

## **OPPINION**

by DSc. Stoyan Milkov Mihov, Associate Professor at IICT-BAS  
on the procedure for obtaining a scientific degree

### **"Doctor of Sciences"**

in professional field 4.5 "Mathematics" (Mathematical logic)

by Dr. Alexandra Andreeva Soskova - Professor at the Department of Mathematical Logic  
and its Applications at the FMI of Sofia University

with a dissertation entitled

“Computable Structure Theory: Jump of Structure, Coding and Decoding”

In accordance with order RD 38-613 / 21.12.2020 of the Rector of Sofia University “St. Kliment Ohridski” I have been appointed as a member of the scientific jury under the present procedure.

### **Biographical information**

Prof. Dr. Alexandra Andreeva Soskova graduated from the Faculty of Medicine at Sofia University “St. Kliment Ohridski” in 1979, obtaining a master's degree in mathematical logic. In 1990, again at the Faculty of Medicine at Sofia University, she defended a PhD thesis. In 2005 Dr. Alexandra Soskova was elected associate professor, and in 2019 she was elected professor at the Department of Mathematical Logic and its applications at the Faculty of Mathematics at Sofia University. The entire professional experience of Alexandra Soskova after 1990 is in FMI at Sofia University “St. Kliment Ohridski”.

### **General description of the presented materials**

The materials presented by Prof. Alexandra Soskova have been prepared in accordance with the Development of Academic Staff in the Republic of Bulgaria Act, the regulations for the application of this act and the Regulations on the terms and conditions for acquiring scientific degrees and holding academic positions at Sofia University “St. Kliment Ohridski”. These include: 1) dissertation in English; 2) abstract in Bulgarian and English; 3) professional CV, copies of the diploma for higher education and the diploma for educational and scientific degree “doctor”; 4) a list of the scientific papers on the topic of the dissertation and a complete list of the scientific papers of Prof. Soskova; 5) copies of the printed scientific publications on the topic of the dissertation; 6) reference for fulfillment of the minimum requirements of Sofia University; 7) screenshots from Scopus, Web of Science and InCites to prove the indexed publications and IF / SJR ranks of the respective scientific journals; 8) feedback letters for the presented dissertation work by Prof. Sergey Goncharov and Assoc. Prof. Ekaterina Fokina.

The report for fulfillment of the minimum requirements for the scientific degree “Doctor of Sciences” in professional field 4.5 “Mathematics” contains in tabular form data by groups of indicators A, Б, Г and Д. The points on the given indicators satisfy the requirements for obtaining the scientific degree “Doctor of Sciences”.

## General characteristics of the candidate's activity

Prof. Alexandra Soskova is an established scientist in the field of mathematical logic. Her research interests are focused on the theory of computability and in particular the computable structures theory. Prof. Soskova has been a member of the program committees of leading world scientific conferences in the field of computational theory, including the Logic Colloquium and Computability in Europa.

## Scientific contributions presented in the dissertation

The dissertation consists of 8 chapters, the first chapter is introductory and the last chapter contains a bibliography (166 titles) with a total volume of 270 pages.

In the introductory, first chapter of the dissertation an overview of the content of the following chapters is made and the obtained original results are presented - the main contributions of the dissertation work. The second chapter introduces the mathematical concepts necessary for the presentation of the remaining parts of the dissertation. These include Turing and enumeration reducibility, Turing and enumeration degrees and degree spectra. In the third chapter the properties of jump of an algebraic structure are considered and the concept of the jump spectrum is introduced. Results for the jump inversion are presented. The fourth chapter explores the concept of strong jump inversion and its properties. Some sufficient conditions for a structure to allow a strong jump inversion are given. Next, Chapter 5 examines another approach to the algorithmic complexity of algebraic structures. The concept of Turing computable embedding and its stronger category-theoretic version — computable functors are considered. General conditions for elimination of the parameters of (effective) field interpretations are presented. Chapter 6 discusses effective versions of some model-theoretic constructions. The concept of cohesive power of structure is considered. The question of when a computable linear ordinance induces isomorphic cohesive power is explored. Chapter 7 contains results on enumeration degrees of subsets of  $\mathbb{N}$ . Also, the chapter discusses the skip operator, which is analogous to the jump operator in the Turing degrees. The structural properties of natural substructures of the structure of enumeration degrees  $\mathcal{D}_e$  are studied.

The abstract lists five main contributions of the dissertation, and they are presented as answers to the following five questions:

- (1) How to define the jump of a structure as an analogue of the Turing jump in the degree structure  $\mathcal{D}_T$  of Turing degrees? Are there any typical structural properties such as jump inversion theorems? Is the set of all jumps of the elements of the degree spectrum of a structure also a spectrum of another structure?
- (2) Are there any model theoretical conditions that are sufficient for a structure to admit strong jump inversion?
- (3) For the known effective codings of one class of structures into another class, is there an effective or more difficult decoding for some special classes as linear orderings and 2-step nilpotent groups, which are on the top of Turing computable embeddings?
- (4) For any two copies of a computable order type, do their cohesive powers has the same order type?
- (5) Are there any substructures with interesting properties in the degree structure  $\mathcal{D}_e$  of the enumeration degrees, other than the total and the continuous degrees?

The questions thus posed are of essential interest for clarifying the relationship between the structural and computational properties of mathematical objects. I accept the scientific contributions described in the abstract. The theoretical contributions are formulated concretely and clearly in the context of the results presented in the dissertation. I believe that these results represent an important contribution to modern computability theory, as evidenced by their publication in the most renowned scientific journals in the field of mathematical logic, including the Journal of Logic and Computation, the Journal of Symbolic Logic and Transactions of the American Mathematical Society. Other evidence for the scientific value of the presented work are the very favourable reference letters sent by experts in the field - Prof. Goncharov and associate Prof. Fokina, as well as the observed 48 citations of publications related to the dissertation.

### **Assessment of the candidate's personal contribution**

The main contributions of the dissertation are presented in 10 articles, of which 8 have been published and 2 have been submitted for publication. One of the published articles is authored by Prof. Soskova only, and the others are co-authored. I accept that in the presented articles co-authored by Prof. Soskova has an equal contribution with the other co-authors.

### **Personal impressions**

I have known Prof. Soskova since 1993 and I highly appreciate her scientific achievements, academic experience and her daily work with students. Her in-depth theoretical research in a complex and highly abstract field of mathematics makes a strong impression.

### **Conclusion**

After getting acquainted with the materials of the procedure, the complex evaluation of the scientific results presented in therein, and taking into account the personal qualities of the candidate, I recommend to award Prof. Dr. Alexandra Andreeva Soskova the scientific degree "Doctor of Sciences" in professional field 4.5 "Mathematics" with a dissertation entitled "Computable Structure Theory: Jump of Structure, Coding and Decoding".

March 16, 2021

Sofia

Member of the scientific jury:

Assoc. Stoyan Mihov