

## Review

Assistant Professor Dr. Venelin Lyubomirov Todorov  
in the competition for academic position "Associate Professor"  
in the professional field 4.6 "Informatics and Computer Science"  
specialty "Informatics (Modeling of complex systems with large dimension)"

Reviewer: Prof. Stefka Stoyanova Fidanova

By Order No 47 of 26.03.2021 of the Director of the Institute of Mathematics and Informatics at the BAS, prof. Peter Boyvalenkov on the grounds of Art. 4, para. 2 of the law and the decision of the Scientific Council of IMI-BAS (Minutes No. 5 of 19.03.2021). I was appointed a member of the scientific jury under the procedure for the academic position of "Associate Professor" in the professional field 4.6 "Informatics and Computer Science", scientific specialty "Informatics" (Modeling of complex systems with large dimension), announced for the needs of section "Information Modeling" in the State Gazette no. 08/29.01.2021. As a member of the Scientific Jury I have received all the documents attached to the application to the Director of IMI-BAS of the only candidate for the competition, Assistant Professor Dr. Venelin Lyubomirov Todorov.

According to the Law on the Development of the Academic Staff in the Republic of Bulgaria, the regulations for its implementation and the specific requirements introduced in the regulations of IMI-BAS, applicants must meet the following requirements:

1. Have acquired a doctorate degree in education and science;
2. Have held the academic position of "Associate Professor" at the same or another higher education institution or scientific organization for at least two academic years;
3. Have submitted published monographs or equivalent publications in specialized scientific editions which do not repeat the ones submitted for the acquisition of the educational and scientific degree "Doctor", the scientific degree "Doctor of Sciences" and for the occupation of the academic position "Associate Professor";
4. Have presented other original scientific works, publications, inventions and other scientific and applied scientific works which are evaluated in aggregate;
5. Meet the national minimum requirements;
6. Not to have plagiarism proven by statutory order in scientific works.

Assistant Professor Dr. Venelin Lyubomirov Todorov receives educational and scientific degree "Doctor" (diploma No 000934 issued it 23.10.2017 from Bulgarian Academy of Sciences) on the basis of a defended dissertation "Monte Carlo methods for multidimensional integrals and integral equations and applications".

Venelin Todorov has a total of 56 publications, 7 of them with impact factor and 27 with impact rank.

For Group B requirements, Venelin Todorov submitted 6 publications, 5 of them with an impact rank and 1 in the global indexing and referral system, without an impact factor or impact rank, the total number points is 112 for required 100.

For Group G indicators, a total of 12 publications are presented, with Impact Rank. The total number of points is 240 for required 220.

Dr. Venelin Todorov submitted 14 citations by other authors. All are with impact factor or impact rank. The total number of points is 84 with a required 70 under indicator D. He has other 41 citations, which are not included in the concurs materials. He has  $h=3$  index.

Dr. Venelin Todorov participated in two projects, funded by the national scientific fund and one funded by the Ministry of Education and Science. The total number of points is 30 with the required 20 under indicator E. In addition, he has been the coordinator of two projects for young scientists, funded by the Bulgarian Academy of Sciences, coordinator of a project young scientists, funded by the national scientific fund and was a participant in a total of 12 research projects.

As proof of his qualities as a scientist, I would like to note that Assistant Professor Venelin Todorov is the winner of the Marin Drinov Award for Young Scientist for 2019. He has an award for the leader of the most successful project for funded under the program for support of young scientists for 2017.

Assistant Professor Venelin Todorov fulfills and, by some indicators, significantly exceeds the national requirements, as well as the specific requirements of BAS and IMI for the academic position of "Associate Professor".

The publications of Ch. Assistant Venelin Todorov are in the field of application of stochastic methods for solving systems of integral and differential equations. The contributions in the presented publications can be grouped in 6 main directions, according to their application:

- Development of new effective stochastic approaches for sensitivity analysis of a complex system of large dimension, describing long-distance transport of air pollutants;
- Development of a new stochastic method for linear systems of large dimension with application in ecology;
- Development of new stochastic approaches for valuation of European options with large dimension;
- Development of new stochastic approaches for estimating high-dimensional multidimensional integrals in statistics;
- Construction of new numerical methods with high order of accuracy for model tasks in ecology with large dimension;
- Other contributions.

### **1. Development of new effective stochastic approaches for sensitivity analysis of a complex system of large dimension, describing long-distance transport of air pollutants**

A systematized scheme for analysis of sensitivity to a large model of air pollutants - Unified Danish Euler Model (UNI-DEM), was applied and studied to study the sensitivity of concentrations of important pollutants in the air to harmful emissions and to rate constants of some selected chemical reactions. Most of the results can be applied to model large-scale complex systems based on other large mathematical models. For sensitivity analysis, a modification of the Latin hypercube sample was applied for the first time and comparisons were made with the adaptive approach.

### **2. Development of a new stochastic method for linear systems of large dimension with application in ecology**

A point set of lattice type with a vector-generating generalized Fibonacci series was developed and was applied for the first time in the sensitivity analysis of UNI-DEM. A new stochastic Monte Carlo method has been developed for large linear systems based on the "random walk through the equations of the linear system" method. Numerical experiments confirm the method as one of the best known methods for large linear systems.

### **3. Development of new stochastic approaches for valuation of European options with large dimension**

For the first time, the point set based on the generalized Fibonacci series is compared with three Monte Carlo algorithms optimal for certain classes of functions for multidimensional numerical integration, using "shifted" quasi-random Sobol series. A point set grid type with a generating

vector has been developed using the reflection approach and has been applied for the first time to evaluate European options. For the first time, a comparison between point sets with different generating vectors was made to evaluate the options, and the optimal generating vector achieves the best results for high dimensions.

#### **4. Development of new stochastic approaches for estimating high-dimensional multidimensional integrals in statistics**

A point set of lattice type with an optimal generating vector was developed by the method of fast construction and was applied for the first time to the sensitivity analysis of UNI-DEM. For the first time, the Faure series was applied to the model problem and a comparison was made between the quasi-random series of Faure and three optimal for certain classes of functions Monte Carlo algorithms for multidimensional numerical integration using "shifted" quasi-random Sobol series. For the first time, stochastic approaches based on the Sobol series with Matusek linear mixing, the adaptive approach and the generalized Fibonacci series are applied to multidimensional integrals with application in statistics and artificial intelligence.

#### **5. Construction of new numerical methods with high order of accuracy for model tasks in ecology with large dimension**

A point set of lattice types with a generating vector of a polynomial transform function has been developed and has been applied for the first time in the calculation of the sensitivity indices obtained in sensitivity analysis. A new compact differential scheme with a fourth order of accuracy in the spatial variable for a model of long-range transport of pollutants in the air has been developed and a comparison has been made between two different approaches for obtaining schemes of the fourth order of accuracy - a compact differential scheme and a standard scheme of increased order with Richardson extrapolation. New compact differential schemes with a fourth order of spatial variable accuracy for an atmospheric model based on the Chapman cycle are applied. A particular difficulty in the considered complex system is the large values of the rate constants of chemical reactions, which has hampered the existing methods and has made a serious scientific and applied contribution to this important atmospheric model. The inverse problem for restoring the right side of a system of parabolic partial differential equations with a predefined setpoint from point sources is investigated and a new numerical method based on a special decomposition of the numerical solution is proposed.

#### **6. Other contributions**

A method for improving the accuracy of numerical solutions of ordinary and partial linear fractional differential equations with singularities using Taylor fractional polynomials is proposed. A new numerical method with a second order of accuracy for the first derivative based on different generating functions was also obtained.

I have known the candidate since he was a doctoral student. I have excellent impressions of his work.

The materials presented by the candidate are complete and detailed. They contain the necessary information required by law. The contributions are presented concisely and summarized, with emphasis on the significant author's contribution.

### **CONCLUSION**

According to the presented documents, the candidate Venelin Lyubomirov Todorov fulfills all the requirements of the law and the Regulations to it and the Regulations for the specific requirements for acquiring academic degrees and occupying academic positions at BAS and IMI-BAS. I give a positive conclusion for the selection of Venelin Todorov in the competition for the academic position of "Associate Professor" in the professional field 4.6 "Informatics and Computer Science", scientific specialty "Informatics" (Modeling of complex systems with large dimension).

I propose that the Scientific Jury unanimously vote on a proposal to the Scientific Council of the Institute of Mathematics and Informatics at the Bulgarian Academy of Sciences to select Assist. Prof. Venelin Todorov for the academic position "Associate Professor" in the professional field 4.6 "Informatics and Computer Science", scientific specialty "Informatics" (Modeling of complex systems with large dimension ) .

22.04.2021