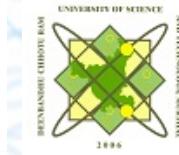**Technical University of Sofia**
Sofia, Bulgaria

Deenbandhu Chhotu Ram University of
Science and Technology, Murthal, Sonepat - INDIA

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6ᵗʰ International Workshop on New Approaches for Multidimensional Signal Processing NAMSP'2025

WORKSHOP PROGRAM

Technical University of Sofia
Sofia, Bulgaria
July 24-26, 2025

Springer

http://rcvt.tu-sofia.bg/NAMSP2025

General Information

The purpose of the workshop is to bring together researchers working in the various areas of Multidimensional Signal Processing and its applications in fields like Telecommunications, Computer Vision, Healthcare, Bioinformatics, Remote Ecological Monitoring, Agriculture, Forestry and others. The workshop proposes themes like: Multidimensional Image Processing, Sensor Heterogeneous Data Clustering, Spatio-Temporal Filtering, Multidimensional Interpolation, Multidimensional Object Segmentation, Multiview Representation, Multidimensional Visualization, Virtual and Augmented Reality and others. Authors are invited to present their recently achieved results, exchange ideas and cooperate in a friendly framework.

The Workshop will take place online with a host TECHNICAL UNIVERSITY OF SOFIA, **Sofia, Bulgaria, between the 24th and 26th of July 2025**. We hope that the participants will appreciate the predisposing environment for future collaboration.

The "International Workshop on New Approaches for Multidimensional Signal Processing" (NAMSP 2025) is part of the "Days of Science" at Technical University of Sofia, with the kind collaboration of the Research and Development Sector at TU of Sofia, Bulgaria.

We welcome you to NAMSP'2025!

Main topics of interest

Image Processing Specific Topics

- N-Dimensional (N-D) Multicomponent Image Processing

- Adaptive N-D Filtration in Intelligent Image Systems

- Multidimensional Image Representation and Super-Resolution

- Compression of Multidimensional Spatio-Temporal Images

- Multidimensional Image Transmission Systems

- Three-Dimensional (3D) Image Processing and Reconstruction

- Multidimensional (MD) Computer Vision Systems

- Multidimensional Multimedia Systems

- Reasoning-Based Intelligent Systems for MD Image Processing

- Intelligent Analysis of MD Medical Images

- Learning-Based MD Image Processing and Expert Systems

- Neural Networks for MD Image Processing

- MD Image Preprocessing for Pattern Recognition

- Generic and Fuzzy Systems for MD Image Processing, Analysis and Recognition

- Data-Based MD Image Retrieval and Knowledge Data Mining

- Watermarking, Hiding and Encryption of MD Images

- Surveillance Systems, Based on Intelligent MD Image Processing

- Objects Detection and Tracking, Based on MD Image Processing

- Intelligent Multi-Spectral and Hyper-Spectral Image Processing

- Intelligent Multi-View Image Processing

- Real-Time MD Image Processing Systems and Transmission

- MD Image Processing in Robot Systems

- Intelligent Visualization of MD Images

- Web-Based Search Systems for MD Images

- Forensic Analysis Systems for MD Images

General Data Processing and Generation Topics

- Pattern Recognition

- Deep Learning

- Machine Learning

- Machine Intelligence

- Neural Networks

- Data Mining

- Tensor-based Data Processing

- Self-organization Modeling

- Biomedicine

- Biological Modeling

- Bio-inspired Methods

- Biomedical Computing

- Financial Modeling

- Social Modeling

- Medical Imagistic

- Virtual Reality

- Augmented Reality

- 3D and Multiview Visualization

- Telepresence

- Computer Graphics

- Computer Animation

and others…

NAMSP'2025 Committees

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NAMSP'2025 Workshop Program

All Hours are Bulgarian Time (GMT+3)

July 24th, 2025 (Thursday)

Join Zoom Meeting Topic: NAMSP 2025 Workshop

Time: Jul 24, 2025 10:00 Sofia

https://us06web.zoom.us/j/87401673905?pwd=RXmaSTjOkRFbSHn7fBtocr2983S3t9.1

Meeting ID: 874 0167 3905

Passcode: 9Cd0T9

10:00 – 10:30 Opening

Greetings from: Prof. Lakhmi Jain, Prof. Srikanta Patnaik

10:30-13:50 Plenary Session

Chairmen: Prof. Parvinder Singh, DCRUST, India

Assoc. Prof. Rumen Mironov, Technical University of Sofia, Bulgaria

10:30 – 11:10 Plenary Lecture 1*:*	*Szilvia Nagy, Analysis of the current trends in computer aided brain lesion classification in MR images*
11:10 – 11:50 Plenary Lecture 2:	*Wenfeng Wang, Spatial Meta-Learning: Theory, Algorithm and Applications*
11:50 – 12:30 Plenary Lecture 3:	*Milanova, M., AI Agents-Driven Multidimensional Medical Imaging and Diagnostics*
12:30 – 13:10 Plenary Lecture 4:	*Singh, P., A Cognitive Content Recommendation Engine Empowered by Ontology-Based Semantics*
13:10 – 13:50 Plenary Lecture 5:	*Sherif, S., Tensor Decompositions for Multidimensional Signal Processing*

13:50 – 14:30 Break

14:30 – 17:00 Paper Session 1: Intelligent Analysis of Multidimensional Signals

Chairman: Prof. Parvinder Singh, DCRUST, India

14:30 – 14:45	*Ishan Wickramasingha, Sherif Sherif, Tensor Elastic Net*
14:45 – 15:30	*Ammu Prakash, Mark Hewko, Michael Sowa, David Allen, Kunal Minhas, Amir Ravandi, Ashish Shah, Sherif Sherif, Automated Identification of Vascular Plaque in Optical Coherence Tomography Images*
15:30 – 15:45	*Bhumica Verma, Parvinder Singh, An In-Depth Review of Routing Protocols in IoT-Oriented Sensor Networks*
15:45 – 16:00	*Ahmed Al-Ashoor, Ferenc Lilik, Szilvia Nagy, Optimizing Dilated SE-DenseNet for Brain Tumor MRI Classification: A Targeted Approach within the Broader Landscape of Computer-Aided Diagnosis*

16:00 – 16:15 Break

16:15 – 17:45 Paper Session 2: Multidimensional Signal Processing

Chairman: Assoc. Prof. Rumen Mironov, Technical University of Sofia, Bulgaria

16:15 – 16:30	*Kountcheva, R., Jain, L., Exploring the Optimizing Tools for Digital Watermarking of Medical Visual Information using DL*
16:30 – 16:45	*Trendafilov I., Unsupervised Signal Decomposition and Tracking using Hyperdimensional Computing and Spiking Neural Networks*
16:45 – 17:00	*Trendafilov I., Neuromorphic Directional Motion Detector*
17:00 – 17:15	*Tsvetkova D., Georgieva V., Wavelet-Based Image Fusion of Pre-Registered MRI and PSMA Scans of the Prostate Gland*
17:15 – 17:30	*Mironov, R., Local Adaptive 3D Recursive Denoising of Multidimensional Images*
17:30 – 17:45	*Draganov, I., Challenges in Air Pollution Forecasting*

July 25th, 2025 (Friday)

Join Zoom Meeting Topic: NAMSP 2025 Meeting

Time: Jul 25, 2025 10:00 Sofia

https://us06web.zoom.us/j/82189688042?pwd=5MOTpUWxZWBOjPIyw7REt1HMYtEnqs.1

Meeting ID: 821 8968 8042

Passcode: 3pvYkK

10:00 – 11:30 Paper Session 1

Chairman: Dr. Bin Hu, Co-Founder of IRnet International Academic Communication Center, China

10:00 – 10:15　　*Bin Hu, Lujie Cui, Wen-Feng Wang, Yabin Li, Zhenrong Pan, Intelligent Decision on Stroke Biomarkers: Potentials and Constraints*

10:15 – 10:30　　*Yiwen Zhang, Correlation Analysis Between Regional Economic Development and Policy Combined with Machine Learning*

10:30 – 10:45　　*Liming Lin, Shipei Du, Lei Yang, Yihui Zhong, Yongxin Jian, Fangting Chen, Empirical Investigation of Random Forest Model's Predictive Capability for A-share Banking and Food Industry Stocks*

10:45 – 11:00　　*Chuanbao Wu, Yanhong Guo, Machine Learning-Based Analysis of the Impact Effect of Digital Transformation in Commercial Banks on Digital Financial Development*

11:00 – 11:15　　*Yingkun Li, Zhicong Song, Jichang Chen, Research on Quantitative Investment Strategy Based on Multifactor Stock Selection and Transformer-SVR Fusion Modeling*

11:15 – 11:30 Break

11:30 – 13:45 Paper Session 2

Chairman: Dr. Bin Hu, Co-Founder of IRnet International Academic Communication Center, China

12:30 – 12:45　　*Wenshen Xu, Research on Visual Understanding Algorithm of Art Aided Design Scene in Digital Background*

12:45 – 13:00　　*Di Zhang, Student Behavior Pattern Mining and Management Optimization in Colleges and Universities Based on Big Data Analysis*

13:00 – 13:15　　*Yang Liu, Zitian Yang, Intelligent Generation and Optimization of China Traditional Cultural Content Based on Large-scale Pre-training Model*

13:15 – 13:30　　*Xuhan Chen, Sang Li, Construction of Intelligent English Writing Scoring Model Integrating Natural Language Processing and Semantic Analysis*

13:30 – 13:45　　*Qi Chen, Multi-source Heterogeneous Data Fusion and Intelligent Decision Algorithm Design for Cross-border Trade*

14:00 Closing

Plenary Speakers

Prof. Dr. Wenfeng Wang, International Academy of Visual Art and Engineering, London, UK

Title of Lecture:
Spatial Meta-Learning: Theory, Algorithm and Applications

Abstract: We will introduce how metalearning process can be integrated with spatial knowledge and quickly adapt to new tasks. Although deep learning has advantages in data processing capabilities and automatic feature extraction, it still faces many problems such as poor robustness and generalization, difficulty in learning and adapting to unobserved tasks. In recent years, the development of meta learning in deep learning has provided a new perspective for solving the above problems. Meta learning can learn new abilities by training a small number of samples, quickly adapt to new environments, and thus improve the model's generalization ability. Due to the limitations of slow learning speed and susceptibility to local minima in BP neural networks, model independent meta learning algorithms are introduced to address the limitations of BP neural networks themselves. The focus of this article is on the SMAML algorithm in optimized meta learning, which supplements the derivation details missing in the doctoral thesis of MAML by Chelsea B. Finn from the University of California. Afterwards, the SMAML-BPNN algorithm was proposed, with BP neural network as the base learner, SMAML algorithm as the meta learner, and EXCEL table data as input data. The experimental classification results were specifically presented from various dimensions, with an accuracy improvement of up to 5 percentage points. In the experimental part, the model was applied to spatial prediction, predicting the distribution of the average soil carbon dioxide intensity every ten years and presenting it in the form of a grid. Finally, further reflection was given to the previous paper. CBAM attention mechanism was added to the extension prototype network algorithm, and detailed experimental results were presented through comparative experiments. The results showed that the prediction results were indeed optimized before and after the addition of attention mechanism. However, the accuracy of the experimental results was not as high as expected, and further improvement and reflection are needed on the research of algorithm parameter update methods and dataset partitioning in the future.

Biographical Notes: Professor Dr. Wenfeng Wang is currently the editor in chief of International Journal of Electrical and Electronics Engineering (IJEEE) and International journal of Applied Nonlinear Science (IJANS). He is also a professor in Shanghai Institute of Technology. He is the director of International Academy of Visual Art and Engineering in London and the JWE Technological Research Center in Shanghai. He is also a tenured professor in IMT Institute in India and the director of Sino-Indian Joint research center of artificial intelligence and robotics. He was selected in 2018 as a key tallent in Ningbo Institute of Materials Technology and Engineering, Chinese Academy of Sciences. He is a reviewer of many SCI journals, including some top ones - Water Research, Science China-Information Sciences, Science of the Total Environment, Environmental Pollution, IEEE Transactions on Automation Science and Engineering and etc. He served as a keynote speaker of AMICR2019, IACICE2020, OAES2020, 3DIT-MSP&DL2020, NAMSP2021, ICCAES 2021, CSAMCS 2021 and etc.

Prof. Dr. Parvinder Singh, Full Professor, Department of Computer Science & Engineering, Deenbandhu Chhotu Ram University of Science & Technology, Murthal, Haryana, India

Title of Lecture:
A Cognitive Content Recommendation Engine Empowered by Ontology-Based Semantics

Abstract: This research presents "A Cognitive Content Recommendation Engine Empowered by Ontology-Based Semantics", a novel framework designed to deliver smarter and more personalized recommendations by combining traditional content-based filtering with ontology-driven semantic reasoning. Unlike conventional systems that rely solely on keyword matching or user-item interactions, this engine integrates domain-specific knowledge graphs, natural language processing, and rule-based inference to understand deeper contextual meaning within content. By incorporating tools like CRFEntityExtractor and DIETClassifier, the system enhances entity recognition and intent understanding, allowing it to interpret unstructured text with higher accuracy.

One of the key strengths of this approach is its ability to address challenges such as cold start, lack of diversity, and semantic sparsity common issues in content-based recommenders.

A key application of this system lies in the mental health domain, where personalized and context-aware support is vital. The proposed engine can recommend self-help resources, therapy content, or support group forums based on a user's emotional state, behavioural cues, and language patterns - captured through their digital interactions. By understanding not just what users say but how they express their thoughts, the system delivers emotionally intelligent, non-intrusive recommendations aligned with individual mental well-being.

Evaluations on real-world social media datasets show notable improvements in relevance, diversity, and personalization compared to traditional models. By embedding semantic inference and user-centric design, this framework offers a scalable solution for sensitive domains like mental health, where trust, empathy, and context are critical to impact.

Biographical Notes: Present position: Full Professor, Department of Computer Science & Engineering, Deenbandhu Chhotu Ram University of Science & Technology, Murthal, Haryana, India

Administrative experience: Dean Faculty of IT & CS, Chairperson CSED, Proctor, Director PG Admission, Chief Security Officer, and Head Computer Centre at DCRUST Murthal

Teaching experience: Total experience - 28 years, Presently working at Deenbandhu Chhotu Ram University of Science & Technology, Murthal, Haryana (India) (DCRUST), Completed 2 terms as Chairman, Department of Computer Science & Engineering, DCR University of Science & Technology, Murthal, Honorary Visiting Professor, University of Deusto, Spain, Worked on India Bulgraia Joint Project with Technical University of Sofia, Working in Collaboration with University of Deusto, Spain, Received two Patents (One International and One Indian) in the field of Security and Image Processing, Awarded two grants from DST and one from UGC for major projects, Organized International and National Workshops/Conferences in various cities of the world and delivered Keynote Addresses, Biography published in 27th edition of Marquis Who's is Who in World 2010 and all the subsequent editions, Inclusion in the Top 100 Engineers - 2012 by Cambridge, England, Published more than 100 Papers in International Journal and Conference Proceedings.

Prof. Mariofanna Milanova, Professor in Computer Science, University of Arkansas at Little Rock, USA, Senior Member of IEEE

Title of Lecture:
AI Agents-Driven Multidimensional Medical Imaging and Diagnostics

Abstract: During the presentation, we'll explore the integration of AI agents into multidimensional medical imaging and diagnostics. Key application areas to be discussed include: automated analysis of various imaging modalities and data integration, personalized treatment planning, predictive analytics, and modeling of disease progression. New foundational models introduce a cutting-edge methodology and overcome manual labeling and model transferability challenges. Outcomes are showcased utilizing various datasets. All participants will receive a personal code to access NVIDIA online courses for free.

Biographical Notes: Dr. Mariofanna Milanova is a professor in the Department of Computer Science at UA Little Rock and has been a faculty member since 2001. She received a M.Sc. in Expert Systems and Artificial Intelligence and Ph.D. in Engineering and Computer Science from the Technical University, Sofia, Bulgaria. Dr. Milanova conducted post-doctoral research in visual perception at the University of Paderborn, Germany. Dr. Milanova has extensive academic experience at various academic and research organizations worldwide.

Dr. Milanova is an IEEE Senior Member, Fulbright U.S. Scholar, and NVIDIA Deep Learning Institute University Ambassador. Dr. Milanova's work is supported by NSF, NIH, DARPA, DoD, Homeland Security, NATO, Nokia Bell Lab, NJ, USA and NOKIA, Finland. She has published more than 120 publications, over 53 journal papers, 35 book chapters, and numerous conference papers. She also has two patents.

Prof. Dr. Szilvia Nagy, Department of Telecommunications at Széchenyi István University, Győr, Hungary

Title of Lecture:

Analysis of the current trends in computer aided brain lesion classification in MR images

Abstract: The brain is the central controlling organ of mammals, including humans, making the detection and classification of lesions in its tissue critically important. The advancement of computational intelligence methods over the past decade has significantly transformed brain lesion diagnosis, enabling more precise, efficient, and automated classification of tumors. Computer-aided diagnostic (CAD) systems play a crucial role in assisting radiologists by enhancing accuracy, reducing variability, and improving early detection. Among the most prominent approaches in the literature, neural networks, fuzzy logic-based models, and genetic algorithms have gained substantial attention due to their ability to process complex medical imaging data.

Deep learning, particularly convolutional neural networks (CNNs), is widely regarded as the most effective image-processing technique today, achieving remarkable accuracy in brain tumor classification. These models excel in feature extraction and pattern recognition, allowing them to outperform traditional machine learning approaches. Hybrid methods that integrate deep learning with fuzzy logic or genetic algorithms have also demonstrated promising results by refining classification boundaries and optimizing feature selection.

Techniques such as data augmentation, transfer learning, and ensemble modeling contribute to enhancing reliability and generalization across different datasets. However, applying these methods in the medical field requires particular caution, as biological variation is significantly greater than in conventional image processing tasks.

The performance evaluation of CAD systems relies on diverse metrics, with accuracy and the DICE similarity coefficient being the most widely used. Sensitivity, specificity, recall, and other domain-specific measures provide further insights into model robustness and clinical applicability.

Despite substantial progress, challenges remain, including the need for larger, well-annotated datasets, the ability to handle rare or highly heterogeneous tumors, and improved interpretability—especially crucial in medical applications. Addressing these challenges will be essential for the continued advancement of CAD methods, leading to more effective and accessible diagnostic solutions.

Biographical Notes: Szilvia Nagy is a full professor at the Department of Telecommunications at Széchenyi István University, Győr. She graduated as an engineer physicist and earned her PhD in Physics from the Budapest University of Technology and Economics, later habilitating in Informatics at Széchenyi István University. Her research focuses on multidimensional signal processing, computational intelligence, and medical image analysis, with significant contributions to colorectal, liver, and brain lesion classification, AI-driven diagnostic methods, and mechanical and digital forensic signal processing. Her work extensively explores wavelet-based approaches and structural entropy for feature extraction and data analysis, contributing to advancements in signal processing and medical imaging. She served as vice dean for research and international relations at the Faculty of Engineering Sciences at Széchenyi István University between 2011 and 2014 and was a working group vice leader at COST Action CA17124 DigForAsp (Digital Forensics: Evidence Analysis via Intelligent Systems and Practices) from 2018 to 2023. In recognition of her scientific contributions, she received the Hungarian Women in Science Excellence Award in 2016. She has published widely

in leading scientific journals and conferences, shaping innovative methodologies at the intersection of artificial intelligence and biomedical engineering.

Prof. Dr. Sherif Sherif, University of Manitoba, Winnipeg, Canada

Title of Lecture:
Tensor Decompositions for Multidimensional Signal Processing

Abstract: I will give an introductory tutorial on techniques to address problems of storing and/or multilinear processing of very large multidimensional data arrays (tensors). Such "big data" could possibly result from multi-sensor measurements. After introducing basic tensor operations, I will cover both theoretical and computational aspects of two classic tensor decompositions: Canonical Polyadic Decomposition (CPD) and Tucker Decomposition (TD). I will also introduce the concept of Tensor Networks, with particular emphasis on the relatively recent Tensor Train Decomposition (TTD).

Biographical Notes:
Sherif S. Sherif is Professor of Electrical & Computer Engineering, and Director of the Biomedical Engineering Graduate Program, at the University of Manitoba, Winnipeg, Canada. His research interests include Digital Image Processing (M.Sc., University of Wisconsin-Madison) and Optics (Ph.D., University of Colorado at Boulder). Before joining the University of Manitoba, he held research positions at the University of Oxford, Imperial College London, and National Research Council Canada. He was also a Lecturer in Applied Optics (Assistant Professor) at the University of Kent, United Kingdom. He is author or co-author of over 130 scientific publications, including five patents.