Lucian Blaga University of Sibiu, Romania

Faculty of Sciences

Research Center in Informatics and Information Technology

MDIS 2020

7th International Conference on

Modelling and Development of Intelligent Systems

Volume of Abstracts and Program

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Volume of Abstracts and Program

7th International Conference on

Modelling and Development of Intelligent Systems

Editor: Assist. Cristina Răulea

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), Regular Lectures (20 min) and Short presentation (10 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 systems

Specialists from Bulgaria, Egypt, France, Germany, Israel, Ireland, Qatar, Romania, Russia, Serbia, Slovenia, United Kingdom and United States join together to this seventh edition of the conference to present and discuss recent problems on mathematical models, design, development and applications of intelligent systems.

All submitted papers will undergo a thorough single - blind peer review; each paper will be reviewed by at least 3 independent experts in the field.

Paper acceptance and publication will be judged on the basis of their relevance to the conference topics, clarity of presentation, originality and accuracy of results and proposed solutions.

The MDIS conference respects Springer Editorial Policies:

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An author can register two (accepted) papers with one registration fee.

A post–conference proceedings containing selected refereed, presented and accepted articles, will be published by Springer Verlag in the series Communications in Computer and Information Science (CCIS).

CCIS is abstracted/indexed in DBLP, Google Scholar, EI-Compendex, Mathematical Reviews, SCImago, Scopus.

CCIS volumes are also submitted for the inclusion in ISI Proceedings.

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Prof. Dr. Dana Simian

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The official language of the conference is English.

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THURSDAY, October 22, 2020

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Modelling and Development of Intelligent Systems

organized by
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$9^{30} – 9^{50}$	**Opening ceremony**
$9^{50} – 10^{30}$	**Keynote Speaker** **Frank-Michael Schleif**, School of Computer Science University of Applied Sciences Würzburg-Schweinfurt, Germany *Learning in indefinite proximity spaces with applications for life science data*
$10^{30} – 11^{30}$	**Papers presentation -** Chair **Frank-Michael Schleif**
$10^{30} – 10^{50}$ $10^{50} – 11^{10}$ $11^{10} – 11^{30}$	**Klaus Schebesch, Ralf Stecking** *Improving credit client classification by using deep neural networks?* **Andreas E. Schütz, Tobias Fertig, Kristin Weber** *Defining a Core Ontology for Medical Devices in Germany to Ensure Semantic Interoperability* **Aleksandr Yurin, Nikita Dorodnykh** *Creating Web Decision-Making Modules on the Basis of Decision Tables Transformations*
$11^{30} – 11^{50}$	**Coffee break**
$11^{50} – 12^{50}$	**Papers presentation -** Chair **Nicolae Constantinescu**
$11^{50} – 12^{10}$ $12^{10} – 12^{30}$ $12^{30} – 12^{50}$	**Nikita Dorodnykh, Aleksandr Yurin** *TabbyLD: A Tool for Semantic Interpretation of Spreadsheets Data* **Florentin Bota, Dana Simian** *Embedding Human Behavior using Multidimensional Economic Agents* **Aine Curran, Tamara Vagg, Sabin Tabirca** *The Virtual Doctor: The Online Tool to Organise Unshedualed Visits for Cystic Fibrosis (Cf) Patients Using Machine Learning*

$12^{50} – 14^{00}$	**Lunch break**
$14^{00} – 14^{20}$	**Keynote Speaker** **Abdel-Badeeh M. Salem**, Founder & Head of Artificial Intelligence and Knowledge Engineering Research, Labs(AIKE-Labs) Faculty of Computer and Information Sciences, Ain Shams University, Cairo, Egypt *Artificial Intelligence in Smart Medical Systems*
$14^{40} – 16^{00}$	**Papers presentation –** Chair **Abdel-Badeeh M. Salem**
$14^{40} – 15^{00}$	**Adrian Florea, Teodora Vasilas** *Optimizing the Integration Area and Performance of VLIW Architectures by Hardware / Software Co-design*
$15^{00} – 15^{20}$	**Paul Brown, Marcello Contestabile, Raka Jovanovic** *A Mixed Integer Program for Optimizing the Expansion of Electrical Vehicle Charging Infrastructure*
$15^{20} – 15^{40}$	**Florin Stoica, Laura Florentina Stoica** *Integrated Tool for Assisted Predictive Analytics*
$15^{40} – 16^{00}$	**Sabin Pruna, Anca Vasilescu** *FitPi: Wearable solution for managing lifestyle choices and daily activity*
$16^{00} – 16^{20}$	**Coffee break**
$16^{20} – 18^{00}$	**Papers presentation –** Chair **Dana Simian**
$16^{20} – 16^{40}$	**Humam Majeed Al-Chalabi, Ufuoma Chima Apoki** *A Semantic Approach to Multi-parameter Personalisation of E-Learning Systems*
$16^{40} – 17^{00}$	**Zalan Bodo** *Fake news detection without external knowledge*
$17^{00} – 17^{20}$	**Atanas Atanasov, Slavi Georgiev, Lubin Vulkov** *Parameter Identification of Colony Collapse Disorder in Honeybees as a Contagion*
$17^{20} – 17^{40}$	**Jean Dezert, Florentin Smarandache** *Canonical Decomposition of Basic Belief Assignment for Decision-Making Support*
$17^{40} – 18^{00}$	**Radu Galan** *Automotive intelligent systems: Tunnel recognition using deep learning techniques*

FRIDAY, October 23, 2020

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$9^{30} - 10^{10}$	**Keynote Speaker** **Milan Tuba**, Singidunum University, Belgrade, Serbia *Artificial Intelligence for Digital Image Classification*
$10^{10} - 11^{30}$	**Papers presentation –** Chair **Milan Tuba**
$10^{10} - 10^{30}$	**Dana Simian, Ralf Fabian, Mihai Stancu** *Automatic watermark identification based on machine learning techniques*
$10^{30} - 10^{50}$	**Atanas Atanasov, Slavi Georgiev** *A Numerical Parameter Estimation Approach of the Honeybee Population*
$10^{50} - 11^{10}$	**Solomovich Lior** *Learning the subject of "big data" using a virtual escape room*
$11^{10} - 11^{30}$	**Dessislava Petrova-Antonova, Olga Georgieva** *Data-Driven Insights on Secondary Education: A Case Study on Teachers' Demography and Qualification*
$11^{30} - 11^{50}$	**Coffee break**
$11^{50} - 13^{10}$	**Papers presentation –** Chair **Daniel Hunyadi**
$11^{50} - 12^{10}$	**Eva Tuba, Peter Korosec, Tome Eftimov** *In-depth Insights into Swarm Intelligence Algorithms Performance*
$12^{10} - 12^{30}$	**Daniela Borissova, Zornitsa Dimitrova, Vasil Dimitrov** *Intelligent System to Support Decision Making using Different Optimization Business Models*
$12^{30} - 12^{50}$	**Stelian Ciurea** *Imperialist Competitive Algorithm to Determine the Parameters of a Mamdani Fuzzy Controller Used in the Regulation of a SISO (Single-input and Single-output) Second-order Linear System*
$12^{50} - 13^{10}$	**Elena Simona Nicoara** *Architectural Design Optimization: Not an Usual Optimization Process*

$13^{10} - 15^{00}$	**Lunch break**
$15^{00} - 15^{40}$	**Keynote Speaker** **Anca Ralescu**, University of Cincinnatit, Ohio, USA *On Explainable Artificial Intelligence*
$15^{40} - 16^{40}$	**Papers presentation** – Chair **Anca Ralescu**
$15^{40} - 16^{00}$ $16^{00} - 16^{20}$ $16^{20} - 16^{40}$	**Stefan Milosevic, Timea Bezdan, Ivana Strumberger,** **Miodrag Zivkovic, Nebojsa Bacanin, Raka Jovanovic, Milan Tuba** *Feed-forward Neural Network Training by Hybrid Bat Algorithm* **Johannes Richter, Johannes Nau, Michael Kirchhoff,** **Detlef Streitferdt** *KOI: An Architecture and Framework for Industrial and Academic Machine Learning Applications* **Diana-Georgiana Mocanu** *Machine Learning based Query Exploration*
$16^{40} - 17^{00}$	**Coffee break**
$17^{00} - 18^{40}$	**Papers presentation –** Chair **Dana Simian**
$17^{00} - 17^{20}$ $17^{20} - 17^{40}$ $17^{40} - 18^{00}$ $18^{00} - 18^{20}$ $18^{20} - 18^{40}$	**Alexander Veit** *Visualization of large quantitative datasets with HiGlass* **Monika Chandrasekaran, Anca Ralescu, D. Kapp, T. Kebede** *Context for API Calls in Malware vs Benign Programs* **Kowshik Bhowmik, Anca Ralescu** *Taking a Close Look at Twitter Communities and Clusters* **Valentin Gabriel Craciun, Matei Florin Graura** *A modified DICOM algorithm for medical images segmentation* **Corina Simian** *Applications of machine learning in protein phase separation*
$18^{40} - 18^{50}$	**Closing ceremony**

A B S T R A C T S

Plenary Lecture 1

Learning in Indefinite Proximity Spaces with Applications for Life Science Data

Frank-Michael Schleif
University of Applied Sciences Würzburg-Schweinfurt, Germany

Abstract: Life science data are often encoded in a non-standard way by means of alpha-numeric sequences, graph representations, numerical vectors of variable length or other formats. The majority of more complex data analysis algorithms require fixed length vectorial input data, asking for substantial preprocessing of non-standard input formats. Domain specific, non-standard proximity measures lead in general to so called indefinite measures and are widely ignored in favour of simple encodings. These encoding steps are not always easy to perform nor particular effective, with a potential loss of information and interpretability. We present some strategies and concepts of how to employ data-driven similarity measures in the life science context to obtain effectively prediction models.

Brief Biography of the Speaker: Frank-Michael Schleif (Dipl.-Inf, University of Leipzig, PhD, TU-Clausthal, Germany) was a Marie Curie Senior Research Fellow at the University of Birmingham, Birmingham, UK and a Post-Doctoral Fellow in the group of Theoretical Computer Science (TCS) at the University of Bielefeld, Bielefeld, Germany, where he also received a venia legendi in applied computer science in 2013. He was also a software developer and consultant for the Bruker Corp. Since 2016 he is with the University of Applied Sciences, Wuerzburg, Germany, where he is a Professor for Database Management and Business Intelligence. His current research interests include data management, computational intelligence techniques and machine learning for non-metric models and large scale problems. Several research stays have taken him to UK, the Netherlands, Japan and the USA. He is a member of the German chapter of the European Neural Network Society (GNNS), the GI and the IEEE-CIS. He is editor of the Machine Learning Reports and member of the editorial board of the Neural Processing Letters.

Plenary Lecture 2

Artificial Intelligence for Digital Image Classification

Milan Tuba

Singidunum University, Belgrade, Serbia

Abstract: Artificial intelligence represents one of the leading research fields and the source of major progress in various fields such as medicine, autonomous vehicles, security, agriculture, etc. One of the common problems that are solved by AI methods is classification. A great improvement in solving this task was achieved by convolutional neural networks, a special class of deep neural networks that considers the spatial correlation of input data rather than just plane data. They are used for digital image classification, voice recognition, EEG signal analysis and classification, etc. The results achieved by the CNN are significantly better in comparison with the previously existing methods. One of the challenges with CNN is finding the network architecture that has the best performance for the specific application. Numerous hyperparameters such as the number of different layers, number of neurons in each layer,

optimization algorithm, activation functions, kernel size, optimization algorithm, etc. have to be tuned. In many cases, CNN's configuration is set by guessing and estimating (guestimating) better values for the hyperparameters but recent studies showed promising results when using swarm intelligence algorithms for solving this hard optimization problem. A few examples of using swarm intelligence algorithms for convolutional neural network hyperparameter tuning will be presented.

Brief Biography of the Speaker:

Milan Tuba is the Vice Rector for International Relations at Singidunum University, Belgrade, Serbia and was the Head of the Department for Mathematical Sciences at State University of Novi Pazar and the Dean of the Graduate School of Computer Science at John Naisbitt University. 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. first 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 scientific projects and theses supervisor. From 1994 he was Assistant Professor of Computer Science and Director of Computer Center at University of Belgrade, from 2001 Associate Professor, Faculty of Mathematics, University of Belgrade, from 2004 also a Professor of Computer Science and Dean of the College of Computer Science, Megatrend University Belgrade. He was teaching

more than 20 graduate and undergraduate courses, from VLSI Design and Computer Architecture to Computer Networks, Operating Systems, Image Processing, Calculus and Queuing Theory. His research interest includes nature-inspired optimizations applied to computer networks, image processing and combinatorial problems. Prof. Tuba is the author or coauthor of more than 200 scientific papers and coeditor or member of the editorial board or scientific committee of number of scientific journals and conferences. He was invited and delivered around 60 keynote and plenary lectures at international conferences. Member of the ACM, IEEE, AMS, SIAM, IFNA.

Plenary Lecture 3

Artificial Intelligence in Smart Medical Systems

Abdel-Badeeh M. Salem
Ain Shams University, Cairo, Egypt

Abstract: Artificial Intelligence (AI) is devoted to create intelligent computer software and hardware that imitates the human mind. The main goal of AI technology is to make computers smarter by creating software that will allow a computer to mimic some of the functions of the human brain in selected applications. Advances in AI paradigms and smart healthcare systems (SHS) domains highlight the need for ICT systems that aim not only in the improvement of human's quality of life but at their safety too. SHS are intelligent systems and based on the concepts, methodologies and theories of many sciences, e.g. artificial intelligence, data science, social science, information science, computer science, cognitive sciences, behavioral science, life sciences and healthcare. The well-known smart healthcare paradigms are: Real-time monitoring devices, Computer-aided surgery devices, Telemedicine devices, Population-based care devices, Personalized medicine from a machine

learning perspective, Ubiquities intelligent computing, Expert decision support systems, and Health 2.0. and Internet of Things (IoT). On the other side, AI can support many tasks and domains e.g. law, education, healthcare, economy, bussines, life sciences, environment, energy and military applications. All of these applications employ knowledge base and inferencing techniques to solve problems or help make decisions in specific domains. This talk discusses the potential role of the AI paradigms, computational intelligence and machine learning techniques which are used in developing the SHS. The talks focus on the AI methodologies and their potential usage in recent trends in developing the smart healthcare and intelligent systems. The following three paradigms are presented: (a) ontological engineering, (b) case-based reasoning, and (c) data mining. Moreover the talk presents, the research results of the author and his colleagues that have been carried out in recent years at Ain Shams University AIKE-Labs, Cairo, Egypt.

Brief Biography of the Speaker: Abdel-Badeeh M. Salem is a full Professor of Computer Science since 1989 at Ain Shams University, Egypt. His research includes biomedical informatics, big data analytics, intelligent education and learning systems, information mining, knowledge engineering and biometrics. He is founder of the Artificial Intelligence and Knowledge Engineering Research Labs, Ain Sham University, Egypt and Chairman of Working Group on Bio-Medical Informatics, ISfTeH, Belgium. He has published around 550 papers (105 of them in Scopus). He has been involved in more than 600 international conferences and workshops as a keynote and plenary speaker, member of Program

Committees, Workshop/Session organizer, Session and Tutorials Chair. In addition he was in the Editorial Board of 50 international and national Journals. He is a member of many international scientific societies and associations: elected member of Euro Mediterranean Academy of Arts and Sciences, Greece; member of Alma Mater Europaea of the European Academy of Sciences and Arts, Belgrade and member of European Academy of Sciences and Arts, Austria.

Plenary Lecture 4

On Explainable Artificial Intelligence

Anca Ralescu
University of Cincinnatit, Ohio, USA

Abstract: In recent years, 'explainable AI' has become one of the most often phrases used in connection with Artificial Intelligence. What does this phrase mean, and what developments in AI made it necessary? This talk aims to discuss these questions through a historical perspective on the field of Artificial Intelligence, and the newer disciplines related to it, Machine Learning and Deep Learning.

Brief Biography of the Speaker: Born and raised in Fagaras, Romania, Anca Ralescu graduated from the University of Bucharest, and Indiana University, Bloomington, where she obtained a PhD in Mathematics. She is currently professor of Computer Science in the EECS Department, University of Cincinnati. Her main interests are in intelligent systems, including Artificial Intelligence, Fuzzy Systems, Machine Learning, with applications to computer vision and image understanding.

Regulary Lectures

A Semantic Approach to Multi-parameter Personalisation of E-Learning Systems

Humam Majeed Al-Chalabi, Ufuoma Chima Apoki

This paper presents a model framework for achieving semantic adaptation in e-learning systems using multiple parameters for personalisation. The proposed model, which utilises semantic technologies, aims to boost learning experiences and outcomes within the process of learning. This is often achieved through a mechanism that adapts the educational contents of a course in keeping with student's preferences expressed by multiple parameters (such as their learning styles, media preferences, level of data, language, etc.). The variation process involves real-time mapping of learning resources and student data, semantic annotation, metadata enrichment of learning resources, creation of student profile with relevant preferences, and personalisation of every course in step with the foremost suitable (or preferred) parameters. Achieving this entailed the creation of an ontology and several other modules that work in the background of the adaptive process.

Keywords: *E-learning Systems, Adaptive Learning, Semantic Web Ontologies, Adaptive Educational Systems.*

A Numerical Parameter Estimation Approach of the Honeybee Population

Atanas Atanasov, Slavi Georgiev

In this study we aim to solve an inverse, or coefficient identification problem for honeybee population dynamics. The model we consider is a weakly coupled system of two nonlinear ordinary differential equations (ODEs) with dependent variables: the total number of bees and the number of bees that work outside the hive referred here as foragers. To recover the constant parameters, we minimize a quadratic discrete cost function, which expresses the difference between the computed and the measured numbers of bees. We present an efficient simple algorithm to solve the inverse problem using numerical optimization via the Trust-Region-Reflective method. To verify the convergence of the algorithm, we suggest particular statistical metrics to be analyzed. Ample computational results, demonstrating the capabilities of the approach, including the possibility to work with noisy measurements, are presented and discussed.

Keywords: *Honeybee Population Dynamics, Parameter Estimation, Cost Function Minimization.*

Parameter Identification of Colony Collapse Disorder in Honeybees as a Contagion

Atanas Atanasov, Slavi Georgiev, Lubin Vulkov

The Colony Collapse Disorder (CCD) is a major problem of honeybee farms because of the massive decline in the colony numbers. The CCD model considered is described by a system of three ordinary differential equations that account for multiple hive population behaviour patterns including colony collapse, environmental issues and Allee effects. The population dynamics is studied by numerical algorithms to solve the parameter identification problem of the model. Computational experiments demonstrate the capabilities of the numerical approach. Moreover, the numerical analysis suggests the farmer about the role of accelerated forager recruitment in employing hives during a colony collapse.
Keywords: *Honeybee Population Dynamics, Colony Collapse Disorder, Allee Effect, Parameter Identification, Cost Function Minimization.*

Taking a Close Look at Twitter Communities and Clusters

Kowshik Bhowmik, Anca Ralescu

The rise in the popularity of Social Networking Sites has made Community Detection in such networks a major research interest. The edges connecting the entities in the network are the principal foci in graphical community detection. At the same time, large volume of data is

produced on these Social Networking Sites, a large portion of which being text data. Document Clustering methods utilize the textual properties of text documents to cluster similar documents together while separating dissimilar documents. This paper treats text data collected from Twitter as a set of documents. The clusters produced by the document clustering methods are associated with the respective users. These clusters are then compared with the communities detected in the graphical representation of the network generated from the users and the relationships between them. NodeXL was used to collect data from Twitter while Gephi was used for visualizing the collected dataset. Different feature representation and clustering methods were applied for clustering the tweets (documents) and in turn the users associated with them.

Keywords: *Community Detection, Document Clustering, Social Media Mining.*

Fake News Detection Without External Knowledge

Zalán Bodó

Although written deception is not a new invention, the emergence and progress of electronic media -and more recently social media- has changed the speed and extent of access to information in a good way, but at the same time facilitating the proliferation of disinformation as well. Automatic veracity determination, therefore, became a widely studied problem in the last years. We claim that without using a knowledge base

and fact-checking, that is based solely on textual content features one cannot truly fight this phenomenon, nevertheless, such a deception detection system can be used beneficially in certain situations. In the present study we apply text categorization methods to detect fake news without involving any external knowledge base (e.g. lexicons, unlabeled corpora, pre-trained word vectors, etc.). We employ traditional bag-of-words and more recent end-to-end neural network models, and evaluate them on eight -five smaller and three larger- fake news datasets. The experimental results show that one can attain considerably precise detection performance, in some cases even in the very close vicinity of the perfect F1 score, using solely the labeled data. We also strive to explain why some of these approaches imply a better performance than others.

Keywords: *Fake News Detection, Text Categorization, Machine Learning.*

Intelligent System to Support Decision Making using Optimization Business Models for Wind Farm Design

Daniela Borissova, Zornitsa Dimitrova, Vasil Dimitrov

In the digital age, all successful business processes depend on well-motivated and effective decision-making. To be more precise, these effective decisions are to be based on properly formulated mathematical models. To achieve such decisions a framework of an intelligent system to support decision-making is proposed. The proposed framework relies on the effective integration of multi-attribute group decision making models

(MAGDM) and mathematical optimization models (single or multi-objective). While the MAGDM models contribute to the determination of the most preferred alternative by aggregation different points of view of the group experts, the goal of using the optimization models aims to determine the effectiveness of the selected alternative. The described framework is applied for the selection of wind turbine types for designing a wind farm. The efficiency of the designed wind farm is evaluated by using an optimization model. It is shown that in some cases the selected preferred turbine type leads to less wind farm performance taking into account the particular farm area and wind conditions.

Keywords: *Decision-making, MAGDM, business optimization models, renewable energy, wind turbine selection.*

Embedding Human Behavior Using Multidimensional Economic Agents

Florentin Bota, Dana Simian

This paper contributes to the design of realistic autonomous agents which can simulate the human behavior and respond to multiple factors such as impulse, emotions, social inuences, etc.

Therefore, "Multidimensional" Agents (MA), embedding several human social features and evolving in time should replace the perfectly rational agents when modeling complex systems which imply human behavior. The features of a MA are dependent on the system we want to model. In

this paper we will refer to the design of Multidimensional Economic Agents (MEA).

We propose a stochastic evolutionary algorithm for the evolution of MEA in a dynamic environment, which takes into account the fairness behavior and the community inufluence as social features. The fairness concept is an anomaly of the standard "homo economicus" model, where the agents are completely rational and self-interested. We used a bottom-up, data-driven approach to find a new fitness function to develop agents which can play the economics experiment called "Ultimatum Game". In order to simulate the human behavior in agent decision we introduced a neural network component.

We used human experiments and simulations to illustrate the effectiveness of our approach.

Keywords: *Multi-agent systems, Evolution strategies, Machine learning.*

A Mixed Integer Program for Optimizing the Expansion of Electrical Vehicle Charging Infrastructure

Paul Brown, Marcello Contestabile, Raka Jovanovic

In recent years there has been a growing interest in the use of electric vehicles. This has resulted in the need to develop the necessary charging infrastructure. In this paper, the issue of optimizing the locations and capacity of charging stations is analyzed through the evaluation of its expansion. This is achieved using a model based on a mixed integer program. Since this is a highly practical problem, one of the main focuses

of this work is in using real world data like population density and the state of the electrical distribution system. An efficient approach is proposed for acquiring such data and its integration into the model. The developed model is used for evaluating the expansion of EV charging infrastructure for the cities of Doha and San Francisco.

Keywords: *Mixed Integer Programming, Electrical Vehicles, Charging Infrastructure.*

Context for API Calls in Malware vs Benign Programs

Monika Chandrasekaran, Anca. Ralescu, David Kapp, Temesgen Kebede

The current progress in computer technology is matched by the increase in the malware and cyber-attacks, resulting in a nearly constant battle between establishing a complete malware detection technique and newly evolving smart malicious code. The analysis of malware is made difficult by the fact that, to a large extent, malware and benign code use the same instructions. This suggests that the difference in behavior might be due not to the instructions used, but in *how* they are used. In particular, the context in which instructions are used seems to play an important role in deciding between malicious and benign code. This work describes progress towards defining and extracting the *context* of API from Portable Execution files of the Windows operating system. It is suggested that the context can be used as a feature in a machine learning algorithm towards identifying attempts

to corrupt the system and to elude the antivirus scanners through code obfuscation.

Keywords: *API Calls, Context, Malware, Skip-gram Model.*

Imperialist Competitive Algorithm to Determine the Parame-ters of a Mamdani Fuzzy Controller Used in the Regulation of a SISO (Single-input and Single-output) Second-order Linear System

Stelian Ciurea

We have implemented a fuzzy controller with a view to regulating a single-input and single-output second-order linear system. To determine the parameters of the fuzzy controller we have used an imperialist competitive algorithm.

Keywords: *Second-order automated regulating system, Fuzzy Controller, Imperialist Competitive Algorithm.*

The Virtual Doctor: the Online Tool to Organise Unscheduled Visits for Cystic Fibrosis (Cf) Patients Using Machine Learning

Aine Curran, Tamara Vagg, Sabin Tabirca

It has been predicted that there will be an influx in the number of adult Cystic Fibrosis (CF) patients over the next five years. This increase will add further strain to the currently overworked system. Patients with CF are required to meet with their Multidisciplinary Team (MDT) approximately

every four months. If a patient has any health-related concerns in-between these appointments, they need to undergo a phone evaluation. These phone calls can be sporadic and require a member of the MDT to be on hand causing a strain on resources and time. The Virtual Doctor project aims to reduce this effect by creating an online evaluation service, where patients interact with the Virtual Doctor using speech recognition and speech synthesis technologies within their own web browser. The Virtual Doctor will work by generating a report from the patient's visit which is then evaluated and sent to the MDT to action. The patient will also be given feedback from the visit which outlines when the team will be in contact. This paper will discuss the design requirements that need to be met for both the CF patient and the MDT, as well as the implementation of the Virtual Doctor tool. The tool has also been placed under a pilot study with 12 participants, where their experience using the tool was rated. The overall results were positive which shows that this tool may benefit both patients and medical staff allowing patients to learn about their own condition and health status while improving time and resource management.

Keywords: *Virtual Doctor, 3D Avatar, Machine Learning, Text-To Speech, Speech Recognition, Interactive.*

Canonical Decomposition of Basic Belief Assignment for Decision-Making Support

Jean Dezert, Florentin Smarandache

We present a new methodology for decision-making support based on belief functions thanks to a new theoretical canonical decomposition of dichotomous basic belief assignments (BBAs) that has been developed recently. This decomposition based on proportional conict redistribution rule no 5 (PCR5) always exists and is unique. This new PCR5-based decomposition method circumvents the exponential complexity of the direct fusion of BBAs with PCR5 rule and it allows to fuse quickly many sources of evidences. The method we propose in this paper provides both a decision and an estimation of the quality of the decision made, which is appealing for decision-making support systems.

Keywords: *Decision-Making, Belief Functions, PCR5.*

TabbyLD: A Tool for Semantic Interpretation of Spreadsheets Data

Nikita O. Dorodnykh, Aleksandr Yu. Yurin

Spreadsheets are one of the most convenient ways to structure and represent statistical and other data. In this connection, automatic processing and semantic interpretation of spreadsheets data have become an active area of scientific research, especially in the context of integrating this data into the Semantic Web. In this paper, we propose a TabbyLD tool for semantic interpretation of data extracted from spreadsheets. Main features of our software connected with: (1) using original metrics for defining semantic similarity between cell values and entities of a global knowledge graph: string similarity, NER label similarity, heading similarity, semantic similarity, context similarity; (2) using a unified canonicalized form for representation of arbitrary spreadsheets; (3) integration TabbyLD with the TabbyDOC project's tools in the context of the overall pipeline. TabbyLD architecture, main functions, a method for annotating spreadsheets including original similarity metrics, the illustrative example, and preliminary experimental evaluation are presented. In our evaluation, we used the T2Dv2 Gold Standard dataset. Experiments have shown the applicability of TabbyLD for semantic interpretation of spreadsheets data. We also identi_ed some issues in this process.

Keywords: *Semantic Table Interpretation, Annotation, Spreadsheet Data, Entity Linking, Linked Data, Knowledge Graph, Dbpedia.*

Optimizing the Integration Area and Performance of VLIW Architectures by Hardware / Software Co-design

Adrian Florea, Teodora Vasilas

The cost and the performance are major concerns that the designers of embedded processors shall take into account, especially for market considerations. In order to reduce the cost, embedded systems rely on simple hardware architectures like VLIW (Very Long Instruction Word) processors and they look for compiler support. This paper aims at developing a design space explorer of VLIW architectures from different perspectives like processing performance and integration area. A multi-objective Genetic Algorithm (GA) was used to find the optimum hardware configuration of an embedded system and the optimization rules applied by compiler on the benchmarks code. The first step consisted in representation of the architectural configurations into chromosomes of GA, mapping each architectural parameter or feature into a gene. Each chromosome from a population is a configuration file, and each gene of that chromosome is the value of an architectural parameter (machine and memory hierarchy) or compiler optimization option. The population is composed from a fixed number of such of chromosomes or individuals. The fitness functions of chromosomes (the processing performance - Instructions per Cycle and the integration area of embedded system) used by NSGA-II algorithm for determining the dominated and non-dominated individuals are obtained after the simulations of architectural

configurations on different benchmarks of the standard MiBench suite. CACTI tool was used to measure the area of the caches as component of embedded system integration area.

Keywords: *Design Space Exploration (DSE), Area and Performance Efficiency, Evolutionary Algorithms, VLIW Architectures, NSGA-II.*

Learning the subject of "big data" using a virtual escape room

Lior Solomovich

The Corona period created great challenges in the teaching and learning process. This presentation describes a research based on studying the subject of big data using virtual escape rooms. Due to the period it was decided that the final task in the Big Data course would be to build a virtual escape room that deals with a topic from the world of Big Data. The aim of the study was to examine how the understanding of various topics related to Big Data is sharpened when they are taught through virtual escape rooms. Each group of students chose a topic from the world of big data and built a virtual escape room around it. Peer learning was then performed, and each group edited rooms of other groups, so that each group learned about a variety of topics related to the big data world. By monitoring peer learning it was possible to assess the nature of the learning process experienced by the group. This unique learning allows for flexibility in terms of time and place in holding meetings. The interactions

between the various group members contribute to enrichment the knowledge and the development of creative ideas.

According to the results of the study, this type of learning sharpened different skills among the participants - social, communicative and thinking. It also developed a deep understanding when the escape room practically demonstrates the topic of big data in an optimal way through a variety of representations. During the activity in the escape room there is created an interesting and original connection between the materials and the ideas, open to a variety of interpretations. Digital tools are used effectively and creatively that contribute to understanding the message (Kemp, 2018).

The idea of learning through play is not new, but it gets better over the years and even expands into higher education. The themes of the escape rooms are very diverse, the challenge levels are varied, and the activity includes a frame story that the participants become acquainted with before entering the room (Nicholson, 2018). In the presentation, I will detail and demonstrate how the game "Escape Room on the subject of Big Data" can be used as an innovative pedagogical tool that allows a deep understanding of the subject of Big Data.

Feed-forward Neural Network Training by Hybrid Bat Algorithm

Stefan Milosevic, Timea Bezdan, Miodrag Zivkovic, Nebojsa Bacanin, Ivana Strumberger, Milan Tuba

Artificial neural networks are very powerful machine learning techniques and they are capable to solve complex problems. In the artificial neural network, one of the most dificult challenges is to _nd the optimal values of the weights during the learning process. To address this issue, we propose a new hybridized metaheuristic method, called BAABC for weight connection optimization. The experiments are per- formed on two binary classification datasets. The obtained results are compared to other similar approaches where other metaheuristics are used. The obtained results show that the proposed algorithm can find the optimal weight connection values and achieve higher performance and the proposed BAABC outperformed the other methods.

Keywords: *Artificial Neural Network, Metaheuristics, Algorithm Hybridization, Bat Algorithm, Artificial Bee Colony.*

Machine Learning based Query Exploration

Diana-Georgiana Mocanu

With the continuous advances in technology, we can observe an increase in the rate at which we acquire new information. Compared with the previous decades, in today's world, we have access to a volume of data on the order of zettabytes. Therefore, scientists find it more challenging to interact with structured databases and implicitly to write relevant and concise SQL queries that will uncover relevant results.

Starting from an initial query, given as input by the user, we will further generate the so-called negated query. The tuples resulted from the execution of this query will be the ones that are undoubtedly unwanted by the user. There are multiple possible ways of building the negation relative to the number of initial conditions. With the help of a machine learning algorithm, that uses the labeled dataset obtained from the positive and negative sets, we can rewrite a different and improved query. This will contain all the initial positive tuples but also some new, very similar ones. The initial search could be expanded from an intuitively written query to a more inclusive one that will select similar tuples with less intuitive feature values. Through this method the user could potentially highlight less important feature correlations and even uncover hidden patterns in the dataset. Most importantly this could be achieved without any knowledge of the logic behind the actual features.

Keywords: *Query Exploration, Query Rewritten, Pattern Mining.*

Architectural Design Optimization: Not an Usual Optimization Process

Elena Simona Nicoara

Whereas optimization dowry is vastly and efficiently applied to many areas, both on academic and practice level, it had a poor influence on the architectural design practice. The complexity of such problems goes beyond the large number of constraints, decision variables and objective functions and beyond the difficulty of an accurate quantification of the customer's intentions. Not all the objectives are known in advance, the design progresses by incorporating constraints and objectives in stages, there is a continuous co-evolution between the problem formulation and the solution space and so on. All these characteristics made up of architectural design an interesting and challenging field of study through optimization glasses. In search of a better design (achieved by an architect), the constant seems to be a continuous travelling on different type problem-formulation spaces, which are vast, complex and significantly interdependent one with each other. The perspectives of classical optimization and of architectural design prove to be very different; therefore special approaches, such as machine learning and other artificial intelligence techniques are more appropriate to tackle architectural design, even if the results obtained so far are still limited in performance. The paper integrates the course of action made by researchers and practitioners in finding adequate approaches for modeling

and solving architectural design optimization. By that, it constitutes an interesting learning experience with unusual optimization contexts.

Keywords: *Architectural Design, Optimization, Machine Learning.*

Data-Driven Insights on Secondary Education: A Case Study on Teachers' Demography and Qualification

Dessislava Petrova-Antonova, Olga Georgieva

The paper presents an application approach based on Big Data Value Chain concept to data collected for teachers' demography and qualification. The proposed approach discovers and further enables to account for the teacher aging as a sensitive factor of the education process. The first step of the study ensures a reliable and holistic dataset by careful preprocessing of the raw data. Different types of data analysis have been applied in the analytical step. As the statistical analysis was not able to discover all existing relations a non-trivial approach was proposed to discover models and connections of the three main teachers' age groups. The analysis of linked data enriches the retrieved information by getting more insight at the relation between the teachers' groups and the municipality of the school they teach. By describing education tendencies and by modeling the significant dependencies of the teachers' age groups the proposed approach enables to reveal information useful for policies making.

Keywords: *Big Data Value Chain, Secondary Education, Data Analytics.*

FitPi: Wearable solution for managing lifestyle choices and daily activity

Sabin Catalin Pruna, Anca Vasilescu

This paper proposes a way to simplify the means through which a person could monitor not only their daily activity such as active minutes, counted steps, heart rate etc. (something which is already available owing to a multiple of wearables on the market), but also their lifestyle (finance, nutrition, work schedule). The FitPi project consists of a solution build using micro services and cloud infrastructure which exposes an interface to the user through a website and a wearable application hosted on the Fitbit ecosystem; with which the user may analyze and edit data for the aforementioned features. The end goal was to provide a central hub to aggregate data related to all routines of one's daily activity, thus providing more functionality to the wearable market.

Keywords: *Wearable, Lifestyle Management, Tracking.*

KOI: An Architecture and Framework for Industrial and Academic Machine Learning Applications

Johannes Richter, Johannes Nau, Michael Kirchhoff, Detlef Streitferdt

A novel framework is presented, which simplifies the integration of machine learning into systems for industrial inspection and testing. In contrast to most approaches utilizing a centralized setup, the proposed work follows an edge-computing paradigm. The scope is not limited to

inspection tasks but includes all requirements connected to such tasks. The support for continual and distributed learning, as well as distributed accumulation of training data, is a crucial feature of the proposed system. An integrated user rights management allows for the collaboration of multiple people with different background of expertise and tasks on the same machine learning models. Through platform-independent design and the use of a progressive web app as a user-interface, this framework supports the deployment in heterogeneous systems. Separation of concerns and clean object-oriented design makes the framework highly extensible and adaptable to other domains.

Keywords: *Machine Learning, Deep Learning, Software Architecture, Distributed Learning, Industrial Machine Learning, Edge Computing.*

Improving Credit Client Classification by Using Deep Neural Networks?

Klaus B. Schebesch, Ralf W. Stecking

Credit client classification which is useful for building models to forecast probable defaulting behavior is of obvious practical importance and interest. There are many technical alternatives in order to achieve this goal. A huge variety of *statistical learning* and *nature inspired* black-box techniques where used to search through different classification templates and to apply many kinds of numerical adaptation. Combinatorial rule complexity was traded for massive parameterization. Retraction to computationally less demanding techniques followed and was generally

well received by financial practitioners. Explainable modeling also grew in demand. This promised to change with the arrival of deep Neural Networks (dNN), a revival of the repeatedly deprecated classical neural nets, but now with essential improvements in its computational structures at the implementation side and also with some conceptual advances. Using two credit client data sets of different sizes and structure we show which out-of-sample performance measure can be consistently improved by dNN and to what extend manual tuning and modeler's decisions may be delegated to automatic modeling process. We compare these new models to our best performing models published in the past, which were obtained using the same input data.

Keywords: *Classification Models, Deep Neural Networks, ROC-AUC Criterion, Client Behavior.*

Defining a Core Ontology for Medical Devices in Germany to Ensure Semantic Interoperability

Andreas E. Schűtz, Tobias Fertig, Kristin Weber

To manage the data of medical devices, systems have to fulfill high demands. These high demands are due to the legal requirements for medical devices and due to specific needs of users of these information. Furthermore, the lack of semantic interoperability prevents a centralized provision of high-quality data sets. The goal of our project was to develop an ontology for medical devices, and to derive a UML data model from our ontology. For this purpose, the approach "Ontology Development 101"

was used. Based on the German law for medical devices and expert interviews, we could identify relevant domain topics and terms. Subsequently, we used the language OWL to define classes, properties and constraints for the ontology. Afterwards, the ontology was translated into a UML data model using an already defined set of rules. This led to the final hypothesis that semantic interoperability between hospital information systems can be achieved when using the ontology.

Keywords: *Medical Devices, Ontology, Semantic Interoperability, Semantic Web.*

Applications of machine learning in protein phase separation

Corina Simian

Recently, it has been found that protein phase separation is connected to various disease. Such implications were explored especially in neurodegenerative diseases like the Alzheimer disease, where tau and amyloid-β are intrinsically disordered proteins that can self-assemble and lead to aggregation and further on to insoluble structures that are associated with the loss of neuronal function.

Therefore, it is important to determine such proteins that can lead to aggregation so that we can further study their properties and how this process can be targeted. Using the protein sequence and additional properties specific for each protein we can predict using different machine learning techniques which protein will phase separate. However, in order to use such techniques different difficulties must be overcome. One of the

bottlenecks is the transformation of protein sequences which have different lengths into our input data. For this we use different techniques similar to natural language processing. Additionally, other techniques must be applied in order to remove the overlap of the homologue's sequences. From our experiments neuronal networks hold the best accuracy in predicting protein phase separation.

Automatic Identification of Watermarks and of Water-marking Robustness Using Machine Learning Techniques

Dana Simian, Ralf D. Fabian, Mihai D. Stancu

The goal of this article is to propose a framework for automatic identification of watermarks from modified host images. The framework can be used with any watermark embedding/extraction system and is based on models built using machine learning (ML) techniques. Any supervised ML approach can be theoretically chosen. An important part of our framework consists in building a stand-alone module, independent of the watermarking system, for generating two types of watermarks datasets. The first type of datasets, that we will name artificially datasets, is generated from the original images by adding noise with an imposed maximum level of noise. The second type contains altered watermarked images obtained from the original ones by using different transformations. The module also performs an automatic labeling process of these data, building watermarks' containers. Then, many models can be built using the watermarks containers and different ML techniques. Comparing the

performances of all the obtained models allows the choice of the best model, or provides details for building ensemble learning. To validate the proposed framework, we conducted experiments using a particular watermarking system, built by us and many models based on artificial neural networks (ANN) and support vector machines (SVM). As a side result we identified a possible methodology for evaluating the robustness of a watermarking system, by using ANN and the two types of datasets generated in our proposed methodology.

Keywords: *Artificial Neural Networks, Support Vector Machines, Watermarking, Robustness.*

Integrated Tool for Assisted Predictive Analytics

Florin Stoica, Laura Florentina Stoica

Organizations use predictive analysis in CRM (customer relationship management) applications for marketing campaigns, sales, and customer services, in manufacturing to predict the location and rate of machine failures, in financial services to forecast financial market trends, predict the impact of new policies, laws and regulations on businesses and markets etc. Predictive analytics is a business process which consists of collecting the data, developing accurate predictive model and making the analytics available to the business users through a data visualization application. The reliability of a business process can be increased by modeling the process and formally verifying its correctness. Formal verification of

business process models aims checking for process correctness and business compliance. Typically, data warehouses are usually used to build mathematical models that capture important trends. Predictive models are the foundation of predictive analytics and involve advanced machine learning techniques to dig into data and allow analysts to make predictions. We propose to extend the capability of the Oracle database with the automatic verification of business processes by adapting and embedding our Alternating-time Temporal Logic (ATL) model checking tool. The ATL model checker tool will be used to guide the business users in the process of data preparation (build, test, and scoring data).

Keywords: *Predictive Analytics, ATL, Oracle.*

In-depth Insights into Swarm Intelligence Algorithms Performance

Eva Tuba, Peter Korošec, Tome Eftimov

Solving hard optimization problems is one of the most important research topics due to the countless applications in different areas. Since solving such problems is of great importance, numerous metaheuristics were developed, many of which belong to the group of swarm intelligence optimization algorithms. In recent decades, there has been an explosion in the number of the proposed swarm intelligence algorithms most commonly compared to other metaheuristics using one statistic such as average or median which can lead to putting algorithms in different rankings even though there are only small differences between them. In order to provide

more insights into swarm intelligence algorithms' performance, a deep statistical comparison is used. Five representative swarm intelligence optimization algorithms are ranked based on the obtained solutions values and their distribution in the search space while solving the CEC2013 benchmark functions. The used analysis differentiates algorithms that have statistically significant performance and measure the qualities of the exploration and the exploitation abilities of the tested algorithms.

Keywords: *Swarm Intelligence Algorithms, Statistical Analysis, Deep Statistical Comparison, Ranking Optimization Metaheuristics.*

Creating Web Decision-Making Modules on the Basis of Decision Tables Transformations

Aleksandr Yu. Yurin, Nikita O. Dorodnykh

Creating embedded decision-making modules for web applications that implement artificial intelligence methods in the form of knowledge bases is quite an interesting task. Specialized methodologies and software are being developed to solve them. At the same time, the use of generative and visual programming principles, as well as model transformations, can provide better results. In our previous works, we proposed to apply these principles combined with the model-driven approach for the automated creation of expert systems and knowledge bases. In this paper, we extend the previously developed method with new platforms, in particular: PHP (Hypertext Preprocessor) and Drools, as well as we add the possibility to

use the decision tables formalism and Microsoft Excel tools for their construction. The modified (extended) method allows one to effectively create knowledge bases with a large number of logical rules and generate the source code for web embedded decision-making modules. This extension is implemented as a plugin for an expert system prototyping system, namely, Personal Knowledge Base Designer. This paper describes the extended method and examples of its application for the development of web application modules: for making decisions when detecting banned messages and identifying customers who violate rules of using the SMS notification service ("Detector"), and interpreting signs of emotions within the HR-Robot application ("EmSiInterpreter"). The proposed method was also evaluated in solving educational (test) tasks.

Keywords: *Model Transformations, Decision Tables, Knowledge Bases, Rules, Web Applications.*

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