

REVIEW

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Member of the Scientific Jury appointed by the Director of IICT-BAS via
Order № 130/27.05.2021

Subject: Dissertation of Ivan Ivanov Blagoev with title "METHODS AND MEANS OF DATA ANALYSIS IN INFORMATION SYSTEMS USING TIME SERIES", presented for the acquisition of educational and scientific degree "doctor" in a doctoral program "Informatics", Professional field 4.6. "Informatics and computer science".

1. General description

As a member of the Scientific Jury I have received:

- Dissertation;
- Abstract in Bulgarian and abstract in English;
- a list of printed scientific publications on the dissertation topic;
- publications on the topic of the dissertation in full text;
- information about the fulfillment of the minimum requirements of IICT;
- other documents related to the defense of the dissertation.

2. Actuality, purpose and tasks of PhD dissertation

The collection and processing of large data sets in the coming years will increase steadily. This requires the development of new methods and technologies for big data processing in various information systems and applications. Time-oriented data analysis is one of the most important issues in many areas, from finance to cybersecurity. A modern method for such processing is the study using time series. Therefore, conducting research related to the development of models and algorithms for processing and analysis of information with time series is a topical research area.

The purpose of this dissertation is to develop new methods and means of data analysis in information systems using timelines.

For this purpose, the following tasks are defined:

1 develop a method for analyzing and predicting price movements in the financial field using time series;

2 to propose an algorithm for the training of artificial neural networks in forecasting financial time lines;

3 propose solutions to increase cryptographic protection in information systems by applying methods of analysis of time lines;

4 to conduct experimental studies to verify the proposed methods of enhancing cryptographic protection in solving cyber security tasks.

3. Analytical characterization of PhD dissertation

The dissertation consists of 125 pages, structured in an introduction, four chapters, a conclusion, a list of dissertation publications, a list of noted citations on the dissertation, a bibliography and appendices. It contains 33 figures, 1 table and 122 literature sources.

Chapter one provides an overview and analysis of scientific problems in the field of data science, and in particular when these data are presented as time series. The many different situations in which research and forecasting are required for planning and decision-making processes are noted. The importance of applying quantitative forecasting techniques using historical data and forecasting models is pointed out. The need to develop new methods and tools for data analysis and forecasting in information systems and services using time series is justified.

Chapter two describes the developed methods for research and forecasting of financial time series using various mathematical devices. The in-depth understanding of the doctoral student in the specifics of the analysis of time series in the financial field is demonstrated. An unconventional method for obtaining a forecast signal for market turnaround is provided, namely the developed MA Volatility Indicator. An algorithm for training an artificial neural network by self-upgrading in forecasting financial time series is proposed, taking into account the maximum information available in the time series and the less informativeness of the older values. Some of the results of Chapter Two are presented in publications № 1, 3 and 8.

Chapter three describes solutions for providing cryptographic protection in the provision of information services by examining random number generators representing time series. A new approach for visualization of time series of random number generators is proposed, presenting the results of the same data with different graphical interpretation, which reveals problems with the quality of the studied RNG values (trends, cycles). The algorithm for detecting repetitive data models in RNG-generated time series has been developed. The practical application of the proposed approaches for cybersecurity is presented. The results of the conducted tests in real conditions are shown, proving the successful solution

of the set tasks. The cryptographic protocols securing the connection between client and server (hosting service) have been scanned. Actions for planning and conducting experimental research give the impression of well thought out and methodologically sound. Some of the results of Chapter Three are presented in publications № 4, 6, 7 and 9.

Chapter four proposes methods using the R programming language to overcome the problems of working with large data sets and limited computing resources with time series research. The described software techniques for optimizing computer memory when working with big data can be used by researchers without the need for in-depth knowledge of computer systems for complex data analysis. Some of the results of Chapter Four are presented in publications № 2 and 5.

The research presented in the dissertation is supported by program code, proving the deep understanding of cryptographic algorithms, programming languages and operating systems. The participation of the doctoral student in two research projects is indicated. Ivan Blagoev also received an award from IICT-BAS for excellent scientific achievements in 2019 in the "PhD students" category.

4. Contributions

I accept all the doctoral student's contributions, namely:

1. A method entitled MA Volatility Indicator has been developed to combine indicators for detecting price movements with new approaches when using time lines of financial data.

2. The apparatus of artificial neural networks shall be applied for the purpose of examining financial time lines. An algorithm has been developed to train the neural network by increasing the size of the neural network input and creating a hybrid structure, and a model for self-build three-layer MLP has been proposed.

3. A method has been developed to increase cryptographic protection in information systems based on studies on the quality of random number generators.

4. Experimental research has been carried out to solve cyber security problems in public widespread hosting services. The results obtained confirm the validity of the proposed method of enhancing cyber security.

5. Programming methods have been developed for efficient operation with large data with means in the R language.

6. The developed methods for increasing cryptographic protection are implemented in the technological infrastructure of IICT-BAS. A study of

cryptographic tests and the quality of entropy on real-world busy server systems with public Internet services was conducted.

5. Abstract and author' declaration

The presented two versions of the abstracts in Bulgarian and English correctly reflect the content of the dissertation and correspond to the requirements of Bulgarian legislation. From the presented declaration of originality, as well as from the presented papers on the dissertation theme, it can be judged that the described results are a personal work of the author.

6. Assessment of compliance with the minimum national requirements

The PhD student Ivan Blagoev has tested parts of his dissertation in 9 scientific publications, 7 in English. Two of the publications are with SJR and are indexed in Scopus and WoS. Two of the publications are co-authored, the others are independent. This shows the doctoral student's ability to conduct independent research.

According to the minimum national requirements for obtaining of the educational and scientific degree „Doctor in the professional field 4.6 " Informatics and computer science ", the required scores are to be at least 30 for the group of indicators G. The same number of scores is required by the Regulations on the Conditions and Procedures for Acquisition of Academic Degrees and Occupation of Academic Positions in BAS and the Regulations on Specific Conditions for Acquisition of Academic Degrees and Occupation of Academic Positions in IICT-BAS. The presented publications on the dissertation form a total 40 scores for the indicators from G group, which is higher than the required minimum of 30 scores. Three of the publications are cited in 5 scientific publications. This proves the necessary publicity of the achieved results.

7. Critical remarks and recommendations

Some of the described results in the dissertation are not reflected in publications and it is recommended to be published.

8. Conclusion

The presented dissertation meets the requirements of the Law on the Development of the Academic Staff in the Republic of Bulgaria, the Rules for its implementation, the Rules for the conditions for the acquisition of academic degrees and for the occupation of academic positions in the

Bulgarian Academy of Sciences and the Rules for the specific conditions for the acquisition of scientific degrees and for academic positions at ICT-BAS.

The described results in the dissertation, along with the fulfillment of the national minimum requirements, give me enough reason to give a positive assessment of the dissertation work and I suggest to the honorable scientific jury to award to **Ivan Ivanov Blagoev** the educational and scientific degree „Doctor” in doctoral program "Informatics", professional field 4.6 "Informatics and computer science".

**NOT FOR
PUBLIC RELEASE**

17.06.2021

/Prof. DSc Ivan Garvanov/