Lucian Blaga University of Sibiu, Romania

Faculty of Sciences

Research Center in Informatics and Information Technology

MDIS 2024

9th International Conference on Modelling and Development of Intelligent Systems

Abstracts and Program

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Abstracts and Program

9th International Conference on

Modelling and Development of Intelligent Systems

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PREFACE

The aim of the conference is to bring together computer scientists, mathematicians, researchers and students interested in the topics of the conference. The conference welcomes submissions of original papers on all aspects of modelling and development of intelligent systems ranging from concepts and theoretical developments to advanced technologies and innovative applications.

The conference includes Plenary Lectures (30 min) and Regular Lectures (20 min).

The topic of the conference includes but is not limited to the following subjects:

- Evolutionary computing
- Grid computing and clustering
- Data mining
- Ontology engineering
- Intelligent systems for decision support
- Knowledge based systems
- Pattern recognition and model checking
- Motion recognition

- Hybrid computation for artificial vision
- Knowledge reasoning for artificial vision
- Geometric modelling and spatial reasoning
- Modelling and optimization of dynamic systems
- Large scale optimization techniques
- Adaptive systems
- Multiagent systems
- Swarm intelligence
- Metaheuristics and applications
- Machine Learning
- Mathematical models for development of intelligent system

Specialists from Argentina, Bulgaria, Germany, Ireland, Iceland, Romania, Serbia, Slovacia and the United States of America join this ninth edition of the conference to present and discuss recent problems on mathematical models, design, development and applications of intelligent systems.

All submitted papers underwent a thorough single - blind peer review; each paper being reviewed by at least 3 independent experts in the field. A post-conference proceedings containing selected, refereed and presented articles, will be published by Springer Verlag in the series Communications in Computer and Information Science (CCIS).

The MDIS conference respects Springer Editorial Policies:

https://www.springer.com/gp/authors-editors/journal-author/journal-author-helpdesk/editorial-policies/14214

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OFFICIAL LANGUAGE

The official language of the conference is English.

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Thursday, October 17, 2024

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organized by
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9^{00} – 9^{20}	**Opening ceremony**
9^{20} – 9^{50}	**Keynote Speaker** **Stefka Fidanova** *Ant Colony Optimization and Applications*
9^{50} – 10^{30}	**Papers presentation –** Chair **Dana Simian**
9^{50} – 10^{10}	**Adrian Bender, Santiago Nicolet** *Pretrained Language Models for Automatic Source Code Generation: Evaluation and Application*
10^{10} – 10^{30}	**Dana Simian, Felix Husac** *Generative AI and Machine Learning-Based Practical Approach for Enhancing the User Experience in the Entertainment Industry*
10^{30} – 10^{50}	**Coffee break**
10^{50} – 11^{50}	**Papers presentation -** Chair **Stefka Fidanova**
10^{50} – 11^{10}	**Cezar-Marian Papară, Ștefan-Horia Schirliu** *Logistics Optimization for Resource Allocation and Scheduling Using Time Slots*
11^{10} – 11^{30}	**Cristiana Constantinescu** *Comprehending Steganography Through a Comparative Analysis with Watermarking: A Study*
11^{30} – 11^{50}	**Marin-Eusebiu Serban** *Intelligent text correction approach for searching queries*
11^{50} – 12^{10}	**Coffee break**
12^{10} – 12^{40}	**Keynote Speaker** **Magda Gregorová** *Deep generative modelling - beyond language and videos*

$12^{40} – 13^{20}$	**Papers presentation -** Chair **Magda Gregorová**
$12^{40} – 13^{00}$	**Esther Ademola, Martin Reich, Magda Gregorova** *An Investigative Study Exploring Machine Learning Approaches for Optimising Deep Brain Stimulation Programming*
$13^{00} – 13^{20}$	**Petar Zhivkov** *Enhancing Liquidity and Stability in DeFi: USD-Collateralized Leveraged Restaking with Stablecoins*
$13^{20} – 14^{40}$	**Break**
$14^{40} – 15^{40}$	**Papers presentation (online) -** Chair **Florin Stoica**
$14^{40} – 15^{00}$	**Daniela Borissova, Naiden Naidenov, Zornitsa Dimitrova, Magdalena Garvanova, Ivan Garvanov, Radoslav Yoshinov** *How to Select Chief Digital Officer to Drive Digital Transformation: A Multiple Attributes Group Decision-Making Model*
$15^{00} – 15^{20}$	**Branislav Radomirovic, Luka Jovanovic, Nebojsa Budimirovic, Miodrag Zivkovic, Nebojsa Bacanin, Milos Dobrojevic** *Augmentation and substitution of medical training data with generative adversarial networks for machine learning*
$15^{20} – 15^{40}$	**Atanas Atanasov, Miglema Koleva, Lubin Vulkov** *Optimization of Diffusion Parameters in Models of Water Uptake in Grains with Spherical Symmetry*
$15^{40} – 16^{00}$	**Coffee break**
$16^{00} – 16^{30}$	**Keynote Speaker (online)** **Milan Tuba** *Intelligent Systems for Digital Images*
$16^{30} – 17^{10}$	**Papers presentation (online) -** Chair **Dana Simian**
$16^{30} – 16^{50}$	**Mihai Petrov,Velichka Traneva, Stoyan Tranev, Venelin Todorov, Slavi Georgiev** *The study of the influence of green house pollutants on the adiabatic constant of the atmospheric air*
$16^{50} – 17^{10}$	**Ryan Soto, Eva Tuba** *The Use of Convolutional Neural Networks in Autism Detection*
18^{10}	**Welcome Dinner**
20^{30}	**Sibiu by night (walking in the downtown Sibiu)**

Friday, October 18, 2024

NTT DATA Romania, 6th Floor, Șerbota Street no. 1A, 550247 Sibiu

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9^{30} – 10^{50}	**Papers presentation -** Chair **Santiago Nicolet**
9^{30} – 9^{50}	**Marcel Kyas, Joshua Springer, Gylfi Þór Guðmundsson** *Safe autonomous control for landing uncrewed aerial vehicles*
9^{50} – 10^{10}	**Stefka Fidanova, Ivan Dimov, Denitsa Angelova** *Ant Colony Optimization for Planting Vegetables and Annual Fruit Crops*
10^{10} – 10^{30}	**Adam Gonšenica, Andrej Mihálik, Roman Ďurikovič** *Queues Detection and Skiers Distribution in the Ski Resorts*
10^{30} – 10^{50}	**Stefan-Bogdan Marcu, Yanlin Mi, Mark Tangney, Sabin Tabirca** *ChemFlow: Bridging Computational Tools and Bioinformatics through LLM-Driven Workflow Automation*
10^{50} – 11^{10}	**Coffee break**
11^{10} – 11^{40}	**Keynote Speaker** **Andrei Paun** *Computing with neuron-like devices: SNP Suystems*
11^{40} – 12^{40}	**Papers presentation -** Chair **Dana Simian**
11^{40} – 12^{00}	**Alexandru Reuț** *Securing software using Genetic algorithms and encoding*
12^{00} – 12^{20}	**Snezhana Ribarska, Olga Georgieva, Sophia Lazarova** *Data Analysis for Cognitive States Identification*
12^{20} – 12^{40}	**Oana-Adriana Ticleanu, Daniel Hunyadi, Nicolae Constantinescu** *Enhanced devices security using elliptic curves defined over particular spaces*
12^{40} – 13^{00}	**Coffee break**
13^{00} – 14^{20}	**Papers presentation -** Chair **Marcel Kyas**

$13^{00} – 13^{20}$	**Amelia Bucur** *Fractional Programming Problems*
$13^{20} – 13^{40}$	**Atanas Atanasov, Slavi Georgiev, Lubin Vulkov** *Parameter Optimization in a Model of Influence of Brood Deaths on Honeybee Population Dynamics*
$13^{40} – 14^{00}$	**Dragoș Iliescu** *Conceptual Modeling of a Laboratory's Products and some Assisted Management Applications*
$14^{00} – 14^{20}$	**Elena Cristina Răulea** *The study of influencing factors impacting the selection of a higher education institution*
18^{00}	**Official dinner**

SATURDAY, October 19, 2024

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Trip on the route
Sibiu - Alba Carolina Citadel (Alba Iulia) - Corvins' Castel Hunedoara – Sibiu

Information on social events

Welcome dinner and Official dinner: Restaurant Impăratul Romanilor, Nicolae Balcescu Street No. 4, Sibiu.

Sibiu by night - Walking in Sibiu downtown: Departing point Restaurant Imparatul Romanilor

Trip departing and arrival point: Thalia coach parking lot (Corneliu Coposu Blvd.)

ABSTRACTS

Plenary Lectures

Ant Colony Optimization and Applications

Stefka Fidanova
Institute of Information and Communication Technologies Bulgarian Academy of Sciences

Abstract: Collective intelligence allows animals to overcome difficulties and obstacles in nature, even when they do not have a high level of individual intelligence. Bees, ant colonies, bird , fish passages, etc. can be given as examples of group intelligence. This phenomenon has inspired scientists to imitate nature in their quest to solve complex problems coming from real life and industry. The unique behavior of ants in nature and their ability to always find the shortest path between the nest and the food source, gives the idea for the creation of the ants method. The application of ant colony optimization include knapsack problem, grid scheduling problem, GPS surveying problem, bioreactor modeling problem, wireless sensor network positioning, image edges detection, workforce planning, agricultural modelling and many others.

The goal of this presentation is to show the diverse capabilities and applications of ant colony optimization.

Brief Biography of the Speaker: Stefka Fidanova is Professor of Computer Science at Institute of Information and Communication Technologies, Bulgarian Academy of Sciences. Her research interests include theory, methods, applications of combinatorial optimization and parallel algorithms. She heads the research group of Parallel Algorithms and Machine Learning. She has authored over 200 refereed journal, proceedings and collection papers, edited 13 proceedings, collections and special issues and written 2 monographs. She belongs to the editorial boards of several international journals. She has received the Career Award 2018 of Marie Curie Alumni Association of EU. She is listed in the World's Top 2% Scientists by Stanford University in 2021.

Deep generative modelling - beyond language and videos

Magda Gregorová
Technical University of Applied Science Würzburg-Schweinfurt, Germany

Abstract. In this talk we will discuss deep generative models for other domains and purposes than generating seemingly realistic pieces of text, images or videos. We will explore a range of problems, where we use deep unsupervised methods to learn high-dimensional data distributions for various downstream tasks. In particular, we will investigate the problem of modelling complex relational structures represented as graphs and the challenges these pose for generating new graph examples (e.g. for de novo drug design), we will see how generative models can be used for explaining decisions of independent predictor models, and we will look at some examples of industrial applications such as deep generative modelling for optimization of electrical engine designs. We will conclude with some more general thoughts about the current state of research in deep generative modelling.

Brief Biography of the Speaker: Magda Gregorova comes from Prague, Czech Republic, where she obtained her Master‘s degree in Statistics (2001)

from the University of Economics. She started her career of an applied statistician in the Czech National Bank, where she headed a technical unit on financial statistics and collaborated closely with the ECB and the IMF. After several years in banking she has decided to follow an international career and joined Eurocontrol, the European Organization for the Safety of Air Navigation based in Brussels, Belgium, as a statistical analyst and forecaster. She then moved to Geneva, Switzerland, where she obtained in 2018 a PhD in machine learning from the Computer Science Department of the University of Geneva. She continued as a post-doc in the Data Mining and Machine Learning group of the University of Applied Sciences of Western Switzerland. In 2021 she got the professorship for representation and learning at the Technical University of Applied Science Würzburg-Schweinfurt, Germany. Since 2022 she heads the research Center for Artificial Intelligence and Robotics (CAIRO) of the University. Her research focuses on deep generative methods for modeling complex high-dimensional distributions, in particular for discrete structures, and for learning useful representations for downstream tasks.

Computing with neuron-like devices: SNP Systems

Andrei Păun
Faculty of Mathematics and Computer Science, University of Bucharest, Romania
Romanian Academy Research Institute for Artificial Intelligence "Mihai Drăgănescu" (ICIA)

Abstract. SNP systems are a type of distributed, parallel, neural-like computation model inspired by how biological neurons process information and communicate through spikes. Over the past decade, significant progress has been made in understanding neurons and the brain, partly due to two major initiatives: the Human Brain Project (Europe) and the BRAIN Initiative (US). We will discuss several findings related to SNP systems and their variants as computational models, many of which demonstrate Turing Universality, even under certain constraints. Recent research results and open questions will also be described, particularly concerning Spiking Neural P systems with communication on request (SNQ P systems). We have been able to design small, Turing universal SNQ P systems using a limited number of neurons. Specifically, a Turing universal generative SNQ P system (or acceptor and

function computing) has been constructed with 12 neurons (11 for acceptor and 21 for function computing).

Brief Biography of the Speaker: Andrei received his BSc in Mathematics with a major in Computer Science from University of Bucharest (Romania) and later he received a Master's followed by a PhD in Computer Science from University of Western Ontario (Canada) in 2003. His PhD supervisor was Dr. Sheng Yu, from whom he "inherited" the interest in Finite Automata and OOP modeling as well as the Biocomputing research field that was the main thrust of his PhD dissertation. Following the PhD Andrei was a postdoc at Technical University of Wien (Austria) and later at University of Rovira i Virgili (Spain). He then moved to the US as an assistant and later associate professor of Computer Science (tenured) at Louisiana Tech University (USA). He later returned to Europe having positions at University of Western Ontario (Spain), University of Bucharest (Romania) and National Institute of R&D for Biological Sciences (Romania).

His main interests are Biocomputing and Bioinformatics as well as finite automata and other related areas.

Intelligent Systems for Digital Images

Milan Tuba
Head of the Artificial Intelligence Project, Singidunum University Belgrade, Serbia
Vice-Rector of Research, Sinergija University Bijeljina, Bosnia and Herzegovina

Abstract. Many modern systems, like self-driving cars, security apps, and automated diagnostics, rely heavily on digital image classification. Over the years, researchers have developed many techniques, but convolutional neural networks (CNNs) have transformed the field, greatly improving classification accuracy. Results of previously advanced research topics are now achievable with CNNS without a lot of effort or time. However, CNNs also introduced new challenges. One big issue is finding the best CNN architecture, which is really tough because there are so many variables to adjust, like the number and type of layers, the number of neurons, kernel size, pooling type, optimization algorithm, padding, and stride. Each model should be fine-tuned for each problem. To handle this, often used method is a trial-and-error approach, or a method called grid search. Since this is an optimization problem, recent studies have also tried metaheuristics like swarm intelligence algorithms. While these

methods take a lot of time, they can significantly boost accuracy. This talk will explore the latest advancements and challenges in CNNs, such as tuning hyperparameters.

Brief Biography of the Speaker: Milan Tuba, Professor of Computer Science, Mathematics and Electrical Engineering, Head of the Artificial Intelligence Project at Singidunum University and Vice-Rector of Research at Sinergia University, is included in both versions of the Stanford University list of 2% of the most influential scientists in the world in all disciplines, one for contribution during the entire career and other for contribution in the previous year (for years 2020, 2021, 2022, 2023 and 2024). Prof. Tuba is highest ranked researcher in Serbia for Computer Science field at AD Scientific Index - World Scientists Rankings. He was Vice Rector for International Relations at Singidunum University, Head of the Department for Mathematical Sciences at State University of Novi Pazar and Dean of the Graduate School of Computer Science at John Naisbitt University. Prof. Tuba is the author or coauthor of around 300 scientific papers (cited more than 7,700 times, h-index 53) and editor, coeditor or member of the editorial board or scientific committee of number of scientific journals, Springer books, congresses and international conferences. He was invited and delivered over 100 keynote and inaugural lectures at international conferences. His research interest includes Artificial Intelligence, Deep Learning, Neural Networks, Nature-inspired Optimization Algorithms, Image Processing, Computer Networks. Senior Member IEEE, Senior Member ACM, AMS, SIAM, IFNA, Executive Board of IASEI. He received B. S. in Mathematics, M. S. in Mathematics, M. S. in

Computer Science, M. Ph. in Computer Science, Ph.D. in Computer Science from University of Belgrade and New York University. From 1983 to 1994 he was in the U.S.A. at Vanderbilt University in Nashville and Courant Institute of Mathematical Sciences, New York University and later as Assistant Professor of Electrical Engineering at Cooper Union School of Engineering, New York. During that time, he was the founder and director of Microprocessor Lab and VLSI Lab, leader of the NSF scientific projects and theses supervisor. He was the mentor of dozens of doctoral and master's dissertations at the Faculty of Mathematics University of Belgrade, Singidunum University, University of Sarajevo, State University of Novi Pazar, John Nesbitt University and University of East Sarajevo. He was teaching more than 20 graduate and undergraduate courses, from VLSI Design and Computer Architecture to Computer Networks, Operating Systems, Artificial Intelligence, Image Processing, Calculus, Probability, Mathematical Statistics and Queuing Theory at numerous universities in Europe and the USA. Prof. Tuba is a member of the National Agency for Accreditation of Universities of the Republic of Serbia.

Regular Lectures

An Investigative Study Exploring Machine Learning Approaches for Optimising Deep Brain Stimulation Programming

Esther Ademola, Martin Reich, Magda Gregorova

This investigative study explores machine learning models for predicting dystonia improvement scores in Deep Brain Stimulation (DBS). Leveraging data from 85 subjects across seven European DBS centres, we employ various linear and non-linear modelling approaches. In contrast to previous studies utilising probabilistic mapping, our direct utilisation of the actual dataset yields improved results. The random forest model emerges as the most accurate predictor, with a mean deviation of 9.54 ± 6.08%. This implies that for a patient with an improvement score of 78%, the model predicts an improvement between 68% and 87%. This advancement in predictive accuracy holds potential implications for refining DBS programming, ultimately enhancing therapeutic outcomes for individuals with dystonia. In addition, regularisation techniques play a pivotal role in determining feature importance thereby contributing to a nuanced understanding of factors influencing DBS therapy outcomes.

Keywords: *Deep brain stimulation, dystonia, machine learning, regularisation.*

Effective LSTM neural network with Adam optimizer for Improving Frost Prediction in Agriculture Data Stream

Atanas Atanasov, Miglena Koleva, Lubin Vulkov

In this work we consider nonlinear parabolic equation with spherical symmetry, describing drying (shrinkage) effects of grain dehydration. The water removal is described by Fickian diffusion model and the diffusion term is dependent on the moisture content and the temperature. The formulated optimization problem for recovering two parameters in the non-linear diffusion coefficient satisfies the state constraints and minimize the cost functional, with a good accuracy, although not exactly. We develop numerical method for recovering these parameters in the non-linear diffusion term. Such two-parameter coefficient inverse problem is ill-posed, since small errors in the input data may leads to large errors in the computed solution. The proposed approach is based on Levenberg-Marquardt method. Computational examples with synthetic and real data for chickpeas, obtained experimentally, are discussed.

Keywords: *Nonlinear diffusion model, spherical symmetry, drying of chickpeas (Cicer arietinum), coefficient inverse problem, optimization*

Parameter Optimization in a Model of Influence of Brood Deaths on Honeybee Population Dynamics

Atanas Atanasov, Slavi Georgiev, Lubin Vulkov

Numerous studies have investigated the various stressors that can cause the collapse of honeybee colonies. Given the challenges in directly observing honeybee population dynamics, it is essential to construct mathematical models to gain insight into the factors that significantly affect bee populations. Several models have been proposed to capture the dynamics of honeybee populations and the effects of human-induced stressors, such as pathogens, parasites, and nutritional deficiencies, on the colony's long-term survival. However, these models generally overlook the death rate of brood, concentrating instead on the mortality rates of foraging bees. We consider a model of a nonlinear system of ordinary differential equations with main unknowns the brood B and the hive bees H. We formulate an optimization problem for recovering coefficients in the system that satisfies the state constraints and minimize the cost functional. The nature of the algorithm is to numerically reconstruct the unknown parameters, i. e. they are f itted with a good accuracy, although not exactly. We develop a computational approach to solve the problem. Numerical experiments with synthetic and real data are analyzed.

Keywords: *Honeybee Population Dynamics Colony Collapse Disorder Brood Death Parameter Identification Adjoint Equations.*

Pretrained Language Models for Automatic Source Code Generation: Evaluation and Application

Adrian Bender, Santiago Nicolet

This study explores the capabilities of the ChatGPT artificial intelligence language model, with the GPT-3 architecture developed by OpenAI, in the task of generating JavaScript source code from Spanish instructions. Transformer language models, as exemplars of deep learning, are effective at learning contextual representations of words and phrases. This allows the model to understand not only individual programming terms but also how they combine into larger structures such as loops and functions. Through a set of unique programming feature requests from a selected set of cases prepared for this work, we examine the model's ability to transcribe these high-level specifications into executable and functional source code. The results of the model were evaluated using a compiler, seeking an objective evaluation of the functionality of the generated code in predefined unit test cases. Overall, the model achieves 100% compilable code and 90% successful individual problem resolution. This work explores the intersection of AI and programming, paving the way for effective automation of code development from sentences in Spanish. While our analysis is centered on Spanish, the insights gained could be relevant for other non-English languages as well. It is expected that this work will contribute to the growing body of literature focusing on code generation and natural language understanding in AI language models.

Keywords: *Artificial Intelligence, Transformer Models, Source Code Generation.*

How to Select Chief Digital Officer to Drive Digital Transformation: A Multiple Attributes Group Decision-Making Model

Daniela Borissova, Naiden Naidenov, Zornitsa Dimitrova, Magdalena Garvanova, Ivan Garvanov, Radoslav Yoshinov

Increasingly, many companies are now creating Chief Digital Officer (CDO) positions to support their digital transformation. As a relatively new po-sition, the responsibilities involved cover various aspects of the company's oper-ations, the most significant of which is culture change. The CDO is expected to develop and implement a digital strategy to be integrated into a digital ecosystem. The CDO must be able to identify new technologies such as artificial intelligence, and the Internet of Things that are relevant to the company's operations and will lead to improving existing solutions. Considering the importance of this position, this paper proposes a CDO selection model. A distinctive feature of the model is the ability to integrate various objective and subjective characteristics of the can-didates for this position. Thus, the proposed group decision-making model could aggregate experts' assessments according to their points of view about the im-portance of the characteristics of candidates. The numerical application of the proposed model is based on six technical skills and seven soft skills forming the general performance of the candidates, evaluated by a group of three experts. The

results show that by aggregating properly different experts' opinions it is possible to determine the most suited candidate for the CDO position.

Keywords: *Chief Digital Officer, Digital Transformation, Technical & Soft Skills, Group Decision-Making.*

Fractional Programming Problems

Amelia Bucur

In this paper we analyze the use of partial derivatives in solving optimization problems. Fractional programming problems have attracted the attention of many specialists due to their applications in many fields as Economics and Finance, Engineering, Biology, Epidemiology, and Medicine. We present the mathematical modeling of fractional programming, and a parallel between the SIR model built using classical differential equations and fractional differential equations. Simulation of many optimization problems were also realized.

Keywords: *Fractional Programming; Simulations, Optimization*

Comprehending Steganography Through a Comparative Analysis with Watermarking: A Study

Cristiana Constantinescu

Steganography and Watermarking represent two key pillars of data hiding and privacy protection. Despite the particular advancement of digital approaches and the expansion of tailored applicability scenarios for each of the two that have occurred in the last decades, steganography and watermarking are often times mistaken to be one and the same science. Within this paper, we acknowledge the importance and magnitude of each and aim to trace clear borders between the two, in accordance to nowadays state of art in data hiding. We comply and accept that in the recent past steganography and watermarking used to be more tangential and in conjunction. However, we take into accountancy that nowadays the two have individually evolved in separate manners. Within this paper, we propose and analyze what makes them apart: the discrepancy elements between the two, with a more thorough perspective on Steganography.

Keywords: *Steganography, Data protection, Information Security, Watermarking, Data hiding, Image Steganography, Steganalysis, CIA Triad, Digital Content Security.*

Ant Colony Optimization for Planting Vegetables and Annual Fruit Crops

Stefka Fidanova, Ivan Dimov, Denitsa Angelova

Growing vegetables and annual fruit crops is an important part of agriculture. They are irreplaceable part of the human diet and are especially important for the body's supply of vital vitamins and minerals. Planning the areas for sowing is a complex task. Expected yields, different types of costs, policies, incentives, and more must be considered. The aim is for farmers to plan their sowing in such a way that they have maximum profit. On the other hand, authorities should be able to assess in advance the impact of various policies, including taxes and incentives, on farmers' sowing decisions. The problem is a complex optimization problem because of the strict constraints that must be satisfied. For problem solving, we apply an algorithm based on the ant colony optimization metaheuristics. In the study, we play out a variety of seeding scenarios involving a distinct opportunity for an adverse event occurring as well as subsidizing unattractive plantings.

Keywords: *Agricultural System Modelling; Planting Vegetables; Ant Colony Optimization; Metaheuristics.*

Queues Detection and Skiers Distribution in the Ski Resorts

Adam Gonšenica, Andrej Mihálik, Roman Ďurikovič

This paper investigates the synergy between Multi-Agentbased Simulation (MAS) and AI-powered queue estimation to understand the complex dynamics of skier behavior and queue formation at ski lifts. We propose a novel approach where groups of skiers are modelled as autonomous agents within the MAS framework. These agents make decisions based on factors such as preferred slopes and runs, and tolerance for waiting in lines. The simulation environment meticulously replicates the ski area layout, encompassing slopes, lifts, and other relevant features. Factors such as lift capacity and travel time are also incorporated to ensure realistic modeling.

To enhance the accuracy of queue predictions, real-time data is obtained through an AI model trained on labeled images from security cameras around the ski lifts. The real-time queue length estimates derived from the AI model are then seamlessly integrated into the MAS simulation. This integration empowers the MAS with a more dynamic and datadriven understanding of queue formation throughout the day, leading to more accurate predictions of congestion patterns and wait times.

By leveraging the insights gleaned from the MAS simulations, operators can make more informed decisions regarding lift operations and strategic layout modifications. Optimized lift usage based on these predictions can potentially lead to reduced waiting times for skiers, significantly enhancing their overall experience. In conclusion, this paper presents a powerful framework that

combines MAS and AI-powered queue estimation to offer ski resorts a valuable tool for optimizing skier experience and operational efficiency.

Keywords: *Multi-agent simulations, Queues, Skier behavior.*

Conceptual Modelling of a Laboratory's Products and Some Assisted Management Applications

Dragos Iliescu

The research investigates by conceptual modelling tools the requirements needed for a proper definition of a laboratory's products or services. By using a high degree generalization modelling language, under the research scope we investigate the product/service as a material test and/or calibration for measuring equipment. The research results expressed in modelling language are later implemented in an Assisted Management Application.

Keywords: *Conceptual Modelling, Laboratory, ISO 17025, Management Integrated System.*

Safe autonomous control for landing uncrewed aerial vehicles

Marcel Kyas, Joshua Springer, Gylfi Þór Guðmundsson

Consumer-grade drones have become practical multimedia collection tools, spring-boarded by rapid improvements in embedded CPUs, GPUs, and cameras. They are best known for collecting high-quality aerial video, 3D

terrain scans, and infrared imagery faster and cheaper than crewed aircraft. However, users also create and attach custom sensors, actuators, or computers so the drone can collect different data, generate composite data, or interact intelligently with its environment, e.g., autonomously changing behaviour to land safely or choosing further data collection sites.

In today's use cases, drones perform many subtasks autonomously, like flying along waypoints, holding a position, or returning to their home. A human operator with a remote control backs up the drone in case it fails a task.

For a drone to remain airworthy, we must demonstrate the safety of the drone's control systems. We distinguish between system safety properties and environmental safety properties. Properties that imply that no operation harms the drone are system safety properties. For example, if a drone lands autonomously, it must select a suitable site, or it might topple over and become inoperational. Properties that imply that no operation damages things or harms people are environmental safety properties. For example, if a drone lands autonomously after identifying a suitable site, it must still avoid people crossing it while it lands.

One requirement is that software control systems on aircraft are deterministic, which excludes many systems based on machine learning. We will discuss strategies to demonstrate the safety of machine-learning-based systems, for example, through metamorphic testing.

Keywords: *Image classification, autonomous drones, safety.*

ChemFlow: Bridging Computational Tools and Bioinformatics through LLM-Driven Workflow Automation

Stefan-Bogdan Marcu, Yanlin Mi, Mark Tangney, Sabin Tabirca

Innovations in computational methodologies have significantly transformed the landscape of scientific research, in silico experiments have replaced some of the physical experiments. ChemFlow, a novel proof-of-concept platform introduced in this paper, coalesces these advancements by automating the creation of workflows. Designed specifically for the bioinformatics field, ChemFlow leverages Large Language Models and prompt engineering techniques to interpret natural language descriptions and convert them into executable workflows without the need for manual coding. Our contributions are two-fold: first, we introduce an innovative workflow generation and execution platform with the help of large language models, and second, we introduce a novel set of prompt optimisation strategies that improve both the accuracy and efficiency of the generated workflows. ChemFlow enables researchers to focus on domain-specific challenges rather than computational intricacies, making it a pivotal tool for advancing scientific productivity and innovation.

Keywords: *Workflow Generation, Prompt Optimisation, Large Language Model, LLM, AI.*

Logistics Optimization for Resource Allocation and Scheduling Using Time Slots

Cezar-Marian Papară, Ștefan-Horia Schirliu

In the field of logistics, efficient scheduling and resource allocation are crucial for maintaining an uninterrupted flow of goods through transportation networks. This paper investigates the Interval Scheduling Problem, a combinatorial optimization problem, within the context of logistics planning for goods transportation. The study explores how optimizing appointment scheduling and resource allocation can enhance transportation network efficiency. By examining the theoretical foundations, algorithmic applications, and practical implications of Interval Scheduling, this work builds and proposes a solution based on both mathematical models related to time, resource, and capacity constraints, as well as a computational implementation. Leveraging advanced computational methods and real-time data integration, the paper aims to offer robust solutions that improve overall efficiency and competitiveness in transportation logistics. This comprehensive approach to optimizing scheduling and resource allocation contributes to improved efficiency and reduced operational costs in transportation networks.
Keywords: *Interval Scheduling Problem, Time Slots, Resource Allocation, Combinatorial Optimization, Logistics, Transportation Networks*.

The study of the influence of green house pollutants on the adiabatic constant of the atmospheric air

Mihai Petrov, Velichka Traneva, Stoyan Tranev,
Venelin Todorov, Slavi Georgiev

The aim of the paper is to develop a recent new achieve of the researches of qualitative and quantitative description based on the laws of thermodynamics describing the atmospheric state. Taking into consideration that the global warming that leads to the increase of the atmospheric temperature due to of the presence of greenhouse gases, is necessary to calculate some values that describe the instability of the climate. Recently, very frequent natural cataclysms such as floods and desertification, strong winds with high speeds have been observed and atmospheric temperature variations in wide intervals. This parameter is the adiabatic constant of the atmosphere. The expression of the variation of the adiabatic constant with the increasing of the temperature is proven. It is observed that the adiabatic constant decreases over time and the calculations of the specific heat capacity of the atmosphere show that these values decrease over time. Lower values of the specific thermal capacity of the atmosphere correspond to higher values of the wind speed. Another parameter is the temperature gradient that increases over time, a fact that confirms the instability of the atmosphere.

Keywords: *Green house pollutants; temperature; adiabatic constant; temperature gradient; winds and hurricanes.*

Augmentation and substitution of medical training data with generative adversarial networks for machine learning

Branislav Radomirovic, Luka Jovanovic, Nebojsa Budimirovic, Miodrag Zivkovic, Nebojsa Bacanin, Milos Dobrojevic

This research underscores the pivotal role of AI in addressing intricate problems, especially in medical diagnosis and predicting treatment outcomes. Despite challenges in algorithm selection, hyperparameter tuning, and limited medical data, simulations with real-world data affirm the effectiveness of machine learning, notably showcasing the random forest model with an impressive 85.19% accuracy. A significant aspect of this work involves the exploration of Generative Adversarial Networks (GANs) for data augmentation and synthesis. GANs enhance classifiers like MLP and AdaBoost but present challenges for decision tree and KNeighbors models. Additionally, leveraging fully synthetic data for training proves promising, offering a potential solution to data scarcity. Feature importance analysis emphasizes the impact of treatment frequency on patient outcomes, enhancing model interpretability. In conclusion, this research addresses challenges, introduces novel GAN-based approaches, and provides valuable insights to advance practical AI applications, particularly in effective data augmentation and synthesis using GANs, ultimately improving the prediction of treatment outcomes.

Keywords: *Machine learning, Generative Adversarial Networks, Feature importance, Medical data, Data augmentation.*

The study of influencing factors impacting the selection of a higher education institution

Elena Cristina Răulea

This paper aim is to identify and analyze the various factors that influence students' decisions when choosing a higher education institution. This can include examining aspects such as, institution reputation, program offerings, location, cost and financial aid, campus facilities, social environment, career opportunities, the behavior of students as consumers of educational services, using methods such as questionnaires, statistical analysis, and data mining techniques. Ultimately, the paper aims to provide insights that can help educational institutions enhance their marketing strategies, improve student recruitment, and better meet the needs and preferences of prospective students. It may also contribute to a broader understanding of the decision-making processes within higher education.

Keywords*: Data mining, educational marketing,higher education, decision-making process.*

Securing software using Genetic algorithms and encoding

Alexandru-Gheorghe Reuț

Protection of software against reverse engineering that is done by individuals with different purposes becomes more and more complex with time due to

evolving technology. No matter how unimportant a piece of software is some kind of protection against intellectual property and data theft must be in place. In the help of protection against reverse engineering, a method of encoding is proposed that encodes the principal section of a Portable Executable (PE) file in such a way that the encoded assembly instruction look like a normal assembly instruction of a program. This method is using a Genetic Algorithm (GA) together with Asm2Vec engine. The Genetic Algorithm has into his population the assembly instructions of the input program and other assembly instructions from other legitimate programs. The decoding is made at the user request based with a key that is uniquely generated for each encoded program. The results show that the encoded program is not obfuscated nor encrypted which may misled the attacker and hide the behavior of the program.

Keywords: *Genetic Algorithm, Asm2Vec, security, obfuscation, encoding.*

Data Analysis for Cognitive States Identification

Snezhana Ribarska, Olga Georgieva, Sophia Lazarova

The current paper introduces an unsupervised data mining methodology applied to medical data to uncover insights into the cognitive states associated with Alzheimer's disease. The methodology emphasizes the integration of algorithmic feature selection with existing knowledge about the disease's manifestation. The data clustering analysis is conducted with two primary objectives: first, to uncover the underlying structure of the data, and second, to examine how well the identified cognitive groups align with existing

diagnoses. The results demonstrate that the most effective clustering approach identifies three distinct cognitive groups. However, while each cluster represents a dominant cognitive group, it does not strongly differentiate between the subjects' diagnoses.

Keywords: *Alzheimer's Disease, Unsupervised Data Mining, Genetic Algorithm, Cluster Analysis, FCM Clustering*.

Determining metabolic pathway in plants

Corina Simian

Natural products are secondary metabolites that are found in different organisms, and herein we will be focused on natural products extracted from plants. Natural products play an important role in drug discovery. However, many of them can not be easily or cost-effectively synthesized chemically. Therefore, other methods must be employed, such as determining the biochemical pathway of these compounds. A combination of strategies is used in the determination of the metabolic pathway of galegine. Galegine is a bioactive compound found in Galega officinalis and was investigated for the treatment of diabetes, in the beginning of 20th century by French researchers. This research lead to the later development of metformin, the main drug that is used to treat diabetes. Specific computational methods combined with genomics, metabolomics and transcriptomics lead to a de novo genome assembly of the plant and further to different candidates, as precursors in the biochemical pathway of galegine. Recently developed AI methods can be used

to understand the enzyme place in the pathway. These newly discovered enzymes are key in understanding the process in which various natural products are produced and key players in determining new drugs that can be ultimately used in cancer treatment.

Keywords: *Computational Methods, Genomics, Machine Learning.*

Generative AI and Machine Learning-Based Practical Approach for Enhancing the User Experience in the Entertainment Industry

Dana Simian, Felix Husac

In this paper, we propose a solution for the use of Machine Learning and Generative AI for improving the user experience in various entertainment events and performances. We propose a solution, based on Generative AI, offering an immersive background for the audience projection. Our proposed solution combines generative AI with sentiment analysis and a threshold based algorithm to choose the strategy for background selection. We use image magnification systems and robotic cameras for real-time tracking of the audience. Ethical aspects related to our study are also considered.

Keywords: *Generative AI, entertainment industry, machine vision.*

The Use of Convolutional Neural Networks in Autism Detection

Ryan Soto, Eva Tuba

Autism, or autism spectrum disorder (ASD), refers to a broad range of conditions characterized by challenges with social skills, repetitive behaviors, speech, and nonverbal communication. It is important to be diagnosed with ASD when you are young. However, ASD is typically diagnosed through the way someone behaves. Convolution Neural Network (CNN) could help in the process. There have been great strides in using CNN for image recognition, as it can isolate parts of an image. Providing a image analysis along with the behavioral diagnosis will help lead to a more accurate result. The proposed model was tested on a standard dataset and the testing percentage of the proposed architecture was around 87%.

Keywords: *Autism Diagnosis, Convolutional Neural Networks, Facial recognition.*

Intelligent text correction approach for searching queries

Marin-Eusebiu Șerban

Efficient and accurate search capabilities prove essential for visitors exploring specialised websites requiring precise information. Common issues like as misspellings, incomplete queries, and text degradation can have a substantial impact on search performance and user satisfaction. To address these

challenges, we propose an intelligent text correction model that uses Gated Recurrent Units (GRUs) together with Bahdanau Attention processes to effectively rebuild and refine user search queries. Our complete methodology and architectural framework are intended to improve search functionality across a network of thematically connected websites.The model's success is demonstrated through its implementation on a consolidated university information platform, where it made noticeable improvements in search accuracy and user engagement. The paper discusses the technical development, integration process, and practical ramifications of using advanced machine learning models for search optimisation in specialised domains.

Keywords: *Search query correction, GRU networks, Bahdanau Attention, machine learning, user experience enhancement.*

Enhanced devices security using elliptic curves defined over particular spaces

Oana-Adriana Ticleanu, Daniel Hunyadi, Nicolae Constantinescu

The use of digital signatures as well as asymmetric cryptography in authentication and data transfers between IT entities has led to the development of related technologies. However, at the same time, cryptographic analysis methods also showed the limits of these models. As an alternative solution, the methods based on spaces defined over elliptic curves have started to be used, but for these the construction requires a specialized

mathematical apparatus, in order to increase the degree of resistance to attack. This study highlights such a customized solution for a concrete problem with applicability in the authentication of the parties in communication, highlighting the advantages but also the subclasses of problems addressed.

Keywords: *Elliptic curve cryptography, applied mathematics.*

Enhancing Liquidity and Stability in DeFi: USD-Collateralized Leveraged Restaking with Stablecoins

Petar Zhivkov

With the advancement of the Proof of Stake (PoS) Ethereum ecosystem, users can now restake their staked derivatives through protocols like EigenLayer and Symbiotic, receiving Liquid Restaked Tokens (LRTs) that represent their restaked assets and earn additional incentives. LRTs enhance the liquidity of restaked assets by enabling their use in secondary markets, such as for collateralized borrowing on Aave or for providing liquidity to yield markets like Pendle.This research proposes a novel approach to USD-collateralized leveraged restaking using stablecoins and explores the integration of Symbiotic's generalized restaking infrastructure, which expands the range of collateral to include any ERC-20 tokens. This approach offers a transformative shift in Actively Validated Systems (AVSs) by mitigating the economic volatility typically associated with cryptocurrency operations. The use of stablecoin derivatives ensures stable operational costs for AVS integrators and

consistent yields for restakers, irrespective of ETH price fluctuations. This work provides a first step in the comprehensive analysis of liquid restaking.

Keywords*: Proof of Stake, Liquid Restaking, Stablecoins.*

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