Adaptive Predicting of Weather Forecasting with ANN using Back Propagation Technique

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Abstract- In URBAN areas of the Indian states, the rainfall creates lot of trouble to people especially for those who are travelling. While the rain always softens the temperatures in the city and provides comfort, it also creates traffic congestions, water logging, breakdown of sewage systems etc. Regular rain fall in the cities is a major problem for people who want to reach their destinations on time. The forecast of extreme weather events become imperative due to the emerging climate change and possible adverse effects in humans. Rainfall is one of the most complex and difficult elements of the hydrology cycle to understand and to model due to the complexity of the atmospheric processes that generate rainfall and the tremendous range of variation over a wide range of scales both in space and time .The objective of this study is to construct predictive models in order to forecast rain intensity (mm/day) in, using Artificial Neural Networks (ANN) models.

Keywords- Feed Forward Networks, Back Propagation, Temperature, ANN, ISMR.

I.INTRODUCTION

ANNs are based on the highly interconnected structure of artificial cells which can behave like brain cells. This approach has been proved fast and robust in noisy environments, flexible enough to deal with the range of problems it can solve, and highly adaptive enough to newer environments.

One major application area of ANNs is forecasting ANNs provide an attractive alter- native tool for both forecasting researchers and practitioners. Several distinguishing features of ANNs make them valuable and attractive for a forecasting task. First, as opposed to the traditional model-based methods, ANNs are data-driven self- adaptive methods in that there are few a priori assumptions about the models for problems under study. The major objective of the present study is to develop ANN based model for prediction of ISMR in monthly and seasonal time scales. The prediction of ISMR is done based on the observed time series of the monthly rainfall data set. This experiment also focuses on using a limited number of input data. ANN is an interconnection of information processing systems, units or nodes whose construction and implementation is based on human brain. ANN can process simultaneously large number of units which are called neurons in parallel mode. There is an interconnection link between one neuron to another neuron.

Rainfall–runoff models are conventionally assigned to one of three broad categories: deterministic (physical), conceptual and parametric. Deterministic models describe the Rainfall–runoff process using physical laws of mass and energy transfer. Conceptual models provide simplified representations of key hydrological process using a perceived system. Parametric models use mathematical transfer functions to relate meteorological variables to runoff. According to these criteria, artificial neural networks should be classified as parametric models that are generally lumped. This is because neural network engineers or ‘neurohydrologists’ regard the rainfall–runoff process as a ‘black box’ system with and outputs. Consequently, ANN usage does not presuppose a detailed understanding of a catchment’s physical characteristics, nor does it require extensive data preprocessing. This is because ANNs can, theoretically, handle incomplete, noisy and ambiguous data. Furthermore, ANNs are often cheaper and simpler to implement than their physically based counterparts. They are also well suited to dynamic problems and are parsimonious in terms of information storage within the trained model. In view of this, ANNs are found to be a suitable approach for the prediction of Indian monsoon rainfall using large scale climate variables as input to the network. The next section provides a brief overview of climate variables and their influence on Indian monsoon rainfall.

II. OVERVIEW OF ANN

The rainfall-runoff process has been described quantitatively since the nineteenth century. However, it is only in the last decade or so that ANNs have been applied to the problem. None the less, ANNs have been in existence since McCulloch and Pitts (1943) introduced the concept of the artificial neuron. The first era involved preliminary work on the development of the artificial neuron until Minsky and Papert (1969) identified several limiting factors. The second era began with the rediscovery and popularization of the backpropagation training algorithm (Rumelhart and McClelland, (1986). Prior to this seminal work it was very difficult to train neural networks of any practical size. The third era is characterized by more rigorous assessments of network limitations and generalizations, fusion with other technologies (such as genetic algorithms and fuzzy logic) (e.g., See and Openshaw, 1999) and the implementation of ANNs using dedicated hardware. The following sections provide an overview of ANNs, including the main structures, network types and training algorithms.

III. APPLICATIONS OF ANN AS FORECASTING

Forecasting problems arise in so many different disciplines and the literature on forecasting using ANNs is scattered in so many diverse fields that it is hard for a researcher to be aware of all the work done to date in the area. In this section, we give overview of research activities in forecasting with ANNs. First we will survey the areas in which ANNs find applications. Then we will discuss the research methodology used in the literature.

IV. INFLUENCE OF CLIMATE VARIABLES ON INDIAN MONSOON

At present, the assessment of the nature and causes of seasonal climate variability is still uncertain. There are still uncertainties associated with local and global climatic variables. For any rainfall prediction model, these are sources of variance in predictability. Recently, researchers have studied the influence and the possible relationships between various global climate variables and Indian monsoon rainfall. Additionally, they brought out several regional parameters based on sea-level pressure, temperature, and wind fields over India and sea surface temperature (SST) data from the adjoining Indian seas. Although their performance in seasonal forecasting has been encouraging, there is still a large variance in the monsoon rainfall unaccounted by the predictors identified so far. Several observational and modeling studies have indicated that the slowly varying surface boundary conditions, particularly in the winter and pre monsoon seasons, constitute a major forcing factor on the inter-annual variability of the monsoon rainfall. Parameters representing these conditions, global as well as regional, provide a handle for seasonal prediction. On inter annual timescales, the Indian monsoon rainfall has a strong and positive correlation with the pre-monsoon spring tropospheric temperature anomaly. Factors that influence the Indian summer monsoon include the sea surface temperature in the Pacific and Indian oceans, the Indian Ocean Dipole Mode, Eurasian snow cover, the Atlantic circulation variation, global warming and human activities, among others. In the subsequent sections some of the highly influencing large scale climate indices, like El-Niño Southern Oscillation (ENSO), EQUitorial INdian Ocean Oscillation (EQUINOO) and Ocean-Land Temperature Contrast (OLTC) are discussed.

V. FORECASTING INDIAN SUMMER MONSOON RAINFALL

Most of the models that were used to forecast ISMR come under empirical modelling approach. A general overview of forecasting models for Indian monsoon rainfall can be found in. Excellent reviews of the empirical models used for prediction of ISMR are presented in. In this study, we considered ANNs as the forecasting tool. A brief description of ANN's applications for rainfall forecasting is given below. Artificial Neural Networks have been used in various fields for the prediction and forecasting of complex nonlinear time series, including the forecasting of Indian monsoon rainfall. The neural network technique is able to learn the dynamics within the time series data. In the past, ANNs have been successfully used to predict Indian monsoon rainfall have used neural network technique to predict monsoon rainfall of India using few predictors and compared the results with linear regression techniques, showing that the model based on neural network technique performed better. Guhathakurta et al. (1999) have used hybrid principal component and Neural Network approach for long range forecasting of the Indian summer monsoon rainfall. They observed improved accuracy in prediction. The neural network technique contains the advantages of both the regression analysis and nonlinear dynamics that need to be incorporated in order to predict the dynamic rainfall values. Sahai et al. (2000) applied the ANN technique to five time series of June, July, August, September monthly and seasonal rainfall. The previous five years values from all the five time-series were used to train the ANN to predict for the next year. They found good performance in predicting rainfall. Other studies, which have used ANNs for summer monsoon rainfall forecasting over India, include Iyengar and Raghukanth (2005). They decomposed the Indian monsoon rainfall data into six empirical time series (intrinsic mode functions). Then they have identified the first empirical mode as a nonlinear part and the remaining as the linear part of the data. The nonlinear part is handled by ANN techniques, whereas the linear part is modelled through simple regression. They showed that their model can explain 75 to 80% of the inter-annual variability (IAV) of eight regional rainfall series, considered in their study.

VI. ARTIFICIAL NEURAL NETWORKS METHODOLOGY

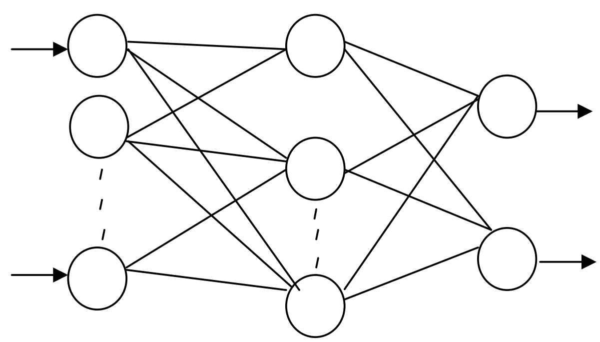
Neural Networks are used to detect hidden relations in the set of patterns given during training period. In this study Feed-forward ANN procedure is used. A typical ANN will have an input layer, an output layer and one or more hidden layers. Neurons in the input layer simply act as a buffer to next layer. The neurons in different layers are connected by means of weights. The neurons in the hidden and output layers use activation function to transfer the received input to the next layer neurons. Neural networks are used to detect hidden relations in the set of patterns given during the training period. The most commonly used training Algorithm is BPNN. The Back Propagation Neural network uses steepest gradient descent procedure. A Back propagation network learns by example. To provide examples to algorithm, what you want the network to do and it changes the network weights so that, when training is finished, it will gives the required output for a particular input. Back propagation networks are ideal for simple pattern recognition and mapping tasks.

VII. PROPOSED APPROACH

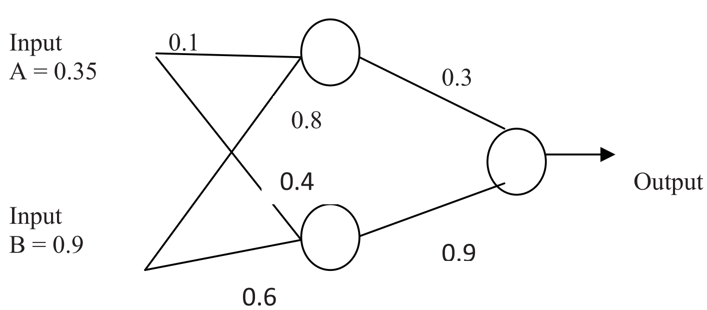
The aim is to get dataset consisting the weather parameters like sea level, temperature, humidity, dew point, wind direction etc., we have normalized the data using the min-max normalization to scale the data set as a range 0 to 1. Then the normalized data is passed to BPNN as an input. The BPNN will update the datasets and will give the good prediction. To improve execution speed and accuracy BPNN will undergone for different neural network Architectures and calculate the mean value, and the same will be predicted as lest errors.

VIII. FEED FORWARD NEURAL NETWORKS

A typical neural network consists of layers. In a single layered network there is an input layer of source node and an output layer of neurons. If it is multi layer network there is an addition according to the inputs for source and output layers of neurons for extension.



For better understanding the back propagation learning algorithm can be divided into two phases: propagation and weighted update.
Consider the following example for BPNN



Assume that the neurons have a Sigmoid activation function and
(i) Perform a forward pass on the network.
(ii) Perform a reverse pass (training) once (target = 0.5).
(iii) Perform a further forward pass and comment on the result.

Answer:

(i)
Input to top neuron = (0.35x0.1)+(0.9x0.8)=0.755. Out = 0.68.
Input to bottom neuron = (0.9x0.6)+(0.35x0.4) = 0.68. Out = 0.6637.
Input to final neuron = (0.3x0.68)+(0.9x0.6637) = 0.80133. Out = 0.69.

(ii)
Output error δ=(t-o)(1-o)o = (0.5-0.69)(1-0.69)0.69 = -0.0406.
New weights for output layer
w1+ = w1+(δ x input) = 0.3 + (-0.0406x0.68) = 0.272392.
w2+ = w2+(δ x input) = 0.9 + (-0.0406x0.6637) = 0.87305.
Errors for hidden layers:
δ1 = δ x w1 = -0.0406 x 0.272392 x (1-o)o = -2.406x10-3
δ2= δ x w2 = -0.0406 x 0.87305 x (1-o)o = -7.916x10-3

New hidden layer weights:
w3+=0.1 + (-2.406 x 10-3 x 0.35) = 0.09916.
w4+ = 0.8 + (-2.406 x 10-3 x 0.9) = 0.7978.
w5+ = 0.4 + (-7.916 x 10-3 x 0.35) = 0.3972.
w6+ = 0.6 + (-7.916 x 10-3 x 0.9) = 0.5928.

(iii)
Old error was -0.19. New error is -0.18205. Therefore error has reduced.

IX. CONCLUSION

In this paper how neural networks are useful in forecasting the weather and the working of most powerful prediction algorithm BPNN was explained. The trained sets are predicted by BPNN with least errors. The feature work is the trained sets or data sets are predicted by BPNN for feature weather conditions. With this research the BPNN will predict the Natural Calamities in future.

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