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Department of Information Technology

RAINFALL PREDICTION

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Introduction

- The primary objective of this project is to predict rainfall patterns with enhanced accuracy using machine learning algorithms. By leveraging historical weather data and advanced modeling techniques, it aims to provide reliable forecasts that can aid in proactive decision-making across various sectors.

Problem Statement

Accurate rainfall prediction is essential for disaster preparedness, agriculture planning, and resource management. Traditional methods often fall short in capturing complex weather patterns and local variations. Our project aims to leverage machine learning to improve the accuracy and timeliness of rainfall forecasts, addressing data complexity, model robustness, and scalability challenges. By developing advanced predictive models and integrating real-time data, we seek to enhance decision-making processes and mitigate the impact of weather-related risks across various sectors.

Existing System

<u>Limited Accuracy</u>: Current methods rely on simplistic statistical models or numerical weather prediction (NWP) models that may not capture localized variations or complex interactions between meteorological variables.

<u>Data Constraints</u>: Reliance on sparse and sometimes outdated weather station data, lacking integration of diverse data sources like satellite imagery or IoT sensors.

<u>Scalability Issues</u>: Difficulty in scaling predictions to smaller geographic regions or providing timely updates for dynamic weather conditions.

Proposed System

Enhanced Accuracy: Develop machine learning models capable of leveraging diverse datasets (e.g., weather stations, satellite imagery, IoT sensors) to improve accuracy in rainfall predictions.

Real-Time Updates: Implement models capable of generating timely forecasts, updating predictions as new data becomes available.

Scalability and Adaptability: Design models that can adapt to local weather patterns and scale predictions to various spatial and temporal scales.

Scope

This project aims to develop and deploy machine learning models for accurate rainfall prediction by leveraging historical weather data from meteorological stations. The scope encompasses data collection, preprocessing to ensure data quality, and feature engineering to extract relevant meteorological variables and geographical factors. Machine learning algorithms including regression, ensemble methods, and possibly deep learning will be implemented and optimized for predicting rainfall intensity and probability

Algorithm

This project utilizes historical weather data from meteorological stations, supplemented by satellite imagery and IoT sensor data for feature extraction. Machine learning models such as linear regression, decision trees, random forests, and potentially deep learning are employed to predict rainfall intensity and probability. Data preprocessing includes handling missing values and outliers, followed by model training and validation using cross-validation techniques. Hyperparameter tuning optimizes model performance, and real-time forecasting capabilities are implemented for continuous updates. Visualization tools are developed to present forecast results intuitively

About the data

We are predicting rainfall on basis of Temperature, Dew Point, Humidity , Sea Level Pressure, Visibility, Wind of all average values.

<u>Temperature</u>: The average temperature of the air as indicated by a properly exposed thermometer during a given time period, usually a day, a month, or a year.

<u>Wind</u>: wind speed is measured using an anemometer, which is then recorded on the Beaufort scale.

<u>Humidity</u>: A quantity representing the amount of water vapor in the atmosphere

Data Cleaning

The data which is obtained from the primary sources is termed the raw data and required a lot of preprocessing before we can derive any conclusions from it or do some modeling on it. Those preprocessing steps are known as data cleaning and it includes, outliers removal, null value imputation, and removing discrepancies of any sort in the data inputs. So there is one null value in the ‘wind direction’ as well as the ‘windspeed’ column

Exploratory Data Analysis

EDA is an approach to analyzing the data using visual techniques. It is used to discover trends, and patterns, or to check assumptions with the help of statistical summaries and graphical representations. Here we will see how to check the data imbalance and skewness of the data.

Correlation analysis assesses relationships between variables, identifying potential multicollinearity. Geographical data is mapped to visualize spatial patterns and their influence on rainfall predictions.

Model Training

The features and target variables are separated ,split them into training and testing data by using which we will select the model which is performing best on the validation data. As we found earlier that the dataset we were using was imbalanced so, we will have to balance the training data before feeding it to the model. The features of the dataset were at different scales so, normalizing it before training will help us to obtain optimum results faster along with stable training. Some state-of-the-art models are trained for classification on training data like Logistic Regression XGB Classifier and SVC.

Outcomes of the project

Here we can clearly draw some observations:

maxtemp is relatively lower on days of rainfall.

dewpoint value is higher on days of rainfall.

humidity is high on the days when rainfall is expected.

Obviously, clouds must be there for rainfall.

sunshine is also less on days of rainfall.

windspeed is higher on days of rainfall.

Conclusion

By integrating diverse data sources and employing models like linear regression, decision trees, random forests, and gradient boosting machines, we achieved significant improvements in forecasting accuracy. Real-time capabilities and intuitive visualizations enhance usability across agriculture, disaster management, and urban planning sectors, supporting informed decision-making and resource optimization. Moving forward, continuous refinement and adaptation will ensure our models remain effective in addressing evolving weather patterns and enhancing resilience against climate-related risks.

Thank you