OPPONENT REVIEW

Competition for holding of academic position "Professor", gazetted on 28 May 2021, No 45

One candidate: Ivan Dimov Lirkov

Procedure Notifier: Institute of Information and Communication Technologies, BAS - Sofia

Professional Direction: 4.5 Mathematics

Scientific Subject: Computational Mathematics (high-performance methods and algorithms)

Opponent: Prof. Michail Todorov, PhD, Dept of Mathematical Modeling and Numerical Methods, Faculty of Applied Mathematics and Informatics by the Technical University of Sofia, Bulgaria, by order 166/13.07.2021 of the Director of Institute of Information and Communication Technologies, BAS - Sofia

1. Short biographical record of the applicant

Dr Ivan Lirkov was born in 1963. He graduated Faculty of Mathematics and Informatics by the St. Kliment Ohridski University of Sofia in 1988, subject Mathematics. In 1987-88 and since 1994 he has been a Mathematician (1987, CCIIT), Assistant Professor (1996, CLPPI), Associated Professor (2002, CLPPI; 2010, IICT). Mean-while he was postgraduated in 1991-1994 in CCIIT and defenced his dissertation thesis in 1996. In 1988-1991 Dr Lirkov is a math teacher in the Acad. Nikola Obreshkov mathematical secondary school.

2. General description of the competition documents

The applicant filled following compulsory documents: CV, copies of Assoc. Professor and PhD diplomas, information about minimal national requirements (NCID) and specific IICT requirements, certificate for a length of service, list of citations, author information for the scientific contributions related to the given competition supplied by PDF copies of all the articles in Bulgarian and English, list of research competitions and projects, abstracts of refereed publications, declaration about the novelty and non-plagiarism.

3. General characterization of the research, teaching and applied activities

The results are presented in complement conferences and seminars in BG and abroad. The total scientific contribution of Dr Lirkov consists of 75 works (53 journal papers and 22 papers in conference proceedings with SJR). Twenty journal works are cited many times like work in Computing (1994) and Ref. [11] from the list of publications are cited 18 and 15 times – totally 64 citations (no autocitations). Let me emphasize that all the citations are in journals and publications with IF and/or SJR.

The applicant presents 44 works for the competition including 7 journal papers, 3 of them with IF belonging to quartile *Q1*, 2 to *Q3* and *Q4*, 2 chapters and the else 36 – in the proceedings of *Springer*, *AIP*, *IEEE*. The total IF is about 7. All of them are published in the period 2007-2021, i.e. they are not included in any previous competitions. The journal works are published in high ranked issues (*J. Computational and Applied Mathematics, Mathematics & Computers with Application, Concurrency and Computation: Practice and Experience, Cybernetics and Information Technologies, Information Technology and Control, Scalable Computing: Practice and Experience, etc.*) The proceedings works are in AIP CP and Springer with SJR. Two works are self-dependent, while the else are with two or more co-authors. The applicant does not present a confirmation for equivalent co-authorship and this is the reason to suppose that his participation is at least of equal value. More details can be seen in the following

Table: Information about the works

	Abroad
Works – 7+2+36 numbers	*Journal of Computational and Applied Mathematics -2 numbers, Computers & Mathematics with Application – 1 number, Concurrency and Computation: Practice and Experience – 1 number, Lecture Notes of Computer Science – 11 numbers, American Institute of Physics Conference Proceedings –14 numbers, etc.*
Reports on national and international scientific events > 25.	*Large-Scale Scientific Computing – 8 times, AMEE – 2 times, AMiTaNS – 13times, NMA – 2 times, NAA - 1 time, etc.*

The applicant announces about 40 independent citations of the works included in this competition. Dr Lirkov is a scientific leader of a numerous national and international research projects including 3 related to the Centers of Excellence, 2 COPERNICUS grants, 1 bilateral with the Chesh Academy of Sciences, big number of projects granted by the National Science Fund of Republic of Bulgaria. Also, he has conducted 4 international and 2 national grants as well as the total amount of the funds involved is about 300K BGN. After the documents one concludes that the applicant does not teach nor train students. My information is that howsoever he taught undergraduate students in Math in TU of Sofia.

Having in mind the said above and according the Regulations in BAS and in particular those in the Institute of Information and Communication Technologies I can conclude that the applicant covers the requirements to hold the academic position of Professor in the professional subject 4.5

Mathematics. Also, he covers and exceeds the minimal national regulations of LDASRB and has not any plagiarism in his works.

4. Analysis of the scientific and applied contributions

Dr Lirkov presents comprehensive author information where he claims his scientific and applied contributions. The investigations are directed to the computational mathematics and cover the creation and development of high-performance methods and algorithms for scientific computing. The problems into consideration can be grouped in 4 directions: theoretical and experimental development of approximate methods for 2D and 3D BVPs by using of differences and finite elements; an investigation of the problems implementing parallel algorithms and multiprocessor architectures; applications of these methods and algorithms for real problems.

- *Methods for approximate solving of 2D and 3D boundary-value problems. Finite differences and finite elements*

Works [1–7] are equivalent to a monography. In works [1–5] is applied parallel algorithm to treat the Stokes equation for an incompressible fluid. To this end a coordinate splitting is used. The method is based on projective schemes widely used in the computational hydrodynamics. The novelty here consists in a singular perturbation of the Navier-Stokes equations by coordinate splitting of the Laplacian. The developed parallel algorithm exploats the partitioning of the domain into subdomains. Standard MPI subroutines communicate between the processors, while for the multicore processors OpenMP is used. In work [6] a version directed to massive parallel computers as well as to clusters composed by multicore nodes is created. A hybrid parallelization based on standard MPI (for computers with a distributed memory) and OpenMP (for computers with a common memory) is developed. Essential improvements of the parallel algorithm can be achieved by two levels. In work [7] numerical experiments with Avitohol supercomputer in IICT are carried out.

A numerical method for system of convection-diffusion PDEs of order two is studied in work [9]. To discretize the original problem conform Courant finite elements are used. A parallel algorithm is developed. To solve the discrete problem – a system of linear algebraic equations a method of the conjugate gradient is applied. To ensure a superlinear convergence of the iteration method discrete Helmholtz preconditioners are used. The obtained and presented numerical results cover systems of PDE containing 2 up to 10 equations.

In work [13] the parallel properties of algorithms allowing circulant block factorization (CBF) for systems with poorly conditioned sparse matrices are investigated. In work [18] the parallel algorithms used MIC(0) and CBF preconditioners are compared. Yet, in both works [13, 18] a 3D linear BVP is considered. The elasticity problem is described by a system of PDEs of order 2. The build 2 efficient parallel algorithms accomplish a method of preconditioned conjugate gradient. In this way two modified algorithms DD MIC(0) and DD CBF are derived.

In work [22] is implemented a parallel realization of the preconditioned method of conjugate gradient (modified incomplete factorization MIC(0)) for solving a system of PDE corresponding to the digital homogenization of the microstructure of human bones. The data are get by a computer tomography with high resolution. To discretize the elliptic problem in question nonconform Rannacher-Turek finite elements are used.

In work [31] a basic mathematical and computer model for a high-frequency interfering device for contactless removing of blood-sucking ectoparasites is developed. The processes are modeled by a nonsteady system of nonlinear PDEs. The heat transport is described by a parabolic PDE. Both basic processes possess nonlinearities and are 3D. The electromagnetic processes are governed by the Maxwell equation. The computer simulation is accomplished by the package Comsol Multyphysics.

In work [41] is created a computer model of the radiofrequency ablation of liver tumors. It covers the heat and electric processes in the liver tissue. The big discrete dimension of the problem is due to the relatively small size of the end of the tube. A 3D voxel description with a big resolution is used.

- *Optimization methods and algorithms*

In works [11,16] is considered the problem for the spatial configuration of amino acids in the protein molecules. This is a fundamental problem in the computational biology and the biochemical physics since the 3D protein structure plays key role to understand and manipulate its biochemical and cell functions. Various optimization methods for solving of the above problem are applied, including Monte Carlo, evolution algorithms, and ant colony optimization (ACO). In work [11] an ACO algorithm for locating of 3D protein structure is build. It is based on a very simple choice of the solution components.

In work [36] experimental results of parallel implementation of an algorithm for image restoration are present. A hybrid parallelization based on the MPI and OpenMP standards is studied.

In work [40] a parallel implementation of the above problem by using of the Anscombe transformation for convex optimization problem with restrictions is analyzed.

In work [44] a comparative analysis of the performance of two algorithms for restoration of tomograph images for the problem in the previous work is conducted. Hybrid gradient algorithms are implemented. The parallel realization of the algorithms again is based on MPI and OpenMP standards.

Work [43] concerns the modern topic of the energy efficiency. An attempt for modern infrastructure in a building aiming energy optimization is done. The architecture uses sensor data in order to control the energy state in the building.

- *Parallel algorithms and applications on distributed computational systems*

In work [8] are used autonomous software agents in computational nets in order Grid's acceleration to get needed functionality. The distributed applications in Java (ADAJ) are a platform developed to realize distributed applications in Java. ADAJ seems to be a media for coding and execution. In [10] is discussed how the original design based on JavaParty, to be replaced by software agents and how to be applied software agents in ADAJ. In [12] the focus is directed over joining of new agents to a team. In [14] is discussed how the offered agent-based system can interact with a real Grid middleware. The intermediate Globus software is chosen as a primary goal. A simple way how to solve the problem and obtain results is present. The paper contains a comprehensive description about the choice of the solution and how it works. An important assertion for the information control is, that the ontology delimiting of data and the semantic processing of the information allow "an intelligence" into information systems to be infused. Work [15] aims to generalize the existing efforts for creating a Grid ontology and main agent-Grid integration. The principal question is whether is there a Grid ontology to be perceived. In work [17] is investigated a model for different Grid applications over distributed computational systems by using a system of agents to contract between the user and the owner of computational resources. The goals of article [19] are two: a short review of the control technics placed in the standard Grid middleware, and considering the attempts to use the standard Grid middleware as a resource broker planning tasks. The goals of the next work [20] again are two: discussion what causes the CorelGRID ontology to be modified and extended to a central part of a project aiming a high level agent-based intelligent Grid middleware, and describing the way how to attain to the object. In work [21] are discussed the information sources generated in the system and which information to be doubled in order to guarantee the long-term survival of the team. In work [25] are outlined the realization and the decisions applied to given technical problems within the AiG proposal. In work [26] is proposed a method for ontological knowledge for the Grid users. Work [27] studies an algorithm for parallel implementation of 3D discrete transform over a computer system where the communications between the particular knots is realized in 3D toroidal net. The algorithm in question is appropriate for Blue Gene supercomputer. To this end a subroutine GEMM from the library BLAS is used. It possesses highest performance. The results obtained are published in work [42]. In work [28] is investigated an agent-based infrastructure for packages distribution and control in Grid medium. The idea is to use expert knowledge to assist the user to choose the best software for solving of a given computational problem. The context of work [29] follows after the project Agents in Grid (AiG) where the choice of software is done if the information corresponding to the problem, the hardware and the software is present ontologically. In the next work [30] the ontologically presented information is combined with the analytical Saaty hierarchy in order to facilitate the Grid user decisions. The method is grounded on double comparisons and rely on the expert team judgement. The purpose of work [32] is to project a decision supporting system based on ontological presentation and semantic technologies. The results obtained in work [33] develop

the points in Agents in Grid (AiG) for Clouds. At last, work [34] is editorial in the special issue „Efficient numerical methods for large-scaled scientific computing". It illustrates the requirements for models with good approximation. The numerical results obtained by UNI-DEM (Unified Danish Eulerian Model) are an example for such efficient numerical methods.

- *Modern information technologies*

In work [23] are considered two nonlinear methods for generation of pseudorandom numbers in the interval [0, 1), i.e., quadratic congruent generator and inverse congruent generator. Analyzing the results it is shown that the combinations of Van der Corput sequence applying these nonlinear generators possess good pseudorandom properties like the generators.

In work [24] is considered b-adic diaphony as a tool to measure uniformly distributed sequences as well as their pseudorandom properties. The results demonstrate the direct relation between the pseudorandomness and the b-adic diaphony and the discrepancy on the other hand.

In work [35] is proposed a general adaptive system allowing voluntary participation in arbitrary crowdsensing initiatives.

Work [37] presents preliminary results by using sensor data and training technics giving information about the transport via phone in real time.

In work [38] is discussed the control system in a port terminal based on semantic technologies.

Work [39] aims to experiment and compare various approaches to facilitate the passengers, who would like to visit given "touristic places". To this end various algorithms including neuron sets of Kohonen kind (usual and elastic) as well as semantic technologies are applied to data extracted from the net.

5. Importance and contribution to the science and practice. Citations by other authors

The works of the applicant clearly indicate the achievements and accents in his scientific production. The conducted investigations possess theoretical significance giving a direction to computing algorithms, their optimization and computer implementation. Undoubtedly Dr Lirkov holds and can apply effectively the mathematical and computational methods, which he complements the knowledge so needed for the successful research. The results obtained definitely got publicity and recognition clearly seen from the impressive number of citations as well as from the journal rank where they are cited.

6. Critical remarks and recommendations

I have not any remarks and criticisms. The documents are prepared diligently and give a real imagination about the scientific activity of the applicant. The statement demonstrates a deep

understanding of the studied matter and possesses good managing makings. There is not any information for the teaching activity and training of students and postgraduates. The reference to the regulations for holding of academic positions demonstrate explicitly that Dr Lirkov covers and exceeds the minimal scientific criteria for professor in mathematical sciences: Group A – 50 points, required 50; Group B – 162 points, required 100; Group Г – 734 points, required 260; Group Д - 384 points, required 140, group E – 498.9 points, required 150. The works are published in journals with IF and/or SJR, and are belonging to quartiles *Q1*, *Q3*, and *Q4*. The number of citations is considerable – 64 (448 of them for this competition) in qualitative issues. In my opinion, the applicant is well qualified and can conduct specialized investigations based on his experience and this is my main recommendation to his future activity. Yet, the gained level of knowledge requires Dr Lirkov to develop this research topic attracting postgraduated students to train.

7. Personal impression

I have known Ivan Lirkov long time ago. We had numerous meetings and discussions in IICT-BAS as well as during the conferences LSSC, AMiTaNS, NMA, etc. where he presented scientific reports and talks and conducted scientific sessions. He strikes me as a high level professional deeply penetrated in his fields of study.

Conclusion

Gaining an impression for the all-round scientific and research activity of the applicant and having in mind the legal rules and criteria (LDASRB and its regulations in the BAS) as well as the specific rules in IICT I **rate positively** the entire activity. On the strength of virtue of the law **I propose Assoc. Prof. Ivan Dimov Lirkov** for academic position Professor in the Institute of Information and Computational Technologies, Professional Direction 4.5 Mathematics, Scientific Subject: Computational Mathematics (High-performance Methods and Algorithms).

(Prof. Michail Todorov)

Sofia, September 5th 2021