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Short Term Load Forecasting Using Time Series Neural Network

Kuldeep S[1] and Anitha G S[2]
[1]Dept. of EEE, Jain University, Bengaluru, India.
[2]Dept. of EEE, R V College of Engineering, Bengaluru, India.

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ABSTRACT
Short term load forecasting is very essential for daily planning in an electrical system. Power demand for the next few hours or days need to be predicted for smooth and economical running of a power system. Prior data is essential to make the prediction. There are different methods to do the forecasting or prediction based on previous data. This paper analyses the time series method of forecasting

I. Introduction

Load forecasting is a very important activity for estimating what future electric load will be for a given period based on the available information about the state of the system [1].

Based on the time period, load forecasting methods can be:

i. Long-term: Months to years. This is for future planning, expansion, staffing, and purchase of equipment.

ii. Mid-term: Weeks to months. Used for scheduling fuel supplies and unit maintenance.

iii. Short-term: Hours to weeks.To plan the generation and transmission of electricity.load transmission and load shedding.

iv. Very short-term: Shorter than a day.To supply necessary information for the system management of day- to-day operation.

Electrical loads are not constant and vary continuously. The reasons for the change in the loads can be classified as [2] -

i. Time:Time of day, type of day(holiday, workday, weekend)

ii. Weather:Temperature,humidity, rain, climate, wind, comfort index

iii. Economic factors: Rural, urban loads, industrialization, cost

iv. Random disturbance: Sudden shutdown and start of large loads, intermittently working machines and industries

II. What is short term load forecasting?

Short-Term Load Forecasting (STLF) is used to predict load behaviour for a period ranging from a few hours to few days. For day to day operation of a power station, substation, STLF is very essential. Proper scheduling of loads can be made with the data provided by STLF.

Short Term Load forecasting methods can be broadly classified as parametric and artificial intelligence methods.

* Parametric methods use previous data as a reference. They can be regression, similar day approach.

* Artificial intelligence methods consist of Artificial Neural Networks (ANN), Fuzzy logic,Expert Systems (ES), Machine Learning, Support Vector Machines (SVM) and Hybrid.

For STLF, feedforward time series model of ANN is suitable for predicting the next time instant load. Whatever is the method used in forecasting, previous data is very much essential for predicting the next unknown variables. Electrical load is a variation of load against different time instants, be it hours, days, weeks, months or years. Traditional time series forecasting method of using similar day approach is simple, but not accurate. Load is nonlinear, so the traditional methods cannot handle such data [3].

In time series method, previous data is used as reference to predict data for the next instants, that is, past data is used to extrapolate the future values. A sequence of values over regular time units is called a time series. In feedforward time series neural network model, a set of data is extracted out of the data for training the network. Time series predictions are of two types, One lag and Multi lag.

In one lag prediction, next immediate value is predicted only on actual past values. For input data of x1 to x4, prediction for the 5th instant, p5 is made only using actual data from x2 to x4.

In multi lag prediction, predicted values are appended to input database and used to predict future values. Value of the fifth instant is predicted without knowing the values of the next five instants

p5 predicted from x1, x2, x3, x4
p6 predicted from x2, x3, x4, p5
p7 predicted from x3, x4, p5, p6
and so on.

Two classes for prediction model networks are-

i. Recurrent neural networks

ii. Feedforward networks

i. Recurrent Neural Networks:

The neural network contains connections from input to output layers through the hidden layers.

Tele:
E-mail address: s.kuldeep@jainuniversity.ac.in

They also contain interconnections between nodes of the same hidden layer

ii. Feedforward networks:

An external input vector i(t) is converted to a preprocessed vector i'(t) and fed to the time series network. The network is trained to calculate the desired output value for a specific input i'(t).

i(t) consists of single input i(t)

i'(t) consists of vector (i(t-1),i(t-2)) supplied as input to the feedforward network, that is, previous instant values

Preprocessing consists of storing past values of the variable and supplying them to the network along with the latest value. This is called Tapped Delay line Neural Network (TDNN) consisting of a sequence of delay units or buffers with the values of variables at recent instants being supplied to the feedforward predictor component [4].

III. Methodology

A case study was taken up for the data provided by Bengaluru Electric Supply Company (BESCOM) for the month of March, 2016. Training the feedforward time series ANN is done by using one day data. This data is preprocessed by normalizing it.

Normalizing is the process of reducing the data into values between 0 and 1. By normalizing, calculations become easier. Neural networks usually output their data between -1 and +1, or 0 and 1. Data preprocessing makes the training faster and accurate. After the data is processed, it can be denormalized to get the actual values.

To normalize, data is all columns is reduced to a base value. This is done by dividing all the elements in that column by the largest number in the column.

Table 1. Actual and normalized values.

Actual	Normalized
276	0.7885
342	0.9771
222	0.6342
350	1.0000
290	0.8285

For example, the largest number in the table is 350, which is used as a base. 276/350 is 0.7885 which is the normalized value for 276 with a base of 350.

For the case study, single input nonlinear autoregressive neural network (NARNET) using MATLAB [5] software is used. A NARNET predicts target outputs using previous values of the target provided to it. A delay of one variable is used using one lag prediction model. Transfer function used is hyberbolic tangent sigmoid (tansig). Data is taken for a period of 23 hours in a single day and this data is randomly divided into training and testing data.

Out of the various training functions like gradient descent,Levenberg-Marquardt back propagation, Scaled conjugate gradient back propagation, Resilient back propagation, One-step secant backpropagation,Bayesian regularization backpropagation was found to be the best suitable for this study.The function updates the weight and bias values according to Levenberg-Marquardt optimization. It minimizes a combination of squared errors and weights, and then determines the correct combination so as to produce a network that generalizes well.The network was trained multiple times and good results were seen with this training function.

The dataset is trained with different combinations of hidden neurons. One hidden layer is used between input and output layer,but the number of neurons in the hidden layer depends on the number of inputs, type of inputs. One single dataset is used and reused to get the next predicted value.

Training the network is done by taking 23 time instant variables, for a 23 hour period, using Bayesian regularization backpropagation. Once trained, the network predicts the next, that is, the 24th instant value. A one lag prediction model is used. For best results, the network is trained multiple times. It was found after repeated trainings that the optimum number of hidden neurons for this set of data is 40. This number may vary for different number of inputs, and different type of inputs.

IV. Observations

Below graph compares the delayed response outputs for different number of hidden neurons.

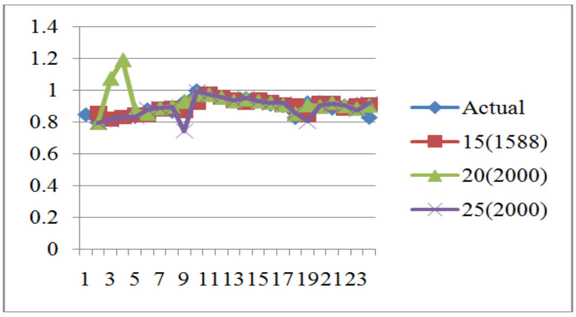

Fig 1. Actual values and outputs for 15, 20, 25 hidden.

In the Figure 1, the graph line with diamond markers represents the actual data. The other graphs are for hidden neurons of 15, 20 and 25. The numbers in brackets represent the maximum epochs reached after multiple trainings.

Similarly, graphs comparing actual and 30, 35, 40 hidden neurons below.

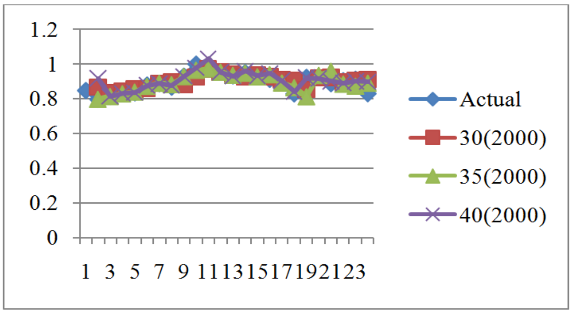

Fig 2. Actual values and outputs for 30, 35, 40 hidden.

As stated earlier, best results were found for 40 hidden neurons for this dataset.

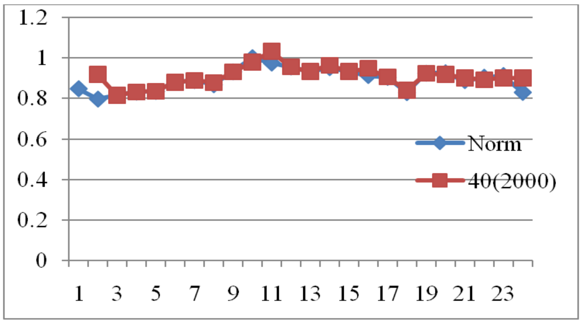

Fig 3. Actual values and output for 40 hidden neurons.

The above graph compares the actual data with the outputs of a network that is trained with 40 hidden neurons. The feedforward time series network predicts the next, 24th variable, for the 24th hour. The data provided by BESCOM for the 24th hour is 3870 MW, which is 0.8295 when normalized with a base of 4665 MW, the highest value on that day. The predicted value by the network is 0.8995, with an error of -0.0699, as displayed in the graph of Fig 3.

V. Conclusion

The one lag feedforward time series neural network takes in a set of values from 1 to 23, for 23 hours, and uses this data to predict the load for the 24th hour. This further can be used to predict the load for subsequent hours. The network is fed data that is raw, that is, it is not segregated into weekday, holiday, or weather factor is not taken into account. This study is mainly to study the one lag network using time series as a tool for prediction. The results can be more accurate if the data is segregated as above. Also, a combination of two or more methods can yield more accuracy in the results. This will be taken up as future work.

References

[1]. Eisa Almeshaiei, Hassan Soltan,"A methodology for Electric Power Load Forecasting", Alexandria Engineering Journal (2011) 50, 137–144

[2]. Isaac Samuel,Tolulope Ojewola, Ayokunle Awelewa ,Peter Amaize,"Short-Term Load Forecasting Using The Time Series And Artificial Neural Network Methods", IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE), e-ISSN: 2278-1676,p-ISSN: 2320-3331, Volume 11, Issue 1 Ver. III (Jan. – Feb. 2016), PP 72-81

[3]. Kwang-Ho Kim, Jong-Keun Park, Kab-Ju Hwang, Sung-Hak Kim, "Implementation of Hybrid Short-term Load Forecasting System Using Artificial Neural Networks and Fuzzy Expert Systems",IEEE Transactions on Power Systems, Vol 10, No 3, August 1995

[4]. Kishan Mehrotra, Chilukuri K Mohan, Sanjay Ranka, “Elements of Artificial Neural Networks”, Second Edition

[5]. https://in.mathworks.com/