REVIEW

By Prof. Asya Georgieva Stoyanova-Doycheva, PhD

Faculty of Mathematics and Informatics at the University of Plovdiv "Paisii Hilendarski"

of a dissertation for awarding the educational and scientific degree "**doctor**"

in field of higher education
4. Natural sciences, Mathematics, and Informatics,

professional field

4.6. Informatics and Computer Science

doctoral program

Informatics

Author of the dissertation: *Veselina Rumenova Naneva*

Topic: **Web-based tools for data visualization**

Scientific supervisor: *Prof. Angel Atanasov Golev, PhD and Prof. Nikolay Velichkov Pavlov, PhD, Faculty of Mathematics and Informatics at the University of Plovdiv "Paisii Hilendarski"*

1. General presentation of the submitted materials

By order № RD 21-2229 of 27 November 2023 of the Rector of the University of Plovdiv "Paisii Hilendarski" (PU), I have been appointed as a member of the scientific jury to participate in a procedure for the defence of a dissertation on the topic of **Web-based tools for data visualization** for acquiring the educational and scientific degree "doctor" in field of higher education 4. Natural sciences, Mathematics, and Informatics, professional field 4.6. Informatics and Computer science, doctoral program Informatics. The author of the dissertation is **Veselina Rumenova Naneva** – a full-time doctoral student at the Department of Software Technologies, with scientific supervisors Prof. Angel Atanasov Golev, PhD, and Prof. Nikolay Velichkov Pavlov from FMI at the University of Plovdiv "Paisii Hilendarski".

The set of materials presented to me by Veselina Rumenova Naneva on electronic media is in accordance with Article 36 (1) of the Law on the Development of the Academic Staff of the University of Plovdiv and includes the following documents:

- an application form to the Rector of PU for initiating a procedure for the defense of a dissertation work;
- CV in European format;
- minutes from the department council related to reporting the readiness to open the procedure and preliminary discussion of the dissertation;

–   a dissertation;

–   an abstract in Bulgarian and in English;

–   a list of scientific publications on the topic of the dissertation;

–   copies of the scientific publications;

–   a declaration of originality and authenticity of the attached documents;

–   a certificate of compliance with the minimum national requirements;

–   a certificate for participation in projects from the Department for Scientific Research;

–   an opinion of scientific supervisors on the readiness of the dissertation for defense before a scientific jury.

The doctoral student has submitted 4 publications.

2. Brief biographical data for the doctoral student

Veselina Naneva completed her bachelor's degree in 2018 at University of Plovdiv, Faculty of Mathematics and Informatics (FMI), specializing in "Business Information Technologies." She obtained her master's degree in FMI at Plovdiv University in 2019, specializing in "Software Technologies with a specialization in Graphic Environments and User Interfaces."

From 2015 to 2019, Veselina Naneva served as a part-time assistant at the Department of Software Technologies, and since 2020, she has been a doctoral student in the same department. Since 2019, she holds the position of an "assistant" in the Department of Software Technologies. She conducts exercises in disciplines such as "Digital Image Processing," "Creation and Processing of Vector Images," "Publishing Systems," "Business Information Systems," "Information Technologies on the Internet," "Internet Technologies", ".NET Programming," and "Software Verification and Validation."

Veselina Naneva currently works as a "Power BI developer" at CODAR Ltd.

3. Relevance of the topic and appropriateness of the set goals and tasks

The dissertation topic is related to the development of web-based tools for data visualization. Despite the availability of ready-made visualizations, businesses often require an individualized approach when creating digital reports. Many systems offer a "store" for external visual elements, but under certain requirements, it may be necessary to create personalized visualization.

Exploring the intersection in the development of personalized visualizations can provide a clearer view of interface options, such as the Power BI Visual API and Tableau Extension API.

This can facilitate the creation of consistent graphical elements for presenting business data regardless of the chosen BI environment.

From the proposed goal and tasks (pages 9-10) of the dissertation, PhD student Veselina Naneva is working on current problems related to the development of an architecture for the unified creation of customized data visualization for Microsoft Power BI environment and Tableau with the ability to integrate with their specific APIs. Also, from the research of the doctoral student (page 9) and my personal research, where I did not find similar tools as the one related to the purpose of the dissertation, give me reason to believe that the problem solved in the dissertation is relevant.

4. Knowledge of the research problem

Veselina Naneva demonstrates a broad knowledge of the field, as evidenced by the extensive number of literary sources cited in the bibliography of the dissertation—86 sources in total. In Chapters 1 and 2, titled "Web-Based Data Visualization" and "Building Personalized Solutions for Information Presentation," respectively, the doctoral candidate thoroughly explores the possibilities and goals of Business Intelligence (BI) environments. Specifically, she provides detailed examinations of Microsoft Power BI and Tableau. This includes delving into the essence of interactive reporting realized through Microsoft Power BI and Tableau, the specifics of processing structured data in both environments, the diversity of visualizations offered, and the nuances of using external extensions in Microsoft Power BI and Tableau.

Furthermore, in Chapter 2, the candidate examines the construction of personalized solutions for information presentation in both proposed systems, utilizing their respective APIs. Extensions have been developed, such as the "Lollipop" personalized visual element for Power BI and the "Tree" graphic element for Tableau.

Considering all of this, I have reason to believe that the doctoral candidate is well-versed in the addressed problem and has conducted thorough research.

5. Research methodology

The chosen methodology for the development of the dissertation aligns with the stated objective. Firstly, the fundamental characteristics of the Business Intelligence (BI) environments Microsoft Power BI and Tableau are examined. Their respective APIs for constructing personalized solutions for information presentation are separately explored. General steps for creating graphic extensions for both environments are discussed. A model architecture for the unified creation of

personalized data visualizations for Microsoft Power BI and Tableau, with the possibility of integration with their specific application interfaces, is developed.

The created model is validated through the implementation of a graphical extension for both environments, named the "Triangle of Insurance Claims." This extension has been implemented and is actively used by business companies, providing tangible evidence of the successful outcome of the research presented in the dissertation.

6. Characteristics and evaluation of the dissertation work

The dissertation consists of 140 pages, including the cited literature and an appendix. There are a total of 86 literary sources, 37of which are Internet sources.

The thesis is structured in an introduction, four chapters, an overview of the author's contribution, an acknowledgment of the results, prospects for future development, a bibliography, and an appendix.

The introduction presents the problem addressed in the dissertation work and gives a clear vision of the set goals and objectives.

Chapter 1 "Web-Based Data Visualization" - this chapter examines the specifics of data visualization in the context of Business Intelligence. The principles of using and processing different data sources are presented in detail. It describes the basic steps that must be taken to extract raw business data, transform it appropriately, and load it into a selected product for subsequent analysis. Various data storage options are presented depending on the volume of work and the specific requirements for the final reference.

Because the result of working with BI tools is an interactive report, the chapter presents the main features and possibilities of accessing data in real time. The emphasis is on the characteristics of the two main BI tools that are considered by the architecture that is the goal of the dissertation - Microsoft Power BI and Tableau. Their principles for the formation of a digital reference, the syntactic differences when working with their databases and the variety of provided ready-made visualizations are presented.

Chapter 2 defines the specifics of interacting with the Application Programming Interfaces (APIs) of the software products Microsoft Power BI and Tableau. The main emphasis is on the characteristics of development and methods for accessing data, dependent on the environment into which each future extension is intended to be integrated. Additionally, methods of the respective additional components that need to be user-configurable are described. To illustrate the process of

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implementation and the nuances related to data access and styling of new views, individually developed sample visualizations are presented. These visualizations are created using the capabilities of each API separately.

Chapter 3 introduces the development of an architectural model for a unified process of creating personalized extensions, called TabWerBI. The central focus of the chapter is on abstractions of data access methods and ways to apply stylistic changes to the extension by the user. Using relevant schemes and classes, the fundamental interfaces, classes, objects, and constants needed to initialize the additional visualization in business metric presentation environments are demonstrated. The position of the architecture in data access and applying formatting settings to the new visualization is explained through diagrams. Templates for reuse related to configuration files necessary for the successful loading of the respective new components into the discussed BI environments are also included.

The *Fourth chapter* presents a specific application of TabWerBI, focusing on a unified process for creating visualizations for Microsoft Power BI and Tableau. By creating an insurance claims diagram in the shape of a triangle, the focus is on illustrating how a specific conceptual business visualization can be built using TabWerBI. The emphasis is on the initialization stages, loading the required fields for the selected positions and styling options. The result is an individually tailored insurance claims triangle that is demonstrated through photos of its implementation in both environments. Creating a dynamic data label in the "Data Label" visualization format is covered separately. Described is the process of building through TabWerBI and integrating Lollipop and Tree views in environments other than those originally presented in Chapter two.

The conclusion of the dissertation includes a summary of the results and related developments, as well as publications presented in a table. It also provides a vision for the future development of the work.

The appendix presents part of the code implementation presented in the dissertation.

7. Contributions and significance of the work for science and practice

The main contributions of the dissertation development have both scientific-applied and applied characteristics. Four main results have been defined in the dissertation, corresponding to the set tasks in the introduction (page 111):

1. Both the necessary dependencies and specifics, as well as the intersection points of the APIs for Power BI and Tableau, are derived, with a view to forming a uniform structure.

2. An architecture for unified development of TabWerBI custom visualizations has been created, which covers two aspects of abstraction - at the level of data access and basic styling of the new extension.

3. The specific requirements of a specific subject area - insurance - have been studied, and an industry-recognizable visualization of the development of the quality of an insurance portfolio has been built.

4. Several prototype visualizations with a specific focus have been developed using TabWerBI's unified custom visualization architecture.

Each of the four results corresponds to the described development in Chapters 2 to 4, so I accept the claims of the doctoral candidate for achieving the set goal of the dissertation.

Result 3 is used in practice – implemented as a prototype in a real insurance information system in a company in the Netherlands.

I believe that the reached results correspond to the normative requirement that they represent an "original contribution to science" (Art. 27(1) of the Rules for the Implementation of the Act for the Development of the Academic Staff in the Republic of Bulgaria).

8. Evaluation of the dissertation publications

The author has presented a list of four publications in proceedings of international conferences, all of which are in English. Two of the publications with numbers 1 and 2 from the list of publications have been indexed in Scopus and/or Web of Sciences and have respective SCImago Journal Rank (SJR). This satisfies the minimum national requirements of the Rules for the Implementation of the Act for the Development of the Academic Staff in the Republic of Bulgaria for a minimum of 30 points under group G indicators, where the doctoral student has 60 points. From Table 3 on page 111, Result 1 (page 111) of the dissertation is reflected in the four publications related to the dissertation, which I am convinced of. The author's publications are co-authored.

The doctoral candidate has participated in six projects, two of which were funded by the National Science Fund of the Ministry of Education and Science, and four were funded by the Scien-

tific Research Fund of Plovdiv University, as evidenced by an official certificate from the Scientific Research Department.

9. Personal participation of the doctoral student

I have no doubts about the personal contribution of Veselina Naneva in the conducted dissertation research and in obtaining the relevant scientific-applied and applied results.

I have not found any plagiarism in the developments and results related to the dissertation work.

10. Abstract

The abstract is provided in Bulgarian and English, according to the requirements, in the volume of 32 pages; in terms of size and content, it meets the requirements for accurate, complete, and concise coverage of the dissertation.

11. Critical remarks and recommendations

I have the following questions and remarks for the doctoral student:

1. All my recommendations related to defining the goals and tasks of the dissertation, presenting the relevance of the problem, and some syntactic and grammatical notes that I made during the preliminary discussion of the dissertation have been considered and addressed in the final version of the dissertation.

2. The four publications related to the dissertation reflect Result 1 from the dissertation (page 111). I recommend to the doctoral candidate to publish the remaining results from 2 to 4 in international conferences and journals.

3. The developed abstract model of architecture for unified creation of additional visualizations for Business Intelligence tools Microsoft Power BI and Tableau is, for me, the primary scientific-applied contribution in the dissertation. My question in this regard to the doctoral candidate is whether there are any shortcomings and/or limitations in the proposed model, and if so, what are they?

4. Some of the results obtained in the dissertation have been implemented as prototype visualizations in a real insurance information system at a company in the Netherlands: the 'Insurance Claims Triangle' and 'Data Label.' I consider this result to be very positive, and my question is whether you have received feedback from users of these prototype visuali-

zations and, if so, what is it? Has this company used TabWerBI, and if yes, do you have feedback on its performance?

Despite the comments made, which do not affect the quality of the presented dissertation work, I must note that the topic of the dissertation is current and the achieved results deserve high praise. The doctoral student has shown in-depth knowledge of the field and the ability for independent scientific research in her work.

12. Personal impressions

"I know Veselina Naneva as a student and a doctoral candidate, and from her work as an assistant in the Department of Software Technologies. My personal impressions are that she is exceptionally responsible and performs her duties as an assistant with great enthusiasm and diligence.

CONCLUSION

The dissertation contains **scientific-applied and applied results**, which represent an original contribution to science and meet all the requirements of the Act for the Development of the Academic Staff in the Republic of Bulgaria, the Rules for the Implementation of the Act for the Development of the Academic Staff in the Republic of Bulgaria (ADASRB), and the relevant Rules of the University of Plovdiv "Paisii Hilendarski". The presented materials and dissertation results fully correspond to the minimum national requirements in the Rules for the implementation of the ADASRB.

Due to the above, I confidently give my **positive** assessment of the conducted research, presented by the above-reviewed dissertation work, abstract, achieved results, and contributions, and I propose to the honorable scientific jury to award the educational and scientific degree "doctor" to Veselina Rumenova Naneva in field of higher education: 4. Natural sciences, Mathematics, and Informatics, professional field: 4.6. Informatics and Computer Science, doctoral program: Informatics.

10.12.2023   Reviewer: ....

                                                                  Prof. Asya Stoyanova-Doycheva, PhD