Research on Short-term Power Load Time Series Forecasting model Based on BP Neural Network

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Abstract—**Time series forecasting is an important aspect of dynamic data analysis and processing, in science, economics, engineering and many other applications there exists using the historical data to predict the problem of the future, and is one considerable practical value of applied research. Time series forecasting is an interdisciplinary study field, this paper is under the guidance of the introduction of artificial neural network and time series prediction theory, and then take artificial neural network into time series prediction in-depth theory, method and model studies. Power system load forecasting is an important component of power generation scheme, and is the basis for reasonable arrangements for scheduling operation mode, unit commitment plan, the exchange of power schemes, so the accuracy of load forecasting whether good or bad will be directly related to the industrial sector's economic interests. In addition, the load forecasting is also conducive to the management of planning electricity, the fuel-efficient, lower cost of power generation; formulating a reasonable power construction plan to improve the economic and social benefits power system. So the forecasting load is necessary .First, we set BP neural network model, and predict the specific time load, and the predicted results are very satisfactory. We can test that BP neural network time series forecasting model has good predictive ability and better promotion of ability. And we also test that the effectiveness and universality of BP neural network time series forecasting model.**

Keywords- BP neural network; short-term electric power load; time series prediction

I. INTRODUCTION

With power system products marketed, the accuracy of electric power load forecasting has become increasingly important for power system security economic operation and national economic development. Power system load forecasting is an important component of power generation scheme, and is the basis of reasonable arrangements for scheduling operation mode, unit commitment plan, the exchange of power schemes, so the accuracy of load forecasting good or bad will be directly related to the industrial sector's economic interests. In addition, the load forecasting is also conducive to the electricity plan management, fuel-efficient and lower cost of power generation, formulate a reasonable power construction plan, and improve power system economic and social benefits.

Load forecasting is one important work of the electricity sector, and accurate load forecasting can be economic and reasonable arrangements for power generating units within the start-stop, make equipment maintenance scheduling, prepare for network construction planning to ensure normal of society production, power consumption and improve economic and social benefits. Therefore, the forecast of the power load changes trends and the accurate of the magnitude is a basic capacity that grid scheduling and planning departments should possess.

So far, it has quite a variety of methods for load forecasting, and has achieved varying degrees of success. These methods can be broadly divided into two categories: the traditional forecasting methods and artificial intelligence methods. The traditional short-term load forecasting includes time series method, regression analysis, trend extrapolation, elastic coefficient method, the gray model, expert system method as well as the optimal combination forecasting method. These algorithms are simple and fast, but more is a linear model, and is difficult to simulate complex power load. Artificial intelligence methods include expert systems, fuzzy logic methods, and artificial neural network methods and so on.

II. TIME-SERIES FORECASTING MODEL

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Practitioners and researchers in the economic, engineering, natural sciences and social sciences fields would have to deal with a series of historical observations. Time series refers to the performance of the number in terms of time to develop a series of changes, and form a dynamic series in chronological order. Time series is also known as time series or dynamic series. Time series may indicate its change process and trend of the phenomenon of socio-economic development and predict the development direction and future prospects of the phenomenon.

Time series consists of two basic elements, one is the time of the phenomenon belong to; the other is the levels the phenomenon attained in different period.

In accordance with the two basic elements, time series can be carried out in two ways classification.

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First of all, according to the nature of the indicators, the time series can be divided into absolute and relative time series. The absolute time series is the original sequence or the foundation time series, and the relative number of time series and the average number of time series is calculated on the basis of the absolute time series.

The absolute time series reflects the phenomenon's the absolute level and processes and trends of its development and change in different periods. According to the nature of their indicators, the absolute time-series are divided into sequences and point time sequence.

The cause of time-series change in each phase of the development level has a variety of reasons; there are political, social reasons, economic and natural causes. Factors for various reasons are intricately intertwined, in certain circumstances, the impact of social phenomena play different roles, so that the same phenomenon in different development period shows the different development outcomes.

Time-series models include deterministic time series model and the stochastic time series model. In deterministic time series model includes a simple extrapolation model and the moving average model, and the stochastic time series models includes the autoregressive models, moving average models and autoregressive - moving average model.

These methods are the data preprocessing, and determine the optimum timing models statistical significance through statistical analysis. It has two main disadvantages:

First, the choice of models requires certain assumptions;

Second, this established model is difficult to effectively deal with the complexity of time series related to non-linear or multi-dimensional non-linear.

III. BP NEURAL NETWORK MODEL DESCRIBES

Artificial Neural Network (ANN) is also known as neural networks (NN), is a network from that a large number of processing units made extensive exchange, and is the abstract, simplified and simulation of the human brain, and reflects the basic characteristics of the brain. The similarities with the human brain are summed up in two aspects: First, the access to knowledge through the learning process using neural network from the external environment; second, the internal neuron is used to store acquired knowledge and information.

The nature of the neural network used to predict are related to the size of the network parameters. Network structure includes the number of neurons, the number of hidden layers and connection methods. For a given structure, the training process is to adjust the parameters to obtain the basic contact approximation, the error is defined as the root mean square error, and the training process can be regarded as an optimization problem. Usually the available time-series data is divided into two parts: training data and test data. Training data is more than twice as much as test data in general.

A. Basic Principles

BP network is based on BP (Back Propagation) algorithm for error back-propagation multi-layer feedback neural network, first proposed by Rumelhart, McClelland in 1985, and it is the most widely used, the most powerful artificial network. BP neural network commonly are three-tier structure: input layer, hidden layer, output layer, and the number of neurons of the input layer and output layer is depended on the specific application areas and the practical problems, while the methods to decide the number of hidden layer neurons are no more mature way, you can first set a different value, according to the final training results, we can decide the number of hidden layer neurons. As is shown in Figure.1:

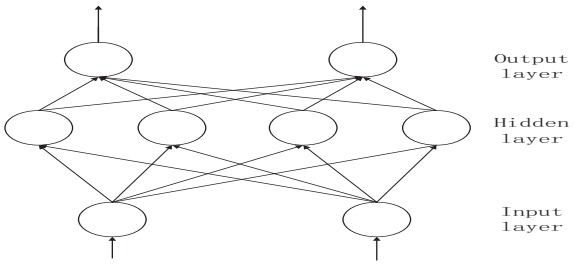

Figure 1. BP neural network structure

B. Steps to make model

Step 1: to determine the network structure, namely, to determine the number of the network layer, neurons and activation function. Input layer i, hidden layer j, the output layer k.

Step 2: to set the neural network connection weights w_{ij}, w_{jk} and neuron threshold θ_j initial values, while the sample data are to initialize, and set the error minimum E, learning rate η, the largest training time n.

Step3: to calculate the network based on the input sample of the hidden layer output and actual output. First we choose the sample to set the input and the output, and pick up the input and the output of the test sample. Through the MATLAB we fulfill the neural network sequence, and then adjust the training times, learning rate and the output layer of hidden layer to improve the forecasting accuracy, and we can check out the results through the test sample. If the result is reasonable, we get the result, while we will continue the adjustment.

Hidden Node Output:

$$o_j = f(\sum_i w_{ij} x_i - \theta_j) \tag{1}$$

Output Node Output:

$$y_k = f(\sum_j w_{jk} - \theta_k) \tag{2}$$

Step 4: to calculate the actual output and expected output of the total error:

$$E = \sqrt{\sum_{u=1}^{N} e_u^2 \Big/ N} \tag{3}$$

Where: N is the sample number; e_u for the error between the actual output and expected output; u is for the sample number.

If the error meets the requirements, then we end the training, or continue to implement Step 5.

Step 5: to repeat adjustment of the network connections of each neuron weight, repeat Step 3-Step 5 to make E achieve error range.

IV. CASE STUDY

This paper selected the data of a city power company from February 1st 0: 00to April thirty 24: 00 to simulate and calculate.

(1)First, data is divided into the training samples and test samples, the training samples are the data from February 2 to April 28 the data, and the data from April 29 and 30 of the 48 points are as the data for validation. And then normalized the data, the data will be transferred to within [0, 1].

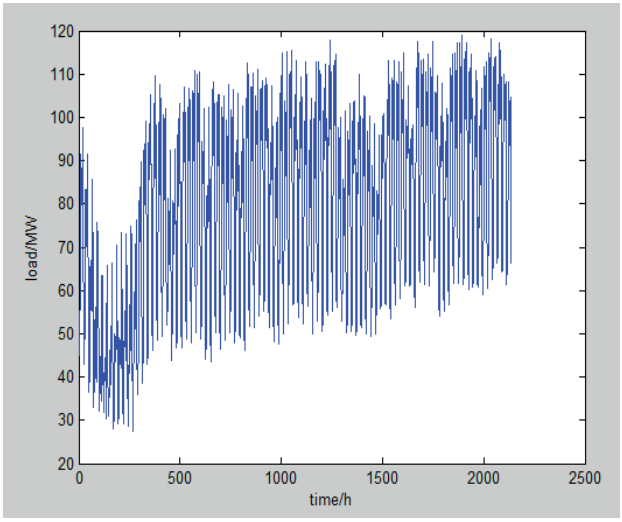

Figure 2. the original data series

(2) The establishment of BP neural network model, and determine the number of network layers and hidden layers, transfer function and training functions, determine the training network. Through constant try and improvement the final training times is 1000, the error is 0.01. After the training with the network as shown, network error meet the requirements.

```
>> net=newff(minmax(trainin),[8,1],{'logsig','tansig'},'trainlm');
net.trainParam.epochs = 1000;
net.trainParam.goal=0.01;
net.trainParam.show=100;
net=train(net.trainin.trainout');
TRAINLM, Epoch 0/1000, MSE 0.77294/0.01, Gradient 2128.62/1e-010
TRAINLM, Epoch 8/1000, MSE 0.00513468/0.01, Gradient 52.9853/1e-010
TRAINLM, Performance goal met.
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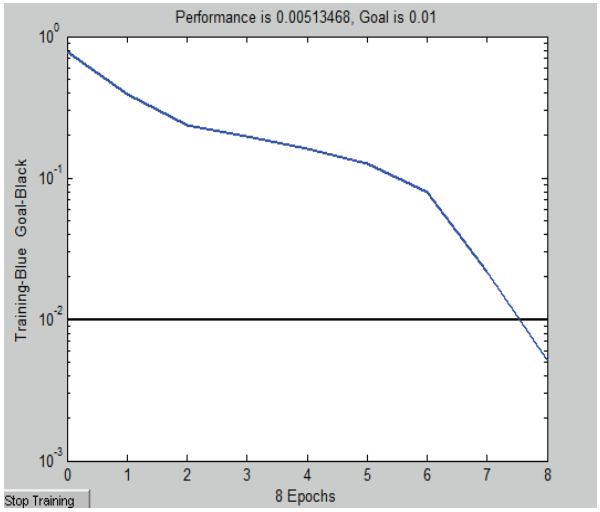

Figure 3. the training result

(3) The result of BP forecasting

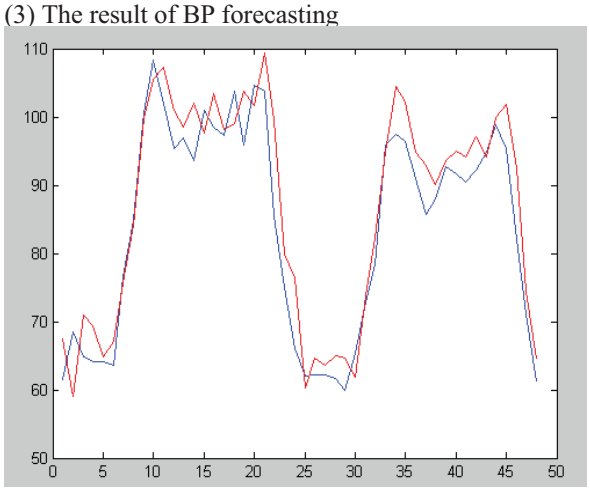

Figure 4. the actual load data and the forecasting load data

We can get load data of the twenty-ninth and thirty through the forecast date, which is shown above.

From the analysis above, we can see that the prediction error is very small, indicating the model forecasts are very accurate, and the model has considerable reference value. It follows that, the time series forecasting model using neural network has good predictive ability, and has good generalization ability.

TABLE I. THE FORECAST RESULT

May.1st	Fore. result	May.1st	Fore. result
1	57.118	13	68.359
2	57.692	14	69.53
3	56.506	15	70.256
4	56.904	16	68.488
5	59.309	17	70.567
6	58.424	18	71.964
7	66.097	19	73.558
8	69.868	20	74.754
9	70.516	21	79.201
10	71.6	22	76.63
11	74.047	23	67.693
12	72.779	24	57.855

V. CONCLUSIONS

Time series prediction problem is that an important aspect of dynamic data analysis and processing, this paper, we discuss that the theoretical basis of BP neural network time series forecasting, and analysis the BP neural network model and structure, and use the BP neural network to make time series prediction model. We also give the MATLA program, and choose one city to apply the model to prove the effective of the model and confirm the study in this paper. Limited by the shortcomings of its own BP neural network, the model also has some flaws. Along with the development of artificial neural networks, artificial neural networks in time series prediction of the applied research will have a very broad prospect.

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