Weather Forecasting Using Machine Learning Techniques

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Abstract: *Weather forecasting plays a pivotal role in diverse sectors such as agriculture, aviation, disaster management, and transportation. Traditionally, numerical weather prediction models have been employed for forecasting; however, these models are computationally intensive and often suffer from limited accuracy due to chaotic atmospheric behavior. In recent years, Machine Learning (ML) has emerged as a powerful tool capable of uncovering hidden patterns in large datasets, making it a promising alternative for weather prediction. This paper presents a comprehensive study on weather forecasting using various ML techniques including Support Vector Machines (SVM), Random Forests, Artificial Neural Networks (ANN), and Deep Learning models such as Convolutional Neural Networks (CNN) and Long Short-Term Memory (LSTM) networks. The study explores data preprocessing methods, feature selection strategies, and model evaluation metrics tailored for weather prediction tasks. The paper also compares traditional and ML-based forecasting methods, highlighting the strengths and limitations of each. Furthermore, a detailed literature survey covering research from the past eight years is provided, emphasizing the progress and challenges encountered in this field. Results from existing studies indicate that ML models, especially deep learning techniques, can significantly improve forecast accuracy and computational efficiency. However, challenges such as overfitting, data scarcity, and interpretability remain. This paper concludes by outlining future research directions including hybrid models, transfer learning, and integration of real-time data sources. Overall, the study establishes that ML-based approaches hold great promise for advancing the accuracy and reliability of weather forecasting systems.*

Keywords: Weather Forecasting, Machine Learning, Deep Learning, Neural Networks, Time Series Prediction, Data-Driven Models, Climate Modeling, Predictive Analytics