REVIEW

by **Professor Leoneed Mihaylov Kirilov, PhD**

Inst. of Information and Communication technologies – Bulgarian Academy of Sciences

on the Thesis for awarding educational and scientific degree "Doctor of Philosophy" (PhD), under the Scientific field: 4. Natural Sciences, Mathematics and Informatics; the Professional area: 4.6. Informatics and Computer Sciences, the Doctoral program: Informatics

Author of the PhD Thesis: **Zornitsa Agresimova Dimitrova**

PhD thesis title: MODELS AND SOFTWARE ARCHITECTURES OF DECISION SUPPORT SYSTEMS

According to the Order No. 339 from December 22, 2025 of the Director of the Institute of Information and Communication technologies – Bulgarian Academy of Sciences Corr. Member Svetozar Margenov, D.Sc., I have been appointed as a member of the Scientific Jury regarding the PhD thesis of Zornitsa Agresimova Dimitrova for awarding educational and scientific degree "Doctor of Philosophy" (PhD) in the Scientific field: 4. Natural Sciences, Mathematics and Informatics; the Professional area: 4.6. Informatics and Computer Sciences, the Doctoral program: Informatics.

At the first meeting of the Scientific Jury on December 23, 2025, it was decided that I would write a review on the dissertation.

As a member of the Scientific Jury I have received:

1. Text of the Thesis for awarding educational and scientific degree "Doctor of Philosophy";
2. Abstract of the Thesis both in Bulgarian and English;
3. Full text of the articles attached to the dissertation as an integral part of it in accordance with the requirements of ZRASRB and the Regulations for its implementation - five articles;
4. A reference for Zornitsa Agresimova Dimitrova on fulfillment of the minimum requirements of the Institute of Information and Communication Technologies - BAS for awarding the educational and scientific degree "Doctor".
5. Order No. 332 from December 20, 2024 issued by IICT – BAS for withdrawing Zornitsa Agresimova Dimitrova from full-time doctoral studies with right up for grant PhD degree when the Thesis is ready within a legal deadline.
6. Order No. 339 from December 22, 2025 issued by IICT – BAS for designation of Scientific Jury;

Scientific advisor of the PhD student is Prof. D.Sc. Daniela Borissova.

The dissertation is written on 143 pages and it consists of introduction, 4 chapters where the scientific results are presented, conclusion-summary of the results obtained, contributions, list of publications attached to the dissertation, declaration of originality. The text is illustrated with 53 figures and 24 tables. The bibliography contains 143 references.

The objective of the dissertation is:

- to propose models and software architectures for decision support Systems (DSS).

To achieve the goals, eight tasks have been formulated, which I present in a summarized form:

1. to perform an analysis of the Weighted Sum Method - WSM and the Weighted Product Method - WPM, as well as of the main software architectural styles and patterns for developing Web applications;
2. to propose modifications of the WSM and WPM algorithms and models, considering the different competence domains of the DMs; and for formalizing the generation of coefficients that give an advantage in the overall performance of the alternatives; and for formalizing the generation of alternatives scores (the latter is for WSM only).
3. to propose a generalized algorithm and combined mathematical models on the base of task 2;
4. to design different software architectures that satisfy conflicting requirements for the decision support systems;
5. to develop prototypes of a DSS in accordance with the designed architectures, including a module for results interpretation;
6. to determine the practical applicability of the proposed modifications.

I consider that the so formulated goal and objectives accurately reflect the main ideas realized in the dissertation. The relevance and significance of the results obtained are well presented in the main text.

The contributions of the dissertation are six in number and are formulated on pages 130-131. They are not grouped into scientific, scientific-applied and applied contributions. According to me, they are as follows:

I. Scientific Contributions

1. Modifications of the weighted sum and weighted product models are proposed for multi-attribute analysis tasks and several DMs. These modifications take into account the different areas of competence of decision makers. Algorithms for solving the models are also proposed.

2. A modification of the weighted sum model is proposed, relating to the generation of estimates for alternatives in multi-attribute analysis tasks with one or several Decision Makers. An algorithm for solving is proposed.

3. Modifications of the weighted sum and weighted product models are proposed for multi-attribute analysis tasks and one or several DMs for generating coefficients for selected criteria that allow for additional comparison of alternatives. Algorithms for solving are proposed.

II. Scientific and applied contributions

4. Two software architectures (three-layer and serverless) are proposed for implementing decision support systems. The main components in the logic of both architectures are combined and generalized models of the three modifications of the weighted sum model and a generalized algorithm combining all modifications of the weighted sum models (9 sub-models) and the weighted product (4 sub-models).

5. Two prototypes of decision support systems have been developed in accordance with the proposed software architectures.

A number of five co-authored publications in English are attached to the dissertation, which reflect some of the scientific results. All publications are in the Scopus database. Two of them have an impact rank of Q4, one of them has an impact rank of Q2. It can be concluded that the results obtained are recognized in scientific circles. The publication activity of the doctoral student significantly exceeds the

required minimum of 30 points. Namely, the total sum is 84 points according to the prepared report for IICT-BAS and 126 points according to the report for NACID.

The abstract in Bulgarian is 46 pages long (in English - also 46 pages long). I consider that it accurately reflects the content of the dissertation.

General opinion about the dissertation: The dissertation is well structured and written. Chapter one is an overview. It shows a good knowledge of the subject area. Chapter two is theoretical in nature. There, the variants of the modifications of the weighted sum and weighted product models for multi-attribute analysis tasks with one and several DMs are presented. The scientific and applied contributions are described in chapter three – two models of software architectures and, respectively, two prototypes of decision support systems. The numerical experiments for testing the three proposed models, as well as the generalized model are presented in chapter four. The experiments were carried out using the solution of selected real tasks in several scenarios. The experiments were conducted using the solving of selected real-world problems in several scenarios. An analysis of the obtained solutions was performed, which shows the effectiveness of the proposed models.

Personal opinion about the doctoral student: I have known Zornitsa Agresimova Dimitrova since she joined the IPDSS section of IICT-BAS. I have not worked with her and we have no joint publications. My opinion is positive.

Critical notes: I have no critical notes or questions about the dissertation.

Conclusion

I accept that the requirements of the Law on the Development of Academic Staff in the Republic of Bulgaria (ZRASRB), the Regulations for its implementation, the Regulations on the terms and conditions for obtaining scientific degrees and holding

academic positions at BAS and the Regulations on specific conditions for acquisition of scientific degrees and for holding academic positions at the Institute of Information and Communication Technologies – BAS are met.

I give **a positive assessment** for the acquisition of the educational and scientific degree "Doctor" of Zornitsa Agresimova Dimitrova.

I recommend to the esteemed Scientific Jury members to award the educational and scientific degree "Doctor" of Zornitsa Agresimova Dimitrova in the scientific field: 4. Natural Sciences, Mathematics and Informatics, Professional field: 4.6 Informatics and Computer Science, doctoral program: Informatics.

February 3, 2026

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