ABSTRACT AND REFERENCES

MATHEMATICS AND CYBERNETICS – APPLIED ASPECTS

DEVELOPMENT OF STATISTICAL MODELS OF MILKING DURATION ON ABREAST MILKING MACHINES (p. 4-9)

Volodymyr Kucheruk, Yevhen Palamarchuk, Pavlo Kulakov

Based on the conducted theoretical and experimental studies, statistical milking duration models were developed, which establish a functional relationship between statistical characteristics of the milking duration on abreast milking machines, and their parameters, type of milking machine, statistical characteristics of the animal preparation time and the animal milking time, number of animals in a herd.

The proposed models are based on the new approach to the statistical characteristics of the animal preparation time and the animal milking time. This will increase the accuracy of determining the productivity of milking machines in their designing or upgrading, develop a methodology for designing information-measuring systems of the parameters of technological processes of milk production and automatic control systems of a farm, ensure further development of the theory of such systems.

The adequacy of the developed models is higher compared to the existing ones, as confirmed by determining the relative estimation of differences between the results of the theoretical calculations and the experimental data.

Keywords: milking duration, preparation duration, statistical model, milking machines, abreast.

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SOLUTIONS OF HELMHOLTZ EQUATION IN COMPLEX DOMAIN (p. 10-15)

Michael Sukhorolsky, Veronika Dostoina, Halyna Ivasyk

A harmonic equation and the Helmholtz equation are elliptic type equations and describe important physical processes (the first – stationary, the second - stationary and dynamic). Effective solutions of boundary value problems for harmonic equation (in different regions in the plane) are constructed by the methods of the theory of analytic functions of a complex variable. These methods can not be applied directly to solving problems for the Helmholtz equation. In the scientific literature, solutions of boundary value problems for this equation are known only in certain areas that are represented by cumbersome formulas.

In the paper, using the solution of the Helmholtz equation in a circle through the functions (not analytical) of complex variable and conformal mapping of a given area on the circle, a general approach to building a solution of the corresponding boundary value problem is formulated. An important prerequisite for presenting this solution as functional series is finding the solution of harmonic equation in a given region that satisfies the given boundary conditions and an analytic function in this region respectively. The solutions of the Helmholtz equation in the plane with an elliptic hole and half-plane are constructed. For effective formulation of boundary value problems and finding analytic functions in these areas, systems of basic functions in the corresponding spaces of analytic functions are found.

Keywords: Helmholtz equation, analytical solution of Helmholtz equation, conformal mapping, boundary value problems.

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METHOD OF MAXIMUM LIKELIHOOD ESTIMATION OF COMPACT GROUP OBJECTS LOCATION ON CCD-FRAME (p. 16-22)

Liubov Mykhailova, Vadim Savanevych, Nataliia Sokovikova, Mihail Bezkrovniy, Sergii Khlamov, Artem Pogorelov

The urgency of developing computational methods of high-accuracy location estimation of nearby objects on a digital image is caused

by a significant increase in penetrating power of optical systems. In this regard, the difficulty of achieving the required observation accuracy of nearby objects with statistically dependent images significantly increases.

The paper proposes a method that allows with potential accuracy to assess the location of several nearby objects on the CCD frame. Using sub-pixel Gaussian model for object image, high measurement accuracy was achieved. The method is based on the maximum likelihood method, which reduces the computational complexity of the method. The developed method can be used in operational automated asteroids detection systems, for example, in the CoLiTec program, to assess the location of several nearby statistically dependent objects.

This method is already being used in the operational automated asteroids detection system CoLiTec. The method has shown high accuracy in estimating the location of several nearby statistically dependent objects [14].

Implementation of the proposed method in CoLiTec software has increased the measurement accuracy of objects. Due to this, program users have improved their rating by the number of measurements of small solar system bodies. Namely, in 2012, among the most productive world observatories, observatories-users of CoLiTec have taken 9, 13, 22 places. According to the RMSD parameter, in pixels, objects location estimates, observatories-partners of CoLiTec for the 2012 have: ISON-NM Observatory (H15) – 0.25 pixels (5th place), Andrushevsky Astronomical Observatory (A50) – 0.23 pixels (3 place), ISON-Kislovodsk Observatory – 0.23 pixels (3rd place). Based on the average module of residuals, observatories-partners of CoLiTec also take leading positions in their class of telescopes. In 2012, this indicator was 0.061" (H15) and 0.06" (A50). So, according to this indicator, observatories H15 and A50 have taken 3 and 2 places among small aperture telescopes.

Keywords: CCD frame, maximum likelihood method, compact group of asteroids, location estimation, CoLiTec.

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THE SAMPLE CENSORING METHOD DEVELOPMENT FOR NEURAL NETWORK MODEL SYNTHESIS (p. 22-27)

Sergey Subbotin

The method of training sample formation is proposed. It allows to characterize the individual instance informativity relative to the centers and boundaries of feature intervals. This allows to automate the analysis of the sample and its separation into sub-samples, and, as a result, to reduce the training data dimensionality. The computer program implementing proposed method has been developed and used in the experiments. The developed software was investigated in solving the problem of diagnosis chronic obstructive bronchitis from the experimentally obtained data of clinical laboratory tests of patients. The experiments found that even a slight reduction of the original sample volume by 25 % (to 75 % of the original volume) yielded acceptable accuracy and reduces training time by more than 1.32 times. The twice reduction of the original sample volume (up to 50 % of the original volume) afforded the gain in speed of 1.99 times. This confirms the usefulness of the proposed mathematical support in the construction of neural network models by precedents.

Keywords: sample, instance selection, data reduction, neural network, dimensionality reduction.

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DEVELOPMENT OF EFFICIENT ALGORITHMS FOR OPTIMAL ELLIPSE PACKING (p. 28-35)

Olexander Pankratov, Tetyana Romanova, Iryna Subota

The problem of packing a set of ellipses, allowing continuous rotations in a minimum size container is considered. For describing nonoverlapping and containment constraints, phi-functions are used for ellipses approximated by circle arcs. A mathematical model is constructed in the form of a non-smooth optimization problem. Algorithms for finding locally optimal solutions to the problem of packing approximated ellipses, based on the construction of a decision tree, the end vertices of which correspond to a system of inequalities with continuously differentiable functions are proposed. Three strategies for solving the problem of optimal packing true ellipses are considered. The first strategy allows to find approximate solutions for packing ellipses in rectangular, circular and elliptic containers. Locally optimal solutions for packing ellipses in a rectangular container can be obtained by applying the second and third strategies. The examples of challenge benchmark instances) for n=140 ellipses are given.

Keywords: packing, ellipses, approximation, continuous rotations, phi-functions, mathematical model, nonlinear optimization.

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DEVELOPING OF APPROACHES FOR THE UNHOMOGENEUS TIME SERIES ANALYSIS BASED ON STATISTICAL CHARACTERISTICS (p. 35-43)

Anna Chistyakova

In this paper, a study of non-homogeneous time series, as a special case of a class of non-stationary time series, which are not given to stationary by integrating the 1st and 2nd order was carried out. Because of the presence of non-homogeneous components, time series is characterized by a non-linear trend, periodic components with variable amplitude, as well as a non-permanent structure. A method for identifying the series of this class based on statistical characteristics, using statistical tests and criteria was proposed. This method allows reasonable approach to selecting a method for forecasting a number of changes with respect to all the hidden features of the original data, as well as the reasons and assumptions of various

forecasting methods. For example, in the construction of forecasting models of the non-homogeneous time series using statistical forecasting methods, such as AR (p), MA (q), ARMA (p, q), AR (p) + linear trend, ARCH (p), GARCH (p, q), SV (p), is inadequate in view of violating the requirements for applying these methods, in particular time invariance. An adaptive approach for forecasting non-homogeneous time series based on the method of singular spectrum analysis and presentation of time series in several phase spaces is proposed in the paper.

Another problem in forecasting the time series is a risk assessment in decision-making based on the forecasting model. A method for estimating the maximum level of losses in forecasting non-homogeneous time series with a given probability was developed in the paper. A confidence interval of forecasting non-homogeneous time series of exchange rates, which allows estimating the adoption of one or other solutions depending on the amount of the transaction was built.

The results obtained in this paper can be used for a sound approach to the selection of a forecasting method in automated systems, as well as in the evaluation of making management decisions.

Keywords: non-homogeneous components, non-stationary time series, statistical characteristics, risk assessment, forecasting.

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"CATERPILLAR"-SSA AND BOX-JENKINS HYBRID MODELS AND METHODS FOR TIME SERIES FORECASTING (p. 43-62)

Vitalii Shchelkalin

Trend and decomposition approaches to non-stationary time series forecasting are considered in the paper. According to them, various hybrid models for non-stationary time series forecasting, as well as identification methods for these models based on the combined use of the "Caterpillar"-SSA and Box-Jenkins methods were proposed. Hybrid mathematical models of the trend approach to forecasting, based on the "Caterpillar"-SSA and Box-Jenkins methods lie in modeling the process as deviation of actual time series values with respect to the trend component, which is represented in the proposed models by the linear recurrence formula (LRF) of the "Caterpillar"-SSA method and its approximation by the SARIMA model. The main goal of the decomposition approach to forecasting based on the "Caterpillar"-SSA and Box-Jenkins methods is the decomposition of the original time series into multiple time series with a simpler structure, considered independently of each other using the "Caterpillar"-SSA method; forecasting the data of decomposition components by SARIMA models and calculating the total forecast by combining forecasts of the constructed simplified models.

The proposed models were tested on the electricity and natural gas consumption time series, and their forecasting results were compared with the results, obtained by classical probabilistic SARIMA models, generalized for the case of several seasonal components.

The obtained results allow to conclude that for effective forecasts, it is necessary to carry out decomposition of the studied time series and combine different models, describing both statistical and deterministic time series components that provides the best forecasting quality.

Keywords: time series forecasting, structural identification of model, decomposition model, Box-Jenkins method, "Caterpillar"-SSA method.

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FUZZY CONSTRAINT HANDLING TECHNIQUE USED WITH GENETIC ALGORITHMS TO OPTIMIZE ORDER QUANTITY (p. 63-67)

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The paper presents the problem of determining the optimal volume of ordering goods with the deferred delivery cost payment taking into account input control errors, the time factor when making financial calculations and inflation. Solving this task is difficult non-trivial process that requires applying evolutionary optimization methods that do not depend on the choice of the starting point and do not need additional constrains on the objective function characteristics.

The most efficient way to find the optimum of constrained problems using evolutionary algorithms is applying adaptive and problem-oriented penalty functions. However, the main problem that accompanies their use is the solution quality sensitivity to the choice of the individual parameters of penalty elements, calculation methods of which are not always known.

The paper proposes using fuzzy penalty functions, the main idea of which is to replace the constraints as inequalities by a set of fuzzy variables. The algorithm for implementing the method in full search space of possible solutions was explored. The aspects of software implementation of the technology were examined. The experimental verification of the method was performed, and the results of a comparative analysis of the dynamic and adaptive penalty functions were given.

Keywords: genetic algorithms, penalty functions, ordering goods, credit, deficit, natural loss, incoming inspection, lack.

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