A Mini Project Synopsis on

Weather Forecasting

T.E. - I.T Engineering

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CERTIFICATE

This to certify that the Mini Project report on Weather Forecasting has been submitted by Atharva Tambde 19104048, Anurag Singh 19104003 and Rajvi Shah 20204001 who are a Bonafede students of A. P. Shah Institute of Technology, Thane, Mumbai, as a partial fulfilment of the requirement for the degree in **Information Technology**, during the academic year **2021-2022** in the satisfactory manner as per the curriculum laid down by University of Mumbai.

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Acknowledgment

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1.Introduction

Weather Prediction is the application of science and technology to predict the amount of rain/storms/cold weather over a region. It is important to exactly determine the rain/storms/cold weather for effective use of water resources, crop productivity and pre-planning of water structures.

In this project, we used Linear Regression to predict the amount of rainfall. Linear Regression tells us how many inches of rainfall we can expect.

Weather forecasting means the prediction of the weather through the application of the principles of physics, supplemented by a variety of statistical and empirical techniques.

In addition to predictions of atmospheric phenomena themselves, weather forecasting includes predictions of changes on the Earth's surface climate. These changes are caused by atmospheric conditions like snow and ice cover, storm tides, and floods.

The basis for weather prediction started with the theories of the ancient Greek philosophers and continued with Renaissance scientists. It was followed by the scientific revolution of the 17th and 18th centuries. The theoretical models of 20th- and 21st-century atmospheric scientists and meteorologists helped for the betterment in applications. The so-called synoptic weather map came to be the principal tool of 19th-century meteorologists. This is used today in weather stations and on television weather reports all over the world. All can happen only through a comprehensive weather forecast. Any weather prediction needs a systematic collection of weather record of various places and proper analysis using the data for prediction.

Weather simply refers to the condition of air on the earth at a given place and time. It is a continuous, data-intensive, multidimensional, dynamic and chaotic process. These properties make weather forecasting is a formidable challenge. Forecasting is the process of estimation in unknown situations from the historical data. Weather forecasting is one of the most scientifically and technologically challenging problems around the world in the last century. To make an accurate prediction is indeed, one of the major challenges that meteorologists are facing all over the world.

Since ancient times, weather prediction has been one of the most interesting and fascinating domains. Scientists have tried to forecast meteorological characteristics using a number of methods, some of these methods being more accurate than others. Knowledge of meteorology forms the basis of scientific weather forecasting, which revolves around predicting the state of the atmosphere for a given location. Weather forecasting as practiced by humans is an example of having to make judgments in the presence of uncertainty. Weather forecasts are often made by collecting quantitative data about the current state of the atmosphere and using scientific understanding of atmospheric processes to project how the atmosphere will evolve in future.

Over the last few years the necessity of increasing knowledge about the cognitive process in weather forecasting has been recognized. For human practitioners, forecasting the weather becomes a task for which the details can be uniquely personal, although most human forecasters use approaches based on the science of meteorology in common to deal with the challenges of the task. Weather forecasting entails predicting how the present state of the atmosphere will change. Present weather conditions are obtained by ground observations, observations from ships, observation from aircraft, radio sounds, Doppler radar and satellites. This information is sent to meteorological centers where the data are collected, analyzed and made into a variety of charts, maps and graphs.

Modern high-speed computers transfer the many thousands of observations onto surface and upper-air maps. Weather forecasts provide critical information about future weather. There are various techniques involved in weather forecasting, from relatively simple observation of the sky to highly complex computerized mathematical models. Weather prediction could be one day/one week or a few months ahead. The accuracy of weather forecasts however, falls significantly beyond a week. Weather forecasting remains a complex business, due to its chaotic and unpredictable nature. It remains a process that is neither wholly science nor wholly art. It is known that persons with little or no formal training can develop considerable forecasting skill.

For example, farmers often are quite capable of making their own short term forecasts of those meteorological factors that directly influence their livelihood, and a similar statement can be made about pilots, fishermen, mountain climbers, etc.

Weather phenomena, usually of a complex nature, have a direct impact on the safety and/or economic stability of such persons. Accurate weather forecast models are important to third world countries, where the entire agriculture depends upon weather. It is thus a major concern to identify any trends for weather parameters to deviate from its periodicity, which would disrupt the economy of the country. This fear has been aggravated due to threat by the global warming and greenhouse effect. The impact of extreme weather phenomena on society is growing more and more costly, causing infrastructure damage, injury and the loss of life.

As practiced by the professionally trained meteorologist, weather forecasting today is a highly developed skill that is grounded in scientific principle and method and that makes use of advanced technological tools. The notable improvement in forecast accuracy that has been achieved since 1950 is a direct outgrowth of technological developments, basic and applied research, and the application of new knowledge and methods by weather forecasters. High-speed computers, meteorological satellites, and weather radars are tools that have played major roles in improving weather forecasts. Several other factors have contributed significantly to this increase in forecasting accuracy.

One is the development of statistical methods for enhancing the scope and accuracy of model predictions. Another is the improved observational capability afforded by meteorological satellites. A third primary reason for the increase in accuracy is the continued improvement of the initial conditions prepared for the forecast models. Statistical methods allow a wider variety of meteorological elements to be predicted than do the models alone, and they tailor the geographically less precise model forecasts to specific locations. Satellites now provide the capability for nearly continuous viewing and remote sensing of the atmosphere on a global scale. The improvement in initial conditions is the result of an increased number of observations and better use of the observations in computational techniques.

Weather forecasting is the application of science and technology to predict the conditions of the atmosphere for a given location and time. People have attempted to predict the weather informally for millennia and formally since the 19th century. Weather forecasts are made by collecting quantitative data about the current state of

the atmosphere, land, and ocean and using meteorology to project how the atmosphere will change at a given place.

Once calculated manually based mainly upon changes in barometric pressure, current weather conditions, and sky condition or cloud cover, weather forecasting now relies on computer-based models that take many atmospheric factors into account.[1] Human input is still required to pick the best possible forecast model to base the forecast upon, which involves pattern recognition skills, teleconnections, knowledge of model performance, and knowledge of model biases. The inaccuracy of forecasting is due to the chaotic nature of the atmosphere, the massive computational power required to solve the equations that describe the atmosphere, the land, and the ocean, the error involved in measuring the initial conditions, and an incomplete understanding of atmospheric and related processes. Hence, forecasts become less accurate as the difference between current time and the time for which the forecast is being made (the *range* of the forecast) increases. The use of ensembles and model consensus help narrow the error and provide confidence level in the forecast.

1.1 Purpose

There are several reasons why weather forecasts are important. They would certainly be missed if they were not there. It is a product of science that impacts the lives of many people. The following is a list of various reasons why weather forecasts are important:

1. Helps people prepare for how to dress (i.e. warm weather, cold weather, windy weather, rainy weather)
2. Helps businesses and people plan for power production and how much power to use (i.e. power companies, where to set thermostat)
3. Helps people prepare if they need to take extra gear to prepare for the weather (i.e. umbrella, rain coat, sun screen)
4. Helps people plan outdoor activities (i.e. to see if rain/storms/cold weather will impact outdoor event)
5. Helps curious people to know what sort of weather can be expected (i.e. a snow on the way, severe storms)
6. Helps businesses plan for transportation hazards that can result from the weather (i.e. fog, snow, ice, storms, clouds as it relates to driving and flying for example)
7. Helps people with health related issues to plan the day (i.e. allergies, asthma, heat stress)
8. Helps businesses and people plan for severe weather and other weather hazards (lightning, hail, tornadoes, hurricanes, ice storms)
9. Helps farmers and gardeners plan for crop irrigation and protection (irrigation scheduling, freeze protection)

1.2 Objectives

- To provide user friendly interface for obtaining weather reports.
- To automate the process of analysing the weather conditions.
- To develop a statistical and analytical report on weather report.
- To compare and contrast the different technologies used to gather weather data.
- To analyse weather symbols, station models and weather maps.
- To describe how weather forecasts are made.
- Systematic weather records were kept after the invention of the instruments for measuring atmospheric conditions during the 17th century.
- Undoubtedly, these early records were employed mainly by those engaged in agriculture.
- Planting and harvesting can be planned better and carried out more efficiently if all the long-term weather patterns are estimated in advance.
- Weather warnings are a special kind of short-range forecasts. It is needed for the protection of human life from weather extremes.
- Weather warnings are issued by government and military organizations throughout the world for all kinds of threatening weather events like tropical storms which are called as hurricanes, typhoons, or tropical cyclones, depending on location.
- Weather forecasting became an important tool for aviation during the 1920s and ’30s. Many oceangoing shipping vessels as well as military ships use optimum ship routing forecasts to plan their routes in order to minimize the loss of time, potential damage, and fuel consumption in heavy seas.

1.3 Scope

- One can implement a few more sensors and connect it to the satellite as a global features of the system.
- In aircraft, navigation and military there is a great scope of this real-time system.
- It can also be implemented in hospitals or medical institutes for the research and study in “Effect of Weather on Health and Diseases”, hence to provide better precaution alerts.
- One can implement a few more sensors and connect it to the satellite as a global feature of this system.
- Long time (> 7days) weather forecasting by using ZigBee Mesh Technology and covering larger area.
- In aircraft, navigation and military there is a great scope of this real-time system.
- It can also be implemented in hospitals or medical institutes for the research & study in "Effect of Weather on Health and Diseases", hence to provide better precaution alerts.

2. Problem Definition

- It is important to exactly determine the rainfall for effective use of water resources, crop productivity and pre-planning of water structures.
- Weather Forecasting sometimes inaccurate.
- How accurate are long term forecasts versus short term forecasts?

  1) A fine grid of data is needed to study the accuracy of weather forecasts

  2) PSOC based weather monitoring system can measure environmental data In urban areas of our country where we have these weather monitoring systems and stations/devices, there are still some constraints; partly due to high cost of importation.
- Predictability inaccuracies are due to the prevailing weather conditions, the high calculation power required to solve atmospheric calculations, the error involved in estimating the initial conditions, and an incomplete understanding of atmospheric processes.
- Therefore, the predictions are less accurate as the difference between the current time and the time the forecast is made (the range of the forecast) increases.
- The use of ensembles and a harmonious model helps to minimize error and select the possible outcome.
- There are various ways to end climate use. Weather warnings are important predictions because they are used to protect health and property.
- Temperatures based on temperatures and rainfall are important for agriculture, so for traders in the middle of the commodity markets.

3.Proposed System

The proposed system is an application where one can check for plagiarism. It is a software that allows you to check for any kind of plagiarism either by typing out the content that you want to check or upload a file of a supported format to check for plagiarism in that file.

User will enter the city name and System will take this input data and give the temperature in degree Celsius as output. The main role of our system is show the temperatures on the basis of city names.

What is a Regression: -

In Regression, we plot a graph between the variables which best fit the given data points. The machine learning model can deliver predictions regarding the data. In naïve words, **"**Regression shows a line or curve that passes through all the data points on a target-predictor graph in such a way that the vertical distance between the data points and the regression line is minimum." It is used principally for prediction, forecasting, time series modelling, and determining the causal-effect relationship between variables.

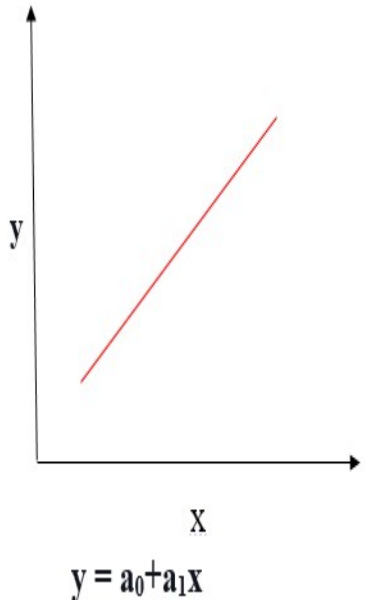
Types of Regression models

1. Linear Regression
2. Polynomial Regression
3. Logistics Regression

Positive Linear Relationship

If the dependent variable expands on the Y-axis and the independent variable progress on X-axis, then such a relationship is termed a Positive linear relationship.

Figure 1: - Positive Linear Relationship



Negative Linear Relationship

If the dependent variable decreases on the Y-axis and the independent variable increases on the X-axis, such a relationship is called a negative linear relationship.

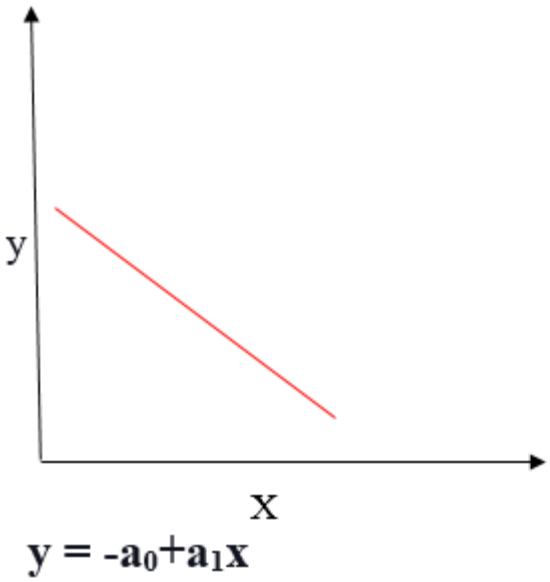


Figure 2: - Negative Linear Relationship

Linear Regression Algorithm: - Linear Regression is a machine learning algorithm based on supervised learning. It performs a regression task. Regression models a target prediction value based on independent variables. It is mostly used for finding out the relationship between variables and forecasting. Different regression models differ based on – the kind of relationship between dependent and independent variables they are considering, and the number of independent variables getting used.

Linear regression is a quiet and simple statistical regression method used for predictive analysis and shows the relationship between the continuous variables. Linear regression shows the linear relationship between the independent variable (X-axis) and the dependent variable (Y-axis), consequently called linear regression. If there is a single input variable (x), such linear regression is called simple linear regression. And if there is more than one input variable, such linear regression is called multiple linear regression. The linear regression model gives a sloped straight line describing the relationship within the variables.

Linear regression performs the task to predict a dependent variable value (y) based on a given independent variable (x). So, this regression technique finds out a linear relationship between x (input) and y(output). Hence, the name is Linear Regression.

$$y = \theta_1 + \theta_2.x$$

Figure 3: - Formula

While training the model we are given :

x**:** input training data (univariate – one input variable(parameter))

y**:** labels to data (supervised learning)

When training the model – it fits the best line to predict the value of y for a given value of x. The model gets the best regression fit line by finding the best θ_1 and θ_2 values.

θ_1**:** intercept

θ_2**:** coefficient of x

Once we find the best θ_1 and θ_2 values, we get the best fit line. So when we are finally using our model for prediction, it will predict the value of y for the input value of x.

How to update θ_1 and θ_2 values to get the best fit line?

Cost Function (J):

By achieving the best-fit regression line, the model aims to predict y value such that the error difference between predicted value and true value is minimum. So, it is very important to update the θ_1 and θ_2 values, to reach the best value that minimize the error between predicted y value (pred) and true y value (y).

$$minimize \frac{1}{n} \sum_{i=1}^{n} (pred_i - y_i)^2$$

$$J = \frac{1}{n} \sum_{i=1}^{n} (pred_i - y_i)^2$$

Cost function(J) of Linear Regression is the Root Mean Squared Error (RMSE) between predicted y value (pred) and true y value (y).

Mathematical explanation for Linear Regression working: -

Suppose we are given a dataset

Experience (X)	Salary (y) (in lakhs)
2	3
6	10
5	4
7	13

Table No.1: - Given Data

Given is a Work Vs Experience dataset of a company and the task is to predict the salary of an employee based on his / her work experience. This article aims to explain how in reality Linear regression mathematically works when we use a pre-defined function to perform prediction task. Let us explore how the stuff works when Linear Regression algorithm gets trained.

Iteration 1 – In the start, θ_0 and θ_1 values are randomly chosen. Let us suppose, $\theta_0 = 0$ and $\theta_1 = 0$.

- Predicted values after iteration 1 with Linear regression hypothesis

$$h_\theta = \begin{bmatrix} \theta_0 & \theta_1 \end{bmatrix} \begin{bmatrix} x_0 & x_0 & x_0 & x_0 \\ x_1 & x_2 & x_3 & x_4 \end{bmatrix}$$

$$= \begin{bmatrix} 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} 1 & 1 & 1 & 1 \\ 2 & 6 & 5 & 7 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 & 0 \end{bmatrix}$$

- **Cost Function – Error**

$$J(\theta) = \frac{1}{2m} \sum_{i=1}^{m} [h_\theta(x_i) - y_i]^2$$

$$= \frac{1}{2 \times 4} \left[(0-3)^2 + (0-10)^2 + (0-4)^2 + (0-3)^2 \right]$$

$$= \frac{1}{8} [9 + 100 + 16 + 9]$$

$$= 16.75$$

- **Gradient Descent – Updating θ_0 value**

Here, j = 0

$$\theta_j := \theta_j - \frac{\alpha}{m} \sum_{i=1}^{m} \left[\left(h_\theta(x_i) - y_i \right) x_i \right]$$

$$= 0 - \frac{0.001}{4} [(0-3) + (0-10) + (0-4) + (0-3)]$$

$$= \frac{0.001}{4} [-3 + (-10) + (-4) + (-3)]$$

$$= \frac{0.001}{4} [20]$$

$$= 0.005$$

- **Gradient Descent – Updating θ_1 value**

Here, j = 1

$$\theta_j := \theta_j - \frac{\alpha}{m}\sum_{i=1}^{m}\left[\left(h_\theta(x_i) - y_i\right)x_i\right]$$

$$= 0 - \frac{0.001}{4}\left[(0-3)2 + (0-10)6 + (0-4)5 + (0-3)7\right]$$

$$= \frac{0.001}{4}\left[-6 + (-60) + (-20) + (-21)\right]$$

$$= \frac{0.001}{4}\left[107\right]$$

$$= 0.02657$$

Iteration 2 – $\theta_0 = 0.005$ and $\theta_1 = 0.02657$

- **Predicted values after iteration 1 with Linear regression hypothesis.**

$$h_\theta = \begin{bmatrix} \theta_0 & \theta_1 \end{bmatrix}\begin{bmatrix} x_0 & x_0 & x_0 & x_0 \\ x_1 & x_2 & x_3 & x_4 \end{bmatrix}$$

$$= \begin{bmatrix} 0.005 & 0.026 \end{bmatrix}\cdot\begin{bmatrix} 1 & 1 & 1 & 1 \\ 2 & 6 & 5 & 7 \end{bmatrix} = \begin{bmatrix} 0.057 & 0.161 & 0.135 & 0.187 \end{bmatrix}$$

Now, similar to iteration no. 1 performed above we will again calculate Cost function and update θ_j values using Gradient Descent. We will keep on iterating until Cost function doesn't reduce further. At that point, model achieves best θ values. Using these θ values in the model hypothesis will give the best prediction results.

3.1 Features and Functionality

- Weather warnings are important forecasts because they are used to protect life and property.
- Forecasts based on temperature and precipitation are important to agriculture, and therefore to traders within commodity markets.
- Temperature forecasts are used by utility companies to estimate demand over coming days.
- We also introduce our social media handles for more information or any user wants to contact us.
- Find Button will show the temperature of current temperature also shows the previous temperature with the time to a user.
- Home button will redirect to the main page of our project, there user can enter the city name, and get the temperature of that city.
- On an everyday basis, many use weather forecasts to determine what to wear on a given day.
- Since outdoor activities are severely curtailed by heavy rain, snow and wind chill, forecasts can be used to plan activities around these events, and to plan ahead and survive them

4. Project Outcomes

- We listed the number of stakeholders and users who are the direct beneficiary of the weather prediction results.
- Our every listed feature focuses on satisfying the present need of weather forecast, as we march towards our goal we seem to suffer certain constraints which we seem to suffer certain constraints which we hope to overcome.
- We developed a project which is near to accurate weather prediction system based on historical data.
- Our system periodically applies Linear Regression algorithms or models on obtained data and store results to the database and shows the current weather.

5. Software Requirements

- Python
    - Python is an interpreted high-level general-purpose programming language. Python's design philosophy emphasizes code readability with its notable use of significant indentation. Its language constructs as well as its object-oriented approach aim to help programmers write clear, logical code for small and large- scale projects.
- Pycharm
    - Pycharm is an integrated development environment (IDE) used in computer programming, specifically for the Python programming language. It is developed by the Czech company JetBrains (formerly known as IntelliJ). It provides code analysis, a graphical debugger, an integrated unit tester, integration with version control systems , and supports web development with Django as well as data science with Anaconda.
- Anaconda
    - Anaconda is a distribution of the Python and R programming languages for scientific computing (data science, machine learning applications, large-scale data processing, predictive analytics, etc.), that aims to simplify package management and deployment. The distribution includes data-science packages suitable for Windows, Linux, and macOS.

- Db browser Sqlitedb

    - DB Browser for SQLite (DB4S) is a high quality, visual, open source tool to create, design, and edit database files compatible with SQLite. DB4S is for users and developers who want to create, search, and edit databases.

- Django

    - Django is a Python-based free and open-source web framework that follows the model–template–views architectural pattern. It is maintained by the Django Software Foundation, an independent organization established in the US as a 501 non-profit.

- Visual studio

    - Microsoft Visual Studio is an integrated development environment (IDE) from Microsoft. It is used to develop computer programs, as well as websites, web apps, web services and mobile apps. Visual Studio uses Microsoft software development platforms such as Windows API, Windows Forms, Windows Presentation Foundation, Windows Store and Microsoft Silverlight. It can produce both native code and managed code.

- Bootstrap

    - Bootstrap is a free and open-source CSS framework directed at responsive, mobile-first front-end web development. It contains HTML, CSS and JavaScript-based design templates for typography, forms, buttons, navigation, and other interface components

- Windows 7 or above
    - Windows 7 is the Microsoft Windows operating system (OS) released commercially in October 2009 as the successor to Windows Vista. Windows 7 is built on the Windows Vista kernel and was intended to be an update to the Vista OS. It uses the same Aero user interface (UI) that debuted in Windows Vista

6. Project Designing

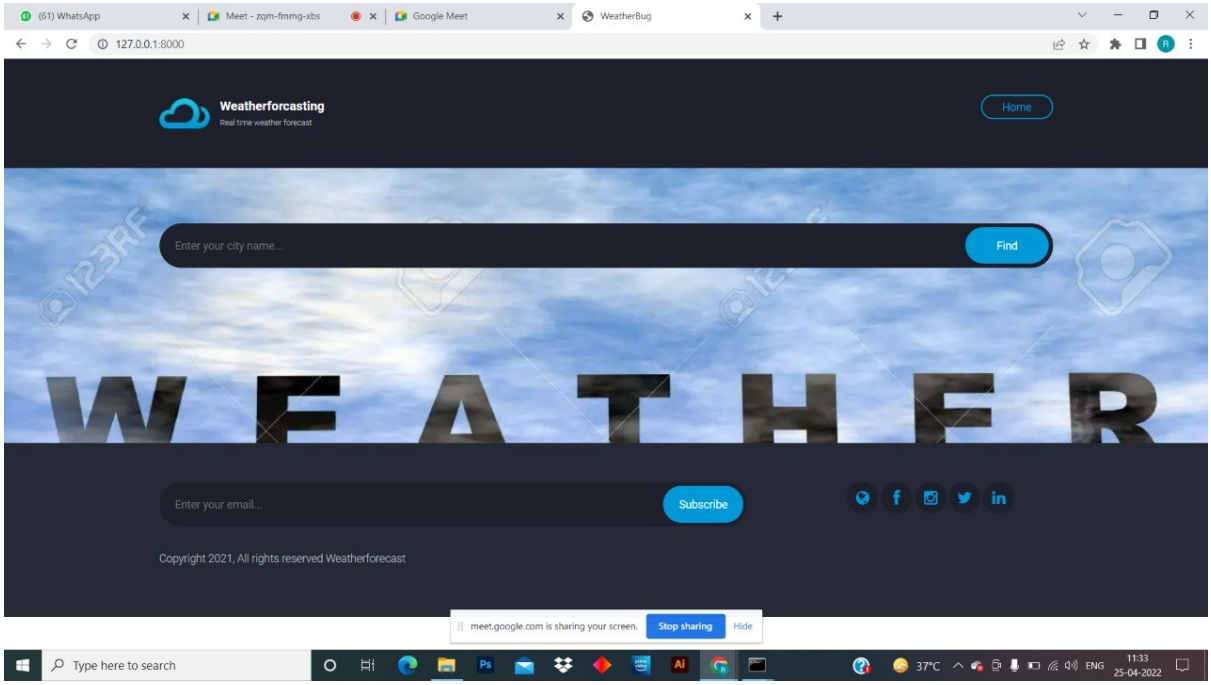


Figure 4: - Home Page

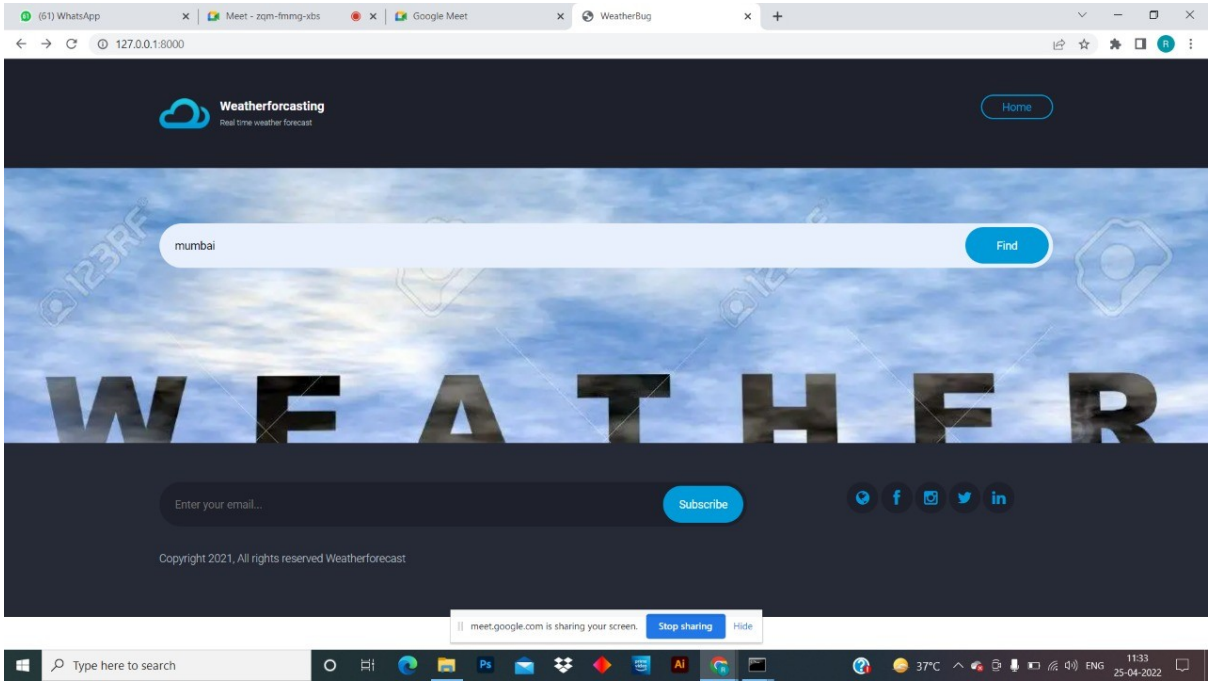


Figure 5: - Input Page

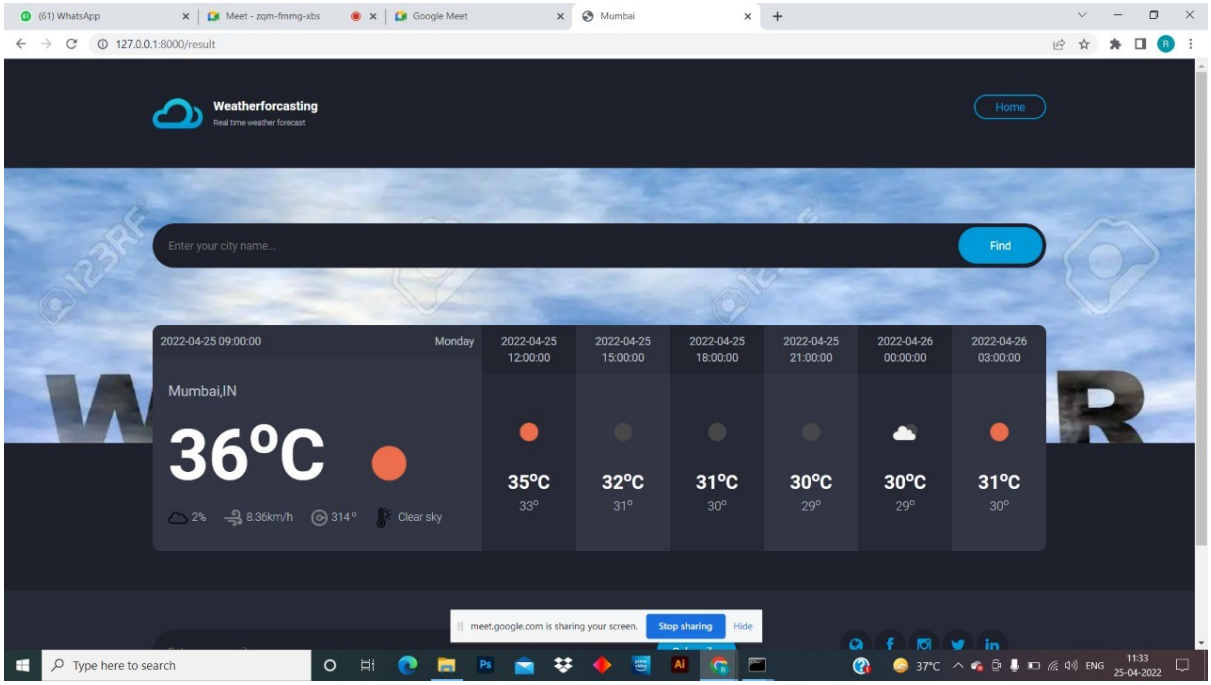


Figure 6: - Result

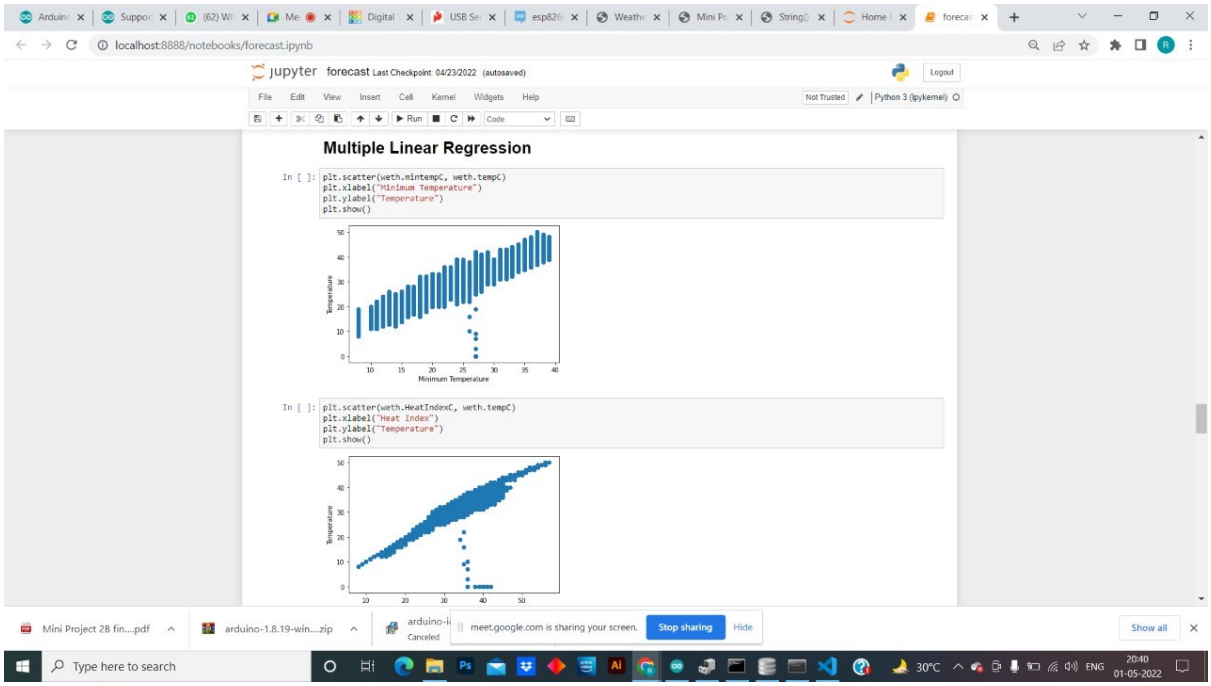
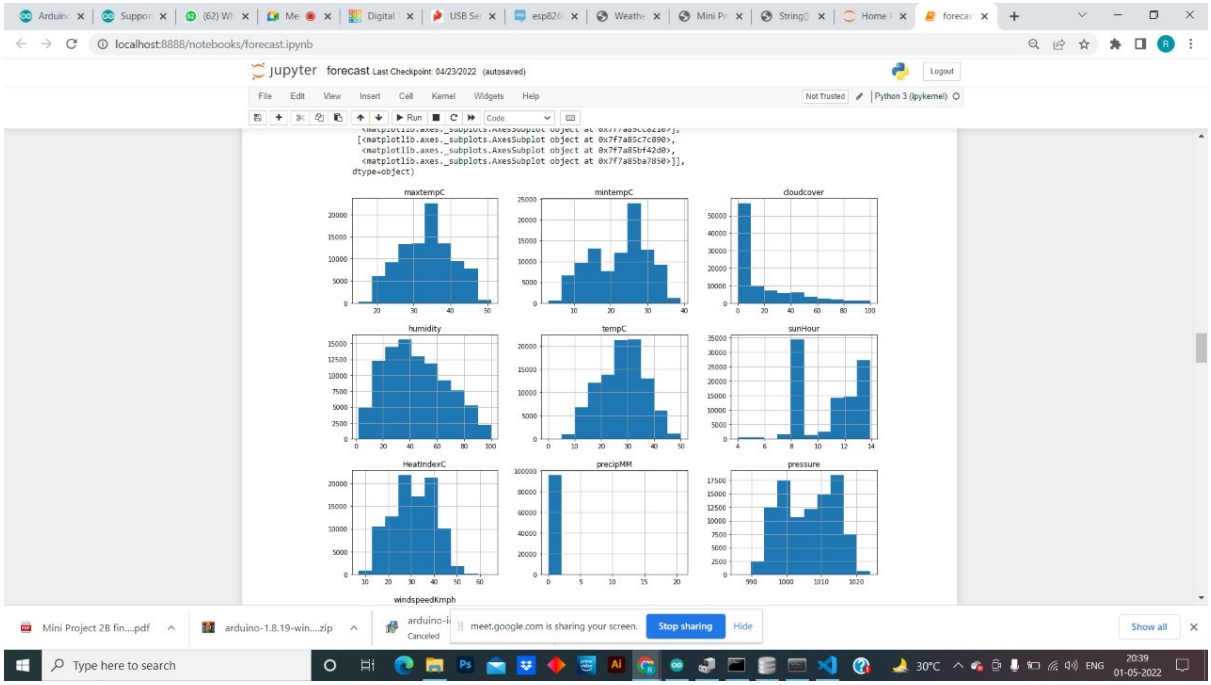


Figure 7


localhost:8888/notebooks/forecast.ipynb
jupyter forecast Last Checkpoint: 04/23/2022 (autosaved)
File Edit View Insert Cell Kernel Widgets Help
Not Trusted
Python 3 (ipykernel)
maxtempC
mintempC
cloudcover
humidity
tempC
sunHour
HeatIndexC
precipMM
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arduino-1.8.19-win....zip
meet.google.com is sharing your screen.
Stop sharing
Hide
Show all
Type here to search
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ENG
20:39
01-05-2022

Figure 8

7.Project Scheduling

Group Member	**Time**	**Work to be done**
Atharva Tambde	2nd week of February	Literature Review, reading papers, Designing UI and choosing algorithm.
Rajvi Shah	4th week of February	Creating the Front end with the text box area and the required buttons.
Anurag Singh	1st week of March	Learning and testing the functionalities and properties.
Rajvi Shah	3rd Week of March	Connecting frontend with the backend
Anurag Singh	4th week of March	Working on ML based work in database
Atharva Tambde	2nd week of April	Testing and fixing errors and making required changes. Making of Report and Presentation.

8. Conclusion

Weather forecasts are increasingly accurate and useful, and their benefits extend widely across the economy. While much has been accomplished in improving weather forecasts, there remains much room for improvement. The forecasting community is working closely with multiple stakeholders to ensure that forecasts and warnings meet their specific needs.

Simultaneously, they are developing new technologies and observational networks that can enhance forecaster skill and the value of their services to their users. Weather plays a major role in our daily life, and without the meteorologist and forecaster we would have difficulty planning our daily activities. As we can see, the weather is not a simple subject like we may have been thinking. The study of weather phenomenon requires the use of science, math, and different types of equipment and technology and data.

Even with all these equipment, data, and observation tools, the weather continues to be a topic to study because it is constantly changing. Meteorologist and forecasters predict the weather and its possible changes, but in reality, weather is still unpredictable. With this system predicting the report become easier. Less chances of malfunctioning exist. The plan has reached a stable stage but further progress is yet to be made. The system operates at a high level of efficiency and every user associated with the system understands its benefits. It was designed to solve as a requirement.

In the future this system can be used all over the world and will be designed in the area of the cross. It is easy to use, so that every user can easily handle it. This application is upgraded in such a way that it will not consume much RAM and phone memory. With the advancement of technology weather forecasting has developed to its level best, but there is yet to develop, as far as nature is so unpredictable. Nature calamity and weather disturbances causing divesting destructions surprisingly.

9.References

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