A comparison study of Energy prediction using artificial neural network by nearest neighbour and back propagation algorithm

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Abstract: System Load forecasting is very essential part for the power system planning and operation. In this paper the modeling and design of artificial neural network for load forecasting is carried out in a particular region of INDIA. Neural network approach helps to reduce the problem associated with conventional method and has the advantage of learning directly from the historical data. The neural network here uses data such as past load, weather information like humidity and temperatures. Once the neural network is trained for the past set of data it can give a prediction of future load.

This reduces the capital investment reducing the equipment to be installed. The actual data are taken from the BSES Electrical Company, INDIA. The data of load for the year 2006, 2008 and 2012 are collected for a particular region called Al DELHI in INDIA and trained using neural networks to forecast the future.

The main objective is to forecast the amount of electricity needed for better load distribution in the areas of this region in INDIA. The load forecasting is done for the year 2012 and is validated for the accuracy.

The aim of this study is to attempt to predict the short-term term future of the electric company and government revenue more specifically prediction of the returns provided by the energy data on daily and hour basis is attempted. The first objective of the study is to examine the feasibility of the prediction task and provide evidence that the energy consumption are not fluctuating randomly. The second objective is, by reviewing the literature, to apply the most suitable prediction models and measure their efficiency.

Keywords: Load forecasting, Neural network, Power system, Back propagation, Energy consumption, Nearest neighborhood
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1. Introduction

Accurate Energy load forecasting is become crucial in power system operation and planning both for deregulated and regulated electricity market. Electric load forecasting can be divided into three categories that are short term load forecasting, medium term load forecasting and long term load forecasting. The short term load forecasting predicts the load demand from one day to several weeks. It helps to estimate load flows that can prevent overloading and hence lead to more economic and secure power system. The medium term load forecasting predicts the load demand from a month to several years that provides information for power system planning and operations. The long term load forecasting predicts the load demand from a year up to twenty years and it is mainly for power system planning.

A variety of methods including neural networks, time series hybrid method and fuzzy logic have been developed for load forecasting. The time series techniques have been widely used because load behavior can be analyzed in a time series signal with hourly, daily, weekly, and seasonal periodicities.

2 Nomenclatures

1.	E	Network error
2.	IB	Input signal of unit B
3.	n	Number of neurons
4.	WnB	Weight connecting neuron n to neuron B
5.	WAB	Weight Connecting neuron A to neuron B
6.	X1	Input 1 to neural network

7. X2 Input 2 to neural network
8. y Output from the neural network

2. Artificial Neural Networks:

A neural network may be considered as a data processing technique that maps, or relates, some type of input stream of information to an output stream of data. Neural Networks (ANNs) can be used to perform classification and regression tasks.

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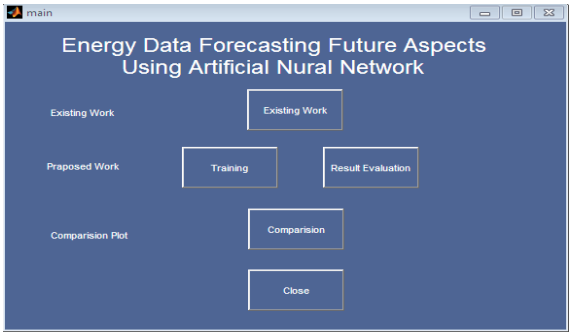
PROBLEM STATEMENT:

With respect to system load forecasting we identify the predictive value on the basis of some previous year data, some rules are applying of means and mode value we identify the data redundancy, if data amount is large and stock of previous year data.
Then we find the system load accuracy very slow. After processing of the data, it shows approx 56% accuracy.

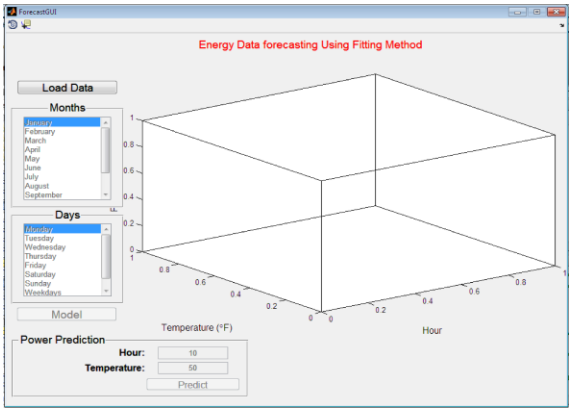
PROPOSED WORK:

When energy consumption is high with respect to system load high, the mobility of the load energy will find the maximum predicted value after preprocess with neural network and fitting method.
With respect to previous study data training and testing work improved and fitting method will roll back the least predictive value on the basis of monthly data in to dataset. Accuracy rate should be moreover as far previous study.

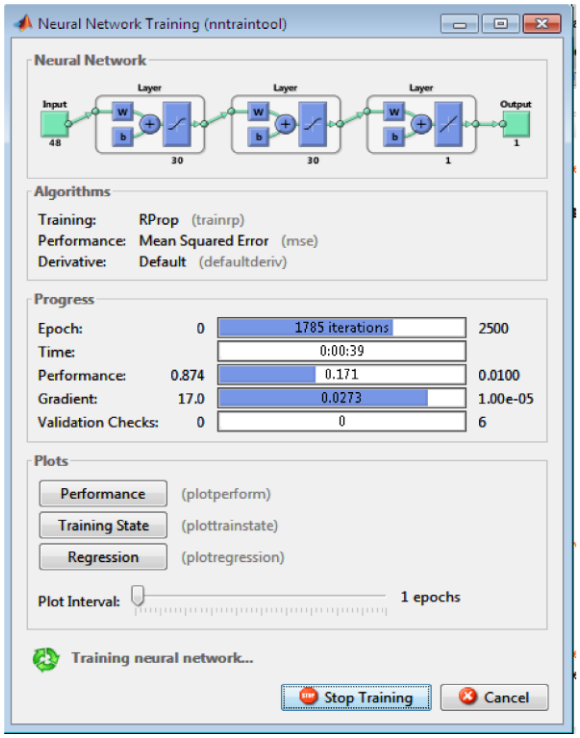
1. Finalayout



2. Existing work



3. Training



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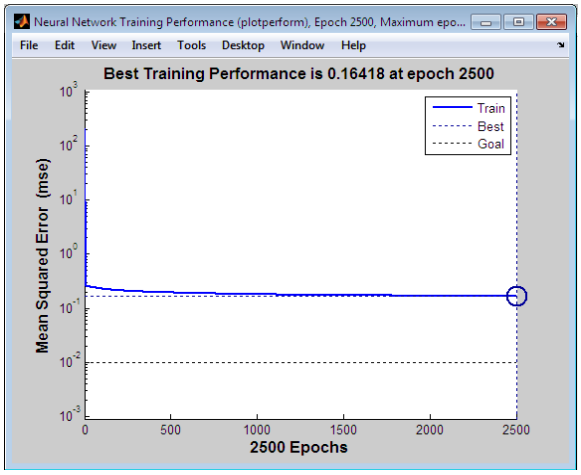
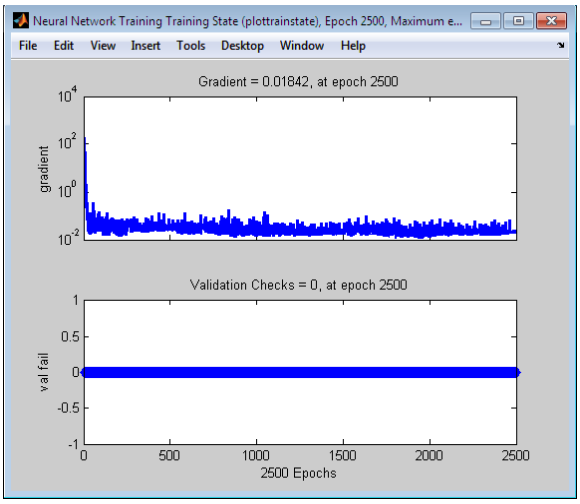
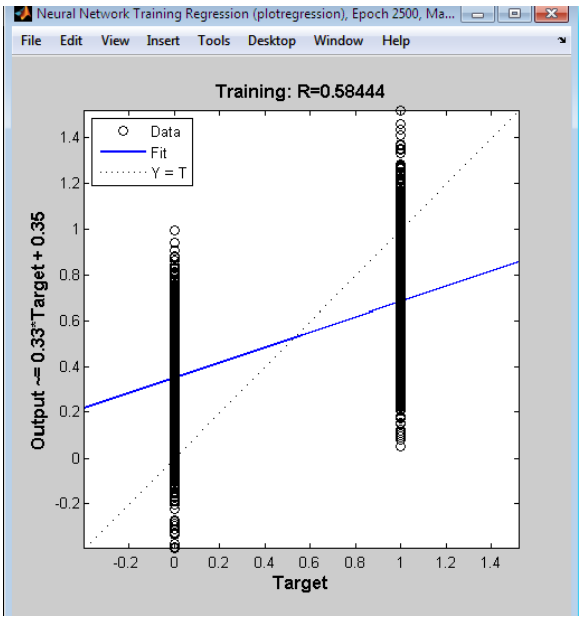


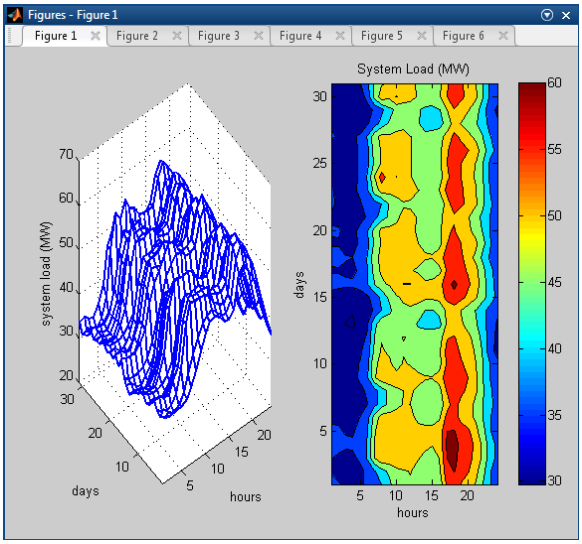
Training state

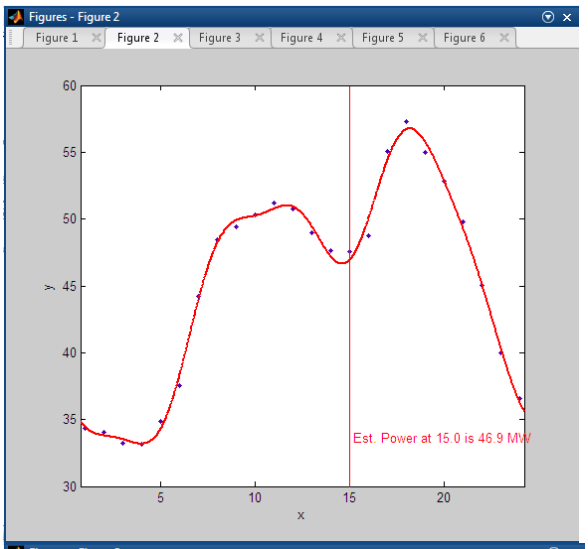


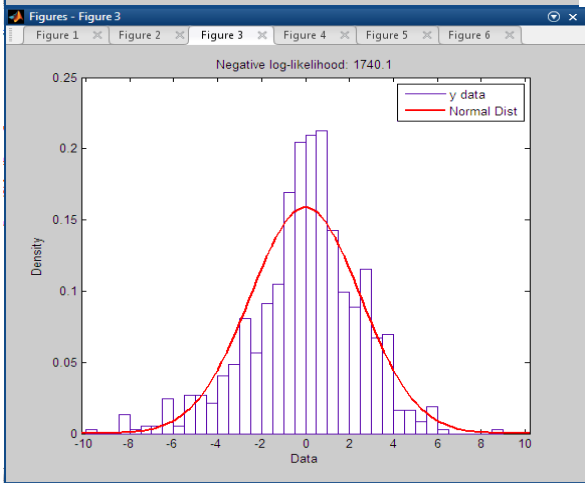
- **Regression**

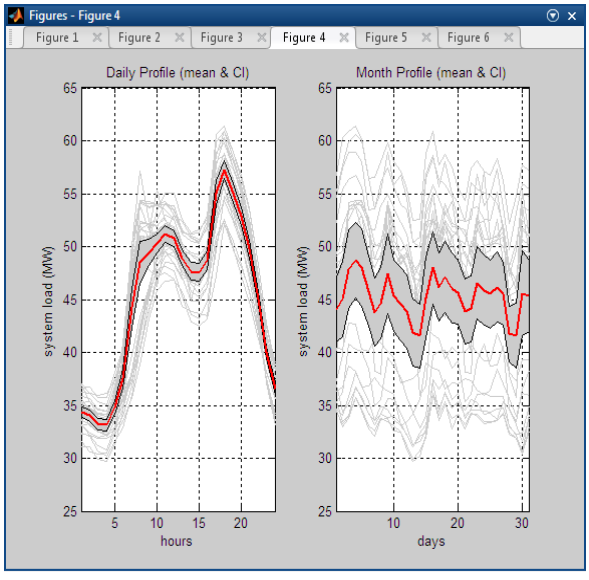


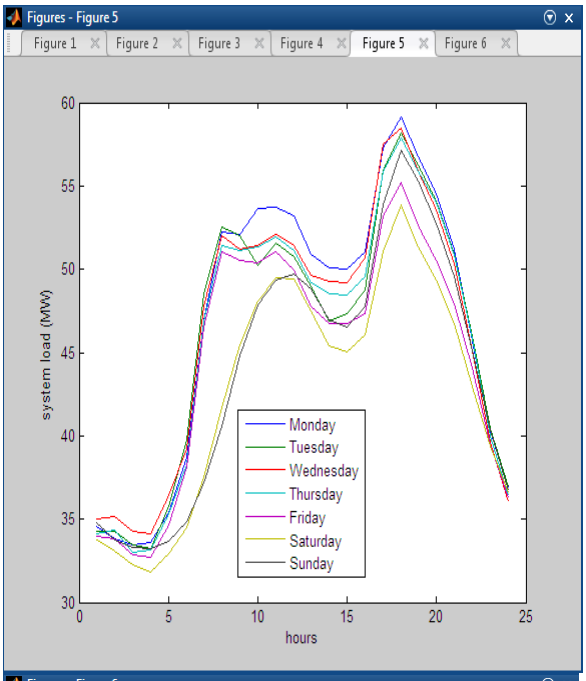
4. Result evaluation

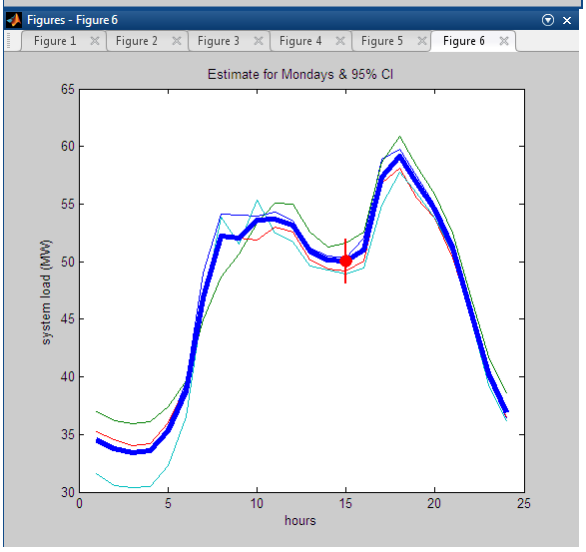




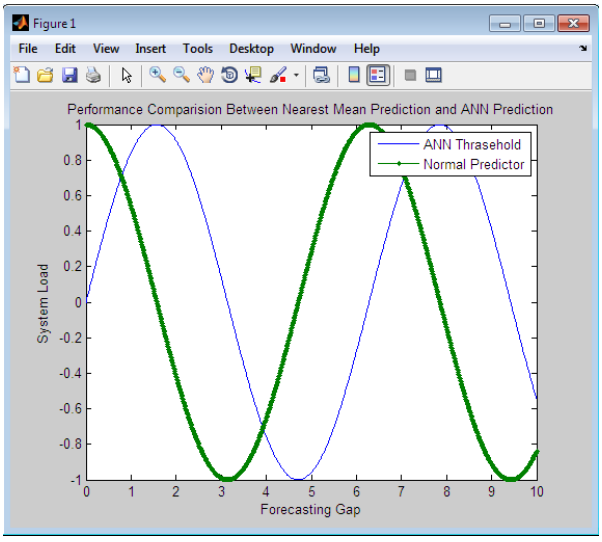








5. Comparison graph



METHODS:

ANN methodology underestimates the design of ANN architecture (topology) and methods of training, testing, evaluating, and implementing the network .Since the data regarding the evaluation and implementation phase were not available in all analyzed articles, the paper is focused on ANN architecture, training and testing.

Tree based classification:

Classification trees are used to predict membership of objects in the classes of a categorical dependent variable from their measurements on one or more predictor variables. The goal of classification trees is to predict or explain responses on a categorical dependent variable, and as such, the available techniques have much in common with the techniques used in the more traditional methods of Discriminant Analysis, Cluster Analysis, Nonparametric Statistics, and Nonlinear Estimation. The flexibility of classification trees makes them a very attractive analysis option as it does not require any assumption on the distribution like traditional statistical methods.

Back Propagation Algorithm

To summarize the process of back propagation:
• A pattern is presented to the network (i.e., the input values)
• The input is propagated through the network to give an output
• The actual output is compared with the desired output and an error function is defined (that we have to minimize)
• The errors are propagated back though the network to determine the amount by which to update the weights
• Update the weights
• Repeat this process for each pattern (when all patterns have been used we say one epoch has been completed)
• Continue until for one epoch, all outputs for each pattern are within the tolerance.
• Then we can say the network is trained and can be tried on test data.

K-nearest neighborhood method:

K-nearest neighbor method is one of the simplest machine learning algorithms used for classifying objects based on closest training examples in the feature space. An object is classified by a majority being assigned to the class most common amongst its k nearest neighbors. Formally, the k-nearest neighbor approach uses the training data set $\{(x1, y1), \ldots, (xn, yn)\}$ closest in input space to x to form Y' .

The algorithm starts with the determination of the optimal k based on RMSE done by cross validation technique, then calculate the distance between the query distance and all the training samples. After sorting the distance and determination of the nearest neighbors based on the kth minimum distance, gather the Y of the nearest neighbors. Finally, use simple majority of the category Y of nearest neighbors as the prediction value of the query distance. Noticeably, the k-nearest neighbor approach does not rely on prior probabilities like LDA and QDA.

Methods are apply towards dataset on nearest neighborhood and ANN

Month	Day	Hour	DayOfWeek	Holiday	Power	Temperature
1	1	1	7	0	54.5448	19.0000
1	1	2	7	0	52.3898	18.8500
1	1	3	7	0	51.6344	17.8650
1	1	4	7	0	51.5597	17.2800
1	1	5	7	0	51.7148	15.9182
1	1	6	7	0	52.6898	16.2400
1	1	7	7	0	55.3410	17.5250
1	1	8	7	0	57.9512	17.2350
1	1	9	7	0	62.3844	18.1500
1	1	10	7	0	66.2962	19.3000
1	1	11	7	0	67.9479	21.0316
1	1	12	7	0	68.4049	22.0650
1	1	13	7	0	67.4961	23.0000
1	1	14	7	0	66.2013	24.1000
1	1	15	7	0	64.9540	24.2350
1	1	16	7	0	65.8897	25.0000
1	1	17	7	0	74.9203	24.9700
1	1	18	7	0	76.4434	24.8300
1	1	19	7	0	74.2872	24.8650
1	1	20	7	0	71.5383	24.2350
1	1	21	7	0	68.4996	25.0000
1	1	22	7	0	63.6414	24.8650
1	1	23	7	0	58.3511	24.1000
1	1	24	7	0	53.7491	24.1000
1	2	1	1	1	51.8118	24.2615
1	2	2	1	1	50.6470	24.1000
1	2	3	1	1	50.1112	24.3423
1	2	4	1	1	49.5164	24.7375
1	2	5	1	1	50.9446	23.6650
1	2	6	1	1	54.3895	21.4700
1	2	7	1	1	59.1938	22.8350
1	2	8	1	1	63.3357	22.2300
1	2	9	1	1	67.5723	24.8200
1	2	10	1	1	70.5170	29.3650
1	2	11	1	1	71.8867	32.6000
1	2	12	1	1	72.5931	36.4500
1	2	13	1	1	71.3522	39.0000
1	2	14	1	1	69.9583	39.1350
1	2	15	1	1	68.8678	39.6000

Benefits and limitations of ANN methodology:

Benefits:

Most of the benefits in the articles depend on the problem domain and the ANN methodology used. A common contribution of ANN applications is in their ability to deal with uncertain and robust data. Therefore, ANN can be efficiently used in stock markets, to predict either energy consumption or system load balancing.

It can be seen from a comparative analysis that the Back propagation algorithm has the ability to predict with greater accuracy than other ANN algorithms, no matter which data model was sed. The variety of data models that exist in the papers could also be considered a benefit, since it shows ANNs flexibility and efficiency in situations when certain data are not available. It has been proven that ANN outperforms classical forecasting and statistical methods, such as multiple regression analysis and discriminate analysis. When joined together, several ANNs are able to predict values very accurately, because they can concentrate on different characteristics of data sets important for calculating the output. Analysis also shows the great possibilities of ANN methodology in various combinations with other methods, such as expert systems. The combination of the ANN calculating ability based on heuristics and the ability of expert systems to process the rules for making a decision and to explain the results can be a very effective intelligent support in various problem domains.

Limitations:

Some of the ANN limitations mentioned in the analyzed articles are:

(1) ANNs require very large number of previous cases

(2) "the best" network architecture (topology) is still unknown

(3) For more complicated networks, reliability of results may decrease

(4) Statistical relevance of the results is needed

(5) A more careful data design is needed.

The first limitation is coANNected to the availability of data, and some researchers have already proven that it is possible to collect large data sets for the effective stock market predictions.

The limitation still exists for the problems that do not have much previous data, e.g. new founded companies. The second limitation still does not have a visible solution in the near future. Although the efforts of the researchers are focused on performing numerous tests of various topologies and different data models, the results are still very dependent on particular cases. The third limitation, concerning to the reliability of results, requires further experiments with various network architectures to be overcome. The problem with evaluating ANN reliability is coANNected with the next limitation,

the need for more complex statistical relevance of the results. Finally, the variety of data models shows that data design is not systematically analyzed. Almost every author uses a different data model, sometimes without following any particular acknowledged modeling approach for the specific problem.

ALGO USED

Existing Algorithm:

The nearest neighbor means algorithm for a 2d feature space. Means is one of the simplest unsupervised learning algorithms that partition feature vectors into k clusters so that the within group sum of squares is minimized. The procedure follows a simple way to classify a given data set and looks like that:

Step 1: Place randomly initial group centroids into the 2d space.
Step 2: Assign each object to the group that has the closest centroid.
Step 3: Recalculate the positions of the centroids.
Step 4: If the positions of the centroids didn't change go to the next step, else go to Step 2.
Step5: basis of centric value will identify the predicted value.
Step 5: End.
Hereby using some mathematical iteration with nearest neighbor.

Proposed algorithm:

Step1.Stochastic Back propagation (training examples, η, n_i, n_h, n_o)

Step2.Each training example is of the form $\langle \vec{x}, \vec{t} \rangle$ where $\vec{x}$ is the input vector and $\vec{t}$ is the target vector. η is the learning rate (e.g., .05). n_i, n_h and n_o are the number of input, hidden and output nodes respectively. Input from unit i to unit j is denoted x_{ji} and its weight is denoted by w_{ji}.

Step3.Create a feed-forward network with n_i inputs, n_h hidden units, and n_o output units.

Step4.Initialize all the weights to small random values (e.g., between -.05 and .05)

Step5.Until termination condition is met, Do For each training example $\langle \vec{x}, \vec{t} \rangle$ Do

1. Input the instance $\vec{x}$ and compute the output o_u of every unit.
2. For each output unit k, calculate

$$\delta_k = o_k(1 - o_k)(t_k - o_k)$$

3. For each hidden unit h, calculate

$$\delta_h = o_h(1 - o_h) \sum_{k \in Downstream(h)} w_{kh}\delta_k$$

4. Update each network weight w_{ji} as follows:

$$w_{ji} \leftarrow w_{ji} + \Delta w_{ji}$$
$$\text{where} \quad \Delta w_{ji} = \eta \delta_j x_j i$$

CONCLUSION:

The result used for LONG short term load forecast for the Delhi region in Delhi shows that any network has a good performance and reasonable prediction accuracy was achieved for this model. Its forecasting reliabilities were evaluated by computing the mean absolute error between the exact and predicted values. We were able to obtain an Absolute Mean Error (AME) of 2.64% which represents a high degree of accuracy. The results suggest that ANN model with the developed structure can perform good prediction with least error and finally this neural network could be an important tool for long term load forecasting.

However, it can be concluded from previous research that:-

(1) ANNs are efficiency methods in the area of power electric predictions, but there is no "recipe" that matches certain methodologies with certain problems.
(2) ANNs are most implemented in forecasting system load and its predictive value, although energy modeling is very promising problem domain of its application.
(3) Most frequent methodology is the Back propagation algorithm, but the importance of
Integration of ANN with other artificial intelligence methods is emphasized by many authors.
(4) Benefits of ANN are in their ability to predict accurately even in situations with uncertain data, and the possible combinations with other methods.
(5) Limitations have to do with insufficient reliability tests, data design, and the inability to identify the optimal topology for a certain problem domain.

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