STATE ESTIMATION METHODS FOR FUZZY INTEGRAL MODELS. PART I: APPROXIMATION METHODS

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Abstract. The existing and newly proposed methods for estimating the state of integral models with fuzzy uncertainty are reviewed. A fuzzy integral model with the limit transition defined in the Hausdorff metric is introduced. This model is used to formulate the state estimation problem for the models described by fuzzy Fredholm–Volterra integral equations. Several fuzzy methods for solving this problem are considered as follows: the fuzzy Laplace transform, the method of "embedding" models (transforming an original system into a higher dimension system and solving the resulting problem by traditional linear algebra methods), the Taylor estimation of the degenerate nuclei under the integral sign that are represented by power polynomials, and the estimation of the nondegenerate nuclei by degenerate forms using the Taylor approximation. As shown below, in some cases, the estimation results are related to the solution of fuzzy systems of linear algebraic equations. Test examples are solved for them.

Keywords: fuzzy Riemann integral, fuzzy integral model, fuzzy methods for estimating integral models.

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INFORMATION COMMUNITIES IN SOCIAL NETWORKS. PART I: FROM CONCEPT TO MATHEMATICAL MODELS

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Abstract. This survey covers the literature related to information communities in mutually complementary areas: the formation of information communities in social networks and some applied aspects of identifying and analyzing information communities in social networks. First, mathematical models describing the formation of information communities under uncertainty are considered. Among these models, the most relevant ones are the mathematical models of opinion/belief dynamics reflecting any changes in the beliefs of nodes under the influence of other network nodes and significant effects (in particular, the preservation of differences in beliefs and the divergence of beliefs) that lead to the formation of information communities. In part I of the survey, the concept of an information community is first presented. Then information processing and decision-making by an agent in a social network under external uncertainty are outlined. The factors influencing the formation of information communities in the network are highlighted, and the basic models of Bayesian agents and their extensions are investigated.

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

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DIFFERENTIAL GAMES OF PURSUIT WITH SEVERAL PURSUERS AND ONE EVADER

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Abstract. A differential game of several players is considered as follows. One player (attacker) penetrates some space, and several other players (pursuers) appear simultaneously to intercept the attacker. Upon detecting the pursuers, the attacker tries to evade them. The dynamics of each player are described by a time-invariant linear system of a general type with scalar control. A quadratic functional is introduced, and the differential game is treated as an optimal control problem. Two subproblems are solved as follows. The first subproblem is to construct a strategy for pursuing the attacker by several players who have complete equal information about the game. The second subproblem is to construct such a strategy under incomplete information about the attacker who is actively opposing the pursuers. The simulation results are presented. The zero-sum differential game solution can be used for studying the final stage of pursuit, in which several pursuers and one evader participate.

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UNCONSTRAINED OPTIMIZATION OF A TIME-VARYING OBJECTIVE FUNCTION ON A DISCRETE TIME SCALE

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Abstract. This paper develops an approximate method to optimize a time-varying objective function on a discrete time scale. The method should provide an admissible (controllable) error value. The conditions to be satisfied by the time scale, the objective function, and the environment's parameters are established. The unconstrained optimization of a time-varying objective function that depends on the control vector components is considered on a discrete set of time instants. To find a solution, a discrete gradient constrained optimization method is proposed. Efficiency conditions for the gradient method are formulated. A lower bound on the solution error is obtained in terms of the time step, the rate of change of the objective function, and its first- and second-order derivatives with respect to the control vector components. The method is illustrated on a numerical example of an optimal controller design for a time-varying plant with a nonlinear objective function. According to the numerical experiments, the wide-range variations of the controller's parameters have no significant effect on the qualitative behavior of the resulting trajectory. The method can be used to calculate an optimal control function for a system with a discrete-valued objective function.

MODELS OF EXPERIENCE

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Abstract. A generalized probabilistic model is proposed that uniformly describes the formation and development of individual, collective, and social experience at various human activity levels. Some of its particular cases are considered, covering many learning models known in mathematical psychology and models of development and mastering of technologies within the methodology of complex activity.

Keywords: experience, activity, knowledge, technology, culture, learning curve.

TAX INCENTIVES FOR PROSOCIAL VOTING IN A STOCHASTIC ENVIRONMENT

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Abstract. Three income redistribution algorithms supporting the agents with prosocial voting are considered within the Voting in Stochastic Environment (ViSE) model of social dynamics. The first algorithm is income tax; the second one ensures that the income of each agent with the prosocial strategy is not smaller than the average income; the third one ensures that the average income of prosocial agents is not smaller than that of the entire society. The social utility of prosocial voting is analyzed. The three algorithms are compared with each other. The effectiveness of income tax depends on the environment. The second and third algorithms do not suffer from this disadvantage. However, under certain conditions, the second algorithm provides too many bonuses to prosocial agents. With any of these income redistribution algorithms, the egoists get more profit than in a society without any prosocial agents. Thus, whenever such tax schemes motivate some participants to choose the prosocial voting strategy, this will increase the expected income of all agents.

Keywords: ViSE model, altruism, voting, social dynamics, tax, pit of losses, prosocial behavior.

TWO-STAGE DUAL PHOTON SWITCHES IN AN EXTENDED SCHEME BASIS

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Abstract. This paper proposes a new method for constructing a two-stage dual photon switch with enhanced functional characteristics in the system basis of low-channel photon switches and photon multiplexers and demultiplexers. The method yields non-blocking switches with static self-routing. Also, the method ensures a significant speed-up for the switches with the same number of channels and a significant increase in the number of channels with the same speed compared to the non-blocking dual switches known previously. The non-blocking self-routing dual photon switches presented below have the highest possible speed and a maximum possible number of channels with almost the same complexity. As is shown in the paper, the dual switches have a switching complexity comparable with full switches and, at the same time, a lower channel complexity.

Keywords: physical level, photon switch, dual switch, multistage switch, conflict-free self-routing, non-blocking switch, static self-routing, quasi-complete digraph, switching properties, direct channels, scalability and speed.