Hessisches Kompetenzzentrum
für Hochleistungsrechnen

Preliminary Study for Power Forecasting of Machines in Industrial Production Systems With Neural Networks



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Clusters
Lichtenberg II Cluster Darmstadt

Software
Python

Institute
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University
Technische Universität Darmstadt

Introduction

Germany has the ambitious goal of covering all electricity generation by renewable sources by 2045. The Kopernikus project SynErgie is designed to investigate how industry can help to compensate for fluctuating availability of renewable energy sources, which is one of the primary disadvantages of using these technologies. The increasing integration of volatile renewable energies creates uncertainties in the adjustment of supply and demand in the power grid. One way to respond to fluctuating power generation is to adapt the consumer side. This can be achieved by industrial entities by, for instance, adapting their processes depending on the availability of electricity - without the quality of the products suffering as a result. [1]

Methods

Power forecasting is a key enabler technology for energy flexible adaptations. A forecasting service was developed for this purpose as part of the second phase of the project. The forecasting service makes it easier for engineers to create forecasting models of different energy carriers (heating, cooling, electricity) in production areas. The service also allows for real-time application in production environments. This supports the predictive control of energy supply systems in energy-flexible factory operation. The forecasting service is implemented in Python and Docker. A schematic representation of the service,

including embedding in an exemplary optimization framework, can be viewed in [2].

Results

The forecasting service developed will be evaluated over the next three years using real industrial use cases. Training the models in Python requires extensive computational resources, scaling with the size of the data sets. The training can be parallelized, because of which the extensive resources of the Lichtenberg Cluster are well suited for reducing computing times. In the current phase, models are being developed for the ETA research factory at the Institute for Production Management, Technology and Machine Tools (PTW) Technical University of Darmstadt. The ETA factory is a tool and demonstrator for innovations in the areas of energy efficiency, energy flexibility and resource efficiency in production. Their approach combines building and machines in a holistically networked energy system and tests real process chains. We implement the methods within the first station of the representative production chain for metalworking, which consists of an EMAG VLC-100Y machine tool for parts lathing. The model is based on the active power at the machine's main power supply, measured using stationary metering devices with a time resolution of 10 seconds. Long Short-Term Memory (LSTM) models are used for modeling. [3]

Discussion

The early phase of the project was mainly concerned with business and data understanding as well as data preparation. For this reason, the results of the modeling have not yet been integrated into publications. However, the preliminary study already provides importantinitial insights into the feasibility of the projects. The computing time can be reduced almost linearly with the number of utilized cores, which has shown the value of the Lichtenberg Cluster in terms of reducing computing times. Furthermore, the degradation behavior of the models will be investigated in the future. To this end, a further project phase is planned at the Lichtenberg Cluster.

Reference

[1]: SynErgie project. https://www.kopernikus-projekte.de/synergie

[2]: Results of the SynErgie project. https://synergie-projekt.de/ergebnis/service-prognose

[3]: ETA research factory at the Institute for Production Management, Technology and Machine Tools (PTW) Technical University of Darmstadt. https://www.ptw.tu-darmstadt.de/eta-fabrik/startseite/index.de.jsp

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