

## STATE ESTIMATION METHODS FOR FUZZY INTEGRAL MODELS. PART II: LEAST SQUARES METHOD AND DIRECT VARIATIONAL CALCULUS METHODS

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**Abstract.** This paper considers the least squares method (LSM) and its modifications for estimating the states of fuzzy integral models, namely, LSM with numerical integration, recurrent and nonlinear LSM, and fuzzy LSM, which is based on fuzzy rules for finding diagonal elements of the weight matrix in generalized LSM. Some examples of fuzzy systems of linear equations (FSLE) that arise in state estimation problems for fuzzy integral models are given and solved. The fuzzy Galerkin method is implemented for the approximate state estimation of a fuzzy integral model. This method leads to a complete FSLE. The emergence of «strong» and «weak» systems is explained using an illustrative example. Chebyshev quadrature methods and sinc functions for the approximate structural estimation of fuzzy integral models are considered. As noted in the paper, the same methodology can be applied to develop other algorithms for estimating fuzzy integral models based on the following methods: residuals, collocation, energy, Ritz, Courant, etc.

**Keywords:** fuzzy least squares method, fuzzy Galerkin method, fuzzy Chebyshev method, fuzzy sinc method.

## INFORMATION COMMUNITIES IN SOCIAL NETWORKS. PART II: NETWORKED MODELS OF FORMATION

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**Abstract.** This survey deals with mathematical models for the formation of information communities under uncertainty. The models of opinion dynamics are considered in detail. Within these models, individuals change their opinions under the influence of other individuals in a social network of a nontrivial structure. Two classes of such models are presented: the models with rational (Bayesian) individuals and the models with naive (heuristic) individuals. For each of the classes, conditions for the formation of information communities in social networks are described. For various information communities to emerge in a society with rational agents, the rationality of individuals is often limited, and some assumptions on different awareness of individuals are introduced considering the network structure. For a society with naive individuals, different modifications of the opinion dynamics mechanism are often adopted.

**Keywords:** social networks, information community, formation of information communities, analysis of information communities, belief formation.

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## MEANS: A MULTICRITERIA APPROACH. PART II

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**Abstract.** In a recent paper by the authors (see *Control Sciences* 2020, no. 5), a new approach to determining means was proposed, and some of their properties were investigated. Being a direct continuation, this paper presents new properties of the means. Their stability to small changes in the initial data is studied, and stable means are identified. The cases of data with repetitions, data with uncertainty, and ordinal data are considered. A simple and accurate analytical method for constructing a set of means is suggested in the applications-relevant case when the closeness of a point to the given ones is estimated using the first ordinal metric scale of criteria. The presentation is accompanied by simple calculation examples that illustrate the main theoretical results.

**Keywords:** means, multicriteria choice problems, preference relations, criteria importance theory, theory of majorization.

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## A SELF-ORGANIZATION MODEL FOR AUTONOMOUS AGENTS IN A DECENTRALIZED ENVIRONMENT

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**Abstract.** A self-organization model for autonomous agents operating in a transparent decentralized environment is developed and investigated. Transparency means that all information about the environment and the agents' community is open. Each agent informs the entire community about his current resources and intentions. The environment consists of cells, and during operation, each cell can generate a new resource using the resources received from agents. Each agent is also aware of the efficiency and resources of the cells. The agent-based approach is adopted to consider the efficient allocation of agents' resources over cells and analyze different resource allocations. Each agent acts rationally based on his goals. An iterative resource allocation method is proposed, in which the agents exchange information to make their decisions. Computer simulations are carried out for several modes of operation: 1) without training but with iterations, 2) with training and iterations, 3) without training and iterations, and 4) with training but without iterations. As indicated by the simulation results, the total resource of the agents' community is significantly higher in the model with training and iterations; due to self-organization and training, the agents are distributed so that their number in each cell is small. According to the experimental evidence, learning works only in combination with iterations.

**Keywords:** multiagent systems, self-organization, decentralization, transparent environment.

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## KEY AREAS FOR IMPLEMENTING MANAGEMENT INNOVATIONS WITHIN DOMESTIC AND MULTINATIONAL COMPANIES OPERATING IN RUSSIA

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**Abstract.** The highly complex, ambiguous, and turbulent business environment forces the leading multinational companies to search for new strategic capabilities, and management innovations are treated as an imperative for this development. However, top-management of the domestic companies operating in the Russian market is not focused sufficiently on management innovations. This paper considers the process of management innovations and key areas of their implementation within domestic and multinational companies operating in Russia. The empirical study described below involves 1025 employees from 791 companies operating in Moscow and Moscow oblast. According to the collected data, the companies operating in the Russian market primarily focus on employee motivation and building an effective communication process as the priority areas for implementing management innovations. Moreover, the type of economic activity, the size of business, and the degree of the company's internationalization are taken into account in the empirical study. Several peculiarities of the implementation areas of management innovations for domestic and multinational companies operating in Russia are identified.

**Keywords:** management innovations, process of management innovations, implementation of management innovations, implementation areas of management innovations, domestic companies, multinational companies.

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## BORDER ACTIVITIES AS A SYSTEM OF MEASURES AND ITS SCIENTIFIC SUPPORT

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**Abstract.** Border activities are aimed at ensuring national security in the border space. They can be treated as a system of preventive measures (border prevention and containment), security and control measures (border service and search), and protective and combat measures (special and combat actions, operational actions). Functions (stages of the activity cycle) are assigned to each type of boundary measure. Border measures can be implemented via operations carried out throughout the country, one or several federal subjects according to a single plan for achieving a specific goal. The problems of border activities are investigated in the science of border activities – the system of knowledge to ensure border security, build state border organizations, prepare and conduct border activities, and provide comprehensive support of border activities. The substantial aspects of the science of border activities are studied. The principles of border activities are systematized as follows: activity, the secrecy and surprise

of actions, flexibility, complex use of forces and means, the continuity of actions in place and time, the concentration of main efforts on the key directions and tasks, interaction, international cooperation, the main link, the balance of security and freedom, deterrence, reliance on the local population, the primacy of preventive measures, a combination of traditional and new technologies, and a comprehensive assessment of border security.

**Keywords:** border activities, system of border measures, principles of border activities, preventive measures, security and control measures, protective and combat measures, basic border security models.

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## NEUROMODULATION AS A CONTROL TOOL FOR NEURAL ENSEMBLES

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**Abstract.** Control mechanisms for the rhythms of neural ensembles based on the neuromodulation effect are described and implemented. The biological mechanisms of neuromodulation are briefly outlined, and some aspects are highlighted to control the patterns of activity of interconnected neurons forming ensembles. Within the suggested model, neuromodulation is a change in the neuron's properties responsible for its sensitivity to excitatory and inhibitory impacts (and, therefore, for its activity). This change is initiated by certain neurotransmitters (modulators), which indirectly influence the electrical activity of all neurons sensitive to them. The asynchronous discrete chemical interaction model of biological neurons in small neural networks is modified and extended to implement this control mechanism inherent in living organisms. The key effect of neuromodulation is the rapid functional reorganization of neural networks without changing their structural properties. Activity patterns are changed not via costly changes in the connections between neurons but by changing the chemical environment of the ensemble's neurons. The mechanism of neuromodulation is formalized. The new model is implemented in software, and several computational experiments are performed to change the gait of hexapods.

**Keywords:** neuron, neuromodulation, neurotransmitters, control, discrete modeling, generator of rhythmic activity.

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## 28th INTERNATIONAL CONFERENCE ON PROBLEMS OF COMPLEX SYSTEMS SECURITY CONTROL

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**Abstract.** The conference took place in December 2020. Scientific results presented by the conference participants are briefly outlined below. The conference sections were theoretical and methodological questions of security support, problems of economic and sociopolitical security support, problems of

information security support, ecological and technogenic security, modeling and decision-making for complex systems security control, automatic systems and means of complex systems security support, and legal aspects of complex systems security support. Special attention was paid to the problems caused by the coronavirus pandemic. At the conference, 130 authors from 42 organizations (Russia and some foreign countries) presented 91 papers.

**Keywords:** conference, complex systems, security control.