

STATEMENT REPORT

according to the procedure for the defense of a dissertation on the topic:

”Branching processes - optimization and applications”

from ass. prof. Dimitar Vladislavov Atanasov, PhD

dep. Informatics, New Bulgarian University,

4.5 Mathematics

for obtaining the scientific degree **Doctor**

in a professional field 4.5. Mathematics

with candidate **Kaloyan Nikolaev Vitanov**

The opinion is in accordance with the order RD-38-308/01.07.2022 of the Rector of SU "St. Kliment Ohridski", appointing a scientific jury in the procedure for the defense of the doctoral dissertation of Kaloyan Nikolaev Vitanov, a full-time doctoral student at the Department of Probability, Operational Research and Statistics of FMI, SU "St. Kliment Ohridski".

The materials submitted to the procedure include:

- The PhD thesis;
- Abstract;
- Declaration of authorship of the dissertation work;
- Reference on the implementation of minimum requirements according;
- Plagiarism check report and originality report, as well as supervisor's opinion;
- List of scientific publications;
- Declaration of coauthors;
- Educational plan;
- curriculum vitae;
- Copy of order appointing scientific jury;
- Enrollment order;
- Deduction order;

- Decision of the primary unit on admission to protection;

Kaloyan Vitanov is a full-time doctoral student at the PORS Department at the FMI of SU "St. Kl. Ohridski enrolled by order RD-20-1013/03.07.2018 and dismissed with the right to defense by order of the Rector of SU, starting from 05.07.2021.

The submitted dissertation entitled "Branching processes - optimization and applications" is presented in English with a total volume of 194 standard pages, including three substantive chapters, a conclusion, an appendix and a bibliography covering 213 literary sources.

The first chapter of the work is devoted to an introduction to the main terminology that will be used in the work, as well as to some classical results. A description of the structure of the dissertation has been made.

The following two chapters present the main results. The second chapter examines a continuous-time multitype process in the presence of mutation probabilities between particles through its relation to classical Sevastianov processes. Particle population sizes for non-degenerate processes are investigated.

In the second chapter, results for integral equations for the generating functions are considered. The main results are presented in Theorems 2.1 to 2.7. The problem considered in section 2.2.5 is interesting, where the time until the appearance of the first particle initiating a non-extinction process is considered (Theorem 2.6.)

The content of the third chapter in the dissertation can be considered as an independent study. Sequential decision problems (SDP) concerning systems with dynamics set by a branching stochastic process are considered. An introduction to the basic concepts of this topic and the definition of the optimization task is made. An innovative approach is to consider the SDP with dynamics set by processes other than the Bieneme-Galton-Watson presented in Sections 3.2 and 3.3. It is noted that standard algorithms require traversal of all elements of the state space and solution space, which poses a challenge to the inclusion of branching processes in the model. Possible future research directions are reported.

In the Conclusion, a summary of the scientific contributions of the work, the approbation of the results in it, as well as some additional explanations are made. The work has been presented at numerous specialized scientific forums, and the results have been published in four publications, three of them in indexed editions.

The following remarks should be noted about the work.

1. Some inconsistencies in thread indexing at work. For example, on page 20, “Theorem 4” and “Theorem 2” are cited, and statements with these numbers are not found in the work. It is probably (though not entirely clear) that we are talking about Theorem 1.4 and Theorem 1.2.
2. Only the statements of Theorem 1.1 and Theorem 1.2 are included in the text without citing their source.
3. A general note to the work concerns the use of software, reference and analysis of its results. For example, the text does not make clear, on the one hand, how the graphs presented in Figures 2.4 to 2.7, which are used to illustrate the obtained results, were obtained. On the other hand, their correct interpretation is not clear. A similar remark applies to almost all graphs and tables of numerical results presented in the work.

The paper cites two libraries that extend Python’s capabilities for scientific computing. They contain thousands of functions with a wide variety of functionality. It is not clear from the dissertation whether new functionality was developed, based on the relevant libraries, or completely ready-made algorithms and procedures were used. If completely off-the-shelf algorithms and procedures are used, it is not clear what the PhD student’s contribution is. It is not specified what the specific functions are that are used in the implementation. This would make it possible to confirm the correctness of their application. Undoubtedly, the work would be of greater value if the implementation details of the individual numerical examples illustrating the theoretical results were given in the text, or if the program code used for them was included in some form in the work.

Conclusion. In view of the above results, I give my **positive evaluation** for the dissertation work, the achieved results and contributions, I propose to the honorable Scientific jury to award the educational and scientific degree "Doctor" to Kaloyan Nikolaev Vitanov in the field of higher education 4. Natural sciences, mathematics and informatics, professional direction 4.5. Mathematics

ass. prof. D. Atanasov, PhD