STATEMENT

regarding the procedure for acquiring the educational and scientific degree " PhD"

by

Alexander Ognyanov Marazov

In scientific area 4. Natural sciences, mathematics and informatics,

Professional field 4.6. Informatics and Computer Sciences,

Doctoral program „Informatics“,

Bioinformatics and Mathematical Modeling Department,

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The statement was prepared by ***Associate Prof. Peter Mladenov Vassilev, PhD — IBPhBME-BAS***, professional field 4.6. Informatics and computer sciences, in his capacity as a member of the scientific jury for the procedure, in accordance with Order 911/28.05.2024 of the Director of IBPhBME -BAS.

1. General characteristics of the dissertation and the materials provided

The documents submitted by the doctoral student in the procedure conform to the requirements of the Act on Development of the Academic Staff in the Republic of Bulgaria (ADASRB), Regulations on the implementation of the development of academic staff in the republic of Bulgaria Act(RIDASRBA), the Regulations for the conditions and procedure for acquiring scientific degrees and for holding academic positions in the Bulgarian Academy of Sciences and the Regulations on the implementation of the development of academic staff in the republic of Bulgaria Act in the Institute of Biophysics and Biomedical Engineering at the Bulgarian Academy of Sciences (RIDASRBA - IBPhBME).

The presented thesis entitled "Deep Neural Networks for the purposes of diagnostics in medicine" is 162 pages long and consists of an Introduction, 5 chapters, a Conclusion-summary of the obtained results and a Bibliography. The text is written in Bulgarian and contains citations to 146 sources. The scientific works presented by Alexander Ognyanov Marazov are 6 in number, including 1 paper in an international journal with an impact factor, one paper in a journal with an SJR, two papers in a Bulgarian scientific journal (where he is sole author) and two conference reports..

The dissertation is dedicated to improving the diagnostic process in medicine by designing, training and optimizing programming algorithms with convolutional deep neural networks. The research is primarily focused on Alzheimer's disease, although as the PhD student notes, his approach is "[...]easy to adapt for the imaging of other diseases." The PhD student is expanding the capabilities of convolutional neural networks using the developed by him inference method, based on the Kemeny-Young aggregation method, so that the results of the trained models are aggregated to achieve better classification accuracy. Additionally, a procedure for evaluating the obtained conclusion by means of an intercriteria analysis has been added. Based on a predetermined accuracy, threshold values for the degrees of membership and hesitancy that achieve the required recognition accuracy вхиле attaining the greatest possible coverage for the considered examples are

experimentally established.

2. Information and personal impressions of the doctoral student

Alexander Ognyanov Marazov completed his master's degree in Applied Mathematics (master's program "Computational Mathematics and Mathematical Modeling") at the Faculty of Mathematics and Informatics of SU "St. Kliment Ohridski" in 2013.

On July 1, 2018, he was enrolled as a doctoral student at IBPhBME-BAS in doctoral program "Informatics". I know the PhD student from his enrollment. Over the years, he has developed as an independent scientist, capable of making bold hypotheses and confirming or rejecting them with practical results and, whenever possible, with strictly theoretical proofs. Research and discussions with the PhD student on the applicability of intercriteria analysis in various fields has led to some of the results included in his dissertation. I am a co-author in one of the papers and one of the reports.

3. Actuality of the topic

The field of research is undeniably topical. On the one hand, the use of automated, diagnostic methods and tools assisting the clinicians will become more and more in demand in the future. On the other hand, the doctoral student has used the potential of convolutional neural networks for the diagnosis of Alzheimer's disease as the basis of his research in this direction - a disease that has an "extreme impact on public health". The goal and the tasks formulated for its achievement follow a clearly justified and realistic plan and are in line with the current state of the research field.

4. Assessment of the PhD student's publications and personal contributions

Four papers are mentioned in the dissertation. The first of them (in which I happen to be a co-author) is in a journal with an impact factor (Mathematics, IF = 2.4 (2023), Q1) – and is concerned with orders between intuitionistic fuzzy pairs; the second is in a journal with an SJR (International Journal Bioautomation, SJR = 0.139 (2023), Q4) – at the time of submission of the thesis, it was in press, and currently has published in Int J Bioautomation, 28 (2), 107-111 – concerned with improving the speed of the intercriteria analysis algorithm. The doctoral student is the sole author of two articles published in the Annual of Section "Informatics", Union of Scientists in Bulgaria - one of them describing the diagnosis of Alzheimer's disease with convolutional neural networks, and the other presenting the method for inference in machine learning proposed by the doctoral student based on the method of Kemeny-Young. Other results corresponding to the dissertation work were presented at two international forums - 10 th European Academy of Neurology Congress, Helsinki, Finland and 3 rd International Symposium on Bioinformatics and Biomedicine, BioInfoMed'2024. The publications contain the main results presented in an expanded form in the dissertation work. The PhD student has indicated 1 noticed citation. The doctoral student's contribution is undoubted, in two of the articles he is the sole author, in two he is the first (which implies a leading role), and in the remaining it should be equal to that of the other co-authors.

I also note that the doctoral student fulfills the specific requirements of RIDASRBA -IBPhBME for having at least three publications, one of which in a foreign journal with IF and one in which he is the first author.

5. Evaluation of contributions of the PhD thesis and their significance

I agree with the scientific contributions of the dissertation in the form formulated by the doctoral student:

1. An inference method based on the Kemeny-Young method is proposed.

2. A method for evaluating inferences of classification tasks in terms of intuitionistic fuzzy sets is proposed, based on intercriteria analysis.

3. A method for applying threshold values to the degrees of membership and uncertainty is proposed, which significantly increases the accuracy of the selected results

4. An algorithm is proposed to improve the speed of Intercriteria Analysis to O(n log(n))

Regarding the scientific and applied contributions, as formulated in the dissertation - most of them actually correspond to the program implementation of the results of the scientific contributions and are rather a necessity for the confirmation of the scientific contributions, rather than contributions in themselves.

6. Correspondence of the summaries of the dissertation and the dissertations

The Bulgarian and English summaries of the dissertation are well written, correspond in content and correctly reflect the most important results obtained in the dissertation work, as well as clearly state the contributions of the doctoral student.

7. Critical remarks and recommendations

In places, there are linguistic and technical inaccuracies in the presented dissertation, but this does not affect the understanding the ideas of the doctoral student. My sincere recommendation to the PhD student is to continue his research in this area and implement the ideas proposed in the guidelines for future work.

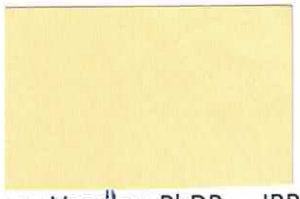
8. Conclusion

On the basis of all of the above, I confirm that the scientific achievements of Alexander Ognyanov Marazov satisfy the requirements of the ADASRB, RIDASRBA and RIDASRBA -IBPhBME for the acquisition of the educational and scientific degree "PhD" in the scientific area 4. Natural sciences, mathematics and informatics and professional field 4.6 . Informatics and Computer Science. In particular, the achieved results exceed the minimum national requirements for the professional field and no plagiarism was found in the scientific works presented by Alexander Marazov under the

procedure. In this sense, I recommend the scientific jury to award Alexander Ognyanov Marazov the educational and scientific degree "PhD" in scientific area 4. Natural sciences, mathematics and informatics, professional field 4.6. Informatics and computer sciences, doctoral program "Informatics".

23 August 2024

Statement prepared by:



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