REVIEW

By Prof. Magdalena Garvanova, PhD

University of Library Studies and Information Technologies – ULSIT

on a dissertation thesis for acquiring the educational and scientific degree "Doctor" in professional field 4.6 "Informatics and Computer Sciences", doctoral program "Informatics"

Dissertation Thesis by Emiliano Maksim Mankolli

Titled "Optimization Methods for Machine Learning Applications"

By Order No 319/06.12.2023 of the Director of the Institute of Information and Communication Technologies – BAS Corr. Member D.Sc. Svetozar Margenov I have been included in the Scientific Jury in connection with the procedure for acquiring the educational and scientific degree "Doctor" in professional field 4.6 "Informatics and Computer Sciences", doctoral program "Informatics" by Emiliano Maksim Mankolli at IICT-BAS with a dissertation thesis titled "*Optimization Methods for Machine Learning Applications*".

As a member of the Scientific Jury, I received:

1. Dissertation thesis for acquiring the educational and scientific degree "Doctor" in English;
2. Abstract of Dissertation thesis in Bulgarian;
3. Abstract of Dissertation thesis in English;
4. List of publications on the PhD student's dissertation;
5. Copies of the publications.

In the evaluation of the dissertation, the terms of the Law for Development of the Academic Staff in the Republic of Bulgaria (LDASRB), the Regulations for Implementation of LDASRB (Decree No 26 of February 13, 2019) and the Regulations of the IICT-BAS for the implementation of the Law for Development of the Academic Staff in the Republic of Bulgaria are decisive.

1. According to Art. 27 (1) of the LDASRB, "the dissertation work should contain scientific or scientific-applied results that represent an original contribution to science. The dissertation should show that the candidate has profound theoretical knowledge in the respective subject, as well as their abilities for independent scientific research."

2. According to Art. 27 (2) of the LDASRB, the dissertation work should be presented in a form and volume corresponding to the specific requirements of the primary unit. The dissertation work should contain: title page; contents; introduction; presentation; conclusion – summary of the obtained results with a declaration of originality; bibliography.

The scientific supervisor of the dissertation thesis is Prof. Vassil Guliashki, PhD.

ACTUALITY

The intensive penetration of technological innovation and artificial intelligence (AI) tools in all spheres of professional life in recent years has led to a significant digital transformation and the need to rethink traditional theories, policies and practices related to the labor market, business process management and strategic decision-making. The actuality, significance, and perspective of the topic of the dissertation related to developing innovative methods and algorithms for optimization of time and resources for personnel selection based on machine learning are indisputable.

GENERAL CHARACTERISTICS OF THE DISSERTATION

The dissertation contains 128 pages, richly illustrated with 17 figures and 5 tables, 131 relevant literature sources are used. The work is structured according to academic standards in 3 chapters, with introduction, conclusion, references, and annexes – a list of contributions and publications, a declaration of originality and a list of figures and tables.

The *aim* of the dissertation research is to develop algorithms that integrate machine learning and natural language processing to optimize recruitment time and resources. The following *tasks* emerge from the goal: 1. Overview of the most up-to-date methods of machine learning and natural language processing; 2. Analysis of optimization approaches for target functions within machine learning techniques; 3. Creating hybrid algorithms to reduce the number of candidates based on positions and the importance of the industry; 4. Derive a model for predicting success in work that integrates both quantitative and textual data, and 5. Generate solutions and recommendations related to the implementation of AI in recruitment. I believe that the purpose and tasks of the dissertation study are well-formulated and successfully realized during the analysis.

The first chapter provides an in-depth overview of the state of the art in terms of machine learning, natural language processing and optimization processes. A second chapter focuses on the use of a hybrid method by combining separate machine learning techniques that improves the accuracy of job matching of candidates and significantly streamlines their selection. Chapter three introduces an advanced machine learning method for predicting work success that improves the effectiveness of traditional manual approaches.

PUBLICATIONS

The more important and indicative results of the dissertation thesis have been published in 5 prestigious editions in English, indexed in Scopus and IEEE, 1 of which is with SJR and confirms the high quality of scientific production. One of the publications is independent and the others – co-authored, showing the skills of the PhD student to work both individually and in collaboration. These publications many times exceed the 30 points required in the Regulations for the Implementation of the Law for Development of the Academic Staff in the Republic of Bulgaria by Group of Indicators G, according to the minimum national requirements for acquiring the educational and scientific degree "Doctor"

in professional field 4.6 "Informatics and Computer Sciences". I have not found plagiarism or other improper use of other authors' ideas.

CONTRIBUTIONS

There are 5 scientific and 3 scientific-applied contributions, which fully reflect the merits of the dissertation research:

Scientific contributions:

1. A profound analysis of the applications of machine learning techniques and natural language processing in the recruitment industry has been made.

2. A combined approach from Word2vec and the SVM method is proposed to create a model that can systematically analyze a set of candidates and compare their qualification characteristics and the specific requirements of the industry.

3. A combined approach from the BERT and XGBoost method has been developed to further increase precision in identifying job similarities.

4. A holistic approach to recruitment assessment is presented to identify candidates' potential for success.

5. A model for predicting success in work is derived.

Scientific-applied contributions:

1. An algorithm is proposed to optimize the set of candidates by using the similarity of applications for effective recruitment.

2. An advanced hybrid method is proposed to reduce execution time and memory consumption by using BERT and XGBoost models.

3. A new perspective has been created for the development of the recruitment industry to cope with changes in the globalization of the labor market in many professions, especially in the era of AI.

The results presented sufficiently cover the scope of the scientific objectives and contain the potential for upgrading and developing in future research.

The abstract in both versions (in Bulgarian and English) is formed according to the requirements and accurately and faithfully represents the content of the dissertation.

CRITICAL REMARKS AND RECOMMENDATIONS

I have no critical remarks, but rather recommendations for the PhD student to continue to publish his scientific works in prestigious publications, referenced and indexed in the world-famous databases with scientific information such as Scopus, Web of Science, ACM, IEEE, and others, and at the next stage to publish a monographic work.

FINAL COMPLEX ASSESSMENT

In conclusion, I can say that the presented dissertation meets the requirements of the Law for Development of the Academic Staff in the Republic of Bulgaria and contains significant scientific and scientific-applied contributions. The achieved results give me reason to confidently propose to the respected Scientific Jury to award to **Emiliano Maksim Mankolli** the educational and scientific degree "Doctor" in professional field 4.6 "Informatics and Computer Sciences", doctoral program "Informatics".

29.01.2024

Sofia /Prof.

На основание ЗЗЛД