OPINION

by: PENCHO GENOV MARINOV, Prof. Dr., IICT - BAS
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on: the procedure for the thesis defense with title:
Composite numerical methods and scalable tile algorithms,
with author: DIMITAR GEORGIEV SLAVCHEV – regular form of study
Scientific advisor: PROF. SVETOZAR MARGENOV
for: to award educational and scientific degree "Doctor" (PhD, Philosophy Doctor)
in: Area of Higher Education 4. "Natural Sciences, Mathematics and Informatics",
Professional field: 4.5 "Mathematics",
Scientific Major: 01.01.09 "Computational Mathematics"

1. Ground and general description of the submitted materials.

By order No.24/31.01.2022 of the Director of IICT at BAS, on the basis of a decision of the Scientific Council (Protocol No.1/26.01.2022), according to Art. 4, Para. 2 of the Act on Development of the Academic Staff in the Republic of Bulgaria (ADASRB), I have been appointed a member of the Scientific Jury according to the procedure described above. As a member of the scientific jury of his first meeting (according to the same Order) on 02.02.2022 I received the following materials on the procedure:

(1) Dissertation application, from 20.01.2022 to the head of the section "Scientific computations with Laboratory of 3D digitalization and microstructural analysis" for the defense of the dissertation. It ends with an inventory of the submitted 5 groups of documents.

(2) Dissertation in Bulgarian, PDF-format Contains: introduction, four chapters, conclusion, two appendices, literature, in the volume of 140 pages, 47 figures, 7 tables, 90 literature items.

(3) Signed declaration of originality.

(4,5) Abstract in Bulgarian – 40 pages, Abstract in English – 36 pages.

(6) Order for deduction with the right to protection, as of 01.02.2020, with No.40 / 14.02.2020, on the grounds of Art. 24, Para. 4 from Regulations on the Implementation of the ADASRB, and decision of the Scientific Council of IICT (Protocol No.1 / 29.01.2020).

(7) List of printed scientific publications on the topic of the dissertation, 5 published, 2 in press, in DOC-format, arranged by the chapters of the dissertation.

(8) The dissertation articles from the previous list, in PDF-format, in a separate directory.

(9) Information on the fulfillment of the minimum requirements of IICT-BAS for this scientific degree. Contains some inaccuracies that are not fatal to the procedure.

2. Structure of the dissertation.

The Introduction gives the motivation for the current work. The methods used and the tasks solved are briefly described.

Chapter 1 is introductory and describes the block solving methods used of dense systems of linear equations, as well as an estimate of their computational complexity. The advantages of the considered method based on Hierarchical semi-separable (HSS) compression are also described.

Chapter 2 presents numerical results for the flow of wing profiles of Zhukovsky. The resulting solid matrix system is used in comparative analysis of the used tiled (block) algorithms.

Chapter 3 discusses the problem of two-dimensional anomalous diffusion modeled with the Laplace fractional operator. The finite element method is used for sampling in space.

Chapter 4 discusses the parabolic problem of two-dimensional anomalous diffusion in space. The main result of the research in this chapter is the analysis of computational complexity and the corresponding consecutive and parallel times.

The following are: Conclusion - summarizing the concluding remarks after each chapter; List of publications on the Dissertation - 5 published, 2 accepted for publication (in press), with their numbers in the Bibliography, grouped by Chapters of the Dissertation; Approbation of the results - the results were reported at 5 international conferences and 2 workshops; Main scientific and scientific-applied contributions; Declaration of originality.

Thanks - I am very impressed, but I attribute it to my inexperience.

Two MatLab Code Applications – Appendix (A) rearrangement of unknowns for hierarchical semi-separable compression; Appendix (B) assembling the mass matrix with a diagonal concentration.

Bibliography with 90 items - 4 are in Bulgarian, the rest in English.

3. Abstract.

The abstract in Bulgarian is 40 pages, with 18 figures, 5 tables, 29 bibliographic sources (bibitems). The English version is 36 pages, with 18 figures, 5 tables, 27 bibliographic sources.

The abstracts correctly reflect the content of the dissertation and the main conclusions from each of the chapters of the dissertation.

4. Evaluate publications.

Two (2) of the publications are with one author, the remaining 5 (five) are with the supervisor, and in only one of the latter there is another co-author.

Five (5) of the articles are visible in Scopus, and two of them in WoS. They have SJR and quartiles in Scopus.

The requirements under Indicator 'G' are met and exceeded (see item 6 below)

5. Estimation of contributions.

I agree with the scientific and scientific-applied contributions indicated by the dissertation, in short:

(1) The performance of the following software packages for solving linear systems with dense matrices was investigated using block LU factorization. The results of numerical experiments for systems obtained by sampling with the method of boundary elements for the boundary value problem for laminar flow around Zhukovsky's wing profiles are in accordance with the asymptotic estimates of the computational complexity. The comparative analysis shows better performance and very good parallel scalability of the Intel Math Kernel Library (MKL) package.

(2) The computational complexity, parallel efficiency and relative error of a hierarchical semi-separable compression (HSS) method have been studied. Characterization was obtained depending on the relative error threshold in HSS compression of the cases in which the hierarchical method has better speed.

(3) It is shown that for the problem of wrapping Zhukovsky profiles in sampling by the method of boundary elements, the sequential numbering of nodes along the boundary of the profiles leads to a matrix with a structure suitable for HSS compression. The comparative analysis shows a significant improvement of the results when applying the methods of embedded sections and recursive bisection.

(4) A method, algorithm and program implementation for numerical solution of a parabolic equation with fractional diffusion operator in space have been developed. It has been confirmed by numerical experiments that for all dimensions of the discrete spatial task, as well as for all variants of the relative error threshold, the version of the program using the solver from the STRUMPACK package has better performance than the one using MKL.

6. Fulfillment of sciento-metrics requirements.

Group indicators	Content of the group	Requirements of IICT – BAS for PhD	Indicators of the candidate Dimitar Slavchev
A	Indicator 1 (thesis)	50	50
G	Indicators 5 to 10	30	140
Total	**for all groups**	**80**	**190**

The table with the implementation of the scientific-metric indicators attached here does not repeat completely the points given in the "Information on the implementation of the minimum requirements". The Reference Table provided by the applicant is in the form required by NACID for "Register of Scientific Activity" and "Register of Academic Staff", but the points are not consistent with *Regulations on the terms and conditions for obtaining scientific degrees and for borrowing to academic positions at BAS*, also with *Regulations on the specific conditions for obtaining scientific degrees and for holding academic positions in IICT - BAS*

I will only note that due to the other coefficients the points for NACID will be more and the overfulfillment in the attached here Table will be even bigger.

7. Critical remarks, compliments and recommendations.

To the inaccuracies in the attached reference, item 9 of the materials, I will add the duplication of one article (numbers 4 and 5).

The abstract indicates 7 (seven) works on the topic of the dissertation - (5 published, 2 in press), and 6 (six) are described.

The structure of the abstract is more balanced than that of the dissertation. (this is a compliment)

It would be good for the numbering of the figures in the abstract to be accompanied by their corresponding numbers in the dissertation. (this is a recommendation)

I have no critical remarks, which would call into question the candidate's contributions and which would influence my positive assessment at the end of my review.

8. Personal impressions about the candidate and other data not mentioned in the previous points.

I do not know the candidate personally, but in addition to the research of his supervisor, Corresponding Member. Prof. Svetozar Margenov I have the best impressions of his work.

Here is the place to declare the lack of plagiarism in the works of Dimitar Slavchev, the results obtained, described and/or published by other scholars are correctly and in detail cited.

We have no conflict of interest in the sense of the rules and on the occasion of my participation in this Scientific Jury.

9. Conclusion.

Considering that: the candidate has sufficient scientific and applied contributions; what has been achieved has been announced among the scientific community in sufficient publications, scientific symposiums – and all requirements, conditions and criteria of are met: *Regulations on the Terms and Conditions for Acquisition of Scientific Degrees and for Occupying Academic Positions at BAS*, also *Regulations on the specific conditions for obtaining scientific degrees and for holding academic positions in IICT – BAS*

I have reason for the following conclusion:

I give a positive assessment of the materials with which the candidate participates in the procedure for obtaining the educational and scientific degree DOCTOR (PhD).

I recommend to the members of this Scientific Jury, to vote in favor and to award DIMITAR GEORGIEV SLAVCHEV educational and scientific degree DOCTOR, in the field of higher education 4. "Natural Sciences, Mathematics and Informatics", professional field 4.6. "Mathematics", scientific specialty "Computational Mathematics" (code 01.01.09).

30.03.2022

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