Development of a Maturity Model for AI and ML enabled Power Demand Forecasting Methods and Tools Based on a Morphological Analysis

Master Thesis

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1 Introduction

Energy has become essential in our modern life. With the growing concern about the reduction of gas emissions and environment protection the need to minimize the inequality between production and the demand also increases. Therefore, the move toward more decentralized and renewable energy systems is of critical importance. Thus, energy load forecasting becomes increasingly important because it can help to minimize the gap between production and consumption and allow efficient management of decentralized energy systems.

Using load forecasts energy utilities and grid operators are able to anticipate future energy loads. Based on these predictions they can then be able to make strategic decisions that can reduce emissions and costs to a great extent. Studies have been conducted on energy load forecasting. These studies have examined the process of load forecasting, the models and techniques used, as well as comparing the effectiveness of the various models for forecasting energy loads. AL MAMUN et al. (2020) have made a review considering load forecasting, factors affecting it and models used for the forecasting. Luis Hernandez et al. (2014) have also investigated load forecasting, its models and the future trends in this field.

Many models have been used for load forecasting and these can be classified into traditional models and AI-based models. As indicated by Kofi Nti et al. (2020), AI-based models have been used more frequently in load forecasting than traditional models in recent years. Many software tools that use AI-models to perform load forecasting have been developed and the focus of this work is to develop a maturity model for this tool that enables the developers and the users to determine the maturity of the tools and identify development paths

The first section of this document provides a theoretical overview of some related topics, such as decentralized energy systems and artificial intelligence. After that, a literature review on AI-models for load forecasting will be conducted. A morphological analysis of load forecasting tools will be performed and using the results of the literature review, morphological boxes for the analysis of the performance and quality of the load forecasting tools will be created. Based on the outcomes of the morphological analysis and using the morphological boxes, a maturity model for the tools will then be developed.

their tools work such as the algorithms used and how the models are combined within the tool. Further, we have tried to gather more information about the tools by sending emails containing some questions to the developers of the tools. Unfortunately, the vast majority of developers did not reply to these emails.

Furthermore, there are not sufficient studies and information addressing the needs of the potential users of forecasting tools, as well as the services they consider to be important and essential to be included and supported by the tools they use.

The lack of information and resources about the tools and the needs and interests of the users may affect the ability of the maturity model to reflect the actual maturity of the tools and the maturity paths that need to be taken to improve the tools. Considering this, further research concerning the tool specifications, the interests and needs of the tool users would be of great interest.

8 Conclusions and Outlook

The purpose of this work was to develop a maturity model for AI-based load forecasting tools based on the outcomes of a morphological analysis. The goal of the model is to aid developers and users in analyzing tool maturity, achieving continuous improvements, and providing a common standard for comparisons among tools.

The forecasting performance of the tools is being examined with the help of the morphological boxes and comparing the tools forecasting specifications with the literature in order to be able to make judgment about the accuracy of the tool. After that the quality aspects of the tool are also being examined with the help of the porphological boxes in order to make a judgment about the service quality of the tool. Using the examination resultes the model then makes a decision about the maturity of the tool.

Using the model, developers or users can make a judgment regarding the maturity of the tool. In addition, the model allows continuous improvement since improvements paths can be derived from configurations in the morphological boxes after examining the tool performance using the boxes. Through the examination of the tools regarding

maturity, forecasting accuracy, the number of horizons supported and other quality aspects the model enables sufficient comparison of the load forecasting tools.

This model can be an effective instrument in assessing, comparing and suggesting improvements for forecasting tools - however, due to the lack of resources and information about the tool specifications and the needs of the users, the model might not be representative of the maturity of the tools in some cases. This could be an exciting point for further developments on the model when sufficient information are available.