

# Weather Forecasting using RNN and LSTM

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**Abstract - Accurate Weather Prediction has become one of the challenging tasks as there are unexpected weather changes occurring every day. A forecast of accurate weather conditions is essential to ensure safe daily life activities. Several Techniques are being proposed to predict weather forecasts, out of which one of the cost-effective and accurate forecasting techniques of weather prediction is by using machine learning and deep learning algorithms. This paper mainly presents the Long Short-Term Memory based on the Recurrent Neural Network to predict the temperature. The main approach presenting this paper is to attain an accuracy of 90-92% in predicting weather conditions over five days.**

**Keywords- Recurrent Neural Network, Long Short-Term Memory**

## I. INTRODUCTION

Weather is an important aspect of life. Nowadays predicting weather has become challenging as there are unexpected weather changes. Due to continuous climate changes, accurate weather forecasting is a need of an hour to ensure safe daily life activities. There are many ways to approach weather prediction right from using traditional physics complex models to using artificial intelligence technologies like machine learning and deep machine learning. The applications of building weather forecasting model are highly important as it is related to vital fields of life. There are important applications like the agriculture sector for detecting drought and climate monitoring. Weather prediction in industries like planning in the energy industry. In the aviation industry, for monitoring pollution, providing weather information to airline operations, and so on. There is also a huge impact of weather forecasting in making accurate decisions by the military to win a battle. The condition of weather is depended on the different parameters, and we consider them as variables, and it is very list of various approaches. Using Levenberg Marquardt's (LM) algorithm, daily weather conditions were measured from PV system [1]. This paper has addressed the electricity demands which depend on weather conditions. So daily maximum temperature prediction is done using a Support Vector Machine. [2]. In this paper, different ANN techniques are being used and they have found the best fitting algorithm to predict daily mean maximum and minimum temperature.[3]. Using weather data of the Western Himalayas region, ANN is used to predict maximum and minimum temperatures.[4] In this paper, all

the complex parameter inputs are taken up by ANN as an input and there is the generation of intelligent patterns during training and the same patterns are used for forecasts.[5] In this paper, fuzzy time series is used to deal with forecasting problems in the historical dataset which cannot be solved by using traditional methods. [6]. In this paper, weather predictions are done using Artificial Neural Network and Back Propagation Algorithm. The data-intensive model has been implemented using a data mining technique. The research has stated ANN is the best approach to traditional methods [7]. In this paper, weather prediction using machine learning models namely Support Vector Machine (SVM), Artificial Neural Network (ANN), and a Time Series based Recurrent Neural Network (RNN) is used, and steps are followed to achieve results [8]. By using RNN and LSTM techniques the daily temperature prediction is predicted and the test was carried out using two optimization models namely SGD and Adam [9]. In this paper, the daily weather forecasting is done using neural networks with backpropagation. 28 input parameters are taken as input and the forecast is given in terms of temperature, rainfall, humidity, cloud condition, and weather of the day[10]. In this paper, a comprehensive review of artificial neural network (ANN)-based approaches (such as recurrent neural network (RNN), long short-term memory (LSTM), etc.), are used to forecast air temperature. [11]. In this paper, daily temperatures over 3 days are predicted in classes namely "Cold", "Cool", "Normal", "Warm" and "Hot" using RNN and LSTM [12]. In this paper, the proposed lightweight model produces better results comparing it to well-known and complex WRF model, predicting accurate weather forecasts for up to 12 hours.

This paper mostly focuses on building a model predicting the average temperature over 5 days using RNN and LSTM. The Output will be displayed on a graphical user interface.

## II. GAP IDENTIFICATION

Artificial Neural Network can be used for storing information on the entire network and it also has fault tolerance, but they pass information in one direction only whereas in RNN, it introduces a loop, whatever hidden layer processes it sends it to output as well as sends it back to itself that means in RNN prediction history is important. Therefore, ANN fails here wherever you need history as ANN does not work taking history. Further by using LSTM

accuracy can also be improved by using a large dataset and training the model, by adding more LSTM layers to the RNN model.

### III. METHODOLOGY

#### RNN Model

Neural Networks have many applications in data mining which are used in numerous fields and yield maximum accuracy. The neural network mainly consists of three parts: input layer, hidden layer, and output layer. The input layer generally represents the real-world data that is to be provided to the network. The hidden layer takes input and multiplies it with certain weight processes further. The weight is multiplied by a hidden unit and processed as output.

Here as shown in Fig.1. RNN model is used. RNN is the sequence of inputs that can be processed and regain its state while processing the next sequence of inputs. In RNN prediction sequential history of data is important. RNN has input neurons, hidden neurons, and output neurons. RNN Neural network introduces a loop, whatever hidden layer processes it sends it to output as well sends it back to itself. The hidden layer takes the input let's say  $X(t)$ , multiplies it with some weight  $Whx$ . But here hidden neuron also takes previous output as the inputs  $h(t-1)$ , which is used with an activation function  $Tanh(Whx.x(t) + Whh.h(t-1))$ . It has some memory, and the output is calculated.

$Whx$  = Data coming from the input to the hidden neuron.

$Whh$  = Data coming from hidden neuron going back to hidden neuron.

$Wyh$  = Data coming from hidden neuron going to output neuron.

At each time current step is dependent on the current input and previously hidden neurons. Here sequence prediction is in many to one forms. LSTM (Long Short-Term Memory) is a type of Recurrent Neural Network. LSTM allows RNN to remember the information which may have been there a long time ago. RNNs are having their data stored in a memory cell in which LSTM can do changes in data like reading, writing, or erasing.

In this proposed paper, there are 1820 samples of data set as shown in Fig.1 After importing the data in CSV format by importing pandas library, data is pre-processed that is there is the conversion of the real-world data into the understandable format. We are using the RNN machine learning model based on LSTM. Input parameters to the input neuron include minimum temperature, maximum temperature, Average temperature, sunrise, and sunset.

For training and testing, we have taken the past 1820 samples dataset out of which the first 1790 is used for training and the last 30 values for testing, shown in Fig.2. first and last 5 values. We have imported Time series Generator which is used for formatting data that is to be given to the neural network model. After this part, there is the import of Sequential, Dense, LSTM class, which are used for the creation of the model. When calling Sequential library, it adds the layer sequentially one after another. We are adding LSTM with 100 neurons and activation function as relu activation function. In the final output layer, which is going to make the final prediction we are compiling the model using Adam optimizer as it is computationally efficient and means square error using loss function. While fitting the model we simply have to call the generator which has the input and output. For predicting output, let's say we have taken a set of values from which we are predicting our next output value say  $o1o1$ , we have to reconsider this in order to predict our next output  $o2o2$ . For this, we need to reformat the data. We will be able to predict  $o2$  from it. We need to append on new input, and we will get our next output  $o2o2$ . The further repeating process will get our next prediction and so on. This is about the backend part of the project. The front-end part is a graphical user interface made up of Html, CSS, JavaScript, and jQuery as shown in Fig.5. Then we will connect the backend and frontend by using the C# language to predict the average temperature.

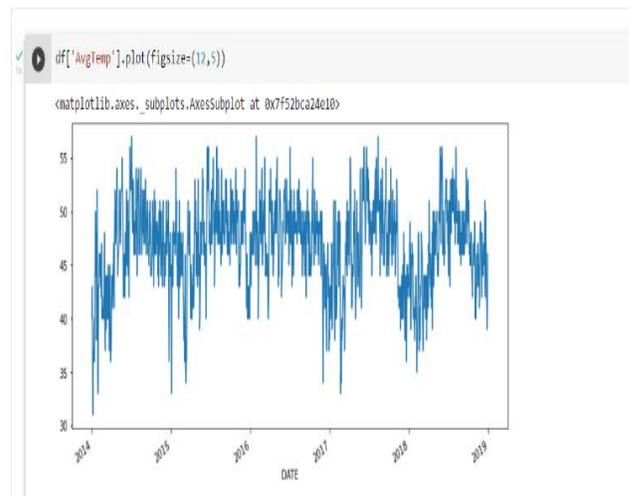


Fig.1. Plot of avg temp Vs date

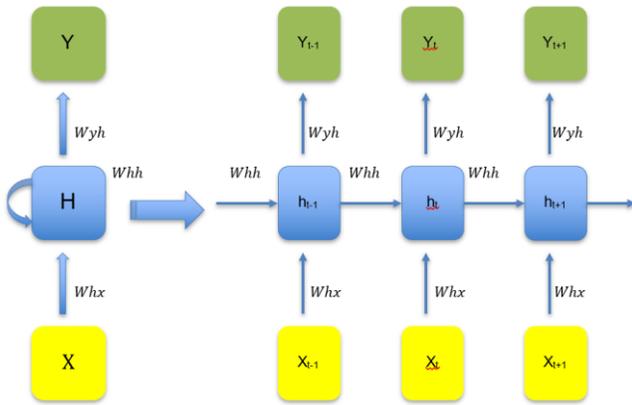


Fig.2. RNN model

Date	Min Temp	Max Temp	Sunrise	Avg Temp	Sunset
2014-01-01	33.0	46.0	657	40.0	1756
2014-01-02	35.0	50.0	657	43.0	1756
2014-01-03	36.0	45.0	657	41.0	1757
2014-01-04	32.0	41.0	658	37.0	1757
2014-01-05	24.0	36.0	658	31.0	1758
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
2018-12-26	35.0	45.0	654	40.0	1752
2018-12-27	33.0	44.0	655	39.0	1752
2018-12-28	33.0	47.0	655	40.0	1753
2018-12-29	36.0	47.0	655	42.0	1753
2018-12-30	39.0	52.0	656	46.0	1754

Fig.3. Data set samples

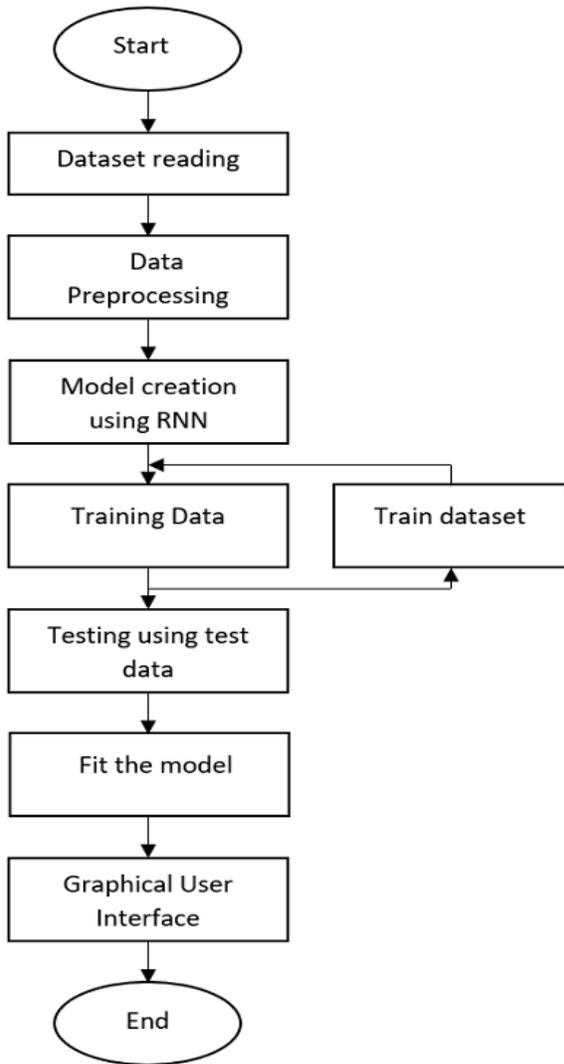


Fig.4. Flow Chart

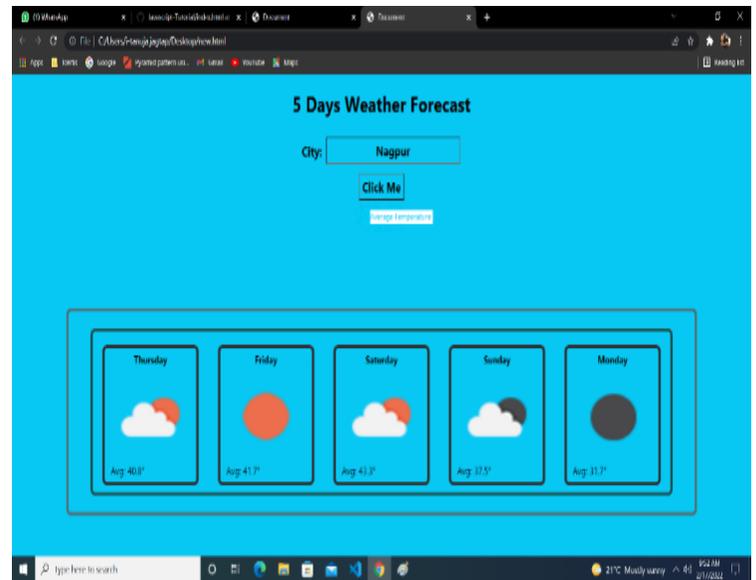


Fig.5. Graphical User Interface

IV. CONCLUSION

Machine learning is an effective approach to predicting the weather. There are several machine deep learning algorithms that have given some limitations. Compared to all those, it has been experimentally proved that in terms of accuracy RNN and LSTM give more accurate results. Recurrent Neural Networks and LSTM are the best-known algorithms for time series prediction. Firstly, there is pre-processing of data. The second step includes training of data using LSTM and RNN. The third step is the testing of data. In this research, we are displaying the output of average temperature using the graphical user interface. The accuracy of output is 90-92%. But this research is limited to only a single parameter for predicting average temperature. In the future, along with Average temperature, we will be able to predict more weather parameters.

V. REFERENCES

- [1]I.S. Isa, S. Omar, Z. Saad, N.M. Noor, and M.K. Osman."Weather Forecasting using photovoltaic system and Neural Networks", July 2010.
- [2]Paniagua-Tineo, A.,S. Salcedo-Sanz, C. Casanova-Mateo, E.G. Ortiz- Garcia, M.A. Cony, and E.Hernandez-Martin. "Prediction of daily Maximum Temperature Using Support Vector Regression Algorithm",2011.
- [3] He, Y., F. Wetterhall, H.L. Cloke, F.Pappenberger, M.Wilson, and J.Freer. "Forecast of Daily Mean, Maximum and Minimum Temperature Time Series by Three Artificial Neural Network Methods", 2009.
- [4]A.Ganju and Piyush Joshi. "Maximum and Minimum temperature Prediction over Western Himalaya Using Artificial Neural Network",2012.
- [5]Imran Maqsood, Muhammad Riaz Khan and Ajith Abraham. "A Neural Network for Weather Forecasting",2004.
- [6]Chen, Shyi-ming, Senior Member, and Jeng-ren Hwang. "Temperature Prediction Using Fuzzy Time Series.",2000.
- [7] Priyanka Mahajan, ChhayaNawale, SiddheshwarKini, Prof,KrishnanjaliShinde. "Weather Forecasting Using Neural Network",2017.
- [8]Siddharth Singh, Mayank Kaushik, Ambuj Gupta, Anil Kumar Malviya. "Weather forecasting using Machine Learning Techniques",March 11,2019.
- [9] Tu Hoang Nguyen,"Weather Prediction based on LSTM model implemented AWS Machine Learning Platform",April 2021.
- [10]MeeraNarvekar, PriyancaFargose."Daily Weather Forecasting using Artificial Neural Network".
- [11]Trang ThiKieu Tran, Sayed.M.Batani, SeoJin Ki, and HamidrezaVosoughifar."A Review of Neural Networks for Air Temperature Forecasting", 4May 2021.
- [12] Ike Sri Rahayu, Esmeralda C Djamal, RidwanIlyas, Abdul Talib Bon. "Daily Temperature Prediction Using Recurrent Neural Networks and Long-Short Term Memory.",August 10-14, 2020.
- [13]Pradeep Hewage, Marcello Trovati, Ella Pereira, ArdhenduBehera."Deep learning-based effective fine-grained weather forecasting model". June-9, 2020