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IEEE WCCI 2024 Welcome Message

Let's celebrate the 30th anniversary of IEEE WCCI!

On behalf of the WCCI 2024 Organizing Committee, we are delighted to invite you to Yokohama, Japan, for the 13th biennial “IEEE World Congress on Computational Intelligence - WCCI 2024” of the Computational Intelligence Society (CIS) of IEEE, the world's largest technical professional organization.

The conference will take place from June 30th to July 5th, 2024, at PACIFICO Yokohama, one of the largest convention centers in Japan.

It is the IEEE CIS flagship conference of more than 2,500 esteemed scientists and professionals in the fields of neural networks, fuzzy systems and evolutionary computation worldwide. It enthusiastically contributes to exchanging views, sharing experiences and mixing young and young-at-heart scientists, by opening new perspectives for research and development in academy and industry.

IEEE WCCI started in 1994 in Orlando, Florida, USA, to enhance the interdisciplinary discussion and cooperation by calling together the people in neural networks, fuzzy systems, evolutionary computation and related computational intelligence areas. At the beginning, it was a quadrennial event, with annually held individual conferences, namely, International Joint Conference on Neural Networks (IJCNN), IEEE International Conference on Fuzzy Systems (FUZZ-IEEE) and IEEE Congress on Evolutionary Computation (IEEE CEC). After 2008, it has been held every two years constantly.

In these years, artificial intelligence (AI) changes the world rapidly and dramatically. This is a great success of our continuous endeavor pioneering the essence, fundamentals, technology and applications in AI as computational intelligence (CI). It is also the consequence of our contributions to strengthen the relationship between engineering and human beings. But, at the same time, AI sometimes gives rise to ethical issues and even conflicts among people. In this sense, human beings are challenged by our own technology.

Now let's sail out to unlimited horizons further, imagine the next 30 years from now, and enjoy our next journey by starting at the WCCI this year!

Yokohama is a port city, known as one of the ports first opened to the world after the closed Edo era in 1859, one of the most exciting melting-pot of eastern and western culture in the world, and for a number of universities, institutes and companies of advanced information technology, electronics, robotics, mobility, medicine and foods. A WCCI held in this area will strongly inspire the attendees to imagine next-generation science and technology.

"Best experience for all the participants" is the motto of the Organizing Committee. We look forward to welcoming you all for a memorable WCCI 2024. Let's put heads and hands together

to explore CI with a long-range scope to develop a society full of comfort, peace and humanity based on our intelligence technology!

Akira Hirose
The University of Tokyo
Japan

Hisao Ishibuchi
Southern University of Science and Technology
China

IJCNN 2024 Welcome Message

On behalf of the IJCNN Organizing Committee, it is my pleasure to extend a warm welcome to all of you attending this year's International Joint Conference on Neural Networks (IJCNN) in Yokohama, Japan. IJCNN 2024 reflects the mission of INNS, a society established in 1987 as the first international, interdisciplinary and inclusive professional organisation focusing on theoretical and computational aspects of brain-inspired learning machines.

This year's IJCNN received over 3272 submissions from 80 countries and regions, out of which 1701 have been accepted. The conference program includes over 40 Special Sessions including Deep Learning for Graphs, Trustworthy and Explainable Federated Learning: Towards Security and Privacy Future, Domain Adaptation for Complex Situations: Theories, Algorithms and Applications, Learning from Small Data: Techniques and Applications, Machine Learning and Signal Processing for Brain or Behavioral Analysis, Neural Network-Based Methods for Human-Centric Perception and Understanding, Neuromorphic/Brainmorphic AI Models, Hardware and Applications and many more sessions on pertinent topics.

I would like to thank everyone who has given their time, energy and ideas to assist in organizing this event, including all the members of the organizing committee, the Technical Chairs (Zeng-Guang Hou, Barbara Hammer, Teresa Ludermir and Seiichi Ozawa, all the reviewers, and our keynote speakers: Johan Suykens, Masashi Sugiyama, Plamen Angelov, Yukie Nagai and Divyashree-Shivakumar Sreepathihalli.

I wish you all a wonderful and memorable experience at the International Joint Conference on Neural Networks in Yokohama, Japan. Your participation here demonstrates the dedication and enthusiasm for neural networks research that will shape and develop the future of this field.

Chrisina Jayne

IJCNN Conference Chair and INNS VP for Conferences

IEEE CEC 2024 Welcome Message

On behalf of the Organizing Committee, it is my greatest pleasure to welcome you to the 2024 IEEE Congress on Evolutionary Computation (IEEE CEC 2024), as part of the 2024 IEEE World Congress on Computational Intelligence (IEEE WCCI 2024), to be held on 30 June to 5 July 2024 at Yokohama, Japan.

IEEE CEC 2024 is a major international conference in the field of evolutionary computation, which covers all topics in evolutionary computation from theory to applications. The aims of this conference are to provide a forum for researchers and practitioners to exchange the latest advances and demonstrate state-of-the-art theory, algorithm design, and real-world applications, and to explore new directions and potentials in the field of evolutionary computation.

This year, CEC highlights 24 tutorials given by experts in the most relevant and emerging topics of evolutionary computation. It also features 49 advanced special sessions organized by domain specialists covering focused topics in evolutionary computation and computational intelligence, 5 workshops in the most exciting and lively research areas and several competitions in the field.

IEEE CEC 2024 received 665 submissions from authors of 64 countries and regions, where the top 10 countries and regions are China, Japan, Mexico, USA, Brazil, United Kingdom, New Zealand, Taiwan, Canada and Australia. Under the guidance of the WCCI 2024 general co-chairs, technical co-chairs of IEEE CEC 2024, and the help of special session organizers, 350 papers (acceptance rate is 52.63%) were accepted for publication in the proceedings after a rigorous review process, where almost all papers have at least three reviews. IEEE CEC 2024 also includes 13 Late breaking papers as well as 16 Journal-to-Conference presentations. The accepted papers cover a heathy mix of research topics ranging from the latest advances in the evolutionary computation area to the next steps in our commitment on mimicking nature to solve real-world problems.

All this would not have been possible without all the people in the organizing committee. I would like to thank the guidance and support of the General Co-Chairs: Akira Hirose and Hisao Ishibuchi. Special thanks also go to the IEEE CEC 2024 Technical Co-Chairs Carlos Coello Coello, Xiaodong Li, Juergen Branke, Nelishia Pillay, and Mengjie Zhang. I am also very grateful to Handing Wang as the Special Session Chair, Chuan-Kang Ting as the Tutorial Chair, Sanaz Mostaghim as the Conflict-of-Interest Chair, Oscar Cordon as the Plenary Session chair, Yaochu Jin as the Panel Session Chair, Jialin Liu as the Competition Chair, Ying Bi as the Workshop Chair, Yi Mei as J2C Papers Chair, Andries Engelbrecht, Kalyanmoy Deb, Pietro Oliveto and Rong Qu as the Best Paper Committee members, as well as other chairs of the WCCI 2024 conference. Last but not least, I would like to thank the plenary/keynote speakers, Akira Oyama, Yew Soon Ong, Handing Wang, Jialin Liu, Mengjie Zhang, and Tobias Rodemann.

Finally, I would like to thank all the authors who submitted their work, to the reviewers, to all the participants of IEEE CEC 2024, and the IEEE WCCI 2024 sponsors for their great support.

Sincerely,

Bing Xue,

IEEE CEC 2024 Conference Chair

FUZZ-IEEE 2024 Welcome Message

On behalf of the Organizing Committee, I would like to welcome all the delegates and their guests to The IEEE International Conference of Fuzzy Systems 2024 (FUZZ-IEEE 2024) as part of the 2024 IEEE World Congress on Computational Intelligence (IEEE WCCI 2024) which is organized from June 30 – July 5, 2024 in Yokohama, Japan. FUZZ-IEEE 2024 is a premier event in the areas of Fuzzy Systems. This conference covers all topics in Fuzzy Systems including Mathematical and theoretical foundations; Fuzzy Set theory, fuzzy measures, fuzzy integrals; Fuzzy control; Robotics and autonomous systems; Fuzzy hardware, software, sensors, actuators, architectures; Fuzzy data analysis; Fuzzy information processing; Type 2 fuzzy sets, computing with words, granular computing, rough set; Computational and artificial intelligence; Optimization and operations research; Decision analysis, multi-criteria decision making, and decision support; Fuzzy modeling, identification, and fault detection; Knowledge discovery; Fuzzy image, speech and signal processing, vision and multimedia data; Linguistic summarization, natural language processing; Fuzzy human interfaces (HCI for and with fuzzy approaches); Deep fuzzy systems; Fuzzy applications; Responsible and trustworthy AI; Role of fuzzy approaches in explainable AI; Multi- and inter-disciplinary advances in, for, or with fuzzy approaches; Fuzzy approaches in the social sciences; and Fuzzy pattern recognition. This year, we also have a session for “Late Breaking” papers to share newly developed ideas with preliminary results and a session called “J2C” for papers that summarize concepts from the authors’ journal publications within 2-year of the conference date. There were 118 accepted regular papers out of 222 submitted papers, while there were 16 accepted late breaking papers out of 32 submitted papers. For the J2C session, the number of accepted papers is 2 out of 13. There were 51 countries and regions of submission authors with the following top-10 countries and regions:- Japan(13.4%), Italy(10.0%), China(8.6%), Spain(8.5%), UK(7%), India(5.4%), USA(5.2%), Taiwan(4.8%), Poland(4.5%), and Canada(3.6%), respectively.

We would like to express our deepest thanks to authors, plenary speakers, and keynote speakers for supporting FUZZ-IEEE by presenting their most recent works and sharing their ideas. We would like to thank reviewers for valuable comments. Finally, we would like to thank our supporting staffs for all helps in making this a great conference.

We wish you a fantastic conference experience and wonderful staying in Yokohama, Japan. **Welcome to Japan.**

Sansanee Auephanwiriyakul, FUZZ-IEEE 2024 Conference Chair

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Linhao Luo
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Pasi Luukka
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Aung Aung Phyo Wai
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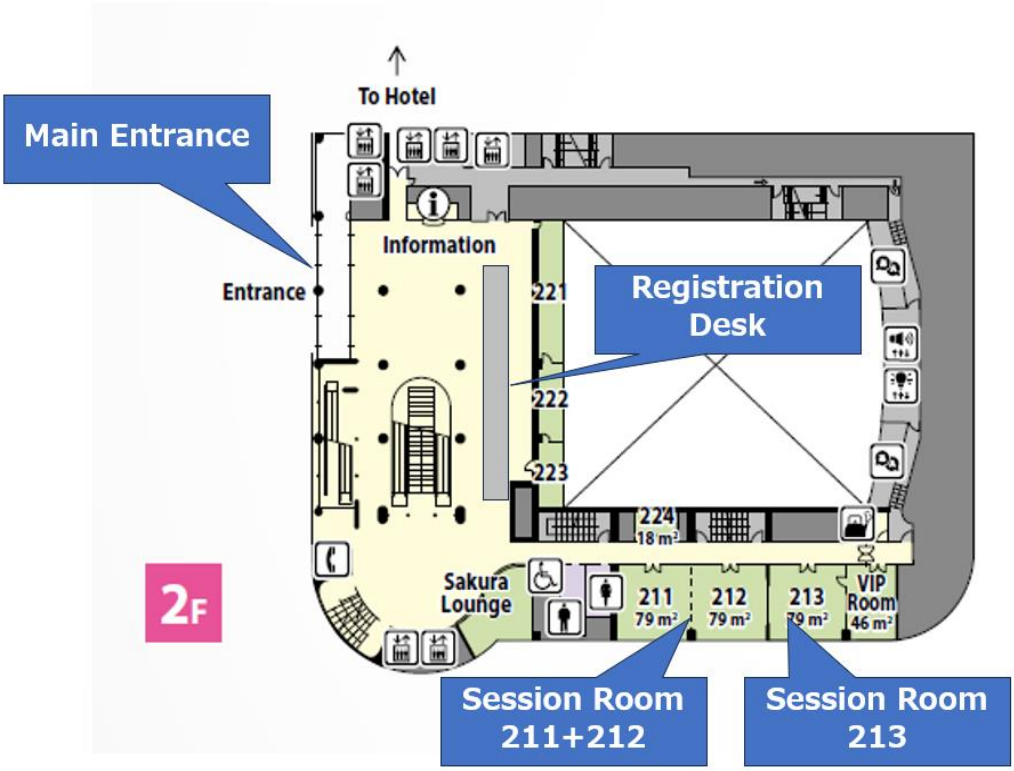
Venue Map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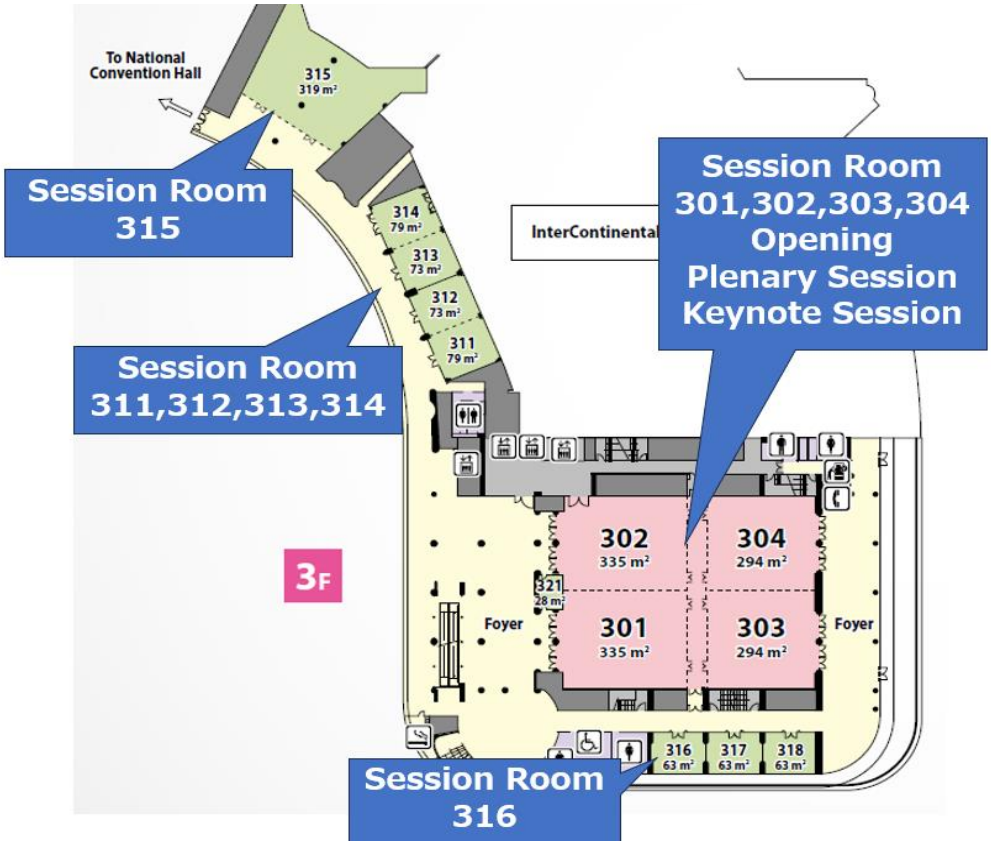
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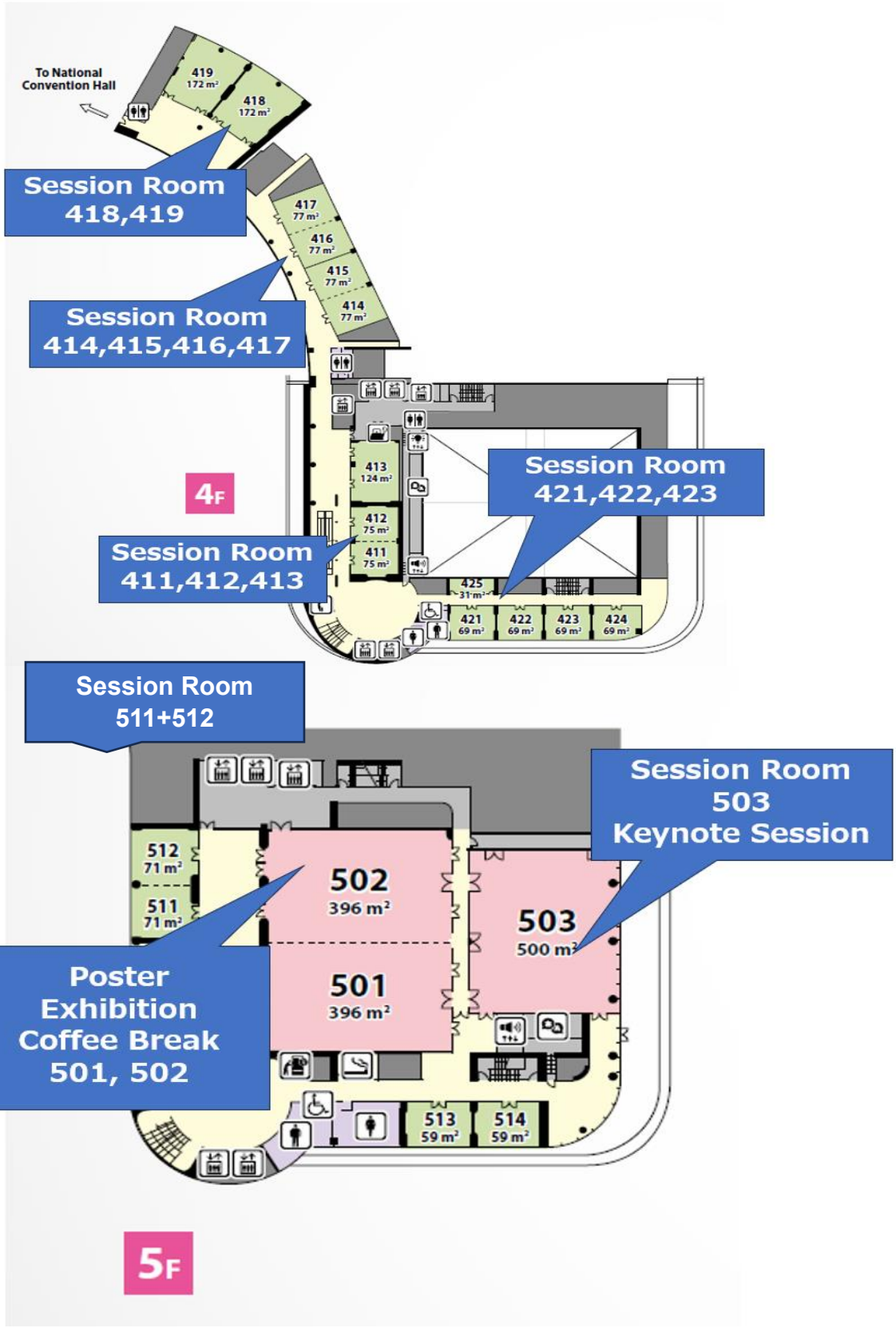
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Poster Floor Map

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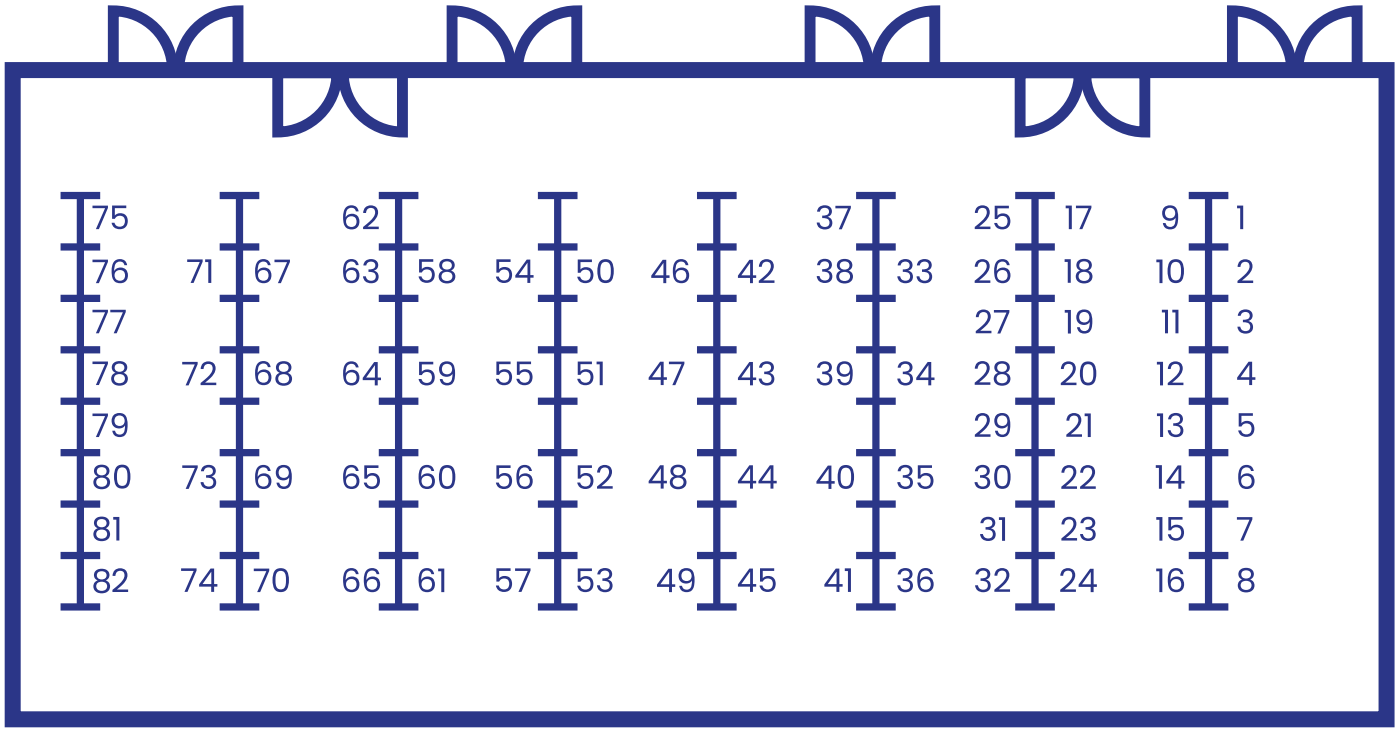

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WCCI Plenary Speakers

Marios M. Polycarpou
"Connecting Computational Intelligence to the Cyber-Physical World"

University of Cyprus

Abstract: The development of cyber-physical systems with multiple sensor/actuator components and feedback loops has given rise to advanced automation applications, including energy and power, intelligent transportation, water systems, manufacturing, etc. Traditionally, feedback control has focused on enhancing the tracking and robustness performance of the closed-loop system; however, as cyber-physical systems become more complex and interconnected and more interdependent, there is a need to refocus our attention not only on performance but also on the resilience of cyber-physical systems. In situations of unexpected events and faults, computational intelligence can play a key role in improving the fault tolerance of cyber-physical systems and preventing serious degradation or a catastrophic system failure. The goal of this presentation is to provide insight into the design and analysis of intelligent monitoring methods for cyber-physical systems, which will ultimately lead to more resilient societies.

Bernadette Bouchon-Meunier
"Can intelligent systems be conscious?"

CNRS-Sorbonne Université

Abstract: The concept of consciousness is complex and takes various forms. The fact that an intelligent system can be conscious has long been discussed and the questions are getting louder as we see systems springing up everywhere that seem capable of dialoguing with humans in a very natural way.
We propose to look at several facets of consciousness, from phenomenological consciousness linked to perceptions to access consciousness, which gives us information about one's actions. In 1982 already, Marvin Minsky 1 was considering that self-conscious systems could be done by providing machines with ways to examine their own mechanisms while they are working. Then Jacques Pitrat 2 in 2009 claimed that, for a conscious artificial being, the possibility of monitoring its own thought enables it to explain its decisions so that they can be accepted by others, which goes in the direction of eXplainable AI. A recent study 3 provides a list of indicator properties derived from scientific theories to assess consciousness for an intelligent system. We offer an overview of some interesting aspects of consciousness from the angle of intelligent systems, which can be different from human consciousness, and we wonder to what extent a present or a future system can have such a form of consciousness and what the advantages and drawbacks are.

Simon See

"Accelerating Science Discovery - High Performance Simulation, Math and AI"

Nvidia

Abstract: Modern scientific discovery relies on advances in data science, mathematics, and artificial intelligence (AI). The combination of these disciplines has led to significant breakthroughs in various fields, including materials science, drug discovery, and chip design. This talk discusses the role of AI-enriched simulation in accelerating science discovery and the use of high-performance computing, math, and AI to drive innovation.

Key aspects of AI-enriched simulation include:

Accelerating the discovery process: AI-enriched simulation uses AI to identify the most promising simulations to run on a massive dataset, reducing the computational expense and saving precious time and resources.

Automating complex simulations: AI-enriched simulation makes complex, predictive simulations automatable and user-friendly for researchers without deep computational expertise, removing a critical research bottleneck

Reducing the number of simulations needed: By using AI to analyze data and determine the most promising simulations, AI-enriched simulation can speed up screening by factors of 10-100 times.

Leveraging AI and machine learning: AI-assisted simulations use neural networks and machine learning algorithms to predict complex properties of materials and other systems, bypassing expensive physics-based routines and accelerating the discovery process.

Collaborative research: AI expertise, such as that found at Berkeley Lab, can be combined with traditional research methods to apply AI to various scientific problems, leading to innovative solutions and new discoveries.

In summary, the future of scientific discovery lies in the integration of high-performance simulation, math, and AI. By harnessing the power of these technologies, researchers can accelerate the discovery process, automate complex simulations, and unlock new possibilities in various fields.

Saori Tanaka

“Utilization of large-scale brain image database for digitalization of psychiatric and neurological disorders”

NAIST, ATR

Abstract: In recent years, neuroimaging databases for psychiatric and neurological disorders have enabled users to find common and disease-specific features and redefine disease spectra using data-driven approaches. In the Brain/MINDs beyond (2018-2023), the neuroimaging database projects have established the multiple sites, multiple disorders MRI database.

A remarkable feature of this database is the traveling-subjects dataset; each participant was scanned at each multisite. This led to the development of a harmonization method to reduce site differences and the development of a generalizable diagnostic marker with brain networks of major depressive disorder (Yamashita, et al., 2020). This database has expanded to 14 disorders and over 16 sites, and over 5,000 MRI data will be collected by the end of the project. This will be the largest MRI database of multiple neurological and psychiatric disorders from multiple sites. In addition, this database includes longitudinal patient data, allowing for the evaluation of treatment effects. This database is expected to lead to the stratification and the development of new treatment methods. Here, as a potential use of the database, I will suggest an integration with approaches based on the computational theory of the brain in addition to data-driven approaches. Computational neuroscience studies understanding the brain mathematically focused on the neural mechanisms of information processing. In recent years, these approaches have been applied to understanding psychiatric disorders. I will show some previous studies using large-scale behavioral data and computational models of psychiatric disorders and demonstrate possibilities of fusion with computational models and neuro-behavioral databases.

Akira Oyama

“Multiobjective evolutionary optimization in space engineering and spin-off to industry”

Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency

Abstract: Multiobjective evolutionary computation (MOEC) is getting popular in Japan because it has various advantages such as capability of finding wide variety of Pareto-optimal designs. In Japan Aerospace Exploration Agency (JAXA), I have been engaged in multiobjective design optimizations in space engineering such as rocket engine turbopump design, spacecraft trajectory design, reusable space transportation system design, spacecraft

landing system design, selection of Moon landing site. In this talk, I will introduce some examples of these applications of MOEC in JAXA.

Then, I will introduce spinoff of the multiobjective design optimization technology to industry. Here, I will present the collaboration work with Mazda, Kobe University, and Hiroshima University for aerodynamic car shape design and the collaboration work with Central Japan Railway Company for aerodynamic and aeroacoustics design of superconducting maglev. Finally, I will discuss current issues in using MOEC for real-world design problems and our recent approaches to overcome these issues.

Keynote Speakers

IJCNN Keynotes Speakers

Johan Suykens
“Least Squares Support Vector Machines and Deep Learning”

Katholieke Universiteit Leuven

Abstract: While powerful architectures have been proposed in deep learning, with support vector machines and kernel-based methods solid foundations have been obtained from the perspective of statistical learning theory and optimization. Simple core models were obtained within the least squares support vector machines framework, related to classification, regression, kernel principal component analysis, kernel canonical correlation analysis, kernel spectral clustering, recurrent models, approximate solutions to partial differential equations and optimal control problems, etc. The representations of the models are understood in terms of primal and dual representations, respectively related to feature maps and kernels. The insights have been exploited for tailoring representations to given data characteristics, both for high dimensional input data and large scale data sets. One can either work with explicit feature maps (such as e.g. convolutional feature maps) or implicit feature maps through the kernel functions.

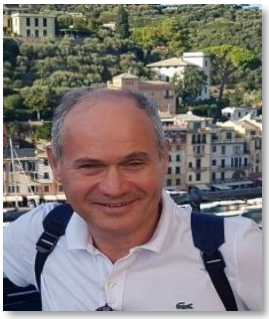
Within this talk we will mainly focus on new insights connecting deep learning and least squares support vector machines. Related to Restricted Boltzmann machines and Deep Boltzmann machines we show how least squares support vector machine models can be transformed into so-called Restricted Kernel Machine representations. It enables to conceive new deep kernel machines, generative models, multi-view and tensor based models with latent space exploration, and obtain improved robustness and explainability. On most recent work, we will explain how the attention mechanism in transformers can be seen within the least squares support vector machine framework. More precisely it can be represented as an extension to asymmetric kernel singular value decomposition with primal and dual model representations, related to two feature maps (queries and keys) and an asymmetric kernel. In the resulting method of "Primal-Attention" a regularized loss is employed to achieve low-rank representations for efficient training in the primal.
Finally, these newly obtained synergies are very promising in order to obtain the bigger and unifying picture. Several future challenges will be outlined from this perspective.

Masashi Sugiyama

"Towards More Robust and Reliable Machine Learning"

Riken, The University of Tokyo

Abstract: In statistical machine learning, training data is often full of uncertainties due to insufficient information, label noise, and bias. In this talk, I will give an overview of our research on reliable machine learning, including weakly supervised learning, noise-robust learning, and transfer learning. Then, I will discuss our recent challenges to integrate these approaches and develop a generic machine learning methodology with fewer modeling assumptions.



Plamen Angelov

"Learning from Data in post-Foundation Models Era: bringing learning and reasoning together"

Lancaster University

Abstract: Deep Learning continues to attract the attention and interest not only of the wider scientific community and industry, but also society and policy makers. Fuelled by the remarkable generalisation and separability capabilities offered by the transformers (e.g. ViT), Foundation Models (FM) offer unparalleled feature extraction opportunities. However, the mainstream approach of end-to-end iterative training of a hyper-parametric, cumbersome, and opaque model architecture led some authors to brand them "black box". This degrades their generalisation, requires many labelled data, compute power and related energy, etc. costs. Cases were reported when such models can give wrong predictions with high confidence - something that jeopardises the safety and trust. Deep Learning is focused on accuracy and overlooks explainability and the semantic meaning of the internal model representations, reasoning and its link with the problem domain. In fact, it shortcuts from the large amount of (labelled) data to the predictions bypassing and substituting the causality with correlation and error minimisation. It relies on assumptions about the data distributions that are often not satisfied and suffers from catastrophic forgetting when faced with continual and open set learning. Once trained, such models are inflexible to new knowledge. They are good only for what they were originally trained for. Indeed, the ability to detect unseen and unexpected and start learning this new class/es in real time with no or very little supervision (zero- or few- shot learning) is critically important but is still an open problem. The challenge is to fill the gap between the high levels of accuracy and the semantically meaningful solutions. This talk will focus on "getting the best from both worlds": the powerful latent feature spaces formed by pre-trained deep architectures such as transformers combined with the interpretable-by-design (in linguistic, visual, semantic, and similarity-based form) models. One can see this as a

fully interpretable frontend and a powerful backend working in harmony. Examples will be demonstrated from the latest projects from the area of autonomous driving, Earth Observation, health and a set of well-known benchmarks.

Yukie Nagai

“Predictive Processing: Illuminating and Modeling Cognitive Development”

The University of Tokyo

Abstract: Cognitive development is an intricate and multifaceted process that has captivated researchers for decades. Human abilities related to perception and action continually evolve during development, exhibiting remarkable diversity among individuals.

This presentation explores the concept of predictive processing as a promising unified theory for illuminating and modeling cognitive development. Rooted in neuroscience, predictive processing offers a unique perspective for understanding how the brain constructs its perception of the world. The core idea posits that the brain continually generates internal models to predict the world and refines them in response to sensory input to minimize prediction errors. This dynamic process underlies the acquisition of cognitive abilities, from self-recognition to goal-directed actions, and even fosters the emergence of social behaviors like imitation and altruism, facilitated through multimodal predictions.

Moreover, this presentation sheds light on how disruptions in predictive processing lead to individual diversities, including developmental disorders. By emphasizing the concept of predictive processing and showcasing its practical application in robotic experiments, we aim to demonstrate its potential as a unifying framework for cognitive development. This presentation opens doors to exciting opportunities for creating more adaptive and intelligent systems.

Divyashree-Shivakumar Sreepathihalli
“Keras, A shortcut to master AI”

Google

Abstract: Discover the transformative capabilities of the Keras 3 API. Delve into deep learning best practices, where you'll gain insights into crafting uncomplicated models and executing them with your preferred backend—be it PyTorch, TensorFlow, or JAX. Explore the dynamic potentials of KerasNLP and KerasCV modules, unveiling the art of constructing powerful AI applications. Witness the seamless creation of generative image and language models, empowering you to achieve remarkable feats with just a few lines of code.

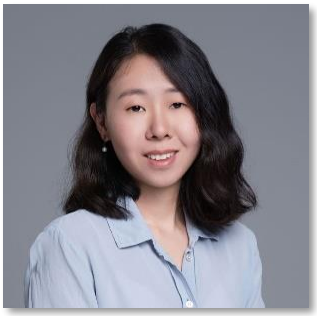
CEC Keynotes Speakers

Yew Soon Ong

"Multifactorial Evolutionary Computation with Applications in Machine Learning and Scientific Discovery"

Nanyang Technological University

Abstract: The human mind demonstrates an exceptional capacity to manage multiple tasks seemingly simultaneously while also exhibiting the ability to leverage knowledge acquired from solving one task and apply it to different yet related challenges. Given the exploding volume and variety of information streams, the opportunity, tendency, and (even) the need to address different tasks in quick succession is unprecedented. Yet, the design of population-based algorithms of evolutionary computation (EC) has traditionally focused on addressing a singular task (or problem) at a time. It is only recently that the idea of multifactorial evolution has come to the fore, leading to the growing popularity of transfer and multitask EC. The nomenclature signifies a search involving multiple optimization tasks, with each task contributing a unique factor influencing the evolution of a population of candidate solutions. The multifactorial evolutionary algorithm (MFEA) is distinguished by implicit genetic transfers between tasks, promising free lunches in optimization by reusing knowledge from related problems. The method makes possible the rapid discovery of diverse, high quality outcomes, and potentially out-of-the-box solutions through inter-task genetic crossovers. In this talk, some of the latest algorithmic advances of MFEAs shall be presented, encompassing both single-objective and multiobjective variants. The impact potential of algorithms designed to leverage multiple related tasks shall be showcased in the field of machine learning (through the creation of diverse sets of small but specialized models extracted from large pre-trained architectures) and in AI for scientific discovery (by facilitating fast simulations of multiple instantiations of the fundamental laws of nature). Multiobjective multitasking as a means to arrive at sets of Pareto optimal solution sets in other application domains shall also be highlighted.



Handing Wang
"Challenges in Data-Driven Evolutionary Optimization"

Xidian University

Abstract: Many real-world problems that are optimized based on data collected from historical records, numerical simulations, or physical experiments are called data-driven optimization problems. The interdisciplinary research area of data-driven evolutionary optimization involves techniques in data science, machine learning, and evolutionary algorithms. In an evolutionary data-driven optimization framework, data will be collected at first. Then, surrogate models, which are machine learning models, are built from the data to approximate the real objective functions and / or constraint functions. Given the approximated objective or constraint functions, evolutionary algorithms can then be applied to perform optimization. This talk will highlight the current challenges of data-driven evolutionary optimization based on the view of real-world applications. Also, the techniques to address those challenges will be introduced.

Jialin Liu
"Designing and playing games with computational intelligence"

Southern University of Science and Technology (SUSTech)

Abstract: Games provide an ideal playground for AI researchers to study, explore, evaluate, and experiment with different ideas in a controllable and safe environment. As an important application and product, games also involve complex decision-making and creative design tasks. Games have played important roles in the development of computational intelligence, while different computational intelligence methods have been widely applied to playing and designing games. In this talk, I will show how different computational intelligence methods (e.g., generative models, reinforcement learning and evolutionary computation) could be harnessed to procedurally generate new game contents, from game levels to accompanying music that correlates with game difficulties. In addition, I will also show how novel computational intelligence techniques, especially evolutionary reinforcement learning, could be used to play a range of different games. I will conclude the talk by discussing current challenges and potential research directions.

Mengjie Zhang
"Evolutionary Machine Learning: 50 Years of Progress"

Victoria University of Wellington

Abstract: Evolutionary machine learning have been very popular over the recent years. In this talk, I will firstly provide a brief overview of the history of evolutionary machine learning with the major developments over the past 50 years, then focus on the main paradigms of evolutionary machine learning and their successes in classification, feature selection, regression, clustering, computer vision and image analysis, scheduling and combinatorial optimisation, deep learning, transfer learning and explainable/interpretable machine learning. The main applications, challenges and lessons as well as potential opportunities will be also discussed.

Tobias Rodemann
"Trust in Optimization Algorithms – The End User Perspective"

Honda Research Institute Europe

Abstract: Evolutionary Algorithms have a potentially wide-spread usage. They can deal with various types of design parameters, constraints and objectives; non-linear, discontinuous, noisy fitness landscapes and many, even conflicting objectives can be handled. There are numerous open-source software packages for quickly applying EA methods on various problems. In practice, however, EAs are not used as frequently as we would hope. In this talk I would like to provide some insights from industrial projects and focus especially on the perspective of the end user. I will argue that hot topics in ML like trust, transparency and explainability, also need to be considered in Computational Intelligence.

FUZZ-IEEE Keynotes Speakers

Qiang Shen

"When There Is Little Data Can AI Still Work? – Approximate Reasoning with Knowledge Interpolation and its Applications"

Aberystwyth University

Abstract: AI is on the brink of revolutionising industries globally, having made significant advancements in recent years. These achievements are primarily attributed to the use of deep learning techniques that process vast amounts of data. Yet, a pivotal question emerges when faced with limited data for a new problem, especially if this data is ambiguously characterised. Can AI maintain its efficacy under these constraints? This presentation delves into contributions addressing this query, highlighting how fuzzy rule interpolation (FRI) enables approximate reasoning in situations marked by sparse or incomplete knowledge.

This is particularly relevant when traditional rule-based inference mechanisms falter because observations do not align with existing rules. Research into FRI techniques has been extensive within the realm of computational intelligence, yielding multiple methodologies. This presentation will centre on a prominent subset, Transformation-based FRI (T-FRI), which operates by mathematically modifying rules that bear resemblance to unmatched observations. Every technique within this category applies linear transformations of the nearest rules, automatically chosen relative to an unmatched observation. The talk will kick off with an exploration of the foundational T-FRI approach and segue into a concise overview of its expanded repertoire: adaptive T-FRI, backward T-FRI, higher-order T-FRI, dynamic T-FRI, and weighted T-FRI. Each addresses certain shortcomings inherent to the original method. Subsequently, real-world applications of these methodologies will be showcased, exemplifying their potency in tackling formidable challenges in domains like network security and medical diagnosis. These cases will underscore AI's capability to function effectively even with incomplete knowledge and ambiguous data. The presentation will wrap up with a glimpse into prospective advancements in this crucial research domain.

Francisco Herrera

"Fuzzy Systems to Support Safe and Trustworthy Artificial Intelligence"

University of Granada

Abstract: Artificial Intelligence (AI) has matured as a technology, AI has quietly entered our lives, and it has taken a giant leap in the last year. Image generative AI models or the latest evolutions of large language models have meant that AI has gone, in just a few months, practically from science fiction to being an essential part of the daily lives of hundreds of millions of people around the world.

This emergence goes hand in hand with a growing global debate on the ethical dimension of AI which raises the need for responsible, fair, inclusive, trustworthy, safe, transparent and accountable frameworks. Two essential concepts emerge in this scenario. 1) Trustworthy AI, supported on the legal, ethical, and technical robustness pillars, including seven technical requirements. 2) AI safety, which encompass machine ethics and AI alignment, aiming to make AI systems moral and beneficial, and robustness technical problems (including monitoring systems for risks, robustness against adversaries, detecting malicious use, attacks and backdoors, …) Safe and trustworthy AI is a critical area to meet upcoming regulations, the necessary auditability metrics for their analysis and compliance, address ethical issues, manage risk analysis in human-AI system interaction, and ensure the technical soundness of responsible AI systems (auditability and accountability during its design, development and use). This talk addresses the role that fuzzy systems can play in supporting the technical requirements of safe and trustworthy AI. The use of fuzzy sets and systems can support auditability and accountability metrics, to address different technical requirements for trustworthy (explainability, privacy and federated learning, fairness, ...), and to design fuzzy monitoring systems for robustness, ... Finally, we should delve into another essential aspect, discuss and think about the development of fuzzy technologies that fit into the design requirements for auditability and design frameworks for accountable AI systems. This is a great opportunity to explore in today's emerging safe and trustworthy AI scenario.

Jim Tørresen
"AI Ethics – Challenges and Opportunities"

University of Oslo

Abstract: Artificial intelligence (AI) has entered an increasing number of different domains. A growing number of people – in the general public as well as in research – have started to consider a number of potential ethical challenges and legal issues related to the development and use of AI technologies. This keynote will give an overview of the most commonly expressed ethical challenges and ways being undertaken to reduce their negative impact.

Among the most important challenges are those related to privacy, fairness, transparency, safety and security. Countermeasures can be taken first at design time, second, when a user should decide where and when to apply a system and third, when a system is in use in its environment. In the latter case, there will be a need for the system by itself to perform some ethical reasoning if operating in an autonomous mode. This keynote will introduce some examples from our own and others´ work and how the challenges can be addressed both from a technical and human side with special attention to problems relevant when working with AI research and development. AI ethical issues should not be seen only as challenges but also as new research opportunities contributing to more sustainable, socially beneficial services and systems.

Gabriella Pasi
"Large Language models: contextual knowledge matters."

University of Milano Bicocca

Abstract: The last few years have witnessed an increasing development of generative AI and its applications, which culminated in the large-scale sharing of ChatGPT on the Web, with its related potentials, risks and limitations. Large Language Models are one of the possible technologies at the basis of generative AI; they are nowadays successfully applied to a variety of NLP tasks, among which are machine translation, conversational agents, and several others. Despite this, LLMs are affected by some limitations, among which a lack in accounting for contextual knowledge related to the task at hand. A research trend is to inject such knowledge (in-context) into LLMs via prompting techniques. A more recent and promising research direction is to make use of neuro-symbolic approaches, to better model and control the process. In this talk, after a short introduction to LLMs, I will present some possible approaches finalized to this latter aim. I will also present the research issue of defining personal language models, i.e. LLMs tailored on the language of specific users or groups of users.

Jie Lu

“Fuzzy Machine learning”

University of Technology Sydney

Abstract: The talk will present the concepts, methodologies, and algorithms of fuzzy machine learning, including fuzzy transfer learning, fuzzy concept drift detection and adaptation, and fuzzy recommender systems. It will also present how the fuzzy machine learning techniques can effectively support data-driven prediction and decision-making in uncertain, complex, and dynamic situations.

Online Invited Speakers

Hussein Abbass
"Explaining Explainable Artificial Intelligence"

School of Systems and Computing, University of New South Wales

Abstract: Explainable Artificial Intelligence (XAI) is one of the hottest topics in AI today. Ironically, one would think that a motivation for the importance of XAI is for people to better understand AI and the AI models in use. However, diversity of opinions and perspectives on XAI has created more ambiguities and confusions than helping in any meaningful way. To even explain what an explanation is, some papers in the literature have confused the term, making it close to impossible to newcomers to the field to find coherence or aspire for consistency. The diversity is reaching unhealthy state with orthogonal definitions and taking antonyms and incommensurable concepts making them synonyms. The aim of this presentation is to disambiguate XAI, taking the audience into a trip that will start from the basics, travel through contemporary literature, land on current challenges of XAI and providing food for thoughts along the way. My aim is not to unify XAI or create a universal agreement. My aim is to maximise people understanding of XAI and to have the basis for those who disagree with me to communicate their disagreement in concise statements.

Erik Cambria
"Seven Pillars for the Future of AI"

NTU Singapore

Abstract: In recent years, AI research has showcased tremendous potential to impact positively humanity and society. Although AI frequently outperforms humans in tasks related to classification and pattern recognition, it continues to face challenges when dealing with complex tasks such as intuitive decision-making, sense disambiguation, sarcasm detection, and narrative understanding, as these require advanced kinds of reasoning, e.g., commonsense reasoning and causal reasoning, which have not been emulated satisfactorily yet. To address these shortcomings, we propose seven pillars (https://sentic.net/seven-pillars-for-the-future-of-artificial-intelligence.pdf) that we believe represent the key hallmark features for the future of AI, namely: Multidisciplinarity, Task Decomposition, Parallel Analogy, Symbol Grounding, Similarity Measure, Intention Awareness, and Trustworthiness .

Workshops

IJCNN Workshops

Workshop: Towards Realizing Whole-Brain Computational Models Guided by Cognitive Models
Organizer(s): Akira Taniguchi, Yoshimasa Tawatsuji, Junya Morita
Date: June 30, 2024
Time: 8:30 – 16:10
Room: 314
Abstract: In recent years, there has been a focused effort to develop Whole Brain Computational Models (WBCMs), aiming to represent the entire brain's functions and contribute to creating artificial intelligence with human-level capabilities. WBCMs involve not only neuroscientific but also cognitive models, especially in constructing a cognitive architecture for consistency. Cognitive models enhance interpretability in implementing WBCMs into AI agents, providing insight into thought processes. This approach, resembling human cognition, offers potential psychological reassurance to users. The discussion about the relationship between cognitive models and WBCMs is linked to AI alignment debates, crucial as powerful AI systems develop. The workshop aims to discuss methodologies to realize WBCMs, emphasizing the role of cognitive models.

Workshop: IEEE Humanitarian Activities Workshop with AI Technologies
Organizer(s): Kojiro Nishimiya; Kohei Ohno; Mayumi Suzuki; Toshihiko Sugie; Yasuhiro Takishima
Date: June 30, 2024
Time: 8:30 – 12:40
Room: 418
Abstract: A workshop to discuss Humanitarian Activity from a broad perspective, including global warming, renewable energy, and the SDGs, with participants. The workshop is divided into two sessions. In the first half, each participant will give a presentation on an issue broadly related to Humanitarian Activity, using his or her own technology to find a solution. In the second half, participants will be divided into small groups for discussion, which may include in-depth discussions of the presentations by the presenters in the first half, or discussions of solutions to the other Humanitarian Activity issues using the participants' own technologies. This workshop is intended for those who are interested in Humanitarian Activity but have not yet started full-scale research, and for those who are motivated by the opinions of others and wish to apply them to their future research. Therefore, student presentations are also welcome. We also welcome those who are already conducting full-scale research on Humanitarian Activity. As for technology, the workshop is open to all those who are broadly involved in computing technology, such as neural networks, fuzzy and Evolutional computing, etc. This workshop is organized by the IEEE Tokyo Section SIGHT (Special Interest Group on Humanitarian Technology).

Workshop: International Workshop on Forging Trust in Artificial Intelligence
Organizer(s): Nistor Grozavu; Nicoleta Rogovschi; Corina Besliu; Seiichi Ozawa; Aikaterini Tzompanaki; Dimitris Kotzinos
Date: July 2, 2024
Time: 8:20-18:40
Room: 211+212
Abstract: Establishing and upholding trust in AI systems is an imperative pursuit as Machine Learning becomes intricately interwoven into our daily lives. The workshop, "Forging Trust in Artificial Intelligence" brings together a group of experts and researchers from diverse subfields, converging on the exploration of how transparency, fairness, privacy, and security collectively contribute to making machine learning trustworthy. By uniting experts across these pivotal disciplines, this workshop illuminates the best practices that not only enhance the trustworthiness of AI but also reinforce its ethical foundations.

Ensuring trust in machine learning is necessary for unlocking its potential while minimizing risks. This is especially true in the current environment, where the constant expansion of data sources aligns with a growing interest in using them to develop comprehensive and universally applicable AI systems. This interest highlights the need to address issues related to transparency, fairness, privacy and security, particularly in the area of multimodal learning, where various data types and learners are combined to create sophisticated, but often opaque AI systems.

Within this context, establishing best practices for data integration is essential to ensure transparency and interpretability of AI systems based on diverse learners. Fairness considerations, on the other hand, may involve identifying and addressing potential biases from different modalities. This includes exploring approaches to mitigate their impact and leveraging fair representation learning when integrating information from sources with varying bias levels. By addressing such issues alongside data privacy and security concerns, this workshop aims to contribute to the development of ethical, transparent, and secure AI that has a positive impact on our global society's well-being.

Workshop: Advances in Optimizing and Transfer Learning Models
Organizer(s): Issam Falih; Chafik Samir
Date: June 30, 2024
Time: 16:20 –18:20
Room: 213
Abstract: Proposal This workshop will cover original and pioneering contributions, theory as well as applications on optimizing, combining, and transferring learning models, and aim at an inspiring discussion on the recent progress and the future developments. Learning models, especially those based on different paradigms, can be combined and optimized for improving their accuracy. Thus, each learning method imposes specific modeling from observations which translates to a set of constrains. However, such assumptions may lead to weak and non adapted learners if they are not satisfied. In many cases, the ill-posed of the learning process and the data partiality of observations make the optimization methods converge to different solutions and subsequently fail under various circumstances. The workshop will be a good opportunity, to discuss recent advances in optimizing and learning models. Furthermore, the effectiveness of these methods will be discussed considering the concepts of diversity and selection of these approaches. The workshop will strive to bring together the practitioners of these approaches in an attempt to study a unified framework under which these interactions can be studied, understood, and formalized. Authors of the most insightful papers already accepted for publication, will be invited to submit an extended version of their work to a Special Issue of the Computational Intelligence journal (IF: 2.8). The following is a partial list of relevant topics (not limited to) for the workshop: Transfer learning and domain adaptation Optimization of cost functions for learning Bagging and boosting techniques Collaborative clustering and learning Hybrid systems Mixtures of distributions or experts Modular approaches Multi-task learning Multi-view learning Task decomposition … Format and activities We propose a Workshop composed of one or two invited speakers, a set of contributed papers and presentations, and a panel discussion around the presented works. Depending on the number of contributions, the workshop's duration would be from half a day to one day. Program Committee members Shantanu Joshi, University of California Los Angeles, USA Razvan Andonie, Central Washington University, USA Rosanna Verde, Università della Campania "Luigi Vanvitelli", Italy Rushed Kanawati, Sorbonne Paris Nord University Seichi Ozawa, Kobe University Engelbert Mephu Nguifo, Clermont Auvergne University Mourad El Hamri, Université Paris cité Nistor Grozavu, CY Cergy Paris University Nicoleta Rogovschi, Paris Descartes University Preliminary list of invited speakers: Shantanu Joshi, University of California Los Angeles, USA Stephane Chretien, University of Lyon, France Razvan Andonie, Central Washington University, USA

Workshop: IEEE Brain Workshop on AI for Neurotechnology
Organizer(s): Damien Coyle, Cuntai Guan, Nik Kasabov
Date: June 30, 2024
Time: 8:30 – 16:10
Room: 301
Abstract: Neural Networks and Computational Intelligence researchers have a lot to offer in terms of dealing with the challenges to create robust and trustworthy AI for Neurotechnology. The IEEE Brain AI for Neurotechnology workshop aims to bring together researchers specifically focused on neurotechnology with experts in AI to present and learn about the most recent advances in AI for neurotechnology data gathering and data sharing initiatives federated learning for privacy preserving model training building towards foundational models approaches

The workshop, associated with the Institute for the Augmented Human at the University of Bath will provide opportunities for AI and neural networks researchers to contribute to and benefit from improving neurotechnology with the latest advances in AI.

The workshop will include a keynote talk, invited speakers, a panel session and a poster session for papers submitted by delegates. Invited speakers will include this working at the cutting edge of applying Deep Neural Network Technologies to process brain data for neurotechnology applications.

There are prizes for best papers/poster.

According to IEEE Brain from whom we have sought sponsorship for this workshop (http://www.ieeebrain.org/), neurotechnologies represent the next technology frontier – the workshop is supported by the IEEE Brain Technical Community and IEEE CIS.

Workshop: AI Innovations for Education: Transforming Teaching and Learning through Cutting-Edge Technologies
Organizer(s): Irwin King, Danilo Mandic, Eyad Elyan and Zenglin Xu
Date: June 30, 2024
Time: 8:30 – 12:40
Room: 423
Abstract: In this workshop, we will explore the latest advancements in AI technology, with a particular focus on its applications in education. Our aim is to provide an in-depth understanding of how these innovations can revolutionize content creation, teaching methods, and assessments. Topics may include Augmented Reality (AR), Virtual Reality (VR), Gamification, Generative AI for content creation, language learning, administrative task automation, accessibility, automated grading and assessment systems, and Intelligent Tutoring Systems.

We will also discuss the practical challenges and ethical considerations related to integrating AI in education. This includes the potential impact of AI on job roles within the education sector, how AI can complement rather than replace teachers, and the importance of developing AI literacy among educators. The need for ongoing research and development in this field will also be emphasized.

The workshop will feature a keynote, a panel discussion, and invited talks. The keynote will underscore the workshop's theme, while the panel will probe into the future of AI in education, exploring potential advancements and their advantages for both educators and students. Invited talks will envision a future where AI holds a substantial role in education and discuss how we can prepare for this change.

Remember, the future of education lies at the crossroads of pedagogy and technology. Join us as we venture into this exciting future.

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FUZZ-IEEE Workshops

Workshop: Computational Intelligence in Human Informatics

Organizer(s): Javier Andreu-Perez; Satoru Hiwa; Tomoyuki Hiroyasu

Date: June 30, 2024 / July 3, 2024

Time: 8:30-12:40 / 14:20 – 18:00

Room: 316 / 213

Abstract: This workshop is a multi-conference event focused on Human Informatics. It is designed for researchers engaged in exploring and modelling human data through computational intelligence. This includes data gathered from real-world observations or experimental situations, with the aim of enhancing human-machine interfaces and deepening our understanding of human behaviours or biological processes. It further included computational theories aimed at improving the harmonious integration of AI and intelligent machines with humans. The goal is to enable these technologies to be effectively utilized by humans, to work collaboratively and in tandem with them, and to promote a deeper comprehension and collaboration between artificial intelligence and their human operators. The event will feature presentations by global experts and panel discussions. These sessions will delve into the newest advancements in computational intelligence within this research area. Additionally, there will be a focus on discussing the current challenges and trends in the field. Existing research can also be brought in for discussion with the community. This platform aims to foster a comprehensive exchange of ideas and insights among senior and early-career scientists in this intense field of research.

CEC Workshops

Workshop: Workshop on Computational Intelligence Applications
Organizer(s): Hiroyuki Sato, Akira Oyama, Ohta Yoshihiro, Takehisa Kohira, Takakuni Minewaki, and Masaya Nakata.
Date: July 2, 2024
Time: 8:20 - 18:40
Room: 213
Abstract: In this workshop, we discuss research related to computational intelligence, mainly evolutionary computation. Computational intelligence is attracting attention as a way to tackle complex and large-scale real-world problems and reduce human intervention. The objectives of this workshop are to share real-world applications using computational intelligence and their methodologies and intensively discuss things that can be, cannot be, and should be done by computational intelligence. Although the main topic is evolutionary computation, other computational intelligence methodologies can be discussed in this workshop to advance the research in this domain further. Each speaker in this workshop can make a presentation with/without paper submission. Organizers will make a proceeding including the submitted papers and share only among the participants of this workshop.

Workshop: Workshop on Search and Selection in Continuous Domains
Organizer(s): Stephen Chen and Marjan Mernik
Date: June 30, 2024
Time: 14:10 – 18:20
Room: 423
Abstract: A recurring theme in metaheuristics research is to consider the balance between Exploration and Exploitation. An often forgotten area of research is the effect of Selection on Search/Exploration. It is noted that Selection has the ability to turn any search process into a hill climber by rejecting all exploratory search solutions (and keeping only exploitative solutions). The first goal of this workshop will be to reanalyze current metaheuristics from the perspective of selection (as opposed to exploration and/or an underlying metaphor). Subsequent results/goals include a selection-based taxonomy for the explosion of metaphor-based metaheuristics, tools to accurately measure exploration and the effects of selection on exploratory search solutions, the identification and categorization of selection errors, and suggestions for future methods of selection and metaheuristic design.

Workshop: Workshop on Multimodal Optimization for Machine Learning
Organizer(s): Jing Liang, Caitong Yue, Kunjie Yu, Ying Bi
Date: July 4, 2024
Time: 14:20-18:40
Room: 211+212
Abstract: The theme of this workshop is the use of multimodal optimization for machine learning, covering ALL different evolutionary computation-based techniques paradigms for machine learning. The aim of this workshop is to investigate both the new theories and applications in different multimodal optimization paradigms for machine learning. This workshop will bring together researchers and practitioners from around the world to discuss the latest advances in the field and will act as a major forum for the presentation of recent research.

Workshop: Privacy-Preserving and Fairness-Aware Optimization
Organizer(s): Xilu Wang, Shiqing Liu, Xiangyu Wang, Yaochu Jin, Ulrich Rückert
Date: July 4, 2024
Time: 8:30 – 16:40
Room: 213
Abstract: Optimization problems widely exist in many economic, scientific and engineering applications. Evolutionary optimization algorithms have been extensively studied and achieved remarkable results in the fields of mathematics, operations research and computer science. A common implicit assumption in most existing optimization methods is that all resources for an optimization task are available and stored on a single device. Unfortunately, the assumption is violated in many applications with the growing storage of personal data and computational power of edge devices. Furthermore, jointly addressing optimization tasks among multiple edge devices with distributed data raises concerns about data security, privacy protection and fairness. As a result, it is crucial to develop new optimization paradigms to leverage the power of distributed computing and storage.

Over the past years, federated learning has become a popular machine learning paradigm that can leverage distributed data without leaking sensitive information. This is achieved by constructing a global model by aggregating local models separately trained on different devices/clients using local data. In contrast to federated learning, privacy preserving optimization has received much less attention. For data-driven optimization, it could be affected by data or algorithmic bias and thus generate unfair results: when the objective function values are correlated with real-world rewards (e.g., money), parties may be hesitant to collaborate if they risk incurring smaller real-world rewards than others. Hence, addressing the potential unfairness problems in optimization is also vital for building a positive and sustainable ecosystem, highlighting the need for new optimization techniques.

Workshop: The Evolutionary Computation in Health (TECH)
Organizer(s): Neil Vaughan
Date: July 1, 2024
Time: 14:20 – 16:20
Room: 213
Abstract: This Evolutionary Computation for Healthcare workshop (TECH-2024) is multidisciplinary, bringing together AI and Healthcare researchers working in the fields of personalised medicine, medical devices; clinical diagnostics, and patient monitoring by applying advanced genetic and evolutionary computation techniques to address critical problems in digital healthcare and medical applications.

The Evolutionary computation for health (TECH) and novel AI solutions, offer the next generation of healthcare solutions, when the demand on health systems and hospitals worldwide is increasingly becoming unsustainable. As the mode of treatment turns from the hospital to the home, there has been a particular focus on AI and EC for personalized medicine in the hope of improving patient care and reducing costs.

Topics of interest include (not exhaustive):

• Medical imaging

• Medical signal processing

• Medical text analysis

• Clinical diagnosis and therapy

• Data mining medical data records

• Clinical expert systems

• Modelling and simulation of medical processes

• Drug description analysis

• Genomic-based clinical studies

• Patient-centric care

• Patient/hospital management optimization

Competitions

CEC Competition Session 1

Date: July 1, 2024
Time: 8:20 – 9:40
Room: 213

Competition: Competition on Multiobjective Neural Architecture Search Challenge for Real-Time Semantic Segmentation
Website: https://www.emigroup.tech/index.php/news/ieee-cec-2024-competition-on-multiobjective-neural-architecture-search/

Competition: Competition on Super Large-scale Multiobjective Optimization for Status Assessment of Measuring Equipment
Website: https://github.com/ChengHust/IEEE-CEC-2024-Competition

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CEC Competition Session 2

Date: July 3, 2024
Time: 16:40 – 18:00
Room: 419

Competition: Competition on Constrained Multiobjective Optimization
Website: http://www5.zzu.edu.cn/ecilab/info/1036/1354.htm

Competition: Competition on Numerical Optimization (Single/Multi-Objectives, with and without constraints)
Website: https://github.com/P-N-Suganthan/2024-CEC

Competition: Competition on Fuzzy AI agent for Python game Kessler
Date: June 30, 2024
Time: 14:10 – 16:10
Room: 213
Website: https://xfuzzycomp.github.io/XFC/

Competition: 2024 IEEE CIS Student Grand Competition on Computational Intelligence in Biomedicine and Healthcare
Date: June 30, 2024
Time: 13:00 – 17:00
Room: 418

Competition: A Sandbox for Teaching and Learning in QCI for Pre-University and Undergraduate Students
Date: June 30, 2024
Time: 8:30 – 18:20
Room: 419
Website: https://sites.google.com/asap.nutn.edu.tw/ieee-wcci-2024/

Competition: Competition on Multi-Objective Black-Box Optimization Benchmarks in Human-Powered Aircraft Design
Date: July 1, 2024
Time: 16:40 – 18:40
Room: 213
Website: https://ec-comp.jpnsec.org/competitions/wcci2024

Panels

Panel: Explainable Artificial Intelligence - Recent Developments and Future Aspirations
Chair(s): Jonathan Garibaldi
Panelist(s): Keeley Crockett, Hussein Abbass, Alexander Gegov, Uzay Kaymak, Joao Sousa
Date: July 3, 2024
Time: 14:20 – 16:20
Room: 503
Explanation: The purpose of this panel session is to provide an open forum for discussing a wide range of important aspects of Explainable Artificial Intelligence (XAI) such as informativeness, trustworthiness, fairness, transparency, causality, transferability, reliability, accessibility, privacy, safety, verifiability and accountability.

Building citizen trust in Artificial Intelligence (AI) products and services requires clear responsibility and accountability pipelines. Human centred explainability is a key aspect of accountability and clear communication of how and why automated decisions are made requires user facing approaches. The panel will discuss explanations from a user perspective and why a mutual language of understanding about AI is important.

The topics discussed at the panel will cover technical aspects of XAI that may include local and global scope, specific and agnostic models, as well as aspects of constructive, what-if, counterfactual and example-based explanations.

Potential topics within the scope of the panel will include aspects related to real world bias of AI, how this bias is reflected in data bias, the encoding of data bias in algorithmic bias, its uncovering by XAI, and how the latter can then be used for closing the loop by mitigating real world bias.

The panel will also explore current challenges and future perspectives in XAI that may include formalisation and evaluation of explanations, their adoption in industry, their potential for improving human machine collaboration as well as their ability to facilitate collective intelligence, responsibility, security and causality in AI.

The actual selection of topics covered will be guided by the questions from the audience.

Panel: IEEE Standards Developments: Recent Advancements and Hot Topics
Chair(s): Bruno DiStefano and Robert Kozma
Panelist(s): Edward Au, Plamen Angelov, Autilia Vitiello
Date: July 1, 2024
Time: 16:20 – 18:40
Room: 301+302
Explanation: The Panel addresses the importance of standards in modern technologies overall, and describes the goals of IEEE Standards Association (SA), in particular. Target audience goes beyond volunteers who are actively involved in standards development at present. We reach out to a wide range of researchers and scientists, academic and industry experts, and describe that involvement in standards can be very beneficial for their professional development, their IEEE membership grades, including Fellows. We also involve young researchers, who are interested in learning about this important technical activity and potentially would get involved in it in the future.

The covered topics include: (i) Main features and advantages of standards development by IEEE SA, considering today's diverse field of Standards Development Organizations (SDOs). (ii) The key role of standards in Strategic Planning of IEEE and other organizations aiming at maintaining cutting edge expertise in technologies. (iii) Common threads and specifics in various industrial segments and geographic regions. (iv) Successful Standards Working Groups (SWGs) in CIS SC, such as Fuzzy Markup Language (FML) SWG, eXtensible Event Streams (XES) SWG, Explainable AI (XAI) SWG, and Video Games Vocabulary (VGV) SWG. (v) Present challenges in standards developments and hot topics, including public perception and ethical issues surrounding AGI, ChatGPT, and computational intelligence, in general.

Panel: Inside the Editorial Room: Conversations with CIS Editors-in-Chief
Chair(s): Kay Chen Tan
Panelist(s): Hussein Abbass, Yiu-ming Cheung, Carlos A. Coello Coello, Jonathan Garibaldi, Yongduan Song, Huajin Tang, Chuan-Kang Ting, Dongrui Wu, Georgios N. Yannakakis
Date: July 2, 2024
Time: 8:20 – 10:00
Room: 301+302+303+304
Explanation: The purpose of the Editors-in-Chief Panel Session is to create a forum where Editors-in-Chief from CIS Transactions/Magazine can share their insights, experiences, and best practices in academic publishing with the conference attendees. As the academic publishing landscape evolves rapidly, this panel discussion will shed light on the latest trends, challenges, and opportunities in the field.

During this panel session, attendees can engage with the Editors-in-Chief as they delve into a range of pertinent topics. The discussion will cover evolving trends in academic publishing and their implications for research dissemination, ethical considerations and best practices for authors, reviewers, and editors; strategies for successful manuscript submission, review, and publication; addressing issues related to peer review, plagiarism, and scientific misconduct, and the importance of collaboration between researchers and journals.

Panel: Can AI Craft AI Inspired by the Brain?: Insights from the Fathers
Chair(s): Hiroshi Yamakawa
Panelist(s): Kunihiko Fukushima, Shunichi Amari, Shiro Takagi
Date: July 3, 2024
Time: 14:20 – 16:20
Room: 301+302
Explanation: In recent years, neural network research has seen remarkable development of Transformer-based models, including large-scale language models, basic models, and generative AI. However, current technological advances may be approaching their limits, and it remains to be seen whether the realization of advanced AI, such as Artificial General Intelligence (AGI), is possible using only existing methods. This may be partly due to the inability to rapidly expand the readily available data.

This panel invites two pioneers in neural network-based AI to explore whether insights from neuroscience can be incorporated into future AI research. The session will begin with a talk by Kunihiko Fukushima. He will discuss lessons learned from AI and its contributions to the technology behind deep learning. Shiro Takagi will then talk about the current state of the art in this field and present the current state and potential of AI research conducted by AI itself. In addition, Shunichi Amari, author of "The New Era of AI," will address a wide range of topics related to evolving AI research in light of the rapid progress of AI.

The panel discussion will delve into AI's impact on AI researchers' work and the evolution of AI research methods. Through this discussion, we aim to explore AI's future of AI research and humans' evolving role in this research domain. Ultimately, this panel discussion will provide valuable insights to the participants and catalyze specific action plans and new research directions for the future of AI research.

Panel: How to Improve and Promote EC Research and EC Conferences
Chair(s): Yaochu Jin and Mengjie Zhang
Panelist(s): Carlos Coello Coello, Kalyanmoy Deb, Hisao Ishibuchi, Yew Soon Ong, Kay Chen Tan, Bing Xue
Date: July 2, 2024
Time: 14:20 – 16:20
Room: 418
Explanation: In recent years, neural network research has seen remarkable development of Transformer-based models, including large-scale language models, basic models, and generative AI. However, current technological advances may be approaching their limits, and it remains to be seen whether the realization of advanced AI, such as Artificial General Intelligence (AGI), is possible using only existing methods. This may be partly due to the inability to rapidly expand the readily available data.

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Panel: What will bring AI towards AGI?
Chair(s): Hava Siegelmann and Robert Kozma
Panelist(s): Hiroshi Yamakawa, Jose Principe, Roy Siegelmann, Alvaro Velasquez, Don Wunch
Date: July 1, 2024
Time: 14:20 – 16:20
Room: 301+302
Explanation: Artificial General Intelligence (AGI) is the not-yet-achieved goal of highly capable systems which can do far more than static classification, playing computer games or operating robot in sterile environments. The strong definition of AGI is a system that is more intelligent than all humanity together, since it will learn all expertise that any person can have, and as such will be able to solve all problems of the world. The weak definition of AGI includes systems capable of performing a wide array of human-like abilities – such as perhaps walking, speaking, and

creating new ideas, rendering them practical to safely perform a variety of tasks including in complex, real-world environments. We will boldly consider the feasibility of both AGI definitions and what steps the community can take to advancing AI to be more general that it is now. Among questions we will ask:

- Is the strong AGI possible, or is it a religious fantasy for people who push the belief in God and want to find a substitute through technology?
- Does the development of Large Language Models change our way in believing or accepting the future of AGI?
- Is the Turing computing enables the existence of AGI? Or does it necessitate the Super-Turing computation?
- What inherent changes do we need to do in our research directions within AI to enable it to develop into AGI? What are the serious hurdles?
- If AI is that strong, how will our world change? Are these changes desirable? What developments are required to improve the chance of good-to-humanity usage?

Panel: Envisioning the Future: Continuing the Legacy of Professor Michio Sugeno
Chair(s): Isao Hayashi
Panelist(s): Kaoru Hirota, Katsushige Fujimoto, Kazuo Tanaka, Ichiro Kobayashi, Hiroshi Nakajima
Date: June 30, 2024
Time: 16:20 – 18:20
Room: 211+212
Explanation: Professor Michio Sugeno (Emeritus, Tokyo Institute of Technology), 83, passed away on August 9th, 2023. He has long been a world authority in the field of fuzzy theory and applications, with countless outstanding achievements ranging from fuzzy measure/Sugeno integral to fuzzy control and everyday language computing. For his achievements, he received the IEEE CIS Fuzzy Systems Pioneer Award in 2000, the IEEE Frank Rosenblatt Award in 2010, and the IEEE Systems, Man, and Cybernetics (SMC) Society's Lotfi A. Zadeh Pioneer Award in 2017 to name a few. His legacy is not only his research achievements but also his attitude and philosophy toward research. This panel welcomes professors closely related to Prof. Sugeno as panelists to discuss the future of the three significant achievements in fuzzy theory that he had developed. Furthermore, this panel also shares his memories and the future that he would have envisioned with the audience.

IEEE CIS Student and Early Career Mentoring Program

Event: Paper Development Workshop (PDW)
Date: July 1, 2024
Time: 14:20 – 16:20
Room: 211+212
Abstract: The purpose of the PDW is to provide the mentoring program's participants the opportunity to hear from and engage with the editorial team(s) from the IEEE CIS flagship journals. The focus of the PDW is for potential authors to learn about paper development for publication in top journals and get hands-on feedback on their own papers. At WCCI 2024, the PDW will be run by members (Editors-in-Chief and Associate Editors) of the IEEE Transactions on Evolutionary Computation (TEC) and IEEE Transactions on Fuzzy Systems (TFS), editorial teams, offering both an overview of the journal and its priorities, as well as small-group, hands-on sessions for participants.

IEEE CIS Young Professionals

Event: Young Professionals Session
Date: July 4, 2024
Time: 8:30 – 10:10
Room: 211+212
Website: https://aingames.cn/wcci2024-yp/

Tutorials

IJCNN Tutorials

Tutorial: Dynamic Programming (DP) for AI with DP Perceptions of Back-Propagation
Organizer(s): Eiji Mizutani
Date: June 30, 2024
Time: 10:40 – 12:40
Room: 311+312
Abstract: In this tutorial, we begin with a quick review of various DP principles for AI including A* search (using cost-so-far and cost-to-go values), dynamic time warping (DTW) for pattern recognition, and temporal-difference reinforcement learning (TDRL) including Q-learning. Then, for neural-network learning, we show an efficient derivation of standard back-propagation (BP) using a nominal state-action Q-value-to-go function in the spirit of DP. We also show how BPTT (back-propagation through time) for recurrent networks will be derived in the same manner as well as for fully-connected cascaded networks.

As an application, we describe a constrained Markov decision process (MDP) problem, in which we first show a standard state-augmenting DP approach and then highlight how a recurrent network function approximation can be employed for model-free TDRL with no state augmentation.

Tutorial: Methods for Learning with Few Data
Organizer(s): Marcus Liwicki; Prakash Chandra Chhipa; Richa Upadhyay
Date: June 30, 2024
Time: 14:10 – 16:10
Room: 302
Abstract: Deep Neural Networks are data hungry, they require millions of labelled data in order to work! — Really? — The last decade has shown useful approaches to work with less labelled data, either by having a lot of data from a similar domain or by letting the network learn meaningful representations without explicit supervision. This tutorial first brings self-supervised learning to a general perspective of learning with few data, covering typical transfer learning and auto-encoder approaches or perceptual loss. Furthermore, the tutorial will investigate some typical (mis-) conceptions of these methods and suggest some practical tips on how to learn with few data. By participating in this tutorial, you will get deep insights in representation learning and learning with few data, as well as practical tools to start working on data in your own domain.

Tutorial: Efficient and Secure Foundation Models
Organizer(s): Minjing Dong; Daochang Liu; Chang Xu
Date: June 30, 2024
Time: 14:10-16:10
Room: 303
Abstract: With the development of machine learning algorithms, more and more challenging tasks can be well-addressed by foundation models, such as Vision Transformers in computer vision tasks, BERT in natural language processing tasks, diffusion models in generative tasks, etc. These models, while achieving remarkable performance, face challenges related to efficiency and security. This tutorial aims to provide a comprehensive exploration of these foundation models, emphasizing their role in addressing real-world applications, and discussing their potential issues as well as current solutions regarding efficiency and security.

Tutorial: From Natural Language Processing to Technical Language Processing
Organizer(s): Marcus Liwicki; Karl Löwenmark; Fredrik Sandin
Date: June 30, 2024
Time: 10:40 – 12:40
Room: 303
Abstract: Narrow AI systems have achieved super-human performance in Natural Language Processing (NLP) - this is at least, what some big companies state and publish. But in most applications, specifically in industrial context, we cannot observe a major adoption of NLP methods. Domain-specific data, technical terms, and expectations for perfect performance are hindering the wide-spread use of NLP.

This tutorial will give a short overview of the recent developments in NLP and introduces into the area of technical language processing. Methods for dealing with technical terms, adapting to specific domains, and integrating log data and sensor values will be presented. Furthermore, this tutorial presents langchain and it's usage in practice to create context-aware, reasoning large language model applications in industrial contexts and beyond.

Tutorial: Instance Space Analysis for Rigorous and Insightful Algorithm Testing
Organizer(s): Kate Smith-Miles; Mario Andrés Muñoz
Date: June 30, 2024
Time: 14:10 – 16:10
Room: 316
Abstract: This hands-on tutorial introduces Instance Space Analysis (ISA), a methodology for experimental evaluation of algorithms, by making use of the on-line tools available at the Melbourne Algorithm Test Instance Library with Data Analytics (MATILDA - https://matilda.unimelb.edu.au). ISA offers a more nuanced opportunity to gain insights into algorithm strengths and weaknesses for various types of test instances, and to objectively assess the relative power of algorithms, free from any bias introduced by the choice of test instances. An instance space is constructed whereby test instances can be visualised as points in a 2d plane, with algorithm footprints identified as the regions of predicted good performance of an algorithm, based on statistical evidence from empirical testing. From this view of a broad instance space, including the theoretical boundary where additional test instances could exist, we can assess the diversity of a chosen test set, and gain much needed insights into how structural properties of various instances influence the strengths and weaknesses of algorithms. Moreover, through ISA we can identify where additional test instances would be valuable to support greater insights. By setting target points in the instance space, new test instances with controllable properties can be generated to fill the instance space, enabling algorithms to be comprehensively "stress-tested" under all possible conditions.

Tutorial: Learning from Imbalanced Data Streams
Organizer(s): Alberto Cano
Date: June 30, 2024
Time: 10:40 – 12:40
Room: 302
Abstract: This tutorial covers the many challenges in learning from data streams with imbalance, including data-level difficulties, concept drift, and the data and algorithm level approaches to address these issues. The tutorial will provide an overview of the state of the art, discuss benchmarks and performance metrics, and will give the participants the code of a framework for evaluating and comparing algorithms for imbalanced data streams. The tutorial can have a duration between 2 and 4 hours.

Tutorial: A Comprehensive Tutorial on Active Learning: Strategies and Applications
Organizer(s): Alaa Othman
Date: June 30, 2024
Time: 8:30 – 10:30
Room: 303
Abstract: This tutorial provides a comprehensive exploration of active learning strategies in machine learning and covers key aspects such as active labeling, active class selection, active feature detection and their integration with deep learning. Participants will gain practical insights into optimizing model performance through strategic data annotation, dealing with uncertainty, and effective use of active learning techniques. The tutorial aims to demystify the basics of active learning and make it accessible to both beginners and practitioners. Join us as we dive into the basics and advanced applications of active learning to unlock its potential for improving machine learning models.

Tutorial: TinyML: An Introduction to Machine Learning on Tiny Devices
Organizer(s): Massimo Pavan; Manuel Roveri
Date: June 30, 2024
Time: 10:40 – 12:40
Room: 304
Abstract: Long considered an impossible task, the execution of Machine and Deep Learning algorithms on tiny devices is becoming more and more feasible every day. Following the computing-everywhere paradigm, the pervasive diffusion of smart, tiny devices (such as Internet-of-things or edge computing devices), is expected to become pervasive in the next few years. Achieving this goal requires a complete redesign of the standard machine and deep learning solutions that until now have been primarily targeting high level hardware.

The tutorial will introduce TinyML models and algorithms, deepening their architectures and the optimizations that enable their execution on tiny devices. A specific focus will be given to the execution of neural networks and deep learning algorithms on tiny devices and approximate computing solutions, such as quantization, pruning and knowledge distillation, will be introduced. This algorithmic deepening will be complemented by a hands-on session, in which the attendees will be introduced to the implementation and porting of TinyML models on tiny devices with a specific focus on the wake-word detection application scenario, a widely used solution in TinyML applications.

Tutorial: Hypercomplex Neural Networks for Multidimensional Data
Organizer(s): Danilo Comminiello; Clive Cheong Took; Danilo Mandic
Date: June 30, 2024
Time: 14:10 – 16:10
Room: 313
Abstract: Hypercomplex algebras have recently become popular in the field of deep neural networks due to their properties that lead to superior results when dealing with multidimensional data in real-world 3D and 4D paradigms.

This tutorial provides a foundational framework that serves as a roadmap for understanding why hypercomplex neural networks are so successful and how their potential can be exploited. Such a theoretical framework is described in terms of inductive bias, i.e., a collection of assumptions, properties, and constraints that are built into training algorithms to guide their learning process toward more efficient and accurate solutions. In the hypercomplex domains, which deal with numbers and data structures beyond the complex numbers, specific inductive biases can be derived to handle the unique properties of such domains as well as the structures of multidimensional data. This novel perspective for hypercomplex deep networks promises to both demystify this class of methods and clarify their powerfulness, under a unifying framework. We show how to develop neural networks in the hypercomplex domain to deal with a wide variety of classic and emerging applications. This may boost the prominence of hypercomplex models as viable alternatives to classical neural networks for multidimensional data.

The tutorial is divided in 5 main parts involving both theoretical and practical aspects of hypercomplex deep learning. Danilo P. Mandic will introduce the topic, problems and motivation, and will explain why hypercomplex models are so advantageous for complex problems. Clive Cheong Took will then talk about the fundamental tools required for the hypercomplex domain in terms of calculus, functions, and statistics, and their exploitation in neural networks. The most popular and important models in the hypercomplex domain will be introduced. Danilo Comminiello will provide an in-depth explanation of inductive biases and why hypercomplex neural networks can provide outstanding results for multidimensional data. Then, an extension of these models is presented to generalize the hypercomplex properties regardless of the dimensionality of the signals. All the speakers will then cover some of the possible applications on which we can successfully apply hypercomplex neural networks. Danilo Mandic will close the tutorial providing a view on future possibilities in this field.

Tutorial: Causal Reinforcement Learning: Empowering Agents with Causality
Organizer(s): Zhihong Deng; Jing Jiang; Chengqi Zhang
Date: June 30, 2024
Time: 14:10 – 16:10
Room: 311+312
Abstract: Reinforcement learning has made significant progress in solving sequential decision problems under uncertainty. However, reinforcement learning agents generally lack a fundamental understanding of the world and must therefore learn from scratch through numerous trial-and-error interactions. They may also face challenges in providing explanations for their decisions and generalizing the acquired knowledge. Causality presents a promising approach to address these issues by formalizing knowledge in a systematic manner and leveraging invariance for effective knowledge transfer. This tutorial aims to comprehensively review the emerging field of causal reinforcement learning. We will introduce the basic concepts of causality and reinforcement learning and demonstrate how causality can enhance traditional reinforcement learning algorithms. The tutorial will categorize and systematically review existing causal reinforcement learning approaches based on their target problems and methodologies. We will also outline open issues and future research directions to foster the continuous development and application of causal reinforcement learning in real-world scenarios. We believe that this tutorial will contribute significantly to the machine learning community, offering a unique perspective on integrating causality into reinforcement learning and providing participants with valuable knowledge to explore this emerging field.

Tutorial: Explainable AI (XAI) for Computer Vision – A Review of Existing Methods and a New Method to Extract a Symbolic Model from a CNN Model
Organizer(s): Asim Roy
Date: June 30, 2024
Time: 14:10 – 16:10
Room: 304
Abstract: Along with the advent of deep learning and its quick adoption, there is concern about using models that we don't really understand. And because of this concern, many critical applications of deep learning are hindered. The concern about transparency and trustworthiness of these models is so high that it is now a major research focus of Artificial Intelligence (AI) programs at funding agencies like DARPA and NSF in the US. If we can make deep learning explainable and transparent, the economic impact of such a technology would be in the trillions of dollars.

One of the specific forms of Explainable AI (XAI) envisioned by DARPA includes the recognition of objects based on identification of their parts. For example, the form requires that to predict an object to be a cat, the system must also recognize some of the specific features of a cat, such as the fur, whiskers, and claws. Object prediction contingent on recognition of parts provides additional verification for the object and makes the prediction robust and trustworthy.

The first part of this tutorial will review some of the existing methods of XAI in general and then those that are specific to computer vision.

The second part of this tutorial will cover a new method that decodes a convolutional neural network (CNN) to recognize parts of objects. The method teaches a second model the composition of objects from parts and the connectivity between the parts. This second model is a symbolic and transparent model. Experimental results will be discussed including those related to object detection in satellite images. Contrary to conventional wisdom, experimental results show that part-based models can substantially improve the accuracy of many CNN models. Experimental results also show part-based models can provide protection from adversarial attacks. Thus, a school bus will not become an ostrich with the tweak of a few pixels.

Tutorial: Deep Learning for Graphs
Organizer(s): Davide Bacciu
Date: June 30, 2024
Time: 16:20-18:20
Room: 311+312
Abstract: The tutorial will introduce the audience to the area of deep learning on graph data and some of its most compelling research challenges. Current models dealing with graph data almost inevitably leverage a neural message-passing like approach. We will first introduce the foundations of such an approach and discuss its reference literature models. Then we will identify and discuss the limitations of these approaches and the research opportunities that are stemming from this. In this second part, we will cover research topics under development in the community, touching upon generative models, neural graph ODEs, dynamic graphs and algorithmic reasoning.

Tutorial: Collaborative Learning and Optimization
Organizer(s): A. Kai Qin
Date: June 30, 2024
Time: 8:30 – 10:30
Room: 304
Abstract: Machine learning (ML) and optimization are two essential missions that Computational Intelligence (CI) aims to address. Accordingly, many CI-based ML and optimization techniques have been proposed, where deep neural networks (used for ML) and evolutionary algorithms (used for optimization) are the most well-known representatives. Intrinsically, CI-based ML and optimization are closely related. On the one hand, CI-based ML consists of various model-centric or data-centric optimization tasks. On the other hand, CI-based optimization is often formulated into ML-assisted search problems. In recent years, there emerges a new research frontline in CI, as the proposed title (COLO), which studies how to synergise CI-based ML and optimization techniques while unleashing the unprecedented computing power (e.g., via supercomputers) to generate more powerful ML and optimization techniques for solving challenging problems. This tutorial aims at introducing this newly emerging research direction. Specifically, we will first introduce CI, CI-based ML and optimization techniques, and their relationships, and then describe COLO from three aspects, i.e., how to make use of ML techniques to assist optimization (Learn4Opt), how to leverage optimization techniques to facilitate ML (Opt4Learn), and how to synergise ML and optimization techniques to deal with real-world problems which involve ML and optimization as two indispensable and interwoven tasks (LearnOpt), where the most representative research hotspot in each of these three aspects, i.e., automated construction of deep neural networks, data-driven evolution optimization, and predictive optimization will be discussed in detail.

Tutorial: Prospects and Limits of Generative Artificial Intelligence for Medical Systems: Intelligent Healthcare
Organizer(s): Eros G Pasero
Date: June 30, 2024
Time: 16:20 – 18:20
Room: 314
Abstract: The elderly population's increasing numbers, dwindling healthcare resources, and the perilous doctor-patient contact due to pathologies like COVID-19 signal a need for a shift in the current medical model. Yet, the question remains: what new model to adopt? Artificial Intelligence (AI), the foundation of contemporary life changes, pledges a transformative impact on patient care and the healthcare system. However, the genuine challenge lies in devising a practical model to curb the escalating demand for elderly operations amidst a larger populace with fewer health issues. The potential frontier emerges in Generative Artificial Intelligence, offering fresh data and models for future healthcare systems. These systems facilitate the interpretation of outcomes and the generation of personalized medicine. Leveraging digital twins, models can discern the treatment effects on patients through their digital counterparts. Additionally, AI wearable technology in virtual hospitals enables the remote monitoring of multiple patients within their homes. An overarching query persists: can these systems earn trust in medicine? Questions revolve around the accuracy, precision, sensitivity, ROC curve, and F-score of data produced by generative AI. Addressing these concerns, the latter part of this tutorial will contribute insights, utilizing metrics common in the world of Metrology

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Tutorial: Conscious Learning vs. Deep Learning
Organizer(s): Juyang Weng
Date: June 30, 2024
Time: 8:30 – 10:30
Room: 302
Abstract: Autonomous development needs a general-purpose theory. Experimental studies require such a theory. Consciousness seems not a wishful add-on to AI, but instead a necessary condition toward strong AI. Unfortunately, consciousness has been largely overlooked or deliberately avoided in AI research. This situation resulted in a major weakness in many well-known neural networks, such as deep learning and ChatGPT. This tutorial will teach basic knowledge about biologically inspired neural networks that enables on-the-fly learning for the three bottleneck problems in AI, Vision, Audition, Natural Languages, plus subjects that have been extremely challenging for neutral networks but are necessary, such as planning and machine thinking. All these subjects are essential for conscious learning. This tutorial will also compare with deep learning, ChatGPT, and evolutional computation that suffer from Post-Selection misconduct. More updated detail of Conscious Learning is available at https://doi.org/10.21203/rs.3.rs-1700782/v2

Tutorial: Neural Network Design and Optimization for 3D Point Cloud Computing
Organizer(s): Wei Gao; Ge Li
Date: June 30, 2024
Time: 10:40 – 12:40
Room: 313
Abstract: 3D point cloud computing has become very popular in both academia and industry communities, due to its powerful modeling capability for 3D real world with high-precision geometry and attributes. Deep learning-based 3D point clouds can bring better visual experience and machine vision performance, where neural network design and optimization play a critical role for efficient compression, enhancement and analysis of this new type of data.

Tutorial: Ethical Risks and Challenges of Computational Intelligence
Organizer(s): Jim Tørresen; Xin Yao
Date: June 30, 2024
Time: 8:30 – 10:30
Room: 313
Abstract: Artificial intelligence (AI) has entered an increasing number of different domains. A growing number of people – in the general public as well as in research – have started to consider a number of potential ethical challenges and legal issues related to the development and use of AI technologies. There have been related initiatives across the globe, such as the High-Level Expert Group on Artificial Intelligence (AI HLEG) appointed by the European Commission that has a general goal of supporting the implementation of the European Strategy on Artificial Intelligence. This has been followed up with the proposal of the European Artificial Intelligence Act (AIA) and the New Machinery Directive (MD), focusing on developing a framework for trustworthy Artificial Intelligence within Europe, laying down harmonised rules for both AI systems with and without a physical layer (e.g., chatbots vs. robots etc.). This tutorial will give an overview of the most commonly expressed ethical challenges and ways being undertaken to reduce their negative impact using the findings in an earlier undertaken review (https://www.frontiersin.org/articles/10.3389/frobt.2017.00075/full) and an overview paper of Artificial Intelligence Ethics
(https://www.computer.org/csdl/journal/ai/5555/01/09844014/1Fnr097UNd6), supplemented with recent work and initiatives.

Among the most important challenges are those related to privacy, fairness, transparency, safety and security. Countermeasures can be taken first at design time, second when a user should decide where and when to apply a system and third when a system is in use in its environment. In the latter case, there will be a need for the system by itself to perform some ethical reasoning if operating in an autonomous mode. This tutorial will introduce some examples from our own and others´ work and how the challenges can be addressed both from a technical and human perspective with special attention to problems relevant when working with AI research and development. AI ethical issues should not be seen only as challenges but also as new research opportunities contributing to more sustainable, socially beneficial services and systems. The tutorial is an updated version of the one given in IJCNN 2023: https://2023.ijcnn.org/tutorials

Tutorial: A Guided Tour of Neural Architecture Search
Organizer(s): Szymon Lukasik; Bing Xue
Date: June 30, 2024
Time: 8:30 – 10:30
Room: 311+312
Abstract: In the ever-evolving landscape of Artificial Intelligence, Deep Learning has emerged as a dominant force, revolutionizing industries and scientific research. However, the success of neural networks-based methods crucially depends on finding the right network architecture—a task that has proven vital and challenging.

The tutorial will aim to provide a comprehensive guide on Neural Architecture Search a category of methods designed to adapt the structures of the network to the problem at hand. We will explore various approaches for NAS, including reinforcement learning-based methods, evolutionary algorithms, and gradient-based optimization techniques. Participants will gain an understanding of the theoretical foundations and practical implications of each approach. Through case studies and practical demonstrations, attendees will also learn about state-of-the-art NAS methods. To facilitate hands-on learning, the tutorial will provide code snippets and practical examples that attendees can readily incorporate into their research and projects. These resources will empower participants to apply NAS techniques to their datasets and problems.

As a follow-up to the highly successful WCCCI 2022 keynote, this tutorial will be primarily intended for early-career researchers and graduate students who are beginning their journey in Deep Learning. Its role will be to serve as a foundational resource, equipping them with the expertise needed to explore NAS.

Tutorial: In-Material Physical Computing
Organizer(s): Takuya Matsumoto; Tsuyoshi Hasegawa; Hirofumi Tanaka; Ryosho Nakane; Seiya Kasai; Akira Hirose
Date: June 30, 2024
Time: 16:20 – 18:20
Room: 316
Abstract: This tutorial will provide an introduction to "computing based on material", which utilizes the inherent structure and properties in materials to perform in-situ environmental recognition such as speech and text. The talks will be given by leading researchers in a wide range of fields, from theoretical background to applications to devices and robotics using inorganic, organic, and nanomaterials. This tutorial contains six talks: 1. Overview – theory and applications, 2. Physical computing based on dynamics in analog electronic devices and circuits, 3. Reservoir computing with spin waves: how to leverage waves in materials, 4. Electrolyte-based physical reservoir computing, 5. Molecular physical computing, 6. Material physical reservoir computing with chemical dynamics.

Tutorial: Quantum Tensor Networks in Machine Learning and Artificial Intelligence
Organizer(s): Jun Qi, Ying-Jer Kao, Samiel Yen-Chi Chen, Mohammadreza Noormandipour
Date: June 30, 2024
Time: 16:20 – 18:20
Room: 313
Abstract: Quantum tensor networks, along with their applications in classification, time-series modeling, and natural language processing, signify a burgeoning and interdisciplinary field within the realms of quantum computing and machine learning. This tutorial strives to empower researchers in the fields of machine learning and artificial intelligence by offering insights and tools to explore this cutting-edge domain, presenting accessible entry points and illustrative code samples.

CEC Tutorials

Tutorial: What You Always Wanted to Know About Evolution Strategies, But Never Dared to Ask
Organizer(s): Hans-Georg Beyer
Date: June 30, 2024
Time: 8:30 – 10:30
Room: 411+412
Abstract: While Evolution Strategies (ES) are widely known as one of the streams of evolutionary computation and are meanwhile regarded as a competitive alternative to standard learning techniques in Reinforcement Learning, most people associate ES with the covariance matrix evolution strategy.

However, there is more than just this particular evolutionary algorithm designed for unconstrained real-valued search spaces.

This introductory tutorial provides a broader perspective and view stressing the design philosophy of Evolution Strategies being not restricted to a specific search space, such as unconstrained real-valued optimization, but also includes discrete and combinatorial search spaces. This philosophy can be best understood from the ES history that started from the evolution of material objects - nowadays often referred to as hardware-in-the-loop evolutionary optimization. That is, evolution is done on the "phenotype."

Accepting the constraints involved in such optimizations, one naturally can derive design principles for mutation and recombination operators and the control of those operators by self-adaptation - one of the great inventions of ES. Special emphasis is put on a vivid understanding of how the ES explores the search spaces. Recent findings will be presented and supported by live experiments to explain the ES's ability to locate global optima in landscapes with a huge number of local optima. The tutorial will also investigate the reasons why ESs are now regarded as a scalable alternative to Reinforcement Learning.

The tutorial will include a live computer experiment demonstrating the relevance of the design and working principles discussed. This tutorial will be on an introductory level requiring only a minimum of maths.

Tutorial: Towards Better Explainable AI Through Genetic Programming
Organizer(s): Yi Mei; Qi Chen; Andrew B J Lensen; Bing Xue; Mengjie Zhang
Date: June 30, 2024
Time: 8:30 – 10:30
Room: 413
Abstract: Although machine learning has achieved great success in many real-world applications, it is criticised as usually behaving like a black box, and it is often difficult, if not impossible, to understand how the machine learning system makes the decision/prediction. This could lead to serious consequences, such as the accidents of the Tesla automatic driving cars, and biases of the automatic bank loan approval systems.

To address this issue, Explainable AI (XAI) is becoming a very hot research topic in the AI field due to its urgent needs in various domains such as finance, security, medical, gaming, legislation, etc. There have been an increasing number of studies on XAI in recent years, which improves the current machine learning systems from different aspects.

In evolutionary computation, Genetic Programming (GP) has been successfully used in various machine learning tasks including classification, symbolic regression, clustering, feature construction, and automatic heuristic design. As a symbolic-based evolutionary learning approach, GP has an inherent great potential to contribute to XAI, as a GP model tends to be interpretable. However, the interpretability in GP is not as straightforward as one expect it to be, and the models evolved by GP can still be huge and complex, thus less interpretable.

This tutorial will give a brief introduction on how one may achieve better model interpretability in XAI using GP. To this end, we will first briefly introduce XAI and GP. Then we will introduce the GP techniques/strategies that could lead to better model interpretability. We follow the common taxonomy of XAI, and divide the techniques into intrinsic and post-hoc methods. In addition, we will also review some visualisation methods by/for GP to improve interpretability. The tutorial is concluded with some discussions on the current trend, challenges, and potential future research directions.

This tutorial will be interested to all researchers who are interested in XAI, GP, and more general evolutionary machine learning and optimisation, as well as practitioners who want to solve their real-world problems with more interpretable solutions.

Tutorial: Decomposition Multi-Objective Optimization: Current Developments and Future Opportunities
Organizer(s): Ke Li; Qingfu Zhang
Date: June 30, 2024
Time: 10:40 – 12:40
Room: 416+417
Abstract: Evolutionary multi-objective optimization (EMO) has been a major research topic in the field of evolutionary computation for three decades. It has been generally accepted that combination of evolutionary algorithms and traditional optimization methods should be a next generation multi-objective optimization solver. As the name suggests, the basic idea of the decomposition-based technique is to transform the original complex problem into simplified subproblem(s) so as to facilitate the optimization. Decomposition methods have been well used and studied in traditional multi-objective optimization. Multi-objective evolutionary algorithm based on decomposition (MOEA/D) decomposes a multi-objective problem into a number of subtasks, and then solves them in a collaborative manner. MOEA/D provides a very natural bridge between multi-objective evolutionary algorithms and traditional decomposition methods. It has been a commonly used evolutionary algorithmic framework in recent years.

Tutorial: Evolutionary Algorithms and Hyper-Heuristics
Organizer(s): Nelishia Pillay
Date: June 30, 2024
Time: 14:10 – 16:10
Room: 411+412
Abstract: Hyper-heuristics is a rapidly developing domain which has proven to be effective at providing generalized solutions to problems and across problem domains. Evolutionary algorithms have played a pivotal role in the advancement of hyper-heuristics and is continuing to do so. The aim of the tutorial is to firstly provide an introduction to evolutionary algorithm hyper-heuristics for researchers interested in working in this domain. An overview of hyper-heuristics will be provided including the assessment of hyper-heuristic performance. The tutorial will examine each of the four categories of hyper-heuristics, namely, selection constructive, selection perturbative, generation constructive and generation perturbative, showing how evolutionary algorithms can be used for each type of hyper-heuristic. A case study will be presented for each type of hyper-heuristic to provide researchers with a foundation to start their own research in this area. The EvoHyp library will be used to demonstrate the implementation evolutionary algorithm hyper-heuristic. A theoretical understanding of evolutionary algorithm hyper-heuristics will be provided. A new measure to assess the performance of hyper-heuristic performance will also be presented. Challenges in the implementation of evolutionary algorithm hyper-heuristics will be highlighted. The tutorial will also examine recent trends in evolutionary algorithm hyper-heuristics such as transfer learning, hyper-heuristics for continuous optimization and machine learning and hyper-heuristics. The tutorial will end with a discussion session on future directions in the field.

Tutorial: Evolutionary Feature Reduction for Machine Learning
Organizer(s): Bach Hoai Nguyen; Bing Xue; Mengjie Zhang
Date: June 30, 2024
Time: 16:20 – 18:20
Room: 414+415
Abstract: We are now in the era of big data, where vast amounts of high-dimensional data become ubiquitous in a variety of domains, such as social media, healthcare, and cybersecurity. When machine learning algorithms are applied to such high-dimensional data, they suffer from the curse of dimensionality, where the data becomes very sparse. Furthermore, the high-dimensional data might contain redundant and/or irrelevant features that blur useful information from relevant features. Feature reduction can address the above issues by building a smaller but more informative feature set.

Feature selection and feature construction are two main approaches of feature reduction. Feature selection aims to select a small subset of original (relevant) features. Feature construction aims to create a small set of new high-level (informative) features based on the original feature set. Although both approaches are essential data pre-processing steps, they are challenging due to their large search spaces and complex interactions between features. While exhaustive searches are impractical due to their intensive computation cost, traditional heuristic searches require less computational resources but can be trapped at local optima. Recently, evolutionary computation (EC) has been widely applied to achieve feature reduction because of its potential global search ability. Existing EC-based feature reduction approaches successfully reduce the data dimensionality while still improve the classification performance as well as the interpretability of the built models.

This tutorial firstly describes a general framework of feature reduction followed by the applications of feature reduction in real-world scenarios. Then, we will show how EC techniques, particularly genetic algorithms, particle swarm optimisation, differential evolution, genetic programming, ant colony optimisation and evolutionary multi-objective optimisation (EMO) can be applied to address challenges in feature reduction. The effectiveness of EC-based feature reduction is illustrated through several applications including bioinformatics, image analysis and pattern classification, symbolic regression, and cybersecurity. The tutorial concludes with existing challenges for future research.

Tutorial: Evolutionary Bilevel Optimization: Methods and Applications
Organizer(s): Ankur Sinha; Hemant K Singh; Kalyanmoy Deb
Date: June 30, 2024
Time: 16:20 – 18:20
Room: 413
Abstract: Many practical optimization problems should better be posed as bilevel optimization problems in which there are two levels of optimization tasks. A solution at the upper level is feasible if the corresponding lower level variable vector is optimal for the lower level optimization problem. Consider, for example, an inverted pendulum problem for which the motion of the platform relates to the upper level optimization problem of performing the balancing task in a time-optimal manner. For a given motion of the platform, whether the pendulum can be balanced at all becomes a lower level optimization problem of maximizing stability margin. Such nested optimization problems are commonly found in transportation, engineering design, game playing and business models. They are also known as Stackelberg games in the operations research community. These problems are too complex to be solved using classical optimization methods simply due to the "nestedness" of one optimization task into another.

Evolutionary Algorithms (EAs) provide some amenable ways to solve such problems due to their flexibility and ability to handle constrained search spaces efficiently. Clearly, EAs have an edge in solving such difficult yet practically important problems. In the recent past, there has been a surge in research activities towards solving bilevel optimization problems. In this tutorial, we will introduce principles of bilevel optimization for single and multiple objectives, and discuss the difficulties in solving such problems in general. With a brief survey of the existing literature, we will present a few viable evolutionary algorithms for both single and multi-objective EAs for bilevel optimization. Recent studies on bilevel test problems and some application studies will be discussed. Finally, a number of immediate and future research ideas on bilevel optimization will also be highlighted.

Tutorial: Fair Performance Comparison of Evolutionary Multi-Objective Algorithms
Organizer(s): Lie Meng Pang; Ke Shang; Hisao Ishibuchi
Date: June 30, 2024
Time: 14:10 - 16:10
Room: 421
Abstract: Evolutionary multi-objective optimization (EMO) has been a very active research area in recent years. Almost every year, new EMO algorithms are proposed. When a new EMO algorithm is proposed, computational experiments are usually conducted in order to compare its performance with existing algorithms. Then, experimental results are summarized and reported as a number of tables together with statistical significance test results. Those results usually show higher performance of the new algorithm than existing algorithms. However, fair comparison of different EMO algorithms is not easy since the evaluated performance of each algorithm usually depends on experimental settings. This is also because solution sets instead of solutions are evaluated.

In this tutorial, we will first explain some commonly-used software platforms and experimental settings for the comparison of EMO algorithms. Then, we will discuss how to specify the common setting of computational experiments, which is used by all the compared EMO algorithms. More specifically, the focus of this tutorial is the setting related to the following four issues: (i) termination condition, (ii) population size, (iii) performance indicators, (iv) test problem. For each issue, we will provide a clear demonstration of its strong effects on comparison results of EMO algorithms. Following that, we will discuss how to handle each of these issues for fair comparison. These discussions aim to encourage the future development of the EMO research field without focusing too much on the development of overly-specialized new algorithms in a specific setting. Finally, we will also suggest some promising future research topics related to each issue.

Tutorial: New EMO Algorithm Framework with an Unbounded External Archive: Basic Ideas and Research Directions
Organizer(s): Lie Meng Pang; Ke Shang; Hisao Ishibuchi
Date: June 30, 2024
Time: 16:20 – 18:20
Room: 421
Abstract: In the field of evolutionary multi-objective optimization (EMO), early EMO algorithms in the 1990s are called non-elitist algorithms where no solutions in the current population are included in the next population. That is, the next population is the offspring population of the current population. This non-elitist algorithm framework is clearly inefficient since we cannot preserve good solutions during the execution of EMO algorithms. As a result, almost all EMO algorithms in the last two decades are based on the elitist framework where the next population is selected from the current population and its offspring population. In both frameworks, the final population is presented to the decision maker as the final output from EMO algorithms. Recently, some potential difficulties of the elitist framework have been pointed out. One is that the final population is not always the best subset of all the examined solutions. It was demonstrated in the literature that some solutions in the final population are dominated by other solutions generated and deleted in previous generations. It is also difficult to utilize solutions in previous generations to generate new solutions. Offspring are always generated from solutions in the current population. Another difficulty is that only a limited number of solutions (i.e., only solutions in the final population) are obtained. A new framework with an unbounded external archive can easily handle these difficulties since the final solution set is selected from all the examined solutions. In this framework, we can select an arbitrary number of solutions as the final output from EMO algorithms. Stored solutions in the external archive can be used to create new solutions and also to select solutions for the next population. In this tutorial, some interesting research issues in the new EMO algorithm framework are explained.

Tutorial: Multi-Objective Machine Learning
Organizer(s): Vishnu Naresh Boddeti; Zhichao Lu; Xi Lin; Qingfu Zhang; Kalyanmoy Deb
Date: June 30, 2024
Time: 14:10 – 16:10
Room: 414+415
Abstract: Real-world applications of machine learning (ML) often have to contend with objectives beyond predictive performance, i.e., more than one equally important and competing objective or criterion. Examples include cost functions pertaining to invariance (e.g., to photometric or geometric variations), semantic independence (e.g., to age or race for face recognition systems), privacy (e.g., mitigating leakage of sensitive information), algorithmic fairness (e.g., demographic parity), generalization across multiple domains, computational complexity (FLOPs, compactness), to name a few.

In such situations, seeking a single solution that optimizes all objectives simultaneously becomes infeasible. Instead, the goal shifts towards finding a set of solutions that adequately describe the trade-off among the objectives. Various strategies have been developed to address these problems, including simple scalarization and population-based methods.

This tutorial aims to provide a comprehensive introduction to fundamentals and recent advances in multi-objective optimization (MOO), and its applications to representative machine learning tasks with hands-on coding examples. Some emerging machine learning applications of MOO include (1) multi-task learning as multi-objective optimization; (2) representation learning for privacy and fairness; and (3) neural architecture search. Potential research directions intersecting MOO and machine learning research will be summarized.

This tutorial also seeks to convene researchers who are pioneering methods and applications at the crossroads of MOO and machine learning. The goal is to foster a dynamic exchange of ideas, reveal new insights, and explore the untapped potential within this interdisciplinary domain.

Tutorial: Pareto Optimization for Subset Selection: Theories and Practical Algorithms
Organizer(s): Chao Qian
Date: June 30, 2024
Time: 8:30 – 10:30
Room: 416+417
Abstract: Pareto optimization is a general optimization framework for solving single-objective optimization problems, based on multi-objective evolutionary optimization. The main idea is to transform a single-objective optimization problem into a bi-objective one, then employ a multi-objective evolutionary algorithm to solve it, and finally return the best feasible solution w.r.t. the original single-objective optimization problem from the generated non-dominated solution set. Pareto optimization has been shown a promising method for the subset selection problem, which has applications in diverse areas, including machine learning, data mining, natural language processing, computer vision, information retrieval, etc. The theoretical understanding of Pareto optimization has recently been significantly developed, showing its irreplaceability for subset selection. This tutorial will introduce Pareto optimization from scratch. We will show that it achieves the best-so-far theoretical and practical performances in several applications of subset selection. We will also introduce advanced variants of Pareto optimization for large-scale, noisy and dynamic subset selection.

Tutorial: Particle Swarm Optimization: A Multi-Purpose Optimization Approach
Organizer(s): Andries Engelbrecht
Date: June 30, 2024
Time: 10:40 – 12:40
Room: 411+412
Abstract: The main objective of this tutorial is to show that particle swarm optimization (PSO) has emerged as a multi-purpose optimization approach. In the context of this tutorial, this means that the PSO can be applied to a wide range of optimization problem types as well as search domain types. The tutorial will start with a very compact overview of the original, basic PSO. The remainder and bulk of the tutorial will cover a classification of different problem types, and will show how PSO can be applied to solve problems of these types. This part of the tutorial will be organized in the following sections, one for each problem type: Continuous-valued versus discrete-valued domains; Unimodal versus multi-modal landscapes; Multi-modal optimization to find multiple solutions; Constrained versus unconstrained problems, also covering boundary constraints; Multi-objective and many-objective optimization; Dynamic environments to include problems where constraints change over time, dynamic multi-objective optimization, tracking multiple optima, and changing problem dimensionality; Large-scale optimization problems. For each problem type, it will be shown why the standard PSO cannot solve these types of problems efficiently without modification. Simple adaptations to the PSO that will allow it to solve each problem type will then be discussed. The focus will be on PSO adaptations that do not violate the foundational principles of PSO. For each of these problem types a small subset of the most successful algorithms will be discussed and links to benchmark problems will be provided.

Tutorial: Genetic Programming and Machine Learning for Scheduling
Organizer(s): Fangfang Zhang; Mengjie Zhang; Yi Mei; Su Nguyen
Date: June 30, 2024
Time: 10:40 – 12:40
Room: 413
Abstract: Scheduling is an important optimisation problem that reflects the practical and challenging issues in real-world scheduling applications such as order picking in warehouses, the manufacturing industry and grid/cloud computing. Job shop scheduling (JSS) is a typical scheduling problem, which covers a full range of topics and tasks including static JSS, dynamic JSS, flexible JSS, dynamic flexible JSS, from basic research to a huge number of real-world industrial applications. With recent technological advances in internet-of-things, artificial intelligence, and automation, modern production systems are digitalized and more flexible, and production environments can be monitored and diagnosed in real-time. Scheduling in such dynamic and complex environments is challenging since scheduling needs to be more efficient and reactive, and scheduling decisions have to incorporate dynamic information and uncertainty.

Instead of manually designing scheduling heuristics and algorithms for each problem, we can use machine learning and hyper-heuristics to automatically learn effective scheduling heuristics from low-level heuristics, characteristics of scheduling problems, and dynamic information from production environments. Among the techniques studied and applied within the research field of JSS, genetic programming (GP), a powerful evolutionary machine learning technique, has been successfully used to learn scheduling heuristics for JSS, especially for dynamic JSS. This automated design approach can significantly reduce the time required to develop solution methods by domain experts and increase the chance of discovering novel and effective scheduling heuristics.

Although GP has shown its advantage in learning scheduling heuristics for JSS, GP still has several limitations for handling JSS such as high computational cost and large search space. In addition, most of existing studies focus mainly on single JSS task optimisation, the multiple tasks solving ability of GP has not been explored.

This tutorial will provide a comprehensive introduction to evolutionary machine learning techniques for JSS. This tutorial will cover different types of (advanced) evolutionary machine learning approaches for JSS. From this tutorial, you are expected to get familiar with evolutionary machine learning in four aspects. First, you will learn the definition of hyper-heuristic learning with a comparison of heuristic learning. Second, the details of JSS (e.g., static, dynamic, flexible JSS) will be given. Third, how to use GP as hyper-heuristic approaches to learn heuristics for JSS will be introduced with examples. Last, this tutorial will show how to use advanced machine learning techniques such as feature selection, surrogate and multitask learning with GP to JSS. All the techniques mentioned will be introduced with promising results.

Tutorial: Evolutionary neural architecture search
Organizer(s): Yanan Sun; Bing Xue; Mengjie Zhang; Gary Yen
Date: June 30, 2024
Time: 10:40 – 12:40
Room: 414+415
Abstract: Deep Neural Networks (DNNs), as the cornerstone of deep learning, have demonstrated their great success in diverse real-world applications, such as image classification, natural language processing, speech recognition, to name a few. The architectures of DNNs play a crucial role in their performance, which is usually manually designed with rich expertise. However, such a design process is labor-intensive because of the trial-and-error process, and also not easy to realize due to the rare expertise in practice.

Neural Architecture Search (NAS) is a kind of technique that could automatically designing promising DNN architectures by formulating the design process as optimization problems. Among existing optimizers for solving NAS, the Evolutionary Computation (EC) methods have demonstrated their powerful ability and have drawn increasing attention.

This tutorial will provide a comprehensive introduction to NAS techniques based on EC, i.e., ENAS, for automatically designing the architectures of DNNs. Specifically, this tutorial will cover the ENAS algorithms over 200 papers of most recent ENAS methods in light of the core components, to systematically show their design principles as well as justifications on the design. From this tutorial, the audiences are expected to get familiar with ENAS in four aspects. First, audiences will learn the encoding space categories, different encoding strategies and architecture representations. Second, audiences will learn a variety of EC paradigms use respective metaphors to generate new individuals. Third, audiences will learn the methods to reduce the need for large amounts of time and computing resources, which is a huge obstacle to efficiency. Last, current challenges and issues will be introduced to identify future research in this emerging field.

Tutorial: A Deep Dive into Robust Optimization Over Time: Problems, Algorithms, and Beyond
Organizer(s): Danial Yazdani; Xin Yao
Date: June 30, 2024
Time: 10:40 – 12:40
Room: 421
Abstract: In the evolving landscape of optimization, Dynamic Optimization Problems (DOPs) manifest as a pivotal area of exploration. These problems, characterized by their changing search space over time, present a maze of challenges for optimization algorithms. While much of the existing literature on DOPs primarily focuses on tracking the moving optimum, many real-world DOPs present a different set of challenges and impose a distinct set of requirements. In many practical scenarios, frequent changes to deployed solutions are often undesirable. This aversion stems from various factors, including the high cost associated with switching between deployed solutions, limitations on the resources required to deploy new solutions, and the system's inability to tolerate frequent changes in the deployed solutions.

Robust Optimization Over Time (ROOT) emerges as a beacon in such dynamic scenarios, intertwining the principles of robust optimization and dynamic optimization to form a robust framework capable of navigating the turbulent waters of DOPs. ROOT acknowledges the high cost and resource limitations associated with frequent solution deployments, striving for algorithms capable of dealing with the implications of deploying or maintaining solutions over longer time horizons involving multiple environmental changes.

In this tutorial, we unravel the intricacies of ROOT, providing a gateway to understand, analyze, and address these problems adeptly. The tutorial is structured to offer a panoramic view of the ROOT realm, covering the underlying problems, innovative algorithms designed to tackle these problems, and benchmarks and performance indicators crucial for evaluating the robustness and effectiveness of these algorithms.

Tutorial: Principle and Applications of Semantic Genetic Programming
Organizer(s): Qi Chen; Bing Xue; Mengjie Zhang
Date: June 30, 2024
Time: 14:10 – 16:10
Room: 413
Abstract: Semantic genetic programming is a rapidly growing research track of Genetic Programming (GP). Semantic GP incorporates semantic awareness into GP and explicitly uses more information on the behaviour of programs in the search. When evaluating a program, semantic GP characterises it with a vector of outputs instead of a single scalar fitness value. Research has demonstrated the successfulness of additional behavioural information to facilitate the design of a more effective GP search. In addition, the geometric properties of the semantic space lead to more attractive search operators with better theoretical characteristics. With the geometric information of semantics, the GP dynamics are easier to understand and interpret. Inappropriate behaviours are easier to prevent. All these contribute to making GP a more informed and intelligent method. This tutorial will give a comprehensive overview of semantic GP methods. We will review various ways of integrating semantic awareness in the evolutionary process of GP. In particular, we will introduce geometric semantic GP and review its formal geometric semantic framework, and analyse the theoretical properties of the fitness landscape under this framework. This will be followed by a review of many novel developments of provably good semantic genetic operators. Another aspect is the efficient implementation of semantic search operators, which is still challenging. We will illustrate efficient and concise implementations of these operators. Another focus of this tutorial is to stimulate the audience by showing some promising applicative results that have been obtained so far in many applications of semantic GP including many symbolic regression and classification tasks in the areas of healthcare, civil engineering, natural language processing and so on. We will also identify and discuss current challenges and promising future directions in semantic GP with the hope of motivating new and stimulating contributions.

Tutorial: Benchmarking and analyzing iterative optimization heuristics with IOHProfiler
Organizer(s): Elena Raponi; Thomas Bäck; Jacob de Nobel; Diederick Vermetten; Anna V Kononova; Niki van Stein; Carola Doerr
Date: June 30, 2024
Time: 16:20 – 18:20
Room: 422
Abstract: Comparing and evaluating optimization algorithms is an important part of evolutionary computation and requires a robust benchmarking setup to be done well. IOHProfiler supports researchers in this task by providing an easy-to-use, interactive, and highly customizable environment for benchmarking iterative optimizers.

IOHProfiler is designed as a modular benchmarking tool. The experimenter module provides easy access to common problem sets (e.g., COCO/BBOB functions) and modular logging functionality that can be easily combined with other optimization functions. The resulting logs (and logs from other platforms, e.g., COCO and Nevergrad) are fully interoperable with the IOHanalyzer, which provides access to highly interactive performance analysis, in the form of a wide array of visualizations and statistical analyses. A GUI, hosted at https://iohanalyzer.liacs.nl/ makes these analysis tools easy to access. Data from many repositories (e.g., COCO, Nevergrad) are pre-processed, such that the effort required to compare performance to existing algorithms is greatly reduced.

This tutorial will introduce the key features of IOHProfiler by providing background information on benchmarking in Evolutionary Computation and showing how this can be done using the modules of IOHProfiler. The key components will be highlighted and demonstrated by the organizers. Guided examples will be provided to highlight the many aspects of algorithm performance, which can be explored using the interactive GUI. Participants will learn how a standardized benchmarking environment can facilitate their experimental setup and data analysis. Following the basic benchmarking setup, we will elucidate how to track adaptive parameters and customize the logging procedure for generating data. Also, we will illustrate how to add new problems to the existing problem sets. We also demonstrate how easy it is to compare your own data to previously recorded ones using IOHProfiler; our data repositories comprise data sets for the BBOB functions of the COCO environment https://github.com/numbbo/coco and from Nevergrad https://facebookresearch.github.io/nevergrad/.

Tutorial: Tracking the moving optimum in dynamic optimization problems
Organizer(s): Michalis Mavrovouniotis; Danial Yazdani
Date: June 30, 2024
Time: 8:30 – 10:30
Room: 421
Abstract: In the ever-evolving landscape of real-world problems, the dynamic nature of optimization challenges is increasingly prevalent. This tutorial delves into the exciting field of evolutionary dynamic optimization, focusing on tracking the moving optimum in both discrete and continuous search spaces. It is designed to cater to a wide audience, ranging from those with an interest in evolutionary computation to those seeking the latest advancements in dynamic optimization.

Tutorial: Evolutionary Diversity Optimization for Combinatorial Optimization
Organizer(s): Aneta Neumann; Frank Neumann
Date: June 30, 2024
Time: 10:40 – 12:40
Room: 422
Abstract: In the classical setting evolutionary algorithms (EAs) are used to compute a single solution of high quality with respect to the objective function or a set of trade-off solutions in the field multi-objective optimization where one deals with multiple, usually conflicting objectives. Here, diversity preservation is usually introduced as a means to prevent premature convergence. In many engineering applications and in the field of algorithm selection/configuration however, it is beneficial to produce a set of solutions that is (1) of high quality and (2) diverse with respect to the search space and/or some features of the given problem. Evolutionary Diversity Optimization enables the computation of a large variety of new and innovative solutions that are unlikely to be produced by traditional evolutionary computation methods for single-objective or multi-objective optimization. Related to evolutionary diversity optimization is the concept of novelty search. Here EAs are used to discover new designs/solutions without focusing on explicit objectives as a driver for the search process. The goal of novelty search is to explore solutions that are different to the ones previously obtained.

In this tutorial, we will give a detailed overview on evolutionary diversity optimization which is a new important research area within evolutionary computation that aims to provide sets of diverse solutions. Apart from that, we give a brief introduction into novelty search, highlight similarities and differences to evolutionary diversity optimization and give an outlook how both fields can benefit from each other.

Tutorial: Designing Metaheuristics with Large Language Models: Challenges and Opportunities
Organizer(s): Michal Pluhacek; Adam Viktorin; Roman Senkerik
Date: June 30, 2024
Time: 8:30 – 10:30
Room: 414+415
Abstract: This tutorial will explore the possibilities of utilizing Large Language Models (LLMs) like GPT-4 for designing metaheuristic algorithms tailored to specific optimization problems. The central theme of the talk revolves around a systematic approach to leveraging LLMs' capabilities in this innovative context.

Workflow and Analysis Process:

Proposing New Algorithms: We will start by prompting the model to propose new metaheuristic algorithms for predefined optimization problems. This will involve inputting detailed problem specifications into the LLM and analyzing the metaheuristic solutions it generates.

Logical and Correctness Evaluation: Each of the proposed algorithms will be meticulously analyzed for their logical structure and correctness. This stage is crucial in assessing whether the solutions provided by LLMs are not only innovative but also logically sound and applicable to the problem at hand.

Viability Assessment: The focus will then shift to evaluating the viability of these proposed algorithms. We will discuss and criticise the practicality of implementing the model output, considering factors such as computational efficiency, scalability, and adaptability to real-world scenarios.

Potential for Novel and Powerful Metaheuristics: A key aspect of the talk will be to determine if LLM's involvement can lead to the development of novel and more powerful metaheuristic algorithms. We will explore whether the LLM contributions can transcend conventional approaches, offering new perspectives and solutions in the field of metaheuristics.

Conclusion and Future Outlook:

The session will conclude with reflections on the broader implications of integrating LLMs like GPT-4 in metaheuristic development. We'll discuss the potential future directions this research could take and how it might shape the evolution of algorithmic problem-solving in various domains.

Tutorial: Embedding Knowledge into Optimization Process
Organizer(s): Amir H Gandomi
Date: June 30, 2024
Time: 14:10 – 16:10
Room: 416+417
Abstract: Real-world optimization problems are usually large-scale and involve several constraints and sometimes even finding a single feasible/acceptable solution is a challenging task. To solve these complex real-world problems, heuristics and concept-based approaches can be very helpful and narrow down the search space. Here, I am going to talk about four approaches used in order to incorporate information into the problem and the optimization process, listed below:

- Variable functioning: In this method, the relationships among one or more subsets of variables are defined with functions using information prior to optimization; thus, instead of modifying the variables in the search process, the function variables are optimized.

- Semi-Independent Variable: the concept of a semi-independent variable (SIV) problem representation is investigated that embodies a set of expected or desired relationships among the original variables, with the goal of increasing search effectiveness and efficiency.

- Boundary update: This study introduces a new approach for implicitly handling constraints. The proposed approach reduces the consideration of infeasible solutions by directly updating variable bounds with constraints, which is called the boundary update (BU) method.

- Variable grouping and co-evolution: In this approach, cooperative coevolution is presented and introduced to efficiently solve optimization problems.

These four approaches are coupled with several evolutionary optimization algorithms and the results show that they are practical and effective approaches, and lead to better solutions with fewer function evaluations in most cases. This tutorial should motivate optimization researchers and practitioners to pay more attention to embedding different sources of knowledge into the optimization process to boost it.

Tutorial: Landscape Analysis for Explainable Optimization
Organizer(s): Arnaud Liefooghe; Sébastien Verel
Date: June 30, 2024
Time: 14:10 – 16:10
Room: 422
Abstract: The aim of optimization algorithm designers is to choose the right algorithm and its proper configuration to solve the problem they face. It is, however, even more important to understand and to be able to explain why this choice is relevant. There is in fact a multitude of algorithms among which it is often difficult to determine which one to use for solving a particular optimization problem — or even a particular problem instance.

Indeed, many evolutionary and related search-based optimization algorithms have been proposed for solving a wide range of problems, ranging from single- to multi-objective or continuous to combinatorial optimization. Nevertheless, despite their efficiency and skillful design, it is not always clear in which context an algorithm works best. It is therefore essential to gain a fundamental understanding of their strength and weakness in view of the problem they are aiming to solve. In addition, the informed design and automated selection or configuration of an efficient optimization algorithm is also a challenge that attracts increasing attention from the research community. Landscape analysis is a well-established field that aims to understand the relationship between the underlying structure of a given problem search space and algorithms as well as their underlying components and parameters.

Starting by introducing state-of-the-art tools for single-objective landscapes, we identify the key differences and additional properties to address multi-objective landscapes. We expose and contrast the impact of landscape characteristics on the performance of single- and multi-objective optimization algorithms. We identify a sound and concise summary of features characterizing the landscape of a problem instance. We also review the fundamental principles for designing new relevant features, and we show the main methodologies for sampling combinatorial and continuous search spaces. By providing effective tools and practical examples from landscape analysis, further insights are provided on the importance of ruggedness, multimodality and objective correlation in predicting algorithm performance for unseens problems. We conclude with guidelines for the design of search-based optimization by means of key landscape features, and we identify a number of open challenges for the future of landscape analysis and (evolutionary) optimization algorithms.

Tutorial: Adversarial Optimisation through Competitive co-Evolutionary Algorithms
Organizer(s): Per Kristian Lehre; Mario A Hevia Fajardo
Date: June 30, 2024
Time: 8:30 – 10:30
Room: 422
Abstract: Classical evolutionary algorithms require a fitness function to compare the quality of candidate solutions. However, the quality of candidate solutions in real-world optimization is often a function of adversarial and unforeseen factors which are difficult to model explicitly. In fact, finding hard or worst-case scenarios to evaluate a given solution is itself a difficult optimization problem. Thus, solutions obtained by EAs using a fixed fitness function may perform poorly when deployed in a competitive, real-world scenario. Co-evolutionary algorithms -- which model evolutionary arms-races between populations of predators and prey -- do not rely on explicit fitness functions. They represent one of the most exciting ideas in evolutionary computation, with successful applications ranging from designing sorting networks, playing backgammon, and patching software bugs. Related approaches from the broader AI field, including self-play in reinforcement learning and generative adversarial networks (GANs), highlight the importance of co-evolution. This tutorial has been designed for those who want an introduction to competitive co-evolution, covering their design, analysis, and applications. It assumes no specific background in evolutionary computation, game theory, or analysis of randomized algorithms. We will begin by giving examples of practical adversarial optimization scenarios where co-evolutionary algorithms are applicable. Then we explain how such problems can be captured within a game-theoretic framework with appropriate solution concepts. This part allows participants to recognize problem types where co-evolution can be used. We will then proceed to give an overview of the design of co-evolutionary algorithms, including essential components such as evaluation and archiving methods. This part also covers so-called co-evolutionary pathologies and how they can be remedied. After attending this part, participants will be able to design and implement existing and new co-evolutionary algorithms. Finally, we will discuss theoretical analyses of co-evolutionary algorithms, including No Free Lunch theorems and runtime analysis. This part will give participants a deeper and theoretically founded understanding of how and why co-evolutionary algorithms work, and why they sometimes fail. Several interactive activities are planned, including visualization of algorithms using our own software. This will give the audience a practical and hands-on experience in how co-evolutionary population dynamics are influenced by characteristics of the game and the design of the algorithm. Based on our previously held tutorials in conferences such as CEC, GECCO, and PPSN, we expect an audience of approximately 50 people.

Tutorial: Evolutionary Multi-task Optimization
Organizer(s): Liang Feng; Abhishek Gupta; A. Kai Qin
Date: June 30, 2024
Time: 16:20 – 18:20
Room: 411+412
Abstract: Evolutionary algorithms (EAs) typically start the search from scratch by assuming no prior knowledge about the task being solved, and their capabilities usually do not improve upon past problem-solving experiences. In contrast, humans routinely make use of the knowledge learnt and accumulated from the past to facilitate dealing with a new task, which provides an effective way to solve problems in practice as real-world problems seldom exist in isolation. Similarly, practical artificial systems like optimizers will often handle a large number of problems in their lifetime, many of which may share certain domain-specific similarities. This motivates the design of advanced optimizers which can leverage on what has been solved before to facilitate solving new tasks. In this tutorial, we will present recent advances in the field of evolutionary computation under the theme of evolutionary transfer and multi-task optimization via automatic knowledge transfer. Particularly, we will describe a general definition of transfer optimization, encompassing the sequential transfer and multitasking paradigms. We will also introduce recent theoretical developments in transfer optimization and describe corresponding evolutionary methodologies that can be put into use in practice. Some potential applications of evolutionary transfer and multi-task optimization in real-world scenarios will also be discussed.

Tutorial: Differential Evolution with Ensembles, Adaptations and Topologies
Organizer(s): Ponnuthurai Nagaratnam Suganthan
Date: June 30, 2024
Time: 16:20 – 18:20
Room: 411+412
Abstract: Differential Evolution (DE) is one of the most powerful stochastic real-parameter optimization algorithms of current interest. DE operates through similar computational steps as employed by a standard Evolutionary Algorithm (EA). However, unlike traditional EAs, the DE-variants perturb the current-generation population members with the scaled differences of distinct population members. Therefore, no separate probability distribution has to be used for generating the offspring. Since its inception in 1995, DE has drawn the attention of many researchers all over the world resulting in a lot of variants of the basic algorithm with improved performance. This tutorial will begin with a brief overview of the basic concepts related to numerical optimization and DE, DE's algorithmic components and control parameters. It will subsequently discuss some of the significant algorithmic variants of DE for bound constrained single-objective optimization. Recent modifications of the DE family of algorithms for constrained, multi-objective and niching problems will also be included. The talk will discuss the effects of incorporating ensemble learning in DE – a relatively recent concept that can be applied to swarm & evolutionary algorithms to solve various kinds of optimization problems. The talk will also discuss neighborhood topologies based DE and adaptive DEs to improve the performance of DE. The talk will finally highlight a few problems that pose challenge to the state-of-the-art DE algorithms and demand strong research effort from the DE-community in the future.

FUZZ-IEEE Tutorials

Tutorial: A primer on challenges in Ethical AI – from practice to teaching
Organizer(s): Keeley Crockett; Tayo Obafemi-Ajayi; Christian Wagner
Date: June 30, 2024
Time: 14:10 – 16:10
Room: 211+212
Abstract: The aim of this tutorial is to briefly introduce and discuss a range of ethical issues that need to be considered by data scientists, software development teams, industry and academia professionals either when applying AI, conducting AI research, or developing teaching materials and research funding applications. We will highlight practical approaches such as consequence scanning to evaluate the ethical impact of AI research ideas/new products and services on individuals and society. There is no specific prerequisite knowledge required. It will be an interactive session where participants are expected to bring their own laptops with internet connection. Tools such as padlet and mentimeter will be used to help facilitate group discussions. Participants will be equipped with skills and tools to empower them to carry out their research and teaching within the scope of Ethical AI.

Tutorial: Interpretable Fuzzy Networks for Explainable Artificial Intelligence
Organizer(s): Alexander Gegov; Farzad Arabikhan
Date: June 30, 2024
Time: 8:30 – 10:30
Room: 211+212
Abstract: This is a 2-hour tutorial that includes two 45-minute parts. Each part will be followed by a 15-minute discussion session with questions and comments from the audience.

The tutorial focuses on the inherent interpretability of fuzzy networks which makes them a suitable tool for building explainable artificial intelligence models. These models facilitate the identification of causal relationships between inputs and outputs by intermediate variables.

The tutorial highlights some recent research results of the presenters that have been published in several specialised journals such as ‘IEEE Transactions on Fuzzy Systems', ‘Fuzzy Sets and Systems', ‘Intelligent and Fuzzy Systems', ‘Computational Intelligence Systems', ‘Uncertainty, Fuzziness and Knowledge Based Systems' as well as in the Springer Book Series ‘Studies in Fuzziness and Soft Computing'.

The tutorial is expected to be attended mainly by participants from the Fuzzy Systems strand of the congress but participants from the other two strands may also be interested to attend. In view of the current high popularity of Explainable Artificial Intelligence and the exponential growth in the number of recent publications in this area, the tutorial is expected to be well attended by a large number of congress participants.

Tutorial: Using Fuzzy Sets and Systems for Explainable Artificial Intelligence – How and Why?
Organizer(s): Jose M Alonso; Direnc Pekaslan; Christian Wagner
Date: June 30, 2024
Time: 10:40 – 12:40
Room: 211+212
Abstract: AI is pervading many aspects of our Society. This poses challenges to avoid people being put aside when their own data are processed by AI systems, which provide decisions that may result in harmful discrimination. Our focus is on knowledge representation and how to enhance human-centered information processing in the context of Explainable Artificial Intelligence (XAI in short). XAI is an endeavor to evolve AI methodologies and technology by focusing on the development of intelligent agents capable of both generating decisions that a human can understand, and explicitly explaining such decisions. This way, it is possible to scrutinize the underlying intelligent models and verify if automated decisions are made based on accepted rules and principles, so that decisions can be trusted, and their impact justified. Accordingly, intelligent systems are expected to naturally interact with humans, thus providing comprehensible explanations of decisions automatically made.

Accordingly, there are three main open research problems: (1) designing explainable algorithms; (2) implementing explainable human-machine interfaces; and (3) evaluating the goodness of explanations.

Even if this tutorial will briefly introduce the main concepts and methods in the context of XAI in general, the focus will be on how to deal (and compute) properly with words and perceptions in both generation and evaluation of explanations. More precisely, we will consider the explainable design of Fuzzy Sets and Systems for paving the way from interpretable machine learning to XAI. Such systems deal naturally with uncertainty and approximate reasoning (as humans do) through computing with words and perceptions. This way, they facilitate humans to scrutinize the underlying intelligent models.

This tutorial is of interest for researchers, practitioners, and students (PhD, MSc, BSc, or undergraduate students) working in the field of XAI; with special emphasis on fuzzy-grounded knowledge representation and reasoning.

Tutorial: A leap forward in overcoming the drawbacks of fuzzy set theory
Organizer(s): Gustavo Rivas-Gervilla
Date: June 30, 2024
Time: 8:30 – 10:30
Room: 213
Abstract: Adapting crisp systems and their crisp foundations (algorithms, concepts and theories) to the fuzzy case is both a necessity and a challenge. A necessity because "fuzziness" is at the core of human reasoning and communication abilities, and we are in the era of systems that intend to manage information provided by humans, communicate with humans using concepts and natural language, and emulate human reasoning. A challenge because, though a plethora of resources have been provided over fifty-five years of research in fuzzy set theory and their extensions, we still have to renounce to properties of crisp systems when moving to the fuzzy side. Paradigmatic examples are the unability of fuzzy set theories to keep all the Boolean properties of set operations simultaneously, and the unability of fuzzy numbers to keep the algebraic structure of crisp numbers. In this tutorial we talk about new theories for representing graduality for a swift, simple and property-lossless move to the fuzzy side.

Tutorial: Efficient Optimization of TSK Fuzzy Systems
Organizer(s): D. Wu
Date: June 30, 2024
Time: 10:40 – 12:40
Room: 213
Abstract: TSK fuzzy systems have been widely used in classification and regression. However, for big data, traditional evolutionary algorithm based and full-batch gradient descent based optimization strategies become too costly. This tutorial first introduces functional similarity/equivalence between TSK fuzzy systems and classical machine learning models such as radial basis function network, mixture of experts. Then, it extends their optimization techniques, such as mini-batch gradient descent, DropOut, Batch normalization and Adam, to the optimization of TSK fuzzy systems.