The evaluation report for the PhD Thesis by Karol Struniawski, entitled

"**Optimization and Applications of Extreme Learning Machine Method**"

This PhD dissertation presents a comprehensive set of high-quality research concerning the optimization and application of extreme learning machine (ELM) method. The dissertation starts with an introduction in Chapter 1, followed by the overview of research and publications in Chapter 2. Chapter 3 summarizes the research outputs on ELM framework, ELMS optimization, and application of ELM. Chapter 4 draw some conclusions, concerning ELM and its applications, followed by a brief discussion of future work in Chapter 5. Finally, Chapter 6 presents a summary of all the publications and the academic achievements of the scholar candidate.

The main contributions of this PhD thesis are the development of Tensorflow-based ELM framework, algorithmic optimization of ELM, and the applications of ELMS to solve biological image processing problems. The research outputs are excellent, and the research quality are also excellent, so I would recommend this PhD thesis to be considered for Distinction because I believe this independent research meets all the criteria and conditions of the PJATK regulations for the Distinction of Doctoral Dissertation.

In the rest of this report, I will explain in detail all criteria and points:

1. The detailed evaluation and review of this PhD thesis are summarized according to the relevant points/items:
   (a) The title of the PhD dissertation is well thought, and it reflects well the actual contents of the dissertation. The extreme learning machine (ELM) is the main focus of this dissertation with optimization and applications.
   (b) The dissertation is also well-structured, with an overall introduction, summary of the relevant research outputs, the actual research contents, and conclusions as well as detailed bibliography.
   (c) The research objectives are all well thought and designed to address important research questions concerning the ELM, its implementation, algorithmic optimization and applications in different context.
   (d) The applications of the ELM demonstrate both the new applications and efficiency of the proposed methodology, and they also show the quality of the research and applicability of the method in different applications, including biological image processing.
   (e) The dissertation is well structured and well organized with main new contributions. The reviewer did not find any irregularity or incorrect information.

(f) The PhD dissertation presents and summarizes original, new contributions related to ELM, optimization and applications. The PhD dissertation also contributes to new knowledge and software development in the field.

(g) Overall, the PhD dissertation is an excellent piece of quality research and knowledge, and an excellent summary of the independent research carried out by the scholar during the PhD studies period. The research method is clearly presented, the research results are presented in detail in different context, and the conclusions are valid. Thus, the scholar should be awarded a PhD degree with distinction.

More detailed comments on each chapter:

Chapter 1: A well-structured and detailed introduction, explaining clearly the basic foundations and background of machine learning, especially extreme learning machine (ELM) based methods, research challenges and problems, which are then linked to the research objectives of this dissertation.

Chapter 2: Presents a summary of each different article/research publication and their new contributions as well as the contribution of each individual author.

Chapter 3: This chapter is the most important part of this PhD dissertation, and it summarizes the main research outputs and contributions. Section 3.1 highlights the ELM framework with Python and Tensor flow, whereas Section 3.2 summarizes the ELM using Apple Silicon system. Section 3.3 evaluates the performance of ELM with nature-inspired metaheuristic algorithms, and the effect of activation functions in ELM as well as other relevant issues such as parameter selection and randomness. Section 3.4 presents the applications of ELMS for single cell region isolation, with convolutional neural networks, and for micro-organisms identification.

Chapter 4: The relevant conclusions are drawn, concerning ELM, its optimization and applications.

Chapter 5: The future work has been discussed, which provides ways and options to improve the current work.

Chapter 6: A detailed, honest summary of all the research outputs and publications, and professional/academic achievements and activities.

2. Based on the research outputs, after reading the dissertation and all the chapters and relevant documents carefully, I can confirm that the dissertation is based on the individual and independent research by the scholar, with enough new contributions required by the PhD degree.

3. According to the Regulations for Doctoral Dissertation at PJATK, I believe the candidate's PhD dissertation meets all the requirements for Distinction. More specifically (for responses of the Regulations):
   The scholar candidate has published 16 papers, including five journal articles with a total of impact factors of 15.6, and overall scores of 1790, far above the minimum 140 points that were required by the Ministry of Education and Science.

   Therefore, I would like to recommend this PhD dissertation to be awarded with distinction.

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