International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-8 Issue-12, October 2019

A Hybrid Genetic Algorithm Based Rainfall Prediction Model Using Deep Neural Network

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Abstract*: This paper is intended to design and develop an efficient prediction algorithm in the context of forecasting in the precipitation as well as the intensity of the rainfall in a local region over a relative short period of time. Despite of several existing addressing the problem of forecasting rainfall, still it is remind as an open challenge in the context of dynamic data acquisition and aggression. Prediction of rain is main application of science and technology to predict the state of the atmosphere. The main objective of the study is to develop a Genetic Algorithm based approach that utilize dimensionality reduction technique and Multi-layer Perceptron for efficient and dynamic analysis of real time data. Furthermore a deep neural networks based framework is proposed to predict rainfall of a certain region. A Hybrid genetic algorithm presents a novel solution to predicting the rainfall in certain area or different regions by using Deep Neural Network.

***Keywords* : Deep neural network, Genetic Algorithm, Multi-layer perceptron, Precipitation..**

I. INTRODUCTION

Machine Learning based rainfall Prediction techniques plays a vital role in the context of designing automated management system and eventually affects the productivity of agriculture. Several research studies addressing this problem have proposed different prediction mechanisms for the development of efficient recommendation systems for early prediction of rainfall. Rainfall plays a vital role in agriculture, so early prediction perceptions is good for better economic growth of our country. The main application of rainfall prediction is science and technology to predict the state of the atmosphere. It is determine to exactly rainfall for effective use of water resources, crop productivity and pre planning of water structure. For Predicting rainfall different techniques are used like Artificial Neural Network, Regression analysis and clustering. The simulated studies indicates in the prediction of rainfall are Rainfall runoff model, Wavelet neural network and Hybrid model.

Rainfall run-off model are mainly helpful for water resources, planning and development. In the rainfall run-off models are based on Artificial Neural Network compared with a mathematically conceptual model.

Revised Manuscript Received on October 30, 2019.
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Most of the Artificial Neural Network models in hydrological applications are feed forward back propagation neural network which are trained by back propagation algorithm [1]. This paper is focused to train the Artificial Neural Network model to forecast the monthly future discharge for short length and low standard dataset.

Wavelet Neural Networks model, mainly contributed for wavelet analysis and Artificial Neural Network that has been proposed for rainfall forecast [2]. This article uses an alternative method by combining ANN with wavelet technique for rainfall prediction. In water resource research, this wavelet technique is applied widely because of their time frequency representation. For modeling the monthly rainfall prediction series and annual rainfall series different time series techniques proposed such as Auto-Regressive model, Fractional Gaussian noise model and ARIMA model. ANN architecture most popular in hydrological modeling is multi layer perceptions with back propagation algorithm.

This Hybrid model focused on time series forecasting using a hybrid ARIMA and neural network model. Auto Regressive Integrated Moving Average (ARIMA) is popular linear models in time series forecasting during the past observation. Recent research activities in forecasting with artificial neural networks (ANNs) suggest that ANNs can be a promising alternative to the traditional linear methods. In this article, a hybrid methodology that combines both ARIMA and ANN models is proposed to take advantage of the unique strength of ARIMA and ANN models in linear and nonlinear modeling. There are several different approaches to time series modeling. Traditional statistical models including moving average, exponential smoothing, and ARIMA are linear in that predictions of the future values are constrained to be linear functions of past observations.

II. LITERATURE SURVEY

Wansik yu [4] presented a study to evaluate flood forecasting based on numerical weather prediction. The main objective of this study is to predict the rainfall that covers horizontal resolution area of 2kms as-well-as forecast time up to 30hrs that could be assessed based on the data generated by the cyclone named TALAS in 2011. The contribution of the study includes an ensemble model with an integration of numerical weather prediction that is designing based on distributed hydrologic framework. The implementation results illustrate that the ensemble model outperforms the deterministic model in terms of forecasting quantitative precipitation when applied with hydrological applications.

In [5] Pravendra Kumar et.al while addressing the problem of rainfall forecasting in Junagadh region of Gujarat developed an hybrid neural network model that integrate neural fuzzy system along with artificial neural networks considering the parameters of wind velocity precipitation level, and mean temperature from previous rainfall data.

The contributions of work includes the study of climatic conditions and collection of meteorological observatory data from agriculture university in Junagadh location, further it include the development of artificial neural networks based on fuzzy interferences system to predict daily rainfall. Based on sensitivity analysis of the proposed system it is identified that precipitation is considered major sensitivity parameter for rainfall prediction when compared to other parameters.

In the context of predicting the rate of rainfall for a frequent period of every month, Purnoma et.al[6] developed two forecasting models based on Artificial Neural Networks. It is observed that both the neural network models include three major steps as follows, initially in the context of feed forward for the first model n input modes that denotes the rate of rainfall for 'n' previous years is given as a input where as in the second model data is trained from the 'm' selected months from the last year rainfall data. And further to it is processed through hidden layer as-well-as output layer. From the simulation results it is observed that the two proposed models the first model outperforms the second models in terms of prediction. The analysis of results withdraw the fact that, both the model performs well while percentage of rainfall prediction fluctuation is low.

Kumar Abhishek et.al[7] addressing the problem of predicting the rainfall have developed an Artificial Neural Networks model that intended to forecast the percentage of rainfall within the Udupi district of Karnataka. The main contribution of his work is to utilize Back Propagation based Artificial Neural Network to forecast rainfall at different seasons within Udupi district. The results indicated in the article specified that the count of neurons increases immensely within the networks while prediction and it is also further observed that multilayer algorithm perform better than single layered algorithm, it is also suggested that, the data which is considered as input and output should be normalized before processing it.

Pengcheng Zhang[8] In atmospheric models Short term rainfall forecasting can be predicted by using numerical models. Many of the countries like china prediction of numerical forecasting models are European Centre for Medium range Weather Forecasts(ECMWF), Japan meteorological Agency numerical weather prediction models(JAPAN) and Regional Assimilated and prediction system(GRAPES). In this numerical models performs the Vienna Mapping Function(VMF) and Japan Meteorological Agent(JMA). But there will be differences between the numerical methods and real situations. This is one of the limitation presented in numerical forecasting and its uses higher end software requirements.

In Machine Learning rainfall prediction uses time series analysis methods. It's a statically tool for analysis data. These techniques are used to analyze methodology and data set of time series analysis models that are implemented in a Auto Regression In Moving Average (ARIMA), WAVLET and Markov model. This model presently trend analysis of pre-monsoon rainfall data over the country. Machine Learning[9] and statistics are two deeply related fields of study. Statistical approaches learn from rainfall sequences and various characteristics of the rainfall series. We can learn the relationship existing between physical factor and rainfall by using different machine learning algorithms. Different approaches or algorithm like Support Vector Machine, Support Vector Regression, Artificial Neural Network. These approaches are based upon time-series prediction and feed forward neural networks and ARIMA model were applied in previous rainfall in Urmia lake basin.

Rainfall prediction using Artificial Neural Network models including Feed forward neural networks, Back propagation neural networks and Radial basis function neural networks. In this researcher assessed ANN by input recognized climate indices, monthly historical rainfall data, time-delay, dynamic and Recurrent. Artificial Neural Networks developed prediction of rainfall for monthly using Input selection and optimization techniques. To identify from traditional Artificial Neural Networks architecture, DNN[10] is used to networks with more layers which is more complex than the traditional network.

Presently this prediction of rainfall using different kinds of Deep Neural Networks attempts. These factor suggestions for meteorologically or physical certain area as certain area as input and rainfall as output. These factors contain typhoon position, wind speed around typhoon, moving direction of the typhoon, moving speed of typhoon and pressure. This typhoon was effectively for prediction of rainfall.

III. PROPOSED METHODS

Genetic algorithms are searching algorithm based upon the methods of natural selection and genetics. This algorithm reflects the process of natural selection where the fittest individuals are selected for reproduction in order to produce offspring of the next generation. This algorithm mainly used to generate high-quality solutions to optimization and search issues by relying on bio-inspired operators such as mutation, crossover and selection. Reproduction or selection means is a function, the separated strings are copied based on their fitness which one has more fitness value will have more chances in next generation. Has over process is separated into two stages. In First stage pair of bit strings will be matter randomly to became the parents of two new bit strings. In second stage it will choose a place in bit string and swap all character parents after that point. Mutation is added because of the probability that a bit cannot be modified by the past operation due to its absence from the generation.

Multi-layer Perceptron: A Multi-layer Perceptron is a class of feed forward Artificial Neural Networks and also a Deep Neural Networks [DNN]. It composed work from input layer to receive the signal, an output layer that makes a decision or prediction about the input, and in between those two, an arbitrary number of hidden layers that are the true computational engine of the Multi Layer Perceptron. Each of the Perceptron in the MLP is used to find linearly separable of sections of input. To generate final Outputs all the outputs of Perceptron are combined.

A Multi Layer Perceptron minimally consists of three layers, the first layer is called input layer, the last layer is called output layer and in between these two layer hidden layer is presented.

In Multi Layer Perceptron Each layer consists many neurons and its uses a nonlinear activation function. In Multi Layer Perceptron for training it uses back propagation algorithm. Deep Neural Networks are differs in network structure, number of parameter layers and number of nodes like weights and optimization technique used.

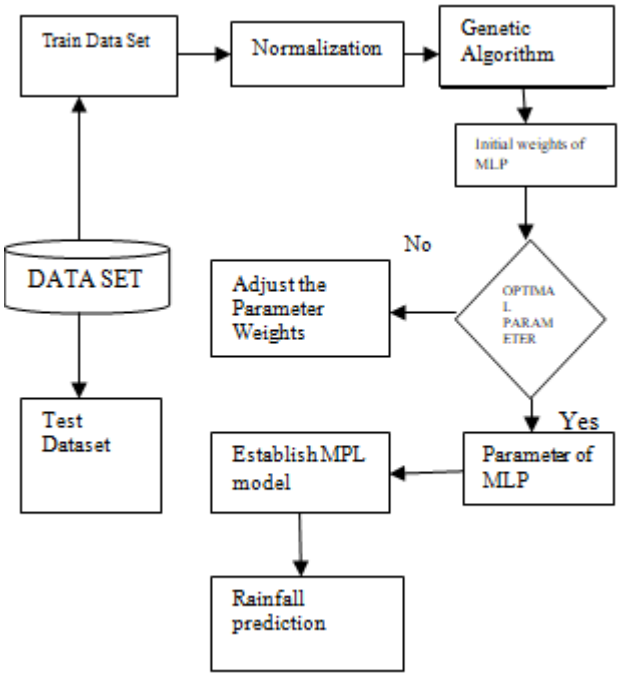
In this paper a novel framework using Deep Neural Network is used for predicting the rainfall in regions to improve the efficient of prediction of rainfall. Each region predicts rainfalls by using Multi Layer Perceptron all are having same structure. The inputs for this Multi Layer Perceptron may changes because inputs are given based on regions. But few have same target output such as prediction of rainfall. Main steps of algorithm are:

1. Data collection and Pre-processing: The data is collected from kerala meterological dataset. By using different Pre-processing techniques the data set is Pre-processed. Genetic Algorithm is used for feature extraction.
2. Structure selection and parameter: Multi Layer Perceptron structure was determined by using greedy search and also by using different parameters like weight, bias and by using adjust algorithm.

Parameter determination and model optimization: In this step the range of the perception is determined by using average of different months of the region suitable Multi Layer Perceptron are used to predict rainfall.

By normalization techniques are used as Pre-processing techniques. Data is extracted from rainfall pattern in Kerala over last years and predict the rainfall in upcoming day/month/year dataset and on that dataset normalization. Pre-processing applied and Genetic Algorithm is applied for feature extraction. Converting data from raw data to a meaningful and efficient format is called data pre-processing. In this mainly three steps are involved data cleaning, data transformation and data reduction. To handle with missing and irrelevant data, data cleaning techniques like growing tuples and filling the missing values are used. In this dataset there is no missing or irrelevant data. In order to transform data in appropriate form different techniques like normalization and attribute selection are applied to dataset.

In this algorithm we used normalization technique. After the normalization Genetic Algorithm is used for feature selection. These features are feed as inputs to input layer of Multi Layer Perceptron and will get the output. The output is verified with optimal value if optimal value is not achieved then the parameter adjustments is done and again the output value is verified until minimal threshold value . Once the minimal value reached parameters are of Multi Layer Perceptron are fixed. For this trained model the test data was applied and predicted the accuracy of rainfall.



IV. RESULTS AND DISCUSSION

A Bar graph between Year (X-axis) and Annual Rainfall (Y-axis) is plotted from 1997 to 2017. From the below graph, the highest Annual rainfall is recorded in the year 2007 with 3489.6 mms and the lowest is 2016 with 1870.8 mms.

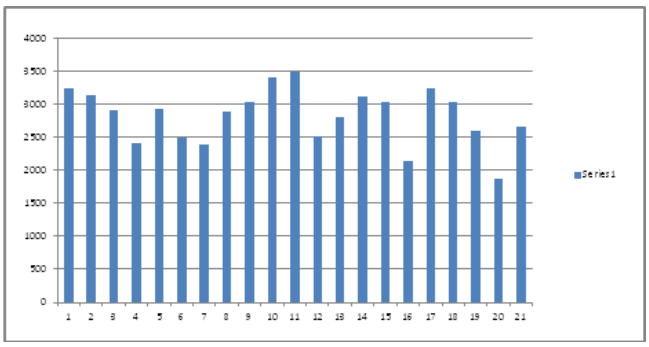


Fig1: Bar graph annual rainfall between1997-2017

A Bar graph is plotted with Year taken as X-axis and JF (Jan - Feb) taken as Y-axis from 1997 to 2017. From the graph, the highest Annual rainfall is recorded in the year 2000 with 69.5 mms and lowest is with 3.7 mms.

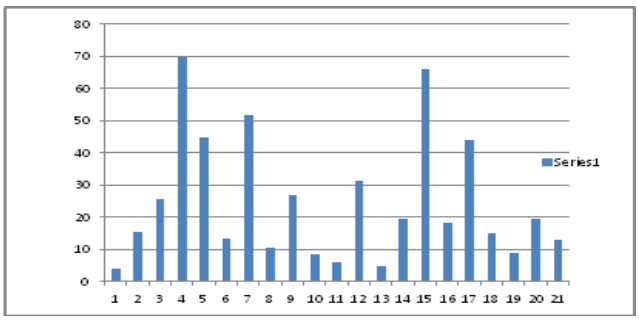


Fig 2: Bar Graph annual rainfall between 1997-2017

A Pie Graph is plotted between Year as X-axis and MAM (Mar – May) as Y-axis. In the year 2004, annual rainfall is as high as 762mms and 3.7mms, the lowest rainfall can be depicted from the below graph.

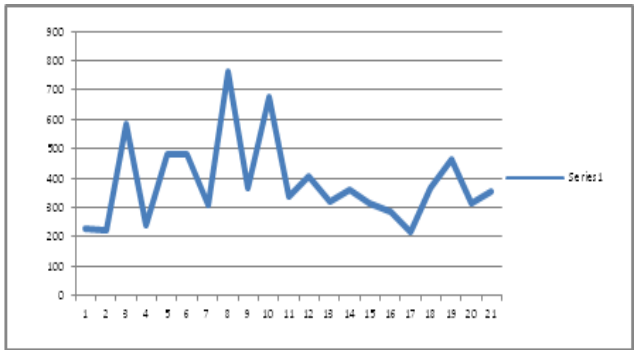


Fig 3: Line Graph annual rainfall between 1997-2017

A Bar graph is plotted by taking Year as X-axis and JJAS (Jun – Sep) as Y-axis. The highest annual rainfall is recorded in the year 2007 having 2688.5 mms and the lowest annual rainfall is in the year 2016 with 1352.3 mms.

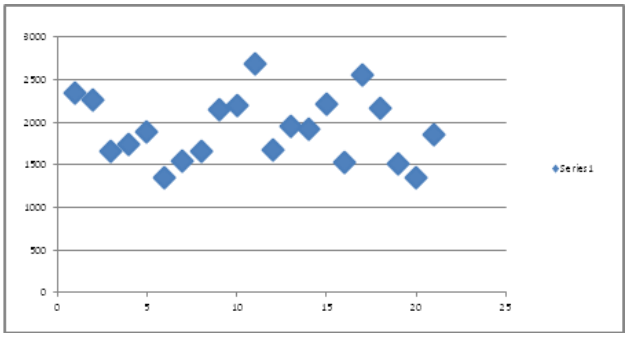


Fig 4: Scatter Plot annual rainfall between 1997-2017

A Bar graph is plotted between Year on X-axis and OND (Oct - Dec) on Y-axis. The highest annual rainfall is 823.3 mms in the year 2010 and in the year 2016, the lowest annual rainfall is 185 mms.

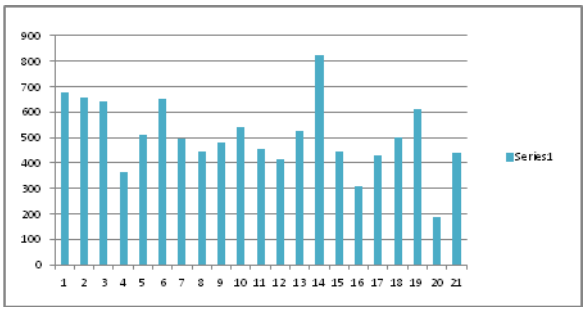


Fig 5:Bar graph annual rainfall between 1997-2017

V. CONCLUSION

This paper presents a Hybrid Genetic Algorithm based approach addressing the problem of predicting rainfall in a specific period of time. In this context it is observed from previous studies that aggression and collection of dynamic rainfall data is considered as major challenge. Several existing studies rainfall prediction model is difficult task in the field of meteorological department. Even though several models have attempted the prediction by training rainfall specific data set to different Machine Learning models the accuracy of prediction was not quantifiably appreciated. The proposed genetic algorithm based approach integrating dimensionality reduction technique have shown descent performance while normalization dataset. The stimulation studies illustrate that the proposed mechanism outperforms various existing techniques in term of prediction accuracy. Deep Neural Network can learn deep links among data, which is proved to be an effective approach for classification and prediction.

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