Dissertation thesis review

The dissertation thesis titled Bio-Inspired Computing, submitted by Hieu Ngoc Duong, describes author’s research in the field of biologically inspired algorithms with applications in weather phenomena modeling (river runoff prediction) and optimization (industrial boiler efficiency maximization). The author studied the aforementioned fields in detail and proposed novel algorithms, based on enhanced and hybridized artificial neural networks, to tackle the challenges of river runoff prediction and optimization of industrial processes. The proposed algorithms were experimentally verified using real-world data and clearly show a good potential.

The thesis is logically structured and presents the research topics and selected algorithms in detail. The author presents the fundamentals of artificial neural networks (perceptron, multilayer perceptron), recurrent fuzzy neural networks (RFNN), and mixture of experts model. Then, he turns in section 3 to advanced topics such as enhancement and hybridization of recurrent neural networks, data preprocessing and transformation, and RNN ensembling. In this part of the thesis, the author interleaves description of models and methods from the literature with own original contributions (a form of GA-RFNN hybridization and a multi-stage algorithm for RFNN ensembling). Sections 4 and 5 of the thesis are dedicated to the description of use cases of the proposed modified RFNNs. Both use cases, river runoff prediction and boiler efficiency maximization, are well described and accompanied by extensive experiments. The experiments are well analyzed and the results clearly show the positive impact of the proposed algorithms. Only after the description of used methods, proposed modifications, and practical application scenarios, section 6 contains the state-of-the-art and discusses relevant bio-inspired algorithms for river runoff prediction and boiler efficiency optimization. Finally, the thesis is concluded and future work is outlined in section 7. Additionally, the thesis includes description and analysis of a "soft" approach employed in the boiler efficiency optimization use case as an appendix. Authors publication portfolio is described in section 7.3. It shows that the outputs of his research have been published in 6 conference proceedings and one journal paper.

The submitted thesis certainly describes interesting application-oriented research that contributes to the area of RFNN as well. The research method, proposed approaches, and achieved results are well-described and indicate no major problems. The language as well as the technical quality of the manuscript are on a solid level, although minor problems such as typos (e.g. data preprocessing), grammatical errors, and mistakes (e.g. F. Rosenblatt is in the list of references included as Frank R.) exist. My major complaint is with regard to the organization of the manuscript, which can certainly cause confusion in the readers. Section 6, describing related work, is one of the key parts of the thesis. It shows what methods have been used in similar use cases in the past and it should be used as a rationale for the selection of methods, employed in the described research. In the order used in the manuscript, the author explains why RFNNs are a reasonable tool for river runoff prediction after the description of the method, enhancements, and experiments. Moreover, the argument used in the manuscript (neural networks have been used for runoff prediction for rivers with sloping terrain, therefore RFNNs and related algorithms are suitable for this task) is not convincing at all. Instead, an experimental evaluation of a battery of different methods (e.g. neural, kernel-based) would be more appropriate. The chaotic organization of the manuscript makes the reading uneasy in general. The reader learns that the
author developed a soft sensor at the very beginning of the manuscript (in abstract) but the term soft sensor is not explained before sec. 6. Section 3 describes a sophisticated method for RNN ensembling but the nature of the data, that explains why such complex model is needed, is not disclosed until sec. 4. And many other examples can be listed here.

Another two points that should be mentioned are the vague title of the thesis (bio-inspired computing says really nothing) and the publication record of the author. Although the publication portfolio shows that the results of this work have been presented at relevant peer-reviewed conferences, at least one publication in a major international journal with impact factor would be something one would expect from a PhD candidate at the end of his studies.

Nevertheless, the thesis clearly presents an original research work with contributions to the design of bio-inspired algorithms and impact on practical applications. The technical quality of the presented work is sufficient and the obtained experimental results convincing. The positive aspects of the work balance very well the imperfections, summarized in part in the text of this review. Because of this, I can, despite the comments raised above, recommend the thesis for defence without any hesitation.

doc. Ing. Pavel Krömer, Ph.D.
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