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DEVELOPMENT OF EFFECTIVE ALGORITHM TO FIND AN OPTIMAL SOLUTION TO THE PROBLEM ON GRAPH MATCHING WITH “DISAPPEARING” ARCS (p. 4-16)**Anna Danylchenko**Zhytomyr state technological university, Zhytomyr, Ukraine
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We performed modification of the problem on graph matching with disappearing arcs for making up a schedule at the assigned constraints. It is proven that the problem “On graph matching with disappearing arcs” is NP-complete in the strong sense.

The algorithm is developed for solving the problem about making up a schedule for taking the procedures by patients in a sanatorium. The algorithm is based on the branch and bound method and makes it possible to consider the limitations in compatibility of therapeutic procedures. The algorithm devised has a lower computational complexity in comparison with the brute force method due to the analysis of upper and lower estimates and selection of active apex for branching, which results in the reduction in the number of graph matchings, which will be analyzed.

We carried out a computational experiment, which established that the proposed optimum algorithm provides for a decrease in the time for making up a schedule by 6 to 8.87 times in comparison with the brute force method, and the time of making up a schedule directly proportionally depends on the number of apexes of the bipartite graph.

The method proposed might be used for the development and implementation of systems for calendar scheduling and operational management in the therapeutic process and when designing control systems for flexible automated systems at the enterprises with discrete character of production.

Keywords: Problem on graph matching, NP-completeness, bipartite graph, optimum algorithm, branch and bound method, the brute force method.

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A STUDY OF ELLIPSE PACKING IN THE HIGH-DIMENSIONALITY PROBLEMS (p. 17-23)**Valentina Komyak**National university of civil protection of Ukraine, Kharkiv, Ukraine
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The problems of optimum ellipse packing belong to the class of NP-hard problems. The issues of development of efficient algorithms based on application of local and global optimization methods, construction of adequate mathematical models based on the analytical description of the ellipse interrelations taking into account their continuous translations and rotations are of vital importance. In this article, the problem of packing of sets of ellipses in a given region taking into account conditions of nonintersection and technological restraints which are concretized in the conditions of the applied problem is formulated. The model of packing of a set of ellipses in a rectangle of minimum dimensions is constructed. Continuous ellipse rotations and translations are allowed, the possibility of availability of minimum admissible distances between them is assumed. New quasi-phi-functions are constructed for modeling of the relations of ellipse nonintersection and to define belonging of an ellipse to the container. The algorithm of search for locally optimal solutions is modified. It consists of two stages: generation of the regions of feasibility which contain the starting point and local optimization in the

constructed region of feasibility. Only the algorithm step concerning construction of quasi-phi-functions is subjected to modification. It is necessary to notice that the algorithm have shown its efficiency when the quantity of ellipses does not exceed the value of 400.

The model of the individual-and-flow movement of individuals approximated by ellipses with specification of technological restraints is constructed. The method of local optimization is given. Examples of computer modeling of the problems assigned in the work are given.

Keywords: packing, continuous rotations, quasi-phi-functions, mathematical model, nonlinear optimization, individual-and-flow movement.

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FORMAL SIGNS DETERMINATION OF EFFICIENCY ASSESSMENT INDICATORS FOR THE OPERATION WITH THE DISTRIBUTED PARAMETERS (p. 24-30)

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Optimization criterion is a reference point for the choice of such technological process parameters to provide the maximum coherence of operational process results with the purpose of its owner. The complexity of this task is mostly connected with the fact that up to the present moment a large number of indicators, designed for operational processes efficiency assessment have already been developed and continue to be developed. It is especially important for operations with the distributed parameters.

Therefore, the priority is a preliminary selection of the known indicators with the use of formal signs. It allows reducing significantly the number and the length of the studies at the second and the final testing stages with applying the methods of mathematical modeling.

With the use of the cybernetic production operation model, created in the work, the formal signs, which should have the estimated indicators, proposed for efficiency definition of operations with the distributed parameters have been defined.

As a result of the performed researches, it has been established that any system operation model can be presented in the form of parametrically comparable input and output functions.

As the efficiency of operations with the distributed in time parameters is essentially affected by the distribution function form, the possibility of separate classes' comparative assessment of such operations has been investigated.

It has been established that the second integrated parameter from the input and output function has sensitivity to a change in the distribution function form.

The obtained results can be used for the selection of indicators designed to measure operations efficiency by formal signs. Also, the results of the work can be used for cybernetic estimated indicators creation.

Keywords: estimated indicators signs, indicators verification method, operation with the distributed parameters.

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VERIFICATION OF REALIZABILITY OF BOOLEAN FUNCTIONS BY A NEURAL ELEMENT WITH A THRESHOLD ACTIVATION FUNCTION (p. 30-40)

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A widespread application of neural network circuits from neural elements with a threshold activation function would be possible if efficient methods for the verification of realizability of functions of the algebra of logic by one neural element are devised, as well as the synthesis of these elements with a large number of inputs. The article examines algebraic structure of kernels and reduced kernels of Boolean functions. A connection is established between the kernels of Boolean functions that are implemented by one neural element with a threshold activation function and tolerance matrices. Based on the convex linear combination of kernel elements of functions of the algebra of logic, we proved a criteria of their realizability by one neural element with a threshold activation function. By using algebraic properties of kernels in Boolean functions and the representations of their reduced kernels by tolerance matrices, we obtained a number of easily verified necessary conditions for the realizability of functions of the algebra of logic by one neural element. These necessary conditions in many cases make it possible not to perform complicated calculations by the methods of approximation of different orders and by the iterative methods, in which, by means of limit cycles, the realizability or non-realizability of Boolean functions by one neural element with a threshold activation function is determined. Based on the sufficient conditions, obtained in the work, for the realizability of functions of the algebra of logic by one neural element, we devised an effective method for the synthesis of integer neural elements with a large number of inputs.

Keywords: tolerance matrix, convex linear shell, structure vector, activation function.

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FACTOR ANALYSIS OF CRISIS EMERGENCE IN FAMILY RELATIONS, CONTRIBUTING TO THE DEVELOPMENT OF DYSCIRCULATORY ENCEPHALOPATHY (p. 40-49)

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We examined the application of factor analysis for studying risk factors of crisis development in family relations, which can lead to dyscirculatory encephalopathy. Data of the study make it possible to reveal at early stages the occurrence and development of discirculatory encephalopathy, which subsequently will help to reveal the development of cerebrovascular pathologies, which lead to invaliding and even mortality. Using a factor analysis, we obtained a mathematical model with the help of which it is possible to reveal emotional and cognitive disorders, which lead to the development of dyscirculatory encephalopathy in patients who live in the crisis-prone families. The factors that make it possible to determine the psycho-correction targets, which include personal qualities and the factors, conditionally related to the family crisis block, were revealed. The information feature space, used in the study, was decreased, which makes it possible to reduce the time for conducting a patient's examination. A mathematical model proposed is of practical interest and may be used for the diagnosis and prediction of development of cerebrovascular diseases. Results, obtained in present study, might be useful for neuropathists, psychiatrists and psychologists who work with the crisis-prone families, as well as for specialists in the field of mathematical modeling of the processes, which may be defined as "weakly formalized".

Keywords: family crisis, dyscirculatory encephalopathy, factor analysis, closeness of connection, cognitive and emotional disorders.

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FORMATION OF SECURITIES PORTFOLIO UNDER CONDITIONS OF UNCERTAINTY (p. 49-55)

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We examined a problem on the formation of securities portfolio. A criterion for portfolio effectiveness is determined – a probability that the total portfolio profitability exceeds a threshold. In connection with real shortage of the volume of initial data, we substantiated the rejection of hypothesis about the normality of their distribution law and the problem is solved under assumption about the worst distribution density of these data. In this case, it is accepted that mathemati-

cal expectation and the dispersion of values for the cost of assets are the fuzzy numbers. The form of membership function of the fuzzy parameters in the problem is selected. We constructed an analytical expression to describe the criterion in the terms of fuzzy mathematics.

In this case, a problem on the maximization of fractional-quadratic functional with linear constraints is obtained. We devised a method for solving the obtained fuzzy problem of mathematical programming, which reduces this problem to the conventional problem of nonlinear programming. In order to solve this problem, it is proposed to employ the optimization method of zero order. It is demonstrated that the portfolio risk depends quadratically on the mathematical expectation of its profitability. Recommendations are given regarding the choice of numerical value for the mathematical expectation of portfolio profitability depending on the acceptable portfolio risk.

Keywords: securities portfolio, fuzzy cost of assets, minimax model, probabilistic fractional-linear criterion.

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THE FEATURE EXTRACTION AND ESTIMATION OF A STEADY-STATE VISUAL EVOKED POTENTIAL BY THE KARHUNEN-LOEVE EXPANSION (p. 56-62)

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The study justifies using the Karhunen-Loeve expansion (KLE) for the feature extraction of a steady-state visual evoked potential (SSVEP), with the research results contributing to this subject area. The obtained parameters that sufficiently describe the study process allow constructing the information technology of visual analyzer diagnostics. It will help ophthalmologists reveal the characteristics of a disease and determine the right diagnosis.

To obtain the research results, the Karhunen-Loeve expansion of the SSVEP was implemented at different stimulation frequencies, which helped determine the optimal number of the informative features: 6 Hz – 18, 8 Hz – 15, and 10 Hz – 12. The expansion results of two one-channel and one two-channel SSVEPs were compared to establish the fact of the channels' correlation effects on the number of the informative parameters. It has been proved that, taking into account the interference between the registration channels, it is possible to use fewer informative parameters for diagnostics. The obtained results will be used at the information technology of ophthalmologic diagnostics; the stage of their evaluation and the number of informative parameters are critically important because it all affects the accuracy and reliability of a diagnosis.

Keywords: steady-state visual evoked potential, linear random process, Karhunen-Loeve expansion.

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