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Short-Term Electricity Load Forecasting Using a Modular Hybrid Framework

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Abstract

Accurate short-term electricity load forecasting is essential for efficient grid operation, especially under increasing variability due to renewable integration, electrification, and behavioral shifts. This paper proposes a novel modular hybrid forecasting framework that integrates Fourier series decomposition, Seasonal ARIMA (SARIMA), and a CNN-BiLSTM residual learning model. The model explicitly captures multi-scale seasonalities (daily, weekly, yearly) using Fourier basis functions, models linear temporal dependencies via SARIMA, and learns nonlinear residual dynamics influenced by weather and calendar variables through a deep learning CNN-BiLSTM architecture. The proposed model is validated on real-world hourly electricity and weather data from the Korean power grid and compared against several benchmarks. Experimental results demonstrate superior performance across all metrics, particularly in peak periods and holiday scenarios. The architecture offers modularity, interpretability, and robustness, making it well-suited for deployment in operational forecasting environments.

Keywords
Electricity Load Forecasting, Modular, Hybrid Framework