



REVIEW

by Corresponding Member of BAS, DSc. Svetozar Dimitrov Margenov,
Professor at IICT-BAS,
of materials submitted for participation in a competition
for holding the academic position "Professor" at IICT-BAS
in professional field 4.5 Mathematics, scientific specialty
"Computational Mathematics (High-Performance Methods and Algorithms)"

In accordance with Order № 166/13.07.2021 of the Director of IICT-BAS and decision of the appointed scientific jury, I am elected as a reviewer under the competition for professor, published in the State Gazette (issue 45/28.05.2021). Documents for participation in the competition were submitted by Dr. Ivan Dimov Lirkov, Associate Professor in the Department of Scientific Computations with Laboratory on 3D Digitization and Microstructure Analysis at IICT-BAS.

1. Brief biographical data

Assoc. Prof. Dr. Ivan Dimov Lirkov graduated in 1988 from the Faculty of Mathematics and Informatics at Sofia University "St. Kliment Ohridski" with a Master's degree in Mathematics with a Specialization in Mathematical Modeling. In the period 1991-1994 he was a graduate student at the Coordination Center for Informatics and Computer Techniques (CCICT) at the Bulgarian Academy of Sciences, where he defended a PhD thesis.

In the period 1988 - 1991 he was a teacher at the High School of Natural Sciences and Mathematics "Academician Nikola Obreshkov", Burgas. Since 1994 he has been working at IICT (including CCIIT, Central Laboratory for Parallel Processing (CLPP) and Institute for Parallel Processing (IPP), of which IICT is the legal successor). Since 2002 he has been an associate professor in the Department of Scientific Computations.

2. General description of the presented materials

The materials presented by Assoc. Prof. Ivan Dimov Lirkov are prepared in accordance with the Development of Academic Staff in the Republic of Bulgaria Act (DASRBA), the Regulations for the Application of DASRBA (RDASRBA), as well as with the specific requirements of the Regulations of BAS and IICT - BAS. They include: application for admission to the competition; curriculum vitae according to the European model; copy of Diploma for the educational and scientific degree

"Doctor" (PhD); copy of a certificate from the Higher Attestation Commission for the scientific title of Senior Researcher. II degree (associate professor); official note for internship in the specialty; list of scientific publications for participation in the competition; list of noticed citations; summaries of the scientific publications with which he participates in the competition – in Bulgarian and English; copies of the scientific publications with which he participates in the competition; reference for the fulfillment of the minimum national requirements under Art. 2b, para. 2 and 3 and the requirements of IICT under Art. 2b, para. 5; reference for the original scientific and scientific-applied contributions; declaration that there is no legally proven plagiarism in scientific works; evidence for participation in and management of scientific and applied research projects.

For participation in the competition Assoc. Prof. Ivan Dimov Lirkov presented 44 scientific publications covering the period 2007 - 2021 (including 17 published in the last 5 years). All publications are in English. There are 5 papers in specialized scientific journals with impact factor (IF), 3 of which are in quartile Q1 (Computers and Mathematics with Applications - 1, Journal of Computational and Applied Mathematics – 2). Of the other papers, 25 are in specialized series with SJR. Of the publications presented for participation in the competition, two are individual, five with two co-authors, 6 with three, 9 with four and 22 with more than four co-authors. Of these 44 papers, 36 have at least 1 co-author from abroad.

The report on the implementation of the minimum national requirements and the requirements of IICT-BAS for the academic position "Professor" contains in a table form data by groups of indicators. The points on each of the indicators significantly exceed the required ones.

3. General characteristics of the candidate's activity

Assoc. Prof. Ivan Dimov Lirkov is an established scientist in the field of computational mathematics and high-performance numerical methods and algorithms. The research methodology is based on advanced mesh numerical methods, the apparatus of modern computer science and technology, efficient parallel algorithms, as well as software implementations and experiments on computer systems with the most modern supercomputer architecture. An important place in experimental research is occupied by the analysis of accuracy, stability, the analysis of computational complexity, parallel speed-up and parallel efficiency.

Assoc. Prof. Lirkov has managed 6 scientific and applied research projects. Four of them are funded by the Bulgarian National Science Fund and 2 under the bilateral agreement with the Polish Academy of Sciences. In addition, he has participated in 17 projects with international (including through the EC framework programs) or national funding.

He has actively participated in the organization of international scientific conferences and forums as a member of organizing and program committees. I will note in particular that Assoc. Prof. Ivan Dimov Lirkov was the editor of 10 conference proceedings with papers from the series of conferences Large-Scale Scientific Computations, published in the series Springer LNCS.

4. Scientific and applied scientific contributions

The presented scientific and scientific-applied contributions of Assoc. Prof. Ivan Dimov Lirkov are in accordance with the scientific specialty "Computational Mathematics (High-Performance Methods and Algorithms)".

In the review I will follow the thematic classification of the presented results in the following four groups:

- I. Methods for approximate solution of two-dimensional and three-dimensional boundary value problems;
- II. Methods and algorithms for solving optimization problems;
- III. Parallel algorithms and applications on distributed computer systems;
- IV. New information technologies.

Publications [1-7] are included in Group B of the reference for fulfillment of the minimum requirements, as equivalent to habilitation thesis. They are on the topic "Parallel algorithm for numerical solution of two-dimensional and three-dimensional Stokes equation for incompressible fluid". This series of works has a well-expressed completed character, including discretization methods in space, discretization methods in time, parallel algorithms and software implementation, as well as analysis of various numerical experiments on state-of-the-art computer architectures.

The number of publications in which results by individual groups are presented is 13, 6, 19 and 6, respectively.

I. Methods for approximate solution of two-dimensional and three-dimensional boundary value problems

The results presented in this section are published in articles [1–7, 9, 13, 18, 22, 31, 41]. Papers [1–7] are devoted to the development of numerical methods and algorithms for solving the nonstationary Stokes equation describing the flow of an incompressible fluid. This group of articles has a common theme and can rightly be considered as equivalent to a habilitation thesis. The methods are based on a projection scheme using a perturbation of the Stokes equation, which allows the representation of the time transition operator as a product of one-dimensional operators with respect to the variables. For discretization in space, a finite difference method is applied, while in time - a Crank-Nicolson-type scheme is used. A significant part of the research is dedicated to the development of efficient parallel

numerical methods and algorithms for different types of parallel architectures, as well as to their software implementation. In papers [9,13,18,22] parallel preconditioning methods and algorithms have been developed, using incomplete factorization of type MIC (0), block circulant factorization, domain decomposition and matrix transformations for solving convection-diffusion problems and the system of Lamé equations from the linear elasticity theory. I will also note works [31,41], which are dedicated to the numerical solution of systems of time-dependent (parabolic) nonlinear partial differential equations describing models of electrosurgical instruments and physiotherapeutic devices. In these studies the most modern numerical methods and algorithms for solving very large-scale real problems are integrated. In them the number of degrees of freedom (unknown) in space reaches $O(10^9)$.

II. Methods and algorithms for solving optimization problems

The results of this part are published in [11,16,36,40,43,44]. Optimization problems are the basis of decision making, and of particular interest in the context of this competition are the tasks with non-polynomial computational complexity. For example, in articles [11,16] determining the spatial structure of amino acids in protein molecules is considered. This is an NP complete problem. Heuristic methods are often used to solve such problems in practice. In these two articles, variants of the ant method are constructed, presenting empirical results for standard test examples. Works [36,40,44] are dedicated to image processing. For example, in [44] a comparative performance analysis of two algorithms for reconstruction of tomographic images using Anscombe transformation to solve the involved constrained convex optimization problem is made. Here it is important to note that tomography of 3D microstructures produces images with a very large voxel dimension. In the last paper of this group [43] is sought the optimal location of sensors in a network for efficient energy management of a building.

III. Parallel algorithms and applications on distributed computer systems

The results presented here are published in articles [8,10,12,14,15,17,19-21,25-30,32,33,42]. These are 19 of the presented papers. They reflect the long-term work of the candidate in a difficult and relevant field. The leading methodology in most of these works is the use of autonomous software agents for resource management in distributed computing systems. An important working hypothesis in these studies is that the ontological differentiation of data and the semantic processing of information allow for additional "intelligence" in management. Articles [8,10,12,14,15,17,19,20,21,25,26,28,32,33] are dedicated to the development of software agent based infrastructures for Grid management. In particular, in [14] an analysis was made of how such systems can interact with an operating Grid middleware. At the end of this group of works I will mention papers [27,47], where an algorithm for parallel realization of three-dimensional discrete transformation on a

computer system in which the communications between the computing nodes are realized in a three-dimensional toroidal network is analyzed.

IV. New information technologies

To this group are regarded publications [23,24,35,37-39]. They reflect another aspect of the applicant's research interests. Articles [23,24] are devoted to the generation of sequences of pseudo-random numbers. In the first of them, quadratic congruent and inverse congruent generators are considered, and the combinations of Van der Corput sequences with the considered nonlinear generators are analyzed. In [24], tools are developed for measuring the uniform distribution of sequences and for studying the pseudorandom properties of sequences based on the b-adic diaphony. The last 3 articles in this group present applications of advanced information technologies, as follows: recurrent neural networks for sensor data analysis [37]; semantic technologies for access control in a port terminal [38]; neural networks for optimization of tourist routes [39].

In conclusion, I will once again note the complex nature and scope of the presented scientific and scientific-applied results of Assoc. Prof. Ivan Dimov Lirkov. Most of the studies are of a pronounced interdisciplinary nature.

5. Impact of the applicant's scientific publications

The candidate has provided a list of 64 citations in publications that are referred and indexed in the scientific information databases WoS and Scopus. In accordance with the requirements, the citations are formed in a table with data in the group of indicators E. With a minimum required 140 points, the presented estimate of the citations is 364 points. All citations included in the table are in the works of foreign authors, including those published in the most highly ranked specialized international journals and series. For example, for the first paper in the list (I. Lirkov, S. Margenov, P. Vassilevski, Circulant block-factorization preconditioners for elliptic problems, Computing, 53 (1), 1994, 59-74) 18 citations are shown, as from 14 of them are in journals with impact factor (IF).

6. Evaluation of the applicant's personal contribution

I accept, that in the joint works, Assoc. Prof. Ivan Dimov Lirkov has an equal role. At the same time, I am convinced that the candidate has a leading role in the works related to parallel implementations, analysis of parallel acceleration and efficiency and supercomputer applications.

7. Critical remarks

I don't have any essential critical remarks about the materials of Assoc. Prof. Ivan Dimov Lirkov, presented within the present procedure.

At the same time, I would like to note a certain imbalance in the summaries of the scientific publications presented for participation in the competition for a professor. The thematic classification at the beginning of the document does not fully correspond to the one used afterwards. The title of the first group is not accurate, because some of the results included in it are for non-stationary tasks.

Undoubtedly, these remarks do not affect the high evaluation of the results presented by the candidate.

8. Personal impressions

I have known Ivan Lirkov since 1991. Our joint work begins within the framework of his postgraduate studies (doctoral studies). I have very good memories of that period. Publications included in the dissertation continue to attract interest. Over the past years we have worked successfully on a number of joint projects. I will also note that we are co-editors of 10 volumes of the Large-Scale Scientific Computations conference series.

I highly appreciate the professional development of Assoc. Prof. Lirkov. He is a correct and responsible scientist and colleague with proven capabilities for in-depth research and analysis, as well as teamwork.

9. Conclusion

After getting acquainted with the materials of the competition, the complex evaluation of the applicant's qualities, including the scientific and scientific applied contributions, **I strongly recommend Assoc. Prof. Dr. Ivan Dimov Lirkov to be elected to the academic position of "Professor" at IICT – BAS in professional field 4.5 Mathematics, scientific specialty "Computational Mathematics (High-Performance Methods and Algorithms)".**

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/ Prof. Svetozar Margenov
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