

## STATEMENT

about the PhD thesis for acquisition of the scientific degree "doctor" in the professional field 5.3 "Communication and computer technics", doctoral program "Computer systems and technologies",

**Author of the PhD thesis:** M.Sc. Eng. Ivan Dimitrov Torlakov

**Topic of the PhD thesis:** "Application of high-performance systems for modeling sustainable processes in Cohen-Grossberg type neural networks"

Member of the scientific jury: Prof. Dr. Eng. Grisha Spasov from TU-Sofia, Plovdiv Branch, e-mail: [gvs@tu-plovdiv.bg](mailto:gvs@tu-plovdiv.bg)

The proposed PhD thesis consists of 151 pages and includes an Introduction, 4 chapters, a Conclusion - a summary of the obtained results and contributions of the dissertation, a Bibliographic reference with 123 literary sources, a List of publications on the dissertation and 13 pages of appendices.

### ***1. Actuality of the problems in the PhD thesis***

The proposed PhD thesis is on an undeniably current and important topic related to the study and analysis of sustainable processes in Cohen-Grosberg type neural networks. Thus defined, the title predetermines that the main research in the dissertation will concern the construction of models, algorithms and applications aimed at sustainable processes in Cohen-Grosberg type neural networks with bidirectional associative memory with time-varying delays and variable impulse disturbances, using a high-throughput and parallel technique. The problem is especially relevant for systems with elements of artificial intelligence.

### ***2. Degree of knowledge of the state of the problem***

The literature review in chapter 1 and the analysis made in it show a very good knowledge of the subject related to analyzing and researching neural networks and their application in different areas.

The bibliography contains a total of 123 references, some of which are direct URL links, all of which are on the subject.

### ***3. Correspondence of the chosen research methodology with the set goal and tasks of the PhD thesis.***

The methodology chosen by the PhD student for scientific research gives the opportunity to realize the main goal of the dissertation work and to solve the defined tasks.

Methodologically, the dissertation follows the logical sequence:

- analysis of the concepts, models and developments of neural networks and their application in recent decades. Study of software solutions for Cohen-Grosberg type neural networks with two-way associative memory or similar model;

- analysis of the mathematical apparatus applicable to the study of the sustainability of neural networks of the Cohen-Grosberg type. Proposing a

bidirectional associative memory Cohen-Grosberg neural network model with time-varying delays and pulse-varying disturbances. Review of the main h-sustainable results for the steady state of the model;

- selection and analysis of the architecture of high-performance computing systems applicable to the implementation of parallel algorithms for the study of Cohen-Grosberg type impulse neural networks;

- development of algorithms and applications of model for sustainability in Cohen-Grosberg type neural networks for VPPS. Experimental studies of the implemented parallel algorithms based on parallel architectures CUDA and OpenMPI.

I believe that the research methodology used is in accordance with the goal and objectives of the dissertation.

#### **4. Contributions to the PhD thesis**

I accept in principle the contributions formulated by the PhD student, which can be classified as scientific and scientific-applied. They are summarized in chapter 5, designed as the conclusion of the dissertation work. I believe that the formulated contributions show that the defined tasks have been fulfilled. This approach to presenting the contributions is appropriate because it connects the formulated goal and tasks of the dissertation work with the achieved results.

The scientific contributions are mainly in the proposal of a theoretical model of Cohen-Grosberg type neural networks with bidirectional associative memory with variable time delays and variable impulse disturbances. A theorem and a proof part for the equilibrium  $z^*$  of an impulse Cohen-Grosberg neural network with two-way associative memory are proposed.

The scientific-applied contributions are mainly in the proposal of parallel algorithms for the study of impulse neural networks of the Cohen-Grosberg type and experimental studies of the implemented parallel algorithms based on parallel architectures CUDA and OpenMPI.

#### **5. Evaluation of the publications on the PhD thesis**

The results of the dissertation work are presented in four publications. One of them [1] was published in the journal "Mathematics" 2020, 8, 335 of MDPI (indexed in SCOPUS with Impact Factor 2.258), has three citations indexed in SCOPUS. Two [2,3] were published in "Lecture Notes in Networks and Systems" Book series of Springer, ISSN 2367-3370 (since 2016 indexed in SCOPUS with SJR 0.151) and one [1] was published at an international conference in Bulgaria. All publications are co-authored with the PhD student's supervisors.

Upon familiarizing myself with the dissertation, I became convinced that the achieved results are primarily the personal work of the PhD student.

The publications reflect the main achievements of the dissertation work, indicating how the publications reflect the research in the individual chapters.

#### **6. Opinions, recommendations and notes.**

The educational objectives of the dissertation have been fully done.

Regarding the content of the dissertation, I have the following remarks and recommendations:

- At the end of the review (first chapter) there are no conclusions presented, on the basis of which the purpose of the dissertation work and the tasks for its realization can be formulated. The purpose and tasks are presented in the introduction, which from a methodological point of view is not correct and it is recommended that they be transferred to the end of the first chapter.

- The contributions of the dissertation work are presented in the conclusion very descriptively, which does not emphasize the research results achieved. It is good to restructure them as: 1. An analysis of ... was made, 2. An analytical study was proposed ... etc.

- Not all scientific and applied contributions resulting from the doctoral student's research are reflected.

It is worth noting that corrections have been made in the autoreferat and the first two remarks and recommendations have been reflected accordingly.

I have no objections regarding the quantity and quality of the work done in the dissertation.

## **10. Conclusion**

My assessment of the dissertation, the autoreferat and the publications presenting the research in the dissertation is positive. The dissertation contains scientific and scientific-applied contributions to a sufficient degree and meets the requirements of the Law for development of the academic staff in the Republic of Bulgaria and the Regulations for its implementation, as well as the Regulations for the conditions for acquiring scientific degrees in the University "Prof. Dr. Asen Zlatarov" Burgas.

**As a result of the above mentioned achievements in the dissertation, I propose to the Scientific Jury to award to MSc eng. Ivan Dimitrov Torlakov educational and scientific degree "Doctor", in the professional field 5.3. "Communication and computer technics", doctoral program "Computer systems and technologies".**

Date: 14.02.2023

signature:

(Prof. eng. Gisha Spasov, PhD)

Подпис заличен

Чл.2 от ЗЗЛД