

Research on BP Neural Network Algorithm Based on Genetic Algorithm Optimization in Short-Term Power Generation Forecasting

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Abstract—In order to overcome the shortcomings of traditional BP neural network, and realize the fast and accurate prediction, this paper will construct a new prediction method by combining genetic algorithm and neural network. The method significantly improves the optimization ability of the model, which can effectively overcome the slow learning speed of neural network, and overcome the blindness of the initial weights of the neural network, so as to effectively improve the accuracy of prediction. The examples show that this method can effectively improve the prediction accuracy.

Keywords—Genetic algorithm, forecasting, BP neural network

I. INTRODUCTION

A city's electricity consumption will change with change of the resident population and the economic growth rate. Prediction has become a hot topic in the research of power investment because of its key role in power investment decision making. Research on prediction method has experienced the development stages from a single prediction method of combination forecasting method; the prediction accuracy has been greatly improved.[1]

In recent years, with the development of artificial intelligence technology, the application of artificial neural network in the prediction of more and more widely, there are commonly used feedforward neural network (BP neural network), but BP neural network has some inherent defects, such as slow convergence, easy to fall into local optimum, the initial weights and threshold value random, the study found that the genetic algorithm is introduced to optimize the neural network, which can effectively improve the prediction accuracy. Based on this idea, this paper uses the genetic algorithm to optimize the BP neural network combination model method, and the forecast of the power generation.

II. A BRIEF INTRODUCTION OF GENETIC ALGORITHM AND BP NEURAL NETWORK

A. Genetic Algorithm

Genetic algorithm (GA) is a kind of parallel random search optimization method, which simulates the genetic mechanism and biological evolution in nature. [2]The nature of "survival of the fittest, the principle of biological evolution

of municipal life" is introduced to optimize the parameters of forming the encoding series groups, according to the selection of fitness function and the genetic selection crossover and mutation of the individual selection of fitness better individual fitness is reserved, poor individuals are eliminated, the new group inherits the generation of information, and better than the previous generation. This is repeated until the condition is satisfied.

B. BP neural network

BP neural network is a kind of multilayer feedforward neural network. The network and its main characteristics are the forward transmission of signals and the error back propagation. Prior to delivery, the input signal from the input layer and hidden layer after treatment, until the output layer. [3]Each layer of neurons only affect the neurons in the next layer. If the output layer can not get the expected output, then transferred to the reverse propagation, according to the prediction error to adjust the network to be advised and threshold value, so that the BP neural network prediction output is expected to approximate the desired output. The topological structure of BP neural network is shown in Fig. 1.[4]

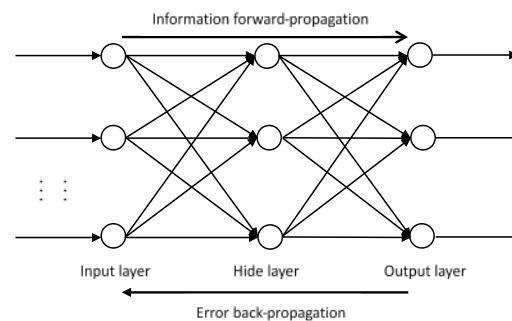


Fig. 1. Three-layer BP network model

III. GABP MODEL BUILDING

Genetic algorithm optimization BP neural network process as shown in Fig. 2.[5]

Genetic algorithm optimization BP neural network is divided into 3 parts: the structure of BP neural network,

genetic algorithm optimization and BP neural network prediction.[6] Among them, the structure of BP neural network determines the structure of BP neural network according to the number of input and output parameters of the fitting function, and then determines the length of the genetic algorithm. The genetic algorithm to optimize BP neural network weights and thresholds of each individual of the population contains a network of ownership and threshold value, the individual

fitness degree is calculated by value the fitness function of genetic algorithm, through selection, crossover and mutation operation to find the optimal fitness value of individual. BP neural network prediction using the genetic algorithm to get the optimal individual neural network initial weights and threshold reproduction, the network after the training to predict the output function.

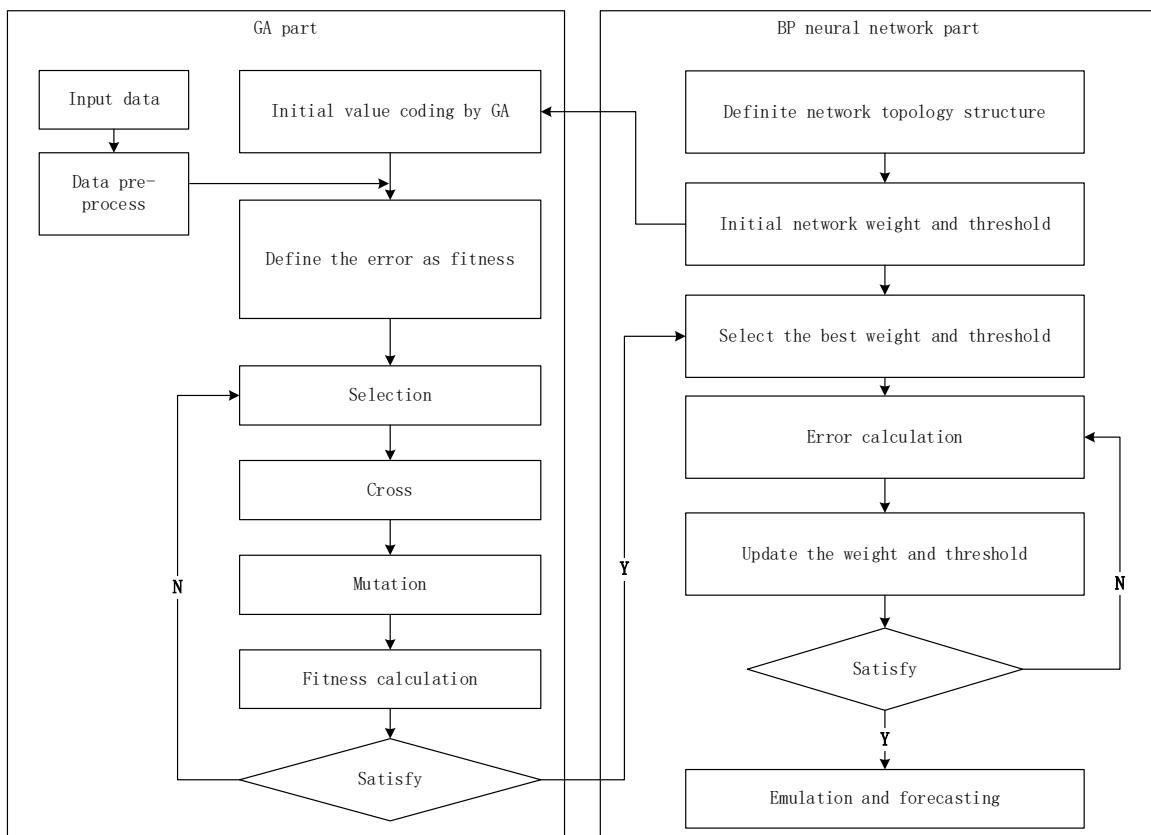


Fig. 2. Optimization of the BP neural network by GA

IV. CASE STUDY

A. Parameters Setting

Forecast future electricity generation by data from 2000--2011 in Xi'an. Permanent population at the end of this year, production capacity, production and second industrial output value to predict the next year's electricity generation.

TABLE I. PARAMETERS OF MODELS MENTIONED IN THE PAPER

Model	Parameters
GA	Iterations=50, size=10, crossover rate=0.4, mutation rate=0.2
BPNN	N _{max} =100; hidden layer node=[5]; learning rate=0.1; goal=0.00004 network structure:4—5--1

B. Model performance evaluation

To examine the performance of model, the mean absolute percentage error (MAPE) and the mean square error (MSE) are proposed to measure the forecast accuracy. The formulas are as follow:

$$MAPE = \frac{1}{n} \sum_{i=1}^n \left| \frac{\hat{y}_i - y_i}{y_i} \right|$$

$$MSE = \frac{1}{n} \sum_{i=1}^n (\hat{y}_i - y_i)^2$$

Where y_i represents the actual value at period i ; \hat{y}_i is the forecasting value at period i and n is the number of forecasting period.

C. Analysis of forecasting results

Fig. 3 shows the prediction results of GABP, Fig. 7 and Fig. 8 show the GABP curve and GABP network prediction error. Table 2 shows the predictive value of BP and GABP. Table 3 shows the prediction accuracy of GABP and BP.

In order to show the superiority of GABP, we compare the traditional BP neural network with the optimized GABP model, and table 2 shows the predicted value and the actual value of the two models. It can be seen clearly that the stability of the GABP model, there is no large fluctuations.

In order to test the validity of the model, we use MAPE and MSE two indexes to measure the accuracy of the model. Can be seen from table 3, the prediction model of GABP MAPE was 0.074287, 0.086709 lower than the BP, and GABP MSE is 55.8401, is lower than the 249.0963 of the BP. It shows that the stability of the GABP prediction model and the prediction accuracy is better than the traditional BP model, which can be used to predict the short-term power generation.

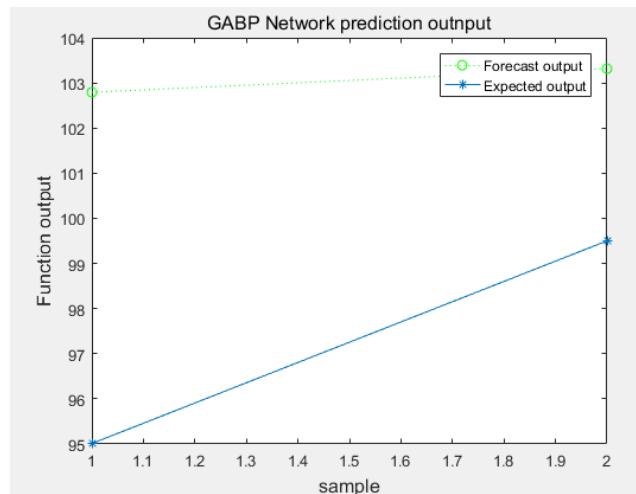


Fig. 3. Forecasting results of GABP

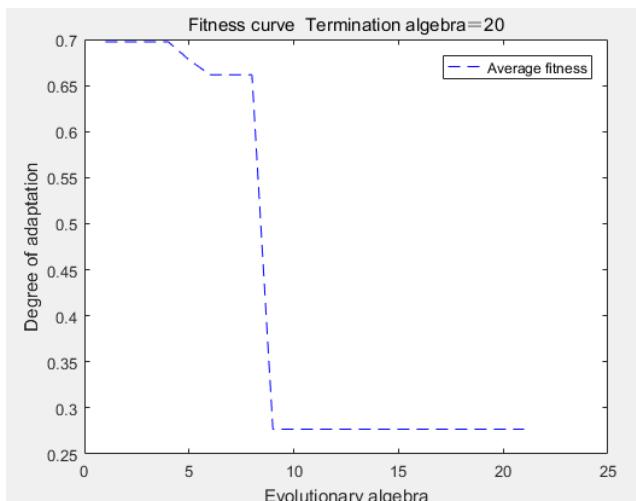


Fig. 4. Fitness curve of GABP

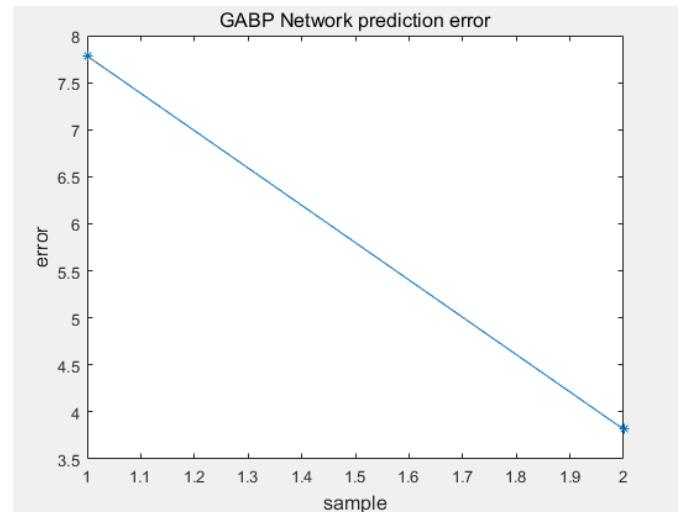


Fig. 5. Error of GABP

TABLE II. RESULTS of models

Model \ Year	2011	2012
Actual	95.01	99.5
GABP	104.27	104.57
BP	116.66	94.07

TABLE III. MODELS PERFORMANCE EVALUATIONS

Model \ Index	GABP	BP
MAPE	0.074287	0.086709
MSE	55.84081	249.0963

V. CONCLUSION

In order to strengthen the economy of electric power investment, to avoid the waste of investment, and to improve the accuracy of power generation forecasting is of great significance.[7] Due to the short-term power generation is affected by many kinds of external factors, its existence is not regular, so it can not use a single model to forecast the power generation. According to the randomness of the traditional neural network weights and threshold, this paper proposes a prediction based on genetic algorithm BP neural network model, and compare it with the traditional BP neural network prediction results, the prediction results of MAPE and MSE is better than BP neural network has higher prediction accuracy. The GA algorithm is simple and easy to understand, easy to operate, and can be widely used in intelligent algorithm parameter optimization. In summary, the GABP prediction model has the characteristics of high precision and simple operation, which provides a scientific and effective reference for Short-Term prediction of power generation.

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