is a complex system [2, 3]. Four categories can be used to group its components together: population, resources (environment), economics, and technology. The human system, which

serves as the core of economics, technology, and environment, has been buried in the three systems, while the environmental system serves as the foundation and the economic system as the major body. The technical system acts as an intermediary between the two. The environment economy system's four primary processes are the circulation of materials, the flow of energy, the transmission of information, and the multiplication of value. The production and reproduction of contemporary society fall within the environmental economy definition of production and reproduction. The total optimization of the environmental-economic system, or the coordinated growth of the environment and economy, must be ensured while pursuing the value multiplication of the environmental-economic system [4]. The goal of the economy-environment coordination

degree is to quantitatively define the degree of connection between the level of regional economic development and the regional environmental carrying capacity at a given stage of economic development. By examining the coordination degree intervals of multiple regions, multiple periods, and various economic development stages, the significance of the research on the degree of economy and environment coordination is to attempt to identify the regular characteristics of the evolution between economy and environment in order to provide reference standards for the development of each region. Theoretically, it can be proved that there is an optimal coscheduling between economy and environment, and the optimal coscheduling is the best combination state of economy and environment that adapts to the stage of regional economic development [5, 6].

Big data can assist people in overcoming sample collection method constraints and realising the collection of all samples, all-weather, all-scene, and all-around data, thereby assisting in improving the predictive capability of economic and social operation entities. Traditional statistics, on the other hand, is primarily based on limited statistical sample data. The new environmental and economic coordination forecast is a significant and intricate piece of work that can give the government, businesses, and other relevant departments a scientific foundation on which to understand future economic operation, assess the pace of development, and create development strategies. However, the model prediction cannot be completed with just large data analysis. In order to improve the structure of the model, it must incorporate some mathematical operations. The goal of neural network integration is to learn the same problem using a small number of neural networks (or other learning systems), and the output of each neural network that makes up the integration under a given input example determines the integration's output under that example. By training numerous neural networks and combining their findings, neural network integration can considerably increase a neural network system's capacity for generalisation. Given the benefits of neural network integration, this research uses the BPNN (back propagation neural network) method to lower the cost of arithmetic execution during neural network integration.

Sustainable development is the active regulation and control of the environment, economy, and society as a whole so that humanity can advance economic progress without going beyond the resource and environmental carrying capacities. To protect the sustainable use of resources and improve the development of living standards, we should not only meet the needs of contemporary people but also not endanger the needs of future generations. It not only meets the needs of people in one region or one country but also does not harm the needs of people in other regions or countries [7]. The human being is a creation of the environment. The process of continuously receiving survival information from the natural environment system in which they exist constitutes the core of human economic activity. It uses the natural environment as the initial stimulus, the medium for delivery, and the setting for the outcome. It falls under the area of interactions between people and the

environment. Therefore, economic system and environmental system are unified, and there are many nonlinear coupling relationships [8]. Only by coordinating the relationship between economy and environment can we realize the harmony between human and environment and the sustainable economic activities. The novel environmental and economic coordination prediction model's feature reconstruction model for the optimum design picture is established in this work. Principal component analysis preprocesses the data. The enhanced BPNN math is used to test the prediction model's accuracy, and the fuzzy characteristic of the new environmental and economic impact variables is extracted. It is innovative in the following:

- (1) In this paper, the BPNN method in neural network integration is used to reduce the execution cost of the arithmetic.
- (2) The big data analysis technology is used to realize the optimised design and identification of the new environmental and economic coordination prediction model in this paper. The key feature quantity of the optimised design image of the new environmental and economic coordination prediction model is constructed.

2. Related Work

Sustainable development has rich theoretical connotation, but when evaluating the sustainable development level of a region, it needs a specific and feasible evaluation statistical index system as a comparative analysis tool [9]. From a macropoint of view, from county and town to province and country, only each level has achieved sustainable development, and the sustainable development of the whole society can be achieved. Therefore, the study of regional sustainable development has high practical significance [10].

Hosseini et al. applied the system method to the analysis of the correlation between environment and economy and proposed the welfare type economic development, i.e., the "spaceship theory," which uses the circular economic system to replace the original linear production mode [11]. The development model of steady-state economy proposed by Varela Santos et al. is discussed from the perspective that economic growth is constrained by environmental resources. It is proposed that the economic structure changes are less and less dependent on scarce resources. As long as the input level in the economy is equal to the external input, the resources can reach the optimal utilization rate [12]. Liu et al. compared the commonly used models by studying the relationship between population, consumption, production and other factors and the environment and found that the basic core and structure of each model are roughly the same [13]. Ifaei et al. pointed out that "sustainable development" is the fundamental principle to solve the environment and development [14]. Zhou put forward the slogan of "human beings want to survive, the Earth needs to be saved, and the environment and development must be coordinated," putting the environment and human development on the agenda, reflecting the emphasis on the

sustainable development of environmental economy [15]. The system of economy-environment development is proposed by Zhang et al. The various models established by the system include the organic combination of the intrinsic and extrinsic nature of the economy. Its analysis has a predictable effect on the changes of the natural environment and can be considered as a specific factor for the endogenous growth based on environmental factors [16]. Li et al. put forward the definition of the connotation of green development, that is, taking coping with climate change and resource and environmental protection as the logical destination, and mainly emphasized that in the process of economic development, we should pay attention to greenhouse gas emission reduction and strengthen resource and environmental protection [17]. The indicator system of regional comprehensive social and economic development strength of Wang et al. clearly puts forward the connotation of comprehensive social and economic strength of provinces (cities and districts) and gives a set of evaluation indicator system and evaluation methods based on quantitative analysis and combining qualitative analysis and quantitative judgment [18]. Ghosal et al. established a relatively complete sustainable development indicator system and used the multiobjective linear weighting function model to conduct a systematic comprehensive evaluation of the regional sustainable development process for the first time [19]. Mojid et al. used the concept of resource carrying capacity to improve the national sustainable development evaluation index system, used five indicators such as resource carrying capacity to determine the regional sustainable development capacity, and used indicators such as resource abundance to determine the sustainable development status [20].

Few qualitative indicators that reflect the system and policies may be found in the assessment index system of the coordinated development of environment and economy at home and abroad. Even while quantitative indicators are helpful for demonstration, the index system of qualitative indicators for normative research is lacking, and it is also important to talk about how thorough and objective the evaluation results were. This study offers a big data analysis and neural network integration optimization design strategy for a new environmental and economic coordination prediction model. New environmental and economic data are processed, the model is checked for errors, and the prediction model is improved in terms of accuracy and real-time detection, making the model prediction more scientific. This is done using big data analysis and neural network integration.

3. Methodology

3.1. Real-Time Monitoring of the New Environmental and Economic Coordination Model Using Big Data Analysis. The environmental and economic composite system is composed of the environmental system and the economic system. The population and the scientific and technological system are the ties and intermediaries between the two. Through a series of economic and living activities, the

economic system and the environmental system are closely linked [21]. The three systems of environment, economy, population, and science and technology are interconnected, influenced, and restricted by each other. They are combined to realize the overall function of the system and promote the coordinated development of the composite system. According to the relationship between the subsystems of the environmental-economic system, the structural diagram of the environmental-economic composite system is drawn, as shown in Figure 1.

As a common arithmetic for data analysis, principal component analysis transforms multiple related variables into a few unrelated comprehensive indicators, simplifies data, eliminates redundancy, and still accurately reflects the original information.

The principal component analysis method realizes replacing the original variables with a few new comprehensive indicators. Instead of directly removing some variables from the original variables, it selects a few new indicators that can comprehensively reflect important information through data processing. The new indicators are called principal components, and there is no correlation and information overlap between the principal components. Multivariable problems occur from time to time. For example, it is necessary to understand more than ten basic indicators such as height, chest circumference, and waist circumference when making a coat. However, in the process of clothing sales, the size selection is usually based on three indicators that reflect the length, fat and thin, and characteristics. This is the meaning of the principal component analysis method, so as to simplify the data structure and describe the information in a more concise and comprehensive manner. Principal component analysis aims to use the idea of dimension reduction to realize the transformation of spatial coordinates and to process the original interrelated information to represent the effective information in a new form independent of each other. Now, the operation steps of principal component analysis are analyzed in depth. Assuming that x_1, x_2, \dots, x_p is the original variable index, there are n samples, forming a $n \times p$ order data matrix:

$$X = \begin{bmatrix} x_{11}, x_{12}, \dots, x_{1p} \\ x_{21}, x_{22}, \dots, x_{2p} \\ \dots \dots \dots \\ x_{n1}, x_{n2}, \dots, x_{np} \end{bmatrix}. \quad (1)$$

The above original variable data are subjected to the principal component analysis, and the precise procedure is as follows:

- (1) The original data were normalized and transformed into effective data between $[0, 1]$.
- (2) A sample correlation matrix is made by computing it.

First, the correlation coefficient between the original information variables needs to be calculated by the following formula:

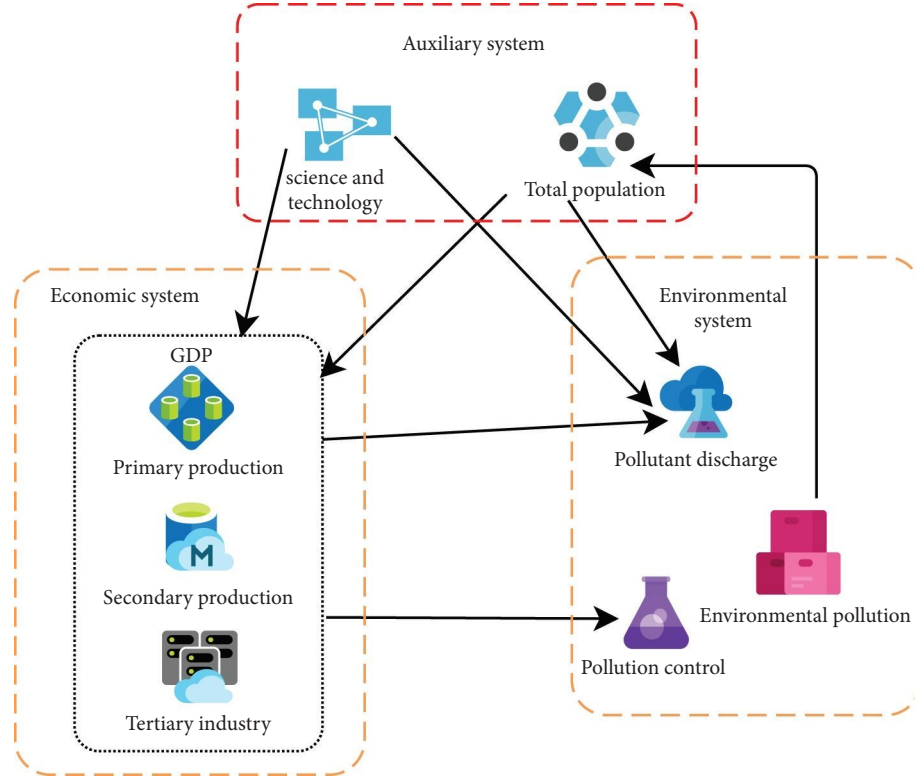


FIGURE 1: Structure of environmental-economic system.

$$r_{ij} = \frac{\sum_{k=1}^n (x_{ki} - \bar{x}_i)(x_{kj} - \bar{x}_j)}{\sqrt{\sum_{k=1}^n (x_{ki} - \bar{x}_i)^2 \sum_{k=1}^n (x_{kj} - \bar{x}_j)^2}} \quad (2)$$

where r_{ij} ($i, j = 1, 2, \dots, p$) is the correlation coefficient between variables x_i and x_j . On this basis, the sample correlation matrix is calculated by the following formula:

$$R = \begin{bmatrix} r_{11} & r_{12} & \dots & r_{1p} \\ r_{21} & r_{22} & \dots & r_{2p} \\ \dots & \dots & \dots & \dots \\ r_{n1} & r_{n2} & \dots & r_{np} \end{bmatrix}. \quad (3)$$

- (3) The eigenvalue is found. The characteristic equation $|\lambda I - R| = 0$ is established and the characteristic value λ_i ($i = 1, 2, \dots, p$) is obtained. A large number of mathematical experiments have proved that the finally selected principal component corresponds to the larger one of the eigenvalues. Therefore, after obtaining the features, it is necessary to sort them in the order from large to small to ensure $\lambda_1 \geq \lambda_2 \geq \dots, \lambda_p \geq 0$. The eigenvalue solution of covariance matrix is the most important in the process of principal component analysis.
- (4) The contribution rates are calculated for the major and cumulative components. The number of principle components that were ultimately chosen must be determined before creating a new comprehensive indicator sample set. The threshold value for the

cumulative contribution rate of the primary components, which is typically set to 85%, is normally the approach that is used for selection.

- (ii) The calculation formula of each principal component contribution rate PV_i is as follows:

$$PV_i = \frac{\lambda_i}{\sum_{k=1}^p \lambda_k}. \quad (4)$$

The calculation formula of principal component cumulative contribution rate APV_m is as follows:

$$APV_m = \frac{\sum_{k=1}^m \lambda_k}{\sum_{k=1}^p \lambda_k}. \quad (5)$$

- (5) A new sample matrix is constructed. Note z_1, z_2, \dots, z_m is a new variable index, and m principal component components are calculated according to the following formula:

$$\begin{cases} z_1 = a_{11}x_1 + a_{12}x_2 + \dots + a_{1p}x_p \\ z_2 = a_{21}x_1 + a_{22}x_2 + \dots + a_{2p}x_p \\ \dots \\ z_m = a_{m1}x_1 + a_{m2}x_2 + \dots + a_{mp}x_p \end{cases}. \quad (6)$$

3.2. Prediction Model Optimization Using Credible Neural Network Integration. The goal of coordinated regulation and control of environment economy system is sustainable development in essence, which can be divided into two aspects.

The first aspect is to achieve rapid economic development on the basis of ensuring good environmental quality and avoiding serious environmental pollution and ecological problems. The second aspect is to reduce the damage to resources and ecology, reduce pollution emissions, and maintain good natural environment quality while the production continues to grow.

In recent years, a lot of research has been done on economic prediction at home and abroad, and many prediction methods have been proposed. Among them, neural network is considered to be a better nonlinear prediction method, especially BPNN.

BPNN can be used to fit any complex nonlinear relationship. The operation process of the whole network model can be expressed by the nonlinear mapping relationship shown in the following formula:

$$F: R^{N_1} \longrightarrow R^{N_3}, G = F(H), \quad (7)$$

where H is the input sample, G is the output, N_1 is the number of input nodes, and N_3 is the number of output nodes. The BPNN arithmetic takes the least square method as the basic idea and adopts the gradient descent method to continuously update the weight and threshold along the negative gradient direction of the error target until the error meets the target requirements. In essence, it is a process of parameter optimization. A multilayer network model is established by means of supervised learning. In the process of network learning, some learning rules are used to adjust and modify the connection weights while the error is back propagated. The connection weights between the network neurons of each layer are modified by the learning process.

The input layer, hidden layer, and output layer make up the BPNN model. While the concealed layer might be single or multilayered, the input and output layers are both single layers. Figure 2 depicts the BPNN's construction, which includes numerous buried layers.

The creation of individual networks and the integration of the outputs of many neural networks are the two main problems involved in credible neural network integration.

Each neural network is given a weight of k_T to meet the following requirements:

$$k_T > 0, \sum_T k_T = 1. \quad (8)$$

The training set is accumulated and extracted from the distribution $p(x)$. Assuming that the output of the network T is $V^T(X)$ for the input X , the output of the neural network integration is

$$\bar{V}(X) = \sum_T k_T V^T(X). \quad (9)$$

The following is a definition of the generalisation error of credible neural networks and neural network integration:

$$\begin{aligned} E^T & \int dx p(x) (f(x) - V^T(X))^2, \\ E & \int dx p(x) (f(x) - \bar{V}(X))^2. \end{aligned} \quad (10)$$

The following is a definition of the credible neural network's difference degree:

$$A^T \int dx p(x) (V(x) - \bar{V}(X))^2. \quad (11)$$

Each network's weighted average generalisation error is expressed as follows:

$$\bar{E} = \sum_T k_T E^T. \quad (12)$$

The following are definitions for different levels of credible neural network integration:

$$\bar{A} = \sum_T k_T A^T. \quad (13)$$

The credible neural network integration generalisation error is as follows:

$$E = \bar{E} - \bar{A}. \quad (14)$$

4. Result Analysis and Discussion

Coordination refers to the mutual relationship between two or more systems or system elements that are coordinated, harmonious, consistent, and virtuous. Coordination is the guarantee for the positive development of multiple systems or elements. Development is an evolutionary process within a system, while coordination is a good cycle between systems or systems, and coordinated development is the intersection of the development and change of the two. In the process of coordinated development, development is the ultimate goal of the system movement, while coordination is the internal and external constraints on the development behavior. Coordinated development requires all elements of the system to achieve from single to complex and from disorder to order on the basis of coordination, harmony, and good circulation. The process of this coordinated development is bound to have diversified development, which is regulated and constrained by various activities, and finally promotes the realization of goals through mutual coordination.

Environmental monitoring data come from different data sources, so it is necessary to integrate data from different sources. In a database with differences, the redundancy and inconsistency of data will be affected by some attribute identification problems, and some attribute problems will be affected by the export of other attributes. Therefore, in the process of data analysis, we must solve the problem of data integration redundancy. In order to solve the problem of data redundancy, data analysis is required. In the face of two given attributes, we can judge the degree of correlation between the two attributes and whether one attribute can contain another attribute by applying analysis methods. In the face of nominal data, the chi square test can be applied to verify whether the two attributes are related.

The average minimum error of the integrated system learning training 5000 is 0.00641 and the prediction error is 0.00712. The fitting curve is shown in Figure 3.

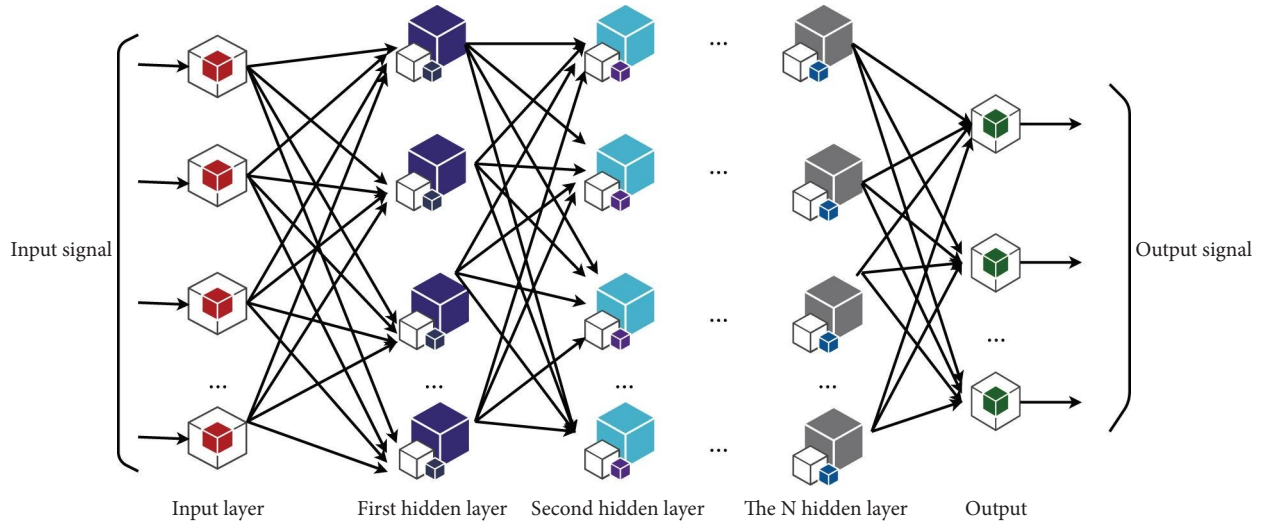


FIGURE 2: Structure of BPNN.

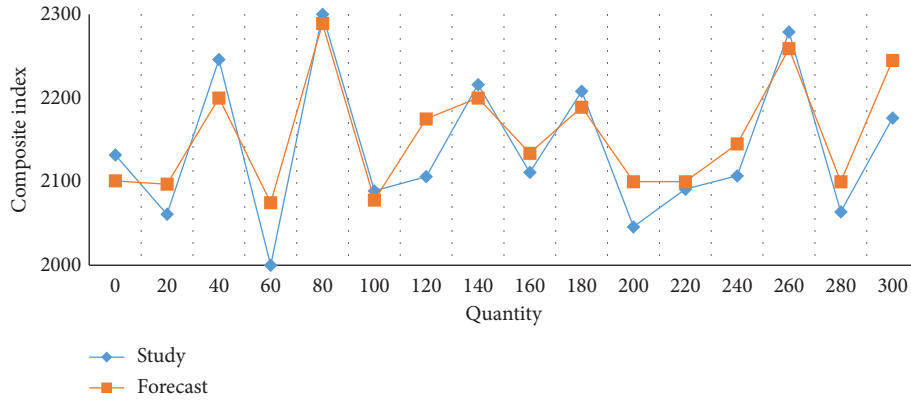


FIGURE 3: Fitting curve of integrated system.

The generalisation ability of the integrated system is higher than that of a single independent model. The integration of these models makes the new integrated system for environmental and economic coordination prediction contain more extensive input information, including basic data information, technical index information, and more economic information. This will certainly make the model more robust and more valuable. At the same time, the artificial neural network model breaks through the limitation of the target time point and provides a new way for the actual economic modeling.

When the standard BPNN performs function fitting, the training error decreases slowly until the maximum number of training steps is reached, and the network error still does not reach the target error. The comparison between the original function curve and the fitting function curve is shown in Figure 4. It can be seen that there is a certain gap between the fitting curve and the real function. Therefore, it can be inferred that the performance of the standard BPNN is poor, the network has a large error, and it is not easy to converge.

The problems of BPNN are as follows. (1) Low learning efficiency and slow convergence speed: the convergence speed is an important standard to evaluate the performance of the network. Due to its own limitations, the learning speed

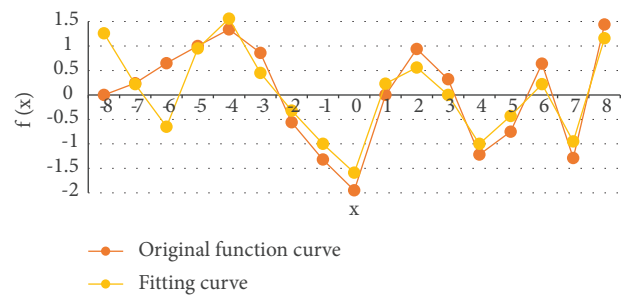


FIGURE 4: Fitting curve of standard BP network function.

of BP arithmetic is set too small to ensure that the neural network can converge. Even if it deals with simple problems, it needs thousands or even tens of thousands of times of training to meet the expected requirements. (2) It is easy to fall into local minima and miss the optimal solution. BPNN is a nonlinear optimization model. It takes gradient descent method as the learning rule and trains along the direction of continuous decline of the error function. The trajectory formed by the value of the error function is a very tortuous curved surface structure, and usually there are many

minima. (3) There are many network parameters and it is difficult to determine. The theory is not mature and can only be determined by experience. (4) It is highly dependent on samples and network structure. The convergence characteristics and approximation ability of BPNN are closely related to the selected training samples. Improper use of sample data directly reduces the effect of BPNN.

Because of its robust nonlinear approximation capability and versatility, BPNN is frequently employed in various disciplines; however, it has certain clear issues during the training phase. The most notable one is the possibility of numerous minimum points and error flat zones on the error surface. When the former occurs, the training may enter a local minimum and the network cannot converge; when the latter occurs, the weight adjustment span will get smaller, the error will decrease gradually, and the convergence speed will be too sluggish. The arithmetic structure is typically altered to optimise the network in order to apply to increasingly complicated practical issues. Among the many optimization techniques, the LM arithmetic used in this study optimises the BP network to provide it a faster convergence speed and good local convergence features, which significantly raises prediction accuracy and efficiency.

In order to verify the good performance of the improved neural network, the improved neural network is applied to the same function $f(x)$ model and the same function fitting is carried out. The network error training curve obtained through training is shown in Figure 5. It can be clearly seen that the training error decreases rapidly and reaches the target error value in Step 10. It can also be clearly seen from its function fitting (Figure 6) that the fitting function almost completely approximates the original function. It is sufficient to prove the superiority of LM-BP improved neural network, which can effectively reduce the error, improve the training speed, and improve the overall network performance.

In order to more clearly reflect the good effect of the arithmetic prediction in this paper, the BPNN prediction method, LM-BPNN prediction method, and the improved prediction method in this paper are compared and analyzed. The relative error comparison curve is shown in Figure 7.

It is easy to find that compared with the BPNN prediction method, the prediction error of the improved prediction method is greatly reduced, and the prediction error curve fluctuates around 1%, the prediction model is more stable, and the prediction accuracy is significantly higher than that of the other prediction method, which fully proves the superiority of the method. Comparing and analyzing the above two short-term load forecasting methods from different angles through numerical analysis can more comprehensively and scientifically verify the advantages and disadvantages of the methods. The comparison of the performance parameters of the two forecasting methods is shown in Table 1.

From the numerical relationship in the table, the convergence performance of the improved prediction method of LM-BPNN is significantly higher than that of the traditional

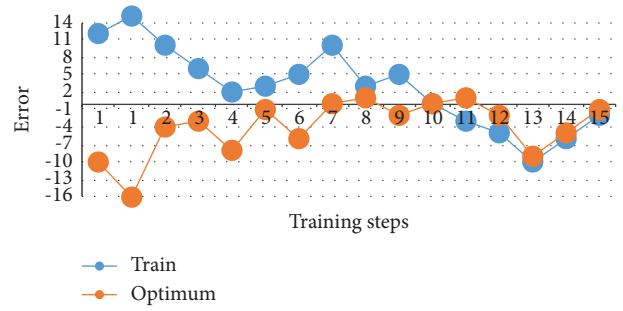


FIGURE 5: LM-BPNN training error curve.

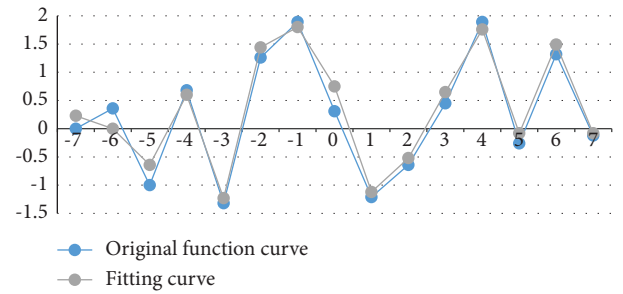


FIGURE 6: LM-BPNN fitting function curve.

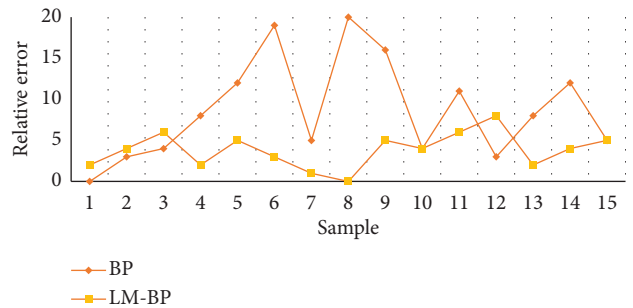


FIGURE 7: Comparison of error curves of two prediction methods.

BP network, and the prediction result is more stable and accurate. It shows that LM arithmetic successfully realizes the optimization of the defects of BPNN, effectively improves the prediction effect, and improves the prediction accuracy and prediction efficiency.

Aiming at the characteristics of data correlation and information embedding of multiparameter new environmental and economic factors, this chapter adopts the big data analysis method to preprocess the data of multiparameter new environmental and economic factors, simplify the data structure, realize the transformation from high dimension to low dimension, and eliminate the correlation between parameters. The application of the prediction model to predict the new environmental-economic data and the error analysis of the prediction results fully proves the practicability of the improved prediction arithmetic in this paper, which can effectively improve the prediction effect and improve the prediction accuracy.

TABLE 1: Comparison of performance parameters of two prediction methods.

Error index	Traditional BP prediction method	LM-BP improved prediction method
Training steps	10000	10
Mean absolute error	245.36	182.31
Mean absolute error	431.26	211.64
Average relative error	2.94	2.12
Proportion of relative error $\leq 1\%$	33.12	33.12
Proportion of relative error $\leq 3\%$	70	64.29
Proportion of relative error $\leq 5\%$	82.12	100

5. Conclusion

This study offers a big data analysis and neural network integration optimization design strategy for a new kind of environmental and economic coordination prediction model. The data of the new type of environmental and economic impact with numerous parameters are pre-processed using big data analysis and principal component analysis. A neural network integration system is used to create the prediction model, and prediction research and error analysis are conducted to enhance the new kind of environmental and economic model. The simulation test analysis is completed lastly. According to the simulation findings, the proposed arithmetic has an accuracy that is 8.56% higher than that of the conventional arithmetic. This result clearly demonstrates that the short-term load forecasting model based on LM-BP enhanced neural network is suggested to fully use BP network benefits in model forecasting research. In addition, LM arithmetic is used to mitigate its drawbacks, accelerate learning, and successfully avoid tumbling into local minima. The experiment shows that using this forecasting strategy can significantly increase predicting accuracy and performance. According to the notion of coordinated development of the environment and economy, consideration must be given to the environment's carrying capacity when developing the economy. Along with maintaining a suitable growth rate, development should pay attention to the effectiveness and quality of economic growth. High growth cannot be pursued unilaterally at the expense of resource depletion and environmental degradation. The two ought to get along well with one another. There are still many shortcomings in this paper. It is necessary to continuously study and improve the indicator system and evaluation method model and the application of the indicator system in other regions and evaluate, analyze, and compare the environmental-economic relations in other regions.

Data Availability

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

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

Acknowledgments

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