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ARTIFICIAL NEURAL NETWORK – A TOOL FOR PREDICTION OF MONSOON RAINFALL OVER TAMIL NADU

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ABSTRACT

Over the last few decades, several models have been developed, attempting the successful forecasting of rainfall in India. Though some of these models show notable accuracies in short term rainfall occurrence prediction, long term prediction and rainfall depth prediction has proven to be somewhat difficult using traditional statistical methods. The reason being, that the rainfall dynamics are dependant upon highly unpredictable physical parameters, such as humidity, wind speed, wind direction, pressure, temperature and cloud amount. This paper gives the idea about Northeast monsoon rainfall over Tamil Nadu through neural network. The model can predict Northeast monsoon rainfall based on the parameters like Outgoing Long wave Radiation (OLR), Global temperature and Sunspot number as input variable. The model can perform well both in training and testing periods.

Key words: Monsoon rainfall, Neural network, Outgoing Long wave Radiation, Global temperature, Sunspot number.

INTRODUCTION

Tamil Nadu, located in southeast peninsular India, receives the major part of its annual rainfall during the northeast monsoon season (the three-month period from October to December). While coastal Tamil Nadu receives about 60% of its annual rainfall and interior Tamil Nadu receives about 40-50% of annual rainfall during northeast monsoon[1]. In comparison with Indian summer monsoon, the Northeast monsoon is characterized by limited aerial extent and average lesser rainfall amount. During northeast monsoon season, Tamil Nadu generally receives rainfall due to the formation of tough of low, cyclonic circulation, easterly waves, low pressure area, depression and cyclonic storm over Bay of Bengal. Because the northeast monsoon season is the major rainy season, the vicissitudes of the rainfall of Tamil Nadu state has led to considerable and widespread interest among the public, farmers and in government circles in recent years, in view of the frequent failure of northeast monsoon rainfall over Tamil Nadu and the consequent water scarcity condition.

There are several papers and documents to explain the relation between OLR and Northeast monsoon rainfall. The inter-annual variation of the outgoing long-wave radiation for the summer monsoon period showing a close association with the large-

scale monsoon rainfall over India has been mentioned by Prasad and Verma[2]. They have concluded that the satellite-derived outgoing long-wave radiation can be used to monitor more comprehensively the large-scale monsoon circulation and its year-to-year variability in view of its spatial coverage over oceanic areas. Prasad and Bansod[3] have found the relationship between averaged OLR for west central India and the Indian summer monsoon rainfall to be stable.

The inter-annual variability of Indian summer monsoon rainfall and Northeast monsoon rainfall is determined by external forcings and nonlinear internal dynamics. Surface air temperature is one of the factors that influence monsoon variability. The distribution of surface air temperature over land and sea determines the locations of heat source and sink which in turn affect circulation patterns through thermal and latent heat energy exchange between atmospheres and the surface beneath. A number of studies addressed the relationship between Indian summer monsoon and land and sea surface temperatures[4,5]. Many studies[6,7] examined the global land surface air temperature anomaly patterns in association with inter annual variability of Indian summer monsoon rainfall. Balachandran et al[8] suggested that, in the correlation coefficient patterns, the positive correlation coefficient regions indicate that when the surface air temperature over these areas are warmer (cooler) than normal, the northeast monsoon is above (below) normal. Similarly, the negative correlation coefficient regions indicate that the surface air temperatures over these areas are cooler (warmer) than normal when the northeast monsoon rainfall is above (below) normal.

Sun is the primary source for all activities of earth atmospheric system. If there is any variation in solar output, it affects the generation of cloud condensation nuclei or wind pattern or droplet growth size. Samuel Selvaraj et al[9] found that the linear correlation between sunspot activity and Tamil Nadu annual rainfall is -0.21, which is significant at 1% level, but it is able to explain the 5% of variations in rainfall. Regression estimation, which is made for Tamil Nadu annual rainfall, using sunspot activity by a quadratic regression equation, is able to explain about 75% of the variations in annual rainfall of Tamil Nadu.

RESEARCH METHODOLOGY

Neural network are signal processing systems that attempts to emulate the behavior of biological nervous systems by providing a mathematical models of combination of numerous basics blocks called neurons connected in a network. It is remotely analogous to living nervous system and hence its name. One can think of neural networks as an extended form of regression which has the properties of

- Adaptivity
- Robustness
- Ruggedness
- Speed (via massive parallelism)
- Nonlinearity
- Optimality with respect to error

For regression, we assume a functional form first, such as linear or exponential, and then we find the coefficients that minimize some measure of errors, whereas for neural networks, the method itself extracts the functional form from the data. As input to the model, a historical set of significant meteorological data is used, whereas the output, northeast rainfall is predicted by the model. The network is

trained with past data. By the proper choice of training sets, after the learning process, the trained network is capable of predicting the northeast rainfall as an output according to the inputs and internal structure of the network established during the learning period. The most common neural network is the feed forward mapping network, it consists of a set of nodes and a set of interconnection between them.

A node contains a computational element called neuron, taking inputs from incoming interconnections (input links) and providing outputs to outgoing interconnections (output links). The units of the neural network are arranged by layers. A unit on one layer takes inputs from the units on the layers below and feeds its output to the units on the layers above. The bottom layer is called input layer whose units take input from the outside and without processing them distribute to the units on the layer above. The top layer is an output layer whose output is the output of the neural network. The layers between input and output layers are called hidden layers. A pattern is defined as a set of input values with the related output values. A typical computational element takes the weighted sum of the input and passes the result through a transfer function. The process of learning the training set of patterns means the determination of the optimum weights, which minimize the mean square error between the outputs in the output layer and the desired values. Most commonly used "back-propagation learning algorithm"[10] is used for the training. Initially random weights between ±0.5 are assigned to each weight as initial guessed. The weights are learned through an iterative process. During learning, the weights are updated.

When the network learns the training set of patterns well enough, it can be used for determining the output values for the pattern with unknown outputs (test period or Prediction period).

Data

The OLR for the period of 1974-2009 and sunspot activity data is collected from the National Geophysical Data centre, Colorado, USA at ngdc.noaa.gov.in. The Global temperature and Rainfall data of Tamil Nadu is collected from Indian Meteorological Department.

RESULT

The data is separated for training of the network and the network was trained. The weight values were fixed. Remaining data was used for testing of the network. The result obtained is shown in the fig.1

Root Mean Square Error of Training Data Set =0.158547 %

Root Mean Square Error of Test Data Set =12.252306 %

The above results validate the proposed model. Hence it is concluded that the above model can be used for predicting Northeast monsoon of Tamil Nadu. If we want to reduce the error the newly correlated parameter are taken as input in the model.

CONCLUSION

The atmosphere is very much chaotic by nature and no prior assumptions can be made while developing any models for chaotic atmospheric processes. Unlike the stochastic modeling techniques, the artificial neural networks (ANN) are capable of modeling highly non-linear relationships without any prior assumption. The percentage errors of prediction from the three inputs ANN models are computed with sigmoid non-linearity for Tamil Nadu rainfall. It is found that the percentage of errors of prediction lie below 15%.

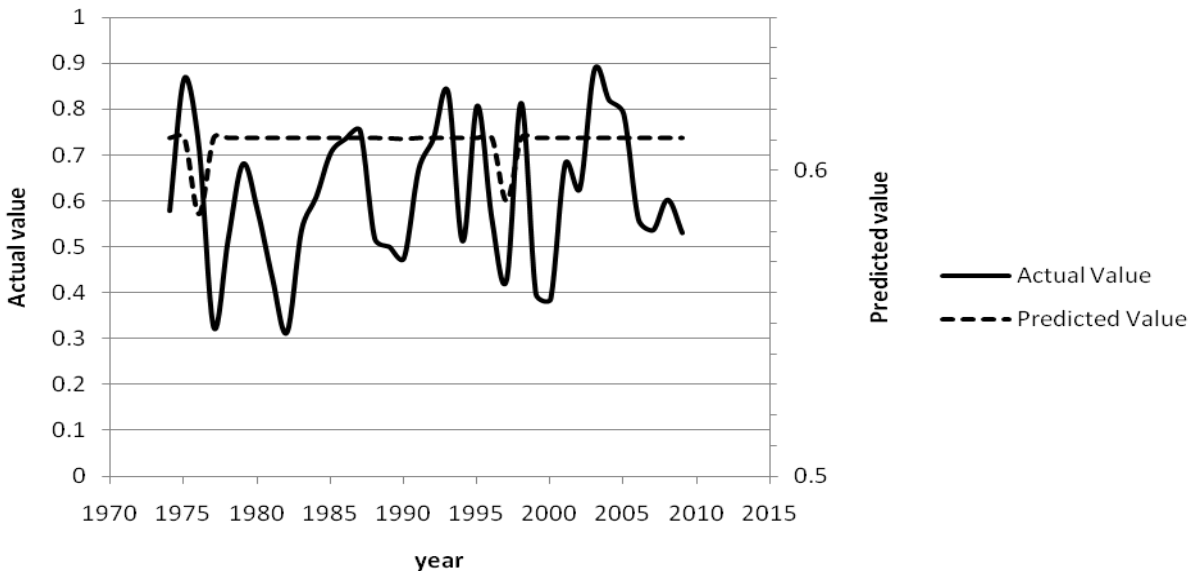

Fig 1: Predicted value verses Actual value

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