Proceedings OLA'2024 International Conference on Optimization and Learning

ola 2024
Dubrovnik, Croatia

13-15 May 2024

Organizers

Université de Lille

RIT | Croatia

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JaxDecompiler: Redefining Gradient-Informed Software Design

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Among numerical libraries capable of computing gradient descent optimization, JAX stands out by offering more features, accelerated by an intermediate representation known as Jaxpr language. However, editing the Jaxpr code is not directly possible. This article introduces JaxDecompiler, a tool that transforms any JAX function into an editable Python code, especially useful for editing the JAX function generated by the gradient function. JaxDecompiler simplifies the processes of reverse engineering, understanding, customizing, and interoperability of software developed by JAX. We highlight its capabilities, emphasize its practical applications especially in deep learning and more generally gradient-informed software, and demonstrate that the decompiled code speed performance is similar to the original.

*Speaker

Fractal Decomposition Algorithm with Bipartite Binarization

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In this article and within the framework of our first study, we propose an innovative strategy that involves the utilization of a metaheuristic initially designed to address continuous problems and adapt it successfully to solve binary domain problems. The specific metaheuristic in question is known as the Fractal Decomposition Algorithm (FDA). The adaptation process consists of two crucial steps. First, we transform the values belonging to the continuous domain into a range of values between 0 and 1. Subsequently, through meticulously defined rules in our study, we are able to map this range of values to binary unit values, i.e., 0 and 1. As a result of these adaptations, we have successfully presented an implementation of FDA, and the obtained results, along with the performance of this metaheuristic in solving the Knapsack Problem, demonstrate its effectiveness.

*Speaker

A Proposal of Evolutionary Hyperheuristics Ecosystem

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In this paper, we propose a framework of evolutionary hyperheuristics ecosystem (EHE). The EHE is a mixture of metaheuristic algorithms with their hyperparameters, each of which is encoded into a vector to be optimized by the meta-level evolutionary algorithm. In each subpopulation assigned to each algorithm, we perform different search depending on the strategies and their hyper- parameters. The objective function of the meta-level evolutionary algorithm is the performance of the target benchmarking problems set, and the obtained information of the mixture of metaheuristic algorithms are transferred to solve similar applications to the benchmarks.

*Speaker

A Constraint Programming Approach for the Preference Tourist Trip Design Problem

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Currently, tourists seek to optimize their time when planning a trip to another country to visit attractions and places that match their tastes and preferences. Among these preferences is slow or relaxed tourism, which demands visiting less popular places and having in mind conscious relaxed tourism. Linear programming has been used in some studies to solve optimization problems related to tourist routes, but its use is limited due to the complexity of the constraints in these problems. In contrast, constraint programming can handle complex constraints more naturally, allowing for better constraint modeling and more efficient problem solving.This paper addresses this problem by using constraint programming techniques for the optimization of tourist routes. Constraint programming has been proven to be an effective technique for solving optimization problems related to tourist routes given its ability to model complex constraints and conflicts in solutions naturally.
The results obtained in this article demonstrate that constraint programming using complete search techniques provides better results compared to linear programming. In particular, the proposed technique achieved the optimal solution for 70% of the tested instances, surpassing the results obtained by state-of-the-art studies and highlighting its efficiency in execution time. In summary, it is concluded that constraint programming is a more effective and efficient technique than linear programming in optimizing tourist routes in view of its ability to naturally model complex constraints and conflicts in solutions.

*Speaker

Optimization of Hydro Generation and Load Forecasting Based On LSTNet

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Renewable energy generation and power load forecasting are important in both advanced smart grid and sustainable development. Many RNN related methods were used in prediction of power generation time series data but they often fails to capture very long-term correlations in practice due to the vanishing gradient problem. We introduced a modified version of the LSTNet model, which incorporates CNN, LSTM, SKIP-LSTM and Dense components. This model captures both short-term patterns and addresses the issue of vanishing gradients when capturing long-term patterns. We applied this model to predict hydro power and grid load, and by comparing the MAPE, MSE, and MAE metrics, it is evident that the performance is superior to the commonly used LSTM, GRU, and SimpleRNN models in time series analysis of smart grid. The integrated model can be applied to the intelligence of renewable energy grids.

*Speaker

HOTS : A containers resource allocation hybrid method using machine learning and optimization.

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One of the main challenges in cloud computing is resource management, the ability to schedule workloads and services over the infrastructure in the most automated way. By optimizing cloud assignment and resource usage, energy can be saved, production incident can be anticipated and services QoS improved. With the recent years emergence of light virtualisation, known as containerization, the resource allocation problem was brought back, notably to support containers elasticity, hence the dynamic allocation of ressource at runtime at a single service scale.

In this paper we show that using an hybrid loop system, which combines unsupervised learning and optimization techniques, our algorithm provides and iteratively improves scheduling solutions to containers resource assignment, enabling capacity planning over dynamic resource loads. Within our benchmarks, these solutions outperform state of the art algorithms, by an average of 6.3%, while providing more expressivity and control over input parameters.

We describe also the implementation of this method, through an open source Python library called HOTS, which allows hybrid optimization for time series based use cases.

*Speaker

Data-driven Learning for the Nurse Scheduling Problem

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Solving a combinatorial optimization problem involves finding a consistent assignment of values to variables satisfying a set of constraints while optimizing some objectives. Before solving a given problem, the latter must be modeled in terms of decision variables, their domains, hard and soft constraints, and one or more objective functions. Modeling can, however, be a tedious task requiring strong expertise. In this context, modeling the Nurse Scheduling Problem (NSP) in healthcare units may be achieved actively through an expert or passively using historical data. Furthermore, passive modeling may be done manually or
automatically. Manual modeling involves examining historical data and eliciting the problem's constraints. However, given the massive amount of available data, this process may be tedious. Therefore, automatic modeling may be considered to overcome this challenge in practice (especially in case of incomplete knowledge about the constraints and preferences). Constraints can be learned implicitly by relying on machine learning methods or explicitly using constraint learners. In this paper, we propose two modeling approaches to learning the NSP; the first approach aims to learn a constraint network, represented as a Constraint Satisfaction Problem (CSP), and the second is to approximate the NSP constraints and preferences from historical data. More precisely, we tackle the following two research questions; "How to learn explicitly a CSP model for the NSP given historical
data?" and 'How can we approximate the constraints and preferences of the NSP using historical data?"

*Speaker

Approaching Single-Episode Survival Reinforcement Learning with Safety-Threshold Q-Learning

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Survival Reinforcement Learning is a specific type of RL problem that is constrained by a risk of ruin. The underlying stochastic sequential decision process with which the agent interacts includes a budget that evolves over time with the received rewards and must remain positive throughout its entire lifetime. The goal is to find a good trade-off between exploration, exploitation, and safety, during a single learning episode, maximizing rewards while managing the available budget to minimize the probability of ruin. Existing approaches do not provide satisfactory solutions to this problem. This paper introduces the safety-threshold heuristic, which is used to extend the standard Q-Learning method. A simulated grid environment was used to evaluate its performance, yielding positive results.

*Speaker

Tabu Tenure Policy with Deep Reinforecement Learning

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Tabu Search is a well-established metaheuristic for tackling complex combinatorial optimization problems. The algorithm utilizes the tabu tenure parameter to prevent revisiting previously explored solutions. Our preliminary findings suggest that various attributes of the tabu search can influence the determination of the tabu tenure policy. Leveraging Reinforcement Learning, this study aims to identify influential attributes and establish guidelines for dynamically setting the tabu tenure parameter during the search.

*Speaker

NeuroLGP-SM: A Surrogate-assisted Neuroevolution Approach using Linear Genetic Programming

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Evolutionary algorithms are increasingly recognised as a viable computational approach for the automated optimisation of deep neural networks (DNNs) within artificial intelligence. This method extends to the training of DNNs, an approach known as neuroevolution. However, neuroevolution is an inherently resource-intensive process, with certain studies reporting the consumption of thousands of GPU days for refining and training a single DNN network. To address the computational challenges associated with neuroevolution while still attaining good DNN accuracy, surrogate models emerge as a pragmatic solution. Despite their potential, the integration of surrogate models into neuroevolution is still in its early stages, hindered by factors such as the effective use of high-dimensional data and the representation employed in neuroevolution. In this context, we address these challenges by employing a suitable representation based on Linear Genetic Programming, denoted as NeuroLGP, and leveraging Kriging Partial Least Squares. The amalgamation of these two techniques culminates in our proposed methodology known as the NeuroLGP-Surrogate Model (NeuroLGP-SM). For comparison purposes, we also code and use a baseline approach incorporating a repair mechanism, a common practice in neuroevolution. Notably, the baseline approach surpasses the renowned VGG-16 model in accuracy. Given the computational intensity inherent in DNN operations, a singular run is typically the norm. To evaluate the efficacy of our proposed approach, we conducted 96 independent runs spanning a duration of 4 weeks. Significantly, our methodologies consistently outperform the baseline, with the SM model demonstrating superior accuracy or comparable results to the NeuroLGP approach. Noteworthy is the additional advantage that the SM approach exhibits a 25% reduction in computational requirements, further emphasising its efficiency for neuroevolution.

*Speaker

A Multi-Objective Metaheuristic Applied to the Airborne Wind Energy Farm Layout Problem

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The power production enhancement and layout design of Airborne Wind Energy (AWE) farms for the dual objective of maximising power output and minimising the number of producing units (kites) are addressed. We employ a multi-objective optimization strategy combining two genetic algorithm metaheuristics: the Non-Dominated Sorting Genetic Algorithm-II (NSGA-II) and the Biased Random Key Genetic Algorithm (BRKGA).
The approach blends elements from both algorithms, incorporating key features such as random keys, Pareto set determination for the selection of an elite set, a biased crossover strategy and immigration. (...)
Please find the full extended abstract attached or in:

https://uporto-my.sharepoint.com/:b:/g/personal/up201806449_up_pt/EUn0xt1vKDBAilqZzp6pk0ABpM6357LWwZKhucCn55JNng?e=kU4fPD

*Speaker

How is the objective function of the Feature Selection problem formulated?

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This paper presents a comprehensive analysis of objective functions used in feature selection, a critical aspect of machine learning. We conducted a systematic literature review, categorizing objective functions into single-objective and multi-objective, with further classification into pure and weighted multi-objective functions. Our study spans research from 2019 to 2023, analyzing a total of 161 articles. We found that weighted multi-objective functions are most prevalent, highlighting their efficacy in balancing model performance and complexity. This work offers a detailed classification of these functions, contributing to a deeper understanding of their role and effectiveness in feature selection challenges. Our findings illuminate trends and preferences in objective function usage, providing valuable insights for researchers and practitioners in the field of machine learning.

*Speaker

Evidence on the regularisation properties of Maximum-Entropy RL

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The generalisation and robustness properties of policies learnt through Maximum-Entropy Reinforcement Learning are investigated on chaotic dynamical systems with Gaussian noise on the observable.
First, the robustness under noise contamination of the agent's observation of entropy regularised policies is observed. Second, notions of statistical learning theory, such as complexity measures on the learnt model, are borrowed to explain and predict the phenomenon.
Results show that complexity measures defined in the paper, such as the trace of the Fisher Information, are reliable indicators of the robustness-to-noise property of the policy.

*Speaker

Benchmarking the operational efficiency of major container ports using machine learning and bootstrap DEA

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This study aims to incorporate a machine learning approach when benchmarking the operational efficiency of 40 container ports located in five different developing regions including North Africa, West Africa, South America, North and Central America, and the Caribbean. A bootstrap data envelopment analysis (DEA) reveals that seven out of ten pairs of geographic regions differ in their operational efficiency scores, which can be explained by the diversity of the regions, port infrastructure dissimilarities, and the heterogeneity of their container port operations. Hence, this study applies a machine learning approach for clustering the container ports by similar infrastructure rather than by geographic region. The ports' infrastructure was defined in terms of quay length, land area, draft length, and number of berths. Preliminary results from this study confirm that infrastructure heterogeneity can be addressed by utilizing an unsupervised machine learning algorithm. The results generated similar efficiency distributions between groups. These results are well aligned with the current challenges faced by decision makers and suggest benchmarking best practices with container ports that are similar in terms of port infrastructure.

*Speaker

A Multi-Objective Approach for Assessing Environmental Responsibility in the Textile and Clothing Industry Supply Chain

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Today, analyzing decision-makers' environmental responsibility index is crucial as it enables us to assess their performance in terms of considering environmental issues in their decisions. This assessment can include criteria such as reducing carbon emissions, improving energy efficiency, managing waste, and utilizing sustainable materials. By evaluating decision-makers' impact on the environmental performance of the supply chain, it becomes possible to identify areas for improvement and develop targeted strategies for promoting more responsible and sustainable management. This study presents a bi-objective mathematical model aiming to minimize both cost and carbon emissions. We used the weighted sum approach method to solve the model and assess the environmental responsibility index of decision-makers in the direct supply chain of the textile and clothing industry. It demonstrates the influence of different factors, such as cost and carbon emissions, on the supply chain configuration.

*Speaker

Learning Insertion Patterns to Enhance Operational Efficiency in Large-Scale Dial-a-Ride Systems

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We study a large-scale dial-a-ride system considering around 300,000 dynamic requests. An efficient routing algorithm is crucial to guaranteeing the viability of the system. Large-scale requests are assumed to be dominated by daily commuting needs and thus should exhibit similar mobility patterns from one day to another. Consequently, daily vehicle trajectories should also be recurring if similar requests can be served in the same manner. We introduce a greedy insertion algorithm integrating a Guided Insertion Mechanism that learns insertion patterns from reference resolution to enhance the operational efficiency of the underlined systems while maintaining high-quality solutions.

*Speaker

Flexible Routing Strategies Based on Heuristic Approaches for Optimizing Last-Mile Delivery

Mohamed-Ali Ejjanfi * [1], Jamal Benhra [1]

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This research paper presents a comprehensive investigation into the development and application of flexible routing strategies to address the Vehicle Routing Problem (VRP) in last-mile delivery scenarios. The study, uniquely, considers the constraint of locker unavailability, an aspect often overlooked in previous research but integral to the optimization of modern urban logistics systems.
The research leverages advanced heuristic methods including Genetic Algorithms (GA), Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO), and Simulated Annealing (SA) to tackle these complex combinatorial problems. By harnessing the strengths of each method and engineering them to adaptively respond to the dynamic nature of last-mile delivery, the study develops innovative strategies that efficiently solve the VRP under this novel constraint.
The findings demonstrate promising routes towards improving logistical efficiency and reducing delivery times, therefore enhancing the overall customer experience in the rapidly evolving e-commerce landscape. Further, the research lays the groundwork for future studies addressing dynamic and stochastic elements in last-mile delivery routing problems, opening new avenues for exploration in this critical field of logistics and supply chain management

*Speaker

Contribution to Forecasting Demand and Occupancy for Smart Lockers in the Context of Last-Mile Delivery

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The aim of this paper is to provide a comprehensive examination and comparison of five key forecasting techniques: Triple exponential smoothing (ETS), ARIMA (autoregressive moving average), SARIMA (Seasonal autoregressive moving average), ANN (Artificial Neural Networks), and LSTM (Long Short-Term Memory). Prior to model training, we perform an extensive hyperparameter optimization to determine the best parameters for each forecasting technique. These techniques have been carefully selected due to their significant relevance and potential in the field of demand prediction, especially in the context of smart parcel locker systems. Each forecasting method is scrutinized in-depth, with a focus on their mathematical underpinnings, their practical applications, and their strengths and weaknesses in predicting demand patterns. Our analysis emphasizes the importance of precise forecasting in ensuring the flexibility of parcel locker systems, by facilitating optimal storage management and adaptation to fluctuations in parcel sizes and quantities. The insights generated from this study offer a roadmap for businesses and organizations to select the most suitable forecasting technique for their specific needs. With a nuanced understanding of these methods, fostered through rigorous hyperparameter tuning, they can enhance the utilization of their smart locker systems, thereby meeting the ever-changing demands of their customers more effectively and efficiently.

*Speaker

Parallel Strategies for Iterative Kriging-Based Surrogate Model Optimization: Bayesian Inference in Engineering Simulations

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1

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The advancement of computer hardware technology significantly contributes to resolving complex engineering challenges that require solution of complex, highly nonlinear equations. With high-fidelity numerical simulators, obtaining a solution can be time-consuming, often requiring several hours. This study aims to integrate high-fidelity analytical tools into the design cycle and thereby to reduce the overall duration of the design process through enhanced computational power. An optimization tool based on Bayesian inference process is developed to find the optimum design. In this study, deterministic numerical simulations are employed to construct a Kriging surrogate model, which represents a stochastic relationship between inputs and outputs, independent of the underlying physics of the simulations. Computational fluid dynamics (CFD), an expensive high-fidelity tool, is replaced by the Kriging surrogate model in Bayesian optimization. Latin Hypercube Sampling, which has randomness and homogeneity, is used to initialize the samples in the design space; however, it is not possible to increase the number of samples for iterative processes. Furthermore, this study investigates a hybrid methodology for parallel incremental sampling, which uses randomness and even distribution of LHS. This method is applicable for any initial quantity of samples to target number of samples. The optimization tool, which contains hybrid parallel algorithms for sampling, is tested with well-known Rosenbrock function and applied for shape optimization of delta wing using meshless CFD.

*Speaker

Optimizing Object Detection Training Over Diverse Datasets

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Object detection in images is one of the classical problems in computer vision and has been widely studied. Numerous models and methods have been proposed in the literature to cater to object detection problems in different application areas. In most recent works the object detection is usually solved by pre-training either the model or the backbone on a large dataset, e.g., MS-COCO or ImageNet and then fine-tuning the model using a application specific curated dataset. Many pretrained models are widely available in the literature. However, there are certain caveats to this approach. Firstly, this method works best when the final application and data characteristics are similar to the pre-training dataset. Secondly, the problem significantly changes when there are limited datasets available to pre-train the model for a specific application. This work addresses these two problems in the context of human search and rescue using infra-red (IR) images from unmanned aerial vehicles (UAV). There are a few reasons behind selecting this use case. Firstly, unlike object detection in ground-based platforms, object detection using drones pose some additional challenges. Some of these include, varying altitude, thus significantly changing the bounding box scales for the same object class. Similarly, varying camera angles provide different visual perception of the same object class. Secondly, for IR-based human detection, only a few open datasets are available to effectively train the model. Lastly, as in most computer vision problems, the final application, can vary significantly from the training setup. This can be in terms of camera, environmental and topographic parameters, etc. All these datasets provide a diverse set of training samples. However when training a single model to learn over diverse datasets, various imbalances like class distribution, scale in-variance, etc., can skew the model learning and its performance towards certain parameters. This works aims to study and develop a strategy to train an object detection model by posing the learning over datasets as an optimization problem. Using an empirical approach, a model is trained to detect humans from IR based images by mixing of available datasets. The main contributions of the work are, firstly, to understand if object detection training over different datasets can be posed as an multi-objective optimization problem and secondly, to evaluate mixing strategies to improve zero-shot cross-dataset performance where the model has not seen certain datasets during the training.

*Speaker

Nature-Inspired Techniques for Combinatorial Reverse Auctions in Electricity Consumption

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With the growing electricity demand, the likelihood of experiencing power outages is also rising. Utility companies have started buying electricity through e-auctions to address this issue. To meet the increasing electricity demand, we propose a solution to procure energy from various sources, trading off multiple objectives while solving a complex winner(s) determination problem for resource procurement optimization. Winner determination is an NP-hard problem, and applying exact methods is impractical. Instead, we rely on nature-inspired techniques as they are appropriate for trading the quality of the returned solution for the required running time. In particular, Genetic Algorithms (GAs) and Whale Optimization Algorithms (WOAs) are explored and evaluated in terms of effectiveness in producing high-quality solutions for several instances of the Combinatorial Reverse Auction (CRA) problem.

*Speaker

A Bayesian Optimization Approach to Algorithm Parameter Tuning in Constrained Multiobjective Optimization

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Algorithm parameter tuning is an often neglected step in the optimization process. This study shows that constrained multiobjective optimization can benefit significantly from tuning, in both the specialized (for an individual problem) and generalized (over a number of problems) parameter setting approaches. Numerical experiments conducted with three multiobjective optimization algorithms on 139 test problems from 13 benchmark suites quantify the algorithm performance improvement on individual problems. Additionally, regarding the generalized approach, alternative default parameter settings are proposed. The study also identifies Bayesian optimization as an adequate method for tuning multiobjective evolutionary algorithms with constraint handling. Overall, it is concluded that, given sufficient computational resources to apply to a problem, parameter tuning, using an approach such as Bayesian optimization, should be conducted. If computational resources do not allow such tuning, then the proposed default parameters are applicable.

*Speaker

Biologically-Inspired Algorithms for Adaptive Non-Player Character Behavior in Video Games

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1

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Video game designers frequently employ different movement algorithms to give players the impression of the intelligent and unpredictable motions of non-player characters or enemy agents. This paper explores the application of metaheuristic biological algorithms in video games to enhance the unpredictability and realism of enemy characters, moving away from traditional pre-programmed NPC behaviors. Developing the bespoke game "Run and Catch" incorporates the utilization of Particle Swarm Optimization (PSO) and Ant Colony Optimization (ACO) for directing the movement of non-player characters. We tackle the premature convergence challenge by introducing an adaptive Finder –Tracker agent approach. This mechanism maintains diversity in enemy movements to ensure responsiveness to real-time player character activities. The findings illustrate the adverse effects of early convergence on both immersion and the variety of non-player character movements within a 2D game environment. Moreover, the study underscores the success of ACO and PSO, equipped with the Finder–Tracker agent framework, in reshaping group movements of non-player characters and effectively dealing with the convergence challenge.

*Speaker

Adapted Q-learning for the Blocking Job Shop Scheduling Problem

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Reinforcement Learning (RL) approaches are becoming increasingly popular in the field of combinatorial optimization problems due to their ability to learn and adapt in unknown environments for decision-making problems. In this paper, we propose an RL agent based on the Q-Learning method to address Blocking Job Shop Scheduling (BJSS). This latter can be used to represent many manufacturing and real-world situations by handling storage-capacity constraints. To evaluate the performance of RL, we first model the BJSS problem as an alternative graph and map it to a Markov decision process. Our adapted Q-learning is based on three reward functions and two action selection methods. The results have shown that the Q-Learning method is capable of finding feasible solutions to complex BJSS problems while also learning effective selection strategies for minimizing Makespan. This is the first time a Reinforcement Learning approach has been used to tackle the BJSS
problem. It presents a good opportunity for further research and the development of more advanced methods.

*Speaker

An hybrid approach based on Graph Attention Network for the Team Orienteering Problem

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We present a Hybrid Graph Attention Model, a learning framework that integrates an efficient splitting algorithm applied to the Team Orienteering Problem (TOP) within a deep learning model. This hybrid approach operates in two steps. Initially, a *giant tour* (a sequence of customers/locations) is generated at once using a deep neural network. Subsequently, it is evaluated using the split algorithm. The primary objective is to narrow down the solution space in which the deep learning model operates, expecting an overall better performance. Two tailored solution approaches are employed to assess both the performance and the quality of the outcomes. Preliminary findings suggest that our method produces competitive solutions for the TOP.

*Speaker

A Parallel Genetic Algorithm for Qubit Mapping on Noisy Intermediate-Scale Quantum Machines

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Quantum computers are getting increasingly large and available thanks to some major technological advancements, but they remain in the realm of NISQ (Noisy Intermediate Scale Quantum) devices. On such devices, due to the limited connectivity of the physical qubits, most quantum circuit-based programs cannot be executed without transpilation. This latter includes an important step, referred to as qubit mapping, which consists in converting the quantum circuit into another one which best matches the graph of physical qubits taking into account its limited connectivity constraint. In this paper, we propose a Parallel Genetic Algorithm to Qubit Mapping (PGA-QM). The challenge is to minimize the depth of the transformed circuit and the execution time and error rate consequently. PGA-QM has been experimented using various medium-to-large scale circuit benchmarks. It is compared against the SABRE heuristic currently implemented in Qiskit, the IBM's library for quantum computing. The reported results show that PGA-QM can provide better solutions and with better consistency than its counterpart while parallelism greatly reduces its execution time during the transpilation.

*Speaker

Machine Learning Applications in Road Safety: A Comprehensive Review

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This comprehensive literature review explores the transformative potential of Machine Learning and Deep Learning methodologies in revolutionizing road safety across five fundamental pillars: Road safety management, safer roads, safer vehicles, safer road users, and post-accident response. As societies worldwide face increasing traffic challenges and encounter various road conditions, the study examines the diverse applications of ML across these critical dimensions. The review illuminates the versatility of ML techniques, ranging from traditional signal processing to advanced deep learning approaches. The findings underscore the profound impact of ML on road safety, offering actionable insights for accident prediction, infrastructure optimization, and a nuanced understanding of user behaviors. This study serves as an instructive roadmap, emphasizing the indispensable role of ML in shaping safer, adaptive, and efficient road environments.

*Speaker

Patient Visits Forecasting in the Post-Pandemic Era at Emergency Departments

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COVID-19 disrupted time series trends in Emergency Departments (ED), causing a notable decrease in patient visits. Many studies focus on pre-pandemic or pandemic-specific data, raising concerns about models trained on altered reality. This paper proposes original strategies for patient visit post-pandemic forecasts. The proposed study couples deep learning models, such as LSTM or CNN, to pandemic-included preprocessing data to reduce accuracy loss. The first approach incorporates explicit COVID-19 features labeling the data in the deep model used for forcecasting. In the second approach, the COVID anomaly period is manually excluded for the data and aggregated pre-COVID and post-COVID data are used. To illustrate the study, we assess the models using a dataset from a public French hospital, acknowledging challenges in time series forecasting. Results reveal that the proposed strategies achieve high performance, showcasing forecasting accuracies with MAPE values of 7.26% and 7.92% for the first strategy, and 8.55% and 8.24% for the second strategy.

*Speaker

Solving a shareable-setup time prize collection VRP applied to an electrical maintenance sector

Roberto Tavares * [1], Arineia Nogueira [1], Mario Batalha [1], Roberto Martins [1], Herick Moralles [1], Rafael Seeberger [2], Gustavo Mendonca [3], Mauro Goncalves [2]

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In this paper proposes a new variation of the prize-collecting vehicle routing problem. This problem, inspired by the daily work of a maintenance sector of an electrical company, considers sequence-dependent setup times, based on the location of each service. Also based on the practical scenario, the prize is defined based on the due date of each pending service. To solve this problem, this research proposes a Mixed-Integer Linear Programming (MILP) formulation and an Iterated Local Search procedure. Our analysis shows that the operators used in the ILS could provide interesting results when compared to the MILP formulation.

*Speaker

Robust Models for Learning Languages

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This paper focuses on learning probabilistic finite state automata in the context of grammatical inference. We introduce a two-step process: first, constructing a robust meta-model of 3-sort Non-deterministic Finite Automaton (3NFA); second, deriving a probabilistic automaton using a weighted-frequency approach. This allows for creating 3NFAs that are more or less accepting, respecting the sample classification. The proposed methodology offers robustness by adjusting weights for higher acceptance or rejection probabilities. Overall, the research extends the application of grammatical inference to probabilistic responses with potential implications in various domains.

*Speaker

Optimisation-based classification tree: A game theoretic approach to group fairness

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The growing use of machine learning algorithms in decisions that significantly affect people necessitate interpretable and fair approaches. Mathematical programming based machine learning models have attracted attention because of the flexibility they provide to integrate features like interpretability and fairness, combined with high accuracy. This work introduces a mathematical programming based classification tree that uses a game theoretic approach to address group fairness. The proposed mathematical formulation is a Mixed Integer Linear Programming model using a piecewise linearisation strategy based on special-ordered sets. The overall misclassification rate is the fairness metric examined and the Nash bargaining scheme is followed to balance the trade off between the misclassification error of the groups. The efficiency of the methodology is evaluated via three binary and multi-class literature datasets, which provide evidence for the fairness and accuracy of the predictions made by the model.

*Speaker

The Capacitated Vehicule Routing Problem with Pickup and Delivery using Suppliers for single and multiple commodities

Damien Blanchard * [1], Hamamache Kheddouci [1]

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In this paper, we deal with a new kind of VRP based on a depot that holds no commodities and instead the commodities can be picked up at suppliers to then be delivered to the customers. It will be named Capacitated Vehicule Routing Problem with Pickup and Delivery using Suppliers (CVRPPD-S). We will modelise it, but focus our efforts on a simpler version of the problem, with one vehicle and one kind of commodity : the 1-commodity Pickup and Delivery Traveling Salesman Problem using Suppliers (1-PDTSP-S). We will explore an algorithm to give us an optimal solution, then heuristics (in particular, a tabu search) to obtain a fast effective solution.

*Speaker

Advancing Road Safety Metrics: Exploring Index construction

El Khalai Ibtissam * [1], Zoubida Chorfi [1], Abdelaziz Berrado [1]

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Composite indicators stand as a powerful instrument for consolidating information from diverse domains into a single index. Their primary purpose is to offer a comprehensive overview of various factors or domains related to the subject under consideration. In recent years, the road safety community has increasingly acknowledged the pivotal role of composite indicators in enhancing decision-making processes. This study explores the specific motivations driving the development of these metrics within the road safety research field and analyzes the procedures and methods employed for this purpose. Through a careful examination of a selection of relevant studies, valuable insights into the significance and use of road safety indexes have been gained. This exploration unveils the reasons behind their widespread use and provides a deeper understanding of the techniques and methodologies applied in their construction. Consequently, our research establishes a robust foundation for future endeavors in the construction and refinement of road safety composite indicators.

*Speaker

Battery Management Strategies Optimization for Urban Plug-in Hybrid Buses

Patricia Ruiz * , Jose Miguel Aragon-Jurado *

, Juan Francisco Cabrera *

, Juan Carlos De La Torre , Bernabe Dorronsoro *

[1]

[1] University of Cadiz (UCA) – Spain

Urban traffic is among the main air pollution sources in our cities. Consequently, one of the main lines of action in the transition towards the future sustainable smart cities is reducing tailpipe emissions. The electrification of vehicles is a feasible solution that is currently being implemented, and it will allow achieving huge savings in traffic pollutant emissions. However, they have some drawbacks like, the limited autonomy or the long recharging times. Plug-in Electric Hybrid (PEH) buses emerge as a more flexible solution while still highly reducing pollution levels. They can switch between electric motor and diesel engine at any time, allowing an efficient location of zero-emission zones (ZEZ) that not only provide environmental benefits but also social. The current strategies for managing the battery are very conservative and na¨ive, but more advance strategies can make use of their full potential.
This extended abstract presents our work (2), recently published in Sustainable Cities and Society where the Multi-objective Efficient PEH Bus Operation Problem, MEPBO for short, was proposed. It proposes that a tailored location of the ZEZ, i.e. a tailored battery management strategy can enlarge the electric range of the bus while at the same time reduce the pollution. A
novel methodology for accurately estimating the energy consumption of the PEH bus is presented and two multi-objective optimization algorithms from the state of the art are used to solve this problem

*Speaker

Automatic Software Performance Optimization using Genetic Algorithms

Jose Miguel Aragon-Jurado * , Juan Carlos De La Torre , Patricia Ruiz *

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Software programs (SW) are who ultimately drives the underlying hardware (HW). Therefore SW should make an efficient use of all available resources in order to achieve high performance levels when executing.

Compilers typically perform a number of code transformations, also known as optimizations, before generating the executable file. The purpose of applying such optimizations is to modify the use of the underlying HW by the considered SW. These are generic sequences of optimizations that are known to generally perform well. However, it is clear that distinct SW programs and HW architectures offer different characteristics, and the same sequence of code transformations cannot fully exploit them for optimal performance.

Therefore, there is a need of finding ad hoc optimization sequences to accurately optimize the performance of every SW/HW pair. However, this is a titanic task, taking into account the immense variety of existing HW architectures, for which every SW must be optimized. In addition, the process of optimizing SW performance for a given HW architecture is a difficult, error prone, and expensive task, requiring the hands of expert programmers with high knowledge on the considered architecture. Automatizing this process would allow the generation of a new generation of smart compilers, able to perform ad hoc transformations for the considered SW and HW for optimal performance.

We propose in this work a novel approach to automatize the process of optimizing the performance of a particular SW program on a specific HW. For that, we define a novel combinatorial optimization problem, that we call SCOP (for Software Code Optimization Problem), consisting in finding a sequence of code transformations that minimizes the runtime of the resulting SW on the considered HW architecture. This extended abstract presents our work (2), recently published in IEEE Transactions on Sustainable Computing.

*Speaker

A Multi-objective Clustering Algorithm Integrating Intra-clustering and Inter-clustering Measures

Beatriz Flamia Azevedo * [1], Ana Maria A. C. Rocha [2], Ana I. Pereira [1]

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This study delves into bio-inspired approaches and clustering methodologies to introduce an automated clustering algorithm named Multi-objective Clustering Algorithm (MCA). Using multi-objective strategies and various combination measures, this algorithm calculates the optimal number of clusters and element partitioning by minimizing intra-clustering measures and maximizing inter-clustering ones. Through experimentation on three benchmark datasets, the results highlight the success of the MCA in obtaining a set of optimal solutions (Hybrid Pareto front) through the integration of multi-objective strategies and clustering measures. Moreover, the Dumn clustering validity index is used to support the decision maker in selecting the optimal solution among the ones presented in the Hybrid Pareto front. This approach allows decision-makers to choose the most suitable solution by incorporating additional insights beyond the model.

*Speaker

A Benchmark for Missing Data Imputation Techniques: development perspectives and comparative of performance

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Knowledge extraction from information stored in databases is always subject to the presence of missing values. Missing data is an unavoidable problem that affects many disciplines of researchers and data scientists. Inasmuch as machine learning algorithms cannot work with incomplete data in the data sets, data imputation is an essential task to obtain quality data. This research approach provides an overview of the data missingness mechanism and the process of generating synthetic missing data, the imputation of all types of variables, and the performance assessment of several imputation methods. Traditional algorithms, Machine Learning methods and various Autoencoder-based deep learning architectures have been studied. An exhaustive analysis and comparison of 21 heterogeneous data sets in various areas has been proposed. They have been exposed to a perturbation procedure with different missingness mechanisms and various missingness rates, covering the different possibilities that can occur in real life. The experimental results show that deep learning models outperform the other methods studied. Furthermore, the performance of data imputation methods does not depend on the missingness mechanism or the synthetic missingness generation method used nor on the percentage of missing values.

*Speaker

Selecting the Most Relevant Objectives Using Data Minning: A Real-World Case Study

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Often in real-world optimization problems is difficult to define the objectives that are important to effectively optimize the process. In the phase of problem definition, the decision maker, who knows the process, is faced with many aims or objectives, but he/she does not know if they are relevant and will help in optimizing the problem. This work proposes a method based on data mining to identify the relations between the data, decision variables and objectives, which enables the determination of the redundant objectives and the ones that are less important to the optimization. This method, together with a multi-objective evolutionary algorithm is used to optimize a problem with a previous definition of twenty-one objectives allowing to identify the set of relevant objectives. The results obtained allow to conclude about the effectiveness of the approach proposed.

*Speaker

On the Organization Network Analysis

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To improve working conditions, increase productivity, and optimize performance, organizations, whatever their activity area, are more and more interested in studying, understanding,
and taking advantage of their informal networks existing between employees
through an Organizational Network Analysis (ONA). ONA is the process that leverages data from informal relationships between different actors within the organization to fit these objectives. It consists of analyzing how the inner work is actually performed and then determining
the most appropriate actions and measures to take for performance purposes.
The main goal of this paper is to discuss the general framework of ONA through reviewing, analyzing, and classifying different recent works on the issue. Also, to highlight the relationships among different ONA objectives considered in the literature and identify and discuss different research gaps worthy of being explored.

*Speaker

GPU Computing in Chapel: Application to Tree-Search Algorithms

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We investigate the design and implementation of a GPU-accelerated tree-search algorithm in Chapel. The latter is motivated by the emerging GPU support of Chapel, which stands as an alternative to traditional low-level programming environments, such as CUDA. The algorithm is based on a general multi-pool approach equipped with a load balancing mechanism. It is experimented on the N-Queens problem and compared to a CUDA baseline implementation using up to 8 GPUs. Both Nvidia and AMD GPU architectures are considered. We demonstrate that the Chapel's high level of abstraction causes a performance loss of only 8% in our experiments, and our algorithm achieves up to 75% of the linear speed-up in best scenarios.

*Speaker

S3EA: A Self-Supervised Stacked Ensemble Framework for Robust Anomaly Detection to Reduce False Alarms

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Anomaly detection plays a critical role in safeguarding critical industrial applications, such as cooling systems. This study proposes a novel self-supervised stacked ensemble framework (S3EA) for robust anomaly detection to reduced false alarms in cooling systems. This framework utilizes five base models, including convolutional autoencoders (CAEs), variational autoencoders (VAEs), hybrid models with LSTM, and conventional autoencoders, that are trained on unsupervised data. Using the output of the base-models the ensemble meta-model identifies the final anomalies. S3EA significantly outperforms individual base models and achieves improvement of model performance - accuracy, false positive rate and mean absolute error. The effectiveness lies in its ability to combine the strengths of multiple models and thus, it reduces false alarms by 20.8%. S3EA's superior performance and adaptability make it a promising tool for proactive risk mitigation in cooling systems

*Speaker

A Parallel Surrogate Approach for High-Dimensional Constrained Optimization with Discrete Variables

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This paper presents a parallel surrogate approach for high dimensional constrained black-box optimization where the decision variables are discrete. The motivation is to solve highly constrained simulation-based optimization problems with a large number of discrete variables such as the Mazda benchmark problem that has 222 ordinal discrete variables and 54 black-box constraints. The proposed algorithm is a parallel implementation of the Two-Phase CONDOR algorithm that begins by using surrogates of the constraints to find a feasible point, and then uses surrogates of the objective and constraint functions to improve on this feasible point. Computer experiments on the Mazda problem and on test problems suggest that Parallel CONDOR yields good speedups in terms of the number of parallel evaluations to find a feasible point. Moreover, it provides a significant improvement in the quality of solution over the original (serial) CONDOR given a fixed number of parallel evaluations.

*Speaker

Feature Selection Based on Membrane Clustering

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1

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Given increased complex data with high dimension, feature selection aims to select a subset of features to increase the efficiency of machine learning. This paper proposes a new feature selection method based on membrane computing. The proposed method has two main advantages. First, it provides a new solution to search for feature combination while requiring no model construction (which is time consuming) to evaluate a feature subset. Second, feature selection is embedded in a membrane clustering algorithm, which is designed to enable searching for the best feature subset and finding active cluster centers at the same time. The designed clustering algorithm mimics the behavior of multiple cells and it has stronger global search ability than existing evolutionary algorithms. The efficacy of the proposed method has been shown by evaluation on a set of benchmark data sets.

*Speaker

Collaborative Smart Agriculture: Leveraging Technology and Community Partnerships to Improve Crop Yields and Sustainability- A Case Study

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2

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In recent times, we have been witnessing the effects of climate change, escalating issues related to energy and food supply, and disruptions in the supply chain. These factors serve as the primary inspiration for our project, which focuses on supporting small family farms engaged in agricultural production.
Collaboration within the agricultural supply chain has garnered considerable attention in response to the growing global demand for increased crop yields and sustainable farming practices. Small family farms, often situated in rural areas, face challenges due to their limited resources, geographical dispersion, and isolation from larger centers and each other. This makes it challenging to exchange experiences, provide education, and establish a robust network.
Typically constrained by limited access to resources such as land, capital, machinery, and technology, small family farms may encounter difficulties in reaching markets and distribution networks. The smaller scale may also make it challenging for these farms to specialize in a particular crop or livestock production, potentially limiting their competitiveness and reliability.
Although the potential benefits of smart collaboration in farming are recognized, its widespread implementation is hindered by high costs and time consumption, especially among individual farmers lacking proper knowledge. Effective collaboration necessitates the sharing of equipment, data, and expertise, but farmers may be hesitant to share confidential information.
In the first part of our project, we focused on implementing technological solutions to enhance agricultural production. During this phase, we installed sensors and collected data. The entire process is still ongoing. Based on the gathered data, we will develop a smart farming model based on IoT for vegetable cultivation management and optimization.
Throughout the process, our host, Darko Hrnčević, who provided his greenhouse for the project, learned alongside us. Additionally, two more owners of small family farms, Zeljka and Predrag, visited him during the process, expressing interest in participating in the project. From their discussions, we can infer that they are open to collaboration and the implementation of new technologies, with Darko's project inspiring them. Interestingly, they independently concluded that, besides advanced technological solutions, their mutual collaboration is essential for success. This leads us to the second phase of our project, where we anticipate providing education and encouraging more owners to collaborate and develop advanced strategies for managing the agri-food supply chain.

*Speaker

Ants' detection and tracking based on Convolution neural networks: a comparative study

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In last few years, deep learning has achieved a lot of success in visual tracking. The purpose of this paper is to review the different tracking methods based on deep learning and traditional tracking algorithms. First, we introduce different traditional and deep visual tracking algorithms, Then we take 4 different trackers and explain its network perspective and workings, to conduct an extensive study to compare the different trackers on our ants dataset. Finally, we give a comparative insight on all the trackers and summarize our findings to point out the future trends for visual tracking.

*Speaker

Through Optimal Vision Transformer architectures based on metaheuristics

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In recent years, classical neural architectures have shown great potential for computer vision tasks, such as image classification and detection. Simultaneously, the exploration of neural architectures has increased, aiming to reduce human efforts. From convolutional neural networks to recent studies on Computer Vision Transformers (ViT) networks, the significance of exploring hybrid architectures with diverse building blocks has become evident. However, manually designing neural network architectures and optimizing their hyperparameters pose significant challenges. It has been observed that the performance of ViT networks is intrinsically linked to factors such as depth, embedding dimension, and the number of heads, which can significantly affect network performance. In this work, we propose a new automatic search technique for a pure ViT network architecture and a hybrid cell-based CNN architecture combined with a Vision Transformers network. The algorithm, based on fractal decomposition, is referred to as Fractal Decomposition Algorithm (FDA)

*Speaker

Neural Architecture Tuning: A BO-Powered NAS Tool

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Neural Architecture Search (NAS) consists of applying an optimization technique to find the best performing architecture(s) in a defined search space, with regard to an objective function. The practical implementation of NAS currently carries certain limitations, including prohibitive costs with the need for a large number of evaluations, an in- flexibility in defining the search space by often having to select from a limited set of possible design components, and a difficulty of integrat- ing existing architecture code by requiring a specialized design language for search space specification. We propose a simplified search tool, with efficiency in the number of evaluations needed to achieve good results, and flexibility by design, allowing for an easy and open definition of the search space and objective function. Interoperability with existing code or newly released architectures from the literature allows the user to quickly and easily tune architectures to produce well-performing solu- tions tailor-made for particular use cases. We practically apply this tool to certain vision search spaces, and showcase its effectiveness.

*Speaker

Adaptive greedy heuristic algorithm for rubber tyred gantry crane scheduling problem at container terminal

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This paper deals with the gantry cranes problem scheduling at a container terminal. The scheduling of this equipment so as to minimize their container assignment time when executing two different operations. A mixed integer linear programming model is developed to minimize the execution time. An optimized greedy heuristic algorithm (GHA) is also applied to solve this problem, with a new best-scheduling update strategy included to improve the stability of the solution. For small-scale problems, the proposed GHA solutions were compared with the optimal solutions obtained from the model using CPLEX software. For large-scale problems, the proposed GHA solutions are compared with large instances due to its inability CPLEX to solve the problem optimally in a reasonable time. Modeling is developed to handle this problem in the context of container traffic at the import or export level. The results of this study confirm that the GHA method proposed in this article is capable of efficiently solving the RTG cranes scheduling problem on the container terminal.

*Speaker

Learning Estimators for Energy Management

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We deal here with the joint management of a photovoltaic platform and of the consumption of resulting energy by jobs subject to temporal constraints. Running a job requires assigning it a battery, loaded by the platform with some amount of energy, and this interaction through the batteries between the energy production activity of the platform and the consumption of this energy by the jobs requires the implementation of complex synchronization mechanisms. Since it most often involves distinct players with their own agenda and non-shared information, we short-cut the production level with the help of surrogate estimators. Those estimators involve pricing mechanisms and machine learning devices. We design and test several algorithms that implement this approach.

*Speaker

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