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Book of Abstracts

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Welcome

Welcome to OL2A 2025 - International Conference on Optimization, Learning Algorithms and Applications.

OL2A offers a forum for the research community on optimization and learning to get together and share the latest developments and techniques, as well as to develop new paths and collaborations. OL2A provides a broad scope of presentations, covering many areas of optimization and learning and state-of-the-art applications to multi-objective optimization, optimization for machine learning, machine learning for optimization, optimization and learning under uncertainty and the fourth industrial revolution.
It is with great pleasure that the Organizing Committee welcomes you all to OL2A 2025!

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Invited Plenary Lectures

Incorporating dissimilarity into alternative paths computation

Marta Margarida Braz Pascoal

Biography: Marta Pascoal received her BSc in Mathematics-Computer Science in 1996 and her MSc in Applied Mathematics in 1998 from the University of Coimbra, Portugal. She completed the PhD in Applied Mathematics from the same university in 2005. From 2005 to 2025 she served as Assistant Professor and then Associate Professor in the Department of Mathematics at the University of Coimbra. Since 2021 she holds the position of Associate Professor in the Operations Research and Discrete Optimization group within the Department of Electronics, Information and Bioengineering of the Politecnico di Milano, Italy. She is the author of a number of articles in international journals, books and conference proceedings in her field. She supervised several doctoral and master's theses. She was a visiting scholar at the Centre interuniversitaire de recherche sur les reseaux d'entreprise, la logistique et le transport (CIRRELT), Montréal, Canada; and the Johannes Kepler University, Linz, Austria. Currently, she serves as an associate editor of the journal "RAIRO: Operations Research" and has refereed articles for various international publications. Her scientific activity has focused on Operations Research, particularly in mono- and multi-objective combinatorial optimization. A significant aspect of her work involves developing mathematical models and efficient algorithms to problems arising in network optimization, telecommunication networks and transportation.

Abstract: The computation of alternative paths in a network is a relevant optimization problem with applications across various fields. Classical approaches to the problem typically guide the search for solutions based on the increasing order of a cost objective function. However, these alternative solutions often exhibit minimal differences, which may be undesired in practice. For instance, in contexts like routing, where the network may be subject to failures, this similarity can jeopardize services. The reliability of the solutions can be enhanced by identifying alternative solutions that are significantly diverse from each other. In the first part of this presentation, we address the problem of finding sets of paths that are dissimilar among them. This is done with different modelling approaches based on mixed integer linear programming. In the second part, we extend the initial models to incorporate the optimization of an additional objective function representing the cost of the solution. Finally, we examine the case in which the dissimilarity between paths is not uniform across the network.

Learning on Graphs: state-of-the-art and open challenges

Nicolò Navarin

Biography: Nicolò Navarin is an associate professor in Computer Science at the Department of Mathematics, University of Padua, Italy. He got his Ph.D. in computer science from the University of Bologna, Italy, in 2014. His research experience includes visiting positions at the University of Freiburg, Germany; the Università della Svizzera Italiana, Lugano, Switzerland; and 3IA Côte d'Azur, Sophia Antipolis, France. He has been a research fellow at the University of Nottingham, UK, and assistant professor at the University of Padua. Prof. Navarin's research interests are in the field of machine learning, including kernel methods and neural networks for structured data, and applications to bioinformatics, business process mining, computer vision, and computational psychology. He is a member of the IEEE Computational Intelligence Society, the IEEE Task Force on Deep Learning, and the International Neural Network Society.

Abstract: In the first part of the talk, we will present some state-of-the-art approaches for graph processing with neural networks, particularly focusing on techniques that go beyond the message-passing framework or that exploit randomization for computational efficiency. In the second part of the talk, we will explore the setting of evolving graphs. We will focus on graph learning for non-i.i.d. data - in particular continual learning on graphs and its online version - exploring the unique challenges that this setting presents and some possible solutions. In particular, we shall see that decoupling representation learning from the training of specific task outputs (e.g. exploiting randomized representations while training only the output layer) provides us with an elegant, effective, and computationally efficient method to tackle continual learning on graphs.

Special Sessions

AIHaM - Artificial Intelligence in Healthcare and Medicine

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Description: Artificial intelligence (AI), optimization, and data analytics significantly impact healthcare systems. Data-driven diagnostic systems and machine learning algorithms are important tools in healthcare to help professionals identify, analyze, and understand patient conditions and disease development. These systems enable early detection and intervention, which are crucial to reducing disease-related complications and supporting decision-making. Therefore, research on AI innovations and challenges in healthcare and medicine is welcome.

Topics: Optimization · Machine Learning · Case Studies · Data Analysis · Healthcare · AI for Diagnostics · Patient Data Privacy and Security.

MLAIR - Machine Learning and AI in Robotics

Organizers:

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Description: Robotics is a vast and complex knowledge field that includes the scientific concepts and principles of different areas of expertise, such as mathematics, physics, computer science, electronics, and mechanics. Since it is extensive, its challenges can be divided into different and active research areas. Despite being a relatively mature subject, it has much to evolve, especially in autonomous robotics. With the advent of machine learning (ML) algorithms, new and improved solutions are being proposed. One example is the application of embedded Machine Learning (also known as Edge ML), which allows local sensor data processing to improve robot perception and control. Although the current hardware is powerful enough to run power-hungry software, machine-learning techniques typically require high processing power and increased energy consumption. This situation creates a gap in implementing Edge ML and AI in equipment with limited processing power, energy, and connectivity, like autonomous robots. Therefore, this session welcomes machine learning works applied to robotics and its sensors, including those related to embedded ML, Edge ML, or Edge AI.

Topics: Robotics · Machine Learning · Case Studies · Deep Learning · Embedded ML · Edge ML · Edge AI.

OCSD - Optimization in Control Systems Design

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Description: Optimization is currently applied to a myriad of different knowledge areas that span from economic applications to social sciences. Optimization plays a fundamental role in several design strategies in the control engineering framework, such as predictive, fuzzy, decentralized and optimum control, among many more. Moreover, due to the increased tendency to integrate soft-computing techniques into control loops, and since those methods frequently rely on optimization algorithms to be able to learn, adapt and react, optimization is fundamentally ubiquitous in the control engineering realm. Since many researchers are working in this area, it is fundamental to provide a vehicle for them to present their results and foster a place where discussion regarding the use of optimization techniques in control can occur.

Topics: Control Systems Sesign · Optimization.

OSDG - Optimization in the SDG Context

Organizers:

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Description: Nowadays optimization significantly contributes to the success of companies. Our vision is that they can also have the same potential to contribute to non-profit organizations, humanitarian issues and societal challenges. The Sustainable Development Goals (SDG) are 17 goals promoted by United Nations with the aim of create balance between social, economic and environmental sustainability. It comprises several aspects of society, such as health, education, clean energy and water, innovation and infrastructures, industry and sustainable cities, among others. Thus, research works on optimization methods applied to non-profit organizations or SDG, are welcome.

Topics: Optimization · Green Industry · Applications of Sustainable Development Goals (SDG) · Case Studies in Non-profit Organizations

Abstracts

Classification of Breast Cancer Subtypes Using Machine and Deep Learning on Gene Expression Data with Hyperparameter Optimization

Ana Beatriz Miranda Valentin, Glaucia Maria Bressan, Leonardo Canuto Junior, and Elisângela da Silva Lizzi

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Correct understanding of the characteristics of breast tumors is important to help identify cancer types, providing a more accurate diagnosis, and directing appropriate treatment. In this context, the objectiveof this work is to apply machine learning and deep learning methods to multiclass classification of genes associated with breast cancer, using gene expression databases, and to evaluate the predictive performance of the used methods. The dataset is obtained from the Gene Expression Omnibus repository and the pre-processing is performed especially to reduce its dimensionality, since it has a high number of variables.Thus, the Principal Component Analysis method is initially applied to reduce the data dimensionality. Next, machine learning methods, such as Logistic Regression, Support Vector Machine, and Random Forest, and deep learning models like Multilayer Perceptron (MLP) and Convolutional Neural Network (CNN) are applied. To improve the performance of the models, the Optuna library is used to optimize the hyperparameters values and the algorithms are then evaluated with and without this optimization method. The analyzes show that Logistic Regression and Support Vector Machine obtained high accuracy. Regarding the deep learning, the MLP and CNN models, especially when optimized with Optuna, also provided competitive results. The optimization process fitted key parameters such as the learning rate and the number of layers, obtaining significant performance improvements. The results show that hyperparameter optimization can improve classifier accuracy and help diagnose breast cancer subtype and clinical outcomes.

Keywords: Breast cancer · Multiclass classification · Hiperparameters optimization · Learning models

Partial Knowledge Predictive Models for Hydrocarbon Storage.

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Clathrate hydrates enable the storage of hydrocarbons in solid form with considerably lower energy requirements than conventional methods. In this study, we use Machine Learning (ML) techniques to develop and validate a model that describes clathrate formation, drawing on laboratory data from propane, ethane, methane, and carbon dioxide. The ML-based framework augments traditional analytical and theoretical approaches by predicting equilibrium points of gas compounds and guiding the process parameters to meet scientific and engineering needs. In addition, we address critical challenges in framing the problem for ML modeling, including selecting pertinent input and output variables and incorporating ML outputs into the physical-chemical equations, thereby providing a physics-informed estimate of the stored gas volume.

Keywords: Hydrocarbon storage · Clathrate · Partial knowledge · Machine Learning

Districting Methods for Water Distribution Networks.

Daniele Bonventre, Francesca Cipollini, Giorgio Spreafico, and Luca Oneto

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Growing awareness of environmental issues and the need for sustainable resource management increasingly underscore the importance of water as a finite and valuable resource. Despite this recognition, many water distribution systems suffer from significant inefficiencies, including excessive leakage, limited preventative measures, and a predominately reactive maintenance approach that often leaves chronic leaks unresolved. These challenges are exacerbated by rising water demand, aging infrastructure, and minimal digital oversight, all of which complicate leak detection and localization. To address these issues, this study introduces methods for clustering system components into geographic districts based on similar leakage behaviors. This "districting" strategy aims to facilitate targeted maintenance by highlighting the most critical areas of the network. We compare our methods with established clustering techniques - such as K-Means, Spectral Clustering, and graph-based algorithms - and explore the impact of the different hyperparameters. Experiments conducted on a modeled urban dataset from the BattLeDIM project demonstrate the effectiveness of our proposed approach in enhancing network segmentation and optimizing leak management. The presented results offer valuable insights for improving the overall performance of water distribution systems.

Keywords: Water Management System · Districting · Graphs · Clustering

TI-FPCA: Effective and Interpretable Dimensionality Reduction with Transform-Invariant Functional Principal Component Analysis

Florian Heinrichs

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Data analysis often requires methods that are invariant with respect to specific transformations, such as rotations in case of images or shifts in case of images and time series. While principal component analysis (PCA) is a widely-used dimension reduction technique, it lacks robustness with respect to these transformations. Modern alternatives, such as autoencoders, can be invariant with respect to specific transformations but are generally not interpretable. We introduce Transform-Invariant Functional PCA (TI-FPCA) as an effective and interpretable alternative to PCA and autoencoders for functional data. We propose to sequentially approximate the components and show that TI-FPCA outperforms alternative methods in experiments based on synthetic and real data.

Keywords: Functional data analysis · Dimension reduction · Principal component analysis

OML-AD: Online Machine Learning for Anomaly Detection in Time Series Data

Sebastian Wette, and Florian Heinrichs

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Time series are ubiquitous and occur naturally in a variety of applications - from data recorded by sensors in manufacturing processes, over financial data streams to climate data. Different tasks arise, such as regression, classification or segmentation of the time series. However, to reliably solve these challenges, it is important to filter out abnormal observations that deviate from the usual behavior of the time series. While many anomaly detection methods exist for independent data and stationary time series, these methods are not applicable to non-stationary time series. To allow for non-stationarity in the data, while simultaneously detecting anomalies, we propose OML-AD, a novel approach for anomaly detection (AD) based on online machine learning (OML). We provide an implementation of OML-AD within the Python library River and show that it outperforms state-of-the-art baseline methods in terms of accuracy and computational efficiency.

Keywords: Time series · Anomaly detection · Online machine learning · Non-stationary data

Decision support system for scheduling vehicle maintenance and repair activities in an automotive repair shop

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To maintain high levels of efficiency and compliance with delivery dates, automotive repair shops must have a good system for scheduling their activities. The scheduling of the activities of an automotive repair shop is a very complex task to be performed manually. Throughout this work, a Decision Support System (DSS) was developed and tested that considers two major constraints in an automotive workshop: human resources (technicians) and physical resources (work stalls). The proposed DSS has an embedded MIP model that assigns a technician and a work stall to each job, according to the input conditions. The DSS also generates schedules with the planning of technicians and jobs.The system was tested with real data from an automotive workshop and was able not only to create plans and schedules for the human and physical resources in question but also to analyse the limiting resources of the workshop.

Keywords: Automotive Repair Shop · Job-Shop Scheduling · MIP Model

The Impact of Data Representation on Predicting Aircraft Component Removals

Gianluca Boleto, Gianluca Sommariva, Luca Oneto, Stefano Rovetta, Alberto Calvo, Luca Martorano, Claudio Porretti, and Davide Anguita

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In the field of aeronautics, predictive maintenance plays a crucial role in maximizing aircraft reliability, operational efficiency, and cost-effectiveness by proactively identifying and preventing potential failures. During flight, aircrafts continuously collect various metrics (such as flight parameters) and generate diagnostic messages (like fault codes).Certain fault codes trigger in-depth investigations, demanding time, expertise, and, sometimes, the removal and replacement of specific components. This work explores how different data representation approaches can significantly influence the effectiveness of predictive maintenance models. We demonstrate that, while traditional feature engineering based on domain expertise can yield strong results, learned representations can outperform these experience-based techniques.Specifically, the aircraft's diagnostic messages can be interpreted as a type of "language" from which a transformer encoder neural network can learn a robust high-quality representation. Experiments on real-world data confirm the effectiveness of this approach, underscoring its potential in enhancing predictive maintenance systems.

Keywords: Aeronautics · Predicting Maintenance · Removals Prediction · Artificial Intelligence · Deep Learning · Transformers

Reward-function design for Discrete and Continuous Mapless Navigation

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This article investigates the effect of the reward mechanism on the performance of an agent tasked with navigating an unknown environment. This study aims to identify which reward formulation is able to equip a mobile robot with goal-reaching and obstacle-avoidance behaviour. We utilize the Deep Q-Network and Deep Deterministic Policy Gradient algorithms to test how actions available to an agent influence its movement and performance measures. We simulate an agent tasked with goal-driven navigation using only laser distance readings. Experiments are conducted in simulation; we test the performance of Deep Q-Network (DQN) and Deep Deterministic Policy Gradient (DDPG) when tasked with goal-driven mapless navigation using sparse and dense reward functions. Our experiments show that DQN can learn goal-reaching with a sparse and dense reward. Furthermore, DQN outperforms DDPG regarding average reward, success rate, and collision rate. Our results show that DQN is more robust regarding changes in the reward function. Our findings show that when using only sparse laser scans as state representation for a mobile robot, the DQN agent outperforms the DDPG agent in all reward configurations. Furthermore, when using the same policy architecture, the DQN agent is able to reach its goal using a sparse reward.

Keywords: Reward function design · Reinforcement Learning · Deep deterministic policy gradient · Deep Q-network · Mapless navigation

PhishVision2.0: an Improved Visual Brand Impersonation Detector for Identifying Phishing Attacks

Giovanni Graziano, Beatrice Clavarezza, Filippo Sobrero, Daniele Ucci, Federica Bisio, and Luca Oneto

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In an increasingly connected world, most adversaries must first breach the target's network in order to maintain persistent access. Phishing attacks remain a common method for compromising networks and gaining initial entry into secure perimeters. Campaigns associated with these attacks span multiple propagation channels; in the case of websites, attackers often mimic legitimate pages to trick users into downloading malicious software or revealing private credentials. In a previous work, we presented PhishVision, a framework designed to visually detect phishing websites by identifying the primary logo that characterizes them and comparing it against a set of protected logos. In this paper, we propose PhishVision2.0 architecture to drastically reduce its running times through an extensive experimental evaluation. This evaluation includes performance studies on a larger protected set, the effect of shrinking training set sizes, the use of different object detection model variants, and a comparison with two state-of-the-art phishing identification solutions (Phishpedia and PhishIntention). PhishVision2.0 achieves 98.8% ROC AUC on a test set of 3625 screenshots, comprising both benign and malicious samples.Moreover, we also demonstrate the robustness of the proposed framework against the most common adversarial attacks, illustrating how an adversarial attack compromises the model's classification capabilities through explainable AI.

Keywords: Brand Impersonation · Phishing · Deep Learning · Adversarial Attacks · Explainability

Intelligent Inventory Rotation and Revenue Optimization Using Integer Linear Programming: A Coffee Shop Case Study

Amin Haghdadi, Mohammad Hossein Zolfagharnasab, Siavash Damari, and Safa Vakili

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This study employs Integer Linear Programming (ILP) to optimize gross profit for a local coffee shop, addressing challenges in inventory management and sale revenue optimization. A dataset of 40 menu items and 34 ingredients was developed, incorporating constraints like capital budget, ingredient availability, costs, and sales ratios to simulate monthly revenue. Utilizing ILP technique, achieved a gross profit of 42.28% of total sales revenue in one month, demonstrating its effectiveness in enhancing profitability. Sensitivity analysis revealed that increasing the budget led to incremental growth in sales revenue and gross profit, with inventory costs rising at a slower rate. The study identified high-performing products like coffee, tea, and cold beverages as key profit drivers, emphasizing the importance of efficient inventory allocation. These findings highlight the potential of ILP-based optimization to improve profitability and inform strategic planning, even with limited resources.

Keywords: Operations Research · Approximation Methods · Integer Linear Programming · Supply Chain Management · Optimization Techniques

Optimizing E-Learning with MoodleCloud: A Framework for Individualized Learning Paths

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E-learning has become an indispensable teaching methodthat offers users the flexibility to overcome time and location constraints. However, despite the development of numerous learning management systems, most have similar limitations in content delivery, as they offer thesame courses and services to all users, without considering their variedprofiles. This paper proposes a model to personalize educational contentby creating an individualized learning path in MoodleCloud. The systemaims to improve learning outcomes and optimize time efficiency by tailoring educational content to individual student profiles. We detect learner characteristics by combining a collaborative and an automatic approach. Then, we apply a dual content-based filtering of academic resources, based on learners' learning styles and knowledge levels. The effectivenes sof the strategy is evaluated through a comparative study involving experimental and control groups. The findings show that the personalized system significantly improves learning outcomes, reduces learning time, and suggests that personalized learning paths can lead to more efficient learning experiences.

Keywords: E-learning · MoodleCloud · Personalized learning paths · Learning Style · Knowledge Level

A classifier based on neural network and differential evolution algorithm for hepatitis prediction

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Predicting hepatitis presents a significant challenge in the field of medical data analysis. Healthcare professionals, including doctors and hepatologists, require automated tools to assist in decision-making and to differentiate between healthy and infected liver conditions. The Mixed Radial Basis Function Neural Network (MRBFNN) is a feedforward artificial neural network that uses radial basis functions as activation functions in the hidden layer. In this paper, we propose a model designed to optimize the selection of radial basis functions, centers, variances, output weights, and architecture for accurate hepatitis prediction. The optimization problem is framed as a mixed-variable optimization task with linear constraints. To address this challenge, the authors propose employing a Differential Evolution (DE)-based approach. This methodology is applied to hepatitis prediction, utilizing the optimized parameters to significantly improve the model's overall accuracy and predictive performance.

Keywords: Hepatitis prediction · Differential evolution · Neural network

Markerless Geometric Inspection Planning based on Greedy Algorithm with Registration Stability Constraint

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Efficient and accurate geometric inspection planning is a critical challenge in robotic automation, particularly for quality assurance and metrology applications. This paper presents a markerless 3D inspection planning framework that addresses the Viewpoint Planning Problem (VPP) using a greedy optimization algorithm. The proposed method discretizes the object and viewpoint search space into point clouds, transforming the VPP into a Set Covering Problem (SCP). A novel registration stability constraint ensures robust markerless alignment of scans, eliminating the need for time-consuming marker placement. Markerless registration is enabled by the smart selection of viewpoints, which ensures optimal coverage while maintaining registration accuracy. Validation of the framework demonstrates its effectiveness in generating near-optimal inspection plans and achieving reliable, high-quality reconstruction without physical markers.

Keywords: Viewpoint planning problem · Rigid registration stability · Geometric inspection

Application of Continuous and Periodic Review Models to Optimize Inventory Management in Dynamic Demand Scenarios

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Inventory management is a cornerstone of efficient supply chain operations, directly impacting on costs, customer satisfaction and, overall, competitiveness. It plays a crucial role in achieving the Sustainable Development Goals (SDGs), by promoting efficient resource use, reducing waste and supporting sustainable economic growth. This study explores the practical application of economic inventory management models, including the Continuous Review (Q-model) and Periodic Review (P-model), in dynamic environments characterized by demand variability and uncertainty. Using real-world data from a high-demand consumable item, the research validates and optimizes these models by integrating predictive analytics to improve decision-making. Results show that the Q-model achieved the lowest total cost of €354 519.50, reducing annual inventory expenses by over €39 000 (7.15%) and decreasing total inventory value by 68.55%, from €118 543 to €37 283. Removing obsolete stock, an additional saving of €750 was achieved. The P-model, while slightly less cost-efficient (€355 132.60, a 6.98% reduction),offered greater simplicity in implementation and alignment with periodic review schedules. Both models ensured a 99.9% service level, balancing cost efficiency and inventory availability. The findings provide actionable insights into selecting inventory policies based on operational context, product characteristics and organizational priorities.

Keywords: Inventory Management · Economic Models · Continuous Review · Periodic Review · Predictive Analytics · Supply Chain Optimization

On the impact of message brokers implementations in the choreography of microservices

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Communication brokers are crucial in modern software development to enable efficient, reliable, and scalable message passing in microservices architectures. However, flawed or delayed communication could be a massive setback that prevents achieving real-time analytics. This paper compares four prominent brokers: Apache Kafka, ActiveMQ Artemis, RabbitMQ, and NATS. Their performance is evaluated in terms of latency, throughput, scalability, and reliability, particularly in the clients implemented in the Java (SpringBoot) and Python languages. Experiments conducted in a standardized environment revealed that Kafka excels in real-time data processing with low latency and high throughput. ActiveMQ Artemis provides reliable performance but with much higher latency. RabbitMQ showed competitive latency but lower throughput than Kafka. NATS, designed for low-latency and high-throughput scenarios, demonstrated excellent scalability and reliability in all scenarios.

Keywords: Microservices · Message brokers · Choreography · Performance

Shadow Dexterous Hand: Kinematic Retargeting Algorithms Comparison

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This paper provides a comparative analysis of kinematic retargeting algorithms for controlling anthropomorphic robotic hands in tasks requiring high dexterity. Three algorithms, namely DexPilot, TeachNET, and BioIK, were evaluated utilising the Shadow Dexterous Hand, a robotic hand with 24 joints designed to replicate human-like movements. Experimental results revealed that DexPilot outperformed the remaining algorithms, offering superior precision, stability, and natural grasping in complex tasks, such as small object manipulation. TeachNET demonstrated competitive performance but fell slightly short of DexPilot, while BioIK faced significant limitations due to instability in the OpenPose hand detection method, responsible for frequent misdetections and consequently reduced accuracy. These findings highlight the strengths and weaknesses of current kinematic retargeting techniques and suggest that further improvements in hand pose acquisition methods, such as motion capture or depth-sensing systems, could significantly enhance robotic hand control in teleoperation scenarios. This study advances the understanding of robotic dexterity and establishes a foundation for future research in human-robot interaction and robotic teleoperation systems.

Keywords: Shadow Dexterous Hand · DexPilot · TeachNET · BioIK

Improved Performance of Stochastic Gradients with Gaussian Smoothing

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This paper formalizes and analyzes Gaussian smoothing applied to two prominent optimization methods: Stochastic Gradient Descent (GSmoothSGD) and Adam (GSmoothAdam) in deep learning. By attenuating small fluctuations, Gaussian smoothing lowers the risk of gradient-based algorithms converging to poor local minima. These methods simplify the loss landscape while boosting robustness to noise and improving generalization, helping base algorithms converge more effectively to global minima. Existing approaches often rely on zero-order approximations, which increase training time due to inefficiencies in weight perturbation. To address this, we derive Gaussian-smoothed loss functions for feedforward and convolutional networks, improving computational efficiency. Numerical experiments demonstrate the enhanced performance of our smoothing algorithms over unsmoothed counterparts, confirming the theoretical benefits.

Keywords: Optimization · Gaussian smoothing · Stochastic gradient descent · Adam

Comparative Study between Digital Image Processing Algorithms and YOLOv11 in the Segmentation of Lettuce Cultivars

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Lettuce (Lactuca sativa L.) is a widely consumed vegetableknown for its metabolic benefits and role in preventing chronic diseases.Due to the morphological complexity and variability in leaf character-istics among different cultivars, segmenting lettuce is essential for auto-mated growth monitoring, early disease detection, and the optimizationof agricultural practices. In this context, this study aimed to evaluatethe effectiveness of classical Digital Image Processing (DIP) techniquesin comparison to the YOLOv11n model for lettuce segmentation. For theanalysis, images of Milena curly lettuce cultivars grown in a hydroponicsystem were captured. The segmentation process for DIP was carriedout using multiple thresholding in the HSV color space. Meanwhile, theYOLOv11n model was trained in the Google Colaboratory environmentusing an NVIDIA A100 GPU. The performance of both approaches wasassessed through metrics such as Intersection over Union (IoU), precision,recall, and execution time. The results revealed that the DIP techniquesachieved average IoU, precision, and recall values of 0.81, 0.90, and 0.89,respectively. In contrast, the YOLOv11n model demonstrated superiorperformance, with IoU, precision, and recall values of 0.92, 0.95, and 0.96,respectively. However, DIP excelled in terms of efficiency, segmenting 10images in just 0.32 seconds, compared to the 28.56 seconds required byYOLOv11n.

Keywords: Lettuce cultivars · Digital Image Processing · Deep Learning

A Secure Architecture for Supply-chain Orders Exchange between Textile and Clothing Companies

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In the digital transformation of industrial sectors, data is a high-value business asset. How companies manage data between systems within the organization or through networks of business partners impacts their competitive factor. Technological maturity may imply several adversities, such as the lack of interoperability standards for simple and transparent data exchange. This paper presents an architecture that enables secure exchanges of supply chain orders between textile and clothing companies. This architecture is based on Electronic Business (eBIZ) 4.0 and International Data Spaces (IDS) frameworks, fostering trust and widespread adoption of platforms in the industry sector, particularly when handling sensitive supply chain information. The architecture was implemented and validated in 3 use cases with Enterprise Resource Plannings (ERPs) from the same vendor, different vendors, and communication from a ERP to a Web portal. Implementing the proposed architecture impacted efficiency, transparency, and accountability within the supply chain network. The lead times for purchases, provisioning, and the number of additional information requests in the ordering were reduced. In subcontracting, a reduction in non-conformities and an overall improvement in delivery times were verified. Moreover, logistics operations and communication with subcontractors were optimized, leading to faster order reception and reducing informal contacts.

Keywords: Supply-chain · Orders Exchange · International Data Spaces (IDS) · EBIZ 4.0 · Industry 4.0

Integrating Aging-Awareness into Price-Optimized PV-Battery Controllers Using Stochastic Dynamic Programming

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This study presents the integration of a battery aging model into a non-linear optimization framework, with the primary goal of optimizing electricity costs through the use of Stochastic Dynamic Programming(SDP) as the solver. By incorporating aging effects into the existing algorithm, the study focuses on enhancing smart energy management in battery systems while extending their operational lifespan. The proposed methodology seamlessly integrates an aging-awareness model into the optimization process, maintaining the mathematical complexity of the original system while incorporating aging dynamics. The new algorithm aligns aging effects with price optimization by integrating them into aStochastic Model Predictive Control (MPC) scheme. The aging-awarecontroller results in a significant improvement in the battery's State of Health (SoH), increasing it from 95% to 98% compared to the non-aging-aware version, without substantially affecting the electricity bill. The findings underscore the potential of multi-objective optimization in real-time PV-battery systems, demonstrating how aging-aware strategies can substantially improve battery performance, cost-efficiency. This approach offers a pathway to more sustainable and efficient energy management systems in renewable energy applications, ensuring longer battery lifeand optimized economic benefits.

Keywords: Aging-aware controller · Battery management · Model Predictive Control · Stochastic · Dynamic Programming · Battery lifespan · Cost optimization · Non-linear optimization

Object Classification using 2D-LiDAR and YOLO for Robot Navigation

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Privacy concerns can potentially make camera-based object classification unsuitable for robot navigation. To address this problem, we propose a novel object classification system using only a 2D-LiDAR sensor on mobile robots. The proposed system enables semantic understanding of the environment by applying the YOLOv8n model to classify objects such as tables, chairs, cupboards, walls, and door frames using only data captured by a 2D-LiDAR sensor. Experimental results show that the resulting YOLOv8n model achieved an accuracy of 83.7% in real-time classification running on Raspberry Pi 5, validating the approach as a privacy-friendly alternative to camera-based methods and illustrating that it can run on small computers on board of mobile robots.

Keywords: YOLO · 2D-LiDAR · Object Detection and Classification · Mobile Robots · Machine Learning · Occupancy Mapping

Risk-Aware Optimal Camera Placement for Forest Fire Detection and Monitoring

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Early wildfire detection is crucial for minimizing environmental and societal impacts. This paper tackles the Camera Placement Optimization (CPO) problem for fire monitoring, optimizing camera placement and orientation to maximize risk-weighted coverage while accounting for visibility constraints, differently from traditional approaches that prioritize total area coverage. Leveraging their advantages in scalability, exploration granularity and abstraction from the specific object function formulation, we employ three metaheuristic techniques, Genetic Algorithms (GA), Tabu Search (TS), and Particle Swarm Optimization (PSO), to efficiently explore the solution space. A large-scale case study in western Piedmont, Italy, demonstrates that all three methods are able to converge outperforming the baseline, particularly in densely packed scenarios where coverage zones overlap. While all three algorithms present comparable performance levels, GA and TS have a lead in simpler scenarios with fewer cameras, while PSO excels in more complex configurations, presenting however an higher computational cost.

Keywords: Camera Placement Optimization · Fire Risk · Tabu Search · Genetic Algorithms · Particle Swarm Optimization

Macroeconomics' Forecasting using Machine Learning Approaches by Policy Makers: A Case Study Analysis

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Macroeconomic forecasting is a fundamental domain for policy decisions, directly impacting the whole population of a country. The use of machine learning (ML) approaches in economics forecasting has been studied in several types of research in the academic field, aiming to improve or even replace traditional econometric approaches. However, the use of ML in forecasting is now getting closer to policy markers, which are the institutions that make policy decisions. Three relevant studies are presented and analyzed in this work; all focused on forecasting using ML of different macroeconomic variables in several economies. The studies were compared, including aspects of methodologies and results, as well as similarities and differences. In addition, several technical, legal, and philosophical questions were raised regarding the effective use of data from ML forecasting in public policies, including topics related to the standardization of the research on this topic, the explanation of the model's output, protection of trust, and ethics issues.

Keywords: Macroeconomic's forecasting · Machine Learning · Policy makers

Performance Benchmarking of OR-Tools Methods for Capacitated Vehicle Routing Problems with Time Windows

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The Capacitated Vehicle Routing Problem with Time Windows (CVRPTW) is a significant challenge in combinatorial optimization, with extensive practical applications in logistics and transportation. This study aims to conduct a comparative analysis of the various methods available in OR-Tools for solving the CVRPTW across datasets of varying sizes and types using the Solomon and the Gehring and Homberger benchmarks. The analysis provided insights into the relative strengths of each method, with a primary focus on Guided Local Search (GLS) and Tabu Search (TS), showing consistent performance and adaptability to different dataset characteristics. The results indicate that GLS is the most robust method overall and that TS can outperform it in specific scenarios. In conclusion, this study offers a practical guide for selecting the most effective methods to solve vehicle routing problems based on the characteristics and scale of the problem.

Keywords: Capacitated Vehicle Routing Problem · Optimization · OR-Tools · Time Windows

Social Context in Fake News Diffusion

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In an era where fake news spreads rapidly, understanding its dynamics has become a critical challenge. This paper explores the modeling of false information diffusion using the SIR, SEIR, and SEIZ models, applying them to three real-world fake news cases: the New Year's Day earthquake rumor in Japan, a false claim about former President Obama's injury, and a dooms day prediction. MATLAB software is used to study and validate the models, offering valuable insights into the factors that influence public responses to untrue information across various social settings. Out of the models, SEIZ fitted the best to the available data in comparison with to the SEIR and SIR models, due to its greater complexity, which stems from the addition of a new population and parameters. The results reveal how these variables affect the spread of false information, underscoring the effect of emotional and cultural factors. The study also points out some limitations, such as the oversimplification of real-world behavior and the limited number of fake news cases analyzed. Understanding the dynamics of false information is paramount and further research studies should be undertaken in order to target wider case studies in terms of themes and geographical context.

Keywords: Epidemiologic Models · Fake News · Social Dynamics

Integrating Renewable Energy into Sustainability Metrics: a multicriteria decision

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The integration of renewable energy into sustainability metrics is essential for achieving the Sustainable Development Goals (SDGs), particularly in regions aiming to balance energy efficiency, waste management, and urban development. This study explores the application of multicriteria decision-making and statistical techniques to evaluate municipal sustainability, with a focus on renewable energy, using the Alto Minho region of Portugal as a case study. The analysis incorporates 12 SDG indicators across ten municipalities, addressing energy consumption, urban renewal, and waste management.Cluster analysis revealed distinct groups of municipalities, highlighting disparities in sustainability performance. Municipalities such as Melgaço and Monção excelled in energy-related metrics, while others showed strengths in waste management and urban renewal. The Analytic Hierarchy Process (AHP) emphasized the importance of renewable energy indicators, revealing notable changes in rankings when energy-related criteria were prioritized. Ponte de Lima and Melgaço ranked highest under energy-focused weighting schemes, showcasing their leadership in energy efficiency and renewable adoption. The findings underscore the need for targeted policies to enhance sustainability across municipalities, particularly in regions lagging in energy performance.

Keywords: Sustainable Development Goals · Multicriteria decision-making · Cluster Analysis · Analytic Hierarchy Process

Interconnection Between Lifestyle, Health, and Academic Outcomes: an Analysis on Study Habits and Well-being

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Balancing academic demands with personal and professional responsibilities has become an increasingly challenging task, making it difficult to maintain well-being and potentially leading to serious health problems. The stress resulting from these multiple daily tasks, combined with the pressure to perform at high academic levels, directly impacts students' mental and emotional health, significantly compromising their quality of life. In this work, statistical and clustering techniques are employed to analyze the dataset "Daily Lifestyle and Academic Performance of Students". The objective of this work is to explore the relationship between students' daily habits, level of stress, and the impact on academic performance. The results point out that many students have difficulty managing time and maintaining well-being (low-stress levels) with high academic performance since, according to the results, the higher the academic outcome, the higher the student's stress level.

Keywords: Wellness · Student performance · Stress level · Data analysis · Machine Learning · Clustering

A Personalized Math Learning Experience with Clustering and Random Forest Algorithms

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Educational methodologies are evolving alongside technological advancement by adopting digital education systems. To increase user engagement and ensure that content aligns with individual needs and learning processes, recommendation systems have been integrated into these platforms. The MathE platform was developed as part of the digital transformation in education. This platform provides personalized assessment and educational content across 22 higher education-level mathematic topics. The recommendation system within MathE customizes content and evaluations based on student needs and expertise by employing clustering for question difficulty, graph-based learning path optimization, and a Random Forest model for dynamic question selection. To evaluate the impact of the developed recommendation system, student assessment results were compared between random question generation and the use of the recommendation system. This study focuses on two commonly used subtopics in MathE: Partial Differentiation and Matrices and Determinants, with 20 - 22 students per subtopic. Results indicate improvement in student performance: a 6.94% increase for Partial Differentiation and a 9.37% increase for Matrices and Determinants. These findings highlight the recommendation system's effectiveness in enhancing student performance, contributing to a more personalized and efficient learning experience.

Keywords: Recommendation systems · E-learning · Active learning · Random forest · Education · Digital learning

Enhancing Soil Organic Carbon Prediction: A Machine Learning Approach with Outlier Removal

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Soil Organic Carbon (SOC) is an indicator of soil fertility and plays an important role in mitigating climate change due to its potential to sequester atmospheric carbon. Laboratory SOC analysis methods are resource-intensive and impractical for large-scale applications. Therefore, there is a need to explore new methods to estimate this element. In this context, a Hackathon was held at the European Space Agency Symposium on Earth Observation for Soil Protection and Restoration, in which the main focus was the development of artificial intelligence models in SOC prediction using remote sensing data. This paper presents the proposed solution, which used Recursive Feature Elimination with Cross-Validation to select the most relevant features and the Extreme Gradient Boosting algorithm to estimate SOC, which a Lazy Regressor indicated as the best regressor for the work in the case. The developed solution achieved a Root Mean Square Error of 0.43354 on the private dataset and won second place in the Hackathon. This result demonstrates the potential of using Machine Learning models and Remote Sensing data in estimating SOC, making obtaining data for large areas at low costs easier, contributing to sustainable land management and climate action strategies.

Keywords: Machine Learning · Soil Organic Carbon · Satellite Data · Remote Sensing

AI-Powered Tutoring for Personalized Learning

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This research paper investigates the potential of AI-driven Intelligent Tutoring Systems (ITS) for enhancing personalized learning. To conduct this research, 50 respondents, including educators, students, and ITS developers, were surveyed to provide insights into user experience, challenges linked with ITS adoption, and perceived benefits. For that, statistical, correlation, and cluster analysis was done. The findings show that ITS effectively delivers personalized learning, with new features like adaptive learning paths, real-time feedback, and interactive content being highly valued. Secondly, the study identifies some vital barriers, including privacy concerns, technical difficulties, and high implementation costs. The respondents focused on data privacy because they considered it extremely important to consider while using ITS. Furthermore, ITS is improving student engagement and concerns regarding adaptability to diverse educational needs. Lastly, there is some discussion about future technologies in ITS to enhance data security, minimize cost, and increase accessibility. The research shows that ITS is a crucial transformative tool in education. It can address individual learning needs and pose challenges that require collective actions from educators, developers, and policymakers.

Keywords: Personalized Learning · AI-driven Intelligent Tutoring System · Education Technology · Adaptive Learning Paths

Schizophrenia Diagnosis Support with Spectral and Cepstral Features of Speech

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Schizophrenia is a severe mental illness affecting over 20 million people worldwide, significantly impairing quality of life and daily functioning. Current diagnostic methods rely heavily on subjective assessments and interactions between doctors and patients, leaving room for potential misdiagnoses. Recent advancements in technology have introduced non-invasive, fast, and user-friendly approaches, such as machine learning, to support psychiatric diagnosis. In this study, spectral features extracted from speech samples of individuals with and without Schizophrenia were analyzed. Using an ensemble bagged tree model, we achieved an accuracy of 96.3%, a sensitivity of 94.6%, and an F1-score of 95.4%. These results highlight the potential of speech-based machine learning models as effective tools for aiding Schizophrenia diagnosis.

Keywords: Schizophrenia · Speech features · Machine Learning · Ensemble · Bagged tree model

An OpenModelica package for BELBIC

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This paper presents the development and implementation of a new package for OpenModelica that integrates the Brain Emotional Learning Based Intelligent Controller (BELBIC) approach into control system simulations. BELBIC, inspired by neurobiological models of emotional learning, has demonstrated effectiveness in handling complex, nonlinear, and adaptive control problems. The proposed package provides a modular and user-friendly framework for integrating BELBIC enabling researchers and engineers to design, simulate, and analyze intelligent control strategies within an open-source environment. Key features of the package include customizable emotional response parameters and compatibility with existing Modelica libraries. To validate the package, a set of examples are included which demonstrates its application to the control of common dynamic systems.

Keywords: Brain emotional learning · Control systems design · Computer aided software · Modelica · OpenModelica

Prediction of Average Power Produced by Wind Turbines Using MLP Neural Networks

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This paper explores wind turbine power output prediction using Multi-Layer Perceptron (MLP) neural networks. Accurate forecasting of wind energy production is critical for grid stability and optimizing energy systems. The study compares various prediction techniques, including physical, statistical, and hybrid methods. The methodology employs real-world data sourced and uses records from 2016-2017. Data preprocessing includes filtering, seasonal decomposition, time series analysis, and dividing the dataset into training, validation, and testing sets. The model's structure and hyperparameters were carefully tuned, employing 144 samples from the produced power as input, representing 24-hour cycles, to forecast the next hour. The study evaluated multiple MLP configurations, varying in hidden layer sizes and training strategies, to identify the optimal architecture for short-term wind power forecasting. The evaluation uses statistical metrics to assess prediction accuracy, including RMSE, NRMSE, and R2. Early stopping and randomized dataset splits were evaluated to enhance model performance and robustness. The main goal of this paper is to demonstrate the utility of MLP in forecasting for wind power generation systems. The models analysed obtained results between 94-95% for the coefficient of determination (R2). To improve performance, we should add environmental variables to the forecasting models or use deep-learning models.

Keywords: Artificial Neural Network · Wind Power Production · Multi-layer Perceptron · Forecasting · Python · Time Series Prediction

Comparing RL Policies for Robotic Pusher

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Reinforcement learning (RL) has been consolidated as a promising approach to optimizing robotic tasks, allowing the improvement of performance and energy efficiency. This study investigates the effectiveness of five RL algorithms in the Pusher environment. Advantage Actor-Critic (A2C), Proximal Policy Optimization (PPO), Deep Deterministic Policy Gradient (DDPG), Soft Actor-Critic (SAC) and Twin Delayed Deep Deterministic Policy Gradient (TD3). We evaluated training time, computational efficiency, and reward values to identify the most balanced solution between accuracy and energy consumption.The results indicate that the PPO offers the best compromise between performance and efficiency, with reduced training time and stability in learning. SAC achieves the best rewards but requires more training time, while A2C faces difficulties in continuous spaces. DDPG and TD3, despite the good results, have high computational consumption, which limits their viability for real-time industrial applications.These findings highlight the importance of considering energy efficiency when choosing RL algorithms for robotic applications. As a future direction, we propose the implementation of these algorithms in a real-world environment, as well as the exploration of hybrid approaches that combine different strategies to improve accuracy and minimize energy consumption.

Keywords: Reinforcement Learning · Autonomous Robotics · Policies Performance · Agent Training

Forecasting COVID-19 in European Countries Using Long Short-Term Memory

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Effective time series forecasts are increasingly important in supporting judgment in various decisions. Various prediction models are available to support these projections based on how each area provides a diverse set of data with variable behavior. Artificial neural networks (ANNs) significantly contribute to medical research since using predictive ideas allows for the study of disease progression in the future, as well as the behavior of other variables. This study implemented the proposed model based on Long Short-Term Memory (LSTM) to forecast COVID-19 daily new cases, deaths, and ICU patients. The methodology uses quantitative and qualitative data from six European countries: Austria, France, Germany, Italy, Portugal, and Spain to predict the last 242 days of the COVID-19 pandemic. The dataset uses the healthcare parameters of the number of daily new cases, deaths, ICU patients, and mitigation procedures, such as the percentage of the population fully vaccinated, the mandatory use of masks, and the lockdown. Two approaches were used to evaluate the model's performance: the mean absolute error (MAE) and the mean square error (MSE). The results demonstrate that the LSTM model efficiently captures general trends in COVID-19 metrics but shows limitations when predicting data with low values or high variability, such as daily deaths. The model reported the lowest errors for Spain and Portugal, while France and Germany exhibited higher error rates due to differences in data reporting and pandemic dynamics. These findings highlight the importance of contextualizing predictive models based on specific regional characteristics.

Keywords: Supporting decision · COVID-19 · Artificial Neural Network · LSTM.

A Deep Learning Approach for Average Height Estimation in Oak Colony Using RGB Images

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Many strategies have been developed to monitor the volume of Above Ground Biomass (AGB) in forest areas, this step is fundamental for managing carbon concentration. This study explores the use of Light Detection and Ranging (LiDAR) data obtained through Unmanned Aerial Vehicles (UAVs) to estimate height values in a vegetation colony composed of oaks (Quercus pyrenaica Willd.) in northern Portugal. The extraction of pertinent information from LiDAR data was facilitated by using the LAStools extension within the Quantum Geographic Information System (QGIS) software framework. The generated raster and image information were used to calculate the height values of the vegetation. Following this extraction, the information was meticulously organized into datasets, which were then employed in Deep Learning (DL) algorithms. The VGG16 model was selected as the underlying framework for the present study. Height predictions were made using dimensions of 16x16, 32x32, and 64x64 pixels for the Red, Green and Blue (RGB) images. The data was estimated and compared using both the standard format of the VGG16 model and a superficially adapted version of its convolution layers. The algorithm's efficacy was validated by comparing the forecast results with the data obtained from QGIS, which revealedminimal discrepancies. It was observed that using 64x64 pixel scale images yielded enhanced accuracy, resulting in reduced values for the Mean Absolute Error (MAE). The study demonstrates the viability of employing DL techniques to accurately capture information about a forest area using RGB images.

Keywords: Deep Learning · LiDAR · QGIS · RGB Images · VGG16

Automated Preprocessing of Olive Leaf Images for Cultivar Classification Using YOLO11

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Olive cultivation is a pillar of Mediterranean agriculture, deeply rooted in both tradition and economic importance. This paper presents a novel two-phase methodology for the automated pre-processing of olive leaf images to facilitate accurate cultivar classification. Lever-aging the state-of-the-art YOLO11 framework, two models (YOLO11nand YOLO11s) were employed for detection and segmentation tasks. A comprehensive dataset, combining in-situ captured images with publicly available data, was meticulously annotated using both manual and semi-automatic processes. The detection model identifies individual olive leaves, while the segmentation model isolates the leaves by replacing the background with a uniform white, thereby simulating laboratory conditions. Experimental results demonstrate that YOLO11n outperforms YOLO11s in terms of mean Average Precision and F1-score, confirming the feasibility of deploying the system on mobile devices for real-time, in-field classification.

Keywords: Olive Cultivation · Leaf Detection · Image Segmentation · YOLO11 · Smart Agriculture

Influence of Habits and Comorbidities on Liver Disease

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The prevalence of hepatocellular carcinoma is expected to continue increasing worldwide, and its difficulty in early detection highlights the need for advanced monitoring technologies. As the disease progresses, it has a serious impact on patients' health and in severe cases liver transplantation becomes the only viable solution, reinforcing its importance as a global health problem. This study proposes the use of different artificial intelligence methods to compare and understand them related to liver disease. Well-known algorithms such as Random Forest and Multi-Layer Perceptron were tested, as well as ensemble methods that exploit different modelling structures. The results showed that AdaBoost, Random Forest and Gradient Boosting performed best with Area Under the Curve of 0.89, 0.86, and 0.84 respectively. To analyze their influence on clinical results, the best-performing model was reapplied only to the non-biochemical features that compose the dataset. The results indicate that portal vein thrombosis, diabetes, and hypertension are the most influential variables, with contributions of 29.48%, 20.50%, and 16.60%, respectively.

Keywords: Hepatocellular carcinoma · Machine Learning · Health diagnosis · Cancer · Ensemble methods · Feature selection

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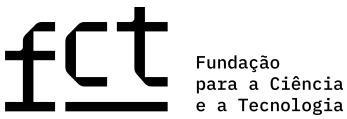

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