===== **THEMATIC ISSUE** =====

Foreword of the Program Committee of the Conference "Mathematical Pattern Recognition Methods"

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Abstract—This thematic issue presents selected articles of the 20th All-Russian Conference with international participation "Mathematical Pattern Recognition Methods" (MPRM) held on December 7–10, 2021 in Moscow.

The conference was first held in 1983 and has been held every two years since then; this allows us to consider it the oldest Russian forum in the field of data mining, machine learning, and artificial intelligence, including both theoretical and applied aspects of these areas.

The MPRM conference is inextricably linked with the names of its founders—two outstanding scientists, Academician of the Russian Academy of Sciences Yurii Ivanovich Zhuravlev (1935–2022) and his student, Academician of the Russian Academy of Sciences Konstantin Vladimirovich Rudakov (1954–2021). Their contribution to the development of mathematical methods of classification, pattern recognition, forecasting, and machine learning methods, which are the main topics of the MPRM conference, can hardly be overestimated.

Yu.I. Zhuravlev organized the first MPRM conference in Zvenigorod and was the permanent head of the organizing committee of all the following conferences, which were held in Dilijan (1985), Zvenigorod (1983, 1991, 1993, 2001, 2005), Kazan (2013), L'vov (1987), Moscow (2019, 2021), Petrozavodsk (2011), Pushchino (1995, 2003), Riga (1989), St. Petersburg (2007), Svetlogorsk (2015), Suzdal (2009), Taganrog (2017), and Tver oblast (1997, 1999).

In 1983, K.V. Rudakov, then still a young candidate of physical and mathematical sciences, participated in the organization of the first MPRM conference. The preparation of all subsequent conferences was also carried out with his active participation. In 2001, the Conference Program Committee was created, and K.V. Rudakov became its chairman. The MPRM Program Committee in 2021 was led by Professor of the Russian Academy of Sciences Konstantin Vyacheslavovich Vorontsov and Doctor of Physical and Mathematical Sciences Vadim Viktorovich Strijov, who also spent decades organizing the conference.

For almost four decades of the conference, the organizers have included the topics of the current scientific agenda while maintaining the same requirements for a deep mathematical study of the results presented. Preference was given to research aimed at developing the fundamental theoretical apparatus for obtaining and evaluating these results. In the early years, the conference was more

Fig. 1. Yu.I. Zhuravlev and K.V. Rudakov at the 12th MPRM conference in 2005 (Zvenigorod, Moscow oblast).
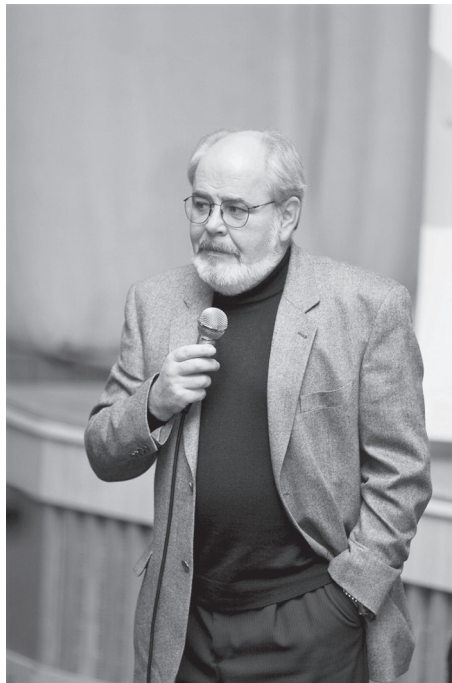

Fig. 2. K.V. Rudakov chairs the meeting at the 12th MPRM conference in 2005 (Zvenigorod, Moscow oblast).

focused on the problems of pattern recognition, classification, and regression, which has a starting point in the analysis of images and signals and is based on algebraic and statistical methods. It is impossible not to mention the scientific discussion on the statistical theory of the reliability of the Vapnik–Chervonenkis algorithms with the participation of one of its authors Vladimir Naumovich Vapnik, which unfolded at the first MPRM conference in 1983.

At the conference, attention was paid to the combinatorial approach to assessing the reliability of algorithms, methods for predicting time series, optimization methods, problems and methods for analyzing medical data, bioinformatics, and expert systems. Then the subject expanded to the field

Fig. 3. Yu.I. Zhuravlev comments on the speeches at the 12th MPRM conference in 2005 (Zvenigorod, Moscow oblast).

Fig. 4. Speech by Yu.I. Zhuravlev with a plenary report at the 19th MPRM Conference. According to the authors, this is the last speech of Yu.I. Zhuravlev with a scientific report.

of data mining and machine learning. In recent years, there have been significant changes associated primarily with the rapid development of deep learning methods, natural language processing methods, methods for analyzing large heterogeneous data (big data), and the field of computer vision.

At the same time, the conference did not disregard the solution of applied problems. In recent years, the interest in MPRM has been growing among representatives of various areas of the Russian and foreign IT industry.

Considerable attention was paid at the MPRM conference to the participation of young scientists. The MPRM gave them the opportunity to learn about the results of new research, get an idea of the trends in the field, and, of course, present their own results to the scientific community for the first time. For many actively working scientists, the MPRM conference has become a starting point in their scientific career.

In 2021, the MPRM conference was held in a mixed format at the Dorodnicyn Computing Centre of the Russian Academy of Sciences. As part of the opening, a memorial meeting dedicated to Konstantin Vladimirovich Rudakov was held, at his students and close colleagues gave speeches. In total, 215 people took part in the conference and 105 reports were made in the following main scientific areas:

– Data mining.

– Neural networks and deep learning.

– Optimization data mining techniques.

– Computational complexity and approximate methods.

– Processing and analysis of images and signals; computer vision.

– Information retrieval and text analysis.

– Web and social media data analysis.

– Industrial applications of data science.

– Biomedical data analysis; bioinformatics.

– Mathematical modeling methods in data mining.

– Geospatial data mining.

– Intelligent optimization and efficient management.

Based on the results of the discussion of the reports made, papers were selected for publication in a special issue of the journal *Automation and Remote Control*, 2022, no. 10. This 10th issue of the journal presents works on image recognition, voice cloning and conversion, surface reconstruction for rover motion, and a number of fundamental mathematical problems.

A considerable part of the papers deal with image recognition. The paper by E.Yu. Minaev, L.A. Zherdeva, and V.A. Fursov "Visual odometry from the images of the reference surface with small interframe rotations" presents the solution of the visual odometry problem based on a sequence of video frames that are formed using a camera directed perpendicularly downwards to the reference surface. The paper by A.S. Markov, E.Yu. Kotlyarov, N.P. Anosova, V.A. Popov, Ya.M. Karandashev, and D.E. Apushkinskaya "Using neural networks to detect anomalies in X-ray images obtained with full-body scanners" studies the detection of anomalies in X-ray images, and preliminary results of using a neural network to detect anomalies are shown. In the paper by D.V. Svitov and S.A. Alyamkin "Distilling face recognition models trained using margin-based softmax function," a distillation method is proposed that uses the class centers of the teacher network to initialize the student network, and then the student network is trained to produce biometric vectors the angles from which to the class centers are equal to the angles in the teacher network. In the paper by A.I. Bazarova, A.V. Grabovoy, and V.V. Strijov "Analysis of the properties of probabilistic models in expert-augmented learning problems," the problem of approximating a set of shapes on a contour image is solved, and calculations are carried out using the example of an iris approximation

problem in a contour image. In the paper by A.A. Zakharov "An image matching method using heat kernels on graphs," an image matching method based on thermal kernels is presented that allows isolating the most stable features of images for subsequent comparison at the initial stage using thermal kernels on graphs. In the paper by M. Gorpinich, O.Yu. Bakhteev, and V.V. Strijov "Gradient methods for optimizing metaparameters in the knowledge distillation problem," a generalization of the distillation problem for the case of optimizing metaparameters by gradient methods is proposed; the proposed approach is illustrated using a computational experiment on CIFAR-10 and Fashion-MNIST samples as well as on synthetic data.

Two papers in this issue deal with no less interesting practical problems. In the paper by D.S. Obukhov "Cloning and conversion of an arbitrary voice using generative streams," an approach based on streaming generative models is proposed that allows solving voice cloning problems by using real vectors of a fixed dimension obtained from an external system containing information about the speaker; thanks to this, the system synthesizes more natural speech with a voice similar to the specified target voice, both in the voice cloning problem and in the voice conversion problem. The paper by A.V. Bobkov and Kh. Aung "Real-time person identification by video image based on YOLOv2 and VGG 16 networks" presents algorithms and methods for real-time person identification by video image.

Further, several articles in the issue deal with fundamental mathematical research. In the work by E.A. Karatsuba "A fast algorithm for computing the psi function," a fast algorithm for calculating psi functions is considered, the mechanism for constructing a fast calculation of E-functions is studied in detail, and the relevant theorems are given and proved. In the study by A.Yu. Gornov, A.S. Anikin, T.S. Zarodnyuk, and P.S. Sorokovikov "Modification of the confidence bar algorithm based on approximations of the main diagonal of the Hessian matrix for solving optimal control problems," an approach is proposed to solving an optimal control problem based on the use of reduction to a finite-dimensional optimization problem with subsequent use of approximation of the Hessian main diagonal using the example of optimization problems for separable and quasiseparable functions and Rosenbrock–Skokov functions. The paper by N.A. Dragunov and E.V. Djukova "One approach to deciphering monotone logical function" considers the problem of deciphering a two-valued monotone function f defined on a k-valued n-dimensional cube; the approach based on applying an asymptotically optimal algorithm of dualization over the product of k-valued chains is proposed and investigated, and applicability conditions are identified. In the article by A.N. Tyrsin "Entropy modeling of network structures," the issues of using differential entropy for network structures presented as connected graphs with correlations are considered, and new characteristics are proposed that expand the possibilities of entropy modeling to the study of network structures. In the paper by Z.M. Shibzukhov "On a robust gradient boosting scheme based on aggregation functions insensitive to outliers," a new robust scheme for constructing gradient boosting algorithms is proposed that is based on the use of differentiable estimates of the mean value, insensitive or insensitive to outliers, and for setting a robust empirical risk functional that allows finding the desired dependence based on data containing a substantial proportion of outliers.

Each manuscript was blindly peer-reviewed by at least two referees and approved for publication by the conference program committee and the editorial board of the journal.