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RAINFALL PREDICTION BY USING TIME-SERIES DATA IN ANALYSIS OF ARTIFICIAL NEURAL NETWORK MODELS

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Abstract - Rainfall prediction is a major problem for meteorological department as it is closely associated with the economy and life of human. It is a cause for natural disasters like flood and drought which are encountered by people across the globe every year. Accuracy of rainfall forecasting has great importance for countries like India whose economy is largely dependent on agriculture. Due to dynamic nature of atmosphere, Statistical techniques fail to provide good accuracy for rainfall forecasting. Nonlinearity of rainfall data makes Artificial Neural Network a better technique. Time Series data is large in volume, highly dimensional and continuous updating. Time series data analysis for forecasting, is one of the most important aspects of the practical usage. Accurate rainfall forecasting with the help of time series data analysis will help in evaluating drought and flooding situations in advance. In this paper, Artificial Neural Network (ANN)technique has been used to develop weather forecasting models for rainfall prediction using rainfall data of India. In this model, Feed Forward Neural Network (FFNN) using Back Propagation Algorithm has been used. The performance of both the models has - been assessed based on Regression Analysis, Mean Square Error (MSE) and Magnitude of Relative Error (MRE). This paper also gives some future directions for rainfall prediction research.

***Key Words*: Rain Fall, ANN,Weather**

1. INTRODUCTION

Weather forecasting is the application of science and technology to predict the conditions of the atmosphere for a given location and time. People have attempted to predict the weather informally for millennia and formally since the 19th century. Weather forecasts are made by collecting quantitative data about the current state of the atmosphere at a given place and using meteorology to project how the atmosphere will change.

Weather forecasting is a process of identifying and predicting to a certain accuracy the climatic conditions using multiple technologies. Many of the live systems rely on weather conditions to make necessary adjustments in their systems. Forecasting helps to take necessary measures to prevent damage to life and property to a large extent. Quantitative forecast like temperature, humidity and rainfall are important in agriculture area, as well as to traders within commodity markets. Temperature forecasts are used by utility companies to estimate demand over coming days. Since outdoor activities are severely restricted by heavy rain, snow and the chill; forecasts can be used to plan activities around these events, and to plan ahead and survive them. Nowadays multiple computing techniques are available which can be used for forecasting enhancing its accuracy. Different categories of forecasting methods are Naive approach, Judgmental methods, Quantitative and Qualitative method, Causal or econometric forecasting methods, Time series methods, Artificial intelligence methods, etc. The weather forecast reports needs some intelligent computing which can read the nonlinear data and generate some rules and patterns to study and train from the observed

Once calculated by hand based mainly upon changes in barometric pressure, current weather conditions, and sky condition or cloud cover, weather forecasting now relies on computer-based models that take many atmospheric factors into account.[1] Human input is still required to pick the best possible forecast model to base the forecast upon, which involves pattern recognition skills, teleconnections, knowledge of model performance, and knowledge of model biases. The inaccuracy of forecasting is due to the chaotic nature of the atmosphere, the massive computational power required to solve the equations that describe the atmosphere, the error involved in measuring the initial conditions, and an incomplete understanding of atmospheric processes. Hence, forecasts become less accurate as the difference between current time and the time for which the forecast is being made (the *range* of the forecast) increases data to predict the weather in future. Use of ANN will give results which

are more accurate. Here, the error may or may not reduce completely. But, the accuracy will improve as compared to previous forecasts.

The weather forecasting is live forecasting where output of the model may be required for daily weather guide or weekly or monthly weather plans. Thus, the accuracy of the result is a very important aspect in this forecasting. Multiple issues are discussed which can be considered to get the accurate results. In Section two, a reviews multiple literature on weather forecasting. Section three introduces different terms about the neural network. Section four proposes neural network model with all the specifications for forecasting weather with a high degree of accuracy.

2. Existing System

It presents a model for rainfall rate prediction 30 seconds ahead of time using an artificial neural network. The resultant predicted rainfall rate can then be used in determining an appropriate fade counter-measure, for instance, digital modulation scheme ahead of time, to keep the bit error rate (BER) on the link within acceptable levels to allow constant flow of data on the link during a rain event. The approach used in this method is pattern recognition technique that considers historical rainfall rate patterns over Durban (29.8587°S, 31.0218°E). The resultant prediction model is found to predict an immediate future rain rate when given three adjacent historical rain rates. For our model validation, error analysis via root mean square (RMSE) technique on our prediction model results show that resultant errors lie within acceptable values at different rain events within different rainfall regimes.

Disadvantages:

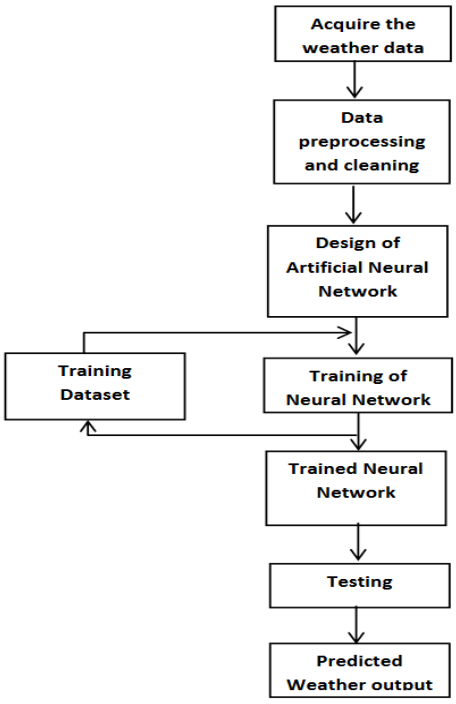
Since it uses the resultant prediction model to predict an immediate future rain rate when given three adjacent historical rain rates. Prediction of Rainfall forecasting with the short time span will not help in evaluating drought and flooding situations in advance.

3. Proposed System

Accurate rainfall forecasting with the help of time series data analysis will help in evaluating drought and flooding situations in advance with Proposed ANN model showed optimistic results for both the models for forecasting and found ahead forecasting model perform better than previous forecasting model.

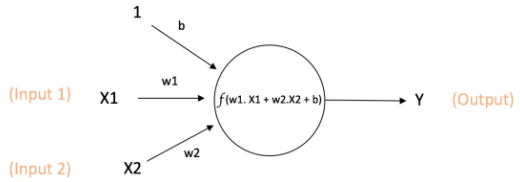
The back propagation algorithm is used in layered feed-forward ANNs. It uses supervised learning, which means the model trains itself with the use of target output. For every set of input data the target output is provided. The neural network model processes the input data with random values for weights and suitable activation function using one or more hidden layer in between and then produces the predicted output. This predicted output is then compared with the target output provided for same input dataset. Thus, error is calculated by subtracting predicted output from target output. Using this error, the weights are adjusted and again the entire process is repeated for multiple epochs until the error is minimal or in acceptable range.

The idea of the back propagation algorithm is to reduce this error, until the ANN learns the training data. The training begins with random weights, and the goal is to adjust them so that the error will be minimal. For practical reasons, ANNs implementing the back propagation algorithm do not have too many layers, since the time for training the networks grows exponentially. Also, there are refinements to the back propagation algorithm which allow a faster learning. The model proposed in this paper for weather forecasting using ANN using BP algorithm is as given below in Figure.



A Single Neuron

The basic unit of computation in a neural network is the neuron, often called a node or unit. It receives input from some other nodes, or from an external source and computes an output. Each input has an associated weight (w), which is assigned on the basis of its relative importance to other inputs. The node applies a function f (defined below) to the weighted sum of its inputs as shown in Figure 1 below:



Output of neuron = Y= $f(w1.\ X1 + w2.X2 + b)$

The above network takes numerical inputs X1 and X2 and has weights w1 and w2 associated with those inputs. Additionally, there is another input 1 with weight b (called the Bias) associated with it. We will learn more details about role of the bias later.

The output Y from the neuron is computed as shown in the Figure 1. The function f is non-linear and is called the Activation Function. The purpose of the activation function is to introduce non-linearity into the output of a neuron. This is important because most real world data is non linear and we want neurons to learn these non linear representations.

Every activation function (or non-linearity) takes a single number and performs a certain fixed mathematical operation on it [2]. There are several activation functions you may encounter in practice:

Sigmoid: takes a real-valued input and squashes it to range between 0 and 1

$\sigma(x) = 1 / (1 + \exp(-x))$

tanh: takes a real-valued input and squashes it to the range [-1, 1]

$\tanh(x) = 2\sigma(2x) - 1$

ReLU: ReLU stands for Rectified Linear Unit. It takes a real-valued input and thresholds it at zero (replaces negative values with zero)

$f(x) = \max(0, x)$

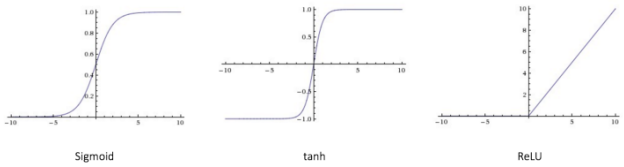


Figure 2: different activation functions

Screen Shot 2016-08-08 at 11.53.41 AMFigure 2: different activation functions

Importance of Bias: The main function of Bias is to provide every node with a trainable constant value (in addition to the normal inputs that the node receives). See this link to learn more about the role of bias in a neuron.

4. Conclusion

In this paper, different methods for weather forecasting are reviewed. ANN with back propagation is recommended for weather forecasting. ANN with back propagation uses an iterative process of training where, it repeatedly compares the observed output with targeted output and calculates the error. This error is used to readjust the values of weights and bias to get an even better output. Hence this method tries to minimize the error. Thus, Artificial Neural network with Back propagation algorithm seems to be most appropriate method for forecasting weather accurately. The weather Forecasting has a big challenge of predicting the accurate results which are used in many real time systems like electricity departments, airports, tourism centers, etc. The difficulty of this forecasting is the complex nature of parameters. Each parameter has different set of ranges of values. This issue is addressed by ANN. It accepts all complex parameters as input and generates the intelligent patterns while training and it uses the same patterns to generate the forecasts. The Artificial Neural Network model proposed in this paper indicates all the parameters for input and output, training and testing data set, number of hidden layers and neurons in each hidden layer, weight, bias, learning rate and activation function. The Mean Squared Error between predicted output and the actual output is used to check accuracy.

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BIBLIOGRAPHY NOTES

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