

Teaching Mode on Short-term Load Forecasting based on BP Neural Network Model

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Abstract

Accurate prediction of the load can make the amount of power generation change with the system load, realize the line load and power balance, so as to help the power department to formulate a reasonable and effective power generation and distribution plan, provide a safe basic environment for the stable development of the power system, avoid energy loss, and fully improve the economic level. Therefore, according to the research of power load prediction, this paper summarizes the principle and technology of BP neural network prediction algorithm, and makes a short-term load prediction model of the power system of the network, and makes prediction results and error analysis for the model with 10 and 20 hidden layers successively.

Keywords

Teaching Mode; BP Neural Network; Short-term Load Prediction.

1. Introduction

With the development of society, there are more and more new energy power generation, such as photovoltaic power generation and wind power generation, etc. However, photovoltaic power generation and wind power generation are unstable, because they can only be generated under specific conditions [1]. Therefore, we need to do a good job in the research of short-term load prediction. It can provide reference for the future general direction of power generation. We have studied the development of electric energy at home and abroad, the western countries in the industrial needs, the load prediction method has been included in the research category. With the development of urbanization and industrialization in the West, some experts and scholars focus their research on short-term load prediction, and few researches on medium - and long-term prediction.

2. Overview of Power Load Forecasting

Table 1. Comparison of different prediction types

Forecast classification	Forecast cycle	role
Ultra-short term forecasting	By hour, divided into units	Plan power network real-time forecast, including all kinds of sudden failure analysis, AGC, real-time economic dispatching, etc
Short-term forecasting	In units of days	Plan the operation mode of power grid, coordinate the output situation of hydropower and thermal power and plan the power exchange, daily start-up and shutdown of units, etc
Medium-term prediction	Take months as a unit.	Arrange operation mode of generator set, reservoir operation plan, electric coal plan, monthly maintenance plan, etc
Long-term forecast	Take the year as the unit	Make long-term plan of power grid, including power grid operation structure and annual maintenance

The prediction of power load value is to find out the nonlinear relationship between the load value and the influencing factors from the point of view of the existing information of the influencing factors, and establish the corresponding model by using some reliable methods and means to predict the future power demand and deduce the load law curve.

According to the time of load forecast, we divide it into four types: long term, medium term, short term forecast and ultra short term forecast. Table 1 compares and analyzes four different forecasting types in terms of the forecasting function and the cycle.

3. BP Neural Network Power System Load Short-term Prediction

After data pretreatment, input layer data is set as 10×27 dimensional matrix (24 hours of power load data, daily maximum and minimum temperature and meteorological characteristic values (sunny, cloudy and rainy days)), and then hidden layer is set as 10 to conduct BP neural network model training. The training process is shown in Figure 1.

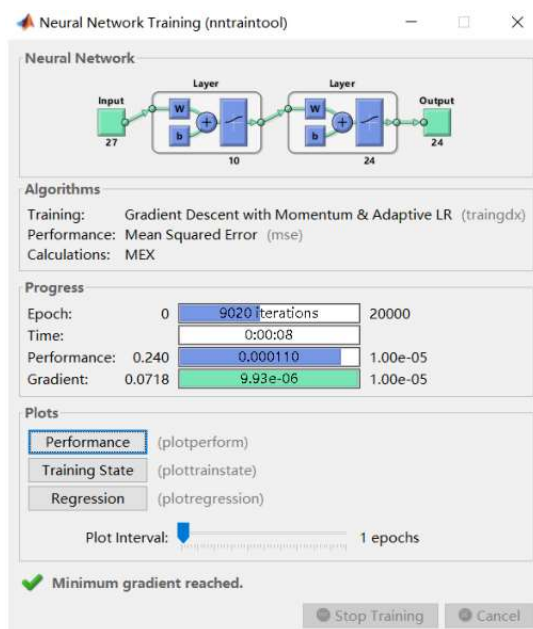


Figure 1. BP neural network with hidden layer 10

(1) Analysis of training process and training step length

The basic Settings of the BP neural network prediction model with 10 and 20 hidden layers are basically the same regardless of the number of layers.

And the number of hidden layer nodes is 10 the same weights and threshold of neural network training, the difference is in the step length is 5991 steps, model training results meet the requirements of the optimal results, achieve the established optimal prediction effect, model training is terminated, hidden layer for 20 training step length curve as shown in figure 3-5, figure 3-5 abscissa for training step, The ordinate is the relative mean square error.

By observing the training step length curve of the BP neural network model with 20 hidden layers, it can be seen that the variation range is large, which reflects that there are certain optimization problems between 0 and 500 steps when using the model for prediction training. The reason for this phenomenon is that the weight and threshold values of BP neural network do not reach the predicted standard during initialization processing, and optimization processing is needed to reduce the occurrence of this situation.

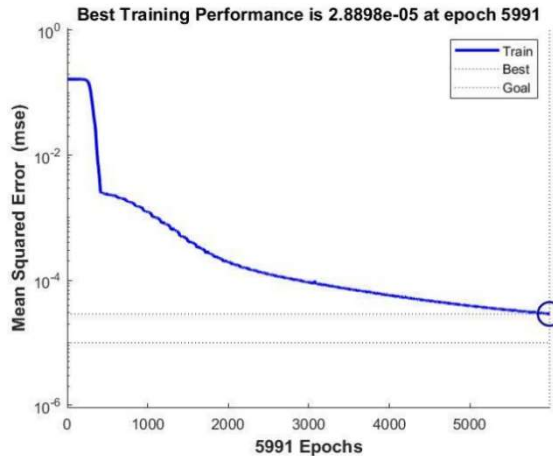


Figure 2. Training step curve of BP neural network model with hidden layer 20

(2) Analysis of prediction results

According to the training results of BP neural network model with hidden layer 20 in Figure 3-5, the average prediction results and single prediction results of BP neural network model were obtained, and the change curves of prediction results and actual results were drawn, as shown in Figure 3-6 below. Based on The analysis of Figure 3-6, it can be seen that the BP neural network model is used to predict the short-term power load within 24 hours. The model has obvious simulation effect on single-day power load, and it can simulate the change and fluctuation of single-day power load from the perspective of single prediction result or average prediction result. However, the difference between it and the hidden layer is that the actual load value is less than the single predicted value and the actual power load value is higher than the average predicted value from the perspective of the training step length curve, which indicates that the training effect of the first time is not ideal while the training effect of the second time is relatively ideal. On the whole, the simulation results of the model are more accurate.

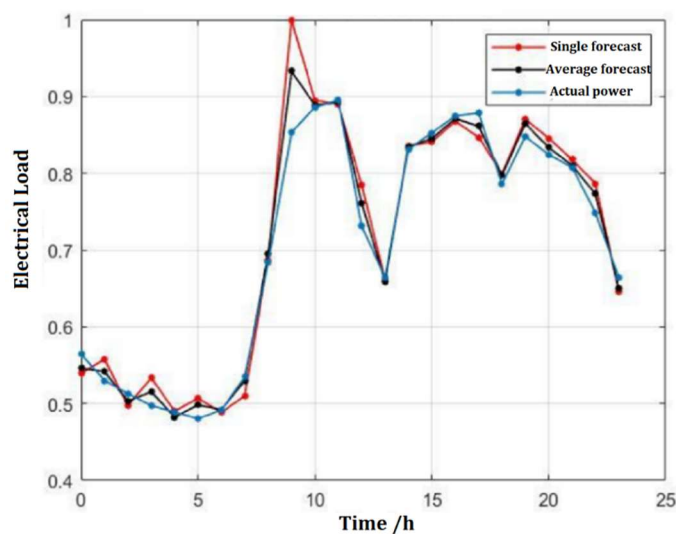


Figure 3. Predicted load and actual load curves of BP neural network model with hidden layer 20

(3) Error analysis

And hidden layer of BP neural network model for 10 forecast analysis, to analyze the load value and the actual load value of prediction error, the actual power load value and the hidden layer are calculated respectively for 20 of the BP neural network model to predict the load of absolute error (%), accumulated absolute error (%), the relative error (%), the cumulative relative error (%), as shown in table 2.

Table 2. BP neural network with 20 hidden layer

moment h	The actual load MW	To predict the load MW	Average forecast load MW	Absolute error%	Cumulative absolute error %	The relative error%	Cumulative relative error %
0	5611.21	5392.51	5462.2	2.51	1.79	4.47	3.17
1	5305.11	5581.44	5412.68	2.81	1.63	5.25	3.08
2	5124.61	4972.14	5033.57	1.56	0.98	3.06	1.91
3	4972.51	5335.1	5155.33	3.60	1.79	7.29	3.65
4	4882.61	4900.51	4822.81	0.13	0.75	0.25	1.54
5	4801.71	5068.3	4980.5	2.63	1.76	2.48	3.66
6	4933.11	4880.7	4922.34	0.34	0.38	0.64	0.75
7	5342.5	5102.07	5302.57	2.44	1.96	4.54	3.68
8	6832.4	6872.14	6948.65	0.34	1.08	0.46	1.60
9	8530.8	9999.14	9322.55	14.68	7.92	17.20	9.33
10	8864.2	8941.37	8885.46	0.85	0.62	1.00	0.70
11	8951.3	8902.4	8920.2	0.47	0.27	0.53	0.32
12	7311.2	7843.53	7611.55	5.32	3.02	7.13	4.12
13	6642.5	6612.57	6582.56	0.26	0.58	0.47	0.84
14	8315.1	8349.24	8346.35	0.41	0.35	0.52	0.45
15	8529.4	8405.73	8451.84	1.18	0.75	1.38	0.91
16	8742.6	8655.27	8712.54	0.68	0.36	0.75	0.42
17	8745.2	8472.27	8615.24	3.11	1.69	3.54	1.93
18	7844.8	7990.62	7970.5	1.33	1.11	1.66	1.44
19	8463.1	8701.44	8646.24	2.25	1.69	2.65	1.98
20	8249.2	8444.62	8334.27	2.15	1.22	2.50	1.47
21	8072.6	8176.58	8102.67	0.98	0.74	1.25	0.92
22	7481.6	7862.5	7725.45	3.81	2.45	5.09	3.26

By analyzing Table 3-2, the maximum values of absolute error (%), cumulative absolute error (%), relative error (%) and cumulative relative error (%) are 14.68%, 7.92%, 17.20% and 9.33%, respectively. The minimum values of absolute error (%), cumulative absolute error (%), relative error (%) and cumulative relative error (%) were 0.13%, 0.26%, 0.25% and 0.32%, respectively. By comparing the prediction effect of the model with 20 hidden layer, it can be seen that although the prediction and simulation effect of the model with 20 hidden layer are reasonable, the accuracy of the model with 10 hidden layer is a little lower than that of the model with 10 hidden layer. But it is worth noting that a maximum of four kinds of forecasting error value when the power system load is generally more than 3% of the standard, and the error value between the four 3% of maximum rose to a certain extent, it reflects the change of the BP neural network model in the prediction of power load without too much local optimization problem, need further improvement, In addition, when the hidden layers of the model are increased to 20 layers, the accuracy of power load prediction of the model decreases.

4. Comparative Analysis of Prediction Results of Different Hidden Layers

The prediction effect of BP neural network model with 20 hidden layer is not ideal. There is a large error between the prediction result and the actual value, and the error is more than 3% in most time periods. The BP neural network model with the hidden layer of 10 has the best prediction effect, and the error between the predicted result and the actual value is the smallest, and the error is less than 2% in different time periods, which indicates that the BP neural network model with the hidden layer of 10 has the best prediction effect. Although with the passage of time, the prediction effect will show a declining trend, but the overall prediction effect is relatively good within the error range of 3% stipulated by the power system.

Using BP neural network model for short-term power load forecasting, the changes of network training curve is obtained by training the network, the hidden layer selected 10, 20, respectively, by comparing the hidden layer of BP neural network model for 10, 20 predicted results can be concluded that although the number of hidden layer of BP neural network model for 20 steps prediction can reduce effectively, The computation time is effectively reduced, but the prediction effect of BP neural network model with the number of nodes is poor. However, this analysis showed that when the Numbers of hidden layers to 10, the established BP neural network model of prediction effect is the best, the predicted value and the simulation result accords with the actual situation the power load change, absolute and relative error of prediction is very small, and as time goes on, the model prediction effect will be better and better.

5. Conclusion

(1) A large number of historical power data should be collected between forecasts. In this study, only 12 days of electricity data information in this area were collected. Due to limited data samples and limited training space, the prediction effect did not reach the expected goal. Therefore, more attention should be paid to the collection of historical data information in future studies.

(2) The season studied in this paper is summer, and some research results have been made on the prediction effect and accuracy of power load in this season. However, the prediction effect of other seasons, especially winter, has not been verified in practice, or the prediction effect of this model in other regions also needs to be confirmed by further research. In the future, the scope of time and space research should be expanded to ensure the integrity of research results.

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