A Survey On Rainfall Prediction Using Machine Learning And Neural Network

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Abstract

Rainfall prediction is one among the foremost important and challenging task within the times. In general, climate and rainfall are highly non-linear and sophisticated phenomena, which require advanced computer modeling and simulation for his or her accurate prediction. Algorithms like Support Vector Machine (SVM), Artificial Neural Network (ANN), regression can be used to predict the behavior of such nonlinear systems. ANN has been successfully employed by most of the researchers during this field for the last twenty-five years. This paper provides a survey of available literature of some methodologies employed by different researchers to utilize Neural Network and machine learning for rainfall prediction. The survey also reports that rainfall prediction using Neural Network and machine learning techniques are more suitable than traditional statistical and numerical methods.

Keywords *— Rainfall, Artificial Neural Network, Prediction, Rainfall, Neural Network, BPN, RBF, SVM, SOM, ANN.*

I. INTRODUCTION

This document is a template. An electronic copy can be downloaded from the conference website. For questions on paper guidelines, please contact the conference publications committee as indicated on the conference website. Information about final paper submission is available from the conference website. Rainfall is a climatic phenomenon whose prediction is difficult and demanding. Rainfall brings the foremost important role within the matter of human life altogether sorts of weather happenings. The effect of rainfall for human civilization is extremely colossal. Accurate information on rainfall is important for the design and management of water resources and also crucial for reservoir operation and flooding prevention. Additionally, rainfall features a strong influence on traffic, sewer systems and other human activities within the urban areas. Nevertheless, rainfall is one among the foremost complex and difficult elements of the hydrology cycle to know and to model thanks to the complexity of the atmospheric processes that generate rainfall and therefore the tremendous range of variation over a good range of scales both in space and time. Thus, accurate rainfall prediction is one among the best challenges in operational hydrology, despite many advances in meteorology in recent decades. Rainfall means crops; and crop means life. Rainfall prediction is closely associated with agriculture sector, which contributes significantly to the economy of the state. On a worldwide scale, large numbers of attempts are made by different researchers to predict rainfall accurately using various techniques. But thanks to the nonlinear nature of rainfall, prediction accuracy obtained by these techniques remains below the satisfactory level. Artificial neural network algorithm becomes a beautiful inductive approach in rainfall prediction due to their highly nonlinearity, flexibility and data driven learning in building models with none prior knowledge about catchment behaviour and flow processes. Artificial neural networks are successfully utilized in lately in various aspects of science and engineering due to its ability to model both linear and non-linear systems without the need to make assumptions as are inherent most traditional statistical approaches. ANN has been used as an efficient model over the straightforward rectilinear regression model. This paper provides a literature survey on rainfall prediction using different neural networks employed by different researchers. The paper also discusses the concept of some neural network architectures briefly which can be helpful to the new researchers during this field. The objective of this survey is to form the prediction of rainfall more accurate within the recent future.

II. LITERATURE SURVEY

Hu (1964) was the first to use ANN in weather forecasting. For pattern categorization, he employed an accommodating system known as Adeline. This method was able to prove "rain"-"no rain" forecasts for identical periods in town Bay house on 100 freelance cases that compared favourably with the official U.S. unit forecasts after being trained on 200 winter water level pressure and 24-hour pressure modification patterns covering the realm from 25N to 65N and 110W to 170W.once this analysis, he prompt that accommodative systems have the flexibility of constructing useful predictions or specifications of weather whereas not complete understanding of the dynamics or complete activity of the physical parameters involved [8].In 1991 Cook and Wolfe given a neural network to predict average air temperatures. They used back-propagation learning formula for this purpose and got satisfactory result [9].

On the basis of surface based increased index and surface wet convergence, McCann (1992) created an Artificial Neural Network model to provide 3-7 unit of time forecasting of major thunderstorms. Their two neural networks were operationally integrated at the National Severe Storms Forecast Centre in Kansas City, Missouri generate a single hourly product and was discovered to help the Ability to recognize patterns [10]. French et al. (1992) conducted a significant study on using ANN for downfall forecasting, using a neural network to anticipate two-dimensional rainfall one day ahead of time. Their ANN model used gift rainfall info, generated by a mathematical downfall simulation model, as AN file. that job was, however, restricted in AN passing number of aspects. as AN example, there was a trade-off between the interaction and so the coaching job time, that could not be merely balanced. When compared to the number of input and output nodes, the number of hidden layers and hidden nodes looked to be insufficient to arrange the higher order. In order to abstract the strategy properly, you'll need to have a relationship with it. Still, it has been thought-about as a result of the first contribution to ANN's application and established a replacement trend in understanding and evaluating the roles of ANN in investigation difficult geophysical processes [11].
Chen and Takagi (1993) have projected a feature based neural network approach for downfall prediction at intervals the area of the open ocean getting ready to island, Japan. A four-layer neural network was accustomed automatically learn the inner relationship between mounted satellite GMS info and rainfall intensity distribution. they have used Back propagation learning formula for coaching job and infrared and visible imaging of GMS image as a result of the pc file to the network [12].
In 1994 Zhang and Snowfield bestowed an artificial neural network (ANN) technique for serious convective downfall estimation and cloud merger recognition from satellite info. They have developed an artificial Neural network knowledgeable system for Satellite-derived Estimation of downfall (ANSER) in the NOAA/NESDIS Satellite Applications Laboratory and found that exploitation artificial neural network cluster techniques, the following are typically achieved. Automated recognition of cloud mergers, ten-fold faster computation of downfall amounts, and average errors in downfall estimates for the entire amount of precipitation that will be reduced to less than ten precent [13]

Michaelides et al. (1995) compared the performance of ANN with multiple linear regressions in estimating missing downfall data over Cyprus. they have projected how which can be put forward thus on get a sufficiently whereas series of downfall records for those locations that the current time series is either interrupted (forward extension) or where the archives have a relatively recent begin (backward extension). The technique uses artificial neural networks to estimate daily downfall at specified observation sites in Cyprus (referred to as target stations), with daily downfall as input. Observations from nearby areas with a considerable amount of information archive that is extensive and comprehensive (termed management stations). In this way, the technique area unit usually used to fill in missing information from the downfall observation network but put together for checking suspected information by exploitation the records from shut stations. This technique of exploitation neural networks is contrasted to the traditional multiple correlation technique. Here, the target station was thought of as a result of the variable and so the control stations as a result of the freelance variables.

Kalogirou et al. (1997) enforced ANN to reconstruct the rain over the statistic in Cyprus. They used feed forward multilayer neural networks for the estimation of precipitation in designated rain assembling stations in Cyprus. Archived information collected for 9 years and 6 management stations distributed around a target station used for

coaching an appropriate artificial neural network. Different neural network topologies and learning rates were investigated with the goal of building a network that leads to the most effective reconstruction of the human brain. Rainfall records are missing. Then they selected multiple hidden layer neural spec for this purpose. This kind of design adopted for resolution issues with similar requirements. The parameters used for the coaching of the network were collected at every management station. Those were the Julian day, height, distance between target and management stations, and therefore the precipitation. The coefficient of correlation obtained for the coaching information set was zero.933. The verification of the network was done by exploitation unknown information for the target station. This was finished a year, whose information were excluded from the coaching set. The coefficient of correlation for the unknown case was zero.961. The prediction error was confined to but seventeen.1mm of precipitation that is taken into account as acceptable. In another analysis work Venkatesan et al. (1997) have used associate ANN to predict the all-Bharat summer monsoon rain with completely different meteoric parameters as model inputs. They used multilayered feed forward neural networks trained with the error-backpropagation (EBP) algorithmic rule. 3 network models that used, severally, 2, three and ten input parameters that square measure known to considerably influence the period of time monsoon rainfall (ISMR) was made and optimized. Then they compared their findings to those of the applied math models. Network models' predictions suggested that they could be a useful tool for ISMR prediction.

Lee et al. (1998) applied ANN in downfall prediction by splitting the offered information into homogenised subpopulations. They projected a divide –and-conquer approach wherever the whole region is split into four sub-areas and every is modelled with a special methodology. for 2 larger areas, they have used radial basis operate (RBF) networks to perform rainfall prediction. the opposite 2 smaller sub-areas, they have used an easy regression toward the mean model to predict the downfall. Then they need created a comparison in between these 2 techniques and unconcealed that RBF networks created sensible predictions whereas the linear model's poor predictions. The authors believed that their methodology was appropriate for emergency conditions moreover as future management of contaminated regions [17].
In 1999 Koizumi projected associate ANN model mistreatment measuring device, satellite and weather-station information along with numerical products generated by the Japan earth science Agency (JMA) Asian Spectral Model and therefore the model was trained mistreatment 1-year information. The ANN capabilities were found to be superior to the persistence forecast (after three hours), regression toward the mean forecasts, and hence the numerical model precipitation prediction. The results were limited because the ANN model was trained with only one year of data. The author was convinced that if additional coaching information became available, the neural network's performance would improve. It's still unclear how much each predictor contributed to the forecast and how new observations might help improve it.

In 2000 Troth et al. compared short downfall prediction models for period flood foretelling. They applied 3 time series models, auto-regressive moving average (ARMA), ANN and k-nearest-neighbours (KNN) methodology for foretelling storm downfall occurring within the Sieve geographical area, Italy, in the period one992- 1996 with lead times variable from 1 to six h. The result showed that the ANN performed the most effective within the improvement of the runoff foretelling accuracy once the anticipated downfall was used as inputs of the downfall run-off model [19].

Multilayer feed forward neural network (MLFN), Elman partial continual neural network (Elman), and temporal delay neural network (TDNN) were created and compared by Luk et al. (2001) for precipitation prediction. within the same year, Ibrahim et al. used four soft computing methods: ANN mistreatment Scaled Conjugate Gradient Algorithm (ANNSCGA), Evolving Fuzzy Neural Network (EfuNN), adaptive Basis operate Neural Network (ABFNN) and General Regression Neural Network (GRNN) for predicting the precipitation statistic. they need used a regression technique known as variable adaptive Regression Splines (MARS) that uses a particular category of basic functions as predictors. within the study, monthly precipitation was used as input data for coaching model. The authors looked at rainfall data from Kerala, a state in the southern part of India, spanning 87 years. When compared to a pure neural network technique, the empirical results showed that neuro fuzzy systems were more cost-effective in terms of performance time and error rates. However, due to the wide range of precipitation, it is one of the twenty most difficult and difficult aspects of the geophysical science cycle to comprehend and model of variation on a wide range of scales in both space and time ([11], [22]), to name a few.

Wong et al. (2003) developed a downfall prediction model based on soft computing techniques such as artificial neural networks and fuzzy logic. they need used Kyrgyzstani monetary unit 1st to divide the information into

population and hopefully scale back the complexness of the complete data house to one thing a lot of solid. After classification, they need used BPNNs to be told the generalization characteristics from the information at intervals every cluster. They extracted fuzzy rules for every cluster. The fuzzy rule base is then used for downfall prediction. They have compared this methodology with a long-time methodology, which uses radial basis operate networks and orographic result ([17]). Their results showed that the projected methodology might offer similar results from the established methodology. However, the authors unconcealed that their methodology has the advantage of allowing analyst to grasp and move with the model using fuzzy rules.

In 2004 Christodoulou et al. used an inspiration is to predict downfall rate by victimization radiolocation rather than rain-gauges mensuration rainfall on the bottom. The neural Kyrgyzstani monetary unit and also the applied mathematics KNN classifier were enforced for the classification task using the measuring system information as input and also the rain-gauge measurements as output. The downfall rate on the bottom was foretold based mostly on the measuring system reflections with a median error rate of twenty third. Ultimately, they need ascertained that the prediction of downfall rate supported radiolocation measurements is feasible. In 2005 sculptor et al. have developed a neural network with 2 hidden layers to forecast hurricane downfall and it's been found that, the foretelling model will manufacture affordable forecasts.
Guhathakurta (2006) developed an Artificial Neural Network model for Long-Range Monsoon rain Prediction for the Districts and Sub-Division Kerala supported the realm weighted value of all district forecast. Finally, he has found that the performance of the model was higher than the applied mathematics technique. Somvanshi et al. (2006) have bestowed tools for modelling and predicting the activity pattern in rain phenomena supported past observations. They need introduced 2 essentially completely different approaches for coming up with a model, the method supported autoregressive integrated moving average (ARIMA) and therefore the rising computationally powerful techniques supported ANN. In order to evaluate the prediction potency, they created use of 104 years of mean annual rain information from year 1901 to 2003 of Hyderabad region (India). The models were trained with ninety-three years of mean annual rain information. The ANN and therefore the ARIMA approaches were applied to the information to derive the weights and the regression coefficients severally. The performance of the model was evaluated by exploitation remaining ten years of information. Finally, the study reveals that ANN model can be used as AN appropriate foretelling tool to predict the rain, which out performs the ARIMA model. Box and Jenkins developed a foretelling technique, referred to as ARIMA model that continues to be very popular among hydrologists [7].

Kumarasiri et al. (2006) utilized Associate in nursing innovative technique for downfall prediction victimization Artificial Neural Networks supported feed-forward back propagation design. The emphasis was on making accurate predictions based on market data, rather than taking into account the physical features of the environment or the real mechanism of downfall incidence. Each short term and long-term prediction were tried for ground level information collected by the meteoric station in national capital, Sri Lanka. They have developed 3 Neural Network models: a one-day ahead model for predicting the downfall incidence of succeeding day, that was ready to create predictions with seventy-four.25% accuracy, and 2 future prediction models for monthly and yearly downfall depth predictions with fifty eight.33% and 76.67% accuracies at intervals a five-hitter uncertainty level. The authors believed that every of those models was extended to form predictions many time steps into the long run, where accuracies were found to be decreasing with the quantity of time steps. they need conjointly studied and given the success rates and downfall trends at intervals the monsoon seasons.

In 2007 Paras et al. projected a prediction model using Neural Network. They need been foreseen the weather parameters like most temperature, minimum temperature and ratio mistreatment the options extracted over different periods in addition as from the weather parameter time series itself. The method used there employs back propagation feed forward artificial neural networks (ANNs) for supervised learning with data gathered at a specific station. The trained ANN was accustomed predict the longer-term weather conditions. The results were terribly encouraging and it was found that the feature based mostly foretelling model will build predictions with high degree of accuracy. The model can be suitably tailored for creating forecasts over larger geographical areas . Chattopadhyay (2007) developed a feed forward Artificial Neural Network model to predict the typical summer-monsoon rain in Asian country. In formulating the ANN based prophetical model, three-layer network has created with sigmoid non-linearity. The monthly summer monsoon rainfall totals, tropical rain indices and ocean surface temperature anomalies have thought-about as predictors whereas generating the input matrix for the ANN. To create the predictive model, data from the years 1950–1995 was examined. Finally, he compared the neural web's

prediction performance to persistence forecast and multiple regressions toward the mean forecast, demonstrating the ANN's domination over the opposing processes.

In the same year Kumar et al. have conferred a synthetic Intelligence approach for regional downfall foretelling for province state, India on monthly and seasonal time scales. They have employed a synthetic Neural Networks (ANNs) methodology to handle the extremely non-linear and complicated behaviour of the environmental condition variables for foretelling the downfall. Genetic Optimizer (GO) was employed by them to optimize the ANN design . In another analysis Chattopadhyay et al. (2007) developed AN ANN model in small stages to predict the average downfall over Asian nation throughout summer-monsoon by exploring the information on the market at the web site (http://www.tropmet.res.in). To develop this model, the monsoon months (June-August) information of year y wants to predict the typical monsoon downfall of year (y+1). They have used seventy fifth of the on the market information as coaching set and remaining 25% as check set. The model was trained up to fifty epochs. The learning rate parameter was fastened at zero.4 and therefore the momentum rate was chosen zero.9. Finally, they need compared the performance of the neural web model with typical persistence forecast and located that the Neural web, within the type of Multilayer Perceptron was adroit within the prediction of monsoon downfall over Asian nation . Chattopadhyay And Chattopadhyay (2008a) created an ANN model to predict monsoon downfall in Asian nation betting on the downfall series alone. they need developed nineteen neural network models with variable hidden layer size. Total downfall amounts within the summer monsoon months of a given year used as input and therefore the average summer monsoon downfall of the following year used because the desired output to execute a supervised back propagation learning procedure. After a thorough coaching and check procedure, a neural network with eleven nodes within the hidden layer was found to be the foremost proficient in foretelling the typical summer monsoon downfall of a given year with the same predictors. Finally, the performance of the eleven hidden-nodes three-layered neural network was compared to that of the asymptotic regression technique. Ultimately, they need concluded that the eleven-hidden-nodes three-layered neural network has a lot of effectuality than straight line regression within the present foretelling task. Hung et al. (2008) used AN Artificial Neural Network model to forecast downfall for Bangkok, Thailand with lead times of one to 6h. a true world case study was originated in Bangkok; four years of hourly information from 75 gage stations within the space were wont to develop the ANN model. Ultimately, they need applied the developed ANN model for real time downfall foretelling and flood management.
In 2009 Xenia et al. have planned a replacement model supported empirical mode decomposition (EMD) and therefore the RBF neural network (RBFN) for rain prediction. when simulation they have all over that the strategy had a high accuracy in demonising and prediction of the rain sequence. Karmapa et al. (2009) have developed a 3 layer perception feed forward back propagation settled and probabilistic artificial neural network models to predict long range monsoon rain over the subdivision EPMB. 61 years data for 1945-2006 have used, of that the primary fifty one years (1945-1995) of information were used for coaching the network and data for the amount 1996-2006 were used severally for validation. but they need found that the performance of the model in probabilistic forecast was higher evaluated over deterministic forecast [36]. during a Case Study on Jarrah Watershed, Suleiman (2009) has studied Rainfall-runoff Prediction supported Artificial Neural Network and he concluded that Artificial Neural Network technique is a lot of appropriate and economical to predict the stream runoff than classical regression model [37].In 2010 man and Sharif used back propagation neural network for predicting the temperature supported the coaching set provided to the neural network. they need used two hundred training knowledge during this analysis for coaching the unreal neural network. The coaching knowledge were created from the info available in knowledge set. When coaching the system, they put it to the test by estimating the temperature of an unknown day and getting accurate results. This approach was able to verify the non-linear relationship that exists between past data (temperature, wind speed, humidity, etc.) equipped to the system throughout the coaching segment and produce a prediction of what the temperature would be in the future based on that data. Vamsidhar et al. (2010) planned a back propagation neural network model for predicting the rain supported humidness, dew point and pressure within the country.

The downfall knowledge has taken from the amount 1901-2000 and therefore the knowledge was taken from the web site (www.tyndall.ac.uk). They need used two third of the info for coaching and common fraction for testing. The numbers {of coaching of coaching} and testing patterns were 250 training and 120 testing. Ultimately, they need obtained ninety nine.79% of accuracy within the coaching and ninety four.28% of accuracy in testing. From these results the authors may ready to predict the downfall for the long run [39]. Wu et al. (2010) have tried conceiving to seek a comparatively optimum data-driven model for downfall forecasting from 3 aspects: model inputs, modelling methods, and knowledge pre-processing techniques. Four rain knowledge records from totally

different regions of Bharat and China, namely two monthly and 2 daily series, were examined. They have made a comparison of seven input techniques and located that linear correlation analysis (LCA) was capable of characteristic model inputs fairly. A planned model, modular artificial neural network (MANN), was compared with 3 models; artificial neural network (ANN), K-nearest-neighbours (K-NN), and statistical regression (LR). Prediction was performed in the context of 2 modes as well as traditional mode (without data pre-processing) and knowledge pre-processing mode. From the normal mode they need got a result that MANN performs the best among all four models, however the advantage of MANN over ANN wasn't vital in monthly downfall series forecasting. below the info pre-processing mode, each of LR, K-NN and ANN is severally in addition to 3 knowledge pre-processing techniques as well as moving average (MA), principal element analysis (PCA), and singular spectrum analysis (SSA). Results indicated that the advance of model performance generated by SSA was respectable whereas those of MA or PCA were slight. Moreover, when MANN was in addition to SSA, results showed that advantages of MANN over alternative models were quite noticeable, notably for daily downfall prediction. Panayiotis et al. (2010) from the Balkan nation of Greece developed prognostic algorithms based on Artificial Intelligence to estimate rain intensity in Athens. They've tested Neural Networks (ANNs) and found that they're effective. The created and applied ANN models yielded positive results. Rain intensity for the next four days is predicted to be fairly accurate. months. Patel and Ghoul (2010) have used totally different artificial neural network topologies like radial basis functions and multilayer perceptron with Liebenberg Marquardt and momentum learning rules for downfall forecasting exploitation native parameters and located that the topologies fit constant task.

hadwick et al. (2011) used a artificial neural network approach to downscale GCM temperature and precipitation fields to regional model scale over Europe. a singular modular-type Support Vector Machine (SVM) have presented by chemical element and Wang (2011) to forecast monthly precipitation inside the Guangxi, China. Finally, they demonstrated that predictions made with the SVM combination model were often superior to those made with wholly distinct models presented in terms of constant analysis measures. The authors powerfully believed that it are often used as Associate in Nursing alternate prediction tool for a Meteorological application in achieving larger prediction accuracy and up prediction quality a lot of. ElShafie et al. (2011) have developed a pair of precipitation prediction models i.e. In Alexandria, Egypt, an Artificial Neural Network (ANN) and a Multi Regression Model (MLR) were developed and implemented. They've employed mathematics parameters as the foundation. Mean square error, Mean Absolute Error, and the constant Of To make a comparison between the two, use correlation and BIAS. two models and found that the ANN model is superior. than the MLR model's performance. A committee of artificial neural networks (ANNs) primarily based model with motion decomposition was projected by Charaniya et al. (2011) for prediction of monthly precipitation on accounts of the preceding events of precipitation information. motion process was used for extraction of approximate and detail constant of the precipitation data series. For the learning and data extraction operations, these coefficients were combined with an ANN. They put the model to the test using precipitation data from a variety of locations. area of the Republic of India, as well as for the entire country, and is placed that The proposed model may forecast monthly precipitation. one month before. El-Safire compared and studied three static neural networks and one dynamic neural network, namely the Multi-Layer Perceptron Neural Network (MLP-NN), Radial Basis Operational Neural Network (RBFNN), and Input Delay Neural Network (IDNN). Those models were created for two time horizons in Malaysia, for monthly and weekly precipitation basis prediction. Ultimately, they over that IDNN could be applicable for modelling the temporal dimension of the rainfall pattern, thus, provides higher prediction accuracy. In Chennai, India, Goethe and Selvaraj (2011) created a back propagation neural network model for precipitation prediction. The average monthly precipitation was predicted to be around they put that model into practice The model is capable of performing effectively in both training and freelance situations. El-sharia et al. (2011) used a neural network and regression technique to try to solve the problem. Prediction of rainfall and runoff and they gradually came to terms with the fact that back propagation (feed forward) ANN can be used to describe The behaviour of the rainfall-runoff relationship is more precise than the regression model (classical). In another analysis integrated artificial neural network-fuzzy logic-wavelet model is employed to predict future precipitation by Afghan et al. (2011). When compared to the two-year projections for predicting the six-month and annual periods, the integrated model produced better results. As a result of the idea mean squared error, predicting the biennial and annual periods is 6.22 and 7.11, severally. However, the expected six months shows 13.15 .Abhishek et al. (2012) have developed Associate in Nursing ANN model to forecast average monthly precipitation inside the Dupe district of Karnataka, India. In Dupe, the months of solar calendar month to Gregorian calendar month were notable as a result of the precipitation season with might, June, July, August, and solar calendar month as a result of the most monsoon seasons. Thus they have explored the data of these eight months from 1960 to 2010. Ultimately, three algorithms were tested in multi-layer architecture: Back Propagation formula (BPA), Layer Recurrent Network (LRN) and Cascaded Back-Propagation (CBP) and additionally the authors have found that BPA is that the most effective algorithm out of the three tested. A

Multilayer Perceptron Neural Network was projected by Desponded (2012) as Associate in nursing intelligent tool for predicting precipitation datum. The samples of precipitation have collected from the licensed Government precipitation observation agency in Yavatmal, Maharashtra state, India. Multi-step ahead (1, 5, 10, 20) predictions of this precipitation information series have administered practice of the projected Multilayer Perceptron Neural Network. They have seen that the performance measures like Mean sq. error, and Normalized mean sq. error on testing nonetheless as training information set for transient term prediction were best in comparison with completely different network like Jordon Elman Neural Network, SOFM (Self organized feature map), RNN (Recurrent neural network) .

III. CONCLUSIONS

This paper reports a close survey on rain predictions using completely different neural network architectures over twenty-five years. From the survey it's been found that almost all of the researchers used back propagation network for rain prediction and got important results. The survey additionally provides a conclusion that the prognostication techniques that use MLP, BPN, RBFN, Kyrgyzstani monetary unit and SVM are appropriate to predict rain than alternative prognostication techniques like applied mathematics and numerical strategies. but some limitation of these methods has been found. The intensive references in support of the various developments of ANN analysis supplied with the paper ought to be of nice facilitating to ANN researchers to accurately predict rain within the future.

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