SHORT REVIEW

REVIEWER: **ASSOC. PROF. PENKA V. GEORGIEVA, PHD**

OF DISSERTATION FOR AWARDING THE EDUCATIONAL AND SCIENTIFIC DEGREE **"DOCTOR"**

DOCTORAL PROGRAM: INFORMATICS, BURGAS FREE UNIVERSITY
FIELD OF HIGHER EDUCATION: 4. NATURAL SCIENCES, MATHEMATICS AND INFORMATICS
PROFESSIONAL FIELD: 4.6. INFORMATICS AND COMPUTER SCIENCE

AUTHOR: **PETYA IVANOVA PETROVA**
TITLE: **"MODELING OF NETWORK ATTACKS AND PROTECTION ALGORITHMS"**

Pursuant to Art. 18, para. 1 and para. 3 of the Regulations for development of the academic staff of BSU and decision of the Scientific Council of BSU from 15.04.2022 for opening a procedure for defence of the dissertation of **Petya Ivanova Petrova** with order UMO 26 from 28.04.2022 of prof. d-r Milen Baltov - Rector of Burgas Free University, I have been appointed a member of the Scientific Jury.

As a member of the Scientific Jury, I received:

1. Order UMO 26 of 28.04.2022 of the Rector prof. d-r Milen Baltov;
2. Dissertation;
3. Abstract of the dissertation;
4. Application form for initiating a procedure to the Dean of BSU;
5. CV;
6. List of publications on the topic of the dissertation;
7. Declaration of compliance with the requirements of Art. 6, para. 3 of ADASRB.

The requirements of the Act on the Development of the Academic Staff in the Republic of Bulgaria (ADASRB) and the Regulations for its implementation (RIADASRB) are the key-stones in dissertation assessment and:

1. according to Art. 6 (3) of ADASRB *"the dissertation must contain scientific or scientific-applied results that represent an original contribution to science. The dissertation must show that the candidate has in-depth theoretical knowledge in the specialty and abilities for independent research";*

2. according to Art. 27 (2) of the RIADASRB *"the dissertation must be presented in a form and volume corresponding to the specific requirements of the primary unit. The dissertation must contain: title page; content; introduction; exhibition; conclusion - summary of the results obtained with a declaration of originality; bibliography".*

The PhD student Petya Ivanova Petrova was trained in a part-time form of education at the Center for Informatics and Technical Sciences at Burgas Free University with scientific supervisors prof. d. t. s. Andon Lazarov and prof. d-r Georgi Dimitrov.

The dissertation consists of 114 pages and includes: list of abbreviations, introduction, three chapters, conclusion, declaration of originality of the results, appendices, bibliography, thanks and a list of publications on the topic of the dissertation.

The abstract is 36 pages long and presents the dissertation.

I. Relevance and significance of the purpose of the dissertation

The aim of the dissertation is " **Mathematical modeling of processes in computer networks when impacted by malware, construction and application of genetic algorithms to detect intrusions into the computer network and data protection** " (p. 22).

To achieve this goal, four tasks have been formulated.

The formulated goals and taskss are relevant in the context of trends in the development of information security, and they have scientific and scientific-applied potential and are a prerequisite for original contribution in the field.

II. Scientific results

The scientific contributions received as a result of the research are formulated on page 89:

- a model of the processes of susceptibility, exposure, infection and recovery of a computer network in case of malware exposure is proposed, described by a system of differential equations for instantaneous and prognostic estimation of the computer network.
- asolution of the system of differential equations is proposed in two cases - equilibrium for constant variables and lack of equilibrium for time-dependent variables, defining machine state classes in the computer network;
- expressions for calculating the network characteristics in case of susceptibility, exposure, infection, and recovery (reconstruction) of machines in the computer network during an attack with malicious software are derived фrom the solution of the system of inhomogeneous differential equations.

III Applied-scientific Results

On page 90 three applied-scientific and contributions are claimed:

- a software tool has been developed to protect the computer network by encrypting the transmitted information using the operators of a genetic algorithm implemented in programming language C#;
- software products implemented in the Matlab environment have been developed to illustrate the solutions of the system of differential equations for instantaneous and prognostic estimation.

IV. Publications on the topic of the dissertation

In the list of publications on the dissertation (p. 114) the PhD student has indicated 6 publications, as there is no individual publication and 3 of the mentioned publications are in English.

Publications are not found in world scientific databases, nor are citations found at the time of writing this short review.

V. Critical remarks and recommendations

1. An incorrect transcription in Bulgarian of the names of scientists has been detected (eg *Пуасон* instead of Поасон on page 8).
2. In many places in the text the terms are explained in brackets, instead of using the exact term in Bulgarian (eg. page 8, etc.).
3. Chapter 2 describes a genetic algorithm but does not clarify how the parameter *i* is determined *("i-th point of recombination"*, p.69), it is not shown how the probability of mutation is determined and there is no description of how the new generation is selected in the implementation of the genetic algorithm.
4. The used literature sources and the publications on the topic of the dissertation are not described with complete bibliographic descriptions. I recommend following, for example, the requirements of IEEE (or other) to include the

publisher, the pages, ISBN / ISSN, etc. The used Internet resources must contain the date on which they were last accessed.

VI. Questions on the dissertation

1. How is the term " *Jacobian matrix"* defined (pp. 29 and 30), how " *Jacobian matrices are calculated* " (ibid.). And how they relate to the name of K. Jacobi, the Jacobi matrix and the determinant of the Jacobi matrix, which is commonly called a Jacobian?
2. What are the "*software products implemented in the Matlab environment* " developed to " *illustrate the solutions of the system of differential equations for instantaneous and predictive estimation* " (applied-scientific result 4.2.2. on p. 90)?
3. What are the differences between " *endemic equilibrium* " (p. 27), "*complet*e *equilibrium of the computer network* " (p. 30), " *asymptotic equilibrium*" (p. 31) and " *global stability in the computer network* " (p. 31). ?
4. What is a "*fixed susceptibility of a computer network to a malicious attac* " (p. 32)?

VII. Conclusion

- **I accept** that the presented results to a large extent cover the scope of the set goals and tasks.
- The dissertation proves that the PhD student **has theoretical and practical knowledge in the scientific area** and has developed skills for research and presentation of results.
- **The requirements** of ADASRB, RIADASRB, and the Regulations for development of the academic staff at Burgas Free Unioversity for awarding the educational and scientific degree "Doctor" in the professional field 4.6. Informatics and computer science **are met.**
- I give **a positive conclusion** for awarding the educational and scientific degree "Doctor" and I propose that the Scientific vote positive on awarding the educational and scientific degree "Doctor" **Petya Ivanova Petrova** in professional field 4.6. Informatics and Computer Science, doctoral program: Informatics.

Date: 22.05.2022 **reviewer: …… ..**

(Assoc. Prof. Dr. P. Georgieva)