Master thesis report assessment

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Report: Prediction of energy load profiles
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Item	Assessment	Grade
Introduction	The motivation for the research is clearly introduced and contains sound reasoning. The societal relevance is placed into context and is motivated with literature findings. The main aims or purpose of the research are formulated, however, a main client is missing. It is therefore unknown who will be using the results of this research and for what further aim.	8
Research plan	The aims are formulated. However, main research questions which are articulated based on an analysis of related work are missing. The reviewer comes to the conclusion that the research questions are formulated as aims. The aims (i.e. main research questions) are worked out towards a working plan with project phases. This is not detailed in the report but the reviewer assumes that given the structured report, the research is executed according to a proper research plan. The scope of the research and the deliverables are defined as well as the boundaries/limitations. Research methods are identified for each aim (i.e. research question). A somewhat serious observation is that the scope of "energy predictions" is not very well defined. It is unclear if the scope is limited to predictions of electricity consumption (typical with smart meter data), or if the scope is aimed at thermal energy consumption for the heating of buildings or domestic hot water. Both are treated in a similar fashion in the literature research chapter. Reading the report, the reviewer has the impression that both scopes are part of the research. However, the various types of energy consumption have quite a different nature (stochastic vs deterministic) and thus may require different methods. This aspect is not discussed in the report.	7
Related work	Related work is investigated and relevant literature results are discussed. However, it would be more logic to switch the placement of chapters 3 and 4 as to first discuss related work and then discuss the data analysis, which are part of the further research methodology. Contributions of the research in relation to gaps in related work are not formulated. The treatment of related work in chapter 4 only lists findings of other authors but does not identify gaps or possible contributions for the present research. Although chapters 5 until 9 are written in a very readable style and as such appreciated as a summary of the available methodologies, the contribution of these chapters is limited when considering the many textbooks on data analysis and control engineering. To the reviewer's opinion, the real contribution of this report is in the application and comparison of these	7

	methods and is therefore written in chapters 10 until 12. This contribution should be more explicitly mentioned in the introduction and conclusions as there are not so many studies available in which different methods are quantitatively compared.	
Report structure	The title of the report is adequate for the research, however the title is quite broad in relation to the research that it covers. The summary is informative but is not a reflection of the entire report. It does not contain the main research questions and results. It is advised to include a management summary which contains also a description of the main results. The table of contents contains all chapters and paragraphs, is well structured and the titles are to some extend informative. However, the titles could be more descriptive towards this specific research, they could also be part of a textbook on mathematical methods. The report contains a clear “head” (introduction with research questions), body (worked out research) and “tail” (conclusions which answer the research questions). The references are adequate and listed according to a recognized style (APA, IEEE). Detailed information on side aspects of the body text is structured into appendices. However, the algorithms and tables listed in chapter 12 are probably more at place in appendices, especially Table 12.8.	8
Approach and results	The problem analysis is worked out towards modeling, model equations and e.g. relevant computer program coding. The modeling contains relevant model parameters and defines inputs and outputs. Results are discussed in relation to the research questions, validity and accuracy. Good practice: accuracy measures (i.e. RMSE, MAPE, MAE, MASE) are defined and applied to make comparisons between the different prediction methods. Good practice: methods for data preparation (algorithms) are discussed. Impressive: methods of data filtering and imputation are illustrated, together with mathematical backgrounds and algorithms, which make the research very complete to read. The report may serve as a good introduction for energy data analysis courses! However, the methods outlined in the report are applied to a single dataset of one house, only using smart meter data (electricity consumption). The report does not discuss validity of the energy consumption data in relation to standard energy consumption profiles (national statistical profiles are available) and total yearly consumption. This is problematic and to my opinion the only weak point of this report. The high quality of the treatment of methodology in this report deserves more carefully chosen and discussed data sets. However, it is understandable that such datasets are hard to obtain. The placement of Figure 12.2 is somewhat confusing while it is about the ES-model but it is placed within the section which discusses the ARMA model. The report compares various methods which are based on state space formulation (white box model) and a machine learning method (neural network) (black box model). Looking at the results of the ES, ARMA and ARMAX model (both state space models), the question arises which model order was selected (or determined). It seems the models are not able to	9

	capture the stochastic nature of the system sufficiently (although the best days are quite good). To some extend this is logic as smart meter data of a single house is “event driven” and thus will be quite stochastic and therefore unpredictable by nature. The question is if a higher model order improves the accuracy of the predictions or not. The conclusions are valid and concisely written. However, what is really the main aim of the research? In smart grids it is at this stage not common practice to predict electricity consumption of single households and in general this is recognized as very difficult to perform accurately. It is more common to predict aggregated consumption profiles, which is a somewhat easier task to perform due to “averaging” of different profiles. To the reviewer’s opinion, it is interesting to be able to predict the consumption of that part of the electric demand which concerns (a) flexible devices, e.g. a heat pump, and (b) devices which have a high consumption rate, e.g. electric boilers. The present research does not consider these practical aspects and does not yet give a clear direction for future applications of the investigated methods. Given the excellent capabilities of the researcher to put theory into practice, a future research project should have a connection with a practical smart grid implementation project which will steer the research and developments into these practical directions.	

Overall I have a good impression of the capabilities of the graduation student. He has clearly demonstrated his ability to translate mathematically difficult theory into practical applications. The last assessment item has the highest weight. For an overal grade (1-10) I would therefore conclude to grade him with an 8.5. Should this be truncated than I would advise towards a 9.

Best regards,

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