

R E V I E W

by: *Prof. Stanimir Ivanov Kabaivanov, PhD;*
Plovdiv University "Paisii Hilendarski" – FESS;
3.8 „Economics“
of: PhD thesis materials in “Data Science” – Sofia University “St.
Kliment Ohridski”.

Ground for the review: member of the scientific committee in accordance with Order № ПД 38-597/03.11.2023.

PhD thesis author: *Vladislav Krasimirov Tanov*
Thesis title: *Game models and time series modelling*

1. General information

Vladislav Krasimirov Tanov completed his BSc studies in "Finance" at George Mason University, in 2012. In 2016, he graduated with honors from a master's program at the same university in "Data Analytics" (Data Analytics Engineering-Predictive Analytics). Vladislav Tanov is a doctoral student in the doctoral program "Data Science" in the period 2018 - 2021. This academic experience facilitates his in-depth and consistent understanding of contemporary issues in economics, finance and use of various analytical methods for data analysis.

Vladislav Tanov's professional experience enriches and complements his scientific interests, as the positions held at Amazon Web Services (AWS) and Microsoft are directly related to data analysis.

2. Thesis general review

The dissertation has a total of 138 pages, of which 106 pages are the main text: introduction, three chapters, a conclusion and discussion, a list of used literary sources and an appendix. The study references 88 sources, most of them in English. It is worth noting that main text refers not only to contemporary and classical research works in the respective area but also to some of Mr. Tanov's own papers. This emphasizes a consistent and logical approach to the construction of the dissertation.

The research focuses on contemporary and significant problems, and the obtained results can be applied to solve important problems in finance and economics. It should be noted that the author's desire to single out precisely these applications leads to a deviation from the imposed structure of dissertation studies, where the object, subject, main hypothesis and solved tasks are defined in the introductory part. It would not be a problem for well-prepared reader to find these elements, but I believe that for the sake of completeness of the dissertation research, it would be better if the author defines them explicitly.

The main tasks of the dissertation work are formed around the search for equilibrium solutions in different game situations, which can develop into general approaches for the study of game models in the presence of a large volume of data. In the search for a solution, adequate and appropriate methods and analytical tools have been used in the separate chapters of the dissertation research.

The **first chapter** contains an introduction to differential stochastic games, the main purpose of which is to propose and consider an iterative algorithm, with the help of which an equilibrium solution according to Nash can be reached. Within this section, several examples and results of preliminary experiments are given to demonstrate the qualities of the considered sequence of steps.

In the **second chapter**, game models with antagonistic and positive models are considered, with the main focus being again on the search for iterative approaches to solve the systems of equations that describe individual situations.

In the **third chapter**, the emphasis is placed on the possibilities for optimizing the classification algorithms and the search for optimal training sets, according to the specifics of the specific problem situations.

The **conclusion** presents the main conclusions of the study, the obtained results and the possibilities for future research. The hypothesis that the author has defined in the conclusion, and which gives direction to his possible future research on the subject, deserves special attention.

The study has a specific structure, placing emphasis on the results achieved and the contributions claimed at the end of each chapter. The individual parts of the dissertation are logically linked and subordinated to the achievement of the final goals.

3. General review of thesis results

The results of the research are practically significant, as they allow to optimize the steps for solving a number of classification problems. The

reviewed and proposed iterative procedures for finding equilibrium and solving Riccati equations are easy to implement using popular programming languages.

The comparisons made in the third chapter contain elements that can be further developed into concrete solutions to important business problems. The PhD student has implemented a detailed Python implementation.

4. Review of scientific contributions and applications

The following important scientific and scientific-applied contributions can be mentioned in the dissertation work:

- In the first chapter, an iterative method for solving a linear-quadratic stochastic game is proposed, which allows achieving a Nash equilibrium.
- In the second chapter, two iterative methods for solving cellular Riccati equations (expressions 2.31-2.38) are discussed, which have an easy program implementation.
- A check and comparison of the effectiveness of different classification algorithms and the solutions proposed by the author was made. The results are systematized, with particular attention paid to explaining the observed differences in performance.

Vladislav Tanov uses analytical tools and models in an interesting way, which are adequate to the set goals and tasks. Contributing points are commented at the end of each individual chapter.

5. Review of publications

The doctoral student has submitted a list of six scientific publications aimed at the issues considered in the dissertation. The publication activity of the author can be considered very high, especially considering that five of the listed studies are in sources indexed in Scopus.

I am not aware of any facts that cast doubt on the personal contribution of Vladislav Tanov, his participation in the conduct of the research, preparation and presentation of the publications indicated in the abstract. There is a correct attitude to the literature used and a detailed description of the personal contributions of the doctoral student.

6. Review of the thesis abstract

The abstract has a volume of 41 pages (33 of them main text). It accurately reflects the conclusions and important elements of the dissertation research. The main results are presented and the contributions are clearly stated.

I have no reason to doubt the originality of the research, the text of the dissertation and the claimed contributions. I can recommend the PhD student to expand the part summarizing the contributions he comments on at the end of the individual chapters.

7. Remarks and recommendations

Dissertation research examines and solves important tasks for data analysis. It should be noted the author's desire to support individual examples and solutions with pseudo-code and a Python implementation to assist readers. The following comments and recommendations could be made to the exhibition:

- Without underestimating the benefits of the results obtained, putting the introductory and concluding part of the dissertation in a form that explicitly states the object, subject, purpose and tasks will make it easier for the readers.
- It would be good if emphasis was placed on specific practical applications, highlighting the benefits associated with using the obtained results.
- I believe that the distribution of the results will be more effective and faster if the author makes them available as open source in one of the known sharing platforms.

The purpose of the notes made is to improve the presentation of the individual stages of the research. They in no way belittle the efforts made and the results achieved by the author.

8. Conclusion

The PhD thesis complies with all legal requirements and internal regulations of Sofia University “St. Kliment Ohridski”. Interesting results have

been obtained, that can be applied to solving a number of classification tasks. The specific structure and concise exposition are the result of the author's professional approach to presenting the research, concisely and to the point. The publications and accompanying research materials are in accordance with the specific requirements of the Faculty of Economics of the SU, and it should be noted that the author's published research finds a precise application and place in the overall research.

Vladislav Tanov impresses with in-depth theoretical knowledge and practical skills, and the individual elements of the dissertation research are argued and presented consistently.

I give my positive assessment of the research presented by the dissertation work, abstract, results and contributions. With conviction I propose to the respected scientific committee to vote to award the educational and scientific degree "doctor" to Vladislav Krasimirov Tanov in 3. Social, economic and legal sciences, 3.8. Economics, "Data Science".

Date / Place
01.12.2023
Plovdiv

Signature:
/Prof. Stanimir Kabaivanov, PhD/