Industrial Engineering Journal
ISSN: 0970-2555
Volume : 53, Issue 7, No.3, July : 2024

AN INTENSE SURVEY OF WEATHER FORECASTING BASED ON MACHINE LEARNING AND DEEP NEURAL NETWORK

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ABSTRACT
The weather forecast determines the future state of the weather. Weather forecasting is very important because both agriculture and business sector rely on weather forecasts. We use artificial neural network and data mining technique to predict weather conditions. Weather is a dynamic process, on-liner artificial neural network (ANN) can operate as process. Our research also pointed out that deep neural network is best methods as compared to traditional algorithms. Main focus is ANN or back propagation methods. Back propagation method is best approach for variation of data as well as long- range weather forecasting. This system will take the parameter and predict weather after analyzing the input information with the information in database. Consequently, two basic functions to be specific classification (training) and prediction (testing) will be performed. The outcomes demonstrated that these data mining procedures can be sufficient for weather forecasting.
KEYWORD: ANN, Weather forecasting, Back propagation Algorithms, Deep Neural Network, Data Mining.

I. INTRODUCTION
Weather forecasting is the act of determining and accurately predicting the climatic condition using multiple tools. Numerous operational systems depend on meteorological condition for implementing the required system modification. The Quantitative forecasts such as temperature, humidity and rainfall are crucial for traders in commodity market and agriculture sector. We use a variety of method these days to forecast the weather like mathematical modelling, statical modeling and artificial Intelligence techniques etc. We use artificial neural networks (ANNs), which are based on clever trend analysis of past data. The other models can adapt to irregular patterns of data that cannot be expressed as a function or derived as a formula, yet they are accurate in calculations but not in predictions [1].
Along with gales, rainstorms, and storm surges, tropical cyclones (TCs) are considered extreme weather occurrences that have the potential to cause enormous losses in coastal areas across the globe. Many meteorologists and warning centers have dedicated the last century to this research, making advancements in intensification physics, observational technology, atmospheric boundary layer and air-sea interface interactions, ocean responses, and forecasting techniques [1]. Predictive skills still have a lot of issues, especially when it comes to TC genesis, intensity, and risk estimates. Because of their coarse resolution, insufficient description of intricate physical processes, and imprecise vortex initiation of tropical cyclones, the most widely used dynamical forecasting models for tropical cyclones often have low accuracy [2, 3]. Artificial neural networks (ANNs), which are regarded as universal approximates for complicated nonlinear mappings, are effectively used in the majority of research done with those mapping tasks [4]. A new chapter in the history of deep learning began in 2006 when Hinton, a renowned machine learning expert, proposed the deep neural network model. A deep neural network with numerous hidden neural layers and exceptional feature learning capabilities can overcome the challenge of layer-by-layer initialization during training and ultimately optimize the network as a whole [5]. Convolutional neural networks (CNNs) [6] and recurrent neural networks (RNNs) [7] are examples of classic networks. Deep learning (DL) offers advantages over typical machine learning algorithms in high-dimensional data, making it better

suited for intricate applications. Consequently, actual problems can be solved more successfully by selecting suitable machine learning methods for various data and demands.

The weather forecast reports require sophisticated computers to analyze online non-linear data and provide rules and patterns that may be examined based on observed data. ANN use will produce more accurate results. In this case, the error might or might not totally disappear. But compared to earlier projections, the accuracy will increase. Seasonal climate forecasting, global data forecasting, general forecasting, and weather research and forecasting (WRF) are suitable models for predicting the weather. Due to the complex nature of these prediction models, computing for them is very costly [8]. On the contrary, data mining models operate based on probability and/or resemblance patterns on historical data. The model operates in a similar way for each prediction category and anticipates returning a moderate level of accuracy. The model's weather forecasting output can be needed for weekly or monthly weather planning, as well as daily weather guides. To produce the best result out of all the weather forecasting models, forecasting accuracy is therefore a crucial factor.

II. LITERATURE REVIEW

Tarun et.al. (2019) used qualitative analysis using classification algorithms like Support vector machines (SVM), Artificial Neural Networks, and Logistic regression, and the dataset used for this classification application is taken from the hydrological department of Rajasthan for rainfall prediction. This model used ANN and has opened up many new paths in the prediction of environment-related phenomena [1] Velasco et.al.(2019) have found MLPNN model architecture for better performance and accuracy of weather forecasting [2] Gouthaman and Dutta (2020) has been achieving an effective way to predict rainfall, there are two ways being compared. One is the machine-learning approach and the second one is the artificial neural networks approach. In the first one, the LASSO regression approach is being taken. Before the comparison is done, a prediction of the dataset is performed which is better for effective comparison. A dataset of 4116 rows is being used that includes previous rainfall amounts in various regions and around the country. The dataset is divided into two parts, train data and test data. Train data is for training the algorithm and test data is for doing the prediction. Both of these processes were compared based on their accuracy and along with that, error types such as MSE, MAE, R-SQUARED, and RSME were considered. After performing the comparison, the conclusion of the system is that LASSO regression process is more accurate than the artificial neural network process. After comparison, the accuracy for LASSO is around 94% whereas ANN is 77%. Therefore, LASSO is the best analytical algorithm for predicting the rainfall in any given region [3] Gyanesh Srivastava et. al. gave BPN and RBFN efficient models for weather prediction as well as other weather parameter prediction over the small geographical region but BPN and RBFN models were given appropriate solutions for the prediction of long-range weather forecasting [4] Biswas et al. introduced a classifier approach for prediction of weather condition and shows how Naive Bayes and Chi-square algorithm can be utilized for classification purpose. The system will take this parameter and predict the weather after analyzing the input information with the information in the database. Consequently, two basic functions, specific classification (training) and prediction (testing) will be performed. The result of data mining procedures can be sufficient for weather forecasting [5] Y. Md. Riyazuddin et.al utilizes artificial neural networks for temperature forecasting and back propagation neural networks which are trained and tested based on the dataset. A back propagation neural network with a gradient descent method minimizes the error rate and it is a promising approach for temperature forecasting [6].

III. Artificial Intelligence

3.1. A Concise Overview of Machine Learning

The main goal of machine learning, which is a collection of computer programs, is to create mathematical models by utilizing statistics to draw conclusions from samples. Learning is the

application of a computer program that, given a model with specified parameters, optimizes the model's parameters using training data or experiences. The model might characterize the knowledge gleaned from the data, forecast the future state, or do both. The following can be used to summarize the practical application of machine learning techniques (1) Establish a hypothetical set H of the solving model and define a problem to an unknown mapping f. (2) Using a finite set, assemble and arrange a training set D. (3) Indicate the model's loss function. (4), decide on learning algorithm A. (5) Find the settings that cause the loss function to retrieve the pole hour and select those as the model's ideal parameters. (6) Save this model g with the ideal settings, then use it to analyze and forecast fresh data.

In accordance with the learning tasks, machine learning methods, including feature selection, dimensionality reduction, and prediction, may also be categorized into multiple groups. This review will solely cover predictive algorithms because it centers on TC forecast modeling. Generally speaking, this type of learning assignment is referred to as "classification" if the model's objective is to predict discrete values; "regression" if the model's goal is to predict continuous values. Furthermore, learning tasks can be generically categorized as either "supervised learning" or "unsupervised learning" based on the labeling of the training data, with the former being represented by classification and regression and the latter by clustering. The goal of the prediction task is to create a mapping, f: X → Y, between the input space X and the output space Y. f is dependent on a vector of nonlinear (generic) factors, w: y = f (x, w). The process of training, which is an optimization of the performance criterion (e.g., a minimization of the mean square error) for the classification or regression/mapping problem, yields the parameters w. Naturally, there are more parameters (hyper parameters) that can be included in a machine learning algorithm itself. Examples of these include the number of hidden neurons and neural network learning rates. For a machine learning-based forecast model to be trained appropriately, choosing the right hyper parameters is also essential. The key references in this section were [19-22].

IV. ARTIFICIAL NEURAL NETWORK FOR WEATHER FORECASTING

Accuracy is very important in weather forecasting. The input parameters are various data kinds and require various methods to be managed appropriately. Artificial intelligence techniques, on the other hand, are linked to non-linear data, whereas statistical methods are associated with linear data. Neural networks, neuro-fuzzy logic, and genetic algorithms are different kinds of AI learning models. Neural networks are providing accurate results among them. Whereas some deep machine learning method to predict the weather accurately like convolution network, Recurrent neural network, Back propagation method, Conditional Restricted Boltzmann Machines (CRBM) etc. ANNs allow for more accurate weather forecasting. Daily weather data includes a variety of factors, including temperature, humidity, rainfall amount, cloud distance and size, direction and speed of the wind, etc. Although all these data are nonlinear, they must be combined in order to calculate the temperature, humidity, rainfall, and weather for the future day [9,12]. Such kinds of applications require sophisticated models to be able to generate the patterns on their own by self-learning with the help of the model's training data which is given to the model. Develop an ANN model for weather forecasting; Region selection of input data and parameters is required to necessary. The input data must come from a designated region where the model is trained and tested so that the model is able to produce correct results. The number of input data given to model to improving accuracy of model by providing a high degree of similarity between projected and actual output data. Similarly, it has to be normalized because, all the parameters are of different units and normalization will help the input and output parameters to correlate with each other. The data should be divided into training and testing samples in proper proportion so that the results can be predicted, tested, and validated properly**.** The NN model's structure also significantly affects the accuracy of the results that are produced. More accurate nonlinear data prediction is made possible by the multilayer ANN. Depending on the requirements, the activation function for each layer of the NN will vary.

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 53, Issue 7, No.3, July : 2024

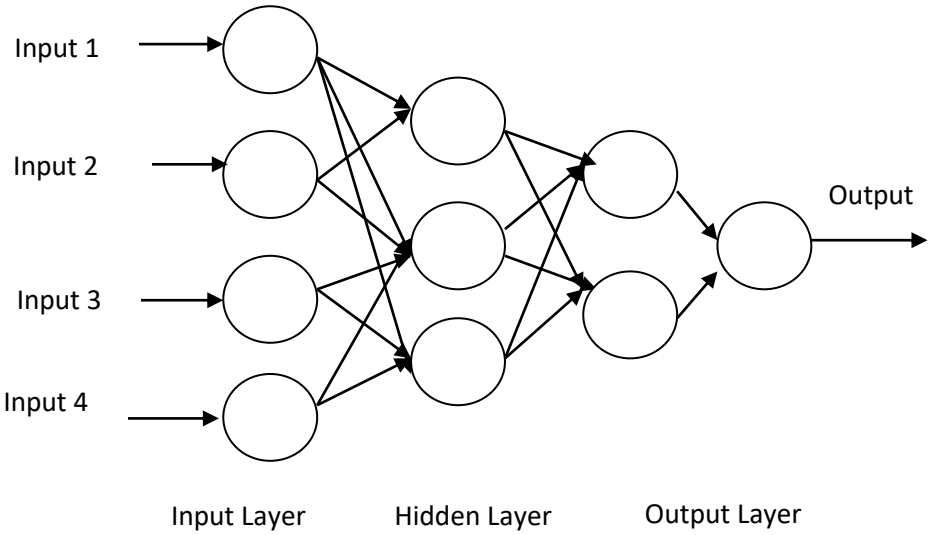

Figure1. Artificial Neural Network

V. PROPOSED METHODOLOGY

One of the most difficult scientific and technological issues in the globe over the past century is weather forecasting. We are investigating how data mining techniques can be used to forecast wind speed, evaporation, maximum temperature, and rainfall This was carried out Using deep neural network and Backpropagation algorithms and Meteorological data gathered during the last three years. use of data mining techniques, specifically deep neural networks (DNNs) with backpropagation algorithms, for weather forecasting [15]. You're focusing on predicting wind speed, evaporation, maximum temperature, and rainfall using the past three years of meteorological data.

5.1. Data cleaning: At this stage, a related data model format was developed, which is finding missing data, recovering data, and erasing terrible data. Eventually, the system cleanup details were converted into the proper data mining format. Data cleaning is a crucial step in any data mining project, and it sounds like you've taken the necessary steps to ensure the quality of your weather data. Here's a breakdown of your data-cleaning process and some additional thoughts:

5.2. Data Collection: The Metrological Department and various official website data used for this study. The 36-month period was covered by the case data. The subsequent methods, including data mining, data transformation, data cleaning, and data selection, were used at this point of the study. data from reputable sources like the Meteorological Department and official websites for your weather forecasting research project. Having high-quality data from these sources strengthens the credibility of your findings. made significant progress in preparing your data for your weather forecasting research project. By following the next steps outlined above, you can leverage data mining techniques and DNNs to develop a potentially more accurate forecasting model [16].

5.3. Data Consolidation: Another name for this stage is Data Transformation. This phase involves transforming the chosen data into formats that are suitable for data mining. The data file is saved in Commas Separated Value (CVS) file format and the datasets were normalized to reduce the effect of scaling. Data transformation is indeed another name for this stage in data preprocessing. It's great that you've recognized the importance of transforming your chosen data into a format suitable for data mining, specifically for your DNN model. data in CSV format and performing normalization are excellent steps in your data transformation process. By carefully addressing these aspects, you're ensuring your data is prepared for effective training of your DNN model [17].

5.4. Data mining phase: This phase is divided into three parts. The meteorological datasets are analyzed by the algorithm used in each stage. The testing method adopted for this research was percentage split that train on a percentage of the dataset, cross validation on it and test on the remaining percentage. Afterward, interesting patterns representing knowledge were identified. it

sounds like you've taken a comprehensive approach to data analysis, model development, and evaluation. By exploring different algorithms, employing a percentage split or cross-validation for testing, and identifying interesting patterns, you're laying a strong foundation for your weather forecasting research project [18].

VI. DATA MINING TECHNIQUE USED IN DATA MINING

The process of extracting interesting information from massive amounts of data is called data mining. Databases, data warehouses, the internet, and other information repositories are examples of data sources. Iterative sequence data is another feature of it. The three most used data mining techniques are decision trees, clustering, and classification.

Accurately defined data mining as the process of extracting valuable knowledge from large datasets. This knowledge can be used for various purposes, including weather forecasting (like your research project!). Correctly identified various data sources where data mining can be applied, including databases, data warehouses, the internet, and other information repositories [20].

Classification: classification is a task in data mining that involve assigning a class label to each instance in a dataset based on its feature. The aim of classification is to build a model that accurately predicts the class labels of new instances based on their feature.

Clustering: clustering is unsupervised machine learning based algorithm that compare a group of data into clusters so that the all member of object belongs to the same group. Clustering helps to divide data into various subsets. Each of these subsets contains data related to each other, and these subsets are called clusters.

VII. BACKPROPAGATION APPROACH

The backpropagation algorithm is used in layered feed-forward neural networks. It uses supervised learning which target output is used to train the model automatically. The desired result is given for each set of input data. The neural network model uses one or more hidden layers to process the input data with random values for weights and an appropriate activation function before producing the anticipated output. Next, the target output for the identical input dataset is compared with the anticipated output [21]. As a result, to assess error, the target output must be subtracted from predicted output. Once the error is small or within an acceptable range, the weights are modified using this error, and the entire process is repeated for a number of epochs.

Backpropagation: is a crucial algorithm used to train feedforward neural networks, a common type of artificial neural network architecture. Supervised Learning: As you explained, supervised learning is a training paradigm where the model is presented with input data and corresponding desired output (targets). The model learns by comparing its predictions with the targets and adjusts its internal parameters to minimize the error.

The next step is to train the random weight, and the goal is to minimize error by adjusting the weights. The input data can be any meteorological station area in which all the data is limited to a certain region. The various input parameters—temperature, relative humidity, air pressure, wind direction and speed, cloud cover and height, rainfall, etc. [22].

After that input data is cleaned and preprocessed. This means that it checks any outliers and eliminates missing values that are entered and data is examined to see if it is within the given range for the given parameter. Later ANN is built with several input and output nodes, hidden layers, activation function, and a maximum number of epochs, weights, bias, goal and learning function. Seventy percent of the input data is used to train the neural network. The remaining thirty percent of the input data are used for testing after the model has been trained to forecast the weather using this observed data. Then mean squared error and accuracy is calculated for the model by comparing the output of testing and targeting output. The output of this model generates the lowest and highest temperatures, relative humidity, and rainfall of the day.

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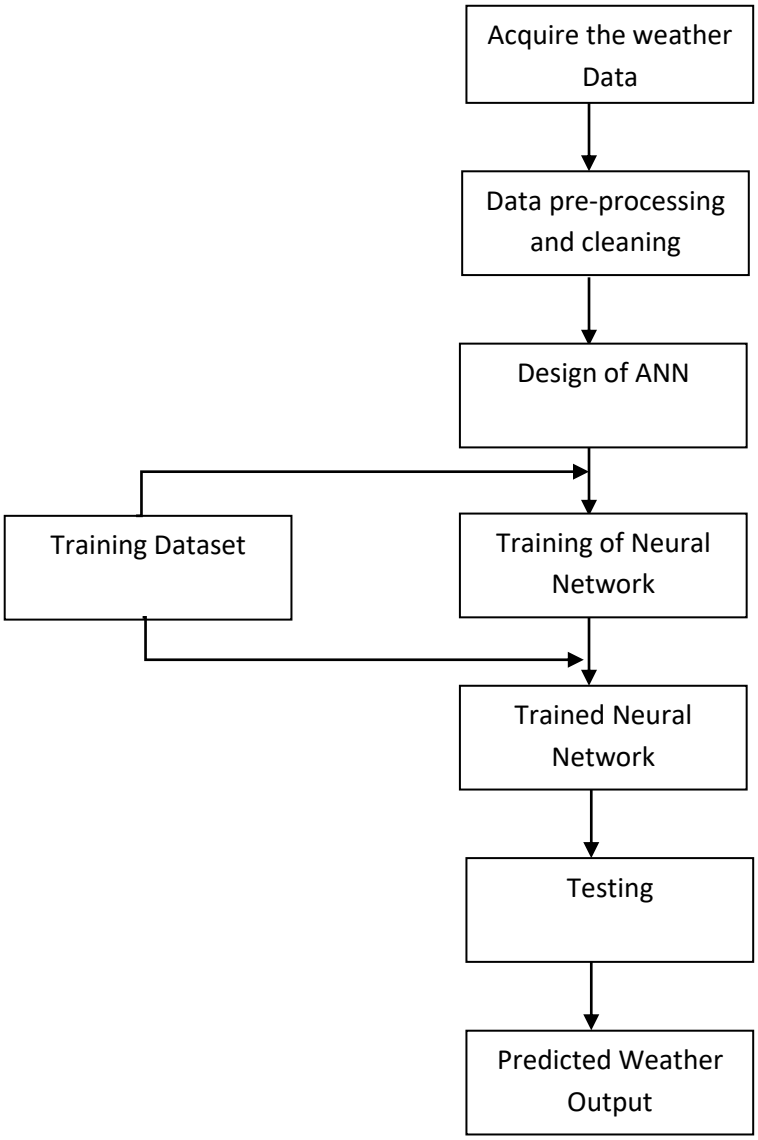

Figure2. Back propagation Approach

A hidden layer is required for processing nonlinear data for better performance and results can be achieved with high accuracy when learning data is smaller but performance is slower. Activation functions are applied to each neuron in a neural network to get the output of the neuron on a given input. The sigmoid function is a special case of logistic function which has a sigmoid curve. The sigmoid transfer function can be used for hidden layers and for the output layer the linear transfer function can be used. The accuracy and correctness of this model can be calculated by the Mean Squared error (MSE) function [23,24]. The MSE measures the average of the squares of errors that is, the main difference between the actual output and the predicted output of the model. The less the MSE value of the model, the more accurate the results are.

VIII. CONCLUSION

With scientific advancements, a lot of research is going on in weather gauging utilizing Data mining, deep learning, and machine learning. However, there was a lack of surveys available on the present status of exploration and application. This paper thus offers a survey of weather forecasting using various techniques. Also summarizing the key concepts and focusing on the existing work on weather forecasting, its types, and its applications. To conclude, how deep learning, data mining, and machine learning algorithms were employed in weather forecasting is exceptionally important to guarantee future exploration will be destined for success, accordingly improving the performance of

weather predictions and backpropagation method is best for nonlinear data as well as long-range for weather prediction.

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