ABSTRACT AND REFERENCES

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ANALOG OF THE CLASSICAL BOREL THEOREM FOR ENTIRE HARMONIC FUNCTIONS IN $\mathbb{R}^n$ AND GENERALIZED ORDERS (p. 4-10)

Olga Veselovska
Lviv Polytechnic National University, Lviv, Ukraine
ORCID: http://orcid.org/0000-0003-4052-1081

The article describes research on the growth of functions that are harmonic in the whole space $\mathbb{R}^n$, $n\geq 3$, and thus they are called entire harmonic.

A relation has been established between the maximum terms of entire functions of finite order in the plane, which are given by power series whose coefficients are somewhat connected. Also, the maximum modulus of a harmonic function in the space $\mathbb{R}^n$ is evaluated through the maximum modulus of some entire function in the plane, the coefficients which are expressed in terms of the coefficients of the expansion of the harmonic function in a series by Laplace spherical functions. These results made it possible to obtain an analog of the classical Borel theorem for entire harmonic functions of finite order in $\mathbb{R}^n$.

Besides, the study has revealed the most general characteristics of the growth of entire harmonic functions in $\mathbb{R}^n$ in terms of the uniform norm of Laplace spherical functions in the expansion of harmonic functions in series. Slow growth of the harmonic functions in the space has also been studied. The obtained results are analogous to the classical results that are known for entire functions of one complex variable.

The research findings are important because harmonic functions occupy a special place not only in many mathematical studies but also in the application of mathematical analysis to physics and mechanics, where these functions often describe various stationary processes.

Keywords: entire harmonic function, Laplace spherical function, generalized order, lower generalized order.

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MODELING OF THE FUNCTIONING OF TERRITORIAL SYSTEMS WITH THE PURPOSE OF IDENTIFICATION OF PROBLEM SITUATIONS (p. 11-18)

Vasiliy Lisitskiy
National Technical University "Kharkiv Polytechnic Institute", Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-6073-0844

Nadezhda Gernet
V. N. Karazin Kharkiv National University, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0001-5458-6076

The purposeful territorial system (country, region), containing production, consumption, management, and environmental spheres is considered. In the process of system functioning, problem situations arise. The method for modeling the functioning of a territorial system by a complex of interacting linear programming problems, reflecting the inextricable link between the mechanism of centralized planning of production and consumption of goods, resources and the mechanism of market pricing is developed. The dependence of system characteristics of the cyclical dynamics on spectral properties of the generalized technological matrices of circulation of goods and resources is proved. The obtained results are relevant for modern Ukraine, other transitional national economies, characterized by an increased occurrence of problem situations. In this case, the territorial system can come very close to the bifurcation point, in which an alternative to further development arises. The choice of any alternative immerses the territorial system in the transition period.

To identify problem situations, it is proposed to form the generalized technological matrixes of circulation of goods and resources on the basis of reporting data, to determine their majorizing roots that characterize the structural stability of the system. It is shown that the right and left eigenvectors found, corresponding to the majorizing matrix roots, determine the effective structures of supply of goods, resources and market prices for them. The system of informative features that determine the deviations of the actual characteristics of the territorial system from efficient ones is constructed. The proposed system of features makes it possible to detect national economic disparities that give rise to problem situations.

Classes of problem situations are distinguished. The class contains problem situations for which the overall technology for their resolution is effective. This allowed assigning a standard case to each class that sets the reference problem situation and the way to resolve it (using an adequate pricing technology, adjusting the structure of the minimum needs of the population, the structure of available resources, forming the main properties of the system).

The obtained results can serve as a platform for creating the information technology of detection and identification of problem situations, which implements the case-based reasoning technology.

Keywords: transitional territorial system, modeling of cyclical dynamics, technology of identification of problem situations.

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DEVELOPMENT OF A TECHNIQUE FOR THE RECONSTRUCTION AND VALIDATION OF GENE NETWORK MODELS BASED ON GENE EXPRESSION PROFILES (p. 19-32)

Sergii Babichev
Jan Evangelista Purkyně University, Ústí nad Labem, Czech Republi
Kherson National Technical University, Kherson, Ukraine
ORCID: http://orcid.org/0000-0001-6797-1467

Maksym Korobchynskyi
Military-Diplomatic Academy named after Eugene Bereznyak, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0001-8049-4730

Oleksandr Lahodynskyi
Military-Diplomatic Academy named after Eugene Bereznyak, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0002-8231-3072

Oleksandr Korchomnyi
Military-Diplomatic Academy named after Eugene Bereznyak, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0001-6563-685X

Volodymyr Basanets
Military-Diplomatic Academy named after Eugene Bereznyak, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0001-8007-1009

Volodymyr Borynskyi
Military-Diplomatic Academy named after Eugene Bereznyak, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0002-6183-0126

We have developed a technique for the reconstruction and validation of models of gene networks based on the gene expres-

sion profiles derived in the course of DNA microchip experiments or by the method of RNA molecules sequencing. A structural block diagram is presented of a stepwise process for determining optimal parameters of the algorithm for reconstruction of a gene network that meet the optimum network topology. We proposed a comprehensive estimation criterion of a gene network topology based on the Harrington desirability function that contains network topological parameters as constituent components. The maximum value of this criterion corresponds to the optimal topology of a gene network. A technique for the validation of models of gene networks is based on a ROC analysis whose implementation implies a comparative analysis of the character of relations between relevant genes in the network on the basis of the totality of genes and gene networks based on the obtained biclusters. Qualitative reconstruction of a gene network makes it possible to explore the nature of interaction between genes that determine the process of functioning of a biological organism at different stages of development of complex genetic diseases for the purpose of early diagnosis and correction of a given process.

It was established that the gene network reconstructed based on the correlation output algorithm is more efficient in comparison with the gene network based on the algorithm ARACNE. The weighted average of relative validation criterion for the derived models based on the correlation output algorithm is significantly greater than the corresponding value when applying the algorithm of ARACNE. This fact indicates a higher degree of compliance with the character of relations between respective genes in the network based on the totality of genes and in the networks based on gene expression profiles in the obtained biclusters. Qualitative reconstruction of a gene network makes it possible to explore the character of development of a biological organism at the gene level, which creates preconditions for early diagnosis and adjustment of the development of different types of genetic diseases.

Keywords: gene network, topological parameters, Harrington desirability index, gene expression, threshold coefficient.

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DEVELOPMENT OF ADAPTIVE COMBINED MODELS FOR PREDICTING TIME SERIES BASED ON SIMILARITY IDENTIFICATION (p. 32-42)

Alexander Kuchansky
Kyiv National University of Construction and Architecture, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0003-1277-8031

Andrii Biloshchytskyi
Taras Shevchenko National University of Kyiv, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0001-9548-1959

Yurii Andrashko
Uzhhorod National University, Uzhhorod, Ukraine
ORCID: http://orcid.org/0000-0003-2306-8377

Svitlana Biloshchytska
Kyiv National University of Construction and Architecture, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0002-0856-5474

Yevheniia Shabala
Kyiv National University of Construction and Architecture, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0002-0428-9273

Oleksii Myronov
Kyiv National University of Construction and Architecture, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0001-7119-2415

Adaptive combined models of hybrid and selective types for prediction of time series on the basis of a program set of adaptive polynomial models of various orders were offered. Selection in these models is carried out according to B-, R-, P-criteria with automatic formation of the basic set of models based on the adaptive D-criterion. It was found that these models had the maximum accuracy in the case of short-term and medium-term prediction of time series.

Adaptive combined selective prediction models based on the R- and B-criteria of selection with identification of similarities in the retrospection of time series by the nearest neighbor method was proposed. An adaptive combined hybrid model of prediction with identification of similarities in the retrospection of time series was constructed. It was found that these models had the highest accuracy in the case of medium-term prediction of time series.

Estimation of the prediction efficiency of various combined models depending on the level of persistency of time series was made. It has been found that in the case of short-term prediction for the prediction period $\tau \leq 2$, the adaptive combined hybrid prediction model is the most accurate. Selective models with various selection criteria are effective in predicting persistent time series with the Hurst index $H>0.75$ for the prediction period $\tau>2$. In the case of prediction of time series with the Hurst index $H \in \left(E\left(\frac{R_m}{S_m}\right), 0.75 \right]$ for the prediction period $\tau>2$, the adaptive combined hybrid and selective models with identification of similarities in the retrospection of the time series are more precise.

Keywords: prediction of time series, search for similarities, adaptive combined model, Hurst index.

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DEVELOPMENT OF TEST OPERATIONS WITH DIFFERENT DURATION IN ORDER TO IMPROVE VERIFICATION QUALITY OF EFFECTIVENESS FORMULA (p. 42-49)

Igor Lutsenko
Kremenchuk Mykhailo Ostrohradskyi National University, Kremenchuk, Ukraine
ORCID: http://orcid.org/0000-0002-1959-4684

Olena Fomovskaya
Kremenchuk Mykhailo Ostrohradskyi National University, Kremenchuk, Ukraine
ORCID: http://orcid.org/0000-0002-8065-5079

Elena Vihrova
Kryvyi Rih State Pedagogical University, Kryvyi Rih, Ukraine
ORCID: http://orcid.org/0000-0002-0647-7665

Olga Serdiuk
Kremenchuk Mykhailo Ostrohradskyi National University, Kremenchuk, Ukraine
ORCID: http://orcid.org/0000-0003-0505-0800

Felix Fomovsky
Kremenchuk Mykhailo Ostrohradskyi National University, Kremenchuk, Ukraine
ORCID: http://orcid.org/0000-0003-3989-3689

Selection of an indicator for assessment of effectiveness of operations is a very essential step, because this choice predetermines the mode of operation for all functional systems at an enterprise.

An axiom is the thesis that all technological processes without exception must be optimized using a coordinated optimization criterion. This is possible only in case if the effectiveness formula is used as a unified criterion. Only in this case, maximizing of financial capabilities of an enterprise is provided.

In order to identify the original effectiveness formula among a set of estimation indicators, which cannot be distinguished based on formal features, it is necessary to use a scientifically substantiated verification method.

A limited class of models of operations with distributed parameters of different duration is determined. Creation of such a class is the most difficult problem, since comparison of operations of different duration requires taking into account the time factor, and the distributed nature of resource consumption and resource transfer in time significantly complicates the problem.

To solve this problem, at the first stage, the rules of composition of an operation with distributed parameters using simple global models of operations with different duration were determined. At the second stage, for each simple model of an operation, there was formed a correspondent simple model of an operation with a longer duration, effectiveness of which was higher than that of the original operation by definition.

At the final stage, we formed a limited class of global models of operations with distributed parameters of different duration with the use of the original and formed simple models of operations.

Development of verification method by determining the class of operations with distributed parameters of different duration significantly enhances reliability and validity of results of verification of the estimation indicator, which is supposed to be used as an effectiveness indicator and an optimization criterion.

Keywords: verification of estimation indicator, operation with distributed parameters, class of operations, verification method.

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CLASSIFICATION RULE HIERARCHICAL TUNING WITH LINGUISTIC MODIFICATION BASED ON SOLVING FUZZY RELATIONAL EQUATIONS (p. 50-58)

Hanna Rakytyanska
Vinnytsia National Technical University, Vinnytsia, Ukraine
ORCID: http://orcid.org/0000-0001-5863-3730

The common problem with the hierarchical tuning methods is the lack of conditions for modification of the primary rules. The incremental approach accelerates the generation of candidate rules, but complicates the selection of the primary and modified rules.

In the paper, the approach that combines semantic training, granular partition and solution of fuzzy relational equations for constructing accurate and interpretable rules is developed. The composite fuzzy model of direct logic inference based on the primary rules with granular parameters is proposed. The method of hierarchical tuning with the linguistic modification based on solving fuzzy relational equations is developed, which allows reducing the training time.

It is shown that the weights of the primary rules, which are subject to modification, as well as the hedging threshold of the primary terms, are solutions of the primary system of fuzzy logic equations with the hierarchical max-min/min-max composition, which solves the problem of the hierarchical selection of the primary and modified rules for the given output classes. The genetic-neural approach was used for tuning the primary rules and solving the system of equations, as well as tuning the composite rules.

The effectiveness of the approach is illustrated by the example of tuning and interpreting the solutions to the technological process quality control problem for the specified productivity classes. The primary model with granular parameters allows reducing the tuning error by 25 % compared to the primary relational model. The solution of the hierarchical selection problem allows reducing the tuning time by half.

Keywords: hierarchical tuning, fuzzy classification knowledge bases, solving fuzzy relational equations.

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DEVELOPMENT OF THE TECHNOLOGY FOR THE SPECTRAL NOISE CONTROL OF THE VIBRATION CONDITIONS OF OFFSHORE PLATFORMS (p. 59-69)

Telman Aliev
Azerbaijan National Academy of Sciences Institute of Control Systems, Baku, Azerbaijan Republic
ORCID: http://orcid.org/0000-0003-2251-9711

Narmin Rzayeva
Azerbaijan University of Architecture and Construction, Baku, Azerbaijan
ORCID: http://orcid.org/0000-0003-0397-5412

Ulkar Sattarova
Azerbaijan University of Architecture and Construction, Baku, Azerbaijan
ORCID: http://orcid.org/0000-0002-0174-1412

Because of the shortcomings in both control and diagnostic systems, the accident rate for offshore oil and gas extracting facilities remains unreasonably high. Accidents are often caused by the errors resulting from the application of traditional analytical technologies to noisy signals received from corresponding sensors. Our research shows that these technologies generally provide the informative attributes required to perform defect diagnostics only after the defect has already become strongly pronounced. For this reason, the results

of monitoring of the beginning of transition of the platforms into an emergency state is sometimes delayed. Therefore, it is obvious that the creation of algorithms and other technologies to monitor the early onset and the development of cracks, wear and tear, corrosion, and other defects in offshore platforms is of enormous importance. Timely, preventive maintenance performed on these platforms can make it possible to avoid catastrophic accidents.

According to the research we found that when defects arise in control objects, the noise $\varepsilon_2(t)$, correlated with the useful signal $X(i\Delta t)$, appears in the signals $g(i\Delta t)$ received from the corresponding sensors. For this case in the article the algorithms and technologies of spectral analysis of both vibration signal and its noise were proposed. By means of them it becomes possible to increase the reliability of monitoring the beginning of a latent period of transition to an emergency state of offshore platforms. This feature helps to improve the effectiveness of the control systems of offshore platforms.

Keywords: diagnostics, noise, offshore platforms, monitoring, spectral analysis, spectral characteristics, vibration signals.

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STUDY OF THE MATHEMATICAL MODELS OF OPTIMAL PARTITIONING FOR PARTICULAR CASES (p. 69-76)

Alexander Firsov
University of customs and finance, Dnipro, Ukraine
ORCID: http://orcid.org/0000-0002-6528-6447

The basic problem of optimal sets partitioning (OSP) for the case, where a segment of a plane curve is a set, was stated. The problem is stated as follows: let us assume there is a segment of a plane curve, it is required to place on it a specified number of sources of a certain resource and allocate each point of the curve to a particular source. In addition, it is necessary to minimize the costs of transportation of a resource is from the sources to the corresponding points of the curve along the shortest route. The basic problem was refined by taking into account geometrical characteristics of the curve. For this, the function of the cost was changed according to such parameters as the length of the curve and its curvature.

As a result, new statements of OSP problems were obtained. It was shown that geometric characteristics of the curve correspond to a subject area. Each of the problems was solved by using the known methods and the numerical experiment was conducted. Analysis of the obtained results was carried out. Thus, the general OSP theory was supplemented with the new models that are applicable for solving optimization problems with taking into account surfaces of a relief.

Keywords: optimal partitioning, continuous set, minimization, arc length, set center, metric, placement.

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DEVELOPMENT OF THE METHOD FOR THE FORMATION OF ONE-DIMENSIONAL CONTOURS BY THE ASSIGNED INTERPOLATION ACCURACY (p. 76-82)

Yevhen Havrylenko
Tavria State Agrotechnological University, Melitopol, Ukraine
ORCID: http://orcid.org/0000-0003-4501-445X

Yuliia Kholodniak
Tavria State Agrotechnological University, Melitopol, Ukraine
ORCID: http://orcid.org/0000-0001-8966-9269

Oleksandr Vershkov
Tavria State Agrotechnological University, Melitopol, Ukraine
ORCID: http://orcid.org/0000-0002-5549-4701

Andrii Naidysh
Bogdan Khmelnitsky Melitopol State Pedagogical University, Melitopol, Ukraine
ORCID: http://orcid.org/0000-0003-4057-7085

The purpose of the study is to develop a method for the formation of a one-dimensional contour with provision of a given accuracy of interpolation. Determination of the accuracy of interpolation relies on the formation of a curve based on known geometric properties. We build the geometric model with the assumption: if there is a curve line without special points that interpolates the point series, then there are no special points in the original object. Such points include: points of inflection, changes in the direction of growth along the curve of values of the curvature, the rounding, etc.

We build the interpolating curve in the form of a condensed point series consisting of arbitrarily large numbers of nodes, which are determined based on the possibility of interpolating their curve with a given line with the given characteristics. The error, with which the discrete representation of the curve represents the original curve, is evaluated as an area of the possible arrangement of all curves that interpolate an output point with proper-

ties identical to the properties of the original curve. We evaluate the error of formation of the interpolating curve line as the area of a possible location of the curve line that interpolates the condensed point series. In the study, we propose the solution of the problem for a flat curve based on the condition of the absence of oscillations and the conditions for the monotonous change of the curvature. The area of a location of the curve determined from the condition of the convexity of the curve is maximal and is the output one. Overlaying the following conditions: monotonous curvature change along the curve and the appointment of fixed positions of tangents and values of the curvature at the output points, localizes an area of a possible solution. One can use the developed method for solving problems requiring determination of the maximum absolute error with which a model represents the original object. These are approximate calculations, construction of graphs that describe processes and phenomena, formation of surface models representing existing physical samples.

Keywords: interpolation error, ordered set of points, oscillation, monotonic change of differential-geometric characteristics.

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