WEATHER FORECASTING USING MACHING LEARNING

A main Project Report submitted in the partial fulfillment of the

requirements for the award of the degree

BACHELOR OF TECHNOLOGY

IN

COMPUTER SCIENCE AND ENGINEERING

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

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CERTIFICATE

This is to certify that the main project entitled **“Weather Forecasting”** is a bonafide work done by Ch. Dharma (19471A0510), Sk. Allabakshu (19471A0556), P. Siva Sankar(19471A0549) partial fulfilment of the requirements for the award of the degree of **BACHELOR OF TECHNOLOGY** in the department of **COMPUTER SCIENCE AND ENGINEERING during 2022-2023.**

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ABSTRACT

Traditionally, climate assessment has been performed reliably by treating the environment as a liquid. The current wind condition is being observed. The future state of the environment is recorded by understanding thermodynamics and the numerical position of the liquid elements. Nevertheless, this traditional arrangement of differential conditions as observed by physical models is at times unstable under oscillating effects and uncertainties when estimating the underlying states of air. This indicates an insufficient understanding of environmental variations, so it limits climate forecasts to 10-day periods because climate projections are essentially unreliable. But machine learning is moderately hearty for most barometric destabilizing effects compared to traditional techniques. Another favourable position of machine learning is that it does not depend on the physical laws of environmental processes.

Purpose of this project is to predict the temperature using different algorithms like linear regression, random forest regression, and Decision tree regression. The output value should be numerically based on multiple extra factors like maximum temperature, minimum temperature, cloud cover, humidity, and sun hours in a day, precipitation, pressure and wind speed

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To emerge as a Centre of excellence in technical education with a blend of effective student centric teaching learning practices as well as research for the transformation of lives and community,

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M2: Build a passionate and a determined team of faculty with student centric teaching, imbibing experiential, innovative skills

M3: Imbibe lifelong learning skills, entrepreneurial skills and ethical values in students for addressing societal problems

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The department of Computer Science and Engineering is committed to

M1: Mould the students to become Software Professionals, Researchers and Entrepreneurs by providing advanced laboratories.

M2: Impart high quality professional training to get expertize in modern software tools and technologies to cater to the real time requirements of the Industry.

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PSO3: Promote novel applications that meet the needs of entrepreneur, environmental and social issues.

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The graduates of the programme are able to:

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PEO2: Use various software tools and technologies to solve problems related to academia, industry and society.

PEO3: Work with ethical and moral values in the multi-disciplinary teams and can communicate effectively among team members with continuous learning.

PEO4: Pursue higher studies and develop their career in software industry.

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2. Problem analysis: Identify, formulate, research literature, and analyzecomplex engineering problems reaching substantiated conclusions using firstprinciples of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complexengineering problems and design system components or processes that meetthe specified needs with appropriate consideration for the public health andsafety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-basedknowledge and research methods including design of experiments, analysis andinterpretation of data, and synthesis of the information to provide validconclusions.

5. **Modern tool usage:** Create, select, and apply appropriate techniques,resources, and modern engineering and IT tools including prediction andmodeling to complex engineering activities with an understanding of thelimitations.

6. The engineer and society: Apply reasoning informed by the contextualknowledge to assess societal, health, safety, legal and cultural issues and theconsequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of theprofessional engineering solutions in societal and environmental contexts,and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

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Project Course Outcomes (CO'S):

CO425.1: Analyse the System of Examinations and identify the problem.

CO425.2: Identify and classify the requirements.

CO425.3: Review the Related Literature

CO425.4: Design and Modularize the project

CO425.5: Construct, Integrate, Test and Implement the Project.

CO425.6: Prepare the project Documentation and present the Report using appropriate method.

Course Outcomes – Program Outcomes mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C425.1		√											√		
C425.2	√		√		√								√		
C425.3				√		√	√	√					√		
C425.4			√			√	√	√					√	√	
C425.5					√	√	√	√	√	√	√	√	√	√	√
C425.6									√	√	√		√	√	

Course Outcomes – Program Outcome correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C425.1	2	3											2		
C425.2			2		3								2		
C425.3				2		2	3	3					2		
C425.4			2			1	1	2					3	2	
C425.5					3	3	3	2	3	2	2	1	3	2	1
C425.6									3	2	1		2	3	

Note: The values in the above table represent the level of correlation between CO’s and PO’s:

1.Low level
2.Medium level
3.High level

Project mapping with various courses of Curriculum with Attained PO’s:

Name of the course from which principles are applied in this project	**Description of the device**	**Attained PO**
C3.2.4, C3.2.5	Gathering the requirements and defining the problem, plan to develop a **weather forecasting.**	PO1, PO3
CC4.2.5	Each and every requirement is critically analyzed, the process model is identified and divided into **five modules**	PO2, PO3
CC4.2.5	Logical design is done by using the unified modelling language which involves individual team work	PO3, PO5, PO9
CC4.2.5	Each and every module is tested, integrated, and evaluated in our project	PO1, PO5
CC4.2.5	Documentation is done by all our four members in the form of a group	PO10
CC4.2.5	Each and every phase of the work in group is presented periodically	PO10, PO11
CC4.2.5	Implementation is done and the project will be handled by the **weather forecasting and in future updates in our project can be done based changing weather details.**	PO4, PO7
CC4.2.8 CC4.2.	**The physical design includes hardware components like sensors, pickel module, software and Arduino.**	PO5, PO6

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1. INTRODUCTION

1.1 Introduction

Weather prediction is the task of predicting the atmosphere at a future time and a given area. This has been done through physical equations in the early days in which the atmosphere is considered fluid. The current state of the environment is inspected, and the future state is predicted by solving those equations numerically, but we cannot determine very accurate weather for more than 10 days and this can be improved with the help of science and technology.

Machine learning can be used to process immediate comparisons between historical weather forecasts and observations. With the use of machine learning, weather models can better account for prediction inaccuracies, such as overestimated rainfall, and produce more accurate predictions. Temperature prediction is of major importance in a large number of applications, including climate-related studies, energy, agricultural, medical, or etc.

There are numerous kinds of machine learning calculations, which are Linear Regression, Polynomial Regression, Random Forest Regression, Artificial Neural Network, and Recurrent Neural Network. These models are prepared dependent on the authentic information gave of any area. Contribution to these models is given, for example, if anticipating temperature, least temperature, mean air weight, greatest temperature, mean dampness, and order for 2 days. In light of this Minimum Temperature and Maximum Temperature of 7 days will be accomplished.

1.2 Existing System

The first method is the climatology method that is reviewing weather statistics gathered over multiple years and calculating the averages.

The second method is an analog method that is to find a day in the past with weather similar to the current forecast.

The third method is the persistence and trends method that has no skill to predict the weather because it relies on past trends.

The fourth method is numerical weather prediction the is making weather predictions based on multiple conditions in the atmosphere such as temperatures, wind speed, high-and low-pressure systems, rainfall, snowfall, and other conditions

Disadvantages:

1. Doesn’t generate accurate and efficient result.
2. Computation time is very high.
3. Lacking of accuracy may result in lack of efficient further treatment.

1.3 Proposed System

By using this project is to predict the temperature using different algorithms like linear regression, random forest regression, and Decision tree regression. The output value should be numerically based on multiple extra factors like maximum temperature, minimum temperature, cloud cover, humidity, and sun hours in a day, precipitation, pressure and wind speed.

Advantages:

1. Generates accurate and efficient results.
2. Computation time is greatly reduced.
3. Reduces manual work.
4. Efficient further treatment.

1.4. System Requirements

Hardware Requirements:

• System type	:	intel-i5
• Cache memory	:	4 MB
• RAM	:	256 GB
• Hard Disc	:	8 GB

1.4.2 Software Requirements:

• Operating System	:	Windows 11
• Frontend	:	Flask, HTML, CSS
• Backend	:	Machine Learning
• Database	:	Dataset
• Editor	:	Jupyter notebook, PyCharm
• Browser	:	Any Latest Browser like Chrome

2. LITERATURE SURVEY

2.1 Machine Learning

Machine learning is relatively robust to perturbations and does not need any other physical variables for prediction. Therefore, machine learning is a much better opportunity in the evolution of weather forecasting. Before the advancement of Technology, weather forecasting was a hard nut to crack. Weather forecasters relied upon satellites, data model's atmospheric conditions with less accuracy. Weather prediction and analysis have vastly increased in terms of accuracy and predictability with the use of the Internet of Things, for the last 40 years. With the advancement of Data Science, Artificial Intelligence, Scientists now do weather forecasting with high accuracy and predictability.

There are many research papers that have been published related to predicting the weather. A paper was published on 'The Weather Forecast Using Data Mining Research Based on Cloud Computing' This paper proposes a modern method to develop a service-oriented architecture for the weather information systems which forecast weather using these data mining techniques. This can be carried out by using Artificial Neural Network and Decision tree Algorithms and meteorological data collected in Specific time. Algorithm has presented the best results to generate classification rules for the mean weather variables. The results showed that these data mining techniques can be enough for weather forecasting. Another paper was published on 'Analysis on The Weather Forecasting and Techniques' where they decided that artificial neural network and concept of fuzzy logic provides a best solution and prediction comparatively. They decided to take temperature, humidity, pressure, wind and various other attributes into consideration.

Another research paper titled 'Issues with weather prediction' discussed the major problems with weather prediction. Even the simplest weather prediction is not perfect. The one-day forecast typically falls within two degrees of the actual temperature. Although this accuracy isn't bad, as predictions are made for further in time. For example, in a place like New England where temperatures have a great variance the temperature prediction are more inaccurate than a place like the tropics. Another research paper titled 'Current weather prediction' used numerical methods to stimulate what is most likely going to happen based on known state of the atmosphere. For example, if a forecaster is looking at three different numerical models, and two model predict that a storm is going to hit a certain place, the forecaster would most likely predict that the storm is going to hit the area. These numerical models work well and are being tweaked all the time, but they still have errors because some of the equations used by the models aren't precise.

2.2 Some machine learning methods

Machine learning algorithms are often categorized as supervised and unsupervised.

- **Supervised machine learning algorithms** can apply what has been learned in the past to new data using labelled examples to predict future events. Starting from the analysis of a known training dataset, the learning algorithm produces an inferred function to make predictions about the output values. The system is able to provide targets for any new input after sufficient training. The learning algorithm can also compare its output with the correct, intended output and find errors in order to modify the model accordingly.

- **unsupervised machine learning algorithms** are used when the information used to train is neither classified nor labelled. Unsupervised learning studies how systems can infer a function to describe a hidden structure from unlabelled data. The system doesn't figure out the right output, but it explores the data and can draw inferences from datasets to describe hidden structures from unlabelled data.

- **Reinforcement machine learning algorithms** is a learning method that interacts with its environment by producing actions and discovers errors or rewards. Trial and error 6 search and delayed reward are the most relevant characteristics of reinforcement learning. This method allows machines and software agents to automatically determine the ideal behaviour within a specific context in order to maximize its performance. Simple reward feedback is required for the agent to learn which action is best. This is known as the reinforcement signal.

USE OF ALGORITHMS:

There are different methods of foreseeing temperature utilizing Regression and a variety of Functional Regression, in which datasets are utilized to play out the counts and investigation. To Train, the calculations 80% size of information is utilized and 20% size of information is named as a Test set. For Example, if we need to anticipate the temperature of Kanpur, India utilizing these Machine Learning calculations, we will utilize 8 Years of information to prepare the calculations and 2 years of information as a Test dataset. The as opposed to Weather Forecasting utilizing Machine Learning Algorithms which depends essentially on re-enactment dependent on Physics and Differential Equations, Artificial Intelligence is additionally utilized for foreseeing temperature: which incorporates models, for example, Linear regression, Decision tree regression, Random Forest regression. To finish up, Machine Learning has enormously changed the worldview of Weather estimating with high precision and predictivity. What's more, in the following couple of years greater progression will be made utilizing these advances to precisely foresee the climate to avoid catastrophes like typhoons, Tornados, and Thunderstorms.

2.3 Applications of machine learning:

1. Virtual Personal Assistants
2. Predictions while Commuting
3. Videos Surveillance
4. Social Media Services
5. Email Spam and Malware Filtering
6. Online Customer Support
7. Search Engine Result Refining
8. Product Recommendations
9. Online Fraud Detection

3. SYSTEM ANALYSIS

3.1 System Architecture:

The system architecture for the given module is as follows:

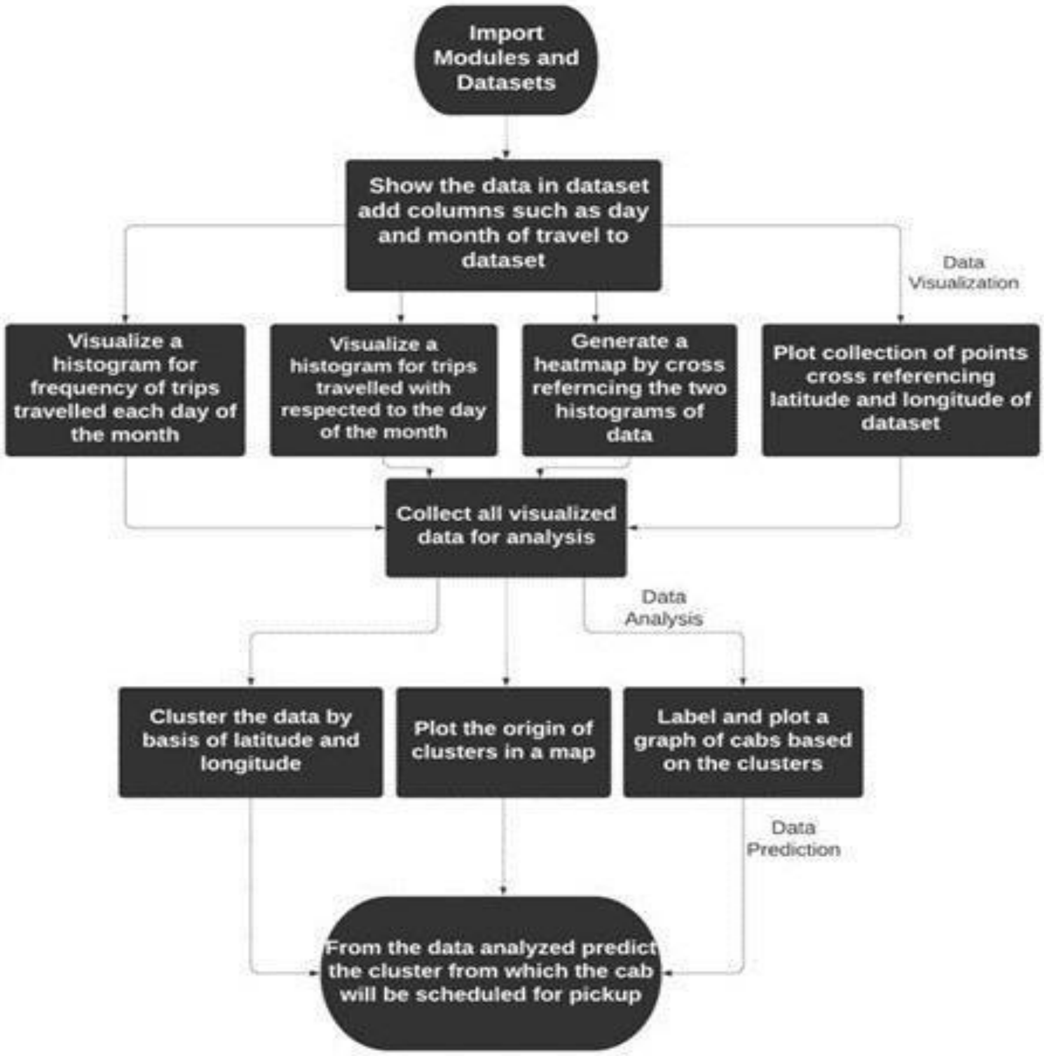

Fig:3.1. System Architecture

3.2 Implementation of machine learning using Python

Python is a popular programming language. It was created in 1991 by Guido van Rossum.

It is used for:

1. web development (server-side),
2. software development,
3. mathematics,
4. system scripting.

The most recent major version of Python is Python 3. However, Python 2, although notbeing updated with anything other than security updates, is still quite popular.

It is possible to write Python in an Integrated Development Environment, such as Thonny, PyCharm, Net beans or Eclipse, Anaconda which are particularly useful when managing larger collections of Python files.

Python was designed for its readability. Python uses new lines to complete a command, as opposed to other programming languages which often use semicolons or parentheses.

Python relies on indentation, using whitespace, to define scope; such as the scope of loops, functions and classes. Other programming languages often use curly-brackets for this purpose.

In the older days, people used to perform Machine Learning tasks manually by coding all the algorithms and mathematical and statistical formula. This made the process time consuming, tedious and inefficient. But in the modern days, it is become very much easy and efficient compared to the olden days by various python libraries, frameworks, and modules. Today, Python is one of the most popular programming languages for this task and it has replaced many languages in the industry, one of the reasons is its vast collection of libraries.

Python libraries that used in Machine Learning are:

1.Numpy

2.Scipy

3.Scikit-learn

4.Pandas

5.Matplotlib

NumPy is a very popular python library for large multi-dimensional array and matrix processing, with the help of a large collection of high-level mathematical functions. It is very useful for fundamental scientific computations in Machine Learning. It is particularly useful for linear algebra, Fourier transform, and random number capabilities. High-end libraries like TensorFlow uses NumPy internally for manipulation of Tensors.

SciPy is a very popular library among Machine Learning enthusiasts as it contains different modules for optimization, linear algebra, integration and statistics. There is a difference between the SciPy library and the SciPy stack. The SciPy is one of the core packages that make up the SciPy stack. SciPy is also very useful for image manipulation.

Scikit-learn is one of the most popular Machine Learning libraries for classical Machine Learning algorithms. It is built on top of two basic Python libraries, NumPy and SciPy. Scikit-learn supports most of the supervised and unsupervised learning algorithms. Scikit learn can also be used for data-mining and data-analysis, which makes it a great tool who is starting out with Machine Learning.

Pandas is a popular Python library for data analysis. It is not directly related to Machine Learning. As we know that the dataset must be prepared before training. In this case, Pandas comes handy as it was developed specifically for data extraction and preparation. It provides high-level data structures and wide variety tools for data analysis. It provides many inbuilt methods for groping, combining and filtering data.

Matplotlib is a very popular Python library for data visualization. Like Pandas, it is not directly related to Machine Learning. It particularly comes in handy when a programmer wants to visualize the patterns in the data. It is a 2D plotting library used for creating 2D graphs and plots. A module named pyplot makes it easy for programmers for plotting as it provides features to control line styles, font properties, formatting axes, etc. It provides various kinds of graphs and plots for data visualization, histogram, error charts, bar chats, etc.

3.3 Scope of the project

Scope of this project is to predict the temperature using different algorithms like linear regression, random forest regression, and Decision tree regression. The output value should be numerically based on multiple extra factors like maximum temperature, minimum temperature, cloud cover, humidity, and sun hours in a day, precipitation, pressure and wind speed.

3.4 Analysis

The dataset contains 7 attributes which are used to predict temperature using different machine learning Algorithms by using dataset

1. Maxtempc
2. Mintempc
3. Humidity
4. SunHours
5. Pressure
6. HeatindexC
7. WindspeedKmph

Maxtempc:

Maximum temperature is the highest temperature at a place in a given time period.

Mintempc:

The lowest temperature of a day is termed as minimum temperature.

Humidity:

Humidity is the concentration of water vapor present in the air. Water vapor, the gaseous state of water, is generally invisible to the human eye.

SunHours:

SunHours represent number of hours sun presented in the day.

Pressure:

The pressure of a given amount of gas is directly proportional to the temperature at a given volume.

HeatindexC:

The heat index, also known as the apparent temperature, is what the temperature feels like to the human body when relative humidity is combined with the air.

WindspeedKmph:

Wind speed is typically judged as the velocity of wind. Most measurements of air movement are taken of outside air, and there are several factors that can affect it.

DATASET:

	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
1	d	maxtemp	mintempC	totalSnow	sunHour	uvIndex	uvIndex.1	moon_illu	moonrise	moonset	sunrise	sunset	DewPoint	FeelsLikeC	HeatIndex	WindChill	WindGust	cloudcove	humidity	precipMM	pressure	tempC	visibility	winddirDe	windspeedKn
2	#	24	10	0	8.7	4	1	31	9:56 AM	9:45 PM	6:57 AM	5:28 PM	2	11	12	11	21	17	50	0	1015	11	10	320	10
3	#	24	10	0	8.7	4	1	31	9:56 AM	9:45 PM	6:57 AM	5:28 PM	3	12	13	12	22	11	52	0	1015	11	10	315	11
4	#	24	10	0	8.7	4	1	31	9:56 AM	9:45 PM	6:57 AM	5:28 PM	4	12	13	12	23	6	55	0	1015	11	10	310	11
5	#	24	10	0	8.7	4	1	31	9:56 AM	9:45 PM	6:57 AM	5:28 PM	5	12	13	12	23	0	57	0	1015	10	10	304	12
6	#	24	10	0	8.7	4	1	31	9:56 AM	9:45 PM	6:57 AM	5:28 PM	5	14	14	14	19	0	54	0	1016	11	10	302	11
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22	#	24	10	0	8.7	4	1	31	9:56 AM	9:45 PM	6:57 AM	5:28 PM	7	12	13	12	13	5	68	0	1016	11	10	302	6
23	#	24	10	0	8.7	4	1	31	9:56 AM	9:45 PM	6:57 AM	5:28 PM	7	12	12	12	13	5	73	0	1016	10	10	297	6
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26	#	23	6	0	8.7	4	1	38	10:26 AM	10:39 PM	6:57 AM	5:29 PM	5	14	14	14	20	0	53	0	1016	10	10	325	9
27	#	23	6	0	8.7	4	1	38	10:26 AM	10:39 PM	6:57 AM	5:29 PM	6	13	13	13	15	0	62	0	1016	9	10	324	7
28	#	23	6	0	8.7	4	1	38	10:26 AM	10:39 PM	6:57 AM	5:29 PM	7	13	13	13	10	0	71	0	1016	8	10	323	5
29	#	23	6	0	8.7	4	1	38	10:26 AM	10:39 PM	6:57 AM	5:29 PM	9	12	12	12	5	0	79	0	1016	6	10	321	3
30	#	23	6	0	8.7	4	1	38	10:26 AM	10:39 PM	6:57 AM	5:29 PM	8	15	15	15	4	0	67	0	1017	9	10	230	2
31	#	23	6	0	8.7	4	1	38	10:26 AM	10:39 PM	6:57 AM	5:29 PM	7	17	17	17	3	0	54	0	1018	12	10	138	2
32	#	23	6	0	8.7	4	4	38	10:26 AM	10:39 PM	6:57 AM	5:29 PM	6	20	20	20	1	0	41	0	1018	14	10	47	1
33	#	23	6	0	8.7	4	5	38	10:26 AM	10:39 PM	6:57 AM	5:29 PM	6	22	22	22	2	0	37	0	1018	17	10	78	1
34	#	23	6	0	8.7	4	5	38	10:26 AM	10:39 PM	6:57 AM	5:29 PM	7	24	24	24	2	0	33	0	1018	19	10	109	2
35	#	23	6	0	8.7	4	6	38	10:26 AM	10:39 PM	6:57 AM	5:29 PM	7	26	26	26	2	0	29	0	1018	21	10	141	2
36	#	23	6	0	8.7	4	6	38	10:26 AM	10:39 PM	6:57 AM	5:29 PM	6	27	26	27	3	1	28	0	1017	22	10	184	3

Fig:3.2. Dataset before pre-processing

3.5 Data Pre-processing:

Before feeding data to an algorithm, we have to apply transformations to our data which is referred as pre-processing. By performing pre-processing, the raw data which is not feasible for analysis is converted into clean data. In-order to achieve better results using a model in Machine Learning, data format has to be in a proper manner. The data should be in a particular format for different algorithms. For example, if we consider Random Forest algorithm it does not support null values. So that those null values have to be managed using raw data.

Data Pre-processing:

Pre-processing refers to the transformations applied to our data before feeding it to the algorithm. Data Pre-processing is a technique that is used to convert the raw data into a clean data set. In other words, whenever the data is gathered from different sources it is collected in raw format which is not feasible for the analysis.

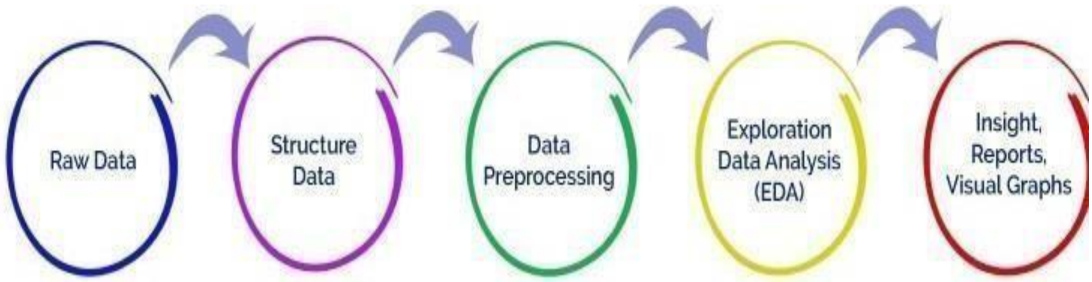

Fig.3.3 Data Pre-processing

Need of Data Preprocessing: For achieving better results from the applied model in Machine Learning projects the format of the data has to be in a proper manner. Some specified Machine Learning model needs information in a specified format. For example, Random Forest algorithm does not support null values, therefore to execute random forest algorithm null values have to be managed from the original raw data set. Another aspect is that data set should be formatted in such a way that more than one Machine Learning and Deep Learning algorithms are executed in one data set, and best out of them is chosen.

3.5.1 Missing values

The dataset doesn't contain any missing values.

3.5.2 Correlation coefficient method

We can find dependency between two attributes p and q using Correlation coefficient method using the formula:

rp, q= ∑(pi-p) (qi-q)/nσpσq = ∑ (pi qi)-np q/ nσpσq

n is the total number of patterns, pi and qi are respective values of p and q attributes in patterns i, p and q are respective mean values of p and q attributes, σp, σq are respective standard deviations values of p and q attributes. Generally, -1≤ rp, q ≤ +1. If rp, q < 0, then p and q are negatively correlated. If rp, q =0, then p and q are independent attributes and there is no correlation between them. If rp, q > 0, then p and q are positively correlated. We can drop the attributes that are having correlation coefficient value as 0 as it indicates that the variables are independent with respect to the prediction attribute.

	maxtempC	mintempC	totalSnow_cm	sunHour	uvIndex	uvIndex.1	moon_illumination	DewPointC	FeelsLikeC	HeatIndexC	WindChillC	V
maxtempC	1.000000	0.881495	NaN	0.785929	0.945121	0.241188	-0.027165	0.142769	0.817037	0.816059	0.873654	
mintempC	0.881495	1.000000	NaN	0.744942	0.913161	0.217436	-0.016930	0.469920	0.873623	0.872525	0.837802	
totalSnow_cm	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
sunHour	0.785929	0.744942	NaN	1.000000	0.754874	0.194483	-0.024647	0.242303	0.705933	0.704134	0.690558	
uvIndex	0.945121	0.913161	NaN	0.754874	1.000000	0.233236	-0.022649	0.225289	0.820046	0.819260	0.855363	
uvIndex.1	0.241188	0.217436	NaN	0.194483	0.233236	1.000000	-0.008186	0.004369	0.525719	0.525129	0.553221	
moon_illumination	-0.027165	-0.016930	NaN	-0.024647	-0.022649	-0.008186	1.000000	0.001654	-0.017124	-0.017854	-0.021441	
DewPointC	0.142769	0.469920	NaN	0.242303	0.225289	0.004369	0.001654	1.000000	0.436862	0.438039	0.217079	
FeelsLikeC	0.817037	0.873623	NaN	0.705933	0.820046	0.525719	-0.017124	0.436862	1.000000	0.998714	0.955773	
HeatIndexC	0.816059	0.872525	NaN	0.704134	0.819260	0.525129	-0.017854	0.438039	0.998714	1.000000	0.954110	
WindChillC	0.873654	0.837802	NaN	0.690558	0.855363	0.553221	-0.021441	0.217079	0.955773	0.954110	1.000000	
WindGustKmph	0.053844	0.067802	NaN	0.106486	0.037093	-0.066426	0.002350	-0.105261	-0.080134	-0.080591	-0.076263	
cloudcover	0.001678	0.302925	NaN	0.092732	0.052818	0.002691	0.035678	0.598397	0.228363	0.225983	0.060321	
humidity	-0.456879	-0.148172	NaN	-0.245537	-0.386380	-0.379412	0.018023	0.692128	-0.255690	-0.253712	-0.483661	
precipMM	-0.020540	0.060246	NaN	-0.006989	-0.018719	0.001941	0.018666	0.165214	0.053347	0.052894	0.001914	
pressure	-0.776002	-0.882492	NaN	-0.753522	-0.777343	-0.202573	-0.003849	-0.512610	-0.824692	-0.823792	-0.742848	
tempC	0.864700	0.870461	NaN	0.710758	0.860180	0.554912	-0.020616	0.267693	0.958251	0.955932	0.981623	
visibility	0.072393	-0.027760	NaN	0.041349	0.078323	0.055872	-0.001492	-0.206422	-0.015946	-0.015712	0.046158	
winddirDegree	-0.115031	-0.220238	NaN	-0.098618	-0.138462	0.093894	0.004984	-0.371298	-0.153756	-0.153221	-0.078560	
windspeedKmph	0.200734	0.244530	NaN	0.245425	0.198872	0.189414	0.001462	-0.011758	0.184589	0.183965	0.190051	

Fig 3.4 Correlation between features

3.6 Classification

It is a process of categorizing data into given classes. Its primary goal is toidentifythe class of our new data.

Machine learning algorithms for classification

Research on data mining has led to the formulation of several data mining algorithms. These algorithms can be directly used on a dataset for creating some models or to draw vital conclusions and inferences from that dataset. Some popular data mining algorithms are Random Forest, Decision tree, multiple linear Regression, Support vector machine etc.

1. Decision Tree:

Decision Tree Analysis is a general, predictive modelling tool that has applications spanning a number of different areas. In general, decision trees are constructed via an algorithmic approach that identifies ways to split a data set based on different conditions. It is one of the most widely used and practical methods for supervised learning. Decision Trees are a non-parametric supervised learning method used for both classification and regression tasks. The goal is to create a model that predicts the value of a target variable by learning simple decision rules inferred from the data features. The decision rules are generally in form of if-then-else statements. The deeper the tree, the more complex the rules and fitter the model.

2. Multiple linear Regression:

Multiple Linear Regression attempts to model the relationship between two or more features and a response by fitting a linear equation to observed data. The steps to perform multiple linear Regression are almost similar to that of simple linear Regression. The Difference Lies in the evaluation. We can use it to find out which factor has the highest impact on the predicted output and how different variables relate to each other.

3. Rondom Forest:

Random Forest is a popular machine learning algorithm that belongs to the supervised learning technique. It can be used for both Classification and Regression problems in ML. It is based on the concept of ensemble learning, which is a process of combining multiple classifiers to solve a complex problem and to improve the performance of the model.

The greater number of trees in the forest leads to higher accuracy and prevents the problem of overfit.

4. IMPLEMENTATION

Implementation of code:

#Impoting libraries

```
import numpy as np

import pandas as pd

import sklearn

from sklearn.model_selection import train_test_split

import matplotlib.pyplot as plt

from sklearn.linear_model import LinearRegression

from sklearn import preprocessing

from sklearn.tree import DecisionTreeRegressor

from sklearn.ensemble import RandomForestRegressor
```

#Reading dataset

```
weather_Data=pd.read_csv("D:\ppp\weatherdataset.csv",parse_dates=['date_time'],

index_col='date_time')

weather_Data.head(5)
```

Checking columns in our dataframe

```
weather_Data.columns

weather_Data=weather_Data.drop(weather_Data[["Unnamed: 0"]],axis=1 )

weather_Data.shape

weather_Data.describe()
```

 # Checking is there any null values in dataset

```
weather_Data.isnull().any()
```

Correlation of the columns

weather_Data.corr()

#Now lets separate the feature (i.e. temperature) to be predicted from the rest of the featured. weather_x stores the rest of the dataset while weather_y has temperature column.

weather_df=weather_Data.loc[:,['maxtempC','mintempC','cloudcover','humidity','tempC', 'sunHour','HeatIndexC', 'precipMM', 'pressure','windspeedKmph']]

weather_df.head()

#Shape of new dataframe

weather_df.shape

#Columns in new dataframe

weather_df.columns

#Ploting all the column values

weather_df.plot(subplots=True, figsize=(25,20))

#Ploting all the column values for 1 year

weather_df['2019':'2020'].resample('D').fillna(method='pad').plot(subplots=True, figsize=(25,20))

#describeing data in histogram

weather_df.hist(bins=10,figsize=(15,15))

weth=weather_df['2019':'2020']

weth.head()

#Remove the Predicted value

weather_y=weather_df.pop("tempC")

weather_x=weather_df

split the dataset into training and testing

```
train_X,test_X,train_y,test_y=train_test_split(weather_x,weather_y,test_size=0.2,random_state=4)
train_X.shape
train_y.shape
train_y.head()
```

#Scatter plots b/w mintempC and TempC

```
import matplotlib.pyplot as plt
plt.scatter(weth.mintempC, weth.tempC)
plt.xlabel("Minimum Temperature")
plt.ylabel("Temperature")
plt.show()
```

#Scatter plots b/w HeatindexC and TempC

```
plt.scatter(weth.HeatIndexC, weth.tempC)
plt.xlabel("Heat Index")
plt.ylabel("Temperature")
plt.show()
```

#Scatter plots b/w Pressure and TempC

```
plt.scatter(weth.pressure, weth.tempC)
plt.xlabel("Pressure")
plt.ylabel("Temperature")
plt.show()
```

#Multiple Linear Regression

```
from sklearn.linear_model import LinearRegression
from sklearn import preprocessing
model=LinearRegression()
model.fit(train_X,train_y)
prediction = model.predict(test_X)
```

#mean absolute b/w prediction and test_y

```
np.mean(np.absolute(prediction-test_y))
```

#Variance Score

```
print('Variance score: %.2f' % model.score(test_X, test_y))
```

#Diffrece between actual vale and prediction

```
for i in range(len(prediction)):
  prediction[i]=round(prediction[i],2)
pd.DataFrame({'Actual':test_y,'Prediction':prediction,'diff':(test_y-prediction)})
```

#Decision Tree Regression

```
from sklearn.tree import DecisionTreeRegressor
regressor=DecisionTreeRegressor(random_state=0)
regressor.fit(train_X,train_y)
prediction2=regressor.predict(test_X)
```

#mean absolute b/w prediction and test_y

```
np.mean(np.absolute(prediction2-test_y))
```

#Variance Score

```
print('Variance score: %.2f' % regressor.score(test_X, test_y))
```

#Diffrece between actual vale and prediction

```
for i in range(len(prediction2)):
  prediction2[i]=round(prediction2[i],2)
pd.DataFrame({'Actual':test_y,'Prediction':prediction2,'diff':(test_y-prediction2)})
```

#Calculating R2-score for Multiple Linear Regression

```
from sklearn.metrics import r2_score

print("Mean absolute error: %.2f" % np.mean(np.absolute(prediction - test_y)))

print("Residual sum of squares (MSE): %.2f" % np.mean((prediction - test_y) ** 2))

print("R2-score: %.2f" % r2_score(test_y,prediction ) )
```

#Calculating R2-score for Decision Tree Regression

```
print("Mean absolute error: %.2f" % np.mean(np.absolute(prediction2 - test_y)))

print("Residual sum of squares (MSE): %.2f" % np.mean((prediction2 - test_y) ** 2))

print("R2-score: %.2f" % r2_score(test_y,prediction2 ) )
```

#Calculating R2-score for Rondom Forest Regression

```
print("Mean absolute error: %.2f" % np.mean(np.absolute(prediction3 - test_y)))

print("Residual sum of squares (MSE): %.2f" % np.mean((prediction3 - test_y) ** 2))

print("R2-score: %.2f" % r2_score(test_y,prediction3 ) )
```

#Testing

```
d1=np.array([[26,15,0,46,8,17,0.0,1022,7]])
print(regressor.predict(d1))
print(model.predict(d1))
```

FrontEnd:

#HTML CODE

Weather.html

```
<!DOCTYPE html>

<html>

<style>

body {

  font-family: Arial, Helvetica, sans-serif;

  background-size: 1800px 1200px;

}

* {

  box-sizing: border-box;

}

/* Full-width input fields */

input[type=text], input[type=password] {

width: 100%;

  padding: 15px;

  margin: 5px 0 22px 0;

  display: inline-block;

  border: none;

  background: #f1f1f1;

}

input[type=text]:focus, input[type=password]:focus {

  background-color: #ddd;
```

```
  outline: none;
}
hr {
  border: 1px solid #f1f1f1;
  margin-bottom: 25px;
}
.registerbtn {
  background-color: #04AA6D;
  color: white;
  padding: 16px 20px;
  margin: 8px 0;
  border:  none;
  cursor: pointer;
  width:25%;
  opacity: 0.9;
  align:right;
 }
.registerbtn:hover {
  opacity: 1;
}
a {
  color: dodgerblue;
}
input{
```

```
width:1300px;

height:40px;

}

label{

color: blue;

font-size: 20px;

}

.signin {

  background-color: #f1f1f1;

  text-align: center;

}

body{

  background-image:    url('https://media.istockphoto.com/id/1011128754/photo/thermometer-in-the-sky-the-heat.jpg?b=1&s=170667a&w=0&k=20&c=kKYCK4MuCkm5dV0isRuV0K5qjLmHEo8m0L8fbnd82KQ=');

  }

</style>

<body>

  <div >

<form action="/predict" class='x' method="post">

  <div class="container">

    <h1 align="center" style="color:blue">Weather forcasting using Machine learning</h1>

   <p>Please fill in these below details.</p>

    <hr>
```

```
    <label><b>MaxtempC</b></label><br>
    <input type="number" placeholder="Enter Maximam temperature" name="MaxtempC" min="20" max="50" required ><br><br>
    <label ><b>MintempC</b></label><br>
    <input type="number" placeholder="Enter Minimum temperature" name="MintempC" min="-30" max="30" required ><br><br>
    <label ><b>Humidity</b></label><br>
    <input type="number" placeholder="Enter Humidity" name="humidity"  min="0" max="100"required ><br><br>
    <label><b>Pressure</b></label><br>
    <input type="number" placeholder="Enter Pressure" name="Pressure"  min="0" max="1500" required><br><br>
    <label><b>SunHour</b></label><br>
    <input type="number" placeholder="Enter SunHour" name="SunHour"  min="3" max="12" required ><br><br>
    <label><b>HeatIndexC</b></label><br>
    <input type="number" placeholder="Enter HeatIndexC" name="heat" min="5" max="25" required ><br><br>
    <label><b>windspeedKmph</b></label><br>
    <input type="number" placeholder="Enter windspeedKmph" name="wind" min="10" max="30"  required ><br><br>
    <hr>
    <input  type="submit" class="registerbtn" value="Submit">
  </div>
</form></div>
</body></html>
```

Result.html

```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <title> Prediction </title>
</head>
<body>
<h1>Temperature is {{Result[0]}}<h1>
</body>
</html>
```

Main.py:

```
from flask import Flask , render_template , request
import numpy as np
import pickle
app=Flask(_name_)
model1 = pickle.load(open('model1.pkl','rb'))
@app.route('/')
def home():
    return render_template('weather.html')
@app.route('/predict',methods=['GET','POST'])
def predict():
    MaxtempC = request.form.get('MaxtempC')
    MintempC = request.form.get('MintempC')
```

```
    humidity = request.form.get('humidity')
    Pressure = request.form.get('Pressure')
    SunHour = request.form.get('SunHour')
    heat = request.form.get('heat')
    wind = request.form.get('wind')
    Result =model1.predict([[MaxtempC, MintempC,humidity, SunHour, heat, Pressure,
wind]])
    return render_template('result.html',**locals())
if__name__== '_main_':
    app.run(debug=True)
```

Model.py

```
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.tree import DecisionTreeRegressor
import pickle
data = pd.read_csv("D:\ppp\weatherdataset.csv")
data1=data[['maxtempC','mintempC','humidity','tempC','sunHour','HeatIndexC',
'pressure','windspeedKmph']]
y=data1["tempC"]
x=data1.drop(['tempC'], axis=1)
train_X, test_X, train_y, test_y = train_test_split(x,y,test_size=0.2)
regressor = DecisionTreeRegressor()
regressor.fit(train_X, train_y)
pickle.dump(regressor, open("model1.pkl", 'wb'))
```

5. RESULT ANALYSIS

```
weather_Data=pd.read_csv("D:\ppp\weatherdataset.csv",parse_dates=['date_time'], index_col='date_time')
weather_Data.head(5)
```

	Unnamed: 0	maxtempC	mintempC	totalSnow_cm	sunHour	uvIndex	uvIndex.1	moon_illumination	moonrise	moonset	...	WindChillC	WindGustKm
date_time													
2009-01-01 00:00:00	0	24	10	0.0	8.7	4	1	31	09:56 AM	09:45 PM	...	11	
2009-01-01 01:00:00	1	24	10	0.0	8.7	4	1	31	09:56 AM	09:45 PM	...	12	
2009-01-01 02:00:00	2	24	10	0.0	8.7	4	1	31	09:56 AM	09:45 PM	...	12	
2009-01-01 03:00:00	3	24	10	0.0	8.7	4	1	31	09:56 AM	09:45 PM	...	12	
2009-01-01 04:00:00	4	24	10	0.0	8.7	4	1	31	09:56 AM	09:45 PM	...	14	

5 rows × 25 columns

Fig.5.1 Importing and reading the dataset

```
weather_Data.isnull().any()
```

```
maxtempC             False
mintempC             False
totalSnow_cm         False
sunHour              False
uvIndex              False
uvIndex.1            False
moon_illumination    False
moonrise             False
moonset              False
sunrise              False
sunset               False
DewPointC            False
FeelsLikeC           False
HeatIndexC           False
WindChillC           False
WindGustKmph         False
cloudcover           False
humidity             False
precipMM             False
pressure             False
tempC                False
visibility           False
winddirDegree        False
windspeedKmph        False
dtype: bool
```

Fig.5.2 Checking null values

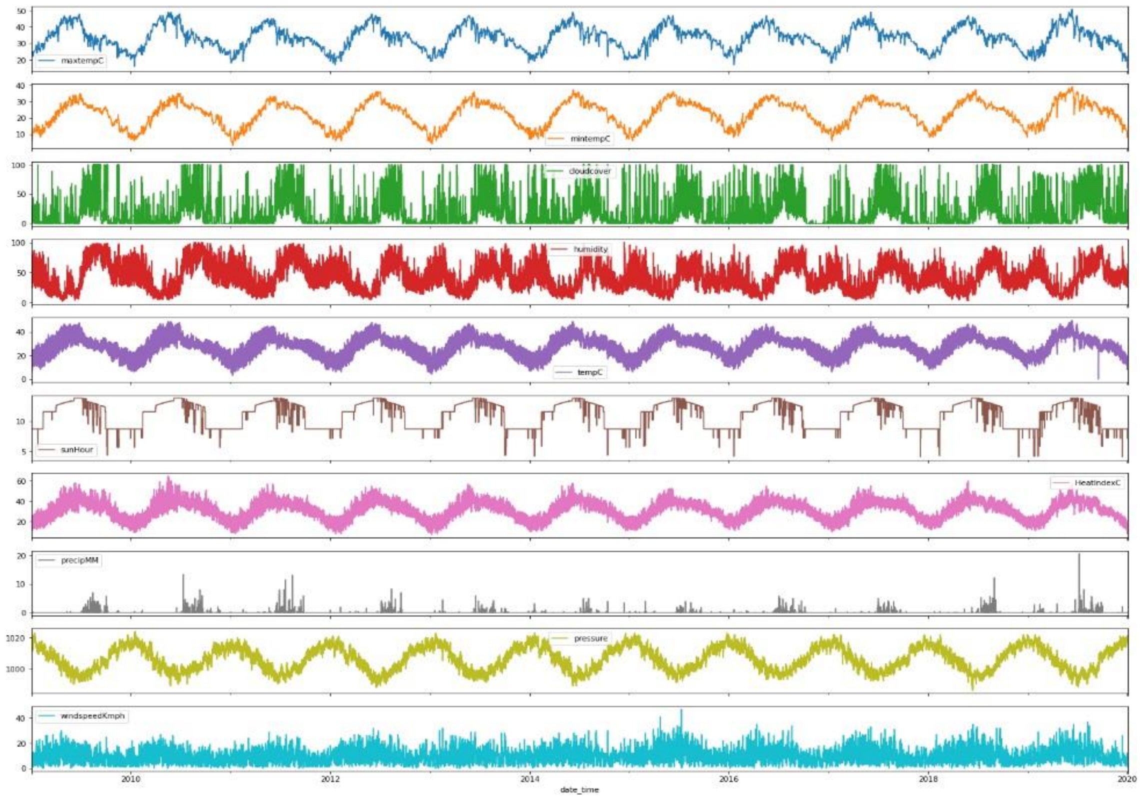

Fig.5.3 Plotting all the column values

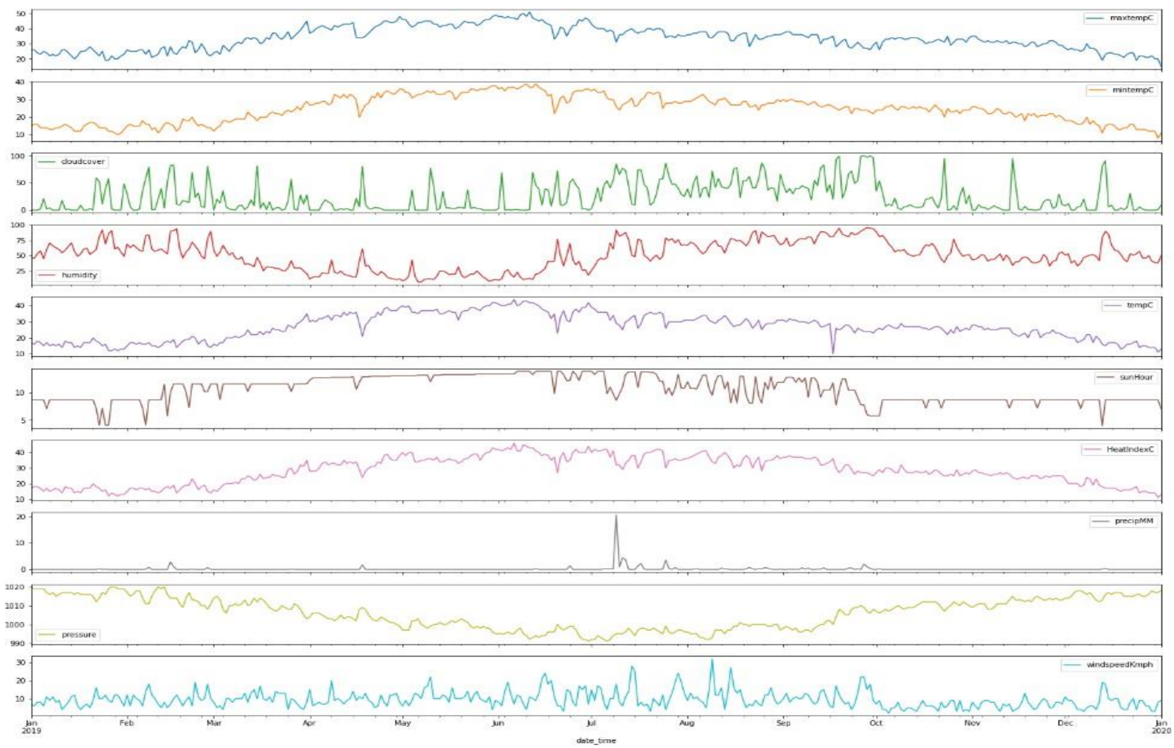

Fig.5.4 Ploting all the column values for 1 year

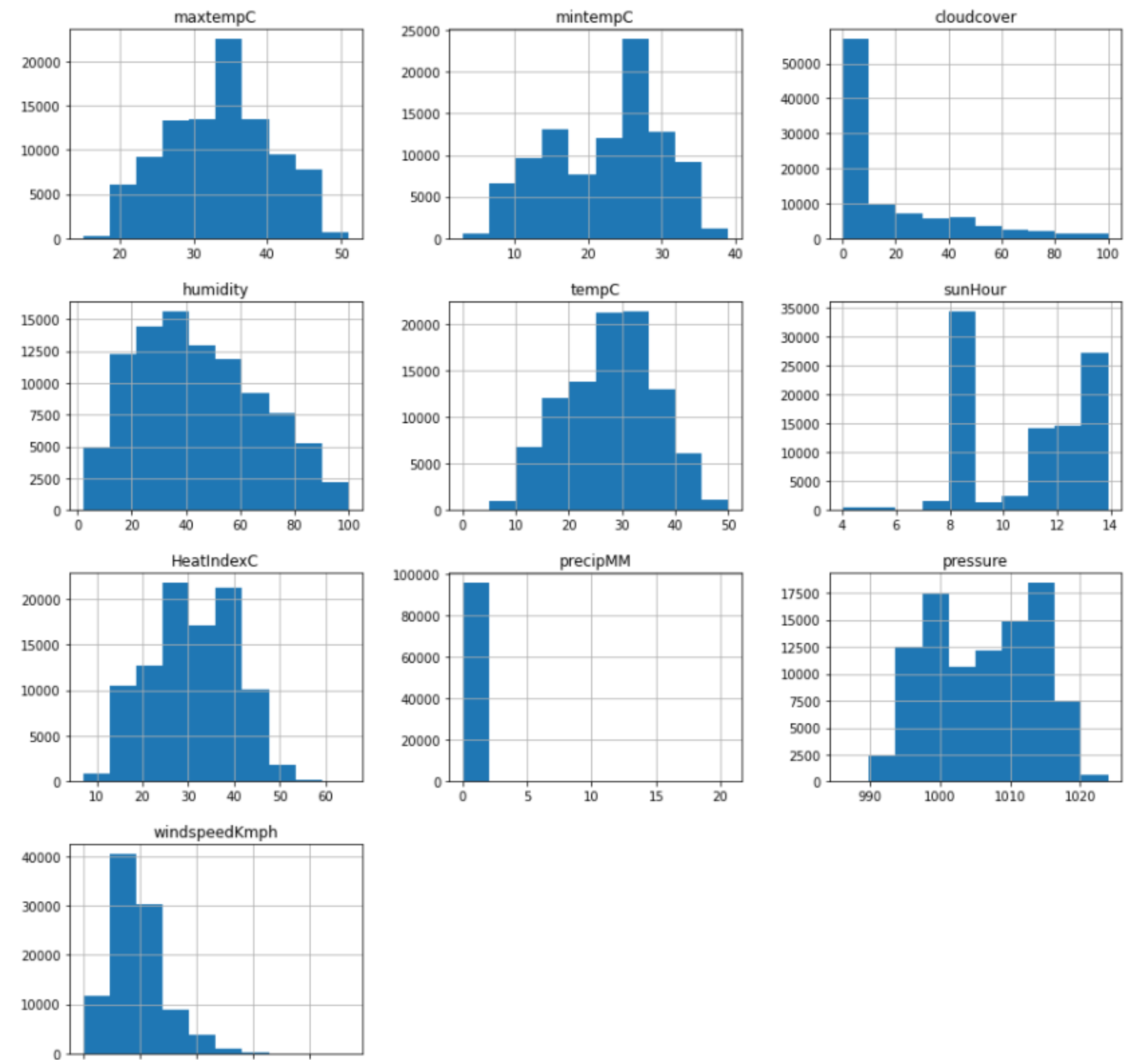

Fig.5.5 Histograms of features

Here above Histograms shows the relation of the features how many records are presented and what range there are present.

```
for i in range(len(prediction)):
  prediction[i]=round(prediction[i],2)
pd.DataFrame({'Actual':test_y,'Prediction':prediction,'diff':(test_y-prediction)})
```

date_time	Actual	Prediction	diff
2013-07-10 08:00:00	34	34.89	-0.89
2015-11-04 20:00:00	25	24.57	0.43
2015-09-21 09:00:00	34	35.08	-1.08
2017-02-16 11:00:00	28	25.22	2.78
2012-07-21 01:00:00	28	28.04	-0.04
...	...	...	...
2019-03-30 09:00:00	37	33.55	3.45
2015-11-12 12:00:00	32	30.36	1.64
2019-12-31 05:00:00	8	9.13	-1.13
2019-08-02 17:00:00	35	35.92	-0.92
2019-10-22 08:00:00	26	25.77	0.23

19287 rows × 3 columns

Fig.5.6 Multiple linear Regression diff between actual vale and predicton

```
for i in range(len(prediction2)):
  prediction2[i]=round(prediction2[i],2)
pd.DataFrame({'Actual':test_y,'Prediction':prediction2,'diff':(test_y-prediction2)})
```

date_time	Actual	Prediction	diff
2013-07-10 08:00:00	34	34.0	0.0
2015-11-04 20:00:00	25	24.0	1.0
2015-09-21 09:00:00	34	34.0	0.0
2017-02-16 11:00:00	28	27.0	1.0
2012-07-21 01:00:00	28	28.0	0.0
...	...	...	...
2019-03-30 09:00:00	37	32.0	5.0
2015-11-12 12:00:00	32	32.0	0.0
2019-12-31 05:00:00	8	9.0	-1.0
2019-08-02 17:00:00	35	35.0	0.0
2019-10-22 08:00:00	26	26.0	0.0

19287 rows × 3 columns

Fig.5.7 Decision Tree of difference actual and prediction

6. OUTPUT SCREENS

In this interface page we give the values of different features values like maxtempc, mintempc, humidity, pressure, sun hours, heatindenx, windspeedkmph after entering all these values by clicking submit button we navigate to another page. In that page we can observe the our output temperature vaule.

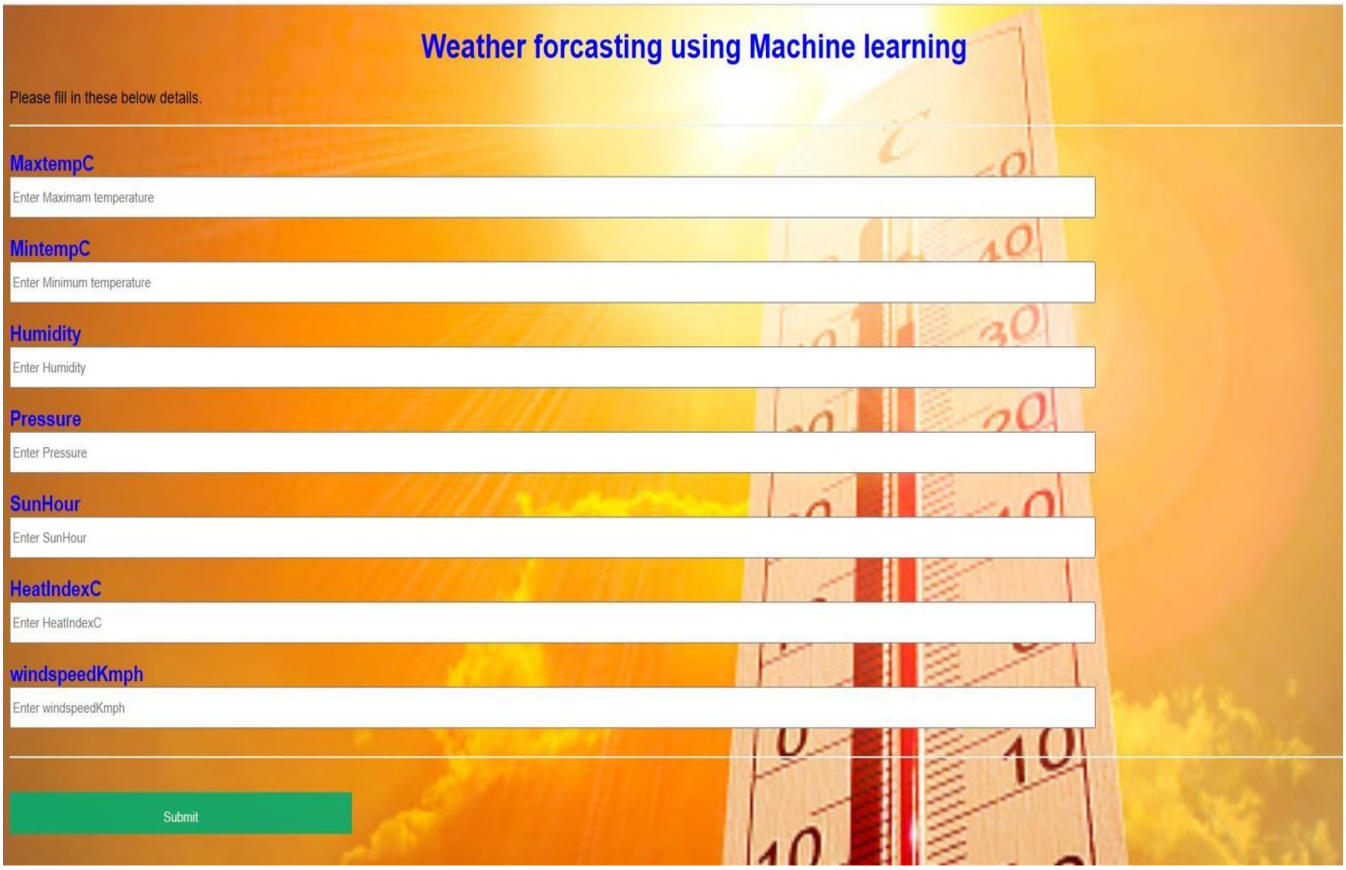

Fig.6.1 Home Screen

Fig.6.2 Output Screen

7. CONCLUSION & FUTURE SCOPE

All the machine learning models: linear regression, various linear regression, decision tree regression, random forest regression were beaten by expert climate determining apparatuses, even though the error in their execution reduced significantly for later days, demonstrating that over longer timeframes, our models may beat genius professional ones.

Linear regression demonstrated to be a low predisposition, high fluctuation model though polynomial regression demonstrated to be a high predisposition, low difference model. Linear regression is naturally a high difference model as it is unsteady to outliers, so one approach to improve the linear regression model is by gathering more information. Practical regression, however, was high predisposition, demonstrating that the decision of the model was poor and that its predictions can't be improved by the further accumulation of information. This predisposition could be expected to the structure decision to estimate temperature dependent on the climate of the previous two days, which might be too short to even think about capturing slants in a climate that practical regression requires. On the off chance that the figure was rather founded on the climate of the past four or five days, the predisposition of the practical regression model could probably be decreased. In any case, this would require significantly more calculation time alongside retraining of the weight vector w, so this will be conceded to future work.

Talking about Random Forest Regression, it proves to be the most accurate regression model. Likely so, it is the most popular regression model used, since it is highly accurate and versatile. Below is a snapshot of the implementation of Random Forest in the project.

Weather Forecasting has a major test of foreseeing the precise outcomes which are utilized in numerous ongoing frameworks like power offices, air terminals, the travel industry focuses, and so forth. The trouble of this determining is the mind-boggling nature of parameters. Every parameter has an alternate arrangement of scopes of qualities

To develop more accuracy using machine learning algorithms and advanced techniques. The work can be extended and improved for the automation of weather forecasting by using peep

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WEATHER FORECASTING USING MACHINE LEARNING

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Abstract: - Weather forecasting is the process of predicting the upcoming state of the atmosphere by analysing current weather conditions and using mathematical models to simulate future weather patterns. Weather forecasting using machine learning involves training models that can automatically learn and analyze large amounts of weather data to predict future weather patterns. This approach involves using a variety of machine learning models, including neural networks, decision tree, and support vector machines, to analyze historical weather data and generate forecasts. The process involves collecting vast amounts of data from various sources, including weather stations, satellites, and other sensors, to create a comprehensive data set for analysis. Machine learning models can improve the accuracy of weather forecasting by detecting patterns in data that may not be apparent to humans. The use of machine learning in weather forecasting is still in its initial stages, but it has the possible to improve weather forecasts significantly in the future.

Keywords:-Weather Forecasting, Prediction, Weather Data, Data Analysis, Accuracy, Decision tree, Multiple Linear Regression, flask.

I. INTRODUCTION

Weather forecasting using machine learning is an emerging field that involves the use of advanced algorithms to analyze past weather data and make predictions about future weather patterns. Machine learning techniques, such as artificial neural networks, decision trees. can be used to detect complex patterns in large data sets, allowing for more accurate and reliable weather forecasts.

Primary benefits of using Machine learning in weather forecasting is that it can benefit improve forecast accuracy, particularly for short-term predictions. Machine learning models can analyze large volumes of data from various sources, including weather stations, satellites, and other sensors, to identify patterns that may not be apparent to humans. This enables them to generate more accurate forecasts and alerts for severe weather events.

Another benefit of using machine learning in weather forecasting is that it can help automate the process of generating weather forecasts, reducing the time and resources required to produce them. This can help make weather forecasts more accessible and affordable, particularly in developing countries where resources may be limited.

Despite these benefits, weather forecasting using machine learning is still in its initial stages, and there are some tasks that need to be overcome. For example, ensuring the quality and accuracy data inputs is essential, and machine learning models need to be continually updated and refined to keep up with changes in the atmosphere.

Overall, weather forecasting using machine learning holds excessive promise for improving weather prediction accuracy and making weather forecasts more accessible to people worldwide. Applications of Machine learning in agriculture is the development of crop recommendation systems.

Weather forecasting is the procedure of forecasting the future atmosphere by analyzing current weather conditions and using mathematical models to simulate future weather patterns.

Weather forecasting is a crucial aspect of modern life, as it helps individuals, businesses, and governments plan and prepare for weather-related events. Weather forecasting involves forecasting the future state of the atmosphere, including changes in temperature, humidity, wind speed, precipitation, and other atmospheric conditions.

Weather forecasts are used to warn people of impending storms, scorchers, or other severe weather events, allowing them to take necessary precautions to protect themselves and their property. They are also used by farmers to plan their planting and harvesting, and by airlines to make decisions about flight routes and schedules.

Weather forecasting has improved significantly over the years with advances in technology, particularly the use of satellites, radar systems, and computer models. In recent years the use of Machine learning and artificial intelligence techniques has also been applied to weather forecasting, leading to further improvements in accuracy and reliability.

II. LITERATURE SURVEY

A literature survey aims to identify the latest trends, advancements, and research gaps in a particular field of study. It helps researchers to get an overview of the current state of research in the area and to identify the most important and relevant research papers and studies. Here is a brief literature review on weather forecasting:

1 "A Review of Machine Learning Approaches in Weather Forecasting" by O. S. Ayodeji and A. O. Awodele. This article provides a inclusive review of Machine learning techniques used in weather forecasting, including artificial neural networks, decision trees.

2 "Advances in Weather Forecasting: A Review of Machine Learning Techniques" by T. Balasubramanian et al. This paper explores the latest advances in weather forecasting using machine learning techniques, including deep learning models and ensemble learning algorithms.

3 "A Review of Statistical Weather Forecasting Methods" by S. H. Lee et al. This article provides an overview of statistical forecasting methods used in weather prediction, including autoregressive combined touching average (ARIMA) models, linear regression, multiple linear regression.

4 "Advances in Numerical Weather Prediction" by E. Kalyan. This paper discusses the history and development of numerical weather prediction models, which use mathematical equations to simulate weather patterns and make predictions about future conditions.

5 "Challenges and Opportunities in Advancing Mesoscale Weather Forecasting" by M. Xue et al. This article explores the challenges and opportunities for improving mesoscale weather forecasting, which focuses on predicting weather patterns at a smaller scale than global weather models.

Overall, these studies demonstrate the significant advancements made in weather forecasting and the potential for further improvements using Machine learning techniques and other approaches.

III. EXISTING SYSTEM

The existing system of weather forecasting typically involves a combination of observational data collection, computer modelling, and meteorological analysis. Here are the main steps involved:

Data collection: Weather data is collected from various sources, such as satellites, weather stations, radars, and buoys. These sources provide information on temperature, humidity, pressure, wind speed, and other meteorological parameters.

Data analysis: The collected data is processed and analysed using mathematical models and statistical methods to create a comprehensive picture of the current weather conditions.

Numerical weather prediction: Numerical weather models are used to simulate the behavior of the atmosphere based on the collected data. These models use complex mathematical equations to calculate the future weather conditions.

Weather forecasting: Based on the data analysis and numerical modeling, meteorologists make weather forecasts for different timeframes, from a few hours to several days or even weeks in advance.

Dissemination of information: The weather forecasts are communicated to the public through various media channels, such as TV, radio, newspapers, and internet websites, as well as through weather apps and social media.

The existing system of weather forecasting is constantly evolving, with new technologies and methods being developed to improve the accuracy and timeliness of weather predictions.

IV. METHODOLOGY

We have used different Machine Learning algorithms to predict the temperature by using mintemp, maxtemp, humidity, sun hours, precipitation, cloud cover features Different evaluation metrics like error rate, accuracy are used to compare the four models. The methodology for weather forecasting using machine learning typically involves the following steps:

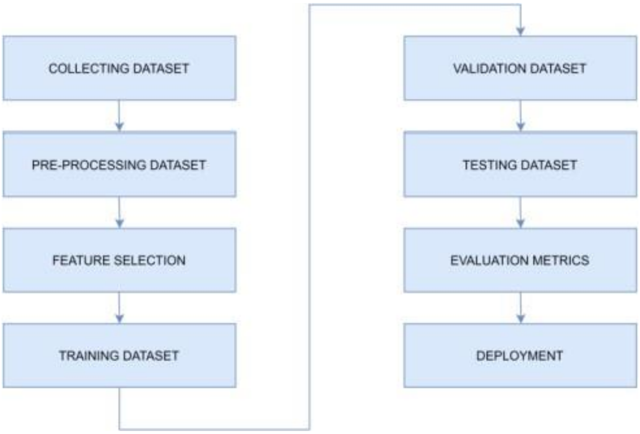
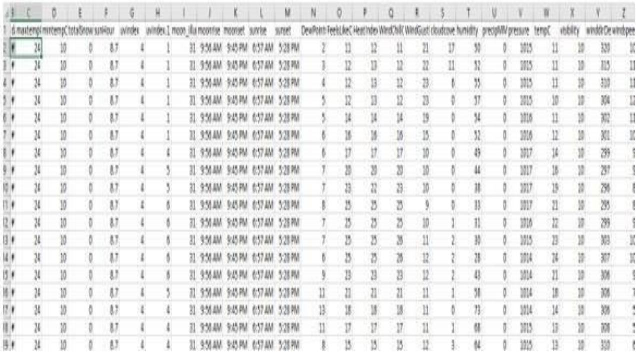


Fig. 1: Proposed system workflow

- Data Collection:

The first step is to gather relevant weather data from various sources, such as weather stations, satellites, and sensors. This data may include historical weather data, current weather conditions, and weather forecasts. Here we collect data from Kaggle Historic weather data of Indian cites from that we choose one of the city weather details. here almost 6K records are present and 19 features from that we only choose 9 features to predict

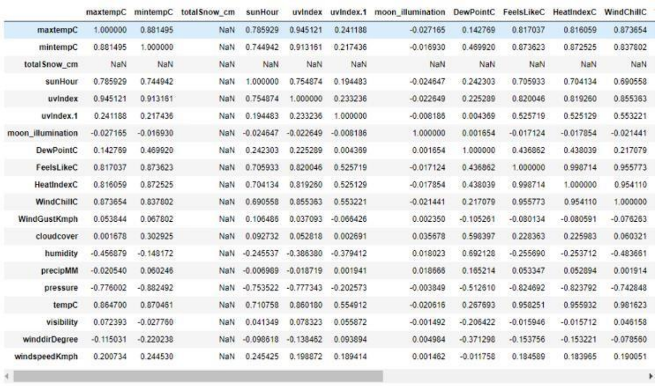


the temperature.

Fig. 2: Dataset diagram

- Data Cleaning and Feature Extraction

Data Preprocessing: Once the data is collected, it needs to be preprocessed to remove any noise or outliers and to normalize the data. This step is essential for ensuring the accuracy of the machine learning model. Fig 3 shows the correlation between the features of the dataset.



	maxtempC	mintempC	totalSnow_cm	sunHour	uvIndex	uvIndex.1	moon_illumination	DewPointC	FeelsLikeC	HeatIndexC	WindChillC
maxtempC	1.000000	0.881495	NaN	0.785929	0.945121	0.241188	-0.027165	0.142769	0.817037	0.816059	0.873654
mintempC	0.881495	1.000000	NaN	0.744942	0.913161	0.217436	-0.016930	0.469920	0.873623	0.872525	0.837802
totalSnow_cm	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
sunHour	0.785929	0.744942	NaN	1.000000	0.754874	0.194483	-0.024647	0.242303	0.705933	0.704134	0.690558
uvIndex	0.945121	0.913161	NaN	0.754874	1.000000	0.233236	-0.022649	0.225289	0.820046	0.819260	0.855363
uvIndex.1	0.241188	0.217436	NaN	0.194483	0.233236	1.000000	-0.008186	0.004369	0.525719	0.525129	0.553221
moon_illumination	-0.027165	-0.016930	NaN	-0.024647	-0.022649	-0.008186	1.000000	0.001654	-0.017124	-0.017854	-0.021441
DewPointC	0.142769	0.469920	NaN	0.242303	0.225289	0.004369	0.001654	1.000000	0.436862	0.438039	0.217079
FeelsLikeC	0.817037	0.873623	NaN	0.705933	0.820046	0.525719	-0.017124	0.436862	1.000000	0.998714	0.955773
HeatIndexC	0.816059	0.872525	NaN	0.704134	0.819260	0.525129	-0.017854	0.438039	0.998714	1.000000	0.954110
WindChillC	0.873654	0.837802	NaN	0.690558	0.855363	0.553221	-0.021441	0.217079	0.955773	0.954110	1.000000
WindGustKmph	0.053844	0.067802	NaN	0.106486	0.037093	-0.066426	0.002350	-0.105261	-0.080134	-0.080591	-0.076263
cloudcover	0.001678	0.302925	NaN	0.092732	0.052818	0.002691	0.035678	0.598397	0.228363	0.225983	0.060321
humidity	-0.456879	-0.148172	NaN	-0.245537	-0.386380	-0.379412	0.018023	0.692128	-0.255690	-0.253712	-0.483661
precipMM	-0.020540	0.060246	NaN	-0.006989	-0.018719	0.001941	0.018666	0.165214	0.053347	0.052894	0.001914
pressure	-0.776002	-0.882492	NaN	-0.753522	-0.777343	-0.202573	-0.003849	-0.512610	-0.824692	-0.823792	-0.742848
tempC	0.864700	0.870461	NaN	0.710758	0.860180	0.554912	-0.020616	0.267693	0.958251	0.955932	0.981623
visibility	0.072393	-0.027760	NaN	0.041349	0.078323	0.055872	-0.001492	-0.206422	-0.015946	-0.015712	0.046158
winddirDegree	-0.115031	-0.220238	NaN	-0.098618	-0.138462	0.093894	0.004984	-0.371298	-0.153756	-0.153221	-0.078560
windspeedKmph	0.200734	0.244530	NaN	0.245425	0.198872	0.189414	0.001462	-0.011758	0.184589	0.183965	0.190051

Fig.3 Correlation

- Feature Extraction:

In this step, the relevant features from the data are extracted, such as temperature, humidity, wind speed, and pressure. These features will be taken as participations for the Machine learning algorithm.

- Model Training:

The next stage is to train the machine learning model using the preprocessed data. Different algorithms can be used, such as artificial neural networks, decision trees. The model is trained to identify patterns in the data and make predictions about future weather conditions.

- Model Evaluation:

Once the model is trained, it needs to be evaluated to assess its accuracy and performance. This is typically done using a separate test dataset that was not used during training.

- Model Deployment:

Lastly, the model is deployed in a making situation, where it can be used to generate weather forecasts in real-time. The model can be continually updated and refined based on new data and feedback.

Overall, the methodology for weather forecasting using machine learning involves a combination of data collection, feature extraction, preprocessing, model training, evaluation, and deployment. These steps are essential for developing accurate and reliable weather prediction systems.

1. Random Forest: Random forest is a popular machine learning algorithm that is widely used for classification and regression tasks. It is an ensemble learning method that combines multiple decision trees to produce more accurate and robust predictions.

Random forest is a versatile and effective algorithm that can be applied to a wide range of machine learning tasks, such as image classification, text classification, and regression analysis. It is particularly useful when dealing with high-dimensional and noisy data, and when the relationships between the input variables and the output variable are complex and nonlinear.

2. Decision Tree: Decision trees are highly interpretable, easy to understand, and can handle both categorical and numerical data. They are also computationally effective and can holder high-dimensional data. But decision trees can be disposed to overfitting, particularly if the tree is too deep or if the dataset is noisy. Techniques such as pruning, regularization, and ensemble methods such as random forests can help to overcome these limitations.

3. Linear Regression: Linear regression can also be used to model the relationship between multiple predictor variables and a target variable, such as temperature or precipitation. In this case, we would collect a dataset of weather observations that includes information on the predictor variables (such as location, time, atmospheric pressure, humidity, wind speed, and precipitation) and the target variable (such as temperature or precipitation). We would then use linear regression to learn the coefficients of the linear equation that best fits the data and predicts the target variable based on the predictor variables.

Linear regression has limitations in weather forecasting, as it assumes a linear relationship between the predictor variables and the target variable, which may not always hold in complex weather systems. However, it can still be a useful tool for simple weather forecasting tasks, especially when combined with other machine learning algorithms and meteorological models

V. RESULT AND ANALYSIS

After created all the models by using the training data , we test the models by using the test data and calculates the accuracies of the models. The following table shows the accuracies of different models:

Algorithms	Accuracy
Linear Regression	94.15
Decision tree	96.52
Random forest	93.21

Fig.4 Accuracy Table

From the above table we selected Decision tree model as our final model because it got more accuracy compared to the other models.

VI. DEPLOYMENT

The final model is deployed into an application by using Flask module of python by creating the user interface. The application simply takes the input and provides output.

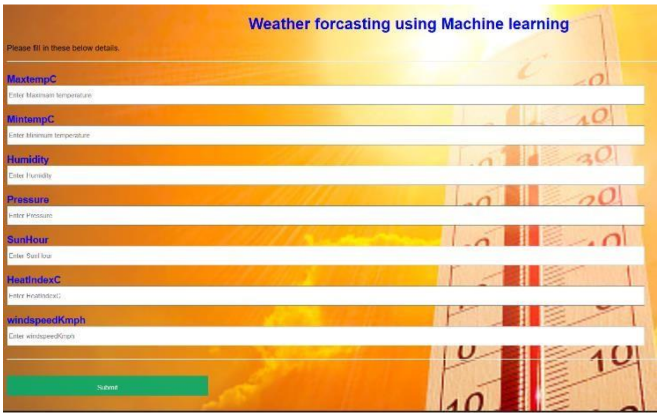


Fig.5 User interface

VII. CONCLUSION

Machine learning algorithms can identify complex patterns in weather data and generate forecasts that are more precise and localized. This technology is being used by various organizations, including government agencies, private companies, and research institutions, to develop more advanced weather prediction systems.

However, there are still challenges associated with Weather forecasting using machine learning, such as data quality, model complexity, and interpretability. It is crucial to ensure that the data used to train machine learning models is of high quality and representative of the weather patterns being predicted. Additionally, the models used must be interpretable, so that meteorologists can understand how they are making predictions and adjust them accordingly.

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[9] GylianVerstraete, “A data-driven sframework for predicting weather impact on high-volume low-margin retail products,” 2

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