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Effects and Analysis of Activation Functions in Artificial Neural Networks Using NN Tool In Matlab on Weather Parameters.

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ABSTRACT: Implementation of Activation Functions in Elman Back propagation Neural Network, NARX(Non-linear Auto Regressive Exogeneous) and Feed Forward Back Propagation Neural Network have been done and also studied the effects of those Activation Functions in terms of Accuracy by using the best measure known as RMSE. We have discussed Best Validation Performance in all the cases. We used very large dataset, which is for a period of five years of our country consisting of Weather parameters such as Minimum Temperature, Maximum Temperature, Visibility and Wind speed for Training, Testing and Validation. In the present work Elman Back Propagation shows accurate results. Simultaneously, Activation Function TANSIG supports the Neural network with not much difference comparing to others.

Keywords: Back Propagation Neural Network, NARX, Feed Forward Neural Network, Activation Function, NN Tool.

INTRODUCTION

NN consists of Input layer, Hidden layer and Output layers. The Artificial neurons are interconnected to each other through a synaptic weight. The input neuron receives weighted values. Some of neurons are processes by activation function and producing the outputs. The data will be divided into 3 fractions i.e. 70% for Testing, 15% for Training and 15% for Validation. So the system is learning data at 70% and for remaining 30% is used as Validating data after Training. The ability of NN is to develop a complex non linear relationship, which can produce accurate results.

Coech[1] in the paper "Forecast Calibration and combination: A simple Bayesian Approach for ENSO" used linear Regression between December and the preceding July Nino – 3.4 index values over the period 1950-2001. For Forecasts accuracy the author used Mean Absolute Error. Sidiq[2] in the article "Forecasting Rainfall with Time Series models" have studied forecast Rainfall with Time series model. The author took 2011 January to 2014 December i.e. 48 observations. They performed ACF and PACF plots and AIC for different ARIMA models and the best among is ARIMA(1,1,1) model with MAD 82.72. Ankit Chaturvedhi[3] discussed about rainfall prediction in Delhi and was analyzed using Neural Network Back Propagation algorithm. Three layer model has been used for training and studying different attributes of the hidden neurons in the network. Zakaria et al[4] published a paper "Enhancing the productivity of Wire Electrical Discharge Machining Toward Sustainable Production by using Artifical Neural Network Modelling". Here ANN technique was carried out for predicting sustainable measures and measured with accuracy of relative error 0.27%. Yousra Amellas et al[5] in their paper wind speed is predicted with the help of Multilayer Perception and NARX and measured Accuracy with performance of Correlation coefficient and RMSE values. Daily data has taken from the year 2015 to 2017. He concluded that NARX shows better performance than MLP. With the help of Artificial Neural Network, Fadairo A.S. Adesina et al[6] explains about mud density of 30 datasets using pressure and temperature Syaharuddin et al [7] in their published paper, 21 times data is trained with help of training functions and transfer functions by considering parameters Rainfall, Air humidity, Temperature and Wind speed for Ten years duration and found that losig and trainrp was the best among them. Jesibha Rani and Kumar Chandar [8] took the monthly data from 2011 to 2017 and Net Asset value is predicted with Feed forward back propagation network with LM algorithm and found with highest R that fits between network output and target output. Shaikh and Sawlani [9] formulated three layered network for rainfall prediction in the region of Mumbai and analyzed using Feed forward network for rainfall months(June to September) from 2013 to 2015. Usman et al [10] showed that Radial Basis Function is capable to forecast

when compared to equivalent Back propagation networks with SSE, MSE and correlation coefficients as measures of Accuracy for the period 1980-2005.

METHODOLOGY

The data is processed using MATLAB software tool. The software will receive the data together with specified initial weight. The system is then training and validated. If output differs, system will retrain weight until there is no error. Finally, we can also do prediction by this process.

a) Data Collection

In the present study, data is retrieved from the particular website[11] for a period of 5 years from 2014 to 2019 having Minimum Temperature, Maximum Temperature, Visibility, Wind speed as parameters.

i) **Temperature :** It is a measure of climatic heat by using latitude and atmospheric variables like wind speed, visibility etc.
ii) **Windspeed:** It is a flow of gases from one place to another place, wind speed is high when gases are low weight and wind speed is low when gases are high in weight. Several variables causes wind speed such as temperature, vibility, strom etc.
iii) Visibility: It is a measure of horizontal opacity of atmosphere at point of observation and expressed in terms of horizontal distance.

b) NNTool

NN tool box provides algorithms, pretrained models which allows us to import, create, use and export NN and data.

Levenbern-Marquadrt(LM) Algorithm is ready to use option to minimize a set of data resulting from a black box equation. It uses Back Propagation which is the most effective in NN literature.

TRAINLM is a network Training Function that updates weight and bias values according to LVM optimization. It is often fastest Back Propagation Algorithm in toolbox and a best supervised Algorithm, although it does require more memory than other. Training function forecast performance using MSE is used as a Performance Function.

LEARNGDM adaption function is used to explain change of weight from layer from input and error and also weight and learning rates. This is a learning function of gradient descent with weight and bias. Generally for measures of network's accuracy performance they used mean square error criteria.

Activation Function or Training function

It decides if neurons should be activated/triggered or not based on total sum. There are different types of Activation Function. In the present study, we are using

1) **TANSIG** – Hyperbolic Tangent is a training function which calculates a layer's output from its net input.
2) **LOGSIG** – It generates output between 0 and 1 as neuron's net input goes from negative to positive infinity.
3) **PURELIN** – It is a neural transfer function and is convenient representation of a linear time invariant dynamic system.

c) Network Types used in this study

There are different kinds of NN in NN tool. Among them, we had implemented

Back Propagation is a common method of training a neural net in which the initial system output is compared to the desired output and the system is adjusted until the difference between the two is minimized. It is an algorithm for supervised learning of ANN using Gradient Descent.

Elman Back Propagation : It is a 2 layered network in which a recurrent connection exists from output of hidden layer to its input.

Feed Forward Back Propagation: Basic type of NN is MultiLayered Perceptron, which is Back Propagation Neural Network. Here nodes never form a cycle. It is the first and simplest type of ANN. This kind of NN has an input, hidden and output layer. It is part of Back Propagation Algorithm but comes before Back Propagation signals from nodes.

NARX : It is a recurrent dynamic network with feedback connections enclosing several layers of network. It is based on Linear ARX model, which is commonly used in Time Series Modelling.

RESULTS AND DISCUSSION

Steps to perform neural networks in METLAB is as follows

i). .Type **NNtool** in Command Window.

ii). Click on **IMPORT** to Import data.

a)Select data for input and click **Input data.**

b)Select data for Target and Click **Target data.**

iii). Click on **New** to create Neural Network. Here we can adjust type of Network, Training and Transfer Function, number of neurons etc. click on Create and close window.

iv). Go back to **Network/Data Manager** and double click on Network.

v). We can adjust training parameters till we get desired output. Click **Train Network**.

vi). The summary of Performance of Training Window will appear. From this window, Plots of Performance, Training state and Regression Plot can be accessed.

vii). At last **Export Errors/Outputs** to Matlab Workspace.

In the present study, We discussed with Performance Plot. In all the cases, Training Function is **TRAINLM**, Learning Function is **LEARNGDM**, Performance Function is MSE. We had changed types of Network and Activation function respectively i.e We used **Elman Back Propagation**, **NARX, Feed Forward Back Propagation** and as activation functions **PURELIN, TANSIG, LOGSIG** had been used simultaneously. The following figures show the Trained Network models and their Performance Plots.

FIGURE 1.1 Elman BPNN with Tansig

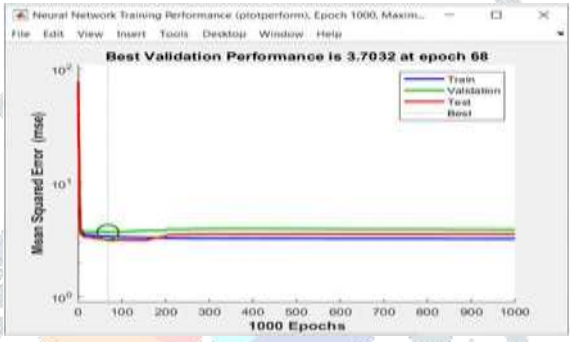


FIGURE 1.2 Elman BPNN with LOGSIG

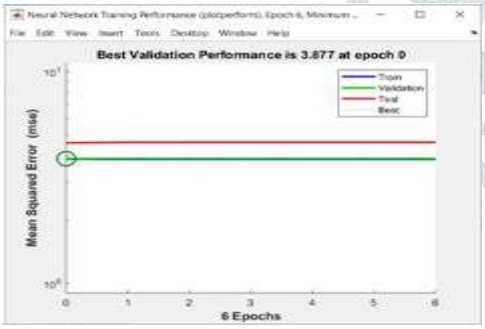


FIGURE 1.3 Elman BPNN with PURELIN

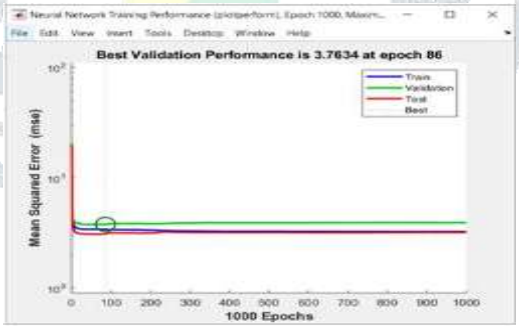


FIGURE 2.1 NARX with TANSIG

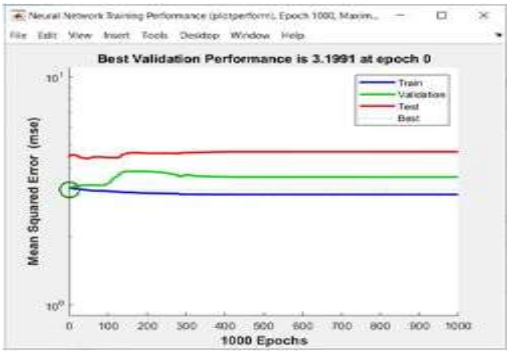


FIGURE 2.2. NARX with Logsig

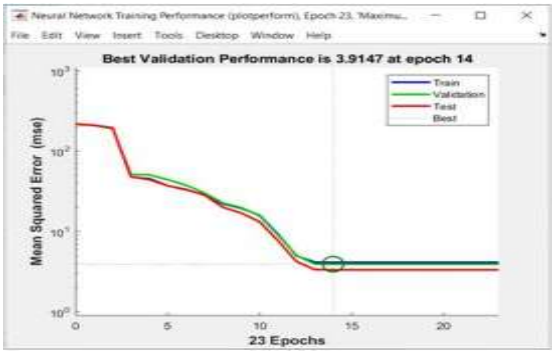
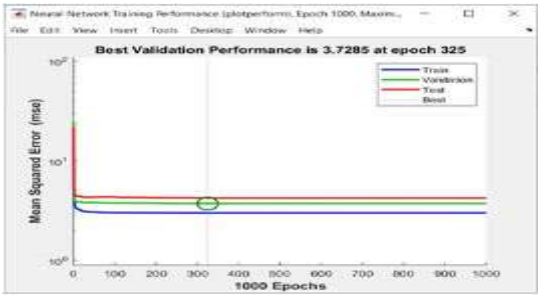


FIGURE. 2.3 NARX with Purelin



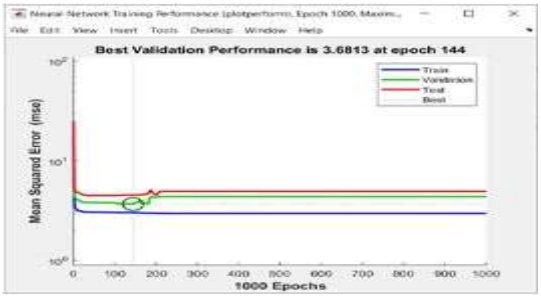


FIGURE 3.1 Feed Forward NN with TANSIG FIGURE 3.2 Feed Forward NN with LOGSIG

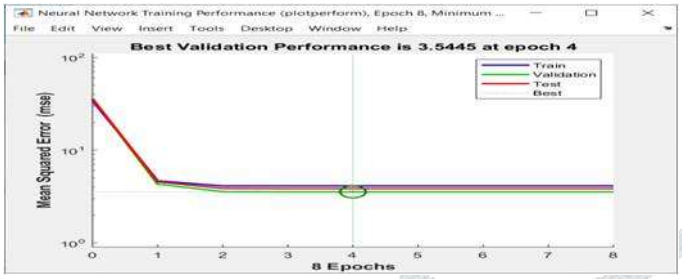


FIGURE.3.3 Feed Forward NN with PURELIN

Performance Graph indicates Performance of the Network. It is displayed when Performance button is clicked in the Training Window. It allows us to know status of the training process. The X-axis indicates number of iterations. The Y-axis represents MSE occurred for each iteration. The Line Graph plotted in blue color represents the Training results, Green color represents the Validation results and Red color represents Test results. The Best Performance is considered when testing, training and validation coincide at a point. At that point, Training should be stopped. It means that no further training is required. The following table shows MSE and RMSE of all Trained Models basing on Performance Plot:

Network	Activation Function	MSE	RMSE
Elman BPNN	TANSIG	3.2243	1.795634
	LOGSIG	3.7032	1.92437
	PURELIN	3.877	1.96901
NARX	TANSIG	3.7634	1.939948
	LOGSIG	3.1991	1.788603
	PURELIN	3.9147	1.97856
FeedForward BPNN	TANSIG	3.7285	1.930932
	LOGSIG	3.6813	1.918671
	PURELIN	3.5445	1.882684

SUMMARY AND CONCLUSIONS

1. Different Networks gives different results with different Training Function.
2. **NARX** shows the best results out of three Network models.
3. Activation Function **LOGSIG** gives the best results.
4. Performance of Network is comparative with less difference.

We observe that both Elman BPNN and NARX had similarity but we can say that NARX gives the best results as it is having lowest RMSE than others. NN tool is the best for training data using algorithm and functions.

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