Book of Abstracts

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III International Conference on Optimization, Learning Algorithms and Applications

OL2A 2023

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Contents

Welcome

Welcome to OL2A 2023 - 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 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 fourth industrial revolution.
It is with great pleasure that the Organizing Committee welcomes you all to OL2A 2023!

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Invited Plenary Lectures

Rethinking AI: From Technical Metrics to Human-Centered Metrics

Luca Oneto

Biography: Luca Oneto was born in Rapallo, Italy in 1986. He received his BSc and MSc in Electronic Engineering at the University of Genoa, Italy. In 2014 he received his PhD from the same university retrieval with the thesis "Learning Based On Empirical Data". In 2018 he was co-funder of the spin-off ZenaByte s.r.l. In 2019 he obtained the Italian National Scientific Qualification for the role of Full Professor in Computer Science and Computer Engineering. In 2019 he became Associate Professor in Computer Science at University of Pisa and currently is Associate Professor in Computer Engineering at University of Genoa. He has been involved in several H2020 projects (S2RJU, ICT, DS) and he has been awarded with the Amazon AWS Machine Learning and Somalvico (best Italian young AI researcher) Awards. His first main topic of research is the Statistical Learning Theory with particular focus on the theoretical aspects of the problems of (Semi) Supervised Model Selection and Error Estimation. His second main topic of research is Data Science with particular reference to the problem of Trustworthy AI and the solution of real world problems by exploiting and improving the most recent Learning Algorithms and Theoretical Results in the fields of Machine Learning and Data Mining.

Abstract: Artificial Intelligence (AI) plays an essential role in the modern world, enabling machines to interact, learn, reason, and make decisions independently. However, to ensure a more responsible design and manufacturing process, there is need a new generation of AIs able to optimize metrics beyond the Technical ones (e.g., accuracy and computational requirements) toward more Human-Centered centered metrics able to holistically emphasizes: 1) Sustainability: optimizing technical metrics under the lights of environmental sustainability; 2) Transparency: enabling humans to evaluate and trust the decisions made by AIs by providing a clear and interpretable explanation of their decision-making process; 3) Fairness: avoiding bias and unintended consequences and discriminatory outcomes ensuring fairer AIs; 4) Privacy and Security: protecting against unauthorized access and misuse of AIs, safeguarding the privacy and security of individuals; 5) Cultural Competency: adapting to the cultural environment in which AIs operate, promoting inclusivity and diversity.

Stress-testing Algorithms via Instance Space Analysis

Kate Smith-Miles

Biography: Kate Smith-Miles is a Melbourne Laureate Professor of Applied Mathematics in the School of Mathematics and Statistics at The University of Melbourne. She is also Director of a doctoral training centre for Optimization Technologies, Integrated Methodologies and Applications (OPTIMA, see optima.org.au), and Associate Dean (Enterprise & Innovation) for the Faculty of Science. Kate obtained a B.Sc(Hons) in Mathematics and a Ph.D. in Electrical Engineering, both from The University of Melbourne. She has published 2 books on neural networks and data mining, and over 280 refereed journal and international conference papers in the areas of neural networks, optimization, data mining, and various applied mathematics topics. She has supervised 30 PhD students to completion, and has been awarded over AUD$20 million in competitive grants, including a prestigious Australian Laureate Fellowship from the Australian Research Council, which enabled her Instance Space Analysis methodology to be advanced and expanded into an online tool (matilda.unimelb.edu.au). Her awards include the Australian Mathematical Society Medal in 2010 for distinguished research; the EO Tuck Medal from ANZIAM in 2017 for outstanding research and distinguished service; and the Ren Potts Medal for outstanding research in the theory and practice of operations research from the Australian Society for Operations Research in 2019. She is frequently invited as keynote speaker at leading international conferences including IFORS, GECCO, and CPAIOR.

Abstract: Instance Space Analysis (ISA) is a recently developed methodology to support objective testing of algorithms. Rather than reporting algorithm performance on average across a chosen set of test problems, as is standard practice, ISA offers a more nuanced understanding of the unique strengths and weaknesses of algorithms across different regions of the instance space that may otherwise be hidden on average. It also facilitates objective assessment of any bias in the chosen test instances, and provides guidance about the adequacy of benchmark test suites and the generation of more diverse and comprehensive test instances to span the instance space. This talk provides an overview of the ISA methodology, and the online software tools that are enabling its worldwide adoption in many disciplines. A case study comparing algorithms for university timetabling is presented to illustrate the methodology and tools, with several other applications to optimization, machine learning, computer vision and quantum computing highlighted.

Special Sessions

LEE - Learning Algorithms in Engineering Education

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Description: The world is changing. Constant technological advances allow for different approaches to teaching. Since Science (e.g. Mathematics, Physics) is a core subject in engineering courses, we intend to highlight the utmost approaches (using learning or optimization methods) in its teaching for engineering students. Technological advances and sometimes world problems induce us towards new methodologies and trends, not only in engineering but also in general. Therefore, research works about learning or optimization methods applied to the educational field, in general, are welcome. Thus, this session focuses on learning algorithms applied to the area of education, e-learning platforms, blended learning, and management systems learning, among others.

Topics: Learning Algorithms Applied in Education · Intelligent Systems for Education - Innovative Learning Systems and Innovative Teaching Systems · Case Studies

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

CVLA - Computer Vision Based on Learning Algorithms

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Description: Computer vision has been used for long years ago. It allows to replace people in some areas (for example repetitive observations) allowing them to do more important tasks. Actually, learning algorithms are applied in a huge number of applications with increasing computational power. The merge of these two concepts allows to "teach" a vision system to be adapted accordingly to the needs. The objective of this special session is to open a discussion forum that allows experts on learning algorithms applied to Computer vision to share recent developments, challenges, and current and new research trends. The CVLA special session will provide common ground in terms of what was brought by research in the last years and what are the actual challenges in CVLA.

Topics: Computer Vision · Learning Algorithms · Deep Learning

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. In the control engineering framework, optimization plays a fundamental role in several design strategies such as predictive, fuzzy, decentralized and optimum control among many, many more. Moreover, due to the increased tendency of integrating soft-computing techniques into control loops, and since those methods frequently rely on optimization algorithms in order 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 to foster a place where discussion regarding the use of optimization techniques in control can take place.

Topics: Control Systems Design · Optimization

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

MLIoT - Machine Learning and Data Analysis in the Internet of Things

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Description: Data processing and acquisition have evolved in recent years into robust instruments for comprehending the world around us. Nowadays, the multiple Internet of Things (IoT) applications offer measurement resources to accomplish this. Furthermore, the expansion of IoT has outcome the massive amount of data produced by intelligent robots, node sensors, data mining, hybrid systems, mobile applications, among others. Consequently, with this expansion, it is necessary to apply efforts and research to analyze and understand the behavior of the acquired data, as well as in reducing the overall complexity of such systems. In this context, this session will encompass the newest IoT advances through the applications that combine machine learning and optimization strategies.

Topics: Machine Learning in the IoT or WSN context · Optimization Methods in IoT or WSN context · Smart/Intelligent Sensors

Abstracts

A YOLO-based Insect Detection: Potential Use of Small Multirrotor UAV Monitoring

Guido Berger, João Mendes, Arezki Abderrahim Chellal, Luciano Junior, Yago Silva, Matheus Zorawski, Ana I. Pereira, Milena Pinto, João Castro, António Valente and José Lima

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This article presents an approach to address the challenges of manual inspection using multirotor Unmanned Aerial Vehicles (UAV) to detect olive tree flies (Bactrocera oleae). The study employs computer vision techniques based on the You Only Look Once (YOLO) algorithm to detect insects trapped in yellow chromotropic traps. Therefore, this research evaluates the performance of the YOLOv7 algorithm in detecting and classifying olive tree flies using images obtained from two different digital cameras in a controlled environment at different distances and angles. The findings could potentially contribute to the automation of insect pest inspection by UAV-based robotic systems and highlight potential avenues for future advances in this field. In view of the experiments conducted indoors, it was found that the Arducam IMX477 camera resulted in images with greater clarity compared to the TelloCam, making it possible to correctly highlight the set of Bactrocera oleae in different prediction models. The results presented in this research demonstrate that with the introduction of data augmentation and auto label techniques on the set of images of Bactrocera oleae, it was possible to arrive at a prediction model whose average detection was 256 Bactrocera oleae in relation to the corresponding ground truth value to 270 Bactrocera oleae.

Keywords: Unmanned Aerial Vehicles · Object classification · Insect detection · Olive fly · YOLOv7

A Comparison of Fiducial Markers Pose Estimation for UAVs Indoor Precision Landing

Luciano Junior, Guido Berger, Alexandre O. Júnior, João Afonso Braun Neto, José Lima, Milena Pinto and Marco Wehrmeister

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Cooperative robotics is exponentially gaining strength in scientific research, especially regarding the cooperation between ground mobile robots and Unmanned Aerial Vehicles (UAVs), where the remaining challenges are equipollent to its potential uses in different fields, such as agriculture and electrical tower inspections. Due to the complexity involved in the process, precision landing by UAVs on moving robotic platforms for tasks such as battery hot-swapping is a major open research question. This work explores the feasibility and accuracy of different fiducial markers to aid in the precision landing process by a UAV on a mobile robotic platform. For this purpose, a Tello UAV was used to acquire images at different positions, angles, and distances from ArUco, ARTag, and ArUco Board markers to evaluate their detection precision. The analyses demonstrate the highest reliability in the measurements performed through the ArUco marker. Future work will be devoted to using the ArUco marker to perform precision landing on a mobile robotic platform, considering the necessary adjustments to lessen the impact of errors intrinsic to detecting the fiducial marker during the landing procedure.

Keywords: Unmanned Aerial Vehicles · Position Tracking · Fiducial Marker

Effect of Weather Conditions and Transactions Records on Work Accidents in the Retail Sector - a Case Study

Lucas D. Borges, Inês Sena, Vitor Marcelino, Felipe G. Silva, Florbela P. Fernandes, Maria F. Pacheco, Clara B. Vaz, José Lima and Ana I. Pereira

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Weather change plays an important role in work-related accidents, it impairs people's cognitive abilities, increasing the risk of injuries and accidents. Furthermore, weather conditions can cause an increase or decrease in daily sales in the retail sector by influencing individual behaviors. The increase in transactions, in turn, leads employees to fatigue and overload, which can also increase the risk of injuries and accidents. This work aims to conduct a case study in a company in the retail sector to verify whether the transactions records in stores and the weather conditions of each district in mainland Portugal impact the occurrence of accidents, as well as to perform predictive analysis of the occurrence or non-occurrence of accidents in each district using these data and comparing different machine learning techniques. The correlation analysis of the occurrence or non-occurrence of accidents with weather conditions and some transactions pointed out the nonexistence of correlation between the data. Evaluating the precision and the confusion matrix of the predictive models, the data indicate a predisposition of the models to predict the non-occurrence of accidents to the detriment of the ability to predict the occurrence of accidents.

Keywords: Predictive Analysis · Correlation Analysis · Weather Conditions · Transactions Records

New Approach to Using a Dataset to Classify Occupational Accidents in the Retail Sector

Inês Sena, Ana Cristina Braga, Paulo Novais, Florbela P. Fernandes, Maria F. Pacheco, Clara B. Vaz, José Lima and Ana I. Pereira

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ALGORITMI Research Centre, LASI, University of Minho

The machine learning approach is used in several application domains, and its exploitation in predicting accidents in occupational safety is relatively recent. The present study aims to apply different Machine Learning Algorithm for classifying the occurrence or not of accidents at work in the retail sector. The approach consists of obtaining an impact score for each store and work unit, considering two databases of a retail company, the preventive safety actions, and the action plans. Subsequently, each score is associated with the occurrence or not of accidents during January and May 2023. Of the five classification algorithms applied, the Support Vector Machine was the one that obtained the best accuracy and precision values for the preventive safety actions. As for the set of actions plan, the Logistic Regression reached the best results in all calculated metrics. With this study, it can be concluded that calculating the impact score of the study variables makes it possible to identify the occurrence of accidents at work in the retail sector with high precision and accuracy.

Keywords: Workplace Accidents Classification · Machine Learning Algorithm · Score Impact

Resource Dispatch Optimization for Firefighting using a Differential Evolution Algorithm

Marina A. Matos, Rui Gonçalves, Ana Maria A. C. Rocha, Lino Costa and Filipe Alvelos

ALGORITMI Research Centre / LASI, University of Minho

The incidence of forest fires has shown an upward trend in recent years. This increase can be attributed to increasing ambient temperatures and population growth, which act as the primary catalysts for these disasters. The application of optimization techniques has significantly contributed to addressing forest firefighting challenges, enabling improvements in the efficiency and promptness of firefighting operations. This study focuses on a specific resource dispatch problem to combat forest fires, which involves assigning 7 resources to extinguish 20 ignitions. The main objective is to minimize the total area burned by these ignitions at minimum time. To solve this problem, the differential evolution algorithm adapted to this context was applied. Furthermore, a statistical analysis was performed to evaluate the performance of differential evolution when different selection and crossover operators are tested. The preliminary results show that the current-to-best selection and exponential crossover operators are the more suitable to solve the resource dispatch problem for forest firefighting.

Keywords: Forest Fires · Single-objective Optimization · Resource Dispatch Problem · Differential Evolution

A Pattern Mining Heuristic for the Extension of Multi-trip Vehicle Routing

Leila Karimi, Connor Little and Salimur Choudhury

Queen's University

Multi-trip Vehicle Routing Problem with a variable number of wagons significantly reduces the number of vehicles and drivers needed to service customers. It is often hard to solve these problems in acceptable CPU times using exact algorithms when the problem contains very big real-world data sets. We use meta-heuristic algorithms to get a solution close to the optimal solutions for Vehicle Routing Problems with a dynamic capacity of a vehicle. First, local search heuristics applied with genetic algorithms are proposed. Then, a pattern-mining algorithm is developed to improve the solutions found from the genetic algorithm. We perform detailed experiments on Solomon instances for Vehicle Routing Problem with time windows (VRPTW). Our experiments establish the effectiveness of the algorithms.

Keywords: Vehicle Routing Problem · Multi-trip · Various capacity · Pattern mining · Pattern mining

Time-dependency of Guided Local Search to Solve the Capacitated Vehicle Routing Problem with Time Windows

Adriano dos Santos Silva, José Lima, Ana I. Pereira, Adrián Silva and Hélder T. Gomes

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Research have been driven by the increased demand for delivery and pick-up services to develop new formulations and algorithms for solving Vehicle Routing Problems (VRP). The main objective is to create algorithms that can identify paths considering execution time in real-world scenarios. This study focused on using the Guided Local Search (GLS) metaheuristic available in OR-Tools to solve the Capacitated Vehicle Routing Problem with Time Windows using the Solomons instances. The execution time was used as a stop criterion, with short runs ranging from 1 to 10 seconds and a long run of 360 seconds for comparison. The results showed that the GLS metaheuristic from OR-Tools is applicable for achieving high performance in finding the shortest path and optimizing routes within constrained execution times. It outperformed the best-known solutions from the literature in longer execution times and even provided a close-to-optimal solution within 10 seconds. These findings suggest the potential application of this tool for dynamic VRP scenarios that require faster algorithms.

Keywords: VRP · Metaheuristic · Scheduling Problems

Accuracy Optimization in Speech Pathology Diagnosis With Data Preprocessing Techniques

Joana Fernandes, Diamantino Rui Freitas and João P. Teixeira

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Using acoustic analysis to classify and identify speech disorders non-invasively can reduce waiting times for patients and specialists while also increasing the accuracy of diagnoses. In order to identify models to use in a vocal disease diagnosis system, we want to know which models have higher success rates in distinguishing between healthy and pathological sounds. For this purpose, 708 diseased people spread throughout 19 pathologies, and 194 control people were used. There are nine sound files per subject, three vowels in three tones, for each subject. From each sound file, 13 parameters were extracted (jitta, jitter, Rap, PPQ5, ShdB, Shim, APQ3, APQ5, F0, HNR, autocorrelation, Shan-non entropy and logarithmic entropy). For the classification of healthy/pathological individuals, a variety of classifiers based on Machine Learning models were used, including decision trees, discriminant analyses, logistic regression classifiers, naive Bayes classifiers, support vector machines, classifiers of closely related variables, ensemble classifiers and artificial neural network classifiers. For each patient, 118 parameters were used initially. The first analysis aimed to find the best classifier, thus obtaining an accuracy of 81.3% for the Ensemble Sub-space Discriminant classifier. The second and third analyses aimed to improve ground accuracy using preprocessing methodologies. Therefore, in the second analysis, the PCA technique was used, with an accuracy of 80.2%. The third analysis combined several outlier treatment models with several data normalization models and, in general, accuracy improved, obtaining the best accuracy (82.9%) with the combination of the Greebs model for outliers treatment and the range model for the normalization of data procedure.

Keywords: Outliers · Normalization · Speech Pathologies · Machine Learning · Vocal Acoustic Analysis

Application of Pattern Recognition Techniques for MathE Questions Difficulty Level Definition

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Active learning is a modern educational strategy that involves students in the learning process through diverse interactive and participatory activities. The MathE platform is an international online platform created to support students and lecturers in the Mathematics teaching and learning process. This platform offers a tool to aid and engage students, ensuring new and creative ways to encourage them to improve their mathematical skills. The study proposed in this paper refers to a comprehensive investigation of the patterns that may exist within the set of questions available on the MathE platform. The objective is to investigate how to evaluate the student's opinions about the question's difficulty levels based on the variables extracted from student answers collected through surveys applied among the platform's users. Moreover, a comparative study between variables is performed using a correlation test and analysis of variance. Furthermore, based on the results obtained for samples of different sizes, it was possible to define the most appropriate number of answers that should be considered to categorize the question's difficulty level. The results demonstrated that the variables extracted could be used to carry out the question level, and 30 answers are the most appropriate number of questions that must be used to categorize the question level.

Keywords: Active learning · e-learning · Higher Education · Mathematics

Predicting Flood Events with Streaming Data: A Preliminary Approach with GRU and ARIMA

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In this paper results are present to forecast flood events using RNNs like LSTM and GRU networks and ARIMA time series forecast model on data collected by sensors mainly rainfall and stream flow values. For dealing with all the difficulties resulting from forecasting rare events transfer learning and undersampling are used to get a richer sample of positive events, combined with simulated events. GRU and ARIMA models performed better than LSTM, using the hit hate measure using 30% of the positive events as test sample and 70% for learning sample. Even though the alert messages are sent by SMS to relevant deciders an application was developed to manage the alerts and the sensors spread by all the islands in Azores archipelago.

Keywords: IoT data · RNN · ARIMA · Azores · Flood forecast

Digital Twin for Regional Water Consumption Simulation and Forecasting

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Water scarcity is a global concern due to population growth, climate change, and industrialization. Accurate water consumption simulation and forecasting are essential for understanding consumption patterns and predicting future demand. The control and visualization of how different aspects such as precipitation, season, and population affect water consumption can be a way for public agencies to plan actions that minimize waste and assist in the correct use of water. Technology, and especially Machine Learning and Digital Twin, can be used as tools for this. In light of this, this project aims to develop a system for simulating and forecasting water consumption in the Braganca region using a Digital Twin. In order to accomplish this, a comprehensive analysis is conducted to determine the necessary requirements for designing the system. This analysis encompasses the evaluation of hardware, software, data, machine learning models, web interface, as well as security and performance requirements. Furthermore, the architecture of this system and how it will be configured is analyzed, proposing a system with Training Data Sources, Training Process, Updated Data Sources, Digital Twin, Web Interface and Monitoring System. The system described in this article is under development and it is hoped to achieve as a result the full design of the Digital Twin and User Interface systems.

Keywords: Water · Consumption · Simulator · Web

Automatic Fall Detection with Thermal Camera

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As people are living longer, there are new challenges in healthcare. Many older adults prefer to age in their own homes rather than in healthcare institutions. Portugal has seen a similar trend, and public and private home care solutions have been developed. However, age-related pathologies can affect an elderly person's ability to perform daily tasks independently. Ambient Assisted Living (AAL) is a domain that uses information and communication technologies to improve the quality of life of older adults. AI-based fall detection systems have been integrated into AAL studies, and posture estimation tools are important for monitoring patients. The approach studied in this ongoing project uses OpenCV and the YOLOv7 machine learning framework to develop a fall detection system based on posture analysis. To protect patient privacy, a thermal camera prevents facial recognition.

Keywords: Fall detection · Pose model · Ambient assisted-living

Image Transfer over MQTT in IoT: Message Segmentation and Encryption for Remote Indicator Panels

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The Internet of Things (IoT) has revolutionized how objects and devices interact, creating new possibilities for seamless connectivity and data exchange. This paper presents a unique and effective method for transferring images via the Message Queuing Telemetry Transport (MQTT) protocol in an encrypted manner. The image is split into multiple messages, with each carrying a segment of the image, and employ top-notch encryption techniques to ensure secure communication. Applying this process, the message payload is split into smaller segments, and consequently, it minimizes the network bandwidth impact while mitigating potential of packet loss or latency issues. Furthermore, by applying encryption techniques, we guarantee the confidentiality and integrity of the image data during transmission, safeguarding against unauthorized access or tampering. Our experiments in a real-world scenario involving remote indicator panels with LEDs verify the effectiveness of our approach. By using our proposed method, we successfully transmit images over MQTT, achieving secure and reliable data transfer while ensuring the integrity of the image content. Our results demonstrate the feasibility and effectiveness of the proposed approach for image transfer in IoT applications. The combination of message segmentation, MQTT protocol, and encryption techniques offers a practical solution for transmitting images in resource-constrained IoT networks while maintaining data security. This approach can be applied in different applications.

Keywords: Message Segmentation · Internet of Things · Message Payload Optimization · Transmission Encryption Algorithm

An Extension of a Dynamic Heuristic Solution for Solving a Multi-Objective Optimization Problem in the Defense Industry

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Digital Excellence Center, Assystem, Technology & Innovation, Assystem

Project scheduling in a real-life scenario often involves multiplecriteria decision-making in which no single solution exists. To solve such a problem, a multi-objective optimization method has been applied to define the satisfying trade-off between different criteria. In this paper, we focus on a specific use case in the defense industry in which the overall mission is to generate a maintenance plan for the transfer operations of power grid consumers to the new service area. The project objectives include restricting the outage duration during transfer operations, grouping operations concerning the proximity between them, moderating the allocation of supporting resource, and regulating human resources intervention outside business hours. To solve this problem, we propose a combination of heuristic approaches starting by defining a sequence of activities based on their complexities to be scheduled. Concerning the obtained order, a serial-schedule generation scheme (S-SGS) is then implemented by iterating through each activity to define the best time period to proceed the operation in accordance with projectŠs multiple objectives. Finally, the output is transferred to our existing parallel scheme-based solver, Optimizio, to finally justify the project planning. The proposed S-SGS solution provides a feasible schedule of 110 transfer operations in 2 seconds with solution evaluation analysis and information of a Pareto frontier in approximately 15 minutes. The set of Pareto optimal solutions allows the expert to explore potential trade-offs between criteria. Together with a fast execution time of the algorithms that benefits a multi-scenario simulation, our tool demonstrates a potential capacity to get the optimum outcome of the multi-objective optimization project.

Keywords: Serial Schedule Generation Scheme · Multi-Objective Programming · Heuristic Algorithms · Resource-Constrained Project Scheduling Problem

BHO-MA: Bayesian Hyperparameter Optimization with Multi-objective Acquisition

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Good hyperparameter values are crucial for the performance of Machine Learning models. In particular, poorly chosen values can cause under or overfitting in regression and classification. A common approach to hyperparameter tuning is grid search, but this is crude and computationally expensive, and the literature contains several more efficient automatic methods such as Bayesian optimization. In this work, we develop a Bayesian hyperparameter optimization technique with more robust performance, by combining several acquisition functions and applying a multi-objective approach. We evaluated our method using both classification and regression, four data sets and compared with eight popular methods. The results show that the proposed method achieved better results than all others.

Keywords: Bayesian Optimization · Multi-Objective Optimization · Hyperparameter Tuning · Automated Machine Learning

Prediction of Health of Corals Mussismilia Hispida Based on the Microorganisms present in their microbiome

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One of the most diverse and productive marine ecosystems in the world are the corals, providing not only tourism but also an important economic contribution to the countries that have them on their coasts. Thanks to genome sequencing techniques, it is possible to identify the microorganisms that form the coral microbiome. The generation of large amounts of data, thanks to the low cost of sequencing since 2005, provides an opening for the use of artificial neural networks for the advancement of sciences such as biology and medicine. This work aims to predict the healthy microbiome present in samples of Mussismilia hispida coral, using Machine Learning Algorithm, in which the algorithms SVM, Decision Tree, and Random Forest achieved a rate of 61%, 74%, and 72%, respectively.

Keywords: Machine Learning Algorithm · Coral · Reef Microbiome

The Consistent Vehicle Routing Problem: an Application to the Pharmaceutical Supply Chain

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With increasingly competitive markets, companies have turned their strate-gies towards process optimization to better respond to customer demands. The Vehicle Routing Problem has gained greater prominence in this paradigm shift since, through its resolution, it can be obtained gains in improving the use of resources. In this paper, we developed a route planning methodology for a pharmaceutical distributor company that has recently changed the structure of its operations, thus being necessary to redefine its entire service to the different pharmacies, based in real instances. The proposed methodol-ogy combines an exact method with cluster-first, routing-second apporach to solve a consistent route planning problem with multiple customers, time window constraints, heterogeneous fleet, and different delivery periods. It was possible to apply the method for large set of customers, achieving results with relatively low computational effort. The results demonstrate the meth-odology's potential to reduce operational costs and improve overall service fulfillment.

Keywords: Consistent Vehicle Routing Problem · Cluster based approach · Pharmaceutical Supply Chain

Using OR-Tools when Solving the Nurse Scheduling Problem

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Scheduling of employees is a common problem that can be found in most organizations all over the world. One example is the nurse scheduling problem (NSP), which is a complex combinatorial optimization problem faced by healthcare institutions in assigning working and nonworking days. The NSP comprises constraints for the nurses, for the hospital, and considers specific labor regulations, as well as the skills and preferences of workers. In summary, it involves hard and soft constraints. It is essential to create a quality timetable that can lead to a more contented and thus, more effective, and productive workforce. To improve this process, it can be used automated approaches and techniques. In this study, a literature review about the nurse scheduling problem and how to use the Google OR-Tools software to solve it is performed. Moreover, an example of an NSP involving 10 nurses being assigned to three shifts a day, seven days a week is presented. Some conditions/constraints have been added in order to reproduce a real situation.

Keywords: Nurse scheduling problem · Constrained optimization · Google OR-Tools

Predicting the Solution Time for Optimization Problems Using Machine Learning Case of Job Shop Scheduling Problem

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In organizations that use optimization and other computer-related problem-solving techniques, a better understanding of the required computational time is essential for efficient decision-making and resource allocation which also directly affects the productivity and operational effectiveness. This study proposes using different Machine Learning (ML) methods to predict the computation time needed to solve job shop problems. Specifically we implemented 11 ML models, including the Deep Neural Network (DNN), which delivered the most accurate results. The proposed approach involves utilizing DNN algorithm to predict computation time for Integer Programming (IP) job shop problems, trained on synthetically generated data which indicate the gap-time correlation in a branch and bound tree. The developed model in this study estimates the total computation time with an accuracy of 92%. The model development process involves collecting data from a set of solved problems using branch and bound method and train the ML models to estimate the computational time required to reach the optimal solution (0% optimality gap) in unsolved similar problems.

Keywords: Machine Learning · Deep Neural Networks · Performance Evaluation · Job Shop Scheduling · Integer Programming · Branch and Bound Method · Computation Time Prediction

Schedule Modeling in a Fire Station: a Linear Approach to Optimize Service and Human Resources

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Polytechnic Institute of Viana do Castelo, CIDMA and Algoritmi

Associations of Volunteer Fireghters form the basis of helping the Portuguese population. In these institutions, to guarantee the first line of assistance, there are volunteers and also a group of professional fireghters. However, there are not always enough funds to hire the human resources effectively needed, or even to guarantee the continuity of services provided 24 hours a day. In this work, the linear programming method was used to study a schedule problem, and the simulations presented were carried out at Excel OpenSolver. The aim was to understand the minimum number of reghters needed to meet the demands of the population and to guarantee a quick response to requests that may occur over the day. Even with some restrictions associated with the specific roles of each fireghter, it was possible to design several scenarios, involving different shifts, and left the decision of the best solution for the responsible of the re station taking into account the trade-off between costs and provided service.

Keywords: Fireghter · Scheduling · Linear Optimization

Help us to Help: Improving Non-urgent Transport on a Portuguese Fire Station

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In Portugal, the transport of non-urgent patients is mostly performed by fire stations. These non-profit organizations have tight budgets and cannot afford to buy expensive software to improve their services. Furthermore, it is not always easy to find open-source tools for this purpose. In this research, an open-source solver, developed in Visual Basic for Applications, is modified and adapted to meet the specificity of a fire station in the North of Portugal and an environmental analysis of the impact of transportation of patients was performed. Here, the modifications to the solver are presented and real instances are tested. Additionally, an analysis of the environmental impacts originated during transportation is presented summarizing the main impact caused during this activity. The results show better use of the ambulances' capacity, and significant reductions in the traveled distances and in the fire station's ecological footprint.

Keywords: OR in Practice · Vehicle Routing Problem · Sustainability

Location of an Electric Vehicle Charging Station: Demographic Factor as Decision Making

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Infrastructure is referred to as being one of the major drivers for the sound economic development of the country, however, the location of the same can become a crucial factor for the population that lives mainly in rural areas. This case study aims to identify the best point for the installation of a new electric charging station in the municipality of Viana do Castelo, Portugal. The method applied is the centre of gravity, using as data the coordinates of the parish councils, the total population, and the administrative division of 2011 and 2021. The goal is to find a central location, considering the population density, and minimizing the distance between the new and existing charging stations. In this work, the coordinates of all the parish councils belonging to the municipality were taken and analyzed, assuming the weight as the totality of the existing population in each parish. The results obtained, applying the gravity centre method directly, in a first approach, was a not viable point, since it represented a space in Lima River. The solution proposed was to allocate the new charging station to the near parish and the impact was evaluated.

Keywords: Electric Charging Stations · Centre of Gravity Method · Location

Speeding up the Oscillation-free Modified Heavy Ball Algorithm

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This paper presents modified, faster momentum minimization algorithms based on existing ones. The modified algorithms monotonically decrease the objective function and do not allow it to oscillate. The modification scheme aims to enhance momentum minimizers by incorporating contemporary line search procedures and restarts, akin to the state-of-the-art unconstrained minimizers. We also investigate the unique resource of oscillation-free momentum minimizers for their further acceleration. In particular, the wider range of variation in the friction-related coefficient within the model significantly impacts the performance time.Our previously developed techniques can be used to prove the convergence of modified algorithms. In this paper, we focus on the technical and experimental aspects of these algorithms. To determine the efficiency of the new algorithms, numerical experiments were conducted on standard optimization test functions and on single-layer neural networks for several datasets. Comparisons were made with the best unconstrained minimization algorithms – LCG, LBGFS and ADAM. Oscillation-free momentum algorithms are significantly easier to design and implement than LCG and LBFGS, while still being competitive in terms of performance. Collections of minimizers and test functions have been uploaded to GitHub.

Keywords: Polyak's heavy ball method · Nesterov's accelerated gradient method · L-BFGS · LCG

Performance Comparison of NSGA-II and NSGA-III on Bi-objective Job Shop Scheduling Problems

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Job Shop Scheduling (JSS) problems emerge in many industrial sectors, where it is sought to maximize efficiency, minimize costs, minimize energy consumption among other conflicting objectives. Thus, these optimization problems involve two or more objectives. In recent years, new algorithms have been developed and proposed to tackle multi-objective problems such as the Non-dominated Sorting Genetic Algorithm II (NSGA-II) and the Non-dominated Sorting Genetic Algorithm III (NSGA-III), among others. It is well-known that NSGA-II has a good performance on problems with two or three objectives while NSGA-III is particularly suited for many-objective problems (with more than three objectives). The main goal of this work is to compare the performance of these algorithms on solving bi-objective JSS problems on unrelated parallel machines with sequence-dependent setup times. For comparison purposes, the results of the hypervolume performance measure are statistically analysed. The results obtained show that the performance of these two algorithms is not significantly different and, therefore, NSGA-III does not represent a clear advantage on solving bi-objective JSS problems.

Keywords: Multi-Objective Optimization · Job Shop Scheduling · Algorithms

A Multiobjective Tuning of a Procedural Content Generator for Game Level Design via Evolutionary Algorithms

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This work introduces a new multiobjective modeling approach for fine-tuning the parameters of a procedural game level generator in the platform game Infinite Mario Bros. The optimization problem aims to maximize three objectives related to game difficulty, including enemy placement, types of movements required, and time limits. The multiobjective problem is solved using two well-known evolutionary algorithms, NSGA-II and C-TAEA. To evaluate candidate parameter configurations, the averaged values of indicators returned by three artificial intelligent agents playing the levels are considered. A comprehensive computational experiment is conducted, and a statistical comparison using the Wilcoxon test is performed based on hypervolume values. The results include a nondomination analysis, an exploration of the distribution of final solutions, and the illustration of three levels from the final Pareto front. The key contribution of this work lies in the development of a multiobjective methodology that leverages evolutionary algorithms and incorporates agent-based evaluation, providing an effective approach for tuning procedural game level generators.

Keywords: Multi-Objective Optimization · Parameter tuning · Procedural game level generation

Optimal Location of Electric Vehicle Charging Stations in Distribution Grids using Genetic Algorithms

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In recent years we have been faced with a significant amount of harmful gas emissions into the atmosphere, so it is necessary to find solutions to reduce these emissions. This will make it more attractive to use electric vehicles, thus reducing the high dependency on internal combustion vehicles. For example, it is necessary to build fast charging stations that allow electric vehicle owners to charge their vehicles as quickly as possible. Due to the high power involved, there are voltage drops that affect the voltage profile. This paper presents a genetic algorithm (GA) that is used to determine the optimal location of charging stations in places that cause the minimum impact on the grid voltage profile. Two case studies are considered to evaluate the behavior of the distribution grid with the EV charging stations connected. From the results obtained, it can be stated that the GA results in an efficient way to find the best locations where the grid voltage profile is within the regulatory limits and the value of losses is minimized.

Keywords: Fast charging stations · Genetic algorithm · Distribution network · Optimal placement · Power-Flow

Nonlinear Regression on Growth Curves for Placental Parameters in R

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Growth charts play a crucial role in the evaluation and surveillance of paediatric populations, serving as indispensable tools for paediatricians and public health researchers. The development of these growth charts for fetal parameters has been extensively used in recent decades.However, investigation of placental parameters and their relationship with obstetric outcome has been relatively neglected, resulting in a significant gap in understanding their biological significance. This study presents an alternative approach for constructing reference growth curves specific to the placental parameter, Diameter 2. Our methodology uses the generalized additive models for location, scale, and shape (GAMLSS) framework, offering distinct advantages over traditional quantile regression methods. One of the key advantages of GAMLSS is its flexibility to accommodate any statistical distribution, allowing for the modelling of various parameters that characterize the distribution of the response variable. Through the application of our proposed methodology, we demonstrated that by using P-splines as a smoothing function and Box-Cox t (BCT) as a distribution, we can achieve a representative growth curve for the Diameter 2 of the placenta throughout gestational age (GA). Moreover, our approach has the ultimate goal to facilitate early diagnosis of fetal complications, thereby providing valuable assistance to healthcare professionals.

Keywords: Placenta · Growth curves · Non-linear · Semi-parametric regression model · Smoothing functions · Distributions · GAMLSS · LMS

GLM's in Data Science as a tool in the prediction of Delirium

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Delirium is an acute neuropsychiatric dysfunction, prevalent in patients admitted to hospitals for inpatient and intensive care, being clinically characterized by attention deficit and clouding of the state of consciousness associated with cognitive disorders. Since this is a multifactorial manifestation that develops over a short period of time, it is usually underdiagnosed and neglected. Consequently, this disorder appears associated with high rates of mortality and morbidity, leading to a longer period of hospitalization. Additionally, delirium can be categorized, according to the motor activity profile, into two subtypes: hypo and hyperactive.Currently, there are studies and assessment instruments for the study and prediction of the disease at an earlier stage, based on a set of risk factors. However, in the context of a hospital emergency, time is essential, as well as a correct and early diagnosis to intervene as quickly as possible. In this context, the goal of this paper arises, which aims to implement a diversity of techniques to preprocess the data to perform the multinomial logistic regression. The ultimate goal is to identify the most effective data balancing technique for accurate prediction of delirium occurrence and its subtypes, based on the methodology of generalized linear models (GLMs), specifically multinomial logistic regression (MLR).

Keywords: Delirium · Generalized Linear Models · Multinomial Logistic Regression

Federated Learning for Credit Scoring Model using Blockchain

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In the last years technologies have emerged in a very disruptive way, model-ling and navigating a big part of human life. Recently blockchain and ma-chine learning technologies reached a new level of maturity. From low pene-trated tech, blockchain become in the bottom of the digital crypto currencies and many projects out of them. At the same time, Machine Learning is be-coming more powerful and strong technology and many companies start to adopt it as a solution for non-trivial technical problems leveraging on the tones of data they use and generate in their daily functioning. Both block-chain and Machine Learning technologies have become a big part of our life and different studies show how much potential they have. The paper pre-sents a system architecture approach for building a decentralized FELScore platform based on federated learning paradigm and blockchain technology for credit score modelling. The main goal is to provide a platform for distrib-uted Machine Learning that several financial institutions could leverage on without having the need to exchange real customer or product data and with-out the requirement to trust each other. To further improve the security of the federated learning and to improve the accuracy of the credit score models the proposed approach uses blockchain technology.

Keywords: Credit Score · Federated Learning · Smart Contract · Blockchain

PhishVision: a Deep Learning based Visual Brand Impersonation Detector for Identifying Phishing Attacks

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aizoOn Technology Consultin, University of Genoa

With the rapid growth of online space and the rising number of interconnected devices, security threats related to both personal and corporate data have increased considerably. Phishing attacks are commonly used to target corporate networks and gain initial access into security perimeters. The campaigns associated to these attacks span different propagation media and, in the case of web pages, attackers mimic real pages to trick users into downloading malicious software or sharing their credentials. In this paper we propose PhishVision, a framework for visually detecting phishing websites by identifying the main logo that characterizes them and comparing it with a set of logos which PhishVision protects. In case of presence of multiple logos, the framework is able to reconstruct which logo identifies the page while ignoring the others. The framework has been designed to have a lower false positive rate, fast detection times, and works in near-real-time fashion to provide a phishing detection service to Security Operation Centers. Its operators can use it make informed decisions about potential phishing activities by offering a comprehensible grey box explanation about how the framework has reached its conclusions. PhishVision achieves 0.997 ROC AUC on a test set of 404 screenshots, including both benign and malicious samples.

Keywords: Deep Learning · Explainability · Brand Impersonation · Phishing

Call Centre Optimization based on Personalized Requests Distribution

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The paper is devoted to the appointments' problem in the framework of optimizing the call centre work based on a scheduling theory online model. A multi-criteria problem is considered, which includes not only formal theoretical indicators of the obtained schedules (average delay), but also taking into account the human factor (client satisfaction and operator fatigue). The paper proposes a new approach and DCSF algorithm (Deadline, Compatibility and Safe Factor) for optimizing appointments within the call centre. An important feature of this work is the algorithm personalization, achieved by taking into account the individual customers and operators parameters. The paper also uses the concept of calculating deadlines based on the client's readiness to wait and the concept of taking into account the safety factor. These approaches are used for the first time to manage the call centre work.

Keywords: Queuing system optimization · Online schedule model with deadlines · Personalized Appointments · Multi-criteria problem

AquaVitae: Innovating Personalized Meal Recommendations for Enhanced Nutritional Health

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In this study, we present an advanced recommendation system specifically engineered to aid nutritionists in developing personalized, optimized nutritional plans. Our system operates by amassing a broad range of data including users' preferences, dietary restrictions, and specific nutritional requirements, which it then utilizes to craft a diverse assortment of meal choices individually tailored to each user. A key innovation of our system is its ability to facilitate continuous diet monitoring, eliminating the need for repeated consultations to update the nutritional plans. This allows for real-time dietary adjustments and provides nutritionists with more accurate data for subsequent plans. Additionally, the system prioritizes the inclusion of thermogenic foods to maximize nutritional efficiency, while simultaneously providing a pleasurable experience for the users. This combination of sophisticated data collection and innovative food recommendations underscores the potential of our system to improve the process of nutritional counseling and the generation of nutritional plans, bringing notable benefits to both practitioners and clients alike.

Keywords: Recommendation System · Thermal-Based · Nutritional Plan · Food Ranking

Barriers to Organizations to Adopt Digital Transformation for Driving Eco-innovation and Sustainable Performance

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This article presents a literature review on the barriers faced by organizations in adopting digital transformation for eco-innovation and sustainable performance to address the surprising little research has explored the connection between digitalization and eco-innovation. Through a systematic review of relevant literature, the article identifies and categorizes key barriers into three categories: technological, organizational, and environmental. Technological barriers include issues related to technological readiness, data management, interoperability, and cybersecurity. Organizational barriers encompass challenges related to organizational culture, leadership, change management, and resistance to change. Environmental barriers involve external factors such as regulatory frameworks, legal constraints, and stakeholder pressures. The review reveals that these barriers can significantly impede or-ganizations' efforts to drive eco-innovation and sustainable performance. The article concludes by proposing avenues for future research and practical im-plications for organizations seeking to overcome these barriers. This contrib-utes to the literature on digital transformation, eco-innovation, and sustainable performance, and provides insights for scholars and practitioners in this field.

Keywords: Digital Transformation · Eco-innovation · Sustainable Performance · Emerging Technologies · Technology Management

Interpretable Structural Analysis for Evolutionary Generative Design of Coastal Breakwaters

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This paper presents an interpretable approach for the generative design of coastal breakwaters that combines evolutionary optimization and structural analysis of solutions. It allows both to improve the convergence of optimization for breakwaters structure and analyze the sensitivity of each sub-part of the solution to various changes. We conduct experiments on synthetic harbour configuration to validate this approach. The results confirm the effectiveness of our method in generating high-quality and explainable breakwater designs.

Keywords: Generative design · Coastal breakwaters · Structural analysis

Assessing the Reliability of AI-based Angle Detection for Shoulder and Elbow Rehabilitation

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Angle assessment is crucial in rehabilitation and significantly influences physiotherapistsŠ decision-making. Although visual inspection is commonly used, it is known to be approximate. This preliminary study aims to integrate and evaluate AI image-based approaches for assessing upper-limb angles. The study involved 28 participants performing four different rotational joints movement in the shoulder and elbow complex. Two AI algorithms, utilizing MediaPipe Holistic and Yolo v7, were employed for angle estimation. The accuracy of the estimations was evaluated against a wall-mounted compass, considering the ground truth. The results showed that the AI image-based algorithms displayed promising capabilities in assessing the exercises. Yolo v7 achieved the highest quality of estimations, with MAE equal to or less than 5ž, while MediaPipe, despite producing poorer results, where the MAE reaches values of 17ž, offered more features and required lower computational power than Yolo v7. However, it is worth noting that Yolo v7 was limited to exercises in 2D and did not estimate the position of key body points in 3D. Nevertheless, Yolo v7 would provide a cost-effective and easily implementable solution for measuring angles in rehabilitation activities for 1 Degree of Freedom (DOF) exercises. Overall, this study demonstrates the great promise of angle estimation for rehabilitation purposes of the AI approach.

Keywords: Join Angle Measurement · Artificial Intelligence · Motion Capture · Robotic Rehabilitation

Movement Pattern Recognition in Boxing Using Raw Inertial Measurements

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In the paper, a new machine learning technique is proposed to recognize movement patterns. The efficient system designed for this purpose uses an artificial neural network (ANN) model implemented on a microcontroller to classify boxing punches. Artificial intelligence (AI) enables the processing of sophisticated and complex patterns, and the X-CUBE-AI package allows the use of these possibilities in portable microprocessor systems. The input data to the network are linear accelerations and angular velocities read from the sensor mounted on the boxerŠs wrist. By using simple time-domain measurements without extracting signal features, the classification is performed in real time. An extensive experiment was carried out for two groups with different levels of boxing skills. The developed model demonstrated high efficiency in the identification of individual types of blows.

Keywords: Activity recognition · Artificial Intelligence · Artificial Neural Networks · Edge computing · Microcontrollers

An Evaluation of Image Preprocessing in Skin Lesions Detection

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This study aims to evaluate the impact of image preprocessing techniques on the performance of Convolutional Neural Network (CNNs) in the task of skin lesion classification. The study is made on the ISIC 2017 dataset, a widely used resource in skin cancer diagnosis research. Thirteen popular CNN models were trained using transfer learning. An ensemble strategy was also employed to generate a final diagnosis based on the classifications of different models. The results indicate that image preprocessing can significantly enhance the performance of CNN models in skin lesion classification tasks. Our best model obtained a balanced accuracy of 0.7879.

Keywords: Skin Lesion Classification ·Convolutional Neural Network · Deep Learning · Image Preprocessing

Pest Detection in Olive Groves Using YOLOv7 and YOLOv8 models

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Modern agriculture faces important challenges for feeding a fast-growing planetŠs population in a sustainable way. One of the most important challenges faced by agriculture is the increasing destruction caused by pests to important crops. It is very important to control and manage pests in order to reduce the losses they cause. However, pest detection and monitoring are very resources consuming tasks. The recent development of computer vision-based technology has made it possible to automatize pest detection efficiently. In Mediterranean olive groves, the olive fly (Bactrocera oleae Rossi) is considered the key-pest of the crop. This paper presents olive fly detection using the lightweight YOLO-based model for versions 7 and 8, respectively, YOLOv7-tiny and YOLOv8n. The proposed object detection models were trained, validated, and tested using two different image datasets collected in various locations of Portugal and Greece. The images are constituted by sticky yellow trap photos and by McPhail trap photos with olive fly exemplars. The performance of the models was evaluated using precision, recall, and mAP.95. The YOLOV7-tiny model best performance is 88.3% of preci-sion, 85% of Recall, 90% mAP.50, and 53% of mAP.95. The YOLOV8n model best performance is 85% of precision, 85% of Recall, 90% mAP.50, and 55% of mAP.50 YOLO8n model achieved much worst results than YOLOv7-tiny for a dataset without negative images (images without olive fly exemplars). Aiming at installing an experimental prototype in the olive grove, the YOLOv8n model was implemented in a Ubuntu Server 23.4 (64 bit) Raspberry PI 3 microcomputer.

Keywords: Olives sustainable production · Deep Learning · YOLOv7 · YOLOv8

An Example of Ontology in Medical Diagnosis: A Case Study

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The widespread use of AI tools in recent years has put even more emphasis on the interaction between humans and computers in terms of information exchange and knowledge representation. Appropriate knowledge representation is im-portant in the context of human-computer interaction because the knowledge has to be represented in a manner that is understandable to humans while still being useful for computers. This paper describes the approach of knowledge represen-tation using ontologies and provides a use case example of using this approach in medical diagnosis.

Keywords: Ontologies · Knowledge Representation · Artificial Intelligence

Text Chunking To Improve Websites Classification

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Website classification is a crucial task in various applications such as web search, content filtering, and recommendation systems. Effectively categorizing long web pages into different categories based on their content is essential for providing accurate and personalized user experiences. Traditional transformer based models, such as BERT and RoBERTa, have significantly advanced the field of natural language processing. However, such models face limitations when handling long sequences due to their fixed-length input restrictions resulting from their quadratic complexity. This paper presents a simple Frequency-based split approach (FSA), to address the limitations of BERT and RoBERTa, in processing long text sequences for website classification. FSA consists into chunking web pages into smaller chunks, then a new train chunks dataset is generated by a stratified frequential based split following the distribution of the categories in the whole chunks dataset. This train chunks dataset is then used to train the models. Our approach improves the accuracy of BERT and RoBERTa models, surpassing the performance of Longformer and BigBird models. The proposed solution enables efficient processing and data augmentation, with reasonable fine-tuning times for BERT and RoBERTa models. Inference times remain efficient, showcasing the practicality of these models in real-time website classification tasks. The combination of FSA with the index web page performs exceptionally well, highlighting its effectiveness in addressing the long text sequence limitation and improving transformer-based models for website classification.

Keywords: Website Classification · Natural Language Processing · Transformers · Machine Learning · Data Splitting

Automatic Speech Recognition for Portuguese: A Comparative Study

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This paper provides some comparisons of Automatic Speech Recognition (ASR) services for Portuguese that were developed in the scope of the Safe Cities project. ASR technology has enabled bi-directional voice-driven interfaces, and its demand in Portuguese is evident due to the language's global prominence. However, the transcription process has complexities, and a high accuracy depends on the ability of capturing speech variability and language intricacies, while being rigorous in terms of semantics. The study first describes ASR services/models by Google, Microsoft, Amazon, IBM, and Voice Interaction regarding their main features. To compare them, three tests were proposed. Test A uses a small dataset with six audio recordings to evaluate in terms of word hit rate the accuracy of online services, with IBM outperforming others (pt-BR:93.33%). Tests B and C utilize the Mozilla Common Voice database filtered by a keywordsŠ set to compare online and offline models for Brazilian and European Portuguese regarding accuracy (Ratcliff-Obershelp algorithm), Word Error Rate, Match Error Rate, Word Information Loss, Character Error Rate and Response-Request Ratio. Test B highlights the higher accuracy of Google Cloud (pt-PT:94.90%) and Azure (pt-BR:98.11%). Test C showcases the potential of Voice Interaction's real-time application despite its lower accuracy (pt-PT:78.81%). The tests were carried out using a framework developed using Python 3.x on a Raspberry Pi 4 model B with a server desktop and the REST APIs from the companiesŠ repositories.

Keywords: Automatic Speech Recognition · Portuguese · Language Model · Transcription · Mozilla Common Voice · ASR accuracy

Comparative Analysis of Windows for Speech Emotion Recognition using CNN

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The paper presents the comparison of accuracy in the Speech Emotion Recognition task using the Hamming and Hanning windows for framing the speech and determining the spectrogram to be used as input of a convolutional neural network. The detection of between 4 and 10 emotional states was tested for both windows. The results show significant differences in accuracy between the two window types and provide valuable insights for the development of more efficient emotional state detection systems.

Keywords: Speech Emotion Recognition · Hamming · CNN

Exploring the Role of OR/MS in Cancer Research

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This study aims to explore and analyze the significant role of Operations Research/Management Science (OR/MS) in the field of cancer research. The purpose of this work is to identify and highlight the various applications, methodologies, and contributions of OR/MS techniques in advancing cancer research, as well as to establish how OR/MS can effectively contribute to the development of innovative strategies, optimization of treatment protocols, decision-making processes, and overall improvement in cancer treatment.

Keywords: OR/MS · Methods · Modeling · Cancer

On the Use of VGs for Feature Selection in Supervised Machine Learning - A use case to detect distributed DoS attacks

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Information systems depend on security mechanisms to detect and respond to cyber attacks. One of the most frequent attacks is the distributed Denial of Service (distributed DoS): it impairs the performance of systems and, in the worst case, leads to prolonged periods of downtime that prevent business process from running normally. To detect this attack, several supervised Machine Learning (ML) algorithms have been developed and companies use them to protect their servers. A key stage in these algorithms is feature selection, in which, input data features are assessed and selected to obtain the best results in the subsequent stages that are required to implement supervised ML algorithms. In this article, an innovative approach for feature selection is proposed: the use of Visibility Graphs (VGs) to select features for supervised Machine Learning Algorithm used to detect distributed DoS attacks. The results show that VG can be quickly implemented and they can compete with other methods to select ML features, as they require low computational resources and they offer satisfactory results, at least in our example based on the early detection of distributed DoS. The size of the processed data appears as the main implementation constraint for this novel feature selection method.

Keywords: Artificial Intelligence · Machine Learning · Supervised Learning · Denial of Service attack · Visibility Graph · Cybersecurity

An Artificial Intelligence-Based Method to Identify the Stage of Maturation in Olive Oil Mills

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Identifying the stage of maturation is an added value for olive oil producers and consumers, whether this is done to predict the best harvest time or to give us more information about the olive oil or even to adapt techniques and extraction parameters in the olive oil mill. In this way, the proposed work presents a new method to identify and count the number of olives that enter the mill as well as their stage of maturation. It is based on artificial intelligence (AI) and deep learning algorithms, using the two most recent versions of YOLO, YOLOv7 and YOLOv8. The obtained results demonstrate the possibility of using this type of applications in a real environment, managing to obtain a mAP of approximately 79% with YOLOv8 in the five maturation stages, with a processing speed of approximately 16 FPS increasing this speed with Yolov7 to 36.5 FPS reaching a 66% mAP

Keywords: Olive ripening stages · You Only Look Once (YOLO) · Counting

Enhancing Forest Fire Detection and Monitoring through Satellite Image Recognition: A Comparative Analysis of Classification Algorithms Using Sentinel-2 Data

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Worldwide, forests have been harassed by fire in recent years. Either by human intervention or other reasons, the history of the burned area is increasing considerably, harming fauna and flora. It is essential to detect an early ignition for fire-fighting authorities can act quickly, decreasing the impact of forest damage impacts. The proposed system aims to improve nature monitoring and improve the existing surveillance systems through satellite image recognition. The soil recognition via satellite images can determine the sensor modules' best position and provide crucial input information for artificial intelligence-based systems. For this, satellite images from the Sentinel-2 program are used to generate forest density maps as updated as possible. Four classification algorithms make the Tree Cover Density (TCD) map, consisting of the Gaussian Mixture Model (GMM), Random Forest (RF), Support Vector Machine (SVM), and K-Nearest Neighbors (K-NN), which identify zones by training known regions. The results demonstrate a comparison between the algorithms through their performance in recognizing the forest, grass, pavement, and water areas by Sentinel-2 images.

Keywords: Machine Learning · Classification algorithm · Satellite Imagery · Wildfires · The Tree Cover Density

Assessing the 3D Position of a Car with a Single 2D Camera using Siamese Networks

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Using computer vision for the classification of an object's 3D position using a 2D camera is a topic that has received some attention from researchers over the years. In these, visual data is interpreted by the computer to recognize the objects found. In addition, it is possible to infer their orientation, evaluating their spatial arrangement, rotation, or alignment in the scene. The work presented in this paper describes the training and selection of a siamese neural network for classifying the 3D orientation of cars using 2D images. The neural network is composed of an initial phase for feature selection through Convolutional Neural Network followed by a dense layer for embedding generation. For fea- ture selection, four architectures were tested: VGG16, VGG19, ResNet18 and ResNet50. The best result of 95.8% accuracy was obtained with the VGG16 and input images preprocessed for background removal.

Keywords: Computer Vision · Maintenance support · Siamese networks · Object Orientation

Deep Learning-based Hip Detection in Pelvic Radiographs

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Radiography is the primary modality for diagnosing canine hip dysplasia (CHD), with visual assessment of radiographic features sometimes used for accurate diagnosis. However, these features typically constitute small regions of interest (ROI) within the overall image, yet they hold vital diagnostic information and are crucial for pathological analysis. Consequently, automated detection of ROIs becomes a critical preprocessing step in classification or segmentation systems. By correctly extracting the ROIs, the efficiency of retrieval and identification of pathological signs can be significantly improved. In this research study, we employed the most recent iteration of the YOLO (version 8) model to detect hip joints in a dataset of 133 pelvic radiographs. The best-performing model achieved a mean average precision (mAP50:95) of 0.81, indicating highly accurate detection of hip regions. Importantly, this model displayed feasibility for training on a relatively small dataset and exhibited promising potential for various medical applications.

Keywords: Deep Learning · Hip Detection · Canine Hip Dysplasia

Using LiDAR Data as Image for AI to Recognize Objects in the Mobile Robot Operational Environment

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Nowadays, there has been a growing interest in the use of mobile robots for various applications, where the analysis of the operational environment is a crucial component to carry our special tasks or missions. The main aim of this work was to implement artificial intelligence (AI) for object detection and distance estimation to effectively navigate the developed unmanned platform in unknown environments. Conventional approaches are mainly based on vision systems analysis using neural networks for object detection, classification, and distance estimation. Unfortunately, in the case of precise operation, the used algorithms do not provide accurate data required by platforms operators as well as autonomy subsystems. To overcome this limitation, the authors propose a novel approach using the spatial data from laser scanners supplementing the acquisition of precise information about the detected object distance in the mobile robot's operational environment. In this article, we introduced the application of pretrained neural network models, typically used for vision systems, in analyzing flat distributions of LiDAR point cloud surfaces. To achieve our goal, we have developed the software that fuse detection algorithm, based on YOLO (You Only Look Once) network, to detect objects and estimate their distances using the MiDaS depth model. Initially, the accuracy of distance estimation was evaluated through video stream testing in various scenarios. Furthermore, we have incorporated data from a laser scanner into the software, enabling precise distance measurements of the detected objects in the operating environment of a mobile platform.The paper provides discussion on conducted experiments, obtained results, and possible implementation for applications where accurate spatial orientation is required in coexistence with image vision algorithms. The proposed approach improves performance of the described modular mobile platform in uncertain and complex environments to carry out the remote operation and autonomous mode.

Keywords: Convolutional Neural Network · Depth Estimation · Point Clouds · You Only

Look Once (YOLO) · MiDaS

Adaptive Convolutional Neural Network for Predicting Steering Angle and Acceleration on Autonomous Driving Scenario

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This paper introduces a novel approach to autonomous vehicle control using an end-to-end learning framework. While existing solutions in the field often rely on computationally expensive architectures, our proposed lightweight model achieves comparable efficiency. We leveraged the CARLA simulator to generate training data by recording sensor inputs and corresponding control actions during simulated driving. The Mean Squared Error (MSE) loss function served as a performance metric during model training. Our end-to-end learning architecture demonstrates promising results in predicting steering angle and throttle, offering a practical and accessible solution for autonomous driving. Results of the experiment showed that our suggested network is ≈ 5.4 lighter than Nvidia's PilotNet and had a slightly lower testing loss. We showed that our network is offering a balance between performance and computational efficiency. By eliminating the need for handcrafted feature engineering, our approach simplifies the control process and reduces computational demands. Experimental evaluation on a testing map showcases the model's effectiveness in real-world scenarios whilst being competitive with other existing models.

Keywords: Autonomous Vehicles · End-to-end Learning · CARLA Simulator · Convolutional Neural Network · Deep Learning

Deep Learning-Based Classification and Quantification of Emulsion Droplets: A YOLOv7 Approach

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This study focuses on the analysis of emulsion pictures to understand important parameters. While droplet size is a key parameter in emulsion science, manual procedures have been the traditional approach for its determination. Here we introduced the application of YOLOv7, a recently launched deep learning model, for classifying emulsion droplets. A comparison was made between two methods for calculating droplet size distribution. One of the methods, combined with YOLOv7, achieved 97.26% accuracy. These results highlight the potential of sophisticated image-processing techniques, particularly deep learning, in chemistry-related topics. The study anticipates further exploration of deep learning tools in other chemistry-related fields, emphasizing their potential for achieving satisfactory performance.

Keywords: YOLOv7 · Image processing · Learning method

Identification of Late Blight in Potato Leaves using Image Processing and Machine Learning

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Potato is a widely consumed food worldwide, and its productivity has increased due to new varieties and the use of technologies related to irrigation, nutrition, and soil preparation, among others. However, diseases such as late blight disease can often affect the crop, impacting many farmers around the world. As a way to help production, technology in agriculture is increasing. Among the various computational techniques that can be applied, those based on digital image processing associated with Machine Learning Algorithm stand out, producing excellent results. This work aimed to develop a methodology for recognizing late blight disease in potato leaves using digital image processing techniques and Machine Learning Algorithm. It was possible to obtain promising results. The experiments were carried out in a set of images from a public database containing images of healthy and unhealthy leaves (with late blight). We compare the performance of Machine Learning Algorithm using feature vectors obtained with SIFT algorithm and RGB descriptors. The best performance was using the Decision Tree algorithm and SIFT vectors, with 99.24% of accuracy.

Keywords: Automatic disease recognition · Digital Image · Machine Learning · Computer Vision

Deep Learning-Based Localization Approach for Autonomous Robots in the RobotAtFactory 4.0 Competition

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Accurate localization in autonomous robots enables effective decision-making within their operating environment. Various methods have been developed to address this challenge, encompassing traditional techniques, fiducial marker utilization, and Machine Learning approaches. This work proposes a deep-learning solution employing Convolutional Neural Network (CNN) to tackle the localization problem, specifically in the context of the RobotAtFactory 4.0 competition. The proposed approach leverages transfer learning from the pre-trained VGG16 model to capitalize on its existing knowledge. To validate the effectiveness of the approach, a simulated scenario was employed. The experimental results demonstrated an error within the millimeter scale and rapid response times in milliseconds. Notably, the presented approach offers several advantages, including a consistent model size regardless of the number of training images utilized and the elimination of the need to know the absolute positions of the fiducial markers.

Keywords: Indoor Localization · CNN · Robotic Competition

Deep Learning and Machine Learning Techniques Applied to Speaker Identification on Small Datasets

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In this study, we explore the capabilities of speaker recognition technology for biometric authentication. Our focus was on developing and evaluating Machine Learning and deep learning models, such as the Gaussian Mixture Model, Multilayer Perceptron, Convolutional Neural Network, and Residual Neural Networks for speaker identification. The models were trained and tested on both private and public datasets. We explain our methodology for creating and training models on private and public datasets. The model ResNet50 slightly outperformed the other models on two versions of our private dataset, achieving accuracies of 97.93% and 100% for each. This research explores developing speaker recognition-based access control systems, serving as a resource for future research and improvements in secure and efficient speaker identification solutions.

Keywords: Speaker Identification · Convolutional Neural Network · Deep Learning

Impact of EMG Signal Filters on Machine Learning Model Training: A Comparison with Clustering on Raw Signal

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Our current society faces challenges in integrating individuals with disabilities, making this process difficult and painful. People with disabilities (PwD) are often mistakenly considered incapable due to the difficulties they face in daily tasks due to the lack of adapted means and tools. In this context, assistive technologies play a crucial role in improving the quality of life for these individuals.However, assistive technologies still have various limitations, making research in this area essential to enhance existing solutions and develop new approaches that meet individual needs, aiming to promote inclusion and equal opportunities.This article presents a research project that focuses on the study of electromyography (EMG) signal processing generated by individuals who have undergone amputations. These signals are essential in assistive technologies, such as myoelectric prostheses. The study focuses on the impact of different filters and Machine Learning training methods on this processing.The results of this study have the potential to provide relevant findings for the development of more efficient assistive technologies. By understanding the processing of EMG signals and applying Machine Learning techniques, it is possible to improve the accuracy and response speed of prosthetics, increasing the functionality and naturalness of movements performed by users, as well as paving the way for the emergence of new technologies.

Keywords: Assistive technologies · Electromyography (EMG) signal processing · Machine Learning

Fault Classification of Wind Turbine: A Comparison of Hyperparameter Optimization Methods

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The last few years have been marked by the insertion of renewable technologies in the global energy matrix, such as wind and solar energy, which are considered clean energies with low environmental impact. Wind turbines, responsible for the energy conversion process, are complex equipment that is expensive and susceptible to numerous failures. Monitoring turbine components can help detect failures before they occur, reducing equipment maintenance costs. This work compares the training time of different techniques for tuning hyperparameters in supervised machine-learning models for fault detection in wind turbines. Results show the importance of data optimization during model training.

Keywords: Wind turbine · Machine Learning · Fault classification

Realistic Model Parameter Optimization: Shadow Robot Dexterous hand Use-case

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The notable expansion of technologies related to automated processes has been observed in recent years, largely driven by the significant advantages they provide across diverse industries. Concurrently, there has been a rise in simulation technologies aimed at replicating these complex systems. Nevertheless, in order to fully leverage the potential of these technologies, it is crucial to ensure the highest possible resemblance of simulations to real-world scenarios. In brief, this work consists of the development of a data acquisition and processing pipeline allowing a posterior search for the optimal physical parameters in MuJoCo simulator to obtain a more accurate simulation of a dexterous robotic hand. In the end, a Random Search optimization algorithm was used to validate this same pipeline.

Keywords: Optimization · Realistic Simulation · Model · Pipeline

Performance of Heuristics for Classifying Leftovers from Cutting Stock Problem

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The one-dimensional cutting stock problem is dened in the literature as a branch of the classic cutting stock optimization problem, involving one dimension in the cutting process, like cutting bars. The bar cutting optimization problem can generate leftovers - reusable- or losses - disposable. The objective of this paper is to compare the performance of OptimizationDistBSP and OptimizationTREE heuristics (proposed in [2]) for classifying leftovers or losses, from the cutting stock problem (specically from cutting one-dimensional bars), using the dataset proposed in [3], since this dataset allows the application of Machine Learning methods - Logistic Regression, Naive Bayes, Decision Tree and Random Forest - to classify the output data as leftover or loss. Results show that the OptimizationDistBSP and OptimizationTREE heuristics provide better performance in the classication task than the Greedy heuristic used in [2]. Thus, we can conclude that the heuristics can be applied in a more realistic problem, using bars of dierent sizes, and the dataset can be validated, providing good results for the classication using heuristics other than Greedy.

Keywords: One-dimensional cutting stock problem · Leftover classification · Machine Learning · Comparison of heuristics

On Strong Anti-Learning of Parity

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On some data, Machine Learning displays anti-learning; that is, while the classifier demonstrates excellent performance on the training set, it performs much worse than the random classifier on the test set. In this paper we study what we call strong anti-learning, that is, the most surprising scenario, in which the more examples you place in the training set, the worse the accuracy becomes, until it becomes 0% on the test set. We produce a framework in which strong anti-learning can be reproduced and studied theoretically. We deduce a formula estimating anti-learning when decision trees (one of the most important tools of Machine Learning) solve the parity bit problem (one of the most famously tricky problems of Machine Learning). Our estimation formula (deduced under certain mathematical assumptions) agrees very well with experimental results (produced on random data without these assumptions).

Keywords: Machine Learning · Anti-learning · Decision trees · Parity problem · Theoretical model

Sub-system Integration and Health Dashboard for Autonomous Mobile Robots

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Data visualization has become increasingly important to improve equipment monitoring, reduce operational costs and increase process efficiency with the ever-increasing amount of data being generated and collected in various fields. This paper proposes the development of a health monitoring system for an Autonomous Mobile Robot (AMR) that allows data acquisition and analysis for decision-making. The implementation of the proposed system showed favourable results in data acquisition, analysis, and visualization for decision-making. Through the use of a hybrid control architecture, the data acquisition and processing demonstrated efficiency without significant impact on battery consumption or resource usage of the AMR embedded microcomputer. The developed dashboard proved to be efficient in navigating and visualizing the data, providing important tools for the platform managerŠs decision-making. This work contributes to the health monitoring of devices based on Robot Operating System (ROS), which may be of interest to professionals and researchers in fields related to robotics and automation. Furthermore, the system presented will be open source, making it accessible and adaptable for use in different contexts and applications.

Keywords: Human Machine Interface · Data visualization · Autonomous Mobile Robot · Robot Operating System · Open Source Software

Optimization Models for Hydrokinetic Energy Generated Downstream of Hydropower Plants

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The mitigation of the energy crisis necessitates the exploration of alterna-tive sources, including hydrokinetic energy derived from downstream re-gions of hydroelectric facilities. In this context, harnessing the defluent flow from hydroelectric plants through hydrokinetic turbines has become increasingly vital. This study aims to develop a comprehensive model that provides essential parameters for the design of hydrokinetic turbines posi-tioned downstream of dams. The model comprises two key modules: a module for predicting remaining energy and defluent flow, and a module for optimizing reservoir operation. The first module employs a Multi-Layer Perceptron (MLP) model with Backpropagation (MLP-BP) and integrates Autoregressive Integrated Moving Average (ARIMA) models. The second module leverages non-linear programming optimization techniques and ad-vanced process modeling. This module ensures efficient reservoir operation by optimizing generation and defluent flow in hydroelectric plants. It ena-bles sustainable operational simulations, capable of minimizing conflicts arising from periods of flood, drought, and high- energy demands. The re-sults demonstrate the model's fundamental significance in both the design and operation of hydrokinetic turbines installed downstream of hydroelec-tric plants. It enables the optimization of generation and defluent flow, even during challenging conditions, while facilitating sustainable operational simulations that mitigate conflicts of use. The developed model thus emerg-es as a crucial tool in enhancing the efficiency and sustainability of hydroe-lectric power generation.

Keywords: Optimization Models · Non-linear programming · Hydrokinetic Energy

Vehicle Industry Big Data Analysis using Clustering Approaches

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Considering a globalized world economy and industry, data analysis and visualization offer enlightening information for decision-making and strategic planning. Data science provides diverse statistical and scientific methods to extract the most value possible from a data set, covering all data preparation, cleaning, aggregation, and manipulation. Machine learning (ML) and Artificial Intelligence (AI) come with it to learn and explore the data, uncovering patterns that can not be seen with only the analyst experi-ence. This work performs a study exploring clustering methods in a data set of a vehicle manufacture, a Big Data problem. Some knowledge discovery and data mining methods were used, namely the K-means and Fuzzy C-means (FCM) algorithms. They are compared to the GTA method, implemented in vehicles. The evaluation metrics addressed are sum of squares within clusters, the sum of squares between clusters, and silhouette index. The proposed approach showed satisfactory results and demonstrated how the application of ML can bring benefits to this important real task, espe-cially the FCM.

Keywords: Clustering · K-means · Fuzzy C-means · Trucks · Slope

Multi-Objective Optimal Sizing of an AC/DC Grid Connected Microgrid System

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Considering the rising energy needs and the depletion of conventional energy sources, microgrid systems combining wind energy and solar photovoltaic power with diesel generators are promising and considered economically viable for usage. To evaluate system cost and dependability, optimizing the size of microgrid system elements, including energy storage systems connected with the principal network, is crucial. In this line, a study has already been performed using a uni-objective optimization approach for the techno-economic sizing of a microgrid. It was noted that, despite the economic criterion, the environmental criterion can have a considerable impact on the elements constructing the microgrid system. As a continuation, in this paper, two multi-objective optimization approaches are proposed, including a non-dominated sorting genetic algorithm (NSGA-II) and the Pareto Search algorithm (PS) for the eco-environmental design of a microgrid system. The K-means clustering of the non-dominated point on the Pareto front has delivered three categories of scenarios: best economic, best environmental, and trade-off. Energy management, considering the three cases, has been applied to the microgrid over a period of 24 hours to evaluate the impact of system design on the energy production system's behavior.

Keywords: Microgrid · Optimal sizing · NSGA-II · Pareto-Search · Clustering

Deep Conditional Measure Quantization

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Quantization of a probability measure means representing it with a finite set of Dirac masses that approximates the input distribution well enough (in some metric space of probability measures). Various methods exists to do so, but the situation of quantizing a conditional law has been less explored. We propose a method, called DCMQ, involving a Huber-energy kernel-based approach coupled with a deep neural network architecture. The method is tested on several examples and obtains promising results.

Keywords: Optimal quantization · Sampling probability measure · Conditional sampling · Conditional neural network

ECG and sEMG Conditioning and Wireless Transmission with a Biosignal Acquisition Board

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The market for wearable vital signs monitoring systems (WHMS) has grown together with the demand for devices that offer greater medical reliability and lower cost. This study introduces a wearable system comprising conditioning blocks for electrocardiogram and surface electromyogram signals, an analog-to-digital converter, and wireless data transmission capabilities. These features have been implemented reliably in accordance with the specific requirements of these signals, as well as complying with patient safety directives and ensuring the quality of the resulting signal, allowing it to be used as a data collector for subsequent software implementation. To evaluate its performance, this system is compared against commercially available wearable devices, and the expected outcomes are examined. The obtained results are then presented, showcasing the system's capabilities and leading to a positive conclusion. As future work, there is a focus on enhancing the user interface and implement digital processing in the result for use in pathology recognition software with greater accuracy.

Keywords: Electrocardiogram · Surface Electromyogram · Signal Conditioning

An Efficient GPU Parallelization of the Jaya Optimization Algorithm and Its Application for Solving Large Systems of Nonlinear Equations

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This paper presents a new GPU-accelerated parallel version of Jaya, a simple and efficient population-based optimization algorithm that has attracted increasing interest in different areas of science and engineering. Jaya has recently been demonstrated to be relatively effective at solving nonlinear equation systems, a class of complex, challenging problems that are hard to solve using conventional numerical methods, especially as the size of systems increases. This class of problems was chosen to illustrate the application of the proposed GPU-based parallel Jaya algorithm and its efficiency in solving difficult large-scale problems. The GPU parallelization of Jaya was implemented and tested on a GeForce RTX 3090 GPU with 10496 CUDA cores and 24 GB VRAM, using a set of scalable nonlinear equation system problems with dimensions ranging from 500 to 2000. With significant average speedups with factors between 70.4 and 182.9 in computing time for the set of problems considered, the obtained results showed the efficiency of the proposed GPU-based massively parallel version of Jaya.

Keywords: Metaheuristic Optimization · Jaya Algorithm · Parallel GPU algorithms · NVIDIA CUDA · Nonlinear equation systems

Authors Index

Keywords Index

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