Enhancing Wind Power Predictions by Using Weather Data and Improving LSTMs

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Wind energy has reduced our environmental impact, but it has also destabilized the power grid, which is an obstacle to green energy integration. If we can predict short-term (2-5 minutes) wind power output, then we can proactively shunt energy between wind farms, increasing stability. The objective of this project is to construct Long Short-Term Memory Neural Network (LSTM) models and supplement them with weather forecast data to improve performance. I acquired wind power and weather forecast data from 2010 on open source databases, which were then processed, combined, and normalized. However, a generic LSTM model performed poorly on this data, with erratic behavior observed on even low-variance data sections. It was clear that the unpredictability of wind power and the large amounts of forecast data were undermining model performance. From the diagnosis of the generic LSTM, multiple new LSTM modifications were proposed to address specific issues like cell state divergence. To ensure objective cross-model comparison, I kept the test set and all optimization algorithms constant throughout testing, and I measured the Mean Absolute Error for each model, as well as the Naive Ratio, a measurement that I proposed to quantify unwanted reactionary behavior. Results showed a statistically significant increase in model accuracy with the addition of weather forecast data on the majority of LSTM modifications, which can be attributed to the increased context and the reduced redundancy of the new models. These new and improved models have the potential to improve power grid stability and expedite renewable power integration.

Awards Won:

American Statistical Association: Third Award of $250