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Comparative Analysis of Machine Learning and Statistical Models for Short-Term Energy Production Forecasting in Poland

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This paper investigates short-term energy production forecasting in Poland using three distinct predictive models: LightGBM, an ARIMA-based model, and a Long Short-Term Memory (LSTM) network. Leveraging historical data from Poland's energy sector, our study evaluates each model's performance in terms of accuracy, robustness, and computational efficiency. The LightGBM model employs gradient boosting techniques to capture non-linear relationships, while the ARIMA approach provides a classical linear autoregressive approach. Meanwhile, the LSTM network exploits its recurrent architecture to model complex temporal dependencies inherent in the time-series data. Comparative analysis based on metrics such as RMSE and MAE demonstrates that although all models exhibit competitive forecasting abilities, the LSTM model exhibits a modest performance advantage over the other approaches within the examined forecast scenario. However, both the LightGBM and ARIMA models offer advantages in terms of reduced computational overhead and ease of implementation. Furthermore, I analyze ensemble models in search of the most accurate predictions. The insights derived from this analysis aim to assist policymakers and energy sector stakeholders in making informed decisions regarding energy distribution and operational planning in Poland.

Index Terms—energy forecasting, time series, machine learning, LightGBM, LSTM, ARIMA

Author: KARPIŃSKI, Jakub (Warsaw University of Technology)

Presenter: KARPIŃSKI, Jakub (Warsaw University of Technology)

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