

(English translation)

## **REVIEW**

on Competition procedure for the position of

### **Associate Professor**

in the field 4.5 Mathematics (Mathematical Logic)

Announced by Sofia University St. Kliment Ohridski, Faculty of Mathematics and Informatics in the State Gazette, issue 105/11.12.2020 and on both the main Sofia University St. Kliment Ohridski and the Faculty of Mathematics and Informatics web pages

By **Prof. Dr. Tinko Velichkov Tinchev**,

Sofia University St. Kliment Ohridski, Faculty of Mathematics and Informatics, professional field 4.5 Mathematics (Mathematical Logic) in his capacity of Scientific Jury Member following

Order# RD 38-84 / 10.02.2021 of the Rector of Sofia University St. Kliment Ohridski

The **only candidate** in this competition procedure for Associate Professor is **Stefan Vladimirov Gerdzhikov, Ph.D., currently Ch. Assistant Professor, at the Faculty of Mathematics and Informatics, Sofia University St. Kliment Ohridski.**

The candidate was admitted to the competition by a commission appointed by Order of the Rector № RD 38-73 / 08.02.2021.

## **I. GENERAL DESCRIPTION OF THE SUBMITTED MATERIALS**

### **1. Details of the application**

To participate in the competition, Dr. Gerdjikov presents all the documents required by law and regulations for its application: curriculum vitae, scanned diplomas (for higher education with an appendix to it and for the scientific-educational degree "Doctor" in professional field 4.5 Mathematics (Mathematical logic)); certificate of academic position;

certificate of work experience; list of publications (16 articles, 6 of which in scientific journals and 10 in conference proceedings); list of publications for participation in this competition (9 articles, 4 of which in renowned scientific journals and 5 papers at respected scientific conferences); list of publications, participations in conferences, projects and Master's thesis supervisions, generated by the Sofia University "Authors" system; statement on fulfillment of the minimum national requirements for the competition's scientific field and the additional requirements of Sofia University St. Kliment Ohridski, with the required attachments; list of citations with full bibliographic description of the citing publications; statement the original scientific contributions; list for the indicators under art. 112, para. 2 (scientific supervisor of 1 diploma thesis, scientific consultant of 2 diploma theses and member of the program committee of Computational Linguistics in Bulgaria, 2018 and 2020); scientific papers submitted for participation in the competition; summaries of peer-reviewed publications in Bulgarian and English; a copy of the announcement of the competition in the State Gazette.

The documents submitted in the competition by the candidate fully comply with the requirements of the Law on Development of Academic Staff in Republic of Bulgaria (ZRASRB), the State Rules of Procedure for its application, the Rules for Acquisition of Scientific Degrees and Occupation of Academic Positions at Sofia University St. Kliment Ohridski.

For participation in the competition, Ch. Assistant Prof. Dr. Stefan Vladimirov Gerdjikov presented a list of a total of 9 articles, 4 of which are in renowned scientific journals, referenced and indexed in WoS (2 in Q1, 1 in Q2 and 1 in Q4; in the the list, respectively 5, 6, 7 and 3), the other 5 are papers in prestigious international conferences proceedings, referenced and indexed in SCOPUS. Two of these articles are single-authored by the candidate, 2 with another co-author, 3 with two more co-authors and 2 with more than two co-authors. The author's statement of scientific contributions clearly and unambiguously notes the contribution of Dr. Gerdjikov in each of the articles. A very good impression is made by his approach to give a vivid description of the occasion, environment and circumstances under which the specific joint research arose and how it developed - what he calls "context".

## **2. Details on the candidate**

Dr. Gerdjikov is a graduate of Faculty of Mathematics and Informatics of Sofia University St. Kliment Ohridski (FMI) - in 2006 he graduated with a bachelor's degree in Informatics, in 2008 completed the master's program Logic and Algorithms as a master in Informatics, and in the period 2009-2012 he was a full-time doctoral student at Department of

Mathematical Logic and its applications with supervisor Assoc. Prof. Dr. Stoyan Mihov. In February 2014 he defended a dissertation on „Efficient algorithm for the approximate search problem in regular sets“ for the educational and scientific degree "Doctor" in the professional field 4.5 Mathematics (Mathematical Logic).

In the period 2005-2006 he was an assistant researcher at the Faculty of Informatics of the Technical University of Karlsruhe under the supervision of Alexander Wolf, as an Erasmus student. From 2014 to 2016, he specialized as a Marie-Curie Fellow at the Center for Information Processing and Natural Language, CIS, at Ludwig-Maximilian University of Munich, Germany, under the direction of Klaus U. Schulz.

Dr. Gerdjikov participated in two projects under OP "Human Resources", co-financed by the EU ESF, for doctoral students, young scientists and postdoctoral students - "Mathematical logic and computational linguistics: development and mutual penetration" (contract № BG051PO001-3.3.04 / 27, 2009-2011) and "Integration of new practices and knowledge in computer linguistics training" (contract № BG051PO001-3.3.06-0022, 2012-2014). Dr. Gerdjikov participated also as a researcher in two projects with European Union funding - FP-7 IP project "Improving Access to Text" (2010-2011) and FP-7 STReP project: "Cultivating and Understanding Research through Adaptivity" (01.02.2011- 31.01.2014).

As a student at FMI he participated in the International Mathematics Competition for Students in 2003 (3rd prize) and in the Bulgarian National Mathematical Olympiad for Students in 2003 (2nd prize) and in 2005 (2nd prize). In 2004 he was awarded the Kliment Ohridski Order by the FMI for achievements in the field of mathematics.

Stefan Gerdjikov is the winner of a prestigious scientific award - first place in the international scientific competition Scalable String Similarity Search / Join, part of EDBT / ICDT Workshop, Genoa, 2013 with the WallBreaker system, jointly developed with Peter Mitankin, Stoyan Mihov and Klaus Schulz.

In the period 2007-2009 and in the period 2012-2014 he was an Assistant Professor at the FMI, and since 2014 he has been a Ch. Assistant Professor at the FMI.

### **3. Characterisation and evaluation of the candidate's teaching experience**

Dr. Stefan Gerdjikov has solid experience in teaching. As a student in 2003, and later as an Assistant Professor, he led seminars on practical all basic programming courses Introduction to Programming, Object Oriented Programming, Data Structures in Programming and Functional Programming until 2008. In the period 2008-2013 he led

seminars on mathematical basics of informatics - Semantics of Programming Languages, various courses in discrete mathematics - Languages, Automata and Computability, Finite Automata Applications and Logical Programming.

Judging by the opinion of the students and my direct observations from our joint work on Logical Programming course, Dr. Gerdjikov has high standards, with which he attracts students into in-depth work. I would like to draw special attention to the content of the discrete mathematics courses in the Bachelor's programs at FMI, which he has been giving for several years. Due to his broad mathematical culture and knowledge of the students' needs, these basic mathematical programming courses were considerably improved and refreshed.

His rich mathematical culture, original research and profound knowledge of the current state of his field, combined with his responsibility in teaching, are most evident in the courses he created alone or together with Dr. Mitankin and Dr. Vatev: Fast Algorithms on Data Structures, Grammars, Computability and Complexity, Machine Learning Theory and Applications in Neural Networks and Machines, Languages, Complexity and Computability.

He is a research supervisor of one diploma thesis and a scientific consultant of two diploma theses in Master's programs. He is the Head of the Master's program Computer Linguistics, speciality in Informatics.

#### **4. General characteristics of the scientific works and achievements of the candidate**

Generally speaking, the research of Dr. Stefan Gerdjikov is in the field of abstract algebraic approach to algorithmic problems in the theory of finite state machines.

Creative mastery of classical techniques and algorithms combined with mathematical ingenuity is crucial to achieving the scientific results in his research: from specific algorithms of practical value (e.g. REBELS from article [9] in the list) to an elegant axiomatic description of a rich class of monoids, for which Dr. Gerdjikov offers efficient algorithms for determinization, canonization and minimization, summarizing the relevant classical algorithms (in the list of articles [1] and [4]). The 9 articles submitted by Dr. Gerdjikov for participation in the competition contain significant scientific contributions in the field of active interest and are not accidentally published in renowned journals ([3], [5], [6] and [7] in the list) and proceedings of prestigious international conferences ([1], [2], [4], [8] and [9] on the list). More precisely, the order of the list follows:

[1] в Proceedings of the 12th International Conference on Language and Automata Theory and Applications, LATA 2018, referenced and indexed in SCOPUS

[2] в Proceedings of the 22nd International Conference Implementation and Application of Automata, CIAA 2017, referenced and indexed in SCOPUS

[3] в Theoretical Computer Science, vol. 790, referenced and indexed in WoS quartile Q4 for the corresponding year

[4] в 23rd International Conference on Implementation and Applications of Automata, referenced and indexed in SCOPUS

[5] в Computational Geometry Theory and Applications, vol. 41, referenced and indexed in WoS quartile Q1 for the corresponding year

[6] в Fuzzy Sets and Systems, vol. 397, referenced and indexed in WoS quartile Q1 for the corresponding year

[7] в ACM SIGMOD Record, vol. 43, referenced and indexed in WoS quartile Q2 for the corresponding year

[8] в Proceedings of the First International Conference on Digital Access to Textual Cultural Heritage, referenced and indexed in SCOPUS

[9] в Proceedings of 11th IAPR International Workshop On Document Analysis Systems, referenced and indexed in SCOPUS

An unambiguous evidence of the relevance and scientific value of the publications of Dr. Gerdjikov presented for the competition is their citation in articles by other researchers. Following SCOPUS:

[5] is cited 4 times,

[7] is cited 6 times,

[8] is cited 5 times,

[9] is cited 2 times.

After the presented detailed analysis of the publications submitted for the competition by the candidate, I can make the following conclusions:

a) The publications presented for the competition **meet the minimum national requirements** (under Art. 2b, para. 2 and 3 of ZRASRB) **and the additional requirements** of Sofia University St. Kliment Ohridski for holding the academic position of Associate Professor in the scientific field and professional domain of the competition.

**b) The scientific publications submitted by the candidate do not repeat those from previous procedures for acquiring a scientific title and academic position.**

**c) There is no legally proven plagiarism in the scientific publications submitted at the competition.**

**5. Analysis of the scientific and scientific-applied achievements of the candidate contained in the works submitted for participation in the competition**

**[1] A General Class of Monoids Supporting Canonisation and Minimisation of (Sub)sequential Transducers** (without co-authors)

This is an article that I highly appreciate as a set and accomplished research goal. It largely characterizes Dr. Gerdjikov as a mathematician who sees meaningful problems, sets his task in an appropriate way and solves it in a meaningful generality. The problem here is under what assumptions for the output monoid the previously noticed similarities in the implementation of classical constructions (determinisation, canonisation, minimisation, etc.) can be algorithmically solved. Stefan notes that for the so-called "monoids with most general equalizer" (mge-monoids) in the previous article, the language with a naturally defined preorder is more appropriate. In this language he succeeds to express appropriate conditions (axioms) for conducting the constructions of interest to him for subsequential transducers. The rest is mastery of good algebraic technique and perfect understanding of constructions. The results are beautiful. I will not describe them, because they are very well described in the author's reference and in the abstracts. In fact, the latter applies also to the other 8 scientific publications.

**[2] A Simple Method for Building Bimachines from Functional Finite-State Transducers, and**

**[3] Space-Efficient Bimachine Construction Based on the Equalizer Accumulation Principle** (both with co-authors Stoyan Mihov and Klaus U. Schulz)

Both articles are devoted to direct constructions of bimachines from a given functional transducer. The advantage of this approach is that for some classes of transducers the direct constructed bimachine has exponentially fewer states. The main contribution of Dr. Gerdjikov in the first of these two articles is mainly in the development of an interesting class of examples showing the advantages of the specialized direct approach. The second article uses another idea for constructing a bimachine from a given transducer, which comes mainly from the observation

of Dr. Gerdjikov. With this new design, the size of both the left and right automaton does not exceed  $2^N$ , where  $N$  is the number of states of the transducer. The result in paragraph 6, showing that the bimachine thus constructed is almost optimal, comes again from Dr. Gerdjikov. Working on this article the authors notices the usefulness of a family of monoids, from which Schulz (I suppose thanks to his experience in unification theory) abstracts the concept of "monoids with the most general equalizers" (mge-monoids).

[4] Generalised Twinning Property (without co-authors)

This article is in some sense continuation of [1]. A class of monoids is axiomatically defined (in the language from [1]), for which Gerdjikov provides a sequentialisation construction for transducers and gives an appropriate generalization of twinning property. A construction is shown that recognizes whether a transducer above this class of monoids satisfies twinning property. The main result is very interesting: the twinning property is a necessary and sufficient condition for the sequentialisation construction to terminate.

[5] Decomposing simple polygon into pseudo-triangle and convex polygons (co-author Alexander Wolff)

This article is in the field of computational combinatorial geometry. It solves the problem of decomposing a simple polygon into a minimum number of polygons, each of which is a convex polygon or pseudo-triangle. The proposed algorithm is of cubic complexity with respect to the number of vertices of the given simple polygon. It is a modification of the Keil and Snoeyink algorithm, which allows the resulting polygons to be of only convex polygons.

[6] Conditions for the existence of maximal factorizations (co-author José Ramon González de Mendivil)

In this paper the maximal factorization being a sufficient condition for many practical problems, e.g. minimization and canonization, is studied in terms of mge-monoids. The relation between monoids admitting a maximal factorization and mge-monoids is studied. In this paper necessary conditions for the existence of a maximal factorization are found and sufficient conditions for an mge-monoid to admit a maximal factorization are provided. The main theoretical results are in Section 4 and are by Dr. Gerdjikov. The technical lemma from Section 3 is also by him.

[7] State-of-the-art in string similarity search and join (с още 9 съавтори)

This article describes the results of the first international scientific competition for fast algorithms for approximate search. The winner of the competition is the WallBreaker algorithm, developed by Gerdjikov and Mitankin with the participation of Mihov and Schultz.

[8] An approach to unsupervised historical text normalization (co-authors Mitankin and Mihov)

A new approach for unsupervised correction of historical texts is considered. It is based on the REBELS algorithm developed by Dr. Gerdjikov. Based on the automatic extraction of patterns from historical variations, the structure of the words from the corpus of historical texts is analyzed and a comparison is made with the structure of the words in a modern dictionary. The REBELS algorithm generates correction candidates that may not be from the modern language. The results of experiments for quality assessment are presented.

[9] Flexible Noisy Text Correction (with 6 co-authors)

Since I am one of the co-authors, it is unethical to make any comment or analysis of the article. I will only note that the central place in it is occupied by the algorithm REBELS developed entirely by Stefan.

## **6. Critical remarks and recommendations**

I have no critical remarks.

## **7. Personal impressions of the candidate**

I have known Stefan Gerdjikov directly since 2006, when he entered the Master's program Logic and Algorithms. I have witnessed his growth as a researcher and lecturer at FMI. He is responsible and has high standards for himself. Energetic, with extensive mathematical interests and knowledge, with a rich linguistic culture, he is a desirable interlocutor and collaborator.

For ten years he has been a valuable and respected member of the logical programming team with competent comments and suggestions, an inexhaustible source of meaningful and diverse mathematical logic problems for students to solve, combining the students' knowledge from different courses. Stefan is a respected and active participant in the life and work of the department and the faculty.

Stefan has an academic spirit and behaviour.



## **8. Conclusion on the application**

After careful study of the materials and scientific works presented in the competition and based on the analysis of their significance and the scientific and scientific-applied contributions contained in them, I confirm that the scientific achievements meet the requirements of ZRASRB, the Regulations for its application. and the relevant Regulations of Sofia University St. Kliment Ohridski for candidates for the academic position Associate Professor in the scientific domain and professional field of the competition. In particular, the candidate satisfies the minimum national requirements in the professional field and no plagiarism has been established in the scientific publications submitted at the competition.

I give my positive assessment of the candidacy.

## **II. OVERALL CONCLUSION**

Based on the above, I **strongly recommend** the scientific jury to propose to the competent authority for the candidate selection in the Faculty of Mathematics and Informatics at Sofia University St. Kliment Ohridski **to elect Ch. Assistant Professor Dr. Stefan Vladimirov Gerdjikov** to take the academic position of **Associate Professor** in the professional field 4.5 Mathematics (Mathematical Logic).

April 7, 2021

Prepared the review:

(Prof. Dr. Tinko Velichkov Tinchev)