

REVIEW

on dissertation
for obtaining an educational and scientific degree PhD
in scientific field 4. Natural Sciences, Mathematics and Informatics,
professional field 4.6. Informatics and Computer Science,
doctoral program Informatics (code 01.01.12)
author of the dissertation doctoral student Angel Ivanov Dimitriev
with scientific supervisors: acad. dmsci dtsci, Krasimir Atanasov
assoc. prof. dr, Nora Angelova
title Software product for implementation of generalized network
models and its applications
Reviewer Pencho Genov Marinov, professor dr, BAS-IICT
section "Parallel Algorithms"

0. General description of the presented materials

By Order № 231, dated 24.03.2026 of the Director of the Institute of Biophysics and Biomedical Engineering (IBPhBME) – BAS, (based on the Decision of the Scientific Council (Protocol № 5 / 19.03.2026) and in accordance with Art. 9 of the Law on the Academic Staff Development Act of the Republic of Bulgaria (ASDARB). I was appointed as an external member of the Scientific Jury for the defence of a dissertation for the award of the Education Scientific Degree "Doctor" / PhD / (the scientific field, professional direction, scientific speciality, topic, etc. are described above).

By Order № 276, dated 31.03.2026 of the Director of the IBPhBME – BAS, on the basis of Order № 231, above, a date was set for the First Meeting of the Scientific Jury, and on 02.04.2026, and at this meeting I was elected as a reviewer.

The following is a list of the materials I received:

0. *Application* from part-time doctoral student Angel Ivanov Dimitriev for admission to defense. / at the end with date 06.03.2026, and the file is named 00_Zayavlenie.pdf from 2026-03-16 / and ends with a list of 9 (nine) attached documents according to *Regulations of the Institute of BPhBME – BAS for the implementation of the Law on the State of the Republic of Bulgaria on the Admission and Training of Doctoral Students at the BAS*

1. "1. European-style CV;" , (2 pages, in English)

/ In the ZIP-archive, this is a file with the name 01_Angel-Dimitriev-Cv.pdf and the date 2026-03-20 /.

Some data about the doctoral student: Personal data: born in Sofia, 24/04/1995
Education and training: Secondary Education: (15/09/2009 - 30/06/2014) – German Language Highschool Sofia; Higher Education: (01/10/2016 - 30/09/2020) – Sofia University - Faculty of Economics - Informatics, Bachelor; (01/10/2020 - 31/03/2022) – Sofia University - FMI - Informatics, Master's degree, in Logic and Algorithms; (01/07/2022 - current) – Bulgarian Academy of Sciences - IBPhBME, PhD student.
Work experience: (15/04/2020 - 30/06/2022) – Sofia - FLATEXDEGIRO, software engineer; (10/02/2018 - current) – FMI - Sofia University, lecturer and assistant; (03/02/2020 - current) – Sofia - SENIOR SOFTWARE ENGINEER - PROS, C++

and *Java* developer; Skills and competencies: *C++*, *Java*, *MySQL*, *MongoDB*, *Linux*; strengths - software development, mathematics, team leadership, teamwork, training/teaching; Languages: native - Bulgarian, English and German - level *C1* - for writing, speaking, reading and comprehension.

2. "2. Copy of Master's Degree Diploma,"

/ In the ZIP-archive, this is a file with the name *02_Diploma_Master_ADimitriev.pdf* and date *2026-03-16* /. The volume is 3 pages (each with 2 pages of the document), in Bulgarian. The main facts of the document are: Series A-2021 SU Reg. № M 267031 / 08.06.2022 ; Specialty *Informatics*; Master's program (professional qualification) *Logic and algorithms*; Graduated in 2022 three-semester course (1.5 academic years) of study; With an average grade point average from the course of study *Excellent 5.90*; Total number of credits 93 (78+15); Average grade point average from the diploma thesis / state exam *Excellent 6.00*; Protocol of the State Examination Commission № 819 / 31.03.2022; In the left half is Main page of the Diploma of Higher Education OIC Master, issued by FMI – Sofia University "St. Kl. Ohridski" ; / this is on the 1st page /; On the 2nd page is an Appendix to the Diploma of Higher Education, with a repetition of the information from above, and with the new elements for: Faculty № 26478; Form of study – full-time; Title of the Diploma Thesis *Stochastic analysis of the amount of memory of the algorithmic search scheme with return* Number of credits 15; On the 3rd page /in the left half / is a Reference (table) with academic disciplines, hours, credits, grades, number of credits 78, success 5.90

3. "3. Report on exams taken and credits received by the doctoral student"

/ In the ZIP, the file is named

03_Справка_за_Изпълнение_на_образователно_научниата_апропбация.docx and dated *2026-03-20* /. (the name of this file is the only one that is not in Latin letters in the ZIP package, and is misspelled)

According to the Appendices below, Angel Dimitriev has passed all the necessary exams and has covered all the necessary credits for admission to the defense:

40 credits from the implementation of the scientific program /scientific seminars/conferences, mandatory 40/ (8 + 32) ;

implementation of the educational program – 130 credits from courses/exams (with a mandatory minimum of 130) /1 x 40 + 2 x 20 + 1 x 25 + 1 x 25/

66 – from publications, scientific results on the topic of the dissertation (mandatory minimum 30), / 2 x 25 + 1 x 6 + 1 x 10 /;. The reviewer noticed the following: one publication is with 0, and is under №3 in the List (see below item 4.), and is with IF; and one publication is with 10 and is unnumbered, and is under №2 in the List (see below item 4.) – otherwise there is no shortage of points.

Total 236 (with a mandatory minimum of 200) / 40 + 130 + 66 /.

3.1 "3.1. completed Table for the evaluation of the preparation of a doctoral student at the IBPhBME-BAS by credit system;" /In the ZIP, a file with the name *03_1_table_angel_phd.xlsx*, and date *2026-03-16*/. The main data (numbers) are described in detail above.

3.2 "3.2. protocols and certificates of successfully passed exams according to the individual training plan;"

/ In the ZIP, 4 files with the names *03_2_1Certifikati_OM_IRM.pdf*,
03_2_2Certifikat_Anglijski.pdf, *03_2_3Certifikat_Danni_R.pdf*,
03_2_4Minimum.pdf; all dated *2026-03-16* /.

where

03_2_1 is a Certificate from the Training Center – BAS, in confirmation of having successfully completed the courses of Acad. Kr. Atanasov *Intuitionistic Fuzzy Sets* and *Generalized Networks* in January, 2022.

03_2_2 is a Certificate for the English Language (dated 27.10.2023), and has №110 / 2023, for Level B_1^+ , with a grade of 5.25;

03_2_3 is Protocol of the test held on 23.04.2023, by examiner Todor Balabanov, on the topic *Data Analysis with R*, with a grade of 6.00.

03_2_4 is Protocol of the exam for the doctoral minimum in the specialty *Intuitionistic Fuzzy Sets*, according to the doctoral plan, held on 07.04.2025, by a commission approved by Order №216 / 19.03.2025, the grades given in the exam are: written - 5.50, oral - 6.00, total - 5.75.

4. “4. list of publications;” - is in the Application, respectively in the ZIP is a file named 04_List_of_publications.docx and dated 2026-03-20,

We noted above in item3., regarding publications №№ 2 and 3 of this List, that they were not fully accounted for,

5. “5. copies of publications;” – is in the Application, respectively in the ZIP is a folder named 05_Publications/ and dated 2026-03-20. Five (5) files are of the publications themselves:

05_Publications/1_DrawGenNets_fin.pdf ,

05_Publications/2_KCI_FI003299764.pdf ,

05_Publications/3_Software - Parallel Towers of Hanoi via Generalized
Nets Simulated.pdf ,

05_Publications/4_Mathematics-Modeling-the-Production-Process-of-Fuel-
-Gas,-LPG,-Propylene,-and-Polypropylene-in-a-Petroleum-Refinery-Using
-Generalized-Nets.pdf ,

05_Publications/5_Mathematics-Generalized-Net-Model-of-Heavy-Oil-Pro
ducts'-Manufacturing-in-Petroleum-Refinery.pdf .

one (1) acceptance letter for printing, and a certificate of presentation:

05_Publications/1_DrawGenNets_fin acceptance letter.pdf,

with date at the end 10.10.2024, and

05_Publications/1_DrawGenNets_fin certificate presentation.pdf,

with date 18.10.2024 .

and two (2) separation protocols indicating the contribution of the co-author to the respective article:

05_Publications/4_Mathematics_razdelitelen_protokol.pdf, dated 27.10.2025,

05_Publications/5_Mathematics_razdelitelen_protokol.pdf, dated 27.10.2025 .

6. “6. list of noted citations – is in the Application, and in the ZIP is a file named 06_List_of_citations.docx dated 2036-03-20. Not required for this procedure, but 7 (seven) are marked – one article with 6 citations, 1 – with one (five of which are visible with *Scopus*).

7. “7. 3 copies of the dissertation; – is in the Application, and in the ZIP is a file named 07_dissertation-main-bg.pdf dated 2026-03-20

In short: volume – 182 pages; Figures – 85; code fragments – 25; formulas – 19; literature sources – 104. It consists of the following parts: Table of Contents, Introduction, 4

Chapters, Conclusion, Author's reference for contributions, List of publications on the topic, Bibliography, and Declaration of originality of the results.

8. "8. 9 copies of the abstract in Bulgarian or English of the dissertation work; – is in the Application, and in the ZIP are the files:

file with the name 08-abstract-main-bg.pdf dated 2026-03-20,

and file with the name 08-abstract-main-en.pdf dated 2026-03-20,

The numbering of the figures and the literary sources from the dissertation is preserved in the abstracts. One figure is cited in the abstract (in both languages), but is missing and is only present in the dissertation / refers to Fig. 60 /, And another 9 (nine), are not mentioned, but they are present.

The parts of the Abstracts are almost like the Dissertation, they are the same - with the exception of the last element - The Declaration.

9. "9. 6 CD with all the above documents, an abstract in Bulgarian and English, and a copy of the Regulations." – is in the Application, and in the ZIP there is a file named "10_Pravilnik_ZRASRB_IBPhBME.pdf dated 2026-03-16", and these are 26 pages (together with the annexes) of REGULATIONS ON THE IMPLEMENTATION OF THE LAW ON THE DEVELOPMENT OF THE ACADEMIC STAFF IN THE REPUBLIC OF BULGARIA AT THE INSTITUTE OF BIOPHYSICS AND BIOMEDICAL ENGINEERING AT THE BULGARIAN ACADEMY OF SCIENCES

1. Relevance of the problem and appropriateness of the set goals and objectives

The Introduction states the main goal of the development: the creation of the software system OnlineGN – a web-based simulator that combines the theoretical foundations of GN with modern web technologies.

In Chapter 1, Section 1.3. the goal is set and 9 tasks are described to achieve the goal:

Task 1. Development and implementation of an algorithm for automatic drawing of *GN* according to their description in structured text format.

Task 2. Development and implementation of an algorithm for converting SVG image of *GN* into *TeX* format, in order to easily include visualizations in scientific publications.

Task 3. Formulation of requirements for a web-based solution.

Task 4. Design of the architecture of the *OnlineGN* system and definition of the main modules (network storage, visualization, editing, simulation, import/export, *API*).

Task 5. Implementation of a web-based graphical interface for visualization, editing and personalization of the generated image (positions, transitions, connections and visual parameters).

Task 6. Implementation of a convenient interface for editing predicates in the indexed matrix and characteristic functions of the positions.

Task 7. Implementation of a mechanism for online storage and sharing of networks through a unique hyperlink (link), based on centralized storage in a database.

Task 8. Creation and formalization of new GN models of real processes, which have not been described using *GN* so far.

Task 9. Simulation and verification of the developed models in *OnlineGN* through scenarios and experiments.

2. Knowledge of the state of the problem and the literary material by the dissertation candidate

There is no doubt that the dissertation candidate has entered the scientific issue very well. The list of cited literary sources is up-to-date – publications from the last 10 years predominate, 56 out of 104, the rest are older sources. The total number of cited sources is 104, 91 of which are in English, 13 in Bulgarian. The dissertation candidate's knowledge of the problem is very well illustrated by Chapter 1 of the dissertation. It is an introduction to the theory of generalized networks GN. There, a detailed literature review of the developments related to GN and their applications is presented.

3. General analytical characteristic of the dissertation work

We wrote above about the general characteristics of the Dissertation: 182 pages, 85 figures, 25 code fragments, 19 formulas, 104 literary sources.

[Introduction]

Here the main goal is stated - creation of a software system *OnlineGN*;

[Chapter 1] presents the theoretical basis of OM and the software for their simulation. The first two sections contain notes on the theory of OM and the current state of the software for their simulation. The third section sets the goal and describes in detail the 9 tasks for achieving the goal. (see above in item 1. Relevance of the problem and appropriateness of the set goals and tasks)

[Chapter 2] is devoted to newly introduced algorithms for automatic drawing of OM and conversion of graphic images into TeX format. There are two sections, the first is for *Task 1* of the nine formulated above in item 1. – the development of an algorithm for automatic drawing of OM and drawing of graphs with *Graphviz*, the second section is for a description of an Algorithm for converting an *SVG* image of a generalized network into *TeX* format, a pseudocode of the Algorithm is given (this Chapter also contains nine algorithms and seven of the figures) and ends with an Example of the result of the operation of the Algorithm in *TeX* format. This also solves *Task 2*.

[Chapter 3] describes the architecture, design and implementation of the developed software simulator *OnlineGN*. The first two sections are described: Requirements and goals of the system (*Task 3*), System architecture (*Task 4*)– the first two sections; Application design and modules, Algorithms and implementation details, Interface and user experience (*Tasks 5, 6 and 7*) – are the next three sections. The chapter ends with tests and validation. This Chapter also contains all 25 code fragments and 37 figures. The source code of the application is published in [41], and all the functionalities of the software system are presented visually in a prepared video demonstration in [42], which illustrates the practical cycle of working with the developed simulator.

[Chapter 4] considers the creation of OM models for processes for which OM has not been applied so far or other approaches have been used, as well as the applications of the simulator, with each of the specified networks being simulated and verified through it. The readable sections of this Chapter represent the solution to (*Problems 8 and 9*) Simulation of finite state machines using generalized networks – is the first section; Parallelization of the Towers of Hanoi problem using generalized networks – is the second section, which touched the reviewer's heart i.e. he probably liked it a lot; A generalized network model of the production of gas and polymer products in an oil refinery; and A generalized network model of heavy oil refinery production – are the last two sections of this Chapter and concern the creation of OM models of processes in an oil refinery. These and other developed models

are published and available in the examples folder of the application repository [41]. The remaining 39 figures are in this Chapter.

[Conclusion] summarizes the results achieved and outlines directions for future work. Here is also Author's Reference - A reference to the contributions of the dissertation candidate to the dissertation work.

[Author's Reference] – A reference to the contributions to the dissertation work, described in more detail in item 4. below,

[Publications on the dissertation work] described in more detail in item 5. below.

[Bibliography] as described above, consists of 104 sources, including the 5 publications on the dissertation, specifically these are [39], [56], [62], [78], [89], and two more sources by the dissertation [41], [42], which are on-line-accessible repositories with the dissertation and with a video demonstration respectively.

[Declaration of originality of the results] is according to the references, and is on the last 182 pages, of the Dissertation.

4. Assessment of the contributions of the dissertation and their significance

The dissertation claims the following contributions:

Scientific contributions:

1. *Algorithms for automation and visualization of OM and an algorithm for converting vector images from SVG-format for OM to TeX-format by identifying graphic primitives and transforming coordinates has been created.*
2. *Parallel solution of an exponential problem (Towers of Hanoi), by formalizing a new parallel variant of the Towers of Hanoi problem, allowing simultaneous movement of up to k rings, a theorem for the minimum number of parallel steps $H(n, k) = 2^{\lceil \frac{n}{k} \rceil} - 1$ has been proved, and a constructive algorithm for solving the problem has been implemented.*
3. *Generalized network modeling and simulation of the parallel exponential Towers of Hanoi problem, creating an original OM model of parallel Towers of Hanoi using ρ kernels for objects and χ kernels for resources, proving the applicability of the formalism through simulations in the *OnlineGN* environment, demonstrating effective management of competitive processes and logical constraints.*

Scientifically applied contributions:

1. *Design, implementation and application of the software system *OnlineGN*, and functionality for export from SVG to TeX has been implemented, which optimizes the preparation of graphic materials for academic publications.*
2. *A new method for representing finite state machines using OM, and a methodology for describing deterministic and non-deterministic finite state machines using OM has been developed, allowing for the capture of parallel computational paths.*
3. *Modeling of existing processes in an oil refinery using OM, and OM models of real technological processes in an oil refinery have been developed, including the production of gas, polymer and heavy oil products.*

4. Verification of the new OM models through *OnlineGN*, all newly created models in the dissertation work are verified through simulations in *OnlineGN*, which simultaneously verifies the correctness of the models and the capabilities of the system.

Guidance is given for possible future development of the topic. (described in Conclusion, in the above point 3.)

1. New OM models and applications, which have so far been considered mainly theoretically;
2. Extension of the application to support other modifications of OM;
3. Extension of the software functionalities;
4. Stress testing and increasing performance by improving the speed, scalability and overall efficiency of the application;
5. Increasing the reliability and security of the system.

5. Evaluation of dissertation publications

The publications of the Dissertation fully satisfy: (1) National requirements, according to National Centre for Information and Documentation –(NACID);(2) requirements of the Bulgarian Academy of Sciences (BAS), according to the Regulations of the Bulgarian Academy of Sciences; (3) requirements of the IBPhBME–BAS.

There are even 6 citations described, which are not required for this procedure, but are an additional PLUS for the dissertationist, and show the quality of his publications.

Below, the reviewer offers a comparative table for the points scored by the dissertationist and the points that are required according to the three Regulations cited above.

Group of Indicators	Group Content	Requirements according to NACID Regul	Requirements according to BAS Regul.	Requirements according to IBPhPME	Angel Ivanov Dimitriev points
A	Indicator 1	50	50	50	50, 50, 50
B	Indicator 4	00	00	00	00, 00, 00
C	Indicator 7	30	30	30	198, 132, 66
D	Indicator 11	00	00	00	48, 36, 36
Total	across all indicators	80	80	80	296, 218, 152

The last column contains the points of the dissertation candidate, according to the three Regulations, above, separated by a comma. The difference in the points is due to the different coefficients of the three Regulations, by which the points from publications and citations are multiplied.

Group of indicators Requirements according to the NACID Regulations

6. Abstract Regarding the abstracts (in Bulgarian and English it is written above in point 0.8., i.e. in sub-point 8. of point 0. – here I will only state: not mentioning in the Abstract that all nine tasks set at the beginning have been successfully solved, (refers to *Tasks 3 and 7*), and that the Abstract meets all the requirements for its preparation and fully and accurately presents the topic, objectives, content, achieved results and contributions of the Dissertation.

7. Critical Notes and Praise

Angel Dimitriev has taken into account the previously made comments and notes. I accept that all essential notes have been reflected. In the review so far, some minor inaccuracies have been written. I will add here that the reviewer was missing two additions to the content: (1) *List of Figures* – 85 figures in the Dissertation, 29 in the Abstract - with /1/ one missing; (2) *List of Code Fragments* – 25 figures in the Dissertation,

I have no critical remarks that would question the doctoral student's contribution and would affect my positive assessment at the end of the review.

8. Conclusion

Based on the above, I highly appreciate the scientific work carried out by Angel Dimitriev and the results achieved.

All requirements, conditions and criteria of the *Law on the Development of the Academic Staff in the Republic of Bulgaria*; *The Regulations for the Implementation of the Development of the Academic Staff in the Republic of Bulgaria Act*; *The Regulations on the Conditions and Procedure for Acquiring Scientific Degrees and Holding Academic Positions in the Bulgarian Academy of Sciences*; *The Regulations on the Conditions and Procedure for Acquiring Scientific Degrees and Holding Academic Positions in the Institute of Biomedical Sciences and Biomedical Sciences – Bulgarian Academy of Sciences (IBPhBME – BAS)* – have been fulfilled.

CONCLUSION

After my acquaintance with the presented scientific works, their significance, the scientific, scientifically-applied and applied contributions contained in them, I find it reasonable to **propose** to the esteemed Scientific Jury to award Angel Ivanov Dimitriev the “PhD” to award Angel Ivanov Dimitriev the Educational and Scientific Degree “Doctor” / “PhD” / in the professional field: 4.6. Informatics and Computer Sciences, in the scientific field 4. Natural Sciences, Mathematics and Informatics, doctoral program Informatics (01.01.12).

Date: 15.06.2026

Sofia city

REVIEWER:

/prof. Dr., Pencho Genov Marinov/