WEATHER FORECASTING SYSTEM

# Introduction:

Weather forecasting is the prediction of what the atmosphere will be like in a particular place at a particular time of the day or the week by using technology and scientific knowledge to make weather observations.

In other words, it's a way of predicting things like cloud cover, rain, snow, wind speed, and temperature before they happen using science and technology. The main ways the weather can be forecast include looking at current weather conditions, tracking the motion of air and clouds in the sky, finding previous weather patterns that resemble current ones, examining changes in air pressure, and running computer models on the details available from various sources like weather satellites.

The concept of weather forecasting existed even among the earlier civilizations which used recurring astronomical and meteorological changes to predict seasonal changes in weather.

The Babylonians(around 650 BC) used visual signs such as clouds and haloes to try and predict the short-term changes that may occur in the weather.

The Chinese had developed a calendar (around 300 BC) that divided a year into 24 festivals, each festival was associated with a different type of weather.

Around 340BC, the Greek philosopher Aristotle wrote his philosophical treatise called Meteorologica. This had theories about astronomy, geography, and various natural phenomena like clouds, rain, hail, lightning & thunder, wind, and hurricanes. The observations made by Aristotle regarding these phenomena and weather were remarkably accurate along with some which had flaws or were totally wrong.

Nabatean Agriculture by Ibn Wahshiyya discussed the prediction of rainfall from various lunar phases and the dependency of weather on the planetary astral alterations.

Despite claims of errors in theories proposed by Aristotle, his theories continued to be in use till the 17th century, when it was overthrown by more accurate scientific methods.

The issue with the above-followed methods was that the earlier methods were of the opinion that the weather was under the control of only visual changes in the atmosphere, they relied on visual patterns in the atmosphere (pattern recognition) and the theories of Aristotle had no experimentally proven ways to back up his theories and were merely just his opinion about what could be the reason.

By the end of the Renaissance Era of Europe, there was an increasing idea that the speculations of natural philosophers were not enough to know about the weather, and the emphasis now shifted to understanding more about the atmosphere to know the weather.

This Era also marked the inventions of many scientific instruments that played a huge role in weather forecasting like

* Hygrometer
  + Invented by Nicholas Cusa, it measures the humidity of the air
* Thermometer
  + Galileo Galilei invented the early thermometer
* Barometer
  + Invented by Evangelista Torricelli, it is used to measure atmospheric pressure.

These meteorological devices continued to be refined to be more precise all the way through the 19th century. This period also marked the increase in theoretical knowledge about the weather and our atmosphere, because of these advancements individuals scattered at various locations started to make observations of the weather, which resulted in more precise weather reports of different areas. The invention of the electric telegraph in 1835 further helped with the development of weather forecasts with faster travel of data to various places.

In October 1859, the Royal Charter Ship sank off the North coast of Anglesey. This led to Beaufort’s Royal Navy protégé Robert Fitzroy to develop a weather chart referred to as Forecasts which is the first known use of the term Weather Forecasts. Following this, 15 land stations were set that used the telegraph to transmit reports daily, thus creating a gale warning service.

The first weather forecast was first published in the Times in 1861.

The weather forecast done in the modern day is what is referred to as the Numerical Prediction. The concept of numerical prediction was the result of advancements in atmospheric physics during the 20th century. But at that period of time numerical prediction seemed impossible as the sheer number of calculations needed cannot be performed accurately by humans. The first computerized weather report was performed by a team of American Meteorologists on the ENIAC The practical use of numerical weather prediction became mainstream in 1955 with the development of programmable electronic computers.

The basic idea of numerical weather prediction is to sample the state of the fluid at a given time and use the equations of fluid dynamics and thermodynamics to estimate the state of the fluid at some time in the future. The main inputs for these equations are from land stations and weather buoys at sea. The other source of data used to be through devices (radiosondes) launched to higher areas of the atmosphere using helium-filled weather balloons. Nowadays there are hundreds of land stations around the world that launch radiosondes every twelve hours. Moreover, the weather satellites launched into orbit provide a large quantity of data regarding cloud formations, and so on.

The issue with the currently used method is that it is dependent on indications of specific weather patterns that show up in the atmosphere. Moreover, large computational power is used to provide a report that is still not highly accurate. The modern forecast is not much useful in disaster management as the duration between the generation of reports and the weather event is usually low, and the generation of the forecast is rather slow.

This is where the role of developing technologies like AI comes in. AI can be used to study previous weather patterns and use the data thus collected along with data collected currently to predict weather events in the future faster and almost as quickly as the current method of the forecast. Although it may be less effective than the current system, it is estimated to require 7000 times less computational power than the current method of the forecast. This decrease in the need for computational power gives extra speed in the production of the weather prediction. Moreover, it allows running multiple models parallelly to encompass a wider range of possible outcomes.

After training an AI on previous models it can generate connections between parameters that existing physics models cannot, using a lot fewer variables to create a considerably quicker model. But at the current state, despite being slower and resource-heavy the numerical prediction offers a better output than currently used AI models.

# Problem Definition

Weather simply refers to the state of the atmosphere at a particular place and time as regards the heat, cloudiness, dryness, sunshine, wind, rain, etc. It is a continuous, data-intensive, multidimensional, dynamic and chaotic process. These properties make weather forecasting a formidable challenge. Forecasting is the process of estimation in unknown situations from historical data. Weather forecasting is one of the most scientifically and technologically

challenging problems around the world in the last century. Making an accurate prediction is true, 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. So the problem arises to produce an environment/ application that can successfully predict the weather at any given location accurately, with minimal room for error, and to be able to do so immediately with the minimal waiting time. This was what led to our group

choosing this topic, the opportunity to learn about how this system works, and the daunting

challenge of being able to successfully research and implement this project within a deadline.

# Objective:

Weather forecasts are made by collecting as much data as possible about the current state of the atmosphere (particularly the temperature, humidity, and wind) and using an understanding of atmospheric processes (through meteorology) to determine how the atmosphere evolves in the future.

Traditional observations made at the surface of atmospheric pressure, temperature, wind speed, wind direction, humidity, and precipitation are collected routinely from trained observers, automatic weather stations, or buoys.

During the data assimilation process, information gained from the observations is used in conjunction with a numerical model's most recent forecast for the time that observations were made to produce the meteorological analysis.

This brings us to the Objective of this Weather forecasting project, which is to use all the information collected and use it to create an application that is capable of forecasting/ predicting the weather accurately with minimal margin for error at any given time.

# Methodology -:

Some popular weather forecasting methods include-:

* Persistence forecasting
* Climatology forecasting
* Using a barometer
* By Data mining techniques
* By Using API

The method we are using is by using the Weather API.

To get access to current weather, minute forecast for 1 hour, hourly forecast for 48 hours, and daily forecast for 7 days.

Fields in API response-:

* [minutely] Minute forecast weather data API response
  + minutely.dt - Time of the forecasted data, unix, UTC
  + Minutely.precipitation - Precipitation volume, mm
* [hourly] Hourly forecast weather data API response
  + hourly.dt - Time of the forecasted data, Unix, UTC
  + hourly.temp Temperature. Units – default: kelvin, metric: Celsius, imperial: Fahrenheit.
  + hourly.feels\_like Temperature. This accounts for the human perception of weather. Units – default: kelvin, metric: Celsius, imperial: Fahrenheit.
  + hourly.pressure Atmospheric pressure on the sea level, hPa
  + hourly.humidity Humidity, %
  + hourly.dew\_point Atmospheric temperature (varying according to pressure and humidity) below which water droplets begin to condense and dew can form. Units – default: kelvin, metric: Celsius, imperial: Fahrenheit.
  + hourly.clouds Cloudiness, %
  + hourly.visibility Average visibility, metres. The maximum value of the visibility is 10km
  + hourly.wind\_speed Wind speed. Units – default: metre/sec, metric: metre/sec.
  + hourly.pop Probability of precipitation. The values of the parameter vary between 0 and 1, where 0 is equal to 0%, 1 is equal to 100%
  + hourly. rain
    - hourly. rain.1h Rain volume for last hour, mm
  + hourly.snow
    - hourly. snow.1h Snow volume for last hour, mm
  + hourly.weather
    - hourly. weather.id Weather condition id
    - hourly.weather.main Group of weather parameters (Rain, Snow, Extreme etc.)
* [daily] Daily forecast weather data API response
  + daily.dt Time of the forecasted data, Unix, UTC
  + daily.sunrise Sunrise time, Unix, UTC
  + daily.sunset Sunset time, Unix, UTC
  + daily.moonrise The time of when the moon rises for this day, Unix, UTC
  + daily.moonset The time of when the moon sets for this day, Unix, UTC
  + daily.temp Units – default: kelvin, metric: Celsius, imperial: Fahrenheit.
    - daily.temp.morn Morning temperature.
    - daily.temp.day Day temperature.
    - daily.temp.eve Evening temperature.
    - daily.temp.night Night temperature.
    - daily.temp.min Min daily temperature.
    - daily.temp.max Max daily temperature.
  + daily.pressure Atmospheric pressure on the sea level, hPa
  + daily.humidity Humidity, %
  + daily.dew\_point Atmospheric temperature (varying according to pressure and humidity) below which water droplets begin to condense and dew can form. Units – default: kelvin, metric: Celsius, imperial: Fahrenheit.
  + daily.wind\_speed Wind speed. Units – default: metre/sec, metric: metre/sec.
  + metre/sec, metric: metre/sec, imperial: miles/hour.
  + daily.wind\_deg Wind direction, degrees (meteorological)
  + daily.clouds Cloudiness, %
  + daily.uvi The maximum value of UV index for the day
  + daily.pop Probability of precipitation. The values of the parameter vary between 0 and 1, where 0 is equal to 0%, 1 is equal to 100%
  + daily.rain Precipitation volume, mm
  + daily.snow Snow volume, mm
  + daily.weather
    - daily.weather.id Weather condition id
    - daily.weather.main Group of weather parameters (Rain, Snow, Extreme etc.)
    - daily.weather.description Weather condition within the group. Get the output in your language
    - daily.weather.icon Weather icon id.

By using these API responses we will collect the information and use it on our website.

# Summary -:

Weather forecasting is the application of science and technology to predict the state of the atmosphere for a given location and they are made by collecting quantitative data. Soft

computing is an innovative approach to constructing computationally intelligent systems that are supposed to possess humanlike expertise within a specific domain, adapt themselves, and learn to do better in changing environments.

# Conclusion -:

This paper works with a mix of the Weather API method to predict weather conditions. The constant information i.e. time-series data is assembled and analysis is performed on this dataset utilizing an interface named Weather Prediction System, developed utilizing Java

using Eclipse tools.

This framework arranges the given information into various classifications and furthermore predicts the risk of the weather prediction of obscure example is given as an input.

This methodology can decide the nonlinear relationship that exists between the historical data (temperature, wind speed, humidity, and so forth.,) provided to the system during the training phase and on that premise, make a prediction of what the weather would be in future. The Future work of this project is to incorporate more attributes of weather conditions to predict

and to work with another classification algorithm to become more accurate in prediction.

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