

## SUPERVISOR'S RECOMMENDATION FOR DISSERTATION DEFENCE

Applicant: Ing. Aliaksandr Barushka  
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Title of dissertation thesis: Machine learning techniques in spam filtering

Study programme: Applied Informatics

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The dissertation thesis submitted by Ing. Aliaksandr Barushka deals with spam filtering in various application domains using machine learning techniques with an emphasis on neural networks. The thesis is divided into 11 sections and has 116 pages.

### *Topicality of the dissertation*

Spam filtering (spam detection) using machine learning techniques has attracted much research interest due to the rapid growth of electronic communication, including e-mail, SMS, consumer review portals, social media, etc. Sending spam messages is increasingly tempting for users because spam can be sent relatively easily and may have huge impact, including economic benefits for the sender. It must also be noted that spam messages are increasingly sophisticated in these communication channels. Indeed, both human spammers and recently also spam produced by artificial intelligence generate spam messages that are difficult to distinguish from the legitimate content. Therefore, complex spam filters have been developed by using user-based and content-based features. These approaches have demonstrated effective performance in filtering spam recently. Various machine learning techniques are used to process these features. However, recent development in this domain signifies that spam senders are inventive in overcoming existing spam filters and, therefore, more effective models must be developed to keep up with this development. To sum up, I consider the topic of the dissertation thesis to be highly topical field of research.

### *Aim and objectives of the dissertation*

The aim of the dissertation is to propose a novel content-based spam filtering model that considers both bag-of-words and word context. Thus, a high-dimensional feature representation is produced and regularized deep neural networks are used to process this representation and effectively detect spam messages. This aim is sufficiently challenging and novel because it requires to develop an integrated context-specific text classification model utilizing deep learning. Such a complex model is shown to be more effective than existing approaches. The partial objectives are logical and specific, suggesting that the applicant is able to propose a solid research methodology.

### *Research methodology, results and contributions of the dissertation*

The applicant divided the dissertation thesis into 11 sections. In Section 1, state-of-the-art in spam filtering is provided. The literature review is up-to-date, well-arranged and systematic. Most importantly, the weaknesses of earlier approaches are clearly identified. To

overcome the identified problems, Section 2 presents the aim and objectives of this dissertation thesis. Section 3 introduces the main steps of the research methodology proposed for the dissertation. This section is clear and short as the next four sections elaborate the research methodology in detail. The experiments are well described in Section 8 and the results are reported in Section 9. As the benchmark datasets are publicly available, the experiments are easily reproducible. The results show that the proposed spam filtering model is more effective than the state-of-the-art spam filtering models. Importantly, the results do not only report the accuracy of the proposed model but computational effectiveness is also considered. From Section 10 it is clear that the model can be further improved and, thus, it provides several interesting directions for future research.

#### *Formal aspect of the dissertation*

The dissertation is technically well prepared, the language is clear and comprehensible. All tables and figures are well arranged and readable, although the figures presenting the results in terms of misclassification cost could be a bit larger. However, this is due to a large number of experiments performed using a number of methods and datasets. Concerning the remaining formal aspects, I found only several typos.

#### *Publication and other activities of the applicant*

The list of author's publications is presented in a separate section on page 115. It is obvious that the dissertation thesis is based on the results obtained in those publications. Notably, the list of papers includes three papers in journals with high impact factors (indexed in both Scopus and Web of Science). In addition, the paper entitled "Review spam detection using word embeddings and deep neural networks" has received the best paper award at the 15<sup>th</sup> International Conference on Artificial Intelligence Applications and Innovations in May 2019. Four conference papers are indexed in Scopus or Web of Science. His publications also received a considerable interest from the scientific community, with 20 citations in Scopus and 13 citations in Web of Science. In addition to his publication activity, he also participated in pedagogical activities in the first academic year of his study. As a student, he also participated in four projects of the Student Grant Competition and two projects of the Czech Science Foundation. He also has strong practical experience in the role of security engineer within a cybersecurity company, which provided him with a valuable practical insight into the problem solution.

#### *Conclusion*

The applicant has demonstrated the ability to conduct research on a complex problem. As his supervisor, I can state that the applicant has worked actively, came up with novel ideas frequently and worked to a large extent independently. The objective of the thesis is sufficiently challenging, and the proposed research methodology is well justified. The results obtained provide strong empirical support to the proposed approach. Therefore, I believe that the dissertation thesis entitled "Machine learning techniques in spam filtering" **does fulfil** requirements expected for a dissertation in the field of Applied informatics and I **do recommend** it for defence in the study programme Applied informatics.

In Pardubice, March 30, 2020

doc. Ing. Petr Hájek, Ph.D.