

REVIEW

of the dissertation submitted by

Angel Ivanov Dimitriev

on the topic:

“A Software Product for the Implementation of Generalized Net Models and Its Applications”

for the acquisition of the educational and scientific degree **“Doctor”**

in Professional Field 4.6 **“Informatics and Computer Science”**

at the Institute of Biophysics and Biomedical Engineering

by **Prof. Dr. Sotir Sotirov**, Burgas State University “Prof. Dr. Asen Zlatarov”

On the grounds of an Order issued by the Director of the Institute of Biophysics and Biomedical Engineering, I was appointed as a member of the scientific jury to prepare a review of the dissertation submitted by Angel Ivanov Dimitriev on the topic “A Software Product for the Implementation of Generalized Net Models and Its Applications”.

Brief Biographical Information

Angel Dimitriev holds Bachelor’s and Master’s degrees in Informatics and Logic from Sofia University “St. Kliment Ohridski”, where he acquired a solid theoretical background in the fields of algorithms, discrete mathematics, and computability. His professional career is related to software engineering, where he has worked as a senior software engineer and developed solutions for processing large volumes of data, search systems, and artificial intelligence applications. He has accumulated practical experience in the development of highly reliable systems using technologies such as C++, Java, databases, and Linux environments.

In parallel with his industrial career, he has also developed active teaching experience as a lecturer and teaching assistant. He has participated in the teaching of key disciplines such as algorithms, data structures, object-oriented programming, and probability. He is distinguished by teamwork skills, leadership qualities, and research activity.

Description of the Dissertation

The dissertation comprises 182 pages and represents a completed scientific study with clearly expressed theoretical, algorithmic, and applied contributions. It contains an introduction, four chapters, a conclusion, a statement of contributions, a list of publications, and a bibliography. The structure is logically consistent and demonstrates a systematic progression from theoretical foundations to practical implementations.

The first chapter is fundamental in nature. It examines the theoretical foundations of generalized nets in the context of their development as a generalization of Petri nets. The formal apparatus is presented with the necessary rigor, including definitions, functioning algorithms, and structural characteristics of the models. The analysis of existing software solutions is carried out critically and convincingly, clearly outlining their limitations.

The second chapter contains substantial algorithmic developments. Approaches are proposed for the automated visualization of generalized nets through transformation into graph representations, as well as a method for converting graphical models into TeX format. Although part of the implementation is based on existing tools such as Graphviz, the contribution lies in the integration and formalization of the process.

The third chapter represents the central part of the study. It presents the development of a web-based system, OnlineGN, which implements a complete environment for modeling, visualization, and simulation. The architectural solutions are modern, modular, and aligned with the requirements for extensibility and integration. The presence of a real software implementation significantly increases the value of the dissertation.

The fourth chapter demonstrates the applicability of the developed approaches through the modeling of classical and real processes, including finite automata, algorithmic tasks, and industrial systems. These applications show the practical relevance of the research.

Overall, the dissertation is characterized by good scientific culture, correctness of exposition, and a clear orientation toward applicability.

Relevance and Significance of the Topic

The topic is undoubtedly relevant. The modeling and simulation of complex processes are key areas in contemporary informatics and artificial intelligence.

The correct identification of the need for an integrated online environment for working with generalized nets deserves particular positive evaluation. The developed system represents a natural stage in the evolution of existing tools, and the technologies used have been appropriately selected.

The work has a clearly expressed interdisciplinary character and demonstrates the candidate's research independence.

Main Scientific and Scientific-Applied Contributions

The dissertation contains contributions of both scientific and scientific-applied nature.

Scientific Contributions

The following scientific contributions have been achieved in the present dissertation:

1. **Algorithms for automation and visualization of generalized nets (GNs):**
 - An algorithm has been developed for the automated drawing of GNs based on their abstract description, eliminating the need for manually specifying coordinates.
 - An algorithm has been created for converting vector images (SVG) of GNs into TeX format by identifying graphical primitives and transforming coordinates.
2. **Parallel solution of an exponential problem — the Tower of Hanoi:**
 - A new parallel variant of the Tower of Hanoi problem has been formalized, allowing the simultaneous movement of up to k disks.

- A theorem on the minimum number of parallel steps has been proven, and a constructive algorithm for solving the problem has been implemented.
3. **Generalized net modeling and simulation of the parallel exponential Tower of Hanoi problem:**
- An original GN model of the parallel Tower of Hanoi problem has been created, using ρ -kernels for objects and χ -kernels for resources.
 - The applicability of the formalism has been proven through simulations in the OnlineGN environment, demonstrating effective management of concurrent processes and logical constraints.

Scientific-Applied Contributions

From a scientific-applied perspective, the following results have been achieved:

1. **Design, implementation, and application of the OnlineGN software system:**
 - An innovative web-based platform for modeling, simulation, and visualization of GNs has been developed, offering a centralized environment without the need for local installation.
 - A convenient and interactive interface has been developed for modifying each component of the GN in the simulator, as well as for tracking details related to the execution of the net.
 - Functionality for exporting from SVG to TeX has been implemented, optimizing the preparation of graphical materials for academic publications.
2. **A new method for representing finite automata through GNs:**
 - A methodology has been developed for describing deterministic and nondeterministic finite automata through GNs, allowing the representation of parallel computational paths.
3. **Modeling of existing processes in an oil refinery through GNs:**
 - GN models of real technological processes in an oil refinery have been developed, including the production of gas, polymer, and heavy petroleum products.
4. **Verification of the new GN models through OnlineGN:**
 - All newly created models in the dissertation have been verified through simulations in OnlineGN, which simultaneously verifies the correctness of the models and the capabilities of the system.

I accept the candidate's contributions.

Approbation of the Results

The doctoral student's publication activity is characterized by good focus and consistency, covering the main areas of the dissertation: algorithmic developments, software implementation, and applied aspects of generalized nets. The five scientific publications presented demonstrate the logical development of the research — from theoretical formulations and visualization methods, through the implementation of the OnlineGN system, to its application in solving classical algorithmic tasks and modeling real industrial processes.

Particularly noteworthy are the publications in international journals, including journals with high scientific visibility, which testifies to the quality and significance of the results. Participation in joint research with established scholars further emphasizes the doctoral student's integration into an active scientific environment. The publication activity fully meets the requirements for the acquisition of the educational and scientific degree "Doctor".

The submitted documents indicate that the doctoral student has 7 citations. According to the Scopus reference, Angel Dimitriev has 5 publications, 10 citations, and an h-index of 2.

From the presented report on the fulfillment of the requirements under the credit system, it is established that the doctoral student fully meets and exceeds the legally defined criteria for admission to defense.

Under the indicator for educational training, 130 points have been accumulated, which covers the required minimum. Under the indicator for approbation of scientific results, 40 points have been achieved, which corresponds to the requirements and confirms the doctoral student's active participation in scientific forums.

Particularly significant is the performance under the indicator for publication activity, where 66 points have been reported against a minimum requirement of 30 points. This testifies to high scientific productivity and to the significance of the achieved results.

The total number of points amounts to 236 against the legally required 200, which clearly demonstrates that the doctoral student not only meets but significantly exceeds the requirements of the credit system.

On this basis, it can be categorically accepted that all quantitative and formal criteria for the acquisition of the educational and scientific degree "Doctor" have been fulfilled.

Critical Remarks

Along with the indisputable merits of the dissertation, the following critical remarks may be noted:

In Chapter 2, the terminological designation of the developments as "algorithms" should be clarified, insofar as they include the use of external tools.

In Chapter 3, there is insufficiently detailed analysis of the simulation mechanism and no quantitative assessment of the non-functional characteristics. The aspect of security is also not discussed, which is essential for web-based systems.

In Chapter 4, inaccuracies can be observed in some of the formulations and proofs, as well as insufficient clarity regarding the use of real data.

The system code contains solutions that could create risks from the point of view of security and reliability. The dissertation also contains a considerable number of syntactic and technical errors. The remarks noted above do not call into question the scientific value of the dissertation.

Personal Impressions

I do not know the candidate personally and have no personal impressions.

Conclusion

The dissertation of Angel Ivanov Dimitriev represents an independent, completed, and scientifically grounded study with a contributory character.

The results obtained have both theoretical and applied significance and correspond to the contemporary level of development of the scientific field. The doctoral student has completed all necessary activities and publications in accordance with the regulations of the Institute of Biophysics and Biomedical Engineering.

On the basis of all the above, I give my positive opinion and recommend to the esteemed members of the Scientific Jury to award Angel Ivanov Dimitriev the educational and scientific degree “**Doctor**” in Professional Field 4.6 “**Informatics and Computer Science**”.

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