

REVIEW

by Acad. Ivan Petkov Popchev

on a D.Sc. thesis for obtaining the scientific degree

“Doctor of Sciences”

in the professional field

4.6. Informatics and Computer Sciences

on the topic

“Metaheuristic Algorithms for Nonlinear Dynamic System Identification”

by Prof. Olympia Nikolaeva Roeva, Ph.D.

By Order No. 560 / 01.06.2026 of Prof. Tanya Pencheva – the Director of IBPhBME – BAS, in accordance with a decision of the Scientific Council of IBPhBME – BAS (Protocol No. 7 / 29.05.2026), and Art. 13 of the Act of the Development of Academic Staff in the Republic of Bulgaria (ADASRB), I have been appointed as a member of the Scientific Jury, for acquiring the scientific degree “Doctor of Sciences” by Prof. Olympia Nikolaeva Roeva, Ph.D. with D.Sc. thesis “Metaheuristic Algorithms for Nonlinear Dynamic System Identification” in area of higher education 4. “Natural Sciences, Mathematics and Informatics”, professional field 4.6. “Informatics and Computer Sciences”, on 8.09.2026.

For the evaluation the D.Sc. thesis, the determining factors are the conditions of ADASRB, the Regulations of the Implementation of the ADASRB (Decree No. 202 / 10.09.2010, its amendments and supplements in SG15 / 19.02.2019), and the Regulations of IBPhBME – BAS, and therefore they will be precisely transmitted:

1. According to the Art. 12(4) of ADASRB “the D.Sc. thesis under paragraph 2 must contain theoretical conclusions and solutions to major scientific or scientific-applied problems that correspond to the up-to-date achievements and can be regarded as a considerable and original contribution to science.”

2. According to the Regulations of IBPhBME – BAS “Candidates for obtaining the scientific degree “Doctor of Sciences” must have at least 10 papers with an impact factor on the D.Sc. thesis, of which at least 7 are in international journals.”

On page 4 of the D.Sc. thesis, the objective is defined – theoretical investigation, development, and experimental validation of metaheuristic algorithms and hybrid approaches, with systematic application to bioprocess modeling and control, aimed at the design of high-performance and efficient optimization algorithms.

To achieve the formulated objective, the following main tasks are formulated:

1. To perform a critical and systematic analysis of established metaheuristic optimization algorithms, with emphasis on their mathematical foundations, exploration-exploitation mechanisms, convergence behaviour, and limitations in nonlinear dynamic optimization problems.
2. To investigate, implement, and apply selected metaheuristic algorithms in order to analyse their search dynamics, performance characteristics, and suitability for solving complex nonlinear optimization problems.
3. To investigate the theoretical foundations of hybridization in metaheuristic optimization, including the structural integration of heterogeneous search operators and diversity preservation mechanisms.
4. To propose novel hybrid metaheuristic algorithms, based on the analysis of the application results of the selected metaheuristic algorithms.
5. To investigate, implement, and apply the proposed hybrid algorithms to parameter identification problems in bioprocess modeling and control and to evaluate their performance.
6. To establish a methodological framework for the evaluation of hybrid metaheuristic performance, including benchmark testing, statistical analysis and InterCriteria analysis.

The D.Sc. thesis has a volume of 288 pages, with a bibliography of 581 sources and includes:

- Preface (pp. 1-6);
- State of the art in metaheuristic algorithms and bioprocess modelling (**Chapter 1**, pp. 7-27);
- Materials and methods (**Chapter 2**, pp. 29-45);

- Metaheuristic algorithms (**Chapter 3**, pp. 47-71);
- Application of metaheuristic algorithms for parameter optimization problems (**Chapter 4**, pp. 73-149);
- Hybrid metaheuristic algorithms (**Chapter 5**, pp. 151-177);
- Application of hybrid metaheuristic algorithms for parameter optimization problems (**Chapter 6**, pp. 179-227);
- Conclusion and future work directions (**Chapter 7**, pp. 229-257);
- Bibliography (pp. 259-288).

In item 7.4. Publications on the thesis (pp. 235-236), **20 publications** in English are presented.

An **analysis** of these publications shows the following:

- 10 publications are in **journals with IF** (No. 1-10);
- 6 publications are in **journals/series with SJR** (No. 11-16);
- 4 publications are in other journals/series (No. 17-20);
- **1 publication is without co-authors** (No. 18).

All publications are published in the period 2011-2025.

In item 7.5. List of Scopus-indexed citations of publications related to the D.Sc. thesis (pp. 237-257) has **304 citations**, including **146 citations in journals with IF**, **93 citations in journals with SJR**, and 65 citations in other scientific publications.

The analysis of the publications and citations proves that Prof. Olympia Roeva, Ph.D. categorically fulfils the requirements of the Regulations of IBPhBME – BAS and the minimum national requirements for the scientific degree “Doctor of Sciences” of 350 points, which at the moment are 2278 points.

In item 7.3. Contributions of the D.Sc. thesis (pp. 233-234), the main contributions can be summarized as follows:

I. Scientific contributions

1. A systematic analysis of ten metaheuristic algorithms was performed, and specific hybridization guidelines were formulated to address and overcome their inherent limitations.

2. A generalized theoretical framework for the hybridization of metaheuristic algorithms was formulated, based on their representation as stochastic dynamical systems.
3. New hybrid metaheuristic algorithms (EA-GA, ABC-GA, ALO-GA, GACSA, and CEFO) were synthesized, and individual component integration schemes along with their corresponding algorithmic structures were developed.
4. A theorem for the global convergence in probability of hybrid metaheuristic algorithms was proven.
5. A generalized comparative analysis of the behavior and performance of hybrid metaheuristic algorithms was proposed.

II. Scientific-applied contributions

6. A multi-level evaluation framework was developed for the systematic validation and benchmarking of metaheuristic algorithms.
7. The metaheuristic algorithms and their hybrids were applied to the modeling and control problems of various bioprocess systems.

The presented 7 contributions of the D.Sc. thesis correspond to the current state-of-the-art advancements in the field of metaheuristic algorithms, representing an original contribution to the development of hybrid metaheuristic algorithms and their application for parameter optimization problems.

The conditions of ADASRB, the Regulations for the implementation of ADASRB, and the Regulations of IBPhBME – BAS for the scientific degree “Doctor of Sciences” have been fulfilled.

As a “generalized scientific image” of Prof. Olympia Roeva, Ph.D., the world scientific databases show the following:

Web of Science: 90 documents, 583 citations, h-index 12;

Scopus: 131 documents, 1327 citations, h-index 19;

Google Scholar: 2810 citations, h-index 26, i10-index 86;

Research Gate: 164 documents, 1115 Research interest score, 1987 citations, h-index 20;

zbMath: 23 documents;

IEEE Xplore: 23 documents;

ORCID: 50 documents.

The **“generalized scientific image”** of Prof. Olympia Roeva, Ph.D. shows sustainable development, effectiveness, and recognition in the international scientific community as well.

My **personal impressions** strongly confirm these qualities, and from my review for a professor dated 03.02.2021, I can quote the following two sentences:

- “As a reviewer of the Ph.D. thesis of Assoc. Prof. O. Roeva for the educational and scientific degree “Doctor” (2007) and her papers, I am familiar with both the progress and the potential of the candidate.”
- “I am convinced of her capabilities to present a thesis for a “Doctor of Sciences”.”

I take the liberty of offering to submit a monograph in English with the working title **“Metaheuristics: Development and Applications”** to a reputable international publishing house.

The author’s summaries are in Bulgarian and English, respectively, and represent the D.Sc. thesis.

Conclusion

The D.Sc. thesis meets the conditions of the ADASRB, the RIADASRB, and the Regulations of the IBPHBME – BAS.

I give a **positive conclusion** for acquisition of the scientific degree **“Doctor of Sciences”** of Prof. Olympia Nikolaeva Roeva, Ph.D.

I propose to the Scientific Jury to unanimously vote for Prof. Olympia Nikolaeva Roeva, Ph.D. the scientific degree **“Doctor of Sciences”** in the professional field 4.6. **“Informatics and Computer Sciences”**.

22.06.2026 r.

Sofia

Reviewr: .

(Acad. Ivan P. Popchev)