Karlsruhe Institute of Technology

Institute for Automation and Applied Informatics (IAI)

Bachelor Thesis

Analyzing day-ahead system load forecasts with SHAP

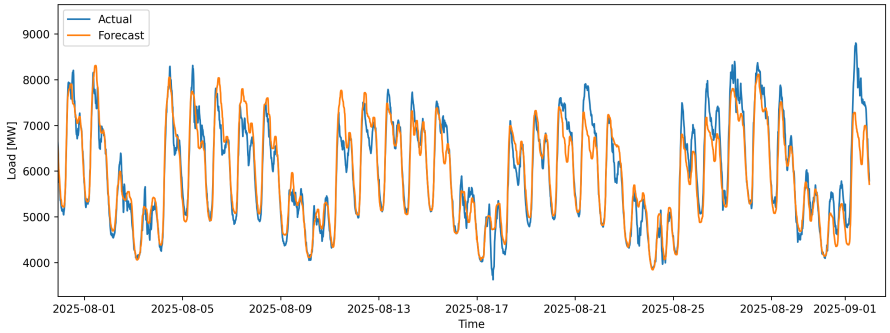

Figure 1: Day-ahead forecast and actual load of Baden-Württemberg in August.

With increasing shares of fluctuating renewable energy in the electricity mix, short-term forecasts of the electrical load (i.e. electricity demand) and renewable generation are important to foresee energy supply shortages and grid bottlenecks, and then plan redispatch and demand-response measures. Thereby, accurate forecasts help to increase the share of renewable energy and to reduce grid expansion and costs for balancing energy.

The Transmission System Operator (TSO) is obliged to deliver a day-ahead load forecast to the ENTSO-E transparency platform [1]. Often, these forecasts deviate significantly from the actual load of the next day (see Figure 1). Such forecast errors pose a financial risk due to the need for energy curtailment or procurement of balancing energy.

The goal of this thesis is to improve the forecast by using a machine learning model (e.g. XGBoost, neural network) to predict the residuals. We expect to find systematic errors in the TSO's forecast, driven by daily, weekly and yearly patterns as well as weather influences. These effects shall be analyzed using the Shapley Additive Explanations (SHAP) framework to understand when and why the TSO's forecast is inaccurate.

The proposed thesis consists of the following parts:

- Familiarization with SHAP [2, 3]
- Visual and statistical analysis of the TSO's load forecast residuals to identify candidate features for a machine learning model
- Training and evaluating one or multiple machine learning model(s)
- Applying SHAP to explain the model(s)
- Optional 1: Next to explaining the residuals, a machine learning model could be trained to replicate the TSO's forecast and analyzed with SHAP (that is, reverse engineering the TSO's forecast)
- Optional 2: Extension to other time series, e.g. renewable generation forecasts or load forecasts from other TSOs

We are happy to answer any questions you might have. Feel free to reach out via e-mail and ask for an appointment.

Advisor:
Matthias Hertel
Alexandra Nikoltchovska

Programming language:
Python

System, Framework(s):
sklearn + SHAP

Required skills:

- Machine learning basics
- High level of independence (meeting with supervisors every 1 or 2 weeks)

Language(s):
German, English

Starting date:
As soon as possible

For more information, please contact:

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References

[1] https://transparency.entsoe.eu/load-domain/r2/totalLoadR2/show?areaType=BZN&biddingZone.values=CTY|10Y1001A1001A83F!BZN|10Y1001A1001A82H
[2] Molnar, C. (2023). *Interpreting machine learning models with SHAP: A guide with python examples and theory on Shapley values*. Chistoph Molnar c/o MUCBOOK, Heidi Seibold.
[3] https://shap.readthedocs.io/en/latest/