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AN INVESTIGATION INTO PREDICTION FORECASTING METHODS IN VARIOUS CHHATTISGARH INDIAN WEATHER CONDITIONS

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ABSTRACT

Existing climate prediction models are physics-based and use supercomputers to predict future climate evolution. Physics-based predictions require improved atmospheric models, which can be challenging to find and develop, and improving the fundamental resolution of simulations can be computationally demanding. Measuring rainfall around the world has many scientific and social benefits. These benefits include of the processes that cause global climate change, increased precipitation and hydrological processes, improved weather information, Better identification of severe storms, including predictions of storm size and landfall. The Global Precipitation Measure (GPM) has completed the work of defining the scientific and metric goals and framework needed to achieve those goals. Precipitation forecasting is the prediction of the amount and type of precipitation (rain, snow, sleet, etc.) that will fall in a specific location over a certain period of time. This is typically done using numerical weather prediction models, which take into a wide range of atmospheric and oceanic data to make predictions about the weather. Precipitation forecast is the process that predicts the possibility of weather conditions at an exact time and place. An artificial neural network is a type of machine learning model that can be used for long-term precipitation forecasting. This model is trained on a large amount of historical weather data and uses this data to predict future rainfall. Artificial neural networks can be used to model complex and linear relationships between atmospheric and oceanic variables and precipitation. The Model may help us in forecasting long-range precipitation, approximately before one month of monsoon season over Kabirdham.

Keywords: Artificial Neural Networks, Precipitation Forecasting, Weather Monitoring, Climate Prediction

1. INTRODUCTION

Precipitation forecasting is the prediction of the amount and type of precipitation (rain, snow, sleet, etc.) that will fall in a specific location over a certain period of time. This is typically done using numerical weather prediction models, which consider a wide range of atmospheric and oceanic data to make predictions about the weather. These models are run on powerful computers and are constantly updated with new data to improve the accuracy of the forecasts [1]. However, it is important to note that precipitation forecasting can be challenging due to the complex and chaotic nature of the atmosphere and the potential for inaccuracies in the input data.The success of a precipitation forecasting technique depends on various factors such as the quality of data, the algorithms used, the level of understanding of the weather system, and the overall skill of the forecaster.Precipitation forecasting for India's weather is a complex challenge due to the country's diverse geography and weather patterns. Forecasters use a variety of methods and tools, including numerical weather prediction models, remote sensing, and traditional knowledge, to predict precipitation

patterns in India [2]. Numerical weather prediction models: These models use mathematical equations to simulate atmospheric processes and predict future weather patterns. The models are based on data from weather stations, satellites, and other sources, and are run on supercomputers. Remote sensing: Remote sensing technologies, such as weather radars and satellites, can provide real- time information on precipitation patterns, allowing forecasters to make more accurate predictions. Traditional knowledge: In many parts of India, traditional knowledge, such as observations of cloud patterns, bird migration patterns, and local folklore, is still used to make precipitation forecasts [3].

In addition to these methods, forecasters also use a variety of data sources, including meteorological data, soil moisture data, and climate records, to make precipitation forecasts in India. The Indian Meteorological Department (IMD) is the primary agency responsible for providing weather forecasts in India.Precipitation forecasting in India is a complex challenge that requires the integration of multiple sources of information and techniques, including numerical weather prediction models, remote sensing, and traditional knowledge. The goal is to provide accurate, timely, and reliable precipitation forecasts to support decision-making in agriculture, water resource management, and disaster preparedness [4].

2. NATIONAL WEATHER FORECASTING CENTER

The National Weather Forecasting Center (NWFC) at IMD New Delhi provides operational and technical coordination related to forecasting services. The center coordinates forecasting/navigating work at national, regional, and state levels, prepares papers on actual weather with the involvement of the Meteorological Department, IMD, Pune, RMC, and MC, issues circulars related to forecasting, annual monsoon and organizes storm study meetings. Reviewing the forecast performance of the previous year, reviewing user feedback, and, forecasting methods for various centers and instruments to improve services. NWFC, IMD New Delhi acts as the main operational interface for all meteorological matters of Government of India and provides appropriate information/interpretation of felt and forecasted weather for the entire country to various government agencies including the National Disaster Management Authority (NDMA). NWFC provides forecast and warning information to the press and media, All India Radio, Doordarshan and other users [5]. It provides forecasts for the western Himalayan region and national-level weather forecasting services with special forecasts for various activities such as sports, tourism, mountain tourism, VVIP movements, and Independence and Republic Day celebrations. The Regional Weather Forecasting Centers (RWFCs)/State Weather Forecasting Centers (SWFCs) in the RMCs are the operational interfaces for weather forecasting and warning services to the respective State Governments and various departments of the Government, providing necessary information/summaries. Forecast of weather conditions at district level and major cities of the state. It provides weather information to all users and electronic and print media related to State Disaster Management [6].

3. OBJECTIVE

The purpose of this paper is to study the generalization performance and the impact of this non-linear adaptive neural network learning system to study real-time factors. Specifically, this paper studies the effect of initial weights, learning rates, and regularization coefficients on the general efficiency and learning speed. Based on this, this paper proposes a method to dynamically adjust the learning rate and regularization coefficient by simultaneously considering the three factors of hybrid learning methods [7][8].

4. INDIAN GEOGRAPHY & WEATHER CONDITIONS

Precipitation forecasting techniques for Indian weather conditions can include a variety of methods, including statistical models, numerical weather prediction (NWP) models, and machine learning algorithms. The choice of technique depends on various factors such as the availability of data, the complexity of the weather system, the lead time of the forecast, and the desired level of accuracy. Statistical models use historical data to make predictions about future precipitation patterns, while NWP models use complex mathematical equations to simulate atmospheric processes and predict future weather conditions. Machine learning algorithms use patterns in large amounts of data to make predictions, and have been shown to be effective in precipitation forecasting [2]. In addition to these techniques, other methods such as data assimilation, radar data, and remote sensing can also be used to improve precipitation forecasts in India.

5. INDIAN DIVERSE GEOGRAPHICAL AND WEATHER CONDITIONS

India is a vast country with diverse geographical and weather conditions. This presents a significant challenge for

precipitation forecasting, as local weather patterns can vary significantly from region to region. Some of the specific issues related to Indian weather and geography that impact precipitation forecasting include:

1) **Monsoons:** India is heavily dependent on the monsoon season for its rainfall, which can result in significant seasonal variability in precipitation patterns. Accurately forecasting monsoon patterns is crucial for agricultural planning and water resource management.
2) **Topography:** India has a complex topography, with a range of mountainous regions, plateaus, and coastal areas. This can result in localized weather patterns and microclimates that can impact precipitation forecasts.
3) **Data availability:** India has a limited network of weather stations, which can impact the quality and accuracy of meteorological data used for forecasting. This is especially challenging in remote or rural areas.
4) **Natural disasters:** India is prone to natural disasters such as floods, landslides, and cyclones, which can have a significant impact on precipitation patterns. Accurate forecasting can help mitigate the impact of these events [7][8][9].

Precipitation forecasting is important in India for a variety of reasons, including agriculture, water resource management, infrastructure planning, and disaster preparedness. Accurate forecasts can help farmers make informed decisions about planting and harvesting, while also providing critical information for water resource management and infrastructure planning. In addition, accurate precipitation forecasts can help minimize the impact of natural disasters such as floods and landslides.Overall, the need for accurate precipitation forecasting in India is driven by the country's dependence on seasonal precipitation patterns and the significant impact that weather and precipitation can have on the economy, agriculture, and infrastructure [10].

6. DISASTER DUE TO DIFFERENT WEATHER CONDITIONS

India is prone to a variety of natural disasters due to its diverse weather patterns and geography. Some of the most common weather-related disasters in India include:

Floods: India is susceptible to flash floods and riverine floods due to its high rainfall and topography, which can result in significant loss of life and property damage.

Cyclones: India is located in a region that is prone to cyclones, which can cause widespread damage and disrupt normal life [11].

Drought: Drought is a common problem in India, particularly in arid regions, and can result in food and water shortages and impact agriculture.

Heat waves: India experiences frequent heat waves, particularly in the summer months, which can result in heat-related illnesses and deaths, particularly among the elderly and those with pre-existing medical conditions.

Landslides: India's mountainous regions are prone to landslides, which can be triggered by heavy rainfall or earthquakes [12].

Dust storms: Dust storms are a common occurrence in northern India during the summer months, and can cause damage to crops, homes, and infrastructure.

The frequency and intensity of these disasters can be impacted by changing weather patterns, such as the El Niño Southern Oscillation, which can result in changes in precipitation patterns and increased risk of certain types of weather-related disasters. Accurate precipitation forecasting can help reduce the impact of these disasters by providing advance warning and allowing for better preparation and response [13].

7. IMPORTANCE OF PRECIPITATION FORECASTING IN INDIA

Precipitation forecasting is important in India for several reasons:

- Agriculture: India is an agriculture-based economy, and accurate precipitation forecasting can help farmers make informed decisions about planting and harvesting. This can result in improved crop yields and reduced waste due to inappropriate planting.
- Water resource management: India is heavily dependent on monsoon rains for its water supply, and accurate precipitation forecasting can help ensure that water resources are managed effectively and efficiently [22].
- Infrastructure planning: Precipitation forecasts can inform infrastructure planning, such as the construction of dams, reservoirs, and canals, helping to minimize the risk of damage due to extreme weather events.
- Disaster preparedness: Accurate precipitation forecasts can help minimize the impact of natural disasters, such as floods, cyclones, and droughts, by providing advance warning and allowing for better preparation and response.
- Energy demand management: Precipitation forecasts can help inform energy demand management, as changes in

weather patterns can impact energy demand for heating, cooling, and hydropower generation [7][11][13].

An accurate precipitation forecasting is important in India due to the country's dependence on monsoon rains for its water supply and agriculture, as well as its vulnerability to natural disasters. By providing advance warning of changes in precipitation patterns, accurate precipitation forecasting can help minimize the impact of these events and support sustainable economic growth and development.

8. EXISTING PRECIPITATION SYSTEM IN INDIA

Precipitation forecasting techniques can be broadly categorized into two main types:

8.1 Traditional methods

These methods rely on the understanding of physical processes, meteorological observations, and climatological data to make predictions. They include statistical models, numerical weather prediction (NWP) models, and persistence forecasting.

8.2 Modern techniques

These methods leverage the advancements in technology and data science to make more accurate predictions. They include machine learning techniques, such as artificial neural networks (ANNs), and support vector machines (SVMs), and hybrid methods that combine traditional and modern techniques [14].

The choice of technique depends on the specific needs of the forecast, such as the lead time, the desired accuracy, and the availability of data. Some of the most commonly used precipitation forecasting techniques include:

1) **Persistence forecasting:** A simple method that assumes that the weather conditions will remain the same as they were in the previous time period.
2) **Statistical models:** These models use historical data to make predictions based on relationships between variables and past weather patterns.
3) **NWP models:** These models use mathematical equations to simulate atmospheric processes and make predictions about future weather conditions.
4) **Machine learning algorithms:** These algorithms use patterns in large amounts of data to make predictions, and have been shown to be effective in precipitation forecasting.
5) **Hybrid methods:** These methods combine traditional and modern techniques to improve the accuracy of precipitation forecasts [15][2][8].

Each of these precipitation forecasting techniques has its own strengths and weaknesses, and the choice of technique depends on the specific needs of the forecast, such as the lead time, the desired accuracy, and the availability of data. For example, persistence forecasting is simple to implement and fast, but

its accuracy is limited. Statistical models can provide more accurate forecasts, but they may be limited by the quality and availability of historical data. NWP models can provide very detailed forecasts, but they require significant computational resources and may not be feasible for short-term forecasts.

9. PROPOSED METHODOLOGY

Artificial neural networks (ANNs) are a type of machine learning model that can be used for long- range precipitation forecasting. These models are trained on large amounts of historical weather data and use this information to make predictions about future precipitation. ANNs can be used to model the complex and non-linear relationships between various atmospheric and oceanic variables and precipitation.

One example of ANN-based long-range precipitation forecasting is the use of a type of ANN called a Long Short-Term Memory (LSTM) network. These networks are particularly well-suited for time- series prediction problems, such as precipitation forecasting because they can capture patterns in the data that span long periods of time [16][17][18].

It's important to note that ANN-based long-range precipitation forecasting is still in the research phase and not yet fully operational. The model performance is not yet comparable to the traditional models and still have to be improved in terms of accuracy and reliability. One advantage of ANN-based methods is that they can automatically identify complex relationships in the data, which can lead to more accurate predictions. However, it is also important to carefully validate the results and consider potential limitations, such as the need for large amounts of data and the potential for overfitting the model to the training data.

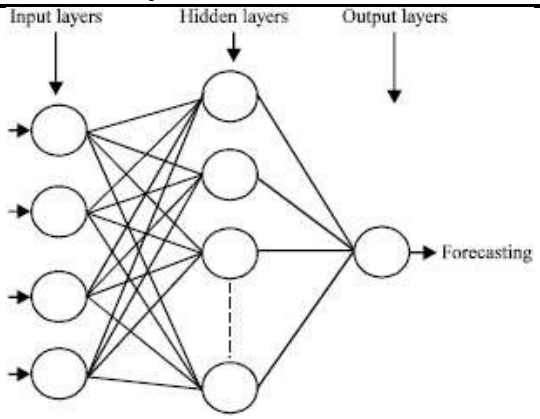

Figure 1: Precipitation forecasting network model

One of the widely used ANN models for computer modeling applications is the multilayer perceptron model based on BP. Multilayer Perceptron (MLP) layer feed forward networks are usually trained with continuous backpropagation. These networks have found their way into countless applications that require standard pattern classification. Their main advantage is that they are easy to use and can approximate any input/output graph. The main disadvantages are that they train slowly and require a lot of training data (typically three times more training samples than network weights) [19]. In the learning-based BP algorithm, the initial weights of the links are randomly selected. Let there be N learning examples, each example has n inputs and l outputs, input vector X_j = (X1j, ..., Xnj) and output vector A_j = (B1j, ..., Blj), 1 ≤ j can be described as ≤ n. The learning process takes place using the following two steps [20][21].

10. MULTIPLE LINEAR REGRESSION

A statistical metric called regression looks for the degree of correlation between a single dependent variable, typically represented by Y, and a number of other fluctuating variables, or independent variables. Regression model with additional. The term "multiple regression model" refers to a set of two predictor variables. Multiple regression model is of the form: Y=b0+b1x1 +b2x2 +b3x3+ b4x4+...e where b0,b1,b2,b3,b4 are regression coefficient e is unexplained portion of dependent variable with zero mean and constant variance. Multiple regression fits a model to predict a dependent (Y) variable from two or more independent (X) variables

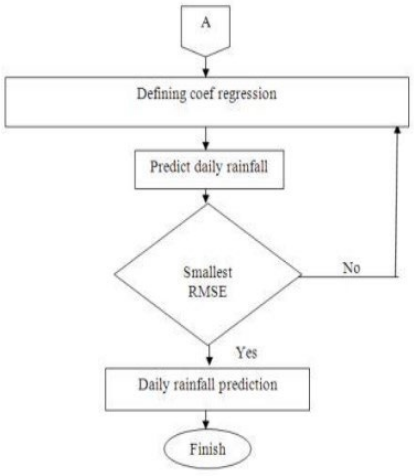

Figure 2: Double Regression Steps

11. EXPECTED OUTCOMES

This paper proposes a new approach for rainfall forecasting based on a deep learning model. Combining unsupervised learning and supervised learning, a model was established based on deep belief networks between environmental factors and future rainfall characteristics. The properties of each latent element are fully exploited in the hydrologic time series. A set of experiments is conducted to compare it with other approaches. The results suggest that ANN can overcome these shortcomings in traditional forecasting techniques. Several directions are possible for future work. First, we plan to develop a Solution that automatically finds the optimal solution for the model, since an inappropriate model

structure can significantly affect the forecast results. Finding the optimal structure requires more effort. Because of this, how can we find an algorithm that can automatically transform hydrological big data to get the desired fine structure?

Weight	Mean	SD	Minimum	Maximum
WI_1H_1	2.2606	6.8558	0.0400	51.8120
WI_1H_2	−1.4271	1.2574	−7.9018	0.5149
WI_1H_3	0.1696	0.2485	−0.3696	1.4233
WI_2H_1	0.1581	0.5680	−2.5079	7.9536
WI_2H_2	−0.6799	0.5564	−2.5378	0.5543
WI_2H_3	0.0775	0.2187	−1.1424	1.3929
WI_3H_1	0.5042	1.6997	−0.0382	23.1163
WI_3H_2	−1.2952	0.7605	−2.8182	0.5544
WI_3H_3	0.0714	0.2243	−0.3753	1.4606
WI_4H_1	−2.6998	9.6876	−74.4496	19.3496
WI_4H_2	31.8005	16.1115	−2.2918	59.9072

12. CONCLUSION

Precipitation is an important factor in predicting rain-induced landslides. Different methods of precipitation transformation give different forecast results in terms of success rate and forecast probability. Landslide prediction models can be improved through precipitation transformation methods that increase the weight and sensitivity of precipitation to small scales and transform precipitation curves such as square root transformation, cube transformation, and logarithmic transformation of landslide infiltration curve. The precipitation helps to country economic growth in different ways Agriculture: Accurate precipitation forecasting can help farmers make informed decisions about planting and harvesting, resulting in improved crop yields and reduced waste due to inappropriate planting.

1) **Water resource management:** Precipitation forecasts can help ensure that water resources are managed effectively and efficiently, which is crucial in areas dependent on monsoon rains for their water supply. Disaster preparedness: Advance warning of changes in precipitation patterns can help minimize the impact of natural disasters, such as floods, cyclones, and droughts, by allowing for better preparation and response.
2) **Energy demand management:** Precipitation forecasts can inform energy demand management, as changes in weather patterns can impact energy demand for heating, cooling, and hydropower generation.
3) **Tourism:** Precipitation forecasts can support the tourism industry by providing information on expected weather patterns, which can impact travel plans and outdoor activities.
4) **Infrastructure planning:** Precipitation forecasts can inform infrastructure planning, such as the construction of dams, reservoirs, and canals, helping to minimize the risk of damage due to extreme weather events.

CONFLICT OF INTERESTS

None.

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REFERENCES

P. Zhang, L. Zhang, H. Leung and J. Wang, "A Deep-Learning Based Precipitation Forecasting Approach Using Multiple Environmental Factors," 2017.

A. Zahraei, K. lin Hsu, S. Sorooshian, J. J. Gourley, Y. Hong and A. Behrangi, "Short-term quantitative precipitation forecasting using an object-based approach," *Journal of Hydrology,* vol. 483, 2013.

C. Yang, Z. Yan and Y. Shao, "Probabilistic precipitation forecasting based on ensemble output using generalized additive models and bayesian model averaging," *Acta Meteorologica Sinica,* vol. 26, no. 1, 2012.

R. A. J. Y.E. A., J. A. Y. A. N. T. A. SARKAR and B. RAMAKRISHNAN, "Daily rainfall
forecasts through a quantitative precipitation forecasting (QPF) model over Thiruvananthapuram and Madras areas for the monsoons of 1992," *MAUSAM,* vol. 47, no. 4, 1996.

J. Wu, G. Lu and Z. Wu, "Flood forecasts based on multi-model ensemble precipitation forecasting using a coupled atmospheric-hydrological modeling system," *Natural Hazards,* vol. 74, no. 2, 2014.

M. Sun, X. Li and G. Kim, "Precipitation analysis and forecasting using singular spectrum analysis with artificial neural networks," *Cluster Computing,* vol. 22, 2019.

A. Solgi, V. Nourani and M. B. Marzouni, "Evaluation of nonlinear models for precipitation forecasting," *Hydrological Sciences Journal,* vol. 62, no. 16, 2017.

J. Shivang and S. S. Sridhar, "WEATHER PREDICTION FOR INDIAN LOCATION USING
MACHINE LEARNING," *International Journal of Pure and Applied Mathematics,* vol. 118, no. 22, 2018.

M. Rajavel, P. Khare, M. L. Sahu and J. R. Prasad, *District level weather forecast verification in Chhattisgarh,* vol. 70, 2019.

D. Ponnoprat, "Short-term daily precipitation forecasting with seasonally-integrated autoencoder," *Applied Soft Computing,* vol. 102, 2021.

S. Paul, S. Ghosh, R. Oglesby, A. Pathak, A. Chandrasekharan and R. Ramsankaran, "Weakening of Indian Summer Monsoon Rainfall due to Changes in Land Use Land Cover," *Scientific Reports,* vol. 6, 2016.

V. Nourani, M. T. Sattari and A. Molajou, "Threshold-Based Hybrid Data Mining Method for Long-Term Maximum Precipitation Forecasting," *Water Resources Management,* vol. 31, no. 9, 2017.

S. G. Meshram, E. Kahya, C. Meshram, M. A. Ghorbani, B. Ambade and R. Mirabbasi, "Long- term temperature trend analysis associated with agriculture crops," *Theoretical and Applied Climatology,* vol. 140, no. 3-4, 2020.

O. Kisi and M. Cimen, "Precipitation forecasting by using wavelet-support vector machine conjunction model," *Engineering Applications of Artificial Intelligence,* vol. 25, no. 4, 2012.

A. M. Kalteh, "Enhanced Monthly Precipitation Forecasting Using Artificial Neural Network and Singular Spectrum Analysis Conjunction Models," *INAE Letters,* vol. 2, no. 3, 2017.

M. K. Jindal and S. K. Sar, "Blueprint of indoor gamma dose rate through statistical modelling for Kabirdham district," *Journal of Radioanalytical and Nuclear Chemistry,* vol. 325, no. 1, 2020.

D. Hirani and N. Mishra, "A Survey On Rainfall Prediction Techniques," *International Journal of Computer Application,* vol. 6, no. 2, 2016.

B. W. Golding, "Quantitative precipitation forecasting in the UK," *Journal of Hydrology,* vol. 239, no. 1-4, 2000.

N. I. Fox and J. W. Wilson, "Very short period quantitative precipitation forecasting,"
Atmospheric Science Letters, vol. 6, no. 1, 2005.

S. L. Dance, *Issues in high resolution limited area data assimilation for quantitative precipitation forecasting,* vol. 196, 2004.

V. Coban, E. Guler, T. Kilic and S. Y. Kandemir, "Precipitation forecasting in Marmara region of Turkey," *Arabian Journal of Geosciences,* vol. 14, no. 2, 2021.

F. B. Banadkooki, M. Ehteram, A. N. Ahmed, C. M. Fai, H. A. Afan, W. M. Ridwam, A. Sefelnasr and A. El-Shafie, "Precipitation forecasting using multilayer neuralNetwork and support vector machine optimization based on flow regime algorithm taking intoAccount uncertainties of soft computing models," *Sustainability (Switzerland),* vol. 11, no. 23, 2019.