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## Characterization of Graphs with a Small Number of Additional Arcs in a Minimal 1-vertex Extension

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A graph  $G^*$  is a  $k$ -vertex extension of a graph  $G$  if every graph obtained from  $G^*$  by removing any  $k$  vertices contains  $G$ .  $k$ -vertex extension of a graph  $G$  with  $n + k$  vertices is called minimal if among all  $k$ -vertex extensions of  $G$  with  $n + k$  vertices it has the minimal possible number of arcs. We study directed graphs, whose minimal vertex 1-extensions have a specific number of additional arcs. A solution is given when the number of additional arcs equals one or two.

*Key words:* minimal vertex extension, exact extension, fault tolerance, graph theory.

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## On Stability Theory of Autonomous Angular Stabilization System for Combined Dynamical Systems

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Studied the effect on the stability of the longitudinal acceleration discretely-continuum model of single-channel angular stabilization system with of delayed argument. Methods of construction asymptotic stability areas and analysis of impulse transition functions are developed. The critical values of the longitudinal acceleration are defined.

*Key words:* combined dynamical systems, stabilization systems.

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## Identification of a State Machine Structure with Finites Fragment of Behavior

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Identification of a state machine structure with finite fragments of behavior is discussed. The state machine behavior is a set of various finite-sequential (f.-s.) functions realized in a state machine, and under a finite fragment of behavior we mean traces of f.-s. functions and state machines. The concept of an identifying trace for a state machine irredundant over its realization is introduced. The approach is suggested that enables to separate and describe in the set of traces identifying a state machine the finite set of irredundant traces consisting of only essential information for identification of a state machine.

*Key words:* state machine, experiments with a state machine, subexperiment of experiment, trace of f.-s. function and state machine, identifying trace of state machine, operation of trace reduction, irredundant identifying trace of state machine.

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## Queueing Networks with Batch Movements of Customers, Blocking and Clusters

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Two types queueing networks with batch movements of customers — networks with blocking and networks with clusters are investigated. Product form stationary distribution for networks with blocking of transitions in states, in which the number of customers in queueing systems exceeds given values, is derived. For queueing networks with disjoint clusters of systems the problem of analyzing is solved and the product form stationary distribution is found. Examples of analysis of the network with blocking and the network with clusters are presented.

*Key words:* queueing networks, batch movements of customers, blocking, clusters, analysis of queueing networks.

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## Representation of Universal Planar Automata by Autonomous Input Signals

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Universal planar automata are universally attracted objects in the category of automata, whose sets of states and output signals are endowed with structures of planes. The main result of the paper shows that any universal planar automaton is isomorphic to a many-sorted algebraic system canonically constructed from autonomous input signals of the automaton.

*Key words:* automata, semigroups, planes, many-sorted algebraic systems.

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## Models of Multi-criteria Optimization with Quality Criteria

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We consider mathematical models of multi-criteria optimization with quality criteria. The main problem is a construction of preference relations on the set of alternatives and an investigation of its mathematical properties. Two methods for contraction of Pareto-optimal set are proposed. The first method is based on introduction of a partial order relation on the set of criteria and the second leans selection of the most important groups of criteria.

*Key words:* model of multi-criteria optimization, preference relation, Pareto-optimality, winning coalition of criteria.

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## The Ordered Set of Connected Parts of a Polygonal Graph

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Under a polygonal graph is meant an oriented graph obtained from a cycle by some orientation of its edges. The set of all abstract (i. e. pairwise non-isomorphic) connected parts of a polygonal graph is ordered by graph embedding. Polygonal graphs are characterized for which this ordered set is a lattice.

*Key words:* polygonal graph, linear graph, binary vector, duality, ordered set, lattice.

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## Combining De Bruijn Graphs, Overlap Graphs and Microassembly for *De Novo* Genome Assembly

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In this paper we present a method for *de novo* genome assembly that splits the process into three stages: quasicontig assembly; contig assembly from quasicontigs; contig postprocessing with microassembly. The first stage uses de Bruijn graph, the second one uses overlap graph. We have carried out experiments of assembling the *E. Coli* genome (size  $\approx 4.5$  Mbp) and *Maylandia zebra* genome (size  $\approx 1$  Gbp). Advantage of proposed method is a low memory consumption.

*Key words:* genome assembly, contigs, de Bruijn graph, overlap graph, microassembly.

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## Automata on Algebraic Structures

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A survey of results obtained in investigations of automata determined over finite algebraic structures. The objects of research are automata over some finite ring, automata determined in terms of ideals, automata over varieties, and families of hash-functions determined by automata without output function. Computational security, complexity of simulation and homomorphisms of investigated automata are characterized.

*Key words:* rings, automata, identification, computational security.

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UDC 62-50

## On Diagnostic Experiments for Fuzzy Automata

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The concept of a generalized diagnostic experiment for fuzzy automata is introduced. A method constructing diagnostic experiments for fuzzy automata is proposed. The method is based on diagnostic tree structure. It is established that the problem of diagnostic experiment synthesis is a multi-criteria optimization problem.

*Key words:* diagnostic experiment, fuzzy automata.

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## Discrete Dynamical Systems Defined Geometrical Images of Automata

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The object of study is the dynamic system defined by geometrical images of automata. The phase space of the system is determined by orthogonal and affine transformations of geometric images. Compositions of dynamical systems of a given type and their characteristics are studied.

*Key words:* automata, discrete dynamical systems, geometric images of automata.

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## Simultaneous Approximation of Polynomial Functions and Its Derivatives by Feedforward Artificial Neural Networks with One Hidden Layer

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In this paper we propose the algorithm for finding weights of feedforward artificial neural networks with one hidden layer to approximate polynomial functions and its derivatives with a given error. We use the rational sigmoidal function as a transfer function.

*Key words:* neural networks, approximation.

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## A Method of Routing Control in Queueing Networks with Changing Topology

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Closed exponential queueing networks with changing topology are considered. A method of routing control in given type queueing networks is proposed.

*Key words:* queueing networks, changing topology, routing control, reliability.

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## Differential Evolution Algorithm for Solving the Portfolio Optimization Problem

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In the paper we develop metaheuristic method based on differential evolution for finding efficient frontier in solving the portfolio optimisation problem for investor with non concave utility function which reflects asymmetric investor attitude to losses and gains.

*Key words:* heuristic search, portfolio optimization problem, prospect theory.

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## Heuristic Algorithm for the Cardinality Constrained Portfolio Optimization Problem

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In the paper we consider the cardinality constrained portfolio optimization problem. Constraint on the number of assets in portfolio leads to the mixed integer optimization problem. Effective frontier is constructed using the metaheuristic approach by genetic algorithm.

*Key words:* mixed-integer optimization, genetic algorithms, portfolio optimization problem.

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