

REVIEW

by

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member of the Scientific jury (№ ПД 38-591/10.12.2021)

Regarding the application for an academic position “Associate Professor”
in the professional field 4.5 Mathematics (Mathematical Logic)
for the needs of Sofia University “St. Kliment Ohridski“, Faculty of Mathematics and Informatics
announced in SG no. 87/19.10.2021 and on the websites of FMI and Sofia University

Only **one candidate** has applied for the position: Chief Assistant Professor Dr. **Ivan Dimitrov Georgiev**.

I. General description of the submitted materials

1. Details of the application

The presented documents for participation in the competition are in full accordance with the requirements of the Bulgarian law and the internal regulations of Sofia University. The documents fully comply with the requirements of ZRASRB, PPZRASRB and the Regulations on the terms and conditions for acquiring scientific degrees and holding academic positions at Sofia University “St. Kliment Ohridski” (PURPNSZADSU). These are: curriculum vitae, diploma for higher education, diploma for scientific degree, certificate of work experience in the specialty, documents proving the fulfillment of the requirements under Art. 105, para. 1, item 2, medical certificate, criminal record certificate, list of selected and list of all publications, reference for the contributions, reference for the citations, reference for fulfillment of the minimum national requirements under art. 2 b, para. 2 and 3 of ZRASRB, abstracts of the articles in Bulgarian and English and others.

For participation in the competition the candidate Chief Assistant Professor, Dr. Ivan Dimitrov Georgiev presented a total of 8 articles, in particular 4 scientific publications with a total IF 6,313, referenced and indexed by the Web of Science, 3 scientific publications in publications with SJR without IF, referenced and indexed by Scopus, 1 scientific publication without IF and SJR, referenced and indexed by ZBlattMath. Four of the publications are independent and the others are co-authored. The author has a total of 20 articles, of which 7 with IF, 5 with SJR, 1 referenced in ZBlattMath and 7 in other referenced editions. A list of 12 citations of 4 articles of the author is given, and for the minimum requirements the list is of 7 citations for 3 of the articles.

2. Details of the candidate

Ivan Georgiev graduated from FMI, Sofia University with specialty Informatics in 2007. In 2009 he became a Master of Mathematics, majoring in Logic and Algorithms, at FMI, Sofia University. In the period 2011-2016 he was a graduate student at FMI, SU. In 2016 he defended his dissertation under the supervision of Prof. Dimiter Skordev. From 2009 to 2016 he was an Assistant Professor at the university “Prof. Dr. Asen Zlatarov”, Bourgas, and from 2016 to 2021-Chief Assistant there. In 2018 and 2019 he was a part-time lecturer during the summer semester at FMI, Sofia University. As a student he wrote Computer Science problems for national competitions at the Union of Mathematicians in Bulgaria. In 2019 he was a postdoctoral researcher in the National Program “Young Scientists and Postdoctoral Fellow”. He participated in three projects with FNI, MON, in a joint project between the University of Ghent and IMI at BAS, in a project of NSF-SU and one to support the development of PhD students, funded by the ESF and DG SFIEP at MON.

He was a laureate of the annual award for research and scientific achievements in the field of Computer Science, Mathematical Logic, and Computability in the name of Prof. Dr. Ivan Soskov in 2014. He received a scholarship to participate in the Computability in Europe conference in 2012, 2013 and 2016. He is a member of the scientific organizations ASL, CiE and CCA.

3. General characteristics of the scientific work and achievements of the candidate

The candidate's scientific work is in the field of Computational Analysis, very active now, studying problems of Analysis, from the point of view of the Theory of Computability. One major problem is the representation of real numbers and operations with them. The concept of computable real number appears in the works of Alan Turing. This is a real number that has a decimal representation, computed by a Turing machine. Intuitively, there should be an effective method for constructing sufficiently close rational approximations of this real number. It turns out that various other representations of real numbers lead to an equivalent concept in terms of Turing computability. But if we work with more limited computability such as polynomial or primitive-recursive and other subrecursive computability, they differ. The main research of the candidate is related to the complexity of real numbers and real functions in Grzegorzczuk's subrecursive hierarchy of primitively recursive functions, in the class M^2 of total functions in the set of natural numbers, which are polynomially bounded and with definable graphs. In a joint article with Weierman and Skordev, the author considers subrecursive computability of real functions by examining the concept of uniform computability. They show that all elementary functions of the analysis are uniformly computable with respect to the class of M^2 substitution operators, but after limiting them to compact domains. In order to remove the last restriction, some of the presented papers consider conditional computability regarding the class of M^2 substitution operators.

For participation in the competition the candidate Chief Assistant Professor Dr. Ivan Dimitrov Georgiev has presented a total of 8 articles, including: (the numbering of the papers is according to the list of selected papers)

- 4 scientific publications with a total IF 2,242, referenced and indexed by the Web of Science:
 - two in Q2: [1] and [3] in *Annals of Pure and Applied Logic*,
 - one in Q3: [5] in *Logical Methods in Computer Science*,
 - one in Q4: [2] in *Comptes rendus de l'Académie bulgar des Sciences*.
- 3 scientific publications with a total SJR 0,543, no IF, referenced and indexed by Scopus:
 - [4] in *Sailing Routes in the World of Computation. Computability in Europe, 2018*,
 - [6] in *Learning Systems: From Theory to Practice. Studies in Computational Intelligence, 2018*,
 - [7] in *IEEE 8th International Conference on Intelligent Systems (IS), 2016*.
- 1 scientific publication, referenced by ZBlattMath:
 - [8] in *Annuaire de l'Université de Sofia "St. Kliment Ohridski" Faculté de Mathématiques et Informatique, 2017*.

The scientific works of the candidate fully meet the minimum national requirements (under Art. 2b, para. 2 and 3 of ZRASRB) and respectively the additional requirements of Sofia University "St. Kliment Ohridski" for holding the academic position of "Associate Professor" in the scientific field and professional field of the competition. The scientific publications submitted for participation in the competition do not repeat the ones submitted for obtaining the educational and scientific degree "Doctor". The author's report accurately reflects the candidate's contributions. No plagiarism was found in the scientific papers submitted at the competition.

4. Characteristics and evaluation of the teaching activity of the candidate

Even as a student Ivan Georgiev proved to be smart and thorough, and extremely precise. I remember his group, where I taught Computability and Complexity problems, as the strongest, I trained, with the most extra credits. He has wonderfully taken lecture notes on all the subjects he has listened to. As a graduate student, he translated Schoenfield's book on the doctoral minimum. He developed a new course "Computability in Analysis" for bachelors and masters, with great care for students.

At the University "Prof. Dr. Asen Zlatarov" in Burgas, as a Chief Assistant in the Department of Mathematics and Physics, he has thought Higher Mathematics, First and Second part (problems and

lectures), including the following disciplines: Linear and General Algebra, Analytical Geometry in the plane and space, Differential and Integral Calculus, Functions of two variables, Double and Curvilinear integrals, Differential Equations, Probability Theory. He is involved in a creation of a program of the third part of Higher Mathematics for the specialty Engineering and Technology in Transport, which includes work with a computer system for symbolic computations. He prepares two disciplines Computer Security (cryptography, noise protection coding) and Computer Architectures (data presentation, Assembler programming). During the period of online training in the last two years, he uses the meet.jit.si platform and a graphic tablet, with the help of which he simulates a whiteboard shared on the screens of the participating students.

5. Analysis of the scientific and scientific-applied achievements of the candidate, contained in the materials for participation in the competition.

The papers can be grouped thematically:

- ***Subrecursive representation of the irrational numbers*** [1,4]. The complexity of representations of irrational numbers such as Cauchy series, Dedekind cuts, chain fractions, representations in a number system, etc., is studied. From the point of view of Turing computability, all these representations describe the same class of real numbers. However, if we are interested in bounded computability such as polynomial, primitive-recursive, or in a subrecursive class in which unbounded search is not allowed, this is not the case. The proposed research method is based on the following representation: for each fast-growing computable function, an irrational number is defined using a series of reciprocal powers of prime numbers. It is shown how to construct irrational numbers whose representations with Cauchy series have low complexity, while their representation in a number system is arbitrarily high. Thus, two numbers from Grzegorzczuk's second class can have representations of low complexity, but the decimal representation of their sum can be of arbitrarily high complexity. The paper [1] is an extended version of paper [4] with some new results as a construction with diagonalization of an irrational number with an elementary Cauchy series, but whose representation in a b-number system is of arbitrarily high complexity for each base b. The left and right best approximations are studied. The history of these articles is remarkable, Ivan Georgiev as a referee of a paper by Kristiansen and Stephan, finds many gaps and omissions, some of which are not obvious how to correct and the paper is rejected. He fills in these gaps and then they decide to include him in the team. It is a great credit for the paper to be accepted next year. He is credited with proving the non-closedness of the sum of all representations, except the Cauchy series, as well as the representation of the Liouville number.
- ***Uniform and conditional computability of real numbers*** [2,3,5,8]. The complexity of the representation of real numbers and real functions with respect to the subrecursive class M^2 of polynomially bounded and Δ_0 -definable total functions is considered. The class of uniformly computable real functions with respect to a small subrecursive class of operators computes the elementary functions of the analysis, limited to compact subsets of their domains. In order to remove the latter constraint, the class of conditionally computable real functions with respect to the same class of operators is considered. In both cases, transformations with infinite names of real numbers are used. In [5] the candidate characterizes the conditional computability of real functions in the spirit of Tent and Ziegler by avoiding the use of infinite names. The complexity of the integration operator for real functions with respect to the subrecursive class M^2 is considered. In [3] the author shows that the definite integral of a uniformly M^2 -computable analytic real function with M^2 computable limits is an M^2 -computable real number. As an application, it is shown that the Euler-Mascheroni constant is M^2 -computable. The explicit form of the integral representation of the same constant is shown in [8], using the exponential-quadrature rule of trapezoids. In [2] the results for the subrecursive complexity of the integration are applied, showing that the gamma function limited to positive real numbers and the Riemann zeta function limited to real numbers greater than 1 are conditionally M^2 -computable.
- ***Multidimensional Intuitionistic Fuzzy Quantifiers and Level Operators*** [6]. Three groups of a certain type of multidimensional quantifiers are introduced, which act on predicates with a finite

number of arguments and whose true interpretation is borrowed from the theory of intuitionistic fuzzy sets, as well as from temporal intuitionistic fuzzy logic. The author shows that it is necessary to introduce a linear order in the main set, where the variables are interpreted, to allow a well-defined iteration of the finite conjunctions and disjunctions that replace the quantifiers of universality and existence, respectively. This is necessary because many of them are neither associative nor commutative. In both articles [6,7] the author gives many clarifications of the definitions to achieve the maximum level of generality, while maintaining their mathematical correctness, such as the use of supremum and infimum in the case of infinite sets, explicit type of weights in the universal quantifier, etc.

From the above it can be seen that the candidate has a number of scientific contributions. In addition to his contributions to the joint papers [1] and [4], he proved in [5] a characterization theorem for conditional computability, which bypasses the use of operators and representations of real numbers and works more directly with rational approximations. In a previous article, Prof. Skordev proved a similar characterization theorem for uniform computability. An important consequence of the characterization theorem is the possibility of using wider classes of operators that are equivalent to the substitution ones in terms of real functions.

The results were presented at the conferences CiE 2011, 2012, 2014, 2016, 2018, 2021, CCA 2012, 2017, 2019, Higher-order Complexity Theory and its Applications, Shonan Village Center (Japan), 12th Panhellenic Logic Symposium 2019, Intelligent Systems 2016, and many others.

6. Critical remarks and recommendations

I have no remarks on the merits.

7. Personal impressions of the candidate

I have known Ivan Georgiev since his student years. I was extremely impressed by his accuracy, precision and depth, his sharp thought, he always had an idea of how to find a solution, he solved all the extra credits I gave. Then we became colleagues and my respect for his scientific work and teaching grew. We have participated in a joint project with the University of Ghent, as well as in many scientific conferences. Two months ago, we were together at a prestigious conference in Dagstuhl, where I was impressed that all colleagues from computational analysis know him well. As a person he is responsible, modest and well-meaning, a person you can count on.

8. Conclusion on the application

After getting acquainted with 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 **confidently confirm** that the scientific achievements meet the requirements of ZRASRB, the Regulations for its application and the respective Regulations of Sofia University “St. Kliment Ohridski” for holding the candidate for the academic position “Associate Professor” in the scientific field 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 papers submitted at the competition.

I give **my positive assessment** of the candidacy.

II. OVERALL CONCLUSION

Based on the above, I **confidently recommend** to the scientific jury to propose to the competent authority for the selection of the Faculty of Mathematics and Informatics at Sofia University “St. Kliment Ohridski” to elect Ivan Dimitrov Georgiev to take the academic position of Associate Professor in the professional field of 4.5 Mathematics (Mathematical Logic).

29.01.2022

Referee:

Prof. Dr. Alexandra Soskova