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Artificial Neural Network Model for Weather Predication

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ABSTRACT
Weather prediction is stimulating area of research for scientists. In this paper the application of artificial neural networks model to predict the weather has been proposed. Weather parameters like maximum temperature, minimum temperature and relative humidity etc. has been predicted. Execution of predictive modeling, the key criteria is always meticulousness. Using prediction model trying to predict future weather condition based upon above parameters by Artificial Neural Network. The model performance is analogized with Multi layered perceptron network. The proposed network is trained with actual data of the 10 years of Mumbai, Maharashtra and tested which comes from meteorological department. ANN is used with C4.5 for classification.

Keywords
Artificial Neural Networks, Weather Prediction, Single Layer Perceptron, Multi Layer Perceptron, Back Prapogation, C4.5.

1. INTRODUCTION
Weather Prediction is the application of science and technology to predict the state of the atmosphere for a future time and given location. Agriculture sectors and many industries are largely dependent on the weather conditions. Weather Predictions is often used to warn about natural disasters that are caused by abrupt change in climatic conditions. As the difference in current time and the time for which the forecast is being made increases, forecast become less accurate.

Several steps to predict the temperature are

- Data Collection(atmospheric pressure, temperature, wind speed and direction, humidity, precipitation),
- Data assimilation and analysis,
- Numerical weather prediction
- Model output post processing

A neural network is a powerful data modeling tool that is able to capture and represent complex input/output relationships. The motivation for the development of neural network stemmed from the desire to develop an artificial system that could perform intelligent tasks similar to those performed bye the human brain. Neural network works like the human brain in the following two ways: A neural network acquires knowledge through learning. A neural network's knowledge is stored within interneuron connection strengths known as synaptic weights.

The true power and advantages of neural networks lies in the ability to represent both linear and nonlinear relationships directly from the data being modeled.

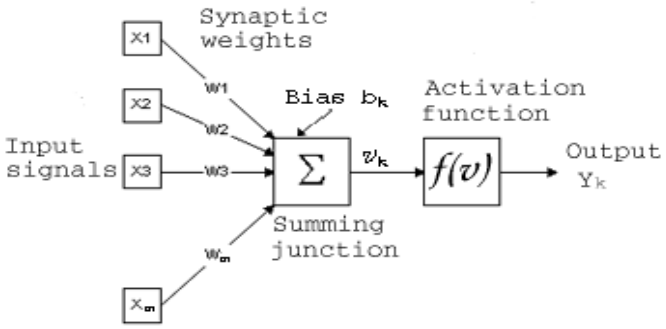

Figure 1 Analogy of Biological and Artificial Neuron

From a given set of data, neural network model is a tool that can be adjusted to produce a mapping among the data. Network model is trained using a collection of data, referred to as trained set. After successful training of the neural network, it will be capable to perform prediction, classification, estimation or simulation on new data from the same or similar sources.

ANNs, like people, learn by example. An Artificial Neural Network (ANN) is an information processing system that is inspired by the way biological nervous systems, which process information. The key element of this system is the new structure of the information processing system. It is composed of a vast number of highly interconnected processing elements which is called neurons working in union to solve specific problems. An ANN is organized for a particular application, such as pattern recognition, data classification, through a learning process. Learning in biological systems adds adjustments to the synaptic connections that exist between the neurons.

Single-layer perceptron network, which consists of a single layer of output nodes. The inputs are directly fed to the outputs via a series of weights. It can be considered the simplest kind of feed-forward network. Back propagation network consists of minimum three layers which is called multi layer perception. In this network an input layer, at least one intermediate hidden layer, and an output layer. Input units are connected in a feed-forward style with input units fully connected to units in the hidden layer and hidden units fully connected to units in the output layer. Output produced by Back propagation is not understandable because it is in the form of weights. But it produces accurate results. So according to proposed method, to extract rules from the ANN. By this method we can achieve trade off between Accuracy & Comprehensibility. It means produced output is accurate as well as understandable. The tradeoff termed as accuracy vs. comprehensibility can be achieved by converting opaque model into transparent model.

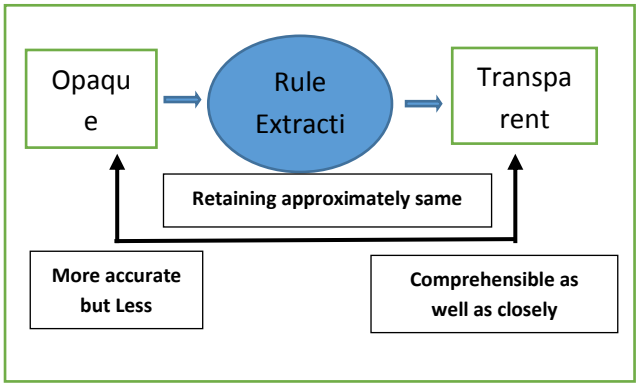

Fig. 2 Rule Extraction: transform opaque model into transparent model

Rule extraction from neural networks solves two important problems: it gives insight into the logic behind the network and, in many cases, it progresses the network's ability to simplify the acquired knowledge. Rule extraction with neural networks is attracting wide attention because of its simplicity and flexibility. Model is using C4.5 for classification. It is a simple decision learning algorithm developed by J. Ross Quinlan (1986). This algorithm generates a classification decision tree for the given data set. It is done by recursive partitioning of data. The given sets of training data to test each attribute at every node and selects a test that gives the best information gain.. It uses statistical property call *information gain* to select which attribute to test at each node in the tree. Information gain measures how well a given attribute separates the training examples according to their target classification. A major concept involved in this algorithm is the Entropy. The Entropy is used to find the most significant parameter in characterizing classifier.

2. RELATED WORK

Many works were done related to the temperature prediction, Weather Prediction system using BPN network. They are précised below.

Y.Radhika and M.Shashi presents an application of Support Vector Machines (SVMs) for weather forecasting. Time series data of daily maximum temperature at location is studied to forecast the maximum temperature of the next day at that location based on the daily maximum temperatures for a span of previous n days referred to as order of the input. Performance of the system is detected for various spans of 2 to 10 days by using optimal values of the kernel.

Brian A. Smith et.al, attentive on developing ANN models with reduced average forecast error by increasing the number of distinct observations used in training, adding additional input terms that describe the date of an observation, increasing the duration of prior weather data included in each observation, and reexamining the number of hidden nodes used in the network.

Arvind Sharma et.al, explains how the different connectionist paradigms could be expressed using different learning methods and then studied whether they can provide the required level of performance, which are satisfactorily good and robust so as to provide a reliable forecast model for stock market indices. Research results exposes that all the connectionist paradigms considered could represent the stock indices performance very accurately. Mohsen Hayati et.al studied about Artificial Neural Network based on MLP was trained and tested using ten years (1996-2006) meteorological data. The results show that MLP network has the minimum forecasting error and can be considered as a good method to model the short-term temperature forecasting systems.

3. WEATHER PREDICTION MODEL

Proposed system is a whether forecasting model based on neural network and decision tree. The main aim of our proposed data model is to analysis of previous data and prediction is based on the previous data. Thus system is used with neural network for data analysis and the concluded data is represented in the form of rules. Because of the output of neural network is an opaque model, further uses the C4.5 decision tree to convert the out put of neural network into the form of transparent data model.

The steps followed in developing the Weather Prediction Systems are:

Phase 1*: Network Construction and training* – this phase constructs and trains neural network.

Phase 2*: Decision Tree*-Supply output from neural network to C4.5 Decision tree to extracts the classification rules from the network

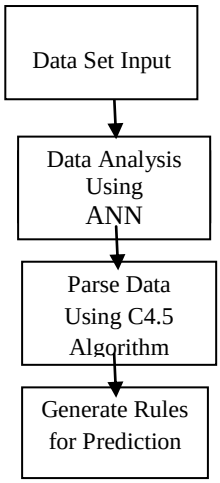

Figure3 System Architecture

The following conditions are to be examined for input to Neural Network

- Atmospheric Pressure
- Atmospheric Temperature
- Relative Humidity
- Wind Velocity and
- Wind Direction

4. METHODOLOGY

1) ***Data Collection***

The interpretations of atmospheric pressure, temperature, wind speed, wind direction, humidity, and precipitation are made near the earth's surface by trained observers. Here system takes the input data set (the data is whether

data collection of previous Daily data sets of last 10years (2001-2010) of Mumbai, Maharashtra)

2) ***Data Assimilation***
This is the best approximation of the current state of the atmosphere. It is a three dimensional representation of the distribution of temperature, moisture and wind.

3) ***Weather Prediction***
Weather Prediction uses the power of computers to make a forecast. Complex computer programs, also known as forecast models, run on supercomputers and provide predictions on many atmospheric variables such as temperature, pressure, wind, and rainfall.

We used the back propagation neural network model to train neural network after training neural network produces the out put equivalent to the input data. Parse data using c4.5 the output of neural network is produced over the tree and c4.5 convert the final output into rules.

4. EXPERIMENTATION AND RESULT

To test the proposed system dataset is taken from Weather Underground. This dataset contains the real time observation of the weather for a particular period of time of Mumbai city. For this research, an observation of the complete previous year from January 2001 to December 2010 is taken. The dataset contains many attributes such as Temp. (°C), Humidity (%),Wind (km/h), Dew Point (°C), Sea Level Pressure (hPa), Visibility (km), Gust Speed (km/h) and Precip (cm). From the observation, it can inspect that the temperature peeks during the month of May, its range is 40 degree centigrade. The temperature drops to the dead end during the month of January. The minimum temperature is 12 degree centigrade. The wet days occur during the month of November.

The DataSet-RMSE graph describes that the error is high when the iteration is less and vice versa. In the above graph it describes that when the iteration is increases error is going to decrease.

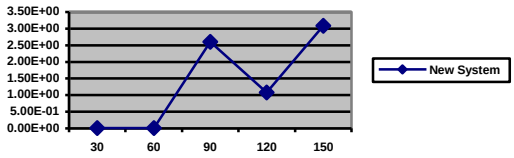

Figure 4 DataSet vs RMS Error Graph

The performance of artificial neural network is specified by the RMSE value. Experiment was done in various training parameter value of artificial neural network, i.e., various numbers of hidden layers, various number of neuron per layer, and various value of learning rate.

Table 1- Dataset – Rms Error Value

Data Set size	RMS error
30	4.213e-3
60	5.718e-3
90	2.604
120	1.074
150	3.081

Accuracy Of The System
As shown in Table I accuracy of the system is increases and error is decreases with dataset. Following graph is the System accuracy graph. With the help of proposed method system accuracy is 99.4%.

Build time
Build time of the model (i.e. training time increase) is increase as data set size increases. Build time is defined as total time required to train model over given dataset

Memory Used
Memory uses due to different size of dataset is not much considerable because it remain constant all the time if data size is large or small.

Search Time
Search time increase as size of data set is increase. Search time is defined as the total time required predicting a value using given data model

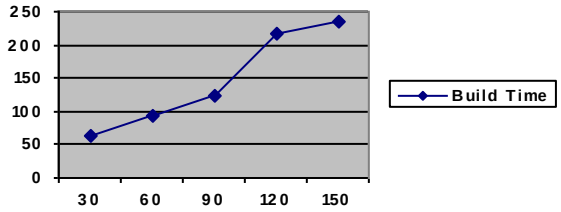

Figure 5 Build Time of the System

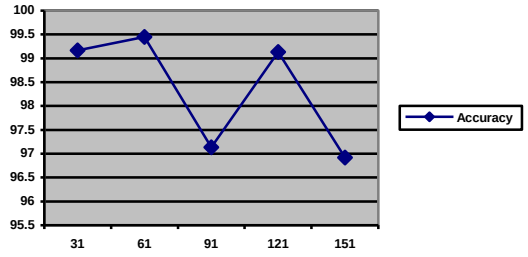

Figure 6 Accuracy Graph

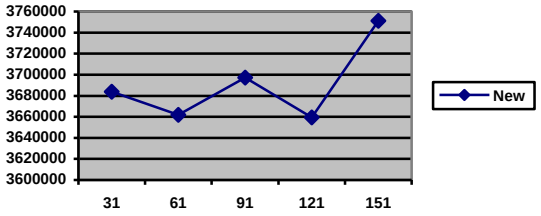

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Figure7 Memory Graph

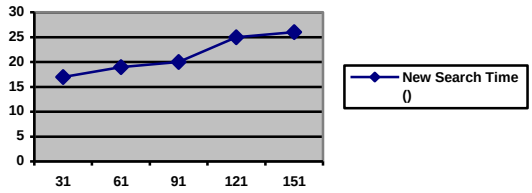

Figure 8 Search Time Graph

Accuracy for the proposed methods trained model is given in above table. It is basically depends upon by which values the neural network is prepared and after calculation how much error remain in the trained model. Here we found a better trained model and system generates less error

Table2- Accuracy of the System

DataSet Size	*RMS Error*	*%Error*	*% Accuracy*
30	5.213 e-3	.8370	99.163
60	6.718 e-3	.5483	99.4517
90	2.607	2.8648	97.1352
120	1.078	.8693	99.1307

5. CONCLUSION

Neural Networks are capable of modeling a weather forecast system. In this paper, BPN is used for forecasting the temperature based on the training set provided to the neural network with c4.5 decision tree to convert, neural network into the form of transparent data model. Through the implementation of this system, it is illustrated, how an intelligent system can be proficiently integrated with a neural network prediction model to predict the weather. The results show that an appropriate accuracy can be achieved using this network. This model is capable of yielding to traditional meteorological approaches. This model is able to determine the nonlinear relationship that exists between the historical data (Temperature, wind speed, humidity, etc.) supplied to the system during the training phase and on that basis, make a prediction of what the temperature would be in future.

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