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Deep Hybrid CNN-Transformer Model for Accurate Weather Forecasting Using Machine Learning

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Abstract: *Weather forecasting is a critical function that influences sectors like agriculture, transportation, aviation, disaster management, and energy. Traditional weather forecasting models often rely on numerical simulations and complex physical equations that demand high computational resources and sometimes produce less reliable results in rapidly changing environments. With the rapid evolution of artificial intelligence, machine learning (ML) has emerged as a promising alternative for forecasting by learning complex, non-linear patterns from historical data. This research explores the role of advanced ML models such as Convolutional Neural Networks (CNN), Long Short-Term Memory (LSTM), and Vision Transformers (ViT) in weather prediction. We propose a novel hybrid CNN-Transformer architecture that captures both spatial and temporal dependencies in meteorological data. The paper provides a thorough review of recent developments, discusses essential preprocessing techniques, compares model performance across datasets, and outlines challenges and future directions. It highlights how ML models enhance forecasting accuracy, reduce computational complexity, and adapt dynamically to new weather conditions. The study concludes that integrating ML with traditional models can improve both accuracy and interpretability, paving the way for robust hybrid forecasting systems.*

Keywords: Weather Forecasting

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