

REVIEW

**of the dissertation thesis of Prof. Stefka Fidanova, PhD,
titled “Ant colony method for solving of combinatorial optimization
problems”, submitted for acquisition
of the scientific degree “Doctor of Sciences”
in Professional Field 4.6 “Informatics and Computer Science”**

By order № 92/31.03.2023 of the Director of the Institute of Information and Communication Technologies (IICT) of the Bulgarian Academy of Sciences (BAS), I was appointed a member of the Scientific Jury for the procedure of Prof. Stefka Fidanova, PhD, for obtaining the scientific degree “Doctor of Sciences” in the Professional Field 4.6 “Informatics and Computer Science”.

1. Stefka Fidanova was born on 14 February 1964 in Stara Zagora. In 1988 she obtained a master degree at the Faculty of Mathematics and Informatics of Sofia University “St. Kliment Ohridski”. In 1999 she defended a dissertation work for obtaining of the educational and scientific degree “Doctor” (PhD). Since 1993 she has been working at IICT-BAS where she held the position of Associate Professor in the period 2005–2016. Since 2016 she has held the position of Professor.

2. The dissertation work of Prof. Fidanova comprises of 187 pages and consists of an Introduction, six chapters, a Conclusion, a List of publications, a List of citations, an Author’s Reference for the contributions in the dissertation, a Statement for originality, Acknowledgements and a Bibliography of 128 sources.

The dissertation work is devoted to an actual area of Informatics – Ant Colony Optimization (ACO) – as a tool for solving of combinatorial optimization problems. In the recent 30 years, this area of research, established by Marco Dorigo in the 1990s, has been an object of intensive research. Prof. Fidanova is the most noteworthy Bulgarian specialist working in the area.

Without discussing the content, I will outline the most important contributions of the dissertation.

In Chapter 2, some basic information about the ACO is given and critical analysis of the main variants of the ACO algorithm is carried out – 6 variants in total, two of which have been proposed by Prof. Fidanova and accepted by the scientific community.

The third chapter describes the ACO for solving of the widely known difficult combinatorial optimization problem known as the knapsack problem. It is important to

note that in the papers, which this chapter is based upon, the idea of pheromone estimation of the ants through intuitionistic fuzzy values has been proposed for the first time. Various static and dynamic heuristics for solving the problem have been discussed and the results were compared using InterCriteria analysis.

The fourth chapter is devoted to the ACO algorithms (standard ACO, hybrid ACO, ACO with environment changes) for compilation of a schedule for GPS networks inspection. At this point, I would like to draw attention to the fact that unlike the widely used correlation analyses which can point out the degree of proximity between two objects, i.e., whether they are in consonance, the InterCriteria Analysis points out the pairs of objects which drastically differ. Hence, the first case indicates positive consonance, while the second case –negative consonance. In the rest of the cases, each of the analyses indicates dissonance between the objects.

In Chapter 5, single and multi-objective ACO procedures are described for determining the way of positioning a wireless sensor network. For comparison, the results use four modifications of InterCriteria Analysis.

Chapter 6 describes a standard and hybrid ACO for solving the famously difficult combinatorial problem of workforce planning. The effect of ACO parameters on the algorithm's efficiency is studied. The results are compared to those of two other algorithms and it is shown that the ACO algorithm gives better and faster solutions.

The final chapter (Chapter 7) is dedicated to ACO algorithms for passenger flow modelling on the Sofia – Varna route.

As one of the authors of the InterCriteria Analysis method, I can note with satisfaction that the dissertation thesis discusses some interesting and useful applications of the method.

I accept the contributions of Prof. Fidanova formulated on pages 170-171.

Given that I was among the preliminary reviewers on this procedure, I provided my critical remarks during the thesis predefense, and I confirm that these have mostly been taken into account in the final variant of the dissertation. Yet, for example, the Bulgarian translation of the term “index matrix” has not been corrected but another expression has been used instead.

The author's synopsis of the dissertation reflects its content and meets the requirements of the Act on Development of the Academic Staff in the Republic of Bulgaria.

3. Prof. Fidanova has authored 19 publications related to the dissertation. They can be summarized as follows:

- one monograph in Springer of which I was a reviewer.
- one publication in a journal with IF – No. 2;
- publications in thematic journals of Springer with SJR – 10: No. 3–9, 11–13;

- one publication in an international scientific journal published in Bulgaria with SJR – 1: No. 10;
- publications in proceedings of international conferences – 5: No. 14 – 18.

Out of the 19 publications related to the dissertation thesis of Prof. Fidanova only the Springer monograph and two of the papers have Prof. Fidanova as the single author. Therefore, my recommendation to Prof. Fidanova is to start publishing more single-authored papers and conference communications.

4. Prof. Fidanova has presented information for 52 citations – those citing the publications, related to her dissertation thesis, but in practice she has many more citations. For example, a check in Google Scholar shows more than 1000 citations of her works.

5. Prof. Fidanova has taken part in 43 projects, 17 of which are funded by the Bulgarian National Science Fund; 17 are international projects; 9 are with other organizations. She has been project coordinator of 9 of these projects, and for 3 others she has been the project coordinator for the teams from IICT.

6. The scientometric indicators of Prof. Fidanova meet the requirements of the Act on Development of the Academic Staff in the Republic of Bulgaria and the Regulations for its implementation, as well as the Regulations of IICT. Furthermore, Prof. Fidanova is among the top 2% of scientists included in the Stanford Ranking for 2021.

All of the above is the reason to evaluate positively the dissertation work of Prof. Fidanova and to recommend to the honorary members of the Scientific Jury to vote for awarding **Prof. Stefka Fidanova, PhD**, the Scientific degree “**Doctor of Sciences**” in Professional Field 4.6 “**Informatics and Computer Science**”.

6 May 2023

Reviewer

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mathematical modelling”,