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Research Article

Macroeconomic Forecast Model System Based on Digital Information and Blockchain Technology

Lianfeng Ma [1,2]

[1]*School of Finance and Economics, Xi'an Jiaotong University, Xi'an 710061, Shaanxi, China*
[2]*Financial Department, Guangzhou Civil Aviation College, Guangzhou 510403, Guangdong, China*

Correspondence should be addressed to Lianfeng Ma; malianfeng@stu.xjtu.edu.cn

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Since the reform and opening up, China's economy has developed rapidly, becoming the second largest economy in the world. The state of macroeconomic development has a great influence on the government's policy introduction and the investment decisions of individual institutions. Therefore, forecasting the macroeconomy is of great significance to the country. This paper aims to study the macroeconomic forecasting model system based on digital information and blockchain technology. This paper proposes an artificial neural network prediction algorithm based on digital information and blockchain technology, and the artificial neural network and particle swarm algorithm are combined to become the hybrid artificial neural network algorithm, and the conception of the establishment of the macroeconomic forecast model is proposed. The experimental results of this paper show that according to the prediction results of artificial neural network, the prediction and actual error in 2010 is 0.10, while the new method proposed in this paper predicts the error of 0.056. In 2016, the prediction error based on artificial neural network was 0.14, while the prediction result of the new method proposed in this paper showed an error of 0.008. In each year's economic forecast, the neural network model of the new method proposed in this paper has higher prediction accuracy and smaller error. It can be seen that the neural network model based on artificial neural network and PSO algorithm proposed in this paper is beneficial to macroeconomic forecasting.

1. Introduction

Big data is also the product of network communication technology and is closely related to digital information resources. The development of digital information resources is rooted in the generation of big data. Big data represent the dynamic changes in the digital space constructed based on network communication technology. Digital information resources are information resources used by human society based on big data. In addition, the development index level and growth trend of digital information change with the continuous development of network information technology. Human society is closely related to the Internet environment, so the combination of the human social environment and the dynamic Internet environment can better understand the meaning of digital information resources.

With the active development of blockchain technology, more and more industries and academic groups have participated in the development and scientific research of blockchain. The blockchain community is currently receiving attention from governments, venture capital, financial institutions, and the banking industry, including early public chain projects such as Bitcoin and Ethereum. Since the intelligent constructor technology of the blockchain architecture can encode practical problems, various transactions and information exchanges can be performed automatically in strict accordance with the rules established in the network environment. This is very important to improve the sharing and exchange mechanism, and the development of blockchain technology in the financial field has also received active attention from the Chinese government.

The innovations of this paper are the following: (1) The related theoretical knowledge of digital information and blockchain technology is introduced, and the forecasting function of the macroeconomic forecasting model system is analyzed by using the forecasting method of artificial neural network. (2) Experiments and analysis of the application of the forecasting method based on the artificial neural network to the macroeconomic forecasting model system. Through investigation and analysis, it is found that the method based on the combination of artificial neural network and PSO has a stronger effect on economic forecasting and a smaller error.

2. Related Work

In various fields of society and economy, a large number of decision-making problems are inseparable from the prediction of the future value of variables or the prediction of difficult-to-observe variables. Hou discovered vector autoregressive models with infinite hidden Markov structures, motivated by forecasting in financial and macroeconomic applications. This method is an accuracy-based algorithm, which can improve the computational efficiency, and the results show that the prediction performance of the Markov switching model is better [1]. Bd et al. examines whether professional forecasters incorporate high-frequency information about credit conditions in their economic forecasts. Using a mixed data sampling regression method, he found that daily credit spreads have significant predictive power on monthly forecast revisions of output growth. This suggests that forecasters expect the impact of a credit crunch to be more pronounced during a recession [2]. Aromi evaluated the information content of indicators through business cycle forecasting exercises. He used vectors to learn meaningful economic correlations. These associations were used to construct predictors. A sample forecasting exercise shows that these indicators contain valuable information about future economic activity [3]. Broughton and Lobo found multiple biases among test analysts in forecasting the Institute for Supply Management's Manufacturing Purchasing Managers' Index (PMI). The test he employs does not require the predictor's prior information set and is robust to rational clustering, correlated prediction errors, and outliers. He also found that analysts' forecasts of PMI were poor and exhibited multiple biases in forecasting [4]. Pedersen found that part of forecasting is the judgment applied by the forecaster, and this judgment input may be affected by the forecaster's mood swings. These fluctuations have been shown to affect returns in, for example, the stock market. He analyzed the extent to which sentiment affects macroeconomic forecast errors. Evidence suggests that sentiment can influence forecasts of inflation and output growth [5]. Manski found that economists often assume that people have probabilistic expectations about uncertain events, but empirical studies measuring expectations have long been rare. He described research on three topics that macroeconomists should focus directly on: stock return expectations, inflation expectations, and professional macroeconomic forecasting [6]. Prediction itself is a predictive science, which makes it impossible to be 100% accurate. In the forecasting process, people usually idealize certain factors, but in the actual economic development process, economic indicators will be affected by various unknown factors, so the traditional general forecasting model has been unable to accurately predict the economy.

The artificial neural network prediction model only needs a part of the relevant data of the prediction object, the investment is relatively low, and the prediction result is also relatively good. In order to determine the heat transfer coefficient in the range of supercritical water pressure, Ma et al. collected 14 sets of experimental data. Based on the experimental data, a BP neural network prediction model for determining the heat transfer coefficient of supercritical water is established. The research is carried out using the BP neural network prediction model. The prediction results show that the BP neural network prediction model can be used to better predict and understand the heat transfer coefficient of supercritical water [7]. Gamidi and Ke found that different artificial neural network (ANN) models have been developed and tested for predicting eutectic properties. The model successfully predicted the corresponding melting properties of the cocrystal and the ideal solubility of the cocrystal from the molecular weight and melting temperature of the pure compound [8]. Pattnaik and Sutar study reveals a new computational prediction model to predict response, making material removal rate (MRR) more accurate. The model he developed is based on the artificial neural network (ANN) model, which overcomes the limitation of traditional artificial neural network that requires a large amount of experimental data to accurately predict the response. It can more accurately predict the response at any point in between and at selected parameter levels [9]. At present, artificial neural network prediction model has become a new and widely recognized method in prediction. In terms of application, the ANN prediction model does have certain advantages over other prediction methods.

3. Neural Network Prediction Method Based on Digital Information and Blockchain Technology

3.1. Overview of Digital Information Blockchain Technology. Digital information means that data are no longer just a link, but can realize the collusion between information and equipment, that is, microscopic digital processing. It can realize the mutual conversion of analog information and digital information and also realize the aggregation of digital information into intelligent macrodata that conform to human thinking habits. The active development of digital networks in the information age has promoted another great change in human society. With the continuous development of more convenient and advanced technologies, digital space and human society are more deeply integrated. Human beings are more and more involved in the practical activities of digital space, leaving immeasurable huge information data in social life. As the driving force of invention and service in the emerging information society, it is now

showing an active trend all over the world. The high-speed popularization channel promotes the digitization of information resources, and the popularization of digital information based on new data has achieved rapid development [10].

The leap of science and technology has provided new energy for great social changes. With the rapid development of Internet technology, information has become a new force for social change with unparalleled advantages. The great contribution of information to the economic field has led to a thorough study of information resources by scholars. After that, human's exploration of information resources began to sweep all areas of social life [11–13]. Information resources will be converted into digital form in cyberspace and developed into important digital information resources. This is a new type of resource and a further development of information resources in the information age. This not only means that the physical representation of information resources has changed, but more importantly, that the process of information generation and disappearance has changed, which means that the entire process of the information production chain has undergone qualitative changes. Various aspects of society, such as human lifestyles, business operation models, and social management models, are closely related to various forms of information.

Digital informatization is an international development trend, and all countries attach great importance to the development of digital informatization [14, 15]. Among China's "digital China," "digital healthcare" best reflects China's emphasis on digital informatization.

Blockchain technology, referred to as BT, also known as distributed ledger technology, is an Internet database technology. It is characterized by decentralization, openness, and transparency, allowing everyone to participate in database records. It was the basic technology of Bitcoin at first, and it is currently being studied all over the world, and it can be widely used in various fields such as finance. The current blockchain is divided into three types, and the three types of blockchain systems are compared as follows: The public blockchain is an architectural method of the blockchain system [16]. As shown in Figure 1:

As shown in Figure 1, the blockchain network under this architecture system does not restrict the authority of any participant. Any member participating in the blockchain network can read the information stored in the blockchain, and any member participating in the blockchain network can send transaction information, and the transaction information can be effectively confirmed. Any member participating in the blockchain network can participate in the consensus building process [17, 18]. Therefore, the public blockchain does not have a central structure that can control the entire network and is a completely decentralized new network structure [19].

Private Chains—Rights are in the hands of a few, and private blockchains are permissioned blockchains where a permissioned network places restrictions on who is allowed to participate in the network and what transactions can be made. A private blockchain is a blockchain system that is used and managed by a single organization, and the

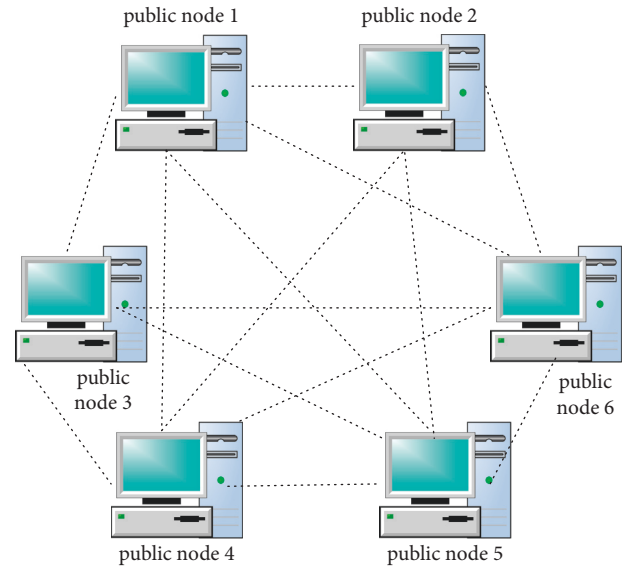

Figure 1: Public chain architecture diagram.

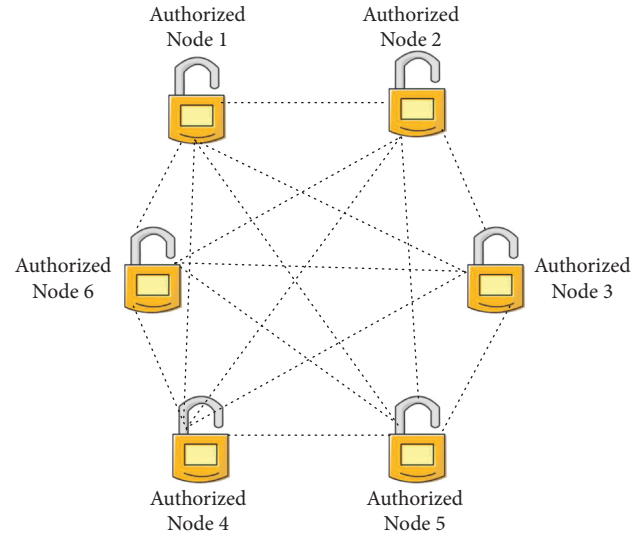

Figure 2: Private chain architecture diagram.

management organization completely controls the writing rights of the blockchain system and has the characteristics of centralization. Whether the read permission is open to the outside world is decided by the administrator of the blockchain system. Its structure is shown in Figure 2:

As shown in Figure 2, the consortium blockchain is generated, which can be understood from the groups used by the consortium chain. Their main groups are banks, insurance, securities, business associations, group companies, and upstream and downstream enterprises. Consortium blockchain refers to a blockchain whose consensus process is controlled by preselected nodes, and is a blockchain system that mixes the characteristics of private blockchains and public blockchains. Under this architecture, the writing right of the system is controlled by the organizations participating in the alliance, which has the characteristics of

multicentralization, and the reading authority of the system can be restricted by the alliance to any extent [20].

The right to write in the alliance blockchain is limited to participating in alliance organizations. Consensus decisions are generally reached through voting. Preselected nodes are set in each organization participating in the alliance to vote. Any activity that writes or modifies the data stored in the block requires a certain number of votes to be considered legitimate activity. The participation and complexity of this consensus system are in the middle, and consensus decision-making is faster than that of public blockchains, but it is not as good as private blockchains, and the overall efficiency of the system is higher [21]. As shown in Figure 3:

As shown in Figure 3, the development of blockchain technology is the embodiment of realizing the value of Internet popularization, and it is also a new model for building reliable scenarios of network peers [22–24]. At the time of writing this article, many chain applications like mushrooms have appeared, completing the construction of reliable systems combined with the advantages of traditional industries. It can be assumed that new applications incorporating blockchain will increase and will appear in the industry in the future [25].

3.2. Macroeconomic Model

3.2.1. Vector Autoregressive Model. The vector autoregressive model, referred to as the VAR model, is a commonly used econometric model. The construction model of vector autoregression improves the accuracy of economic forecasting. The model does not need to be established according to economic theory, and it mainly combines all current variables, regresses some delayed variables of all variables, and excludes the possibility of wrong prediction results based on wrong economic theory [26]. The autoregressive model has many advantages, it has no limitation, every variable in the model can be regarded as an internal dependent variable. This is often used to deal with analysis and forecasting of multiple relevant economic indicators.

However, the vector autoregressive model also has some shortcomings, because the relationship between the model variables does not give the exact form of the current period. In addition, the model does not consider economic theory, so it cannot do policy analysis and policy simulation [27].

3.2.2. Computable General Equilibrium Model (CGE) Horizontal Type. As a powerful tool for policy analysis, CGE model has been widely used in the world after more than 30 years of development and has gradually developed into a branch of applied economics. The CGE model is a powerful tool for analyzing the impact of policy changes on the economy and is often used to analyze the impact of changes in taxation, public spending, and tariffs on industrial structure, labor market, income distribution, etc. By establishing the relationship between various economic variables, the disturbance of a certain factor to the economy is easier to predict [28]. However, the model also has certain limitations, because the model assumes that policy changes will not affect unemployment and capital levels, technological progress rates, and competition among firms. The model itself does not provide a valuable predictive tool. On the other hand, the data required by the model are more complex, and it is not easy to obtain in some cases, which limits the application of the model in some data-deficient fields.

3.3. Neural Network Prediction Method. The production, distribution, exchange, and consumption activities carried out by individuals, households, and enterprises in the macroeconomy are the microeconomy. The macroeconomy is still based on a single microeconomic subject as the basic unit. Whether the macroeconomic forecast results can truly reflect the economic development trend mainly depends on the economic theorizing and the economic models and methods used. At present, many prediction models and methods have been proposed by the academic community, and new theories, methods, and models are constantly improving. Although the development of China's macroeconomic forecasting started relatively late, there have been many kinds of scientific macroeconomic forecasting methods and models suitable for China's socialist market economy [29].

With the rapid development of neural network, the field of application is getting wider and wider, and the ability to solve practical problems is getting stronger and stronger. This is determined by the excellent performance of the neural network and its important role in the national economy. Prediction based on neural network is an application research that uses the network model of neural network to analyze and predict and is applied to the actual prediction environment. Neurons are neuron cells, which are the most basic structural and functional units of the nervous system. It is divided into two parts, the cell body and the protrusion. The basic structure model of neurons is shown in Figure 4:

As shown in Figure 4, this is a multiinput, single-output nonlinear element, and its input–output relationship can be simplified as formula (1):

$$I_i = \sum_{j=1}^{n} w_{ji} a_j - b_i. \tag{1}$$

Among them, a_j $(j = 1, 2, \ldots, n)$ is the input signal from other cells, b_i is the bias of the neuron, and b_i is the formula (2):

$$b_i = f(I_i). \tag{2}$$

I_i is the neuron output, $f(\cdot)$ is called the transfer function, sometimes called the excitation or excitation function, the transfer function can be a linear function. But usually nonlinear functions, such as excitation functions or signaling curves. A linear function is another name for a linear function, and a nonlinear function, that is, the function image, is not a function of a straight line. Nonlinear functions include exponential functions, power functions, logarithmic functions, polynomial functions, and the like.

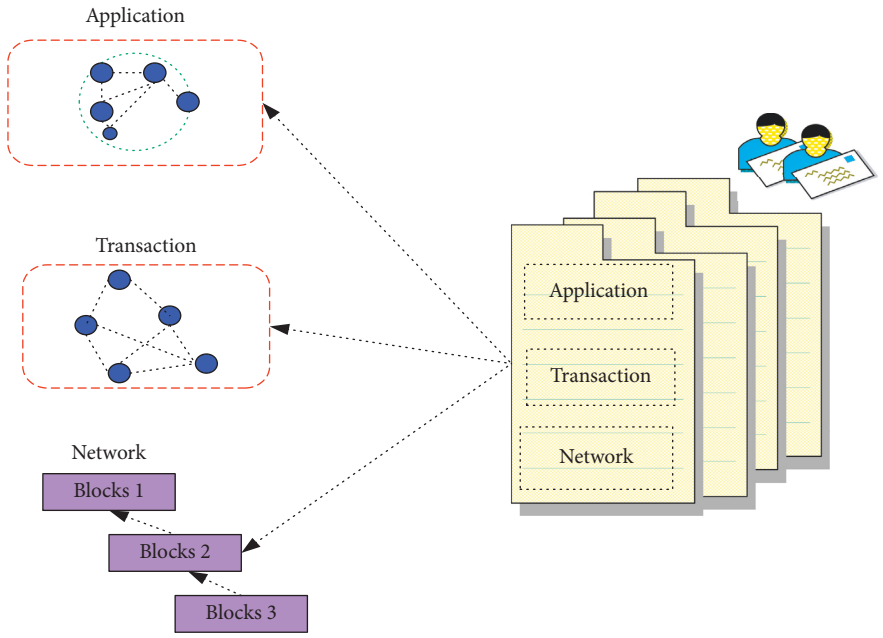

Figure 3: Blockchain 2.0 and smart contract architecture.

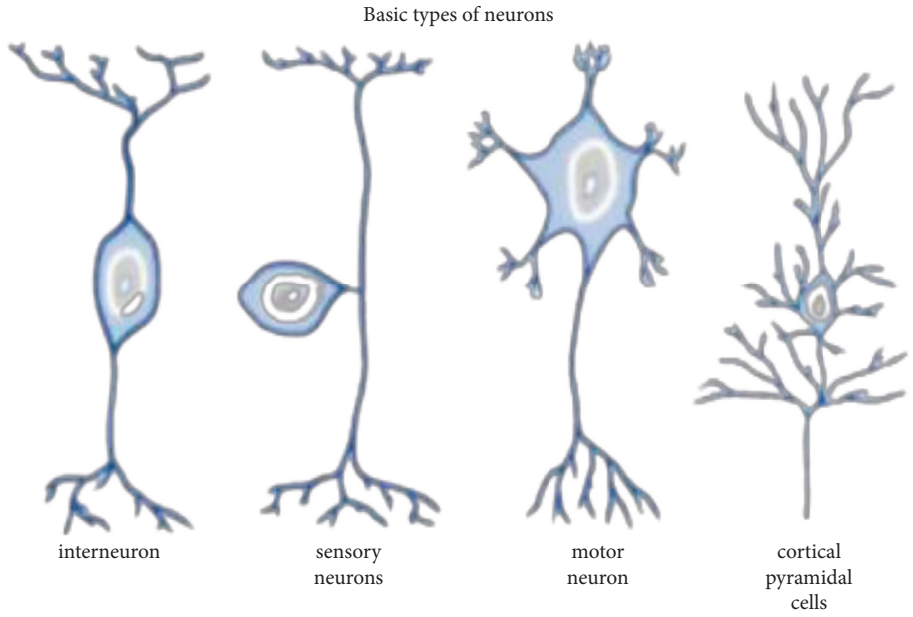

Figure 4: Basic structural model of neurons.

The nonlinear function of the commonly used neuron is shown in Figure 5:

As shown in Figure 5, threshold function: when b_i is 0 or 1, $f(a)$ is a step function, which is formula (3):

$$f(a) = \begin{cases} 1, a \geq 0, \\ 0, a < 0. \end{cases} \tag{3}$$

The sigmoid function is a common sigmoid function in biology also known as the sigmoid growth curve. In information science, the sigmoid function is often used as the activation function of neural network due to its monoincreasing and inverse-function monoincreasing properties. Sigmoid function is the most commonly used excitation function in artificial neural networks, which are usually represented by the class of sigmoid curves, is formula (4):

$$f(a) = \frac{1}{1 + \exp(-ax)}. \tag{4}$$

When $f(a)$ tends to infinity, the sigmoid curve tends to a step function, usually a value is 1. In this paper, the

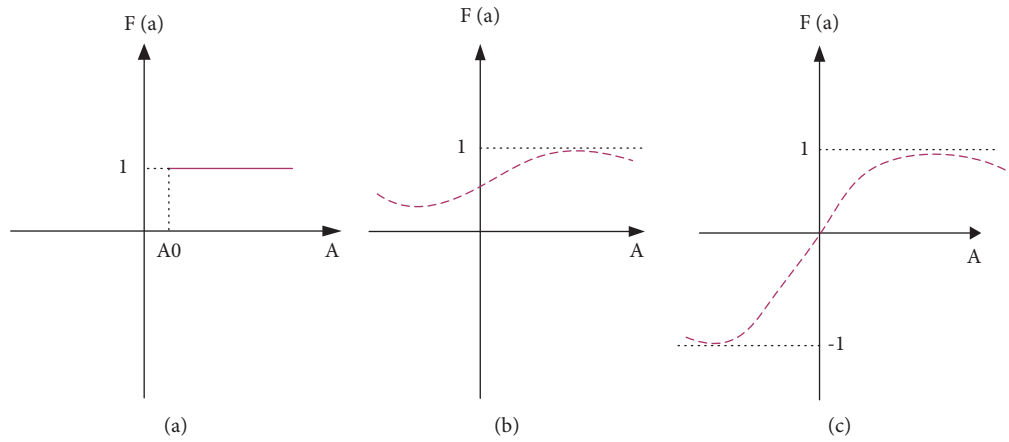

Figure 5: Some excitation functions in neurons.

excitation function of the following form will be used, which is formula (5):

$$f(a) = \frac{1 - \exp(-ax)}{1 + \exp(-ax)}, -1 \prec f(a) \prec 1. \tag{5}$$

The function has the characteristics of continuous derivation, the definition domain is $(-\infty, +\infty)$, and the value domain is $(-1, +1)$. One gets a sigmoid function with different slopes. Assuming that the BP network has a total of L layers, for a given P samples, the expected output of the network is formula (6):

$$T_d = \left[T_{d1}, T_{d2}, \ldots, T_{dp}\right]. \tag{6}$$

When the P-th sample is input, the operating characteristic for the j-th neuron in the L-th layer in the network is formula (7):

$$net_{jp}^{(l)} = \sum_{i=1}^{n_{l-1}} w_{ji}^{(l)} o_{ji}^{(l)} - \theta_j^l. \tag{7}$$

Among them, $w_{ji}^{(l)}$ is the connection weight from neuron i to neuron j, and there is formula (8) for the output layer:

$$o_{ji}^{(l)} = f_l\left(net_{jp}^l\right). \tag{8}$$

f_l is a nonlinear differentiable and nondecreasing function, which is generally taken as an S-shaped function, that is, formula (9):

$$f_l(a) = \frac{1}{1 + e^{-a}}. \tag{9}$$

The purpose of neural network learning is to achieve each pair of samples, as in formula (10):

$$E_p = \frac{1}{2}\sum_{j=1}^{m}\left(T_{jdp} - T_{jp}\right)^2, (p = 1, 2, \ldots, p). \tag{10}$$

Among them, m is the number of output nodes to the minimum, so as to ensure that the total error of the network is minimized as in formula (11):

$$E = \sum_{p=1}^{P} E_p. \tag{11}$$

E_p and T_{jdp} are the expected output and actual output of the jth node of the output layer, respectively. Gradient descent is an iterative method that can be used to solve least squares problems. Gradient descent is one of the most commonly used methods when solving model parameters of machine learning algorithms, that is, unconstrained optimization problems. Gradient descent is used to calculate the inverse properties of weight changes and errors, and gradient algorithms are used to modify the weights and thresholds of the network. The weight coefficient of the first layer is formula (12):

$$W(k+1) = W(k) + \Delta_p W(k+1). \tag{12}$$

Among them, k is the number of iterations, and the modified network connection weight is as in formula (13):

$$W_{ij}(k+1) = W_{ij}(k) + \eta \delta_{jp}^{(l)} O_{jp}^{(l-1)}. \tag{13}$$

In the formula, k is the number of learning times, and η is the learning factor.

But artificial neural networks also have many problems. For example, in a neural network, the learning time is too long and the learning purpose may not be achieved. The PSO algorithm is a global optimization search algorithm, which continuously transforms the potential solutions through certain rules, and finally finds the optimal solution through cyclic processing. Therefore, in this paper, the artificial neural network is used to build the prediction model of China's GDP, and the PSO algorithm is used to train the model and optimize the weights and thresholds [30, 31].

3.4. Particle Swarm Optimization (PSO). The advantage of PSO is that it is simple to implement not only suitable for scientific research and engineering applications but also has a profound intelligence background. Therefore, after the appearance of PSO, it immediately attracted the attention of

researchers, and there were many research results in just a few years, which became a research hotspot.

Particle swarm algorithm imitates the swarming behavior of insects, herds of animals, flocks of birds, and schools of fish, which search for food in a cooperative way. Each member of the group continually changes its search pattern by learning from its own experience and the experience of other members. The basic PSO algorithm does not require many parameters from the user, so it can be used more conveniently. However, it is easy to become a minimum value and has the disadvantage of low retrieval accuracy, which needs to be improved. Its improved formula is as formula (14):

$$A_{id} = V_{id} + W_{id}. \tag{14}$$

Among them, W is a nonnegative number called the inertia factor. Some scholars have proposed a compression factor for the speed of the PSO algorithm, such as in formula (15):

$$V_{id} = K * \left(V_{id} + \Phi_1 r_1 \left(p_{id} - A_{id}\right)\right). \tag{15}$$

Among them,

$$K = \frac{2}{\left|2 - \Phi - \sqrt{\Phi^2 - 4\Phi}\right|}. \tag{16}$$

The fitness function is a correspondence between all individuals in the problem and their fitness, which is generally a real-valued function. Here, people choose the error function of the network as the fitness value function, and the particle with large error has small fitness. The specific representation of the fitness value function adopted in this paper is shown in formulae (17) and (18):

$$F_i = \frac{1}{1 + E}, \tag{17}$$

$$E = 0.5 * \sum_{j=1}^{N} \left(t_j - y_j\right)^2. \tag{18}$$

PSO algorithm is widely used in various engineering fields because of its simplicity, easy implementation, and strong problem-solving ability. In this paper, when using particle swarm optimization algorithm to train the weights and thresholds of neural network model, the above-mentioned compression coefficient method is used to change the "flying" speed of particles.

3.5. Establishment of Macroeconomic Forecasting Model. With the establishment and continuous improvement of the socialist market economic system, since China's economic reform and opening up, although there have been some low-growth risks, the rest of the time has been relatively balanced, which fully reflects the positive level of China's economic growth. Economic development is more regular and economic growth is more stable. The premise of macroeconomic forecast in this thesis is that China's economic policy maintains stability and continuity, and there will be no major emergencies in the short term.

3.5.1. Indicator Selection and Data Processing. Macroeconomics has obvious fluctuations, correlations, systemic and specific randomness, and ambiguity. All economic events are in a complex economic system and are affected by various uncertainties and factors. The macroeconomic forecasting methods formulated under the guidance of various economic theories need to use various methods to complement the emerging problems. However, each method faces the problem of how to choose the method.

GDP reflects the total value added of various sectors of the national economy. In the past 10 years, under the international environment of slow development of the world economy, China's economy has prospered, and the GDP growth rate has remained at around 8%. Even in the face of the downturn of the world economy and the complex international situation, China's GDP can continue to maintain a high growth rate. Correctly predicting the future GDP trend is a common concern of the country and the people. The rapid growth of fixed asset investment has also become an important force driving China's economic growth in recent years, and foreign trade has also become an important force driving China's economic growth.

Unemployment and economic growth are closely related. After studying the relationship between economic growth rate and unemployment rate, a simple formula is obtained, such as formula (19):

$$\Delta u = -0.5\,(y - 3). \tag{19}$$

Δu in the formula represents the change in the unemployment rate, and y represents the economic growth rate, which is the famous Okun's law. If the economic growth rate is higher than this, the unemployment rate will fall.

In this paper, the standard deviation is used as a measure to test the accuracy of the overall prediction. a_i is the actual value, a_j is the predicted value, and N is the number of samples. The calculation formula is as formula (20):

$$AARE = \frac{1}{N} \sum_{i=1}^{N} \left|\frac{a_i - a_j}{a_i}\right|. \tag{20}$$

Doing a good job in the forecasting and processing of GDP is very important for judging macroeconomic operations and formulating correct macroeconomic policies. Therefore, the judgment of macroeconomic operation must be based on the historical data of GDP.

3.5.2. Design of Neural Network Prediction Method. In the past ten years, the research work of artificial neural network has been deepened and great progress has been made. It has successfully solved many practical problems that are difficult to solve by modern computers in the fields of pattern recognition, intelligent robot, automatic control, prediction and estimation, biology, medicine, economy, and so on, and has shown good intelligence characteristics. Artificial neural

networks can be divided into various forms according to various connection methods and learning rules. The knowledge of artificial neural network has been introduced in the previous article. Before designing a neural network model for macroeconomic forecasting, the structure of the neural network must be determined. The multilayer neuron network is shown in Figure 6:

As shown in Figure 6, for a multilayer neuron network, the selection of several hidden layers is first determined. If the thresholds of each node are different, the continuous function of any closed interval can be approximated by the hidden layer network. The three-layer neural network can complete the mapping from N-dimensional to N-dimensional, so this paper uses a three-layer neural network to predict the GDP model with only one hidden layer.

The Chinese GDP forecasting model established in the paper has three layers, input layer, hidden layer, and output layer. The input layer has been mentioned above, and the final consumption, gross capital formation, and net exports of goods and services in the first year are used as the information of the input layer. The hidden layer selects three neurons according to experience. The output layer neural network model has only one output, which is China's GDP in the tenth year; the excitation function adopts the type excitation function.

Because the PSO algorithm is suitable for global search, the PSO algorithm is used as the learning algorithm of the neural network, that is, after the neural network model is established, the PSO algorithm is used to optimize the weights and thresholds of the neural network. The weights and thresholds are evolved within a certain range, and then the network model is used to obtain the prediction results.

4. Experiment of Macroeconomic Forecasting Model Based on Neural Network

Compared with TSP and MATLAB statistical software or measurement tools generally used in economic analysis, using VC + 6.0 programming software to make data processing programs has higher efficiency and higher flexibility.

So this paper uses VC + 6.0 programming software to make computer program, after converting the designed model into computer language, input the learning data and test data into the computer program. The computer runs according to the compiled program. During the execution of the program, the computer will continuously optimize the model parameters according to the input learning data and test data, and finally obtain the best prediction model. The prediction results will also be output with the trained model, which is the GDP that people want to predict.

4.1. Experiment on the Effect of Prediction Model Combined with Neural Network and POS Algorithm. The following is the training method combining neural network and POS algorithm. In order to predict the sample results, various numbers of neurons are set to train various networks. Finally, the neural network with fast convergence speed and good prediction results is selected. The comparison between

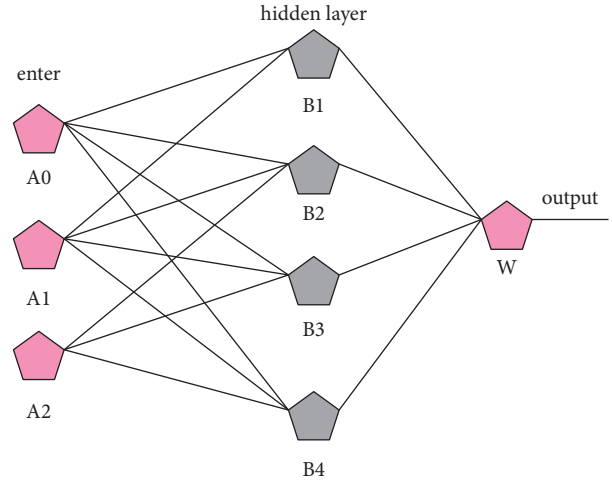

Figure 6: Multilayer neuron network.

training and prediction results using the trainlm method is shown in Figure 7:

As shown in Figure 7, the trainlmLM algorithm is a nonlinear optimization method between Newton's method and gradient descent method, which not only speeds up the training speed but also reduces the possibility of falling into a local minimum the results obtained by using. The trainlm method have high accuracy, fast training speed, fewer training times, and more accurate prediction results. The average error is within 10%, which belongs to the allowable range. In addition, with the increase of the number of neurons in the hidden layer, the memory occupied by the training also increases, and the error decreases with the increase of the number of hidden layers.

In this paper, by comparing a single artificial neural network prediction model with a prediction model based on the combination of artificial neural network and PSO algorithm, the lower the column representing time in the figure, the faster the model training rate. The comparison of the training time of the two prediction models on 10 datasets is shown in Figure 8:

As shown in Figure 8, according to the experimental results, the prediction model combining the neural network and the POS algorithm proposed in this paper shortens the network training time and improves the efficiency of the hybrid model construction. In experiments with a larger amount of data and a higher data compression rate, the learning rate of the prediction model combined with the neural network and the POS algorithm is more obvious. It is shown that the greatly reduced data volume increases the training efficiency of the neural network exponentially, and the experimental results show that the rate of increase is far greater than the data reduction.

4.2. Experiment of Combining Neural Network and POS Algorithm for Macroeconomic Forecasting Model. Macroeconomic modeling must use historical data. This paper uses the data from 2010 to 2016 to train the network, so as to train a more accurate model for economic

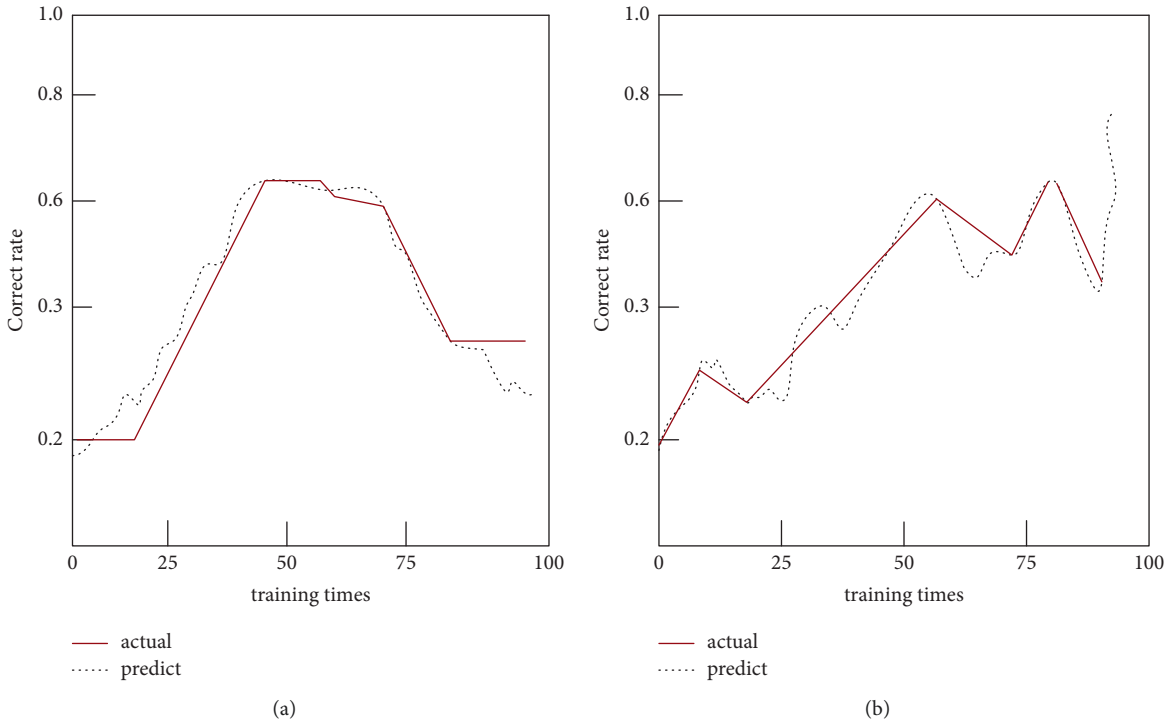

Figure 7: The prediction result of using the trainlm method with a hidden layer of 100 neurons: (a) Results of training samples. (b) Results of predicted samples.

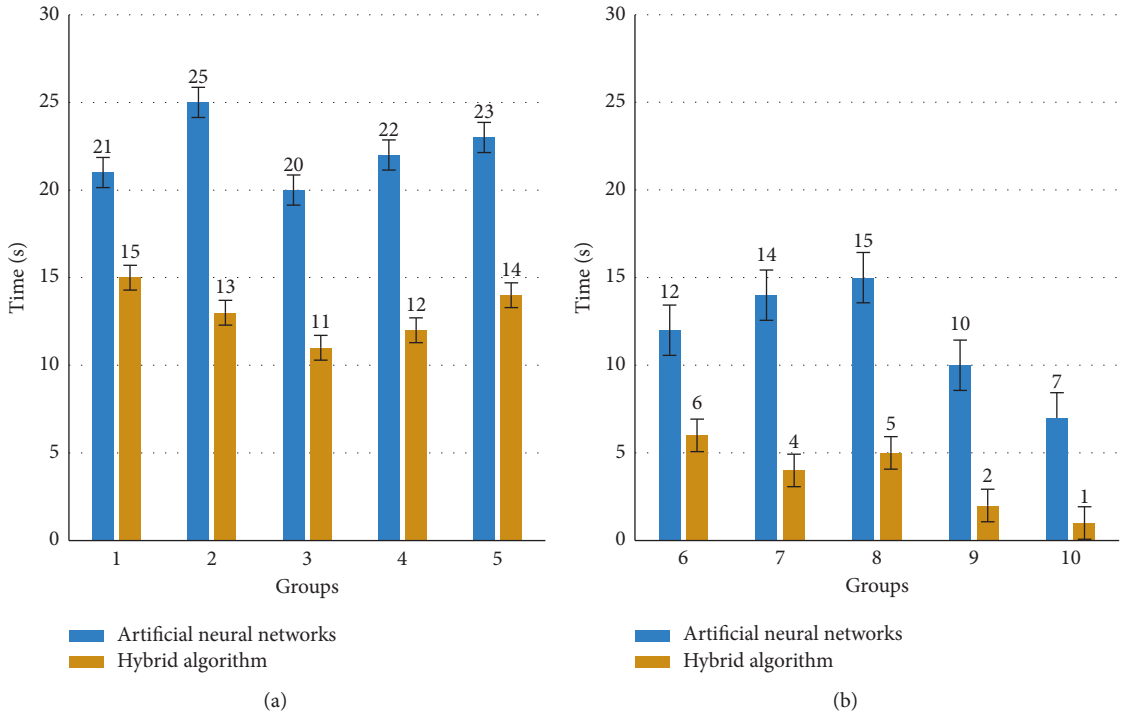

Figure 8: Network training time for two prediction models on 10 sets of data: (a) Network training time of artificial neural network prediction model. (b) Network training time of hybrid neural network prediction model.

Table 1: 2010–2016 economic statistics from China statistical yearbook.

Year	GDP (100 million yuan)	Final consumption (100 million yuan)	Total capital formation (100 million yuan)	Total export value (100 million yuan)
2010	410708	198998	185827	15057
2011	486038	241022	219671	11688
2012	540989	271113	244601	14636
2013	596963	300338	270924	14552
2014	647182	328313	290053	16152
2015	699109	362267	301503	24007
2016	746315	400176	318912	16412

Table 2: Prediction results based on artificial neural network.

Year	Actual expenditure method GDP (100 million yuan)	Model forecast spending GDP (100 million yuan)	Error
2010	410708	410707.90	0.10
2011	486038	486037.62	0.38
2012	540989	540988.35	0.65
2013	596963	596962.13	0.87
2014	647182	647181.10	0.90
2015	699109	699108.88	0.12
2016	746315	746314.86	0.14

Table 3: Results of neural network model based on artificial neural network and PSO algorithm.

Year	Actual expenditure method GDP (100 million yuan)	Model forecast spending GDP (100 million yuan)	Error
2010	410708	410707.944	0.056
2011	486038	486037.957	0.043
2012	540989	540988.979	0.021
2013	596963	596962.932	0.068
2014	647182	647181.943	0.057
2015	699109	699108.969	0.031
2016	746315	746314.992	0.008

forecasting. In the process of building the model, the data from 2010 to 2016 was used as the learning data, and the ideal prediction result was slightly different from the actual prediction result after training. The situation of China's GDP is shown in Table 1:

As shown in Table 1, substituting the test data into the determined artificial neural network model can obtain ideal prediction data, which prove that the combination of neural network and POS algorithm has strong prediction ability.

The main and fundamental task of a neural network is to confirm that the trained network model has excellent generalization ability for untrained samples. Since the error of the training samples may be very small, it is reasonable and reliable to use a part of the error of the test samples randomly selected from the whole sample in order to express the accuracy of the calculation and prediction of the network model. The prediction results are shown in Tables 2 and 3:

As shown in Tables 2 and 3, According to the calculation results, China's macroeconomic trends can be fully predicted within one year. The state can carry out macromanagement according to the forecast results, and enterprises and individuals adjust economic actions such as investment and savings according to the situation in order to optimize economic decision-making and maximize economic benefits.

In order to verify the validity of the forecasting model proposed in this paper, the macroeconomic forecast for 2017 and 2018 is also carried out, as shown in Figure 9:

As shown in Figure 9, it can be seen from the prediction results that the neural network model based on artificial neural network and particle swarm optimization algorithm is more accurate in GDP prediction. Therefore, as a forecasting scheme for forecasting $n+1$ years, a neural hybrid neural network model can be constructed.

Input the original data into the model, classify the samples, the training samples are the data of 2019, and the test samples are the data of 2019, as shown in Figure 10:

As shown in Figure 10, it can be seen from the prediction results that the error of the artificial neural network is small and basically meets the requirements. It can be seen that the neural network model based on artificial neural network and particle swarm optimization algorithm is more accurate in

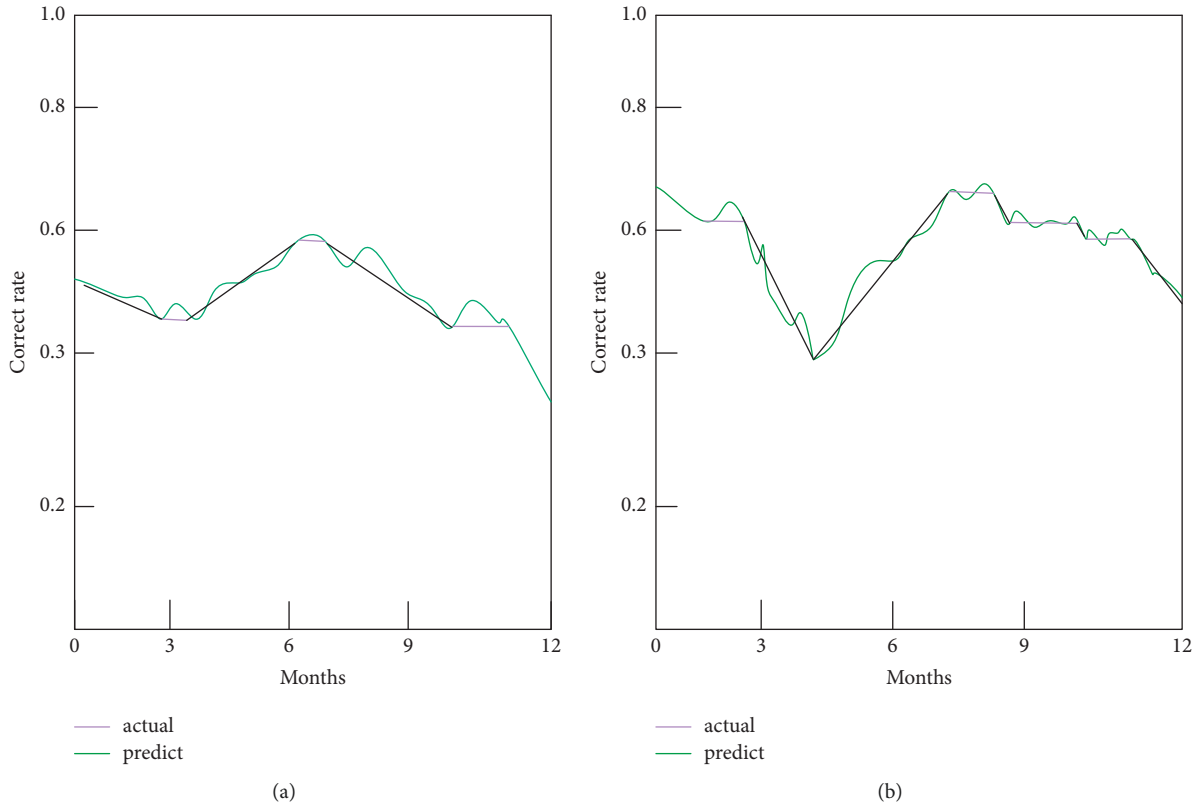

Figure 9: Macroeconomic forecast results for 2017 and 2018 based on artificial neural network and PSO algorithm: (a) Macroeconomic forecast results in 2017. (b) Macroeconomic forecast results in 2018.

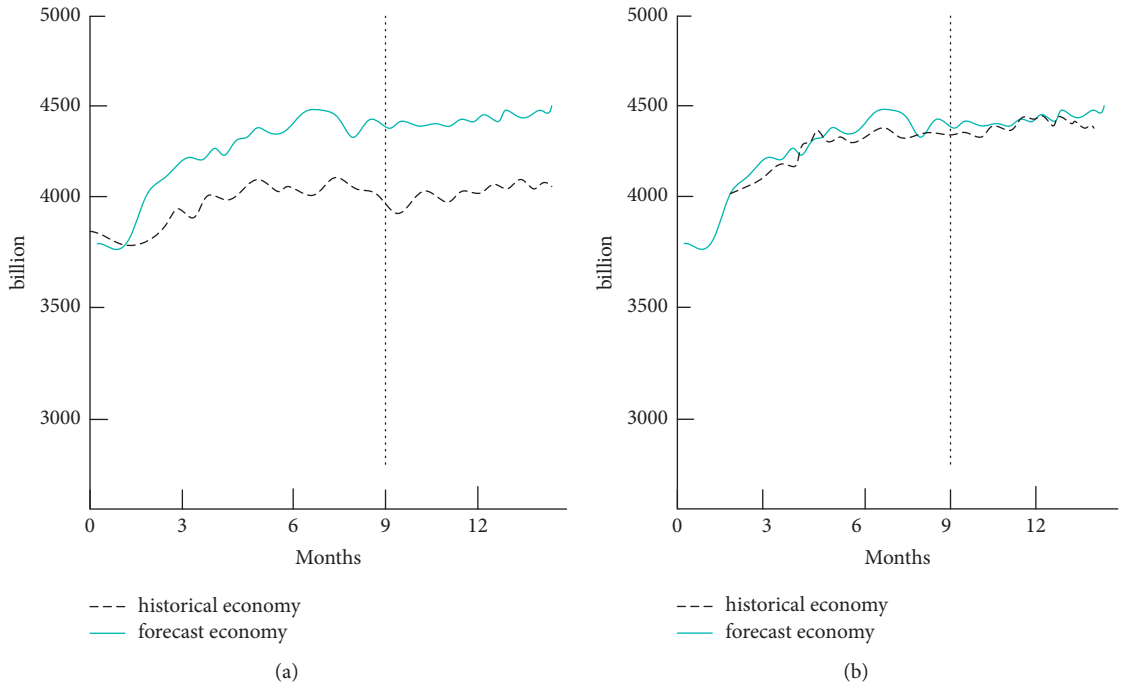

Figure 10: Comparison of prediction results for two different algorithms: (a) Single ANN prediction results. (b) Hybrid ANN prediction results.

predicting China's GDP. According to the calculated results, people can predict China's GDP in the short term.

5. Conclusions

This paper introduces the theoretical knowledge of digital information and blockchain technology. On the basis of them, the artificial neural network prediction method is proposed, and the artificial neural network and PSO algorithm are described in detail in the method part. Then, the construction of the macroeconomic forecasting model is proposed. In the experimental part, the forecasting method combining artificial neural network and PSO algorithm is used to forecast the macro economy. Finally, it is found that the neural network has excellent nonlinear quality, flexible and effective learning method, and fully decentralized storage structure. The prediction method using the combination of artificial neural network and PSO algorithm may obtain accurate prediction results. After forecasting the economy, it is found that the forecast effect of the combination of artificial neural network and PSO algorithm proposed in this paper is higher than the forecast effect of single neural network.

Data Availability

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

Conflicts of Interest

The authors declared no potential conflicts of interest with respect to the research, author-ship, and/or publication of this article.

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