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**REPORT**

**By a member of the dissertation committee of the dissertation of BULGAKOVA Mariia Aleksandrovna on the theme: "Dynamic Network Games with Pairwise Interactions", submitted in conformity with requirements for the degree of Candidate (PhD) of Physico-Mathematical Sciences in Speciality 1.2.3 — Theoretical Informatics, Cybernetics.**

The dissertation of Mariia Bulgakova is dedicated to the analysis of dynamic network games with pairwise interactions. The dissertation is mostly focused on the approaches of cooperative games. This is a very contemporary and important topic as many modern technological, economical and sociological systems (e.g., online social networks or telecommunication systems) can be adequately described by network models.

The dissertation of Mariia Bulgakova consists of four technical chapters as well as of Introduction, Conclusions and Bibliography. In the Introduction, the candidate carefully described the motivation of the work, the main contributions of the thesis and the main methodologies.

Chapter 1 is the central chapter of the dissertation. In this chapter the author introduces a basic two-stage bimatrix game with pairwise interactions. The other chapters develop and generalize the model presented in this chapter. The game is played in two stages, where during the first stage the players form a network, and then during the second stage the players play bimatrix games on the links formed in the first stage. The author proposes a characteristic function based on the antagonistic game of coalitions. The author proves that the cooperative game with the introduced characteristic function is convex, which is a very useful property. In particular, this allows the author to calculate tau-value by a simple formula and to establish a series of important properties of the core. Moreover, the author investigated the time-consistency of this game. In particular, three specific important games (including Prisoner's dilemma and coordination games) on star restrictive topology

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demonstrate that the Shapley value chosen as an imputation in the cooperative two-stage game with pairwise interaction can be both time consistent and time inconsistent.

In Chapter 2 the author studies the multistage bimatrix games with pairwise interactions on the complete graph. The assumption about the complete graph seems to be restrictive at the first sight. However, the development of the chapter demonstrates that even with this assumption this setting presents a rich model.

In Chapter 3 the author proposes alternative ways for computation and approximation of characteristic functions in network games with pairwise interactions. This is a practically important topic, since in a typical situation the calculation of a characteristic function presents a combinatorial problem.

Finally, in Chapter 4 the author introduces and analyses a multi-stage game with pairwise interactions and with additional state based dynamics. The first stage of this game is special as during this stage, the player form a network. During the next stages the players can only destroy the links of the network and play pairwise, link-restricted games. The author proposes a characteristic function different from the one introduced in the first chapter. This new characteristic function still possesses the property of supermodularity. As a solution of the game, the author considers both the Shapley value and the core. A strongly time consistent solution is proposed.

Even though the overall writing is good, I wished in many places the author provided more explanations, intuition and background definitions. Just to give a few examples: an intuitive explanation of formula (1.21) would be welcome and the definition of tau-value is missing as well as a reference for its basic formula. Also, more explanations of the characteristic function in Chapter 4 will be helpful. Of course, this does not impact the originality of the obtained results.

The results of the thesis have been presented in important conferences on games, optimization and control (such as *GTM*, Game Theory for Networks, Networking Games and Management, Control Processes and Stability) and in high-level journals (such as Automation and Remote Control, Mathematical Game Theory and its Applications, Mobile Networks and Applications), indexed by Scopus and Web of Science.

For all the above reasons, I conclude that the dissertation of BULGAKOVA Mariia Aleksandrovna on the theme "Dynamic Network Games with Pairwise Interactions" meets the requirements established by Order No. 11181/1 of 19 November 2021, "On the procedure for awarding academic degrees at Saint Petersburg State University", and BULGAKOVA Mariia Aleksandrovna deserves the award of the degree of Candidate (PhD) of Physico-Mathematical Sciences in the Speciality 1.2.3 — Theoretical Informatics, Cybernetics. Clauses 9 and 11 of the aforementioned Order by the author of the thesis is not broken.

Member of the Dissertation Council,

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