

A review of Weather Forecasting Using CNN and Cloud

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ABSTRACT:-

Weather conditions play a major role in our daily life of a farmer. It affects the productivity of the work and results in the loss. It plays important in getting good productivity from the crops he grows by getting early warning and insights of what will be the weather conditions so that he can be ready and save his crops. There are lot of websites which keep daily weather data which if used properly can give correct insight of the weather behaviour in a specific month. So, the current data with the historical data can prove to be very helpful in developing a weather forecast system for a specific area using latest technologies such as Artificial Intelligence, Cloud computing and Mobile computing together and give a better prediction to a user. So, we are developing a system where a mobile app will be provided to the user side from where he can register and authenticate himself first. Then he will enter a place name and address and send the weather forecast prediction request. This request is then forwarded to the admin which will be a desktop application. The admin will then view all the requests and then select a request. The address will then be converted to latitude and longitude using reverse geocoding and the historical data for this location will be downloaded using worldweatheronline.com API. Then this data which is in JSON format will then be converted to a training dataset. This training dataset will then be used to train the deep learning algorithm CNN which will have various layers in its architecture. Then the CNN will predict the weather forecast which will be sent to the app user automatically. All the communication between an admin and user will be handled using Google cloud platform.

Keywords:- Weather Forecast, Historical Data, CNN, API, GCP, Cloud Computing.

1. INTRODUCTION

Today weather plays a major role in a farmer's life. If the weather remains good then the crops will be good and the farmer will reap rich crops increasing his quality of life. But if a weather changes differently many times in a life cycle of a crop, then the farmer needs to spray lot of pesticides to save his crops. The pesticides have to be sprayed in time and if they are late then they are of no use and the crops will get damages from the diseases that are being originated by the atmosphere created by the bad and unpredictable weather. So, there should be mechanism where a farmer can get insights of the weather conditions that will happen using latest technologies and save farmer from loss and improve his life style.

As the processing power of the computer increases many intensive technologies such as artificial intelligence can be used in our daily work. The main AI based algorithm which is very powerful and accurate is convolutional neural networks (CNN). The CNN has layers in it like input layer, dense layer, convolutional layer, output layer etc. in its architecture. This algorithm can be easily fine-tuned and the results returned can be improved. So, if the CNN used with a large historical weather data it will easily help in predicting the future weather conditions

at a great extent. So, this technology if used with other technologies such as mobile computing, cloud computing a good and efficient weather forecasting system can be developed which will turn help farmers prepare for the weather conditions and take care of their crops. So, the main motivation of our project is to.

- To develop a better and easy to use weather forecasting system.
- To make use of latest technologies such as mobile computing, cloud computing and artificial intelligence together.
- To increase farmers income.
- To make use of secured cloud computing technology.
- To make the system operatable 24x7 without any failures and help farmers.

Thus, the rest of the paper is structured as follows:

- Section 2. explains literature survey which help us in designing a CNN based weather forecasting system using studies published by other researchers.
- Section 3. explains problem definition with goals of the new CNN based weather forecasting framework, methodology i.e., mathematical model and algorithms to be used by the system and explains proposed system with block diagram or system architecture and working of the system.
- Section 4. shows the discussion with charts of how much time will the framework take to create a training dataset and get results.

2. LITERATURE REVIEW

This section describes the fundamentals of various techniques that can be used in designing a CNN based weather forecasting system using artificial intelligence-based algorithm CNN. It helps in understanding various ideas put forward by other researchers and how the drawback in their system can be overcome to design a better and reliable weather forecasting framework. Some of the ideas with technique and drawbacks are mentioned below:

In 2020 Rahul et al. [1] put forward a paper which mainly emphasises on “CNN based weather forecasting” technique to predict weather conditions. This research is efficient to cover all the things needed for a to develop a successful weather forecasting framework which can be improved by adding mobile access using cloud computing so that it can be used from anywhere anytime.

In 2020 ZHANG et al. [2] put forward a paper which mainly emphasises on “air quality prediction using Light GBM” technique to predict air quality. This research is efficient to cover all the things needed for a to develop a successful weather forecasting framework which can be improved by adding mobile access using cloud computing so that it can be used from anywhere anytime.

In 2020 Zhan et al. [3] put forward a paper which mainly emphasises on “Deep learning-based air quality prediction” technique to predict weather conditions. This research is efficient to cover all the things needed for a to develop a successful weather forecasting framework which can be improved by adding mobile access using cloud computing so that it can be used from anywhere anytime.

In 2020 Madan et al. [4] put forward a paper which mainly emphasises on “Machine Learning based air quality prediction” technique to predict weather conditions. This research is efficient to cover all the things needed for a to develop a successful weather forecasting framework which can be improved by adding mobile access using cloud computing so that it can be used from anywhere anytime.

In 2020 Dobrea et al. [5] put forward a paper which mainly emphasises on “air pollutant forecasting using machine learning” technique to predict weather conditions. This research is efficient to cover all the things needed for a to develop a successful weather forecasting framework which can be improved by adding mobile access using cloud computing so that it can be used from anywhere anytime.

3. PROJECT DESIGN

This section describes all the issues which we can face while designing a weather forecasting system using CNN algorithm and how to resolve it using a methodology to solve the problem and design a successful system.

3.1 Problem Statement

Today farming is perceived by many as their main occupation. If farmers crops are in good conditions, then he can get a good produce which he will get good rates. If the farmers' incomes are increased so does his lifestyle improve. But if weather conditions are bad a lot of diseases are originated on the crops which if not detected early may damage the crops and the losses are incurred by the farmer. So, a mechanism has to be developed using latest technologies such as cloud computing, mobile computing and artificial intelligence together to give farmer a better insight of the weather conditions in coming days or months. Thus, by using this kind of system a farmer can be better ready to handle the diseases originating from the bad weather and take of his crops properly. This system will help in increasing the farmers income as they will be ready to handle the weather conditions and save their crops from losses. So, our major goals and objectives to solve this problem is stated as follows:

- To use historical weather data from as many years as possible.
- To use reverse geocoding to get location data from address.
- To use artificial intelligence-based CNN algorithm
- To use Google Cloud Platform (GCP) as our cloud provider.
- To predict weather for coming days or months.

3.1.1 Mathematical Model

Our weather prediction system framework can be explained in two sets with probability, success and failure conditions.

- Mobile Module:
Set (M)= {M0, M1, M2, M3, M4}

M0∈M = Register and authenticate app.

M1∈M = Enter address and select a month.

M2∈M = Send prediction request.

M3∈M = Fetch prediction response.

M4∈M = View weather forecast prediction.

- Weather Forecasting Module:
Set (W)= {W0, W1, W2, W3, W4}

W0∈W = Fetch prediction requests.

W1∈W = Fetch historical data.

W2∈W = Create training dataset.

W3∈W = Train and apply CNN.

W4∈W = View weather forecast prediction.

W4∈W = Send prediction response.

So, by studying the sets we come to notice that many elements are common in both modules and used in coordination in both sets so they be placed as

$$x \in M \cap W \text{ if } x \in M \text{ and } x \in W. \quad (1)$$

Thus, the probability of intersection of elements in both modules can be given as

$$P(M \cap W) = P(M) + P(W). \quad (2)$$

So, intersection of common elements can be shown as

$$M \cap W = \{M4\}. \quad (3)$$

The conditional probability of both modules using the same element can be shown as

$$P(M | W) = \frac{P(M \cap W)}{P(W)}. \quad (4)$$

Thus, we conclude that our project “Weather forecasting using CNN and cloud” success and failure will depend upon the internet as our weather conditions historical data will be fetched using internet, i.e., if the internet connection is not good or not present the historical data will not be fetched and the project won’t work, thus this is a case of failure, so our framework supports NP-Hard and not NP-Complete.

3.1.2 Algorithms Used

The project will use deep learning-based CNN algorithm for successful implementation of the weather forecasting framework.

- CNN:

This algorithm will be used to forecast the weather conditions for a specific location or address. A convolutional Neural Network (CNN) is an artificial intelligence based deep learning algorithm. The CNN architecture has various layers for e.g., input layer, dense layer, convolution layer, SoftMax layer etc. which takes text or image as input and converts in to a layered data. Not much of pre-processing of data is required in CNN layers as compared to other classification algorithms. With good training dataset and enough training the CNN algorithm can learn and predict the results with high accuracy. The layers in the CNN architecture are connected like neurons in the human brain so called as Convolution Neural Network.

3.2 Proposed System

This section is mainly divided in three main modules with other sub modules in them. The modules and submodules are explained using a block diagram or system architecture as shown in Figure.1. to illustrate them. The working of the framework or its blocks can be explained as:

- Historical Weather Data:

This block in system architecture shows how a standalone application will fetch historical weather data using worldweatheronline.com API which hosts a large amount of weather data for a specific address.

- Pre-process Historical Data:

This block in system architecture shows how the historical data is fetched using an address in JSON format. The JSON data is then parsed and relevant information is used to create a training dataset which will be used to train a CNN architecture.

- Train and Apply CNN:

This block in system architecture shows how a CNN architecture will be designed using layers such as input layer, convolution layer, dense layer and SoftMax layer etc. Then the CNN architecture will be trained using previously created training dataset and then it will predict the weather conditions. The results are then sent back to respective user who can view it on his mobile using cloud computing as a medium.

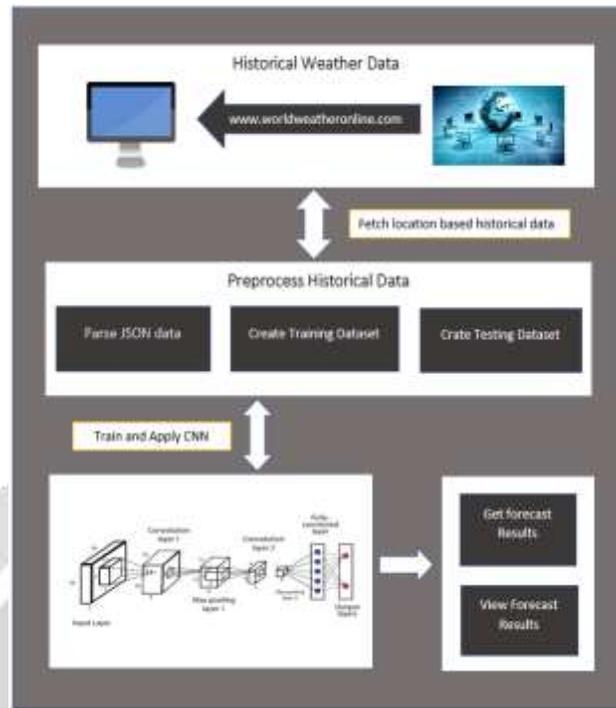


Figure 1: Block Diagram/ System Architecture

4. RESULTS AND DISCUSSION

In this section we are presenting two charts which mainly focuses on the time taken create a training dataset and the training of CNN and get weather prediction results from it.

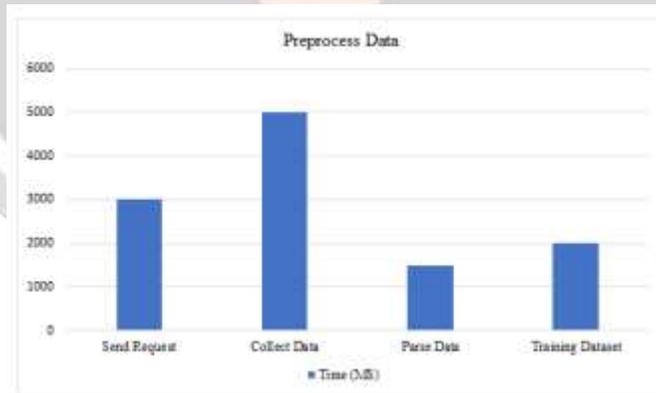


Figure 2: Pre-process Data Time Chart

The chart in Figure 2. explains how much time is taken to collect the weather prediction request and collect relevant data from it and create a training dataset from the JSON data returned for the address in the request. It shows that it takes more time to collect historical weather data then other processes.

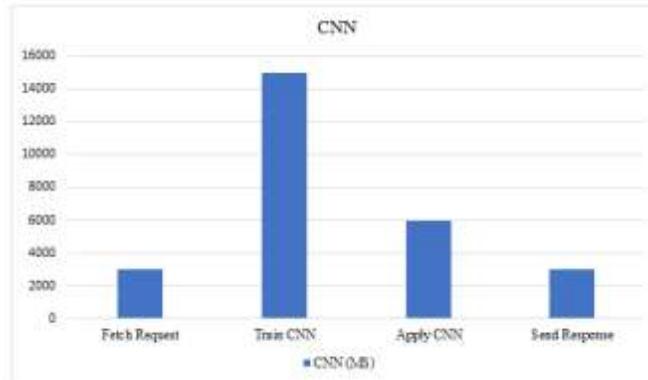


Figure 3: CNN Results Time Chart

The chart in Figure 3, explains how much time is taken to fetch the user request and create a CNN architecture and train it using previously created training dataset and get weather prediction from it and send the predictions back to user. It shows that training a CNN architecture takes a lot of time then other processes.

5. CONCLUSIONS

In this paper, we have presented how we are going to design a weather forecasting system by combining various technologies such as historical covid-19 data and artificial intelligence-based CNN together to predict weather conditions for a specific location. The basic idea of this study is to help farmers get better insight on the weather conditions in the coming days. We studied and tried to study drawbacks of various researches [1][2][3][4][5] and decide how to improve our new weather forecasting framework. We are fetching weather data for a specific address using API available on the internet. Using an API, the JSON data will be parsed to create a training dataset. We are using deep learning-based CNN algorithm to predict the future weather conditions for a specific location. We are predicting the weather conditions so that the farmers can use it to take care of his crops and avoid loss due to bad weather as much as possible.

REFERENCES

- [1] Govind Kumar Rahul, Saumya Singh and Saumya Dubey., "Weather Forecasting Using Artificial Neural Networks.," in IEEE-2020.
- [2] YING ZHANG , YANHAO WANG, MINGHE GAO, QUNFEI MA, JING ZHAO, RONGRONG ZHANG, QINGQING WANG and LINYAN HUANG., "A Predictive Data Feature Exploration-Based Air Quality Prediction Approach.," in IEEE-2020.
- [3] Choujun Zhan, Songyan Li, Jianbin Li, Yijing Guo, Quansi Wen and WeiSheng Wen., "Prediction of Air Quality in Major Cities of China by Deep Learning.," in IEEE-2020
- [4] Tanisha Madan, Shreddha Sagar and Deepali Virmani "Air Quality Prediction using Machine Learning Algorithms –A Review.," in IEEE-2021.
- [5] Marius Dobrea, Andreea Bădicu, Marina Barbu, Oana Șubea, Mihaela Bălănescu, Geroge Suci, Andrei Bîrdici, Oana Orza and Ciprian Dobre., "Machine Learning algorithms for air pollutants forecastin.," in IEEE-2020
- [6] Kaimian, Q. Li, C. Wu, Y. Qi, Y. Mo, G. Chen, X. Zhang, and S. Sachdeva, "Evaluation of different machine learning approaches to forecasting pm2. 5 mass concentrations," Aerosol and Air Quality Research, vol. 19, no. 6, pp. 1400–1410, 2019.
- [7] Q. Di, H. Amini, L. Shi, I. Kloog, R. Silvern, J. Kelly, M. B. Sabath, C. Choirat, P. Koutrakis, A. Lyapustin, et al., "An ensemble-based model of pm2. 5 concentrations across the contiguous united states with high spatiotemporal resolution," Environment international, vol. 130, p. 104909, 2019.