iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 **Issue:** VIII **Month of publication:** August 2020

DOI: https://doi.org/10.22214/ijraset.2020.30948

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue VIII Aug 2020- Available at www.ijraset.com

Rainfall Modeling using Artificial Neural Network for Gwalior (M.P.)

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Abstract: ***Rainfall prediction has become an important area of research in the last few decades. In most of the literature the researchers attempted to establish a linear relationship between the input rainfall data and the corresponding target data. However due to the uncertainty in the nature of rainfall data, now the focus has shifted towards the nonlinear prediction of the rainfall. The application of Artificial Neural Network (ANN) has evolved out to be a better technique in bringing out the relationship between the various input and output parameters. In the present research, the paper examines the application of ANN by developing effective and reliable model for rainfall prediction in Gwalior district of Madhya Pradesh. And also evaluates the performance of the developed multilayered neural network models using different hidden layers and different backprapogation techniques. The monthly rainfall predictions that obtained after training and testing of models are then compared with actual data to ensure the accuracy of the described model. The results of this study outline that the model is successful in predicting the monthly rainfall data with the selected parameters.***
Keywords: Rainfall modeling, artificial neural network, back propagation algorithm, multilayer neural network, MATLAB.

I. INTRODUCTION

The rainfall is the most significant feature that has always been associated with the increasing demands of human beings. It is a result of natural processes which is uncertain, non-linear and highly complex. It plays a significant role in various sectors such as agriculture, water resource management, flood management, construction management etc. The Problem here is to formulate the data for the prediction of rainfall and create a successful model that would be based upon the previous findings & similarities and will try to give the out predictions that are appropriate and reliable. And also to suggest a system that is more precise and accurate because it will save time and resources. The findings will lead to perform best during crisis such as poor agriculture practices, flood management, drought management, construction practices, etc. In order to overcome all such problems to predict rainfall in a very effective way this paper proposes a rainfall prediction model to predict average monthly rainfall in Gwalior district of Madhya Pradesh using Artificial Neural Network. The advantage of ANN over other present method is that the ANN minimizes the error using various algorithms and provides us a predicted value which is nearly equal to the actual value.

II. LITERATURE REVIEW

This section focuses on survey that investigates the work that has been already done on rainfall modeling and prediction using artificial neural networks.

Jeongwoo Lee [3] carried out an assessment to develop a late spring-early summer rainfall forecasting model using an ANN for Geum River Basin in South Korea. The suggested ANN model incorporates the lagged global climate indices that ensure management of water resources, drought prediction effectively.

H D Purnomo [2] applied Artificial Neural Network for Monthly Rainfall Rate Prediction. They used two neural network models for monthly rainfall rate forecasting. The performance of suggested model is assesses based on monthly rainfall rate in Ampel, Boyolali, from 2001- 2013. On comparison, the experiment results showed that the accuracy of the first model is quite better than that of the second model.

Dhawal Hirani [1] presented a study in which author widely used techniques for prediction are Regression analysis, clustering, and Artificial Neural Network (ANN) etc. The paper represents an elaborated review of different rainfall prediction techniques that are used for the early prediction of rainfall.

Tomoaki Kashiwaoa [9] developed a neural network based on local rainfall prediction system using meteorological data from the Japan Meteorological Agency. In this study, researches developed and tested a local rainfall (precipitation) prediction system based on artificial neural networks (ANNs). The goal of this study was to use the “big data” present on the Internet. Researches predicted local rainfall in regions of Japan using data from the Japan Meteorological Agency (JMA).

Kumar Abhishek [4] suggested the possibility of predicting average rainfall over Udupi district of Karnataka through the help of artificial neural network models. A three layered network has been constructed in formulating artificial neural network based predictive models. Different number of hidden neurons is taken for various models under study.

Saeed R. Khodashenas [8] uses a three-layer feed-forward perceptron network with back propagation algorithm with Several ANN models developed to predict the monthly precipitation in Mashhad station. The data was collected from 1958 to 2008 gives out total 636 monthly precipitation data, a 580 data set has been used for training the networks and the rest has been used for validation of the models to predict the precipitation of this station.

Mustapha Ben el Houari [6] developed mathematical models for forecasting the monthly precipitation. For this research, the Multi Layer Perceptron (MLP) artificial neural network model was used in predicting the monthly average precipitation in the region of Meknes in Morocco. There were eight meteorological parameters namely minimum temperature, average temperature, maximum temperature, pressure, visibility, moisture, average wind speed and maximum wind speed. The data from 1996 to 2013 with a data cover of 209 months was analyzed, and linear correlation coefficient was used to inter relate the studied meteorological parameters to the precipitation by nonlinear relationships. The efficiency of the model was found by the calculating the Root Mean Square Error.

III. EXPERIMENTAL SETUP

A. Study Area

Gwalior District lies between latitude 25°43′ and 26°43′ in North and longitude 77°40′and78°39′in East. The district is bounded by Morena and Bhind in the North, Shivpuri in the southern and Datia in the East direction. The entire area of Gwalior district falls under Sindh & Kunwari sub basin that of Yamuna basin. The major triburaties of the river Sindh are Baisali, Parbati, and Pahuj. The tributaries of Kunwari are Asan and Sank.

The normal annual precipitation of Gwalior district is about 764.4 mm. The district receives a maximum rainfall during southwest monsoon period that is between June to September and about 89% of the annual rainfall received during monsoon period and about 11% takes place during non- monsoon period i.e. October to May. The average maximum temperature is observed during the month of May that is 42.1° C and minimum during the month of January that is 7.1° C. The relative humidity generally exceeds to 83% whereas the wind velocity is usually higher during pre-monsoon period as compared to post-monsoon period.

B. Data Specification

For data pre-processing, the monthly rainfall data from 1901 to 2002 for Gwalior (M.P.), is collected from the Indian Metrological Department (IMD) and Madhya Pradesh Water Resource Department (MPWRD) to outline the trends and variations in the data within this time period. The collected data represents monthly average value of rainfall, temperature, cloud content, vapour pressure.

C. Data analysis and data preparation

The collected dataset consists of corresponding average monthly Temperature data, Vapour pressure data, Cloud content data as input variable and rainfall data as a target data of 101 year (1901-2002) arranged column-wise in an Excel sheet which is later imported into the MATLAB workspace. The collected data from sources is monthly records, because this study will also focus on the monthly rainfall prediction. The statistical data studied and examined in this study is used as input for processing the rainfall modeling work. The analysis and preprocessing of raw collected data is done by Microsoft Excel software. Data preprocessing include statistical analysis of data (mean, mode, standard deviation, skew ness, and kurtosis), finding correlation and relation between input and output parameter, random sampling of input data.

TABLE I
Summary of sampled data

Sampling of dataset	70% training data**,** 75% training data, 80% training data, 85% training data, 90% training data**.**
Testing dataset	30%test data, 25%test data, 20%test data, 15%test data, 10%test data,
Input parameters	Temperature. Cloud content, Vapour pressure.
Target and Output parameter	Rainfall

D. Methodology

The artificial neural architecture contains three layers namely input layer, hidden layer and output layer. ANN networks are based on basic elements called as neurons and these neurons receive data as input variables that are required for processing the results. The networks are formed by multilayered nonlinear nodes that are connected by the designated weights. ANN algorithm consists of two stages a forward pass and a backward pass. In forward pass, an input is applied to the multilayered nodes of the network and it propagates through a network layer by layer and a set of outputs are produced as the actual response of the network. During the process of forward pass the weights are randomly assigned whereas on the other hand in the backward pass (backpropagation technique) the assigned weights are all adjusted in accordance to an error correction rule in different backprapogation algorithms. The typical backpropagation network contains an input layer, output layer and hidden layers. The numbers of hidden layers are determined according to the accuracy and precision of model.

E. Neural Network Model

The Neural Network tool available in MATLAB is used to carry out the analysis on the rainfall data using Artificial Feed-Forward Neural Network along with back-propagation principles. However, we have started our research with a multilayered neural network with three different back propagation techniques in different models. The input parameters and output neurons are the building blocks of ANNs. The following tools were used for implementing the algorithms in MATLAB.

Nntool;-In the nntool, the single layer and the multi layer algorithms are implemented.

Nftool:-Stands for Neural network fitting tool. In this tool backpropagation Algorithm (BPA) is implemented.

A multilayer neural network with back propagation network have at least three layers i.e. input layer, hidden layer and output layer. The selection of appropriate number of hidden layers in each model needs experimentation. The various networks are aimed at predicting the rainfall by using the data with inputs and different number of hidden layers. Subsequently, different network model trained with three algorithms namely Levenberg Marquardt, Baysian Regularization and Scaled Conjugate Gradient. The set of test data is applied to the trained neural network and to test the performance and accuracy of the neural network. The experimentation are analyzed by changing number of hidden layers (5, 10, 15, 20……..…100) and algorithms, the error is reported in each case to check the accuracy of each network model. The study is aimed at minimizing the errors between the predicted and the actual output that is rainfall.

After several numbers of iterations, 300 neural networks are trained and algorithms are saved. Then the testing dataset data is presented to the trained neural network models to test the accuracy of the models in each of the following case the error is recorded to examine how well the network model is able to predict the output rainfall data.

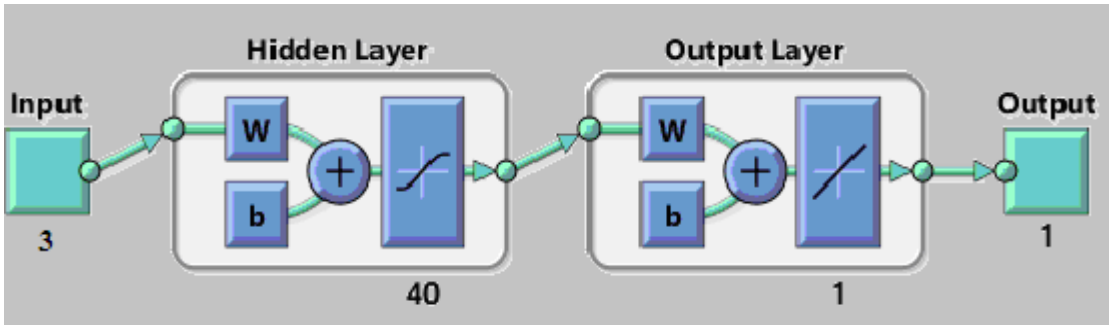


Fig 1: Architecture of neural network

IV. RECORDED OBSERVATION

This study focused on using the artificial neural networks for determining best model that can predict the rainfall data on monthly basis. The study proved that using different back propagation in different neural network models can be used to obtain output readings for rainfall accurately and precisely, as demonstrated in this study.

300 models were developed and trained using the existing data sets. Model consists of 3 inputs parameters with different set of hidden layer and Levenberg Marquardt, Baysian Regularization, and Scaled Conjugate Gradient backprapogation technique respectively in different NN models. The error is reported for each model to check the accuracy of all network models is presented below.

TABLE II
Test result on Levenberg Marquardt backprapogation technique on different training dataset reporting Minimum Error

Model code	Dataset detail	Reported error
LM70-15	70% training data	0.008904365
LM75-35	75% training data	0.001501736
LM80-40	80% training data	0.001615338
LM 85-25	85% training data	0.090779304
LM 90-55	90% training data	0.059716233

TABLE III
Test result on Baysian Regularization backprapogation technique on different training dataset, reporting Minimum Error

Model code	Dataset detail	Reported error
BR70-80	70% training data	0.008904044
BR75-40	75% training data	0.000106889
BR80-60	80% training data	0.030382197
BR85-70	85% training data	0.007930882
BR90-85	90% training data	0.015831479

TABLE IV
Test result on Scaled Conjugate Gradient backprapogation technique on different Error

Model code	Dataset detail	Reported error
SCM70-30	70% training data	0.006084363
SCM75-45	75% training data	0.048751411
SCM80-30	80% training data	0.02955906
SCM85-20	85% training data	0.027219453
SCM90-05	90% training data	0.032289954

V. RESULT AND DISCUSSION

From the all set of observations presented above, we found out the following outcomes as a result.

1) *Sampling:* Out of the created 5 datasets namely 70% training data, 75% training data, 80% training data, 85% training data, 90% training data the 75% training dataset has deduced minimum error among all.
2) *Backprapogation Algorithm for hidden Layers:* - The Baysian Regularization (trainbr) algorithm proved out to be best among Levenberg Marquardt, Baysian Regularization, and Scaled Conjugate Gradient backprapogation algorithm.
3) *No. of Hidden Layers:* - From above observation we concluded that optimum number of hidden layers that predict minimum error in best fit model is 40.
4) *Model:* Out of created 300 network models BR75-40 (75% random sampling dataset with Baysian Regularization as a backprapogation technique and 40 numbers of hidden layers) has proven out best model among all having minimum error and most accurate result during testing.

5) Comparison Between Actual Rainfall And Predicted Rainfall Through Model

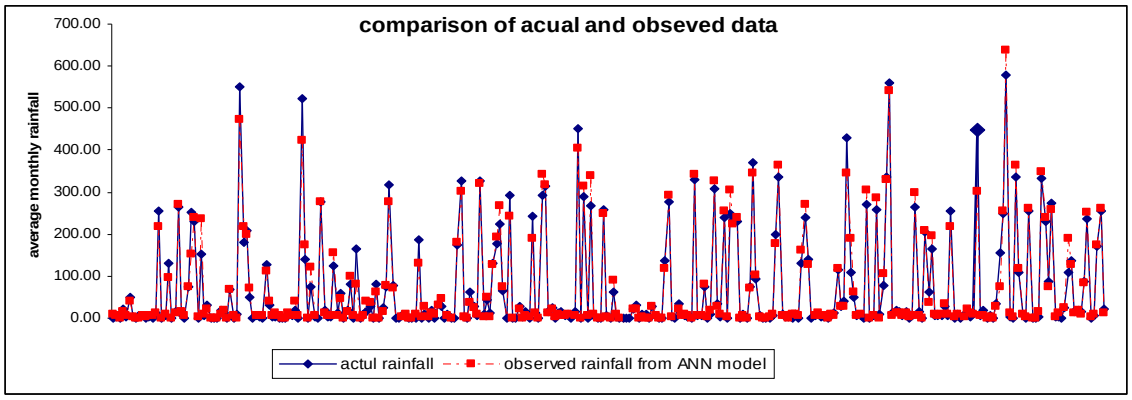


Fig 2: comparing actual and predicted rainfall data

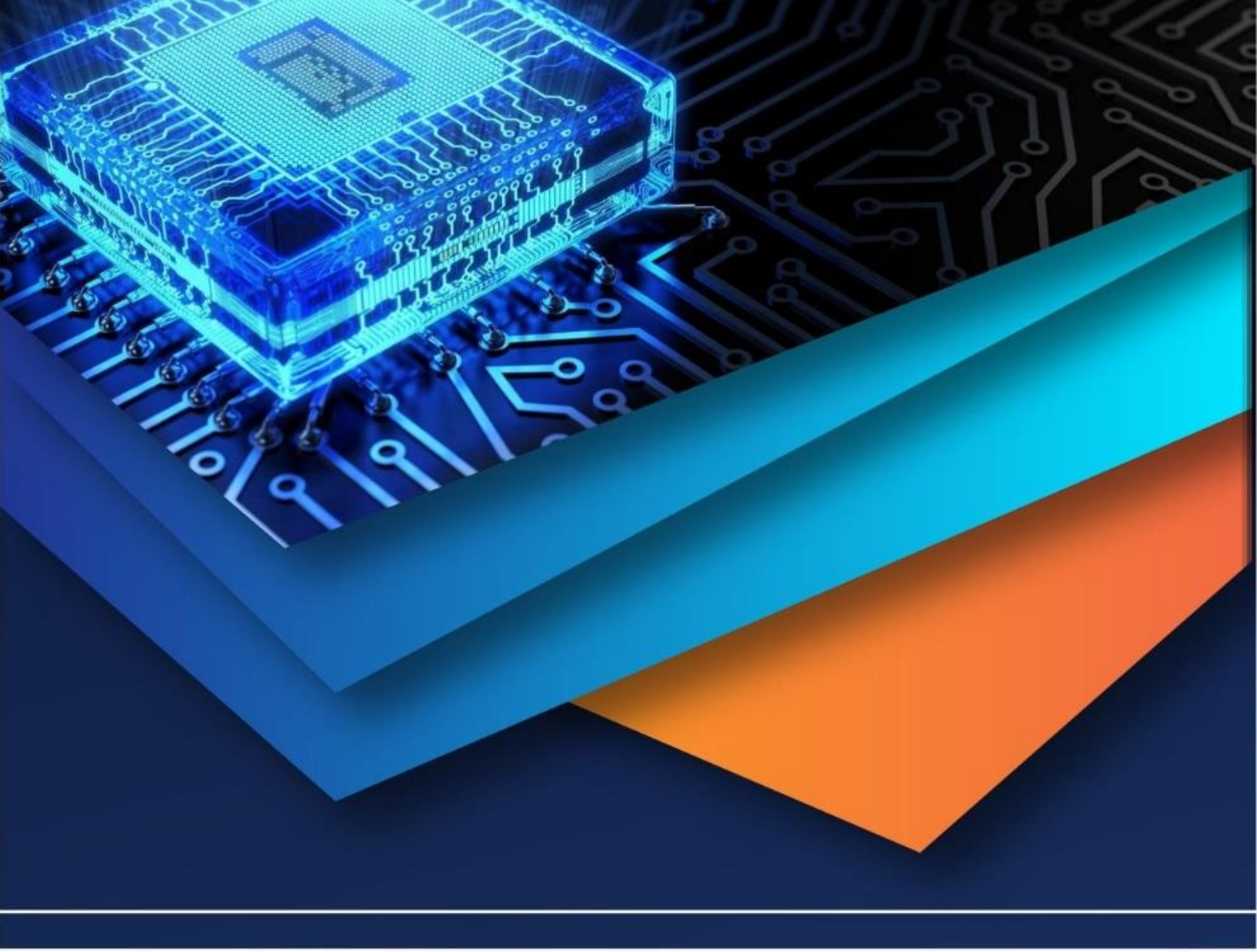
The above figure 5 illustrates the graph comparing actual and predicted data for Gwalior using selected BR75-40 model. The graph demonstrates that there is some difference between the actual and the predicted data.

VI. CONCLUSION

In this paper, 300 different multi layer neural networks (ANN) are proposed to examine best neural architecture to predict average monthly rainfall. The performance of the entire proposed model is evaluated on based of the monthly rainfall data in Gwalior from 1901 to 2002. The input parameters used in model are determined through correlation analysis among input parameters and rainfall. The models are trained on Levenberg-Marquardt algorithm, Baysian Regularization algorithm, Scaled Conjugate Gradient algorithm for different numbers of the hidden layer. The experiment result shows that the accuracy of the BR75-40 model (75% data set with 40 number of hidden layer with Baysian Regularization algorithm) found out significantly better than the other entire model. Its error is minimum among all models. The result also reveals that the selected models perform better during testing that lead to create efficient and reliable model for prediction of average monthly rainfall in Gwalior.

REFRENCES

[1] Dhawal hirani, Dr. nitin mishra, A Survey On Rainfall Prediction Techniques, International Journal of Computer Application, Volume 6– No.2, March- April 2016.
[2] H D Purnomo, K D Hartomo, S Y J Prasetyo, Artificial Neural Network for Monthly Rainfall Rate Prediction, IOP Conf. Series: Materials Science and Engineering 180, 2017.
[3] Jeongwoo Lee, Chul-Gyum Kim, Jeong Eun Lee, Nam Won Kim and Hyeonjun Kim, Application of Artificial Neural Networks to Rainfall Forecasting in the Geum River Basin, Korea, Water 2018, 10, 1448.
[4] Kumar Abhishek, Abhay Kumar, Rajeev Ranjan, Sarthak Kumar, A Rainfall Prediction Model using Artificial Neural Network, IEEE Control and System Graduate Research Colloquium (ICSGRC 2012) July 2012.
[5] Mohini P. Darji, Vipul K. Dabhi, Harshadkumar B.Prajapati, Rainfall Forecasting Using Neural Network: A Survey, International Conference on Advances in Computer Engineering and Applications (ICACEA) 19-20 March, 2015.
[6] Mustapha Ben el Houari, Omar Zegaoui, Abdelaziz Abdallaoui, Development of Mathematical Models To Forecasting The Monthly Precipitation, American Journal of Engineering Research (AJER) Volume-03, Issue-11, 2014, pp-38-45.
[7] Oseni Taiwo Amoo (South Africa), Bloodless Dzwairo (South Africa), Trend analysis and artificial neural networks forecasting for rainfall prediction, Environmental Economics, Volume 7, Issue 4, 2016, p.p.149-160.
[8] Saeed R. Khodashenas, N. Khalili, K. Davari, Monthly Precipitation Prediction by Artificial Neural Networks (Case study: Mashhad synoptic station), Session 1.7, Novatech, 2010.
[9] Tomoaki Kashiwaoa, Koichi Nakayamaa, Shin Andoc, Kenji Ikeda d, Moonyong Leee, Alireza Bahadori , A neural network-based local rainfall prediction system using meteorological data on the Internet: A case study using data from the Japan Meteorological Agency, Applied Soft Computing 56 Elsevier B.V, , 2017, p.p. 317–330.
[10] www.indiawaterportel.org/met_data
[11] www.mpwrd.gov.in/rainfall



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