REER REVIEW
for the competition for the academic position "Associate Professor"
in the Professional Field 4.5 Mathematics (Mathematical Logic),
for the needs of the Sofia University "St. Kliment Ohridski"
Faculty of Mathematics and Informatics (FMI of SU),
announced in Newspaper of State, No. 87 of 19.10.2021
and at the Internet pages of FMI and SU

The peer review is written by **Prof. D.Sci. Vesselin Stoyanov Drensky, Full Member of the Bulgarian Academy of Sciences**, working in the Institute of Mathematics and Informatics of the Bulgarian Academy of Sciences, Professional Field 4.5 Mathematics, as a member of the Scientific Jury for the competition by Order No. РД 38-591/10.12.2021 of the Rector of the Sofia University.

The only applicant who has applied for the position is

Ph.D. Ivan Dimitrov Georgiev, till 01.09.2021 Chief Assistant Professor from the Department of Mathematics and Physics at the Faculty of Natural Sciences of the Burgas University "Prof. D-r Asen Zlatarov".

I.   Description of the presented documents
1. Information about the documentation

The documentation presented by the applicant is in accordance with the requirements of the law and the accompanying rules of the Sofia University.

The applicant for the position Chief Assist. Prof. Ph.D. Ivan Dimitrov Georgiev participates in the competition with 8 publications in Bulgarian and foreign scientific issues. He has also added all other documents required for the application for the position which concern: the statement that he wants to apply for the position; CV, diplomas for B.Sci, M.Sci. and Ph.D.; documents confirming the scientific positions which he had; proofs that he covers the minimal scientific requirements of the law for the position; medical certificate; criminal record certificate; the announcement for the competition as well as data for the scientific activity of the applicant which we shall comment below.

2. Information for the applicant

The applicant Ivan Georgiev graduated the FMI of SU first as a Bachelor in Informatics and then received a Master of Science diploma in Mathematics, specialization "Logic and Algorithms". As a student he past all examinations with "Excellent" with two exceptions (one "Very Good" and one "Good"). Later, he completed the Ph.D. program at the FMI of SU and defended his Ph.D. Thesis on "Subregular Computability in Analysis" with scientific advisor Prof. D.Sci. Dimitar Skordev. He worked as an Assist. Professor and Chief Assist. Professor at the Burgas University "Prof. D-r Asen Zlatarov" and in a part time position at the FMI of SU as well as a PostDoc in the frames of the National Program "Young Scientists and Post-Docs".

3. General characteristic of the scientific work and achievements of the applicant

The main scientific results of Chief Assist. Prof. Georgiev are published in the period 2011–2021 and are in the Computational Theory and Recursion, Constructive and Recursive Analysis, Number Theory and Theory of Fuzzy Sets, as well as mathematical problems related with political elections. According to Mathematics Subject Classification MSC accepted by Mathematical Reviews and Zentralblatt his publications are in the fields:

03Dxx Computability and recursion theory:

03D15 Complexity of computation (including implicit computational complexity);

03D20 Recursive functions and relations, subrecursive hierarchies;

03D78 Computation over the reals, computable analysis;

03F60 Constructive and recursive analysis;

03E72 Theory of fuzzy sets, etc.;

05D05 Extremal set theory;

11-xx Number theory;

68Qxx Theory of computing.

Most of the main results of the applicant are in the problematics successfully developed both abroad and by the members of the Bulgarian school in Mathematical Logic. Most of the results are in the meeting points with Mathematical Analysis. Chief Assist. Prof. Georgiev has obtained interesting results in the above listed branches of Mathematics and has shown that he is a successful member of the Bulgarian school. The list of his publications consists of 20 papers; 9 of them are with the applicant as a single author, 5 are with one coauthor, 4 – with 2 coauthors and 2 – with three coauthors; 7 papers are with impact factor, other 5 with SJR, one is refereed in Zentralblatt and 7 other are in refereed Bulgarian issues. The applicant has presented for the competition 8 papers; 4 papers were used in his Ph.D. Thesis: 1 in Journal of Logic and Computation (quartile Q1 of WoS), 1 in Annals of Pure and Applied Logic (quartile Q2 of WoS), 1 in Mathematical Logic Quarterly (quartile Q4 of WoS), 1 in LNCS (indexed in Scopus) and 8 other publications: 1 in LNCS, 3 in Annual of Assen Zlatarov University, Burgas, 2 in the Proceedings of the Spring Conferences of the Union of Bulgarian Mathematicians, 1 in another journal published in the Burgas University "Prof. D-r Asen Zlatarov", 1 in a journal published by the Union of Scientists in Stara Zagora. It makes a pleasant impression that the applicant works successfully in a team. Although all his scientific career up till now is in a university with a small number of mathematicians he has succeeded to find common topics for research (two joint papers with Dimitrova and one with Yanakiev). From the other joint papers 3 are in the Ph.D. Thesis (jointly with his advisor Prof. Skordev, one of them with Andreas Weiermann from Belgium). The work in team of the applicant continues and after the defense of his Ph.D. Thesis with two joint papers with Kristiansen (Norway) and Stephan (Singapore) and two with Krassimir Atanassov, Szmidt (Poland) и Kacprzyk (Poland), as well as one paper with Alexandra Soskova and Lyubomir Ivanov dedicated to the jubilee of their advisor Prof. Skordev.

The applicant has presented a list of 12 citations (all by foreign authors) of 4 of his papers: 7 citations are of papers included in the Ph.D. Thesis and 5 are of papers presented for the application; 7 of the citations are in the list of the proofs that he covers the minimal scientific requirements of the law for the position. The citation is one of the main indicators for the impact of the results of the scientist on the area of the research. I think that 12 citations is a modest achievement and the applicant has to try to make his investigations more attractive for the experts and as a consequence to increase their citation. It would be also nice if he tries to involve to the field of his reseach other Bulgarian mathematicians and to have also such citations.

One can see from the data presented for the application that starting in 2011 the obtained results have been reported at 26 international and national forums (the latest talk, not included in the documentation, was on 14.01.2022) in Bulgaria, Belgium, Croatia, Germany, Greece, Hungary, Japan, Republic of Korea, UK. Another confirmation follows from the fact that 8 of the publications of the applicant are in proceedings of conferences which means that the results have been presented at these meetings. I want also to mention that Chief Assist. Prof. Georgiev has participated in several projects with funding from National Science Fund, the University of Sofia and the Bulgarian Academy of Sciences.

It can be concluded from the applied documentation that:

a) The scientific publications satisfy the minimal requirements of the law and the accompanying rules of the Sofia University for the academic position "Associate Professor" in the scientific field of the competition. With minimum requirements for groups of indicators B, D and E

respectively 100, 200 and 50 points, the applicant has submitted information for 105, 204 and 56 points. In my opinion, it would be more convincing if the applicant had included more contributions in the list in order to meet the minimum requirements with a greater surplus;

b) The scientific publications submitted for the position have not been used in previous applications. In this regard, I have the remark that in his Ph.D. Thesis the applicant states that he plans to write two more papers of his own based on the results of sections 5.3 and 5.4. In my opinion, one of these papers is No. 5 of the papers submitted for participation in the competition, but this is not a formal violation, because the paper is not in the list of references of the Ph.D. Thesis and was written after its defense;

c) No plagiarism has been established in the presented for the competition works.

4. **Characteristics and evaluation of the teaching activity of the applicant**

Most of the teaching activity of Chief Assist. Prof. Georgiev is in the Department of Mathematics and Physics of the Burgas University "Prof. D-r Asen Zlatarov":

- The applicant had lessons and seminars on the first and the second part of the course of Higher Mathematics for the first year undergraduates. The course contains the standard material of Higher Mathematics for students of technical, economical and chemical specializations;
- He participated in the preparation of the third part of the course of Higher Mathematics with includes work with symbolic computations;
- He had seminars on Comuter Security and Computer Architectures. For one of the courses he prepared individual tests for the students for solving problems requiring writing of computer programs;
- The online seminars in the last two years are posted in Youtube with free access;

As a part time employed at the University of Sofia the applicant lectured the course of Computability in Analysis for master students in the specialization "Logic and Algorithms" and for bachelor students.

Chief Assit. Prof. Georgiev was also an author of problems for the Autumn Tournament in Informatics in Shumen.

5. **Analysis of the scientific and scientific-applied achievements of the applicant contained in the documents and publications presented for the competition**

Of the 13 papers of the applicant with an impact factor, SJR or reviewed in Zentralblatt, 4 are included in the Ph.D. Thesis and 8 of the remaining 9 papers are in the list of the application for the position. Of these 5 are in journals (2 in the Annals of Pure and Applied Logic – in quartile Q2 of WoS and 1 in each of: Logical Methods in Computer Science – in quartile Q3 of WoS, in C.R. Acad. Bulg. Sci. – in quartile Q4 of WoS and in the Annuaire of Sofia University). Of the remaining 3 papers 2 are in the proceedings of international conferences and 1 is in a thematic collection, all with SJR. The papers are published in the period 2016 – 2021; 4 of them are without coauthors, 2 are with Kristiansen and Stephan and 2 with Atanassov, Szmidt and Kacprzyk.

Besides the abstracts of the papers presented for the competition in Bulgarian and English Chief Assist. Prof. Georgiev has included in his documentation detailed exposition for his achievements which gives a good possibility for orientation in the problems and exactly reflects his achievements and their place in the general picture. The applicant very precisely has described his contribution in the joint papers. It would be good to add to the materials of the application some of the papers which in the scientific field of the position, but are without impact factor or SJR and are not reviewed in Zentralblatt. This would make the picture of the achievements of the applicant more complete.

The applicant has grouped his publications in three groups related with logical aspects of representations of irrational numbers, computability of real functions and logical questions of the theory of intuitionistic fuzzy sets.

1. *Subrecursive representability of irrational numbers.* This group consists of two joint papers with Kristiansen and Stephan, where the first paper is an extended version of the second one (but contains also results which are not included there). Translated in a language understandable by non-experts, primitive recursive functions can be realized by a computer program where in each loop of the program we know in advance an upper bound for the number of iterations needed to continue further the work of the program. Recursive functions solve problems which depend on solutions to smaller instances of the same problem. We do not know in advance how long the program will work in the case of a total recursive function and whether it will stop at all when the function is partially recursive. This group of papers is devoted to the study of different representations of irrational numbers from the point of view of Computability Theory. The representations are assumed by subrecursive classes of functions. It is well known that real numbers can be represented in many ways – with Cauchy sequences, Dedekind cuts, as infinite fractions expansions with different bases, continued fractions, etc. It is known that these representations give the same classes of numbers from the point of view of the Turing computability. But this is not the case when we pose some restrictions on the possibilities for computability, e.g. polynomial time computability or primitive recursive computability. In paper No. 4 the authors study approximations from below and from above of real numbers in the interval $[0,1)$ by fractions in fixed b-based system using functions from a given class of subrecursive functions. (If $\alpha = 0.D_1 D_2 \ldots_b$ is the representation of α in a b-based system, then α is approximated from below by the function defined by $n \rightarrow (0.D_1 D_2 \ldots D_n)_b$.). Then the numbers obtained in this way are compared with those obtained by a generalized approximation from below, i.e. by functions in two arguments (b,n) from the same subrecursive class where the first argument b shows the base of the system. We shall mention a typical result only. The irrational numbers which are approximated from below by elementary functions with respect to any b-based system may have an arbitrary high degree of complexity with respect to the generalized approximation from below. It is interesting that in paper No. 4 the authors succeed to establish their results without the use of standard methods in the Computability Theory and use only natural and transparent definitions. Paper No. 1 contains not only modifications of results in paper No. 4. It also gives a new construction based on diagonalization of the irrational number by an elementary Cauchy sequence. The paper gives also other constructions which are equivalent to the general approximation from below and from above.

2. *Uniform and conditional computability of real functions.* This group consists of the papers of the applicant (without coauthors) with numbers 2, 3, 5 and 8 from the list of papers submitted for the application. Real functions are of higher complexity than functions in natural argument which are among the main objects studied in the Computability Theory. Hence the investigations have to involve computational procedures of higher order. The applicant uses operators introduced before in his paper with Skordev and Weiermann. We shall mention only the characterization theorem for conditional computability in paper No. 5 and the study of the complexity of the integration in paper No. 3. As a consequence in paper No. 3 the applicant answers into affirmative the problem (open for a decade of years) for the M^2-computability of the constant of Euler-Mascheroni and in paper No. 5 he proves the conditional M^2-computability of the gamma-function and the Riemann zeta-function.

3. *Multidimensional intuitionistic fuzzy quantifiers.* This group consists of two joint papers with Atanassov, Szmidt and Kacprzyk. As in the first group of papers, one of the papers is

an extended verison of the other (but again contains results which are not there). In a series of papers the coauthors of the applicant introduced the concepts of multidimensional intuitionistic fuzzy sets and logic. In papers under Nos 6 and 7 the authors introduce multidimensional intuitionistic fuzzy quantifiers which act on predicats in finite number of arguments whose truth interpretation uses ideas from the Theory of Intuitionistic Fuzzy Sets and Temporal Intuitionistic Fuzzy Logic. In these papers the author demonstrates his abilities as an expert in mathematical logic and has an essential contribution for the statement of the results in their maximal generality and the good level from mathematical point of view.

I want to mention that in order to establish the results in the papers presented for the competition the applicant uses a large arsenal of techniques of different branches of Mathematics. He has also a lot of problems from technical and principal character

The character of the scientific contributions of the applicant are in developing of new methods and enriching of the existing knowledge. Since the results in the third group are motivated by practical problems of Artificial Intelligence they may have also direct practical applications.

6. Critical remarks and recommendations

I do not have essential critical remarks and recommendations to the documentation presented for the competition.

7. Personal impressions for the applicant

My only personal impressions for the applicant are based on two of his talks (at a conference in 2016 and at a seminar in 2022). The applicant was in the scientific team for a bilateral cooperation between the Bulgarian Academy of Sciences and the Research Foundation – Flanders where I was the principal investigator of the Bulgarian team, but our communications were only by correspondence. But I want to state that the existence of the joint paper between Prof. Dimitar Skordev and Ivan Georgiev from the Bulgarian side and Andreas Weiermann from the Belgian side was crucial for the approval of the project both from Bulgarian and Belgian sides.

8. Conclusion for the application

After my careful and critical reading of the documentation and the publications presented for the competition and my analysis of their significance and the scientific and scientific-applications contributions **I confirm** that the scientific contributions are sufficient as required by the law and the additional requirements of the Sofia University for the position "Associate Professor" in the scientific field of the competition. In particular, the applicant satisfies the minimal national requirements for the scientific field and there is not a plagiarism in the presented publications for the competition.

I give my **positive** evaluation for the application.

II. CONCLUSION

I **recommend** the Scientific Jury to suggest that the Council responsible for the election of the Faculty of Mathematics and Informatics of the Sofia University "St. Kliment Ohridski" to elect Chief Assist. Prof. Ph.D. Ivan Dimitrov Georgiev for the academic position "Associate Professor" in the professional field 4.5 Mathematics (Mathematical Logic).

February 7, 2022   Referee:

(Prof. D.Sci. Vesselin Drensky, Full member of the BAS)