

Economic Forecast Model and Development Path Analysis Based on BP and RBF Neural Network

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Abstract—In recent years, the economy of Guangdong province has ranked first in China for many consecutive years, with a strong growth momentum. In the future, whether Guangdong's GDP can maintain high-quality growth is an important issue. Neural network is an important tool for prediction. The neural network is mainly divided into BP neural network and RBF neural network. Combining the economic forecasting theory and the characteristics of BP neural network algorithm and RBF neural network, this paper studies the economic growth prediction of Guangdong province based on the artificial neural network algorithm and RBF neural network algorithm. The results of empirical research show that the artificial neural network has good prediction accuracy, but the data of economic growth prediction by various neural networks are different, and some errors are very large. Compared with BP neural network, RBF neural network model is one of good economic prediction models with high accuracy and less time.

Keywords—Economic forecast model, BP neural network, RBF neural network, Guangdong province, GDP

I. INTRODUCTION

The historical data in regional economic development and the current statistical survey data information are extremely complex, including many factors with different degrees of influence on economic development. However, due to their mutual correlation, mutual influence, and complex relationship, it is very difficult to find the factors that objectively and comprehensively reflect economic development. Traditional analysis methods ignore one thing and lose another when dealing with complex problems, which easily leads to insufficient prediction accuracy. When traditional methods are used to predict the development potential of regional economy, they mainly use linear models such as multiple linear regression, gray correlation model and time series [1]. However, these prediction methods mainly analyze the linear regional economic indicators, which cannot effectively analyze the regional economic indicators with high degree of linearity, and cannot obtain accurate economic prediction results. With the continuous development of nonlinear dynamics technology, there are many prediction technologies with strong nonlinear analysis ability, which can comprehensively explore the nonlinear development trend of regional economy. In the actual forecast analysis, the artificial neural network is utilized to establish the economic forecast model system to make the forecast results more accurate. The neural network gives a

clearer description of the economic development trend, which is great for the future economic development [2].

II. NEURAL NETWORK MODEL

A. Model Overview

The neural network appeared in the 1940s. In its development process, it has experienced the initial development stage, the low tide period, the revival period, and the high tide period [3]. As a computer or information processing system, artificial neural network simulates the function and structure of biological brain. As a nonlinear complex network system, it contains many processing units like neurons. Through the simulation of brain neural network memory and information processing methods, the human brain can process information. Neural network is a new algorithm mathematical model based on the trend features of animal neural network [4]. Its main function is to process distributed parallel information. Its internal system is relatively complex. The whole system uses the network to process data based on adjusting the connection relationship of internal nodes. The ability to deal with nonlinear problems is relatively high, which improves the shortcomings of traditional artificial intelligence methods in dealing with unstructured information. Artificial neural networks are widely used and successful in the current information society. In the process of the artificial neural network utilization, we first get some information from the external environment. The role of each neuron inside the network is to store the information obtained. Its self-learning ability is high. For the information input into the system, it can be transformed into a logical output. In its learning phase, it can continue to improve itself, making the results more effective and accurate. Due to the rapid development of artificial neural network, it has gradually been widely utilized in management, economics, and other aspects. We will get ideal results when it is used in regional economic forecasting [5].

B. BP Neural Network

It is a feedforward neural network learning model under the guidance of a tutor [6]. It is mainly composed of forward propagation of input signals and back propagation of error signals. The standard BP includes the input layer, hidden layer and output layer. The forward propagation is input through the input layer and output through the hidden layer

through nonlinear mapping [7]. As shown in The model structure of BP network is shown in Fig. 1.

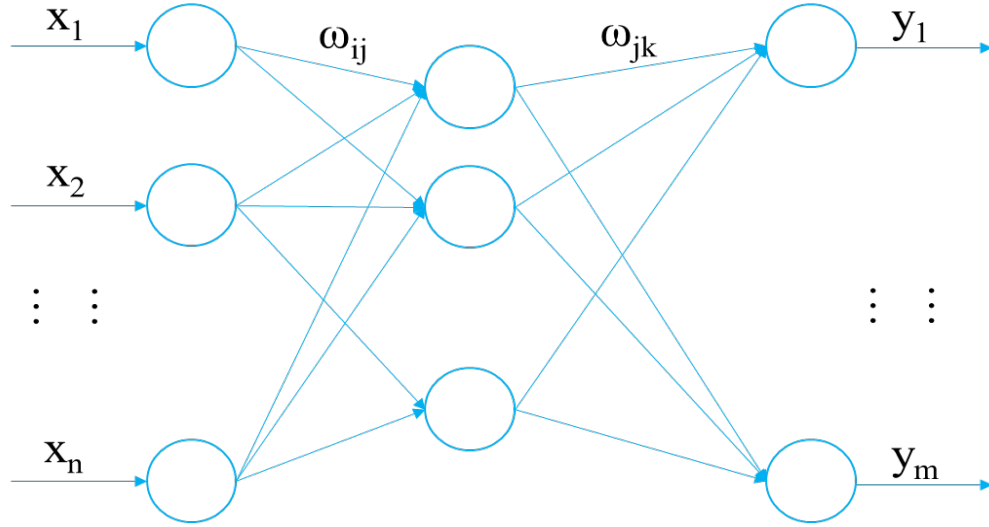


Fig. 1. Model structure of BP neural network

C. RBF Neural Network

The Radial Basis Function (RBF) neural network was developed by D. Broomhead and D A feedforward neural network proposed by Lowe. RBF is composed of three parts: input layer, hidden layer and output layer. Unlike BP neural network, RBF neural network's hidden layer node activation function is a radial basis function, which only adjusts the output weight value. RBF neural network has three layers of feedforward neural network. The first layer is the input layer. It is a layer directly connected with the external input data. Set the input vector as the number of input neuron nodes [8]. The second layer is the hidden layer. The number

of nodes in the hidden layer needs to be judged by the specific model and data characteristics. The hidden layer uses the radial basis function to form new data from the input layer through the nonlinear changes of the radial basis function; The third layer is the output layer, which generally uses the linear activation function. The output value is obtained by linearly summing the output signals generated by the hidden layer through the radial basis function. When we use the RBF network, we can see that it may approximate the nonlinear functions and have the characteristics of simple training and fast convergence [9]. The model structure of RBF network is shown in Fig. 2.

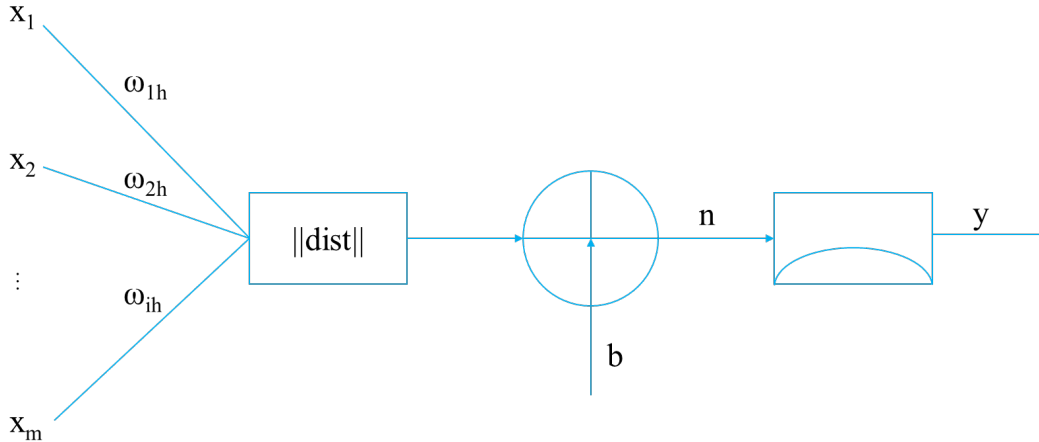


Fig. 2. Model structure of RBF neural network

III. CURRENT SITUATION OF REGIONAL ECONOMIC DEVELOPMENT IN GUANGDONG PROVINCE

The most direct embodiment of regional economic development is regional GDP. GDP is the core indicator of

national economic accounting, and an important indicator to measure the economic situation and development level of a country or region. As shown in Fig. 3, Guangdong's GDP will reach 12.4 trillion yuan in 2021, up 8% year on year.

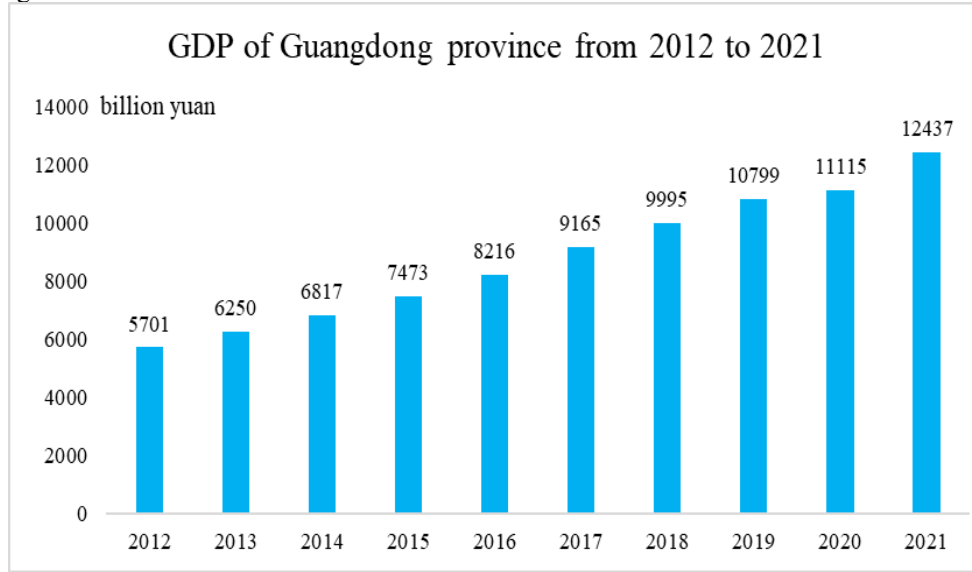


Fig. 3. Figure of GDP of Guangdong province from 2012 to 2021

IV. ECONOMIC FORECAST OF GUANGDONG PROVINCE BASED ON BP AND RBF NEURAL NETWORK

A. Data Preprocessing

The normalization method adopted in this paper is the maximum and minimum normalization method. Use Matlab random number generator to generate a 1 by instructing $k = \text{rand}(1, 10) \times 10$, using Matlab own sort function to pair 1×10 vectors are sorted and returned to the index array n , and the initial sample data to be trained is randomly selected as the training data through the index array n . Matlab built-in function `mapminmax` is used to normalize the data [5].

B. Training Process of BP and RBF Neural Network

Ten groups of data were analyzed with BP neural network. The training process of BP neural network is composed of two processes: forward propagation of signal and back propagation of error. In forward propagation, the input signal is processed layer by layer from the input layer through the hidden layer to the output layer. If the output

layer does not get the expected output, it is switched to back propagation, and the weights and thresholds of the network are updated until the network prediction error meets the requirements. Thus, the output is constantly approaching the expected output. By training a certain sample, the weights and thresholds held by the network are the correct internal representation obtained by the network through adaptive learning. At this time, the test data of the sample to be identified is input into the trained network, and the network can automatically infer and identify the attributes of the sample. The BP neural network training function `train` is called to train the initial sample data, The network can predict the output of nonlinear functions. The first five groups of data are used as training samples, and 5-10 groups of data are used as test data. RBF neural network is created with `newrbf` function in neural network toolbox of MATLAB.

C. Result Analysis

The GDP forecast results of Guangdong province based on BP and RBF neural networks are shown in Table I and Table II.

TABLE I. PREDICTION RESULTS OF GDP OF GUANGDONG BASED ON BP NEURAL NETWORK

Year	GDP of Guangdong	Prediction	Absolute error	Relative error
2012	5701	5714	-13	-0.23%
2013	6250	6310	-60	-0.95%
2014	6817	6907	-90	-1.32%
2015	7473	7391	82	1.10%
2016	8216	8105	111	1.35%

2017	9165	9166	-1	-0.01%
2018	9995	9962	33	0.33%
2019	10799	10888	-89	-0.83%
2020	11115	11125	-10	-0.09%
2021	12437	12511	-74	-0.60%

TABLE II. PREDICTION RESULTS OF GDP OF GUANGDONG BASED ON RBF NEURAL NETWORK

Year	GDP of Guangdong	Prediction	Absolute error	Relative error
2012	5701	5708	-7	-0.13%
2013	6250	6171	79	1.27%
2014	6817	6807	10	0.15%
2015	7473	7483	-10	-0.13%
2016	8216	8165	51	0.62%
2017	9165	9108	57	0.62%
2018	9995	9931	64	0.64%
2019	10799	10721	78	0.72%
2020	11115	11056	59	0.53%
2021	12437	12469	-32	-0.26%

To compare the accuracy of RBF neural network and BP neural network, the BP neural network model of dynamic prediction is built using the existing sample data set. After many debugging, when the expansion center is 7, the simulation prediction result is the best. The MSE of BP neural network is 4554.8; The MSE of BP neural network is 2701.3. Obviously, the accuracy of RBF neural network is higher than that of BP neural network. The whole training process of BP neural network and RBF neural network lasts 21 s and 11 s respectively, and the training speed of RBF neural network is significantly faster. The comparison results are shown in the Table III.

TABLE III. COMPARISON RESULTS OF BP NEURAL NETWORK AND RBF NEURAL NETWORK

Item	BP neural network	RBF neural network
MSE	4554.8	2701.3
Training duration (s)	21	11

To sum up, RBF neural network overcomes the shortcomings of BP neural network such as too many training times and low learning efficiency, accelerates the learning speed of samples, and improves the simulation prediction efficiency and accuracy.

V. ECONOMIC DEVELOPMENT PATHS OF GUANGDONG PROVINCE BASED ON PREDICTION

A. Coordinate Economic Development

Guangdong Province has repeatedly introduced policies to promote the coordinated development of regional economy and narrow the regional development gap.

Although we see that the gap between the Pearl River Delta region and non-Pearl River Delta regions is indeed huge, we cannot ignore the rapid development of eastern and northwestern Guangdong, which is still due to the strengthening of the Pearl River Delta region's diffusion effect on the surrounding areas, driving the surrounding areas to achieve rapid development. Therefore, first, we must adhere to the current regional development policy of the government, give full play to the economic radiation and diffusion driving capacity of the Pearl River Delta region, and strengthen the construction of industrial transfer parks, which is to build industrial transfer parks into economic carriers to undertake the diffusion effect of the Pearl River Delta region, Strengthen the industrial connection and economic exchange between the Pearl River Delta region and the growth pole center in the east, west and north of Guangdong, accelerate the formation of regional growth poles in the east, west and north, form a regional growth pole with gradient development, and coordinate regional development with regional growth poles. The three regions should establish cooperation platforms to reduce regional competition, grasp the policy dividend issued by Guangdong Provincial Government, and strengthen regional industrial cooperation and investment promotion cooperation. At the same time, the Pearl River Delta region will strengthen its counterpart support for the construction of precision industries and infrastructure in surrounding areas, and increase investment [10]. Guided by the international market and relying on the domestic market, we will promote the development of an export-oriented economy at a high level and at a fast speed.

B. Strengthen Regional Characteristics

Strengthen regional characteristics, reduce mutual competition between regions at the same level, form a

complementary pattern with the central region, and stagger the industrial hedging of economic development [10]. Therefore, the control ability and forward-looking vision of sub regional governments are more needed. The sub region should try to strengthen the economic connection with the peripheral regions, strengthen the infrastructure construction in the small region, strengthen the traffic connection, and strengthen the small radiation effect of the sub region through the infrastructure construction. The peripheral regions should make full use of the improvement of transportation infrastructure to attract the industrial transfer and factor return of the central region, and actively attract the investment and product demand of the central region. Secondly, the level of urbanization is still one of the most important factors to promote local economic growth. Therefore, we should adhere to promoting urbanization construction, and promote the adjustment, optimization and upgrading of the industrial structure of the peripheral regions and sub regions, further release the labor force from the primary industry, promote the population concentration in the peripheral areas and sub regions, and at the same time strengthen the urbanization construction to adapt to the industrial structure adjustment. The government should combine the non-governmental forces, mobilize the urbanization enthusiasm of the government and the people, provide appropriate financial transfer payments, weaken the urban-rural dual structure work, and improve the residents' sense of life. As the provincial capital of Guangdong, Guangzhou's comprehensive economic strength is far higher than that of other cities. Therefore, Guangzhou has the responsibility to play a leading role and lead the rise of other underdeveloped regions. Guangzhou should further consolidate and enhance its position as a hub, build an economic metropolis with Guangzhou as the core, constantly improve the modern industrial system, accelerate the process of urban-rural integration, and build an enterprise-oriented economy, A new modern city based on higher education institutions promotes the urban independent innovation system.

C. Develop Digital Economy

In the process of digital industrialization, Guangdong should focus on information communication, software services and other industries, cultivate and expand emerging digital industries such as artificial intelligence, big data and blockchain, and improve the level of communication equipment, key software, and other industries. Build application scenarios and industrial ecology, and carry out pilot projects in intelligent transportation, intelligent logistics, intelligent energy, and other fields. Industrial digitalization can drive reform through innovation and stock through increment, and improve social total factor productivity through deep integration of artificial intelligence, Internet of Things, and big data with the real economy. Therefore, Guangdong should promote the development of sensors, ultra-high-definition video, and industrial robots in the process of industrial digitalization, and realize the collaborative upgrading of the whole industrial chain of data empowerment. To deepen reform

and break the system incompatible with the high-quality development of the digital economy? We will take the lead in breaking through and experimenting with the international allocation of innovative resources, the cultivation of data factor markets, and the tackling of key problems in core technologies, build a national demonstration and leading area for the innovation and development of digital economy, and radiate and drive the innovation and development of the national digital economy. Data driven to stimulate vitality. By giving full play to the unique advantages of Guangdong's rich data resources, we will promote the orderly flow and efficient convergence of Guangdong's data elements, fully tap the value of data resources to create a new driving force for economic development, and build a new form of digital economic development in Guangdong with the key feature of data driven. At the same time, we will focus on tackling key industrial software, core electronic components, high-end chips, and other short board technologies to create a new highland of Guangdong's digital economy.

D. Improve Knowledge Economy

As the provincial capital of Guangdong, Guangzhou's comprehensive economic strength is far higher than that of other cities. Therefore, Guangzhou has the responsibility to play a leading role and lead the rise of other underdeveloped regions. Guangzhou should further consolidate and enhance its position as a hub, build an economic metropolis circle with Guangzhou as the core, constantly improve the modern industrial system, accelerate the process of urban-rural integration, build a new modern city with enterprises as the main body and universities as the basis, and promote the city's independent innovation system. While introducing foreign capital and expanding foreign trade, we should also introduce advanced technology and equipment. Guangdong Province has a large population, especially many migrant populations, and has a broad labor and commodity market. However, the generally low quality of labor force also hinders the overall economic development of Guangdong Province to a certain extent. Therefore, the way out for Guangdong Province is to improve the quality of talents and take the road of knowledge-based economy. The government should increase investment in education and improve the quality of the whole people. Knowledge economy needs knowledge-based and innovative talents. Society and individuals should actively create conditions to provide learning opportunities for everyone. The government should increase investment in higher education, improve employability, optimize employment methods, and take the road of knowledge economy.

E. Increase Effective Investment

We will give full play to the guiding role of special bonds, vigorously promote the construction of water conservancy, transportation infrastructure, major industries and science and technology projects, and form the main force of effective investment and steady growth throughout the year. Accelerate the transformation and upgrading of traditional power grids and coal-fired units, as well as the construction of offshore wind power, hydropower, nuclear

power and solar photovoltaic power generation, and take energy investment as a new growth pole for stable growth. Actively take new measures to promote private investment policies, and make greater efforts to stimulate private investment to enter the core links of Guangdong's industrial chain, new energy, urban infrastructure, and other key areas. Make full use of Guangdong's advantages of good business environment and high industrial concentration to attract more domestic private capital to invest in Guangdong. We should pay more attention to the guidance of provincial financial investment in technological transformation and expand the investment demand of Guangdong Province. We will actively sort out and introduce policies and measures to stabilize the reasonable expectations of real estate investment, consumption and housing prices, more accurately link financial and real estate investment and consumption, vigorously support the transformation of old residential areas in Guangzhou, Shenzhen and other cities, accelerate the construction of affordable housing and long-term rental housing, and actively and effectively meet the reasonable demand for commercial housing. Strengthen the planning and reserve of major projects. Focusing on major scientific and technological infrastructure, key projects of industrial chain development, as well as infrastructure construction such as high-speed rail network, expressway network, airport cluster, port cluster, inland high-grade waterway, water resource allocation backbone network, new power system, etc., through systematic policy and scientific planning, a batch of major projects with strong driving force and high technology content will be formed as early as possible, laying a more solid foundation for promoting high-quality development of Guangdong. Through joint efforts, we will give full play to the multiplier effect of investment on stabilizing growth and promoting consumption.

VI. CONCLUSIONS

Economic forecasting is an important part of government decision-making. To improve the correctness of decision-making, we should provide information about the future by prediction, so that decision-makers can increase their

understanding of the future and reduce uncertainty or ignorance to the minimum. We use BP and RBF neural network models to forecast the economy of Guangdong province. Comparing RBF neural network model with BP neural network model, it is found that RBF model has higher prediction accuracy and higher speed, so RBF neural network is better for surface roughness prediction.

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