IWANN

PROGRAM

16-18 June, 2025

A Coruña, Spain

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IWANN 2025 Short Program

NOTE: All **Sessions A** and **Sessions B** will be held in Hotel Meliá Maria Pita (A Coruña, Spain). They are **face-to-face sessions.** All **Sessions C** will be held on-line (virtual) using Zoom.

Monday, June 16th, 2025			
8:30-9:00	**REGISTRATION DESK** *(start at 8:30h but it is opened during all the conference)*		
9:00-10:45	**Session A.1: Deep Learning (I)**	**Session B.1: New and future advances in BCI-based Spellers**	
10:45-11:30	**COFFEE BREAK**		
11:30-12:30	**OPENING PLENARY LECTURE**		
12:30-14:00	**Session A.2: Deep Learning applied to Computer Vision, Healthcare and Robotics (I)**	**Session B.2: ITOMAD – Intelligent Techniques for Optimization, Modeling, and Anomaly Detection (I)**	**Session C.1: General Applications of AI (I)**
14:00-16:00	**LUNCH**		
16:00-17:10	**Session A.3: AI:Bioinformatics and Biomedical Applications**	**Session B.3: Advanced Topics in Computational Intelligence (I)**	**Session C.2: Deep Learning (Part II)**
17:10-17:40	**COFFEE BREAK**		
17:40-18:45	**Session A.4: Deep Learning (Part III)**	**Session B.4: Machine Learning for 4.0 Industry Solutions**	**Session C.3: Deep Learning (Part IV)**
18:45-19:45	**Session A/B-5. Poster Session/ Demo Session**		

Tuesday, June 17th, 2025			
8:30-9:00	REGISTRATION DESK *(start at 8:30h but it is opened during all the conference)*		
9:00-10:55	Session A.6: ANN HW-Accelerators	Session B.6: ITOMAD – Intelligent Techniques for Optimization, Modeling, and Anomaly Detection (II)	Session C.4: Advanced Topics in Computational Intelligence (II)
10:55-11:30	COFFEE BREAK		
11:30-12:30	PLENARY LECTURE		
12:30-14:15	Session A.7: Explainable and Interpretable Machine Learning (xAI) with a focus on applications	Session B.7: Advances in Machine Learning for Photovoltaic System Optimization and Control in Modern Energy Grids	Session C.5: Deep Learning applied to Computer Vision, Healthcare and Robotics (I)
14:15-16:00	LUNCH		
16:00-17:10	Session A.8: Deep Learning applied to Computer Vision, Healthcare and Robotics (II)	Session B. 8: Bio-Inspired Systems and Neuro-Engineering	Session C.6: General Applications of AI (II)
17:10-17:40	COFFEE BREAK		
17:40-18:45	Session A.9: Advances models in Time Series Forecasting		
20:15	Gala Dinner		

Wednesday, June 18th, 2025		
8:30-9:00	**REGISTRATION DESK** ***(start at 8:30h but it is opened during all the conference)***	
9:00-10:00	**Session A.10: General Applications of AI (III)**	**Session B. 9: Social and Ethical aspects of AI**
10:00-10:40	**COFFEE BREAK**	
10:45-11:45	**PLENARY LECTURE**	
11:50-13:30	**TUTORIAL:** **AI and Digital Twins in Healthcare: Synergies of Physics-informed Models and Machine Learning for Precision Medicine**	

NOTES:

- All **Sessions A** and **Sessions B** will be held in Hotel Meliá Maria Pita (A Coruña, Spain). They are **face-to-face sessions.** The **plenary lectures** are in **Session A.**
- All **Sessions C** will be held on-line (virtual) using Zoom.
- **Oral** Presentation: **20 minutes** (including questions). Depending on whether there are absent speakers, times may be adjusted.
- **Poster** authors are requested to place their posters on the panels before the start of the poster session (e.g. during the coffee break or lunch). It is recommended to use **A0 size** and large fonts.

IWANN 2025 PROGRAM

Monday, June 16th 2025

*Note: Chairman remains tentative

(9:00-10:45) Session A.1: Deep Learning (Part I)

Chairman: Dr. Edward Sykes and Dr.Miguel Atencia

Domain Adaptation of the Whisper ASR Model for Tourism Call Center Transcription in Polish **(Ref: *757*)**
Maria Bollin, Wojciech Meler, Jan Piesiewicz and Łukasz Rąbalski

Learning to Search with Subgoals **(Ref: *4993*)**
Petr Hyner, Jan Mrógala, Kryštof Krmaschek and Jan Hůla

Towards Speaker Independent Speech Emotion Recognition by means of Dataset Aggregation **(Ref: *5785*)**
Francisco Portal, Javier de Lope and Manuel Graña

Learning Heuristics for k-NANN-A*: A Deep Learning Approach **(Ref: *8132*)**
Enrique Aldao, Laura María Fernández Pardo, Fernando Veiga López, Caroline Ponzoni Carvalho Chanel, Yoko Watanabe and Higinio González Jorge

Evaluating Higher-Level and Symbolic Features in Deep Learning on Time Series: Towards Simpler Explainability **(Ref: *9365*)**
Leonid Schwenke, Till Stückemann and Martin Atzmueller

(9:00-10:45) Session B.1: New and future advances in BCI-based Spellers

Chairman: Dr. Ivan Volosyak, Dr. Ricardo Ron Angevín and Dr.Roberto Hornero

Exploring Code-Modulated Visual Evoked Potentials Spellers in Realistic Scenarios **(Ref: *300*)**
Ana Martín-Fernández, Víctor Martínez-Cagigal, Selene Moreno-Calderón, Eduardo Santamaría-Vázquez, Beatriz Pascual-Roa and Roberto Hornero

Towards Secure Transaction Authentication Using a cVEP-Based BCI **(Ref: *1494*)**
Ayas Kiser, Atilla Cantürk and Ivan Volosyak

Evaluating Color Heterogeneity in RSVP-Based ERP-BCIs **(Ref: *4028*)**
Álvaro Fernández-Rodríguez, Mattieu Marchais, Lou Pépin, Lucas Sainte-Croix, Julia Zitouni-Flambard, Véronique Lespinet-Najib, Jean-Marc André and Ricardo Ron-Angevin

Graph-Attentive CNN for cVEP-BCI with Insights into Electrode Significance **(Ref: *4104*)**
Milan Andras Fodor and Ivan Volosyak

BCI with Intuitive Object Control based on Code-Modulated Visual Evoked Potentials **(Ref: *4673*)**
Hanneke A. Scheppink, Atilla Cantürk and Ivan Volosyak

Exploring the integration of c-VEP-based BCI spellers in mixed reality: a pilot study **(Ref: *7716*)**
Selene Moreno-Calderón, Víctor Martínez-Cagigal, Ana Martín-Fernández, Eduardo Santamaría-Vázquez, Beatriz Pascual-Roa and Roberto Hornero

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(11:30-12:30) Opening Plenary Talk: Prof. Barbara Hammer

Research Institute for Cognitive Interaction Technology (CITEC), Bielefeld University.

Title of the presentation: Harnessing the power of deep surrogate models

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(12:30-14:00) Session A.2: Deep Learning applied to Computer Vision, Healthcare and Robotics (Part I)

Chairman: Dr. Enrique Dominguez and Dr. Ramon Moreno Jiménez

Knee osteoarthritis severity grading using soft labelling and ordinal classification **(Ref: *278*)**
Francisco Bérchez-Moreno, Victor M. Vargas, Antonio M. Gómez-Orellana, David Guijo-Rubio, Luca Romeo, Edoardo Conti, Pedro Antonio Gutierrez and César Hervás-Martínez

Hybrid dropout for deep ordinal classification **(Ref: *4395*)**

Francisco Bérchez-Moreno, Francisco Moreno-Cano, David Guijo-Rubio, Víctor M. Vargas, Pedro A. Gutierrez and César Hervás-Martínez

Enhanced video-based eye status detection in term infants **(Ref: *6690*)**

Nuria Velasco, Juan Arnaez, Álvaro Herrero, Nuño Basurto and Daniel Urda

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(12:30-14:00) Session B.2: ITOMAD – Intelligent Techniques for Optimization, Modeling, and Anomaly Detection

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Chairman: Dr. Esteban Jove, Dr. Paulo Novais and José Luis Calvo Rolle

Design and Capture of a 5G SA Traffic Dataset Under Jamming Conditions **(Ref: *1829*)**

Diego Narciandi-Rodríguez, Guillermo Martínez-Martínez, José Aveleira Mata, Martín Bayón Gutiérrez, Javier Alfonso-Cendón and Isaias Garcia

Predicting TiO2 and FeO Concentrations in Lunar Regolith Using Machine Learning Models: A Spectral Reflectance Approach **(Ref: *6906*)**

Julia Fernández-Díaz, Francisco Javier de Cos Juez, Fernando Sánchez Lasheras, Javier Gracia Rodríguez, Santiago Iglesias, Javier Rodríguez, Saúl Pérez and Alejandro Buendía

Optimal malware mitigation in IoT networks: A comparative study of Neural ODEs and Pontryagin's maximum principle **(Ref: *6987*)**

Roberto Casado-Vara, Rafael Rodríguez García, Branly Martínez, Marta-María Álvarez-Crespo, Antonio Díaz-Longueira and Carlos Cambra

Study on the Impact of Low-Cost Sensor Alternatives for Photovoltaic Panel Modelling in Smart Grid Applications **(Ref: *9537*)**

Anabel Díaz-Labrador, Ángel Delgado, Héctor J.Pérez-Iglesias, Óscar Fontenla-Romero and Jose Luis Calvo-Rolle

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(12:30-14:15) Session C.1: General Applications of AI (I)

Chairman: Dr. Medabalimi Ravi Kumar and Dr. Myriam Emperatriz Cumbajin Alferez

A Review of Machine Learning Applications in Film Industry: Trends, Techniques, and Future Directions **(Ref: *356*)**

Pratik Kalamkar and Dr. Yogesh Kumar Sharma

Empowering Scalable Fraud Detection Using Graph Neural Networks and Incremental Learning **(Ref: *1922*)**

Medabalimi Ravi Kumar, Nikhil Gumasthi, Kapil Sangani, Saurav Singla and Satyaprasad Rao

Transfer Learning approach for prediction of maximum wave height in two locations of the Bay of Biscay: Bilbao and Cabo de Peñas **(Ref: *3997*)**

J. David Nuñez-Gonzalez, Lucía Porlán Ferrando, Manuel Graña and Alain Ulazia Manterola

Classifier fusion for the detection of defects from active thermography **(Ref: *7526*)**

Addisson Salazar, Rocco Zito, Stefano Laureti, Marco Ricci and Luis Vergara

Multimodal analysis of neuropsychological tests from EEG and fMRI data **(Ref: *8561*)**

Addisson Salazar, Luis Vergara and Alberto González

(16:00-17:15) Session A.3: AI:Bioinformatics and Biomedical Applications

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Chairman: Dr. John Nelson and Dr. Ignacio Rojas

A transformer-based model to predict micro RNA interactions **(Ref: *1566*)**

Marco Nicolini, Federico Stacchietti, Carlos Cano, Elena Casiraghi and Giorgio Valentini

Leveraging Large Language Models on Assay Descriptions to Improve the Prediction of Inhibitors for Mycobacterium tuberculosis **(Ref: *3145*)**

Nuno Alves, Nuno S. Osório, Vítor Pereira and Miguel Rocha

Advancing Imminent Fracture Risk Prediction: Integrating Machine Learning with Enhanced Feature Engineering **(Ref: *7730*)**

Mohammad Maghsoudimehrabani and Edward Sykes

Self-organizing Maps for Missing Value Imputation in Transcriptomic Datasets **(Ref: *8545*)**

Louzanne Swart and Andries Engelbrecht

(16:00-17:10) Session B.3: Advanced Topics in Computational Intelligence (I)

Chairman: Dr. Heydar Khadem and Dr. Xavier Llanas Parra

Incremental Feature Learning of Shallow Feedforward Regression Neural Networks using Particle Swarm Optimisation **(Ref: *6544*)**
Ross Naylor and Andries Engelbrecht

Resilience Under Attack: Benchmarking Optimizers Against Poisoning in Federated Learning for Image Classification Using CNN **(Ref: *7780*)**
Yohannes Biadgligne Ejigu, Yassine Baghoussi Baghoussi and Alípio Jorge

VIDEM: VIDeo Effectiveness and Memorability Dataset **(Ref: *9945*)**
Rukiye Savran Kızıltepe, Sohail Sahab, Rodrigo Valladares Santana, Faiyaz Doctor, Kate Paterson, David Hunstone and Alba García Seco de Herrera

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(16:00-17:10) Session C.2: Deep Learning (Part II)

Chairman: Dr. David Fernández Martínez and Dr.Anibal Mantilla

Energy-Efficient Radio Resource Allocation in 5G Using Deep Q-Networks **(Ref: *1719*)**
David Fernández Martínez, Lorena Chinchilla Romero, Pablo Muñoz Luengo and Pablo Ameigeiras Gutiérrez

Multi-view Cross Contrastive Learning for Multimodal Knowledge Graph Recommendation **(Ref: *2151*)**
Zhong Liu, Zhengguang Liang, Minlong Huang, Tingjuan Li and Xiaoming Zhang

MuleTrack: A Lightweight Temporal Learning Framework for Money Mule Detection in Digital Payments **(Ref: *2460*)**
Ganesh Jambhrunkar, Harsh Sharma, Saurav Singla and Thirumalai Kailasam

Modular Deep Neural Networks with residual connections for predicting the pathogenicity of genetic variants in non coding genomic regions **(Ref: *7994*)**
Federico Stacchietti, Marco Nicolini, Leonardo Chimirri, Peter N. Robinson, Elena Casiraghi and Giorgio Valentini

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(17:45-19:05) Session A.4: Deep Learning (Part III)

Chairman: Dr. Kurosh Madani and Dr. Francisco Javier de Cos Juez

Modeling Student–Subject Interactions with GNNs for Grade Prediction **(Ref: *3857*)**
Ghaidaa Ahmed-Ali, Jose Luis Avila-Jimenez, Mohammed Ibrahim Al-Twijri and Sebastián Ventura

Artificial intelligence model for the prediction of cleansing foam formulations with excellent make-up removability Is an "in silico formulator" superior to a human formulator? **(Ref: *5034*)**

Masugu Hamaguchi, Hideki Miwake, Ryouichi Nakatake and Noriyuki Arai

Deploying Vision Foundation AI Models on the Edge. The SAM2 Experience **(Ref: *9316*)**

Zheshuo Lin, Ruben Tous and Beatriz Otero

Generative AI for Contextualizing Bronze Age Objects in Historical Scenes **(Ref: *9588*)**

Mircea-Andrei Radu, Ionut-Cristian Calinescu, Nebojsa Bacanin, Leonard Ionescu, Lucian Popescu-Vava and Catalin Stoean

(17:45-18:50) Session B.4: Machine Learning for 4.0 Industry Solutions

Chairman: Dr. Ángel Arroyo and Dr. Paula Patricia Arcano Bea

Physics Informed Machine Learning for Power Flow Analysis: Injecting Knowledge via Pre-, In-, and Post-Processing **(Ref: *4303*)**

Guido Parodi, Giulio Ferro, Michela Robba, Andrea Coraddu, Francesca Cipollini, Davide Anguita and Luca Oneto

Dimensionality Reduction and Outlier Analysis for the NF-ToN-IoT Cybersecurity Dataset **(Ref: *6977*)**

Angel Arroyo, Diego Granados, Félix de Miguel, Nuria Velasco and Álvaro Herrero

Smart Incident Prediction from NOC Alert Events in Digital TV Broadcasting Networks **(Ref: *7899*)**

Francisco Javier González-Serrano, Lorena Álvarez-Pérez, Harold Y. Molina-Bulla and Marcelino Lázaro

(17:45-18:50) Session C.3: Deep Learning (Part IV)

Chairman: Dr. Ganesh Jambhrunkar

G-TED SAM: Node Classification via Graph Transformer to Simple Attention Model Distillation **(Ref: *2540*)**

Aditya Mathur, Nikhil Gumasthi, Kapil Sangani, Shriram Ankitha, Mohit Agrawal, Satyaprasad Rao, Medabalimi Ravi Kumar and Saurav Singla

Expression Recognition in Faces Partially Occluded by Head-Mounted Displays **(Ref: *4546*)**

José Luis Gómez-Sirvent, Francisco López de la Rosa, Roberto Sanchez Reolid and Antonio Fernández-Caballero

Reinforcement Learning for Mapless Navigation: Enhancing Exploration with Image-Based Rewards **(Ref: *8616*)**

Vernon Kok, Absalom Ezugwu and Michael Olusanya

(18:50-20:00) Session A/B.5: Poster Session/Demo Session

Chairman: Dr. Gonzalo Joya Caparrós and Dr. Miguel Atencia

Hardware and Software influence on EAs power consumption **(Ref: *195*)**

Josefa Díaz-Álvarez, Maribel García Arenas, Abel Sánchez Venegas, Gustavo Romero López, Francisco Fernández de Vega and Pedro Castillo Valdivieso

AEROFER: An aeroponics demonstration project **(Ref: *405*)**

Marta Musté, Xavier Parra, Marga López, Núria Jiménez and Elsa Pérez

A Self-Supervised Transfer Learning Approach for Collision Cross Section Prediction **(Ref: *586*)**

Guillermo Ramajo Fernández, Constantino García, Alberto Gil-de-la-Fuente, Víctor González-Ruiz and Abraham Otero

Quantitative and qualitative evaluation on local explainability models for anomaly detection algorithms **(Ref: *1935*)**

David Esteban-Martínez, Carlos Eiras Franco, Bertha Guijarro-Berdiñas and Amparo Alonso-Betanzos

An event-related potential BCI speller using a wearable, single-channel EEG headset with electrodes on the forehead **(Ref: *2716*)**

Arne Van Den Kerchove, Mani Mirsaeedi, Bob Van Dyck and Marc M. Van Hulle

Specialized Electronics for Electrochemical Impedance Spectroscopy of Zinc-Air Batteries **(Ref: *3446*)**

Felix Winters, Jan-Ole Thranow, Andre Löchte, Markus Gregor and Peter Glösekötter

Power Quality 24-hour Prediction Based on L-Transform Derivative Modular and Deep Learning Statistics Using Environmental Data in detached Smart Buildings **(Ref: *4034*)**

Ladislav Zjavka and Václav Snášel

Trustworthy AI Benchmark for Responsible Smart Grid as Critical Infrastructure **(Ref: *4380*)**

Federico Grasso Toro and Guglielmo Frigo

Machine learning-based surrogate models for atmospheric pollutant dispersion prediction: a comparative analysis Between conventional and alternative fuels **(Ref: *5330*)**

Omar Hassani, Moisès Graells, Eva Gallego and José Francisco Perales

A Novel q-Rung Orthopair Hesitant Fuzzy Aggregation Approach for Multicriteria Group Decision Making: Application to Electric Vehicle Charging Station Selection in Kolkata, India **(Ref: *5786*)**

Arun Sarkar

Physics-Informed Deep Learning Approach for Reintroducing Atomic Detail in Coarse-Grained Configurations of Multiple Poly(lactic acid) Stereoisomers **(Ref: *5963*)**

Eleftherios Christofi, Petra Bačová and Vagelis Harmandaris

A Framework for Controlling NV Centers with OPX+: Design, Implementation, and Applications **(Ref: *7215*)**

David Ahlmer, Jan Meijer, Peter Glösekötter and Bernd Burchard

Data-Driven All-Optical Magnetometry: A Comparative Evaluation of Regression Models Using NV Center Fluorescence Lifetimes **(Ref: *7687*)**

José Luis Ávila-Jiménez, Ann-Sophie Bülter, Ludwig Horsthemke, Francisco Javier Rodríguez Lozano, Manuel Agustín Ortiz López and Peter Glösekötter

A Transformer-Based Deep Learning Framework for Battery Aging Characterization, Synthetic Data Generation, and Real-Time Parameter Adaptation **(Ref: *7952*)**

Carlos Cano, Manuel Soler Ortiz, David Modesto, Anas Belfadil, Ruxandra Stoean and Joan Farnós

Mathematical and theoretical methods in computational intelligence **(Ref: *8187*)**

Saeid Karimi

Assessment of biowaste composting process for industrial support tool development through macro data approach **(Ref: *8304*)**
Cecilia Giron-Rojas, Emilio Gil, Albert García-Ruíz, Noemí Iglesias and Marga López

Machine Learning based Screening for Psychological Distress using a Perceived Control Mobile App **(Ref: *8863*)**
Prosper Azaglo, Pepijn van de Ven and John Nelson

Tobacco and Weed Segmentation from Remote Images Using Artificial Intelligence **(Ref: *9232*)**
Alexandru Bunica-Mihai, Loretta Ichim and Dan Popescu

Bio-inspired Systems and Neuro-engineering: Bridging Biology and Technology **(Ref: *9265*)**
Mehrzad Mohammadian

A Hybrid ResNet50-LSTM Architecture for Video Sentiment Analysis **(Ref: *9342*)**
Radu Marian Macovei, Dan Popescu and Loretta Ichim

Towards a Framework that facilitates the Construction of Image Segmentation Models **(Ref: *9713*)**
Joaquín Ortíz de Murua, Cesar Dominguez, Jónathan Heras and Vico Pascual

TASER-Net: Transformer Based Speech Emotion Recognition **(Ref: *9880*)**
M Srinivas, U Shivani Sri Varshini, Pradumya Kumar and Jenni K

Experimental Analysis and Modeling of Electrochemical Oxygen Pump Cell ECOpump **(Ref: *9895*)**
Ivan Kolesnikov, Nils Höing, Peter Glösekötter and Tilman Sanders

Tuesday, June 17th, 2025

(9:00-10:55) Session A.6: ANN HW-Accelerators

Chairman: Dr. Ulrich Rückert

RECS: A Scalable Platform for Heterogeneous AI Acceleration in the Cloud-Edge Continuum **(Ref: *687*)**

René Griessl, Florian Porrmann, Kevin Mika, Lennart Tigges and Jens Hagemeyer

Evaluating HBM to accelerate neural networks on FPGAs demonstrated using binary neural associative memories **(Ref: *1376*)**

Florian Porrmann, Sarah Pilz, Jens Hagemeyer and Ulrich Rückert

Resource-efficient Implementation of Convolutional Neural Networks on FPGAs with STANN **(Ref: *3410*)**

Yu Li, Marc Rothmann and Mario Porrmann

High-Performance FPGA-based CNN Acceleration for Real-Time DC Arc Fault Detection **(Ref: *7200*)**

Yu Li, Yufei Mao, Roland Weiss and Mario Porrmann

Optimizing AI on the Edge: Partitioning Neural Networks Across Heterogeneous Accelerators **(Ref: *7698*)**

Kevin Mika, Nils Kucza, Florian Porrmann and Jens Hagemeyer

Comparison of Hardware Component and Manycore Implementation for Anomaly Detection in Trustworthy System-on-Chips **(Ref: *9864*)**

Martin Flasskamp, Christian Klarhorst and Jens Hagemeyer

(9:00-10:55) Session B.6: ITOMAD – Intelligent Techniques for Optimization, Modeling, and Anomaly Detection (II)

Chairman: Dr. Esteban Jove, Dr. Paulo Novais and Dr.José Luis Calvo Rolle

A Short Analysis of Hybrid Frameworks Based on Self-Organizing Maps to Improve Traditional Systems **(Ref: *2569*)**

Dragan Simić, José Luis Calvo-Rolle, José R. Villar, Svetislav D. Simić and Svetlana Simić

Comparative Performance of Convolutional Neural Networks and Vision Transformers for Quality Assurance of a Welding Process **(Ref: *2936*)**
Paula Arcano-Bea, Agustín García-Fischer, Manuel Rubiños, Pablo Fariñas Alvariño, Francisco Zayas-Gato and Jose Luis Calvo-Rolle

A Novel Indicator for Nitrogen Prediction in Wastewater Treatment Plants. Implementation of Intelligent Agent-Based **(Ref: *3935*)**
Miriam Timiraos, Emilio Lima Bullones, Alejandro Vidal-Bralo, José-Luis Casteleiro-Roca and José Luis Calvo-Rolle

Power Prediction System for Photovoltaic Panels Using Artificial Intelligence **(Ref: *4720*)**
Noel Freire-Mahía, Álvaro Michelena, Antonio Díaz-Longueira, Héctor Quintián and Esteban Jove

Towards safer hydrogen infrastructure: anomaly detection in synthetic hydrogen dispensing data **(Ref: *7196*)**
Nuria Velasco, Félix de Miguel, Carolina Gutiérrez, David García, Luis Miguel Lozano, Daniel Urda and Álvaro Herrero

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(9:00-10:00) Session C.4: Advanced Topics in Computational Intelligence (II)

Chairman: Dr. Ajalmar Rego da Rocha Neto and Dr.David de la Rosa de la Rosa

Penetration Testing with AI: Case Studies on LLM and RL-Based Attack Agents **(Ref: *3559*)**
Rui Fernandes, Nuno Lopes and Joaquim Gonçalves

A comparative study of deep learning approaches for classifying wild and cultivated fish **(Ref: *4287*)**
Mario Jerez Tallon, Ismael Bevia Ballesteros, Nahuel Garcia D'Urso, Andrés Fuster Guillo, Jorge Azorin Lopez and Kilian Toledo Guedes

Sparse Least Square SVM in Primal via Nesterov Accelerated Alternating Directions Method of Multipliers **(Ref: *6994*)**
Felipe Marinho, Wellington de Almeida, Victor Santos, Ajalmar Neto and Paulo Ricardo Bernardo Silva

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(12:30-13:30) Plenary Talk: Prof. Gustavo Deco

Institució Catalana de Recerca i Estudis Avançats / Pompeu Fabra University.
Title of the presentation: The Thermodynamics of Mind

(12:30-14:15) Session A.7: Explainable and Interpretable Machine Learning (xAI) with a focus on applications

Chairman: Dr. Carlos Cano Domingo

Understanding of Latent spaces in a battery aging prediction model through eXplainable AI **(Ref: *1760*)**
Carlos Cano, Manuel Soler Ortiz, David Modesto, Anas Belfadil, Ruxandra Stoean and Joan Farnos

Exploring brain lateralization using Tensor decomposition of EEG phase-amplitude coupling **(Ref: *1798*)**
Andres Ortiz, Nicolás Gallego-Molina, Ignacio Rodriguez-Rodriguez, Alberto Peinado, Maria Dolores Gil-Montoya, Pablo Martinez-Cañada and Christian Morillas

Decoding Mental States in Social Cognition: Insights from Explainable Artificial Intelligence on HCP fMRI Data **(Ref: *7721*)**
Jose Diogo Marques dos Santos, Luis Paulo Reis and Jose Paulo Marques dos Santos

Kolmogorov-Arnold Networks for the Development of Intrusion Detection Systems **(Ref: *7935*)**
Pablo González Santamarta

Ethical Considerations in Artificial Intelligence and Machine Learning **(Ref: *7136*)**
Rita Lino, Fernando Alves and Manuel Rodrigues

(12:30-14:15) Session B.7: Advances in Machine Learning for Photovoltaic System Optimization and Control in Modern Energy Grids

Chairman: Dr. Peter Glösekötter, Dr.Ignacio Rojas, Dr. Catalin Stoean and Dr. Ruxandra Stoean

Symmetrical Magnetic Field Reconstruction for Sector-shaped Multi-Wire Cables using Machine Learning **(Ref: *3990*)**
Ariana-Andra Șerpar, Ruxandra Stoean, Carlos Cano Domingo, Ignacio Rojas Ruiz, Peter Glösekötter and Jens Pogorzelski

Comparison of Multiclass Classification on Impedance Spectra to Estimate the State of Charge of Zinc-Air Batteries **(Ref: *5390*)**
Jan-Ole Thranow, Andre Löchte, Felix Winters, Markus Gregor and Peter Glösekötter

Computational Approaches for Resolving the Low-Field Ambiguity in All-Optical Magnetic Field Sensing With NV Centers **(Ref: *9565*)**
Ann-Sophie Bülter, Ludwig Horsthemke, José Luis Ávila-Jiménez, Frederik Hoffmann, Francisco Javier Rodriguez-Lozano, Sarah Kirschke, Tilman Sanders, Markus Gregor and Peter Glösekötter

Edge Machine Learning for All-Optical Fluorescence Lifetime-Based Sensing With NV Centers **(Ref: *5956*)**
Ludwig Horsthemke, Ann-Sophie Bülter, Jens Pogorzelski, Dennis Stiegekötter, Frederik Hoffmann, José Luis Ávila-Jiménez, Markus Gregor and Peter Glösekötter

Improved Post Processing Model for Photovoltaic Power Forecasting based on Clustering **(Ref: *9580*)**
Angellina Ebenezer Anitha, Katrin Handel, Katrin Schulte and Jens Haubrock

Evaluating LSTM Model Performance for Solar Energy Prediction Using Real vs. Forecasted Exogenous Weather Data **(Ref: *7811*)**
Alexandru-Adrian Ciobanu, Nebojsa Bacanin and Catalin Stoean

(12:30-14:25) Session C.5: Deep Learning applied to Computer Vision, Healthcare and Robotics (I)

Chairman: Dr. Enrique Dominguez and Dr.Ramon Moreno Jiménez

Self-attentive bidirectional LSTM networks for temporal decoding of EEG motor states **(Ref: *2223*)**
Sara Kamali, Fabiano Baroni and Pablo Varona

Improving Coffee Disease detection using Faster R-CNN framework **(Ref: *3680*)**
Nameer Baht, Enrique Dom'Inguez and Basil Hasan

Human Activity Recognition in the Classroom using Low-cost Sensors **(Ref: *3367*)**
Sergio Suescun-Ferrandiz, Miguel Cazorla and Francisco Gomez-Donoso

Effects of Grouped Structural Global Pruning of Vision Transformers on Domain Generalisation **(Ref: *8169*)**
Hamza Riaz and Alan Smeaton

MORENA: Empty images detection based on unsupervised reconstruction error analysis **(Ref: *8613*)**
David de la Rosa, María José del Jesus, María Dolores Pérez-Godoy and Francisco Charte

Methodological framework for the creation of digital twins for photovoltaic power plants **(Ref: *9578*)**
Anibal Mantilla, Jorge Azorin-Lopez and Jose Garcia Rodriguez

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(16:00-17:10) Session A.8: Deep Learning applied to Computer Vision, Healthcare and Robotics (II)

Chairman: Dr. Enrique Dominguez and Dr.Ramon Moreno Jiménez

Bone Fracture Recognition using Robust Deep Learning Techniques **(Ref: *958*)**
Samson Akinpelu and Serestina Viriri

ThermoCycleNet: Stereo-based Thermogram Labeling for Model Transition to Cycling **(Ref: *7253*)**
Daniel Andrés López, Vincent Weber, Severin Zentgraf, Barlo Hillen, Perikles Simon and Elmar Schömer

Decoding Brain Lobe Contributions in EEG for automatic detection of obstructive sleep apnea **(Ref: *7357*)**
Jonathan Quintuña and Vinicio Changoluisa

(16:00-17:10) Session B.8: Bio-Inspired Systems and Neuro-Engineering

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Chairman: Dr. Manuel Rodrigues and Dr. Marina Sparvoli de Medeiros

An Emotional Classifier for Machine's Artificial Visual Aesthetic Appraisal **(Ref: *116*)**
Fatemeh Saveh, Mohand Tahar Soualah, Kurosh Madani and Abdennasser Chebira

Properties of monoclinic gallium oxide film and its photomemristor application in nonlinear RMC circuit **(Ref: *2909*)**
Marina Sparvoli, Ronaldo Mansano, Fábio Jorge, Daniel Fidelis, Gilson Goveia, Cleber Rodrigues, Tiago Silva, Antônio Ferreira Da Silva, Jaime Freitas, Henrique Gulino, Gustavo Pedretti and José Chubaci

A perceptron-like neural network implementing a learning-capable K-nearest neighbor classifier **(Ref: *3751*)**
Alexander Goltsev and Oleksii Holtsev

From Biological Neurons to Artificial Neural Networks: A Bioinspired Training Alternative **(Ref: *3946*)**
Alberto Fernandez-Sanchez, Marcos Gestal, Julián Dorado and Alejandro Pazos

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(16:00-18:00) Session C.6: General Applications of AI (II)

Chairman: Dr. Luis Vergara and Dr.Tinh Pham

Solid-waste Classification Using Deep Learning Fusion Model **(Ref: *3661*)**
Tinh Pham and Minh Le

Improving PV power prediction based on GRU and meteorological factors **(Ref: *4123*)**
Myriam Cumbajin, Ruxandra Stoean, Jose Aguado and Gonzalo Joya

Poisson Hamiltonian Neural Networks: Structure-Preserving Learning of Dynamical Systems **(Ref: *6817*)**
Adérito Araújo, Gonçalo Oliveira and João Nuno Mestre

SEF-Net: A Hybrid Deep Learning Architecture for Multi-Step Forecasting in Sustainable Energy Markets **(Ref: *8349*)**
Frédéric Mirindi and Derrick Mirindi

A new approach to detecting occupational diseases using time series **(Ref: *9990*)**
Antonio Díaz-Longueira, Noel Freire-Mahía, Oscar Fontenla-Romero and José Luis Calvo-Rolle

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(17:45-19:30) Session A.9: Advances models in Time Series Forecasting

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Chairman: Dr. Míriam Timiraos Díaz and Dr. Andrés Ortiz García

Assessing bias in the evaluation of blood glucose prediction models **(Ref: *9402*)**
Ciro Rodriguez-Leon, Maria Dolores Aviles, Oresti Banos, Pablo Lopez-Ibarra, Manuel Munoz-Torres, Miguel Quesada-Charneco and Claudia Villalonga

Prediction of osteoporosis and Learning of Neural Network with Optimal Control Tools **(Ref: *552*)**
Andrzej Nowakowski, Piotr Fulmanski and Marta Lipnicka

Forecasting Non-Stationary Time Series: A Comparison of Deep and Shallow Neural Network Architectures **(Ref: *2010*)**
Takudzwa Masunungure and Andries Engelbrecht

Analyzing the Limitations of Tree-Based Models for Multivariate Time Series Forecasting **(Ref: *2258*)**
Pablo Reina-Jiménez, María Martínez-Ballesteros and José C. Riquelme

Hybrid AI Models for Structured Mobility Prediction in Metropolitan Areas **(Ref: *2400*)**
Adrian M.P. Brasoveanu, Lyndon J.B. Nixon and Arno Scharl

XAI for univariate and multivariate time series forecasting. A case study on electricity consumption in Romania's National Electricity Network **(Ref: *3899*)**
Bogdan Marian Diaconu and Luminita Georgeta Popescu

Wednesday, June 18th, 2025

(9:00-10:00) Session A.10: General Applications of AI (III)

Chairman: Dr. Andrzej Nowakowski and Dr.Dragan Simic

Tackling Missing Data Head-On: Strategies to Mitigate Survival and Confirmation Bias **(Ref: *94*)**
Mario Villaizán-Vallelado, Matteo Salvatori, Belén Carro Martinez and Antonio Sánchez Esguevillas

A Pragmatic Framework for In-House AI Recommender Systems in Digital Coaching **(Ref: *5147*)**
Heydar Khadem, Markel Vigo, John Keane and Xiao-Jun Zeng

Comparative Analysis of Spiking Neurons Mathematical Models Training using Surrogate Gradients Techniques **(Ref: *9881*)**
Abdelkader Haddag, Elisa Guerrero Vazquez, Hayat Yedjour and Maria de La Paz Guerrero Lebrero

(9:00-10:00) Session B.9: Social and Ethical aspects of AI

Chairman: Dr. Andreu Catalá Mallofre

Bias and Fairness in NLP: Addressing Social and Cultural Biases **(Ref: *4148*)**
Sattam Almatarneh, Ghassan Samara, Ahmed Banimustafa and Raed Alazaidah

TextNet: End-to-End Deep Learning Framework for Dynamic and Contextually Aware Text Clustering **(Ref: *5777*)**
U Shivani Sri Varshini, K Jenni and M Srinivas

Implications of Human+Machine Systems as Critical Infrastructures under Sustainable Development Goals **(Ref: *8060*)**
Federico Grasso Toro and Javier Bolaños

(10:45-11:45) Plenary Talk: Prof. Julià Camps

University of Oxford.

Title of the presentation: AI and Digital Twins in Healthcare: Synergies of Physics-informed Models and Machine Learning for Precision Medicine

(11:50-13:30) Tutorial

Practical Tutorial. Julià Camps, University of Oxford

AI and Digital Twins in Healthcare: Synergies of Physics-informed Models and Machine Learning for Precision Medicine.

IWANN 2025. Abstracts

[0094] *Tackling Missing Data Head-On: Strategies to Mitigate Survival and Confirmation Bias*

Mario Villaizán-Vallelado (Telefónica Scientific Research;Universidad de Valladolid), Matteo Salvatori (Telefónica Scientific Research), Belén Carro Martinez (Universidad de Valladolid) and Antonio Sánchez Esguevillas (Universidad de Valladolid).

Most Artificial Intelligence models require the information in the records to be used to be fully informed. These models require a policy for handling missing information. However, traditional policies have tried to fill in the missing information with known information. This approach is correct when the missing information is random and wrong when it is not. In this article we start with a review of the main policies employed, and analyse the consequences of elimination or imputation policies and argue that these policies are sometimes unwise.

[0116] *An Emotional Classifier for Machine's Artificial Visual Aesthetic Appraisal*

Fatemeh Saveh (Université Paris-Est Créteil, LISSI EA 3956 Laboratory, Senart-FB Institute of Technology), Mohand Tahar Soualah (Université Paris-Est Créteil, LISSI EA 3956 Laboratory, Senart-FB Institute of Technology), Kurosh Madani (Université Paris-Est Créteil, LISSI EA 3956 Laboratory, Senart-FB Institute of Technology) and Abdennasser Chebira (Université Paris-Est Créteil, LISSI EA 3956 Laboratory, Senart-FB Institute of Technology).

Recent emergence of artificial creativity, consequent from latest advancements of AI, questions traditional standpoints relating "creativeness" commonly considered as the exclusive expression of humans' intellect. However, from our point of view, artificial creativity cannot be addressed without considering the philosophical deliberations relating human's intellect and his self-sufficiency in aesthetic perception of the surrounding. In this paper we present an Emotional Unsupervised Classifier achieving the aesthetic artificial visual appreciation of visual information. The unsupervised nature of our classifier makes the issued decision mechanism an emerging pro-cess by opposition with imitative nature of supervised classifiers. It is important for blending in aesthetic experience based appraisal. Operating as a self-organizing map issued from a hybrid dual process, its topological bearing follows an emotions model issued from behavioral psychology. This latest character makes as well its operational mechanism as the issued results explainable. Experimental results validating the investigated EUC are reported and discussed.

[0195] *Hardware and Software influence on EAs power consumption*

Josefa Díaz-Álvarez (Universidad de Extremadura), Maribel García Arenas (Universidad de Granada), Abel Sánchez Venegas (Universidad de Extremadura), Gustavo Romero López (Universidad de Granada), Francisco Fernández de Vega (Universidad de Extremadura) and Pedro Castillo Valdivieso (Universidad de Granada).

Artificial Intelligence (AI) is the fastest-growing area in recent years to support decision-making but it may also involve environmental impacts and energy implications. Researchers emphasize the importance of considering energy consumption to ensure sustainable AI solutions. This paper examines how evolutionary algorithms (EA), specifically genetic algorithms (GA), affect energy consumption when applied to optimization problems. It compares GA analyzing the impact of parametersacross several GPU and CPU architectures. Results showed that using a GPU for parallel processing with different values of population size does not always mean that we will have great energy savings. However, if we look at the instantaneous consumption, small differences can be seen for large population sizes. Interestingly, smaller populations sometimes require higher energy consumption. Regarding programming languages, the

instantaneous energy consumption on the CPU is directly related to the population size. On the GPU, the energy performance with C++ is consistently lower than with Python.

[0278] *Knee osteoarthritis severity grading using soft labelling and ordinal classification*

Francisco Bérchez-Moreno (Universidad de Córdoba), Victor M. Vargas (Universidad de Córdoba), Antonio M. Gómez-Orellana (Universidad de Córdoba), David Guijo-Rubio (Universidad de Córdoba), Luca Romeo (University of Macerata), Edoardo Conti (Marche Polytechnic University), Pedro Antonio Gutierrez (Universidad de Cordoba) and César Hervás-Martínez (Universidad de Córdoba).

Knee Osteoarthritis (KOA) is a progressive joint disease characterised by stiffness and pain, among others. It is generally diagnosed by evaluating physical symptoms, medical history, and screening techniques. However, conventional methods are often subjective, posing a significant challenge to the early grading of disease progression. To address this issue and support clinical decision-making, we propose an ordinal deep learning framework to study the optimal combination of loss functions, and output methodologies with soft labelling approaches, for automatic KOA severity grading based on Kellgren and Lawrence scores from X-ray images. A total of 20 combinations (2 loss functions x 2 output methodologies x 5 soft labelling approaches) are compared in this study, using a public dataset. The optimal configuration uses the categorical cross entropy loss, a cumulative link model as output, and a beta distribution for soft labelling. The results achieved demonstrate the efficacy of these ordinal classification approaches.

[0300] *Exploring Code-Modulated Visual Evoked Potentials Spellers in Realistic Scenarios*

Ana Martín-Fernández (Universidad de Valladolid), Víctor Martínez-Cagigal (Universidad de Valladolid), Selene Moreno-Calderón (Universidad de Valladolid), Eduardo Santamaría-Vázquez (Universidad de Valladolid), Beatriz Pascual-Roa (Universidad de Valladolid) and Roberto Hornero (Universidad de Valladolid).

Brain-computer interfaces (BCI) enable communication by decoding brain signals, with code-modulated visual evoked potentials (c-VEP) showing promise in accuracy and speed. However, challenges as reducing eyestrain and developing user-friendly wearables remain. This study evaluates c-VEP in realistic scenarios, a crucial step for integrating BCI into practical uses. Two aspects are explored: stimulus opacity and background effects. Ten participants tested six conditions with varying opacity and backgrounds. Results showed c-VEP performance remained robust across backgrounds, with no recalibration needed when scenarios changed. However, performance varied with opacity. When stimulus shifted from black-white to black-transparent, accuracy dropped from 99.4% to 85.0%. At this point, brain responses also changed, and calibration data became non-generalizable. Participants preferred more transparent conditions due to reduced eyestrain, indicating a trade-off between accuracy and user comfort. A configuration with 100% opacity for black flicker and 50% for white provided the optimal performance, balancing accuracy, visual fatigue, and generalization.

[0356] *A Review of Machine Learning Applications in Film Industry: Trends, Techniques, and Future Directions*

Pratik Kalamkar (Shri Jagdishprasad Jhabarmal Tibrewala University) and Dr. Yogesh Kumar Sharma (Shri Jagdishprasad Jhabarmal Tibrewala University).

The entertainment industry has been widely revolutionized with the incorporation of ML techniques in the spheres of film production, analysis, certification, and content moderation. In recent times there has been lot of research going on, this review gives an overview of ML applications in these various areas by outlining the importance of automation in simplifying processes that revolve around the classification of scripts, success prediction, and content censorship. We highlight some of the key challenges of ML applications concerning data availability issues, ethical concerns about automated censorship, and model generalization across genres and cultures in the context of this work. We also contribute some future directions for research, identifying possibilities for creation of more diversified datasets, the enhancement of model generalization. Our review point out that continuous developments in ML have the potential to further increase film production efficiency and open up new creative avenues in storytelling and content management.

[0405] *AEROFER: An aeroponics demonstration project*

Marta Musté (Universitat Politècnica de Catalunya), Xavier Parra (Universitat Politècnica de Catalunya), Marga López (Universitat Politècnica de Catalunya), Núria Jiménez (Universitat Politècnica de Catalunya) and Elsa Pérez (Universitat Politècnica de Catalunya).

Recently, aeroponics has gained popularity mainly due to water savings, as it con-sumes up to 90% less water than traditional systems, which is very relevant in a con-text of climate change and reduced water availability. The latest developments in this system are aimed to have more efficient and automated water supply and to the use of sensors to monitor and regulate the conditions in which the crop is grown. The already proven effectiveness in commercial situations leads us to see this technology as a possible solution to the problem of the surplus liquid waste generated in the agri-food sector, rich in nutrients, as it can be a substi-tute for the water with nutrients that is normally used. On the other hand, there is a growing interest in the use of agriculture-based therapies to treat human health problems and in educational context. The project Aerofer involves all the aforementioned aspects

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[0552] *Prediction of osteoporosis and Learning of Neural Network with Optimal Control Tools*

Andrzej Nowakowski (University of Lodz), Piotr Fulmanski (University of Lodz) and Marta Lipnicka (University of Lodz).

Osteoporosis means deteriorating bone structure causing chance of fractures. We propose novel approach to processing data using neural controlled differential equation for evaluating time-series. We develop machine learning methodology, approximate control tools to prove verification theorem for predicting osteoporosis. Any artificial neural network on given set of observations represents function of several variables. However, it is unknown and we have trouble to tell anything about its properties behind very general results received from learning data. In applications it needs to say not only that on training data we get some error, we have to know that error is not greater than some value for all data we consider system. We develop dual dynamic programming ideas to formulate new optimization problem. We apply it to derive and to prove sufficient approximate optimality conditions for approximate neural network which should work correctly with given error on data different than set of observations.

[0586] *A Self-Supervised Transfer Learning Approach for Collision Cross Section Prediction*

Guillermo Ramajo Fernández (CEU-San Pablo University), Constantino García (CEU-San Pablo University), Alberto Gil-de-la-Fuente (CEU-San Pablo University), Víctor González-Ruiz (CEU-San Pablo University) and Abraham Otero (CEU-San Pablo University).

Computational prediction of molecular properties from their 3D formulas is a valuable tool for supporting metabolite annotation. Predicting Collision Cross Section (CCS) values from molecular structures remains challenging because models trained over one database present a significant performance degradation when applied to another databse. In this work we propose a transfer learning approach leveraging molecular structure information from a larger chemical database to improve CCS prediction accuracy across CCS databases. An undercomplete encoder was trained on the Human Metabolome DataBase (HMDB), generating a latent representation 10 times smaller than the original molecular representations. Then, the encoder was fine-tuned on CCS-specific tasks. Our results show that models using this self-supervised pre-training approach present better generalization across databases when compared to traditional fingerprint-trained models.

[0687] *RECS: A Scalable Platform for Heterogeneous AI Acceleration in the Cloud-Edge Continuum*

René Griessl (Research Associate), Florian Porrmann (Research Associate), Kevin Mika (Research Associate), Lennart Tigges (Research Associate) and Jens Hagemeyer (Research Associate).

The rising demand for specialized hardware acceleration across diverse applications calls for innovative architectures that integrate such capabilities into the Cloud-Edge continuum. This paper presents RECS, a modular microserver platform designed to enable heterogeneous hardware acceleration in distributed Cloud-Edge environments. By incorporating CPUs, GPUs, FPGAs, and specialized accelerators, RECS configures optimized processing platforms tailored to performance-critical workloads. Its architecture supports orchestration and deployment strategies vital for accelerated workflows, while a robust communication infrastructure ensures efficient data management and fault tolerance. Management subsystems offer sophisticated monitoring tools that enhance reliability and security in distributed settings. We detail the RECS platform, its diverse microservers, and summarize performance and efficiency gains drawn from

collaborative research projects. On average, applications achieve a 3.9x performance boost and a 5.2x improvement in energy efficiency, compared to their baselines. These results underscore RECS's effectiveness for challenging use cases across multiple domains in both academic and industrial settings.

[0757] *Domain Adaptation of the Whisper ASR Model for Tourism Call Center Transcription in Polish*

Maria Bollin (Wakacje.pl S.A.), Wojciech Meler (Wakacje.pl S.A.), Jan Piesiewicz (Wakacje.pl S.A.) and Łukasz Rąbalski (Wakacje.pl S.A.).

Automatic Speech Recognition (ASR) has become a crucial technology in automating transcription and enhancing efficiency in various domains, including tourism-focused call centers. This study investigates fine-tuning of the Whisper ASR model for a domain-specific call center task within the Polish language and tourism sector, addressing challenges related to language-specific complexities, domain adaptation, and background noise. Accordingly, a novel, specialized dataset was developed from Polish call center conversations, capturing authentic customer interactions with various accents, industry-specific terminology, and diverse noise conditions. The Whisper model was fine-tuned on this dataset and evaluated against baseline and commercial systems to assess performance. The results demonstrated that fine-tuning on the custom dataset significantly improved transcription accuracy in domain-specific contexts, while maintaining strong performance on an external benchmark within the same tourism domain. This work highlights the Whisper model's adaptability and underscores the value of targeted data curation for enhancing ASR in low-resource, domain-specific settings.

[0958] *Bone Fracture Recognition using Robust Deep Learning Techniques*

Samson Akinpelu (University of KwaZulu-Natal) and Serestina Viriri (University of KwaZulu-Natal).

Bone fractures are a prevalent medical problem necessitating prompt intervention to prevent enduring effects. Although conventional diagnostic techniques like X-rays are prevalent, they necessitate skilled radiologists for precise image interpretation. Recent advancements in deep learning, especially Convolutional Neural Networks (CNNs), have demonstrated significant potential in automating and enhancing the precision of fracture identification. In this study, the application of robust CNN-based deep learning methods for the identification of bone fractures is presented. We investigate the utilization of CNNs on a large dataset (FracAtlas) of medical images, illustrating the model's ability to classify the existence of fractures autonomously. Our model attains a substantial accuracy of 98.7% and sensitivity of 100%, facilitating expedited diagnosis and aiding physicians in their decision-making process compared with a class attention transformer, which only achieves 53%. Furthermore, we compare conventional approaches and cutting-edge deep learning models, emphasizing CNN's enhanced efficacy in recognizing bone fractures.

[1376] *Evaluating HBM to accelerate neural networks on FPGAs demonstrated using binary neural associative memories*

Florian Porrmann (Bielefeld University), Sarah Pilz (Bielefeld University), Jens Hagemeyer (Bielefeld University) and Ulrich Rückert (Bielefeld University).

This paper focuses on implementing a binary neural associative memory (BINAM) using high-bandwidth memory (HBM) using modern FPGA technology. The target platform for this implementation is the AMD/Xilinx VCU128 evaluation kit, which is based on an UltraScale+ FPGA and provides 8 GB of high-bandwidth memory. The implementation was carried out using high-level synthesis (HLS). For the learning component of the BINAM, two different approaches for learning sparsely coded data were evaluated: one with single accesses and the other with burst row accesses. Additionally, the overall performance was assessed when varying the number of processing elements (PEs) that can operate in parallel due to the segmented architecture. Compared to a previously published BINAM architecture on a similar FPGA that used DDR4 memory for storing the weight matrix, our implementation achieved speedups of up to 4.43 times for learning the weight matrix and 1.8 times for data retrieval by association.

[1494] *Towards Secure Transaction Authentication Using a cVEP-Based BCI*

Ayas Kiser (Rhine-Waal University of Applied Sciences), Atilla Cantürk (Rhine-Waal University of Applied Sciences) and Ivan Volosyak (Rhine-Waal University of Applied Sciences).

User authentication has been standing out as a non-trivial system that is essential for daily use in the manner of technological necessities. Although incredible developments have been reported in this field, current bio-authentication technologies indicate a number of issues arising in the means of security and reliability. Brain-Computer Interface (BCI) has been recently spotlighted to be suitable for biometric authentication and identification systems. Electroencephalography (EEG) based BCI technologies offer better resistance against spoof attempts among other conventional biometrics, such as fingerprints, retina, iris patterns, face or voice recognition. In this context, code-modulated visual evoked potentials (cVEPs) have spotlighted among several visual stimuli based BCI systems. In this study, we propose a cVEP-based Transaction Authentication Number (TAN) authenticator system integrated into a web browser and evaluate its feasibility and effectiveness in securing online transactions. Our approach achieved an average accuracy of 88.53% across 17 participants.

[1566] *A transformer-based model to predict micro RNA interactions*

Marco Nicolini (Università degli Studi di Milano), Federico Stacchietti (Università degli Studi di Milano), Carlos Cano (Ciencias de la Computacion e Inteligencia Artificial, Universidad de Granada, Spain), Elena Casiraghi (Università degli Studi di Milano) and Giorgio Valentini (Università degli Studi di Milano).

The prediction of the interactions of micro RNA (miRNA) for the regulation of the cellular biological processes represents a challenging bioinformatics problem, with important implications for the design of new RNA-based drugs. We present miRInter-Trans, a model that integrates the RNA-FM foundation model pre-trained on a large corpus of non coding RNA (ncRNA) data with a feed-forward neural network trained on the RNA-FM hidden representations of ncRNA sequences. The model is able to successfully predict miRNA interactions using only the sequence of the ncRNA pairs. Results compared with a state-of-the-art Minimum Free Energy method show the effectiveness of the proposed approach.

[1719] *Energy-Efficient Radio Resource Allocation in 5G Using Deep Q-Networks*

David Fernández Martínez (Universidad de Granada), Lorena Chinchilla Romero (Universidad de Granada), Pablo Muñoz Luengo (Universidad de Granada) and Pablo Ameigeiras Gutiérrez (Universidad de Granada).

5G deployments highlight the need for efficient infrastructure optimization. As networks become more complex, traditional algorithms struggle, requiring AI and ML approaches. This paper presents a deep Q-Network (DQN)-based agent for optimal Physical Resource Blocks (PRBs) allocation, focusing on energy saving while ensuring service requirements through interference mitigation and resource allocation. The agent employs a multi-stage reward algorithm to achieve distinct sub-goals and a training process that enables generalizable optimization across all cells in the scenario. The results demonstrate that this design enables the agent to efficiently optimize multiple cells in a coordinated manner.

[1760] *Understanding of Latent spaces in a battery aging prediction model through eXplainable AI*

Carlos Cano (Universidad Politecnica de Catalunya - Barcelona Supercomputing Center), Manuel Soler Ortiz (University of Almeria), David Modesto (Barcelona Supercomputing Center BSC-CNS), Anas Belfadil (Barcelona Supercomputing Center BSC-CNS), Ruxandra Stoean (University of Craiova) and Joan Farnos (Barcelona Supercomputing Center BSC-CNS).

This work investigates the interpretability of autoencoder-derived latent spaces for characterizing battery aging dynamics. We propose a dual-path architecture where a primary network reconstructs the healthy voltage response from current inputs, while a secondary variational autoencoder (VAE) branch encodes aging-related deviations into a latent space. The latent variables, decoded into a residual signal, are combined with the healthy pathway output to reconstruct the observed voltage. We focus on an exploratory analysis of the latent space to answer: (1) How do latent dimensions encode aging-specific information? and (2) What relationships exist between latent variables and empirical aging parameters)? Using dimensionality reduction, clustering, and correlation analysis, we demonstrate that the VAE latent space organizes aging signatures into interpretable, low-dimensional structures. This analysis provides a framework for mapping latent representations to physically meaningful aging trends. The approach leverages xAI principles to uncover hidden insights and guide data-driven strategies for battery management.

[1798] *Exploring brain lateralization using Tensor decomposition of EEG phase-amplitude coupling*

Andres Ortiz (Universidad de Malaga), Nicolás Gallego-Molina (Universidad de Malaga), Ignacio Rodriguez-Rodriguez (Universidad de Malaga), Alberto Peinado (Universidad de Malaga), Maria Dolores Gil-Montoya (Universidad de Almeria), Pablo Martinez-Cañada (Universidad de Granada) and Christian Morillas (Universidad de Granada).

Tensor decomposition methods constitute an alternative way to analyze multi-dimensional data, with advantages with respect to classical linear techniques such as PCA (Principal Component Analysis). This is especially useful in the context of phase-amplitude coupling data, where different band combinations for each channel are computed for each subject and each channel. Unlike PCA, which assumes linear relationships and typically focuses on variance maximization, tensor decomposition methods can handle multi-dimensional data, decomposing it into components that are not only spatially but also temporally and spectrally meaningful. This enables to model interactions across multiple modes, allowing a more accurate representation of the brain activity by capturing non-linear patterns, providing a more interpretable, robust and unique solution. In this work, we propose a method to study cerebral lateralization using tensor decomposition to identify multimodal patterns, providing insights into hemispheric differences in cognitive processing to detect abnormal patterns linked to language impairments.

[1829] *Design and Capture of a 5G SA Traffic Dataset Under Jamming Conditions*

Diego Narciandi-Rodríguez (RIASC. Research Institute of Applied Sciences in Cybersecurity. Universidad de León, MIC. Campus de Vegazana), Guillermo Martínez-Martínez (RIASC. Research Institute of Applied Sciences in Cybersecurity. Universidad de León), José Aveleira Mata (Research Institute of Applied Sciences in Cybersecurity (RIASC)), Martín Bayón Gutiérrez (SECOMUCI Research Group. Department of Electric, Systems and Automatics Engineering.), Javier Alfonso-Cendón (Department of Mechanical, Computer Science and Aerospace Engineering.) and Isaias Garcia (SECOMUCI Research Group. Department of Electric, Systems and Automatics Engineering.).

5G technology, increasingly present in sectors such as industrial automation and smart cities, represents a major advance in connectivity, speed, and latency. However, these environments can also be affected by interference, such as jamming attacks, which can physically deny service by overwhelming the radio spectrum. This work presents a labeled dataset generated in a controlled private 5G SA (standalone) network environment, including both legitimate traffic and traffic affected by jamming. To this end, an experimental scenario was prepared using real devices and a dedicated system to perform the interference attack. The analysis focuses on key protocols such as NGAP and GTP, with the aim of providing a dataset for the development of AI-based intrusion detection systems in 5G environments, adapted to the specific characteristics of these networks.

[1922] *Empowering Scalable Fraud Detection Using Graph Neural Networks and Incremental Learning*

Medabalimi Ravi Kumar (Indian Institute of Technology Hyderabad), Nikhil Gumasthi (Indian Institute of Technology Hyderabad), Kapil Sangani (National Payments Corporation of India), Saurav Singla (National Payments Corporation of India) and Satyaprasad Rao (National Payments Corporation of India).

In recent years, graph-based methods have been exploited to identify anomalous activities by using graph structures and the underlying relational data. Recently, with the swift adoption of Graph Neural Networks for fraud detection, assessing node suspiciousness using neighborhood information has gained importance. However, large-scale datasets and imbalanced class distribution continue to be the key challenges in this domain, which can hinder model performance. Additionally, fraud patterns and behaviors may evolve over time, necessitating the adoption of incremental learning techniques to adapt to these changes. To tackle these challenges, we propose an approach that incorporates scalable clustering and effective weighted undersampling for the majority class, tackling the issue of data imbalance. Furthermore, to mitigate the problem of catastrophic forgetting when learning from new data, we utilize a regularization-based incremental learning framework called Elastic Weight Consolidation. This method enables the model to preserve previously learned knowledge while adjusting to new patterns.

[1935] *Quantitative and qualitative evaluation on local explainability models for anomaly detection algorithms*

David Esteban-Martínez (Universidade da Coruña - CITIC), Carlos Eiras Franco (Universidade da Coruña - CITIC), Bertha Guijarro-Berdiñas (Universidade da Coruña - CITIC) and Amparo Alonso-Betanzos (Universidade da Coruña - CITIC).

There is an increasingly urgent need to address the lack of transparency and clarity in the internal processes of AI (Artificial Intelligence) algorithms. In this paper, we explore local explainability techniques, LIME (Local Interpretable Model-agnostic Explanations) and SHAP (SHapley Additive exPlanations), to create a new layer of explanations on top of any anomaly detection model. This layer helps human supervisors better understand model behavior and the rationale behind its classification decisions. To assess the quality of these explanations, we conducted a qualitative analysis through a survey and a quantitative analysis using Quantus, a robust Python toolkit for evaluating explainability. The results of our experiments underscore the subtle trade-offs among various explainability techniques and emphasize the importance of carefully considering the context when applying explainability techniques.

[2010] *Forecasting Non-Stationary Time Series: A Comparison of Deep and Shallow Neural Network Architectures*

Takudzwa Masunungure (Stellenbosch University) and Andries Engelbrecht (University of Stellenbosch).

Deep neural network (DNN) and shallow NN (SNN) models are compared on various non-stationary time series prediction problems. The models include feedforward NNs (FNNs), Elman NNs (ENNs), Jordan NNs (JNNs), multi-recurrent NNs (MRNNs), time delay NNs (TDNNs), long short-term memory (LSTM) networks, gated recurrent unit (GRU) networks, recurrent convolutional NNs (RCNNs), and temporal convolutional NNs (TCNNs). Particle swarm optimization (PSO), adaptive moment estimation (Adam), resilient propagation (RPROP), and quantum PSO (QPSO) were used as training algorithms. The models are evaluated under different change severities and change frequencies. Results indicate that DNNs outperform SNNs. Further, results show that QPSO-trained FNNs outperform shallow recurrent NNs (SRNNs) trained using PSO, RPROP or QPSO. Additionally, the findings of the paper showed that DNNs trained using QPSO perform as well or better than DNNs trained using Adam.

[2151] *Multi-view Cross Contrastive Learning for Multimodal Knowledge Graph Recommendation*

Zhong Liu (Anhui University), Zhengguang Liang (Anhui University), Minlong Huang (Anhui University), Tingjuan Li (Qinghai Institute of Science and Technology Information) and Xiaoming Zhang (Anhui University).

Multimodal recommendation systems leverage multimodal information such as text and visuals to introduce additional knowledge, and typically achieve better recommendation accuracy compared to traditional knowledge graph-based recommendation systems. This paper proposes a multimodal knowledge graph recommendation method based on Multi-view Cross Contrastive Learning (MVCC). MVCC constructs multiple views based on multimodal knowledge graph information, user-item interaction information, and knowledge graph information. It utilizes graph neural networks to learn user and item representations under different views and fuses these views to obtain the final user and item representations. Additionally, MVCC employs contrastive learning to perform cross-view alignment, enabling the different views to align with each other, thereby capturing more comprehensive and accurate features of items and users, and improving the generalization ability of the model. We conduct evaluation experiments on two real-world datasets, and the results show that MVCC significantly outperforms other classic recommendation models, demonstrating its effectiveness.

[2223] *Self-attentive bidirectional LSTM networks for temporal decoding of EEG motor states*

Sara Kamali (GNB. Dpto. de Ingenieria Informatica. Escuela Politecnica Superior, Autonomous University of Madrid), Fabiano Baroni (GNB. Dpto. de Ingenieria Informatica. Escuela Politecnica Superior, Autonomous University of Madrid) and Pablo Varona (GNB. Dpto. de Ingenieria Informatica. Escuela Politecnica Superior, Autonomous University of Madrid).

Understanding and decoding movement-related brain activity from EEG is essential for advancing brain-computer interfaces and other neurotechnology applications. We propose a deep learning framework that leverages band-limited mu and beta power of single independent components, enabling the network to autonomously learn discriminative features without relying on handcrafted extraction. By avoiding traditional feature engineering, this approach minimizes bias and preserves richer spatiotemporal information embedded in the brain signal. The sequential structure of EEG data poses computational challenges on neural network models. To address this, we integrate a self-attention mechanism into a bidirectional LSTM architecture. This augmentation enhances the model's ability to attend to temporally salient regions, improves the representation of long-range dependencies, and yields interpretable attention. Our results demonstrated that the attention-augmented BiLSTM achieves high classification performance metrics and revealed that pre-movement neural activity carries the most discriminative information for decoding motor intention.

[2258] *Analyzing the Limitations of Tree-Based Models for Multivariate Time Series Forecasting*

Pablo Reina-Jiménez (University of Seville), María Martínez-Ballesteros (University of Seville) and José C. Riquelme (University of Seville).

Multivariate time series forecasting has evolved significantly with the adoption of techniques based on artificial intelligence. Traditional methods such as regression trees provided robust and efficient solutions, while modern deep learning models like Long Short-Term Memory networks, Convolutional Neural Networks, and graph neural network architectures excel at capturing complex temporal dependencies. However, these advancements incur high computational resource demands and increased energy consumption. This challenge has spurred interest in developing sustainable forecasting approaches under the principles of Green Artificial Intelligence. The study presents a review and analysis of traditional machine learning techniques with deep learning models, using Bayesian tests to evaluate both prediction error and computational time. The analysis clearly outlines the trade-offs between accuracy and efficiency, emphasizing the importance of implementing environmentally responsible forecasting methods.

[2400] *Hybrid AI Models for Structured Mobility Prediction in Metropolitan Areas*

Adrian M.P. Brasoveanu (Modul University), Lyndon J.B. Nixon (Modul University Vienna) and Arno Scharl (Modul University Vienna).

This paper introduces hybrid AI models for structured mobility prediction in metropolitan areas, focusing on Vienna, to guide citizens toward greener transport options. The AI-CENTIVE project explores how AI can identify effective incentives by forecasting future trips using a combination of traditional machine learning and modern deep learning architectures. Trained on a dataset of commuter trips from the Ummadum app, the models predict transport mode, time, origin, destination, distance, and duration. The best predictions trigger notifications suggesting sustainable alternatives. The evaluation of various hybrid architectures revealed that a graph convolutional network that uses statistical patterns offered the best results for the analyzed dataset. The research contributes to leveraging AI to promote sustainable mobility through targeted incentivization.

[2460] *MuleTrack: A Lightweight Temporal Learning Framework for Money Mule Detection in Digital Payments*

Ganesh Jambhrunkar (National Payments Corporation of India), Harsh Sharma (National Payments Corporation of India), Saurav Singla (National Payments Corporation of India) and Thirumalai Kailasam (National Payments Corporation of India).

Money laundering is a substantial danger to financial systems, with money mules playing an important role in hiding the origins of illicit funds. The current paper presents a novel hybrid framework for detecting money mule accounts within the Unified Payments Interface (UPI). The UPI is India's payment gateway, developed by National Payments Corporation of India (NPCI) that processed more than 130 billion transactions worth US$ ≈ 2.5 trillion in year 2024, representing 9% of the global digital transaction traffic. In this paper, we present the design and implementation of large-scale data analytics for mule detection at the NPCI. Our approach integrates domain-driven heuristics with probabilistic modeling via Markov Chain, supported by comparisons with supervised machine learning models. The proposed method captures temporal patterns in account behavior, leading to better identification of money laundering strategies.

[2540] *G-TED SAM: Node Classification via Graph Transformer to Simple Attention Model Distillation*

Aditya Mathur (National Payments Corporation of India), Nikhil Gumasthi (Indian Institute of Technology Hyderabad), Kapil Sangani (National Payments Corporation of India), Shriram Ankitha (National Payments Corporation of India), Mohit Agrawal (National Payments Corporation of India), Satyaprasad Rao (National Payments Corporation of India), Medabalimi Ravi Kumar (Indian Institute of Technology Hyderabad) and Saurav Singla (National Payments Corporation of India).

Fraud detection in financial networks requires models that are both accurate and efficient for real-time inference. In this work, we propose a knowledge distillation framework where a GraphTransformer based teacher model distills its key and query components to a lightweight Simple attention model (SAM) student model. Our approach enables the student model to learn meaningful attention representations from the teacher without direct access to graph edges, significantly reducing computational overhead. We evaluate our method on a financial transaction dataset from the Unified Payments Interface (UPI) for fraud detection. Experimental results demonstrate that our distilled G-TED SAM model achieves improvement over baseline models while significantly reducing inference time and model size. This method offers a promising direction for deploying efficient fraud detection systems in UPI.

[2569] *A Short Analysis of Hybrid Frameworks Based on Self-Organizing Maps to Improve Traditional Systems*

Dragan Simić (University of Novi Sad, Faculty of Technical Sciences), José Luis Calvo-Rolle (University of A Coruña, Department of Industrial Engineering), José R. Villar (University of Oviedo), Svetislav D. Simić (University of Novi Sad, Faculty of Technical Sciences) and Svetlana Simić (University of Novi Sad, Faculty of Medicine).

Self-Organizing Map (SOM), unsupervised learning method, is an artificial neural network (ANN) able to handle non-linear problems that can be used for exploratory data analysis, pattern recognition, and variable relationship assessment. Much more power ability is gained when the SOM-based model is merged with other clustering algorithms, creating hybrid frameworks and archi-tectures. In this paper, hybrid frameworks and architectures are presented to improve the performance of simple one-layer SOM in different domains such as image classification, assessing environmental pollutants, real-time scheduling, and other real-world problems.

[2716] *An event-related potential BCI speller using a wearable, single-channel EEG headset with electrodes on the forehead*

Arne Van Den Kerchove (KU Leuven, University of Lille), Mani Mirsaeedi (KU Leuven), Bob Van Dyck (KU Leuven) and Marc M. Van Hulle (KU Leuven).

We evaluate the feasibility of controlling an event-related potential (ERP) matrix speller using a comercially available, wearable, EEG headset with single-channel electrodes placed on the forehead in a headband configuration. Despite the suboptimal recording location for detecting typical visual ERP components, we conducted experiments with 11 right-handed healthy. Time-domain analysis revealed significant differences between attended and non-attended conditions in 6 participants, as determined by cluster-based permutation testing. A separate decoding analysis using linear discriminant analysis identified above-chance single-trial accuracy in a different subset of 6 participants. The highest decoding accuracy reached 52.5\% with 12 repetitions, below the 80\% usability threshold. These results show that limited ERP-based communication is possible using forehead single-channel EEG, although current performance is insufficient for practical use. We outline signal processing and interface improvements that could enhance the utility of low-cost, wearable ERP-based BCIs.

[2909] *Properties of monoclinic gallium oxide film and its photomemristor application in nonlinear RMC circuit*

Marina Sparvoli (University of São Paulo), Ronaldo Mansano (LSI-EPUSP), Fábio Jorge (Instituto de Física da USP), Daniel Fidelis (Instituto de Física da USP), Gilson Goveia (Instituto de Física da USP), Cleber Rodrigues (Instituto de Física da USP), Tiago Silva (Instituto de Física da USP), Antônio Ferreira Da Silva (UFBA), Jaime Freitas (U.S. Naval Research Laboratory), Henrique Gulino (LSI-EPUSP), Gustavo Pedretti (Instituto de Física da USP) and José Chubaci (Instituto de Física da USP).

Gallium oxide (Ga_2O_3) is a semiconductor with significant potential due to its ultrawide band gap (4.5–5.3 eV) and photosensitive properties. β-Ga_2O_3 is the most studied and thermodynamically stable, with a monoclinic crystal structure. It is widely used for applications in electronics and photodetectors. In this study, Ga_2O_3 thin films were grown using an upgraded ion beam-assisted deposition (IBAD) system with ultra-high vacuum (UHV) capabilities. The films were grown on p-type silicon substrates, and their crystallographic phases were identified using X-ray diffraction (XRD). The Rutherford Backscattering (RBS) technique determined the stoichiometry of gallium and oxygen, while the Tauc method was employed to calculate the band gap, found to be 4.35 eV. Electrical measurements on devices made from these films showed photoelectric behavior, confirming their potential for photomemristors applications. The photomemristor was used in an RMC (resistor-memristor-capacitor) circuit to study the nonlinear behavior when emulating the neuronal membrane.

[2936] *Comparative Performance of Convolutional Neural Networks and Vision Transformers for Quality Assurance of a Welding Process*

Paula Arcano-Bea (University of A Coruña), Agustín García-Fischer (University of A Coruña), Manuel Rubiños (University of A Coruña), Pablo Fariñas Alvariño (University of A Coruña), Francisco Zayas-Gato (Universidade da Coruña) and Jose Luis Calvo-Rolle (University of A Coruña).

The accuracy and reliability of welded components are essential in industrial manufacturing, where ensuring high-quality welds is essential for maintaining production standards. This study investigates the application of advanced object detection models-YOLO12, RT-DETR, and Faster R-CNN to classify friction stir welding (FSW) results of aluminum alloys such as AA5083 and AA6061 as successful, semi-successful, or unsuccessful. We evaluated these models using both original and preprocessed images, incorporating several techniques to improve image quality. The results were analyzed to determine the impact of preprocessing on detection accuracy. Our findings showed that preprocessing significantly improved the performance of the models. Also, we evaluated the inference times to identify the best-performing model for this application, balancing speed and accuracy. The results highlight the potential of these models to improve welding quality inspection, providing a foundation for further improvement and potential real-time application in industrial environments.

[3145] *Leveraging Large Language Models on Assay Descriptions to Improve the Prediction of Inhibitors for Mycobacterium tuberculosis*

Nuno Alves (University of Minho), Nuno S. Osório (University of Minho), Vítor Pereira (University of Minho) and Miguel Rocha (University of Minho).

Tuberculosis (TB) remains a global health threat, intensified by rising drug resistance. We present a pipeline leveraging large language models (LLMs) to extract structured metadata from assay descriptions in ChEMBL, enabling automated curation of biologically relevant datasets for Mycobacterium tuberculosis (Mtb). Using these curated datasets, we train and compare machine learning (ML) models to predict minimum inhibitory concentration (MIC) values, with subsets focused on the H37Rv yielding the best performance (R2 up to 0.65, MAE 0.41). We further introduce a multi-task classification model to predict compound activity across resistance profiles—non-resistant, single-drug resistant, and multidrug-resistant (MDR) cases—achieving F1 scores of 0.84, 0.81, and 0.67, respectively. This highlights strong predictive power for susceptible strains while exposing challenges in MDR contexts. Our results demonstrate that LLM-based curation enhances data quality and supports more effective ML-driven drug discovery pipelines, with potential for broader application across resistant pathogens.

[3367] *Human Activity Recognition in the Classroom using Low-cost Sensors*

Sergio Suescun-Ferrandiz (University Institute for Compute Research. University of Alicante.), Miguel Cazorla (University Institute for Compute Research. University of Alicante.) and Francisco Gomez-Donoso (University Institute for Compute Research. University of Alicante.).

Human Activity Recognition (HAR) using wearable devices has gained increasing attention due to its potential for real-time, non- intrusive monitoring. This work presents a HAR system specifically de- signed for educational environments, leveraging Inertial Measurement Unit data from smartwatches. We introduce a custom dataset compris- ing classroom-related activities indicative of student engagement, and develop a neural network-based model capable of classifying these ac- tivities in real time. Experimental results demonstrate approximately 80% accuracy in recognizing continuous gestures such as typing, writing, and drawing, and around 72% accuracy for instantaneous gestures like raising a hand or drinking. These findings suggest the feasibility of using smartwatch-based HAR systems for enhancing personalized learning and classroom management.

[3410] *Resource-efficient Implementation of Convolutional Neural Networks on FPGAs with STANN*

Yu Li (Osnabrueck University), Marc Rothmann (Osnabrueck University) and Mario Porrmann (Osnabrueck University).

The implementations of deep learning algorithms on embedded devices often face challenges such as energy efficiency, scalability, throughput, and the need for real-time processing in resource-constrained environments. To tackle the challenges in this domain, we have developed STANN, an open-source hardware-software co-design workflow for both training and inference of deep learning algorithms on Field-Programmable Gate Arrays (FPGAs). In this paper, we show the implementation of one-dimensional layers, including convolutional layers, more data type options, an automatic code generator based on high-level Python description, and a complete end-to-end FPGA workflow. Based on the SECOM dataset, we implemented hardware accelerators with convolutional layers on an embedded FPGA board. With an accuracy of 97.45%, the one-dimensional convolution algorithm shows advantages for time-series data over other algorithms like random forest. Using the FPGA platform, an execution time of 131µs can be achieved, nearly three times faster than the baseline using a desktop CPU.

[3446] *Specialized Electronics for Electrochemical Impedance Spectroscopy of Zinc-Air Batteries*

Felix Winters (Department of Electrical Engineering and Computer Science, FH Münster), Jan-Ole Thranow (Department of Electrical Engineering and Computer Science, FH Münster), Andre Löchte (Department of Electrical Engineering and Computer Science, FH Münster), Markus Gregor (Department of Engineering Physics, FH Münster) and Peter Glösekötter (Department of Electrical Engineering and Computer Science, FH Münster).

This paper discusses a promising approach for Electrochemical Impedance Spectroscopy (EIS) applied to zinc-air batteries to enhance battery parameter estimation. Zinc-air batteries present challenges due to flat charge and discharge curves, but EIS offers a method to estimate the state of charge (SoC) and state of health (SoH) by analyzing impedance spectra influenced by various factors. The paper introduces a cost-effective EIS meter, called Eco-EIS, that uses a Raspberry Pi Pico and two DACs for voltage control and measurement, ensuring precise impedance calculations. This system is tailored for the unique three-electrode structure of zinc-air batteries, allowing uninterrupted measurements through sinusoidal discharge methods with offset compensation. Machine learning algorithms are integrated to estimate vital battery parameters from the collected impedance spectra.

[3559] *Penetration Testing with AI: Case Studies on LLM and RL-Based Attack Agents*

Rui Fernandes (2AI IPCA), Nuno Lopes (2AI IPCA) and Joaquim Gonçalves (2AI IPCA).

The rapid increase in cyber threats and the persistent challenge of limited Cybersecurity resources raise a pressing need for automation and Artificial Intelligence in Penetration Testing. With the range of different network types and configurations associated with dynamic attack sorts and strategies, there is a demand for AI-driven solutions that adapt to different situations. This paper examines two AI-driven approaches: a Large Language Model–based penetration testing agent (PenTest++) and a Reinforcement Learning agent (Cyberwheel), trained in both simulation and emulation scenarios. Our study reveals that the LLM-based agent excels at integrating current threat intelligence and adapting to emerging attack patterns, while the RL-based agent demonstrates robust performance in controlled, scenario-based

environments. The comparative analysis offers valuable insights into the strengths and limitations of each approach, suggesting that a hybrid strategy may yield improved effectiveness in both real-world and controlled settings.

[3661] *Solid-waste Classification Using Deep Learning Fusion Model*

Tinh Pham (School of Electrical and Electronic Engineering, Hanoi University of Science and Technology) and Minh Le (School of Electrical and Electronic Engineering, Hanoi University of Science and Technology).

Classification of municipal solid waste (MSW) at the source is essential in environmental protection and recycling. Most studies focus on the visual characteristics of objects in classification algorithms. However, many objects have similar visual characteristics but very different material properties, so distinguishing them using visual features is impossible. This paper proposes an advanced deep learning fusion model for object classification that adaptively combines visual features and collision sounds of objects. Experimental results demonstrate that the model achieves competitive classification performance, attaining an accuracy of 98.92%. In addition, the proposed model is also deployed in a prototyped smart bin and yields promising results.

[3680] *Improving Coffee Disease detection using Faster R-CNN framework*

Nameer Baht (University of Malaga, Dept. of Computer Science, Malaga, Spain), Enrique Dom'Inguez (University of Malaga, Dept. of Computer Science, Malaga, Spain) and Basil Hasan (Universiti Sains Malaysia, Dept. of Computer Science, Kuala Lumpur, Malaysia).

Coffee production faces a variety of challenges, one of the most significant being the prevalence of diseases that severely affect both the quantity and quality of the harvest. These diseases can cause considerable economic losses for farmers and producers worldwide. This approach holds great promise for enhancing the sustainability and prof itability of coffee production worldwide. The selection used the Arabica coffee dataset JMuBEN and JMuBEN1 including 58.555 images, a wide variety of images of coffee leaves affected by different diseases. We pro cessed the dataset using the F-RCNN algorithm, the model achieved an impressive overall accuracy rate of 97 % in diagnosing coffee leaf diseases.

[3751] *A perceptron-like neural network implementing a learning-capable K-nearest neighbor classifier*

Alexander Goltsev (IInstitute of Information Technologies and Systems) and Oleksii Holtsev (IInstitute of Information Technologies and Systems).

Abstract. A neural network is developed, that implements a learning-capable K-Nearest Neighbor algorithm (KNN). The main peculiarity of the network is its capability for learning by means of modification of the network's connec-tions. This type of learning is a full-fledged learning and it provides a signifi-cant improvement of recognition performance of the network. A new type of features is also proposed for describing and recognizing the shapes of objects, that belong to the type of biologically inspired orientation features. The proposed neural network is implemented as a computer program and is trained on a reduced training set of the MNIST database (RMNIST/10). The experiments demonstrate a work-capability of the neural network and its possibility to learn by means of modification of the network's connection weights. Compared to the recognition performances of a number of classifiers also trained on RMNIST/10, the proposed network shows better recognition results.

[3857] *Modeling Student–Subject Interactions with GNNs for Grade Prediction*

Ghaidaa Ahmed-Ali (Dept. of Computer Science and Numerical Analysis. Universidad de Córdoba.), Jose Luis Avila-Jimenez (Dept. of Computer and Electronic Engineering. Universidad de Córdoba.), Mohammed Ibrahim Al-Twijri (King Abdulaziz University) and Sebastián Ventura (Dept. of Computer Science and Numerical Analysis. Universidad de Córdoba).

This study presents a graph-based predictive framework for student performance, leveraging Graph Neural Networks (GNNs) to model the complex relationships between student profiles and academic subjects. Students and courses are represented as nodes in a bipartite graph, with enrollment links serving as edges. By learning edge embeddings, the model captures latent interactions often missed by conventional approaches. These representations are then used to train a regression model that estimates student grades across diverse academic faculties. Empirical evaluations show

strong predictive accuracy across most datasets, though performance varies with institutional and curricular heterogeneity. These findings underscore the need for adaptable models tailored to specific educational environments. The proposed approach highlights the potential of GNNs for uncovering structural patterns in academic data and supporting personalized learning strategies through data-driven decision-making.

[3899] *XAI for univariate and multivariate time series forecasting. A case study on electricity consumption in Romania's National Electricity Network*

Bogdan Marian Diaconu (University "Constantin Brancusi" of Tg Jiu, Romania) and Luminita Georgeta Popescu (University "Constantin Brancusi" of Tg Jiu, Romania).

This study investigates the impact of various attributes on forecasting daily electricity consumption within Romania's national grid. Time-series data comprising instantaneous power values, recorded by the National Grid Operator, were extracted from their continuously updated database from 2013 to 2021. A set of exogenous variables was integrated, including meteorological parameters represented by daily averaged weather conditions, calen-dar-related data, and an energy policy measure (Daylight-Saving Time). The resulting dataset was used to train five deep learning architectures, both univariate and multivariate. Explainability techniques SHAP and LIME were employed to derive local and global interpretability insights. Both methods indicated the day type as the most influential factor. Attributes traditionally regarded as critical in shaping electricity load profiles, such as temperature, were ranked lower in terms of influence. Additionally, it was observed that LIME is more effective for generating localized instance-specific explanations, whereas its suitability for global interpretability remains limited.

[3935] *A Novel Indicator for Nitrogen Prediction in Wastewater Treatment Plants. Implementation of Intelligent Agent-Based*

Miriam Timiraos (University of A Coruña), Emilio Lima Bullones (University of A Coruña), Alejandro Vidal-Bralo (University of A Coruña), José-Luis Casteleiro-Roca (Universidade of A Coruña) and José Luis Calvo-Rolle (University of A Coruña).

This work addresses the optimization of wastewater treatment plants (WWTPs) through the implementation of an intelligent agent. This agent interacts with sensors and the environment, makes decisions based on real-time data, and acts on the system to improve water treatment efficiency. Using regression models, the agent provides accurate estimates of total nitrogen in the effluent, thereby optimizing this critical process parameter. The proposed solution is adaptable and scalable, offering an innovative tool to address the complex and dynamic challenges of this type of plant environment, improving treatment accuracy and efficiency without requiring significant investment in additional infrastructure.

[3946] *From Biological Neurons to Artificial Neural Networks: A Bioinspired Training Alternative*

Alberto Fernandez-Sanchez (Departamento de Ciencias de la Computación y Tecnologías de la Información, Universidade da Coruña), Marcos Gestal (Departamento de Ciencias de la Computación y Tecnologías de la Información, Universidade da Coruña), Julián Dorado (Departamento de Ciencias de la Computación y Tecnologías de la Información, Universidade da Coruña) and Alejandro Pazos (Departamento de Ciencias de la Computación y Tecnologías de la Información, Universidade da Coruña).

Artificial neural networks often rely on fixed architectures and uniform training strategies, overlooking adaptive mechanisms found in biological learning. This work presents a proof of concept for a bioinspired training algorithm that emulates human learning, where knowledge is acquired progressively based on data complexity. Drawing on principles like synaptic plasticity, dendritic computation, and hierarchical skill acquisition, the method restructures training into stages of increasing difficulty. Each stage reuses earlier representations while expanding the network's architecture.

Unlike other approaches that modify neuron structure, this strategy preserves standard components and introduces a curriculum-aligned training process based on neurodevelopmental patterns. The system dynamically adjusts to input complexity, scaling its capacity over time.

Although not yet empirically validated, the framework outlines a plan for future evaluation. If successful, it could improve performance and computational efficiency, contributing to green machine learning. This work bridges biological and artificial systems through a scalable, interpretable learning paradigm.

[3990] *Symmetrical Magnetic Field Reconstruction for Sector-shaped Multi-Wire Cables using Machine Learning*

Ariana-Andra Șerpar (West University of Timișoara), Ruxandra Stoean (University of Craiova), Carlos Cano Domingo (Universitat Politecnica de Catalunya), Ignacio Rojas Ruiz (Universidad de Granada), Peter Glösekötter (University of Applied Sciences Münster) and Jens Pogorzelski (University of Applied Sciences Münster).

Electricity generation is moving away from fossil fuels and towards renewable energy, which requires streamlined power distribution. Strategic modifications are essential to enhance the smart grid's stability, safety, and efficiency. One such modification is replacing traditional multi-wire conductors with sector-shaped multi-wire cables, which have superior conductive properties. To facilitate this transition, we explore contactless measurements using fluxgate sensors and Machine Learning (ML) to predict symmetrical current flow from magnetic field data. Mathematical formulations, such as the Biot-Savart Law, are inadequate for sector-shaped multi-wire cables. On the other hand, employing noninvasive sensors and ML reduces unwanted power losses in current flow monitoring. Among the 18 ML regressors tested, the K-Nearest Neighbour predicted the amplitude with an error of 0.015 when tested on augmented data. The results of the experiments show that magnetic field reconstruction using ML is a worthy contender in our efforts to improve the smart power grid.

[3997] *Transfer Learning approach for prediction of maximum wave height in two locations of the Bay of Biscay: Bilbao and Cabo de Peñas*

J. David Nuñez-Gonzalez (University of Basque Country), Lucía Porlán Ferrando (University of the Basque Country), Manuel Graña (University of the Basque Country) and Alain Ulazia Manterola (University of the Basque Country).

The transition to renewable energy sources has intensified interest in marine energy due to its predictability and availability. Accurate wave height prediction is critical for optimizing wave energy converters, designing offshore structures, and ensuring maritime safety. Traditional forecasting methods, based on physical and statistical models, often lack adaptability to dynamic ocean conditions. This study explores the use of transfer learning for predicting maximum wave height in the Bay of Biscay, leveraging data from two offshore buoys. Various neural network architectures—MLP, CNN, RNN, LSTM, and GRU—were evaluated, comparing their performance with and without transfer learning. The results demonstrate that transfer learning enhances generalization capabilities, particularly in recurrent architectures, reducing prediction errors while maintaining model stability. However, its effectiveness depends on dataset characteristics and model fine-tuning. These findings highlight the potential of artificial intelligence in improving wave height forecasting, contributing to the development of more efficient marine energy systems and offshore operations.

[4028] *Evaluating Color Heterogeneity in RSVP-Based ERP-BCIs*

Álvaro Fernández-Rodríguez (University of Malaga), Mattieu Marchais (Bordeaux INP-ENSC), Lou Pépin (Bordeaux INP-ENSC), Lucas Sainte-Croix (Bordeaux INP-ENSC), Julia Zitouni-Flambard (Bordeaux INP-ENSC), Véronique Lespinet-Najib (Bordeaux INP-ENSC), Jean-Marc André (Bordeaux INP-ENSC) and Ricardo Ron-Angevin (University of Malaga).

Rapid serial visual presentation (RSVP) is a gaze-independent paradigm for visual brain-computer interfaces (BCIs) based on event-related potentials (ERPs), benefiting individuals with limited motor control. This study examines how different pictogram presentations affect ERP-BCI performance under RSVP. Nine participants tested three conditions: pictograms without a background circle (C1), with a red circle (C2), and with uniquely colored circles (C3). Results showed that C3 achieved higher accuracy than C2 in certain trial intervals, suggesting that distinct colors enhance performance over a uniform scheme. Subjective ratings supported these findings, as C3 was associated with lower ocular fatigue than C2 and required less mental effort than C1 and C2. These results highlight the impact of stimulus design in RSVP-based ERP-BCIs, emphasizing color heterogeneity as a factor for improving performance and user experience.

[4034] *Power Quality 24-hour Prediction Based on L-Transform Derivative Modular and Deep Learning Statistics Using Environmental Data in detached Smart Buildings*

Ladislav Zjavka (VŠB-Technical University of Ostrava) and Václav Snášel (VŠB-Technical University of Ostrava).

Verification of power quality (PQ) in autonomous grid systems is essential to prepare credible daily plans for the use of renewable energy (RE) and consequent load scheduling considering the source potential and user needs. Differential Learning (DfL) is a novel unconventional neuro-computing strategy that compos-es step by step a modular-based derivative model that enables computing of next states for high alterative indefinable physical and electrical systems. Training data are first searched for optimal day intervals using AI testing evaluation. The 2-step PQ-assessment management verifies the preliminary composed load scheduling plans according to the availability of the RE sources and backup charge. The ef-fectiveness of the system is guaranteed without failures in the operation of the system according to the first 24 h forecast of photovoltaic (PV) and wind power supply. Secondary PQ check-up handles the user-adapted algorithmically gener-ated load utilisation schemes by evaluating uncertain state charges and RE pro-duction capacity.

[4104] *Graph-Attentive CNN for cVEP-BCI with Insights into Electrode Significance*

Milan Andras Fodor (Rhine-Waal University of Applied Sciences) and Ivan Volosyak (Rhine-Waal University of Applied Sciences).

Brain-computer interfaces (BCIs) enable direct communication between the brain and external devices. BCIs based on code-modulated visual evoked potentials (cVEPs) utilize predefined code patterns to generate distinct visual stimuli, thereby evoking characteristic responses in the occipital region. However, these responses are challenging to classify due to temporal overlap, morphological variations, and individual differences. Research in this field aims to improve system performance while maintaining user-friendliness. In this study, we address both challenges by developing a Graph-Attentive Convolutional Neural Network (GAT-CNN) architecture for rapid and flexible cVEP classification that also provides insights into the electrodes most critical for classification. Our approach achieved a mean validation accuracy of 94% in predicting the observed cVEP stimuli at a temporal resolution of approximately 3.91 ms (1/256 s) across 30 participants, and revealed significant patterns of electrode importance.

[4123] *Improving PV power prediction based on GRU and meteorological factors*

Myriam Cumbajin (Universidad Tecnológica Indoamérica), Ruxandra Stoean (University of Craiova), Jose Aguado (University of Malaga) and Gonzalo Joya (University of Málaga).

The gradual integration of solar renewable energy sources represents a great step towards sustainability. The main objective of this work is to develop an optimized Gated Recurrent Unit (GRU) architecture, for single-step prediction, and multi-step forecasting, by using the own PV generation as endogenous variable and a set of eight meteorological factors as exogenous variables. The result is a reliable prediction and forecasting error for an electrical generation system with typical meteorological factors of Ibarra - Ecuador. Among the evaluation metrics used, the mean squared error decreased 19.61% and 23.69% for the single-step prediction and multi-step forecasting, respectively. So, the GRU model has been able to reduce the error by a moderate percentage, with a significant difference, supported by the evaluation metrics and the Wilcoxon-Mann-Whitney U-test. Thus, one of the main conclusions of this work is that the developed GRU architecture provides reliable performance for electrical generation systems.

[4148] *Bias and Fairness in NLP: Addressing Social and Cultural Biases*

Sattam Almatarneh (Zarqa University), Ghassan Samara (Zarqa University), Ahmed Banimustafa (Higher Colleges of Technology) and Raed Alazaidah (Zarqa University).

Natural Language Processing (NLP) is the foundation that supports the technology around us today: from search engines to automated customer service. As these systems gain an increasing influence on social and economic outcomes, however, the question of bias in NLP has become hugely important. In this paper, we provide a comprehensive review of bias in NLP, from its sources, and societal impacts to the current approaches to mitigating it. We look at recent studies of data and algorithmic biases that persist and have a disproportionate impact on marginalized communities. Our results stress the necessity of interdisciplinary approaches to these challenges by merging the insights of computer science, linguistics, and ethical and social sciences. To this end, we develop a framework for building fairer, more inclusive NLP systems that leverage diverse data in combination with state-of-the-art debiasing methods and ethical AI guidelines.

[4287] *A comparative study of deep learning approaches for classifying wild and cultivated fish*

Mario Jerez Tallon (University of Alicante), Ismael Bevia Ballesteros (University of Alicante), Nahuel Garcia D'Urso (University of Alicante), Andrés Fuster Guillo (University of Alicante), Jorge Azorin Lopez (University of Alicante) and Kilian Toledo Guedes (University of Alicante).

This work presents a comparative study of advanced methods focused on exploring strategies to improve the classification of two commercially important Mediterranean fish species, S. aurata and D. labrax, as wild or farmed. This task is crucial for environmental conservation and aquaculture management, as it supports responsible aquaculture practices and maintains consumer confidence by verifying the origin and authenticity of fish products. Approaches, such as CNNs and ViTs, often rely on task-specific training, limiting their adaptability across domains. In this work, we compare the potential of CLIP for multimodal fish classification. By combining CLIP's pretrained architecture with a lightweight linear classifier and incorporating real-world textual descriptions from domain experts, we achieve high classification accuracy with minimal task-specific training. The results demonstrate that CLIP, even with a simple linear probe, surpasses convolutional models in accuracy, generalization and adaptability, showcasing its potential for niche classification tasks and broader applications.

[4303] *Physics Informed Machine Learning for Power Flow Analysis: Injecting Knowledge via Pre-, In-, and Post-Processing*

Guido Parodi (University of Genoa), Giulio Ferro (University of Genoa), Michela Robba (University of Genoa), Andrea Coraddu (Delft University of Technology), Francesca Cipollini (aizoon), Davide Anguita (University of Genoa) and Luca Oneto (University of Genoa).

Modern power grids are increasingly complex, integrating diverse distributed energy resources and necessitating efficient, accurate Power Flow Analysis. Iterative numerical techniques (INT) remain physically consistent and accurate but can be computationally expensive and susceptible to convergence issues, while machine learning (ML) methods are faster yet data-hungry and limited in extrapolation and physical interpretability. Physics-informed ML (PIML) combines domain knowledge with ML to address these drawbacks, but existing approaches rarely leverage the full potential of pre-, in-, and post-processing stages. We propose a novel PIML framework incorporating physical insights at all three steps to boost accuracy and efficiency. Our method includes a new post-processing scheme that partitions the grid into mesh and radial segments, relying on a convex optimization step for radial portions informed by PIML outputs. Tests on realistic networks show significantly improved performance in speed and accuracy, highlighting our framework's ability to enhance power flow analysis in practical settings.

[4380] *Trustworthy AI Benchmark for Responsible Smart Grid as Critical Infrastructure*

Federico Grasso Toro (GRASSO TORO Digital Solutions) and Guglielmo Frigo (Swiss Federal Institute of Metrology METAS).

Artificial Neural Networks are increasingly integrated into critical infrastructures in Europe, enhancing their efficiency and functionality. However, this presents significant ethical and technical challenges, related to privacy, fairness, transparency, and accountability. We address this by proposing a trustworthy AI benchmark (TAIB), which incorporates both quantitative and qualitative aspects, towards responsible sensor networks. Quantitatively, TAIB evaluates measurable metrics, e.g., accuracy, latency, and robustness. Qualitatively, TAIB tackles unforeseen uncertainties through verifiability, explainability, and transparency, fostering accountability as digital trust. With a smart grid case study we define countermeasures, including validation and verification of ANN models, to be translated into drafted TAIB metrics, for reporting ANNs accountability as a human-oriented digital trust service, converging with regulations like EU AI Act and OIML-D31 to serve the public good, while contributing to a sustainable future. Finally, discussion and conclusion sections present potential further work, inviting others to participate in this AI ethics challenge.

[4395] *Hybrid dropout for deep ordinal classification*

Francisco Bérchez-Moreno (Universidad de Córdoba), Francisco Moreno-Cano (Universidad de Córdoba), David Guijo-Rubio (Universidad de Córdoba), Víctor M. Vargas (Universidad de Córdoba), Pedro A. Gutierrez (Universidad de Cordoba) and César Hervás-Martínez (Universidad de Cordoba).

This paper presents a hybrid dropout technique for Ordinal Classification (OC), based on a novel regularisation method. Unlike standard dropout, which ignores class ordering, this hybrid dropout integrates ordinal information by adjusting neurons dropout probabilities based on their correlation with target labels. We evaluate its effectiveness using a

ResNet18 architecture over three OC datasets and compare it with the standard dropout approach and with an architecture with no dropout. Results show that the hybrid dropout consistently achieves the best performance across multiple well-known metrics (1-off, QWK, MAE, AMAE, and RPS), while also reducing prediction variability. Statistical analysis using the Wilcoxon signed-rank test confirms its robustness, obtaining 21 significant wins out of 30 comparisons, with no losses. These results highlight the importance of designing regularisation strategies that consider the problems ordinal structure, demonstrating that hybrid dropout effectively enhances generalisation and predictive accuracy.

[4546] *Expression Recognition in Faces Partially Occluded by Head-Mounted Displays*

José Luis Gómez-Sirvent (Universidad de Castilla-La Mancha), Francisco López de la Rosa (Universidad de Castilla-La Mancha), Roberto Sanchez Reolid (Universidad de Castilla-La Mancha) and Antonio Fernández-Caballero (Universidad de Castilla-La Mancha).

Facial expression recognition (FER) has gained significant attention due to its applications in fields such as healthcare, education, and social robotics. However, its application to virtual reality headset users is challenging due to the occlusion generated by the device. This paper explores FER using only the lower third of the face, introducing a novel pooling method that transforms static image classification architectures into robust video classification models. We evaluated the method on CK+ and Oulu-CASIA datasets, comparing its performance with state-of-the-art video processing architectures. The models studied in this paper outperform the state-of-the-art achieving up to 93.3% classification accuracy in the CK+ dataset with 70% occlusion. The results show that the evaluated models with the proposed pooling achieve competitive accuracy and exhibit robustness against temporal variations. The proposed pooling method can potentially be applied to any existing image classification deep learning architecture without increasing the number of trainable parameters.

[4673] *BCI with Intuitive Object Control based on Code-Modulated Visual Evoked Potentials*

Hanneke A. Scheppink (Rhine-Waal University of Applied Sciences), Atilla Cantürk (Rhine-Waal University of Applied Sciences) and Ivan Volosyak (Rhine-Waal University of Applied Sciences).

In recent years, brain-computer interface (BCI) research has rapidly evolved. The current primary focus of the field is to improve the speed, accuracy and overall performance of the system, however, slowly the focus is shifting to taking applications out of the laboratory environment and into the real world. Some of these solutions involve using augmented reality (AR) or virtual reality (VR), allowing for a stimulation that is incorporated into the real world. To create a more intuitive control option, this study investigated the feasibility of stimulation of the objects themselves. We studied the accuracy, speed, and subjective user experience and compared those between flashing the objects and flashing the box-stimuli with text descriptions. We found that the condition in which the generic boxes with text were used was more accurate, reliable and faster than the condition in which the objects themselves were flickering.

[4720] *Power Prediction System for Photovoltaic Panels Using Artificial Intelligence*

Noel Freire-Mahía (Universidade da Coruña), Álvaro Michelena (Universidade da Coruña), Antonio Díaz-Longueira (University of A Coruña), Héctor Quintián (Universidade da Coruña) and Esteban Jove (Universidade da Coruña).

The crucial role of photovoltaic systems in the transition towards sustainable energy goals has intensified due to the growing global interest in renewable energies. Accurate forecasting of PV generation is essential to optimise energy management and ensure grid stability, which motivates the exploration of advanced predictive methodologies. This study leverages PVGIS, a comprehensive and freely available solar energy and radiation database, to develop and evaluate intelligent time series forecasting models for power generation. By employing machine learning techniques specifically tailored to the time series data, this approach achieves high accuracy in predicting short-term PV production under varying weather conditions. The results demonstrate the model's potential as a reliable tool for proper energy management in installations, allowing operators to optimise resource allocation and improve system efficiency with greater predictability. This research highlights the value of integrating open databases with intelligent forecasting methods for operational efficiency of solar energy systems.

[4993] *Learning to Search with Subgoals*

Petr Hyner (University of Ostrava), Jan Mrógala (University of Ostrava), Kryštof Krmaschek (University of Ostrava) and Jan Hůla (University of Ostrava, Czech Institute of Informatics, Robotics and Cybernetics).

This work investigates whether a Transformer-based lan- guage model can learn to imitate a problem-solving process that de- composes tasks into subgoals, akin to human cognitive strategies. We train the model to replicate a solver that employs a greedy approach, switching to subproblems upon encountering obstacles. Using two syn- thetic tasks—the Countdown arithmetic puzzle and a Reachability with Obstacles pathfinding task—we demonstrate successful imitation of a simple solver, with generalization to unseen input samples and solution path lengths. We evaluate several variants of the Pythia model, finding that even a compact model (310k parameters) performs competitively, though larger models converge faster. Our results suggest that even small language models can internalize structured, hierarchical problem-solving, highlighting their potential for understanding how human-like subgoal decomposition can be implemented with neural networks.

[5034] *Artificial intelligence model for the prediction of cleansing foam formulations with excellent make-up removability ～Is an "in silico formulator" superior to a human formulator?～*

Masugu Hamaguchi (Keio University), Hideki Miwake (Fancl Corporation), Ryouichi Nakatake (Fancl Corporation) and Noriyuki Arai (Keio University).

Cleansing foam formulations are challenging to optimize due to the countless possible ingredient combinations. This study introduces an AI-based system using machine learning to predict cleansing performance by considering both surfactant self-assembly and ingredient chemical properties. Over 500 cleansing foam samples were prepared and evaluated. Molecular descriptors and Hansen solubility parameters were used to characterize formulations, and five machine learning models were developed for prediction. The best model achieved an R^2 of 0.765. Notably, interactions among cosmetic ingredients led to non-linear behavior, complicating prediction accuracy. However, incorporating chemical descriptors improved performance significantly. An in-silico formulation approach was also introduced, allowing virtual generation and prediction of formulations. This method identified a high-performing cleansing foam composed of eicosaglycerol hexacaprylate with either PPG-9 diglyceryl ether or cyclohexylglycerin, achieving over 85% eyeliner removal efficiency. The system is expected to streamline the development of effective cosmetic products by reducing experimental workload.

[5147] *A Pragmatic Framework for In-House AI Recommender Systems in Digital Coaching*

Heydar Khadem (University of Manchester), Markel Vigo (University of Manchester), John Keane (University of Manchester) and Xiao-Jun Zeng (University of Manchester).

While large enterprises and AI research labs benefit from proprietary models and data infrastructure, small and mid-sized enterprises (SMEs) and academic teams face challenges in accessing sufficient training data and adapting off-the-shelf AI systems to their specific needs. This paper presents a scalable, cost-effective ap-proach to building an in-house AI prompt-based recommender system tailored for digital learning environments. We propose a practical development framework that leverages synthetic single-label data to bootstrap initial model training. This approach enables efficient model construction without requiring large-scale real-world datasets. Additionally, the use of single-label data structures supports in-cremental learning and domain adaptability over time. Results from both quanti-tative evaluation and user feedback confirm the effectiveness of the proposed sys-tem in a real-world digital coaching context. This work demonstrates that a strate-gic combination of synthetic data and modular design can unlock scalable, adapt-able in-house AI recommender systems tailored to personalised learning and be-havioural development.

[5330] *MACHINE LEARNING-BASED SURROGATE MODELS FOR ATMOSPHERIC POLLUTANT DISPERSION PREDICTION: A COMPARATIVE ANALYSIS BETWEEN CONVENTIONAL AND ALTERNATIVE FUELS*

Omar Hassani (Universitat Politècnica de Catalunya), Moisès Graells (Universitat Politècnica de Catalunya), Eva Gallego (Universitat Politècnica de Catalunya) and José Francisco Perales (Universitat Politècnica de Catalunya).

Atmospheric dispersion models are essential tools for assessing the air quality impact of industrial emissions, but their high computational demands limit real-time applications for incident response. This study explores machine learning (ML) algorithms as surrogate models to replicate dispersion model results while significantly reducing computational costs. We evaluated multiple ML approaches—including tree-based ensemble methods (Random Forest, Gradient Boosting) and

recurrent neural networks (LSTM) using dispersion data for NO_2, NOx, SO_2, and particulate matter generated by the TAPM dispersion model (Hurley et al., 2005). Performance evaluation using Mean Absolute Error (MAE), Mean Squared Error (MSE), and coefficient of determination (R^2) demonstrated that tree-based models, particularly Gradient Boosting and Random Forest, consistently outperformed other approaches, with R^2 values reaching 0.88 for NOx prediction. This research contributes to the development of efficient computational methods for industrial emission monitoring and impact assessment, providing valuable insights for real-time pollution forecasting systems and emergency response planning.

[5390] *Comparison of Multiclass Classification on Impedance Spectra to Estimate the State of Charge of Zinc-Air Batteries*

Jan-Ole Thranow (Department of Electrical Engineering and Computer Science, FH Münster), Andre Löchte (Department of Electrical Engineering and Computer Science, FH Münster), Felix Winters (Department of Electrical Engineering and Computer Science, FH Münster), Markus Gregor (Department of Engineering Physics, FH Münster) and Peter Glösekötter (Department of Electrical Engineering and Computer Science, FH Münster).

This study proposes a comparison of state-of-charge estimation utilizing machine-learning classification to address the current limitations in battery management systems for zinc-air batteries. This objective is pursued by means of an analysis of features including impedance spectra. The examination encompasses three machine learning algorithms namely distance-weighted k-nearest neighbors, support vector classification with different kernels, and decision tree classification. The performance of these algorithms is evaluated in comparison to a baseline model, designated as Naive Bayes. The input features utilized by these algorithms include measurements of voltage, current, temperature, and complex impedance across various frequencies, along with additional extracted features that were evaluated.

[5777] *TextNet: End-to-End Deep Learning Framework for Dynamic and Contextually Aware Text Clustering*

U Shivani Sri Varshini (Manipal Institute of Technology, Udupi), K Jenni (King Khalid University) and M Srinivas (National Institute of Technology Warangal).

The exponential growth of internet usage has flooded us with an immense volume of unannotated textual content. Annotating such vast data requires considerable time and expertise, making it a daunting task. While dealing with such massive datasets in an unsupervised manner has its advantages, the challenges inherent in effectively grouping this data highlight the importance of text clustering. To address this challenge, we introduce TextNet, an end-to-end deep learning model. Unlike traditional methods, TextNet doesn't rely on external labels. Instead, it capitalizes on the assumption that different clusters exhibit variations in their distributions i.e., samples within a cluster share similar distributions, while samples from different clusters vary in their distributions. Innovation of TextNet lies in its utilization of dual models, one processes the original text input, while the other handles augmented samples generated to resemble input. TextNet employs the Clussimloss function to refine the model leading to effective text clustering.

[5785] *Towards Speaker Independent Speech Emotion Recognition by means of Dataset Aggregation*

Francisco Portal (Department of Artificial Intelligence, Universidad Politécnica de Madrid (UPM)), Javier de Lope (Department of Artificial Intelligence, Universidad Politécnica de Madrid (UPM)) and Manuel Graña (Computational Intelligence Group, University of Basque Country (UPV/EHU)).

This paper investigates the development of robust Speaker-Independent Speech Emotion Recognition (SI-SER) systems, which are essential for enabling more empathetic and natural human-computer interaction. To address the challenges of real-world deployment, we present a comprehensive analysis of publicly available SER datasets for the construction of SI-SER models. We perform rigorous cross-dataset validation, revealing the difficulty in achieving generalization across unseen speakers and domains, as reflected in initially low accuracy scores. To overcome this, we explore the aggregation of datasets as a strategy to improve generalization. Our results show that the combination of datasets yields significant performance gains, with an average accuracy improvement of 14.98% for the six datasets considered and a maximum improvement of 24.45%. We conduct a comparative study on the individual contributions of each dataset, revealing their distinct influences. Our analysis demonstrates that aggregation significantly enhances performance, suggesting a shared feature space for SER across diverse datasets.

[5786] *A Novel q-Rung Orthopair Hesitant Fuzzy Aggregation Approach for Multicriteria Group Decision Making: Application to Electric Vehicle Charging Station Selection in Kolkata, India*

Arun Sarkar (Heramba Chandra College, Kolkata, India).

The q-rung orthopair hesitant fuzzy (q-ROHF) set is a powerful tool for managing uncertainty in complex decision-making scenarios. To enhance its aggregation flexibility, operations based on Sugeno-Weber t-norms and t-conorms are introduced. Utilizing these, two novel aggregation operators, q-ROHF Sugeno-Weber weighted averaging and geometric operators, are de-veloped, and their core properties, including idempotency, boundedness, and homogeneity, are examined. Additionally, a new distance measure based on the least common multiple expansion is proposed for q-ROHF data. A mul-ticriteria group decision-making framework is then established by integrating SWARA and PROMETHEE methods, effectively handling cases where both decision-maker and criterion weights are unknown. The framework's validity is demonstrated through a case study selecting an optimal electric vehicle charging station in Kolkata, India. Results show that KMC station is the most suitable choice. Sensitivity and comparison analyses confirm the robustness of the rankings, indicating the model's adaptability and accuracy under vary-ing constraints and uncertainties.

[5956] *Edge Machine Learning for All-Optical Fluorescence Lifetime-Based Sensing With NV Centers*

Ludwig Horsthemke (Department of Electrical Engineering and Computer Science, FH Münster—University of Applied Sciences), Ann-Sophie Bülter (Department of Electrical Engineering and Computer Science, FH Münster—University of Applied Sciences), Jens Pogorzelski (Department of Electrical Engineering and Computer Science, FH Münster—University of Applied Sciences), Dennis Stiegekötter (Department of Electrical Engineering and Computer Science, FH Münster—University of Applied Sciences), Frederik Hoffmann (Department of Electrical Engineering and Computer Science, FH Münster—University of Applied Sciences), José Luis Ávila-Jiménez (Department of Electronic and Computer Engineering, University of Córdoba), Markus Gregor (Department of Engineering Physics, FH Münster—University of Applied Sciences) and Peter Glösekötter (Department of Electrical Engineering and Computer Science, FH Münster—University of Applied Sciences).

The integration of edge machine learning into all-optical fluorescence lifetime-based sensing with nitrogen-vacancy (NV) centers enables efficient, real-time magnetic field measurements. NV center-rich diamonds have demonstrated high precision and non-invasive capabilities for magnetic field detection. By leveraging fluorescence decay characteristics, low-field ambiguities can be resolved and sensing accuracy can be enhanced under varying environmental conditions. This work adapts established NV-based sensing methodologies for a low-cost commercial analyzer platform, implementing lightweight neural networks for real-time inference of magnetic fields. The proposed approach reduces computational overhead and latency, making high-precision magnetic field sensing more accessible for industrial applications. Additionally, challenges related to model optimization and deployment in resource-constrained environments are investigated.

[5963] *Physics-Informed Deep Learning Approach for Reintroducing Atomic Detail in Coarse-Grained Configurations of Multiple Poly(lactic acid) Stereoisomers*

Eleftherios Christofi (The Cyprus Institute), Petra Bačová (University of Cadiz) and Vagelis Harmandaris (The Cyprus Institute).

Multiscale modeling of complex molecular systems encompasses methods that combine information from fine and coarse representations of molecules to capture material properties over a wide range of spatiotemporal scales. Being able to exchange information between different levels of resolution is essential for the effective transfer of this information. The inverse problem of reintroducing atomistic degrees of freedom in coarse-grained (CG) molecular configurations is particularly challenging as, from a mathematical point of view, it is an ill-posed problem. Here, we introduce a versatile deep learning approach for backmapping multicomponent CG macromolecules with chiral centers, trained to learn structural correlations between polymer configurations at the atomistic level and their corresponding CG descriptions. This method is intended to be simple and flexible while presenting a generic solution for resolution transformation. As an illustrative example, we apply the model on linear poly(lactic acid) in melt, which is one of the most popular biodegradable polymers.

[6544] *Incremental Feature Learning of Shallow Feedforward Regression Neural Networks using Particle Swarm Optimisation*

Ross Naylor (Stellenbosch University) and Andries Engelbrecht (Stellenbosch University).

Incremental feature learning (IFL) is a supervised learning paradigm for neural networks (NNs), where the input layer is incrementally expanded over time. NNs dynamically expand the input layer with new features, while also reducing overfitting and model complexity. Feature ranking based on feature importance determines the order of feature integration. The incremental nature of IFL results in a dynamic optimization problem (DOP), where both the search space and its dimensionality changes over time. Particle swarm optimisation (PSO) has been extended to dynamic environments. This study adapts various dynamic PSO variants to train incrementally constructed NNs (INNs). The performance of INNs is compared to fully constructed NNs (FNNs) trained with BP and standard PSO on seven regression tasks. Results demonstrate that IFL effectively allows NNs to incorporate new features dynamically and acts as a regularisation technique.

[6690] *Enhanced video-based eye status detection in term infants*

Nuria Velasco (Universidad de Burgos), Juan Arnaez (Unidad Neonatal, Hospital Universitario de Burgos), Álvaro Herrero (Universidad de Burgos), Nuño Basurto (Universidad de Burgos) and Daniel Urda (Universidad de Burgos).

Continuous monitoring of neonatal behavior in the Neonatal Intensive Care Unit (NICU) is essential for early detection of neurological disorders. Among behavioral indicators, eye state (open vs. closed) serves as a clinically relevant marker for alertness, sedation, and responsiveness. This study presents a deep learning-based system for automated eye state detection in NICU video recordings. Using a manually labeled dataset of 7,388 facial frames extracted from 154 clinical videos, we trained and evaluated binary classifiers based on VGG16 and VGG19 convolutional neural network architectures. A five-fold cross-validation scheme was implemented to ensure subject-independent evaluation. The models achieved mean frame-level accuracies above 0.86 and AUC-PR values of 0.97. Additionally, video-level evaluation under realistic conditions yielded up to 0.79 accuracy and 0.84 AUC-PR. These results support the feasibility of integrating eye state detection into broader AI frameworks for neonatal monitoring and early neurological assessment.

[6817] *Poisson Hamiltonian Neural Networks: Structure-Preserving Learning of Dynamical Systems*

Adérito Araújo (CMUC, Department of Mathematics, University of Coimbra), Gonçalo Oliveira (CMUC, Department of Mathematics, University of Coimbra) and João Nuno Mestre (CMUC, Department of Mathematics, University of Coimbra).

In this work, we introduce Poisson Hamiltonian Neural Net- works (PHNNs) as an extension of Hamiltonian Neural Networks to bet- ter capture the dynamics of Poisson-Hamiltonian systems. By incorpo- rating structure-preserving numerical methods, PHNNs can learn a wider range of dynamical systems beyond traditional symplectic models. We explored different training strategies, comparing Explicit Euler (EE) and Poisson-Hamiltonian Integrators (PHI). Our results showed that, while Euler-trained models offer better short-term accuracy, PHI-trained mod- els stand out for their long-term stability and preservation of geometric structures. A hybrid approach – training with EE and testing with PHI – proved to be the best balance between accuracy and stability. These results highlight the potential of combining machine learning with geo- metric numerical methods to model complex dynamic systems without the need for explicit governing equations.

[6906] *Predicting TiO2 and FeO Concentrations in Lunar Regolith Using Machine Learning Models: A Spectral Reflectance Approach*

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This study investigates the distribution of titanium dioxide (TiO2) and iron oxide (FeO) in the lunar regolith, critical for lunar exploration and in-situ resource utilization (ISRU). It integrates spectral reflectance data from the RELAB database with geochemical compositions from the Lunar Sample Compendium, using machine learning models (Random Forest) to predict TiO2 and FeO concentrations. These models are applied to Clementine mission data to estimate the distribution of both oxides across lunar regions. Instead of validating the models solely with discrete sample concentrations, we assess their reliability by analyzing the correlation between TiO2 and FeO in well-characterized areas. Additionally, Principal Component Analysis (PCA) is performed to verify that the most relevant wavelengths align with those identified in the scientific literature for TiO2 and FeO detection. This approach enhances the robustness of the methodology, ensuring its applicability in regions with limited compositional data.

[6977] *Dimensionality Reduction and Outlier Analysis for the NF-ToN-IoT Cybersecurity Dataset*

Angel Arroyo (UBU), Diego Granados (UBU), Félix de Miguel (UBU), Nuria Velasco (UBU) and Álvaro Herrero (University of Burgos).

This study investigates the application of outlier detection and Dimensionality Reduction techniques to enhance the analysis of Internet of Things cybersecurity datasets, focusing on the NF-ToN-IoT dataset, and evaluates the effectiveness of Principal Component Analysis and t-Distributed Stochastic Neighbor Embedding in visualizing high-dimensional data, combined with Grubbs's test outlier removal technique. Results indicate that t-Distributed Stochastic Neighbor Embedding outperforms Principal Component Analysis in clustering and differentiating attack types, particularly injection and password-based threats. The Euclidean and Cityblock metrics proved to be the most efficient in terms of computational performance and accuracy. These findings highlight the potential of integrating outlier detection with nonlinear dimensionality reduction to improve intrusion detection systems in Internet of Things environments.

[6987] *Optimal malware mitigation in IoT networks: A comparative study of Neural ODEs and Pontryagin's maximum principle*

Roberto Casado-Vara (University of Burgos), Rafael Rodríguez García (University of Burgos), Branly Martínez (University of Burgos), Marta-María Álvarez-Crespo (Universidade de A Coruña), Antonio Díaz-Longueira (Universidade de A Coruña) and Carlos Cambra (University of Burgos).

The increasing prevalence of malware propagation in IoT networks requires the development of efficient and adaptive mitigation strategies. Classical approaches based on optimal control theory, such as Pontryagin's Maximum Principle (PMP), provide mathematically optimal solutions, but require solving a complex two-point boundary value problem. Recent advances in machine learning have introduced Neural Ordinary Differential Equations (ODEs) as a new alternative, allowing learning of non-linear control policies through gradient-based optimization. In this work, we apply neural ODEs to solve an optimal control problem in a modified SIR model of malware propagation, incorporating two control functions: $u_1(t)$, which reduces transmission, and $u_2(t)$, which enhances recovery. We compare this approach with a PMP-based control solution obtained using the shooting method. Our results show that both methods effectively reduce the infection peak, but exhibit different behaviours in the timing and magnitude of interventions.

[6994] *Sparse Least Square SVM in Primal via Nesterov Accelerated Alternating Directions Method of Multipliers*

Felipe Marinho (Federal University of Ceará), Wellington de Almeida (Federal University of Ceara), Victor Santos (University of Guelph), Ajalmar Neto (Federal Institute of Ceara) and Paulo Ricardo Bernardo Silva (Federal Institute of Ceara).

It is well known that the training of Least Squares Support Vector Machines (LSSVM) is carried out via the solution of a Karush-Kuhn-Tucker (KKT) linear system. Such an approach provides improved computational efficiency in the training stage when compared to standard Support Vector Machine (SVM) in which training involves quadratic program solution. However, a disadvantage of LSSVM refers to the lack of sparsity in the optimal solution of Lagrange multipliers, limiting the use of such a model in the context of training on large datasets. In order to induce the obtaining of sparse solutions, a new methodology was developed that employs LASSO regularization in the LSSVM primal problem, with a solution obtained via the Alternating Directions Method of Multipliers (ADMM) accelerated via Nesterov. The experimental results demonstrate that the proposed model presented reduced processing time in the training stage than the standard LSSVM without loss of predictive performance.

[7136] *Ethical Considerations in Artificial Intelligence and Machine Learning*

Manuel Rodrigues (ALGORITMI - Centre LASI, University of Minho Braga, Portugal), Rita Lino (ALGORITMI - Centre LASI, University of Minho Braga, Portugal), Fernando Alves (ALGORITMI - Centre LASI, University of Minho Braga, Portugal) and Paulo Novais (ALGORITMI - Centre LASI, University of Minho Braga, Portugal).

With the seemingly ever-growing developments on Artificial Intelligence (AI) and Machine Learning (ML), it is crucial to address the ethical challenges posed by these technologies. This work examines the key ethical concerns, such as algorithmic biases, privacy violations, lack of transparency, social impact and fairness. By exploring the current laws concerning AI, it aims to critically assess their adequacy in addressing these ethical issues. The analysis focuses on the robustness of the existing regulations and the potential consequences of it.

[7196] *Towards safer hydrogen infrastructure: anomaly detection in synthetic hydrogen dispensing data*

Nuria Velasco (Universidad de Burgos), Félix de Miguel (Universidad de Burgos), Carolina Gutiérrez (DHG Tecnological Solitions S.L.), David García (DHG Tecnological Solitions S.L.), Luis Miguel Lozano (Desarrollo de Máquinas y Soluciones Automáticas S.A.), Daniel Urda (Universidad de Burgos) and Álvaro Herrero (Universidad de Burgos).

The safe and efficient operation of hydrogen refueling stations is essential to support the global transition towards low-carbon energy systems. However, the scarcity of real-world operational data remains a major obstacle for advanced monitoring and anomaly detection. This study proposes a deep learning framework that combines LSTM-based synthetic data generation with unsupervised anomaly detection. A generative LSTM was used to simulate 756 realistic hydrogen refueling scenarios enriched with physically plausible anomalies. An LSTM-Autoencoder was subsequently trained to detect deviations in key process variables, achieving 92% accuracy for sustained anomalies, a 31% improvement compared to punctual anomaly detection. The proposed hybrid approach offers a scalable solution for intelligent diagnostics in emerging hydrogen infrastructure.

[7200] *High-Performance FPGA-based CNN Acceleration for Real-Time DC Arc Fault Detection*

Yu Li (Osnabrueck University), Yufei Mao (Siemens AG), Roland Weiss (Siemens AG) and Mario Porrmann (Osnabrueck University).

Direct current (DC) series arc fault detection is a critical challenge in electrical safety systems, which requires high accuracy, low latency, and power efficiency. Convolutional neural networks (CNNs) have shown promise in addressing this challenge, but their implementation on suitable embedded hardware platforms remains an active research area. This study presents an approach using CNNs accelerated on Field-Programmable Gate Arrays (FPGAs) for efficient arc fault detections. We leverage the STANN library for high-level synthesis (HLS) to overcome challenges associated with CNN implementations for FPGA acceleration. Our fine-tuned CNN model achieves high accuracy, which is maintained when implemented on the FPGA platform, while also delivering low latency. A comparative analysis with the Nvidia Jetson GPU platform demonstrates the performance advantages of our FPGA-based solution. This work contributes to the advancement of real-time, efficient arc fault detection systems, potentially enhancing the safety and reliability of DC electrical systems across various industries.

[7215] *A Framework for Controlling NV Centers with OPX+: Design, Implementation, and Applications*

David Ahlmer (FH Münster), Jan Meijer (University of Leipzig), Peter Glösekötter (FH Münster) and Bernd Burchard (Elmos Semiconductor SE).

We present a modular Python-based framework for the au- tomated control of nitrogen-vacancy (NV) centers using the OPX+ con- troller. While OPX+ enables real-time pulse generation and adaptive feedback, its configuration remains complex, requiring manual setup Our framework simplifies this process by automatically generating con- figuration files and dynamically assembling experimental parameters, pulse sequences, and hardware definitions. It supports real-time adap- tation, reduces human error, and accelerates multi-NV experiments, lay- ing the groundwork for integrating advanced optimization techniques and machine-learning-driven calibration routines in future work. Validation through experiments at the University of Leipzig confirms its effective- ness in quantum control tasks such as Rabi oscillations and ODMR, with significantly reduced setup time and maintained precision. The frame- work is scalable, extensible, and suitable for both research and education. It lays the foundation for future integration of optimization algorithms and hybrid quantum-classical systems.

[7253] *ThermoCycleNet: Stereo-based Thermogram Labeling for Model Transition to Cycling*

Daniel Andrés López (Johannes Gutenberg University, Mainz, Germany), Vincent Weber (Johannes Gutenberg University, Mainz, Germany), Severin Zentgraf (Johannes Gutenberg University, Mainz, Germany), Barlo Hillen (Johannes Gutenberg University, Mainz, Germany; University Medical Center, Mainz, Germany), Perikles Simon (Johannes Gutenberg University, Mainz, Germany) and Elmar Schömer (Johannes Gutenberg University, Mainz, Germany).

Infrared thermography is emerging as a powerful tool in sports medicine, allowing assessment of thermal radiation during exercise and analysis of anatomical regions of interest, such as the well-exposed calves. Building on our previous advanced automatic annotation method, we aimed to transfer the stereo- and multimodal-based labeling approach from treadmill running to ergometer cycling. Therefore, the training of the semantic segmentation network with automatic labels and fine-tuning on high-quality manually annotated images has been examined and compared in different data set combinations. The results indicate that fine-tuning with a small fraction of manual data is sufficient to improve the overall performance of the deep neural network. Finally, combining automatically generated labels with small manually annotated data sets accelerates the adaptation of deep neural networks to new use cases, such as the transition from treadmill to bicycle.

[7357] *Decoding Brain Lobe Contributions in EEG for automatic detection of obstructive sleep apnea*

Jonathan Quintuña (Universidad Politecnica Salesiana) and Vinicio Changoluisa (Universidad Politecnica Salesiana).

Obstructive Sleep Apnea (OSA) is a common disorder that affects quality of life and increases the risk of serious diseases. This study proposes an automatic system for OSA detection based on EEG signals, implementing optimal electrode selection and analyzing the impact of different brain regions on model performance. Using the public ISRUC-SLEEP database, the EEG were preprocessed to extract relevant features and train a supervised learning model. The results show that combining channels from the central and occipital regions provides an optimal balance between accuracy and computational cost (AUC-ROC of 95.72\%). Although the configuration using all EEG channels achieved the highest overall accuracy (95.88\%), reduced configurations such as F4-O2 deliver good performance (94\%) with a 55\% reduction in computational cost. This study contributes to the design of accessible and accurate systems for OSA detection, demonstrating the effectiveness of optimal electrode selection while maintaining a balance between accuracy and computational cost.

[7526] *Classifier fusion for the detection of defects from active thermography*

Addisson Salazar (Universitat Poltècnica de València), Rocco Zito (Università della Calabria), Stefano Laureti (Università della Calabria), Marco Ricci (Università della Calabria) and Luis Vergara (Universitat Poltècnica de València).

This paper presents a new method for detecting defects in composite materi-als examined by non-destructive testing using active thermography. The proposed method includes a fusion stage where the scores from multiple classifiers are fused under the mean-square error optimization criterion using alpha integration method. The goal is to improve the performance of indi-vidual classifiers based on different and sometimes complementary principles and that fusion can be

used to exploit such a complementarity in both accu-racy and variance. Several time-domain, frequency-domain, and statistics features were extracted from a dataset of thermography signals measured in composite material specimens. Seven individual classifiers were implement-ed. The results of fusion based on alpha integration were compared to the ones of the individual classifiers and the fusion by the mean showing the superiority of the proposed method in terms of several indices such as re-ceiver operating characteristic and precision-recall curves.

[7687] *Data-Driven All-Optical Magnetometry: A Comparative Evaluation of Regression Models Using NV Center Fluorescence Lifetimes*

José Luis Ávila-Jiménez (Department of Electronic and Computer Engineering, Universidad de Córdoba.), Ann-Sophie Bülter (Department of Electrical Engineering and Computer Science, FH Münster University of Applied Sciences), Ludwig Horsthemke (Department of Electrical Engineering and Computer Science, FH Münster University of Applied Sciences), Francisco Javier Rodríguez Lozano (Department of Electronic and Computer Engineering, Universidad de Córdoba.), Manuel Agustín Ortiz López (Department of Electronic and Computer Engineering, Universidad de Córdoba.) and Peter Glösekötter (Department of Electrical Engineering and Computer Science, FH Münster University of Applied Sciences).

Negatively charged nitrogen-vacancy (NV) centers in diamonds enable magnetic field sensing without microwave excitation, simplifying sensor design. This study explores an all-optical method using fluorescence lifetime measurements and evaluates regression models to infer magnetic field strength. A dataset of 22,758 observations is used to compare machine learning approaches, including symbolic regression, ensemble methods, and linear models. Results show that LightGBM, XGBoost, and Random Forest achieve near-perfect accuracy while symbolic regression underperforms. Computational efficiency analysis highlights models like XGBoost and LightGBM provide an optimal balance between accuracy and execution time, making them strong candidates for deployment in resource-constrained environments. These findings advance all-optical magnetometry through data-driven approaches.

[7698] *Optimizing AI on the Edge: Partitioning Neural Networks Across Heterogeneous Accelerators*

Kevin Mika (Bielefeld University), Nils Kucza (Bielefeld University), Florian Porrmann (Bielefeld University) and Jens Hagemeyer (Bielefeld University).

Edge AI requires efficient deployment of complex neural networks under strict resource constraints, especially for real-time applications like autonomous vehicles, smart surveillance, and automatic inspection. The u.RECS platform, a modular microserver for heterogeneous AI workloads, integrates an NVIDIA Jetson Orin NX, three M.2 slots, and a SMARC slot in a compact Mini-ITX form factor. We propose a novel neural network partitioning strategy, using YOLOv7 as a case study, to distribute layers across accelerators, leveraging the GPU's parallel processing and the Hailo-8's energy-efficient inference. This approach optimizes edge inference by balancing computational load and minimizing communication overhead. Experimental results with INT8 accuracy show up to 1.7x improvements in performance and energy efficiency over single-accelerator setups, with partitioned configurations achieving up to 95 FPS and 3.3 FPS/Watt. Far-edge applications, distant from the cloud and closer to embedded systems, particularly benefit.

[7716] *Exploring the integration of c-VEP-based BCI spellers in mixed reality: a pilot study*

Selene Moreno-Calderón (Universidad de Valladolid), Víctor Martínez-Cagigal (Universidad de Valladolid), Ana Martín-Fernández (Universidad de Valladolid), Eduardo Santamaría-Vázquez (Universidad de Valladolid), Beatriz Pascual-Roa (Universidad de Valladolid) and Roberto Hornero (Universidad de Valladolid).

This pilot study evaluates the integration of mixed reality (MR) with code-modulated visual evoked potential (c-VEP)-based brain-computer interface (BCI) systems. The performance and visual fatigue were compared between MR and conventional screen conditions using a 36-character speller. Results showed 99.39% accuracy in MR and 95.32% on conventional screens, with information transfer rates (ITR) of 28.95 bpm and 26.83 bpm, respectively. No significant differences in visual fatigue were observed, which remained low in both conditions. Usability received an average system usability scale (SUS) score of 86.90. These results suggest that integrating MR with c-VEP-based BCI systems is feasible, achieving performance levels comparable to conventional setups, with high usability and no increase in visual fatigue.

[7721] *Decoding Mental States in Social Cognition: Insights from Explainable Artificial Intelligence on HCP fMRI Data*

Jose Diogo Marques dos Santos (University of Porto), Luis Paulo Reis (University of Porto/LIACC) and Jose Paulo Marques dos Santos (University of Maia).

Machine Learning & Knowledge Extraction (JCR: Q2; Scopus: 83rd percentile) This study applies shallow neural networks (SNNs) with explainable AI techniques to Theory of Mind (ToM) cognitive task fMRI data from the Human Connectome Project. While previous applications focused on motor tasks, this work extends to more complex cognitive functions involving non-linear brain processes. Using the HCP multimodal parcellation atlas to segment the brain, we trained, pruned, and retrained an ANN, achieving an initial accuracy of 88.2%, which dropped to 80.0% after pruning but recovered to 84.7% after retraining. Shapley values explained the network's decisions, with results aligning with General Linear Model analysis and known ToM-related brain regions. The successful application to cognitively complex paradigms demonstrates how neural networks combined with explainability techniques can advance understanding of non-linear brain processes, showing particular promise for mental health research and brain state decoding.

[7730] *Advancing Imminent Fracture Risk Prediction: Integrating Machine Learning with Enhanced Feature Engineering*

Mohammad Maghsoudimehrabani (University of Guelph) and Edward Sykes (University of Guelph).

Osteoporotic fractures are a major healthcare concern, particularly among aging populations. Traditional tools like FRAX estimate 10-year fracture risk but often miss Imminent Fracture Risk (IFR)—fractures likely within two years. This study evaluated machine learning models, including ensemble methods, to predict IFR using real-world data from 2,949 patients in Ontario's Fracture Screening and Prevention Program. Predictive performance at two years was moderate (PR-AUC ≈ 0.45), limited by class imbalance and missing features. Performance improved with downsampling, SMOTE, and notably when predicting five-year IFR (PR-AUC ≈ 0.60), where class distribution was naturally balanced. A fully balanced pre-split dataset yielded similar gains, highlighting the effect of class imbalance. SHapley Additive exPlanations (SHAP) identified fall history, prior fractures, and age as key predictors. While not yet ready for clinical deployment, this work underscores the need for richer datasets and improved modeling strategies, offering a foundation for future IFR prediction in real-world healthcare contexts.

[7780] *Resilience Under Attack: Benchmarking Optimizers Against Poisoning in Federated Learning for Image Classification Using CNN*

Yohannes Biadgligne Ejigu (INESC TEC, University of Porto), Yassine Baghoussi Baghoussi (INESC TEC, University of Porto) and Alípio Jorge (INESC TEC, University of Porto).

Federated learning (FL) enables decentralized model training while preserving data privacy but remains susceptible to poisoning attacks. Malicious clients can manipulate local data or model updates, threatening FL's reliability, especially in privacy-sensitive domains like healthcare and finance. While client-side optimization algorithms play a crucial role in training local models, their resilience to such attacks is underexplored. This study empirically evaluates the robustness of three widely used optimization algorithms—SGD, Adam, and RMSProp—against label-flipping attacks (LFAs) in image classification tasks using Convolutional Neural Networks (CNNs). Through 900 individual runs in both federated and centralized learning (CL) settings, we analyze their performance under IID and Non-IID data distributions. Results reveal that SGD is the most resilient, achieving the highest accuracy in 87% of cases, while Adam performs best in 13%. Additionally, centralized models outperform FL on CIFAR-10, whereas FL excels on Fashion-MNIST, highlighting the impact of dataset characteristics on adversarial robustness.

[7811] *Evaluating LSTM Model Performance for Solar Energy Prediction Using Real vs. Forecasted Exogenous Weather Data*

Alexandru-Adrian Ciobanu (University of Craiova), Nebojsa Bacanin (Singidunum University) and Catalin Stoean (University of Craiova).

Accurate solar energy forecasting plays a very important role in incorporating renewable energy into the power grid. This study compares the performance of two Long Short-Term Memory approaches: a single-view model that relies solely on

historical energy production and weather data for predictions and a dual-view model that incorporates both historical data and future weather forecasts. Although it is widely acknowledged that the model using future weather data yields superior results compared to the single-view model, we assess the comparative performance of the dual-view model with recorded vs forecasted weather data. Although the results demonstrate a slight degradation in accuracy when using forecasted compared to using actual weather data, the dual-view model still outperformed the model that looks only into the past. This study highlights the importance of incorporating future weather forecasts in solar energy forecasting, even in the presence of forecast inaccuracies.

[7899] *Smart Incident Prediction from NOC Alert Events in Digital TV Broadcasting Networks*

Francisco Javier González-Serrano (Universidad Carlos III de Madrid), Lorena Álvarez-Pérez (Universidad Carlos III de Madrid), Harold Y. Molina-Bulla (Universidad Carlos III de Madrid) and Marcelino Lázaro (Universidad Carlos III de Madrid).

This paper presents the design of an automated alarm-based incident prediction system using machine learning techniques, developed in collaboration with Cellnex, one of the leading digital television broadcasting network operators in Spain. The system is evaluated across three representative scenarios, Baseline, Degraded, and Alarm-storm, each simulating different network states. In each scenario, alarm events have been normalized and encoded under four contextual settings: (i) without additional information; (ii) including pattern-based features to capture interactions with other network elements; (iii) incorporating time-based statistical features extracted from alarm activity; (iv) combining both types of contextual information. Experimental results show that incorporating temporal contextual information improves incident prediction, particularly in highly imbalanced scenarios. Among the classifiers evaluated, LGBM consistently achieves the highest balanced accuracy when time-based statistical features derived from alarms are used. These results highlight the importance of temporal modeling and imbalance handling in developing effective incident prediction systems based on alarms.

[7935] *Kolmogorov-Arnold Networks for the Development of Intrusion Detection Systems*

Pablo González Santamarta (University of León).

This study evaluates the performance of Kolmogorov-Arnold Networks in anomalous traffic detection, a key task in development of Intrusion Detection Systems. Their ability to achieve strong results with fewer resources and explainability makes them particularly suitable for real-world cybersecurity applications. We compared Kolmogorov-Arnold Networks with Multilayer Perceptrons, Gradient Boosting, and Random Forests using the NSL-KDD dataset. One of the key advantages of Kolmogorov-Arnold Networks is their inherent explainability. After evaluation, we extract an elementary function-based expression from the trained Kolmogorov-Arnold Network, demonstrating its potential for feature relevance analysis. This capability aids in feature selection and problem characterization. The results show that Gradient Boosting achieves the highest performance across all metrics. Although Kolmogorov-Arnold Networks are outperformed by Gradient Boosting, they outperform Multilayer Perceptrons, offering superior effectiveness with a smaller neural network architecture and enhanced explainability. Among the two configurations of hidden layers for Kolmogorov-Arnold Networks, the shallower one showed better results.

[7952] *A Transformer-Based Deep Learning Framework for Battery Aging Characterization, Synthetic Data Generation, and Real-Time Parameter Adaptation*

Carlos Cano (Barcelona Supercomputing Center), Manuel Soler Ortiz (University of Almeria), David Modesto (Barcelona Supercomputing Center BSC-CNS), Anas Belfadil (Barcelona Supercomputing Center BSC-CNS), Ruxandra Stoean (University of Craiova) and Joan Farnós (BARCELONA Supercomputing Center - Centro Nacional de Supercomputación).

In this work, we present a comprehensive framework that bridges advanced bat- tery modeling, synthetic data generation, and deep learning architectures to ad- dress two core challenges in battery system research: (1) the scarcity of suitable data for training large-scale models and (2) the real-time adaptation of parame- ters in equivalent circuit models (ECMs) with battery aging. Most conventional battery management systems rely on ECMs whose parameters are insufficiently updated to account for degradation. As a result, their predictive accuracy de- grades significantly over time. We tackle this limitation through a multifaceted approach that comprises (a) a systematic model calibration procedure, (b) the generation of a large, synthetic battery degradation dataset using a high-order model, and (c) the design of a dual-

path autoencoder to disentangle healthy behavior from aging effects, exposing interpretable latent space. (d) Show how this latent representation can adjust ECM parameters in real time.

[7994] *Modular Deep Neural Networks with residual connections for predicting the pathogenicity of genetic variants in non coding genomic regions*

Federico Stacchietti (Università degli Studi di Milano), Marco Nicolini (Università degli Studi di Milano), Leonardo Chimirri (Berlin Institute of Health at Charite Universitaetsmedizin Berlin), Peter N. Robinson (Berlin Institute of Health at Charite Universitaetsmedizin Berlin), Elena Casiraghi (Università degli Studi di Milano) and Giorgio Valentini (Università degli Studi di Milano).

Predicting pathogenic single nucleotide variants (SNVs) in non-coding regions of the human genome presents a significant challenge for the extreme class imbalance between pathogenic “positive” variants and physiological “negative” ones, since most machine learning methods are biased toward predicting negative examples. We designed two “block-shaped” tabular-DNN architectures: a Modular Block-Deep Neural Network (MoB-DNN) and a tabular Residual Network (T-ResNet), able to address the class imbalance problem through a mini-batch balancing strategy. We employed a hierarchical optimization approach to efficiently tune hyper-parameters related to training procedure, architecture, batch size, and mini-batch balancing ratio. Our experimental results demonstrate that T-ResNet outperforms and MoB-DNN shows competitive performance with a state-of-the-art hyper-ensemble method, suggesting that residual connections provide significant advantages for capturing complex patterns in non coding regions of the human genome.

[8060] *Implications of Human+Machine Systems as Critical Infrastructures under Sustainable Development Goals*

Federico Grasso Toro (GRASSO TORO Digital Solutions) and Javier Bolaños (GRASSO TORO Digital Solutions).

The proliferation of artificial intelligence across multiple sectors signifies a pivotal shift in how tasks are performed and decisions are made. This evolution needs a thorough examination beyond technical specifications to encompass its broader social and ethical implications. Critical infrastructures emerge as a particularly crucial point for integrating Artificial Neural Network systems, requiring careful scrutiny. In this paper, we explore the intersection of the "Human+Machine" paradigm and its implications for their deployment as critical infrastructures under EU AI Act. Relying solely on technical trustworthiness metrics will not be sufficient to foster genuine human trust and adoption. Hence, by defining deeper human factors, ’satisfaction’ and ’tranquility’, we present a redefined human-AI relationship, bridging this to responsible AI principles, e.g., Sustainable Development Goals. We propose a holistic understanding of human-oriented AI innovation, while introducing the concept of "human-on-the-loop" from a digital trust service perspective.

[8132] *Learning Heuristics for k-NANN-A*: A Deep Learning Approach*

Enrique Aldao (University of Vigo), Laura María Fernández Pardo (University of Vigo), Fernando Veiga López (University of Vigo), Caroline Ponzoni Carvalho Chanel (ISAE-SUPAERO), Yoko Watanabe (ONERA) and Higinio González Jorge (University of Vigo).

Navigation in complex environments is a key challenge in robotics and autonomous systems, traditionally tackled with pathfinding algorithms like A* and its variants. These methods discretise the domain into a uniform grid, enabling movement between adjacent nodes. While computationally efficient, these approaches compromise path smoothness and optimality due to the limited number of movement directions. Alternatively, Any-Angle path planning methods address this by using visibility graphs, allowing direct connections between nodes when there is no obstacle between them. This improves trajectory flexibility but significantly increases computational costs, limiting scalability. To overcome these challenges, this paper introduces a Deep Learning-accelerated approach for efficient navigation in obstacle maps. A customised Conditioned U-Net, trained on a solution database, provides heuristic estimates to guide the search. Combined with a k-Non-Aligned Nearest Neighbours (k-NANN) graph structure, this method ensures smooth, optimal trajectories while reducing computational overhead.

[8169] *Effects of Grouped Structural Global Pruning of Vision Transformers on Domain Generalisation*

Hamza Riaz (Dublin City University) and Alan Smeaton (Dublin City University).

With the growing sizes of AI models like large language models (LLMs) and vision transformers, deploying them on devices with limited computational resources is a challenge particularly when addressing domain generalisation (DG) tasks. This paper introduces a novel grouped structural pruning method for pre-trained vision transformers (ViT, BEIT, and DEIT), evaluated on the PACS and Office-Home DG benchmarks. Our method uses dependency graph analysis to identify and remove redundant groups of neurons, weights, filters, or attention heads within transformers, using a range of selection metrics. Grouped structural pruning is applied at pruning ratios of 50%, 75% and 95% and the models are fine-tuned on selected distributions from DG benchmarks to evaluate their overall performance in DG tasks. Results show significant improvements in inference speed and fine-tuning time with minimal trade-offs in accuracy and DG task performance.

[8187] *Mathematical and theoretical methods in computational intelligence*

Saeid Karimi (University of Pavia).

Mathematical optimization is a cornerstone of computational intelligence (CI), enabling the development of algorithms and models that learn, adapt, and solve complex problems. This article explores the pivotal role of optimization techniques in CI, covering both classical methods (e.g., gradient descent, linear programming) and modern approaches (e.g., evolutionary algorithms, swarm intelligence). We discuss how optimization drives advancements in machine learning, robotics, and data science, and highlight emerging trends such as metaheuristics and quantum-inspired optimization. By examining the synergy between optimization and computational intelligence, this article underscores the transformative potential of these methods in shaping intelligent systems.

[8304] *Assessment of biowaste composting process for industrial support tool development through macro data approach*

Cecilia Giron-Rojas (Universitat Politècnica de Catalunya), Emilio Gil (Universitat Politècnica de Catalunya), Albert García-Ruíz (Agencia de Reisidus de Catalunya), Noemí Iglesias (Agencia de Reisidus de Catalunya) and Marga López (Universitat Politècnica de Catalunya).

This study aims to assess composting efficiency and quality of compost through the study of the parameters of the Catalan Waste Agency (ARC) data-base by developing indicators useful for industrial sector. The study includes 17 composting plants for an 8-years period (2010–2017), the quantities of materials treated and generated in these plants: biowaste, yard trimmings, refuse and compost, as well as chemical characterization of compost: moisture, total organic matter, organic nitrogen, pH, electrical conductivity, self-heating test, pollutants and ammonium. Plant were sorted into 4 size classes depending on size capacity and into 4 technologies employed during thermophilic phase. Different indicators were developed related to improper fraction content, yard trimmings ratio, mass losses, compost production, refuse generation and plant saturation. The indicators were useful to assess the process and were related to the compost quality obtained.

[8349] *SEF-Net: A Hybrid Deep Learning Architecture for Multi-Step Forecasting in Sustainable Energy Markets*

Frédéric Mirindi (University of Manitoba) and Derrick Mirindi (Morgan State University).

This paper presents the Sustainable Energy Forecasting Network (SEF-Net), a novel deep learning architecture for multi-step time series forecasting in sustainable energy markets. SEF-Net integrates Convolutional Neural Networks (CNNs), Long Short-Term Memory (LSTM) networks, and Transformer models to capture complex patterns and dependencies in energy price data. We evaluate SEF-Net's performance using a comprehensive dataset from a major European energy exchange, comparing it against traditional time series models and individual deep learning approaches. Results demonstrate that SEF-Net consistently outperforms existing methods across multiple forecasting horizons, achieving a 14.6% improvement in Mean Absolute Percentage Error for 168-hour forecasts. The architecture's ability to extract relevant features, model temporal dependencies, and capture long-range interactions makes it particularly well-suited for predicting future energy demand and prices in volatile sustainable energy markets.

[8545] *Self-organizing Maps for Missing Value Imputation in Transcriptomic Datasets*

Louzanne Swart (Stellenbosch University) and Andries Engelbrecht (University of Stellenbosch).

This paper proposes an approach to missing value imputation in a transcriptomic dataset using a self-organizing map. The selforganizing map is trained on a complete subset of the data. Instances with missing values are presented to the trained map and the best matching unit is used to impute the missing values in the instance. The empirical results show promise in the application of self-organizing maps for missing value imputation in transcriptomic datasets.

[8561] *Multimodal analysis of neuropsychological tests from EEG and fMRI data*

Addisson Salazar (Universitat Politècnica de València), Luis Vergara (Universitat Politècnica de València) and Alberto González (Universitat Politècnica de València).

The availability of data from different sources or modalities had empowered the capabilities for analysis of different complex phenomena. However, there are several inherent issues to develop a joint analysis of several modalities such as time and spatial synchronization of the data. I this paper, we propose a method for the joint analysis of functional magnetic resonance imaging (fMRI) and electroencephalography (EEG) recordings measured simultane-ously. The method considers fusion of features extracted from the data and fusion of the classification results from several methods. Several single clas-sifiers were implemented, which results were fused using average fusion and alpha integration, an advanced fusion method. This later ensures optimality from the point of view of least mean-square error. The results show the ca-pabilities of the fusion to improve the results of single classifiers and possi-ble clinical meaning of the results.

[8613] *MORENA: Empty images detection based on unsupervised reconstruction error analysis*

David de la Rosa (Universidad de Jaén), María José del Jesus (Universidad de Jaén), María Dolores Pérez-Godoy (Universidad de Jaén) and Francisco Charte (Universidad de Jaén).

Camera traps are a widely used tool for analyzing and studying natural environments. Equipped with motion sensors, these cameras can capture a series of photographs when an animal passes by. However, a significant number of these images are empty, meaning no wildlife is present. Automatically detecting and discarding these empty images is a crucial task. Many existing solutions in the literature rely on supervised machine learning techniques, which require labeling numerous images. In this article, we present MORENA, an unsupervised algorithm for empty image detection, eliminating the need for costly manual labeling.

[8616] *Reinforcement Learning for Mapless Navigation: Enhancing Exploration with Image-Based Rewards*

Vernon Kok (North-West University), Absalom Ezugwu (North-West University) and Michael Olusanya (Sol Plaatje University).

Mapless navigation has gained significant attention in recent years, yet designing such navigation agents remains complex, requiring intricate environment and agent dynamics models. Reinforcement learning (RL) offers a robust framework for solving control problems. This paper explores mapless navigation from visual input using a data-driven, model-free off-policy RL approach. A mobile robot, simulated in Gazebo and controlled via ROS, is equipped with an onboard camera and LiDAR sensor. Various reward formulations were tested, and an image-based reward system leveraging a fine-tuned U-Net model trained on expert demonstrations was proposed. This formulation enhances exploration and success rates. Experimental results show that for goal-driven mapless navigation in unknown environments, a soft actor-critic (SAC) agent outperforms DQN and DDPG, with the maximum entropy objective yielding better results than traditional return-maximizing agents. Additionally, including the goal state in the agent's representation negatively impacts performance, providing deeper insights into reward mechanisms and state representations.

[8863] *Machine Learning based Screening for Psychological Distress using a Perceived Control Mobile App*

Prosper Azaglo (University of Limerick), Pepijn van de Ven (University of Limerick) and John Nelson (University of Limerick).

Perceived control is the belief that individuals can take actions to achieve desired outcomes, significantly impacting mental health. Those with higher perceived control tend to experience less anxiety, stress, and depression, and often perform better in their fields. This study investigates a mobile app designed to assess users' sense of control. Participants, evaluated through trials and self-reported ratings, interacted with the app to determine how much outcomes depended on their actions versus external factors.

The analysis utilized machine learning models, including Random Forest and Support Vector Machine, to predict symptoms of psychological distress from perceived control data. Conducted in Ghana with 118 participants and 401 valid samples, the findings revealed that perceived control was influenced by both user judgments and app configurations, such as the activation of buttons in feedback messages.

[9232] *Tobacco and Weed Segmentation from Remote Images Using Artificial Intelligence*

Alexandru Bunica-Mihai (National University of Science and Technology Politehnica Bucharest), Loretta Ichim (National University of Science and Technology Politehnica Bucharest) and Dan Popescu (National University of Science and Technology Politehnica Bucharest).

Using specialized software, such as various forms of image processing and artificial neural networks, precision agriculture solutions attempt to arrive at accurate estimates of weed and, consequently, target automatic herbicide applications. One of the ways through which such estimations may be accomplished is the semantic segmentation of crop and weed regions. The paper proposes a two-stage segmentation neural network pipeline for tobacco and weed segmentation, trained and tested using a publicly available dataset of field images captured with a drone. The two stages are carried out by independent U-Net models with EfficientNet backbones. In the first stage, the model segments regions covered by vegetation, including tobacco plants and weeds. In the second stage, the model segments the tobacco plants. The final segmentation mask is created by combining the two intermediary masks. The model has good performance, with Dice scores exceeding 90% for crop and weed segmentation.

[9265] *Bio-inspired Systems and Neuro-engineering: Bridging Biology and Technology*

Mehrzad Mohammadian (university of pavia).

Bio-inspired systems and neuro-engineering represent a rapidly evolving interdisciplinary field that seeks to harness the principles of biological systems to develop innovative technologies. By drawing inspiration from the complexity and efficiency of natural organisms, researchers aim to create advanced systems that mimic biological processes, particularly those of the nervous system. This paper explores the foundational concepts of bio-inspired systems and neuro-engineering, their applications, and the potential future directions of this exciting field. We discuss how these technologies are transforming areas such as robotics, artificial intelligence, medical devices, and neural interfaces, ultimately bridging the gap between biology and engineering.

[9316] *Deploying Vision Foundation AI Models on the Edge. The SAM2 Experience*

Zheshuo Lin (Universitat Politècnica de Catalunya), Ruben Tous (Universitat Politècnica de Catalunya) and Beatriz Otero (Universitat Politècnica de Catalunya).

As AI-driven applications expand across industries, the need for efficient edge computing solutions becomes increasingly critical. Traditional AI models are designed for high-performance cloud infrastructures, but emerging constraints—such as privacy requirements, network limitations, and real-time processing needs—necessitate optimized deployment on resource-constrained edge devices. This study presents a practical experience in adapting Segment Anything Model 2 (SAM2), a vision foundation model, for edge AI environments. The adaptation process involved translating the model to C++ using ONNX Runtime, enabling efficient execution on heterogeneous hardware. Experimental evaluations demonstrate that deploying SAM2 at the edge enhances processing efficiency, reduces reliance on network stability, and improves real-time responsiveness. This research provides valuable insights into AI in pervasive computing environments, contributing to the sustainable and scalable deployment of foundation models on edge devices.

[9342] *A Hybrid ResNet50-LSTM Architecture for Video Sentiment Analysis*

Radu Marian Macovei (National University of Science and Technology Politehnica Bucharest), Dan Popescu (National University of Science and Technology Politehnica Bucharest) and Loretta Ichim (National University of Science and Technology Politehnica Bucharest).

Sentiment analysis has applications in many fields where there is a need for emotion recognition without human intervention. The advances in deep learning implementation have led to higher-performing classification systems for complex input data. From all data modalities that can be used for emo-tion classification, this study focuses on the use of visual data for sentiment analysis. In this paper, we propose a hybrid system, by combining a pre-trained CNN for visual feature extraction and a recurrent neural network for encoding temporal data. The CREMA-D dataset was used to train machine learning models and to validate the system. The results of the CREMA-D visual dataset approach are better than other works.

[9365] *Evaluating Higher-Level and Symbolic Features in Deep Learning on Time Series: Towards Simpler Explainability*

Leonid Schwenke (Osnabrück University), Till Stückemann (Osnabrück University) and Martin Atzmueller (Osnabrück University).

Deep neural networks (DNNs) on time series data are not yet as developed regarding performance and explainability. Hence, more domain-specific approaches are needed, as time series data is less intuitive compared to natural language or image data. For this reason, non-deep-learning approaches apply standardized preprocessing or feature-extraction frameworks to boost performance and interpretability. While preprocessing already showed promising results on DNNs, feature extraction frameworks are still relatively underexplored. Additionally, recently, the advantages of symbolic abstraction for explainability and performance on DNNs have emerged, by showing that disentangled and symbolic concepts are desired for easier interpretability: In this work, we explore and analyse higher-level features in combination with symbolic approximation approaches on time series data. We perform an in-depth performance evaluation using a comprehensive set of datasets from the UCR UEA time series repository and argue towards the explainability benefits of our approach, making the input data more meaningful.

[9402] *Assessing bias in the evaluation of blood glucose prediction models*

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This work demonstrates that evaluating blood glucose level (BGL) prediction models without considering different BGL ranges, hypoglycemia, hyperglycemia, and normoglycemia, introduces bias in assessing the prediction results. Time series data from the T1DiabetesGranada dataset are segmented into windows with a 2-hour history length and prediction horizons of 30 and 60 minutes. An LSTM architecture is used to predict BGL values due to its ability to capture temporal dependencies. The evaluation combines traditional non-clinical metrics (RMSE, MAE, MAPE) with clinical metrics derived from the Clarke Error Grid. The newly proposed evaluation strategy assesses BGL prediction models performance not only across the entire BGL range but also within different BGL ranges. Results indicate that evaluation metrics computed using the entire BGL range may suggest satisfactory BGL prediction model performance. However, significant deficiencies emerge in hypoglycemic ranges, implying that conventional evaluation strategies may overestimate BGL prediction models capabilities.

[9537] *Study on the Impact of Low-Cost Sensor Alternatives for Photovoltaic Panel Modelling in Smart Grid Applications*

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The growing use of photovoltaic systems in smart grids requires the proper monitoring and effective management of power generation. Typically, an accurate photovoltaic model uses radiation sensors to model power generation. However, these sensors are expensive, limiting their use in smaller installations or resource limited environments. This research work investigates low-cost sensors alternatives, specifically ambient and panel temperature sensors, for photovoltaic performance modelling. Two experimental setups were evaluated: one using a traditional radiation sensor and another using only temperature-based sensors. Several regression models including linear, polynomial, ridge, and lasso regression were systematically compared. The results show that radiation sensors have better performance ($R^2 \approx 0.93$, polynomial regression), but temperature sensors still give reasonable accuracy ($R^2 \approx 0.86$). Therefore, temperature sensors are a viable and much less expensive alternative. Future research should explore additional atmospheric variables and other types of machine learning techniques to further improve accuracy in a low-cost approach.

[9565] *Computational Approaches for Resolving the Low-Field Ambiguity in All-Optical Magnetic Field Sensing With NV Centers*

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This paper presents an all-optical setup utilizing NV-rich diamonds for magnetic field measurements in the frequency domain. The study focuses on resolving the low-field ambiguity that occurs in the magnetic field range up to 8 mT. Two approaches are examined to address this issue. The first employs non-linear least squares fitting, providing a straightforward and interpretable solution without the need for machine learning techniques. The second approach uses a fully connected neural network, which achieves higher accuracy in predicting the magnetic field. In order to optimize the network for a possible implementation in microcontrollers, the size of the neural network and the used data are considered more closely. A comparative analysis will outline the strengths and limitations of each method.

[9578] *Methodological framework for the creation of digital twins for photovoltaic power plants*

Anibal Mantilla (Universidad Central del Ecuador), Jorge Azorin-Lopez (University of Alicante) and Jose Garcia Rodriguez (University of Alicante).

We propose a methodological framework to develop a digital twin of a pho-tovoltaic power plant, using electrical and meteorological data. As a case study, the solar plant on Baltra Island in Galapagos is used, where variables such as current, voltage, irradiance and temperature were collected. A neural network LSTM (Long Short-Term Memory) was applied due to its ability to model complex temporal relationships in data series. The methodology in-cludes data collection, synchronisation, cleaning and scaling, time sequence training, LSTM model design and performance evaluation with metrics such as MAE and RMSE. The results show high pre-accuracy in the prediction of generated power. It is concluded that it is feasible to build robust digital twins for photovoltaic systems, although advanced technical skills in AI and data processing are required. This approach offers key benefits for sustainable energy management, maintenance and planning in sensitive environments such as the Galapagos Islands.

[9580] *Improved Post Processing Model for Photovoltaic Power Forecasting based on Clustering*

Angellina Ebenezer Anitha (Hochschule Bielefeld University of Applied Sciences and Arts), Katrin Handel (Hochschule Bielefeld University of Applied Sciences and Arts), Katrin Schulte (Hochschule Bielefeld University of Applied Sciences and Arts) and Jens Haubrock (Hochschule Bielefeld University of Applied Sciences and Arts).

With the increase in volatile power generation from photovoltaic systems, an accurate forecasting of said power is gaining importance to mitigate undesired effects on the electrical grid. However, the accuracy of power forecasts is significantly impaired by uncertainties in weather forecasts and long term recurring effects on the photovoltaic yield like seasonal trends or frequent shading of the system. This paper therefore introduces an optimized post processing model for photovoltaic power forecasts that takes trends in photovoltaic yields into account and thus corrects and improves the original power forecast. Clustering based feature engineering is used to extract an optimal feature for capturing otherwise undetectable trends. The nominal error of the photovoltaic power forecast can thus be reduced from 8.76 % for the initial forecast to 7.67 % for the forecast and optimized post processor.

[9588] *Generative AI for Contextualizing Bronze Age Objects in Historical Scenes*

Mircea-Andrei Radu (University of Craiova), Ionut-Cristian Calinescu (University of Craiova), Nebojsa Bacanin (Singidunum University), Leonard Ionescu (Restoration and Conservation Lab, Oltenia Museum), Lucian Popescu-Vava (Restoration and Conservation Lab, Oltenia Museum) and Catalin Stoean (University of Craiova).

Contextualizing museum objects into their historical scene is important, both for understanding how those items are genuinely used and for testing the capabilities of Stable Difussion (SD) methods to generate historical scenes with unusual, ancient items. For these aims, we propose two approaches based on SD: one that relies on inpainting and outpainting and one that uses LoRA model training and generation again with SD. We make a comparison between the two approaches. We evaluate how these methods excel and fail, respectively, with the help of two cultural heritage experts. They evaluate the produced images based on six criteria that take into account information like historical context alignment, coherence and aesthetic quality, object integration, proportionality, clothing accuracy and atmospheric appropriateness, respectively.

[9713] *Towards a Framework that facilitates the Construction of Image Segmentation Models*

Joaquín Ortíz de Murua (Universidad de La Rioja), Cesar Dominguez (Universidad de La Rioja), Jónathan Heras (Department of Mathematics and Computer Science) and Vico Pascual (Universidad de La Rioja).

Semantic segmentation models based on deep learning techniques have been successfully applied across a wide range of domains. However, their adoption can be challenging for non-expert users due to several factors. These include the need to experiment with different algorithms implemented across heterogeneous libraries, the use of different annotation formats, or the inconsistency in evaluation metrics used across different tools. In this work, we present the first steps towards building an AutoML framework that facilitates the construction of segmentation models implemented across multiple libraries. The framework supports users throughout the entire pipeline including the analysis and split of datasets of images, the training of the models, and their evaluation. Thus, this framework will help to lower the entry barrier for applying state-of-the-art segmentation techniques.

[9864] *Comparison of Hardware Component and Manycore Implementation for Anomaly Detection in Trustworthy System-on-Chips*

Martin Flasskamp (Bielefeld University), Christian Klarhorst (Bielefeld University) and Jens Hagemeyer (Bielefeld University).

Trustworthy embedded systems are essential for ensuring security and reliability in modern System-on-Chip (SoC) architectures. This paper explores hardware and software implementations of a monitoring unit that classifies bus transactions using decision tree algorithms to detect anomalies in real time. The hardware implementation achieves low latency and high throughput, while the software approach provides greater flexibility and scalability on manycore platforms. Experimental results demonstrate significant improvements in detection accuracy and system performance, offering valuable insights into the trade-offs between performance and adaptability in embedded system design. In the analyzed scenario, the hardware implementation achieves one classification per cycle with 13-26 cycles latency, while the manycore solution can be scaled to up to 32 cores. The dedicated hardware implementation can reach a maximum operational frequency of 200-333 MHz on an Xilinx Virtex-7 FPGA, while the CoreVA CPU runs at 100 MHz.

[9880] *TASER-Net: Transformer Based Speech Emotion Recognition*

M Srinivas (National Institute of Technology Warangal), U Shivani Sri Varshini (Manipal Institute of Technology), Pradumya Kumar (National Institute of Technology Warangal) and Jenni K (King Khalid University).

Emotional information is present in every spoken audio event that individuals frequently hear. As a result, Speech Emotion Recognition (SER) has gained widespread recognition. Over the past ten years, this has grown into a significant research topic. Through the use of human voices or everyday conversation, SER can detect people's emotional states. It is essential for developing Human-Computer Interaction (HCI) and signal processing systems. Emotions in humans also evolve with time. Therefore, to comprehend the dependencies in the speech sign over time, a strong model is required. In this work, Transformer-based method using the CNN model in parallel (TASER-Net) method is used for SER. With the use of a parallel CNN model, our novel approach to temporal emotion modelling for SER overcomes information loss from noise and bi-directional propagation while creating multi-scale contextual emotional representations across a range of time frames.

[9881] *Comparative Analysis of Spiking Neurons Mathematical Models Training using Surrogate Gradients Techniques*

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Multimodal data is emerging from different sources and in large quantities, which has allowed researchers to train highly-performing intelligent models and agents. However, the computational and environmental costs of the current deep learning trends are against the sustainability goals set worldwide, including the environmental concerns about its carbon footprint. Spiking neural networks offer a bio-plausible alternative given their low computational needs, hence less carbon emissions. In this work, we analyze the performance of different spiking neurons, propose a new spiking layer implementation trained using surrogate gradients, and test against different feature extraction scenarios in fully connected spiking neural networks. We also introduce a new metric to compare in-model and cross-model for better decisions when designing and training spiking neural networks.

[9895] *Experimental Analysis and Modeling of Electrochemical Oxygen Pump Cell ECOpump*

Ivan Kolesnikov (FH Münster), Nils Höing (FH Münster), Peter Glösekötter (FH Münster) and Tilman Sanders (FH Münster).

This paper describes a prototype of an electrochemical oxy- gen pumping cell, ECOpump, which can be used for both oxygen genera- tion and oxygen removal. Electrochemical impedance spectroscopy (EIS) was used to analyze the ECOpump cell and develop its equivalent circuit model. The development of a neural network is planned to extract the cell parameters from the EIS measurement while the cell is under load.

[9945] *VIDEM: VIDeo Effectiveness and Memorability Dataset*

Rukiye Savran Kızıltepe (Ankara University, Ankara, Türkiye), Sohail Sahab (Hub Productions, London, UK), Rodrigo Valladares Santana (Hub Productions, London, UK), Faiyaz Doctor (University of Essex, Colchester, UK), Kate Paterson (Hub Productions, London, UK), David Hunstone (Hub Productions, London, UK) and Alba García Seco de Herrera (UNED).

Video content has become a crucial tool for marketers seeking to engage audiences and strengthen brand recognition. Nonetheless, creating videos that are both memorable and impactful remains a challenge, highlighting the need for robust datasets to evaluate video and brand memorability. In this paper, we introduce VIDEM (VIDeo Effectiveness and Memorability Dataset), a new dataset designed to advance research on video effectiveness, memorability and brand recognition. VIDEM is the result of a large-scale annotation campaign that employed the Video Effectiveness Measurement Tool (VEMT), which incorporates advanced crowdsourcing techniques and quality control mechanisms. The dataset comprises 424 YouTube videos, annotated by 1403 participants across two main tasks: video memorability and brand memorability. We perform a quantitative statistical analysis to highlight key insights from the dataset. By making VIDEM available at the MediaEval Multimedia Evaluation Benchmark, we foster research on video memorability, brand impact, and marketing analytics, aiding information retrieval and access.

[9990] ***A new approach to detecting occupational diseases using time series***

Antonio Díaz-Longueira (University of A Coruña), Noel Freire-Mahía (University of A Coruña), Oscar Fontenla-Romero (University of A Coruña) and José Luis Calvo-Rolle (University of A Coruña).

Occupational diseases are one of the greatest concerns for any worker, as they significantly affect their quality of life and represent an economic burden on companies and governments. This article proposes an artificial intelligence model capable of predicting a worker's future medical referral, one to two years from now, based on the progress of their medical examinations. To do so, recurrent neural networks with Long Short-Term Memory are used to determine the severity of the referral. The results, although not ideal, indicate a good starting point for the development of more models that allow for personalized prevention of occupational diseases.

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