IWIM-2019 PROGRAM&ABSTRACTS

Section 1. New approaches in inductive modelling

On Asymptotic Properties of the GMDH Criteria

Volodymyr Stepashko (**Ukraine**)

The paper analyses the problem of the convergence investigation for typical GMDH criteria based on the data sample division into two subsamples. This study is significant for additional justification of applying the GMDH-based inductive modeling in case of large samples. The inductive modeling problem is defined and main external criteria are presented. An approach to the asymptotic investigations is explained based on assumptions of strong regularity of regressors. The study results demonstrate the convergence of any external criterion to some finite values in probability. Moreover, the minimal value of an accuracy criterion at infinity corresponds to the true model. This means that such criteria are consistent.

Application of Optics Density-Based Clustering Algorithm Using Inductive Methods of Complex System Analysis

Sergii Babichev, B. Durnyak, V. Zhydetskyy, I. Pikh, V. Senkivskyy (**Czech Republic, Ukraine**)

The research results concerning application of Optics density-based clustering algorithm with the use of inductive methods of complex systems analysis are presented in the paper. Implementation of this approach allows determining the optimal parameters of the clustering algorithm in terms of the maximum values of the complex balance clustering quality criterion. Evaluation of effectiveness of the proposed technique was performed based on the use of two-dimensional data which contains clusters of various shapes. The results of the simulation have shown high effectiveness of the proposed technique. The investigated objects were divided into clusters correctly in all cases.

Transformation of the Euclidian data space into a homogeneous event space for the inductive construction of classification rules

Tatjana Lange (**Germany**)

The paper deals with a special problem of supervisor-based classification that can be solved with the help of a method that is known as Alpha-procedure. This problem consists in the following: Normally, the construction of the separating rule is performed during a training phase where a supervisor defines the belonging of objects to different classes using a training set of data. Often, this training set may even be short. But obviously the rich mental experience of the supervisor somehow influences his decision. This intuitive experience is not described quantitatively. E.g., it is not known which features of the objects are important and which of them are useless or even disturbing. By this reason, the construction of the separation rule directly in the Euclidian data space leads to instability of that rule in certain cases. This paper explains why the Alpha-procedure that performs an inductive construction of the separating rule in the homogeneous Lorentz space allows a stable classification of new objects in the after-training application phase where the supervisor is no longer involved.

A method of formation of structural elements in the task of structural identification of interval discrete models of the atmosphere pollution processes by harmful emissions of motor vehicles

Mykola Dyvak, Natalia Porplytsya, Yurii Maslyiak (**Ukraine**)

The method of structural identification of interval discrete dynamic models based on a behavioral models of a bee colony is considered in the paper. It is shown that in order to increase its efficiency,

it is expedient to pre-process the input data obtained in an interval form. It is proposed to use the "mountain" clustering method for this purpose.

Optimal Complexity Models in Individual Control Strategy Task for Objects that Cannot be Re-trialed

Ie. Nastenko, V. Pavlov, O. Nosovets, K. Zelensky, Ol. Davidko, Ol. Pavlov **(Ukraine)**

The conventional approach for calculating individual optimal strategies assumes that the best control actions are calculated for the same object that has been studied monitoring or active trials. However, the class of objects for which is impossible to organize repeated tests is widespread. An example is patients with a particular disease, for each of which it is impossible to organize the separate trials to study possible strategies for its cure. The paper proposes an approach for calculating the individual objects strategies, for which observational data obtained during the monitoring or active experiment on an objects sample is used. To construct an effective calculation technology is proposed to obtain the state models of the optimal complexity object, nonlinear on the parameters and initial conditions of the object and linear on control actions. Limitations of approach and an example of calculating an individual's strategy are considered.

Revised Successive Search GMDH Algorithm with Recurrent Estimating Model Parameters

Serhiy Yefimenko, Volodymyr Stepashko **(Ukraine)**

The paper presents a successive search algorithm MULTI-R GMDH being an improved and revised version of the known algorithm MULTI. This new version differs from the original algorithm by using a recurrent procedure of parameters estimation and additional optimizing the model structure. The numerical characteristics of the processing speed and structural accuracy of this algorithm are given for several test tasks.

A Correlation-Based Sorting Algorithm of Inductive Modeling using Argument Rating

Halyna Pidnebesna **(Ukraine)**

In this paper, a sparse regression algorithm is proposed that corresponds to a linear model with the smallest possible number of regressors without loss of quality of the model based on correlation analysis and using an external criterion for choosing an optimal model based on the division of the input data sample. That is why the proposed method relates to the class of GMDH algorithms. The main stages of the algorithm work are described. The core feature of the algorithm is the use of frequency analysis of regressor ratings. The results of testing its effectiveness on test experiments are shown in comparison with the known algorithm LASSO.

Section 2. Real-world applications of inductive modeling

Modeling of dynamics of harmful emissions from motor vehicles using a procedure of automated formation of structural elements of a model

Mykola Dyvak, Natalia Porplytsya, Yurii Maslyiak **(Ukraine)**

The paper deals with a problem of modeling of dynamics of harmful emissions from motor vehicles using a mathematical model in the form of a difference equation. To build such models, a method of structural identification based on the bee colony behavioral models is widely used. It is shown that in order to reduce the time complexity of this method and simultaneously ensure the possibility of finding of a unified model that would be applicable for different points in the city, it is important to ensure the completeness of a set of structural elements. An example of building of such a model using the cluster analysis of experimental data to form the initial set of structural elements is considered.

Software tool for solving inductive modelling tasks based on self-organizing combinatorial-genetic method
Olha Moroz **(Ukraine)**

The article presents results of application of the software package based on self-organizing combinatorial-genetic algorithm COMBI-GA for inductive construction of optimal models from observation data under incomplete information about an object and investigating the capabilities of the algorithm, in particular, for solving large dimensional problems. Characteristics and capabilities of the software package built on the basis of this algorithm are considered. The analysis of the COMBI-GA effectiveness in the sense of the restoration accuracy of a given test model and the time to find it was carried out in comparison with the LASSO algorithm as well as with the sorting-out GMDH algorithms COMBI and MULTI. It is shown that all algorithms find the correct models but COMBI-GA does it much faster.

Multiclass Classifiers for Processing Archives of Accidents in Manufacturing
Bulat Shkanov, Mikhail Alexandrov **(Russia, Spain)**

The impossibility of total state control in hundreds of thousands enterprises leads to numerous industrial accidents that is a significant social problem. The traditional way for solution of this problem includes careful work of experts with the archives of accidents, which reflect their causes and preventive measures to avoid such cases in the future. Nowadays, the work with these archives is carried out manually due to the lack of tools for processing acts of accidents. In this paper we offer classifiers for these archives, which could facilitate the work of experts and thus improve the quality of their solutions. Our contribution is: 1) comparison and choice of the best procedures for preprocessing data, and 2) choice and adjustment of the best methods of classifications. The program platform is Python. The results of experiments proved to be very promising.

Classification of Schoolchildren on Professional Trajectories using Experience of Successful Specialists
Svetoslav Zverev, Mikhail Alexandrov, Angels Catena, John Cardiff, Elena Shushkevich, Dmitry Srefanovskiy **(Ireland, Spain, Russia)**

In the paper, we propose a new approach to vocational guidance of schoolchildren based on classification of pupil wishes between given professional trajectories, which are presented by profiles of successful professionals. Both wishes and profiles are replies in free text form on a questionnaire proposed by skilled psychologists. Such an approach avoids the well-known deficiencies of traditional methods including binary questioning, talks about concrete professions, and interviews with school psychologists. We use the simple terms selection for preprocessing and the traditional method of voting for classification. The mentioned procedures are discussed and the proposed approach is preliminary checked on invited specialists. This joint Russian-Irish research has been carried out with Moscow schoolchildren (2 schools) and Moscow specialists (2 trajectories). The results of presented pilot study look very promising. It is the basis for current applied research in Moscow and the future activities in Dublin.

Modelling of Dependence of Mechanical Properties of Cast Iron on Chemical Composition of Raw Materials
Olena Tokova, Yevgeniya Savchenko **(Ukraine)**

The problem of the influence of the chemical composition of pig iron on its mechanical properties, such as ultimate tensile strength, elongation, impact test and hardness by Brinell solved. Based on the combinatorial GMDH algorithm, linear and nonlinear models of dependence of the mass fraction of components of raw materials on each of the indicators describing the quality of the

casting are constructed. The obtained models allow us to analyze how changes in the mass fraction of each of the components affect each of the variables of mechanical properties.

Modeling of Dynamic Energy-Management Scenarios in Local Polygeneration Microgrids Using Inductive Bi-clustering Algorithm
Volodymyr Osypenko, Victor Kaplun (Ukraine)
In this paper, one of the approaches to solving a certain small but important layer of a general problem, namely, the intelligent modeling of dynamic energy-management strategies in polygenerating microgrids with the use of elements inductive system-analytical technologies is presented. Modeling on the basis of collected statistical data using inductive be-clustering algorithm has been performed. The results can be applied in processes of electricity pricing for microgrid or smartgrid dynamic management with renewable sources.