ANNOTATIONS OF THE SCIENTIFIC WORKS

for participation in the contest for the academic position of "Associate Professor" by field of higher education 4. Natural sciences, mathematics and informatics, professional direction 4.5. Mathematics (Approximation models and applications)

of Assistant Professor Maria Tonkova Vasileva-Chilibinova, PhD

Department of Computer Technologies FMI of PU "Paisii Hilendarski"

Twelve (12) scientific publications, one (1) monograph and one (1) textbook are presented for participation in this contest (see *List of scientific papers for participation in the contest*).

PUBLICATIONS

1. P. Proinov, **M. Vasileva**, *On the convergence of high-order Gargantini-Farmer-Loizou type iterative methods for simultaneous approximation of polynomial zeros*, Applied Mathematics and Computation, (2019) 361 202-214. http://doi.org/10.1016/j.amc.2019.05.026, WOS:000474545500020, ISSN: 0096 – 3003.

(IF (2019): 3.472, SJR (2019): 0.969, JCR – Q1, SJR – Q1)

In 1984, Kyurkchiev, Andreev and Popov constructed an infinite sequence of iterative methods for simultaneous approximation of polynomial zeros (with known multiplicity). The first member of this sequence of iterative methods is the famous root-finding method derived independently by Farmer and Loizou (1977) and Gargantini (1978). In the case when all the zeros are simple classical Gargantini-Farmer-Loizou method coincides with the famous Ehrlich's method. For every given positive integer N , the Nth method of Gargantini–Farmer–Loizou family has the order of convergence 2 N + 1. In this paper, we prove two new local convergence results for this family of iterative methods. The first one improves the result of Kyurkchiev, Andreev and Popov (1984). We end the paper with a comparison of the computational efficiency, the convergence behavior and the computational order convergence of different methods of the family.

2. P. Proinov, **M. Vasileva**, *A new family of high-order Ehrlich-type iterative methods*, Mathematics, (2021) 9(16), 1855; https://doi.org/10.3390/math9161855, WOS:000689375600001, ISSN 2227-7390

(IF (2021): 2.592, SJR (2021): 0.538, JCR – Q1, SJR – Q2)

One of the famous third-order iterative methods for finding simultaneously all the zeros of a polynomial was introduced by Ehrlich in 1967. In this paper, we construct a new family of high-order iterative methods as a combination of Ehrlich's iteration function and an arbitrary iteration function. We call these methods *Ehrlich's methods with correction*. The paper provides a detailed local convergence analysis of presented iterative methods for a large class of iteration functions. As a consequence, we obtain two types of local convergence theorems as well as semilocal convergence theorems (with computer verifiable initial condition). As special cases of the main results, we study the convergence of several particular iterative methods. The paper ends with some experiments that show the applicability of our semilocal convergence theorems.

3. P. Proinov, **M. Vasileva**, *Local and semilocal convergence of Nourein's iterative method for finding all zeros of a polynomial simultaneously*, Symmetry (2020) 12(11), 1801; https://doi.org/10.3390/sym12111801, WOS: 000594268200001, ISSN 2073-8994

(***IF(2020): 2.713, SJR (2020): 0.385, JCR – Q2, SJR – Q2)***

In 1977, Nourein constructed a fourth-order iterative method for finding all simple zeros of a polynomial simultaneously. This method is also known as Ehrlich's method with Newton's correction because it is obtained by combining Ehrlich's method and the classical Newton's method. The paper provides a detailed local convergence analysis of a well-known but not well-studied generalization of Nourein's method for simultaneous finding of multiple polynomial zeros. As a consequence, we obtain two types of local convergence theorems as well as semilocal convergence theorems (with verifiable initial condition and a posteriori error bound) for the classical Nourein's method. Each of the new semilocal convergence results improves the result of Petković, Petković and Rancić (2007) in several directions. The paper ends with numerical experiments.

4. M. Vasileva, *Some notes for two generalized trigonometric families of distributions*, Axioms, (2022) 11(4), 149; https://doi.org/10.3390/axioms11040149, WOS:000785120800001, ISSN 2075-1680

(IF (2022): 2.000, SJR (2022): 0.388, JCR – Q2, SJR – Q3)

The paper deals with two general families of cumulative distribution functions based on arctangent function. We provide analysis of the error of the best one-sided Hausdorff approximation for some special cases of these families. We obtain precious estimates for the value of the Hausdorff distance that can be used as an additional criterion in practice. Further, the family of recurrence generated adaptive functions is constructed and investigated. All new results are illustrated with suitable numerical experiments. Simple dynamic software modules show applicability of Hausdorff approximation.

5. M. Vasileva, *Some notes on the omega distribution and the pliant probability distribution family*, Algorithms, (2020) 13(12), 324; https://doi.org/10.3390/a13120324, WOS:000601665400001, ISSN 1999-4893

(Web of Science, SJR (2020): 0.346, SJR – Q3)

In 2020 Dombi and Jónás introduced a new four parameter probability distribution which they named the Pliant probability distribution family. One of the special members of this family is the so-called omega probability distribution. This paper deals with one of the important characteristic "saturation" of these new cumulative functions to the horizontal asymptote with respect to Hausdorff metric. We obtain upper and lower estimates for the value of the Hausdorff distance. A simple dynamic software module using *CAS Mathematica* and *Wolfram Cloud Open Access* is developed. Numerical examples are given to illustrate the applicability of obtained results.

6. M. Vasileva, A. Iliev, A. Rahnev, N. Kyurkchiev, *On the approximation of the Haar scaling function by sigmoidal scaling functions*, International Journal of Differential Equations and Applications (2021) 20(1), 1-12, https://doi.org/10.12732/ijdea.v20i1.932, ISSN: 1311-2872

(SJR (2021): 0.214, SJR – Q4)

In this article we study the Hausdorff approximation of the Haar scaling function by sigmoidal scaling functions. We prove upper and lower estimates for the value of the Hausdorff distance. A simple dynamic software module is developed and some numerical examples are considered using *CAS Mathematica* and *Wolfram Cloud Open Access*.

7. M. Vasileva, O. Rahneva, A. Malinova, V. Arnaudova, *The odd Weibull-Topp-Leone-G power series family of distributions,* International Journal of Differential Equations and Applications (2021) 20(1), 43-61, https://doi.org/10.12732/ijdea.v20i1.4, ISSN: 1311-2872

(SJR (2021): 0.214, SJR – Q4)

In 2021 Oluyede, Chipepa and Wanduku developed a new generalization called the odd Weibull–Topp–Leone–G–power series (OW–TL–GPS) family. The main aim of the paper is investigation of the degree of "saturation" of the cumulative functions to the horizontal asymptote with respect to Hausdorff metric. We obtain two-sided estimates for the Hausdorff distance. Also we construct and study families of recurrence generated adaptive functions based on the odd Weibull-Top-Leone-G power series family. In additional we consider a new adaptive model with "polynomial variable transfer". Our investigations are complemented by appropriate numerical experiments.

8. M. Vasileva, A. Malinova, O. Rahneva, E. Angelova, *New properties of the odd Weibull Inverse Topp-Leone cumulative distribution function,* International Journal of Differential Equations and Applications (2021) 20(2), 263-272, https://doi.org/10.12732/ijdea.v20i2.12, ISSN: 1311-2872 ***(SJR (2021): 0.214, SJR – Q4)***

In 2021 Almetwally introduced a new lifetime distribution named the odd Weibull inverted Topp-Leone (OWITL) distribution. In this note we study approximation of Heviside function by this new cumulative function in terms of Hausdorff metric as we prove some estimates. In additional we consider a new adaptive model with "polynomial variable transfer". The applicability of the model is proved in simulation study to "COVID-19 data".

9. V. Kyurkchiev, **M. Vasileva**, A. Iliev, A. Rahnev, N. Kyurkchiev, *Comments on some inverted cumulative distributions: "Saturation in the Hausdorff sense", applications*, International Journal of Differential Equations and Applications (2021) 20(2), 187-196, https://doi.org/10.12732/ijdea.v20i2.5, ISSN: 1311-2872

(SJR (2021): 0.214, SJR – Q4)

In the paper we study properties of some inverted cumulative distribution functions. More precisely, we prove estimates for the "saturation" about Hausdorff metric using two–parameters generalized inverted exponential cumulative distribution function. The technique used can be successfully applied to other commonly used CDFs in practice. We consider also modified families of adaptive functions with "polynomial variable transfer" with applications to the Antenna–feeder Analysis.

10. M. Vasileva, A. Malinova, O. Rahneva, E. Angelova, *A note on the Unit-Rayleigh "Adaptive function",* AIP Conference Proceedings 2459, 030039 (2022); https://doi.org/10.1063/5.0083539, ISBN: 978-0-7354-4186-6

(SJR (2021): 0.189)

Some new facts about a simple one-parameter unit distribution, called the unit-Rayleigh distribution are given by Bantan, Chesneau, Jamal, Elgarhy, Tahir, Ali, Zubair and Anam in 2020. When studying the intrinsic properties of these families, in addition to the analysis of the important characteristic "confidential bounds", it is appropriate to study the "saturation" to the horizontal asymptote in the Hausdorff sense. In this work we also define a new "adaptive unit–Rayleigh model with polynomial variable transfer". The applicability of the model is proved in simulation study to real data sets as "neck cumulative cancer data".

11. M. Vasileva, N. Kyurkchiev, *Some notes on Arcsine Exponentiated-X family*, In: New Trends in the Applications of Differential Equations in Sciences. NTADES 2022, Springer Proc. Math. Stat. (2023) 412, 451-460. https://doi.org/10.1007/978-3-031-21484-4_41 ISSN:2194-1009, ISBN: 978-3-031-21483-7

(SJR (2022): 0.181)

In 2020, He, Ahmad, Afify and Goual proposed a new family based on classical Arcsine distribution and exponentiated family named Arcsine Exponentiated-X family. The main purpose of this work is studying the "saturation" to the horizontal asymptote in the Hausdorff sense. We obtain precious estimates for the value of the Hausdorff distance. We consider Hausdorff approximation of two submodels from the proposed family with baseline distribution some extensions of the classical Weibull distribution. In this study, we also define a new "adaptive ASE-W model with polynomial variable transfer". We develop several simple dynamic programming modules implemented within the programming environment *CAS Wolfram Mathematica*. All new results are illustrated with suitable numerical experiments with real cumulative data.

12. M. Vasileva, *Comments on a new Exponential-X family and applications to actuarial sciences,* International Scientific Conference "Informatics, Mathematics, Education and their Application", 23-25 November 2022, Pamporovo, Bulgaria, 121-129, Plovdiv University Press, ISBN: 978-619-7663-33-4, https://fmi-plovdiv.org/GetResource?id=4392

Heavy-tailed distributions play a prominent role in actuarial and financial sciences. This talk deals with a new exponential-X (NE-X) family. We prove some new properties with respect to Hausdorff approximation. The applicability of the proposed model is proved in simulation study to real insurance data. Also, we provide investigation of some actuarial metrics.

MONOGRAPHS AND TEXTBOOKS

13. M. Vasileva, *Approximation problems and applications***,** Plovdiv, Plovdiv University Press (2023), ISBN: 978-619-7663-77-8

The construction of adequate, accurate and sufficiently flexible approximation models is dictated by the growing amount of data from various application areas. The monograph is dedicated to investigation of some new approximation models in theoretical and practical aspect. The book consists of seven chapters, organized into two parts. The aim of first part (Chapters 2 -- 5) is examination of models based on statistical distribution. Over the last few years statisticians developed new probability distributions for data modelling in various fields including engineering, medicine, insurance, finance and others. The greatest attention is paid to investigation of intrinsic characteristic "saturation" to the horizontal asymptote in the Hausdorff sense. The applicability of the obtained results is illustrated with numerous examples with real life data. Several dynamic modules implemented in CAS Wolfram Mathematica are included. A cloud version that requires only a browser and internet connection is offered for some of them. The proposed modules can be upgraded as well as adapted for other distributions and data sets. In the second part of the book (Chapters 6 and 7) we restrict our attention to analyzing some new classes' activation function. We consider a smooth approximation using Gaussian error function. Each chapter ends with conclusion remarks. Related problems and extensions for future investigations are proposed to the reader.

14. M. Vasileva, N. Kyurkchiev, *Insurance mathematics*, Plovdiv, Plovdiv University Press (2023), ISBN: 978-619-7663-24-2

Actuarial science is the discipline of studying and assessing risk using mathematical and statistical tools. The uncertainty experienced in life insurance, health insurance, property insurance and pension insurance are modelled. The main goal is to acquire fundamental competence in simulation modeling, simulation and analysis of insurance events. The basic knowledge necessary to apply for a responsible actuary is provided. The exposition is organized in six chapters and several appendices. The most used distributions in insurance are discussed in detail. Particular attention is paid to checking whether samples belong to different probability distributions, which actually arise and are examined when specific insurance events occur. Methods and ways for approximating real data from insurance claims in automobile insurance are considered. The concepts of risk and uncertainty as well as the role of risk in insurance are examined in detail. The main risk indicators and measures such as – *Value at risk (VaR)* and *Tail value at risk (TVaR)* are determined. The mathematical mechanism of insurance and reinsurance is clarified. The main principles for calculating insurance premiums as well as types of fluctuations are considered. Wherever possible, example modules implemented in the *CAS Wolfram Mathematica* programming environment are provided.

Signature:

ASSIST. PROF. MARIA VASILEVA-CHILIBINOVA, PHD

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Plovdiv