Book of Abstracts

Wednesday December 6, 2023

WeA1 Imperio A

Deep Learning (DL) 1

Organizer: Sperduti, Alessandro — University of Padova
Organizer: Angelov, Plamen — Lancaster University
Organizer: Principe, Jose C. — University of Florida

13:30-13:50 WeA1.1

A Deep Mixture of Experts Network for Drone Trajectory Intent Classification and Prediction Using Non-Cooperative Radar Data , pp. 1-6

Fraser, Benjamin — Cranfield University
Perrusquia, Adolfo — Cranfield University
Panagiotakopoulos, Dimitrios — Cranfield University
Guo, Weisi — Cambridge University

The intent prediction of unmanned aerial vehicles (UAVs) also known as drones is a challenging task due to the different mission profiles and tasks that the drone can perform. To alleviate this issue, this paper proposes a deep mixture of experts network to classify and predict drones trajectories measured from non-cooperative radars. Telemetry data of open-access datasets are converted to simulated radar tracks to generate a pool of heterogeneous trajectories and construct three independent datasets to train, validate, and test the proposed architecture. The network is composed of two main components: i) a deep network that predicts the class associated to the input trajectories and ii) a set of deep experts models that learns the extreme bounds of the trajectories in different future time steps. The proposed approach is tested and compared with different deep models to verify its effectiveness under different flight profiles and time-windows.

13:50-14:10 WeA1.2

Machine Learning Approaches for Community Detection in Online Social Networks , pp. 7-12

Ribeiro Costa, Aurélio — University of Brasília
Henrique Nogalha de Lima, Rafael — University of Brasília
Ghedini Ralha, Célia — University of Brasília

Network analysis is responsible for taking insights or generating predictions from networked data sources where community detection finds chunks of related data in a network. The importance of community detection spans in different domain applications, from social network formation to protein interaction predictions. This work compares five state-of-the-art solutions to community detection using machine learning approaches in the context of online social networks - GraphGAN, SDNE, ComE, AC2CD, and CLARE. The experiments using real-world online social network datasets (Email-EU-Core, BlogCatalog3, Flickr) with micro-F1, macro-F1, and NMI scores demonstrate that graph neural networks and deep reinforcement learning approaches are better suited for the community detection task than others based on probabilistic or shallow networks.

14:10-14:30 WeA1.3

An Actor-Critic Architecture for Community Detection Ablation Study , pp. 13-18

Henrique Nogalha de Lima, Rafael — University of Brasília
Ribeiro Costa, Aurélio — University of Brasília
Faleiros, Thiago de Paulo — University of Brasília
Ghedini Ralha, Célia — University of Brasília

This article conducts an ablation study of the Actor-Critic Architecture for Community Detection (AC2CD). The AC2CD uses Deep Reinforcement Learning (DRL) and Graph Attention Networks (GAT). Our ablation study method adheres to the principles of explainable artificial intelligence, focusing on assessing performance factors, including execution time, memory usage, and GPU utilization. We carried out experiments using two real-world datasets: Email-Eu-Core (EC), an email network among members of a European research institution (comprising 1,005 nodes, 25,571 edges, and 42 communities) available through the Stanford Snap Project, and a High School contact and friendship network (HS) in Marseilles, France, from December 2013 (comprising 329 nodes, 45,047 edges, and nine communities), obtainable from the Socio Patterns Website. We evaluated performance while considering three hyperparameters: learn_rate (LR), batch_size (BS), and n_games (NG), varying them at 10%, 30%, 50%, and 70%. The LR of 70% yielded optimal results with execution time for both EC and HS datasets. Furthermore, a BS of 70% indicated an ideal balance between execution time, GPU usage, and memory consumption for the HS dataset.

14:30-14:50 WeA1.4

OSVAE-GAN: Orthogonal Self-Attention Variational Autoencoder Generative Adversarial Networks for Time Series Anomaly Detection , pp. 19-24

Li, Zhi — Northeastern University
Xu, Danya — Northeastern Univerisity
Li, Yuzhe — Northeastern University
Chai, Tianyou — Northeastern University
Yang, Tao — Northeastern Univerisity

Time series anomaly detection is a binary classification problem with unbalanced data, which aims to identify data that fall outside of the normal behaviors. Since the proportion of the abnormal data is very small, the cost of labeling all data is prohibitively high. Therefore, unsupervised methods are more suitable than supervised methods. With the rapid development of deep learning, various multivariate time series anomaly detection methods based on deep learning have been proposed. However, existing methods do not fully capture the spatial-temporal correlations and are not robust to noise. To address these issues, we propose an unsupervised anomaly detection method called Orthogonal Self-Attention Variational Autoencoder Generative Adversarial Networks (OSVAE-GAN). To fully extract the spatial-temporal correlations, we use an orthogonal self-attention (OS) mechanism. Moreover, to increase the capability to deal with complex multivariate data, we integrate two generative adversarial networks (GANs) with the variational autoencoder (VAE). Finally, to reduce the influence of noise, we introduce the maximum mean discrepancy (MMD) loss. Experiments are conducted on five public datasets, which show that the proposed method is superior to the existing methods.

14:50-15:10 WeA1.5

Cryptocurrency Portfolio Optimization by Neural Networks , pp. 25-32

Nguyen, Quoc Minh — Tampere University
Tran, Dat Thanh — Tampere University
Kanniainen, Juho — Tampere University
Iosifidis, Alexandros — Aarhus University

Gabbouj, Moncef	Tampere University

Many cryptocurrency brokers nowadays offer a variety of derivative assets that allow traders to perform hedging or speculation. This paper proposes an effective algorithm based on neural networks to take advantage of these investment products. The proposed algorithm constructs a portfolio that contains a pair of negatively correlated assets. A deep neural network, which outputs the allocation weight of each asset at a time interval, is trained to maximize the Sharpe ratio. A novel loss term is proposed to regulate the network's bias towards a specific asset, thus enforcing the network to learn an allocation strategy that is close to a minimum variance strategy. Extensive experiments were conducted using data collected from Binance spanning 19 months to evaluate the effectiveness of our approach. The backtest results show that the proposed algorithm can produce neural networks that are able to make profits in different market situations.

15:10-15:30 WeA1.6

Physics Informed Data Driven Techniques for Power Flow Analysis , pp. 33-40

Parodi, Guido	University of Genoa
Oneto, Luca	University of Genoa
Coraddu, Andrea	Delft University of Technology
Ferro, Giulio	University of Genoa
Zampini, Stefano	University of Genoa
Robba, Michela	University of Genoa
Anguita, Davide	University of Genoa

The last decade has seen significant changes in the power grid complexity due to the increased integration of multiple heterogeneous distributed energy resources. Accurate and fast power flow analysis tools have then become essential to guarantee grid stability, reliable operation, strategic planning, and market strategies. State-of-the-art approaches to power flow analysis are based on iterative numerical techniques which exhibit high accuracy but slow-, or even no-, convergence. For this reason, researchers have investigated the use of data-driven techniques that, while exhibiting lower accuracy with respect to iterative numerical ones, have the advantage of being extremely fast. To address the lack of accuracy, physics-informed data-driven techniques, i.e., techniques that leverage both the data and domain knowledge to generate simultaneously fast and accurate models, have been proposed. Nevertheless, these works exhibit two main limitations: i) they do not fully leverage the physical knowledge, and ii) they do not fairly compare the different approaches. In this paper, we propose a novel physics informed data-driven model able to address both limitations by fully leveraging the physical knowledge into the data-driven, i.e., constraining the model and augmenting the available data, and proposing a framework able to fairly compare the different approaches proving the actual effectiveness of the proposal. Results on the IEEE 57 realistic power network will support the proposal.

WeA2 Imperio B

CI for Brain Computer Interfaces (CIBCI)

Organizer: Wang, Yu-Kai	University of Technology Sydney
Organizer: Deligianni, Fani	University of Glasgow

13:30-13:50 WeA2.1

Integrated Connectivity-Based Stacking Ensemble Learning with GCNNs for EEG Representation , pp. 41-46

Almohammadi, Abdullah	CIBCI Lab, Faculty of Engineering and Information Technology, Un
Wang, Yu-Kai	CIBCI Lab, Faculty of Engineering and Information Technology, Un

This study proposes a novel approach that combines stacking ensemble learning with Graph Convolutional Neural Networks (GCNNs) to enhance the classification accuracy of Motor Imagery (MI) tasks in supporting individuals with injuries or impairments, enabling more effective rehabilitation and assistance. The method integrates both structural and functional connectivity information to leverage the benefits of GCNNs and ensemble learning techniques. The BCI Competition IV-2a dataset is used for evaluation. The approach employs a stacked ensemble model consisting of nine baseline models and six combining meta-models, including Logistic Regression, Neural Networks, Support Vector Machines, Random Forest, K-Nearest Neighbor, and Gradient Boosting Machines. By leveraging information from both structural and functional connectivity, the GCNNs extract meaningful features from MI data, leading to improved classification accuracy. The stacking ensemble learning technique combines multiple GCNN models trained on different connectivity aspects, resulting in a robust and accurate classifier. The fusion of structural connectivity (ADJ-CNNM) capturing anatomical connections and functional connectivity (PLV-CNNM) measuring brain activity synchronization enables a comprehensive analysis of MI data. The proposed approach effectively captures both local and global connectivity patterns, addressing the challenges associated with MI data analysis. By considering both types of connectivity, a holistic understanding of the dynamics of the underlying brain network during MI tasks is achieved. Experimental results demonstrate the effectiveness of the proposed approach, achieving an accuracy of 86.23% with K-Nearest Neighbor as the meta-model. Comparisons with state-of-the-art and baseline methods on the same dataset validate the approach's superiority, emphasizing the importance of GCNNs and stacking ensemble learning for accurate MI task classification.

13:50-14:10 WeA2.2

Resting-State EEG in the Vestibular Region Can Predict Motion Sickness Induced by a Motion-Simulated In-Car VR Platform , pp. 47-52

Li, Gang	University of Glasgow
Wang, Yu-Kai	University of Technology, Sydney
McGill, Mark	University of Glasgow
Pöhlmann, Katharina	KITE Research Institute
Brewster, Stephen	University of Glasgow
Pollick, Frank	University of Glasgow

Monitoring in-car VR motion sickness (VRMS) by neurophysiological signals is a formidable challenge due to unavoidable motion artifacts caused by the moving vehicle and necessary physical movements by the user to interact with the VR environment. Therefore, this paper for the first time investigates if resting-state neurophysiological features and self-reports of stress levels collected prior to exposure to a motion-simulated in-car VRMS induction platform could predict final motion sickness ratings. Our results of linear regression modeling show that the traditional EEG power spectrum was the only resting-state feature set that could predict in-car VRMS ratings. Further, the best regression result was achieved by beta power spectrum in the left parietal area with adjusted R2=22.6% versus 11.6% in the right. This result not only confirmed the left parietal involvement in motion sickness susceptibility observed in a previous resting-state fMRI study, but also advanced that methodology to mobile neurotechnologies, represented by mobile EEG, referenced by other types of resting-state features. Together, this study may offer a new mobile neurotechnology-based approach to predict passengers' VRMS levels before they start to use VR apps in a moving vehicle.

14:10-14:30 WeA2.3

EEG-Based TNN for Driver Vigilance Monitoring , pp. 53-57

Sia, Justin	University of Technology Sydney
Chang, Yu-Cheng	University of Technology Sydney
Lin, Chin-Teng	University of Technology Sydney
Wang, Yu-Kai	University of Technology Sydney

Transformer neural network (TNN) has demonstrated its remarkable capacity to analyze and discern complex sequential datasets. This approach has achieved unprecedented success, particularly in the

domain of natural language processing (NLP). TNN has since consistently proven to perform remarkably in other fields where long-term dependencies in the data are prevalent. Electroencephalography (EEG) data has historically posed a challenge for even modern deep neural networks to classify as EEG is notably complex and noisy, making training laborious and time-consuming. Though, there has been significant research done recently into the application of TNNs in EEG classification, often the task involved does not infer the TNN's ability for long-term dependencies. In this paper, we propose a TNN-based model for EEG-based driver vigilance monitoring, emphasizing the classification of driver vigilance states. This study utilized the data of 11 subjects taken from a public EEG dataset, focusing solely on single-channel analysis. Results indicate that the proposed TNN model can achieve average accuracies of up to 92.69% for Single-Subject analysis, 94.09% for Cross-Subject analysis and 74.74% for Leave-One-Subject-Out analysis, which surpasses state-of-the-art methods. The proposed TNN model's potential lies in not only driver vigilance state monitoring but also paving the way for broader applications of biosignal processing.

14:30-14:50 WeA2.4

Residual Attention Module on EEGNet for Brain-Computer Interface , pp. 58-63

dos Santos, Davi Esteves — Federal University of Juiz De Fora
de Souza, Gabriel Henrique — Federal University of Juiz De Fora
Bernardino, Heder — Federal University of Juiz De Fora
Vieira, Alex Borges — Federal University of Juiz De Fora
Motta, Luciana Paixão — Federal University of Juiz De Fora

Brain-computer interfaces (BCI) allow for the brain to communicate with electronic devices. Concerning the BCI paradigms, motor imagery uses brain signals to decode an imagined movement. However, this is a hard task given the low signal-to-noise ratio. Usually, the main steps in BCI models are pre-processing, feature extraction, and classification. In recent years, Convolutional Neural Networks (CNNs) have been gaining relevance in several areas of science due to their feature extraction, translation invariance, and parameter sharing capabilities. Another, more recent way of feature extraction is using attention mechanisms, which are layers of neural networks based on human attention and have the ability to highlight important features. A variation of the attention mechanism is the Convolutional Block Attention Module, which combines the CNN structure with the attention mechanism. In this work, we propose a new model that joins the core architecture of EEGNet, a compact CNN widely used in the literature, with the Convolutional Block Attention Module and residual connections. The residual connections were introduced to lower data degradation throughout the model. The results highlight the residual connection's importance for the performance of the model. The proposed model obtained a kappa result 5.2% better than the EEGNet with a p-value less than 0.01 on BCI Competition IV dataset 2a, which is a well-known dataset for Motor Imagery. Furthermore, the proposal was better than EEGNet for most subjects and had the best-worst case.

14:50-15:10 WeA2.5

Quantitative Quality Assessment for EEG Data: A Mini Review , pp. 64-68

Wei, Chun-Shu — National Yang Ming Chiao Tung University

Electroencephalography (EEG) is an essential neuromonitoring modality, deeply integrated across scientific disciplines such as psychology, cognitive science, computational neuroscience, neurology, and psychiatry. Its relevance has surged with the rise of brain-computer interfaces. However, the potential of non-invasive EEG is hindered by compromised signal quality compared to invasive methods. The distinction between the modest EEG source amplitudes and the pronounced magnitudes of non-EEG physiological signals and environmental interferences complicates the analysis. The coexistence of subtle neural signals and prominent artifacts, both intrinsic and acquired, characterizes EEG signal processing. Various artifact management techniques have been proposed, yet the pursuit of EEG signal quality assessment remains underexplored. This mini-review addresses this gap by emphasizing the vital role of quality assessment in EEG recordings. The article highlights the significance of rigorous signal evaluation, emphasizing reliable EEG data. It also encapsulates evolving quantitative methodologies that bolster signal fidelity assessment. By delving into these aspects, the article presents a compact overview of ongoing advancements in quantitative EEG quality assessment techniques in the research field of EEG analysis and applications.

15:10-15:30 WeA2.6

Adversarial Attention for Human Motion Synthesis , pp. 69-74

Malek-Podjaski, Matthew — University of Glasgow
Deligianni, Fani — University of Glasgow

Analysing human motions is a core topic of interest for many disciplines, from Human-Computer Interaction, to entertainment, Virtual Reality and healthcare. Deep learning has achieved impressive results in capturing human pose in real-time. Acquiring human motion datasets is highly time consuming, challenging, and expensive. Hence, human motion synthesis is a crucial research problem within deep learning and computer vision. We present a novel method for controllable human motion synthesis by applying attention-based probabilistic deep adversarial models with end-to-end training. We show that we can generate synthetic human motion over both short- and long-time horizons through the use of adversarial attention.

WeA3 — Imperio C

CI for Financial Engineering and Economics (CIFEr) 1

Organizer: Thulasiram, Ruppa — University of Manitoba
Organizer: Alexandrova Kabadjova, Biliana — Banco De México

13:30-13:50 WeA3.1

Comparing Effects of Price Limit and Circuit Breaker in Stock Exchanges by an Agent-Based Model , pp. 75-82

Mizuta, Takanobu — SPARX Asset Management Co., Ltd
Yagi, Isao — Kogakuin University

The prevention of rapidly and steeply falling market prices is vital to avoid financial crisis. To this end, some stock exchanges implement a price limit or a circuit breaker, and there has been intensive investigation into which regulation best prevents rapid and large variations in price. In this study, we examine this question using an artificial market model that is an agent-based model for a financial market. Our findings show that the price limit and the circuit breaker basically have the same effect when the parameters, limit price range and limit time range, are the same. However, the price limit is less effective when limit the time range is smaller than the cancel time range. With the price limit, many sell orders are accumulated around the lower limit price, and when the lower limit price is changed before the accumulated sell orders are cancelled, it leads to the accumulation of sell orders of various prices. These accumulated sell orders essentially act as a wall against buy orders, thereby preventing price from rising. Caution should be taken in the sense that these results pertain to a limited situation. Specifically, our finding that the circuit breaker is better than the price limit should be adapted only in cases where the reason for falling prices is erroneous orders and when individual stocks are regulated.

13:50-14:10 WeA3.2

Fundamental, Technical and Sentiment Analysis for Algorithmic Trading with Genetic Programming , pp. 83-89

Christodoulaki, Evangelia Paraskevi — University of Essex
Kampouridis, Michael — Univ. of Essex, Essex, UK

Algorithmic trading is a topic with major developments in the last years. Investors rely mostly on indicators derived from fundamental (FA) or technical analysis (TA), while sentiment analysis (SA) has also received attention in the last decade. This has led to great financial advantages with algorithms being the main tool to create pre-programmed trading strategies. Although the three analysis types have been mainly considered individually, their combination has not been studied as much. Given the ability of each individual analysis type in identifying profitable trading strategies, we are motivated to investigate if we can increase the profitability of such strategies by combining their indicators. Thus, in this paper we propose a novel Genetic Programming (GP) algorithm that combines the three analysis types and we showcase the advantages of their combination in terms of three financial metrics, namely Sharpe ratio, rate of return and risk. We conduct experiments on 30 companies and based on the results, the combination of the three analysis types statistically and significantly outperforms their individual results, as well as their pairwise combinations. More specifically, the proposed GP algorithm has the highest mean and median values for Sharpe ratio and rate of return, and the lowest (best) mean value for risk. Moreover, we benchmark our GP algorithm against multilayer perceptron and support vector machine, and show that it statistically outperforms both algorithms in terms of Sharpe ratio and risk.

14:10-14:30 WeA3.3

Stock Volatility Forecasting with Transformer Network , pp. 90-96

Sababipour ASL, GOLNAZ	University of Manitoba
Thulasiram, Ruppa	University of Manitoba
Thavaneswarn, Aerambamoorthy	University of Manitoba

Financial market is in general volatile with so many uncertainties and volatility is one of the main measures of uncertainty in the market among other measures. Hence, forecasting volatility is a critical component in risk management, optimizing portfolios, and in algorithmic trading among other financial problems. There have been few machine learning and artificial intelligence techniques used in the literature for the forecasting problem. Transformer Network (TN) architecture is one of newest such techniques proposed. In this work, we utilized this architecture with multi-head attention mechanism for volatility forecasting. To enhance the performance of the TN, we incorporated different variations of the feed forward layer. The performance of three distinct TN models was evaluated by implementing three different deep learning layers (CNN, LSTM, and a hybrid layer (CNN-LSTM)) in the encoder block of TN as the feed forward layer. The results clearly demonstrate that the TN model with the hybrid layer (CNN-LSTM) outperformed the other models, including a recently proposed data-driven approach.

14:30-14:50 WeA3.4

Portfolio Diversification with Clustering Techniques , pp. 97-102

Dip Das, Joy	University of Manitoba
Bowala Mudiyanselage, Sulalitha	University of Manitoba
Thulasiram, Ruppa	University of Manitoba
Thavaneswarn, Aerambamoorthy	University of Manitoba

Diversifying asset allocation is a crucial aspect of building a profitable portfolio. The resiliency of the portfolio depends on the optimization techniques as well as algorithms used in the asset allocation. Clustering techniques would help in designing a diversified portfolio. This study investigates the resiliency of different traditional and recently proposed data-driven portfolio techniques in conjunction with four clustering techniques under varying market conditions. The novelty of the study is to present a resilient portfolio optimization using DBSCAN and Affinity Propagation clustering techniques.

14:50-15:10 WeA3.5

Facilitating Investment Strategy Negotiations through Logic , pp. 103-108

Callewaert, Benjamin	KU Leuven
Decleyre, Nicholas	Intelli-Select
Vandevelde, Simon	KU Leuven
Nuno, Comenda	Intelli-Select
Coppens, Bart	Intelli-Select
Vennekens, Joost	KULeuven

In the process of negotiating investment strategies between a fund and investors, establishing trust, transparency, traceability, and correctness among the involved parties is crucial to ensure smooth and successful outcomes. The adoption of logic-based AI, with its reliability, consistency, and explainability, can serve as a crucial catalyst to assist parties during negotiations by providing useful insights and explainable suggestions. This paper showcases how various Knowledge Representation and Reasoning (KRR) techniques can be leveraged to assist financial parties during investment negotiations. It demonstrates the use of logical definitions to represent complex financial investment strategies, allowing parties to gain a comprehensive understanding of the policies under discussion. Furthermore, automated reasoning is used to generate useful insights and actionable information enabling informed decision-making and enhancing the overall negotiation process.

15:10-15:30 WeA3.6

FinSenticNet: A Concept-Level Lexicon for Financial Sentiment Analysis , pp. 109-114

Du, Kelvin	Nanyang Technological University
Xing, Frank	National University of Singapore
Mao, Rui	Nanyang Technological University
Cambria, Erik	Nanyang Technological University

Sentiment lexicons are important tools for research involving opinion mining and sentiment analysis. They are highly inter-operable, and address critical limitations of learning-based or large language model-based sentiment analysis, providing better reproducibility and explainability. Existing financial sentiment lexicons, manually crafted or automatically constructed, primarily comprise single-word entries despite the fact that jargon, terminologies, and collocations in finance are often multi-word expressions. To address this gap, we present FinSenticNet, a concept-level domain-specific lexicon specifically designed for financial sentiment analysis, where over 65% entries are multi-word expressions. Our construction approach is semi-supervised: the framework consists of a concept parser, a sentiment seeds generation module, and a semantic graph construction module. Each concept (graph node) is subsequently classified in terms of its polarity using the Label Propagation Algorithm and Graph Convolutional Network. Compared to other financial sentiment lexicons, FinSenticNet captures domain-specific language features and has a broader coverage. We demonstrate this with superior evaluation results, i.e., sentiment analysis accuracy and F-scores, on multiple well-received benchmark datasets.

WeA4 Constitución A

CI for Human-Like Intelligence (CIHLI)

Organizer: Mańdziuk, Jacek Warsaw University of Technology

13:30-13:50 WeA4.1

A Definition and a Test for Human-Level Artificial Intelligence , pp. 115-120

Park, Deokgun	University of Texas at Arlington
Mondol, Md Ashaduzzaman Rubel	University of Texas at Arlington
Pothula, Aishwarya	University of Texas at Arlington
Islam, SM Mazharul	University of Texas at Arlington

Although AI research aims to build human-level artificial intelligence, it was not clearly defined. Furthermore, many tests for HLAI have been proposed, but those are not practical and thus are not used in evaluating AI research. We conjecture that learning from others' experience with the language is the essential characteristic that distinguishes human intelligence from the rest. Humans can update the behavior policy with verbal descriptions as if they had experienced it first-hand. We present a classification of intelligence according to how individual agents learn and propose a definition and a test for HLAI. The main idea is that language acquisition without explicit rewards can be a sufficient test for HLAI. We built a simulated environment to conduct this test practically, and we hope other researchers can use it to facilitate the research on HLAI.

13:50-14:10 WeA4.2

Why Is That a Good or Not a Good Frying Pan? – Knowledge Representation for Functions of Objects and Tools for Design Understanding, Improvement, and Generation , pp. 121-128

Ho, Sengbeng — Institute of High Performance Computing

The understanding of the functional aspects of objects and tools is of paramount importance in supporting an intelligent system in navigating around in the environment and interacting with various objects, structures, and systems, to help fulfil its goals. A detailed understanding of functionalities can also lead to design improvements and novel designs that would enhance the operations of AI and robotic systems on the one hand, and human lives on the other. This paper demonstrates how a particular object – in this case, a frying pan – and its participation in the processes it is designed to support – in this case, the frying process – can be represented in a general function representational language and framework, that can be used to flesh out the processes and functionalities involved, leading to a deep conceptual understanding with explainability of functionalities that allows the system to answer “why” questions – why is something a good frying pan, say, or why a certain part on the frying pan is designed in a certain way? Or, why is something not a good frying pan? This supports the re-design and improvement on design of objects, artifacts, and tools, as well as the potential for generating novel designs that are functionally accurate, usable, and satisfactory.

14:10-14:30 WeA4.3

Appearance-Based Gaze Estimation Enhanced with Synthetic Images Using Deep Neural Networks , pp. 129-134

Herashchenko, Dmytro — Comenius University Bratislava

Farkaš, Igor — Comenius University Bratislava

uman eye gaze estimation is an important cognitive ingredient for successful human-robot interaction, enabling the robot to read and predict human behavior. We approach this problem using artificial neural networks and build a modular system estimating gaze from separately cropped eyes, taking advantage of existing well-functioning components for face detection (RetinaFace) and head pose estimation (6DRepNet). Our proposed method does not require any special hardware or infrared filters but uses a standard notebook-builtin RGB camera, as often approached with appearance-based methods. Using the MetaHuman tool, we also generated a large synthetic dataset of more than 57,000 human faces and made it publicly available. The inclusion of this dataset (with eye gaze and head pose information) on top of the standard Columbia Gaze dataset into training the model led to better accuracy with a mean average error below two degrees in eye pitch and yaw directions, which compares favourably to related methods. We also verified the feasibility of our model by its preliminary testing in real-world setting using the builtin 4K camera in NICO semi-humanoid robot's eye.

14:30-14:50 WeA4.4

Comparing Behaviour Tree and Hierarchical Task Network Planning Methods for Their Impact on Player Experience , pp. 135-139

Kedalo, Alexander — Innopolis University

Zykov, Andrey — Innopolis University

Aslam, Hamna — Innopolis University

Mazzara, Manuel — Innopolis University

The AI in games has a large impact on the player's experience, but the large variety of available AI implementation methods makes it difficult to determine which one(s) to use in any particular project, and the differences in their impact on players are mostly unstudied. This paper presents a comparative study to analyse the effects of Behaviour Tree AI and Hierarchical Task Network Planning AI on players experiences. The study participants (players) were given two prototypes of a third-person shooter game, each utilising different AIs, to play and give feedback on. According to the results obtained, players did not notice any major differences between the two prototypes, leading us to believe that the Behaviour Tree AI may be a better solution in most cases, as it is easier to implement.

14:50-15:10 WeA4.5

Comparative Analyzes of Human and Machine Randomness: Insights into Decision-Making Models , pp. 140-145

Marshallowitz, Sofia Tzvika — Federal University of Rio Grande Do Sul

PIGNATON DE FREITAS, EDISON — Federal University of Rio Grande Do Sul

Human decision theory focuses on the reasoning behind the choices an individual makes. Human decision modelling is developed through mental models and can be modelled in different ways, such as fuzzy logic, deductive logic and probabilistic logic. On the other hand, machine learning techniques use a variety of statistical, probabilistic, and optimization methods to learn and detect useful patterns. In this context, this study investigates the complexities of human and machine randomness, utilizing two distinct datasets: one representing the perceived randomness of humans through the selection of nine numbers and the other encapsulating algorithmically generated random numbers from machines. The comparison of these datasets aims to understand the similarities and divergences between human (brain) randomness and machine randomness, primarily through the lens of fairness, neurocomputational, and decision-making simulations.

15:10-15:30 WeA4.6

Superiority of Neural Networks for Trading Volume Forecasts of Stocks and Cryptocurrencies , pp. 146-151

Bowala Mudiyanselage, Sulalitha — University of Manitoba

Thavaneswaran, Aerambamoorthy — University of Manitoba

Thulasiram, Ruppa — University of Manitoba

Hoque, Md Erfanul — Thompson Rivers University

Paseka, Alex — University of Manitoba

Trading volume is an important variable to successfully capture market risks along with asset price/returns. Recently, there has been a growing interest in deep learning methods to forecast the trading volume of stocks using historical volatility as a feature. Unlike the existing work, a novel data-driven log volatility forecast is proposed in this paper as an extra feature to improve trading volume forecasts. Recently, neural networks for volatility and neural nets for electricity demand forecasting, constructed with nnetar function, have shown to be superior. The novelty of this paper is to demonstrate the neural network based on the nnetar function from the forecast package in R for trading volume forecast shows superiority over the other neural network.

WeA5 Constitución B

CI for Industrial Process (CIIP) 1

Organizer: Yu, Wen — CINVESTAV-IPN

Organizer: Ding, Jinliang — Northeastern University

13:30-13:50 WeA5.1

Multi-Objective Evolution for Automated Chemistry , pp. 152-157

Aslan, Bilal	University of Cape Town
Soares Correa da Silva, Flavio	University of São Paulo
NITSCHKE, GEOFFREY	University of Cape Town

A fundamental problem in chemical product design is how to suitably identify chemical compounds that optimise multiple properties for a given application whilst satisfying relevant constraints. Current product synthesis generally uses trial-and-error experimentation, requiring lengthy and expensive research and development efforts. This paper introduces a novel computational chemistry approach for product design combining geometric deep learning for inference of property values and evolutionary multi-objective optimisation for identification of products of interest. Preliminary empirical results indicate that the proposed approach can be used to optimise product design considering multiple objectives and constraints given incomplete molecular attribute information.

13:50-14:10 WeA5.2

Type-2 Fuzzy LSTM for Nonlinear System Modeling , pp. 158-163

Francisco, Vega	CINVESTAV-IPN
Li, Xiaoou	CINVESTAV-IPN
Ovilla-Martinez, Brisbane	CINVESTAV-IPN
Yu, Wen	CINVESTAV-IPN

Type-2 fuzzy systems have a great adoption in different branches of engineering, due to the fact that this type of fuzzy systems are very well suited to tasks related to nonlinear systems. Data driven models like neural networks and fuzzy systems have some disadvantages, such as the high and uncertain dimensions and complex learning process. In this paper, we show the advantages of type-2 fuzzy systems over type-1 fuzzy systems in modeling nonlinear systems. We combine Type-2 Takagi-Sugeno fuzzy model with the popular deep learning model, LSTM (long-short term memory), to overcome the disadvantages fuzzy model and neural network model. We propose a fast and stable learning algorithm for this model. Comparisons with others similar black-box and grey-box models are made, in order to show the advantages of the type-2 fuzzy LSTM neural networks.

14:10-14:30 WeA5.3

Imitation Learning of Diverse Expert Behaviors for Advanced Machining System Optimizations , pp. 164-169

Xiao, Qinge	Shenzhen Institute of Advanced Technology
Yang, Zhile	Shenzhen Institute of Advanced Technology
Wu, Chengke	Shenzhen Institute of Advanced Technology
Guo, Yuanjun	Shenzhen Institute of Advanced Technology

The potential intelligence behind advanced machining systems (AMSs) offers positive contributions toward process improvement. Compared with conventional meta-heuristics, imitation learning (IL) appears to provide a more powerful tool to exploit such intelligence by observing demonstrations from technologists. This paper proposes a novel IL-based policy search algorithm that equips the agent with the optimization knowledge by executing upper-level policy learning to generate an imitation policy distribution with diverse decision behaviors. The experimental results of heavy cutting scenarios show that the proposed method rather than meta-heuristics is more viable for solving AMS optimization problems.

14:30-14:50 WeA5.4

Carbon Monoxide Emission Prediction Based on Concept Drift Detection Using KPCA for Municipal Solid Waste Incineration Processes , pp. 170-173

Runyu, Zhang	Beijing University of Technology
Jian, Tang	Beijing University of Technology
Xia, Heng	Beijing University of Technology

Municipal solid waste incineration (MSWI) technology has developed rapidly worldwide. Carbon monoxide (CO) is one of the to be controlled key operating index of such processes. CO emission concentration prediction is a challenge problem duo to its large fluctuation range. A new CO emission concentration prediction method based on concept drift detection using kernel principal component analysis (KPCA) is proposed. The proposed approach includes off-line model construction module, on-line concept drift detection prediction and updating module. First, we construct the LSTM-based CO prediction model using historical data and KPCA-based concept drift detection model for calculating the evaluation index. Then, recursive KPCA is used to adaptive monitor the concept drift of the time-varying process. Finally, based on continuous updating of the historical LSTM mode with the concept drift samples, we achieve higher prediction accuracy. The rationality and validity are verified with the actual data of MSWI processes.

14:50-15:10 WeA5.5

Online Soft Sensing of Dioxin Emission Based on Fast Tree BLS and Robust PCA , pp. 174-179

Xia, Heng	Beijing University of Technology
Jian, Tang	Beijing University of Technology
Runyu, Zhang	Beijing University of Technology

Municipal solid waste incineration (MSWI) is a crucial technology for waste treatment in densely populated cities. It plays a vital role in contributing to the hot concept of waste-to-energy. However, the effectively measuring of dioxins (DXN) emission from MSWI plants presents a complex challenge duo to its high economical cost and large lag time. To address the challenge, we propose a soft sensing method of DXN emission concentration based on the fast tree broad learning system (FTBLS) and the robust principal component analysis (RPCA). FTBLS can swiftly construct the DXN emission model with increment learning for obtaining accurate measuring results. RPCA is capable decomposing high-dimensional small sample data into low-rank and noise matrices, achieving robust operation condition drift detection in the presence of noise process data. The similarity estimation is used to aid the soft measuring value's obtainment for concept drift sample. The experiment and application results demonstrate the effectiveness of our proposed online soft sensing approach.

15:10-15:30 WeA5.6

Leveraging Ensemble Structures to Elucidate the Impact of Factors That Influence the Quality of Ultra–High Performance Concrete , pp. 180-187

Rezazadeh P., Farzad	University of Kassel
Duerrbaum, Axel	University of Kassel
Zimmermann, Gregor	G.tecz Engineering GmbH
Kroll, Andreas	University of Kassel

Concrete is an essential material ubiquitously employed in construction. Yet, deciphering the factors that influence its quality is a formidable challenge due to partially understood physical relationships, the high dimensionality of the data, and its limited availability. This study introduces an ensemble framework designed to address these challenges. It uses a combination of individual methods within an ensemble configuration to identify the critical features that determine concrete quality. Within this framework, diverse base methods are harmonized using an average-based technique, leading to a robust final verdict. After selecting the potential influencing factors, 50 experiments are conducted using the Taguchi Orthogonal Array (L-50) to generate the data points. The proposed ensemble learning framework underscores the substantial impact of storage conditions during the curing time on the final quality

of concrete.

WeA6	Constitución C
CI in Vehicles and Transportation Systems (CIVTS)	
Organizer: Yi Lu, Murphey	University of Michigan-Dearborn
Organizer: wei, xian	CAS

13:30-13:50 WeA6.1

Estimation of Drivers' Cognitive Load through Foot Placement Analysis in a Car-Sharing Service , pp. 188-193

Sukegawa, Takuya	The University of Aizu
Hashimoto, Yasuhiro	The University of Aizu
Hata, Keisuke	University of Aizu

Driver behavior plays a pivotal role in preventing traffic accidents. Unlike previous studies primarily focused on observable car maneuvers, our research delves into actions that precede observable car maneuvers or remain unmanifested. We collected data from a car-sharing service frequently used by university students, meticulously analyzing the frequency of pedal changes through foot camera images. This dataset was compared with pedal depression data from the Controller Area Network (CAN) bus to detect potential safety risks attributable to cognitive load.

Our investigation revealed the existence of unrecorded driver behaviors that could potentially lead to traffic accidents. Even in the absence of recorded pedal operations in the CAN bus data, we identified locations with high pedal change frequency, signifying elevated cognitive load.

We utilized foot camera footage to track pedal changes and correlated this data with the frequency of pedal depressions recorded in the CAN bus data. This analysis evaluates the cognitive load by the gap between the frequency of pedal changes in the CAN bus data and the foot camera. As a significant outcome of our research, we developed a practical spatial map illustrating the distribution of cognitive load, as estimated through our foot placement analysis.

Notably, this cognitive load distribution map closely aligned with local knowledge and provided intuitively interpretable scenarios. It emerged as a valuable tool in identifying potential high-risk zones on the road, thereby contributing to ongoing efforts to enhance driving safety. Our findings substantially impact traffic safety measures and offer innovative insights into mitigating accidents by addressing cognitive load-induced driver behaviors.

13:50-14:10 WeA6.2

A Novel Traffic Sign Dataset with Condition Annotations , pp. 194-199

Sandhu, Hanni	IAV GmbH
Kühne, Joana	IAV GmbH
Sawade, Oliver	IAV GmbH
Stellmacher, Martin	IAV GmbH
Matthes, Elmar	IAV GmbH
Hellwich, Olaf	Technical University Berlin

To develop robust and secure automated transportation systems, Traffic Sign Detection and Recognition (TSDR) is a key part. It plays a crucial role in Advanced Driver Assistance Systems (ADAS), self-driving vehicles and traffic safety. However, the task of TSDR can be challenging due to traffic signs being subject to damages, discoloration, vandalism and occlusion. Even though a lot of progress is made in both research areas of Traffic Sign Detection (TSD) and Traffic Sign Recognition (TSR), no study explicitly deals with the problem of qualitative poor traffic signs appearing in real-world scenarios. This can be assigned to the lack of an extensive traffic sign dataset containing flawless signs as well as imperfect signs. Neural networks trained exclusively on untainted data might fail at detecting flawed signs as they occur in real-world scenarios. Therefore, in this paper, a novel traffic sign dataset with condition annotations is proposed, indicating if a sign is good, discolored, vandalized, dirty or occluded. The custom dataset is created with a semi-supervised approach, in which machine learning models are trained to classify traffic signs in the condition categories. The resulting dataset can be used as basis for more precise traffic sign recognition as well as traffic sign condition classification which can be useful for maintenance planning. The dataset includes approx. 20.000 images of 10 sign classes, where 70% of data is incorporated in the training set, 10% in the validation set and 20% in the test set.

14:10-14:30 WeA6.3

Airport Ground Movement Optimization Revisited: Coupling Airport Runway Spacing to Multi-Objective Routing and Scheduling through Genetic Algorithms , pp. 200-206

Parra Perea, Francisco Ruben	Queen Mary University of London
Chen, Jun	Queen Mary University of London
Weiszer, Michal	University of Westminster
Korna, John	NATS
Cannon, Richard	NATS

A routing and scheduling optimization approach for the airport ground movement problem considering runway spacing is introduced. An integrated modeling that considers both the routing of aircraft and runway required separations, is implemented through Aircraft Multi-Objective Optimization Algorithm AMOA* and a correct spacing validation module, coupled by a genetic algorithm in search of real-world feasible, yet optimized solutions, for a modern-day aviation setting based on London's Stansted Airport. The proposed genetic algorithms successfully optimize taxiing time and fuel consumption for different airport traffic scenarios while fully respecting runway separation constraints. The difference between algorithms is emphasized to stress the risk of over-evaluation of savings by overlooking real-world operational conditions in the modeling phase of the problem.

14:30-14:50 WeA6.4

HSI-Drive V2.0: More Data for New Challenges in Scene Understanding for Autonomous Driving , pp. 207-214

Gutiérrez-Zaballa, Jon	University of the Basque Country
Basterretxea, Koldo	University of the Basque Country
Echanobe, Javier	University of the Basque Country
Martínez, M. Victoria	University of the Basque Country
Martinez-Corral, Unai	University of the Basque Country

We present the updated version of the HSI-Drive dataset aimed at developing automated driving systems (ADS) using hyperspectral imaging (HSI). The v2.0 version includes new annotated images from videos recorded during winter and fall in real driving scenarios. Added to the spring and summer images included in the previous v1.1 version, the new dataset contains 752 images covering the four seasons. In this paper, we show the improvements achieved over previously published results obtained on the v1.1 dataset, showcasing the enhanced performance of models trained on the new v2.0 dataset. We also show the progress made in comprehensive scene understanding by experimenting with more capable image segmentation models. These models include new segmentation categories aimed at the identification of essential road safety objects such as the presence of vehicles and road signs, as well as highly vulnerable groups like pedestrians and cyclists. In addition, we provide evidence of the performance and robustness of the models when applied to segmenting HSI video sequences captured in various environments and conditions. Finally, for a correct assessment of the results described in this work, the constraints imposed by the processing platforms that can sensibly be deployed in vehicles for ADS must be taken into account. Thus, and although implementation details are out of the scope of this paper, we focus our research on the development of computationally efficient, lightweight ML models that can eventually operate at high throughput rates. The dataset and some examples of segmented videos are available in https://ipaccess.ehu.eus/HSI-Drive/.

14:50-15:10 WeA6.5

Multi-Sensor Object Detection System for Real-Time Inferencing in ADAS , pp. 215-220

Mandumula, Sai Rithvick	Kettering University
Jungme, Park	Kettering University
Asolkar, Ritwik Prasad	Kettering University
Somashekar, Karthik	Kettering University

Abstract— Advanced Driver Assistance Systems (ADAS) are designed to assist drivers in various driving scenarios, and the object detection system is a critical component of ADAS. This paper aims to develop and evaluate an object detection system using two cameras placed on the vehicle's front and rear sides for real-time inferencing in ADAS. The real-world data set is collected under different weather and lighting conditions to evaluate the object detection system. The object detection system is further optimized using the TensorRT engine to deploy the system on the in-vehicle computing unit, NVIDIA Jetson AGX Xavier. The object detection system achieved 18 fps to process two cameras simultaneously on the in-vehicle computing unit, NVIDIA Jetson AGX Xavier. The experimental findings of this study will be useful for researchers, engineers, and manufacturers in the field of ADAS and autonomous vehicles to improve road safety and reduce accidents.

15:10-15:30 WeA6.6

Traffic Scene Similarity: A Graph-Based Contrastive Learning Approach , pp. 221-227

Zipfl, Maximilian	FZI Research Center for Information Technology
Jarosch, Moritz	KIT
Zöllner, Marius	FZI Research Center for Information Technology

Ensuring validation for highly automated driving poses significant obstacles to the widespread adoption of highly automated vehicles. Scenario-based testing offers a potential solution by reducing the homologation effort required for these systems. However, a crucial prerequisite, yet unresolved, is the definition and reduction of the test space to a finite number of scenarios. To tackle this challenge, we propose an extension to a contrastive learning approach utilizing graphs to construct a meaningful embedding space. Our approach demonstrates the continuous mapping of scenes using scene-specific features and the formation of thematically similar clusters based on the resulting embeddings. Based on the found clusters, similar scenes could be identified in the subsequent test process, which can lead to a reduction in redundant test runs.

WeA7 Colonia

CI Applications in Smart Grid (CIASG)

Organizer: Srinivasan, Dipti	National University of Singapore
Organizer: Venayagamoorthy, Ganesh	Clemson University

13:30-13:50 WeA7.1

Integrating Agent-Based Control for Normal Operation in Interconnected Power and Communication Systems Simulation , pp. 228-233

Radtke, Malin	University of Oldenburg
Stucke, Christoph	University of Oldenburg
Trauernicht, Malte	University of Oldenburg
Montag, Carsten	University of Oldenburg
Oest, Frauke	University of Oldenburg
Frost, Emilie	University of Oldenburg
Bremer, Jörg	University of Oldenburg
Lehnhoff, Sebastian	University of Oldenburg

Power grids must be stable and reliable, but the growing importance of intelligent control in smart grids creates new challenges due to the increasing dependence on communication networks. This paper investigates the influence of communication on power systems in a future scenario. The simulation environment contains a power grid of a medium-sized city in northwest Germany, in the year 2035, where the normal operation of the power system is disturbed by increased communication traffic. The power and communication networks are integrated into a co-simulation environment, that implements smart grid services in an agent-based control structure. In a case study, multiple scenarios are compared that differ in the configuration of the communication network, to show how the simulation environment can be used to study the interactions between power and communication networks.

13:50-14:10 WeA7.2

Differential Evolution Algorithm Based Hyper-Parameters Selection of Transformer Neural Network Model for Load Forecasting , pp. 234-239

Sen, Anuvab	Indian Institute of Engineering Science and Technology, Shibpur,
Mazumder, Arul	Carnegie Mellon University
Sen, Udayon	Indian Institute of Engineering Science and Technology, Shibpur,

Accurate load forecasting plays a vital role in numerous sectors, but accurately capturing the complex dynamics of dynamic power systems remains a challenge for traditional statistical models. For these reasons, time-series models (ARIMA) and deep-learning models (ANN, LSTM,GRU, etc.) are commonly deployed and often experience higher success. In this paper, we analyze the efficacy of the recently developed Transformer-based Neural Network model in load forecasting. Transformer models have the potential to improve load forecasting because of their ability to learn long-range dependencies derived from their Attention Mechanism. We apply several metaheuristics namely Differential Evolution to find the optimal hyperparameters of the Transformer-based Neural Network to produce accurate forecasts. Differential Evolution provides scalable, robust, global solutions to non-differentiable, multi-objective, or constrained optimization problems. Our work compares the proposed Transformer-based Neural Network model integrated with different metaheuristic algorithms by their performance in load forecasting based on numerical metrics such as Mean Squared Error (MSE) and Mean Absolute Percentage Error (MAPE). Our findings demonstrate the potential of metaheuristic-enhanced Transformer-based Neural Network models in load forecasting accuracy and provide optimal hyperparameters for each model.

14:10-14:30 WeA7.3

Industry-Led Blockchain Projects for Smart Grids: An In-Depth Inspection , pp. 240-245

Zhao, Wenbing	Cleveland State University
Qi, Quan	Shihezi University
Zhou, Jiong	Northwestern Polytechnical University
Luo, Xiong	University of Science and Technology Beijing

In this paper, we investigate industry-led blockchain projects in the field of smart grids. Our investigation is guided by five research questions related to each industry-led project: (1) is the project active? (2) what smart grid applications does the project target? (3) what technical approach does the project take? (4) what is the maturity level of the project? and (5) what we can learn from the success or failure of the project? Our findings show that only a few projects are still active, and many have been terminated when the funding was exhausted. Nevertheless, the few active projects give us hope that sustainable technical approaches in conjunction with sound business models could lead to long-term blockchain-based projects in smart grids. Most of the active projects are targeting energy trading and using custom tokens to incentivize the production of green

energy and energy savings. Furthermore, it appears that layer-2 blockchains are becoming the preferred platform for achieving high throughput with low transaction fees while preserving the security and trust of traditional large public blockchains.

14:30-14:50 WeA7.4

Data-Driven Digital Twins for Power Estimations of a Solar Photovoltaic Plant , pp. 246-251

Walters, Michael — Clemson University
Yonce, John — Clemson University
Venayagamoorthy, Ganesh — Clemson University

Renewable energy generation sources (RESs) are gaining increased popularity due to global efforts to reduce carbon emissions and mitigate effects of climate change. Planning and managing increasing levels of RESs, specifically solar photovoltaic (PV) generation sources is becoming increasingly challenging. Estimations of solar PV power generations provide situational awareness in distribution system operations. A digital twin (DT) can replicate PV plant behaviors and characteristics in a virtual platform, providing realistic solar PV estimations. Furthermore, neural networks, a popular paradigm of artificial intelligence may be used to adequately learn and replicate the relationship between input and output variables for data-driven DTs (DD-DTs). In this paper, DD-DTs are developed for Clemson University's 1 MW solar PV plant located in South Carolina, USA to perform realistic solar PV power estimations. The DD-DTs are implemented utilizing multilayer perceptron (MLP) and Elman neural networks. Typical practical results for two DD-DT architectures are presented and validated.

14:50-15:10 WeA7.5

Digital Twins for Creating Virtual Models of Solar Photovoltaic Plants , pp. 252-257

George, Deborah — Clemson University
Venayagamoorthy, Ganesh — Clemson University

Amidst the challenges posed by the high penetration of distributed energy resources (DERs), particularly a number of distributed photovoltaic plants (DPVs), in modern electric power distribution systems (MEPDS), the integration of new technologies and frameworks become crucial for addressing operation, management, and planning challenges. Situational awareness (SA) and situational intelligence (SI) over multi-time scales is essential for enhanced and reliable PV power generation in MEPDS. In this paper, data-driven digital twins (DTs) are developed using AI paradigms to develop actual and/or virtual models of DPVs, These DTs are then applied for estimating and forecasting the power outputs of physical and virtual PV plants. Virtual weather stations are used to estimate solar irradiance and temperature at user-selected locations in a localized region, using inferences from physical weather stations. Three case studies are examined based on data availability: physical PV plant, hybrid PV plants, and virtual PV plants, generating real-time estimations and short-term forecasts of PV power production that can support distribution system studies and decision-making.

15:10-15:30 WeA7.6

Parameter Optimisation for Context-Adaptive Deep Layered Network for Semantic Segmentation , pp. 258-263

Mandal, Ranju — Torrens University
Verma, Brijesh — Instiute for Integrated and Intelligent Systems, Griffith Univer

Evolutionary optimization methods have been utilized to optimize a wide range of models, including many complex neural network models. Manual parameter selection requires substantial trial and error and specialist domain knowledge of the inherent structure, which does not guarantee the best outcomes. We propose a three-layered novel architecture for semantic segmentation and optimize it using two distinct evolutionary algorithm-based optimization processes namely genetic algorithm and particle swarm optimization. To fully optimize an end-to-end image segmentation framework, the network design is tested using various combinations of a few parameters. An automatic search is conducted for the optimal parameter values to maximize the performance of the image segmentation framework. Evolutionary Algorithm (EA)-based optimization of the three-layered semantic segmentation network optimizes parameter values holistically, which produces the best performance. We evaluated our proposed architecture and optimization on two benchmark datasets. The evaluation results show that the proposed optimization can achieve better accuracy than the existing approaches.

WeA8 — Conquista

CI for Multimedia Signal and Vision Processing (CIMSIVP) 1

Organizer: Al-Sahaf, Harith — Victoria University of Wellington
Organizer: Mesejo, Pablo — University of Granada
Organizer: Bi, Ying — Victoria University of Wellington

13:30-13:50 WeA8.1

Neural-Based Cross-Modal Search and Retrieval of Artwork , pp. 264-269

Gong, Yan — Loughborough University
Cosma, Georgina — Loughborough Unviersity
Finke, Axel — Loughborough Unviersity

Creating an intelligent search and retrieval system for artwork images, particularly paintings, is crucial for documenting cultural heritage, fostering wider public engagement, and advancing artistic analysis and interpretation. Visual-Semantic Embedding (VSE) networks are deep learning models used for information retrieval, which learn joint representations of textual and visual data, enabling 1) cross-modal search and retrieval tasks, such as image-to-text and text-to-image retrieval; and 2) relation-focused retrieval to capture entity relationships and provide more contextually relevant search results. Although VSE networks have played a significant role in cross-modal information retrieval, their application to painting datasets, such as ArtUK, remains unexplored. This paper introduces BoonArt, a VSE-based cross-modal search engine that allows users to search for images using textual queries, and to obtain textual descriptions along with the corresponding images when using image queries. The performance of BoonArt was evaluated using the ArtUK dataset. Experimental evaluations revealed that BoonArt achieved 97% Recall@10 for image-to-text retrieval, and 97.4% Recall@10 for text-to-image Retrieval. By bridging the gap between textual and visual modalities, BoonArt provides a much-improved search performance compared to traditional search engines, such as the one provided by the ArtUK website. BoonArt can be utilised to work with other artwork datasets.

13:50-14:10 WeA8.2

Return of Small-Scale Crowd Counting Via Fast and Accurate Semi-Supervised Least Squares Model , pp. 270-275

Luo, Hao — Xi'an Jiaotong University
Du, Shaoyi — Xi'an Jiaotong University
Tian, Zhiqiang — Xi'an Jiaotong University

Existing crowd counting techniques have achieved significant progress with the emergence of deep learning. During development, emerging crowd counting methods have generally become more and more complex and enormous, enabling them to understand and process more prior knowledge from input data. However, they suffer from two major drawbacks: 1) they generally require a significant amount of labeled training samples, which is labor-intensive, and 2) they require increasing computational hardware resources, making it luxurious and impractical to apply directly in small-scale scenes. To address these issues, we formulate crowd counting as a classification problem and leverage least squares model with a novel semi-supervised strategy. Technically, we construct the least squares model based on only two regularization terms: a regression term and a discriminative relaxation term. Moreover, we propose a

semi-supervised soft label correcting strategy incorporated in the model. As a result, a fast and accurate crowd counting method is achieved. Experimental results on five small-scale benchmarks demonstrate the proposed method outperforms the other competitors in terms of both regression metrics and consumed time.

14:10-14:30 WeA8.3

A Self-Supervised Few-Shot Detection Method for Magnetic Tile Defects Detection , pp. 276-281

Zhang, Zhiyu	Xi'an Jiaotong University
Dong, Liangjie	Xi'an Jiaotong University
Luo, Hao	Xi'an Jiaotong University
Tian, Zhiqiang	Xi'an Jiaotong University

Current Defect detection methods have made significant progress on ideal datasets that typically contain a large number of defect samples. This enables the traditional defect detection methods to achieve great detection performance. However, in practical applications, the training samples obtained are often highly imbalanced, with the majority being non-defective samples and only a few being defective samples. It will generally lead to performance degradation of traditional methods if using such imbalanced samples for training. To address this issue, we propose a few-shot defect detection method based on self-supervised learning. Specifically, we propose to use a transfer learning strategy to transfer from traditional full-shot learning to few-shot learning. Next, we propose to process the training data in a self-supervised manner. As a result, the proposed method is enabled to achieve satisfactory detection performance on the industrial magnetic tile defect dataset. Experimental results verify the effectiveness of our proposed method.

14:30-14:50 WeA8.4

Hyperbolic Tangent Sigmoid As a Transformation Function for Image Contrast Enhancement , pp. 282-287

Perez-Enriquez, Laritza	INAOE
Zapotecas-Martinez, Saul	INAOE
Altamirano-Robles, Leopoldo	INAOE
Oliva, Diego	Universidad De Guadalajara

Contrast enhancement is critical for investigating and highlighting important hidden features in a computer vision system. Continuous functions, such as incomplete beta or sigmoid functions, have traditionally been used for histogram equalization. However, histogram equalization cannot uniformly enhance the local contrast of an image, which is its main limitation. In this study, we investigate a contrast enhancement method based on a hyperbolic tangent sigmoid whose parameters can be optimized by metaheuristics. In our study, we investigated the performance of three popular metaheuristics when coupling the proposed hyperbolic tangent sigmoid to find the optimal pixel values that can intensify features of low-contrast images. The proposed method is studied on a public domain image dataset and evaluated using standard performance indicators. Preliminary results show that the proposed hyperbolic tangent sigmoid can improve image contrast and quickly adapt to other metaheuristics.

14:50-15:10 WeA8.5

Neuromorphic Event Alarm Time-Series Suppression , pp. 288-293

Harrigan, Shane Patrick	Ulster University
Coleman, Sonya	University of Ulster
Kerr, Dermot	University of Ulster
Quinn, Justin	Ulster University
Madden, Kyle	K.madden@ulster.ac.uk
Lindsay, Leeanne	Ulster University
Henderson, Benn	Ulster University
Rahman, Shammi	Ulster University

The field of neuromorphic vision systems aims to replicate the functionality of biological visual systems by mimicking their physical structure and electrical behaviour. Unlike traditional full-frame sensors, neuromorphic systems process data asynchronously and at the pixel level, modelling biological signalling processes. This allows for high-speed operations with lower energy consumption, making them suitable for applications like autonomous vehicles and embedded robotics. This work introduces the Neuromorphic Event Alarm Time-Series Suppression (NEATS) framework, designed to filter noise and detect outlier behaviours in event data without the need for 2-D transformations. NEATS employs rolling statistics and advanced neuromorphic data structures to minimise noise while identifying changes in scene dynamics. This framework injects attention into scene processing, similar to summarisation frameworks in traditional image processing. A novel event-vision alarm change collection (EACC) database is presented, containing controlled stimuli pattern changes captured using leading neuromorphic imaging devices. This database facilitates future benchmarking of neuromorphic attention frameworks, advancing the development of efficient and accurate artificial vision systems.

15:10-15:30 WeA8.6

Quantifying Temporal Entropy in Neuromorphic Memory Forgetting: Exploring Advanced Forgetting Models for Robust Long-Term Information Storage , pp. 294-299

Harrigan, Shane Patrick	Ulster University
Coleman, Sonya	University of Ulster
Kerr, Dermot	University of Ulster
Quinn, Justin	Ulster University
Madden, Kyle	K.madden@ulster.ac.uk
Liu, Shuo	Ulster University
Lindsay, Leeanne	Ulster University

This paper presents a progression of a popular neuromorphic memory structure by exploring advanced forgetting models for robust long-term information storage. Inspired by biological neuronal systems, neuromorphic sensors efficiently capture and transmit sensory information using event-based communication. Managing the decay of information over time is a critical aspect, and forgetting models play a vital role in this process. Building upon the foundation of an existing popular neuromorphic memory structure, this study introduces and evaluates four advanced forgetting models: ROT, adaptive, emotional memory enhancement, and context-dependent memory forgetting models. Each model incorporates different factors to modulate the rate of decay or forgetting. Through rigorous experimentation and analysis, these models are compared with the original ROT forgetting model to assess their effectiveness in retaining relevant information while discarding irrelevant or outdated data. The results provide insights into the strengths, limitations, and potential applications of these advanced forgetting models in the context of neuromorphic memory systems, thereby contributing to the progression of this popular neuromorphic memory structure.

WeB1 Imperio A

Deep Learning (DL) 2

Organizer: Sperduti, Alessandro	University of Padova
Organizer: Angelov, Plamen	Lancaster University
Organizer: Principe, Jose C.	University of Florida

16:00-16:20 WeB1.1

Improved Knowledge Distillation Via Teacher Assistants for Sentiment Analysis , pp. 300-305

Dong, Ximing	University of Manitoba
Huang, Olive	University of Auckland
Thulasiraman, Parimala	University of Manitoba
Mahanti, Aniket	University of Auckland

Bidirectional Encoder Representations from Trans- formers (BERT)

has achieved state-of-the-art results on various NLP tasks. However, the size of BERT makes application in time-sensitive scenarios challenging. There are lines of research compressing BERT through different techniques and Knowledge Distillation (KD) is the most popular. Nevertheless, more recent studies challenge the effectiveness of KD from an arbitrarily large teacher model. So far, research on the negative impact of the teacher-student gap on the effectiveness of knowledge transfer has been confined mainly to computer vision. Additionally, those researches were limited to distillations between teachers and students with similar model architectures. To fill the gap in the literature, we implemented a teacher assistant (TA) model lying between a fine-tuned BERT model and non-transformer- based machine learning models, including CNN and Bi-LSTM, for sentiment analysis. We have shown that teaching-assistant- facilitated KD outperformed traditional KD while maintaining a competitive inference efficiency. In particular, a well-designed CNN model could retain 97% of BERT's performance while being 1410x smaller for sentiment analysis. We have also found that BERT is not necessarily a better teacher model than non-transformer-based neural networks.

16:20-16:40 WeB1.2

Fuzzy Detectors against Adversarial Attacks , pp. 306-311

Li, Yi	Lancaster University
Angelov, Plamen	Lancaster University
Suri, Neeraj	Lancaster University

Deep learning-based methods have proved useful for adversarial attack detection. However, conventional detection algorithms exploit crisp set theory for classification boundary. Therefore, representing vague concepts is not available. Motivated by the recent success in fuzzy systems, we propose a fuzzy rule-based neural network to improve adversarial attack detection accuracy. The pre-trained ImageNet model is exploited to extract feature maps from clean and attacked images. Subsequently, the fuzzification network is used to obtain feature maps to produce fuzzy sets of difference degrees between clean and attacked images. The fuzzy rules control the intelligence that determines the detection boundaries. In the defuzzification layer, the fuzzy prediction from the intelligence is mapped back into the crisp model predictions for images. The loss between the prediction and label controls the rules to train the fuzzy detector. We show that the fuzzy rule-based network learns rich feature information than binary outputs and offers to obtain an overall performance gain. Our experiments, conducted over a wide range of images, show that the proposed method consistently performs better than conventional crisp set training in adversarial attack detection with various fuzzy system-based neural networks. The source code of the proposed method is available at https://github.com/Yukino-3/Fuzzy.

16:40-17:00 WeB1.3

SemanticSLAM: Learning Based Semantic Map Construction and Robust Camera Localization , pp. 312-317

Li, Mingyang	Syracuse University
Ma, Yue	Syracuse University
Qiu, Qinru	Syracuse University

Current techniques in Visual Simultaneous Localization and Mapping (VSLAM) estimate camera displacement by comparing image features of consecutive scenes. These algorithms depend on scene continuity, hence requires frequent camera inputs. However, processing images frequently can lead to significant memory usage and computation overhead. In this study, we introduce SemanticSLAM, an end-to-end visual-inertial odometry system that utilizes semantic features extracted from an RGB-D sensor. This approach enables the creation of a semantic map of the environment and ensures reliable camera localization. SemanticSLAM is scene-agnostic, which means it doesn't require retraining for different environments. It operates effectively in indoor settings, even with infrequent camera input, without prior knowledge. The strength of SemanticSLAM lies in its ability to gradually refine the semantic map and improve pose estimation. This is achieved by a convolutional long-short-term-memory (ConvLSTM) network, trained to correct errors during map construction. Compared to existing VSLAM algorithms, SemanticSLAM improves pose estimation by 17%. The resulting semantic map provides interpretable information about the environment and can be easily applied to various downstream tasks, such as path planning, obstacle avoidance, and robot navigation. The code will be publicly available at https://github.com/Leomingyangli/SemanticSLAM

17:00-17:20 WeB1.4

Improving Natural Language Inference in Arabic Using Transformer Models and Linguistically Informed Pre-Training , pp. 318-322

Saad Al Deen, Mohammad Majd	Fraunhofer IAIS and Hochschule Bonn-Rhein-Sieg
Pielka, Maren	Fraunhofer IAIS
Hees, Jörn	Hochschule Bonn-Rhein-Sieg
Abdou, Bouthaina Soulef	Fraunhofer IAIS and University of Bonn
Sifa, Rafet	Fraunhofer IAIS and University of Bonn

This paper addresses the classification of Arabic text data in the field of Natural Language Processing (NLP), with a particular focus on Natural Language Inference (NLI) and Contradiction Detection (CD). Arabic is considered a resource-poor language, meaning that there are few data sets available, which leads to limited availability of NLP methods. To overcome this limitation, we create a dedicated data set from publicly available resources. Subsequently, transformer-based machine learning models are being trained and evaluated. We find that a language-specific model (AraBERT) performs competitively with state-of-the-art multilingual approaches, when we apply linguistically informed pre-training methods such as Named Entity Recognition (NER). To our knowledge, this is the first large-scale evaluation for this task in Arabic, as well as the first application of multi-task pre-training in this context.

17:20-17:40 WeB1.5

Variational Voxel Pseudo Image Tracking , pp. 323-328

Oleksiienko, Illia	Aarhus University
Nousi, Paraskevi	Aristotle University of Thessaloniki
Passalis, Nikolaos	Aristotle University of Thessaloniki
Tefas, Anastasios	Aristotle University of Thessaloniki
Iosifidis, Alexandros	Aarhus University

Uncertainty estimation is an important task for critical problems, such as robotics and autonomous driving, because it allows creating statistically better perception models and signaling the model's certainty in its predictions to the decision method or a human supervisor. In this paper, we propose a Variational Neural Network-based version of a Voxel Pseudo Image Tracking (VPIT) method for 3D Single Object Tracking. The Variational Feature Generation Network of the proposed Variational VPIT computes features for target and search regions and the corresponding uncertainties, which are later combined using an uncertainty-aware cross-correlation module in one of two ways: by computing similarity between the corresponding uncertainties and adding it to the regular cross-correlation values, or by penalizing the uncertain feature channels to increase influence of the certain features. In experiments, we show that both methods improve tracking performance, while penalization of uncertain features provides the best uncertainty quality.

17:40-18:00 WeB1.6

Opinion Classifier Transfer Learning from Review Data , pp. 329-334

Ozeki, Jin	Meiji University
Sakurai, Yoshitaka	Meiji University
Terada, Yuna	TSP Co., Ltd

Companies use users' opinions to improve their products and marketing activities. In recent years, the development of Internet technology has made it possible to extract users' opinions from text on the Web. There are many ways for users to post their opinions on the Internet, and Twitter is considered to be a platform that allows users to easily tweet their opinions. However, manually extracting opinions from Twitter is time-consuming, costly, and labor-intensive due to the relatively low percentage of opinions. Therefore, some companies aim to efficiently extract user opinions from Twitter using machine learning. However, the attempt to create a dataset for building a machine learning system produced an unbalanced dataset that does not extract opinions with sufficient accuracy because the proportion of views on Twitter is small. There are solutions to this problem of insufficient teacher data, such as utilizing knowledge from other domains through transfer learning. Although transfer learning is sometimes used to solve such problems, accuracy cannot be improved if the knowledge domains are far apart before and after the transfer. Therefore, we proposed a new method called OTR, which stands for Opinion classifier Transferred from Review data. OTR transfers knowledge of review submissions that are considered to be close in domain to opinion extraction. However, since the phrasing of review sentences and that of Social Networking Service (SNS) such as Twitter are different, there is a possibility that sufficient knowledge transfer cannot be achieved. In order to address this problem, we proposed an Opinion classifier Transferred from Review data with Pseudo-labels (OTR-P), a method that brings the domains of the source and target tasks closer. Here, the target task discriminated opinions regarding leisure facilities, and the source task estimated review ratings using Rakuten travel review data. And while performing these tasks, we attempted to bring the domains closer by attaching pseudo-labels to the tweet data. This approach improved accuracy compared to the conventional method of shifting Bidirectional Encoder Representations from Transformers (BERT).

WeB2 — Imperio B

Automated Algorithm Design, Configuration and Selection (AADCS)

Organizer: Pillay, Nelishia — University of Pretoria
Organizer: Qu, Rong — University of Nottingham

16:00-16:20 — WeB2.1

Analyzing the Generalizability of Automated Algorithm Selection: A Case Study for Numerical Optimization , pp. 335-340

Škvorc, Urban — Jožef Stefan Institute
Eftimov, Tome — Jožef Stefan Institute
Korošec, Peter — Jožef Stefan Institute

In numerical single-objective optimization, automated algorithm selection that uses exploratory landscape analysis to describe problem features has achieved great results when the machine learning models used for prediction are trained and tested on the same problem set. However, recent work has shown that the performance of such models decreases when the training and testing sets contain different problems. In this paper, we examine a recently developed algorithm selection model trained on a set of artificial problems and tested on a well-known set of hand-made benchmark problems. This model performed poorly when it was originally presented. Here, we provide an explanation for its poor performance by analyzing the feature importance of the model using Shapley Additive Explanations. We then compare these results to an alternative algorithm selection model that was both trained and tested on the same set of hand-made benchmark problems and achieved much higher performance. This allows us to determine which features each model considers as most significant for their predictions, and where they differ. We show that the original and the alternative model use different landscape features for their predictions, which explains the difference in their performance. Further, by plotting the SHAP values on a 2D plane, we show that the original model is unable to distinguish between certain types of problems. Finally, we show that regardless of their differences in utilizing the features both the original and the alternative models perform poorly on a specific group of problems.

16:20-16:40 — WeB2.2

How Far Out of Distribution Can We Go with ELA Features and Still Be Able to Rank Algorithms? , pp. 341-346

Petelin, Gašper — Jožef Stefan Institute
Cenikj, Gjorgjina — Jožef Stefan Institute

Algorithm selection is a critical aspect of continuous black-box optimization, and various methods have been proposed to choose the most appropriate algorithm for a given problem. One commonly used approach involves employing Exploratory Landscape Analysis (ELA) features to represent optimization functions and training a machine-learning meta-model to perform algorithm selections based on these features. However, many meta-models trained on existing benchmarks suffer from limited generalizability. When faced with a new optimization function, these meta-models often struggle to select the most suitable algorithm, restricting their practical application. In this study, we investigate the generalizability of meta-models when tested on previously unseen functions that were not observed during training. Specifically, we train a meta-model on base COmparing Continuous Optimizers (COCO) functions and evaluate its performance on new functions derived as affine combinations between pairs of the base functions. Our findings demonstrate that the task of ranking algorithms becomes substantially more challenging when the functions differ from those encountered during meta-learning training. This indicates that the effectiveness of algorithm selection diminishes when confronted with problem instances that substantially deviate from the training distribution. In such scenarios, meta-models that use ELA features to predict algorithm ranks do not outperform mere predictions of the average algorithm ranks.

16:40-17:00 — WeB2.3

Algorithm Package of AI-Driven SDN Controller-Switch Load Balancing Strategies , pp. 347-354

Emu, Mahzabeen — Queen's University
Hassan, Md Yeakub — Siemens Digital Industries Software
Fadlullah, Zubair Md — Western University
Choudhury, Salimur — Queen's University

Recently, Software-Defined Networking (SDN) is receiving much research attention due to its ability to decouple the data plane from the control architecture by associating the network switches to one (centralized) or more (distributed) controller(s). Traditionally, switches are assigned to the controllers in a static manner which results in under-utilization of the resources of the controllers and increased response delays to user requests. In this paper, we consider a practical load-balancing and agile scenario by formulating the dynamic associations of switches and controllers as an NP-hard optimization problem to minimize the maximum resource utilization of the controllers. Therefore, we propose an Ant Colony Optimization (ACO)-based algorithm to deal with the aforementioned request satisfiability issue in large SDN systems in polynomial-time. Furthermore, we envision a hybrid deep learning model consisting of Convolutional Neural Network (CNN) and Gated Recurrent Unit (GRU) structures to achieve near-optimal resource utilization for real-time SDN applications. Experimental results demonstrate that our customized CNN-GRU model outperforms the other techniques in terms of resource utilization (15%-45% optimality gap) within a significantly reduced computational running time (0.1s).

17:00-17:20 — WeB2.4

Breaking the Cycle: Exploring the Advantages of Novel Evolutionary Cycles , pp. 355-360

Tisdale, Braden N. — Auburn University
Tauritz, Daniel R. — Auburn University

There have been many different forms of evolutionary algorithms (EAs) designed by humans over the past 50 years, with many variants optimized for specific classes of problems. As computational resources grow, the automated design of EAs has become an increasingly viable method for improving performance. However, many components of EAs have been treated as largely immutable, for both human and automated designers, dramatically constraining design space. In particular, the evolutionary cycle (the repeating pattern of reproduction and survival) has little or no differences between most popular forms of EA. In a previous paper, we proposed a technique for automatically designing evolutionary cycles using directed graphs, greatly increasing the explorable design space. In this paper, we showcase an improved representation and evolutionary process, provide preliminary experiments demonstrating that EAs produced by this process can outperform those with a traditional cycle, and explore the phenotype landscape to show that the new space explored by our technique may contain better EAs than traditional cycles allow.

17:20-17:40 WeB2.5

Using Reinforcement Learning for Per-Instance Algorithm Configuration on the TSP , pp. 361-368

Seiler, Moritz Vinzent	University of Münster, Germany
Rook, Jeroen	University of Twente, Netherlands
Heins, Jonathan	TU Dresden, Germany
Preuß, Oliver Ludger	University of Münster, Germany
Bossek, Jakob	RWTH Aachen University, Germany
Trautmann, Heike	University of Münster, Germany

Automated Algorithm Configuration (AAC) usually takes a global perspective: it identifies a parameter configuration for an (optimization) algorithm that maximizes a performance metric over a set of instances. However, the optimal choice of parameters strongly depends on the instance at hand and should thus be calculated on a per-instance basis. We explore the potential of Per-Instance Algorithm Configuration (PIAC) by using Reinforcement Learning (RL). To this end, we propose a novel PIAC approach that is based on deep neural networks. We apply it to predict configurations for the Lin–Kernighan heuristic (LKH) for the Traveling Salesperson Problem (TSP) individually for every single instance.

To train our PIAC approach, we create a large set of 100,000 TSP instances with 2,000 nodes each --- currently the largest benchmark set to the best of our knowledge. We compare our approach to the state-of-the-art AAC method Sequential Model-based Algorithm Configuration (SMAC). The results show that our PIAC approach outperforms this baseline on both the newly created instance set and established instance sets.

17:40-18:00 WeB2.6

Characterization of CEC Single-Objective Optimization Competition Benchmarks and Algorithms , pp. 369-374

Misir, Mustafa	Duke Kunshan University

The present study provides an analysis on the characteristics of single-objective optimization benchmark problems as well as the algorithms used to solve them. The target optimization domain involves the CEC competitions, each consisting a set of mathematical functions. Concerning the optimization tasks, the idea is to investigate the dis/-similarities between different competition scenarios and individual benchmarks. For the solvers, the goal is to detect the dis/-similarities between the algorithms applied to the CEC benchmarks. Those analysis missions are carried out by using the features directly and automatically extracted from the performance data, the quality of the solutions achieved by each algorithm on the benchmarks. The feature extraction process is realized through Singular Value Decomposition. Following the analysis on the algorithms, the potential of algorithm selection has been evaluated to see the performance improvement without actually developing a new algorithm, against those 20 algorithms.

WeB3 Imperio C

CI for Financial Engineering and Economics (CIFEr) 2

Organizer: Thulasiram, Ruppa	University of Manitoba
Organizer: Alexandrova Kabadjova, Biliana	Banco De México

16:00-16:20 WeB3.1

High Frequency Data-Driven Dynamic Portfolio Optimization for Cryptocurrencies , pp. 375-380

Bowala Mudiyanselage, Sulalitha	University of Manitoba
Thavaneswaran, Aerambamoorthy	University of Manitoba
Thulasiram, Ruppa	University of Manitoba
Ranathungage, Thimani Dananjana	University of Manitoba
Dip Das, Joy	University of Manitoba

Recently there has been a growing interest in constructing portfolios with stocks and cryptocurrencies. As cryptocurrency prices increase over the years, there is a growing interest in investing in cryptocurrencies, along with diversifying portfolios by adding multiple cryptocurrencies to the existing portfolios. Even though investing in cryptocurrency leads to high returns, it also leads to high risk due to the high uncertainty of cryptocurrency price changes. Thus, more robust risk measures have been introduced to capture market risk and avoid investment loss, along with different types of portfolios to mitigate risks. Many portfolio techniques assume asset returns are normally distributed with constant variance. However, these assumptions are violated in many cases. Unlike the existing work, this study investigates the recently proposed data-driven exponentially weighted moving average (DDEWMA) covariance model to estimate the variance-covariance matrix for high frequency (hourly data) cryptocurrency returns in Markowitz portfolio optimization. The experimental results show that for high-frequency data, the DDEWMA approach outperforms the existing portfolio optimization model that uses the empirical variance-covariance matrix. Improvements have been identified in terms of the Sharpe ratio as well as risks (volatility, mean absolute deviation (MAD), Value-at-Risk (VaR), and Expected shortfall (ES)).

16:20-16:40 WeB3.2

Domain-Specific Large Language Model Finetuning Using a Model Assistant for Financial Text Summarization , pp. 381-386

Avramelou, Loukia	Aristotle University of Thessaloniki
Passalis, Nikolaos	Aristotle University of Thessaloniki
Tsoumakas, Grigorios	Aristotle University of Thessaloniki
Tefas, Anastasios	Aristotle University of Thessaloniki

The financial market and public opinion are correlated. This means that changes in the financial market can result in changes to public opinion and changes to public opinion can result in changes to the financial market. Accordingly, it is essential for understanding and interacting with the financial market to gather text content from online sources and process it. As a result of the rapid growth of social media and other online sources, we have seen an exponential rise in data, particularly textual data, in recent years. It can be difficult for a person to read, let alone process, the massive volumes of data generated every day. This indicates that we need automated methods for processing textual data and extracting useful information. Automated text summarization is a method of shortening huge amounts of text without losing essential information. Transformers, which can efficiently manage and analyze textual data, are state-of-the-art text summarization models. However, developing such an automated text summarization model specialized in a domain (e.g. finance) can be challenging since we lack necessary domain-specific summarization datasets. In this work, we propose a pipeline for fully automating the

finetuning of a text summarization model in a specific domain, namely cryptocurrency domain, without the involvement of human annotators. To this end, we introduce a novel method for self-improvement of text summarization models which relies on a model assistant which encodes domain knowledge, enabling finetuning text summarization models in specific domains in which we lack specific-domain summarization datasets. The proposed method is evaluated on a cryptocurrency-related text summarization problem and three well-known Large Language Models (LLMs) used for text summarization.

16:40-17:00 WeB3.3

High Frequency Trading with Deep Reinforcement Learning Agents under a Directional Changes Sampling Framework , pp. 387-394

Rayment, George — University of Essex
Kampouridis, Michael — University of Essex

High frequency trading strategies in the foreign exchange (FX) market often attempt to extract the latent signals in extremely noisy price moves to help inform trading decisions. Due to the fast-paced environments within which these decisions are made, intelligent trading is an impossible task for the human mind. Deep reinforcement learning (DRL) offers human-like intelligence and high speed computation but, due to the noisy nature of the tick data, can be prone to learning sub-optimal policies as a result of misleading feature and reward signals. In this work we use an intrinsic time sampling method referred to as directional changes (DC), which reports information whenever there is a significant change in price. By sampling tick data from nine FX currency pairs for 2250 datasets, we were able to train reinforcement learning (RL) agents using the Proximal Policy Optimisation (PPO) algorithm to identify and trade profitable strategies in high frequency FX environments. The resultant models were compared to four benchmarks including buy and hold, moving average crossover, relative strength index and a rule-based DC strategy, across three different metrics (namely returns, maximum drawdown, and Calmar ratio), with the reinforcement learning models outperforming them all.

17:00-17:20 WeB3.4

Deep Learning-Based Credit Score Prediction: Hybrid LSTM-GRU Model , pp. 395-400

Sababipour ASL, GOLNAZ — University of Manitoba
Shamsi, Kiarash — University of Manitoba
Thulasiram, Ruppa — University of Manitoba
Akcora, Cuneyt Gurcan — University of Manitoba
Leung, Carson — University of Manitoba

Credit score prediction is a crucial task in financial industry, as it helps lenders and financial institutions evaluate the creditworthiness of borrowers and manage credit risk. In this work, we present a comparative study of deep learning (DL)-based credit score prediction models. To achieve this objective, we compare the performance of DL models against traditional methods in credit scoring. We train and test the models using a real-world dataset of credit histories, containing various features such as credit card balances, payment history, and employment status. Our experimental results show that the hybrid LSTM-GRU model outperform both the LSTM and GRU models in credit score prediction, as well as traditional methods. The hybrid LSTM-GRU model demonstrates higher accuracy and better predictive power, indicating its potential for improving credit scoring models in the financial industry.

17:20-17:40 WeB3.5

Portfolio Return Maximization Using Robust Optimization and Directional Changes , pp. 401-406

Almeida, Rui Jorge — School of Business and Economics, Maastricht University
Basturk, Nalan — School of Business and Economics, Maastricht University
Rodrigues, Paulo — School of Business and Economics, Maastricht University

Dynamic portfolio optimization is inherently challenging due to the complexity of asset price dynamics and forecasts. Robust optimization is proposed as an alternative that incorporates return and risk uncertainty in portfolio optimization.

Directional change (DC) methods complement the standard, fixed time interval, and asset price data in terms of measuring the relationships and scaling laws between different types of events. DC methods can be extended for portfolio optimization using DC representations of assets and empirical scaling laws which indicate expected price changes and their duration.

In this paper, we study a robust DC-based portfolio optimization (RDC) method, for returns maximization. The proposed method uses price signals from the DC representations of multiple assets for portfolio rebalancing and optimization, together with a robust portfolio optimization rule that maximizes portfolio returns under return uncertainty.

We empirically study the effect of the robust DC-based portfolio optimization method with an application to 29 exchange-traded funds where each fund is a well-diversified asset with typically low-risk values. We compare the obtained portfolio results with benchmarks. The results indicate that the proposed method performs comparably to several benchmarks, and particularly improves a specific risk measure, maximum drawdown, in comparison to the benchmarks.

17:40-18:00 WeB3.6

Credit Card Fraud Detection with Subspace Learning-Based One-Class Classification , pp. 407-412

Zaffar, Zaffar — Tampere University
Sohrab, Fahad — Tampere University
Kanniainen, Juho — Tampere University
Gabbouj, Moncef — Tampere University

In an increasingly digitalized commerce landscape, the proliferation of credit card fraud and the evolution of sophisticated fraudulent techniques have led to substantial financial losses. Automating credit card fraud detection is a viable way to accelerate detection, reducing response times and minimizing potential financial losses. However, addressing this challenge is complicated by the highly imbalanced nature of the datasets, where genuine transactions vastly outnumber fraudulent ones. Furthermore, the high number of dimensions within the feature set gives rise to the ``curse of dimensionality''. In this paper, we investigate subspace learning-based approaches centered on One-Class Classification (OCC) algorithms, which excel in handling imbalanced data distributions and possess the capability to anticipate and counter the transactions carried out by yet-to-be-invented fraud techniques. The study highlights the potential of subspace learning-based OCC algorithms by investigating the limitations of current fraud detection strategies and the specific challenges of credit card fraud detection. These algorithms integrate subspace learning into the data description; hence, the models transform the data into a lower-dimensional subspace optimized for OCC. Through rigorous experimentation and analysis, the study validated that the proposed approach helps tackle the curse of dimensionality and the imbalanced nature of credit card data for automatic fraud detection to mitigate financial losses caused by fraudulent activities.

WeB4 — Constitución A

CI and Ensemble Learning (CIEL)

Organizer: Suganthan, Ponnuthurai Nagaratnam — Nanyang Technological University

16:00-16:20 WeB4.1

A Weighted Ensemble of Regression Methods for Gross Error Identification Problem , pp. 413-420

Dobos, Daniel	Robert Gordon University
Dang, Truong	National Subsea Centre, Robert Gordon University
Nguyen, Tien Thanh	National Subsea Centre, Robert Gordon University
McCall, John	National Subsea Centre, Robert Gordon University
Wilson, Alan	Accord Energy Solutions
Corbett, Helen	Accord Energy Solutions
Stockton, Phil	Accord Energy Solutions

In this study, we proposed a new ensemble method to predict the magnitude of gross errors (GEs) on measurement data obtained from the hydrocarbon and stream processing industries. Our proposed model consists of an ensemble of regressors (EoR) obtained by training different regression algorithms on the training data of measurements and their associated GEs. The predictions of the regressors are aggregated using a weighted combining method to obtain the final GE magnitude prediction. In order to search for optimal weights for combining, we modelled the search problem as an optimisation problem by minimising the difference between GE predictions and corre- sponding ground truths. We used Genetic Algorithm (GA) to search for the optimal weights associated with each regressor. The experiments were conducted on synthetic measurement data generated from 4 popular systems from the literature. We first conducted experiments in comparing the performances of the proposed ensemble using GA and Particle Swarm Optimisation (PSO), nature-based optimisation algorithms to search for com- bining weights to show the better performance of the proposed ensemble with GA. We then compared the performance of the proposed ensemble to those of two well-known weighted ensemble methods (Least Square and BEM) and two ensemble methods for regression problems (Random Forest and Gradient Boosting). The experimental results showed that although the proposed ensemble took higher computational time for the training process than those benchmark algorithms, it performed better than them on all experimental datasets.

16:20-16:40 WeB4.2

Enhancing Conducting Gesture Analysis: Integrating Laban Movement Analysis with Tree Ensembles and Neural Networks , pp. 421-426

Tsang, Herbert H.	Trinity Western University
Pierce, Sean	Trinity Western University

Our research focuses on integrating Laban Movement Analysis (LMA) with neural network technologies for analyzing conducting gestures. While promising, this approach faces challenges in real-time speed and adaptability. To overcome these limitations, we propose using tree ensembles, conducting LMA classification on conducting gestures with time-invariant transforms. This study aims to outperform the previous neural network approach in terms of time and set a benchmark for comparison, contributing valuable insights to enhance real-time applications in conducting gestures.

16:40-17:00 WeB4.3

An Ensemble Deep Learning Approach for Enhanced Classification of Pituitary Tumors , pp. 427-432

Deen Muhammad, Sumaiya	University of Windsor
Kobti, Ziad	University of Windsor

Tumor detection has emerged as a significant aspect of neuro-oncology and neuroradiology, with critical importance in improving patient survival rates. Tumors, whether benign (non-cancerous) or malignant (cancerous), can result in severe morbidity, and their accurate detection is very important for treatment. In recent years, medical imaging modalities such as Magnetic Resonance Imaging (MRI) and Computed Tomography (CT) have been extensively utilized for non-invasive tumor detection. These imaging techniques provide in-depth information about the tumor's location, size, and morphology, which is pivotal for diagnosing and planning therapeutic interventions. However, the manual interpretation of these imaging modalities is time-intensive and susceptible to human inaccuracies. Moreover, the subtle features of tumors can be easily missed in the manual assessment. Hereby, we propose an ensemble deep learning approach to classify pituitary tumors, based on the weighted average technique that incorporates three base deep learning models: ResNet 152, DenseNet 201, and VGG 16. Moreover, we implement the Segment Anything Model (SAM) to perform segmentation to our dataset and then execute the ensemble model to classify pituitary tumors from normal/healthy brain images. We compare our proposed approach using segmented data and non-segmented data, finding that the segmented data outperforms the non-segmented data by a margin of 1.77%.

17:00-17:20 WeB4.4

Empirical Hypervolume Optimal μ-Distributions on Complex Pareto Fronts , pp. 433-440

Shang, Ke	Southern University of Science and Technology
Shu, Tianye	Southern University of Science and Technology
Wu, Guotong	Southern University of Science and Technology
Nan, Yang	Southern University of Science and Technology
Pang, Lie Meng	Southern University of Science and Technology
Ishibuchi, Hisao	Southern University of Science and Technology

Hypervolume optimal mu-distribution is the distribution of mu solutions maximizing the hypervolume indicator of mu solutions on a specific Pareto front. Most studies have focused on simple Pareto fronts such as triangular and inverted triangular Pareto fronts. There is almost no study which focuses on complex Pareto fronts such as disconnected and partially degenerate Pareto fronts. However, most real-world multi-objective optimization problems have such a complex Pareto front. Thus, it is of great practical significance to study the hypervolume optimal mu-distribution on the complex Pareto fronts. In this paper, we study this issue by empirically showing the hypervolume optimal mu-distributions on the Pareto fronts of some representative artificial and real-world test problems. Our results show that, in general, maximizing the hypervolume indicator does not lead to uniformly distributed solution sets on the complex Pareto fronts. We also give some suggestions related to the use of the hypervolume indicator for performance evaluation of evolutionary multi-objective optimization algorithms.

17:20-17:40 WeB4.5

Analysis of Partition Methods for Dominated Solution Removal from Large Solution Sets , pp. 441-448

Shu, Tianye	Southern University of Science and Technology
Nan, Yang	Southern University of Science and Technology
Shang, Ke	Southern University of Science and Technology
Ishibuchi, Hisao	Southern University of Science and Technology

In evolutionary multi-objective optimization (EMO), one important issue is to efficiently remove dominated solutions from a large number of solutions examined by an EMO algorithm. An efficient approach to remove dominated solutions from a large solution set is to partition it into small subsets. Dominated solutions are removed from each subset independently. This partition method is fast but cannot guarantee to remove all dominated solutions. To further remove remaining dominated solutions, a simple idea is to iteratively perform this approach. In this paper, we first examine three partition

methods (random, objective value-based and cosine similarity-based methods) and their iterative versions through computational experiments on artificial test problems (DTLZ and WFG) and real-world problems. Our results show that the choice of an appropriate partition method is problem dependent. This observation motivates us to use a hybrid approach where different partition methods are used in an iterative manner. The results show that all dominated solutions are removed by the hybrid approach in most cases. Then, we examine the effects of the following factors on the computation time and the removal performance: the number of objectives, the shape of the Pareto front, and the number of subsets in each partition method.

17:40-18:00 WeB4.6

Normalization in R2-Based Hypervolume and Hypervolume Contribution Approximation , pp. 449-456

Wu, Guotong	Southern University of Science and Technology
Shu, Tianye	Southern University of Science and Technology
Shang, Ke	Southern University of Science and Technology
Ishibuchi, Hisao	Southern University of Science and Technology

In this paper, we examine the effect of normalization in R2-based hypervolume and hypervolume contribution approximation. The fact is that the region with different scales on objective space brings approximation bias. The basic idea of normalization is to perform a coordinate transformation to make the shape of the approximated region more regular, and then transform it to obtain the final value according to the property of hypervolume and hypervolume contribution. The performance of normalization is evaluated on different datasets by comparing it with the original R2-based method. We use two different metrics to evaluate hypervolume and hypervolume contribution separately, and the results indicate that normalization does exactly improve the approximation accuracy and outperforms the original R2-based method.

WeB5 Constitución B

CI for Industrial Process (CIIP) 2

Organizer: Yu, Wen CINVESTAV-IPN

Organizer: Ding, Jinliang Northeastern University

16:00-16:20 WeB5.1

Local Search Enhanced Multi-Objective Evolutionary Algorithm for Fuzzy Flexible Job Shop Scheduling , pp. 457-462

Zhang, xuwei	Northeastern University
Zhao, Ziyan	Northeastern University
Liu, Shixin	Northeastern University

The uncertainty in actual manufacturing systems often manifests as uncertain processing times, especially in flexible manufacturing systems. This work proposes a Decomposition-based Evolutionary Algorithm with Local Search (DLSEA) to solve flexible scheduling with fuzzy processing times by minimizing makespan and total machine workload. Considering the different scales of objectives, two normalization methods are employed on subpopulations, respectively, aiming to mitigate the potential detrimental effects of a single normalization method. This work also introduces a local search method to enhance the performance of DLSEA. The proposed DLSEA is compared with four state-of-the-art algorithms on two series of cases. The experimental results show that DLSEA exhibits superior search capabilities.

16:20-16:40 WeB5.2

Protecting Vulnerable Road Users: Semantic Video Analysis for Accident Prediction , pp. 463-469

Petzold, Julian	University of Lübeck
Wahby, Mostafa	University of Lübeck
Ziad, Youssef	University of Lübeck
ElSheikh, Mostafa	University of Lübeck
Dawood, Ahmed	University of Lübeck
Berekovic, Mladen	University of Lübeck
Hamann, Heiko	University of Konstanz

Pedestrians and cyclists are some of the most vulnerable, but also least predictable traffic participants. Due to their ability to move in urban environments with high degrees of freedom and sudden changes of direction, their movement is still challenging to predict. We present a driver assistance system that tackles some of these challenges. Our system consists of a world model made of a variational autoencoder and a long short-term memory network. The world model takes vision and action data from the perspective of the vulnerable traffic participant and generates a visual prediction (image) of their environment up to one second in advance. The second part of our system is a transformer-based description system that takes the predicted perceptions and here, as a showcase, abstracts them down to a textual warning if a collision between car and vulnerable traffic participant seems imminent. Our description system helps contextualize the dangerous situation for the driver and could be extended to other driver assistance systems, such as blind spot detection. We evaluate our system on a dataset generated in simulations using CARLA.

16:40-17:00 WeB5.3

Parameter-Adaptive Paired Offspring Generation for Constrained Large-Scale Multiobjective Optimization Algorithm , pp. 470-475

Zhu, Haiyue	Northeastern University
Chen, Qingda	Northeastern University
Ding, Jinliang	Northeastern University
Zhang, Xingyi	Anhui University
Wang, Hongfeng	Northeastern University

There are significant challenges in designing optimization algorithms for constrained large-scale multiobjective optimization problems due to numerous decision variables and constraints. For example, the decision space size exponentially grows with the number of decision variables, and constraints restrict the feasible range, increasing the complexity of the search space. To solve these problems, this paper presents a constrained large-scale multiobjective optimization algorithm based on adaptive paired offspring generation (aPOCEA). Specifically, an adaptive parameter adjustment strategy is proposed to determine the number of solutions in each subpopulation and balance the exploration and exploitation ability of the algorithm, enhancing the convergence speed of aPOCEA. Meanwhile, we propose a parent selection strategy to select high-quality parent solutions, increasing the probability of generating high-quality offspring solutions. Experimental results on ten benchmarks, each with two to three objectives, multiple constraints, and hundreds of decision variables, demonstrate that aPOCEA outperforms other representative optimization algorithms.

17:00-17:20 WeB5.4

Mechanism-Integrated LSTMM Model for Speed Trajectory Prediction of Heavy Haul Trains , pp. 476-481

Xu, Kexuan	Northeastern University
Liu, Qiang	Northeastern University

The trajectory prediction of heavy heavy trains (HHTs) is crucial for ensuring the safe and automatic operation. It is inevitably to design a train model for predicting train operation trajectory for HHTs. However, large capacity, complex line parameters, and the existence of many unmodeled dynamics in the operation process including air resistance, working condition switching, external environment make it difficult to establish accurate speed trajectory prediction models (STPMs) using traditional mechanism-based modeling methods. Most

research now consider using data-driven model to learn information from data, but they have on information about the physical characteristic of the STMP model. This makes it difficult to accurately describe the relationship between the control force and the running speed during the train operation. To overcome these issues, this study combines the mechanism-driven mechanism model with the deep learning model to construct a new long and short-term memory hybrid (LSTMM) model. Specifically, the mechanism model describes the change of control force, while the LSTM captures the unmodel dynamic characteristics of long time series of running process. The effectiveness of the proposed method is demonstrated while the performance is compared with the traditional LSTM and mechanism models using the real data.

17:20-17:40 WeB5.5

Energy-Efficient Hot-Rolling Scheduling of High-Quality Steel Products , pp. 482-487

Zhao, Ziyan	Northeastern University
Bian, Zikuo	Northeastern University
Wang, Chenglong	Shandong Iron & Steel Group Rizhao Co., Ltd
Zou, Kun	Northeastern University
Liu, Shixin	Northeastern University

Steel production involves many energy-intensive processes. Under the goal of carbon peak and carbon neutrality, it is essential to study the steel production scheduling problems aiming at energy saving to realize the green manufacturing of steel production processes. Aiming at the hot rolling process of high-quality steel products, a novel energy-saving production scheduling problem is studied in this paper. Unlike existing research, this paper additionally considers temperature constraints and the optimization of temperature-keeping equipment assignment in producing high-quality steel products. To solve it efficiently, this paper presents an improved simulated annealing algorithm where destruction and construction strategies from iterated greedy algorithms are embedded into it. Experimental results show that the presented algorithm has obvious advantages compared with other competitive peers. Its excellent solution performance means its great application potential.

17:40-18:00 WeB5.6

Exploring the Potential of World Models for Anomaly Detection in Autonomous Driving , pp. 488-495

Bogdoll, Daniel	FZI Forschungszentrum Informatik
Bosch, Lukas	Karlsruhe Institute of Technology
Joseph, Tim	FZI Forschungszentrum Informatio
Gremmelmaier, Helen	FZI Forschungszentrum Informatik
Yang, Yitian	FZI Forschungszentrum Informatik
Zöllner, Marius	Forschungszentrum Informatik

In recent years there have been remarkable advancements in autonomous driving. While autonomous vehicles demonstrate high performance in closed-set conditions, they encounter difficulties when confronted with unexpected situations. At the same time, world models emerged in the field of model-based reinforcement learning as a way to enable agents to predict the future depending on potential actions. This led to outstanding results in sparse reward and complex control tasks. This work provides an overview of how world models can be leveraged to perform anomaly detection in the domain of autonomous driving. We provide a characterization of world models and relate individual components to previous works in anomaly detection to facilitate further research in the field.

WeB6 Constitución C
CI for Engineering Solutions (CCES)

16:00-16:20 WeB6.1

Which Activation Function Works Best for Training Artificial Pancreas: Empirical Fact and Its Theoretical Explanation , pp. 496-500

Dénes-Fazakas, Lehel	Óbuda University
Szilágyi, László	Obuda University
Eigner, Gyorgy	Obuda University
Kosheleva, Olga	University of Texas at El Paso
Ceberio, Martine	The University of Texas at El Paso
Kreinovich, Vladik	University of Texas at El Paso

One of the most effective ways to help patients at the dangerous levels of diabetes is an artificial pancreas, a device that constantly monitors the patient's blood sugar level and injects insulin based on this level. Patient's reaction to insulin is highly individualized, so the artificial pancreas needs to be trained on each patient. It turns out that the best training results are attained when instead of the usual ReLU neurons, we use their minor modification known as Exponential Linear Units (ELU). In this paper, we provide a theoretical explanation for the empirically observed effectiveness of ELUs.

16:20-16:40 WeB6.2

Why Fuzzy Control Is Often More Robust (and Smoother): A Theoretical Explanation , pp. 501-505

Csiszar, Orsolya	Aalen University
Csiszár, Gábor	Óbuda University
Kosheleva, Olga	University of Texas at El Paso
Ceberio, Martine	The University of Texas at El Paso
Kreinovich, Vladik	University of Texas at El Paso

In many practical situations, practitioners use easier-to-compute fuzzy control to approximate the more-difficult-to-compute optimal control. As expected, for many characteristics, this approximate control is slightly worse than the optimal control it approximates. However, with respect to robustness or smoothness, the approximating fuzzy control is often better than the original one. In this paper, we provide a theoretical explanation for this somewhat mysterious empirical phenomenon.

16:40-17:00 WeB6.3

Imprecise Survival Signature Approximation Using Interval Predictor Models , pp. 506-511

Behrensdorf, Jasper	Leibniz University Hannover
Broggi, Matteo	Leibniz University Hannover
Beer, Michael	Leibniz University of Hannover

This paper presents a novel technique for the approximation of the survival signature for very large systems. In recent years, the survival signature has seen promising applications for the reliability analysis of critical infrastructures. It outperforms traditional techniques by allowing for complex modelling of dependencies, common causes of failures and imprecision. However, as an inherently combinatorial method, the survival signature suffers greatly from the curse of dimensionality. Computation for very large systems, as needed for critical infrastructures, is mostly infeasible. New advancements have applied Monte Carlo simulation to approximate the signature instead of performing a full evaluation. This allows for significantly larger systems to be considered. Unfortunately, these approaches will also quickly reach their limits with growing network size and complexity. In this work, instead of approximating the full survival signature, we will strategically select key values of the signature to accurately approximate it using a surrogate radial basis function network. This surrogate model is then extended to an interval predictor model (IPM) to account for the uncertainty in the prediction of the remaining unknown values. In contrast to standard models, IPMs return an interval bounding the survival signature entry. The resulting imprecise survival signature is then fed into the reliability analysis, yielding upper and lower bounds on the reliability of the system. This new method provides a significant reduction in numerical effort enabling the analysis of larger systems where the required computational demand was previously prohibitive.

17:00-17:20 WeB6.4

Semantically Enhanced System and Automation Design of Complex Marine Vessels , pp. 512-518

Kougiatsos, Nikos	Delft University of Technology
Zwaginga, Jesper	Delft University of Technology
Pruyn, Jeroen	Delft University of Technology
Reppa, Vasso	Delft University of Technology

To integrate and assist the system and automation design phases of complex marine vessels, this paper proposes a two-level semantically enhanced scheme. At the design level, the system components are described and automatically connected by a developed graph-making tool using semantic “knowledge“. Decisions regarding the system selection are made based on certain Quality of Service Criteria (QoS) and enforced in the final semantic database using a dedicated cognitive agent. The automation level leverages the selected systems semantic information with that of the associated automation components and reuses the graph-making tool to update the connection graph. The resulting knowledge-graph is then used to “reason“ for the creation of feasible closed-loop control architectures while a cognitive agent determines which closed-loop architecture to use based on various QoS criteria. The chosen closed-loop architecture can then change in an online manner during the vessel operation in case that system reconfiguration is required either due to malfunctioning components, or aiming to satisfy mission's goals. The applicability and efficiency of the proposed method are shown using a case study for marine propulsion.

17:20-17:40 WeB6.5

ForestMonkey: Toolkit for Reasoning with AI-Based Defect Detection and Classification Models , pp. 519-524

Zhang, Jiajun	Loughborough Unviersity
Cosma, Georgina	Loughborough Unviersity
Bugby, Sarah	Loughborough Unviersity
Watkins, Jason	Railston & Co. Ltd

Artificial intelligence (AI) reasoning and explainable AI tasks have gained popularity recently, enabling users to explain the predictions or decision processes of AI models. This paper introduces Forest Monkey (FM), a toolkit designed to reason the outputs of any AI-based defect detection and/or classification model with data explainability. Implemented as a Python package, the FM takes input in the form of dataset folder paths (including original images, ground truth labels, and predicted labels) and provides a set of charts and a text file to illustrate the reasoning results and suggest possible improvements. The FM toolkit consists of processes such as feature extraction from predictions to reasoning targets, feature extraction from images to defect characteristics, and a decision tree-based AI-Reasoner. Additionally, this paper investigates the time performance of the FM toolkit when applied to four AI models with different datasets. Lastly, a tutorial is provided to guide users in performing reasoning tasks using the FM toolkit.

17:40-18:00 WeB6.6

Applicability Study of Model-Free Reinforcement Learning towards an Automated Design Space Exploration Framework , pp. 525-532

Hoffmann, Patrick	Robert Bosch GmbH
Gorelik, Kirill	Robert Bosch GmbH
Ivanov, Valentin	Technische Universität Ilmenau

Design space exploration is a crucial aspect of engineering and optimization, focused on identifying optimal design configurations for complex systems with a high degree of freedom in the actor set. It involves systematic exploration while considering various constraints and requirements. One of the key challenges in design space exploration is the need for a control strategy tailored to the particular design. In this context, reinforcement learning has emerged as a promising solution approach for automatically inferring control strategies, thereby enabling efficient comparison of different designs. However, learning the optimal policy is computationally intensive, as the agent determines the optimal policy through trial and error. The focus of this study is on learning a single strategy for a given design and scenario, enabling the evaluation of numerous architectures within a limited time frame. The study also highlights the importance of plant modeling considering different modeling approaches to effectively capture the system complexity on the example of vehicle dynamics. In addition, a careful selection of an appropriate hyperparameter set for the reinforcement learning algorithm is emphasized to improve the overall performance and optimization process.

WeB7 Colonia

CI in IoT and Smart Cities (CIIoT)

Organizer: Gandomi, Amir H	University of Technology Sydney
Organizer: Daneshmand, Mahmoud	Stevens Institute of Technology

16:00-16:20 WeB7.1

Refrigerated Showcase Fault Detection by an Autoencoder with Coin Betting and Maximum Correntropy Criterion , pp. 533-538

Igarashi, Masato	Meiji University
Fukuyama, Yoshikazu	Meiji University
Shimasaki, Yuichi	Fuji Electric Co., Ltd
Osada , Yuto	Fuji Electric Co., Ltd
Murakami, Kenya	Fuji Electric
Iizaka, Tatsuya	Fuji Electric
Santana, Adamo	Fuji Electric
Matsui, Tetsuro	Fuji Electric

This paper proposes refrigerated showcase fault detection by an autoencoder with coin betting and Maximum Correntropy Criterion (MCC). In actual situations, showcase data may include outliers which are incorrectly stored data. Radio frequency interference or incorrect sensor setting cause the outliers. When the outliers are included in learning data, the conventional autoencoders using least square error (LSE) may be influenced by the outliers. On the other hand, even when the outliers are included in learning data, autoencoders using MCC can reduce influence from the outliers. Moreover, the conventional artificial neural networks utilize various learning algorithms such as stochastic gradient descent with momentum (SGDM), adaptive moment estimation (Adam), adaptive gradient algorithm (AdaGrad). These methods have hyperparameters related to a learning rate. Since the hyperparameters affect learning strongly, it is required to tune the hyperparameters appropriately and the tuning requires engineering costs. On the other hand, coin betting can automatically tune a learning rate appropriately while learning. Therefore, the coin betting is expected to reduce the engineering costs for parameter tuning. Practicability of the proposed method is verified by comparison with an autoencoder with SGD and LSE, an autoencoder with SGDM and MCC, an autoencoder with Adam and MCC, and an autoencoder with AdaGrad and MCC. The results are verified by the Friedman test, a post hoc test using the Wilcoxson signed-rank sum test with the Holm correction, and parameter sensitivity analysis.

16:20-16:40 WeB7.2

A Task Scheduler for Mobile Edge Computing Using Priority-Based Reinforcement Learning , pp. 539-546

Avan, Amin	Ontario Tech University
Kheiri, Farnaz	Ontario Tech University
Mahmoud, Qusay	Ontario Tech University
Azim, Akramul	Ontario Tech University
Makrehchi, Masoud	Ontario Tech University
Rahnamayan, Shahryar	Brock University

Edge computing offers cloud-like services closer to users and IoT devices, providing high speed and accessibility for network users. Edge computing, often called Mobile Edge Computing (MEC), is a distributed paradigm that utilizes heterogeneous computational and storage resources with well-provisioned capabilities rather than relying on the ample resources of the cloud. In addition, edge users usually refer to portable and mobile devices that connect to and disconnect from the network at will. Therefore, scheduling tasks at the appropriate time and allocating the right resources can be modeled as a multi-objective optimization problem in MEC. Moreover, each task has specific requirements, further adding to the complexity of the optimization problem. In this study, we formulate the scheduling problem as a Markov Decision Process (MDP) to schedule the tasks. The learning time of the task scheduler is minimized when it faces new users and edge servers. Subsequently, we employ the Q-learning (QL) algorithm from the Reinforcement Learning (RL) paradigm to address the optimization problem and effectively adapt the proposed scheduler to the dynamic nature of MEC. Accordingly, we designed the valid state space, action space, and reward function with appropriate conditions and proper rewards for the proposed QL-based technique. We conducted comprehensive experiments to validate the results of the proposed solution, taking into account the inherent randomness of the QL-based technique. The experimental results demonstrate that the proposed technique achieves the lowest learning time compared to Deep learning-based and Deep RL-based approaches. Furthermore, on average, the proposed technique obtains a 72% faster runtime compared to previous works, using 58% fewer computation cycles and 50% less memory. These improvements make the proposed approach an efficient and lightweight task scheduler for MEC.

16:40-17:00 WeB7.3

A Federated Transfer Learning-Empowered Blockchain-Enabled Secure Knowledge Sharing Scheme for Unmanned Any Vehicles in Smart Cities , pp. 547-552

Islam, Anik	University of Calgary
Karimipour, Hadis	University of Calgary

Smart cities embrace unmanned autonomous vehicles (UxVs) for urban mobility and addressing challenges. UxVs include UAVs, UGVs, USVs, and UUVs, empowered by AI, particularly deep learning (DL), for autonomous missions. However, traditional DL has limitations in adapting to dynamic environments and raises data privacy concerns. Limited data availability and starting from scratch to adapt to a new environment during missions pose challenges. Additionally, cyber threats, particularly in terms of communication and data security, can jeopardize the missions performed by UxVs. This paper proposes a federated transfer learning scheme for UxVs, sharing prior knowledge and training with limited data while ensuring security through blockchain. Domain adaptation with maximum mean discrepancy enhances the DL model's performance in target domains. The proposed scheme's feasibility is demonstrated in an empirical environment, and it outperforms existing works.

17:00-17:20 WeB7.4

Ressource-Efficient Moth Detection for Pest Monitoring with YOLOv5 , pp. 553-558

Farooq, Muhammad Tallal	University of Erlangen-Nuremberg
Leipert, Martin	University of Erlangen-Nuremberg
Maier, Andreas	University of Erlangen-Nuremberg
Christlein, Vincent	University of Erlangen-Nuremberg

Moths pose a significant threat to agricultural crops, and identifying them accurately is crucial for effective pest monitoring and crop conservation efforts. However, manually evaluating glue traps is a time-consuming and labor-intensive process, which has led to the development of automated solutions. In this study, we present a deep learning-based automated detection pipeline that can detect moths in images captured by field traps with pheromone-emitting glue pads. To train our model, we collected a comprehensive dataset that includes moths from various environments, such as agricultural plants, homes, and food production facilities. We augmented this dataset and included additional glue pad datasets, enabling the model to detect moths regardless of the species. We base our model on the YOLOv5 algorithm and fine-tune it using transfer learning, which enables us to identify moths in real-time and on embedded hardware. Our evaluation of the algorithm reveals that it achieves an average precision of 98.2 % on a test dataset, which outperforms reference models from previous research. We also assess the model's ability to handle disturbances such as other insects, varying lighting conditions, and foreign objects. Importantly, our solution maintains a tiny memory footprint and low inference time of 2.3 ms, making it a highly efficient and effective tool for moth detection in the field.

17:20-17:40 WeB7.5

Crowd Counting on Heavily Compressed Images with Curriculum Pre-Training , pp. 559-564

Bakhtiarnia, Arian	Aarhus University
Zhang, Qi	Aarhus University
Iosifidis, Alexandros	Aarhus University

JPEG image compression algorithm is a widely used technique for image size reduction in edge and cloud computing settings. However, applying such lossy compression on images processed by deep neural networks can lead to significant accuracy degradation. Inspired by the curriculum learning paradigm, we propose a training approach called curriculum pre-training (CPT) for crowd counting on compressed images, which alleviates the drop in accuracy resulting from lossy compression. We verify the effectiveness of our approach by extensive experiments on three crowd counting datasets, two crowd counting DNN models and various levels of compression. The proposed training method is not overly sensitive to hyper-parameters, and reduces the error, particularly for heavily compressed images, by up to 19.70%.

17:40-18:00 WeB7.6

Optimal Production Scheduling by Integer Form of Population-Based Incremental Learning with Initial Probability Matrix Setting Methods and a Practical Production Simulator , pp. 565-572

Katagiri, Ryusei	Meiji University
Fukuyama, Yoshikazu	Meiji University
Kawaguchi, Shuhei	Meiji University and Mitsubishi Electric Co
Takahashi, Kenjiro	Mitsubishi Electric Co., Ltd
Sato, Takaomi	Mitsubishi Electric Co., Ltd

This paper proposes an optimal production scheduling method using a practical production simulator and integer form of population-based incremental learning (IF-PBIL) with two initial probability matrix setting methods. There are three parameters for decision variables in a target factory. It is necessary to optimize these three parameters at the same time in order to evaluate them. Moreover, IF-PBIL is one of the cooperative metaheuristics and determines integer values based on probability values and generates solutions. Initial integer values are determined by equal probability values, and various solutions are generated. Hence, there is a possibility that it is difficult to search high-quality solutions from initial stages of the search. Furthermore, since the production simulator requires long execution time, the execution number of the production simulator should be reduced as much as possible. In order to tackle the challenge, the proposed method applies two initial probability matrix setting methods. It is confirmed that the proposed method can search high-quality solutions from initial stages of the search and can reduce the production costs with the fewer execution number of the production simulator using actual factory data of a polishing process of an assembly processing factory.

WeB8 Conquista

CI for Multimedia Signal and Vision Processing (CIMSIVP) 2

Organizer: Al-Sahaf, Harith — Victoria University of Wellington
Organizer: Mesejo, Pablo — University of Granada
Organizer: Bi, Ying — Victoria University of Wellington

16:00-16:20 WeB8.1

Video Anomaly Latent Training GAN (VALT GAN): Enhancing Anomaly Detection through Latent Space Mining , pp. 573-578

Sethi, Anikeit — Indian Institute of Technology Indore
Saini, Krishanu — Indian Institute of Technology Indore
Singh, Rituraj — Indian Institute of Technology Indore
Saurav, Sumeet — CSIR-Central Electronics Engineering Research Institute
Tiwari, Aruna — IIT INDORE
Singh, Sanjay — CSIR - Central Electronics Engineering Research Institute (CSIR
Chauhan, Vikas — NTUT Taipei

Anomaly detection in video data plays a crucial role in numerous applications, such as industrial monitoring and automated surveillance. This paper presents a novel method for video anomaly detection (VAD) using Generative Adversarial Networks (GANs). The proposed method called VALT-GAN combines two separate branches, one for spatial information and the other for temporal information, to capture relevant features from video data. The framework is utilized to learn the normal features from the training video dataset, enabling the generator to produce realistic samples. However, existing GAN-based methods face challenges in detecting subtle or unseen anomalies. To address this, we introduce latent mining for adversarial training which allows us to train a robust GAN model with high anomaly detection (AD) capability. We exploit the latent space following the continuous nature of the generator using the Iterative Fast Gradient Signed Method (IFGSM) which improves the quality of the generated images. Experimental evaluations show the effectiveness of VALT-GAN as compared to traditional methods on UCSD (University of California, San Diego) Peds2, CUHK (Chinese University of Hong Kong) Avenue, and ShanghaiTech datasets.

16:20-16:40 WeB8.2

Image Forgery Detection Algorithm Using Particle Swarm Optimization , pp. 579-586

Alibrahim, Hussain — North Dakota State University
Ludwig, Simone — North Dakota State University

Copy-move forgery is one of the most used ma- nipulations for tampering with digital images. The authenticity of the image becomes more crucial when the images are used in important processes. keypoints-based algorithms have been reported to be very effective in revealing copy-move evidence due to their robustness against various attacks. However, these approaches sometimes fail to make good prediction because of different factors such small number of keypoints detected, or wrongly detected keypoints. Matching the correct keypoints and filtering the wrong keypoints are other difficult tasks. One reason behind these issues is the parameters used to configure the key point detection algorithm. In this paper, another CMF (copy-move forgery) detection algorithm is proposed, by applying particle swarm optimization to find the best parameters for the algorithm for all different phases. Furthermore, filtering is achieved through two stages to remove most of the wrong keypoints detected. Additionally, triangulation is used as another technique applied to the algorithm in order to increase the detection area. Experimental results shows that the algorithm has good performance.

16:40-17:00 WeB8.3

A ResNet-9 Model for Insect Wingbeat Sound Classification , pp. 587-592

Szekeres, Béla János — ELTE Eötvös Loránd University, Faculty of Informatics
Gyöngyössy, Natabara Máté — ELTE Eötvös Loránd University, Faculty of Informatics
Botzheim, János — ELTE Eötvös Loránd University, Faculty of Informatics

Sound-based insect wingbeat classification presents a unique challenge with implications for areas such as mosquito control and the prevention of mosquito-borne diseases. This paper introduces a straightforward modified ResNet-9 model to address this challenge by utilizing one-dimensional convolutional layers. The architecture of the proposed ResNet-9 model is outlined in detail. Impressively, the model can accurately classify fruitflies and mosquitoes using raw audio data instead of relying on spectrograms. Its performance surpasses the majority of preceding models while concurrently reducing the number of trainable parameters by 90%. The results from this research carry notable significance for practical applications in insect control and disease prevention.

17:00-17:20 WeB8.4

Monocular Vision for 3D Distance Computation in Augmented Reality Applications , pp. 593-597

Martínez-Díaz, Saúl — Tecnologico Nacional De Mexico/Instituto Tecnologico De La Paz

Augmented reality is a growing technology with potential applications in education, medicine, entertainment, and tourism, among others. Basically, what this technology seeks is to combine information from the real world with virtual information, without the user perceiving the difference between the two. To achieve this, the augmented reality system must be able to dimension the real-world objects in real time, to generate realistic virtual scenarios. To carry out this dimensioning, a good alternative is to use an artificial vision system that provides a good compromise between cost and performance. In this work a method is presented to calculate the distances among known reference objects in real world and the camera, using a monocular artificial vision system.

17:20-17:40 WeB8.5

Symmetric Fine-Tuning for Improving Few-Shot Object Detection , pp. 598-602

Mpampis, Emmanouil — Aristotle University of Thessaloniki
Passalis, Nikolaos — Aristotle University of Thessaloniki
Tefas, Anastasios — Aristotle University of Thessaloniki

Object detection plays a crucial role in automated image analysis by identifying and localizing objects within an image. One-stage Deep Learning (DL)-based object detectors have achieved impressive results, primarily due to large-scale datasets available for training them. However, these approaches rely heavily on abundant labeled data, posing challenges when only a few samples per class are available. To this end, few-shot object detection approaches have been proposed. Among them, fine-tuning the final detection head while keeping the feature extractor/backbone frozen is a commonly used approach for few-shot object detection. This approach effectively utilizes pre-existing knowledge encoded in the backbone, using a small number of samples to learn new object categories. However, in this paper, we argue that fine-tuning only the last layers may limit accuracy and lead to overfitting if the initial layers of the detection head are not adapted for the new task. The data processing inequality, which states that information lost in early network layers cannot be recovered in subsequent ones, supports this argument. To address this issue, we propose a symmetric fine-tuning method that involves both the first and last layers of the detection head, aiming to maintain a fixed trainable parameter budget while strategically selecting parameters for fine-tuning. Experimental results demonstrate the effectiveness and efficiency of this approach and open up several interesting future research directions.

17:40-18:00 WeB8.6

Prediction of Flight Arrival Delay Time Using U.S. Bureau of Transportation Statistics , pp. 603-608

Li, Jiarui	University of Nottingham Ningbo China
Ji, Ran	University of Nottingham Ningbo China
LI, Cheng'ao	University of Nottingham Ningbo China
YANG, Xiaoying	University of Nottingham
Li, Jiayi	University of Nottingham, Ningbo China
Li, Yiran	University of Nottingham Ningbo China
Xiong, Xihan	Imperial College London
Fang, Yutong	Ningbo Open University
Ding, Shusheng	Ningbo University
Cui, Tianxiang	University of Nottingham Ningbo China

According to the data from the Bureau of Transportation Statistics (BTS), the number of passengers and flights has been increasing year by year. However, flight delay has become a pervasive problem in the United States in recent years due to various factors, including human factors such as security regulations, as well as natural factors such as bad weather. Flight delay not only affects the profits of airlines but also affects the satisfaction of passengers. Therefore, a model that can predict the arrival time of airplanes needs to be developed. Machine learning methods have been widely applied to prediction problems. In this paper, a variety of machine learning and computational intelligence methods, including linear regression, decision tree (DT), random forest (RF), gradient boosting (GB), gaussian regression models and genetic programming were trained on the U.S. Department of Transportation's (DOT) BTS dataset. The results show that genetic programming performs best and can be used to predict the arrival time of the U.S. flights in advance, which is beneficial for airlines and passengers to make timely decisions.

Thursday December 7, 2023

ThC1 Imperio A

Swarm Intelligence (POP)

10:30-10:50 ThC1.1

Spider Monkey Optimization for Optimal Operational Planning of Energy Plants, pp. 609-610

Kobayashi, Yuto	Meiji University
Fukuyama, Yoshikazu	Meiji University
Wananabe, Takuya	Fuji Electric Co., Ltd
Iizaka, Tatsuya	Fuji Electric
Matsui, Tetsuro	Fuji Electric

This paper proposes a spider monkey optimization (SMO) based method for optimal operational planning of energy plants. SMO is one of the cooperative metaheuristics. In the optimal operation of energy plants in commercial buildings and factories, it is required to determine startup and shutdown status of each machine and its input/output values during startup, as well as to consider linear and nonlinear machine characteristics. Thus, this problem can be formulated as a mixed integer non-linear optimization problem, and it requires application of evolutionary computation methods. The effectiveness of the proposed spider monkey optimization (SMO) based method is verified by comparing with the conventional differential evolutionary particle swarm optimization (DEEPSO), brain storm optimization (BSO), modified BSO (MBSO), and multi-population MBSO (MP-MBSO) based methods. The results are verified using the Kruskal-Wallis test and the Mann-Whitney U tests with holm correction.

10:50-11:10 ThC1.2

City Assignment by Multi-Objective Evolutionary Artificial Neural Networks for Multiple TSP, pp. 611-612

Katada, Yoshiaki	Setsunan University
Watanabe, Shinya	Muroran Institute of Technology
Ohkura, Kazuhiro	Hiroshima University

In the multiple traveling salesman problem (TSP), a group of cities to be visited has been assigned to each salesman based only on the cities' geographic information, and the visiting routes of the salesmen are planned. However, there is no guarantee that the adopted clustering method is appropriate for route planning. In this study, we proposed a two-stage search method, where the clustering is performed using an artificial neural network, its weights are designed through a multi-objective evolutionary algorithm (MOEA), and each salesman's visiting route is solved using a TSP solver. We conducted computational experiments for a test problem to compare the performance of the proposed method to a canonical clustering method. Additionally, we examined the characteristics of the balanced solution selected from the obtained non-dominated solution set.

11:10-11:30 ThC1.3

Towards Interpretable Digital Twins for Self-Aware Industrial Machines, pp. 613-614

Santos da Silva Júnior, Adelson	University of Pernambuco
Vilar Dias, João Luiz	Universidade De Pernambuco
Buarque de Lima Neto, Fernando	University of Pernambuco

In this research, we introduce a methodology that combines digital twins and Particle Swarm Optimization (PSO) to improve real-time adaptability and interpretability in industrial systems. Using an industrial DC motor simulation as a case study, our approach involves creating a digital twin, performing online parameter estimation via PSO, and identifying unknown system components. The results, especially from scenarios like armature resistance degradation and unbalanced shaft conditions, highlight the digital twin's accuracy and adaptability. This work showcases the potential of our method for real-time monitoring and proactive maintenance in industrial applications.

ThC2 Imperio B

Image Processing (POP)

10:30-10:50 ThC2.1

Real Time Continuous Image Stitching Algorithm Based on SIFT, pp. 615-616

Yang, RUIJun	Shanghai Institute of Technology
Zhang, Chu	Shanghai Institute of Technology
Cheng, Yan	East China University of Political Science and Law

Image stitching technology has application scenarios in many fields. This algorithm achieves the acquisition of simultaneously synthesized images, using the RGB module of the Intel Realsense D435 camera for image acquisition. Firstly, a raw image is created to store the final result, and one image is collected at 100ms intervals each time. Images with similarity less than 5/8 are taken and saved. Use the SIFT scale invariant feature detection algorithm to extract image feature points from the collected images, use RANSAC to extract feature points, use the random sample consistency algorithm to filter effective points, and calculate the homography transformation matrix. Synthesize every two collected images into one image and overlay it at the corresponding position in the resulting image. Through the experiment in this article, the average time for single acquisition and synthesis is 70ms, achieving the real-time goal. The similarity between the experimental group and the control group can reach 70%, and the resolution has been increased by 1.65 times, achieving the goal of continuous splicing.

10:50-11:10 ThC2.2

Synthetic Generation of Pneumonia Images Using CycleGAN Model, pp. 617-618

Lugo Torres, Gerardo	Centro De Investigación En Computación, Instituto Politécnico Nac
Peralta, Diego Antonio	Instituto Politécnico Nacional
Valdez-Rodríguez, José E.	Centro De Investigación En Computación
Calvo, Hiram	CIC-IPN

The utilization of generative models in image synthesis has become increasingly prevalent. Synthetic medical imaging data is of paramount importance, primarily because authentic medical imaging data is scarce, costly, and encumbered by legal considerations pertaining to patient confidentiality. Consent forms are typically required from patients in order to utilize their data for publication in medical journals or educational purposes. Consequently, the accessibility of medical data for general public research is limited. Synthetic medical images offer a potential resolution to these issues. The predominant approaches primarily assess the quality of images and the degree of resemblance between these images and the original ones employed for their generation. In this study, we employ a CycleGAN model to produce artificial images depicting several types of pneumonia, including general, bacterial, and viral pneumonia. We then evaluate the performance of these synthetic images by comparing them with ratings made by three respiratory care professionals. Consequently, a range of pneumonia pictures were acquired, exhibiting diverse levels of performance, ranging from being easily identified as false to being correctly identified as real in over 80% of cases.

11:10-11:30 ThC2.3

Time Series Prediction Based on Randomly Weighted Neural Networks, pp. 619-620

Wang, Xizhao — Shenzhen University
Wang, Qin — Shenzhen University
Liu, Qiang — Canghai Campus, Shenzhen University, Nanshan District, She

One of the most frequently used models for time series prediction is the Long Short Term Memory (LSTM). LSTM can leverage the past patterns to efficiently forecast the future observations but it is often criticized as very computationally expensive due to the iterative training. In this paper, to reduce the computational workload and improve the prediction performance of time series, we propose a novel auto-regression framework based on Random Vector Functional Link (RVFL). The new framework offers a lighter network structure with higher training efficiency compared to LSTM-based approaches. It is a new attempt to utilize randomized learning algorithms for time series prediction, providing valuable insights for developing faster and more efficient models in the future.

ThC3 Imperio C
Deep Learning 1 (POP)

10:30-10:50 ThC3.1

Seed Kernel Counting Using Domain Randomization and Object Tracking Neural Networks, pp. 621-624

Margapuri, Venkata Siva Kumar — Villanova University
Thapaliya, Prapti — Villanova University
Neilsen, Mitchell — Kansas State University

High-throughput phenotyping (HTP) of seeds is the comprehensive assessment of complex seed traits and the measurement of parameters that form more complex traits. The key aspect of seed phenotyping is cereal yield estimation. While mechanized seed kernel counters are available in the market currently, they are often priced high and sometimes outside the range of small scale seed production firms' affordability. The development of object tracking neural network models such as You Only Look Once (YOLO) enables computer scientists to design algorithms that can estimate cereal yield inexpensively. The key bottleneck with neural network models is that they require a plethora of labelled training data before they can be put to task. We demonstrate that the use of synthetic imagery serves as a feasible substitute to train neural networks for object tracking. Furthermore, we propose a seed kernel counter that uses a low-cost mechanical hopper, trained YOLOv8 neural network model, and object tracking algorithms on StrongSORT and ByteTrack to estimate cereal yield from videos. The experiment yields a seed kernel count with an accuracy of 95.2% and 93.2% for Soy and Wheat respectively using the StrongSORT algorithm, and an accuray of 96.8% and 92.4% for Soy and Wheat respectively using the ByteTrack algorithm.

10:50-11:10 ThC3.2

Detecting Automated Generated Text with LLMs, pp. 625-626

Aguilar-Canto, Fernando — CIC IPN
Cardoso-Moreno, Marco A. — Cic - Ipn
Jiménez López, Diana Laura — Centro De Investigación En Computación, Instituto Politécnico Na
Calvo, Hiram — CIC-IPN

The development of Large Language Models (LLMs) like GPT-series and BLOOM has revolutionized Artificial Intelligence, yet it has also brought forth challenges in misuse, such as fake content generation and academic cheating. Detecting whether a text is generated by an LLM or written by a human has become imperative. Fine-tuned LLMs have proven to be a promising approach in this regard. In our study, we fine-tuned seven LLMs (BERT, DeBERTa-v3, RoBERTa, XLMRoBERTa, GPT-2 Medium, GPT-2 Large, GPT-2 XL) to detect text generated by even larger models (GPT-3 and BLOOM) in the AuTexTification task. Among the models, GPT-2 Medium exhibited the best performance in the testing set, achieving an F1-macro score of 0.83272 and an accuracy of 0.83442, surpassing the benchmark's best-known result.

11:10-11:30 ThC3.3

Explainable Image Recognition with Graph-Based Feature Extraction and Classification, pp. 627-630

Azam, Basim — Griffith University
Kuttichira, Deepthi — Instiute for Integrated and Intelligent Systems, Griffith Univer
Verma, Brijesh — Instiute for Integrated and Intelligent Systems, Griffith Univer

Deep learning models have proven remarkably adept at extracting salient features from raw data, driving state-of-the-art performance across many domains. However, these models suffer from a lack of interpretability; they function as black boxes, obscuring the feature-level support of their predictions. Addressing this problem, our work presents an innovative framework that fuses the power of convolutional layers for feature extraction with the versatility of Graph Neural Networks (GNNs) to model relationships among neuron activations. Our framework operates in two phases: first, it identifies class-oriented neuron activations by analyzing image features, then these activations are encapsulated within a graph structure. The GNN leverages the relationships among these neuron activations to generate a final, interpretable classification. As a result, predictions can be reverse-engineered to pinpoint the specific contributing neurons, thereby enhancing explainability. The proposed model not only matches, but at times exceeds, the accuracy of current leading models, all the while providing transparency via class-specific feature importance. This novel integration of convolutional and graph neural networks offers a significant step towards interpretable and accountable deep learning models.

ThC4 Constitución A
Learning Algorithms (POP)

10:30-10:50 ThC4.1

MRNA Robust Signatures for IBD Using Machine Learning, pp. 631-632

Rojas-Velazquez, David — Utrecht University
Kidwai, Sarah — Utrecht University
de Vries, Luciënne — Division of Pharmacology, University of Utrecht,
Garssen, Johan — Division of Pharmacology, University of Utrecht
Tonda, Alberto — UMR 518 MIA-PS, INRAE, Université Paris-Saclay
Lopez-Rincon, Alejandro — Utrect University

Inflammatory bowel disease, including Crohn's disease and ulcerative colitis, is a rising global issue. Accurate diagnosis is vital but challenging. This study used the REFS algorithm to identify IBD biomarkers using three mRNA datasets from the GEO repository. The selected genes demonstrated excellent diagnostic accuracy, highlighting the potential of machine learning in advancing IBD research.

10:50-11:10 ThC4.2

Predicting Directional Change Reversal Points with Machine Learning Regression Models, pp. 633-636

Rayment, George — University of Essex
Kampouridis, Michael — University of Essex
Adegboye, Adesola — University of Kent

Traditional trading methods often use fixed-interval sampling to capture price changes. In this work, we use an intrinsic time sampling method referred to as directional changes (DC), which reports information whenever there is a significant price change. Tick data from an array of seven FX currency pairs is sampled using the DC framework. We then compare eleven different machine learning (ML) algorithms in a regression task of predicting when the current trend in the market will reverse. These algorithms are: decision tree, random forest, support vector regression, linear regression, stochastic gradient descent regression, kernel ridge regression, elastic net regression, bayesian ridge regression, gradient boosting regression, multilayer perceptron, and long short-term memory neural network. Predicting trend reversal is crucial in trading, as it allows us to anticipate changes in the market and take the relevant actions that are necessary to maximise our returns. After identifying the best ML algorithm for a dataset, we use this prediction as an input of a DC-based trading strategy, and report its performance in terms of return and risk (maximum drawdown). We also benchmark this strategy against four other trading strategies, which include technical analysis and buy and hold. Results over 349 datasets show that the proposed DC-based trading strategy is able to consistently offer high returns at low risk, statistically and significantly outperforming all other benchmarks.

11:10-11:30 ThC4.3

Enhancing Solar Panel Efficiency through Deep Deterministic Policy Gradients (DDPG) Reinforcement Learning Control, pp. 637-638

Ortiz-Munoz, Diana	Universidad Autonoma De Ciudad Juarez
Luviano-Cruz, David	Universidad Autonoma De Ciudad Juarez
Perez-Dominguez, Luis	Universidad Autonoma De Ciudad Juarez
Rodriguez-Ramirez, Alma	Universidad Autonoma De Ciudad Juarez

This study introduces a novel two-degree-of-freedom orientation mechanism for photovoltaic panels, utilizing 3D-printed gears and controlled by the DDPG reinforcement learning algorithm. The research highlights the potential for enhanced solar energy capture. The integration of mechanical design with machine learning showcases a promising interdisciplinary approach to renewable energy systems.

ThC5 Constitución B
Deep Learning 2 (POP)

10:30-10:50 ThC5.1

Simultaneous Facial Age Transformation and Reenactment, pp. 639-640

Zhang, Jie-Ying	National Taiwan University of Science and Technology
Hsiung, Li-Syun	National Taiwan University of Science and Technology
Hsu, Gee-Sern	National Taiwan University of Science and Technology

This paper explores concatenating pre-trained models for simultaneous facial age transformation and face reenactment, emphasizing image quality enhancement. We introduce an identity recognition loss function during age transformation model development to separate identity and age features, optimizing it with a finely-tuned age prediction model. Our research highlights the success of this concatenated training process, especially in remarkable image generation results.

10:50-11:10 ThC5.2

Classification of Songs in Spanish with LLMs: An Analysis of the Construction of a Dataset, through Classification, pp. 641-642

Alcantara, Tania	Centro De Investigación En Computación, Instituto Politécnico Na
Omar, Garcia-Vazquez	CIC-IPN
Cardoso-Moreno, Marco A.	Cic - Ipn
Calvo, Hiram	CIC-IPN

Songs convey emotions through melody and lyrics. They capture feelings in small text fragments. Emotions within songs vary: positive, negative, or neutral. This study merged two datasets to create a third, leveraging LLMs for competitive song text classification results.

11:10-11:30 ThC5.3

Convolutional Autoencoder-Based Multimodal One-Class Classification, pp. 643-644

Laakom, Firas	Tampere University
Sohrab, Fahad	Tampere University
Raitoharju, Jenni Karoliina	University of Jyväskylä
Iosifidis, Alexandros	Aarhus University
Gabbouj, Moncef	Tampere University

One-class classification refers to approaches of learning using data from a single class only. In this paper, we propose a deep learning one-class classification method suitable for multimodal data, which relies on two convolutional autoencoders jointly trained to reconstruct the positive input data while obtaining the data representations in the latent space as compact as possible. During inference, the distance of the latent representation of an input to the origin can be used as an anomaly score. Experimental results using a multimodal macroinvertebrate image classification dataset show that the proposed multimodal method yields better results as compared to the unimodal approach. Furthermore, study the effect of different input image sizes, and we investigate how recently proposed feature diversity regularizers affect the performance of our approach. We show that such regularizers improve performance.

ThC6 Constitución C
Automated Algorithm (POP)

10:30-10:50 ThC6.1

TransOpt: Transformer-Based Representation Learning for Optimization Problem Classification, pp. 645-646

Cenikj, Gjorgjina	Jožef Stefan Institute
Petelin, Gašper	Jožef Stefan Institute
Eftimov, Tome	Jožef Stefan Institute

In this work, we propose a novel representation of optimization problem instances using a transformer-based neural architecture trained for the task of problem classification of the 24 problem classes from the Black-box Optimization Benchmarking (BBOB) benchmark. We show that transformer-based methods can be trained to recognize problem classes with accuracies in the range of 70%-80% for different problem dimensions, suggesting the possible application of transformer architectures in acquiring representations for black-box optimization problems.

10:50-11:10 ThC6.2

Leveraging Automation, Optimization, and Distributed Computing to Perform High-Fidelity Regional Seismic Risk and Resilience Assessment, pp. 647-648

Dahal, Laxman	University of California Los Angeles
Burton, Henry	University of California Los Angeles
Zhong, Kuanshi	University of Cincinnati

The primary objective of this study is to develop a suite of computational engines that leverage automation, optimization, and high-performing computing resources to facilitate high-fidelity (HiFi) seismic risk and resilience assessments. In the context of regional-level assessment, HiFi risk simulations are based on the modern performance-based earthquake engineering (PBEE) methodology, which is designed to conduct individualized and explicit loss (e.g., financial loss and functional recovery time) analysis. The methodology is inherently cumbersome and compute-intensive as it relies on building-, site-, and hazard-specific information that requires substantial data preprocessing. At its core, the methodology systematically transforms seismic hazard into quantifiable risk metrics through three major computational modules: 1) probabilistic seismic hazard analysis (PSHA), 2) probabilistic seismic demand analysis (PSDA), and 3) loss analysis using Monte Carlo simulation. The PSHA is a mathematical representation of the seismic hazard that encompasses uncertainties in the size, location, rate of occurrence, and resulting ground motions that a particular site is likely to observe. Subsequently, the PSDA computes the structural response, ideally via nonlinear response history analyses using the ground motion records selected as part of the PSHA. The distribution of the structural response is ultimately used to perform Monte Carlo simulation-based loss assessment. In this study, the economic loss is assessed following the FEMA P-58 guidelines while the time to regain functionality of a building is calculated based on the ATC-138 procedure. The three modules are executed sequentially as each module hinges on the inputs from the preceding one.

11:10-11:30 ThC6.3

Context-Based Classification of Sensitive Personal Information, pp. 649-650

De Jesus, Sara — CIC-IPN
Aguirre Anaya, Eleazar — Instituto Politecnico Nacional
Calvo, Hiram — CIC-IPN
Coyac-Torres, Jorge E. — Centro De Investigación En Computación - IPN
Acosta Bermejo, Raúl — Instituto Politécnico Nacional

Sensitive personal information is at risk of exposure by the institutions it is shared. Institutions are responsible for preserving the privacy of the personal data they hold, even more so, in the case of sensitive data. ICIS, a model for context-based identification and classification of sensitive personal information, considers the context to identify personal data in unstructured texts of government type documents, regardless the size and type, and then classify each text segment as sensitive personal information, using natural language processing and machine learning techniques. ICIS not only indicates whether a text segment contains sensitive information or not, it also indicates personal data identified in each text segment, their location in the document and whether each text segment is classified as sensitive information. The main contributions of this work are both the identification of personal data and the classification of sensitive information based on the context, and the definition of sensitive personal information, in computational terms.

ThC7 Colonia
Decision Making (POP)

10:30-10:50 ThC7.1

Profit Allocation in Logistics Enterprise Coalitions Based on Fuzzy Cooperative Game Theory, pp. 651-652

He, Xi — Tsinghua University
Huang, Shuangxi — Tsinghua University

In the context of e-commerce, establishing a stable alliance is crucial in the logistics industry. Consequently, the challenge of ensuring a fair profit allocation arises. In this study, we address the problem of profit allocation for logistics enterprise coalitions with inadequate information and propose a relevant model. To demonstrate the effectiveness of the model, a case study is provided. The results show that our method enhances the multi-party cooperation and serves as an effective tool for the fair and equitable allocation of profits.

10:50-11:10 ThC7.2

Optimizing a Prediction-Based, Mixed-Asset Portfolio Including REITs, pp. 653-656

Habbab, Fatim Zahra — University of Essex
Kampouridis, Michael — Univ. of Essex, Essex, UK

The real estate asset class has captured the attention of billions of global investors due to its ability to generate consistent returns and offer diversification benefits within a mixed-asset portfolio. Prior research has highlighted the advantages of including real estate in portfolio optimization. However, existing studies have primarily focused on historical data when addressing this optimization problem. This paper presents an analysis of the performance of a portfolio that incorporates real estate using price predictions derived from a Long Short-Term Memory (LSTM) model. To provide a comprehensive evaluation, we compare the performance of our portfolio against a benchmark portfolio consisting of stocks and bonds only. To this end, we run a genetic algorithm on the two portfolios. Our findings demonstrate a substantial improvement in the average risk-adjusted return of the portfolio that includes real estate with a magnitude of around 100%, highlighting the substantial value that real estate brings to a diversified portfolio. In this way, we propose a novel approach for showing the benefits of investing in real estate.

11:10-11:30 ThC7.3

Computational Intelligence for Equity-Aware STEM Student Recruitment, pp. 657-658

Abid, Noor — University of Calgary
Yanushkevich, Svetlana — University of Calgary

This paper makes a contribution to the CI platform aimed at enhancing the efficiency of student recruitment procedures. Our study entails a comprehensive follow-up audit of this domain, and identifies the key challenges to the integration of equity-conscious practices into the recruitment process. We propose an innovative solution designed to bridge the relevant socio-technological gaps, that is a self-aware recruitment engine. This engine functions within two interconnected conceptual paradigms: machine learning and probabilistic reasoning. To illustrate our approach, we offer a demonstrative example that showcases its practical application.

ThC8 Conquista
Data Mining (POP)

10:30-10:50 ThC8.1

Performance Comparison of Augmented Reality Frameworks, pp. 659-660

Villagran-Vizcarra, Dafnis Cain — Universidad Autonoma De Ciudad Juarez
Luviano-Cruz, David — Universidad Autonoma De Ciudad Juarez
Perez-Dominguez, Luis — Universidad Autonoma De Ciudad Juarez

In our quest to incorporate Augmented Reality (AR) into industrial and university laboratories for training purposes, we conducted an analysis of four AR frameworks. Our goal was to develop a portable Starter Kit (SK) and determine the most sustainable option for our project. This kit integrates both hardware and software components, designed to improve an optimize AR functionality on computers, smartphones, and tablets. The research involves four key stages: beginning with NAS configuration, followed by 3D model creation, next is the generation of QR code identifiers, and finally, the development of a cross-platform (C-P) solution.

10:50-11:10 ThC8.2

Structural Analysis of the Mexico-Toluca Interurban Train with Data Science, pp. 661-662

Arellano, Osmar David	Universidad Autónoma Del Estado De México
Valdovinos, Rosa María	Universidad Autónoma Del Estado De México
Guzmán, Angélica	Universidad Jaume I
Delgado, David Joaquín	Universidad Autónoma Del Estado De México

As part of an initiative to mitigate transportation congestion of more than 230,000 daily travellers between Mexico City and Mexico State, the Mexican Federal Government, through the Secretariat of Communications and Transportation, began the construction of the Mexico-Toluca Interurban Train in January 2015. In this paper, an exhaustive analysis of the train infrastructure in an event of a high-magnitude earthquake is carried out. For that, a scenario of a large earthquake in which the train moves at high speed transporting passengers is considered. Specifically, we analyse the structure behaviour when it is exposed to an earthquake comparable in magnitude to those experienced on September 19th 1985, in Mexico, and May 22nd 1960, in Chile. Preliminary results confirm the useful of data science techniques for the study, and offer a comprehensive analysis of the train structural integrity under earthquake conditions via simulations conducted using the SAP 2000 software.

11:10-11:30 ThC8.3

Neural Network Regression for Structural Health Monitoring Using Smartphones, pp. 663-664

yingqin, zhu	CINVESTAV-IPN
Li, Xiaoou	CINVESTAV-IPN
Ovilla-Martinez, Brisbane	CINVESTAV-IPN

n/a

ThA1 Imperio A

Deep Learning (DL) 3

Organizer: Sperduti, Alessandro	University of Padova
Organizer: Angelov, Plamen	Lancaster University
Organizer: Principe, Jose C.	University of Florida

13:30-13:50 ThA1.1

Video-Based Skeleton Data Analysis for ADHD Detection , pp. 665-670

Li, Yichun	Newcastle University
Nair, Rajesh	Cumbria, Northumberland, Tyne and Wear NHS Foundation Trust
Naqvi, Syed Mohsen	Newcastle University

Attention Deficit Hyperactivity Disorder (ADHD) is a common neurobehavioral disorder in humans worldwide. While extensive research has focused on machine learning methods for ADHD detection and diagnosis. Most methods rely on high-cost equipment and trained staff for data collection, e.g., Magnetic Resonance Image (MRI) machine and Electroencephalography (EEG) patch. Therefore, low-cost sensors-based easy-to-process methods for ADHD detection by exploiting action and behavior symptoms are required. We present that skeleton-based action recognition has the potential to address the application due to the action-focused nature of ADHD. Hence, this work proposes a novel ADHD detection system with a privacy-mitigating skeleton-based action recognition framework by utilizing our new real multi-modal ADHD dataset. Compared to the conventional methods, the proposed method shows cost efficiency and significant performance improvement. This method also outperforms the conventional methods in accuracy and AUC on the real multi-modal dataset. Furthermore, our proposed method based on simple non-wearable sensors is widely applicable for ADHD screening.

13:50-14:10 ThA1.2

Relationship between Model Compression and Adversarial Robustness: A Review of Current Evidence , pp. 671-676

Pavlitska, Svetlana	FZI Research Center for Information Technology
Grolig, Hannes	Karlsruhe Institute of Technology (KIT)
Zöllner, Marius	Forschungszentrum Informatik

Increasing the model capacity is a known approach to enhance the adversarial robustness of deep learning networks. On the other hand, various model compression techniques, including pruning and quantization, can reduce the size of the network while preserving its accuracy. Several recent studies have addressed the relationship between model compression and adversarial robustness, while some experiments have reported contradictory results. This work summarizes available evidence and discusses possible explanations for the observed effects.

14:10-14:30 ThA1.3

Enhancing Gesture Recognition for Musical Conducting: A Study on Diverse Data Classification and Stacked Neural Network Architectures , pp. 677-682

Tsang, Herbert H.	Trinity Western University
Woo, Gideon	Trinity Western University
Tan, Faith	Trinity Western University

This study addresses the limitations of many gesture recognition algorithms, which predominantly employ machine learning-based approaches tailored to specific types of gestures, leaving niche gestures such as musical conducting gestures largely unexplored. To advance the research in musical conducting gesture recognition, we focus on two key aspects: (1) broadening the dataset to encompass various conducting speeds and investigating its impact on performance, and (2) introducing a stacked neural network architecture to explore performance improvements beyond conventional node increase. The study demonstrates that incorporating diverse data significantly enhances performance and that stacking neural network layers yields notable performance gains.

14:30-14:50 ThA1.4

Diffusion Model in Causal Inference with Unmeasured Confounders , pp. 683-688

Shimizu, Tatsuhiro	Waseda University

We study how to extend the use of the diffusion model to answer the causal question from the observational data under the existence of unmeasured confounders. In Pearl's framework of using a Directed Acyclic Graph (DAG) to capture the causal intervention, a Diffusion-based Causal Model (DCM) was proposed incorporating the diffusion model to answer the causal questions more accurately, assuming that all of the confounders are observed. However, unmeasured confounders in practice exist, which hinders DCM from being applicable. To alleviate this limitation of DCM, we propose an extended model called Backdoor criterion-based DCM (BDCM), whose idea is rooted in the Backdoor criterion to find the variables in DAG to be included in the decoding process of the diffusion model so that we can extend DCM to the case with unmeasured confounders. Synthetic data experiment demonstrates that our proposed model captures the counterfactual distribution more precisely than DCM under the unmeasured confounders.

14:50-15:10 ThA1.5

PyramidEnsemble: Joining Large and Small Models , pp. 689-694

Köring, Adrian	Otto-Von-Guericke-University Magdeburg

Steup, Christoph — Otto-Von-Guericke-University Magdeburg

In this paper, we aim to improve segmentation performance and uncertainty calibration within a fixed computational budget. We propose PyramidEnsembles, which contain members ranging from small over medium and large, to overcome one major problem in applying neural networks to the automotive domain: the trade-off between model performance and overconfidence in the uncertainty predictions. PyramidEnsembles use multiple models of different sizes from the same family in order to combine their strengths: good segmentation performance and well-calibrated uncertainties. We focus our experiments on EfficientNet-based segmentation models applied to the Cityscapes dataset, which is widely used in the field of autonomous driving. We evaluate single models, uniform ensembles (one architecture repeated) and PyramidEnsembles (combination of different model capacities) composed of the EfficientNet model family. Our evaluations show that within the same computational budget, PyramidEnsembles can outperform a single model in terms of segmentation performance while providing better calibrated uncertainties. Scaling over different computational budgets shows that this performance gap increases further. Different uniform ensembles offer a comparable segmentation or uncertainty calibration performance: 3 copies of the EfficientNet-B3 achieve an IoU of 0.7195 while an ensemble of 7 EfficientNet-B0 models yields an Expected Calibration Error (ECE) of 0.0667. One PyramidEnsemble containing an instance of EfficientNet-B0 through B3 is a close second on either metric at 0.7188 IoU and 0.0698 ECE and offers a better trade-off between segmentation performance and uncertainty calibration in this computational budget.

15:10-15:30 — ThA1.6

Disentangled (Un)Controllable Features , pp. 695-702

Kooi, Jacob Eeuwe — Vrij Universiteit Amsterdam
Hoogendoorn, Mark — Vrije Universiteit Amsterdam
Francois-Lavet, Vincent — VU Amsterdam

In the context of MDPs with high-dimensional states, downstream tasks are predominantly applied on a compressed, low-dimensional representation of the original input space. A variety of learning objectives have therefore been used to attain useful representations. However, these representations usually lack interpretability of the different features. We present a novel approach that is able to disentangle latent features into a controllable and an uncontrollable partition. We illustrate that the resulting partitioned representations are easily interpretable on three types of environments and show that, in a distribution of procedurally generated maze environments, it is feasible to interpretably employ a planning algorithm in the isolated controllable latent partition.

ThA2 — Imperio B

CI in Data Mining (CIDM) 1

Organizer: Ni, Zhen — Florida Atlantic University

13:30-13:50 — ThA2.1

Unsupervised Unlearning of Concept Drift with Autoencoders , pp. 703-710

Artelt, André — Bielefeld University
Malialis, Kleanthis — University of Cyprus
Panayiotou, Christos — University of Cyprus
Polycarpou, Marios — KIOS Research and Innovation Center of Excellence and Department
Hammer, Barbara — Bielefeld University

Concept drift refers to a change in the data distribution affecting the data stream of future samples. Consequently, learning models operating on the data stream might become obsolete, and need costly and difficult adjustments such as retraining or adaptation. Existing methods usually implement a local concept drift adaptation scheme, where either incremental learning of the models is used, or the models are completely retrained when a drift detection mechanism triggers an alarm. This paper proposes an alternative approach in which an unsupervised and model-agnostic concept drift adaptation method at the global level is introduced, based on autoencoders. Specifically, the proposed method aims to ``unlearn'' the concept drift without having to retrain or adapt any of the learning models operating on the data. An extensive experimental evaluation is conducted in two application domains. We consider a realistic water distribution network with more than 30 models in-place, from which we create 200 simulated data sets / scenarios. We further consider an image-related task to demonstrate the effectiveness of our method.

13:50-14:10 — ThA2.2

Stock Price Movement Prediction Based on Optimized Traditional Machine Learning Models , pp. 711-716

Silva, José Júnior de Oliveira — Universidade Federal De Pernambuco
Barros, Roberto Souto Maior de — Universidade Federal De Pernambuco-UFPE
Santos, Silas Garrido Teixeira de Carvalho — Universidade Federal De Pernambuco

Stock price prediction has attracted several investors willing to maximize their profits, believing the opportunities to expand their earnings are higher than using conventional financial approaches, such as savings or fixed deposits. Market analysts, traders, and researchers have investigated different techniques such as Bayesian model, Fuzzy classifiers, Artificial Neural Networks (ANN), Support Vector Machines (SVM), etc. to analyze stock markets and make trading decisions. More recently, deep learning models have gained prominence. However, because of the large amount of data required for training, these techniques typically aggregate all stocks in a single database, creating a generic model. On the contrary, we propose to predict stock price movements considering each stock as a distinct dataset, training specialized machine learning traditional classifiers for each one. We compare the proposed procedure, using different learners, mainly with state-of-the-art deep learning techniques. The results suggest that using specific models for each stock, employing simple and small feature sets, significantly contributes to improved model performance. Our best model, using Logistic Regression, outperformed all the other models.

14:10-14:30 — ThA2.3

Features and Classes Drift Detector to Deal with Imbalanced Data Streams , pp. 717-722

Santos, Silas Garrido Teixeira de Carvalho — Universidade Federal De Pernambuco
Cabral, Danilo Rafael de Lima — Universidade Fderal De Pernambuco
Barros, Roberto Souto Maior de — Universidade Federal De Pernambuco-UFPE

Data streams, due to their dynamic nature, tend to impose a number of constraints on the functioning of the learning models used to extract knowledge from these environments. In this context, concept drift is an emerging research area, as they negatively affect the performance of classifiers: after they have been trained with a specific concept, they tend to lose accuracy in the presence of a new concept. Additionally, this problem is often worsened in environments with imbalanced classes, because the identification of changes in the distributions of examples belonging to minority classes is usually more complex, due to their lack of representativeness in the data stream. This work proposes the Features and Classes Drift Detector (FCDD), a new method specially designed to deal with the problem of concept drifts in imbalanced data streams, aiming to maintain the accuracy of detections in minority classes and, in addition, to avoid discarding the knowledge inherent to the classes unaffected by drifts. Experiments conducted in an imbalanced scenario with partial concept drift demonstrated the effectiveness of the proposed method

when compared to the current state of the art detectors.

14:30-14:50 ThA2.4

Fourier U-Shaped Network for Multi-Variate Time Series Forecasting , pp. 723-729

Xu, Baowen	Institute of Automation, Chinese Academy of Sciences
Wang, Xuelei	Institute of Automation, Chinese Academy of Sciences
Liu, Chengbao	Institute of Automation, Chinese Academy of Sciences
Li, Shuo	Institute of Automation, Chinese Academy of Sciences

Multi-variate time series forecasting plays a crucial role in addressing key tasks across various domains, such as early warning, pre-planning, resource scheduling, and other critical tasks. Thus, accurate multi-variate time series forecasting is of significant importance in guiding practical applications and facilitating these essential tasks. Recently, Transformer-based multi-variate time series forecasting models have demonstrated tremendous potential due to their outstanding performance in long-term time predictions. However, Transformer-based models for multi-variate time series forecasting often come with high time complexity and computational costs. Therefore, we propose a low time complexity model called Fourier U-shaped Network (F-UNet) for multi-variate time series forecasting, which is non-Transformer based. Specifically, F-UNet is composed of low time complexity neural network components, such as Fourier neural operator and feed-forward neural network, arranged in a Ushaped architecture. F-UNet conducts channel and temporal modeling separately for the multi-variate time series. The UNet constructed based on Fourier neural operators is employed to achieve channel interactions, while linear layers are used to realize temporal interactions. Experimental results on several realworld datasets demonstrate that F-UNet outperforms existing Transformer-based models with higher efficiency in multi-variate time series forecasting.

14:50-15:10 ThA2.5

Experimenting with Supervised Drift Detectors in Semi-Supervised Learning , pp. 730-735

Pérez, José Luis Martínez	Universidade Federal De Pernambuco - UFPE
Barros, Roberto Souto Maior de	Universidade Federal De Pernambuco-UFPE
Santos, Silas Garrido Teixeira de Carvalho	Universidade Federal De Pernambuco

Machine learning algorithms to aid decision-making processes are increasingly common in several areas., e.g. mobile phones, internet, sensor applications, etc. When fully-trained, algorithms tend to perform better, but the availability of data labels shortly after testing without human intervention is a challenging task in many areas, especially in data stream learning with concept drifts, where data is generated very fast, in real-time, with the possibility of changes in the data distribution. Concept drifts have been addressed in different ways, but using drift detectors with base classifiers in semi-supervised learning is not so common. This article shows how to use state-of-the-art supervised detectors in semi-supervised learning problems, and it also includes an extension to the MOA framework. The Experiments designed to test our proposal used Hoeffding Tree (HT) as base classifier, combined with eight drift detectors and a total of 62 artificial and five real-world datasets, configured with 15% and 30% labeled instances. The results indicate that drift detectors designed for supervised learning can also be effectively used in semi-supervised environments. This finding could lead to a change of paradigm for future research, since supervised drift detectors have never been considered as a viable alternative due to the absence of labels shortly after testing in many real-world data streams.

15:10-15:30 ThA2.6

A Game Theoretic Based K-Nearest Neighbor Approach for Binary Classification , pp. 736-740

Lung, Rodica Ioana	Babes-Bolyai University
Suciu, Mihai Alexandru	Babes-Bolyai University

K-nearest neighbor is one of the simplest and most intuitive binary classification methods providing robust results on a wide range of data. However, classification results can be improved by using a decision method that is capable of assigning, if necessary, the minority label from the list of neighbors of a tested instance. In this paper, we propose using a simple game-theoretic model to assign labels based on the neighbors' information to enhance its performance for binary classification.

ThA3 Imperio C

CI in Healthcare and E-Health (CICARE) 1

Organizer: Hussain, Amir	Edinburgh Napier University
Organizer: Sheikh, Aziz	University of Edinburgh

13:30-13:50 ThA3.1

Artificial Intelligence and Features Investigating to Detect Neuropsychiatric Symptoms in Patients with Dementia: A Pilot Study , pp. 741-746

Badawi, Abeer	Ontario Tech University
Choudhury, Samira	University of Toronto
Badawi, Abeer	Ontario Tech University
M. Burhan, Amer	University of Toronto

Dementia is a chronic and irreversible condition characterized by progressive cognitive and functional decline. While the cognitive and functional decline is profoundly disabling, the non-cognitive Neuropsychiatric Symptoms (NPS) negatively impact these patients' quality of life. In this study, we investigate using artificial intelligence with a wide range of features from wearable sensor data collected from patients with dementia (PwD). Our goal is to develop an assistive artificial intelligence approach that detects NPS in PwD in an institutional setting to understand their behaviors and detect episodes of agitation. We present the preliminary results of a real-world study at Ontario Shores Centre for Mental Health Sciences. The results suggest that using sequential feature selection improved results with fewer features after selecting the optimal features from 198 features. We also found that the Extra Trees classification model can classify the non-agitated normal events and agitated events with the best accuracy compared to other algorithms. Our results demonstrate that the personalized model produced better results, with an average of 5-10% higher than all patients combined.

13:50-14:10 ThA3.2

Smart Camera-Based Patient-Specific Seizure Detection , pp. 747-752

Minasyan, Georgiy	Telefactor Robotics
Chatten, Martha Jane	Telefactor Robotics
Schuman, Adam	Telefactor Robotics
Tyczka, Dale	Telefactor Robotics
Lindoerfer, Daniel	Telefactor Robotics

Detection of seizures using smart cameras has potential benefits since it does not require contact with the patient and can be easily deployed. Timely seizure alerts are crucial to prevent potential complications from seizures such as secondary injuries, and to initiate treatment to stop a seizure. In our small, preliminary study, we demonstrated that camera-based patient-specific seizure detection can provide reliable detection of convulsive seizures and in some cases, even outperform the EEG-based seizure detector. We therefore see a need for the development of user-friendly, trainable, smart camera system which can be easily re-trained for each patient by a caregiver or at home by a family member.

14:10-14:30 ThA3.3

Towards a Safety Culture in Workplaces: Intelligent Rest Breaks and Social Support , pp. 753-758

Zhao, Wenbing	Cleveland State University
Cheng, Jinsai	Kent State University
Tao, Shen	Kent State University
Luo, Xiong	University of Science and Technology Beijing

Musculoskeletal disorders (MSDs) are pervasive in the workforce and constitute the single largest category of work-related illness. The root cause for MSDs is complex. However, there is little dispute that MSD morbidity is primarily due to physical and psychosocial risk factors, and these two domains of risk factors share a common upstream determinant. A work organization influences both the physical load patterns and psychosocial features. In this paper, we propose a technology-facilitated intervention program that could lead to an improved safety culture in workplaces. The program is aimed at addressing one of the physical risk factors, ie rest breaks, and a psychosocial risk factor, ie social support. First, a wearable soft orthosis is used to detect the types of physical activities and load patterns, and to derive an intelligent rest break schedule for each type of activity and load patterns. The orthosis would also remind the participant to take a rest break at appropriate times. Second, a mobile app is developed to cultivate a learning community where the participants could seek and provide social support and increase their awareness of occupational safety. We collected some preliminary app usage data and developed a methodology of identifying app usage patterns using both supervised and unsupervised learning. The feasibility of the method is validated using synthesized data derived from the collected data.

14:30-14:50 ThA3.4

Decision Support Component for the Localized Epidemiological Modelling of COVID-19 , pp. 759-764

Ciunkiewicz, Philip	University of Calgary
Yanushkevich, Svetlana	University of Calgary

This study develops a decision support system for localized epidemiological modelling of infectious disease spread. We propose a Bayesian network topology for performing inference supplementary to an epidemiological simulation framework and a cohesive integration of this decision support system with the framework. The Bayesian network topology is structured with data defined as inputs, outputs, or derived features within the simulation framework. All features are motivated by their clinical relevance and utility for administrative policy guidance. Edges in the final network are quantitatively assessed using structural equation modelling to ensure strong causal connections. Various inference scenarios are demonstrated to provide proof of concept for real-world application and validation in future directions. The outcomes of this project contribute to a larger body of work for infectious disease risk mitigation and emergency management in generalized environments.

14:50-15:10 ThA3.5

On the Impact of ECG Data Quality for Arrhythmia Detection Using Convolutional Neural Networks and Wearable Devices , pp. 765-771

Sancho, Juan Manuel	Universidad Tecnologica Del Uruguay
Tyska Carvalho, Jonata	Federal University of Santa Catarina

Cardiovascular diseases are the leading cause of death in the world, with arrhythmias being a significant symptom and risk factor. Advancements in technologies such as low-cost and low-power wearable devices, and machine learning techniques for analyzing big volumes of data offer opportunities to address this issue. However, low-cost devices may have limitations, including reduced data quality due to lower sampling rates, bit depth, and the number of leads recorded. These limitations might produce a significant decrease in machine learning models' performance in detecting arrhythmias. This study investigates the impact of data quality reduction on arrhythmia classification using deep neural network models. High-quality ECG data with 12 leads, 500Hz sampling rate, and 32-bits resolution were transformed into low-quality versions with varying leads (from one to six), 100Hz sampling rate, and 8-bits resolution. Training a state-of-the-art deep learning arrhythmia detection model on both high-quality and low-quality datasets revealed a decrease in performance from 95.3% to 93.9% in the worst case, which is concerning given the critical nature of the domain. To mitigate this performance loss, we propose an ensembling method that compensates for 42% of the loss, achieving an accuracy of 94.5% even with the low-quality dataset. The analysis also identifies the leads with the most promising classification performances. These results can aid in making better design decisions when creating cost-effective wearable ECG devices.

15:10-15:30 ThA3.6

Synchronization of External Inertial Sensors and Built-In Camera on Mobile Devices , pp. 772-777

Malawski, Filip	AGH University of Science and Technology
Kapela, Ksawery	AGH University of Science and Technology
Krupa, Marek	AGH University of Science and Technology

The fusion of inertial and visual data is an effective approach to human motion analysis, with applications in areas such as sports or rehabilitation exercise monitoring. Employing wireless, low-cost, external inertial sensors and a built-in camera on mobile devices provides a convenient acquisition system, available for wide range of potential users. In order to take advantage of both data modalities, robust time synchronization is required. We consider consumer-grade devices, for which direct access to internal clocks is not available and only high-level API is provided. At the same time, we aim to avoid event-based synchronization that would require additional user actions. We investigate sources of acquisition errors on mobile devices, and then we propose and evaluate a novel synchronization method for inertial and visual data. Experimental results indicate that the proposed method provides robust synchronization.

ThA4 Constitución A

Computational Intelligence in Power and Energy Systems (CIPES)

Organizer: Lezama, Fernando	Polytechnic of Porto
Organizer: Venayagamoorthy, Ganesh	Clemson University

13:30-13:50 ThA4.1

A Novel Population Optimizer for Unit Scheduling Problems in Power Systems , pp. 778-782

Zhao, Huashi	China Southern Power Grid Dispatching and Control Center
He, Yubin	China Southern Power Grid Dispatching and Control Center
liang, shouyu	China Southern Power Grid Dispatching and Control Center
Zhou, Huafeng	China Southern Power Grid Dispatching and Control Center
Gu, Huijie	China Southern Power Grid Dispatching and Control Center
Li, Yingchen	China Southern Power Grid Dispatching and Control Center
Fu, Qiujia	China Southern Power Grid

The unit commitment (UC) problem is the first step in power system

optimal scheduling and system planning. However, the UC problem is a mixed integer optimization problem, which usually has the characteristics of high dimension, non-convex and nonlinear. Plug-in electric vehicles (PEVs) integration into the grid can help improve stability and flexibility of the grid. However, Large-scale PEVs charging demand may put pressure on the grid and may lead to grid overloads. Recently, a competitive swarm optimizer (CSO) is proposed to settle optimization problems, which is considerably challenging in evolutionary computation. In this paper, a binary competitive swarm optimizer (BCSO) is proposed to tackle UC problems integration with PEVs. Finally, comparison experiments on economic problems with dimensionality increasing from 10 to 100 units, which confirm the competitive performance of the proposed optimizer.

13:50-14:10 ThA4.2

Explainergy: Towards Explainability of Metaheuristic Performance in the Energy Field , pp. 783-788

Lezama, Fernando	GECAD, LASI, Polytechnic of Porto
Almeida, José	GECAD, LASI, Polytechnic of Porto
Soares, Joao	GECAD, LASI, Polytechnic of Porto
Vale, Zita	GECAD, LASI, Polytechnic of Porto

We propose the concept of ”explainergy”, a new way of including explainability in the metaheuristic performance of algorithms solving problems in the energy domain. To this end, we open the discussion around eXplainable Computational Intelligence (XCI), focusing on using metaheuristic optimization for complex energy-related problems. It is well known that computational intelligence applied to optimization cannot guarantee optimality theoretically and also faces issues related to premature convergence, tuning parameters, and variability of the results. These aspects slow the adoption of such methods by energy industry practitioners. Our proposal considers incorporating ideas already applied to the artificial intelligence paradigm, namely those related to eXplainable AI, to motivate current research in this field and provide solutions from metaheuristics with explainability characteristics. Through a case study solving a bidding problem in local electricity markets, we shed light on some ideas that might be advantageous to understanding the metaheuristic performance for energy experts unfamiliar with approximate algorithms. If an XCI framework is successfully developed, it can increase metaheuristic adoption, reliability, and broader success.

14:10-14:30 ThA4.3

Insights into the 2022 WCCI-GECCO Competition: Statistical Analysis of Evolutionary Computation in the Energy Domain , pp. 789-794

Lezama, Fernando	GECAD, LASI, Polytechnic of Porto
Almeida, José	GECAD, LASI, Polytechnic of Porto
Soares, Joao	GECAD, LASI, Polytechnic of Porto
Canizes, Bruno	GECAD, LASI, Polytechnic of Porto
Vale, Zita	GECAD, LASI, Polytechnic of Porto

In the energy field, the "WCCI(CEC)/GECCO Competition Evolutionary Computation in the Energy Domain: Risk-based Energy Scheduling" is a platform for testing and comparing new evolutionary algorithms (EAs) to address complex energy problems. Nonetheless, the current competition ranking metric is not statistically significant in assessing algorithm performance and only considers the mean fitness value associated with the objective function. Thus, this work undertakes a statistical analysis using the Shapiro-Wilks test, the Wilcoxon pair-wise comparison, and the Kruskal-Wallis technique to comprehensively study algorithm performance based on statistical grounds. The results reveal that, according to the Wilcoxon test, the top three algorithms demonstrate significant superiority over the other algorithms. In contrast, the Kruskal-Wallis test shows that the top four algorithms belong to the same group based on the ranks resulting from the test. This rigorous analysis provides valuable insights into the stochastic performance of algorithms, contributing to a deeper understanding of their capabilities in the context of the competition.

14:30-14:50 ThA4.4

Optimal Allocation of PV Systems on Unbalanced Networks Using Evolutionary Algorithms , pp. 795-800

Bai, Wenlei	Oracle Corporation
Zhang, Wen	Baylor University
Meng, Fanlin	University of Manchester
Allmendinger, Richard	University of Manchester
Lee, Kwang	Baylor University

As the distributed energy resources (DERs) increasingly penetrate the unbalanced distribution network, it becomes challenging to accommodate such penetration technically and economically. Therefore, this paper tackles an optimal allocation of PV systems (locations and sizes) to maximize the penetration while minimizing voltage violation. It is challenging because the problem is a mixed integer nonlinear programming (MINLP) problem with non-linear and non-convex properties. In addition, the network is unbalanced which brings burdens on solving load flows. Computational intelligent methods, particularly evolutionary algorithms (EAs) have proven its efficiency and robustness in large optimization problems and thus, this paper explores two EAs on the problem with the help of a robust unbalanced load flow algorithm. A comparative study is conducted on particle swarm optimization (PSO) and artificial bee colony (ABC) based on IEEE 13 and 37 bus systems. Optimal allocation based on peak hour and day-ahead scenarios are considered. After 30 times run, the test cases have shown that both EAs are successful and yet ABC generally converges to better solution and yet with larger statistical deviations on solutions.

14:50-15:10 ThA4.5

Evolved Neural Networks for Building Energy Prediction , pp. 801-806

Santana, Roberto	University of the Basque Country
Prol-Godoy, Irati	University of the Basque Country
Picallo-Perez, Ana	University of the Basque Country
Inza, Iñaki	University of the Basque Country

Improving buildings' energy efficiency is an essential component in the efforts for reducing the carbon footprint. The design of more accurate machine learning models for forecasting energy use in buildings can help to reach this goal since these models can be integrated as part of the management systems. A variety of machine learning algorithms have been used for different classes of building energy predictions problems. In this paper we investigate two questions related to the use of neural networks for building energy predictions: The benefits of optimized neural network configurations that include the architecture and some hyperparameters, and the impact on the performance of the amount of data available to train the networks. Our results show that combine optimization of architectures and hyperparameters can significantly improve the accuracy of the neural networks in some problems and that the availability of training data should be taken into account when deciding to apply neural networks over other machine learning methods for building energy prediction problems.

ThA5 Constitución B

CI for Security and Defense Application (CISDA)

Organizer: Abielmona, Rami	Larus Technologies
Organizer: Bolia, Robert	Defence Science & Technology Group

13:30-13:50 ThA5.1

Intrusion Detection for Wireless Sensor Network Using Graph Neural Networks , pp. 807-813

Gharavian, Vida	Ontario Tech University
Khosrowshahli, Rasa	Ontario Tech University
Mahmoud, Qusay	Ontario Tech University
Makrehchi, Masoud	Ontario Tech University
Rahnamayan, Shahryar	Brock University

Wireless Sensor Networks (WSNs) are rapidly employed in many applications due to highly demanded autonomous systems. These networks are of immense importance due to their ability to collect data from remote and challenging environments, their impact on various sectors like healthcare, agriculture, industry, environment, and their role in enabling smart technologies for a sustainable, secure, and connected future. Nevertheless, these systems can be attacked by adversaries. Usually, the WSNs are designed with lightweight sensor nodes with limited computation and memory resources. Therefore, employing a firewall system on every sensor node is unacceptable. This paper tackled this problem with a very lightweight Graph Neural Network-based model. The conducted experiment performed in this work demonstrates promising attack-type detection by our proposed approach to the WSN-DS dataset. In this article, our proposed method is compared with other the-state-of-the-art works, and we could discover all Blackhole attacks, one of the most common Denial-of-Service attacks.

13:50-14:10 ThA5.2

Multi-Agent Pathfinding with Obstacle Movement for Realistic Virtual Tactical Simulations on Topographic Terrains , pp. 814-821

Perotti Souza, Luigi	Federal University of Santa Maria
PIGNATON DE FREITAS, EDISON	Federal University of Rio Grande Do Sul
Ceretta Nunes, Raul	Federal University of Santa Maria
de Lima Silva, Luís Alvaro	Federal University of Santa Maria

Multi-Agent Pathfinding (MAPF) algorithms represent a powerful tool for modeling realistic tactical movements of troops in military simulation systems. Solving MAPF problems while dealing with topographic terrains involves computing the most cost-effective and safe relief routes for agents with movement constraints. To minimize the overall topographic cost of agents' movement and the need to deviate from other stationary agents, this work considers a MAPF approach that respects real-world agents' movement characteristics, such as the agents' orientation, the limits of the agents' turning angles, and the relief inclinations they can safely navigate. To solve conflicts between agents while navigating uneven terrains, the proposed approach explores the attribution of agents' movement priorities related to the need to execute given missions. Most importantly, other agents without planned movement at the current mission situation, as they are stationary on safe and low-cost routes according to the terrain relief, are minimally displaced to nearby locations to give passage to the mission-critical agents. The MAPF algorithm is evaluated on a comprehensive set of test scenarios, with results analyzed using Generalized Linear Regression models. This analysis provides valuable insights into the MAPF algorithm's effectiveness in virtually modeling organized agent movement behaviors for developing simulation-based training and instruction activities.

14:10-14:30 ThA5.3

Federated Self-Supervised Learning for Intrusion Detection , pp. 822-828

Meyer, Bruno Henrique	Federal University of Paraná
Pozo, Aurora	Federal University of Parana
Nogueira, Michele	Federal University of Minas Gerais
Zola, Wagner M. Nunan	Federal University of Paraná

Deep learning and federated learning show significant success in cybersecurity for Intrusion Detection Systems (IDS). This paper presents the Federated Self-Supervised Learning (FSSL) framework proposed for IDSs. FSSL combines Self-Supervised Learning (SSL) with federated learning to obtain a global model. SSL works at the client level, where only unlabeled data is available, and thus it enables the learning from these data. This knowledge enhances the training of the target model. Therefore, FSSL follows a federated learning approach, where private data from multiple clients help to create a global model. Each client learns an unsupervised model, which is then transmitted to a server and combined into a single model. The communication between clients and the server aims to improve model performance and convergence. Conducted experiments compare FSSL with a baseline approach using limited data and a deep learning model. FSSL utilizes an autoencoder to learn a representational model on unlabeled data and transfers knowledge by initializing deep learning model weights with the encoder layers. Results show that FSSL significantly improves the F1-Score of detection systems across three well-known datasets (NSL-KDD, TonIoT, and BotIoT). Moreover, the proposed model demonstrated a noteworthy capability to detect previously unidentified attacks when compared to the baseline.

14:30-14:50 ThA5.4

Evaluation of Gender Bias in Masked Face Recognition with Deep Learning Models , pp. 829-835

Atay, Mustafa	Winston-Salem State University
Poudyel, Megh	Winston-Salem State University
Evora, Saul	Winston-Salem State University

We explore gender bias in the presence of facial masks in automated face recognition systems using various deep learning algorithms in this research study. The paper focuses on an experimental study using an imbalanced image database with a smaller percentage of female subjects compared to a larger percentage of male subjects and examines the impact of masked images in evaluating gender bias. The conducted experiments aim to understand how different algorithms perform in mitigating gender bias in the presence of face masks and highlight the significance of gender distribution within datasets in identifying and mitigating bias. We present the methodology used to conduct the experiments and elaborate the results obtained from male only, female only, and mixed-gender datasets. Overall, this research sheds light on the complexities of gender bias in masked versus unmasked face recognition technology and its implications for real-world applications.

14:50-15:10 ThA5.5

Data Augmentation for Cardiovascular Time Series Data Using WaveNet , pp. 836-841

Feldhans, Robert	Bielefeld University
Schulz, Alexander	Bielefeld University
Kummert, Johannes	Bielefeld University
Habigt, Moriz	Anaesthesiology Clinic RWTH Aachen University
Stemmler, Maike	Institute of Automatic Control RWTH Aachen University
Kohler, Christina	Institute of Automatic Control RWTH Aachen University
Abel, Dirk	RWTH Aachen University
Rossaint, Rolf	Anaesthesiology Clinic RWTH Aachen University Faculty of Medicin
Hammer, Barbara	Bielefeld University

In this work we present a novel approach for generating cardiovascular data using a modified WaveNet architecture. This can enable further research in areas where data is scarce and hard to obtain. By generating additional time series data in a set of animal tests performance of existing models could be improved and more

difficult approaches, that require substantial amounts of data, attempted. We validate our approach on a classification task and compare it to similar methods of data augmentation.

15:10-15:30 ThA5.6

Exploring Heterogeneous Open Multi-Agent Systems on Cloud Using a Docker-Based Architecture , pp. 842-849

de Lima, Gustavo UFPEL

Aguiar, Marilton UFPel

In Open Multi-Agent Systems (OMAS), heterogeneous agents in varying environments or models can transition from one system to another, retaining their attributes and knowledge. This migration process results in an augmented development complexity compared to conventional Multi-Agent Systems. Additionally, the intricacy of this transition arises from uncertainties and dynamic behaviors associated with the agent's changes, necessitating the formulation of techniques to analyze this complexity and comprehend the system's overall behavior. To address these challenges, we employed Docker, which enables a flexible architecture that accommodates different programming languages and frameworks for the agents. This paper introduces a Docker-based architecture that aids OMAS development, facilitating agent migration between various models operating in heterogeneous hardware and software setups. To validate the proposed approach, we conducted simulations using NetLogo's Open Sugarscape 2 Constant Growback and JaCaMo's Gold Miners. These simulations were executed locally, in the cloud, and in a hybrid mode to assess the feasibility of the proposed architecture.

ThA6 Constitución C

CI in Cyber Security (CICS) 1

Organizer: Dasgupta, Dipankar — University of Memphis

13:30-13:50 ThA6.1

Explainable Artificial Intelligence for Improving a Session-Based Malware Traffic Classification with Deep Learning , pp. 850-855

Machmeier, Stefan — University Heidelberg, Engineering Mathematics and Computing Lab

Hoecker, Maximilian — University Heidelberg, Engineering Mathematics and Computing Lab

Heuveline, Vincent — University Heidelberg, Engineering Mathematics and Computing Lab

In network security, applying deep learning methods to detect network traffic anomalies has achieved great results with various network traffic representations. A possible representation is the transformation of raw network communication to images to extract valuable information from the unmanageable amount of network traffic by applying representation learning. However, since deep learning models can result in black boxes for users, it is interesting to understand what valuable information is learned from network communication converted into images. This paper elaborates on that question using explainable artificial intelligence (XAI) methods to identify network packets that most influence the prediction and verify that packets in a malware communication containing malicious payloads have high influence on the prediction. We inspect the *Grad-CAM* and visualize the *Integrated Gradients* of Xception and VGG-19 model and investigate the attention heat maps of our Vision Transformer (ViT) model. In addition, we present a novel transformation of sessions to a new image representation to expand the informativeness of network communication. For multiclass classification, our best model Xception achieves an accuracy of *97.95%*, whereas, for binary classification, Xception and VGG-19 achieve well above *99.50%*. Our ViT model achieves a significantly lower performance with *95.86%* for multiclass and *99.36%* for binary classification. In particular, computing centers could benefit by examining their inbound and outbound traffic to detect malicious behaviors ahead of time.

13:50-14:10 ThA6.2

BLB-GAFS: An Efficient, Multi-Objective Genetic Algorithm Based Feature Selection Method for Intrusion Detection Systems , pp. 856-861

Singh, Arihant — The Early College at Guilford

Roy, Kaushik — North Carolina A&T State University

Protecting Internet of Things (IoT) networks from threats is becoming increasingly important as these devices continue to grow in adoption. Modern and unseen attacks that require the analysis of more complex network traffic data for effective identification and mitigation are becoming more prevalent. Traditional machine learning approaches in current intrusion detection systems (IDS) struggle with these volumes of data, prompting exploration into the feature selection space. One class of such feature selection methods is evolutionary algorithms, in which systems mimicking real-life evolution optimize solutions for some problem. In this paper, we propose bag-of-little-bootstraps genetic algorithm feature selection (BLB-GAFS), a novel variant of the genetic algorithm feature selection method that maintains a global search of the solution space while reducing computational cost. This is accomplished with the bag-of-little-bootstraps method for approximating classifier performance. We test the BLB-GAFS technique on three modern intrusion datasets—CCD-INID-V1, detection_of_IoT_botnet_attacks_N_BaIoT, and CIRA-CIC-DoHBrw-2020—that represent updated network patterns and are highly dimensional. We found that the BLB-GAFS method matches or outperforms embedded feature selection methods on the same datasets. Furthermore, the feature sets selected by BLB-GAFS result in significantly improved multiclass precision, recall, and F1-score. Traditionally expensive wrapper feature selection methods like the genetic algorithm can be used on larger datasets through BLB-GAFS, opening the door to other applications with highly dimensional data.

14:10-14:30 ThA6.3

Ransomware Detection and Classification Using Machine Learning , pp. 862-866

Zaman, ANK — Wilfrid Laurier University

Kunku, Kavitha — Wilfrid Laurier University

Roy, Kaushik — North Carolina A&T State University

Vicious assaults, malware, and various ransomware pose a cybersecurity threat, causing considerable damage to computer structures, servers, and mobile and web apps across various industries and businesses. These safety concerns are important and must be addressed immediately. Ransomware detection and classification are critical for guaranteeing rapid reaction and prevention. This study uses the XGBoost classifier and Random Forest (RF) algorithms to detect and classify ransomware attacks. This approach involves analyzing the behaviour of ransomware and extracting relevant features that can help distinguish between different ransomware families. The models are evaluated on a dataset of ransomware attacks and demonstrate their effectiveness in accurately detecting and classifying ransomware. The results show that the XGBoost classifier, Random Forest Classifiers, can effectively detect and classify different ransomware attacks with high accuracy, thereby providing a valuable tool for enhancing cybersecurity.

14:30-14:50 ThA6.4

Facial Shape-Based Eyeglass Recommendation Using Convolutional Neural Networks , pp. 867-872

Rifat, Rakib Hossain — BRAC University

Siddique, Sunzida — Daffodil International University

Das, Laxmi Rani — Noakhali Science and Technology University

Haque, Mohd Ariful Clark Atlanta University

Eyeglasses are not only used to protect our vision and prevent dust from getting into our eyes. Additionally, glass that fits properly can give a person an elegant appearance. However, people often find it difficult to choose eyeglasses that fit their face shape; to address this issue, we have proposed a novel architecture in this paper. In order to do this, we created a pipeline that can recommend eyeglasses based on the form of the eyes using multiple transfer learning architecture to predict the face shape from a given image. We utilized InceptionV4 [17], InceptionV3 [18], Vit Small [12], DenseNet121 [10], ResNet50 [9], and VGG16 [16] to predict the facial shape from the image and achieve a test accuracy of 75%. We used 5500 photos with five different face shapes (Heart, Oblong, Oval, Round, Square) for this experiment, and two distinct datasets were gathered from Kaggle [2] and GitHub [1]. By simply uploading the photograph to our recommendation system, our proposed solution can assist users in selecting the appropriate eyewear.

14:50-15:10 ThA6.5

Cyber Security Issues in the Industrial Applications of Digital Twins , pp. 873-878

Siddique, Sunzida Daffodil International University
Haque, Mohd Ariful Clark Atlanta University
Shujaee, Khalil Clark Atlanta University
George, Roy Clark Atlanta University
Gupta, Kishor Datta Clark Atlanta University

Transformative developments have been brought in across several industries. Digital twin technologies are one of them. This revolutionary innovation has enhanced efficiency, optimized production, and elevated product design to new heights. Nevertheless, as industries embrace the potential of digital twins, cybersecurity concerns come to the forefront due to the convergence of physical and virtual realms. By addressing cybersecurity challenges effectively, industries can fully capitalize on the transformative capabilities of digital twin technology, driving competitiveness and resilience in the face of evolving digital landscapes. Our research explores the various industrial applications of digital twin technology. It also highlights the urgent need for strong cybersecurity measures. Secure data transmission, access control, encryption, and threat detection become crucial elements that must be ensured for digital twin systems in the industrial sector. Our study fills cybersecurity gaps in digital twin applications, offering actionable information for strong security.

15:10-15:30 ThA6.6

An Ensemble Learning to Detect Decision-Based Adversarial Attacks in Industrial Control Systems , pp. 879-884

Babadi, Narges University of Calgary
Karimipour, Hadis University of Calgary
Islam, Anik University of Calgary

An increasing number of Intrusion Detection Systems (IDSs) rely on Artificial Intelligence (AI), specifically Machine Learning (ML) algorithms, to distinguish between benign and malicious data and detect cyber attacks. However, using ML algorithms exposes IDSs to Adversarial Machine Learning (AML) attacks during the training and test phase. These AML attacks aim to deceive ML algorithms by misclassifying data, posing significant disruptions to the system and its users. Two critical categories of AML attacks are White-box and Black-box attacks, with Black-box attacks being more practical and representative of real-world scenarios. This paper investigates the impact of adversarial examples on supervised ML models in IDSs and proposes an ensemble learning-based detection approach. The study uses a power system dataset and employs Random Forest, AdaBoost, and Decision Tree classifiers to achieve this. During the test phase, adversarial examples are generated using the decision boundary and HopSkipJump attacks, two types of Black-box decision-based attacks. The research applies a deep neural network to the dataset containing the generated adversarial examples to detect these AML attacks, achieving an accuracy of 98% to 99%.

ThA7 Colonia

Computational Intelligence for Robotics (CIR)

Organizer: Yu, Wen CINVESTAV-IPN
Organizer: Hou, Zeng-Guang Chinese Academy of Science

13:30-13:50 ThA7.1

Robot PID Control Using Reinforcement Learning , pp. 885-890

Guillermo, Puriel CINVESTAV-IPN
Li, Xiaoou CINVESTAV-IPN
Ovilla-Martinez, Brisbane CINVESTAV-IPN
Wen, Yu CINVESTAV-IPN

In this paper, the robot PID control is compensated by the reinforcement learning. The controller adjustment is proposed by the stability analysis. The reinforcement learning can compensate the dynamics of the robot. This method avoids the problems due to big integral gain of classical PID control. The experimental results show the effectiveness of the proposed controller.

13:50-14:10 ThA7.2

Digital Twin System for Home Service Robot Based on Motion Simulation , pp. 891-896

Jiang, Zhengsong Shandong University
Tian, Guohui Shandong University
Cui, Yongcheng Shandong University
Liu, Tiantian Shandong University
Gu, Yu Shandong University
Wang, Yifei University of California

In order to improve the task execution capability of home service robot, and to cope with the problem that purely physical robot platforms cannot sense the environment and make decisions online, a method for building digital twin system for home service robot based on motion simulation is proposed. A reliable mapping of the home service robot and its working environment from physical space to digital space is achieved in three dimensions: geometric, physical and functional. In this system, a digital space-oriented URDF file parser is designed and implemented for the automatic construction of the robot geometric model. Next, the physical model is constructed from the kinematic equations of the robot and an improved particle swarm optimization algorithm is proposed for the inverse kinematic solution. In addition, to adapt to the home environment, functional attributes are used to describe household objects, thus improving the semantic description of the digital space for the real home environment. Finally, through geometric model consistency verification, physical model validity verification and virtual-reality consistency verification, it shows that the digital twin system designed in this paper can construct the robot geometric model accurately and completely, complete the operation of household objects successfully, and the digital twin system is effective and practical.

14:10-14:30 ThA7.3

Deep Active Perception for Object Detection Using Navigation Proposals , pp. 897-901

Ginargiros, Stefanos Aristotle University of Thessaloniki
Passalis, Nikolaos Aristotle University of Thessaloniki
Tefas, Anastasios Aristotle University of Thessaloniki

Deep Learning (DL) has brought significant advances to robotics vision tasks. However, most existing DL methods have a major shortcoming - they rely on a static inference paradigm inherent in traditional computer vision pipelines. On the other hand, recent studies have found that active perception improves the perception abilities of various models by going beyond these static paradigms. Despite the significant potential of active perception, it poses several

challenges, primarily involving significant changes in training pipelines for deep learning models. To overcome these limitations, in this work, we propose a generic supervised active perception pipeline for object detection that can be trained using existing off-the-shelf object detectors, while also leveraging advances in simulation environments. To this end, the proposed method employs an additional neural network architecture that estimates better viewpoints in cases where the object detector confidence is insufficient. The proposed method was evaluated on synthetic datasets - constructed within the Webots robotics simulator -, showcasing its effectiveness in two object detection cases.

14:30-14:50 ThA7.4

A Knowledge Acquisition Framework for Autonomous Decision Making in Service Robots , pp. 902-907

Wu, Hao	ShanDong University
Zhao, Zhixian	ShanDong University
Ma, Qing	ShanDong University
Tian, Guohui	Shandong University

Service robots are expected to autonomously perform a wide range of service tasks to satisfy users' needs, but are limited in practice by their weak decision-making capabilities. This work introduces a Knowledge Acquisition Framework (KAFS) to help robots make autonomous decisions through this knowledge. This framework is divided into two parts: service knowledge acquisition and scene knowledge construction and uses a variety of intelligent methods to easily and accurately acquire a large amount of service and scene knowledge. We demonstrate the knowledge acquired by KAFS and validate the effectiveness of KAFS on robot service tasks.

14:50-15:10 ThA7.5

Hybrid Human/Robot Team Establishment Using E-CARGO and Role-Based Collaboration , pp. 908-913

Zhu, Haibin	Nipissing University
AKBARI, BEHZAD	Nipissing University
Wan, Lucas	Dalhousie University
Pan, Ya-Jun	Dalhousie University

This paper clarifies the requirements of a hybrid team including both humans and robots, then analyzes and confirms that the Role-Based Collaboration (RBC) methodology and the Environments - Classes, Agents, Roles, Groups, and Objects (E-CARGO) model can meet the requirement and assist in establishing such teams. Following this assessment, this paper proposes to use E-CARGO/RBC in building human/robot teams. Simulations and experiments are used to verify the proposed method.

ThA8 Conquista

Model-Based Evolutionary Algorithms (MBEA)

Organizer: Liu, Jing	Xidian University
Organizer: Wu, Kai	Xidian University

13:30-13:50 ThA8.1

Adaptive Geodesic Flow Kernel Transfer for Many-Task Optimization , pp. 914-919

Dai, Yang-Tao	Nankai University
Liu, Xiao-Fang	Nankai University
Zhan, Zhi-Hui	South China University of Technology
Zhong, Jinghui	South China University of Technology
ZHANG, Jun	Hanyang University

Many-task optimization problems (MaTOP) involve more than three tasks, which can be solved simultaneously via knowledge transfer by utilizing complementary information of different tasks. Due to the biases between tasks, relevant tasks are usually selected for knowledge transfer to avoid negative effects. There are two challenging issues, i.e., source task selection and inter-task knowledge transfer. To address these issues, this paper proposes an adaptive geodesic flow kernel transfer method (AGFKTM) for MaTOP. In AGFKTM, multiple source tasks are selected based on both the similarity between tasks and the performance of tasks. In this way, similar and well-performed tasks are selected with a high priority. In addition, an adaptive geodesic flow kernel is constructed to implement knowledge transfer, in which the adopted subspaces along the geodesic flow path are adaptively controlled. Particularly, the transferred solutions are used to generate new ones using mutation operators. Integrating the AGFKTM into differential evolution, a new algorithm named AGFKT-DE is put forward. Experimental results on GECCO20MaTOP benchmark show that the new algorithm outperforms state-of-the-art algorithms.

13:50-14:10 ThA8.2

Conjugate Surrogate for Expensive Multiobjective Optimization , pp. 920-925

Yang, Qi-Te	South China University of Technology
Luo, Liu-Yue	South China University of Technology
Xu, Xin-Xin	Ocean University of China
Chen, Chun-Hua	South China University of Technology
Wang, Hua	Victoria University
ZHANG, Jun	Hanyang University
Zhan, Zhi-Hui	South China University of Technology

The Kriging surrogate (KS) has been widely used in surrogate-assisted multiobjective evolutionary algorithms (SAMOEAs) for solving expensive multiobjective optimization problems (EMOPs). Typically, when tackling an M-objective EMOP, a KS consists of M Kriging models, in which each model is used to approximate one objective function to replace the expensive fitness evaluation. Since such a KS is only efficient in solving low-dimensional EMOPs, the dimension reduction method has been adopted to construct the reduction surrogate (RS) to reduce training costs. However, both KS and RS can only approximate the mapping from variables to different objectives (i.e., objective function) but ignore the potential relationship between objectives. For practical applications, it is necessary to take into account the mapping between different objectives for the reliability of the surrogate. Therefore, we for the first time propose the concept of the conjugate surrogate (CS) and construct a simple CS to realize the approximated mapping from objectives to objectives. Different from KS or RS, all models in CS are conjugate symbiosis. In collaboration with RS, CS can not only benefit the light training cost, but also improve the convergence speed. Compared with five state-of-the-art SAMOEAs, the CS-assisted algorithm shows its effectiveness and competitiveness in solving EMOPs.

14:10-14:30 ThA8.3

Improved Evolutionary Strategies for Sparse Large-Scale Many-Objective Optimization Problems , pp. 926-932

Chen, Jiawei	National University of Defense Technology
He, Lei	National University of Defense Technology
Chen, Yingwu	National University of Defense Technology

Multi-objective optimization problems with various attributes are studied for two decades. Sparsity, as one of them, sparked many researchers. However, they usually focused on sparse large-scale bi-objective optimization. The result is unsatisfying when applying their algorithms to optimization problems with more than three objectives. To solve this issue, this paper selects a classical algorithm

for large-scale sparse multi-objective optimization problems and proposes the reference points and adaptive crossover and mutation strategies to the original algorithm, adapting it to the sparse many-objective optimization problem. After a series of experiments, the algorithm with this modification mostly dominates other state-of-the-art multi-objective optimization algorithms. Although several best performance metrics are obtained from other competitors, the highest sparsity on the Pareto optimal solution is still completed by the proposed algorithm.

14:30-14:50 ThA8.4

Effects of Initialization Methods on the Performance of Surrogate-Based Multiobjective Evolutionary Algorithms , pp. 933-940

Zhang, Jinyuan	Southern University of Science and Technology
Ishibuchi, Hisao	Southern University of Science and Technology
He, Linjun	Southern University of Science and Technology
Nan, Yang	Southern University of Science and Technology

Initialization plays a crucial role in surrogate-based multiobjective evolutionary algorithms (MOEAs) when tackling computationally expensive multiobjective optimization problems. During the initialization process, solutions are generated to train surrogate models. Consequently, the accuracy of these surrogate models depends on the quality of the initial solutions, which in turn directly impacts the performance of surrogate-based MOEAs. Despite the widespread use of Latin hypercube sampling as an initialization method in surrogate-based MOEAs, there is a lack of comprehensive research examining the effectiveness of different initialization methods. Additionally, the impact of the number of initial solutions on the performance of surrogate-based MOEAs remains largely unexplored. This paper aims to bridge these research gaps by comparing the usefulness of two commonly employed initialization methods (i.e., random sampling and Latin hypercube sampling) in surrogate-based MOEAs. Furthermore, it investigates how varying the number of initial solutions influences the performance of surrogate-based MOEAs.

14:50-15:10 ThA8.5

Offline Data-Driven Mixed-Variable Optimization Algorithm Using a Step-Wise Strategy , pp. 941-946

Xu, Yiteng	Xidian University
Wang, Handing	Xidian University

Some real-world engineering problems are offline data-driven mixed-variable optimization problems, which involve optimizing both continuous and discrete variables using only historical experimental data. The main challenges are handling mixed variables and utilizing surrogate models effectively. We propose a novel algorithm that uses a step-wise strategy to optimize the discrete and continuous variables in two stages. In the first stage, we use different radial basis function networks models as surrogates and a voting method to select a promising subspace of discrete variable values. In the second stage, we fix the discrete variable values and use a selective ensemble strategy to optimize the continuous variables. We test our algorithm on 30 test problems and compare it with two representative algorithms. The results show that our algorithm is superior and more stable on most problems, especially on complex multimodal problems. Our algorithm is an effective and flexible framework for handling mixed variables and improving search efficiency and quality.

15:10-15:30 ThA8.6

Exploring the Uncertainty of Approximated Fitness Landscapes Via Gaussian Process Realisations , pp. 947-952

Karatas, Melike Dila	University of Exeter
Goodfellow, Marc	University of Exeter
Fieldsend, Jonathan Edward	University of Exeter

Gaussian processes (GPs) serve as powerful surrogate models in optimisation by providing a flexible data-driven framework for representing complex fitness landscapes. We provide an analysis of realisations drawn from GP models of fitness landscapes—which represent alternative coherent fits to the data—and use a network-based approach to investigate their induced landscape consistency. We consider the variation of constructed local optima networks (LONs: which provide a condensed representation of landscapes), analyse the fitness landscapes of GP realisations, and delve into the uncertainty associated with graph metrics of LONs. Our findings contribute to the understanding and practical application of GPs in optimisation and landscape analysis. Particularly that landscape consistency between GP realisations can vary considerably depending on the model fit and underlying landscape complexity of the optimisation problem.

ThB1 Imperio A

Deep Learning (DL) 4

Organizer: Sperduti, Alessandro	University of Padova
Organizer: Angelov, Plamen	Lancaster University
Organizer: Principe, Jose C.	University of Florida

16:00-16:20 ThB1.1

A Clustering-Based Support Vector Classifier for Dynamic Time-Linkage Optimization , pp. 953-958

Gao, Meng	Nankai University
Liu, Xiao-Fang	Nankai University
Zhan, Zhi-Hui	South China University of Technology
ZHANG, Jun	Hanyang University

Dynamic time-linkage optimization problems (DTPs) bring challenges to existing evolutionary algorithms due to the influence of a current decision in the future. Existing methods usually model the rewards of a current decision in the future for prediction. However, these methods often present low prediction accuracy due to the lack of sufficient training data. In addition, they often require a long computational time. To address these issues, the problem of predicting rewards is converted into a simpler binary classification problem, which evaluates whether a current solution can bring positive or negative influence in the future. This paper proposes a clustering-based support vector classifier for solution evaluation. In the proposed method, the density of the time-linkage property is detected first. Historical data are divided using k-means clustering so as to train a support vector classifier for solution evaluation. Good solutions are selected to generate a final decision solution using a crossover operator. Integrating the clustering-based support vector classifier into particle swarm optimization, a new method named CSVC-PSO is put forward. Multiple instances are constructed using a recent DTP test suite with different types of time-linkage patterns and density. Experimental results demonstrate that the proposed CSVC-PSO outperforms state-of-the-art algorithms on most instances using a shorter time.

16:20-16:40 ThB1.2

Context-Adaptive Deep Learning for Efficient Image Parsing in Remote Sensing: An Automated Parameter Selection Approach , pp. 959-964

Azam, Basim	Griffith University
Verma, Brijesh	Instiute for Integrated and Intelligent Systems, Griffith Univer
Zhang, Mengjie	Victoria University of Wellington

The paper presents a novel parameter selection-based image parsing framework that explores additional contextual information to produce final labels. The notable novelties include the optimization of parameters, and the computation of contextual information. The

paper demonstrates the improved pixel accuracy, mean pixel accuracy, mean intersection over union and f1-scores using the proposed image parsing architecture. The architecture achieves 84%-pixel accuracy, 77% mean pixel accuracy, mIoU 61% and F1-score of 73% on WHDLD dataset. In comparison to the state-of-the-art techniques the proposed approach achieves better scores. The incorporation of optimization algorithm and the additional context information improves the segmentation accuracies. In our future research, the aim will be to investigate the proposed architecture on a number of real-world image parsing datasets.

16:40-17:00 ThB1.3

Opposition-Based Crossover Operation for Differential Evolution Algorithm , pp. 965-971

Ebrahimi, Sevda — Ontario Tech University
Rahnamayan, Shahryar — Brock University
Asilian Bidgoli, Azam — Wilfrid Laurier University

Differential Evolution (DE) is widely recognized as an effective, robust, and gradient-free global optimization algorithm. However, the DE algorithm's search strategy has certain limitations that present opportunities for further improvement. Opposition-based Learning (OBL) as one of the efficient computational concepts provides the optimizer with the capability of exploring the search space in opposite directions. This research paper introduces a novel crossover scheme for the DE algorithm based on OBL concept. Unlike existing approaches in the literature, which primarily focus on utilization of OBL in population level, proposed scheme takes the advantage of OBL in operation level. In proposed scheme, the crossover operator generates two trial vectors in opposite directions, enhancing the exploration capability of the search strategy and taking a cautious approach by regularly examining the opposite directions during crossover. To evaluate the effectiveness of the proposed method, a series of experiments are conducted using the CEC-2017 benchmark functions with two different numbers of dimensions: 30 and 50. The results demonstrate a significant improvement in performance of the DE algorithm through the proposed method.

17:00-17:20 ThB1.4

Long Short-Term Memory Network Assisted Evolutionary Algorithm for Computationally Expensive Multiobjective Optimization , pp. 972-978

He, Cheng — Huazhong University of Science and Technology
Li, Hongbin — Huazhong University of Science and Technology
Lin, Jianqing — Huazhong University of Science and Technology
Lu, Zhichao — City University of Hong Kong

Computationally expensive multiobjective optimization problems (EMOPs) that require significant computational resources are commonly encountered in real-world applications. To address the challenges associated with such problems, using computationally inexpensive surrogate models to approximate objectives has emerged as an effective approach to handle EMOPs. However, the current collaboration between evolutionary algorithms (EAs) and surrogate models is limited, relying on static regression or classification methods that do not fully capture the dynamic evolution process of EAs. This study aims to advance the integration of surrogate-assisted multi-objective optimization by incorporating time-series prediction models. The target is to track the evolutionary trajectory of an EA and enhance its search capability. Specifically, long short-term memory (LSTM) networks are embedded into an EA for surrogate-assisted optimization (SAO). The role of LSTM networks in SAO is thoroughly investigated through ablation studies. Experimental results on six EMOPs demonstrate the potential of using LSTM networks in SAO. The results are compared with those obtained from four representative surrogate-assisted EAs, providing insights into the effectiveness of LSTM-based approaches in addressing EMOPs.

17:20-17:40 ThB1.5

Interpreting Restricted Boltzmann Machines from Optics Theory Perspectives , pp. 979-984

Guo, Ping — Beijing Normal University

Currently, lack of interpretability (or explainability) is one of the major drawbacks for artificial intelligence (AI) models. When we intend to build a physical artificial intelligence (PAI) systems, the model interpretability (MI) becomes a crucial problem. To tackle MI problem, we give the explanation of restricted Boltzmann machines (RBM) from optics theory perspectives in this work. Furthermore, we present a discussion about how to implement optical learning neural network with our developed Optics Theory and Design Methods -- OTDMs. With OTDMs, we can better understand the principle behind the good performance of deep neural networks. OTDMs not only give us an alternative explanation of RBM with optics theories, but also provide the guidance on designing a reliable PAI system also. Consequently, OTDMs pave the road to PAI systems, and make it to become possible for realizing all-optical learning neural network.

17:40-18:00 ThB1.6

Graph Convolutional Network Based Ant Colony Optimization for Robot Task Allocation , pp. 985-991

Qiu, Jiang — Fudan University
Liu, Yi — Fudan University
Yu, Yilan — Fudan University
Li, Wei — Fudan University

The robot task allocation is a crucial problem in logistics and distribution where robots are required to perform an array of tasks, with differing locations and numbers. As a result, optimally allocating tasks to available robots to minimize associated costs has become a challenging but essential optimization problem. This paper presents a Graph Convolutional Network (GCN) based Ant Colony Optimization (ACO) denoted as GCN-ACO, to solve the robot task allocation problems, which are formulated as the Travelling Salesman Problems (TSP) and Vehicle Routing Problems (VRP). The GCN-ACO algorithm comprises two stages. In the first stage, a GCN model is trained to predict a heatmap, which represents the probability of each edge belonging to the optimal route within the graph. In the second stage, we integrate the predicted heatmap into ACO to guide the ant colony to select edges with greater potential during the search process.We evaluate our approach's performance through testing on standard TSP and VRP datasets. The experimental results demonstrate that our proposed method has a faster convergence rate and a higher quality of solutions compared to the baseline approaches.

ThB2 — Imperio B

CI in Data Mining (CIDM) 2

Organizer: Ni, Zhen — Florida Atlantic University

16:00-16:20 ThB2.1

Doubly Robust Estimator for Off-Policy Evaluation with Large Action Spaces , pp. 992-997

Shimizu, Tatsuhiro — Waseda University
Forastiere, Laura — Yale University

We study Off-Policy Evaluation (OPE) in contextual bandit settings with large action spaces. The benchmark estimators suffer from severe bias and variance tradeoffs. Parametric approaches suffer from bias due to difficulty specifying the correct model, whereas ones with importance weight suffer from variance. To overcome these limitations, Marginalized Inverse Propensity Scoring (MIPS) was proposed to mitigate the estimator's variance via embeddings of an action. To make the estimator more accurate, we propose the doubly robust estimator of MIPS called the Marginalized Doubly Robust (MDR) estimator. Theoretical analysis shows that the proposed estimator is unbiased under weaker assumptions than MIPS while

maintaining variance reduction against IPS, which was the main advantage of MIPS. The empirical experiment verifies the supremacy of MDR against existing estimators.

16:20-16:40 ThB2.2

A Multi-Population Genetic Algorithm for Multiobjective Recommendation System , pp. 998-1003

Hong, Jun	South China University of Technology
Shi, Lin	South China University of Technology
Du, Ke-Jing	Victoria University
Chen, Chun-Hua	South China University of Technology
Wang, Hua	Victoria University
ZHANG, Jun	Hanyang University
Zhan, Zhi-Hui	South China University of Technology

Nowadays, recommendation systems (RSs) have been widely used in many real-world applications. However, traditional recommendation techniques mainly aim at improving recommendation accuracy, while other metrics to measure the performance of the RSs are not considered. In this paper, a multiobjective recommendation model that considers different metrics, including accuracy, diversity, and novelty of recommendations is established. Compared with recommendation models that only consider accuracy, this model can recommend more different items with higher diversity and more fresh items with higher novelty to enhance the long-term performance of RSs. Moreover, to efficiently solve this multiobjective recommendation model, a multi-population genetic algorithm (MPGA), which follows the multiple populations for multiple objectives (MPMO) framework, is proposed. As far as we know, it is the first time that the advanced MPMO framework is used in RSs. We conduct comparison experiments on three real-world datasets with three state-of-the-art multiobjective recommendation algorithms and two traditional multiobjective evolutionary algorithms. The experimental results indicate that the performance of MPGA is better than all the compared methods.

16:40-17:00 ThB2.3

Incremental Human Gait Prediction without Catastrophic Forgetting , pp. 1004-1011

Jakob, Jonathan	Bielefeld University
Hasenjäger, Martina	Honda Research Institute EU
Hammer, Barbara	Bielefeld University

Human gait prediction is an important task in predictive exoskeleton control. However, if static models are used to facilitate this task, two problems arise. First, the models cannot adapt to new environments and terrains during deployment, and second, the models cannot be personalized to any given end user without costly involvement of a human expert. Incremental models can alleviate these shortcomings, but they usually are prone to catastrophic forgetting, which can be dangerous during live deployment. In this work, we introduce an incremental model, that can learn human gait from scratch without outside interference, but does not fall prey to catastrophic forgetting. We test and evaluate our model on a real world gait database and show, that it delivers competitive results with regard to other standard approaches.

17:00-17:20 ThB2.4

Advancing Smart Cities through Novel Social Media Text Analysis: A Case Study of Calgary , pp. 1012-1017

Mirshafiee, Mitra	University of Calgary
Barcomb, Ann	University of Calgary
Tan, Benjamin	University of Calgary

In numerous cities, population expansion and technological advancements necessitate proactive modernization and integration of technology. However, the existing bureaucratic structure often hinders local officials' efforts to effectively address and monitor residents' needs and enhance the city accordingly. Understanding what people find important and useful can be inferred from their posts on social media. Twitter, as one of the most popular social media platforms, provides us with valuable data that, with the right tools and analysis, can provide insights into the performance of urban services and residents' perception of them. In this study, we used the city of Calgary as an exemplar to gather tweets and analyze topics relating to city development, urban planning, and minorities. Natural language processing (NLP) techniques were used and developed to preprocess stored tweets, classify the emotions, and identify the topics present in the dataset to eventually provide a set of topics with the prevalent emotion in that topic. We utilized a variety of methods to analyze the collected data. BERTopic for topic modeling and few-shot learning using Setfit for emotion analysis outperformed the others. Hence, we identify issues related to city development, senior citizens, taxes, and unemployment using these methods, and we demonstrate how delving into these analyses can improve urban planning.

17:20-17:40 ThB2.5

A Novel Feature Extraction Approach for the Clustering and Classification of Genome Sequences , pp. 1018-1023

Dwivedi, Rajesh	Indian Institute of Technology Indore, Indore
Tiwari, Aruna	IIT INDORE
Bharill, Neha	Mahindra University Hyderabad
Ratnaparkhe, Milind	ICAR-Indian Institute of Soybean Research
Tripathi, Abhishek	Indian Institute of Technology Indore, Indore
Jha, Preeti	Indian Institute of Technology Indore, Indore

Feature extraction is essential in bioinformatics because it transforms genome sequences into the feature vectors required for data mining activities such as classification and clustering. The data mining activities enable us to classify or cluster the newly sequenced genome to the known families. Nowadays, a variety of feature extraction strategies are available for genome data. Nevertheless, several existing algorithms do not extract context-sensitive key properties, also some approaches extract features, which are unable to distinguish between two non-similar sequences. In addition, the efficacy of existing feature extraction techniques is evaluated on either supervised or unsupervised learning models, but not on both. Thus, an efficient feature extraction technique that extracts significantly relevant features from genome sequences is required. In this paper, a novel feature extraction method is proposed that extracts features based on the length of the sequence, the frequency of nucleotide bases, the modified positional sum of nucleotide bases, the distribution of nucleotide bases, and the entropy of the sequence to generate a 14-dimensional fixed-length numeric vector to describe each genome sequence uniquely. By applying extracted features to both supervised and unsupervised machine learning approaches, the performance of the proposed feature extraction method is assessed. The experimental results show that the proposed strategy for clustering and classifying novel genome sequences into recognized genome classes is highly effective and efficient. The same is proven by comparing the proposed method to the standard state-of-the-art method.

17:40-18:00 ThB2.6

Predicting Merger and Acquisition Deal Completion and Stock Movement with Stance Detection , pp. 1024-1031

Leyden, Connor	St Albans School
Chen, Bruce	St. Albans School

Annually, approximately 500,000 Merger and Acquisition (M&A) transactions are disclosed globally, each transaction inciting substantial perturbations to the associated companies' equity prices. The probability of an M&A transaction's closure, as perceived by the

public, inherently influences the stock price of the target company leading up to the proposed date of the deal. Given the recent advancements in the realm of Natural Language Processing (NLP), we propose an empirical investigation into the correlation between digital dialogue surrounding M&A transactions and consequent movements in the stock prices of involved companies. Utilizing transformer-based encoder-only architectures, we fine tune a stance detection model on an extensive dataset, amassed from digital communication platforms, featuring public discourse related to five historical M&A transactions. Ultimately, we achieved 70% accuracy on deal-completion stance detection using the Roberta-base model. We subsequently employ the aggregated the public sentiment towards the completion or termination of a proposed M&A transaction to model stock price movement. Utilizing a multitude of time series based approaches, we achieve a mean absolute error of 2.29 USD for next-day price prediction and 3.40 USD for next-week price prediction. Ultimately, we find an existing but tenuous relationship between online discourse and the price trajectory of target companies, ultimately highlighting the complex social and economic phenomena behind M&A deals.

ThB3 — Imperio C

CI in Healthcare and E-Health (CICARE) 2

Organizer: Hussain, Amir — Edinburgh Napier University

Organizer: Sheikh, Aziz — University of Edinburgh

16:00-16:20 — ThB3.1

After-Stroke Arm Paresis Detection Using Kinematic Data , pp. 1032-1037

Lai, Kenneth — University of Calgary

Almekhlafi, Mohammed — University of Calgary

Yanushkevich, Svetlana — University of Calgary

This paper presents an approach for detecting unilateral arm paralysis/weakness using kinematic data. Our method employs temporal convolution networks and recurrent neural networks, guided by knowledge distillation, where we use inertial measurement units attached to the body to capture kinematic information such as acceleration, rotation, and flexion of body joints during an action. This information is then analyzed to recognize body actions and patterns. Our proposed network achieves a high paretic detection accuracy of 97.99%, with an action classification accuracy of 77.69%, through knowledge sharing. Furthermore, by incorporating causal reasoning, we can gain additional insights into the patient's condition, such as their Fugl-Meyer assessment score or impairment level based on the machine learning result. Overall, our approach demonstrates the potential of using kinematic data and machine learning for detecting arm paralysis/weakness. The results suggest that our method could be a useful tool for clinicians and healthcare professionals working with patients with this condition.

16:20-16:40 — ThB3.2

Bruxism: Teeth Grinding Time-Series Episode Detection through Wearable Sensors , pp. 1038-1042

Bensen, Jonah — University of St. Thomas

Min, Cheol-Hong — University of St. Thomas

This preliminary study uses a fine-tree machine learning algorithm to replicate bruxism biofeedback systems by detecting bruxism episodes using a wearable sensor system. The detection of bruxism grinding was performed among five different resting/sleeping positions--laying on the front, back, left, and right, and sitting up from four participants. A sequence of ten activities (each activity is a combination of sleeping position and grinding or not grinding) was recorded while wearing the wireless sensing system on the front of the chin directly under the mouth. Both time and frequency domain features were extracted from each axis of the wearable sensor system's accelerometer data sets. They were used to determine the presence of teeth grinding with 98% accuracy, and these features were used and experimented with to optimize the classification accuracy of the system.

16:40-17:00 — ThB3.3

A Computational Approach to Uncertainty in DNA Sequences , pp. 1043-1048

Melaugh, Melissa — Ulster University

Coleman, Sonya — University of Ulster

Kerr, Dermot — University of Ulster

DNA sequencing is the process of reading individual base pairs from a section of DNA. Genes are the name given to parts of the DNA which encode proteins; for example ion channels are proteins that maintain concentrations of ions within cells. The sequencing of these genes can offer insights into factors such as evolution and disease. During the sequencing process, unknown values 'N' can be substituted in the sequence where the sequencing machine is unable to identify a nucleotide as Adenine (A), Cytosine (C), Thymine (T), or Guanine (G). These gene sequences vary in length; this includes individual genes across the same species. This has led to the use of a process known as k-mer encoding so that a machine learning algorithm can assess these genes without the need for pre-alignment. K-mer encoding works by taking small sections of the sequence and tallying the number of times that such a sequence appears, such as, how many times the k-mer 'ACCT' appears in the overall sequence. The unknown 'N' value presents a problem in k-mer encoding, as this value increases the size of the k-mer feature vector exponentially as the k-mer length increases. In this paper we research the accuracy and computational impact of including, removing, or ignoring this 'N' value for the k-mer lengths 3, 6, and 9 across four Machine Learning algorithms: Random Forest, Multinomial Naive Bayes, Neural Networks, and Linear Support Vector Machine.

17:00-17:20 — ThB3.4

Hand Inertial Parameters Calculation for Any Position through the Kinematic Model , pp. 1049-1053

Pescador-Salas, Alejandro — National Technological Institute of Mexico

Rosales-Huie, Juan Pablo — National Technological Institute of Mexico

Martinez-Peon, Dulce — Tecnologico Nacional De Mexico

Olguín-Díaz, Ernesto — Research Center for Advanced Studies (CINVESTAV)

In biomechanics, the calculation of inertial parameters for the upper and lower limbs is studied for motion analysis or the design of prostheses or exoskeletons. However, the calculation of inertial parameters for the hand is performed without considering that the geometry of this segment can change depending on the posture. This work presents a geometric method based on the kinematic model to estimate the inertial parameters of the hand segment for different hand postures. The resulting inertia tensor is calculated at the center of mass according to the segment axes' International Society of Biomechanics (ISB) designation. It considers the principal moments of inertia and the products of inertia of the hand segment. To demonstrate the use of this tool, six healthy subjects participated. The anthropometric measurements of their hand were obtained, the inertial parameters were calculated with our proposal, and they were compared with two methods, Dumas and De Leva, using the Euclidean and Frobenius norms for the center of mass and the inertia tensor, respectively. The mean difference and SD between the proposed method for the relaxed hand position against the Dumas method is 0.0049 m (SD 0.002) and 0.00016·(10e−3) kg−m2 (SD 0.00009) and the De Leva method is 0.011 m (SD 0.0013) and 0.00023·(10e−3) kg−m2 (SD 0.00004) for the center of mass and the inertia tensor, respectively. However, our method can be extended to different hand positions. The proposed method can be used in applications such as the analysis of the three-dimensional motion of the upper limb or in the design of biomedical devices such as hand or wrist and forearm exoskeletons.

17:20-17:40 — ThB3.5

EMG Classification of Hand and Wrist Force Tasks Using Fractal Algorithms , pp. 1054-1059

Pérez-Espinoza, Marcos	Tecnologico Nacional De Mexico
Martinez-Peon, Dulce	Tecnologico Nacional De Mexico
Góngora Rivera, J. Fernando	Universidad Autónoma De Nuevo León
Ortíz Jiménez, Xóchitl A.	Universidad Autónoma De Nuevo León
Contró Esparza, Michelle	Tecnologico Nacional De Mexico
Maldonado-Jauregui, Juan	Tecnologico Nacional De Mexico
Tinoco-Ramírez, Isaac	Universidad Autónoma De Nuevo León
Castillo-Herrera, Francisco	Universidad Autónoma De Nuevo León
Estrada-Cortez, Hector	Universidad Autónoma De Nuevo León

The hand has excellent functional, aesthetic and social importance. However, Parkinson's disease, stroke, and other myopathies can cause motor impairments. Patients require a rehabilitation program to follow their progress, and one of the tools used to do that is the electromyographic (EMG) signals. This article proposes using algorithms to characterize and classify EMG signals during force exercises for the wrist and forearm. Eight healthy subjects participated in this study. They performed seven exercises, making five trials for each one. Signal features were analyzed in different time windows using a genetic algorithm and machine learning techniques to select the window that maximizes the classification. Combining four electrodes, seven exercises, and 14 algorithms achieved a classification accuracy of 92.41% using the Multilayer Perceptron classifier. The study demonstrates a highly reliable method for classifying forearm and wrist exercises based on EMG signals, useful for exoskeletons or rehabilitation platforms. Future work will focus on implementing EMG signals to enhance motor rehabilitation therapy and provide findings that will help the scientific community investigate the combination of EEG signals for rehabilitation purposes.

17:40-18:00 ThB3.6

Multimodal Gait Analysis Acquisition System: Challenges and Lessons Learned , pp. 1060-1065

Márquez Ruiz, Karla Michelle	Univerdad Panamericana
Pineda Cervantes, Pilar	Universidad Panamericana
Villa, Carlos	Massachusetts Institute of Technology
Martinez-Villaseñor, Lourdes	Universidad Panamericana
Ponce, Hiram	Universidad Panamericana
Barrera-Animas, Ari Y.	Universidad Panamericana

Nowadays, gait data analysis has become an extremely valuable tool that, without much knowledge, provides significant support in various areas, especially in medicine. This type of analysis not only contributes to generating accurate diagnoses but also plays a fundamental role in physical rehabilitation processes.

To harness the potential of this analysis, a multimodal system is being developed with the purpose of enhancing the storage, analysis, and synchronization of multiple modules. The imperative arises from certain constraints within prevailing devices and methods, which stem from their intricate and delicate nature. Therefore, the aim of the study involves creating an implementation that prioritizes flexibility, lightness, and autonomy, all with the ultimate aim of attaining complete self-sufficiency in future advancements.

ThB4 Constitución A

Evolvable Systems (ICES)

Organizer: Tyrrell, Andy	University of York
Organizer: Trefzer, Martin A.	University of York

16:00-16:20 ThB4.1

Morphological-Novelty in Modular Robot Evolution , pp. 1066-1071

Weissl, Oliver	Vrije Universiteit Amsterdam
Eiben, A.E.	Vrije Universiteit Amsterdam

This study investigates how the introduction of morphological novelty affects the fitness and diversity of a population of modular robots. Novelty is usually measured in behavioral space, while the approach discussed in this paper assesses novelty solely using morphologies. The proposed algorithm is inspired by the histogram of oriented gradients, in combination with elements of principal component analysis, and the Wasserstein distance. The experiments conducted utilize novelty in parent selection, with different configurations. Analyzing the results, the introduction of morphological novelty promotes beneficial effects on fitness and diversity when applied correctly.

16:20-16:40 ThB4.2

An Approach to Representation Learning in Morphological Robot Evolution , pp. 1072-1077

Stuurman, Aart C.	Vrije Universiteit Amsterdam
Yaman, Anil	Vrije Universiteit Amsterdam
Eiben, A.E.	Vrije Universiteit Amsterdam

A key challenge for evolving complex physical objects is to design a representation, that is, to devise suitable genotypes and a good mapping from genotypes to phenotypes (the objects to be evolved). This paper outlines a new approach to address this challenge for evolving robot morphologies and presents a proof-of-concept study to assess its feasibility. The key idea is to design genotype-phenotype mappings using variational autoencoders. This idea is implemented and tested for the evolution of modular robots for a locomotion task. The experiments show the practicability of this idea where the representation is not hand-designed, but algorithmically generated. This indicates a great future potential for the evolution of complex objects where there are no straightforward representations to use.

16:40-17:00 ThB4.3

Investigation of Starting Conditions in Generative Processes for the Design of Engineering Structures , pp. 1078-1083

Buchanan, Edgar	University of York
Dubey, Rahul	University of York UK
Hickinbotham, Simon	University of York
Friel, Imelda	Queen's University Belfast
Colligan, Andrew Robert	Queen's University Belfast
Price, Mark	Queen's University Belfast
Tyrrell, Andy	University of York

Engineering design has traditionally involved human engineers manually creating and iterating on designs based on their expertise and knowledge. In Bio-inspired Evolutionary Development (EvoDevo), generative algorithms are used to explore a much larger design space that may not have ever been considered by human engineers. However, for complex systems, the designer is often required to start the EvoDevo process with an initial design (seed) which the development process will optimise. The question is: will a good starting seed yield a good set of design solutions for the given problem? This paper considers this question and suggests that sub-optimal seeds can provide, up to certain limits, better design solutions than relatively more optimal seeds. In addition, this paper highlights the importance of designing the appropriate seed for the appropriate problem. In this paper, the problem analysed is the structural performance of a Warren Truss (bridge-like structure) under a single load. The main conclusion of this paper is that up to a limit sub-optimal seeds provide in general better sets of solutions than more optimal seeds. After this limit, the performance of sub-optimal seed starts to degrade as parts of the phenotype landscape become inaccessible.

17:00-17:20 ThB4.4

Theory of Evolutionary Systems Engineering , pp. 1084-1089

Hickinbotham, Simon	University of York
Dubey, Rahul	University of York
Buchanan, Edgar	University of York
Friel, Imelda	Queen's University Belfast
Colligan, Andrew Robert	Queen's University Belfast
Price, Mark	Queen's University Belfast
Tyrrell, Andy	University of York

Evolutionary approaches to engineering design involve generating populations of candidate solutions that compete via a selection process iteratively, to improve measures of performance over many generations. Although the attractive properties of biological evolutionary systems have motivated researchers to investigate emulating them for engineering design, there has been an emphasis on using encodings of the technical artefacts themselves, rather than encoding a complete bio-inspired system which is capable of producing such artefacts. It is the latter approach which is the subject of this contribution: how might a bio-inspired system be designed that self-organises the process of engineering design and manufacture? To make progress in the application of evolutionary processes to problems in engineering design, the evolutionary model must encompass the complexity of systems engineering. A new theory of evolutionary systems engineering is presented, based on von Neumann's Universal Constructor Architecture (UCA), drawing from more recent understanding of biology and applying the resulting system to the task of engineering design. It demonstrates how individual bioinspired algorithms fit into a coherent whole, and how they can be combined to drive open-endedness in automated design. The resulting system provides a common language for multidisciplinary applications in generative design, whereby industrial systems engineering approaches can be developed using principles from the UCA for the first time.

17:20-17:40 ThB4.5

Open-Endedness Induced through a Predator-Prey Scenario Using Modular Robots , pp. 1090-1095

Kachler, Dimitri Roman	Vrije Universiteit Amsterdam
Miras, Karine	Vrije Universiteit Amsterdam

This work investigates how a predator-prey scenario can induce the emergence of Open-Ended Evolution (OEE). We utilize modular robots of fixed morphologies whose controllers are subject to evolution. In both species, robots can send and receive signals and perceive the relative positions of other robots in the environment. Specifically, we introduce a feature we call a tagging system: it modifies how individuals can perceive each other and is expected to increase behavioral complexity. Our results show the emergence of adaptive strategies, demonstrating the viability of inducing OEE through predator-prey dynamics using modular robots. Such emergence, nevertheless, seemed to depend on conditioning reproduction to an explicit behavioral criterion.

17:40-18:00 ThB4.6

Crowding and Mutation Improvements in an EA for Flight Control Correction in a Flapping-Wing Vehicle , pp. 1096-1103

Gallagher, John	University of Cincinnati
Oppenheimer, Michael	Autonomous Control Branch, AFRL, Wright-Patterson Air Force Base
Matson, Eric	Purdue University

Small Flapping-Wing Micro Air Vehicles (FW-MAVs) may be subjected to either or both of manufacturing defects or in-service damage that render their pre-designed controllers less than adequately effective. Even minor damage to wings, for example, can remove the vehicle's ability to reliably follow waypoint trails even if that same damage does not result in a catastrophic loss of altitude. One solution to this problem is to adapt the core wing motion scripts (wing gaits) in an attempt to use wing motion to compensate for losses of force and torque generation due to in-service damage or manufacturing faults. This approach presents a number of challenges - especially if it is to be deployed in a resource restricted vehicle in an online mode during an actual mission. Prior to this paper, we had presented only anecdotal treatment of fully unrestricted, 3D flight. In this paper, we will definitively establish the utility of EA adaptation of flight control in unrestricted flight in a pendulum-stable FW-MAV. We will, additionally, introduce mutation and crowding modifications that provide demonstrable utility in a manner amenable to implementation on a resource-restricted micro vehicle. The paper will conclude with a discussion of open-issues and the potential application of the reported methods to other problems.

ThB5 Constitución B

CI in Feature Analysis, Selection and Learning in Image and Pattern Recognition (FASLIP)

Organizer: Zhang, Mengjie	Victoria University of Wellington
Organizer: XUE, Bing	Victoria University of Wellington

16:00-16:20 ThB5.1

Morphological Image Analysis and Feature Extraction for Reasoning with AI-Based Defect Detection and Classification Models , pp. 1104-1111

Zhang, Jiajun	Loughborough Unviersity
Cosma, Georgina	Loughborough Unviersity
Bugby, Sarah	Loughborough Unviersity
Finke, Axel	Loughborough Unviersity
Watkins, Jason	Railston & Co. Ltd

As the use of artificial intelligence (AI) models becomes more prevalent in industries such as engineering and manufacturing, it is essential that these models provide transparent reasoning behind their predictions. This paper proposes the AI-Reasoner, which extracts the morphological characteristics of defects (DefChars) from images and utilises decision trees to reason with the DefChar values. Thereafter, the AI-Reasoner exports visualisations (i.e. charts) and textual explanations to provide insights into outputs made by masked-based defect detection and classification models. It also provides effective mitigation strategies to enhance data pre-processing and overall model performance. The AI-Reasoner was tested on explaining the outputs of an IE Mask R-CNN model using a set of 366 images containing defects. The results demonstrated its effectiveness in explaining the IE Mask R-CNN model's predictions. Overall, the proposed AI-Reasoner provides a solution for improving the performance of AI models in industrial applications that require defect analysis.

16:20-16:40 ThB5.2

Evaluating the Potential and Realized Impact of Data Augmentations , pp. 1112-1119

Heise, David	Lincoln University
Bear, Helen L.	YLB Tech, Ltd

Data augmentations have been shown to improve predictive performance of machine learning models in many domains. Augmentations are typically used to improve classification performance, but augmentations can distort the intrinsic properties of the original data, thus reducing the utility of a model for real-world applications. Because augmentations directly affect the training data, and thus also affect the machine learning models trained with said data, intelligent selection of augmentations is as critical as the selection of input features and other options in the machine learning pipeline. Such an approach will enable greater transferability of trained models from the research lab to products and services.

This paper presents two metrics to evaluate the potential and realized impact of data augmentations. The first metric, eff-score, assesses the relative efficacy of prospective data augmentations before model training. To observe augmentation effects on the intrinsic properties

of the training data, the second metric, nirvana distance, measures the effect of data augmentations beyond overall predictive performance after model training. These metrics are tested with a well known multi-purpose audio data set and augmentations from the domain of environmental sound scene analysis. The relative eff-scores correlate with classification results from predictive models trained on the augmented data sets, and the distance components of the nirvana distance explain results observed but not previously understood from output confusion matrices. These results demonstrate promise for data-driven, efficient selection of data augmentations whilst exposing previously hidden impacts on machine learning models. Furthermore, since eff-score and nirvana distance are domain-independent, these metrics have widespread applicability.

16:40-17:00 ThB5.3

Enhancing Content-Based Histopathology Image Retrieval Using QR Code Representation , pp. 1120-1125

Rouzegar, Hamidreza	Ontario Tech University
Rahnamayan, Shahryar	Brock University
Asilian Bidgoli, Azam	Wilfrid Laurier University
Makrehchi, Masoud	Ontario Tech University

The growing field of Content-Based Medical Image Retrieval (CBMIR) plays an integral role in the diagnosis and treatment plan of numerous diseases, including cancer. However, the effective representation of gigapixel medical images via a large number of extracted features remains a challenging task, crucially influencing other processes in a digital workflow. In this paper, we propose a novel QR code representation strategy to enhance retrieval performance. Unlike the traditional one-dimensional binary representation methods (i.e., barcodes), this 2D approach captures more intricate and informative patterns from the features by differentiating each pair of features resulting in a 2D binary vector. We delve into three distinct QR code generation strategies, namely, the Thresholding QR, the MinMax QR, and the Hybrid QR, each offering unique strengths. Our experiments on representing whole slide images of the Cancer Genome Atlas (TCGA) dataset reveal that while the Hybrid QR tends to provide balanced performance, there are instances where the other two methods outshine. Even though this approach requires more memory usage, the considerable enhancement in accuracy justifies this trade-off; obviously, in medical applications, accuracy holds the highest priority. Hence, the findings indicate that QR codes can effectively improve the performance of CBMIR systems by not only accelerating the retrieval process but also increasing the accuracy of image retrieval, leading to potentially more accurate diagnoses and treatment planning.

17:00-17:20 ThB5.4

An Intelligent Email Classification System , pp. 1126-1131

Luo, Zili	Queen's University, School of Computing
Zulkernine, Farhana	Queen's University

Email is one of the most common methods of official and personal communication to exchange information. For the administration department, dealing with hundreds of emails with the same type of inquiries or requests results in a huge operational overhead. In this study, we explore email classification models. An email classification system should understand the topics in the email content for categorizing emails and indicate if an incoming email should be handled by the mailbox owner. Email categorization based on topics is a multi-label classification task. Most existing email categorization models perform binary classification to identify spam, phishing, or malware attacks. We propose a CNN-BiLSTM model for multi-class email classification. Our experiments show that compared to the two other models that we implemented namely CNN (76.19%) and BiLSTM (61.9%) models, the CNN-BiLSTM (83.33%) and Hierarchical CNN-BiLSTM models (85.33%) have much better performance.

17:20-17:40 ThB5.5

Semi-Supervised and Incremental Sequence Analysis for Taxonomic Classification , pp. 1132-1138

Fasino, Adriana	Rowan University
Ozdogan, Emrecan	Rowan Univesity
Sokhansanj, Bahrad	Drexel University
Rosen, Gail	Drexel University
Polikar, Robi	Rowan University

Metagenomic analysis is vital in determining what organisms are present in a microbial sample and why they are present. In this study, we explore the utility of MMseqs2, a bioinformatics pipeline, for taxonomic classification in metagenomics, focusing on 16S rRNA gene sequences. We evaluate the algorithm's performance in full dataset as well as batch-by-batch incremental processing, and more importantly, we add the capability of semi-supervised classification to this otherwise clustering-only algorithm. Incremental updating is important because it allows seamless integration and processing of new data, whereas semi-supervised classification allows taxonomic identification of previously unknown organisms. We also evaluate the different clustering modes offered by MMseqs2, and compare MMseqs2 to our previously developed semi-supervised incremental algorithm SSI-VSEARCH. We show that MMseqs2's built-in clusterupdate function works well, and our semi-supervised classification capability adds new functionality to this bioinformatics processing pipeline.

17:40-18:00 ThB5.6

Image Caption Generation Based on Image-Text Matching Schema in Deep Reinforcement Learning , pp. 1139-1144

Rashno, Elyas	Queen's University
Safarzadehvahed, Mahdieh	Queen's University
Zulkernine, Farhana	Queen's University
Givigi, Sidney	Queen's University

Image captioning applications require prompt and precise caption generation, which can improve the accessibility and understanding capabilities of images. We utilize an actor-critic approach based on deep reinforcement learning and propose a two-fold approach to enhance the performance of the actor-critic approach. First, we propose a novel image-text matching module to compute the reward in image-matching, for the actor-critic model. This module enables more accurate and meaningful evaluations, contributing to improved caption generation. Second, we apply various training scenarios in reinforcement learning, strategically updating both the policy and value networks. The scenarios ensure more effective learning dynamics and lead to enhanced overall performance. To assess the efficiency of our approach, we employ the Microsoft COCO dataset. The experiments demonstrate the superiority of our method in terms of both speed and precision compared to the existing techniques.

ThB6 Constitución C

CI in Cyber Security (CICS) 2

Organizer: Dasgupta, Dipankar	University of Memphis

16:00-16:20 ThB6.1

A Distributed Multi-User Access Control Middleware for Critical Applications , pp. 1145-1150

Williams, Alexander	University of Memphis
Roy, Arunava	The University of Memphis
Dasgupta, Dipankar	University of Memphis

We present a novel access control middleware for distributed multi-user review. The system uses a fuzzy inference system trained on real world access control rules to evaluate and select reviewers as an extension to a more traditional access control system. The method is intended for high security need specific requests, as a supplement to regular access control methods. In this way, it models a multi-person access system common in mechanical controls like

missile launches, bank vault opening, and other high criticality domains. The proposed method improves security by increasing the number of compromised users needed to perform an attack, taking advantage of situational awareness of peer users in a system. We evaluate the proposed system with an example implementation based on a real-world organization, and show that the system can be used to effectively implement a secure resource access control system. Our work contributes to the growing body of research into fuzzy-logic access control, ML in access control, and multi-user authentication systems.

16:20-16:40 ThB6.2

Optimized Machine Learning-Based Intrusion Detection System for Internet of Vehicles , pp. 1151-1157

Limouchi, Elnaz — Royal Military College of Canada
Chan, Francois — Royal Military College of Canada

Abstract—Internet of Vehicles (IoV) represents the application of Internet of Things (IoT) within vehicular communication environments. Internet of vehicles refers to a network of interconnected sensors, network layers, and communication systems that enable vehicles to connect with everything (V2X communication). IoV networks face numerous security challenges due to the emergence of modern types of attacks with unusual patterns. Therefore, it is a crucial and demanding task to design intelligent Intrusion Detection Systems (IDSs) for IoV networks. In this paper, we propose an optimized Machine Learning-based IDS to detect attacks in IoV networks. We deploy highly efficient Machine Learning models, Light Gradient Boosting Machine, Extra Trees Classifier, and Extreme Gradient Boosting, to detect attacks in the CICDDoS2019 dataset. We apply the Synthetic Minority Oversampling Technique to resolve the issue of imbalanced data distribution of target class. A Correlation-based Feature Selection is conducted to reduce the computational cost by decreasing the number of input variables. In order to enhance the performance of the attack detection, hyperparameters are optimized using the Bayesian Optimization algorithm. The performance evaluation results show that these ML models perform well. Notably, the Extreme Gradient Boosting classifier outperforms other Machine Learning models, and our proposed solution outperforms existing systems in terms of Accuracy score.

16:40-17:00 ThB6.3

Challenges and Opportunities of Computational Intelligence in Industrial Control System (ICS) , pp. 1158-1163

Siddique, Sunzida — Daffodil International University
Haque, Mohd Ariful — Clark Atlanta University
Rifat, Rakib Hossain — BRAC University
Das, Laxmi Rani — Noakhali Science and Technology University
Talukder, Sajedul — University of Alabama at Birmingham
Alam, Syed — Missouri University of Science and Technology
Gupta, Kishor Datta — Clark Atlanta University

Artificial intelligence (AI) is not a fancy term anymore, or not limited to only researchers and academia. AI is currently becoming a part and parcel of our daily life, we are using AI/ intelligent systems by knowing or without knowing. Event product manufacturers are also trying to incorporate AI with their products to make it more preferable to consumers and trying to get the full benefit of using AI in their production and control units even for business decisions. Therefore, In our paper, we give a comprehensive survey of recent advances in Computational intelligence in industrial Control Systems and cover many usages of how industrial Control Systems are getting benefits from using Computational intelligence. We covered multiple domains like Manufacturing, Energy Management, Transportation, Food and Beverage Industry, and Pharmaceutical Industry, how these industries are utilizing multiple CI-based control systems like Programmable Logic Controllers, Distributed Control Systems, Supervisory Control and Data Acquisition, Industrial Automation, and Control Systems, Intelligent Electronic Devices and found benefits in their operations and manufacturing which helping them to focus more in innovation and improvement of their products. We believe that this survey shall be valuable to researchers across academia and industry.

17:00-17:20 ThB6.4

Vulnerability of Open-Source Face Recognition Systems to Blackbox Attacks: A Case Study with InsightFace , pp. 1164-1169

Sadman, Nafiz — Queen's University
Hasan, Kazi Amit — Queen's University
Rashno, Elyas — Queen's University
Alaca, Furkan — Queen's University
Tian, Yuan — Queen's University
Zulkernine, Farhana — Queen's University

This paper presents a comprehensive analysis of the security aspects of the InsightFace project (a popular open-source face recognition system) focusing on its susceptibility to three distinct black box attacks: Face Swap, Morphing, and Presentation. Open-source face recognition models are used in commercial applications, thereby motivating our security analysis. Our investigation entails a meticulous evaluation of the susceptibility of the project to false authentication when subjected to the three attacks. We observed from our experiments that InsightFace was not able to differentiate between legitimate images and manipulated images. The principal aim of this research is to draw attention to the security challenges inherent in open-source face recognition systems, often integrated into various public applications.

17:20-17:40 ThB6.5

A Survey on Bias Mitigation in Federated Learning , pp. 1170-1175

Ude, Bassey — North Carolina Agricultural and Technical State University
Odeyomi, Olusola — North Carolina Agricultural and Technical State University
Roy, Kaushik — North Carolina A&T State University
Yuan, Xiaohong — North Carolina Agricultural and Technical State University

Federated learning (FL) enables collaborative model training while keeping data decentralized. However, system heterogeneity and statistical differences in decentralized data can introduce biases and unfairness. This paper surveys existing bias mitigation techniques in FL across various phases of the training process. We identify sources of bias and present a critical analysis of current fairness-aware FL algorithms, categorizing them as preventive (Pre-processing) or reactive (in-processing and Post-processing) based on when bias mitigation is applied. In addition, this paper reveals open challenges in balancing fairness and efficiency in FL, handling non-independent and identically distributed (non-IID) data, and ensuring privacy. This survey lays out the foundation for developing unbiased and privacy-preserving FL systems without discrimination in the future.

17:40-18:00 ThB6.6

One-Class Classification for Intrusion Detection on Vehicular Networks , pp. 1176-1182

Guidry, Jake — University of Louisiana at Lafayette
Sohrab, Fahad — Tampere University
Gottumukkala, Raju — University of Louisiana at Lafayette
Katragadda, Satya — University of Louisiana at Lafayette
Gabbouj, Moncef — Tampere University

Controller Area Network bus systems within vehicular networks are not equipped with the tools necessary to ward off and protect themselves from modern cyber-security threats. Work has been done on using machine learning methods to detect and report these attacks, but common methods are not robust towards unknown attacks. These methods usually rely on there being a sufficient representation of attack data, which may not be available due to there either not being enough data present to adequately represent its distribution or the distribution itself is too diverse in nature for there to be a sufficient representation of it. With the use of one-class classification methods, this issue can be mitigated as only normal data is required to train a model for the detection of anomalous instances. Research has been done on the efficacy of these methods, most notably One-Class Support Vector Machine and Support Vector Data Description, but many new extensions of these works have been proposed and have yet to be tested for injection attacks in vehicular networks. In this paper, we investigate the performance of various state-of-the-art one-class classification methods for detecting injection attacks on Controller Area Network bus traffic. We investigate the effectiveness of these techniques on attacks launched on Controller Area Network buses from two different vehicles during normal operation and while being attacked. We observe that the Subspace Support Vector Data Description method outperformed all other tested methods with a Gmean of about 85%.

ThB7 Colonia

Swarm Intelligence Symposium (SIS)

Organizer: Mostaghim, Sanaz — University of Magdeburg

Organizer: Shi, Yuhui — Southern University of Science and Technology

16:00-16:20 ThB7.1

XF-OPT/META: A Hyperparameter Optimization Framework Applied to the H-SPPBO Metaheuristic for the Dynamic TSP , pp. 1183-1188

Werner, Daniel — Leipzig University

Turna, Fatma — Leipzig University

Le, Hoang Thanh — Leipzig University

Middendorf, Martin — Leipzig University

This paper has two objectives. Firstly, to introduce a new framework XF-OPT/META for testing and comparing Hyperparameter Optimization (HPO) methods. The framework supports model-free methods, e.g., Random Search (RS), as well as model-based methods, such as Bayesian Optimization (BO), with various surrogate models. Due to the generalized and modular structure of the XF-OPT/META framework, it can be easily extended to other optimization methods for different optimization problems. The second objective is to empirically compare the performance of various HPO methods for population-based metaheuristics. For that the XF-OPT/META framework is used to apply HPO methods to the Hierarchical Simple Probabilistic Population-Based Optimization (H-SPPBO) metaheuristic for the Dynamic Traveling Salesperson Problem (DTSP) and to calculate high-performing parameter values for H-SPPBO. Promising results are obtained using the parameter values found by BO. In particular, a parameter set obtained with Gradient-Boosted Regression Trees (GBRT) outperforms a reference parameter set for H-SPPBO from an existing study.

16:20-16:40 ThB7.2

A Cautionary Note on Poli's Stability Condition for Particle Swarm Optimization , pp. 1189-1194

von Eschwege, Daniel Heinrich — Stellenbosch University

Engelbrecht, Andries — Stellenbosch University

Particle swarm optimization (PSO) is a swarm intelligence algorithm that finds candidate solutions by iteratively updating the positions of particles in a swarm. PSO performance depends on the use of a suitable control parameter (CP) configuration, which governs the trade-off between exploration and exploitation in the swarm. Various methods of adapting or tuning CPs exist, but many result in exploding particle velocities and an unstable search process. Poli's stability condition ensures convergence in the mathematical limit, and is often used to inform CP configuration. However, this study shows that since it does not place any practical convergence constraints, it cannot be used to guarantee a stable search process. Velocity explosion occurs nonetheless and can lead to floating-point overflow and numerical instability. The investigation into various CP configurations across diverse functions and measurements of particle velocities provides empirical evidence of velocity explosion, and cautions against the assumption that enforcing Poli's criterion guarantees stability. The findings underline the need for comprehensive understanding of CP tuning and stability conditions in PSO, as well as the crucial role of empirical evidence in evaluating the real-world performance of swarm intelligence algorithms.

16:40-17:00 ThB7.3

Framework of Systems for Creating Intelligent Behaviors of Imaginary Creatures for Humans , pp. 1195-1200

Ohnishi, Kei — Kyushu Institute of Technology

Kumano, Yusuke — Kyushu Institute of Technology

The paper proposes a framework of systems for creating intelligent behaviors of imaginary creatures for humans, which is built upon a framework of swarm intelligence optimization algorithms. The paper assumes and models an imaginary slime mold, which is an amoeboid unicellular creature, as an imaginary creature in the framework concretely. In addition, the paper conducts basic evaluations of the framework. Various swarm intelligence optimization algorithms have been proposed so far, but there is a common feature among them. That is that a set of search points in a search space, which are called individuals, move around in the space according to algorithm specific rules using fitness values of the individuals, and the differences among algorithms are in algorithm specific rules. Therefore, under the use of one swarm intelligence optimization algorithm, that is, one particular set of rules, if a fitness function is varied, behaviors of individuals are also varied. Based on this fact, the proposed framework optimizes a parametric fitness function for individuals to behave intelligently for a human. In the basic evaluation of the concrete system, a fitness function of computer program which returns a fitness value calculated with a distribution of individuals is used instead of a human, and it is demonstrated that optimization of a parametric fitness function indeed yields desired behaviors of individuals.

17:00-17:20 ThB7.4

Swarm Intelligence Numerical Optimization Algorithm Representing Individuals As Dynamic Graphs in the Euclidean Search Space , pp. 1201-1207

Hayashi, Kaho — Kyushu Institute of Technology

Ohnishi, Kei — Kyushu Institute of Technology

We propose a new swarm intelligence numerical optimization algorithm that represents individuals as dynamic graphs in the Euclidean search space. We call it Graph Building Optimization Algorithm or GBO. The unique point of GBO is that an individual is represented by a dynamic graph whose nodes have coordinates (search points) in the Euclidean search space. Due to this unique point, we can draw a GBO's search process as a generation-transition of a feature of a graph. It is expected that we can obtain better understandings on a given problem by comparing the generation-transition for the given problem to the baseline for the simplest unimodal problem. We assume the maximum node degree in the best individual as the feature and the generation-transition of the feature for F1 in the CEC'13 test problems as the baseline. We demonstrate that we can guess the characteristics of other 27 problems in the CEC'13 test problems by comparing their generation-transitions to the baseline. In addition, we evaluate GBO using the same problems and show that GBO is capable of finding good solutions for various problems.

17:20-17:40 ThB7.5

Weight Binary Fish School Search Algorithm for Feature Selection , pp. 1208-1212

Alexandria, Fabiana	University of Pernambuco
Buarque de Lima Neto, Fernando	University of Pernambuco

This study proposes a multimodal approach to enhance the Improved version of Binary Fish School Search (IBFSS) algorithm by incorporating aspects of the Weight Based Fish School Search (wFSS) algorithm to address the attribute selection problem. The proposed model, named Weight Binary Fish School Search (wBFSS), was evaluated on three benchmark datasets, consistently delivering the best solutions in most of the runs. Additionally, two variations of the new wBFSS model were tested to understand the impact on the algorithm's performance by adding a fitness function evaluation before executing the Collective Instinctive Movement.

17:40-18:00 ThB7.6

Impressionist Hole Detection and Healing Using Swarms of Agents with Quantized Perception , pp. 1213-1220

Simionato, Giada	University of Pisa
Parola, Marco	University of Pisa
Cimino, Mario G. C. A.	University of Pisa

Coverage holes are a key problem in wireless sensor networks. Methods that use relative localization techniques to restore the service, or heal the holes, rely on accurate range and bearing measurements. However, high-precision range and bearing sensors are too heavy, expensive, and range-limited for the agents tasked with healing. To overcome these limitations, we propose a novel impressionist algorithm, inspired by a recent swarm-based approach, that works with extremely coarse range and bearing information and at low perception frequency, to detect and heal the holes. In the proposed approach, a swarm of agents uses quantized information to navigate a potential field, generated by network nodes, to reach the nearest hole. The swarm adopts a greedy deployment behavior, preventing concurrent placement in close-by locations. After deployment, agents use their coarse perception to update the potential field, leading the rest of the swarm to unhealed area. Simulation results demonstrate that our algorithm achieves similar or better coverage compared to the state-of-the-art and to a benchmark based on random walk. This is achieved using just three bearing quantization levels and four times lower perception frequency. Overall, our impressionist approach shows faster healing, albeit at the expense of employing slightly more agents.

ThB8 Conquista

Evolutionary Scheduling and Combinatorial Optimisation (ESCO)

Organizer: Mei, Yi	Victoria University of Wellington
Organizer: Qu, Rong	University of Nottingham

16:00-16:20 ThB8.1

A Simulation Hyper-Heuristic Method for Multi-Floor AGV Delivery Services in Hospitals , pp. 1221-1226

Yuan, Haocheng	University of Nottingham Ningbo China
Chen, Xinan	University of Nottingham Ningbo China
Zhu, Junsong	University of Nottingham Ningbo China
Bai, Ruibin	University of Nottingham Ningbo China

Automated Guided Vehicles (AGVs) enhance transportation efficiency in different domains such as warehouses, factories, and container ports. Much research has been done into optimal scheduling and routing of multiple AGVs to improve the overall efficiency of the systems. However, more research efforts are required when addressing more complex real-life systems where the mobility of AGVs is highly constrained due to special geometric shapes and dimensions. Focusing on a real-world hospital AGV routing problem, this paper tackles the additional complexity arising from space capacity constraints long narrow corridors and lifts for cross-floor deliveries. A simulation optimisation approach is introduced to accurately model complex interactions of AGVs under conditions like floor switching, charging, and passing narrow corridors. To tackle the underlining vehicle routing problems with pickup and delivery (VRPPD) which is NP-Hard, this paper presents a simulation-based hyper-heuristic optimization approach to minimize the makespan of all tasks. A surrogate model is integrated to expedite the search process, and several experiments are conducted to properly evaluate the performance of our method. Based on the results, our method exhibits great potential in improving efficiency while maintaining the excellent practicality of AGV routing for complex environments like hospitals.

16:20-16:40 ThB8.2

Quantum Representation Based Job Shop Scheduling , pp. 1227-1233

Ripon, Kazi Shah Nawaz	Oslo Metropolitan University
Singh, Ashay	Høgskolen I Østfold

This paper proposes a quantum representation-based genetic algorithm for solving the job-shop scheduling problem, aiming to minimize the makespan. The job-shop scheduling is a typical scheduling problem that falls under the NP-hard combinatorial optimization problems and has undergone extensive investigation in the literature. Over time, various heuristic and intelligent methods have been developed to tackle this challenging problem. Inspired by the promise of quantum computing, this paper explores using quantum information representation and processing techniques to enhance the performance of conventional genetic algorithms on classical computers to solve the job-shop scheduling problem. The proposed quantum-inspired genetic algorithm employs a conversion mechanism of quantum representation to code the schedule; and utilizes a rotation angle table to update the population. The effectiveness of the quantum-inspired genetic algorithm is compared to that of a standard genetic algorithm, with experimental results confirming the potential of the proposed approach in tackling complex combinatorial optimization problems.

16:40-17:00 ThB8.3

Neutrosophic Fuzzy Selected Element Reduction Approach (NF-SERA) : Assessment of E-Scooter Parking Area , pp. 1234-1238

ÇAKIR, ESRA	GALATASARAY UNIVERSITY

Along with awareness of global warming, there have been many developments in recent years on carbon emissions in transportation. The use of micromobility vehicles has become widespread due to reasons such as energy saving, reducing carbon footprint and reducing traffic density in urban transportation. Although there are useful applications, this new concept has brought with it some problems. It is clear that new regulations are needed on issues such as accessibility, parking areas, security, charging stations, city planning etc. and the big cities need to adapt. Therefore, the carbon neutral districts have been started to be tested in small areas in many parts of the world and their effects are observed. This study performs Selected Element Reduction Approach (SERA), which is a Multi Criteria Decision Making (MCDM) criterion weighting method to determine the weight of the criteria to be used to assess the parking area of e-scooters in carbon neutral areas. SERA is a fuzzy environment MCDM method that aims to give weight to the criterion by the absence effect, which occurs by subtracting the criteria from the general evaluation. In this study, SERA is extended for the first time with single-valued neutrosophic fuzzy sets (SVNFS), which is a three- dimensional fuzzy environment. This study contributes to the literature by analyzing the application of NF-SERA with a numerical example. It also assesses the criteria for the e-scooter parking case

for the carbon neutral areas that are currently discussed in the sustainable urban transportation literature.

17:00-17:20 ThB8.4

Multimodal Multi-Objective Football Game Algorithm for Optimizing Test Task Scheduling Problems , pp. 1239-1244

Fadakar, Elyas Beihang University (BUAA)

This paper presents an innovative approach to addressing the complex challenges posed by Test Task Scheduling Problems (TTSPs) through the utilization of Multimodal Multi-objective Football Game Algorithm (MM-FGA). TTSPs hold significant importance in industries where testing plays a critical role in ensuring product quality. This study outlines the integration of MM-FGA with the Normalized Factor Random Key (NF-RK) encoding scheme, tailored to the discrete nature of TTSPs. Four real-world TTSPs are investigated with the objectives of minimizing makespan and mean workload. Comparative analyses are conducted against other prominent multiobjective algorithms, including NSGA-II, DN-NSGA-II, Tri-MOE-TA&R, MP-MMEA, and MO-Ring-PSO-CD. The results exhibit MM-FGA's competitive performance, particularly in terms of the diversity of solutions obtained in the decision space. This underscores MM-FGA's prowess in addressing the multimodality challenges of optimization problems. The study further suggests the prospect of advancing step-size control strategies through meta-optimization, aiming to refine the algorithm's exploration and exploitation balance for even more potent optimization outcomes. Overall, MM-FGA demonstrates promise in solving multimodal multiobjective discrete problems like TTSPs, while indicating room for future enhancements.

17:20-17:40 ThB8.5

Fixed Set Search Applied to the Maximum Set K-Covering Problem , pp. 1245-1250

Jovanovic, Raka Hamad Bin Khalifa University

The MKCP (Maximum Set k-Covering Problem) is a widely recognized combinatorial problem that falls under the category of NP-hard problems. It has diverse applications and involves the goal of covering a maximum number of elements using a limited number of candidate sets. In this paper, the novel fixed set search (FSS), a population based metaheuristic, is applied on the problem of interest. The FSS adds a learning mechanism to the greedy randomized adaptive search procedure (GRASP) based on elements frequently occurring in high quality solutions. The main advantage of the proposed approach is the simplicity of implementation compared to the current state-of-the-art methods. The conducted computational experiments show that the FSS even when using a simple local search manages to be highly competitive to state-of-the-art methods. In addition, the FSS manages to find two new lower bounds for the standardly used benchmark test instances. Finally, the performed computational experiments show that the learning mechanism of the FSS significantly improves the performance of the underlying GRASP algorithm.

17:40-18:00 ThB8.6

A Novel Robust Kernelized FCM Based Multi-Objective Simultaneous Learning Framework for Clustering and Classification , pp. 1251-1256

Innani, Saketh Mahindra University
Chinnari, Pawan Sai Mahindra University
Sinha, Soumen Mahindra University
Khan, Mehek Mahindra University
Bharill, Neha Mahindra University Hyderabad
Patel, Om Prakash Mahindra University Hyderabad

Clustering and classification are the two important tasks involved in pattern recognition. Both tasks are interrelated with each other. The generalization ability of classification learning can be enhanced with clustering results. On the contrary, the class information helps in improving the accuracy of clustering learning. Thus, both learning strategy complements each other. To amalgamate the benefits of both learning strategies, therefore in this paper, we proposed a novel robust kernelized Fuzzy c-Means based multi-objective simultaneous learning framework(RKFCM-MSCC) for both clustering and classification. RKFCM-MSCC employs multiple objective functions to compose the clustering and classification problem, respectively. Both the formulated objective functions are simultaneously optimized using the particle swarm optimization approach. Moreover RKFCM-MSCC uses Bayesian theory that make these multiple objective functions dependent on the single parameter i.e., cluster centers that connect both the clustering and classification learning. The Pareto-optimal solution attained with the RKFCM-MSCC approach complements the clustering and the classification learning process. The effectiveness of the proposed RKFCM-MSCC is empirically investigated on four benchmark datasets and the results are compared with the state-of-the-art approaches.

Friday December 8, 2023

FrA1 Imperio A

CI in Control and Automation (CICA)

Organizer: Dong, Daoyi — Australian National University
Organizer: Zeng, Xiaojun — University of Manchester
Organizer: PAN, YU — Zhejiang University

13:30-13:50 FrA1.1

Sliding Mode Observer Based Fuzzy Control for TS Systems , pp. 1257-1262

Lazar, Bogdan — Technical University of Cluj-Napoca
Lendek, Zsofia — Technical University of Cluj-Napoca

This paper presents a sliding mode observer based fuzzy control. The sliding mode observer is developed for a linear dominant system, but taking into account the model mismatch. After that a fuzzy state feedback controller is designed. To ensure the stability of the closed loop system in the presence of uncertainties, Lyapunov synthesis is used. The results are illustrated on a numerical example. Simulations on the nonlinear system are presented to demonstrate the effectiveness of the observer based control.

13:50-14:10 FrA1.2

Designing Heuristic-Based Tuners for PID Controllers in Automatic Voltage Regulator Systems Using an Automated Hyper-Heuristic Approach , pp. 1263-1268

Zambrano-Gutierrez, Daniel — Tecnologico De Monterrey
Molina-Porras, Alberto C. — Universidad De Guanajuato
Avina-Cervantes, Juan G. — Universidad De Guanajuato
Correa, Rodrigo — Universidad Industrial De Santander
Cruz-Duarte, Jorge Mario — Tecnologico De Monterrey

Engineering processes often require optimizing model variables for satisfactory solutions. Reliable approaches exist in literature but are application-dependent. In that sense, metaheuristics have been proven to deliver outstanding results while imposing a low computing burden. However, choosing the most suitable one from the many available can overwhelm even experts. This study implements a methodology that automatically tailors a problem-based metaheuristic through a hyper-heuristic approach. We select the tuning problem of a Proportional Integral Derivative controller as a case study for achieving the best stable features in an Automatic Voltage Regulator system. The numerical results demonstrate the reliability and potential of the implemented methodology in solving control system tuning. Plus, we conduct an in-depth quantitative comparison with recent works in the literature that support those conclusions.

14:10-14:30 FrA1.3

Model-Free Optimal Control Based on Reinforcement Learning for Rotary Inverted Pendulum , pp. 1269-1273

Yudho, Eduardo — CINVESTAV-IPN
Li, Xiaoou — CINVESTAV-IPN
Ovilla-Martinez, Brisbane — CINVESTAV-IPN
Yu, Wen — CINVESTAV-IPN

N/A

14:30-14:50 FrA1.4

On the Feasibility of Using a High-Level Solver within Robotic Mobile Fulfillment Systems , pp. 1274-1279

Benavides-Robles, Maria Torcoroma — Tecnologico De Monterrey
Cruz-Duarte, Jorge Mario — Tecnologico De Monterrey
Ortiz-Bayliss, José Carlos — Tecnologico De Monterrey
Amaya, Ivan — Tecnologico De Monterrey

A Robotic Mobile Fulfillment System~(RMFS) is a collaborative environment in which a robot delivers products to human for fulfilling orders. However, it is a computationally complex optimization problem. % that integrates diverse optimization problems. In this work, we analyze the feasibility of using high-level solvers for selecting suitable low-level methods. To this end, we generate 111 instances distributed into two datasets. Moreover, we implement two kinds of high-level solvers. The first one is a set of handcrafted rules. The second approach uses a decision tree. % to choose a suitable low-level method for each instance. Our data reveals that it is possible to construct high-level solvers that benefit from the different strengths of the low-level methods by selecting which one to apply. The rules produced by hand and the decision trees high-level solvers are competitive concerning the best individual performer in terms of two standard metrics for this problem: throughput time and orders completed.

14:50-15:10 FrA1.5

Constrained Neuro-Identifier for Controlling the Unicycle Mobile Robot , pp. 1280-1285

Salgado, Ivan — Instituto Politécnico Nacional
Mera, Manuel — ESIME IPN
Ríos, Héctor — Tecnológico Nacional De México/I.T. La Laguna
Ballesteros-Escamilla, Mariana — CIDETEC Instituto Politécnico Nacional

This work proposes the design of a robust controller for the perturbed kinematic model of the unicycle mobile robot, considering a neuro-identifier that imposes restrictions on the identification error. The controller is based on integral sliding modes (ISMs) and the approximation provided by a differential neural network (DNN) for the tracking error dynamics, represented as an uncertain time-varying linear system. The methodology ensures asymptotic stability for the tracking error despite multiplicative disturbances in the control channel. The ISM compensates for the matched dynamics identified with the DNN. Then, a feedback controller based on a Barrier Lyapunov function minimizes the effect of unmatched dynamics while fulfilling state restrictions by solving a set of Linear Matrix Inequalities. Simulation results show the feasibility of the proposed strategy against classical controllers.

15:10-15:30 FrA1.6

Dynamic Neural Network with Guaranteed Sensitivity to External Influences , pp. 1286-1291

Chernozubov, Danil — Lomonosov Moscow State University
Mukhamedov, Arthur — Lomonosov Moscow State University
Bugriy, Grigory — Lomonosov Moscow State University
Chertopolokhov, Viktor — Lomonosov Moscow State University
Chairez, Isaac — Tecnologico De Monterrey

Mathematical models are used to represent a vast array of complex processes in engineering, physics, biology, social science, and economics. Model parameters with significant impacts on identification outcomes are ascertained through parametric sensitivity analysis. Authors previously considered an approximation models for systems with uncertain dynamics using a dynamic neural network. The results obtained from studying the problem of predicting the response variable, indicated that this model has a structural flaw. This

flaw manifests as an insensitivity of the weight coefficients to external influences, leading to inaccurate predictions. This insensitivity is marked by the minimal contribution of weight coefficient components in the identification process. This paper discusses modifying learning laws to enhance the sensitivity of the weight coefficients to external signals. Through Lyapunov stability analysis, stable algorithms for weight component evolution that minimize identification error were derived.

FrA2 Imperio B

CI in Data Mining (CIDM) 3

Organizer: Ni, Zhen — Florida Atlantic University

13:30-13:50 FrA2.1

Generating Cardiovascular Data to Improve Training of Assistive Heart Devices , pp. 1292-1297

Kummert, Johannes — Bielefeld University
Schulz, Alexander — Bielefeld University
Feldhans, Robert — Bielefeld University
Habigt, Moriz — Anaesthesiology Clinic RWTH Aachen University
Stemmler, Maike — Institute of Automatic Control RWTH Aachen University
Kohler, Christina — Institute of Automatic Control RWTH Aachen University
Abel, Dirk — RWTH Aachen University
Rossaint, Rolf — Anaesthesiology Clinic RWTH Aachen University Faculty of Medicin
Hammer, Barbara — Bielefeld University

In many medical applications data is a scarce resource and can often only be obtained with invasive surgery. This is for instance the case for physiological cardiovascular data that is necessary to improve the functionality of assistive heart devices. In this work we explore the viability of a GAN architecture to generate cardiovascular data towards enriching a data set obtained in animal testing on which training of future applications can be improved which potentially reduces the need for further animal testing. We evaluate the usefulness of our synthesized data using a downstream task.

13:50-14:10 FrA2.2

Automatic Distance-Based Interpolating Unit Detection and Pruning in Self-Organizing Maps , pp. 1298-1303

van Heerden, Willem S. — University of Pretoria

The self-organizing map (SOM) is an unsupervised neural network that uses neuron weight vectors to model training data. Some neurons, called interpolating units, have weight vectors that do not model training data, and instead represent boundaries between emergent data clusters. Interpolating units are useful for distinguishing such clusters using SOM visualizations. However, automatic (non-visual) detection of interpolating units would be advantageous for SOM analysis. This paper proposes a novel algorithm, based on inter-neuron distances in weight vector space, for identifying and possibly pruning interpolating units. Existing methods for interpolating unit detection are surveyed, highlighting drawbacks not associated with the proposed algorithm. Focusing on classification task performance, SOMs which are pruned using the proposed algorithm are compared to unpruned SOMs. This analysis demonstrates that interpolating unit pruning does not adversely affect SOM model quality, and suggests that the proposed algorithm warrants further investigation for application in data science.

14:10-14:30 FrA2.3

Unveiling Precision Medicine with Data Mining: Discovering Patient Subgroups and Patterns , pp. 1304-1309

Mosavi, Nasim Sadat — University of Minho, Algoritmi Research Center
Santos, Manuel Filipe — University of Minho

Data mining techniques, prominently clustering, assume a pivotal role in fortifying precision medicine by facilitating the revelation of patient subgroups that share common attributes. By harnessing clustering for the analysis of data behavior within the realm of precision medicine, distinctive disease patterns, and progression dynamics are unveiled, thereby contributing to the formulation of precisely tailored treatment strategies. This paper aims to present the outcomes derived from a clustering analysis applied to diverse clinical datasets encompassing critical facets such as vital signs, laboratory exams, medications, sepsis, Glasgow Coma Scale, procedures, interventions, diagnostics, and admission/discharge records. This compilation of datasets pertains to a cohort of seventy patients. The resultant analysis uncovers intrinsic patterns and relationships residing within intricate datasets. Executed following the rigorous CRISP-DM methodology, this discovery study identified three distinct clusters that group similar data characteristics, encompassing both categorical and numerical clinical data, and resulted in three major groups: patients with stable health conditions, recovery stage, and at risk. This pivotal outcome catalyzes future endeavors, including classification tasks aimed at identifying new patients within specific classes, thereby advancing the horizons of precision medicine.

14:30-14:50 FrA2.4

Neural Network for Musical Data Mining for Phrase Boundary Detection , pp. 1310-1315

Henel, Daniel — AGH University of Krakow
Mazur, Aleksander — AGH University of Krakow
Retajczyk, Marcin — AGH University of Krakow
Adrian, Weronika Teresa — AGH University of Krakow
Kluza, Krzysztof — AGH University of Krakow
Horzyk, Adrian — AGH University of Krakow

The surge of interest in artificial intelligence systems has sparked new directions of research in the realm of music data analysis. At the same time, the exploration and exploitation of intrinsic musical structures and sequences, a timeless endeavor, continue to captivate scholars and practitioners alike.

In this context, the fusion of computational techniques with music analysis emerges as a natural progression. One of the pivotal crossroads in this convergence is the identification of musical phrase boundaries, pivotal demarcations that underpin the organizational fabric of a musical composition.

This article pioneers an inventive approach to address the challenge of detecting these musical phrase boundaries, harnessing the power of artificial neural networks. However, the innovation does not stop there; the pinpointed phrase boundaries undergo a comprehensive dissection utilizing pattern mining techniques. The focus of this analysis is on unveiling recurrent motifs and classifying phrases into coherent clusters, predicated on the repetitions and similarities exposed through these neural network-driven techniques.

This exploration was conducted using an extensive repository of folk songs, a treasure trove of foundational musical expressions that indelibly shape the stylistic contours of musical compositions. We claim that the presented approach not only opens avenues for penetrating and nuanced analysis, but also enriches our comprehension of the intricate interplay of musical components and their manifestations inspired by neural networks.

14:50-15:10 FrA2.5

Detection of Real Concept Drift under Noisy Data Stream , pp. 1316-1321

Parasteh, Sirvan — University
Sadaoui, Samira — University of Regina
Khosravani, Mohammad Sadegh — University of Regina

Concept drift detection in noisy data streams is challenging yet essential. This paper introduces NPRDD, a new concept drift detection algorithm that is robust to noise and accurately identifies Real drifts. NPRDD operates on a moving window of recent data, utilizing predicted class probabilities and cross-entropy-based surprise measures to weigh real drift candidates. In line with the Bayesian definition of Real concept drift, NPRDD considers a sample as a drift candidate when the classifier makes an error but is highly confident in its judgment. We evaluate NPRDD on synthetic datasets by varying the noise levels and comparing its performance with other well-established methods. Our results show that NPRDD outperforms other methods regarding ROC-AUC and Accuracy metrics.

15:10-15:30 FrA2.6

Scalable Kernelized Deep Fuzzy Clustering Algorithms for Big Data , pp. 1322-1327

Jha, Preeti	Koneru Lakshmaiah Education Foundation, Bowrampet, Hyderabad
Tiwari, Aruna	IIT INDORE
Bharill, Neha	Mahindra University Hyderabad
Ratnaparkhe, Milind	ICAR-Indian Institute of Soybean Research
Patel, Om Prakash	Mahindra University Hyderabad
Gupta, Anjali	Indian Institute of Technology, Indore
Sukhija, Deepali	Indian Institute of Technology Indore
SUKHIJA, DEEPIKA	Indian Institute of Technology Indore
Dwivedi, Rajesh	Indian Institute of Technology Indore

Conventional scalable clustering-based Deep Neural Network (DNN) algorithms cluster linearly separable data, however, non-linearly separable data in the feature space is harder to cluster. This paper proposes a novel Scalable Deep Neural Network Kernelized Literal Fuzzy C-Means (SDnnKLFCM) and Scalable Deep Neural Network Kernelized Random Sampling Iterative Optimization Fuzzy C-Means for Big Data (SDnnKRSIO-FCM). These kernelized clustering methods solve non-linear separable issues by non-linearly transforming the input data space into a high-dimensional feature space using a Cauchy Kernel Function (CKF). We create kernelized deep neural network fuzzy clustering methods using Apache Spark in-memory cluster computing technique to efficiently cluster Big Data on a High-Performance Computing (HPC) machine. To demonstrate the effectiveness of the proposed (SDnnKLFCM) and (SDnnKRSIO-FCM) in comparison to previous scalable deep neural network clustering methods, extensive tests are carried out on a variety of large datasets. The reported experimental results show that the kernelized non-linear deep clustering algorithms in comparison with linear fuzzy clustering algorithms achieve significant improvement in terms of Normalized Mutual Information (NMI), Adjusted Rand Index (ARI), and F-score, respectively.

FrA3 Imperio C

CI in Healthcare and E-Health (CICARE) 3

Organizer: Hussain, Amir	Edinburgh Napier University
Organizer: Sheikh, Aziz	University of Edinburgh

13:30-13:50 FrA3.1

A Comparative Analysis of Machine Learning Models for Parkinson's Diagnosis Using MRI and Acoustic Data , pp. 1328-1333

Shaffi, Noushath	University of Technology and Applied Sciences
Viswan, Vimbi	College of Computing and Information Sciences, University of Tec
Mahmud, Mufti	Nottingham Trent University
Hajamohideen, Faizal	University of Technology and Applied Sciences
Subramanian, Karthikeyan	University of Technology and Applied Sciences

In this study, we focus on Parkinson's Disease (PD) classification and present a comparative analysis of prominent machine learning models using two distinct and independent modalities: Magnetic Resonance Imaging (MRI) and Acoustic data. Unlike many existing works that typically focus on a single modality, our research study provides performance evaluation on the performance of various algorithms on both MRI and Acoustic data. Through a detailed investigation, we provide an understanding of how different models perform when applied to each modality individually. Furthermore, our study extends beyond this comparative framework by introducing an ensemble approach aimed at enhancing the performance of machine learning models for PD classification using the acoustic data. Notably, our ensemble approach yields around a 12% increase in overall performance.

13:50-14:10 FrA3.2

A Comparative Study of Pretrained Deep Neural Networks for Classifying Alzheimer's and Parkinson's Disease , pp. 1334-1339

Viswan, Vimbi	Univ. of Technology and Applied Sciences
Shaffi, Noushath	Univ. of Technology and Applied Sciences
Mahmud, Mufti	Nottingham Trent University
Subramanian, Karthikeyan	Univ. of Technology and Applied Sciences
Hajamohideen, Faizal	Univ. of Technology and Applied Sciences

Early detection of neurodegenerative diseases can be challenging, where Deep Learning (DL) techniques have shown promise. Most DL techniques provide a robust and accurate classification performance. However, due to the complex architectures of the DL models, the classification results are difficult to interpret, causing challenges for their adoption in the healthcare industry. To facilitate this, the current work proposes an effective and interpretable analysis pipeline that compares the performances of pre-trained models for the early detection of Alzheimer's Disease (AD) and Parkinson's Disease (PD). The proposed pipeline allows tuning of hyperparameters, such as batch size, number of epochs, and learning rates, to achieve more robust and accurate classification. Additionally, validation of predictions using heatmaps drawn from GradCAM are also provided.

14:10-14:30 FrA3.3

Insole Design and Optimization Processes for Gait Analysis , pp. 1340-1345

Orozco Villanueva, Kevin Alejandro	Universidad Paramericana
Richter, Miguel	Universidad Panamericana
Villa, Carlos	Massachusetts Institute of Technology
Martinez-Villaseñor, Lourdes	Universidad Panamericana
Ponce, Hiram	Universidad Panamericana
Barrera-Animas, Ari. Y.	Universidad Panamericana

<i>Abstract—Gait analysis is becoming increasingly central in various fields such as biomechanics, medicine, and sports. This complex study assesses how individuals walk, weighing in on aspects like bone alignment, joint range of motion, and neuro- muscular activity. Its profound importance emanates from its capability to identify potential walking anomalies at an early stage, which can

offset the need for invasive medical interventions and offer valuable insights for clinicians to make well-informed decisions. Inspiration for this in-depth gait analysis research was sourced from previous attempts that employed tools like step mats and cameras to track and analyze movement. Several design imperatives were consolidated within this framework, including the vital need of user safety, assuring comfort throughout usage, preserving system stability, and the undoubtedly significant feature of keeping the insole lightweight. These priorities were not merely for user comfort but were essential for the fidelity of the data being captured. In this paper, it is described the design and optimization processes of an insole for gait analysis following an agile methodology which involves the following stages: requirements, design, implementation and testing. This study delves deeply into the challenges of designing, implement- ing, and optimizing instrumented insoles for gait analysis. The requirements were successfully achieved by creating a 3mm-thick, flexible insole using TPU 95 material through 3D printing. This insole effectively encapsulates electronic components, ensuring comfort, durability, and safety. Index Terms—Gait analysis, insole, unobtrusive wearable</i>

14:30-14:50 FrA3.4

Multi-Objective Evolutionary Quantization of Randomization-Based Neural Networks , pp. 1346-1351

Del Ser, Javier	TECNALIA/University of the Basque Country (UPV/EHU)
Andres, Alain	TECNALIA
Bilbao, Miren Nekane	University of the Basque Country (UPV/EHU)
Laña, Ibai	TECNALIA
Lobo, Jesus L.	TECNALIA

The deployment of Machine Learning models on hardware devices has motivated a notable research activity around different strategies to alleviate their complexity and size. This is the case of neural architecture search or pruning in Deep Learning. This work places its focus on simplifying randomization-based neural networks by discovering fixed-point quantization policies that optimally balance the trade-off between performance and complexity reduction featured by these models. Specifically, we propose a combinatorial formulation of this problem, which we show to be efficiently solvable by multi-objective evolutionary algorithms. A benchmark for time series forecasting with Echo State Networks over 400 datasets reveals that high compression ratios can be achieved at practically admissible levels of performance degradation, showcasing the utility of the proposed problem formulation to deploy reservoir computing models on resource-constrained hardware devices.

14:50-15:10 FrA3.5

On the Use of Associative Memory in Hopfield Networks Designed to Solve Propositional Satisfiability Problems , pp. 1352-1358

Weber, Natalya	Okinawa Institute of Science and Technology Graduate University
Koch, Werner	Independent Scholar
Erdem, Ozan	Independent Scholar
Froese, Tom	Okinawa Institute of Science and Technology Graduate University

Hopfield networks are an attractive choice for solving many types of computational problems because they provide a biologically plausible mechanism. The Self-Optimization (SO) model adds to the Hopfield network (HN) by using a biologically founded Hebbian learning rule, in combination with repeated network resets to arbitrary initial states, for optimizing its own behavior towards some desirable goal state encoded in the network. However, the solutions to the abstract problems used in the literature offer little insight into how HN arrive at solutions or partial solutions. In order to better understand that process, we demonstrate first that the SO model can solve *concrete* combinatorial satisfiability problems: The Liars problem and the map coloring problem. Based on these solutions, we discuss how under certain conditions critical information might get lost forever with the learned network producing seemingly optimal solutions that are in fact inappropriate for the problem it was tasked to solve. What appears to be an undesirable side-effect of the SO model, can provide insight into its process for solving intractable problems.

15:10-15:30 FrA3.6

An Adaptive Multiform Evolutionary Algorithm for Global Continuous Optimization , pp. 1359-1365

Ling, Hongtao	South China University of Technology
Zhong, Jinghui	South China University of Technology
Dong, Junlan	South China University of Technology
Wang, Shanxia	Henan Normal University
Wang, Shibin	Henan Normal University
Zhang, Qin	The Communication University of China

Evolutionary algorithm(EA) with knowledge transfer is an emerging research topic that has attracted a lot of attention in the EA community. The multiform evolutionary algorithm is a promising algorithm framework concept falling in this direction, but little work has been done so far to design and discuss this new EA framework. In this paper, we proposed an adaptive multiform evolutionary framework, which integrates the idea of transfer optimization and population-based evolutionary algorithms. The main idea is to utilize multiple equivalent or similar formulations to solve the given problem cooperatively. By adaptively adjusting computational resources of different formulations and transferring knowledge among formulations, the search efficiency and the population diversity can be improved. Furthermore, a new multiform algorithm is implemented based on the proposed framework, which utilizes two different coordinate systems, namely the Cartesian and polar coordinate systems, to model the given problem. To test the effectiveness of the proposed algorithm, we conducted numerical experiments on CEC2013 benchmark test functions, and the experimental results have verified the efficacy of the proposed algorithm.

FrA4 Constitución A

Foundations of CI (FOCI)

Organizer: Lopez-Rodríguez, Domingo	Universidad De Málaga
Organizer: Franco, Leonardo	University of Florida

13:30-13:50 FrA4.1

Results on the Empirical Design of a Residual Binary Multilayer Perceptron Architecture , pp. 1366-1371

Solis Winkler, Agustin	Universidad Autonoma Del Estado De Mexico
López-Chau, Asdrúbal	Universidad Autónoma Del Estado De México
Osnaya Baltierra, Santiago	Universidad Autonoma Del Estado De Mexico

Binary neural networks have emerged as an efficient solution for resource-constrained devices due to their reduced computational, memory, and storage requirements. However, binary neural networks often suffer from decreased accuracy compared to floating-point models. In this study, we propose a binary residual multilayer perceptron architecture that mitigates the degradation caused by binarization through the incorporation of normalization layers and residual connections. By leveraging design recommendations from state-of-the-art binary architectures, we aim to create a user-friendly model that can be easily implemented without requiring extensive neural network design expertise. This paper presents the empirical results of our proposed architecture, demonstrating its effectiveness in reducing degradation and improving performance for

hardware-constrained devices.

13:50-14:10 FrA4.2

Newton Method-Based Subspace Support Vector Data Description , pp. 1372-1379

Sohrab, Fahad — Tampere University
Laakom, Firas — Tampere University
Gabbouj, Moncef — Tampere University

In this paper, we present an adaptation of Newton's method for the optimization of Subspace Support Vector Data Description (S-SVDD). The objective of S-SVDD is to map the original data to a subspace optimized for one-class classification, and the iterative optimization process of data mapping and description in S-SVDD relies on gradient descent. However, gradient descent only utilizes first-order information, which may lead to suboptimal results. To address this limitation, we leverage Newton's method to enhance data mapping and data description for an improved optimization of subspace learning-based one-class classification. By incorporating this auxiliary information, Newton's method offers a more efficient strategy for subspace learning in one-class classification as compared to gradient-based optimization. The paper discusses the limitations of gradient descent and the advantages of using Newton's method in subspace learning for one-class classification tasks. We provide both linear and nonlinear formulations of Newton's method-based optimization for S-SVDD. In our experiments, we explored both the minimization and maximization strategies of the objective. The results demonstrate that the proposed optimization strategy outperforms the gradient-based S-SVDD in most cases.

14:10-14:30 FrA4.3

Runtime Analysis of (1+1)-EA on a Biobjective Test Function in Unbounded Integer Search Space , pp. 1380-1385

Rudolph, Günter — TU Dortmund University

Runtime results of multiobjective evolutionary algorithms in unbounded integer spaces are scarce at present. In order to advance this research field we consider two versions of the (1+1)-EA and analyze their runtime to the Pareto front of a carefully designed biobjective test problem.

14:30-14:50 FrA4.4

Effects of Optimal Genetic Material in the Initial Population of Evolutionary Algorithms , pp. 1386-1391

Benecke, Tobias — Otto Von Guericke University Magdeburg
Mostaghim, Sanaz — University of Magdeburg

The quality of individuals in evolutionary algorithms (EAs) is usually measured in terms of their fitness. If an individual has a good fitness, a good genome is assumed. However, a good fitness value does not guarantee that the individual can produce good offspring and guide the algorithm towards the global optimum. Answering the question of what makes a genome good is not trivial, especially when considering different types of crossover operators, copying or combining genome values. This work aims towards answering this question by evaluating the influence of optimal gene values in the initial population of EAs. In computational experiments, a random population is seeded with generated individuals of different fitness qualities and containing different amounts of optimal genetic material. Tests are done for multiple dimensions and with crossover operators copying or combining the parents genes to the offspring. Data is evaluated both in terms of algorithmic performance and population dynamics, clearly showing the influence of optimal gene values.

14:50-15:10 FrA4.5

What Drives Evolution of Self-Driving Automata? , pp. 1392-1397

Dube, Michael — University of Guelph
Olenic, Kevin — Brock University
Houghten, Sheridan — Brock University

Self-Driving Automata (SDAs) are variations on finite automata that both read and output symbols. They are versatile and practical when used for the generation of data for a variety of problems. In this study, we examine several questions regarding their operation, using sequence matching as a test problem in the analysis. We present a new mutation operator and four dynamic mutation adjusters. We analyze these, along with crossover, for their ability to solve the problem and their relative ability to improve the population; in all of these, we also examine population diversity over time. We find that using mutation that implements a static quantity of changes outperforms one with dynamic changes. Further, while population diversity does decrease somewhat, evolution is still possible.

15:10-15:30 FrA4.6

Initial Populations with a Few Heuristic Solutions Significantly Improve Evolutionary Multi-Objective Combinatorial Optimization , pp. 1398-1405

Gong, Cheng — Southern University of Science and Technology
Nan, Yang — Southern University of Science and Technology
Pang, Lie Meng — Southern University of Science and Technology
Ishibuchi, Hisao — Southern University of Science and Technology
Zhang, Qingfu — City University of Hong Kong

Population initialization is a crucial and essential step in evolutionary multi-objective optimization (EMO) algorithms. The quality of the generated initial population can significantly affect the performance of an EMO algorithm. However, few studies have focused on designing a generalized initialization method to improve the performance of EMO algorithms in solving multi-objective combinatorial optimization (MOCO) problems. Most of the existing advanced initialization methods involve complex techniques tailored to the specific characteristics of the problems to be solved. In this paper, we propose a general and effective framework of population initialization for EMO algorithms, aiming to improve their performances in solving various MOCO problems. Our approach involves the inclusion of a few specific heuristic solutions, including extreme solutions and a center solution, into the initial population. This inclusion serves to guide the evolution of the population throughout the optimization process. Our experimental results show that initial populations with a few heuristic solutions significantly improve the performance of EMO algorithms. Algorithm behavior analysis and further study are also provided, allowing for a comprehensive understanding of the effectiveness and applicability of our proposed method.

FrA5 Constitución B

Adaptive Dynamic Programming and Reinforcement Learning (ADPRL)

Organizer: Ni, Zhen — Florida Atlantic University
Organizer: Si, Jennie — Arizona State University

13:30-13:50 FrA5.1

Reinforcement Learning-Guided Channel Selection across Time for Multivariate Time Series Classification , pp. 1406-1413

Pantiskas, Leonardos — Vrije Universiteit Amsterdam
Verstoep, Kees — Vrije Universiteit Amsterdam
Hoogendoorn, Mark — Vrije Universiteit Amsterdam
Bal, Henri — Vrije Universiteit Amsterdam

The promising results of machine learning in time series classification, along with the rise in sensor data-driven use cases, have led to the increasing deployment of models in IoT environments, on edge devices. Since these devices are typically resource constrained, they cannot always execute large and complex models,

so they often offload (part of) their tasks to remotely located models. This synergy however introduces the need to transfer a large amount of sensor data to the cloud, which can be detrimental to bandwidth cost and inference speed of the application, and energy utilization of the device. Although techniques such as early classification can limit the data that has to be transferred, there are still unexplored opportunities when it comes to input filtering. A recent versatile early-exit framework, extending early classification and adapting it to multivariate time series, has investigated this potential. In this work, we propose a variation of this method, creating a more flexible, reinforcement learning-enabled framework that can adapt the input variables (channels) considered for classification across time, aiming for maximizing accuracy while minimizing the input data necessary. Extensive testing on synthetic data and real datasets shows that our method can, in multiple cases, achieve better accuracy for a similar percentage of input filtering, both compared to the baseline framework, as well as to the conventional early classification approach.

13:50-14:10 FrA5.2

Enhanced Generalization through Prioritization and Diversity in Self-Imitation Reinforcement Learning Over Procedural Environments with Sparse Rewards , pp. 1414-1420

Andres, Alain	TECNALIA
Zha, Daochen	Rice University
Del Ser, Javier	TECNALIA/University of the Basque Country (UPV/EHU)

Exploration poses a fundamental challenge in Reinforcement Learning (RL) with sparse rewards, limiting an agent's ability to learn optimal decision-making due to a lack of informative feedback signals. Self-Imitation Learning (self-IL) has emerged as a promising approach for exploration, leveraging a replay buffer to store and reproduce successful behaviors. However, traditional self-IL methods, which rely on high-return transitions and assume singleton environments, face challenges in generalization, especially in procedurally-generated (PCG) environments. Therefore, new self-IL methods have been proposed to rank which experiences to persist, but they replay transitions uniformly regardless of their significance, and do not address the diversity of the stored demonstrations. In this work, we propose tailored self-IL sampling strategies by prioritizing transitions in different ways and extending prioritization techniques to PCG environments. We also address diversity loss through modifications to counteract the impact of generalization requirements and bias introduced by prioritization techniques. Our experimental analysis, conducted over three PCG sparse reward environments, including MiniGrid and ProcGen, highlights the benefits of our proposed modifications, achieving a new state-of-the-art performance in the MiniGrid-MultiRoom-N12-S10 environment.

14:10-14:30 FrA5.3

Hierarchical Reinforcement Learning for Non-Stationary Environments , pp. 1421-1428

Haighton, Rachel	Carleton University
Asgharnia, Amirhossein	Carleton University
Schwartz, Howard	Carleton University
Givigi, Sidney	Queen's University

What indications are there when the environment changes and the learned policy is no longer optimal? Is it possible to predict when a non-stationary environment changes in some way? In this paper we propose a method that helps agents know when to retrain their policies via reinforcement learning. The agents detect changes based on the temporal difference. A hierarchical learning model is used to aid in these non- stationary environments. The hierarchical learning model has two levels, the higher-level policy, which we call the learning switch, and the lower-level policy, which tells the agents their suitable action to play the game. The higher-level policy determines when reinforcement learning should be turned on or off based on the temporal differences calculated within a game or episode. Two multi-agent differential games are used as examples. The first two examples tackle the problem in cooperative games, while the last example addresses the competitive game. The results show that the agents can maintain suitable performance by switching on the learning process for a few iterations after environment changes occurs.

14:30-14:50 FrA5.4

Uncertainty Quantification for Efficient and Risk-Sensitive Reinforcement Learning , pp. 1429-1434

IBRAHIM, Mohamed-Harith	Mines Saint-Etienne
Lecoeuche, Stéphane	IMT Nord Europe
Boonaert, Jacques	IMT Nord Europe
BATTON-HUBERT, Mireille	Mines Saint-Etienne

In complex real-world decision problems, ensuring safety and addressing uncertainties are crucial aspects. In this work, we present an uncertainty-aware Reinforcement Learning agent designed for risk-sensitive applications in continuous action spaces. Our method quantifies and leverages both epistemic and aleatoric uncertainties to enhance agent's learning and to incorporate risk assessment into decision-making processes. We conduct numerical experiments to evaluate our work on a modified version of Lunar Lander with variable and risky landing conditions. We show that our method outperforms both Deep Deterministic Policy Gradient (DDPG) and TD3 algorithms by reducing collisions and having significant faster training. In addition, it enables the trained agent to learn a risk-sensitive policy that balances performance and risk based on a specific level of sensitivity to risk required for the task.

14:50-15:10 FrA5.5

MEWA: A Benchmark for Meta-Learning in Collaborative Working Agents , pp. 1435-1442

Stoican, Radu	The University of Manchester
Cangelosi, Angelo	University of Manchester
Weisswange, Thomas	Honda Research Institute Europe GmbH

Meta-reinforcement learning aims to overcome important limitations in reinforcement learning, like low sample efficiency and poor generalization, by creating agents that adapt to new tasks. The development of intelligent robots would benefit from such agents. Long-standing issues like data collection and generalization to real-world dynamic environments could be mitigated by sample-efficient adaptable algorithms. However, most such algorithms have only been proven to work in low-complexity environments. These provide no guarantee that a near-optimal global policy does not exist, which makes it difficult to evaluate adaptable policies. This hinders the in-depth analysis of an agent's potential to adapt, while also introducing a gap between controlled experiments and real-world applications. We propose MEWA, a collection of task distributions used as a benchmark for adaptable agents. Our tasks contain a shared structure that an agent can leverage to learn the task-specific structure of new tasks. To ensure our environment is adaptive, we select some of the task parameters using the solution to a constrained optimization problem. Other parameters are randomized, allowing the creation of arbitrary task distributions. We evaluate three state-of-the-art meta-reinforcement learning algorithms on our benchmark, that were previously shown to adapt to new tasks with a simpler structure. Results show that the algorithms can reach meaningful performance on the task, but cannot yet fully adapt to the task-specific structure. We believe this benchmark will help identify some of the issues that hinder adaptability, ultimately aiding in the design of new algorithms, more suitable for real-world human-robot applications.

15:10-15:30 FrA5.6

SIGNRL: A Population-Based Reinforcement Learning Method for Continuous , pp. 1443-1448

Zambrano-Gutierrez, Daniel	Tecnologico De Monterrey
Molina-Porras, Alberto C.	Universidad De Guanajuato

Ovalle-Magallanes, Emmanuel — Universidad De Guanajuato
Amaya, Ivan — Tecnologico De Monterrey
Ortiz-Bayliss, Jose Carlos — Tecnologico De Monterrey
Avina-Cervantes, Juan G. — Universidad De Guanajuato
Cruz-Duarte, Jorge Mario — Tecnologico De Monterrey

In engineering processes that require continuous control, it is common to face significant challenges. Addressing these challenges through explicit modeling can take much work and effort. For this reason, Reinforcement Learning (RL) has gained popularity as a feasible strategy for solving this problem. In this context, various value-based methodologies, policies, or combinations have been employed to obtain an optimal learning policy. However, problems such as convergence to local maxima and high variance in training persist. In addition, computational time and cost increase in complex environments, so more robust RL methodologies are required. This paper proposes a Swarm Intelligence Guided Neural Reinforcement Learning (SIGNRL) algorithm, which uses Particle Swarm Optimization as a multi-agent parameter explorer to find the optimal policy. Numerical results obtained in the OpenAI Gym Cart-Pole environment show that SIGNRL, with its gradient-free learning, exhibits good convergence and lower variance in continuous control tasks.

FrA6 — Constitución C

Computational Intelligence and Cognitive Science (CIMEX)

Organizer: Gonzalez-Mendoza, Miguel — ITE430714KI0
Organizer: Calvo, Hiram — CIC-IPN

13:30-13:50 — FrA6.1

Optimizing Strategy Games: Ant Colony Optimization vs. Minimax Algorithm , pp. 1449-1454

Angeles Garcia, Yoqsan — Instituto Politécnico Nacional
Legaria-Santiago, Valeria Karina — Instituto Politécnico Nacional
Anzueto, Alvaro — Instituto Politécnico Nacional
Calvo, Hiram — Instituto Politécnico Nacional

This article proposes an Ant Colony Optimization (ACO) algorithm, an optimization method to find paths in graphs, adapted to solve strategic games. The games of study are Tic-Tac-Toe (also known as noughts and crosses, three in a row, or Xs and Os), and Chess. The algorithms' performance is contrasted by contending ACO against the Minimax algorithm, in different setups of Tic-Tac-Toe and Chess. The performance is explained in terms of average time response, correctness of the move choice, and memory used when executing the function. Results reveal a slightly better average performance by the ACO algorithm compared to Minimax. These findings highlight the ability of ACO in decision-making algorithms without requiring knowledge of previous games. Furthermore, the results suggest that the ACO-based path optimization approach can be an effective alternative to improve the efficiency of decisions made by intelligent systems in environments that require rapid response.

13:50-14:10 — FrA6.2

Search of Highly Selective Cells in Convolutional Layers with Hebbian Learning , pp. 1455-1460

Aguilar-Canto, Fernando — CIC IPN
Calvo, Hiram — CIC-IPN

Deep Convolutional Neural Networks (ConvNets) have demonstrated successful implementations in various vision tasks, including image classification, segmentation, and image captioning. Despite their achievements, concerns persist regard- ing the explainability of these models, often referred to as black- box classifiers. While some interpretability papers suggest the existence of object detectors in ConvNets, others refute this notion. In this paper, we address the challenge of identifying such neurons by utilizing Hebbian learning to discover the most associated neurons for a given stimulus. Our method focuses on the VGG19 and ResNet50 networks with the Dogs- vs-Cats dataset. During experimentation, we found that the most associated hidden neurons to the labels are not object detectors. Instead, they seem to encode relevant aspects of the category. By shedding light on these findings, we aim to improve the understanding and interpretability of deep ConvNets for future advancements in the field of computer vision.

14:10-14:30 — FrA6.3

Enhancing Document Digitization: Image Denoising with a Cycle Generative Adversarial Network , pp. 1461-1466

Lugo Torres, Gerardo — Centro De Investigación En Computación, Instituto Politécnico Nac
Peralta, Diego Antonio — Instituto Politécnico Nacional
Valdez-Rodríguez, José E. — Centro De Investigación En Computación
Calvo, Hiram — CIC-IPN

In the era of big data, we now live on, there is an increasing demand to convert large amounts of scanned documents, such as texts, medical records, and images into digital formats. However, often when scanning introduces imperfections such as salt-and-pepper or background noise, blurring caused by camera motion, watermarking, coffee stains, wrinkles, or faded text. These imperfections carry significant challenges to current algorithms of text recognition, leading to a decline in their performance. To date, a wide range of methods are aimed at reducing noise. This work compares the performance of a CycleGAN model concerning median filter, Wiener filter, adaptive threshold, morphological filtering, and a CNN-based autoencoder. While the CNN-based autoencoder technique gave us the best results, the CycleGAN model approach provided us with comparable results with only 50 training epochs in contrast to the 700 epochs of the CNN-based autoencoder and was superior to the rest of the other contrasted methods. Likewise, data preparation for the training is much simpler in the CycleGAN model due to its property of requiring only unpaired data for training.

14:30-14:50 — FrA6.4

Analysis of Emotions in Speech Acts for Chatbots: An Overview and a Model Proposal , pp. 1467-1471

Castro, Emmanuel — CIC-IPN
Calvo, Hiram — CIC-IPN
Kolesnikova, Olga — CIC-IPN
Castro, Citlali — CECyT 6 - IPN

A chatbot is a machine with conversational capabilities that tries to resemble a person. In the 90s the A.L.I.C.E. chatbot was created, showing significant advances over its predecessors. Since then, different progress has been made until, thanks to the advancement of technology, the development of current improved models has been achieved. However, now special attention is being paid to chatbots having affective recognition capabilities to enrich the user experience, which is an understudied area. This paper overviews state of the art works on recognition of speaker's emotions and intentions and proposes to design a speech acts-based model of a chatbot that can interpret human emotions in text and give a coherent response in content and the expressed feelings. A set of techniques will be included in the design to recognize both the user's emotions and her intentions when expressing herself.

14:50-15:10 — FrA6.5

Convolving Emotions: A Compact CNN for EEG-Based Emotion Recognition , pp. 1472-1476

Cardoso-Moreno, Marco A. — Cic - Ipn
Macias, Cesar — Centro De Investigación En Computación
Alcantara, Tania — Centro De Investigación En

	Computación, Instituto Politécnico Na
Soto, Miguel	Centro De Investigación En Computación, Instituto Politécnico Na
Calvo, Hiram	CIC-IPN
Yáñez-Márquez, Cornelio	Instituto Politécnico Nacional

Emotion Recognition is a research area that has had a surge in interest, since areas such as mental health, psychological diagnosis, e-learning and assistance for people who are not capable of communicating their feelings, depend on certain level, on the capacities of computer systems to reliably identify emotions. There are several approaches to this task, for instance, analyzing facial expressions, speech, and physiological signals (electrocardiogram, galvanic skin response, electroencephalogram, among others). Electroencephalogram is one of the preferred methods due, in part, to is great temporal resolution. Therefore, in this paper we used the EEG Brainwave Dataset as benchmark to test our model, which is a four layer, one dimensional convolutional neural network. After the preprocessing pipeline, consisting on considering certain features of the dataset as signals and processing them accordingly, by creating several channels by two decomposition methods, our model achieved accuracy values of 98.36% and 95.31%, which is competitive with what is found on the state of the art, while being a significantly less complex model.

15:10-15:30 FrA6.6

Hypertension and Its Relationship with Socioeconomic Factors in Mexico Using Clustering Techniques, pp. 1477-1478

OBED SALOMON, CASILLAS BALTAZAR	Instituto Politécnico Nacional
Pichardo-Lagunas, Obdulia	Instituto Politécnico Nacional
Martinez-Seis, Bella	IPN (UPIITA)

According to Ministry of Health in Mexico, Hypertension, commonly referred to as High Blood Pressure (HBP), continues to rank among the foremost ten causes of mortality in Mexico. This document describes the methodology for unearthing correlations between non-clinical variables and HBP, utilizing data clustering techniques in a data set derived from diverse Mexican institutions

FrA7 Colonia

Multicriteria Decision-Making (MCDM)

Organizer: Singh, Hemant Kumar	UNSW Canberra
Organizer: Deb, Kalyanmoy	Michigan State University

13:30-13:50 FrA7.1

On the Choice of Unique Identifiers for Predicting Pareto-Optimal Solutions Using Machine Learning , pp. 1479-1484

Suresh, Anirudh	Michigan State University
Deb, Kalyanmoy	Michigan State University

Incomplete or sparse non-dominated fronts are unavoidable in multi-objective optimization due to complexity of problems, morphology of Pareto optimal fronts, and stochasticity involved in evolutionary optimization algorithms. It is pragmatic to develop methods that can alleviate some of these issues after the optimization run is complete, without the need for re-optimization or additional solution evaluations. Previously developed methods demonstrated that it is possible to predict Pareto-optimal solutions from pseudo-weight vectors using Gaussian Process Regression (GPR) models. We extend the GPR-based method to predict new Pareto-optimal solutions using reference vectors as unique identifiers and demonstrate that like the pseudo-weight vectors, reference vectors can also used instead in learning the association between identifiers and corresponding variable vectors. Results on many test problems indicate that the choice of a suitable identifier makes a large impact on the decision-making process, particularly for visualizing the newly created non-dominated (ND) solutions. In this study, we discuss the advantages and disadvantages of using pseudo-weights and reference vectors as unique identifiers for ND solutions, paving the way to devise further identifiers for predicting new Pareto-optimal solutions.

13:50-14:10 FrA7.2

Multi-Objective Island Model Genetic Programming for Predicting the Stokes Flow Around a Sphere , pp. 1485-1490

Reuter, Julia	Otto-Von-Guericke-University Magdeburg
Pandey, Pravin	Otto-Von-Guericke-University Magdeburg
Mostaghim, Sanaz	Otto-Von-Guericke-University Magdeburg

This paper is aimed at enhancing the success rate of Genetic Programming (GP) algorithms for symbolic regressions. It is shown that the outcome of GP algorithms over several runs can lead to an optimal solution for such problems, but the success rate, i.e., the number of successful runs, is sometimes small. We address this issue by proposing multi-objective and island model (IM) optimization for GP. We study the influence of various objective functions and IM configurations on the success rates and present 36 algorithm variants, which are tasked with solving two benchmark equations from the fluid mechanics area. This specific benchmark problem has been previously shown to suffer from a low success rate and high variations between the results of multiple runs. Our experiments show a strong influence of the objective functions on the success rate. The additional IM implementation improves the results for some objectives. The algorithm with the highest success rate on the more complex benchmark problem employs both, multiple objectives and IM.

14:10-14:30 FrA7.3

Managing Objective Archives for Solution Set Reduction in Many-Objective Optimization , pp. 1491-1496

Peerlinck, Amy	Western Colorado State University
Sheppard, John	Montana State University

As objectives increase in many-objective optimization (MaOO), often so do the number of non-dominated solutions, potentially resulting in solution sets with thousands of non-dominated solutions. Such a larger final solution set increases difficulty in visualization and decision-making. This raises the question: how can we reduce this large solution set to a more manageable size? In this paper, we present a new objective archive management (OAM) strategy that performs post-optimization solution set reduction to help the end-user make an informed decision without requiring expert knowledge of the field of MaOO. We create separate archives for each objective, selecting solutions based on their fitness as well as diversity criteria in both the objective and variable space. We can then look for solutions that belong to more than one archive to create a reduced final solution set. We apply OAM to NSGA-II and compare our approach to environmental selection finding that the obtained solution set has better hypervolume and spread. Furthermore, we compare results found by OAM-NSGA-II to NSGA-III and get competitive results. Additionally, we apply OAM to reduce the solutions found by NSGA-III and find that the selected solutions perform well in terms of overall fitness, successfully reducing the number of solutions.

14:30-14:50 FrA7.4

Analyzing Different Protocols of Information Granularity Distribution to Improve Consistency of Fuzzy Preference Relations in Decision-Making , pp. 1497-1502

González-Quesada, Juan Carlos	University of Granada
Perez, Ignacio Javier	University of Cadiz
Morente-Molinera, Juan	University of Granada

Antonio
Alonso, Sergio — University of Granada
Herrera Viedma, Enrique — University of Granada (Spain)
Cabrerizo, Francisco Javier — University of Granada (Q1818002F)

A fundamental principle of Granular Computing is that of an information granularity distribution and its optimization process. It has been used in system modelling to elevate a numerical model to its granular counterpart, which is more in rapport with reality. For example, in decision-making with fuzzy preference relations, it has been applied to enhance the existing numerical consistency improvement procedures. However, even though different protocols of information granularity distribution have been proposed, only the one based on a uniform and symmetric distribution and the one based on a symmetric but non-uniform distribution have been considered. Given that there exist others, this study aims to analyze how we can take advantage of all of them to improve the consistency of the fuzzy preference relations. Some numerical experiments are also completed to show the performance of these protocols

14:50-15:10 FrA7.5

Ensemble R2-Based Hypervolume Contribution Approximation , pp. 1503-1510

Wu, Guotong — Southern University of Science and Technology
Shu, Tianye — Southern University of Science and Technology
Nan, Yang — Southern University of Science and Technology
Shang, Ke — Southern University of Science and Technology
Ishibuchi, Hisao — Southern University of Science and Technology

The hypervolume-based multi-objective evolutionary algorithms (HV-MOEAs) have proven to be highly effective in solving multi-objective optimization problems. However, the computation time of the hypervolume calculation increases significantly as the number of objectives increases. To address this issue, an R2-based hypervolume contribution approximation (R2-HVC) method was proposed. Nevertheless, the original R2-HVC generates a large number of vectors and computes the HVC only once. In this study, we propose an ensemble method based on the R2-HVC method. By using a small number of vectors for repetitive computation and majority voting, the ensemble method can reduce the probability of making incorrect choices. Experimental results show that the proposed method can improve the approximation accuracy while maintaining a similar computation time to the original R2-HVC method.

15:10-15:30 FrA7.6

A Brief Review of Multi-Concept Multi-Objective Optimization Problems , pp. 1511-1517

Niloy, Rounak Saha — University of New South Wales
Singh, Hemant Kumar — University of New South Wales
Ray, Tapabrata — University of New South Wales

In the context of design, multi-concept optimization (MCO) refers to the task of concurrently identifying the best concept and the corresponding variable values to optimize certain objective(s). Despite its relevance in various practical domains such as engineering, transport, and product design, there have been limited studies on developing computationally efficient algorithms specialized for MCO problems. One of the contributing factors towards this gap is the lack of benchmark problems for MCO that offer diverse challenges for the systematic evaluation and development of advanced algorithms. In this paper, we conduct a brief review of some existing multi-objective test problems in the domain and discuss some of their shortcomings. The key aim is to highlight the need for the development of a more extensive set of benchmark problems that are flexible and tunable in terms of the challenges posed to the solution methodologies. In turn, we hope that this will encourage the development of more advanced algorithms to solve practical MCO problems in the future.

FrA8 — Conquista

Evolving and Autonomous Learning Systems (EALS)

Organizer: Angelov, Plamen — Lancaster University
Organizer: Kasabov, Nikola — Auckland University of Technology

13:30-13:50 FrA8.1

A Comparison of Controller Architectures and Learning Mechanisms for Arbitrary Robot Morphologies , pp. 1518-1525

Luo, Jie — Vrije Universiteit Amsterdam
Miras, Karine — Vrije Universiteit Amsterdam
Tomczak, Jakub — Eindhoven University of Technology
Eiben, A.E. — Vrije Universiteit Amsterdam

The main question this paper addresses is: What combination of a robot controller and a learning method should be used, if the morphology of the learning robot is not known in advance? Our interest is rooted in the context of morphologically evolving modular robots, but the question is also relevant in general, for system designers interested in widely applicable solutions. We perform an experimental comparison of three controller-and-learner combinations: one approach where controllers are based on modelling animal locomotion (Central Pattern Generators, CPG) and the learner is an evolutionary algorithm, a completely different method using Reinforcement Learning (RL) with a neural network controller architecture, and a combination `in-between' where controllers are neural networks and the learner is an evolutionary algorithm. We apply these three combinations to a test suite of modular robots and compare their efficacy, efficiency, and robustness. Surprisingly, the usual CPG-based and RL-based options are outperformed by the in-between combination that is more robust and efficient than the other two setups.

13:50-14:10 FrA8.2

Evolving Behavior Allocations in Robot Swarms , pp. 1526-1531

Scott, Hallauer — University of Cape Town
Nitschke, Geoffrey — University of Cape Town
Hart, Emma — Edinburgh Napier University

Behavioral diversity is known to benefit problem solving in biological social systems such as insect colonies and human societies, as well as in artificial distributed systems including large-scale software and swarm-robotics systems. We investigate methods of evolving robot swarms in which individuals have heterogeneous behaviours. Two approaches are investigated to create swarm of size n. The first encodes a repertoire of n behaviours on a single individual, and hence evolves the swarm directly. The second approach uses two phases. First, a large repertoire of diverse behaviours is evolved and then another evolutionary algorithm is used to search for an optimal allocation of behaviours to the swarm. Results indicate that the two phase approach of generate then allocate produces significantly more effective collective behaviors (in terms of task accomplishment) than the direct evolution of behaviorally heterogeneous swarms.

14:10-14:30 FrA8.3

Knowledge Extraction about Beer Classification Using Evolving Fuzzy Neural Networks , pp. 1532-1539

Campos Souza, Paulo Vitor de — Fondazione Bruno Kessler

Evolving Fuzzy Neural Networks (EFNNs) are well-regarded for their interpretability and proficiency in pattern classification tasks. However, their accuracy may need to be improved when confronted

with limited samples for specific classes or the emergence of new classes in the data stream. To overcome this limitation, we applied the EFNN-Gen, a novel approach that integrates a priori knowledge through generalist rules to solve a beer classification problem. These rules are derived from assessing the specificity of Gaussian functions within the first layer neurons of the EFNN. They represent expert knowledge about the classification problem and are aimed at enhancing the network's performance. Experimental tests conducted on the Beer dataset, a real-world multiclass pattern classification dataset, demonstrate that integrating generalist rules leads to a significant accuracy improvement of 97.14%.

14:30-14:50 FrA8.4

Training Artificial Neural Networks by Coordinate Search Algorithm , pp. 1540-1546

Rokhsatyazdi, Ehsan	Ontario Tech University
Rahnamayan, Shahryar	Brock University
Zanjani Miyandoab, Sevil	Ontario Tech University
Asilian Bidgoli, Azam	Wilfrid Laurier University
Tizhoosh, Hamid	Mayo Clinic

Training Artificial Neural Networks (ANNs) poses a challenging and critical problem in machine learning. Despite the effectiveness of gradient-based learning methods, such as Stochastic Gradient Descent (SGD), in training neural networks, they do have several limitations. For instance, they require differentiable activation functions, and cannot optimize a model based on several independent non-differentiable loss functions simultaneously; for example, the F1-score, which is used during testing, can be used during training when a gradient-free optimization algorithm is utilized. Furthermore, the training (i.e., optimization of weights) in any DNN can be possible with a small size of the training dataset. To address these concerns, we propose an efficient version of the gradient-free Coordinate Search (CS) algorithm, an instance of General Pattern Search (GPS) methods, for training (i.e., optimizing) neural networks. The proposed algorithm can be used with non-differentiable activation functions and tailored to multi-objective/multi-loss problems. Finding the optimal values for weights of ANNs is a large-scale optimization problem. Therefore instead of finding the optimal value for each variable, which is the common technique in classical CS, we accelerate optimization and convergence by bundling the variables (i.e., weights). In fact, this strategy is a form of dimension reduction for optimization problems. Based on the experimental results, the proposed method is comparable with the SGD algorithm, and in some cases, it outperforms the gradient-based approach. Particularly, in situations with insufficient labeled training data, the proposed CS method performs better. The performance plots demonstrate a high convergence rate, highlighting the capability of our suggested method to find a reasonable solution with fewer function calls. As of now, the only practical and efficient way of training ANNs with hundreds of thousands of weights is gradient-based algorithms such as SGD or Adam. In this paper we introduce an alternative method for training ANN.

14:50-15:10 FrA8.5

Improving Metaheuristic Algorithm Design through Inequality and Diversity Analysis: A Novel Multi-Population Differential Evolution , pp. 1547-1552

Ramos-Michel, Alfonso	Universidad De Guadalajara
Navarro, Mario A.	Universidad De Guadalajara
Oliva, Diego	Universidad De Guadalajara
Morales-Castañeda, Bernardo	Universidad De Guadalajara
Casas-Ordaz, Angel	Universidad De Guadalajara
Valdivia G, Arturo	Universidad De Guadalajara
Rodríguez-Esparza, Erick	University of Deusto
Mousavirad, Seyed Jalaleddin	Mid Sweden University

In evolutionary algorithms and metaheuristics, defining when applying a specific operator is important. Besides, in complex optimization problems, multiple populations can be used to explore the search space simultaneously. However, one of the main problems is extracting information from the populations and using it to evolve the solutions. This article presents the inequality-based multi-population differential evolution (IMDE). This algorithm uses the K-means to generate subpopulations (settlements). Two variables are extracted from the settlements, the diversity and the Gini index, which measure the solutions' distribution and the solutions' inequality regarding fitness. The Gini index and the diversity are used in the IMDE to dynamically modify the scalation factor and the crossover rate. Experiments over a set of benchmark functions with different degrees of complexity validate the performance of the IMDE. Besides comparisons, statistical and ranking average validate the search capabilities of the IMDE.

15:10-15:30 FrA8.6

Training Data Leakage Via Imperceptible Backdoor Attack , pp. 1553-1559

Yang, Xiangkai	Harbin Institute of Technology, Shenzhen
Luo, Wenjian	Harbin Institute of Technology, Shenzhen
Zhou, Qi	Harbin Institute of Technology, Shenzhen
Chen, zhijian	Harbin Institute of Technology (Shenzhen)

Recently, deep neural networks (DNNs) have been widely used and proven successful in many real-world tasks. There are many third-party DNN services available for data holders who want to develop custom DNN applications for their data and tasks. To ensure data privacy, it is crucial to safeguard the data holder's training data. This paper explores a unique attack paradigm where a hostile third-party DNN model supplier subtly obtains training data from the data holder. Prior attacks which can steal training data typically use augmented datasets to memorize the information of the data that the attacker intends to steal. However, these attacks are easily identified since the augmented datasets are visually different from the original dataset and rendered ineffective. In this attack, we generate an augmented dataset by modifying a portion of the training data using the DNN-based image steganography technique. This approach creates an augmented dataset that is visually identical to the original training dataset, making it difficult for humans to detect. Through extensive experiments, we have successfully and quietly accessed the confidential training data of data holders.

FrB1 Imperio A

Intelligent Biomedical Data Analysis (IBDA)

Organizer: Wang, Alan	University of Auckland
Organizer: Kasabov, Nikola	Auckland University of Technology

16:00-16:20 FrB1.1

Classification Using Deep Transfer Learning on Structured Healthcare Data , pp. 1560-1565

FARHADI, AYDA	University of Georgia
Chen, David	Mayo Clinic
mccoy, rozalina	Mayo Clinic
scott, christopher	Mayo Clinic
Ma, Ping	UGA
Vachon, Celine	Mayo Clinic
Zhang, Jingyi	Tsinghua University
Ngufor, Che	Mayo Clinic
Miller, John	UGA

In healthcare, building a supervised learning system faces the challenge of access to a large, labeled dataset. To overcome this problem, we propose a deep transfer learning method that addresses imbalanced data problems in healthcare, focusing on structured data.

We use publicly available breast cancer datasets to generate a source model and transfer learned concepts to predict high-grade malignant tumors in patients diagnosed with breast cancer at Mayo Clinic. The diabetes dataset is then used to generalize the transfer learning idea. We compare our results with state-of-the-art techniques and demonstrate the superiority of our proposed methods. Our experiments on breast cancer data under simulated class imbalanced settings further demonstrate the proposed method's ability to handle different degrees of class imbalance. We conclude that deep transfer learning on structured data can efficiently address imbalanced class and poor performance learning on small dataset problems in clinical research.

16:20-16:40 FrB1.2

Deep Learning and Explainable Artificial Intelligence for Improving Specificity and Detecting Metabolic Patterns in Newborn Screening , pp. 1566-1571

Zaunseder, Elaine	University Heidelberg
Mütze, Ulrike	Heidelberg University Hospital
Garbade, Sven	Heidelberg University Hospital
Haupt, Saskia	University Heidelberg
Kölker, Stefan	Heidelberg University Hospital
Heuveline, Vincent	University Heidelberg

In medical applications, artificial intelligence (AI) methods have achieved considerable progress in various areas and also in newborn screening programs. In particular, interpretable AI methods have been applied in newborn screening aiming to increase analytical specificity and predictive power of screening results. In this study, we apply ensemble and deep learning methods in newborn screening for isovaleric aciduria (IVA) on a data set containing more than 2 million newborns. We show that these methods can reduce the number of newborns falsely classified with IVA by 100% with Extreme Gradient Boosting (XGBoost), by 78.94% with Random Forest (RF), and by 78.94% with Feed Forward Neural Networks (FFNN) compared to currently applied newborn screening methods. Furthermore, we show how explainable AI (XAI) methods can be used to interpret these black-box classification results and further apply them for potential biomarker discovery. The XAI methods reveal that besides the biomarker isovaleryl carnitine (C5), the birth year and the amino acid tryptophan (Trp) are influential in reducing the false positive rate. By this, we show that ensemble and deep learning could be highly beneficial in newborn screening and could have a major impact on newborns and their families, as it reduces false positive screening results and guides new directions for future research in this field.

16:40-17:00 FrB1.3

Image-Based Screening of Oral Cancer Via Deep Ensemble Architecture , pp. 1572-1578

Parola, Marco	University of Pisa
La Mantia, Gaetano	University of Palermo
Galatolo, Federico Andrea	University of Pisa
Cimino, Mario G. C. A.	University of Pisa
Campisi, Giuseppina	University of Palermo
Di Fede, Olga	University of Palermo

Oral squamous cell carcinoma (OSCC) is a significant health issue in the oral cancer domain; a screening tool for timely and accurate diagnosis is essential for effective treatment planning and prognosis in patients' life expectancy. In this paper, we address the problem of object detection and classification in the context of OSCC, by presenting a comparative analysis of three state-of-the-art architecture: YOLO, FasterRCNN, and DETR. We propose a deep learning ensemble model to address both object detection and classification problem leveraging the strengths of individual models to achieve higher performance than single models. The proposed architecture was evaluated on a real-world dataset developed by experienced clinicians who manually labeled individual photographic images, producing a benchmark dataset. Results from our comparative analysis demonstrates the ensemble detection model achieves superior performance compared to the individual models, outperforming the average value of the individual models' map@50 metric by 24% and the value of the map@95-50 metric by 44%

17:00-17:20 FrB1.4

Inference of Genetic Networks from Steady-State and Pseudo Time-Series of Single-Cell Gene Expression Data Using Modified Random Forests , pp. 1579-1586

Kimura, Shuhei	Tottori University
Kitajima, Hirotaka	Tottori University
Tokuhisa, Masato	Tottori University
Okada, Mariko	Osaka University

A number of the genetic network inference methods have been proposed. These methods have been basically designed to analyze gene expression data of bulk cells. Recently, on the other hand, researchers have been capable of using gene expression data measured at single-cell resolution. The existing inference methods are however incapable of analyzing time-series of single-cell data because of high cell-to-cell variation in gene expression. This study therefore proposed the new inference method that has an ability to analyze steady-state and pseudo time-series of single-cell gene expression data. The pseudo time-series data are obtained through the pseudo-temporal ordering analysis. As the precise information about the measurement time is unavailable in pseudo time-series data, our method infers a genetic network using the signs of time derivatives of gene expression levels, that can be estimated from the given data. Through the numerical experiments, we finally confirmed the effectiveness of the proposed method.

17:20-17:40 FrB1.5

Using Contrastive Learning to Inject Domain-Knowledge into Neural Networks for Recognizing Emotions , pp. 1587-1592

Gagliardi, Guido	University of Pisa
Alfeo, Antonio Luca	University of Pisa
Catrambone, Vincenzo	University of Pisa
Cimino, Mario G. C. A.	University of Pisa
De Vos, Maarten	KU Leuven
Valenza, Gaetano	University of Pisa

With application contexts ranging from psychophysiology to neuromarketing, electroencephalography (EEG)-based emotion recognition is a fundamental technology for affective computing. In this context, EEG signals can be processed via artificial neural networks (NNs) to achieve accurate recognition of users' emotions. Still, NNs are rarely employed in real-world decision-making processes, since their internal model works as a hardly trustable black box. A NN's reasoning can be explained in a human-comprehensible manner by exploring its latent space to understand if some domain knowledge is actually represented and exploited for the classification. Those approaches assume that a trained NN autonomously organizes its latent space according to some domain concepts to process the data via human-like reasoning. However, there is no guarantee that such an assumption holds, since the latent space is not built for this aim. On the other hand, forcing the organization of the latent space (e.g. via contrastive learning) can result in poor recognition performances due to information loss. To guarantee great recognition performances and provide a domain-knowledge-driven organization of NNs' latent space, we combine the well-known training procedure based on a categorical cross-entropy loss with a supervised contrastive learning approach for continuous values labels. The proposed approach enables the explanation of NN's reasoning in terms of the importance of high-level domain concepts in the final classification, and (ii) results in a recognition performance comparable to or better than the one achieved via an approach based solely on maximizing recognition. The proposed approach is tested on the publicly available MAHNOB dataset.

17:40-18:00 FrB1.6

Bayesian Optimization for the Inverse Problem in Electrocardiography , pp. 1593-1598

Lopez-Rincon, Alejandro	Division of Pharmacology, University of Utrech/Department of Dat
Rojas-Velazquez, David	Division of Pharmacology, University of Utrech/Department of Dat
Garssen, Johan	Division of Pharmacology, University of Utrecht
van der Laan, Sander W.	UMC Utrecht
Oberski, Daniel	Department of Data Science, Julius Center for Health Sciences An
Tonda, Alberto	UMR 518 MIA-PS, INRAE, Université Paris-Saclay

The inverse problem in electrocardiography is an ill-posed problem where the objective is to reconstruct the electrical activity of the epicardial surface of the heart, given the electrical activity on the thorax' surface. In the forward problem, the electrical propagation from heart to thorax is modeled by the volume conductor equation with Dirichlet boundary conditions in the heart's surface, and null flux coming from the thorax. The inverse problem, however, does not have a unique solution. In order to find solutions for the inverse problem, techniques such as Tikhonov regularization are classically used, but they often deliver unrealistic solutions. As an alternative, we propose a novel approach, where a fixed solution of the volume conductor model with a source in a forward scheme is used to solve the inverse problem. The unknown values for parameters of the fixed solution can be found using optimization techniques. Due to the characteristics of the problem, where each single evaluation of the cost function is expensive, we use a specialized CMA-ES-based Bayesian optimization technique, that can deliver good results even with a reduced number of function evaluations. Experiments show that the proposed approach can deliver improved results for in-silico simulations.

FrB2 — Imperio B

Robotic Intelligence in Informationally Structured Space (RiiSS)

Organizer: Botzheim, Janos	Eötvös Loránd University
Organizer: Chin, Wei Hong	Tokyo Metropolitan University

16:00-16:20 FrB2.1

Deep Active Robotic Perception for Improving Face Recognition under Occlusions , pp. 1599-1602

Dimaridou, Valia	Aristotle University of Thessaloniki
Passalis, Nikolaos	Aristotle University of Thessaloniki
Tefas, Anastasios	Aristotle University of Thessaloniki

Recent studies have demonstrated that active perception can improve the perception abilities of deep learning (DL) models. However, there are challenges associated with using active perception in DL models, including the need for datasets and/or realistic simulations that can support the training process, along with the difficulty of predicting the final target position, which reduces planning efficiency. To address these challenges, this work presents a methodology for enhancing the perception abilities of DL models through active perception. The methodology proposes a way to create datasets for active perception by fusing existing large-scale datasets and decomposing the active perception problem into three sub-tasks for face recognition. The sub-tasks aim to determine the appropriateness of the current view for face recognition, the direction in which the robot should move for a better viewpoint, and the expected amount of movement required. A novel trial-based approach is introduced to estimate the final target position, making the method platform-agnostic and easily applicable to different robots. The proposed methodology is validated through experiments on two well-known face verification datasets that have been augmented with occlusions, demonstrating its effectiveness in enhancing the perception abilities of DL models through active perception.

16:20-16:40 FrB2.2

FedLoop: A P2P Personalized Federated Learning Method on Heterogeneous Data , pp. 1603-1606

LI, FEI	Universiti Malaya
Loo, ChuKiong	University of Malaya
Liew, Wei Shiung	Universiti Malaya
Liu, Xiaofeng	Hohai University

In federated learning scenarios, data heterogeneity can significantly impact performance. Personalized federated learning seeks to provide individualized models for each client to enhance convergence on heterogeneous data. We discovered that initially training the personalized layers, also known as the head, of the model first can alleviate the effects of data heterogeneity. As a result, we propose a simple method named FedLoop. This method uses a loop topology structure, eliminating the need for a central server or data exchanges between participants, thereby safeguarding privacy. Within FedLoop, clients act as nodes in a loop. The training process for each node consists of two phases: an initial phase solely for the personalized layers and a subsequent phase dedicated to the training of all layers. This looping process continues until a set round limit is achieved. Experimental findings reveal that FedLoop outperforms the existing state-of-the-art algorithm, FedALA. FedLoop effectively addresses challenges posed by data heterogeneity and its rapid convergence significantly cuts down communication overheads in federated learning.

16:40-17:00 FrB2.3

Real-Time Neural Control for Discrete Nonlinear Systems under Unknown Input and State Disturbances , pp. 1607-1612

Alanis, Alma Y.	Universidad De Guadalajara
Alvarez, Jesus G.	University of Guadalajara
Sanchez, Oscar Didier	Universidad De Guadalajara
Zuñiga, Pavel	Universidad De Guadalajara
Munoz-Gomez, Gustavo	Instituto Tecnologico Nacional De Mexico

Abstract—This paper presents the design of an intelligent controller for uncertain discrete-time nonlinear systems. The proposed controller is resilient to external unknown disturbances as well as state and input uncertainties, even though the model of the system is considered unknown. An intelligent controller is designed for an unknown discrete-time nonlinear system, this controller is model-free and it is based on sensor measurements and therefore including unknown system dynamics, actuator nonlinearities, measurement errors, noise, uncertainties, external disturbances and other phenomena associated to real-world applications. Then, using the neural model, a backstepping controller is designed to ensure a resilient performance. Finally, real-time results are included to demonstrate the effectiveness of the proposed approach using a three-phase induction motor. Index Terms—Uncertain discrete-time nonlinear system, Intelligent control, Neural control, Resilience, Experimental results, Induction motor

17:00-17:20 FrB2.4

Intelligent Backoff Management Scheme Applying Adaptive Neuro-Fuzzy Inference System in Vehicular Ad-Hoc Networks , pp. 1613-1619

Limouchi, Elnaz	Royal Military College of Canada
Chan, Francois	Royal Military College of Canada

Intelligent Transportation Systems rely heavily on the Vehicular Ad-hoc Network to enhance road safety and comfort. This research proposes and evaluates an intelligent backoff management scheme, utilizing Adaptive Neuro-Fuzzy Inference System (ANFIS), for the Vehicular Ad-hoc Networks. The proposed scheme is trained by

TensorFlow to adjust the contention window size at the MAC layer of IEEE 802.11p. Taking into account the local density, local spatial distribution, and successful/unsuccessful transmission records, each transmitting node can determine the best contention window value for transmitting packets. This scheme effectively mitigates packet collisions, ensuring a high packet delivery ratio and average throughput, along with a low average end-to-end delay for various network scenarios. Simulation results confirm the efficiency of the proposed scheme and also show that it outperforms the conventional IEEE 802.11p method and other recent protocols.

17:20-17:40 FrB2.5

Conditioning Latent-Space Clusters for Real-World Anomaly Classification , pp. 1620-1625

Bogdoll, Daniel	FZI Forschungszentrum Informatik
Pavlitska, Svetlana	FZI Research Center for Information Technology
Klaus, Simon	KIT Karlsruhe Institute of Technology
Zöllner, Marius	Forschungszentrum Informatik

Anomalies in the domain of autonomous driving are a major hindrance to the large-scale deployment of autonomous vehicles. In this work, we focus on high-resolution camera data from urban scenes that include anomalies of various types and sizes. Based on a Variational Autoencoder, we condition its latent space to classify samples as either normal data or anomalies. In order to emphasize especially small anomalies, we perform experiments where we provide the VAE with a discrepancy map as an additional input, evaluating its impact on the detection performance. Our method separates normal data and anomalies into isolated clusters while still reconstructing high-quality images, leading to meaningful latent representations.

17:40-18:00 FrB2.6

Construction of Domain-Specific Lexicons Based on Term Statistics , pp. 1626-1631

Rojas-Hernández, Rafael	Universidad Autónoma Del Estado De México
López-Chau, Asdrúbal	Universidad Autónoma Del Estado De México
Valle-Cruz, David	Universidad Autónoma Del Estado De México
Trujillo-Mora, Valentín	Universidad Autónoma Del Estado De México
González-Jaimes, Elvira Ivone	Universidad Autónoma Del Estado De México

Lexicons are a fundamental resource for sentiment analysis, offensive language identification, trend detection, and document classification. Lexicons have the advantage of being easy to use, but most of the existing lexicons have been created manually. Recently, researchers have been interested in extending the use of lexicons to different fields. In this paper, an easy-to- compute statistics-based method for extracting lexicons in specific domains or ad-hoc lexicons is shown. The proposed method was evaluated on two datasets and achieved 80% accuracy in document classification. This novel approach is expected to be a valuable tool for researchers and practitioners who need to quickly and efficiently create domain-specific and ad-hoc lexicons

FrB3 Imperio C

CI in Biometrics and Identity Management (CIBIM)

Organizer: Yanushkevich, Svetlana	University of Calgary

16:00-16:20 FrB3.1

A Transfer Learning Approach to Cross-Domain Author Profiling , pp. 1632-1637

Zalzala, Ali	Community Tracks Ltd
Lain, Alexander	UoEO

Author profiling is the process of analysing text to determine one or more identifying characteristics of the author, mostly used to determine key demographic information. This type of classification problem is ideally suited to machine learning approaches. In this study, a new transfer learning approach is introduced using a pre-trained XLNet language model which was then fine-tuned to the specific author profiling task. Informed by previous literature, a Support Vector Machine, Feed-Forward Neural Network, and Convolution Neural Network were also developed for comparison. These algorithms were used to predict gender and age group on a single training and testing domain. As a model that works across multiple domains is desirable, each model was also tested on two domains which were independent of the training domain. The results demonstrated that the transfer learning model is superior to the other methods used for comparison in this study. Although applying the transfer learning model to the cross-domain context decreased its performance, it was still able to achieve a higher degree of accuracy on one testing domain than the Support Vector Machine which was trained and tested on that same domain. In addition, some interesting results emerged regarding the transfer of hyperparameter performance between tasks that share a common factor, be that classification task or training domain.

16:20-16:40 FrB3.2

Intelligent Stress Assessment for E-Coaching , pp. 1638-1643

Lai, Kenneth	University of Calgary
Yanushkevich, Svetlana	University of Calgary
Shmerko, Vlad	University of Calgary

This paper considers the adaptation of the e-coaching concept at times of emergencies and disasters, through aiding the e-coaching with intelligent tools for monitoring humans' affective state. The states such as anxiety, panic, avoidance, and stress, if properly detected, can be mitigated using the e-coaching tactic and strategy. In this work, we focus on a stress monitoring assistant tool developed on machine learning techniques. We provide the results of an experimental study using the proposed method.

16:40-17:00 FrB3.3

Causal Models Applied to the Patterns of Human Migration Due to Climate Change , pp. 1644-1649

Lai, Kenneth	University of Calgary
Yanushkevich, Svetlana	University of Calgary

The impacts of mass migration, such as crises induced by climate change, extend beyond environmental concerns and can greatly affect social infrastructure and public services, such as education, healthcare, and security. These crises exacerbate certain elements like cultural barriers and discrimination by amplifying the challenges faced by these affected communities. This paper proposes an innovative approach to address migration crises in the context of crisis management through a combination of modeling and imbalance assessment tools. By employing deep learning for forecasting and integrating causal reasoning via Bayesian networks, this methodology enables the evaluation of imbalances and risks in the socio-technological landscape, providing crucial insights for informed decision-making. Through this framework, critical systems can be analyzed to understand how fluctuations in migration levels may impact them, facilitating effective crisis governance strategies.

17:00-17:20 FrB3.4

Integration of Structural Equation Models and Bayesian Networks for Cognitive Load Modeling , pp. 1650-1655

Shaposhnyk, Olha	University of Calgary
Yanushkevich, Svetlana	University of Calgary

This study offers a causal probabilistic modeling for inferring the relationship between humans' cognitive load, the physiological signal

predictors of such load, and personality traits. We selected a subset of such signals (heart rate, intervals between successive heartbeats, galvanic skin response, and temperature) from the CogLoad dataset using wearable devices. Structural Equation Modeling techniques were employed to select the predictors to identify the level of cognitive load, for which the ground truth was assessed using subjective tests such as HEXACO that determine the personality traits of the human subjects. Bayesian networks were deployed to investigate the causal relationship and model the inference scenarios. The proposed model is intended to contribute to developing a Computational Intelligence tool for monitoring social health in scenarios of future potential crises such as pandemics and mass migration.

17:20-17:40 FrB3.5

Unraveling Body Vitals As Traumatic Event-Caused Stress Indicators , pp. 1656-1661

Zahorska, Daria	National Technical University of Ukraine
Babenko, Vitalii	Igor Sikorsky Kyiv Polytechnic Institute
Shaposhnyk, Olha	University of Calgary
Chernykh, Maksym	National Technical University of Ukraine “Igor Sikorsky Kyiv Pol
Yanushkevich, Svetlana	University of Calgary
Nastenko, Ievgen	Igor Sikorsky Kyiv Polytechnic Institute

Exploration and analysis of changes in human biometrics, such as heart rate and blood pressure associated with exposure to traumatic events is the primary goal of this article. We aimed at answering the questions on whether there is a significant difference in biometrics observed in the peaceful and disaster times. Overall, we developed and tested a new technique to measure the difference in the indicators of stress during relatively peaceful times, and during natural and human-made disasters and crises. The proposed approach holds significant potential in the context of e-health and mass migration, offering a valuable tool to recognize and address stress in traumatic events resulting from, for example, forced displacement, armed conflicts, and the impacts of climate change.

17:40-18:00 FrB3.6

Computational Intelligence Driven Motor Function Assessment in Post-Stroke Patients , pp. 1662-1667

Yankovyi, Illia	University of Calgary
Shaposhnyk, Olha	University of Calgary
Horn, MacKenzie	University of Calgary
Almekhlafi, Mohammed	University of Calgary
Yanushkevich, Svetlana	University of Calgary

This paper offers an investigation into leveraging computational intelligence (CI) for the assessment of stroke-induced motor weakness in post-stroke survivors, serving as an indicator of neurological function. The proposed methodology deploys deep learning algorithms to analyze video recordings obtained during the post-stroke hospitalization phase. The model effectively categorizes the degree of stroke-induced weakness in the patient's left arm across two and three distinct classes aligned with the National Institutes of Health Stroke Scale. This study was motivated by the limitations of existing monitoring technologies, such as using pressure sensing mattresses (such as low resolution and low accuracy). Our long-term strategy is to deploy several means for monitoring the patients' motor function. This study demonstrated a binary classification model using video data collected from a cohort of 23 post-stroke patients in a clinical setting for 48 hours. Employing a 3-fold cross-validation methodology, the developed model showcases an accuracy rate of 92.10 ± 4.08% for the binary classification, distinguishing between mild and severe stroke-induced weakness in the left arm. In the case of three classes, the model achieves an accuracy of 89 ± 4.95%.

FrB4 Constitución A

Multi-Agent System Coordination and Optimization (MASCO)

Organizer: Cheng, Ran	Southern University of Science and Technology
Organizer: Lozano, Jose A.	University of the Basque Country

16:00-16:20 FrB4.1

Multi-Robot System Architecture Focusing on Plan Recovery for Dynamic Environments , pp. 1668-1673

da Silva, Carlos J. T.	University of Brasilia
Ghedini Ralha, Célia	University of Brasília

The complexity of multi-robot systems (MRS) involves the challenging task of robot coordination to achieve the system's goal. That indicates the necessity to integrate automated planning to mitigate disruptions and continually adjust the behavior of robots in the presence of failures. Adequate architectures to integrate MRS with automated planning present a gap in the literature, indicating the necessity for further research. To address this gap, we present the Multi-Robot System Architecture with Plan (MuRoSA-Plan) for mission coordination of heterogeneous robots illustrated with a healthcare service case. This work contribution is the MuRoSA-Plan architecture to MRS domain applications focusing on plan recovery. The experimental results show that MuRoSA-Plan generates runtime-adapted plans satisfying the goals of the multi-robot coordination case mitigating mission disruptions.

16:20-16:40 FrB4.2

Learning Control Policies for Variable Objectives from Offline Data , pp. 1674-1681

Weber, Marc	Siemens AG
Swazinna, Phillip	Siemens AG
Hein, Daniel	Siemens AG
Udluft, Steffen	Siemens AG
Sterzing, Volkmar	Siemens AG

Offline reinforcement learning provides a viable approach to obtain advanced control strategies for dynamical systems, in particular when direct interaction with the environment is not available. In this paper, we introduce a conceptual extension for model-based policy search methods, called variable objective policy (VOP). With this approach, policies are trained to generalize efficiently over a variety of objectives, which parameterize the reward function. We demonstrate that by altering the objectives passed as input to the policy, users gain the freedom to adjust its behavior or re-balance optimization targets at runtime, without need for collecting additional observation batches or re-training.

16:40-17:00 FrB4.3

Balancing Matching of Two-Sided Agents with Adaptive and Fair Instability , pp. 1682-1689

Saha, Peash Ranjan	Queen's University
Choudhury, Salimur	Queen's University
Salomaa, Kai	Queen's University

The concept of stable matching is substantially used in bipartite graphs with individual preferences of the vertices. The existence of stability restricts the weight and size of the matching to be satisfactory. We study the trade-offs in stability, weight and cardinality in a one-to-many capacitated weighted bipartite matching with an edge-weight-oriented preference setting. We establish a stability relaxation framework which is adaptive to the pairing suitability and capacity of the vertices. The purpose of the relaxation is to update the stable matching towards the balance of stability, weight and cardinality in the result. The relaxation preserves fairness by keeping the satisfaction degradation of the vertices with the potential new partner in a desired range. We propose an algorithm to produce a new matching using the stability relaxation framework. Furthermore,

we define a novel popularity measurement model of matching based on the edge weight with the multi-voting ability of one-sided vertices. We show the resulting matching is also popular as stable matching. The experimentation performed based on the use case of the homeless placement system complements the claim of improving the weight and cardinality in the matching with marginal and fair relaxation of stability.

17:00-17:20 FrB4.4

Using Graph Theory to Produce Emergent Behaviour in Agent-Based Systems , pp. 1690-1695

Gower-Winter, Brandon — University of Cape Town
Nitschke, Geoff — University of Cape Town

Cooperation is a defining trait of Multi-Agent Systems. At the centre of these systems lies a communication network which governs how information flows from one agent to the next. However, the design of these networks is often overlooked despite the profound impact it can have on both the task performance of the agents and the emergent phenomena they produce. In this work we aim to illustrate this by investigating whether network centrality impacts the task performance and emergent inequality (unequal distribution of resources) of resource gathering agents.

We achieve this by constructing several communication networks with increasing centrality and use them with an Agent-Based Model called GATHER. Our results indicate that as the variance of the population's centrality increases, the task performance of an agent population will decrease. Furthermore, we demonstrate that simply changing the centrality of the network can produce distinct results and emergent phenomena (inequality or the lack thereof in our case). We then further support this claim by increasing the reciprocity of one of our communication networks which results in a system with greater task performance and significantly lower inequality, further illustrating the impact communication network topology can have on Multi-Agent Systems.

17:20-17:40 FrB4.5

GLocal: A Hybrid Approach to the Multi-Agent Mission Re-Planning Problem , pp. 1696-1703

Frasheri, Mirgita — Aarhus University
Miloradovic, Branko — Malardalen University
Esterle, Lukas — Aarhus University
Papadopoulos, Alessandro — Malardalen University

Multi-agent systems can be prone to failures during the execution of a mission, depending on different circumstances, such as the harshness of the environment they are deployed in. As a result, initially devised plans for completing a mission may no longer be feasible, and a re-planning process needs to take place to re-allocate any pending tasks. There are two main approaches to solve the re-planning problem global re-planning techniques using a centralized planner that will redo the task allocation with the updated world state and (ii) decentralized approaches that will focus on the local plan reparation, i.e., the re-allocation of those tasks initially assigned to the failed robots, better suited to a dynamic environment and less computationally expensive. In this paper, we propose a hybrid approach, named GLocal, that combines both strategies to exploit the benefits of both, while limiting their respective drawbacks. GLocal was compared to a planner-only, and an agent-only approach, under different conditions. We show that GLocal produces shorter mission make- spans as the number of tasks and failed agents increases, while also balancing the trade-off between the number of messages exchanged and the number of requests to the planner.

17:40-18:00 FrB4.6

Large Language and Text-To-3D Models for Engineering Design Optimization , pp. 1704-1711

Rios, Thiago — Honda Research Institute Europe
Menzel, Stefan — Honda Research Institute Europe
Sendhoff, Bernhard — Honda Research Institute Europe

The current advances in generative artificial intelligence for learning large neural network models with the capability to produce essays, images, music and even 3D assets from text prompts create opportunities for a manifold of disciplines. In the present paper, we study the potential of deep text-to-3D models in the engineering domain and focus on the chances and challenges when integrating and interacting with 3D assets in computational simulation-based design optimization. In contrast to traditional design optimization of 3D geometries that often searches for the optimum designs using numerical representations, e.g. B-Spline surfaces, natural language challenges the optimization framework by requiring a different interpretation of variation operators while at the same time may ease and motivate the human user interaction. Here, we propose and realize a fully automated evolutionary design optimization framework using Shap-E, a recently published text-to-3D asset network by OpenAI, in the context of aerodynamic vehicle optimization. For representing text prompts in the evolutionary optimization, we evaluate (a) a bag-of-words approach based on prompt templates and Wordnet samples, and (b) a tokenisation approach based on prompt templates and the byte pair encoding method from GPT4. In our experiments, we show the text-based representations allow the optimizer to find better performing designs. However, it is important to ensure that the designs generated from prompts are within the object class of application, i.e. diverse and novel designs need to be realistic. Furthermore, more research is required to develop methods where the strength of text prompt variations and the resulting variations of the 3D designs share causal relations to some degree to improve the optimization.

FrB5 Constitución B

Computational Intelligence for Fault Detection and Isolation (CIFDI)

Organizer: Alanis, Alma Y. — Universidad De Guadalajara
Organizer: Anzurez-Marin, Juan — Universidad Michoacana De San Nicolas De Hidalgo

16:00-16:20 FrB5.1

Online Neural-Detection of False Data Injection Attacks on Financial Time Series , pp. 1712-1717

Alanis, Alma Y. — Universidad De Guadalajara
Sanchez, Oscar Didier — Universidad De Guadalajara
Ibarra, Alejandra — University of Guadalajara
Mendez, Eduardo — University of Guadalajara
Sanchez, Jorge D. — University of Guadalajara
Galvez, Jorge — University of Guadalajara

Abstract—False data injection detection is a topic of interest because systems are prone to cyberattacks which can manipulate the state estimation process by injecting malicious data into the measurements, bypassing the detection of the security system. Causing the results of the state estimation to deviate from the safe values. This work proposes a false data injection detection methodology based on deep neural networks using sliding windows to generate online error vectors in order to detect and classify malicious data from measurement data. Two multilayer perceptron deep neural networks and the convolutional neural network were used in this work. In order to verify the feasibility of the proposed methodology, it is tested on data daily closing prices of the S&P 500 Index, pulled from Yahoo Finance for the years 2013–2022 to which false data were injected via software. The results show that the convolutional neural network presents the best results, with an accuracy above 93% and an F1-score of 0.91. It is shown that deep neural networks are a powerful tool in the detection of false data in data obtained through measurements.

16:20-16:40 FrB5.2

Anomaly Behavior Analysis for Sensors Fault Detection , pp.

1718-1723

Perez, Guillermo	Universidad De Sonora
Pérez, Guillermo	Universidad De Sonora
Benitez Baltazar, Victor Hugo	Universidad De Sonora

In today's world, sensors play a crucial role, as they feed information to make accurate decisions and take actions; therefore, making sure that sensors behave correctly is critical. In this work, we focus on inspecting the data provided by sensors, aiming at discovering any issue due to malfunction, misuse, or any other source of error before the issue is propagated through the system. To achieve that, we propose a novel approach based on wavelets embedded in a microcontroller to analyze data from sensors. The objective is to determine whether the sensor is issuing correct data (normal behavior) or not (abnormal behavior), to prevent the error from reaching other parts of the system.

16:40-17:00 FrB5.3

Fault Identification of Discrete-Time Unknown Non-Linear Systems: A Two-Dimensional Convolutional Neural Network Approach , pp. 1724-1729

Rangel-Carrillo, Eduardo	COPSIJAL
Alanis, Alma Y.	Universidad De Guadalajara

A complex system that is governed by several smaller sub-systems whose coordinated functionality allows it to work properly over time can be challenging to analyze for faults on real time by an observer; moreover, if such failing system could work with no obvious signs of fault over time until it becomes catastrophic and clearly identifiable. Because the variables involved in such system's functionality are usually not easily correlated, the different time-series they might generate can be extremely difficult to analyze by conventional means. Lately, 2-dimensional Convoluted Neural Networks (2D-CNN) have been used to introduce artificial intelligence into diagnosis and fault detection with success; however, the systems that so far have benefited from this are mainly those that deal with images, like medical diagnosis using x-ray images, or autonomous driving using real time pictures, although recently, some resent research on robotic sensor fault and signal analysis have been published using 1-dimensional CNN (1D-CNN) for time-domain signals. This paper proposes a novel 2D-CNN approach to fault identification of an unknown, discrete-time, non-linear system; by recognizing features that are consistent with a fault in a signal-image of several layers. With such signal-image being an artificial picture created by combining all the system signals in a single high-layered image format that is recognizable by a conventional 2D-CNN. This paper also includes the results of its applicability in a fault identification of a three-phase induction motor in a simulation environment and with measurements of a real motor with injected faults.

Keywords—deep learning, fault identification, fault prediction, applied artificial intelligence. Convolutional neural networks non-linear systems.

17:00-17:20 FrB5.4

Computational Intelligence-Based Fault Detection in Refrigeration Systems: A Study on Enhancing System Reliability , pp. 1730-1734

Cardoso Fernández, Víctor	Universidad Autónoma De Yucatán
Ricalde, Luis	Universidad Autonoma De Yucatan
Ali, Bassam	University Autonomous of Yucatán

The utilization of computational intelligence, particularly Artificial Neural Networks (ANNs), for fault detection is of paramount importance as it empowers industries to proactively identify anomalies, leading to improved system reliability, reduced downtime, and enhanced safety. By leveraging the pattern recognition capabilities of ANNs, complex data patterns indicative of faults can be accurately identified and analyzed in real-time, enabling early intervention and preventing potential catastrophic failures. Additionally, the importance of fault detection in refrigeration systems lies in its ability to proactively identify and address potential issues, ensuring optimal performance, energy efficiency, and longevity of the system while preventing costly breakdowns and ensuring product safety and quality. The main aim of this study is to create a computational intelligence model that can accurately depict the energy and exergy performance of a GAX hybrid refrigeration system. Moreover, the model aims to identify potential instrument failures occurring at different parts of the system. The primary findings indicate that creating a numerical database using the governing equations of the GAX system enables the identification of anomalies in the instrumental measurements of operating parameters. Subsequent research aims to incorporate experimental data from a broader range of parameters, encompassing additional sections of the GAX system.

17:20-17:40 FrB5.5

Low-Cost Automated Visual Screw Inspection System , pp. 1735-1740

Li, Yiran	University of Nottingham Ningbo China
Li, Jiayi	University of Nottingham, Ningbo China
YANG, Xiaoying	University of Nottingham
LI, Cheng'ao	University of Nottingham Ningbo China
Xiong, Xihan	Imperial College London
Fang, Yutong	Ningbo Open University
Ding, Shusheng	Ningbo University
Cui, Tianxiang	University of Nottingham Ningbo China

Despite the significant achievements in the development of automation technologies, the application of autonomous robots to improve the production efficiency of small-scale industries has been largely ignored. While there has been excellent progress in industrial image processing systems implementation, most of the work has focused on a unique aspect of specific objects rather than introducing a general inspection system. Thus, this paper discusses the critical industrial topic of quality control, which develops rapidly through the use of autonomous systems. Given the high cost of implementing automated systems, this paper presents an affordable low-budget solution for the visual inspection system. This method of inspecting screw dimensions consists of four visual inspection parts and a special mechanical supporting structure. The designed system was able to check the overall screw dimensions, including screw head diameter, screw head driven type, screw length, screw thread length, and screw head thickness. It could also separate the qualified screws from the unqualified ones after the inspection process. The accuracy of most inspection cases is 100%, meaning the error ranges within 0.1mm, which meets all the non-negotiable requirements and most of the target requirements. The visual inspection parts can be further enhanced by building a template matching library that includes different angles of the screw head or by using Hough Transform to identify the defect types of the screw thread.

FrB6 Constitución C

Computing Intelligence in Scheduling and Optimization of Complex Systems (CISO)

Organizer: He, Lijun	Wuhan University of Technology
Organizer: Li, Wenfeng	Wuhan University of Technology

16:00-16:20 FrB6.1

The Integraeted Scheduling for the Multi-Stage Transshipment System Considering AGVs and ETs , pp. 1741-1746

Zhong, Lingchong	Wuhan University of Technology

Wuhan, Hubei 430063, P.R. China
Li, Wenfeng — Wuhan University of Technology Wuhan, Hubei 430063, P.R. China
Zhou, Zecheng — Wuhan University of Technology Wuhan, Hubei 430063, P.R. China
Li, Yongcui — Qingdao New Qianwan Container Terminal Co., Ltd. Qingdao, Shandon
Chen, Qiang — Qingdao New Qianwan Container Terminal Co., Ltd. Qingdao, Shandon
Liu, Yaohui — Qingdao New Qianwan Container Terminal Co., Ltd. Qingdao, Shandon

In sea-road intermodal container terminals, the integrated scheduling problem for the multi-stage transshipment system (ISP_MST_CT) is influenced by factors such as the number of containers, multi-stage interactions, and various types of equipment, making it challenging to construct the model. Additionally, assigning an appropriate number of AGVs to the transshipment tasks can significantly avoid resource waste at the terminals. This paper, for the first time, considers the ISP_MST_CT of quay cranes, AGVs, yard cranes, and external trucks, encompassing four operational stages. A mixed-integer programming model is formulated to simultaneously optimize the maximum completion time, total energy consumption of quay cranes and yard cranes, and total waiting time of AGVs. The nondominated sorting genetic algorithm II (NSGAII) algorithm is employed to solve this problem. The experiment results validate that NSGAII is capable of efficiently solving ISP_MST_CT of different scales and obtaining superior solutions within a short time. Furthermore, a series of experiments with 20 containers demonstrates that 8 AGVs can keep the balance among the three optimization objectives, while reducing the waste of AGVs and providing valuable insights to terminal managers.

16:20-16:40 FrB6.2

A Hybrid Approach Optimizing Both Terminal Resource Configuration and External Truck Waiting Time under Truck Appointment System , pp. 1747-1752

Diao, Cuijie — Dalian Maritime University
Yang, Huiyun — Dalian Maritime University
Wang, Wenmin — Dalian Maritime University
Gan, Yuxin — Dalian Maritime University
JIN, Zhihong — Dalian Maritime University

For the truck appointment system in a container terminal, optimizing the configuration of gate lane and yard crane based on the appointment information is the key to shorten the external truck waiting time and reduce the redundancy of terminal resource. A hybrid approach combining deep neural network and optimization model is proposed. The deep neural network is applied to predict the truck waiting time in the yard based on the yard data. The optimization configuration model for gate lane and yard crane is established by combining the predicted result. The average waiting time of trucks, the configuration of gate lanes and yard cranes before and after optimization are compared. The results show the effectiveness of the proposed approach, which also provides a new road map for optimizing container terminal resource configuration.

16:40-17:00 FrB6.3

A Proactive-Reactive Approach for Dynamic Hybrid Berth Allocation Problem Considering Vessels Arrival Delay , pp. 1753-1758

Yang, Pengfei — Wuhan University of Technology
CAI, LEI — Wuhan University of Technology
Guo, Wenjing — Wuhan University of Technology
Li, Wenfeng — Wuhan University of Technology

Dynamic Berth Allocation Problem (DBAP) is an essential problem in container terminal operations. Most studies focus on discrete or continuous berths in DBAP. However, affected by the geographical conditions, the mixture of discrete and continuous berths which are called hybrid berths often appear in real port container terminals. Moreover, the arrival time of vessels is often fluctuant due to the influence of environmental factors. To solve such a Dynamic Hybrid Berth Allocation Problem (DHBAP) under vessels' arrival delay, this study develops a proactive-reactive approach. Specifically, we establish a mixed-integer programming model with a buffer as the proactive strategy to obtain a baseline schedule. Then, we propose a hybrid berth reactive strategy (HBRS) to adjust the baseline schedule for vessels that are delayed. To get a better solution in a short time, a genetic algorithm is designed. We verify the effectiveness of the proposed HBRS by comparing it with the most commonly used right-shift strategy. Experimental results show that the longer the buffer is, the better the robustness of the model is, but the total time of the vessel in terminals will also increase. Compared with the right-shift strategy, the proposed HBRS can obtain an allocation plan with similar robustness in a shorter total time of the vessel in terminals.

17:00-17:20 FrB6.4

Mixed-Integer Programming with Enterprise Risk Analysis for Vehicle Electrification at Maritime Container Ports , pp. 1759-1766

Baker, Robert — University of Virginia
Marcellin, Megan C. — University of Virginia
Riggs, Robert — University of Virginia
Hendrickson, Daniel C. — University of Virginia
Polmateer, Thomas L. — University of Virginia
Chen, T. Donna — University of Virginia
Iqbal, Tariq — University of Virginia
Slutzky, David L. — University of Virginia and Fermata Energy LLC
Lambert, James H. — University of Virginia

There is urgency for electrifying fleet vehicles as a means to reach net-zero emissions and promote sustainability, including at maritime container ports. Ports are exploring the incorporation of electric terminal tractors and supporting infrastructure in an effort to minimize the environmental effects of their operations while simultaneously improving service performance. The challenges include planning of investments in infrastructure that will meet charging requirements of these terminal tractors while maintaining operational efficiencies. This paper develops an optimization and associated risk register for strategic capacity expansion of electric vehicle fleets at maritime container ports. The approach includes multi-criteria decision analysis (MCDA) and a characterization of enterprise risk as a disruption of system order. A demonstration of schedule optimization uses linear programming models for thirty-two combinations of plug-in, wireless, and wireless dynamic charging infrastructure configurations to determine optimal charger locations. In a robust ensemble model, the optimization accompanies a comprehensive risk analysis that disrupts importance orders across seven scenarios: (1) Environmental Change, (2) Policy Revision, (3) Technology Innovation, (4) Cyber Attack, (5) Market Shift, (6) Electrical Grid Stress, and (7) Workforce Interruption. The results support the decisions and enterprise risk management for a $1.5 billion strategic plan for port infrastructure. The plan involves selecting charging station locations, determining charging schedules, and selecting charger models while considering multiple performance criteria such as safety, operational efficiency, cost-effectiveness, and reliability. The approach is generally applicable for a variety of complex systems to mitigate schedule and cost risks while improving sustainability. The audience of the paper includes owners and operators of transportation and energy infrastructures, asset managers, logistics service providers, and others.

17:20-17:40 FrB6.5

Designing Large-Scale Intelligent Collaborative Platform for Freight Forwarders , pp. 1767-1772

Tan, Pang Jin	Singapore Management University
Cheng, Shih-Fen	Singapore Management University
Chen, Richard	N.A

In this paper, we propose to design a large-scale intelligent collaborative platform for freight forwarders. This platform is based on a mathematical programming formulation and an efficient solution approach. Forwarders are middlemen who procure container capacities from carriers and sell them to shippers to serve their transport requests. However, due to demand uncertainty, they often either over-procure or under-procure capacities. We address this with our proposed platform where forwarders can collaborate and share capacities, allowing one's transport requests to be potentially shipped on another forwarder's container. The result is lower total costs for all participating forwarders. The collaboration can be formulated as an integer linear program we call the Freight Forwarders' Collaboration Problem (FFCP). It is a variant of the bin-packing problem, hence it is NP-Hard. In order to solve large-scale FFCP instances efficiently, we propose a two-step approach involving an initial greedy assignment followed by a fine-tuning step. Computational experiments have shown that our approach can offer a significant reduction of run-time between 77% and 97%, without any loss of solution quality.

17:40-18:00 FrB6.6

An Ensemble Method for Applying Particle Swarm Optimization Algorithms to Systems Engineering Problems, pp. 1773-1774

Hampshire, Ken	George Washington University
Mazzuchi, Thomas	George Washington University
Sarkani, Shahram	George Washington University

As a subset of metaheuristics, nature-inspired optimization algorithms such as particle swarm optimization (PSO) have shown promise both in solving intractable problems, and in their extensibility to novel problem formulations due to their general approach requiring few assumptions. Unfortunately, a given algorithm requires detailed tuning of parameters and cannot be proven to be best suited to a particular problem class on account of the “no free lunch” (NFL) theorems. Using these algorithms in real-world problems requires exquisite knowledge of the many approaches and applying them based upon intuition. This research aims to present a unified view of PSO-based approaches from the perspective of relevant systems engineering problems, with the purpose to then elicit the best solution for any problem formulation in an ensemble learning approach. The central hypothesis of the research is that using the PSO algorithms found in literature to solve real-world optimization problems requires a general ensemble-based method for all problem formulations but a single implementation and solution for any instance. The main results will be a problem-based literature survey and a general method to find more globally optimal solutions for any systems engineering optimization problem.

FrB7 Colonia

Ethical, Social and Legal Implications of Artificial Intelligence (ETHAI)

Organizer: Crocket, Keeley	Manchester Metropolitan University
Organizer: Garratt, Matthew	University of New South Wales

16:00-16:20 FrB7.1

Harmony Unleashed: Exploring the Ethical and Philosophical Aspects of Machine Learning in Human-Robot Collaboration for Industry 5.0 , pp. 1775-1780

Zafar, Muhammad Hamza	University of Agder, Grimstad, Norway
Sanfilippo, Filippo	University of Agder (UiA)
Blazauskas, Tomas	Kaunas University of Technology

As Industry 5.0 emerges by blending advanced technologies with human-centered approaches, the integration of machine learning (ML) in human-robot collaboration (HRC) becomes increasingly prominent. This paper explores the philosophy and ethics underlying the application of machine learning in Industry 5.0, specifically focusing on HRC. It examines the ethical considerations, philosophical implications, and potential challenges that arise in this evolving paradigm. The paper emphasises the need for a thoughtful and ethical approach to ensure the beneficial and responsible use of ML in Industry 5.0.

16:20-16:40 FrB7.2

The GM AI Foundry: A Model for Upskilling SME's in Responsible AI , pp. 1781-1787

Lawton, Roxana	IN4 Group
Boswell, Sara	University of Salford
Crockett, Keeley	Manchester Metropolitan University

Building responsible and trustworthy AI solutions is now the norm, yet the challenge of bridging the ethical AI principles to practice gap especially for small to medium businesses is significant with the forthcoming European Union AI ACT (2023) becoming a major disrupter for global businesses. AI Adoption by SMEs is growing but there are many barriers including limited AI skills, complexity of projects, lack of understanding of what is trustworthy and responsible AI and the tools needed to consequence scan the wider impact on stakeholders of innovative products and services prior to market. This paper presents a case study of the Greater Manchester AI Foundry (GMAIF) - a consortium model for University – SME collaboration designed to foster ethical and responsible AI design and development practices into SMEs and new start-ups. The GMAIF model supports the creation of proof-of-concept demonstrator projects, forming a number of tangible products or eservices, that demonstrate how AI can be used to enhance or provide new products and services. Whilst the model is demonstrated within the UK, its concepts are generalizable and applicable globally. GMAIF has impacted 186 SMEs in the UK, with 67 new AI products being developed by SMEs and an additional 80 innovative products to market.

Keywords—ethics artificial intelligence, toolkits, responsible technology, industry, SME

16:40-17:00 FrB7.3

Harnessing Digital Twins for Human-Robot Teaming in Industry 5.0: Exploring the Ethical and Philosophical Implications , pp. 1788-1793

Langås, Even Falkenberg	University of Agder
Zafar, Muhammad Hamza	University of Agder, Grimstad, Norway
Sanfilippo, Filippo	University of Agder (UiA)

In the era of Industry 5.0, the convergence of humans and robots in collaborative work environments has brought forth the concept of digital twins (DTs) of humans and robots. These virtual replicas, mirroring their physical counterparts, have become integral to the design and operation of complex systems. This paper aims to explore the ethical and philosophical implications associated with the design and use of DTs of humans and robots in human-robot collaboration (HRC), and even further in human-robot teaming (HRT). By examining the potential benefits, challenges, and risks, this research seeks to shed light on the responsible development and application of DTs in the context of Industry 5.0.

17:00-17:20 FrB7.4

From Rigid to Hybrid/Soft Robots: Exploration of Ethical and Philosophical Aspects in Shifting from Caged Robots to Human-Robot Teaming , pp. 1794-1799

Hua, Minh Tuan	University of Agder

Langås, Even Falkenberg — University of Agder
Zafar, Muhammad Hamza — University of Agder, Grimstad, Norway
Sanfilippo, Filippo — University of Agder (UiA)

This paper delves into the ethical, philosophical, and practical dimensions associated with the transition from caged robots to human-robot teaming (HRT). By exploring the evolving dynamics between humans and robots, this paper examines the ethical challenges, philosophical implications, and practical considerations that arise as collaboration and integration between humans and robots deepen. It emphasises the need for responsible design, implementation, and ethical frameworks to guide the development and deployment of human-robot teams. Particular focus is put into the ethical ramifications of choosing between rigid and soft actuators. The study underscores the significance of employing admittance and impedance control techniques to regulate interaction forces and compliance between humans and robots. By analysing the ethical implications of utilising soft actuators, the paper emphasises the potential advantages, such as enhanced safety and reduced risk of harm during close human- robot collaboration.

17:20-17:40 FrB7.5

Systems Analysis of Bias and Risk in AI-Enabled Medical Diagnosis , pp. 1800-1807

Moghadasi, Negin — University of Virginia
Piran, Misagh — HDZ-NRW
Baek, Stephen — University of Virginia
Valdez, Rupa S. — University of Virginia
Porter, Michael D — University of Virginia
Johnson, DeAndre — University of Virginia
Lambert, James H. — University of Virginia

AI technologies have made significant advancements across various sectors, especially healthcare. Although AI algorithms in healthcare showcase remarkable predictive capabilities, apprehensions have emerged owing to errors, biases, and a lack of transparency. These concerns have led to a decline in trust among clinicians and patients, while also posing the risk of further accentuating pre-existing biases against marginalized groups and exacerbating inequities. This paper presents a scenario-based preferences risk register framework for identifying and accounting AI algorithm biases in diagnosing diseases. The framework is demonstrated with a realistic case study on cardiac sarcoidosis. The framework identifies success criteria, initiatives, emergent conditions and the most and least disruptive scenarios. The success criteria align with the National Institute of Standards and Technology AI Risk Management Framework (NIST AI RMF) trustworthy AI characteristics, and the scenarios are based on various statistical/computational bias that causes algorithmic bias. The framework provides valuable guidance for leveraging AI in healthcare, enhancing objective designs, and mitigating risks by adopting a figure of merit to score the initiatives and measuring the disruptive order. By prioritizing transparency, trustworthy AI, and identifying the most and least disruptive scenarios/biases, the framework promotes responsible and effective use of AI technologies in healthcare.

FrB8 Conquista

Evolutionary Neural Architecture Search and Applications (ENASA)

Organizer: Sun, Yanan — Sichuan University

16:00-16:20 FrB8.1

Interpretation of Neural Network Players for a Generalized Divide the Dollar Game Using SHAP Values , pp. 1808-1813

Greenwood, Garrison — Portland State University
Abbass, Hussein — University of New South Wales
Hussein, Aya — University of New South Wales-Canberra

Machine learning models can make accurate predictions but trust in the models depends on being able to understand why those predictions were made. Unfortunately, machine learning models are black boxes making interpretation difficult. Previously we used an evolutionary algorithm to evolve triplets of neural network players for instances of the Generalized Divide-the-Dollar, which is an economic bargaining game. The players produced fair bids with high bid totals, which is a desirable outcome, but no attempt was made to understand why the players performed so well. In this paper, we interpret the behavior of those neural networks using SHapley Additive exPlanations (or SHAP). Surprisingly, the neural network players exhibited both altruistic and exploitative behavior. Both a global and a local interpretation analysis is presented. The experiments conducted in this work demonstrate a simple method for understanding players' strategies in multi-player games.

16:20-16:40 FrB8.2

A Two-Stage Hybrid GA-Cellular Encoding Approach to Neural Architecture Search , pp. 1814-1820

Londt, Trevor — Victoria University of Wellington
Gao, Xiaoying — Victoria University of Wellington
Andreae, Peter — Victoria University of Wellington

Neural Architecture Search (NAS) aims to automate the creation of Artificial Neural Networks, including Convolutional Neural Networks (CNN), lessening the reliance on labour-intensive manual design by human experts. A CNN architecture can be decomposed into a micro- and macro-architecture, each influenced by distinct design and optimisation strategies to contribute to the overall construction and performance of the CNN. Cellular Encoding (CE), an evolutionary computation technique, has been successfully used to represent diverse network topologies of varying complexities. Recently, CE has been applied to evolve CNN architectures, showing promising results. However, current CE-based NAS approaches focus on evolving either the micro- or macro-architectures without considering the evolution of both in the same algorithm. Evolving the micro- and macro-architecture together can increase the performance of evolved CNN architectures. This research introduces a novel two-stage hybrid approach, combining Genetic Algorithms (GA) and CE to evolve both the micro- and macro-architectures to synthesise CNNs for classification tasks. Candidate macro-architectures are evolved using a CE approach, while a GA approach is used to explore the micro-architecture search space. The proposed algorithm is evaluated across four commonly used datasets and compared against six NAS peer competitors and five state-of-the-art manually designed CNN architectures. The results validate the approach's high competitiveness, outperforming several peer competitors on image and text classification tasks.

16:40-17:00 FrB8.3

Examination of the Multimodal Nature of Multi-Objective Neural Architecture Search , pp. 1821-1828

Gong, Cheng — Southern University of Science and Technology
Nan, Yang — Southern University of Science and Technology
Pang, Lie Meng — Southern University of Science and Technology
Ishibuchi, Hisao — Southern University of Science and Technology
Zhang, Qingfu — City University of Hong Kong

Remarkable successes in deep learning have spurred significant growth in the field of neural architecture search (NAS), which is rapidly advancing as a promising technique for automating the design of network architecture. From an optimization standpoint, a NAS task for a given search space can be viewed as a multi-objective optimization problem (MOP) when considering multiple design criteria simultaneously (e.g., prediction accuracy, architecture complexity,

hardware efficiency). However, whether a NAS problem is a multimodal multi-objective optimization problem or not (i.e., whether a single non-dominated solution in the objective space has multiple different neural network architectures or not) has not been examined in the literature. This presents an intriguing research question that merits further investigation. To fill this gap, we examine the multimodal nature of seven multi-objective NAS problems. By doing so, this work aims to help MOP researchers to better understand the characteristics of the multi-objective NAS problems.

17:00-17:20 FrB8.4

Connectivity Schemas in NeuroEvolution: What Neural Architectures Does GEPNN Evolve? , pp. 1829-1836

Mwaura, Jonathan Northeastern University

Heminway, Ryan Northeastern University

In recent years, there has been a rise in popularity of using evolutionary algorithms (EA's) in conjunction with artificial neural networks (ANN's). This approach is commonly known as NeuroEvolution (NE). NeuroEvolutionary approaches typically optimize just the weights of an ANN or optimize the architecture, learning rates, thresholds, and weights together. Algorithms capable of the latter are known as Topological and Weight Evolving ANN (TWEANN). One such TWEANN is Gene Expression Programming for Neural Networks (GEPNN). This paper presents an empirical investigation of the network topologies that arise when GEPNN is used and whether evolved architectures have any relation to state of the art architectures. Results show that GEPNN naturally discovers powerful structural motifs such as shortcut connections and also creates sparse networks. Both these schemas have been shown to be advantageous in deep learning techniques. As an additional contribution from this work, we provide an open source library for developing GEPNN solutions in Python.

17:40-18:00 FrB8.6

Efficient Neuroevolution Using Island Repopulation and Simplex Hyperparameter Optimization , pp. 1837-1842

Thakur, Aditya Shankar Rochester Institute of Technology

Awari, Akshar Bajrang Rochester Institute of Technology

Lyu, Zimeng Rochester Institute of Technology

Desell, Travis Rochester Institute of Technology

Recent studies have shown that the performance of evolutionary neural architecture search (i.e., neuroevolution) algorithms can be significantly improved by the use of island based strategies which periodically experience extinction and repopulation events. Further, it has been shown that the simplex hyperparameter optimization (SHO) method can also improve neuroevolution (NE) performance by optimizing neural network training hyperparameters while the NE algorithm also trains and designs neural networks. This work provides an extensive examination of combining island repopulation events with five different island-based variations of SHO. These methods are evaluated for the evolution of recurrent neural networks for the challenging problem of multivariate time series forecasting on two real world datasets. We show with statistical significance that adding repopulation to the SHO variants in almost every case improves performance, and for those that does there is no statistical difference. In addition, we find that one variant in particular, multi-island, random island best genome (MIRIB) performs the best across all experiment types.