Hessisches Kompetenzzentrum
für Hochleistungsrechnen

Electric Load Forecasting

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Introduction

The energy transition and the associated expansion of renewable energies are leading to volatile electricity supply and thus to decreasing grid stability. The flexibilization of the industrial electricity demand is therefore of central importance to achieving the ambitious climate goals. To adapt the industrial load demand to the volatile electricity supply by means of demand side management, it is necessary to know future energy demands. Precise forecasting models can be created using energy, process, and operating data as well as specified planning data. Due to the increasing availability of computing power and efficient algorithms, machine learning algorithms, especially deep learning algorithms are promising to achieve this objective. However, deep learning models typically have numerous hyperparameters, which must be chosen wisely. Therefore, the usage of Neural Architecture Search-Algorithms are promising to achieve high-quality results.

Methods

The load forecasting models were implemented in python. For Neural Architecture Search we used a self-developed evolutionary algorithm called TinyEvo. The TinyEvo Algorithm used a combination of Long Short-Term Memory (LSTM) or Gated Recurrent Units (GRU) to sample Architectures. Additionally Convolutional Neural Networks (CNNs) were used in parts of the developed models.

Results

We developed a hierarchically structured forecasting model of

the ETA Research Factory`s production system for a forecasting horizon of 4 hours with a resolution of 10 seconds. Production systems consist of many interacting subsystems, which can be displayed as a system. A hierarchical modelling approach is chosen to address this composition of production systems. The hierarchical modelling approach constitutes a basic generic structure that allows the production system to be modelled in any complexity concerning the representation of the individual subsystems. For the use case, the hierarchical structure is based on the forecasting models of five production machines and additional influencing factors. Additionally, different hyperparameters of the Neural Architecture Search Algorithm and of the forecasting models were evaluated.

Discussion

The validation based on actual factory data confirms that the chosen deep learning architectures are well suited to develop forecasting models for implementing energy flexibility measures in the industry. The development of load forecasting models lays the foundation for energy-flexible behaviour in the industry and thus makes the industry’s flexibility potential usable for stabilising the electricity grid. The results show that the chosen deep learning-based forecasting models outperform other methods such as multitask-lasso regression.

Publications

Walther, Jessica: “Hierarchical Electrical Load Forecasting of Industrial Production Systems in the Manufacturing Industry based on Deep Learning.” Ph.D. Thesis (2022) https://tuprints.ulb.tu-darmstadt.de/21767/

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