Lucian Blaga University of Sibiu, Romania

Faculty of Sciences

Research Center in Informatics and Information Technology

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8th International Conference on Modelling and Development of Intelligent Systems

Abstracts and Program

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Abstracts and Program

8th 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 Bulgaria, Ecuador, France, Germany, India, Ireland, Romania, Serbia, Ukraine, United Arab Emirates, United Kingdom and United States of America join together to this eighth 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 will be 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:

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OFFICIAL LANGUAGE

The official language of the conference is English.

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FRIDAY, October 28, 2022

Room A27

International Conference – MDIS 2022
Modelling and Development of Intelligent Systems

organized by
Research Center in Informatics and Information Technology
Faculty of Sciences, Lucian Blaga University of Sibiu, Romania

$10^{00} – 10^{10}$	**Opening ceremony**
$10^{10} – 10^{40}$	**Keynote Speaker** **Dan Cristea** *A Technology of Deciphering Old Cyrillic-Romanian*
$10^{40} – 11^{40}$	**Papers presentation -** Chair **Dan Cristea**
$10^{40} – 11^{00}$ $11^{00} – 11^{20}$ $11^{20} – 11^{40}$	**Dana Simian, Felix Husac** *Overview of challenges and opportunities in Deep Learning driven Fashion and Textiles development* **Cezar-Marian Papară** *An empirical study of large transportation networks and solutions for the cost optimization* **Marco Leon Olescu** *Is low-code the new high?*
$11^{40} – 12^{00}$	**Coffee break**
$12^{00} – 12^{30}$	**Keynote Speaker** **Marcel Kyas** *Autonomous Drones and Analogue Missions*
$12^{30} – 13^{30}$	**Papers presentation -** Chair **Dana Simian**
$12^{30} – 12^{50}$	**Marko Stankovic, Nebojsa Bacanin, Miodrag Zivkovic, Dijana Jovanovic, Milos Antonijevic, Milos Bukmira, Ivana Strumberger** *Feature Selection and Extreme Learning Machine Tuning by Hybrid Sand Cat Optimization Algorithm for Diabetes Classification* **Zornitsa Dimitrova, Daniela Borissova, Rossen Mikhov, Vasil**

$12^{50} – 13^{10}$	**Dimitrov** *Group Decision-Making Involving Competence of Experts in Relation to Evaluation Criteria: Case Study for e-Commerce Platform Selection*
$13^{10} – 13^{30}$	**Roman Peleshchak, Vasyl Lytvyn, Oleksandr Mediakov, Ivan Peleshchak** *Morphology of Convolutional Neural Network with Diagonalized Pooling*
$13^{30} – 15^{00}$	**Lunch break**
$15^{00} – 16^{20}$	**Papers presentation -** Chair **Florin Stoica**
$15^{00} – 15^{20}$	**Venelin Todorov, Slavi Georgiev** *Innovative lattice sequences based on component by component construction method for multidimensional sensitivity analysis*
$15^{20} – 15^{40}$	**Nebojsa Bacanin, Aleksandar Petrovic, Milos Antonijevic, Miodrag Zivkovic, Marko Sarac, Eva Tuba, Ivana Strumberger** *Intrusion Detection by XGBoost Model Tuned by Improved Social Network Search Algorithm*
$15^{40} – 16^{00}$	**Venelin Todorov, Slavi Georgiev** *On an optimization of the lattice sequence for the multidimensional integrals connected with Bayesian statistics*
$16^{00} – 16^{20}$	**Jean Dezert, Florentin Smarandache, Albena Tchamova** *Analytical Solution of the Simplest Entropiece Inversion Problem*
$16^{20} – 16^{40}$	**Coffee break**
$16^{40} – 17^{40}$	**Papers presentation -** Chair **Nicolae Constantinescu**
$16^{40} – 17^{00}$	**John Musgrave, Temesguen Messay-Kebede, David Kapp, Anca Ralescu** *Latent Semantic Structure in Malicious Programs*
$17^{00} – 17^{20}$	**Edwin Cocha Tobanda, María Cristina Erazo, Sang Guun Yoo** *Gaze Tracking: A Survey of Devices, Libraries and Applications*
$17^{20} – 17^{40}$	**Kowshik Bhowmik, Anca Ralescu** *Bridging the Resource Gap in Cross-lingual Embedding Space*
18^{30}	**Welcome Dinner**

SATURDAY, October 29, 2022

Room A27

International Conference – MDIS 2022

Modelling and Development of Intelligent Systems

organized by
Research Center in Informatics and Information Technology
Faculty of Sciences, Lucian Blaga University of Sibiu, Romania

$10^{00} – 10^{30}$	**Keynote Speaker** **Detlef Streitferdt** *Inside Neural Networks*
$10^{30} – 11^{10}$	**Papers presentation -** Chair **Dana Simian**
$10^{30} – 10^{50}$ $10^{50} – 11^{10}$	**Cristian Popescu, Alina Bărbulescu** *Flash flood simulation between Slănic and Vărbilău rivers in Vărbilău village, Prahova county, Romania, using hydraulic modeling and GIS techniques* **Sorin Ionut Conea, Gloria Cerasela Crisan** *Integrated system for sensing home hazards*
$11^{10} – 11^{30}$	**Coffee break**
$11^{30} – 12^{30}$	**Papers presentation -** Chair **Nicolae Constantinescu**
$11^{30} – 11^{50}$ $11^{50} – 12^{10}$ $12^{10} – 12^{30}$	**Andreea Vântu, Anca Vasilescu, Alexandra Băicoianu** *ML-based Solution for Emergency Room Triage* **Stefan-Bogdan Marcu, Sabin Tabirca, Mark Tangney, Yanlin Mi, Venkata V B Yallapragada** *Generating Jigsaw Puzzles and AI powered solver* **Amelia Bucur, Dana Simian** *A Generalization of the SEIR model*
$12^{30} – 13^{30}$	**Lunch break**
$13^{30} – 14^{50}$	**Papers presentation -** Chair **Florin Stoica**
$13^{30} – 13^{50}$ $13^{50} – 14^{10}$	**Livia Sangeorzan, Nicoleta Enache-David, Claudia-Georgeta Carstea, Ana-Casandra Cutulab** *Tasks Management Using Modern Devices* **Atanas Atanasov, Miglena Koleva, Lubin Vulkov** *Numerical Optimization Identification of a Keller-Segel Model for Thermoregulation in Honey Bee Colonies in Winter*

$14^{10} – 14^{30}$	**Hafeez Khan Mohammed Abdul, Hrishikesh Sabnis, Angel Arul Jothi J., Kanishkha J., Deva Prasad A M** *Classification of Microstructure Images of Metals using Transfer Learning*
$14^{30} – 14^{50}$	**Ahmad Rezaei, Johannes Richter, Johannes Nau, Detlef Streitferdt, Michael Kirchhoff** *Transparency and Traceability for AI-based Defect Detection in PCB Production*
$14^{50} – 15^{10}$	**Coffee break**
$15^{10} – 16^{30}$	**Papers presentation -** Chair **Dana Simian**
$15^{10} – 15^{30}$	**Tihomir Gyulov, Lubin Vulkov** *Gradient Optimization in Reconstruction of the Diffusion Coefficient in a Time Fractional Integro-Differential Equation of Pollution in Porous Media*
$15^{30} – 15^{50}$	**Sabina Surdu** *Enriching SQL-Driven Data Exploration With Different Machine Learning Models*
$15^{50} – 16^{10}$	**Kiril Alexiev, Nevena Slavcheva** *A Method for Target Localization by Multistatic Radars*
$16^{10} – 16^{30}$	**Monika Arya, Hanumat Sastry G** *Effective LSTM neural network with Adam optimizer for Improving Frost Prediction in Agriculture Data Stream*
$16^{30} – 17^{00}$	**Keynote Speaker** **Milan Tuba** *Recent Topics of Convolutional Neural Networks Applications*
18^{30}	**Conference dinner**

ABSTRACTS

Plenary Lectures

A Technology of Deciphering Old Cyrillic-Romanian

Dan Cristea

Alexandru Ioan Cuza University of Iaşi, Romania

Between the 16th century and the middle of the 19th, a unique Cyrillic alphabet has circulated on the territories of historical Romania, with slight variations in the shapes of graphemes or their phonetic values. As such, a huge bibliography of Cyrillic-Romanian texts has been accumulated in various libraries, while very few of these books have been transliterated by a small number of specialised linguists. The access of the large public of Romanian readers, interested in knowing these documents, is yet very restricted. This is why, an automatic deciphering of old Romanian documents from Cyrillic to Latin would be most welcome. I will present the DeLORo project (Deep Learning for Old Romanian), which aimed to build such a technology for printed and uncial Cyrillic-Romanian documents (not for manuscripts). In this talk I will describe the structure of DeLORo's data repository, which includes images of scanned pages, annotations operated collaboratively over them, and alignments between annotated objects in the images and (sequences of) decoded Latin characters. The primary data are used to train the deep learning recognition

technology. Since the manual annotation process is very time consuming and the density of characters is highly non-uniform in documents, I overview also a strategy for data augmentation that exploits a collection of documents entirely transcribed by experts in other involvements than our project. Different phases of processing are applied over the images of pages, combining binarization and partial blurring operations with segmentation of the page image, detection of objects (as rows of text and characters) and labelling of characters. I will also show some results, as they will be reported at the end of the project (October 2022), for character detection and recognition, in comparison with other approaches.

Autonomous Drones and Analogue Missions

Marcel Kyas

Reykjavik University, Reykjavik, Iceland

We report our involvement in an analog space mission testing unmanned aerial systems (UAS) intended for operating on Mars in Holuhraun, Iceland. Our goal in this mission was to test autonomous landing methods: the UAS has to find a suitable, safe landing site and land reliably. Iceland's lava fields, crevasses, and craters resemble the environment we expect on other planets. The environment allows us to experiment with revolutionary approaches to space exploration. At the same time, the mission allowed participating engineers, geologists, and computer scientists to express their views on mission design, equipment, and

programming. Many components of such systems are mission and safety-critical. Their failure jeopardizes the mission and may result in tremendous financial loss. For example, the Perseverance launch is estimated to cost $2.9 billion. Consequently, the developers take utmost care to avoid all potential issues and follow strict coding standards like MISRA. Their goal to ensure predictable and deterministic behavior is at odds with revolutionary developments. We want to use machine learning for landing site identification and autonomous control of unmanned vehicles in planetary environments. Those systems are often unpredictable. Our position is that machine learning can be used safely in space missions and avionics, provided that they are shown not to jeopardize the system's operations or supervised by deterministic components or prioritized modularization.

Inside Neural Networks

Detlef Streitferdt

Technische Universität Ilmenau, Germany

Machine learning became a prominent technology with artificial neural networks as its current and highly discussed model. Although the results of image analysis/recognition or speech detection are very promising the analysis of neural networks itself and their behavior is still a very hard task due to the complexity of the models. Even a single software neuron puts high demands on the assessment of software quality aspects. Current

models with thousands of interconnected neurons require by far more elaborated software tools and methods.

This talk gives a software engineering overview of the current state in analyzing neural networks within the software development life-cycle. It addresses the limits of using neural networks and emphasizes the corresponding pitfalls a software engineer has to cope with.

Recent Topics of Convolutional Neural Networks Applications

Milan Tuba

Singidunum University, Belgrade, Serbia

Artificial intelligence and machine learning algorithms have become a significant part of numerous applications used in various fields from medicine, and security, to agriculture, astronomy, and many more. In general, most of these applications require a classification algorithm, and often for the classification of digital images. Due to the wide need for classification methods and intensive study of the classification problem, numerous classification methods have been proposed and used. However, the convolutional neural networks have proven to be a far better method for certain classification problems and have brought some revolutionary changes in certain areas. Convolutional neural networks (CNNs) represent the type of deep artificial neural networks that due to preserving spatial correlation in inputs, manage to significantly improve signal classification accuracy, especially of digital images. Using, creating and training CNN is

a relatively simple task due to the various available software tools, but the problem with CNNs is finding the optimal configuration and architecture. Designing and tuning CNN represents a very challenging problem that should be dealt with in order to achieve the best possible results. The optimal CNN's configuration depends on the considered problem and one CNN that is good for one problem is not necessarily good for others. Finding the optimal configuration is not a simple task since there are numerous hyperparameters such as the number, type and order of layers, number of neurons in each layer, kernel size, optimization algorithm, padding, stride, and many others, that should be fine-tuned for each classification problem. There is no unique efficient method for finding optimal values of CNNs' hyperparameters. A commonly used method for setting the CNN's configuration is to guess good starting values and estimate better values for the hyper-parameters (guestimating). This method is simple but not the most efficient. Since this is an optimization problem, some recent studies tested different optimization metaheuristics such as swarm intelligence algorithms. Usage of swarm intelligence algorithms for finding CNNs' configuration can be time consuming but the improvement of the classification accuracy is significant. In this talk, the advantages and challenges of finding the optimal CNN configuration will be presented.

Regular Lectures

A Method for Target Localization by Multistatic Radars

Kiril Alexiev, Nevena Slavcheva

A method for target localization by multistatic radar system is proposed. Two cases are considered – 2D case and 3D case. 2D case considers targets located near ground level (such as low flying drones) and for which the z-coordinate can be ignored. The solution to the problem consists of finding the intersection points of ellipses. The problem is defined also in 3D space where the targets are located at a higher altitude that can‘t be neglected. A solution for finding intersection of ellipsoids is proposed. Target detection is realized by solving nonlinear systems of equations by using homotopy. After target detection target tracking should be realized with big variety of modern methods applicable in different scenarios/cases. The special attention should be paid on data association problem due to unknown labels of detected targets.

Keywords: *Multistatic Radars, MIMO Radar Systems, Target Detection.*

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

Monika Arya, Hanumat Sastry G

A country's economic progress would be impossible without the agriculture sector. The primary source of income for most countries is agricultural prod-ucts and related enterprises. Farming is heavily influenced by weather factors like the amount of sunlight, kind of precipitation, temperature of the air, rel-ative humidity, and speed of wind, as well as fluctuations in these factors. The temperature directly influences the metabolic reactions that take place in plants. For example, freezing damages plants to the point where they can-not grow (frost). Farmers have traditionally monitored the weather in the spring by watching television, reading the newspaper, or following a detailed weather forecast.

Farm sustainability and output can be improved through smart agriculture technologies. Precision Farming (PF) can help farmers deal with various en-vironmental issues instead of traditional agricultural approaches. It is possi-ble to monitor farming conditions using sensors installed in the farmland ar-ea. This system requires predictive systems to increase yield. There is much interest in the field of prediction. Farmers can prevent crop frost by using anti-frost measures, and this research come up with a smart deep learning-based system for agricultural frost forecasting.

This paper uses Long-Short Term Memory (LSTM) neural networks for the time series prediction of low temperatures. Additionally, the LSTM model is combined with an Adam optimizer to intensify the performance

of the pre-diction model. The suggested approach is also compared with LSTM when combined with other optimizers. The findings indicate that the proposed model excels base LSTM and LSTM with other optimizers.

Keywords: *Precision farming, Artificial intelligence, deep learning, smart agriculture, LSTM, IoT.*

Numerical Optimization Identification of a Keller-Segel Model for Thermoregulation in Honey Bee Colonies in Winter

Atanas Atanasov, Miglena Koleva, Lubin Vulkov

The present work is inspired by laboratory experiments providing measurements in a few places of the hive for a long period of time. Based on Keller-Segel model in form of coupled nonlinear parabolic equations for the local temperature T and the bee density $\rho \geq 0$, using the real data, we investigate numerically the thermoregulation in honey bee colonies in winter. We propose a numerical approach, based on conjugate gradient method into two stages: first, we solve a semilinear parabolic inverse problem to recover the density ρ and the temperature T. On the second stage we solve the strongly nonlinear convection-diffusion equation to recover again the density ρ. The numerical tests show the efficiency of the method at the calibration of thermoregulation model.

Keywords: *Keller-Segel model, honeybee thermoregulation, inverse problem, optimization, conjugate gradient method.*

Intrusion Detection by XGBoost Model Tuned by Improved Social Network Search Algorithm

Nebojsa Bacanin, Aleksandar Petrovic, Milos Antonijevic, Miodrag Zivkovic, Marko Sarac, Eva Tuba, Ivana Strumberger

Industry 4.0 flourished recently due to the advances in a number of contemporary fields, alike artificial intelligence and Internet of things (IoT). It significantly improves the industrial process and factory production, by relying on the communication between devices, production machines and equipment. The biggest concern in this process is the security, as each of the network-connected components is vulnerable to the malicious attacks. Intrusion detection is therefore a key aspect and the largest challenge. A novel framework is proposed in this paper that is based on the XGBoost machine learning model, that is optimized with a modified variant of the social network search algorithm. The proposed method has been evaluated on a benchmark intrusion detection dataset, and the experimental findings were put into comparison against the outcomes of other high performing algorithms for the same problem. Alongside the original version of the algorithm and other fused XGB solutions like harris' hawk optimization algorithm (HHO), firefly algorithm (FA), bat algorithm (BA), and artificial bee colony (ABC) were implemented and tested in the same way. The resulting comparative analysis suggests that the proposed approach obtained superior performance, and has shown a potential to be used in practice for intrusion detection. The standard evaluation system was established. The markers

for units were based on truthfulness and polarity for the case. Meaning, that true and false positives exist alongside the same negative counterparts. The results achieved from the formulation of these values into equations is visualized in the work allowing for a detailed comparison. Once again, showing the superiority of the proposed improved solution against other state of the art methods.

Keywords: *Intrusion detection, Swarm intelligence, XGBoost, Optimization, Social network search algorithm.*

Bridging the Resource Gap in Cross-lingual Embedding Space

Kowshik Bhowmik, Anca Ralescu

The mapping based methods for inducing a cross-lingual embedding space involves learning a linear mapping from the individ- ual monolingual embedding spaces to a shared semantic space where English is often chosen as the hub language. Such methods are based on the orthogonal assumption. Resource limitations and typological dis- tance from English often result in a deviation from this assumption and subsequently poor performance for the low-resource languages. In this research, we will present a method for identifying optimal bridge lan- guages to achieve better mapping for the low-resource languages in the cross-lingual embedding space. We also report Bilingual Induction Task (BLI) performances for the shared semantic space achieved using differ- ent cross-lingual signals.

Keywords: *Cross-lingual Word Embeddings, Low-resource Languages, Bilingual Lexicon Induction(BLI).*

A GENERALIZATION OF THE SEIR MODEL

Amelia Bucur, Dana Simian

Compartmental models, such as exponential models, SI, SIS, SIR, SEIRS, SEIAR, SEIAQR, MESIR models, or other generalized SIR models have been remarkable for studying the spread of epidemics. This paper has two main objectives: to suggest a generalization of the SEIR model for analyzing the spread of a disease with an example of simulation and to present conditions of existence for a solution to the proposed generalized SEIR model. The conclusions are that, generally, mathematical models show a value of a reproduction threshold, which can be used to forecast whether the pandemic will be increasing or decreasing.

Keywords: *Mathematical modeling, Simulation, Epidemiological dynamics, Systems of differential equations, Fixed points.*

Gaze Tracking: A Survey of Devices, Libraries and Applications

Edwin Cocha Tobanda, María Cristina Erazo, Sang Guun Yoo

Gaze tracking is a technological discipline that offers an alternative interaction between human and computer. A common solution based on gaze tracking has two elements: a hardware device to obtain data from

user's gaze and a library to process the gathered data. This work makes a formal analysis of previous works in gaze tracking. It presents the most used devices and libraries in gaze tracking solutions in the last 5 years as well as the most important characteristics of each of them. To fulfill this purpose, a search for articles related with eye tracking solutions was carried out in different scientific databases. After that, a classification of results was made, as well as a review of them. In addition, the article offers the areas of IoT in which gaze tracking has had the most influence. Finally, various selection criteria for devices and libraries are offered. These criteria are based on features such as price, technical performance and compatibility.

Keywords: *Gaze tracking, Eye tracking, IoT.*

Integrated system for sensing home hazards

Sorin Ionut Conea, Gloria Cerasela Crisan

Optional home insurance covers material losses due to major events that generate significant, including total, damage to the home. By installing and maintaining the presented system, disasters can be detected immediately and, in some cases, can be automatically mitigated. Homeowners could effectively reduce the hazards effects and massively downsize the recovery costs. The proposed integrated system is designed to be cheap and to have low exploitation costs.

Keywords: *Home Insurance, Arduino, Earthquake Detection, Flood Detection, Gas Detection.*

Analytical Solution of the Simplest Entropiece Inversion Problem

Jean Dezert, Florentin Smarandache, Albena Tchamova

In this paper we present a method to solve analytically the simplest Entropiece Inversion Problem (EIP). This problem consists in finding a method to calculate a Basic Belief Assignment (BBA) from the knowledge of a given entropiece vector which quantifies effectively the measure of uncertainty of a BBA in the framework of the theory of belief functions. We give an example of the calculation of IEP solution for a simple IEP case, and we show the difficulty to establish the explicit general solution of this theoretical problem that involves transcendental Lambert's functions.

Keywords: *Belief functions, Entropy, Measure of Uncertainty.*

Group Decision-Making Involving Competence of Experts in Relation to Evaluation Criteria: Case Study for e-Commerce Platform Selection

Zornitsa Dimitrova, Daniela Borissova, Rossen Mikhov, Vasil Dimitrov

The ongoing digital transformation focuses on adapting companies to new digital technologies. In the digital age, the IT market proposes a huge

amount of different software systems with a variety of capabilities. In this regard, the current article deals with the problem of evaluation and selection of the most appropriate e-commerce platform as a promising tool for improving business processes. For this purpose, groups of main evaluation criteria have been identified and an additional set of sub-criteria for each of them has been assigned. To form the final group decision, the decision makers' preferences are integrated in such a way to take into account each evaluation with different importance. This is done by formulation a new mathematical group decision model considering the differences in background experience, expertise, and qualifications of each decision maker. Instead of considering the weighted coefficient for the DM's expertise with equal importance towards all evaluated criteria, it is expressed by a vector representing the expertise of DM to each criterion. This allows for a more accurate assessment when forming the final group decision. In addition, a set of objective criteria have been defined, with filled-in normalized assessments of alternatives based on research of the options that are offered by the specific alternatives. The numerical testing demonstrates the applicability of the proposed mathematical model for group decision-making considering the decision makers' expertise expressed via a matrix of weighted coefficients over evaluation criteria.

Keywords: *Group decision-making, Multi-criteria decision analysis, Digital transformation, e-Commerce platforms.*

Gradient Optimization in Reconstruction of the Diffusion Coefficient in a Time Fractional Integro-Differential Equation of Pollution in Porous Media

Tihomir Gyulov, Lubin Vulkov

An optimization Lagrange multiplier adjoint equation approach for an inverse problem of estimating a space-dependent diffusion coefficient in a problem of pollution in a porous media is developed. The study is reduced to the reconstruction of the highest derivative coefficient of a time fractional integro-differential equation. The well-posedness of the direct problem is discussed and energy estimates for its solution are obtained. Formula for the gradient of the least-squares cost functional is derived by Lagrange multipliers method. The conjugate gradient method for the unknown diffusion coefficient is also discussed.

Keywords: *Integro-differential equation, Time-fractional derivative, Porous media, Tikhonov cost functional, Lagrange multiplier, Fréchet derivative, Conjugate gradient method.*

Generating Jigsaw Puzzles and AI powered solver

Stefan-Bogdan Marcu, Sabin Tabirca, Mark Tangney, Yanlin Mi, Venkata V B Yallapragada

This paper introduces a technique for generating realistic scrambled jigsaw puzzles and proposes a new solution for solving them. The problem was

selected because it resembles the more complex problem of protein to protein interaction. We discuss previous approaches to solving jigsaw puzzles, describe a way to generate new real life resembling scrambled jigsaw puzzles before proposing a new AI approach based on Deep Neural Networks for solving them.

Keywords: *Jigsaw Puzzle, Deep Neural Network, AI.*

Classification of Microstructure Images of Metals using Transfer Learning

Hafeez Khan Mohammed Abdul, Hrishikesh Sabnis, Angel Arul Jothi J., Kanishkha J., Deva Prasad A M

This research focusses on the application of computer vision to the field of material science. Deep learning (DL) is revolutionizing the field of computer vision by achieving state-of-the- art results for various vision tasks. The objective of this work is to study the performance of deep transfer learned models for the classification of microstructure images. With light optical microscopes, microstructure images of four different metals were acquired for this task, including copper, mild steel, aluminum, and stainless steel. The proposed work employs transfer learned powerful pre-trained convolutional neural network (CNN) models namely VGG16, VGG19, ResNet50, DenseNet121, DenseNet169 and DenseNet201 to train and classify the images in the acquired dataset into different classes of metals. The results showed that the transfer learned ResNet50 model has

obtained the highest accuracy of 99%, outperforming other transfer learning models. This also shows that DL models can be used for automatic metal classification using microstructure images.

Keywords: *Microstructure Images, Deep Learning, Transfer Learning, Convolutional Neural Network, Image Classification.*

Latent Semantic Structure in Malicious Programs

John Musgrave, Temesguen Messay-Kebede, David Kapp, Anca Ralescu

Latent Semantic Analysis is a method of decomposition used for discovering topics in natural language documents. This study uses Latent Semantic Analysis to analyze the composition binaries of malicious programs. The semantic representation of the term frequency vector representation provides a set of topics, each topic being a composition of terms. This semantic analysis provides a more abstract representation of the program derived from it's term frequency analysis.

Keywords: *Malware Analysis, Latent Semantic Analysis, Security.*

Is low-code the new high?

Marco Leon Olescu

For several decades, all the focus went into developing new and improved models for the algorithms that have been existing. Using the technological advancements, it was possible to implement more complex algorithms and reach a level where training and testing would take way less time. But now, as everything shifts into the wider picture, there comes the need for these systems to be used fast, without the need of complex modelling or design. Could it be that into the future the whole focus will be on deploying such complex models into easy-to-use frameworks that can be tested by fresh students as well as professional researchers?

Keywords: *AI, modelling, frameworks, low-code*

An empirical study of large transportation networks and solutions for the cost optimization

Cezar-Marian Papară

We all know how important transportation is nowadays - from one street to another, from one city to another, from one county to another, from one region to another, from one country to another, from one continent to another and this list can go on with examples. The question we ask ourselves is: Can we find a better way? A better solution? A more accurate way? A more efficient, faster route to travel? All things take more or less

time. All journeys matter. Whether you're going for a walk, on a trip, stuck in traffic on your way to work, have a small business and want to save money on bills, or you are one of the world's biggest entrepreneurs, for all of us, every second matters. That is why our transport, or our things, goods and so on, must be as efficient, accurate, correctly planned as possible, but at the same time safe. Nowadays, when everything is in a very accelerated continuous evolution, the efficiency and speed of achieving our goals are very important. There is a lot of emphasis on as little wasted time as possible and as many successes as possible. The expected productivity can only be achieved if all transport features are worked out with great care. Every little detail must be considered, mathematically, computationally, logically and chronologically, so that the overall result is the best, the most suitable, the most efficient for our problem.

This work aims to study some examples of transport networks, following their advantages and limitations, and looks for all kinds of solutions, ideas to improve and optimize their costs.

Keywords: *Transport network, Route, Time, Efficiency, Optimization.*

Morphology of Convolutional Neural Network with Diagonalized Pooling

Roman Peleshchak, Vasyl Lytvyn, Oleksandr Mediakov, Ivan Peleshchak

In the paper, we introduce the structure of a convolutional neural network with diagonalized pooling (DiagPooling). Existing deterministic poolings,

like max or average, cause loss of some critical information, which may be helpful for a further classification task. To minimize that loss, we propose an algorithm that considers information from all values over the pooling window via eigendecomposition. Eigendecomposition changes the basis to one in which the matrix of the pooling window has a diagonal form. Then DiagPooling yields the greatest diagonal element of the matrix, which corresponds to the greatest eigenvalue of the pooling window. The main difference between our idea and classical or PCA pooling methods is a change of basis without returning to it. Also, we suggest combinations of diagonalized pooling with normalization methods that increase models' performance compared to CNNs that use classical pooling layers.

Keywords: *Diagonalized pooling, Convolutional neural network, Matrix diagonalization, Eigendecomposition, Normalization methods.*

Flood simulation between Slănic and Vărbilău rivers in Vărbilău village, Prahova county, Romania using hydraulic modeling and GIS techniques

Cristian Popescu, Alina Bărbulescu

Flash flooding occurs in different hilly regions with circular shaped catch-ments across Europe, including Romania, when heavy rains or rapid melting of the snow are encountered. Vărbilău is a village in the Subcarpathian hills, susceptible to flash floods. In some situations, roads and buildings are af-fected. This study aims to analyze the flash flood from

the 22nd of July, 2018, compare it with the same phenomena formed at higher and lower flow rates, and determine the impact on settlements and roads. The research is done based on field observations, hydrological data from the Romanian Na-tional Institute of Hydrology, Geographic Information System (GIS) data-base, as well as by processing information in GIS environment (ArcMap 10.2.2) and hydraulic modeling in HEC-RAS 6.2. Data is imported in GIS and prepared for the flooding simulation in HEC-RAS. After the model is obtained based on flow values, the affected buildings and roads are quanti-fied in GIS. The area is prone to flooding. Upstream from the confluence the Slănic valley is much more affected than the valley of Vărbilău because the buildings are in the proximity of the river and the valley is narrow, while downstream from the confluence only two bridges and one county road are affected. The utility of protective levees is presented in the paper, while road accessibility for the emergency intervention authorities registers higher val-ues in the northern part.

Keywords: *Flood, Hydraulic Modeling, Settlements, Confluence, Rivers.*

Transparency and Traceability for AI-based Defect Detection in PCB Production

Ahmad Rezaei, Johannes Richter, Johannes Nau, Detlef Streitferdt, Michael Kirchhoff

Automatic Optical Inspection (AOI) is used to detect defects in PCB production and provide the end-user with a trustworthy PCB. AOI systems

are enhanced by replacing the traditional heuristic algorithms with more advanced methods such as neural networks. However, they provide the operators with little or no information regarding the reasoning behind each decision.

This paper explores the research gaps in prior PCB defect detection methods and replaces these complex methods with CNN networks. Next, it investigates five different Cam-based explainer methods on eight selected CNN architectures to evaluate the performance of each explainer.

In this paper, instead of synthetic datasets, two industrial datasets are utilized to have a realistic research scenario. The results evaluated by the proposed performance metric demonstrate that independent of the dataset, the CNN architectures are interpretable using the same explainer methods. Additionally, the Faster Score-Cam method performs better than other methods used in this paper.

Keywords: *PCB defect detection, Automatic optical inspection, Cam explainer methods.*

Tasks Management Using Modern Devices

Livia Sangeorzan, Nicoleta Enache-David, Claudia-Georgeta Carstea, Ana-Casandra Cutulab

Nowadays the people need tools that will help in their work and businesses. For this purpose, mobile applications have been developed for almost all domains, in order to have a quick access to information. The

architecture and the design of a mobile application is very important. When looking for the best mobile application architecture, the developers must choose between MVC, MVP and MVVM models. As a prove of concept we implemented a mobile application for task management that uses the MVC model, the most popular in the mobile app development. Generally, task management tools help the people to work efficiently and to organize their tasks. The aim of this paper is to analyze the advantages of using Java ME, XML, Firebase and its services in mobile applications development.

The conclusion is that these technologies are suitable for mobile task management applications implementation.

Keywords: *Application, Tasks Management, Activities.*

Determining the interactions between natural compounds and proteins using machine learning techniques

Corina Simian

Berberine is a natural product, an isoquinoline alkaloid present in different species of the Berberidaceae family and an important component of the Food Allergy Herbal Formula-2 (FAHF-2), a herbal mixture of traditional medicinal Chinese plants, which recently emerged as a promising candidate in the treatment of food allergies. In order to determine berberine's mechanism of action in food allergies a multitude of in vitro experiments have to be designed. Therefore, in order to understand the

possible interactions in a feasible time, other methods have to be explored. We are using deep learning techniques which take into consideration the binding affinity predictions, the tridimensional structure and chemical properties of the proteins to understand how berberine interacts with these proteins. Understanding such interactions will allow us to explore new classes of possible drugs, which inour case target the proteins which are main contributors to food allergies, and their mechanisms of actions.

Keywords: *Deep Learning, Protein.*

Overview of challenges and opportunities in Deep Learning driven Fashion and Textiles development

Dana Simian, Felix Husac

Creative industries were thought to be the most difficult avenue for Computer Science to enter and to perform well at. Fashion is an integral part of day to day life, one necessary both for displaying style, feelings and conveying artistic emotions, and for simply serving the purely functional purpose of keeping our bodies warm and protected from external factors. The Covid-19 pandemic has accelerated several trends that had been forming in the clothing and textile industry and with the large-scale adoption of AI and Deep Learning technologies, the fashion industry as at a turning point. Big Data, gathered by social media companies and direct user interaction with clothing brands both online and in physical stores is powering the new fashion revolution. AI is now in charge of supervising

the supply chain, manufacturing, delivery, marketing, targeted advertising and end-of-life support for garments and smart wearables, and they may soon replace designers too. Clothing for purely digital environments such as the Metaverse, different games and other on-line specific activities are niche with a huge potential for market growth. This article wishes to explain the post-Covid context and trends of the global fashion market, to provide a brief overview of the uses cases and challenges that manufacturers big and small currently face, the way Big Data and Machine Learning are used to solve important issues in the fashion industry and to explore the future of clothing and apparel design via artificial generative design. Generative models have been around on the Deep Learning scene for quite some time, but this paper aims to explore the new breakthroughs offered by the advent of GANs specifically, and briefly touch on a handful of other similar technologies, their advantages and shortcomings and to suggest and identify future research niches and possible improvements to the models explored in this paper.

Keywords: *GAN, Fashion Industry, Deep Learning.*

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Feature Selection and Extreme Learning Machine Tuning by Hybrid Sand Cat Optimization Algorithm for Diabetes Classification

Marko Stankovic, Nebojsa Bacanin, Miodrag Zivkovic, Dijana Jovanovic, Milos Antonijevic, Milos Bukmira, Ivana Strumberger

It is vitally important to establish a system that is able to provide an early detection of diabetes as a stealth disease of modern era. In order to achieve this goal, this manuscript proposes a novel framework for feature selection and extreme learning machine (ELM) hyperparameter optimization applied to diabetes diagnostics. Feature selection and hyper-parameter optimization are two of the most important challenges in the domain of machine learning and they both belong to the group of NP-hard challenges. To tackle these issues, an improved version of recently proposed sand cat swarm optimization (SCSO) is developed and adapted for ELM hyper-parameter tuning and feature selection. The presented method is implemented to calculate the optimal (sub-optimal) number of neurons for the ELM hidden layer, as well as to establish initial set of biases and weights. Furthermore, each swarm individual also tries to select the most relevant features for classification tasks against a widely utilized diabetes dataset. The performance of proposed methods was compared to other well-known state-of-the-art swarm intelligence algorithms in terms of accuracy, precision, recall and f1 score. Experimental findings

demonstrate that the improved SCSO is more efficient than other algorithms in addressing both challenges.

Keywords: *Machine Learning, Extreme Learning Machine, Sand Cat Optimization Algorithm, Metaheuristic Algorithms, Diabetes Classification.*

Enriching SQL-Driven Data Exploration With Different Machine Learning Models

Sabina Surdu

Nowadays we rely heavily on technology to understand the world around us. Databases and machine learning are key components in this endeavour. In the data exploration realm, users can have difficulties formulating the right queries for various reasons, e.g., the dataset has a large number of attributes, the user doesn't have a clear idea of what they're looking for in their data.

In our previous work, we aimed to bridge the gap between SQL and machine learning by providing the user who poses an SQL query with an answer set and a reformulation of their query, generated using the C4.5 decision tree algorithm.

We now investigate the use of three different machine learning models in a new experimental study and interaction paradigm: LightGbm, FastTree, and GAM. Upon posing an SQL query, the user is presented with: the answer set, three trained models along with a rich set of new metrics that

assess the models' quality, and the most important features for each model, computed with Permutation Feature Importance. By analyzing the metrics' results, the user can decide for themselves which model(s) they'll use further in their exploratory quest. Once a model is chosen, the user can formulate new SQL queries using some of the most important features for the model.

Keywords: *SQL Queries, Machine Learning, Data Exploration.*

Innovative lattice sequences based on component by component construction method for multidimensional sensitivity analysis

Venelin Todorov, Slavi Georgiev

Many challenges in the environmental protection exist since this is one of the leading priorities worldwide. Sensitivity analysis has a foundational role in the validating process of the large-scale computational air pollution models to guarantee their accuracy and reliability. The mathematical problem for the sensitivity analysis leads to computation of multidimensional integrals. In this paper for the first time we develop three new highly accurate lattice sequences based on component by component construction methods: construction of rank-1 lattice sequences with prime number of points and with product weights; construction of rank-1 lattice sequences with prime number of points and with order dependent weigh; construction of polynomial rank-1 lattice sequences in base 2 and with

product weights. Our methods show significantly optimized the results produced by the standard Monte Carlo algorithm and the most widely used lattice sequence. The obtained results will play an extremely principal multi-sided role.

Keywords: *Air pollution modelling, Lattice sequences, Sensitivity analysis.*

On an optimization of the lattice sequence for the multidimensional integrals connected with Bayesian statistics

Venelin Todorov, Slavi Georgiev

Lots of challenges in the Bayesian statistic exists since this is one of the fundamental discipline for neural network and machine learning. In this paper for the first time we develop three new highly accurate lattice sequences based on component by component construction methods: construction of rank-1 lattice rules with prime number of points and with product weights; construction of rank-1 lattice sequences with prime number of points and with product weight; construction of polynomial rank-1 lattice sequences in base 2 and with product weights. Our methods show significantly optimized the results produced by the standard Monte Carlo algorithm and the most widely used lattice sequence. The obtained results will play an extremely principal multi-sided role.

Keywords: *Multidimensional Integrals, Optimization of the Lattice sequences, Bayesian statistics.*

ML-based Solution for Emergency Room Triage

Andreea Vântu, Anca Vasilescu, Alexandra Băicoianu

In recent years, the appearance and evolution of artificial intelligence have generated increasing curiosity in machine learning applications for health care. With the expanding availability of clinical and, more recently, medicare data, it is extremely powerful for emergency medicine clinicians to understand computational techniques like machine learning models that are capable of handling and processing large quantities of complex data and identifying patterns. Without any doubt, there is a tremendous interest in the potential of machine learning solutions to enhance the quality of care in emergency medicine.

Generally, in clinical problems, there is a focus on complex correlation between targets and features and, particularly, the specific context of an emergency room triage is one of the most important decision nodes in a hospital since the process of triage may be prone to human errors due to overcrowding. Different machine learning models are compared here in order to provide a clinical decision support for patient classification with an emergency code. The theoretical and experimental results supply a web-based application for an improved triage flow.

Keywords: *Emergency Medicine, Triage, Clinical Decision Support, Supervised Learning, Neural Network, ROC-AUC, Precision Metric, Recall Metric, Confusion Matrix.*

Scalable execution of portable pipelines on the cloud with Tibanna

Alexander Veit

We present Tibanna, an open-source software tool for automated execution of computational pipelines on Amazon Web Services (AWS). Tibanna accepts reproducible and portable pipeline standards including Common Workflow Language (CWL), Workflow Description Language (WDL) and Docker. It adopts a strategy of isolation and optimization of individual executions, combined with a serverless scheduling approach. Pipelines are executed and monitored using local commands or the Python Application Programming Interface (API) and cloud configuration is automatically handled. Tibanna is well suited for projects with a range of computational requirements, including those with large and widely fluctuating loads. Notably, it has been used to process terabytes of data for the 4D Nucleome (4DN) Network.

Keywords: *Computational Pipelines.*

Gradient Optimization in Parameters Estimation for a Time Fractional Parabolic System of Fractured Porous Media

Lubin Vulkov

The simultaneous estimation of coefficients and initial conditions for model fractional parabolic systems of fractured porous media is reduced to

minimization of a least-squares cost functional . This inverse problem uses information about the pressures at finite number space points and times. The Frechet gradient of the cost functional is derived. The application of the conjugate gradient method for numerical parameter estimation is also discussed.

Keywords: *Parabolic system, Time-fractional derivative, Fractured porous media, Parameter estimation, Optimization, Gradient method.*

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