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Subject Review: Weather Forecasting models that Employing Artificial Intelligence Approaches

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ABSTRACT

Weather forecast updates might mean different things to different individuals, including entrepreneurs, the government, and farmers. It enables them to plan more precisely in the event of a natural disaster. It can help farmers make judgments about planting, for example. Airlines will benefit from the ability to plan their routes ahead of time, as well as the ability to decide whether or not to cancel flights or make an emergency landing in the case of a storm. This research examines a number of weather forecasting models that employ artificial intelligence approaches.

Key Words: Weather Forecasting, Intelligent Approaches, Fuzzy Logic, Neural Network.

1. INTRODUCTION

To estimate how the atmosphere will evolve, Weather predictions are currently made using a combination of quantitative data on the current state of the atmosphere and scientific knowledge of atmospheric dynamics. Because of the chaotic nature of the atmosphere and the massive processing power necessary to solve the equations that describe the environment, forecasts become less accurate as the range of the prediction increases, and a lack of knowledge of atmospheric dynamics. It's simple to see why perfect weather forecasting is so crucial when you consider the advantages. These forecasts may not be able to prevent a tornado, storm, or flood, but they can assist us in planning for them. Significant progress has been made. Meteorologists forecast the weather using a number of methods. In 1922, Lewis Fry Richardson hypothesized that numerical weather prediction may be useful. The first practical use of numerical weather prediction occurred in 1955, when programmable electronic computers were introduced. Air pressure, temperature, wind speed, wind direction, humidity, and precipitation are all monitored near the earth's surface by trained observers and automated weather stations [1].

2. LITERATURE SURVEY

Many studies on weather forecasting model been proposed. The following is a review of some of these studies

2.1- Using a Neural Network to Forecast the Weather:

ANNs have been widely employed in meteorology for classification and forecasting applications due to their precision in tackling pattern recognition, nonlinear function estimation, and optimization challenges. The ability of the ANN to detect nonlinear relationships, as well as the availability of historical data for meteorological variables, contributes to the accuracy of its conclusions, making it a significant study tool for academics all around the world [2].

In 2020 , the model estimates daily temperatures for the following three days using recurrent Neural Networks (RNN) and Long Short-Term Memory, with five classes: "Cold," "Cool," "Normal," "Warm," and "Hot" (LSTM). Pre-processing, which includes interpolation, feature extraction, normalization, and segmentation, is required before data can be projected. SGD and Adam are the two optimization models used. Adam produces the greatest testing results, with a 90.92 percent success rate for training data and

an 80.36 percent success rate for test data, according to the conclusions of this study. The amount of data used and how it is shared can have an impact on the results' accuracy [3].

In 2020 The stone 3S2S (Spatiotemporal Convolutional Sequence to Sequence Network) architecture is a deep learning architecture that uses just convolutional layers to learn both spatial and temporal data interactions. When it comes to anticipating sequences based on past data, convolutional networks have two flaws: 1) They lose temporal order throughout the learning process, and 2) they require input and output sequences of identical length. According to computer experiments using data from South America's air temperature and rainfall, the architecture incorporates spatiotemporal context and outperforms or equals the findings of leading arch models. For example, compared to the baseline RNN-based model, one variation of the suggested architecture is 23 percent faster at training and five times faster at predicting future sequences [4].

In 2019, this paper primarily covers baseline knowledge of ANNs and many neural network-based techniques that have been used to predict precipitation in recent years. It has been demonstrated that neural networks may considerably enhance prediction accuracy and efficiency. Three strategies are discussed in depth. To begin, the RBF-NN architecture is built using the GAPSO algorithm. RBF-NN with GAPSO has proven to be more accurate for precipitation prediction when compared to pure RBF-NN and RBF-GA. However, because of the intricacy, the computing speed is hampered. Second, WNN is an outstanding forecasting tool. The input signal processing is the main emphasis of this approach. When comparing WNN to ANN and AR (auto-regression models), WNN outperforms the other two models in terms of experimental results. The wavelet transform, on the other hand, has a lot of redundancy. Finally, FLANN, a single layer ANN, is demonstrated in this study. It has a higher computing speed than MLP and LPE, demonstrating superior capability. However, because of the simplistic network topology, it may not be able to address complex problems. These three strategies can all be seen to improve the ANN in distinct ways. They can also produce acceptable results when applied to precipitation forecasting [5].

In 2014 , in their paper the authors provide a method for creating Artificial Neural Networks (ANNs) to anticipate air temperatures in their paper. The authors present a method for creating Artificial Neural Networks (ANNs) to anticipate air temperatures in The Radial Basis. The Radial Basis Function (RBF) is a simple neural network architecture that was trained with one year's data and validated with data from another year. Measures of relative humidity, dew point, wind speed, wind direction, and air pressure are among the variables included in the data. The meteorological data was divided into many categories using the k means clustering approach in order to find appropriate placements for the RBF neurons. The purpose of this network is to estimate air temperature and develop a low-prediction-error regression model. Data from one year was used to conduct supervised training with labelled data, while data from the other year was utilized to assess the trained ANN. A series of tests were conducted to discover the best ANN structure for forecasting air temperature with the lowest MSE. The findings revealed that these structures were quite good at predicting the future [6].

In 2013, the authors present a neural network-based technique for forecasting the environment at a certain time and location in the future. The initial modeling stage employs a Back Propagation Neural (BPN) Network. The output of the BPN model is routed through a Hopfield Network. The proposed method was tested using a three-year meteorological data set with 15000 records containing variables such as temperature, humidity, and wind speed (a combined BPN and Hopfield Network approach). The prediction error is incredibly low, and the learning progresses swiftly. This study focuses on predictive data mining, which extracts intriguing patterns or information from massive amounts of meteorological data [7].

2-2 Forecasting the weather Making use of fuzzy:

A collection of multiple-valued logics is fuzzy logic, which means there are more than two true values. It has variables that, based on reasoning, approximate the value between 0 and 1. The outputs are fuzzy subsets that can be crisped using fuzzy logic defuzzification techniques. Variable values are stated as linguistic phrases, relationships are specified as IF-THEN rules, and outputs are fuzzy subsets that can be crisped using fuzzy logic defuzzification techniques. The crisp values are initially fuzzified to explain system variables in English language. A method for assessing the degree to which a value belongs to a fuzzy set is called fuzzification. For the value, the fuzzy set's membership function is used to determine this. A fuzzy set is a mathematical framework for describing variables like seasonal inflows that are susceptible to ambiguity. A fuzzy rule based on human reasoning and decision-making processes is used to explain the relationship between input and output variables [8].

In 2021, the weather is forecasted using fuzzy logic in this study. The crisp values are initially fuzzified to explain system variables in language terms. A technique for identifying the degree to which a value belongs to a fuzzy set is fuzzification. This is determined using the fuzzy set's membership function for the value. The Mamdani technique's fuzzy logic has a 60 percent accuracy level, making it perfect for use as a weather prediction. As a result, the more input variables utilized, the better (more accurate) the output [9].

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In 2019, Forecasts for rainfall are compared and reviewed. Expert knowledge and empirical research may be easily incorporated into conventional mathematical models using fuzzy logic and fuzzy inference systems, which can deal with the ambiguity that often emerges in meteorological prediction.. This research explored the use of Fuzzy Logic in rainfall prediction and constructed a fuzzified model, as well as determining the dependability of the Fuzzy Logic method in rainfall prediction within the indicated rainfall rate approximation. The suggested Fuzzy Inference System model has a 72 percent accuracy rate [10]. .

In 2016, fuzzification and defuzzification were applied to the Fuzzy Logic model. The model's predictions were compared against actual rainfall data. The results of the simulation reveal that the predicted outcomes are fairly similar to the measured data. Based on the findings, it was concluded that the fuzzy approach is capable of properly processing scattered data by computing the Prediction Error and Root Mean Square Error (RMSE). The Prediction Error (PE) and Root Mean Square Error (RMSE) were used to evaluate the performance of the Fuzzy Logic model (RMSE). The RMSE values on the data were considerably reduced as a consequence of the PE; the prediction model is dependable and efficient, and it might be utilized to forecast rainfall [8].

In 2014, It is presented for testing a weather prediction model based on neural networks and fuzzy inference systems (NFIS-WPM), which is then utilized to forecast daily fuzzy precipitation based on meteorological premises. The model is split into two parts: a "fuzzy rule-based neural network," which uses an artificial neural network to simulate sequential relationships between fuzzy sets, and a "neural fuzzy inference system," which is based on the first part but uses the algorithm we proposed to learn new fuzzy rules from previous ones. This model has been upgraded with the NFIS-WPM (High Pro) and NFIS-WPM (Ave) variants. When evaluating the advantages, it is widely recognized that accurate weather prediction is required. On the other side, the obsessive quest of precision in weather forecasting renders some "precise" prediction findings useless, and the numerical prediction model is typically complicated and time-consuming. The predicted precipitation outcomes are more accurate, and the prediction procedures are simplified, when this unique model is used to a precipitation prediction problem , as opposed to using a complex numerical forecasting model that would consume a lot of computing resources, take a long time, and have a low predictive accuracy rate [11].

2.3- SVM-based weather forecasting:

Support Vector Machine is a useful approach for pattern identification, regression, and classification. It's a learning algorithm that goes along with a supervised learning model. The Support Vector Machine works excellently even without any prior knowledge. To categorize a linearly separable dataset, you'll need a linear function, but a non linear dataset will require the separation of two hyper planes [12].

.In 2 017, a prediction model based on Support Vector Machine with Particle Swarm Optimization (PSO-SVM) has been offered in place of the linear threshold used in regular precipitation forecasting. The choice of SVM parameters has a big influence on prediction accuracy, and PSO is a method for figuring out which parameters are best for SVM. The PSO-SVM approach was used to train a precipitation prediction model using historical data, which might be beneficial information for individuals from all walks of life in making wise and informed decisions.. When all other conditions are equal, simulations indicate that the suggested technique outperforms a model for making direct predictions based on a collection of experimental data. Simulated results, highlight the applicability and benefits of the SVM-PSO machine
learning model, on the other hand., as well as its potential for improvement when more and more relevant qualities are utilized to forecast the dependent variables [13].

In 2020, this research looks at a class-based strategy for forecasting rainfall for the following 1 to 30 days. The researchers used daily rainfall maps of the continental United States to make regional estimations, categorizing rainfall into three levels: light, moderate, and heavy. Three zones were chosen, each of which corresponded to three squares on a 5 x 5 grid that encompassed the full map area. The support vector machine (SVM) was used to predict rainfall up to 30 days ahead for these three locations using successive sequences of past daily rainfall map photos.. The researchers observed that a simple untrained classifier's predictions for the grid's corner squares were less accurate.. The untrained classifier and the other two areas, on the other hand, were exceeded by SVM predictions for the center region. SVMs used to large-scale precipitation maps may give helpful information for predicting regional rainfall in some circumstances, while care must be taken to avoid errors [14).

3. CONCLUSION

A survey of weather forecasting models based on artificial intelligence (AI) approaches was given in this research. The studies in this paper are carried out using one of three methods: neural networks, fuzzy logic, and super vector machines. The results of the survey revealed that

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1-Fuzzy logic employing the Mamdani approach performs admirably as a weather prediction.

2-Neural networks have been shown to improve forecast accuracy and efficiency significantly.

3-When a mix of fuzzy and neural network models is utilized, predicted precipitation outcomes are more accurate, and prediction procedures are easier.

4- In certain circumstances, SVMs used to large-scale precipitation maps have proven to be useful in predicting regional rainfall, albeit caution must be exercised to avoid traps.

5- A extremely beneficial tool might be created by combining fuzzy, neural networks, and SVM.

6- Data mining should be done on accessible data before using any machine learning approach.

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