

REVIEW

Of a competition for the academic position “Associate Professor”

Scientific field: 4. Natural Sciences, Mathematics and Informatics
Professional field: 4.5. Mathematics (Approximation models and applications)

For the needs of Plovdiv University “Paisii Hilendarski”, Faculty of Mathematics and Informatics (FMI-PU),

Competition announced in State Gazette no. 96 / 17.11.2023

This review has been prepared by **Prof. DSci Geno Petkov Nikolov, Faculty of Mathematics and Informatics, Sofia University “St. Kliment Ohridski”**

as a member of the scientific jury of the competition according to Order No. ПД-21-289/16.02.2024 of the Rector of the Plovdiv University “Paisii Hilendarski”.

The documents of **only candidate: Chief Assistant Professor Dr. Maria Tonkova Vasileva-Chilibinova, Faculty of Mathematics and Informatics, Plovdiv University “Paisii Hilendarski”** have been submitted in time for participation in the announced competition.

I. General description of the submitted documents

1. Details of the application

The documents submitted by the candidate Dr. Maria Vasileva-Chilibinova for participation in the competition comply with the requirements of the Act on the Development of the Academic Staff in the Republic of Bulgaria (ADASRB), the Rules for Implementation of the ADAS in the Republic of Bulgaria (RIADAS in the RB) and the Rules on the Terms and Requirements for Acquisition of Scientific Degrees and Occupation of Academic Positions at Plovdiv University “Paisii Hilendarski”. To participate in the competition, the candidate Chief Assistant Professor Maria Tonkova Vasileva-Chilibinova, PhD, presented a list of 14 titles in total, including 12 scientific articles, one monograph and one textbook. In addition to the publications for participation in the competition, the following documents also are presented in electronic form: diplomas for completed higher education and acquisition of PhD Degree, curriculum vitae, a complete list of the candidate's publications, lists of citations of all candidate's works and of those with which she participates in the competition, evidences for satisfying the minimum national requirements and the additional requirements of FMI-PU, abstracts and self-evaluations of the results included in the candidate's works submitted for the competition, declaration of originality and authenticity of the presented documents, certificates of work experience, references for the candidate's teaching experience and for participation in national and in the university scientific projects, and a list of the talks given by the candidate at scientific forums.

2. Short CV of the applicant

Chief Assistant Professor Dr. Maria Vassileva-Chilibinova acquired Master's degree in Applied Mathematics in 2012 at the Faculty of Mathematics and Informatics of Plovdiv University. During the period 2013-2016 she was a PhD student in the PhD program "Mathematical Analysis" of FMI - PU, and in April 2016 she acquired PhD Degree for a dissertation entitled "Accelerated convergence of families of iterative methods for simultaneous approximation of zeros of polynomials". During her doctoral studies, she taught exercises as a part-time assistant. During the period February 2016 - October 2017 she was Assistant Professor, and since October 2017 until now she has been working as a Chief Assistant Professor in the Computer Technologies Department of FMI at Plovdiv University "Paisii Hilendarski".

3. General characteristics of the applicant's scientific work and achievements

The scientific works presented by Dr. Maria Vasileva for participation in the competition show that her scientific interests fall mainly into the following areas of mathematics: A) iterative methods for simultaneously finding the zeros of algebraic polynomials, and B) Approximation of classes of sigmoidal (cumulative) functions in the Hausdorff metric. Publications [1]-[3] belong to the first group, and [4-13] form the second group (here and henceforth I follow the enumeration from the list proposed by the candidate). Three of the presented articles are independent, the rest are co-authored. I assume that the candidate's contribution to the joint articles is equal to that of her co-authors.

Four of the articles ([1] - [4]) are in peer-reviewed scientific journals with impact factor (IF), five ([5] - [9]) are in WoS and/or Scopus indexed scientific journals without IF, three articles are in papers published in proceedings of conferences ([10]-[12]). According to the evaluation methodology, with the publications [1]-[12] Dr. Maria Vasileva scores 480 pts under indicator D for occupying the academic position Associate Professor (at a threshold of 200 pts). The articles [1] - [8] have been cited a total of 44 times, of which 29 citations were in refereed and indexed journals. These citations carry 256 points under indicator G at a threshold of 50 points.

With the presented habilitation thesis [13] entitled Approximation problems and applications, published by the University Publishing House of PU, Dr. Maria Vasileva also fulfills the requirement for 100 points under indicator B.

These data certify that the candidate Dr. Maria Vasileva meets in full the minimum national requirements under Art. 2b, para. 2 and 3 of ADASRB* and the additional requirements of Plovdiv University "Paisii Hilendarski" for holding the academic position of "Associate Professor" in the scientific field and professional field of the competition, and for indicators D and D they exceed them approximately by 5 and 2.4 times, respectively.

The scientific works submitted by the candidate for the competition do not repeat those from previous procedures for acquiring a scientific title or academic position, as they have been published after 2019. There is no evidence of plagiarism in the scientific works submitted for the competition.

4. Characteristics and evaluation of the candidate's teaching experience

Dr. Maria Vasileva began her teaching career as a part-time assistant and a PhD student at the Department of Mathematical Analysis of FMI-PU in 2008-2010 and 2013-2016, respectively. During the period February 2016 - October 2017 is an Assistant Professor, and since October 2017 until now she has been working as a Chief Assistant Professor in the "Computer Technologies" department at the FMI of PU "Paisii Hilendarski". She has been teaching classes for undergraduate students in "Insurance Mathematics", "Discrete Mathematics", "Information Technologies in Mathematics", "Introduction to Information Technology" and "Informatics". In the Master Programs "Applied Mathematics" Dr. Maria Vasileva has been lecturing on "Practical Applications of Insurance Mathematics". In co-authorship with N. Kyurkchiev she wrote the textbook "Insurance Mathematics" [14], published by the PU publishing house. The textbook is intended for students from PU, but it would also be useful for students from other higher schools and specialists working in the field of insurance. It sets out the basic knowledge needed for applicants for a responsible actuary job. The topics of checking for belonging of samples to different probability distributions, approximating real data from insurance claims in automobile insurance, the main risk indicators and measures, mathematical mechanism of insurance and reinsurance, principles for calculating insurance premiums, are covered. Two new families of probability distributions and their applications in insurance are considered.

Dr. Maria Vasileva was the scientific supervisor of four students' theses.

5. Detailed analysis of the scientific and applied achievements of the candidate contained in the materials submitted for participation in the competition

The candidate's papers [1-3] study iterative methods with a high order of convergence for simultaneously finding the roots of algebraic polynomials. The Bulgarian school of mathematics has traditions and enjoys a well-deserved authority in this field, our prominent specialists in it are N. Obreshkov, K. Dochev, V. Popov, N. Kyurkchiev, P. Proinov, A. Andreev, M. Petkov, etc. In these three articles, all of them joint with Prof. Proinov, Dr. Maria Vasileva continues the research laid down in her PhD Thesis.

The article [1] examines a family of iterative methods for simultaneous approximation of zeros of polynomials with known multiplicities, proposed by Kyurkchiev, Andreev and Popov in 1984, a special case of which is the well-known Gargantini-Farmer-Loizou method. Theorem 3.5 and Theorem 4.4 in [1] establish local convergence under different initial conditions, and give estimates

of the error at each iteration. Theorem 3.5 improves the Kyurkchiev-Andreev-Popov result and includes as a special case Proinov's result from 2018. Theorem 4.4 contains as a special case another result of Proinov from 2018. The efficiency index and computational order of convergence of the proposed methods are investigated, and their efficiency is illustrated with examples.

The paper [2] studies a family of iterative methods with a high order of convergence for simultaneously finding all zeros of a polynomial, constructed as a combination of the Ehrlich method and an arbitrary iteration function, called in [2] Ehrlich methods with correction. Special cases are the methods of Nourein (1977) with quartic convergence order, of Proinov, Ivanov and Petkovic (2019) with fifth convergence order, and of Machado and Lopez (2019) with a convergence order of six. In Theorems 2 and 4, local convergence of the first and second kind of the Ehrlich methods with correction is proved. The consequences for the methods of this type proposed by other authors are indicated. Furthermore, estimates for the Q-order of convergence and for the asymptotic error constant are proved in Theorem 2. Theorem 6 establishes semilocal convergence of these methods, and special cases of this theorem include methods proposed by other authors. Numerical examples illustrate the applicability of the proposed methods.

The article [3] is devoted to Nourein's iterative method for simultaneously finding the zeros of a polynomial, with special attention paid to its modification for polynomials with multiple zeros whose multiplicities are known. In Theorems 3 and 5, under different initial conditions, local convergence of fourth order and at least fourth order, as well as estimates of the error of Nourein's method for simultaneously finding the zeros of a polynomial (with known multiplicities) are proved. The case of polynomials with simple zeros is studied in Theorems 7 and 8, in which the local convergence of Nourein's method under different initial conditions of fourth and at least fourth order is proved. For the same case (simple zeros), in Theorems 11 and 12 semilocal convergence under different initial conditions is proved and a posteriori error estimates are derived. An important feature of the semilocal convergence theorems that the initial approximation conditions and error estimates are computationally verifiable.

Without in the least underestimating the theoretical value of the results related to the methods for simultaneously finding the roots of an algebraic equation with preassigned multiplicities, I will allow myself to express some reservations about their practical applicability. While separating the distinct roots of an algebraic polynomial is not a problem, information about their multiplicities is generally not available, and determining these multiplicities is a task as difficult as finding the exact roots of the polynomial.

I will also briefly touch upon the second group [4-13] of the candidate's publications submitted for the competition. The subject of study in these works is the approximation of sigmoidal (cumulative)

functions in Hausdorff metric. The founder of the theory of approximations in Hausdorff metrics is Blagovest Sendov, and important results in this area are due to him and V. Popov. More recently, N. Kyurkchiev has been actively working in this field. A main goal in these works [4-13] is to replace the sigmoidal function with a step function and to provide estimates for this approximation. For estimating the distance between their graphs the Hausdorff metric seems to be the most appropriate. A number of classes of probability distribution functions and their approximations by the Heaviside function at the median level in terms of the Hausdorff distance are considered. Precise two-sided estimates of the Hausdorff distance are obtained, which in statistics can serve as confidence bounds. In these works, the following distribution functions are studied in detail:

- probability distributions based on the inverse trigonometric functions arcsine and arctangent [4,11];
- modified distributions as such based on the special auxiliary function Omega (Omega distribution and Pliant probability distribution family) [5];
- distributions obtained by the general transformed-transformer (T-X) method [12];
- composition of continuous and inverse distribution (Odd Weibull inverted Topp-Leone (OWITL) distribution and Generalized inverted exponential distribution) [8, 9];
- composition of continuous and series-type distribution (Odd Weibull–Topp–Leone–G–power series (OW–TL–GPS) family) [7];
- single one-parameter distribution (Unit–Rayleigh distribution) [10];

In the paper [6] the approximation of the Haar scaling function by sigmoidal scaling functions in terms of the Hausdorff distance is studied. Algorithms for recurrence generated sigmoidal and adaptive functions to clarify the degree of supersaturation are proposed in [4, 7]. New adaptive models with polynomial variable transfer are defined in [7, 8, 10, 11]. Differentiable adaptive function is defined in [6].

The monograph [13] entitled *Approximation problems and applications* is mainly based on the candidate's publications [4-12]. In its first part, models based on statistical distributions are presented, which are basic tools for modeling the characteristics of data sets. Attention is paid to investigation of the intrinsic characteristic “saturation” to the horizontal asymptote in the terms of Hausdorff distance. The second part of the monograph is devoted to the analysis of some new classes of activation functions.

The applicability of the models has been tested through simulations implemented in CAS Wolfram Mathematica. The simulation used up-to-date public datasets, such as the number of operating hours

between consecutive failures of air conditioning systems in Boeing aircraft, medical data related to COVID-19 from Mexico, Italy, Canada, Great Britain and Senegal, and others.

I positively assess the results obtained in the scientific articles and the monograph presented by the candidate for participation in the competition. I define the contributions in them as theoretical-applied. On the one hand, theoretical results have been obtained in: a) the field of computational mathematics, and more specifically for the iterative methods for the simultaneous numerical solution of algebraic equations, and b) the approximation in the Hausdorff metric of sigmoidal functions with step functions. On the other hand, as the candidate in the competition Dr. Maria Vasileva demonstrated with numerous examples, these results can find application in numerical analysis and in statistics, insurance business, medicine, social sciences, etc.

Dr. Vasileva has presented her results giving 12 talks at international scientific forums in Spain, Greece, Kosovo, Turkey and in our country. These results have been echoed in 44 citations in the works of other authors, and considering that her articles for the competition are published in the last five years, this number is expected to increase in the future.

6. Critical notes and recommendations

I have no significant critical comments on the materials submitted by the candidate for participation in the competition. The documentation is well laid out. I noticed that the description of the results in the articles [2] and [3] has been interchanged in the author's self-assessment in Bulgarian.

7. Personal impressions of the applicant

I have a positive impression of the candidate from the report delivered by Dr. Maria Vasileva at the 9th International Conference "Numerical Methods and Applications", held in Borovets, Bulgaria, in August 2018.

8. Conclusion on the application

Having become acquainted with the documents and scientific papers presented in the competition and on the basis of the analysis of their importance and the scientific and applied contributions contained therein, I **confirm** that the scientific achievements meet the requirements of the ADASRB*, the Rules for its Implementation and the corresponding Rules of the Plovdiv University "Paisii Hilendarski" for the occupation by the candidate of the academic position "Associate Professor" in the scientific field and professional field of the competition. In particular, the applicant meets the minimal national requirements in the professional field and no plagiarism has been detected in the scientific papers submitted for the competition. **I give my positive opinion to the application.**

II. GENERAL CONCLUSION

On the basis of the above said, I strongly recommend to the Scientific Jury of the competition to propose to the competent body of choice of the Faculty of Mathematics and Informatics at

Plovdiv University “Paisii Hilendarski” to select Chief Assistant Professor Dr. Maria Tonkova Vasileva-Chilibinova for the academic position “Associate Professor” in the Professional field: 4.5. Mathematics (Approximation models and applications)

April 1, 2024

Reviewer:

/Geno Petkov Nikolov, Professor, DSci/

**ADASRB - Act on Development of the Academic Staff in the Republic of Bulgaria*