

Weather Forecasting using Neural Network

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Abstract - Weather Forecasting determines future state of the atmosphere. Accurate weather forecasting is very important because agricultural and industrial sector are based on it. We are presenting weather predictions using Artificial Neural Network and Back Propagation Algorithm. We are implementing data intensive model using data mining technique. Weather is a dynamic and non-linear process and artificial neural network (ANN) can deal with such type of Process. The research also states that ANN is the best approach than traditional and numerical methods. Data mining technique with neural network gives useful information for weather prediction which reduces cost as compare to other prediction models. The focus is mainly on neural network with back propagation technique for daily weather forecasting.

Keywords: Neural Network, Back propagation Algorithm, Daily Weather Forecasting, ANN, Weather Prediction.

I. INTRODUCTION

Weather forecasting is a process of identifying and predicting to certain accuracy the climatic conditions using multiple technologies. Many of the live systems rely on weather conditions for making necessary adjustments in the systems. Quantitative forecast like temperature, humidity and rainfall are important in agriculture area, as well as to traders within commodity markets [6]. Nowadays there are many approaches we are using for weather forecasting. Mathematical modeling, statistical modeling and artificial intelligence techniques are some of them. Mathematical models of the atmosphere to predict future weather based on current weather conditions is numerical weather Prediction.

It needs full knowledge of atmospheric dynamics and involves calculations with a large number of variables and datasets. Due to the advancement of modern computer hardware there have been many improvements in numerical weather prediction [1]. We are using ANN which is based on smart analyzing the trend from historical data. The other models are accurate in calculation but not in predictions the can not able to adapt the irregular patterns of data which can neither be written in form of function or deducted as formula [2].

The weather forecast reports needs some intelligent computing which can able to read the nonlinear data and generate some rules and patterns to study from the observed Data to predict the weather in future. Use of ANN will give more accurate result. Here, the error may or may not reduce completely. But, the accuracy will improve as compared to previous forecasts. Weather research and forecasting (WRF) model, General Forecasting Model, Seasonal Climate Forecasting, Global Data Forecasting Model, are currently

acceptable models for weather prediction. Also, computing for these prediction models is very expensive because of compute intensive nature.

On the contrary, data mining models works on historical data, it works on probability and/or similarity patterns. For all the prediction categories, the model works in similar fashion, and expects to return the moderate accuracy [9]. In weather forecasting output of the model may be required for daily weather guide or weekly or monthly weather planning. Thus, the accuracy of the result is a very important aspect in forecasting so as to give the best result among all other weather forecasting model.

II. LITERATURE REVIEW

Paras, Sanjay Mathur, Avinash Kumar, and Mahesh Chandra (2009) they eliminate the need of the satellite based systems for weather forecasting which is costlier than data mining system and require complete support system. This model used ANN with time series features [4].

Mohsen Hayati [5] states that ANN for one day ahead prediction of temperature. Here multilayer perceptron (MLP) is trained for ten years meteorological data from Iran which was divided into four seasons namely spring, summer, fall and winter. MLP is a network of three layers having sigmoid transfer function for hidden layers and linear transfer function for output layer. Hidden neurons were decided using the trial and error method. It was concluded that MLP has minimum prediction error, good performance and reasonable prediction accuracy. They have used historical data for ten years and achieve minimum error and reasonable accuracy.

Ch.Jyosthna Devi, B.Syam Prasad Reddy, K. Vagadhan Kumar, B. Musala Reddy, N.Raja Nayak this gives Information about Artificial neural network using Back Propagation Neural Network (BPN). This method was more efficient than numerical differentiation [7].

Gyanesh Shrivastava, Sanjeev Karmakar, Manoj Kumar Kowar, Pulak Guhathakurta given that BPN, RBFN is efficient model to forecast monsoon rainfall as well as other weather parameter prediction over the smaller geographical region. BPN and RBFN were given appropriate solutions for prediction of long-range weather forecasting [8].

Arti R. Naik, Prof. S.K.Pathan [11] has given the limitation about some existing weather forecast model and benefits of artificial neural network. The focus is on different methods of weather prediction using artificial neural networks and training of this network using Backpropagation algorithm.

R Lee [10] proposed an innovative, intelligent, multi-agent based environment called as intelligent Java Agent Development Environment (iJADE). It is used for weather prediction of eleven weather stations in Hong Kong using five years data which provides more than 7000 data records. The model uses GA for input node selection, a fuzzy classification for rainfall parameters and neural network for training using a BPN. Its experimental results are more accurate than single point sources using similar network and other networks like Radial Basis Function Network, Learning Vector Quantization and Naive Bayesian Network.

III. ARTIFICIAL NEURAL NETWORK FOR WEATHER FORECASTING

In any Forecasting accuracy is very important .The input parameters for a weather forecasting model are different types of data required different types of methods; and need to be handled accordingly. Statistical methods are associated with

Linear data on the other hand Artificial Intelligence methods are associated with nonlinear data [12]. Different types of learning models of Artificial Intelligence are genetic algorithms, neuro-fuzzy logic and neural networks. Among which neural networks is more preferred.

Weather forecasting can be done more accurately using ANN. Because daily weather data has multiple parameters such as temperature, humidity, rainfall amount, cloud distance and size, wind speed and direction, etc. All these parameters are non linear, but they required to be processed together to determine temperature, rainfall, humidity or weather status for the future day. Such type of applications need complex models and can able to produce the required result by generating the patterns on its own by performing self-learning using the training data given to the model.

To develop an ANN model for weather forecasting, region selection for input data and parameters is necessary. The input data is to be taken from a specific area on which the model is trained and tested so that the model is able to generate accurate results. The number of input data given to model also helps to improve accuracy of the model by giving the results with a high degree of similarity between predicted and actual output data. The available data may be noisy thus, data should be cleaned. Similarly, it has to be normalized because, all the parameters are of different units and normalization will help the input and output parameters to correlate with each other [6]. The data should be divided in training and testing samples in proper proportion so that the results can be predicted, tested and validated properly. Structure of the NN model also has a great impact on generation of accurate results. The multilayer ANN helps in predicting nonlinear data more efficiently. The activation function will be different for different layers of NN as per need.

IV. METHODOLOGY

Weather forecasting is an application in meteorology and has been one of the most scientifically and technologically challenging problems around the world in the last century. In

this, we are investigating the use of data mining techniques in forecasting maximum temperature, rainfall, evaporation and wind speed. This was carried out using Artificial Neural Network and Back propagation Algorithm and meteorological data collected from previous 3 years.

Data Collection: the data used for this work was collected from different official websites and Metrological Department. The case data covered the period of 36 months. The following procedures were adopted at this stage of the research: Data Cleaning, Data Selection, Data Transformation and Data Mining.

Data Transformation: this step is also known as data consolidation. It is the stage in which the selected data is transformed into forms appropriate for data mining. The data file is saved in Commas Separated Value (CVS) of file format and the datasets were normalized to reduce the effect of scaling.

Data Mining Stage: It is divided into three phases. At each phase the algorithm is used to analyze the meteorological datasets. The testing method adopted for this research was percentage split that train on a percentage of the dataset, cross validation on it and test on the remaining percentage. Thereafter interesting patterns representing knowledge were identified.

On the other side on user device we are creating the Android Application where user need to register him so that daily predicted weather notification will be send on his device.

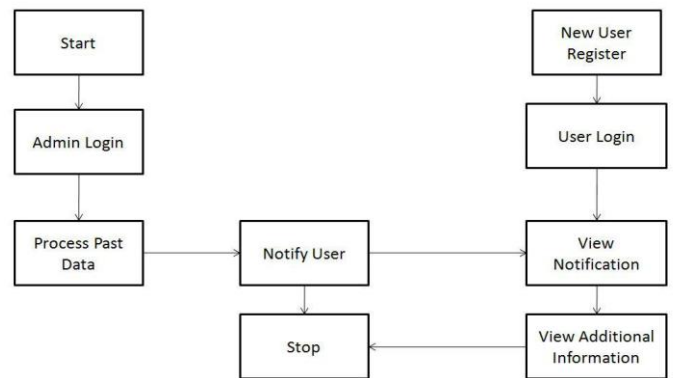


Figure 1: Methodology

A. System Phase:

This system uses the concept of Weather Prediction. The Three phases are as follows:

B. Registration Phase:

In registration process, the user will require to fill all the details such as name, user id, email id, phone number etc. He also requires registering his location so as to get the notification according to location.

C. Login Phase:

In login phase, the admin login to the system which is not allowed to user. After logging in the system the preprocessing of data is done by admin.

D. Notification Phase:

User will get daily weather notification using application which can be installed by the user.

V. BACK-PROPAGATION APPROACH

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 [3].

We start the training with random weights, and the goal is to adjust them so that the error will be minimal. The area for input data can be any one of a meteorological station area in which all the data is limited to a certain region. The different input parameters are taken viz. temperature, relative humidity, air pressure, wind speed and direction, cloud amount and height, rainfall, etc.

Input data is then pre-processed and cleaned. That means it is checked with any outlier and that is removed, missing values are entered, and data is checked if it is in the given range for the given parameter. Later ANN is designed with number of input and output nodes, hidden layers, activation function, and maximum number of epochs, weights, bias, goal and learning function. Neural network is trained with seventy percentages of the input data. Where the model is trained using this observed data to forecast the weather, followed by testing done using remaining thirty percentages of input data. Then the mean squared error and accuracy is calculated for the model by comparing the output of testing with target output. This model generates output in terms of minimum and maximum temperature of the day, relative humidity and rainfall.

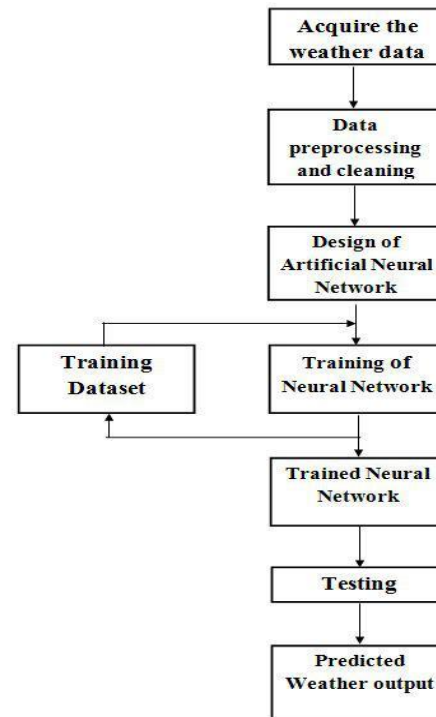


Figure 2: Back Propagation Approach

Seventy percentages of the dataset will be used for training and the other thirty percentages of the dataset will be used for testing and validation. Hidden layers are required for processing nonlinear data. Better results can be achieved with high accuracy when learning rate is smaller but its performance is slower. Activation functions are applied on each neuron to get the output of neuron on a given input in the neural network. The sigmoid function is a special case of logistic function which has a sigmoid curve. The sigmoid transfer function can be used for hidden layers and for the output layer the linear transfer function can be used. The correctness and accuracy of the model can be checked using the Mean Squared error (MSE) function. The MSE measures the average of the squares of errors that is, the difference between the actual output and the predicted output of the model. Lesser the MSE value of the model, more accurate the results are.

VI. FUTURE SCOPE

The accuracy from weather forecasting model using ANN and Back Propagation Algorithm is more than other Statistical Model. An extension to this technology can be done using any of the other technique instead of Data mining and Different Algorithm.

VII. CONCLUSION

The 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 a 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.

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