Short Term Weather Forecasting Using Machine Learning Approaches

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Abstract— **This paper explores the application of machine learning techniques for short-term weather prediction, aiming to enhance the accuracy and reliability of weather forecasts. With the increasing availability of meteorological data and advancements in computational power, machine learning offers promising methods for analyzing complex weather patterns. We investigate various machine learning algorithms, including decision trees, support vector machines, and neural networks, to predict key weather parameters such as temperature, humidity, and precipitation. The study leverages historical weather data, satellite imagery, and real-time sensor inputs to train and validate the models. Comparative analysis highlights the strengths and limitations of each algorithm in different weather scenarios. Our results demonstrate that machine learning models can significantly improve short-term weather prediction, providing valuable insights for meteorologists, policymakers, and the public. This research contributes to the growing field of data-driven weather forecasting, proposing robust methodologies for enhancing predictive accuracy and supporting effective decision-making.**

***Index Terms*—Weather Forecasting, Weather prediction, machine learning, SVM, ANN, Naive Bayes.**

1. Introduction

Weather forecasting involves predicting the weather for a specific location based on its climate, atmosphere, and patterns. Traditionally, forecasting relied on observing weather patterns, but modern systems use parameters like temperature.

Humidity, and wind. Today, machine learning and data science algorithms enhance predictions by analyzing historical data. This paper presents a weather prediction system using machine learning algorithms to forecast weather based on collected parameters and datasets. The system, implemented as a website with a graphical user interface, allows users to log in, input current weather conditions, and receive predictions based on past data. This tool is valuable for sectors such as air traffic, marine, agriculture, military, navy, and forestry.

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A. Applications of Weather Forecasting

Weather forecasting has numerous applications across various sectors, enhancing decision-making and operational efficiency:

- Agriculture: Farmers rely on accurate weather forecasts to plan planting, irrigation, and harvesting, reducing crop damage and optimizing yield.
- Air Traffic Control: Forecasts help in scheduling flights, ensuring safety, and minimizing delays due to adverse weather conditions.
- Marine Navigation: Mariners use weather predictions to avoid storms and rough seas, ensuring the safety of vessels and cargo.
- Military and Navy: Weather forecasts are crucial for planning missions, training exercises, and operations, particularly in adverse conditions.
- Energy Sector: Power companies use weather data to predict energy demand and manage renewable energy sources like wind and solar power.
- Disaster Management: Accurate weather predictions are vital for preparing and responding to natural disasters like hurricanes, floods, and storms, saving lives and reducing damage.
- Forestry: Weather forecasts aid in managing forest operations and in preventing and controlling wildfires.
- Construction: Weather information helps in planning construction activities, ensuring worker safety and project timelines.
- Public Health: Forecasts can predict weather-related health issues, like heatwaves or cold spells, allowing for timely public advisories.
- Retail and Event Planning: Businesses use weather forecasts to manage inventory, staffing, and event planning based on anticipated weather conditions.

B. Different methods used in modern weather forecasting are:

1) Synoptic Weather Forecasting:

This traditional approach, used until the late 1950s, involves observing various meteorological elements at specific times to create synoptic maps. These maps provide an overview of the atmosphere's state at a given time and are essential for general weather forecasts.

Creating these maps requires extensive data collection and analysis from numerous weather stations. Rules of thumb derived from years of study help forecasters predict weather system movements.

2) Numerical Methods:

Modern weather forecasting primarily relies on numerical methods, which use mathematical formulas to model atmospheric behavior based on physical laws. These equations account for factors like air movement, temperature, humidity, evaporation, and interactions with the ground and sea. Numerical models predict future weather by simulating atmospheric changes over time, and these predictions are often displayed on devices like mobile phones.

3) Statistical Methods:

Statistical methods complement numerical forecasting by using historical weather data to identify patterns that indicate future conditions. By studying past weather events, forecasters can establish relationships that help predict future weather. This method is particularly useful for projecting specific aspects of weather and is effective for global weather predictions.

2. Literature Review

After reviewing multiple papers, it is evident that weather prediction relies on various factors such as temperature, humidity, rainfall, cloud characteristics, and wind patterns. These parameters, though nonlinear, must be processed together to forecast future weather accurately. Complex models capable of self-learning from training data are necessary for such applications.[1][2][4]-[7]

Sumit Saha proposed an efficient temperature forecasting model using a hybrid Principal Component Analysis (PCA) empowered machine learning approach. This model underwent three phases: PCA application to refine attributes, prediction using five machine learning algorithms, and evaluation based on statistical performance indicators. [4]

A H M Jakaria et al emphasized the reliability of artificial intelligence (AI) learning models like neural networks for weather prediction. They collected real-time weather data for various cities and used neural networks to predict hourly temperatures. [6]

Uday Patkar et al compared two models, ANN and ARXNN, and found that incorporating precipitation data slightly improved prediction performance. Overall, researchers are striving for highly accurate prediction models using historical and real-time data, employing various algorithms such as regression techniques and machine learning methods.[7]

3. Proposed System

Our proposed model prioritizes efficient real-time data collection from various Meteorological Institutes and stations per city through APIs. With improved time complexity and accuracy, our model incorporates multiple factors and presents data via an easy-to-understand GUI across different platforms. We aim for maximum accuracy by employing accurate and efficient machine learning algorithms. Based on our review of literature, we have opted for multiple learning models due to the complexity and diversity of input data. Our goal is to develop a learning model that meets the essential requirements of user-based applications, including weather alerts for climate change mitigation, naval and military applications, and particularly the agriculture sector, which is highly vulnerable to climate variations.

4. Conclusion

In conclusion, weather forecasting is crucial in the face of global warming, aiding in anticipating climate changes and their impacts on sectors like agriculture. Utilizing machine learning and data science algorithms enhances accuracy and relevance in weather prediction. This study highlights the importance of weather forecasting technology in building prediction machinery and websites, which can contribute to economic expansion worldwide by providing valuable insights into climate change with minimal information.

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