Review

by Professor Nikolay M. Yanev, PhD, D.Sc.,
Institute of Mathematics and Informatics, BAS,
member of a scientific jury in a competition for
the academic position "Associate Professor" at IMI-BAS
4.5. Mathematics (PT and MS),
announced in State Newspaper 8/26. 01. 2024

1. Requirements for the applicant and documentation

The competition concerns academic position "Associate Professor" in professional field 4.5. Mathematics (Probability Theory and Mathematical Statistics), announced in the state gazette, 8/26. 01.2024 for the needs of IMI-BAS with a period of two months from the promulgation in the state gazette. The jury was appointed by order 64/21. 03.2024 of the Director of IMI-BAS according to a decision of the Scientific Assembly of IMI-BAS (2/23.02.2024). The only candidate in the competition for associate professor is Dr. Asen Georgiev Tchorbadjieff, who currently holds the position of Chief Assistant in the section of Operations Research, Probability and Statistics (ORPS).

The submitted documents for participation in the competition are examined by a specially created committee and are adopted by a decision of the jury. I have received 18 publications and 20 documents (or sets of them), which are detailed in an application for participation in the competition. Here are some of the more essential: CV, diplomas, list of publications and copies thereof, reference for contributions and citations, reference for meeting the minimum national requirements, etc., all very detailed and duly formed, which gives me reason to accept them for consideration and to find that all the formal requirements of the procedure have been met.

The candidate's CV (in 2 pages) is prepared according to the requirements of the European model and contains concise data. A. Tchorbadjieff was born on 6.11.1978 in Sofia. It is indicated that he has a master's degree from the Faculty of Physics of Sofia University (2004-2006) in the specialty "engineering physics", with the corresponding diploma attached. In the period 2008-2013 he was a PhD student at the Institute for nuclear research and nuclear energy (INRNE) at the Bulgarian Academy of Sciences, where on 27.11.2013 he defended his thesis on "Studying the influence and correlation between the parameters of the atmosphere and cosmic rays" and received his PhD "Doctor" in physical sciences (particle physics and high energies). It is noted that in the period 2007-2015 A. Tchorbadjiev holds the position of physicist at INRNE and also works as a

programmer at RILA solutions (2004-2007) and at Reflective solutions (2007-2009). Since May 2015, he has been a Chief Assistant in ORPS section. Participation in 3 research projects at the National Fund "Scientific research" is indicated. The following technical skills and competencies are noted: Programming: C/C++, R, PYTHON; DATABASE: SQL; operating systems: LINUX, W.

Scientific interests of A. Chorbadzhiev are (generally speaking) in the field of Probability Theory, Mathematical Statistics, Stochastic Processes and their applications in several different fields. For participation in the competition are presented 18 scientific articles from the total list of 33 scientific publications. The submitted articles have not participated in previous competitions. A detailed reference is presented for the citations, which total 32, and for participation in the competition are 15 for 11 of the submitted works. The report on the implementation of the minimum national scientific requirements (according to the ZRAS) is presented in detail in 7 pages and shows that A. Tchorbadjieff has 618 points with a required minimum of 460 points, i.e. the latter is exceeded by 158 points, and in all groups the minimum is exceeded. A similar reference to the originality of the research is presented, where all the articles are examined in detail. The abstracts of the articles are presented separately, respectively in English and Bulgarian. From the check made there is no finding of absence or presence of violations in the procedure and inadmissibility of the candidate to the contest. On the contrary, it is obvious that the high quality of the materials presented for the competition and the complete satisfaction of all formal regulatory requirements. All this gives me reason to proceed to the following sections, according to the respective rules.

II. Research Analysis and Scientific and Applied Activities

First of all, it should be noted that the 18 articles presented in the competition were published in the period 2015-2023, after the defense of the thesis and taking the position of Chief Assistant in the ORPS section of IMI-BAS, the total number of publications in this period is 23. In the report on the originality of the scientific contributions submitted, the applicant provided detailed information on the scientific indicators presented in a table. Here are some of the most interesting indicators of articles: 6 in journals with IF, 4 in Scopus SJR journals, 5 in collections of reports from Scopus SJR conferences, 2 in Scopus papers without SJR, 1 in a collection of papers indexed and refereed in Zentralbladtt and Mathscinet, of these papers 1-Q2, 1-Q3 and 4 – Q4.

The presented publications can be mainly divided into two groups: branching stochastic processes and modeling with statistical studies. The first group includes articles with numbers [3, 8, 11, 12, 13, 14, 15, 16, 17]. To this group we could also include an article [7] which deals with a class of Levi's processes inspired by the authors ' research in the field of branching processes.

The second group covers the rest of the works [1, 2, 4, 5, 6, 9, 10, 18]. We will focus on the most important results in each of the articles. Note explicitly that here and hereafter the numbering of the articles from the list submitted for the contest is used (because there are two other lists and the reader can be easily misled, besides, the articles are marked with numbers that do not correspond to any of the lists).

Article [3] is published in Pliska Studia Math. (2017) and has an oversight nature. Author A. Chorbadzhiev presented a compact and clear description of the complex cascade processes caused by the entering the atmosphere of cosmic rays, as well as their modeling with the help of branching processes. It is shown how cascade processes can be simulated using branching processes, for which a corresponding computer realization has been developed. Note that since the 50-60s, T. Harris was involved in the applications of branching processes in cosmic rays, with some aspects of this theory (electronic-photonic cascade) being presented as Chapter 7 of his famous monograph Theory of branching processes (1963).

The articles [8, 11-15] are jointly with Dr. Penka Mister and treat interesting theoretical problems regarding branching stochastic processes.

The article [8] is published in *Proceedings of BAS (2019)* and it is considered Markov branching process with one type of particle, which in this case is appropriate to interpret as cells because each cell is divided into two new cells with probability p, and with a probability of 1-p dies without creating offspring. This case is well known in literature (see the famous monograph of B. A. Sevastyanov, Branching Processes (1971), p. 43, Example 2) and directly find that the process's generating function is fractional-linear, i.e. the process has a geometric distribution, in the case when the process starts with one particle (cell). In [8] the supercritical case is examined when the process starts with a random number of cells. §4 represented 3 theorems when the initial distributions are Poisson, Poya-Aepli or Negative-binomial respectively.

The work [11] is published in *Modern Stochastics: Theory and Applications (2020)* and it is considered Markov branching process when the individual particle distribution is geometric. In the subcritical and critical case, we found presentations about the offspring p.g. functions that express themselves quite complexly through special functions – on Wright and Lambert-W. For subcritical processes, the factorial moments of arbitrary order were found, expressed through Bel functions and a conditional limiting distribution was obtained for which the limiting p.g. function was obtained and the corresponding probabilities were found. In Theorem 5 for critical branching processes the probabilities of extinction at finite moments are obtained.

Article [12] has been published in *JOURNAL OF APPLIED STATISTICS (2020)* and is actually continuing research on the model defined in [8], and now the critical case is being considered. There are interesting simulations and evaluations presented in tables and graphics.

Work [13] is published in *Modern Stochastics: Theory and Applications (2022)* and is a natural extension of [11] with the focus on finding the factorial moments for critical processes. The main results are given as Theorem 5.1. These results can be used also for statistical applications.

The article [14] was published in *Proceedings of BAS (2023)* and presents results for subcritical branching processes with logarithmic distribution of the offspring from one particle. Theorem 3.1 gives the p.g function of the process at any time, Theorem 3.2 – probability distribution and factorial moments, and Theorem 3.3 – the corresponding conditional characteristics provided non-extinction. In §5, the equation of the limiting Laplace Transform is examined and its development is obtained. It is shown its performance through the special function of Wright (Theorem 4). The method of reversing Lagrange is applied. Some specific applications have been given.

Work [16] is joint with L. Tomov and P. Master was reported at a conference on Informatics and was published in a collection of reports from the series *LN, Springer (2023).* A software product (called "Simulator") is presented to simulate and evaluate some classes of branching processes. The simulator's work is illustrated with examples and 6 graphics.

Article [17] is published in the *Journal of Applied Statistics (2023*) with 5 co-authors, one of them being a medicinal doctor and the other being mathematicians and informatics. An interesting model of COVID-19 is offered, which is based on branching processes and Change Point Analysis. The model is attached to the data of 38 countries, with the results given in Table A1. Let's also note that the article starts with a competent review of the problem.

Work [7] was published in *Modern Stochastics: Theory and Applications (2019)* and it is co-authored with P. Meister. It is considered a Levi process L(t) whose representative random variable L(1) has a logarithmic distribution. In Theorem 1, the distribution of the process is found, which is expressed by the Bell polynomials, giving two different proofs (interesting in themselves). Section 4 deals with a negative-binomial process with a gamma-subordinator, for which the Bernstein function and the Levi measure are found in Theorem 2, as well as the corresponding transitional probabilities. In section 5, a Levi process with logarithmic distribution and a Poisson subordinator is studied, for which the Bernstein function, the Levi measure, and the transition probabilities are obtained in Theorem 3. Finally, some applications are given, illustrated with interesting graphics.

Before proceeding to the second group of articles, it should be noted that applications of Mathematics related to modeling real phenomena and processes also require certain knowledge in the given field where they are applied. This generally leads to a necessary collaboration with specialists in the relevant scientific discipline or practice.

The second group of 8 Articles [1, 2, 4, 5, 6, 9, 10, 18] can be characterized as scientific-applied, of which [5] is without coauthors, [6, 9] are with one coauthor,

[4, 10, 18] - with three coauthors, [1] - with five, and [2] - with six coauthors. Let us note that these works are in different areas. Thus, the Articles [6, 9] are related to studies of cosmic ray data observed at the Musala Observatory. One of the main statistical methods used is Change Point Analysis, to determine appropriate intervals in which a change in some of the main statistical characteristics of the observed process is observed. Works [1, 2, 5] are related to various observations of atmospheric processes, especially the transmission of pollution and cloud formation, such as the transport of sand from the Sahara. Different statistical characteristics are used and a software system is created. The results obtained are illustrated with many tables and graphs. The Articles [10, 18] examined arsenic contamination of the Ogosta River Valley. Cluster analysis is applied and regression models are used. A number of interesting graphs and tables are presented. Work [4] is in the field of Anthropology, dealing with comparison under two different methods of measurement, assessing different statistical characteristics, and the results are well illustrated with tables and graphs.

Everything stated in this section of the review gives me reason to conclude that Asen Tchorbadjiev's scientific investigations and scientific-metric indicators are at a high level and without doubt fully meet all the conditions for occupying the requested academic position "Associate Professor".

III. Opinions, recommendations and notes

I have been following the scientific development of A. Tchorbadjieff, as I was a reviewer of his PhD dissertation. I also have good impressions from his workshops and international conferences.

The application of the research originality reference is accurately drawn up, as short, but clearly describes the problematics and the main results. Unfortunately, the reader can remain with the impression that there are no proven theorems in the articles, something that is not true, as it is shown by the above. I would recommend the reporting to the National Seminar on Stochastics the latest results in its problems.

IV. Conclusion

As has already been highlighted in the previous sections, Asen Tchorbadjieff' s scientific production is at a high scientific level, as well as its scientific metric indicators, which exceed the minimum requirements. He is a Doctor and he is a participant of scientific and applied projects. In general, we can conclude that the scientific output presented has a significant contribution to the branching stochastic processes as well as some applications. A. Tchorbadjieff is also a specialist in modeling and statistical research in areas related to cosmic rays, atmospheric processes, geomorphological processes, etc. All presented here gives me a strong reason to conclude that the only candidate Chief Assistant Dr. Asen

Georgiev Chorbadzhiev satisfies without doubt all the conditions for “Docent” (Associate Professor) contest at IMI-BAS and I recommend the scientific jury and the Scientific Council to vote positively for his choice.

Date: 03.07.2024

Reviewer:

/Professor Nikolay M. Yanev/