Bachelor/Master Thesis

Physics-informed Machine Learning for Wind Power Generation Forecasting

This thesis targets to develop and implement a physics-informed wind power generation forecasting method, evaluate the performance, and compare it to benchmark methods.

Motivation

Accurate Wind Power (WP) generation forecasting is vital for the efficient operation of Smart Grids. The use of prior knowledge about physical relationships may improve the quality of WP forecasting models. For example, the power generation related to the wind speed (WP curve) has four sections, see Figure 1. Further, the relation between wind speed and height above the ground follows a semi-empirical relationship, see Figure 2. This thesis aims to consider these relationships in the automated design of the WP generation forecasting model. The solution approach may go in the direction of **ensemble learning**, e.g., similar to the approach in [1], or in the direction of **physical-inspired artificial neural networks**, e.g., like in [2]. Depending on the scope of the thesis (Bachelor or Master), either one approach or both approaches can be considered.

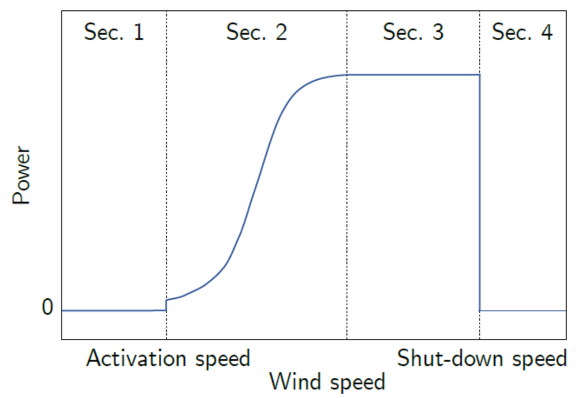

Figure 1 Empirical wind power curve [3]

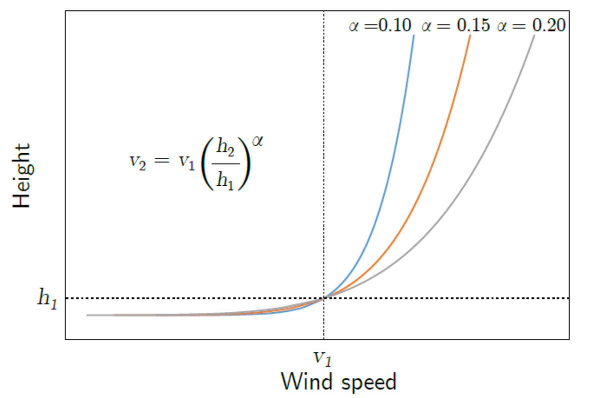

Figure 2 Height correction of the wind speed [3]

Tasks

- Literature research and introduction into WP forecasting.
- Analysis of transferable elements from [1] and [2] to WP forecasting.
- Systematically implement and evaluate the new method for WP forecasting.

Skills

- **Qualification**: Engineering, Informatics, or Scientific studies
- **Personality**: Highly motivated and proactive
- **Experience and Know-How**: Interests in machine learning and energy informatics. First experiences in machine learning and **Python** programming skills are advantageous. The thesis should preferably be written in **English**.

[1] Meisenbacher, S.; Heidrich, B; Martin, T.; Mikut, R.; Hagenmeyer V. (2022) AutoPV: Automated photovoltaic forecasts with limited information using an ensemble of pre-trained models, arXiv pre-print: 2212.06797

[2] Selzer, S. A., Bauer, F., Bohm, S., Bretschneider, P., & Runge, E. (2021). Physik-geführte NARXnets (PGNARXnets) zur Zeitreihenvorhersage. *Proceedings - 31. Workshop Computational Intelligence*, 235–261, doi: 10.5445/KSP/1000138532.

[3] Meisenbacher, S., Pinter, J., Martin, T., Hagenmeyer, V., & Mikut, R. (2021). Concepts for Automated Machine Learning in Smart Grid Applications. *Proceedings - 31. Workshop Computational Intelligence*, 11–35, doi: 10.5445/KSP/1000138532.

Stefan Meisenbacher
KIT, Institut for Automation and Applied Informatics
E-Mail: stefan.meisenbacher@kit.edu

Silas Aaron Selzer
TU Ilmenau, Institute of Electrical Power and Control Engineering
E-Mail: silas-aaron.selzer@tu-ilmenau.de