

# IWIM-2017 PROGRAM AND ABSTRACTS

## Section 1. Theoretical fundamentals of inductive modeling

### **Inductive Modeling from Historical Perspective**

**Volodymyr Stepashko**

The article describes typical problems solved by means of inductive modeling, provides information on the development of this scientific direction in Ukraine and abroad, characterizes the basic fundamental, applied and technological achievements, and formulates the most promising ways of further research.

### **Scalability of predictive ensembles**

**Pavel Kordík, Miroslav Snorek, Miroslav Cepek**

Recent meta-learning approaches are oriented towards algorithm selection, optimization or recommendation of existing algorithms. In this paper we show how inductive algorithms constructed from building blocks on small data subsample can be scaled up to model large data sets. We demonstrate how one particular template (simple ensemble of fast sigmoidal regression models) outperforms state-of-the-art approaches on the Airline data set.

### **An inductive approach to pattern recognition and its connection with geometric invariants**

**Tatjana Lange**

The paper deals with the problem of stability during the solving of pattern recognition tasks from the point of view of transformation groups. It shows the possibility to avoid the necessity of regularization by using the geometric equiaffine Lorentz transformation, exploiting as example the alpha-procedure.

### **Structure-oriented classifiers in objects feature space defined by set of measurements**

**Ievgen Nastenکو, Olena Nosovets, Oleksandra Konoval, Volodymyr Pavlov**

The paper considers a classification problem of objects that are given by a set of measurements. An optimal model structure of classified objects is suggested to obtain for each class to solve the problem. To construct the structures, a new version of GMDH algorithm was developed having a new combined external criterion that includes accuracy and division ability of objects structure of each class. Algorithm settings allow performing objects classification in two ways, using object accuracy at the class structure, or using the “one-vs-all” principle in the parameters space of the obtained structures.

### **Numerical Investigation of the Generalized Iterative Algorithm GIA GMDH with Active Neurons**

**Oleksandra Bulgakova, Volodymyr Stepashko, Vyacheslav Zosimov**

The results of computational investigation of the generalized iterative algorithm GIA GMDH with active neurons are presented. The algorithm’s architecture is based on hybridization of iterative and combinatorial search schemes and comprises six standard variants of typical GMDH algorithms. The experiments demonstrate high performance and accuracy of the algorithm. Results of using the GIA GMDH are given for modeling of Ukraine's Black Sea economic region GRP as dependent on socio-economic indicators of the region.

## **Section 2. New approaches in inductive modelling**

### **Clustering and interval analysis of heterogeneous data sample**

**Mykola Dyvak, Yuri Maslyiak, Oleksandr Papa, Nadiya Savka**

Method for clustering and interval analysis of heterogeneous data sample is considered in the paper and it is shown an algorithm for method implementation. An example of applying of the developed method and the algorithm is represented.

### **Improving the computational implementation of the parametric identification method for interval discrete dynamic models**

**Mykola Dyvak, Natalia Porplytsya, Ihor Borivets, Mykola Shynkaryk**

In the paper, the method of parametric identification of interval discrete dynamic models is considered. An improved scheme of the computational implementation of this method is proposed. The scheme considers an area of permissible values for modeled characteristics. Results of the comparative analysis of the proposed scheme efficiency of this method with a known one are presented.

### **A Hybrid growing ENFN-based neuro-fuzzy system and its rapid deep learning**

**Zhengbing Hu, Yevgeniy V. Bodyanskiy, Oleksii K. Tyshchenko**

An architecture and learning methods for a growing neuro-fuzzy system that enlarges an amount of layers and tunes their synaptic weights in an online way are introduced in the paper. A structure of the hybrid system is built with the help of extended neo-fuzzy neurons which are characterized by improved approximating capabilities. The main peculiar feature of the introduced system is a learning method for each structural element that is carried out sequentially in an online manner.

### **COMBI-GA sorting-out algorithm with evolutionary complication of models**

**Olha Moroz**

The paper presents a new mechanism to apply evolutionary complication of models in the previously introduced hybrid COMBI-GA sorting-out algorithm to find optimal model structure. The mechanism is based on generation of model structures using binomial random number generator with low probability and specific mutation operator. The presented experimental results demonstrate that this algorithm performs quickly, accurately and reliably when solving artificial inductive modelling tasks.

### **On Constructing Ontology of the GMDH-based Inductive Modeling Domain**

**Halyna Pidnebesna**

The paper considers the constructing issue of ontology for the GMDH-based inductive modeling domain. It examines the main components of the GMDH algorithms in terms of their synthesis for designing the domain ontology. Such ontology significantly expands opportunities for construction of inductive modeling tools for model building and forecast of complex processes of different nature.

### **Averaging over matrices in solving discrete ill-posed problems on the basis of random projection**

**Elena G. Revunova**

Analytic and experimental averaging over random matrices for the error of the true signal recovery is carried out for the method of solving the discrete ill-posed problems on the basis of random projection.

## **Recurrent-and-Parallel Computing in the Problem of Vector Autoregressive Modelling**

**Serhiy Yefimenko**

The paper presents theoretical grounds of recurrent-and-parallel computing applying in combinatorial GMDH algorithm for modeling and prediction of complex multidimensional interrelated processes in the class of vector autoregressive models. The effectiveness of the constructed algorithm is demonstrated by modeling of interrelated processes in the field of Ukraine energy sphere with the purpose of effective managerial decision making.

### **Section 3. Real-world applications of inductive modeling**

#### **Navigation learning system for mobile robot in heterogeneous environment: Inductive modeling approach**

**Anatoliy Andrakhanov, Alexander Belyaev**

One of the key tasks of mobile robotics is navigation, which for Outdoor-type robots is exacerbated by the functioning in a priori of an unknown environment. In this paper, for the first time, the learning navigation system for mobile robot based on inductive modeling approach is presented. This approach is based on the principles of the group method of data handling (GMDH), which is one of the first techniques of Deep Learning. The paper presents the results of training models for estimating the robot's coordinates and angular orientation in heterogeneous environment. In addition to the direct readings of the on-board sensors, additional parameters were introduced to train the models, reflecting how the robot perceives the surface terramechanics. The models for estimation of the coordinates on the surface areas of various types and classifiers of the surface type were trained. The obtained results testify the efficiency of the developed Navigation Learning System for Mobile Robot (NLS MR).

#### **Traversability estimation system for mobile robot in heterogeneous environment with different underlying surface characteristics**

**Anatoliy Andrakhanov, Anton Stuchkov**

One of the key tasks of Outdoor-type mobile robotics is traversability estimation of underlying surfaces in a priori of an unknown heterogeneous environment. The paper presents practical realization of traversability estimation system based on group method of data handling (GMDH). This method is classical technique of data mining and one of the first techniques of Deep Learning. The results of color, geometry and texture features extraction by developed computer vision unit are presented step by step. Also the results of model training (Twice-Multilayered Modified Polynomial Neural Network with active neurons is used as one of the GMDH algorithms) for different input features subsets combinations and for two variants of traversability estimation (the robot leaves the area being traversed, but remains within a specified radius and traversing an area within a given time) are considered. The obtained results testify the efficiency of the developed traversability estimation system.

#### **Implementation of the Objective Clustering Inductive Technology Based on DBSCAN Clustering Algorithm**

**Serhii Babichev, Volodymyr Lytvynenko, Volodymyr Osypenko**

The paper presents the results of the research of the clustering algorithm DBSCAN practical implementation within the framework of the objective clustering inductive technology. As experimental, the data Aggregation and Compound of the Computing school of the East Finland University and the gene expression sequences of lung cancer patients of the database ArrayExpress were used. The architecture of the objective clustering model has been developed. The implementation of the model involves the parallel data clustering on the two equal power subsets,

which include the same quantity of pairwise similar objects. The choice of the solution about parameters of the algorithm determination has been carried out based on the minimum value of the external clustering quality criterion, which calculated as normalized difference of the internal clustering quality criteria for the two subsets.

### **Modeling of water use and river basin environmental rehabilitation**

**Pavlo Kovalchuk, Hanna Balykhina, Volodymyr Kovalchuk, Olena Demchuk**

The ecosystem model of surface water quality in the river basin was formalized on the basis of the theory of neural networks. The neural network is trained based on the observation data. Upon that the methods of environmental assessment and suitability of water for irrigation as well as for drinking needs can be used for the neural networking. The developed ecosystem model enables to improve significantly the water use and decision making for the purposes of the environmental rehabilitation of the river basin compared to the existing approaches.

### **Autoregressive Models of Submissions to Municipalities in Czech Republic**

**Anna Pidnebesna**

This paper studies a statistical dataset describing submissions to the municipalities in Czech Republic. The dataset contains five submission-specific subgroups as interdependent time series. The research purpose is to build a suitable model for description of the process. In this work, the autoregressive and vector autoregressive models are used for fitting the data. The obtained results proved to be very promising.

### **About the intelligent decision making system for dynamic electricity pricing on renewable microgrids**

**Volodymyr Osypenko, Viktor Kaplun**

A new approach to solving the problem of interaction between the main suppliers of electricity and private generating stations of different nature in the island renewable energy micro-grids. This approach can be used for small power islands with different natural conditions, which stipulate the use of solar, wind or other energy sources in order to evaluate the dynamic electricity pricing.

### **Inductive Modelling as a Basis of Informational Support of Decisions in Casting Production**

**Olena Tokova, Yevgeniya Savchenko**

The article describes the application of the inductive approach to constructing an informational support system for decision-making in the foundry industry. The purpose is to enhance the efficiency of the casting process by making relevant decisions at every stage of the process. The inductive approach is used first of all for modeling the dependence of the cast cooling temperature on parameters of the casting facility mode and for forecasting the temperature change which determines the final product quality.