REVIEW

by acad. Ivan P. Popchev

of dissertation for scientific degree
"Doctor of Science"
In professional direction 4.6 "Informatics and Computer Sciences"
Titled **"Ant Colony Optimization for Solving Combinatorial Optimization Problems"**
by **Prof. Stefka Stoyanowa Fidanova, PhD**

By order No 92/31.03.2023 of Sv. Margenov – the Director of IICT-BAS in accordance with art. 30 par. 2 of the Regulation on the Implementation of the Development of Academic Staff in Republic of Bulgaria Act and by decision of Scientific Council of IICT (protocol No 3/29.03.2023) in connecting with the procedure for acquiring the scientific degree "Doctor of Science" in professional direction 4.6 "Informatics and Computer Sciences" by Prof. Stefka Stoyanova Fidanova, PhD with dissertation "Ant Colony Optimization for Solving Combinatorial Optimization Problems" I am appointed a member of the Scientific Jury.

For the evaluation of the dissertation paper, the conditions of the Act of Development of the Academic Staff in the Republic of Bulgaria (ADASRB), the Regulation on the Implementation of the Development on Academic Staff in Republic of Bulgaria Act (RIDASRBA) (Decree No 202 of 10.09.2010 ammend and supl. SG 15/19.02.2019) and the Regulation on the specific conditions in the IICT for implementation of the law are defined and will therefore be accurately transmitted:

1. According to Art. 12(4). The dissertation paper must contain theoretical conclusions and solutions of major scientific and applies scientific problems, which correspond to the up-to-date achievements and can be regarded as a considerable and original contribution to science.

2. According to the Regulations on the specific conditions in t he IICT-BAS: Candidates for the Doctor of Science degree must have at least 15 publications with IF/SJR and 50 citations in WoS/Scopus. One monograph indexed in WoS/Scopus equates to 5 IF/SJR publications'.

On page 12 in the "Introduction" is 1.2 **Purpose and tasks of the dissertation**, "development of algorithms, based on the Ant Colony Optimization, for solving problems from real life and industry".

To achieve this goal, the following five tasks have been formulated:

- Development of an algorithm for solving the knapsack problem;
- Development of GPS network inspection algorithm;
- Development of an algorithm for building a wireless sensor network according to two criteria, minimum number of sensors and minimum energy used;
- Development of an algorithm for workforce planing;
- Development of an algorithm for modeling passenger flow according to two criteria, travel time and cost of travel.

The dissertation has a volume of 187 pages, 76 tables, 16 figures, 127 literary sources in the bibliography and includes:

- Introduction (**Chapter 1**, 11 – 16)
- Ant Colony Optimization (**Chapter 2**, 17 – 26)
- Ant Colony Optimization algorithm for Multiple Knapsack Problem (**Chapter 3**, 27 – 64)
- GPS Surveying Network (**Chapter 4**, 65 – 88)
- Wireless Sensor Network Positioning (**Chapter 5**, 89 – 122)
- Workforce planning (**Chapter 6**, 123 – 144)
- Passenger Flow Modeling (**Chapter 7**, 145 – 154)
- Conclusion (**Chapter 8**, 155 – 174)
- Bibliography (175 – 187).

In item 8.1 "List of publications (156 - 158 pages)", there are 19 publications in English. An analysis of these publications shows the following:

- 1 publication is a monograph (No1);
- 1 publication is in journal with IF 2.9 Q1 (No 2);
- 11 publications are in journals/series with an impact rank in Scopus (No. 3 – 13);
- 5 publications are in journals referenced in Scopus(No 14 – 18);
- 1 publication is in international journal Studia Informatica (No 19);

- 3 publications are without co-authors (No 1,3 and 5).

All publications are published in the interval 2016 – 2022.

In item 8.2 **"List of citations** (159 - 169 pages)" there are **52 citations,** visible in Scopus and WoS, of **13 publications**. In the list of citations, 7 citations are marked with IF (No. 5,6,13,15,20, 23 and 48) and 1 citation with SJR (No. 43).

The analysis of the "List of publications" and "List of citations" categorically proves that Prof. Dr. Stefka Fidanova fulfills the requirements for a "Doctor of Sciences" according to the "Regulations for specific conditions at IICT-BAS".

According to Art. 12(4). The dissertation paper must contain theoretical conclusions and solutions of major scientific and applies scientific problems, which correspond to the up-to-date achievements and can be regarded as a considerable and original contribution to science.

On pages (170 – 171) in item 8.3 **Contributions,** 5 scientific contributions and 4 scientific applied contributions are given, for which it is not determined whether they are "theoretical summaries" and whether they represent a "significant and original contribution to science". The lack of such self-assessment can introduce a certain uncertainty.

In short, **the results** in the dissertation work can be systematized as follows:

1. **Hybrid algorithm** for solving **knapsack problem,** as a combination between Ant Colony Optimization and local search.
2. Ant Colony Optimization **algorithms** for:
- GPS surveying;
- Wireless Sensor Network Positioning;
- Workforce planning;
- Passenger Flow Modeling

It must be stated that the developed algorithms are solutions to **essential scientific and applied problems.**

Questions on the dissertation paper:

1. What is the evidence that the developed 5 algorithms are a "significant and original contribution to science" according to the ADASRB. What are the **criteria for originality in science?**

2. Is it possible to mark the upcoming research and applied directions on the dissertation topic over time?

3. Could the four "**software implementations**" listed on page 171 be of programmatic and/or commercial interest? And if the answer is yes, what follows?

4. Are there completed projects and defended dissertations for ONS "Doctor" on the topic "Ant Colony Optimization" after 2016?

5. Is there evidence, with relevant examples of combinatorial optimization problems, that the ant method is preferable? Is this not a matter for future work?

The conditions of the ADASRB, RIDASRBA and the Rules for the special conditions in IICT-BAS for the scientific degree "Doctor of Sciences" have been fulfilled.

As a **generalized "scientific image"** of Prof. Stefka Fidanova PhD, the world's scientific databases show the following:

Web of Science: 99 publications, 387 times cited without self citations, h-index 11;

Scopus: 153 cited documents, 637 total citations without self citations, h-index 12;

Google Scolar: 1858 citations, h-index 19, i10-index 49;

Research Gate: 723.7 Research interest score, 1317 citations, h-index 17;

zbMath: 38 publications, 23 citations;

Mathscienet: 37 publications; 12 citations;

IEEE Explore: 28 results.

The generalized "scientific image" of Prof. Stefka Fidanova PhD, shows sustainable development, effectiveness, recognition in the international scientific community as well.

My personal impressions strongly confirm these qualities and from my review for a professor dated 04/28/2016 I can quote the following two sentences:

- as a comment on the presented results in the candidate's works, it can be marked that there is too broad a base for theoretical generalizations as an essential part **for the scientific degree "Doctor of Sciences".**
- I take the liberty of offering the candidate in the competition to submit a monograph in English with the working title **"Metaheuristics and Applications"** to an authoritative international publishing house.

The **Abstracts** are in Bulgarian and English, respectively and present the dissertation paper.

Conclusion

The dissertation paper meets the conditions of the ADASRBA, the RIDASRBA and the Special conditions of the IICT-BAS.

I give a **positive conclusion** for acquisition of the scientific degree "Doctor of Science" of **Prof. Stefka Stoyanova Fidanova PhD.**

I propose to the Scientific Jury to vote unanimously for **Prof. Stefka Stoyanova Fidanova PhD the scientific degree "Doctor of Science" on professional direction 4.6 "Informatics and Computer Sciences".**

20.04.2023

На основание
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