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SCOOP

MISI'25 aims to bring together researchers, experts, and industry partners to exchange and discuss the latest innovations at the intersection of mathematics, artificial intelligence, and their applications in fields such as industry, healthcare, finance, environment, and education. The conference will address key topics such as mathematical modeling, optimization, machine learning, data-driven decision-making, and intelligent systems applied to real-world challenges.

MISI'25 will feature keynote lectures, scientific presentations, interactive workshops, and networking sessions, providing opportunities for collaboration between academia and industry.

The best papers will be selected and published in Scopus-indexed journals.

A Hybrid Framework Combining Transformers, Reinforcement Learning, and Econometric Models for Multi-Horizon Financial Forecasting

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Forecasting financial markets remains a complex challenge due to their non-linear dynamics, structural shifts, and volatility. Traditional econometric models offer theoretical rigor but struggle to scale with high-dimensional data, while deep learning approaches often lack the statistical consistency required in financial applications. In this work, we propose a hybrid forecasting framework that synergistically integrates three complementary components : transformer-based models for temporal feature extraction, reinforcement learning for trading strategy optimization, and econometric regularization to ensure theoretical soundness. Our method leverages advanced transformer architectures, including Informer and TimesNet, to capture long-range temporal dependencies in financial time series. The predictive outputs feed into a reinforcement learning agent trained to optimize risk-adjusted returns under varying market conditions. To enhance robustness and interpretability, we incorporate econometric constraints such as cointegration relationships and volatility controls, aligning the model with key financial principles. We evaluate the framework across multiple asset classes and time horizons using high-frequency data from NASDAQ, NYSE, the EUR/USD forex pair, and cryptocurrencies (e.g., BTC/USD). Empirical results show that the hybrid system consistently outperforms standalone forecasting and trading models, particularly during periods of market stress. The inclusion of econometric regularization not only stabilizes performance but also improves practical applicability for institutional use. This study demonstrates the potential of combining modern deep learning techniques with econometric rigor and reinforcement learning to create more accurate, resilient, and interpretable financial forecasting systems.

Keywords: Financial forecasting, hybrid models, transformer networks, reinforcement learning, econometric constraints

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A Hybrid Feature Selection Framework Using Genetic Algorithm and LASSO for Robust Deepfake Detection

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In this paper, we propose a hybrid feature selection framework that integrates Genetic Algorithms (GA) and LASSO regularization for robust classification of high-dimensional deepfake features. The GA component performs a global search to explore the feature space and identify promising subsets, while the LASSO stage applies sparse regression to further refine the selected features and eliminate redundancy. This two-stage approach effectively reduces dimensionality while preserving discriminative information. We evaluate the proposed method using multiple classifiers, including Random Forest, Support Vector Machine, k-Nearest Neighbors, Logistic Regression, and Gradient Boosting. Experimental results on deep-fake datasets demonstrate that our framework consistently improves classification accuracy and generalization performance across classifiers, highlighting its effectiveness for deepfake detection in high-dimensional settings.

Keywords: Deepfake detection, feature selection, genetic algorithm, LASSO, dimensionality reduction, machine learning.

*Speaker

Comparative Analysis of Supervised Machine Learning Approaches for 3D Facial Recognition

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This article presents a comprehensive evaluation of various supervised machine learning approaches for 3D facial recognition, aiming to enhance image classification accuracy and robustness in biometric applications. Leveraging 3D facial data, we compare the performance of multiple models, including Convolutional Neural Networks (CNNs), Support Vector Machines (SVMs), Random Forests, and Gradient Boosting Machines, in classifying facial images under diverse conditions such as varying poses, lighting, and partial occlusions. The methodology involves generating 3D face models from 2D images using depth estimation and mesh reconstruction, followed by feature extraction tailored to each algorithm's strengths. A novel multi-ethnic 3D facial dataset is employed to ensure generalizability across demographics. Our experiments reveal that 3D-CNNs outperform other methods, achieving a significant classification accuracy, attributed to their ability to capture intricate spatial and textural features. However, SVMs demonstrate competitive performance in scenarios with limited training data, while ensemble methods like Random Forests excel in handling occlusions. To address security concerns, we integrate liveness detection via 3D surface dynamics, significantly reducing spoofing vulnerabilities. This comparative analysis provides insights into the trade-offs between computational complexity, accuracy, and real-world applicability, offering a roadmap for deploying 3D facial recognition in secure authentication, surveillance, and human-computer interaction systems.

Keywords: 3D facial recognition, supervised machine learning, convolutional neural networks (CNNs), support vector machines (SVMs), random forests, gradient boosting, 3D face modeling, depth estimation

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Toward a Standardized Evaluation of Driving Resumption in Neuro-Ophthalmological Contexts: Cognitive analysis for designing a Clinical Decision Support System

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Driving is a task that requires significant cognitive efforts, as it depends on the coordination of visual, motor and executive functions. Individuals suffering from neuro-ophthalmological pathologies frequently experience subtle impairments in these abilities, which raise concerns about their clinical ability to drive safely. In Morocco, the lack of standardized national protocols and the limited number of neuro-ophthalmology specialists exacerbates this issue, particularly in areas where access to specialized medical services is restricted.
To address this challenge, our project aimed to develop a Clinical Decision Support System (CDSS), designed to assist clinicians in determining whether patients with neuro-ophthalmological conditions are fit to resume driving. This system is based on a dual approach: cognitive task modeling and clinical criteria extraction through expert interviews and literature review. "**Einek mizanek**" is a software application that integrates seven digitized clinical tests (visual acuity, visual field, contrast sensitivity, color vision, reaction time, Stroop test, MMSE) and simulates expert decision-making process through an intuitive interface. The system is multilingual (Moroccan dialect and French) and includes test adaptations for illiterate users, particularly for assessments involving reading or mathematical reasoning. We first constructed decision trees for all seven tests, then built a Figma mock-up comprising 250 screens to simulate the entire clinical process. A functional prototype is currently under development, and the reaction time test has already been fully implemented. We are still working on the full programming of the remaining modules.
This multidisciplinary initiative, combining biomedical engineering, cognitive science and clinical expertise, aims to reduce subjectivity, standardize medical evaluation practices, provide decision support even in the absence of neuro-ophthalmology specialists, and reinforce the medico-legal traceability of clinical decisions regarding driving resumption.

Keywords: Clinical Decision Support System, Neuro, ophthalmology, Return to driving, Cognitive task analysis, Visual function evaluation, Medical decision, making process, Human–machine interaction, Patient safety.

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Modeling Academic Performance Using Regression Techniques in Machine Learning

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In the context of increasingly heterogeneous student populations and a growing emphasis on data-driven decision-making, accurately predicting academic performance remains a major challenge. This study investigates the use of regression-based machine learning models to estimate continuous academic outcomes, specifically the final average scores of adolescent students.Data were collected from Moroccan schools using a cluster sampling strategy, following a methodology inspired by prior educational research. Several supervised learning algorithms including Linear Regression, Random Forest Regressor, Decision Tree Regressor, and K-Nearest Neighbors Regressor, were trained and evaluated using both train-test splits and 10-fold cross-validation. Model performance was assessed with standard regression metrics: coefficient of determination (R2), mean absolute error (MAE), and mean absolute percentage error (MAPE). The ultimate goal is to develop a reliable system that supports the early identification of at-risk students and informs personalized pedagogical interventions. Findings of the practical relevance of machine learning in improving academic guidance and individualized learning strategies

Keywords: Academic performance, Regression, Machine Learning, Predictive modeling, Student scores.

*Speaker

Predictive Maintenance of Turbofan Jet Engine's Remaining Useful Life using C-MAPSS Dataset

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The accurate prediction of Remaining Useful Life (RUL) in critical aerospace systems, particularly turbofan jet engines, is a cornerstone of predictive maintenance strategies aimed at minimizing unscheduled downtime and enhancing operational safety. Building upon prior research in prognostics and health management (PHM) using real flight conditions (1), this research introduces a complete, data-centric pipeline designed for RUL forecasting based on NASA's Commercial Modular Aero-Propulsion System Simulation (C-MAPSS) FD001 dataset. The proposed framework begins with an extensive exploratory data analysis (EDA) phase, where temporal trends, sensor distributions, and inter-feature correlations are examined to identify patterns indicative of mechanical degradation. Subsequent data preprocessing eliminates redundant or non-informative features through constant value detection, low variance filtering, and correlation-based pruning, followed by robust scaling to handle variability and preserve anomaly-related signals.

To capture the temporal dynamics inherent in engine degradation, a sophisticated feature engineering strategy was implemented, leveraging lagged variables, moving statistical windows, and combinatorial transformations across key sensor channels. These features were selected based on their statistical relevance to the RUL target variable. Two modeling paradigms were benchmarked: deep learning via Long Short-Term Memory (LSTM) networks, which are tailored for sequence modeling, and ensemble-based machine learning algorithms including Random Forests, Gradient Boosting, and XGBoost. The LSTM model architecture underwent hyperparameter optimization using a grid search across hidden units, dropout rates, and batch sizes, and was trained using a 30-cycle sliding window input configuration.

Model evaluation employed a combination of Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), and R-squared (R^2) to assess predictive performance. While LSTM demonstrated strong capabilities in capturing long-range dependencies and smoothing degradation trajectories (RMSE = 27.89), the Random Forest model yielded superior accuracy in pointwise RUL estimation (MAE = 20.69, $R^2 = 0.7052$), consistent with findings from recent benchmarking studies (2). This outcome underscores the trade-off between temporal expressiveness and direct interpretability in predictive maintenance applications.

Keywords: Predictive Maintenance, Remaining Useful Life (RUL), C MAPSS Dataset

*Speaker

First Steps in Clinical Implementation of a Lung Nodule Classification Method by Artificial Intelligence

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Lung cancer remains one of the leading causes of mortality worldwide. Early detection is critical to improving patient survival rates. Computed Tomography (CT) imaging is the standard method for lung cancer screening. Recent advancements in Deep Learning (DL) have enhanced the potential for automated cancer detection through medical image analysis. In this study, we propose an approach utilizing a Convolutional Neural Network (CNN) model tailored for the classification of lung nodules. The model was trained on a combined dataset that integrates the IQ-OTH/NCCD and SPIE-AAPM datasets, augmented with CT scan images from Cheikh Zaid Hospital in Morocco. The experimental dataset comprises 1,103 images of malignant cases, 508 images of benign cases, and 427 images of normal cases. To enhance image contrast, Contrast Limited Adaptive Histogram Equalization (CLAHE) preprocessing was applied. The proposed CNN model achieved an accuracy of 99.84%, precision of 100%, sensitivity of 100%, and specificity of 99.9%. Such a high-performance model could support clinicians in their diagnostic process by accurately classifying indeterminate nodules as either benign or malignant. This work marks the initial steps toward the clinical integration of an Artificial Intelligence-based lung nodule classification system at Cheikh Zaid Hospital.

Keywords: lung nodule, nodule classification, Deep Learning, deep neural network, lung cancer, CT scans, Artificial Intelligence, radiology CLAHE, computer, aided diagnosis **Références :**

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Smart Irrigation for Sustainable Agriculture : An IoT and AI-Based Solution

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Abstract :
In the face of growing challenges related to water scarcity and sustainable development, optimizing irrigation has become a priority for modern agriculture. In this context, our paper proposes a smart irrigation system based on an IoT infrastructure and a hybrid artificial intelligence architecture, enabling autonomous, adaptive, and optimized water management.
Beyond the integration of these technologies, our approach introduces a complete and modular framework that combines real-time data acquisition, intelligent decision-making, and automated irrigation control, offering a holistic solution for sustainable water management in agriculture.
The system relies on a network of environmental sensors (soil moisture, temperature, precipitation) connected to microcontrollers and a communication gateway (LoRa, Wi-Fi, GSM), ensuring data transmission to a processing platform. This data is then analyzed in real time to automatically adjust irrigation according to the specific needs of crops.
The core technical innovation of our framework is a hybrid model combining Transformer and RNN (GRU/LSTM). This architecture leverages the attention mechanisms of Transformers, which are capable of modeling complex relationships over long sequences, while capturing temporal dynamics through recurrent networks. This coupling ensures enhanced predictive robustness and high adaptability to changing weather conditions.
Designed to be scalable, this framework can be adapted to different farming scales and crop types, enabling precision irrigation and significantly reducing water waste. It fully aligns with the goals of smart, resilient, and sustainable agriculture.

Keywords: Smart irrigation, Internet of Things Framework, Transformer, RNN Hybrid, Water management, Sustainable agriculture, Forecasting

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Multimodal Generative AI and the Future of Human Communication

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The rise of generative AI represents a paradigm shift in how humans create, consume, and experience communication. No longer confined to static text generation, current models are capable of synthesizing expressive speech, emotionally resonant visuals, and richly contextual content. This communication presents a critical review of the role of generative models across three core modalities : text, audio, and image. We examine how large language models, diffusion networks, and neural audio synthesizers are converging to enable multimodal communication experiences that are efficient, adaptive, persuasive, and increasingly human-like. Through a comparative analysis of use cases in education, marketing, accessibility, and digital storytelling, this work highlights the transformative potential of generative AI technologies. Additionally, it addresses the ethical and social challenges associated with the integration of such systems into daily communication. This paper invites interdisciplinary reflection on the future of digital interaction and underscores the importance of designing responsible and emotionally intelligent generative systems.

Keywords: Generative AI, Multimodal Communication, Language Models, Speech Synthesis, Diffusion Models

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Equivalence of K-functionals and modulus of smoothness constructed by the Mehler-Fock-Clifford transform

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Using athe Mehelt-Fock-Clifford transform, we define generalized modulus of smoothness in the space $L^2(J; x^{-\frac{1}{2}}dx)$. Based on the kernel $P_{i\sqrt{\lambda}-\frac{1}{2}}$ and the operator A_x^m we define Sobolev-type and K-functionals. The main result of the paper is the proof of the equivalence theorem for a K-functional and a modulus of smoothness for the Mehler-Fock-Clifford transform.

Keywords: Mehler, Fock, Clifford transform, Generalized translation operator.

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Urban growth in Morocco : Leveraging Geospatial Big Data for Sustainable Regional Planning using LSTM-based models

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The study of urban growth provides valuable insights for big firms seeking to enter or expand in new markets. By analyzing patterns of population increase, infrastructure development, and economic activity in growing cities, companies can identify emerging commercial hubs and consumer needs. This enables firms to strategically position their products or services in areas with high market potential, optimize supply chains, and anticipate future demand trends, ultimately reducing investment risks and maximizing returns. The Long Short-Term Memory (LSTM)-based models have shown a great capacity to capture intricate temporal correlations in sequential data has made them an effective tool for modeling and predicting urban growth dynamics. Because LSTMs are specifically made to learn from historical sequences, they are ideal for anticipating changes in urban contexts where past development trends have a significant impact on future growth, in contrast to typical machine learning models that frequently struggle with time-dependent patterns. Large-scale geographic time-series data from socioeconomic indicators, urban expansion records, and remote sensing imagery are all well-represented by these models. This paper highlights the dynamics of urban neighborhood growth in Morocco by leveraging LSTMbased models to capture and predict complex spatio-temporal patterns, providing valuable insights for sustainable urban planning and development.

Keywords: Geospatial Big Data, Spatial Analysis, Spatial Clustering, Machine Learning, Spatio, Temporal Patterns.

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Optimizing Student Attendance Systems with Transfer Learning and Vision Transformers: An Iris Recognition Approach

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In modern educational environments, efficient and accurate student attendance systems are essential to streamline processes and prevent fraud. Traditional methods, such as manual attendance and card-based systems, often prove time-consuming and prone to inaccuracies. This study explores the development of an iris recognition-based student attendance system using advanced deep learning techniques, specifically evaluating Transfer Learning with the ResNet50V2 model and Vision Transformers such as ViT-L16, ViT-L32, ViT-B16, and ViT-B32. The UBIRIS.v2 dataset was used for training and testing, with data augmentation applied to improve robustness. Performance metrics including accuracy, precision, recall, and F1 score were used to benchmark the models. Results indicate that ResNet50V2, with an accuracy of 99.57%, outperforms Vision Transformers in both accuracy and computational efficiency. However, Vision Transformers showed strong generalization capabilities, suggesting potential for improved performance with larger datasets. In conclusion, ResNet50V2 is a more viable option for real-time deployment due to its higher accuracy and lower computational requirements, while further optimization of Vision Transformer models is recommended for future research.

Keywords: Optimizing Student Attendance Systems with Transfer Learning and Vision Transformers: An Iris Recognition Approach

*Speaker

Meta-Ensemble Learning for Predicting NASDAQ Stock Movements: An Empirical Study

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Ensemble machine learning (ML) methods have emerged as an alternative to individual ML techniques for solving classification problems. This approach relies on combining the outputs of multiple techniques using a combination rule. These methods have gained significant interest in stock market prediction research due to its ability to capture the nonlinear, volatile, noisy, and complex patterns present in stock market data. This study presents an empirical assessment of three prominent meta-ensemble techniques including Bagging, Boosting, and Random Subspace, implemented with three distinct base classifiers: Support Vector Machines (SVM), Logistic Regression, and Decision Trees. The objective is to predict closing stock market prices of high-technology companies listed in the NASDAQ stock index. Alongside OHLCV (Open, High, Low, Close, Volume) features, ten technical indicators are integrated as input features to enhance prediction performance. Four performance metrics were used to evaluate the ensembles including Accuracy, Precision, Recall, and F1 Score. The hyperparameters of the meta-ensembles were tuned using the Grid Search optimization technique. The findings consistently indicate that ensemble methods yield superior predictive performance compared to their single-model counterparts. Notably, the Bagged SVM ensemble combined with the Random Subspace method achieves statistically significant improvements, attributed to its capacity to mitigate variance while preserving diversity among base learners. These results underscore the efficacy of integrating ensemble learning with feature subspace approaches in enhancing predictive accuracy within the complex and volatile domain of financial market forecasting

Keywords: Ensemble methods, Random Subspace, Stock market, Machine learning, Classification.

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HumanActNet: A Deep Spatio-Temporal Learning Framework for Fine-Grained Human Motion Analysis and Interpretation

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The precise identification and analysis of human movement in dynamic settings continues to present a significant challenge in computer vision, particularly when it involves intricate, fine-grained, or overlapping actions. In response to these complexities, we propose HumanActNet, a novel deep spatio-temporal learning framework designed to improve the automatic recognition and semantic interpretation of human motion across varying environments, camera perspectives, and body types. HumanActNet is constructed on a hybrid architecture consisting of three fundamental components: a pose-constrained encoder that extracts kinematic keypoints from video sequences; a temporal sequence processor utilizing Gated Recurrent Units (GRUs) that captures the evolution and transformation of motion over time; and a semantic motion decoder that correlates the dynamic features to significant action labels. To improve the quality of the learnt representations, we utilize a dual-loss training technique that combines classification loss with contrastive loss.This method guarantees inter-class separation inside the feature space and promotes intra-class cohesiveness, therefore enhancing the capacity of the model to discriminate between closely related activities. Moreover, HumanActNet includes a graph convolutional motion refinement module to capture the dependencies among different body joints and to enrich the structural understanding of human motion. The model supports both single-view and multi-view video inputs and is optimized for real-time inference using GPU acceleration.We evaluated our approach on several benchmark datasets ,NTU RGB+D, Kinetics, and Human3.6M as well as on a curated dataset of annotated daily activities. The experimental results show that HumanActNet consistently outperforms current state-of-the-art methods, achieving a 7% to 10% improvement in Top 1 accuracy and significantly reducing false positives in scenarios involving complex or ambiguous humain movements.
HumanActNet offers a strong method for human motion analysis. Its strength lies in its capacity to learn representations that remain consistent across different viewpoints and individual subjects, while effectively capturing temporal dynamics. These qualities make it particularly suitable for a range of real-world applications, including smart surveillance, physical rehabilitation monitoring, and intelligent human-computer interaction.

Keywords: Human motion analysis, deep learning, spatio, temporal modeling, pose estimation, action recognition, graph convolutional networks, temporal attention.

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GenAI Meets Explainability : Turning Churn Predictions into Personalized Retention Strategies

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In an increasingly competitive financial landscape, retaining existing customers is widely acknowledged to be more cost-effective than acquiring new ones. While artificial intelligence (AI)-based predictive models have achieved high accuracy in identifying customers at risk of churn, they often fail to provide actionable strategies for customer retention. This paper addresses this limitation by proposing a postmodeling framework that translates churn predictions into business-oriented retention actions. Using supervised machine learning techniques on structured customer data-such as transactional and behavioral features-from the financial sector, we first develop a high-performance churn prediction model. We then employ explainability methods, notably SHAP (SHapley Additive exPlanations), to identify the key drivers of churn at both global and individual levels. These insights enable us to segment customers into interpretable profiles (e.g., price-sensitive, service-dissatisfied, inactive), each associated with specific churn triggers. To move beyond prediction and toward proactive intervention, we propose tailored retention strategies aligned with each segment's churn rationale. Furthermore, we explore the integration of Generative AI (GenAI) to support the automatic generation of personalized messages and strategy suggestions, enhancing the decision-making process for financial institutions. The proposed methodology bridges the gap between churn prediction and business actionability, offering a data-driven approach to customer engagement. Our results demonstrate that such an approach not only deepens customer understanding but also significantly improves the effectiveness of targeted retention campaign

Keywords: Explainable AI (XAI), Customer Churn, Gen IA, Data, Driven Decision Making, Artificial Intelligence, Retention Strategy.

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Hybrid-GCNN-CNN approach for Fake News Detection in Social Networks

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The proliferation of fake news on social media is a significant societal issue because of how quickly and easily it can spread across digital platforms, significantly changing public opinion, influencing political outcomes, undermining trust in reliable institutions, and widening social divides. This problem not only jeopardizes the integrity of public discourse but also makes it more challenging to provide accurate information in times of emergency or election. Graph Neural Networks (GNNs) have emerged as a powerful tool for addressing the challenge of fake news detection on social media platforms. Unfortunately, GNNs may unintentionally learn from manipulated structures, reducing their ability to accurately distinguish real from fake news. For this particular reason, this paper proposes an hybrid approach named Hybrid-GCNN-CNN to tackle the challenge of fake news detection by jointly leveraging the structural information from social network interactions through Graph Convolutional Neural Networks (GCNN) and the semantic features of news content via Convolutional Neural Networks (CNN). The hybrid model improves detection performance and interpretability in comparison with conventional methods. Experimental results prove the effectiveness of our method on benchmark datasets.

Keywords: Fake news detection, Hybrid, GCNN, CNN, deep learning, social networks.

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Multimodal Emotion Recognition Using CNNs: A Web-Based Application for Facial and Vocal Analysis

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Understanding human emotions is essential for improving the quality of interaction between people and machines. Emotion recognition systems are gaining increasing importance across various fields such as healthcare, smart living environments, customer service, and affective computing. In this study, we present the development of a user-friendly web application designed to detect emotions from both facial expressions and vocal cues. Relying on deep learning, and more specifically on Convolutional Neural Networks (CNNs), our system is capable of identifying seven core emotions: happiness, sadness, anger, fear, surprise, disgust, and a neutral state. To train and evaluate the system, we used grayscale facial image datasets and the widely known RAVDESS audio database. Audio features were extracted through spectrogram analysis and Mel-Frequency Cepstral Coefficients (MFCCs). The application is built using Python and Django, and integrates machine learning libraries such as TensorFlow, Librosa, and scikit-learn. Its intuitive interface enables users to upload audio or image files-or record directly-and receive real-time emotion classification. Initial tests have shown promising accuracy under controlled conditions, pointing to the system's potential in various smart and adaptive applications.

Keywords: Emotion Recognition, Convolutional Neural Networks (CNN), Artificial Intelligence (AI), Facial Expression, Vocal Analysis, Web, Based Application

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Fine-tuning AraBERT for Legal Arabic Text Extraction and Classification

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This study focuses on the extraction and classification of Arabic legal texts using a fine-tuned version of AraBERT. Targeting legal documents such as contracts, legislative texts, and court decisions, the approach addresses the linguistic complexity and formal structure of legal Arabic. The methodology follows three key steps: (1) preprocessing to handle legal jargon, syntactic complexity, and orthographic variance, (2) fine-tuning AraBERT on a curated corpus of legal documents, and (3) deploying the model for automated extraction and classification within legal information systems. Our findings demonstrate that domain-specific fine-tuning significantly improves performance over generalpurpose models in recognizing legal entities and classifying document types. The system supports enhanced legal text processing, contributing to reduced workload for legal professionals and enabling faster access to relevant legal information. The work highlights the potential of transformative-based models in Arabic Legal NLP, where annotated corpora are scarce and linguistic nuances are critical.

Keywords: AraBERT, Legal NLP, Text Classification, Arabic Legal Documents

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Contribution to glaucoma screening from fundus images by artificial intelligence: Study based on deep learning and optimization of data flow for diagnostic assistance

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Abstract
Glaucoma, a leading cause of irreversible blindness worldwide (affecting nearly 80 million people), could be largely prevented through early detection. However, nearly half of those affected are unaware of their condition, especially in low- and middle-income countries.
Objective: This project aims to propose an automated glaucoma screening solution based on fundus images, using the MobileNetV2 model, known for its efficiency and lightweight design, making it suitable for resource-limited environments.
Materials and Methods: We used an expert-annotated database containing retinograms accompanied by segmentation masks of ocular structures. These data cover a wide variety of cases. Preprocessing was applied (contrast normalization, noise reduction), followed by data augmentation and data resizing to enhance learning.
Results: The MobileNetV2 model was trained for 100 epochs, where it was then fine-tuned to identify the hallmarks of glaucoma. After training, the model achieved 87% accuracy, demonstrating its proficiency in identifying minor lesions. Despite challenges in various aspects, these were overcome through hyperparameter optimization and targeted data augmentation.
Conclusion: In conclusion, this research highlights the potential of artificial intelligence to optimize glaucoma diagnosis, particularly in resource-limited areas. However, challenges remain, such as overfitting, data diversity, and so on. With continued refinement, this model could eventually become a valuable diagnostic support tool for healthcare professionals.

Keywords: Metrics, Deep Learning, Machine Learning, Glaucoma Detection – Artificial Intelligence – Deep Learning – Neural Network – MobileNetV2

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OAL-IDS: An Online Active Learning Intrusion Detection System for Wireless Sensor Networks

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As hyper-connectivity reaches new levels, Wireless Sensor Networks (WSNs) are used predominantly across an assortment of real-time, critical Internet of Things (IoT)-based applications (e.g., infrastructure and environmental monitoring, health monitoring, military surveillance, and seismic sensing). In spite of their growing adoption, these networks confront numerous security threats and are particularly vulnerable to Denial of Service (DoS) attacks. Such attacks can be highly detrimental, causing severe economic, operational, and security damage. The time-sensitivity and high-speed data streaming nature of WSNs, therefore, obliges instantaneous online detection approaches to ensure timely threat mitigation. The existing traditional intrusion detection system (IDS) models rely on the need for extensive labeled data and periodic retraining, which often prove inadequate in effectively addressing these security challenges. In our research, we proposed a novel online active learning IDS (OAL-IDS) that intelligently queries only the most informative packets and updates itself continuously to track new attacks. Our experiments evaluated on the WSN-DS and WSN-BFSF datasets produced compelling results, boosting attack detection quality while cutting the number of labeled instances required, confirming OAL-IDS's suitability for resource-constrained WSN deployments.

Keywords: Wireless Sensor Networks (WSNs), Intrusion Detection System (IDS), Online Active Learning (OAL), Denial of Service (DoS) Attacks, Data Stream Mining, Anomaly Detection.

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Machine Learning and Time Series Forecasting for Solar Resource Prediction in Moroccan Regions

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This study explores the use of machine learning and time series forecasting techniques to predict two key solar related weather variables solar irradiance and temperature across four diverse Moroccan cities: Tangier, Jerada, Meknes, and Dakhla. The primary dataset, covering the years 2017 to 2019, was obtained from the National Renewable Energy Laboratory (NREL). In the first stage, three supervised regression models Support Vector Regression (SVR), Artificial Neural Networks (ANN), and XGBoost were trained on the NREL data to evaluate their predictive performance for both solar irradiance and temperature. The models were assessed using standard performance metrics: coefficient of determination (R^2), Root Mean Squared Error (RMSE), Mean Squared Error (MSE), and Mean Absolute Percentage Error (MAPE).
In the second stage, the Prophet model was employed to forecast solar irradiance and temperature for the years 2020, 2021, and 2022, based solely on historical data from 2017 to 2019. To evaluate the reliability of the forecasts, predicted values were compared with actual data obtained from the Photovoltaic Geographical Information System (PVGIS) database, which provides extended solar records beyond 2019.
The results show that Prophet can effectively capture medium term trends in solar irradiance and temperature. This research highlights the potential of AI based forecasting systems to support solar energy planning and optimization, particularly in regions with varying climatic conditions.

Keywords: renewable energy, weather forecasting, AI, machine learning, sustainable solutions.

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Context-Aware Augmentation for Improving Deep Learning Performance on Scarce Medical Image Data

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Medical image analysis faces a fundamental challenge due to the scarcity of labeled data, resulting from high annotation costs, privacy concerns, and the need for specialized clinical expertise. This data limitation significantly hampers deep learning model performance in critical healthcare applications where misclassification can have severe clinical consequences.
This study introduces a novel context-aware augmentation framework specifically designed to address data scarcity in medical imaging while preserving clinical relevance and diagnostic accuracy. Our approach combines medical context-aware transformations that preserve pathological features, an enhanced DenseNet-121 architecture with Monte Carlo dropout for uncertainty quantification, class-balanced sampling to address label imbalance, and clinician-validated threshold optimization for critical pathologies.
The framework was evaluated on the NIH Chest X-ray dataset with 15 pathology classes, using balanced subsets of 1,000 training and 200 test samples to simulate real-world data scarcity scenarios. Our context-aware augmentation approach demonstrated significant improvements over baseline models, with enhanced AUC and F1 scores across multiple pathology classes. Particularly noteworthy improvements were observed for critical pathologies including Pneumothorax, Pneumonia, Edema, and Hernia.
Monte Carlo dropout-based uncertainty estimation provided valuable confidence measures for clinical decision-making, while Grad-CAM visualizations confirmed that the model learned clinically relevant features with attention maps highlighting appropriate anatomical regions. Clinician-validated threshold adjustment for critical pathologies resulted in improved sensitivity for life-threatening conditions while maintaining overall diagnostic accuracy.
This work presents a practical solution to the pervasive problem of data scarcity in medical imaging. The context-aware augmentation framework not only improves model performance but also provides interpretable results and uncertainty quantification essential for clinical applications. Our approach offers a scalable methodology that can be adapted to various medical imaging domains, potentially accelerating the deployment of AI-assisted diagnostic tools in resource-constrained healthcare settings

Keywords: Deep Learning, Medical Image Analysis, Data Augmentation, Chest X, ray Classification, Multi, label Learning, Uncertainty Quantification, Clinical AI.

*Speaker

Anomaly Detection in Operational MQTT-IoT Ecosystems: Leveraging the MQTTEEB-D Realistic Dataset

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In the midst of the proliferation of Internet of Things (IoT) devices, resilient cybersecurity is critical. This study employs the MQTTEEB-D dataset, a real-world IoT cybersecurity corpus capturing live deployments at Morocco's International University of Rabat (UIR), featuring diverse attacks (DoS, Slow DoS, Malformed Data Injection, Brute Force, MQTT Publish Flooding). Using Random Forest, we achieved 97.09% accuracy in multi-class threat detection (identifying specific attack types) and 99.26% accuracy in binary classification (malicious vs. legitimate traffic), demonstrating high precision/recall for bruteforce and malformed attacks. The performance on legitimate traffic indicated refinement opportunities. Comparative analysis revealed that the MLPClassifier (90.94% accuracy) outperformed Recurrent Neural Networks (74.79%), excelling in detecting brute-force and malformed attacks. Our work underscores the necessity of real-world datasets for validating IoT intrusion detection systems and advancing adaptive AI-driven cybersecurity. The findings highlight the efficacy of machine learning against evolving IoT threats.

Keywords: : IoT Cybersecurity, Anomaly Detection Systems, Machine Learning, Random Forest, MQTTEEBD Dataset, Multi, class Classification, Binary Classification, Cyberattacks, Real, time Dataset, MLPClassifier, Neural Networks, Threat Detection.

*Speaker

Adaptive Blockchain Based Access Control ABAC for Secure Cloud Data Access: A Comprehensive Approach

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Abstract: Cloud computing has become a cornerstone for modern enterprises, offering scalable and on-demand resources. However, its centralized architecture poses significant security challenges, especially concerning data access control and integrity. This paper proposes a novel approach that integrates blockchain technology with attribute-based access control (ABAC) to improve secure, context- aware data access in the cloud. The proposed solution leverages blockchain's decentralized, immutable infrastructure to store access policies as smart contracts, providing dynamic and fine-grained access control. A middleware layer facilitates the evaluation of access requests, collecting contextual attributes such as time, location, and device type, which are validated against policies stored on the blockchain. The framework ensures traceability, transparency, and scalability while mitigating vulnerabilities associated with traditional Role-Based Access Control (RBAC) systems. Comparative analysis highlights the advantages of the blockchain-based ABAC system over conventional methods, demonstrating its potential to address evolving cloud security challenges. Furthermore, scenarios illustrating unauthorized and authorized access underline the robustness and functionality of the proposed approach. This work lays the foundation for secure and adaptive cloud environments, advancing the adoption of blockchain-based access control mechanisms.

Keywords: Blockchain, Cloud computing, Smart contracts, Cryptographic, Middleware

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Translation in the Age of Artificial Intelligence: Machine vs. Human Contribution

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Artificial Intelligence (AI) has become a transformative force in translation, offering significant advantages through Machine Translation (MT): speed, cost-efficiency, and scalability. Tools like multilingual chatbots and neural networks enable global accessibility and real-time processing of vast linguistic data. However, MTfaceslimitations in contextual understanding, idiomatic expressions, and grammatical nuances, often producing incoherent or inaccurate results. This highlights the irreplaceable role of Human Translation (HT) in ensuring precision and cultural sensitivity. This paper examines the hybrid translation paradigm, analyzing collaborative workflows between MT and HT through pre-editing, post-editing, and translation memories. We evaluate performance using automated metrics (e.g., BLEUscore) andhumanassessments, addressingkeyquestions:-HowcanMT complement HT without compromising quality?- What are the ethical and professional implications for translators?- Which tasks should remain human-driven? Our findings advocate for a calibrated integration of both approaches, where MT handles high-volume, repetitive content, while HT focuses on creative, context-dependent tasks. The study draws on case studies from literary, scientific, and commercial translations to propose best practices for hybrid workflows.

Keywords: Machine Translation, Human Evaluation, Post, editing, Hybrid Workflows, BLEU Score, Contextual Accuracy.

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AgriLink: A Smart Solution for Real-Time Monitoring and Enhanced Agricultural Connectivity

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Sustainable agricultural development, grounded in rigorous scientific research, is essential to address the challenges posed by the United Nations' projection that the global population will approach 9.7 billion by 2050. Ensuring food security-especially for smallholder farms-remains a critical concern for the scientific community in the decades to come. Despite occupying only 12% of total agricultural land, small-scale farms contribute approximately 35% of the world's food production. In this context, digital and smart farming solutions, leveraging low-cost and energy-efficient technologies, present a promising path forward.
Low-Power Wide-Area Networks (LPWANs) such as LoRa, Sigfox, and NB-IoT are particularly well-suited for IoT-enabled agriculture, offering affordable deployment, low energy consumption, and optimal transmission ranges tailored to agricultural environments. In contrast, current systems relying on costly technologies like artificial intelligence or satellite imagery are often inaccessible to smallholder farmers due to high expenses, complexity, and inadequate resolution for small-scale plots.

This paper presents AgriLink, a novel IoT-based agricultural platform built on LoRaWAN technology, designed to offer an affordable and effective solution for small-scale farming. The platform integrates sensors that collect environmental data and transmit it to a gateway via LoRaWAN. The data is then processed and stored on a server using Python, SQLite, and InfluxDB. Upon successful transfer confirmation, the data is automatically cleared from the gateway.

This system empowers farmers to monitor and manage irrigation and fertilization processes in real time, significantly improving operational efficiency and user-friendliness, while addressing the limitations of existing agricultural monitoring solutions.

Keywords: Digital Technologies, Industry 4.0, Internet of Things (IoT), LoRaWAN, Smart Agriculture, Smallholder Farmers, Wireless Sensor Networks (WSN)

*Speaker

Integration of IoT Technologies for Predictive Maintenance in Industry 4.0

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The rise of the Internet of Things (IoT) has not merely influenced predictive maintenance-it has revolutionized it. What was once a largely reactive, after-the-fact procedure has evolved into a sophisticated, anticipatory approach, grounded in data and intricately woven into the broader tapestry of Industry 4.0. This paradigm shift, both technological and philosophical, is the focal point of this review, which delves into the dynamic confluence of enabling innovations-namely, wireless sensor networks, cloud-edge synergy, and artificial intelligence-that together empower real-time surveillance and the preemptive detection of faults.

At the heart of this transformation lies connectivity, not just in hardware, but in how industrial systems speak, listen, and respond. Protocols such as MQTT and OPC-UA emerge as key actors, facilitating frictionless communication between heterogeneous systems and distributed environments. This seamless data choreography is further articulated through a proposed multilayered IoT architecture: a cascading flow of intelligence that begins with data acquisition at the sensor or device level, travels through layers of secure transmission infrastructure, and culminates in the cloud or edge with advanced analytics and decision-making algorithms that can act autonomously or in support of human operators.

Nevertheless, the aforementioned discourse would remain incomplete without addressing the more arcane yet transformative elements: digital twins and cyber-physical systems. These constructs enhance predictive maintenance beyond mere monitoring, advancing it into the domains of virtual simulation, continuous feedback, and autonomous adaptation. Concrete benefits such as reduced unplanned downtime, more efficient utilization of physical assets, and improved operational safety are illustrated through examples that encompass manufacturing facilities, power generation plants, and transportation networks.

However, the path forward is not without friction. The journey toward an integrated, intelligent maintenance ecosystem is still obstructed by fragmented standards, cybersecurity vulnerabilities, and interoperability bottlenecks that threaten to undermine scalability and reliability. These challenges are not ignored-they are confronted head-on. The paper concludes by proposing strategic research directions aimed at cultivating secure, interoperable, and scalable frameworks that can underpin the next generation of industrial maintenance-systems that are not just reactive or even proactive, but adaptive, resilient, and self-optimizing in real time.

Keywords: IoT, Predictive Maintenance, Industry 4.0, Smart Sensors, Digital Twin, Edge Computing, Cybersecurity

*Speaker

3D Modeling and Printing of a Middle Ear Surgery Simulator: A Case Study on Cholesteatoma

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The middle ear plays a crucial role in the auditory process by transmitting sound vibrations from the air to the fluids of the cochlea. It consists of delicate structures such as the tympanic membrane and the ossicular chain (malleus, incus, and stapes), which can be severely affected by pathologies like cholesteatoma. This abnormal epithelial growth gradually destroys the ossicles, impairing sound transmission and complicating surgical procedures. Our project focused on the digital 3D modeling of a middle ear surgery simulator, specifically designed for cholesteatoma treatment. The main objective is to enhance surgical training by providing a visual and interactive tool that supports the mastery of operative techniques, while also helping to reduce the risks of recurrence and postoperative complications. We began by analyzing medical imaging data from CT scans, using 3D Slicer for segmentation. However, the limited quality of the DICOM files affected the accuracy of the reconstruction. As a result, we proceeded with manual 3D modeling in Blender, reconstructing key anatomical structures ossicles, tympanic membrane, Eustachian tube, and the cholesteatoma mass based on anatomical reference images. The project initially aimed to produce a physical 3D-printed model, with each component printed separately and assembled manually for better handling. The bony parts were to be manually hollowed out to mimic real cavities, and the cholesteatoma mass was to be represented using a soft material (such as gelatin) to offer realistic tactile and visual feedback. Unfortunately, a delay in filament delivery prevented us from completing this phase. Despite this setback, a fully functional digital version of the simulator was completed in Blender. Each structure was carefully modeled, assembled, and color-coded to ensure easy identification, with a clear representation of the pathological mass. This virtual model offers a high-potential educational tool suitable for training, clinical teaching, and preoperative planning especially for complex procedures like mastoidectomy and tympanoplasty. This project reflects an innovative educational approach by leveraging 3D modeling technologies to support surgical simulation, with educational, clinical, and scientific applications.

Keywords: Cholesteatoma, Middle Ear, 3D Modeling, 3D Printing, Surgical Simulator

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Automated Machine Learning Models for Prediction and Classification of Brain Tumors

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Abstract-Brain tumors represent a severe category of neurological disorders, with a complex prediction task that requires an accurate and early detection for efficient treatment planning. Modalities such as Magnetic Resonance Imaging (MRI) is the most used in brain tumor detection; however, the manual handling impact the efficiency of prediction and results in delays. Automated techniques such as machine learning (ML) revolutionized the healthcare in last decades and improves accuracy and efficiency of prediction of critical medical conditions. In this study, we analyze the performance of six supervised machine learning (ML) methods: Random Forest (RF), Support Vector Machine (SVM), Decision Tree (DT), K-Nearest Neighbors (KNN), Naive Bayes (NB), and Logistic Regression (LR) to automate the prediction and classification of brain tumors using an MRI dataset. This research paper demonstrates the robustness of ML models and achieves the best performance, with 90% accuracy.

Keywords: ML, Classification, RF, SVM, NB, KNN, LR, DT, Medical Imaging

*Speaker

Smart Inventory Management: Q-Learning algorithm for Spare Parts Optimization

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Inventory replenishment is an ongoing process that maintains products in inventory to meet customer demand. The (s, S) policy is a widely used method of inventory control in dynamic systems with random demand. According to this policy, if the initial inventory level of a period is equal to or less than the reorder point, an order is issued for replenishment to bring the stock level to level S. This paper introduces a Markov decision process-based mathematical model for one-echelon system inventory control with the cases of failure that follow the Weibull low. The Q-Learning algorithm is both theoretically and practically well-suited to addressing stochastic transitions and reward structures when there is an unknown model environment a priori. The proposed approach is to determine the optimum order quantity of spare parts per period and reduce overall costs of inventory management through the incorporation of various cost considerations in decision-making.

Keywords: Q, Learning Algorithm, Weibull low, Spare parts, Inventory management

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Framing Adversarial Machine Learning and Federated Learning Threats through MITRE ATLAS

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As the adoption of Federated Learning (FL) accelerates across sectors prioritizing privacy, its decentralized architecture introduces novel cybersecurity threats that remain underrepresented in existing adversarial threat taxonomies. This paper bridges this gap by analyzing FL-specific adversarial techniques and mapping them to the MITRE ATLAS (Adversarial Threat Landscape for Artificial-Intelligence Systems) framework, a living knowledge base for Artificial Intelligence Systems threats. Through a structured proposed methodology and a review of peer-reviewed studies (2021–2025), we identified critical vulnerabilities including model poisoning, privacy leakage, and collusion attacks specific to both cross-silo and cross-device FL contexts. We then proposed a set of ATLAS techniques extensions. Our results highlight substantial omissions in current ATLAS coverage, including the absence of FL-specific subtechniques and inadequate support for privacy-utility tradeoff modeling. We also underscore challenges in mitigation strategies. This study concludes with a proposed roadmap for standardizing FL threat modeling within ATLAS, advocating formal certification mechanisms for robustness. These contributions aim to operationalize AI threat intelligence and elevate the resilience of federated systems in high-stakes domains.

Keywords: Adversarial Machine Learning, Federated Learning, MITRE ATLAS, Cybersecurity of Artificial Intelligence Systems.

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Two-Stage Spectrum Sensing approach based Energy and Entropy for Cognitive Radio - IoT Networks

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As billions of ultra-low-power Internet of Things (IoT) devices vie for fragments of an already-congested spectrum, next-generation networks urgently need sensing techniques that deliver cognitive intelligence without draining a coin-cell battery. Traditional spectrum sensing methods, though reliable, impose si gnificant computational load on battery-limited IoT nodes. This work proposes a novel Hybrid Energy Entropy Spectrum Sensing (HEESS) algorithm tailored for Cognitive Radio-IoT networks, combining the simplicity of energy detection with the robustness of entropy-based sensing in a two-stage approach. In the first stage, an adaptive energy detection mechanism quickly identifies potential Primary User (PU) activity with low computational overhead, making it suitable for resource-constrained IoT devices. The second stage employs a correlation-weighted spectral-entropy metric to refine detection, enhancing ac curacy under low Signal-to-Noise-Ratio (SNR) conditions. Adaptive thresholds, tuned to dynamic chan nel conditions, minimize false alarms and missed detections, while selective activation of the entropy stage preserves energy efficiency. Simulation results demonstrate that HEESS achieves high detection probability at low SNRs, with reduced false-alarm rates and minimal computational complexity. The algorithm therefore offers a scalable, energy-efficient solution for spectrum sensing in CR-IoT, enabling reliable and adaptive spectrum access for next-generation wireless networks.

Keywords: Cognitive Radio, IoT, Spectrum Sensing, Adaptive Energy Detection, Entropy Detection

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Digital Twins for predictive maintenance

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The main aim of this paper is to study the significant applications of Digital Twins (DT) for Industry 4.0 in public health, e.g., predictive maintenance (PdM). In fact, we study Digital Twins and its need and we discuss the process used in Digital Twins for Industry 4.0. So, it can reduce time to specialists by designing and evaluating the processes in virtual environments before acting and operating. Comprehensive simulation platforms can be presented using Digital Twins to simulate and evaluate product and service performances in terms of analysis and modification of produced parts. In addition, basing on the mathematical models, we give the supportive features of (DT) for Industry 4.0 in order to identify some related applications in healthcare and then we discuss the advantages and challenges related to this innovative virtual tool. We intend to analyse the techniques and applications regarding DT, and the perceived benefits of PdM from the DT paradigm are summarized. Finally, challenges of current research and opportunities for future research are discussed especially concerning the issue of framework standardisation for DT-driven PdM.

Keywords: Digital twin, Industry 4.0, Digital health, AI and IoT, Predictive maintenance, Optimization.

*Speaker

Industrial Defect Classification Through 2D and 3D Data Integration

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Ensuring the accurate detection and classification of defects in manufactured components is a critical challenge in industrial quality control, where even minor anomalies can cause substantial economic or operational harm. Traditional inspection systems, which often rely solely on either 2D visual or 3D geometric data, struggle to capture the complex and subtle patterns of real defects. In this work, we propose a supervised deep learning framework that integrates both 2D (RGB) and 3D (depth) data into a unified multimodal representation to enhance defect classification performance. By converting RGB images into grayscale and combining them with depth-derived spatial coordinates (x, y, z), we construct a four-channel input processed through a VGG16-based network adapted for multimodal learning. Only the fifth convolutional block is fine-tuned to prevent overfitting while leveraging pretrained ImageNet features. The proposed method is evaluated on the MVTec 3D-AD dataset and achieves superior image-level classification accuracy compared to state-of-the-art baselines. The results demonstrate the advantages of combining visual appearance and structural depth features, offering a robust solution for automated quality control in industrial environments.

Keywords: Industrial Defect Detection, Transfer Learning, Feature Fusion, 3D defect classification, 3D Anomaly Detection

*Speaker

Deep Learning-Based Segmentation of Industrial XCT Volumes

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X-ray Computed Tomography (XCT) is a widely used non-destructive imaging technique for inspecting complex, multi-material components in industry. However, the analysis of XCT data remains a time-consuming and expertise-driven task due to the volumetric nature of the data and the presence of image artifacts or low-contrast zones.
In this work, we propose a deep learning pipeline to automate the segmentation and classification of XCT volumes. Using a multi-material test case, we trained 2D U-Net architectures enhanced by transfer learning with ResNet34 and InceptionV2 encoders. Our results demonstrate high segmentation accuracy, achieving up to 98% accuracy and a mean Dice coefficient of 98% on unseen test data, enabling robust part identification across 17 object classes.
The workflow includes extensive pre-processing, manual ground truth generation, and post-processing to refine predictions and prepare volumetric outputs suitable for simulation or reverse engineering.
Future work will explore 3D convolutional architectures such as 3D U-Net and V-Net to fully exploit spatial context in volumetric data, with the aim of further improving segmentation quality and enabling more generalized applications in industrial inspection workflows.

Keywords: X, ray Computed Tomography, Deep Learning, Semantic Segmentation, Industrial Inspection

*Speaker

On the Use of 3D Modeling, 3D Reconstruction, and 3D Printing Techniques for the Development of a Personalized Total Ankle Prosthesis: A Case Study in Post-Traumatic and Degenerative Joint Conditions

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Abstract:
Nowadays, the adaptability of ankle prostheses represents a major challenge for both surgeons and patients. Currently, most commercially available prostheses are standardized in size, based on predefined dimensions and shapes. These models are often preferred due to their accessibility. However, their lack of compatibility with each patient's specific anatomy can lead to several complications. In fact, it is often necessary to adapt the patient's anatomy to fit the prosthesis, which can prolong the duration of the surgery, result in a longer and more painful recovery, increase the risk of hospital-acquired infections, and ultimately affect the patient's comfort.
This study aims to examine to what extent the integration of custom-made ankle prostheses could offer a relevant alternative, in terms of improving clinical outcomes, reducing recovery time, and increasing implant longevity.
The primary objective of this study is to design a custom-made ankle prosthesis, specifically adapted to the anatomical characteristics of each patient. This project is part of a biomedical innovation approach aimed at addressing the functional complexity of the talocrural joint, while integrating recent advances in 3D modeling, additive manufacturing, and biomechanical engineering. The method adopted relies on a personalized reconstruction of the bony architecture, followed by the complete modeling of the prosthesis in Blender.
The first step in the process involves the three-dimensional reconstruction of the ankle bones based on medical imaging acquired through computed tomography (CT) or magnetic resonance imaging (MRI). These DICOM datasets are processed in specialized medical segmentation software such as 3D Slicer, allowing for the extraction of the relevant bone structures, particularly the tibia and the talus. The generated meshes are exported in STL format and serve as anatomical references for the custom prosthesis design.
Once the anatomical data are reconstructed, they are imported into Blender, an open-source 3D modeling software particularly well-suited for creating complex shapes. The talus component of the prosthesis was modeled using the extra objects add-on and its "Math Surface" function. This method enables the generation of parametric surfaces based on mathematical equations

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defined in a three-dimensional coordinate system (X, Y, Z). By adjusting the U and V domain parameters and the number of subdivisions, it was possible to create a curved, symmetrical surface that faithfully represents the articular geometry of the talus. To refine the shape, modifiers such as solidify (for thickness) and subdivision surface (for smoothness) were applied, giving the model a realistic and functional appearance.
The insert (or pad) of the prosthesis was modeled from a basic cube. In Edit Mode, the knife tool was used to make precise cuts, defining a topological structure based on ergonomic and mechanical constraints. The cut edges were then extruded to add volume, and the model was smoothed using the subdivision surface modifier. This resulted in a soft, organic form optimized to reduce friction and ensure natural joint motion.
The tibial component was also created from a resized cube, softened using bevel and subdivision surface modifiers to produce a smooth interface with the bone. A second cube was added vertically to ensure mechanical connection with a horizontally positioned cylinder at the top of the structure. This cylinder was then perforated with several small cylinders using the boolean modifier in difference mode, simulating the screw holes required for surgical fixation. Once all forms were validated, the modifiers were applied to finalize the geometry of the model.
All parts modeled in Blender were designed to meet both the mechanical constraints of the joint and the specific anatomical features of the patient. The advantage of this method lies in the advanced customization of each component, making it possible to achieve perfect integration of the prosthesis into the recipient's bone environment. Once modeling is complete, the files are exported in STL format for 3D printing using high-performance biocompatible materials.
In conclusion, this digital design process from bone reconstruction to advanced modeling in Blender enables the development of fully personalized ankle prostheses that are more precise, more functional, and better tolerated. This work demonstrates the potential of integrating digital tools into the field of personalized orthopedic surgery, by reducing postoperative complications and improving patients' quality of life.

Keywords: 3D Modeling, Talocrural Joint, Bone Reconstruction, Blender, Mathematical Surface, 3D Printing, Biocompatible Materials, Custom Prosthesis

An Intelligent RAG-Based Chatbot for Navigating HSE Standards in Industrial Contexts

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Health, Safety, and Environment (HSE) standards in large industrial organizations are extensive and complex, making it challenging for employees to quickly find specific information when needed.
This paper presents an intelligent chatbot system using Retrieval-Augmented Generation (RAG) to provide easy, conversational access to OCP Group's HSE standards. The system integrates a local Large Language Model (LLM) - Mistral 7B via the Ollama framework - with a vector database of HSE documents (ChromaDB), utilizing the LangChain framework.
HSE documents are embedded using a MiniLM sentence transformer and indexed in ChromaDB for efficient semantic retrieval. Upon receiving a user query, relevant excerpts are retrieved and passed to the LLM via a structured prompt to generate accurate answers.
A Streamlit-based user interface allows users to filter the query scope by metadata and provides explainability by highlighting source snippets.
We describe the system architecture and methodological decisions, including prompt design to ensure the accuracy of responses. In evaluations with internal HSE queries, the chatbot demonstrated strong performance in delivering correct, context-grounded answers, receiving positive feedback from OCP HSE experts.
We also discuss the benefits of this approach for industrial knowledge management, along with current limitations such as the LLM's context window size and the potential for hallucinations. Future work will focus on extending context length, improving user experience and incorporating conversational memory. This project illustrates how RAG-based AI systems can enhance corporate knowledge bases, offering a practical tool for improving safety compliance and operational efficiency in industry.

Keywords: Retrieval, Augmented Generation, Health, Safety, and Environment, Large Language Models, Industrial Chatbot, Mistral 7B, Ollama, LangChain, ChromaDB, MiniLM, Semantic Search, Streamlit

*Speaker

Digitalizing Supplier Evaluation: A Multi-Criteria Approach for Performance Management in Moroccan Companies"

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Within the context of persistent inefficiencies in supplier performance management across Moroccan companies, this study addresses the lack of standardized evaluation practices that hinder operational effectiveness and continuous improvement. The aim of this study is to design and implement a structured, digitalized supplier evaluation system that supports better decision-making, enhances operational performance, and contributes to the development of the local suppliers ecosystem. A mixed-method approach was adopted, combining a diagnostic analysis of current supplier issues with a multi-criteria decision-making framework. The methodology is structured in four phases: an initial diagnostic to identify data gaps and adapt evaluation criteria; the use of the Analytic Hierarchy Process (AHP) to weight performance indicators through expert pairwise comparisons; the application of the TOPSIS method to rank suppliers based on proximity to the ideal performance; and finally, the development of a dynamic dashboard for visualization and decision support. The results show that the proposed system enables objective identification of underperforming suppliers, facilitates evidence-based corrective actions, and strengthens supplier engagement through transparent performance feedback. These findings confirm the relevance of an integrated, data-driven approach to supplier evaluation and highlight its potential to support digital transformation and local supplier development in the Moroccan procurement landscape.

Keywords: Supplier Performance Evaluation, Multi, Criteria Decision, Making, AHP, TOPSIS Digital Transformation, Procurement Management

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A Novel Model Based on a Nonlinear Fractional System for Image Restoration

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In this work, we develop a nonlinear system involving the fractional Laplacian operator, based on the H^{-s}-norm and a decomposition approach. The proposed method integrates the advantages of the dynamical threshold-based Perona–Malik (DTPM) model in flat regions with the benefits of incorporating a weak norm in the fidelity term. This weak norm is particularly suited for capturing highly oscillatory features typically interpreted as texture. Using Schauder's fixed point theorem, we establish the existence and uniqueness of a weak solution to the system. To compute the solution numerically, we use a finite difference scheme to approximate the fractional Laplacian. Finally, we present comparative numerical experiments to evaluate the efficiency and effectiveness of the proposed model.

Keywords: Image denoising, Nonlinear diffusion, Fractional, order PDE, Perona–Malik (PM) equation, Dynamical threshold.

*Speaker

Design and 3D Modeling of a Surgical Simulation Platform for Transoral Endoscopic Thyroidectomy via Vestibular Approach (TOETVA)

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Abstract. The primary objective of this study is to design a functional surgical training simulator dedicated to the transoral endoscopic thyroidectomy via vestibular approach (TOETVA). This initiative aligns with the management of benign thyroid pathologies, particularly nodules or adenomas, whose prolonged persistence may have a deleterious impact on the patient's health and generate significant functional and aesthetic discomfort.

TOETVA is an innovative and relatively recent surgical technique that stands out due to its minimally invasive approach and the absence of visible postoperative scarring. It is performed via a transoral endoscopic access through the oral vestibule. Today, this technique is increasingly viewed as a promising alternative to conventional approaches, with particular emphasis on aesthetic outcomes and accelerated postoperative recovery.

However, it is important to underline that the cervical region presents complex anatomical structures, a restricted operative field, and requires the use of specialized endoscopic equipment. These factors confer a high level of technical difficulty to the procedure, making its mastery particularly challenging, especially for surgeons in training.

This project is part of an effort to develop a realistic pedagogical simulation tool that addresses the growing demand for safe, hands-on surgical training, in alignment with the principle of risk-free learning for patients.

The study is structured around several complementary objectives. The first aims to achieve precise anatomical modeling of the cervical thyroid region, with a particular focus on critical structures such as the thyroid gland, trachea, cervical vessels, and especially the recurrent laryngeal nerves. Preservation of these nerves is a major concern in thyroid surgery, as their injury can lead to serious functional complications. The simulation enables the reproduction of key steps in the TOETVA procedure, from the incision at the level of the oral vestibule to the dissection, retraction, and excision of the affected thyroid lobe. The chosen approach seeks not only to illustrate the essential surgical maneuvers but also to raise awareness among users of key anatomical landmarks, the risk of nerve injury, and the strategies for avoiding such complications. To achieve these objectives, a multidisciplinary methodology has been adopted, combining 3D modeling tools, anatomical reference platforms, and a 3D printing process, resulting in a tangible, interactive, and functional training model. This simulator is intended for educational use in surgical training, particularly within hospitals, medical faculties, and specialist residency programs. It aims to reduce operative risks, strengthen the technical skills of trainees, and, more broadly, contribute to the overal improvement of care quality provided to patients with thyroid disorders.

*Speaker

Keywords: TOETVA, Transoral Endoscopic Thyroidectomy, Surgical Simulation, Anatomical Model, 3D Modeling, 3D Printing, Recurrent Laryngeal Nerve, Thyroid Gland, Minimally Invasive Surgery.

Numerical scheme of fractional differential equations with a new mixed fractional derivative

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Fractional derivatives today have a wide range of applications in science and engineering, due to their ability to model complex phenomena with memory. In this article, we present a new numerical method for approximating the mixed fractional derivative recently introduced by Hattaf. The method, based on a finite-difference scheme, is applied to the solution of both linear and non-linear fractional differential equations (FDEs). A comparative analysis between the exact solutions and the numerical solutions obtained demonstrates the accuracy and speed of convergence of the proposed method.

Keywords: Mixed fractional derivative, numerical method, fractional differential equations.

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Mixed Finite Element Method with Newton's Method for variational Inequalities

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This paper presents a numerical approach to solving contact problems between an elastic body and a rigid obstacle, employing the mixed finite element method. The mixed variational formulation of the contact problem is derived, and subsequently discretized using mixed finite elements of second order. The resulting variational inequalities are then solved using Newton's method, which yields accurate and stable numerical solutions. The efficacy of the method is demonstrated through numerical results.

Keywords: Mixed Finite Element Method, Contact Problems, variational Inequalities, Newton's Method

*Speaker

Stability of HIV infection with the New Generalized Hattaf Fractional Derivative and therapy

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In this work, we present a new fractional-order model based on the new generalized Hattaf fractional (GHF) derivative with non-singular kernel, that captures the dynamics of human immunodeficiency virus (HIV). Our model takes into account three modes of transmission, two types of infected cells, the adaptive immune response exerted by antibodies and cytotoxic T lymphocytes (CTLs). Additionally, it integrates four therapeutic parameters to represent different aspects of the therapy, leading to the emergence of two types of viruses, infectious and noninfectious. We identify the equilibrium points and analyze their global stability with respect to specific threshold parameters. Finally, our theoretical results are illustrated through numerical simulations.

Keywords: GHF derivative, HIV infection, global stability.

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A non-overlapping time Schwarz domain decomposition method applied to an Euler-Bernoulli beam equation

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In this work, we have proposed an algorithm based on a time Schwarz domain decomposition method (T-SDDM) applied to a discretized Euler-Bernoulli beam equation. We have studied the convergence of the proposed algorithm in the case of finite difference scheme. Several numerical tests are achieved which show that T-SDDM preserves the properties of the numerical scheme, illustrate the theoretical result of the convergence, and also show the efficiency and the good accuracy in terms of the CPU time.

Keywords: Time, Schwarz domain decomposition method, Euler, Bernoulli beam equation, Finite difference method.

*Speaker

Optimizing Energy Consumption in MEC Task Offloading with Deep Q-Networks

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Edge computing and artificial intelligence models in wireless communication networks represent a technological advancement, as edge computing brings resources, computing and processing capabilities, as well as services, closer to users. This combination improves network performance in terms of latency, bandwidth, and energy consumption. This paper focuses on the Deep Q-Network (DQN) algorithm, a deep reinforcement learning (DRL) approach applied in a multi-user and multi-server environment for task offloading to these servers. The goal of this approach is to determine the best offloading strategies in order to optimize energy consumption. Our approach reduces energy consumption by more than half compared to traditional offloading techniques, where all requests are either executed on the device itself or sent to a cloud computing center.

Keywords: Offloading tasks, energy consumption, Deep Q, Network (DQN)

*Speaker

Error Analysis of Physics–Informed Neural Networks Approximating the Euler–Bernoulli Beam Equation

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1

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Physics–Informed Neural Networks (PINNs) offer a mesh–free, deep–learning framework by embedding the governing differential operator and boundary conditions directly into the training loss. In this work, we develop an error analysis for PINNs applied to the Euler–Bernoulli beam equation, a prototypical fourth–order boundary value problem. By sampling an increasing number of interior collocation points, PINNs produce a sequence of network minimizers. Under some Hölder regularity assumptions on the exact solution and standard stability conditions, we prove that this sequence converges to the unique classical solution as the sample size grows. Moreover, we derive explicit error bounds that quantify the effects of network capacity and regularization. Numerical experiments confirm our theoretical findings and illustrate the practical performance of PINNs in approximating the classical solution of fourth–order ordinary differential equations.

Keywords: Physics, Informed Neural Networks, Convergence, Holder Regularization, Fourth, Order Boundary Value Problem, Euler, Bernoulli beam equation

*Speaker

Towards Spatio-Temporal Forecasting Using Neural Variable-Order Fractional Models on Graph-Structured Data

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This work explores the integration of neural variable-order fractional models with graph-structured data to advance spatio-temporal forecasting. By leveraging the flexibility of fractional calculus with variable differentiation orders, the proposed approach captures complex dynamics and memory effects inherent in spatial networks evolving over time. The framework utilizes graph representations to model spatial dependencies, while neural networks adaptively learn variable fractional orders, enhancing predictive accuracy. Experimental results demonstrate the model's potential in effectively forecasting spatio-temporal phenomena across diverse applications such as traffic flow, environmental monitoring, and social networks.

Keywords: Variable, Order Fractional Calculus Spatio, Temporal Forecasting, Graph Neural Networks

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Stability Analysis of a Delay Differential Model for Unemployment Dynamics

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In this work , we investigate the global dynamics of a delay differential model that describes the evolu tion of unemployment by incorporating key labor market variables, including the unemployed popula tion, employment, and job vacancies. The model accounts for the time delays associated with training or preparation before employment. Using Lyapunov functionals and LaSalle's invariance principle, we establish sufficient conditions for the global asymptotic stability of both the unemployment-free and en demic equilibria. The analysis reveals that the long-term behavior of the system is critically dependent on the basic reproduction number R0. Numerical simulations are presented to illustrate the theoretical f indings and examine the effect of various economic parameters

Keywords: Unemployment model, Delay differential equations, Global stability, Lyapunov functionals, LaSalle's invariance principle, Basic reproduction number

*Speaker

Comparative Study of the Seismic Behavior of a Building With and Without Base Isolation (Case of the 2004 Al Hoceima Earthquake)

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The devastating earthquake that struck Al Hoceima, Morocco, on February 24, 2004,tragically revealed the seismic vulnerability of conventional reinforced concrete buildings in the Rif region. The widespread structural damage highlighted the urgent need for more effective design strategies to enhance the earthquake resilience of buildings in seismic-prone zones.
This research presents a comparative study of the seismic response of two identical reinforced concrete buildings: one with conventional fixed-base foundations, and the other equipped with base isolation using lead-rubber elastomeric bearings. The primary objective is to assess the efficiency of seismic isolation in reducing structural damage and improving the overall safety of buildings subjected to strong ground motions.
Time-history analyses were performed using recorded acceleration data from the Al Hoceima 2004 earthquake. The dynamic behavior of both models was evaluated based on key response parameters such as fundamental period, floor acceleration, inter-story drift, and internal force distribution. The results clearly demonstrate the effectiveness of the isolation system. The base-isolated building showed a significant elongation of the fundamental period, which effectively shifted its dynamic response away from the dominant frequencies of the ground motion. As a result, peak floor accelerations and internal stresses were drastically reduced .

Moreover, the isolators were successful in concentrating most of the lateral displacements at the base level, thereby minimizing the deformation demands on the superstructure. This greatly contributes to the protection not only of structural components but also of nonstructural elements, reducing the risk of human injury and post-earthquake repair costs .

Beyond this comparative evaluation, our study introduces a simplified numerical method for computing deformations in structural elements under seismic loading. This approach offers a practical alternative to the classical Mohr's integral method, which, although widely accepted, is often cumbersome due to the need for moment-distribution diagrams and extensive tabular data. The new method simplifies the process by enabling accurate deformation calculations without relying on pre-defined tables, making it especially suitable for seismic load cases.

*Speaker

To validate the accuracy and reliability of this method, it was tested on both isostatic and hyperstatic structural systems, including cases with moment discontinuities. The results matched those obtained from the traditional Mohr's integral method, confirming the robustness of the proposed approach.

This research not only underscores the undeniable benefits of seismic isolation in mitigating structural damage during earthquakes but also contributes to the advancement of structural analysis by offering engineers a more efficient and user-friendly method for calculating deformations. It opens new possibilities for integrating simplified numerical tools into design practices, especially for performance-based earthquake engineering

Keywords: Seismic isolation, elastomeric bearings, dynamic behavior, beam deformation, Mohr's integral .

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On the Use of 3D Modeling and Printing Techniques for the Development of a Kidney Model for Partial Nephrectomy Training

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Abstract The kidney, a vital organ located deep within the retroperitoneum, plays a crucial role in blood filtration, waste elimination, blood pressure regulation, and maintaining water and électrolyte balance. Its internal structure is particularly complex, traversed by a dense network of blood vessels and collecting ducts, which must be carefully preserved during surgical procedures. Renal carcinoma, the most common form of kidney cancer, is often discovered incidentally and sometimes requires surgical management. Among the available options, partial nephrectomy is a preferred technique aimed at removing the tumor while preserving the maximum amount of functional renal tissue. This is a delicate operation that demands not only precise manual skills but also an excellent understanding of renal anatomy. In this context, our project aims to design and produce a 3D-printed anatomical kidney model specifically intended for training in partial nephrectomy. The goal is to provide a realistic educational tool that allows healthcare professionals to practice under near-real conditions. Thanks to 3D modeling, we were able to reconstruct the renal anatomy in great detail, incorporating both normal structures and pathological lesions typical of kidney tumors. This model serves as a fundamental learning aid for preoperative planning and understanding the relationships between different internal structures. 3D printing plays a key role in bringing the model to life by transforming virtual reconstructions into tangible physical objects. The use of flexible or rigid materials, depending on educational needs, enables faithful reproduction of textures, volumes, and anatomical relationships. This customized manufacturing method offers a realistic and accessible solution for surgical training, allowing risk-free practice while improving teaching quality and future surgical safety.
Our ultimate goal is to contribute to better surgeon training, enhance operative safety, and promote improved clinical outcomes for patients with renal tumors.

Keywords: Anatomical model, Medical training, Renal tumor, Partial nephrectomy, 3D modeling, 3D printing

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Numerical Treatment of a Nonlinear Diffusion Equation

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In this work, we propose a nonlinear diffusion equation, of the form :

$$\frac{\partial u}{\partial t} = \frac{\partial}{\partial x}\left(K(u)\frac{\partial u}{\partial x}\right) \quad x \in \Omega, t > 0 \tag{1}$$

This equation arises in various applications such as fluid mechanics, heat and moisture transfer[1]. The primary objective of solving equation ((1)) is to obtain a highly accurate and reliable numerical solution. To address this challenge, we focus on high-order numerical methods [2]. In this study, we propose a new high-order scheme based on a finite difference formulation. By discretizing the spatial derivative in PDE ((1)), we transform it into a system of first-order ordinary differential equations (ODEs). Finally, we validate the proposed numerical method through several test cases using some exact solutions [3] of the nonlinear diffusion equation, and evaluate the accuracy using the L^{∞}-norm of the error.

Keywords: Non Linear Diffusion equation, Boundary Conditions, High Order Scheme.

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*Speaker

Numerical Study of the Influence of a Corrosion Crack on a Welded Pressure Pipe Made of P265GH Steel

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Gas pipelines are widely used for long-distance transport but are prone to damage, mainly due to corrosion. These welded steel structures, often coated for protection, can fail from both corrosion and welding defects. Corrosion appears as either generalized or localized forms, with the latter including severe types like stress corrosion cracking. Despite much research, the use of the extended finite element method (XFEM) to model corrosion effects remains limited. This study investigates the impact of a 3D external elliptical corrosion defect on a pressurized pipe made of P265GH steel, using XFEM to analyze stress intensity factor variations.

Keywords: Pressurized pipes, corrosion, level set, XFEM, numerical analysis, welded steel.

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Advancing Cardiac Arrhythmia Detection: A MATLAB Approach to Simulated ECG Signal Processing and Atrial Fibrillation Identification

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Abstract . Atrial fibrillation (AF) is one of the most common heart rhythm disorders, marked by an irregular and often rapid heartbeat. This condition can lead to serious health problems like stroke and heart failure, making early and accurate detection vital for effective treatment and patient care. In this study, we developed and validated a reliable method to simulate, process, and automatically detect AF using electrocardiogram (ECG) signals, all within the MATLAB environment.
We chose MATLAB as our primary tool because of its powerful signal processing capabilities and flexibility in handling biomedical data. Its extensive toolboxes allowed us to implement advanced filtering techniques, detect heartbeats precisely, and analyze heart rate variability (HRV). This enabled us to build a complete workflow-from simulating ECG signals to analyzing pathological cases and classifying them automatically.

To ensure a controlled and repeatable testing environment, we generated realistic ECG signals that varied in key physiological features, such as the timing between heartbeats (RR intervals) and the shape of the ECG waves, while also adding different levels of noise. This approach let us thoroughly test our detection algorithms under a wide range of conditions, including extreme scenarios that are often hard to find in real clinical data. We also compared our simulated signals with real clinical recordings to confirm their physiological accuracy.

When processing pathological signals, we applied robust filtering to remove unwanted noise and baseline drift, followed by careful segmentation of individual heartbeats. We developed a new combined indicator that merges the root mean square of successive differences (RMSSD) with the percentage of successive RR intervals differing by more than 20 milliseconds (pNN20). This combined measure proved more sensitive and specific in detecting AF-related irregularities than traditional indicators like pNN50. To deepen our understanding, we also performed frequency-domain analysis, examining low-frequency and high-frequency components and their ratio, which reflect the balance of the autonomic nervous system.

Our validation process involved collaboration between cardiologists and mathematicians. Clinical experts reviewed and labeled ECG segments to provide a trusted reference, while mathematicians ensured the statistical soundness and robustness of our algorithms. This interdisciplinary

*Speaker

approach confirmed that our system is both reliable and clinically relevant. Performance metrics such as sensitivity, specificity, and accuracy demonstrated that our detection pipeline works effectively-even in noisy and artifact-prone signals.

While the results are promising, we recognize some limitations. Simulated signals, although realistic, cannot capture all the complexities of real-world ECGs. Also, while our combined RMSSD-pNN20 indicator improved detection, incorporating advanced techniques like time-frequency analysis and machine learning could make the system even more robust and adaptable. Moving forward, we plan to extend our method to detect other types of arrhythmias, validate it on larger and more diverse clinical datasets, and develop real-time processing capabilities suitable for wearable or embedded cardiac monitors.
In summary, this study offers a comprehensive and effective approach to AF detection based on simulated and pathological ECG signal analysis using MATLAB. Our findings highlight the potential of these methods to significantly enhance automated cardiac rhythm monitoring, improving diagnostic accuracy and ultimately supporting better patient care. The strong interdisciplinary validation and encouraging performance pave the way for future clinical applications and technological advancements.

Keywords: Key Words : Atrial fibrillation (AF), ECG signal processing, MATLAB, Heart rate variability (HRV), RR intervals, RMSSD, pNN20, Frequency, domain analysis, Cardiac arrhythmia detection.

SIR_Thresold, a new compartmental model adapted to major disease disease_X forecasting

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Not long ago, the world was faced with a major problem, which was a situation that was not ideal. The epidemic caused by the SARS-CoV-2 virus turned the lives of people around the world upside down. The strategies developed at international level enabled the epidemic to be eradicated. However, it left behind a heavy socio-economic and health toll.
To reduce the impact of the epidemic, researchers have developed various forecasting models capable of developing proactive interventions and effective strategies. One of these is the SIR model, a model made up of different compartments capable of predicting the dynamics of the epidemic and taking the necessary measures to halt its progress.

The aim of this study is to propose a modified SIR model, called 'SIR-Threshold', with a view to attacking the problem at its root. To achieve this, we will adapt the classic SIR model to distinguish between a developing epidemic and isolated cases. The proposed model modifies the transition from susceptible (S) to infected (I) by introducing a dynamic threshold and a pattern detection function.
This model could be used for the early detection of diseases likely to develop into epidemics, enabling the necessary interventions to be launched and a new cataclysm to be avoided.

Keywords: Disease X forecasting, SIR Threshold, epidemic, proactive intervention

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Stability Analysis of Fractional-Order Epidemic Model With Beddington-Deangelis Incidence Rate

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In this paper, we describe the transmission dynamics of a fractional order of an SnScIQR epidemic model with reaction–diffusion and Beddington-DeAngelis incidence rate. The basic reproduction number R_{0} is obtained according to the next generation matrix. The local stability of the disease free equilibrium is discussed. Further, utilizing the Lyapunov function method, it has been demonstrated that the global stability of each equilibrium: free equilibrium and endemic equilibrium, is mainly based on the fundamental reproduction number R_{0}. Finally, numerical simulations were executed to justify the theoretical findings.

Keywords: SnScIQR epidemic model, fractional order, Stability Analysis.

*Speaker

The Use of AI and Machine Learning in Sales Forecasting and Commercial Performance Optimization in the OPCI Sector.

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This article addresses the lack of empirical studies on the sales generation process within Real Estate Investment Trusts (OPCI), focusing on the impact of client calls on opportunity closures. We employ predictive analysis techniques, including feature selection and hyperparameter optimization, to develop a supervised learning model tailored to the unique dynamics of OPCI sales processes. The objective is to identify critical attributes within the sales funnel that significantly influence the forecasting process, with particular emphasis on the role of client calls in closing opportunities. The paper explores various types of machine learning, with a particular focus on supervised learning, and its applicability in decision-making and commercial forecasting in the context of OPCI. The proposed methodology is presented within the CRISP-DM framework, encompassing phases such as data preparation, cleaning, transformation, and modeling. Challenges related to missing and categorical data, as well as the importance of feature selection and encoding in OPCI sales forecasting, are also examined. The new approach enables effective prediction of sales success probability in OPCI by analyzing the impact of client calls and identifying critical attributes within the sales funnel.

Keywords: OPCI, client calls, CRISP, DM, supervised learning.

*Speaker

PREDICTIVE MODELING OF CUSTOMER CHURN IN THE MOROCCAN TELECOMMUNICATIONS SECTOR USING ADVANCED MACHINE LEARNING ALGORITHMS

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Abstract Customer churn prediction within emerging telecommunications markets presents distinct algorithmic challenges that conventional modeling approaches inadequately address. This research develops a contextually-calibrated predictive framework specifically designed for the Moroccan telecommunications landscape, integrating advanced ensemble learning with domain expertise validation. Our methodology combines XGBoost, neural networks, and LSTM architectures through a two-stage hierarchical framework, processing 22,238 customer records spanning 2021-2023. Expert-informed feature engineering transforms 127 initial variables into 43 optimized predictors, capturing market-specific behavioral patterns often overlooked by traditional approaches. The ensemble model achieves 89.7% prediction accuracy, substantially outperforming conventional methods by 14.7 percentage points. SHAP analysis reveals counterintuitive insights: network quality metrics contribute 34% of predictive power, contradicting conventional emphasis on pricing factors in emerging markets. Critical threshold effects identify specific performance boundaries where customer loyalty degrades rapidly, enabling targeted infrastructure investments. Implementation across customer segments demonstrates differential effectiveness: 93.4% accuracy for high-value urban subscribers versus 86.8% for rural customers. The framework provides actionable retention strategies with projected 15-25% churn reduction and revenue preservation worth 8-12% of annual subscriptions.

Keywords: Ensemble learning, telecommunications analytics, emerging markets, explainable AI, customer retention, contextual modeling

*Speaker

Mapping a Decade of Educational Assessment Research: A Bibliometric Analysis of ILSAs (2015–2025)

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International large-scale assessments (ILSAs) such as PISA, TIMSS, and PIRLS have become vital tools for evaluating educational systems and guiding policy decisions worldwide. These assessments generate extensive datasets that enable cross-national comparisons of student outcomes, curricular effectiveness, and educational equity. In recent years, scholarly interest in ILSAs has expanded markedly, reflecting the global push for data-driven educational reform and benchmarking. This study presents a comprehensive bibliometric analysis of 11099 scientific publications indexed in the Scopus database between 2015 and 2025. The analysis, conducted using the R package bibliometrix, captures contributions from over 26,500 unique authors and spans 3,796 distinct sources, including journals, books, and conference proceedings. The annual scientific output displays a modest decline, with an average growth rate of –1.67 %. Key bibliometric indicators, such as author productivity (Lotka's Law), source concentration (Bradford's Law), and keyword frequency, were examined to identify core contributors, disciplines, and thematic developments. Prominent sources include Large-Scale Assessments in Education, IEA Research for Education, and Studies in Educational Evaluation. The findings highlight the growing emphasis on educational equity, digital assessment, and policy analysis, with ILSAs serving as critical empirical foundations. This research offers valuable insights for educators, scholars, and decision-makers seeking to understand the evolving landscape of international educational assessments and their intersection with analytical technologies.

Keywords: PISA, TIMSS, International Educational Assessment, Bibliometric Indicators, Research Productivity, Educational Measurement Trends

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Machine Learning Enhanced Calibration of Stochastic Volatility Jump-Diffusion Models via Tikhonov Regularization

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We propose a stochastic volatility jump-diffusion (SVJ) model for asset prices in n dimensions with stochastic volatility following a jump-diffusion in d dimensions. The option price is determined as the solution of a partial integro-differential equation (PIDE), whose existence in the multi- dimensional case (s = d + n) has been established.
Our primary contribution is a Tikhonov regularization approach for calibrating the risk-neutral drift term from market option prices, formulated as an inverse problem of partial differential equations derived from a Dupire-like equation. We establish the existence of the minimizer for the cost functional using optimal control theory. This revised version enhances the original work by incorporating machine learning techniques for model calibration, including neural networks for approximating the drift function and reinforcement learning for optimal parameter selection. We provide numerical examples comparing tradi- tional and AI-enhanced calibration methods, demonstrating improved accuracy and computational efficiency. The paper also includes new case studies applying the model to recent market data, showing better performance during volatile periods compared to standard SVJ models.

Keywords: SVJ model, calibration, machine learning, neural networks, reinforcement learning, Tikhonov regularization, inverse problem, optimization method

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Performance evaluation of machine learning models for stock price forecasting using technical indicators

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Stock market prediction is a critical task in the field of financial analysis, providing investors with valuable insights for making informed decisions. Despite numerous approaches developed over the years, accurately forecasting stock prices remains a complex challenge due to the volatile and noisy nature of financial markets. Traditional statistical methods often struggle to capture the nonlinear and dynamic patterns inherent in stock price movements. However, forecasting stock prices remains a complex task due to the influence of various factors, including macroeconomic conditions, company performance, investor sentiment, and government policies. In addition to these, technical indicators provide valuable insights by analyzing historical price and volume data. This paper presents a comparative study of machine learning algorithms for stock price prediction using technical indicators. We focus on four popular regression models:K-Nearest Neighbors(KNN),Decision Tree,Multilayer Perceptron Neural Networks (MLP), and Support Vector Regression (SVR) with different kernels (linear, polynomial, and radial basis function). Using daily historical data from Apple Inc., known as AAPL, between 2022 and 2025, we generate thirteen technical indicators. Model performance was evaluated using 10-fold cross-validation, with hyperparameter tuning performed via Grid Search. The evaluation metrics included Root Mean Squared Error (RMSE), R-squared (R2), and Mean Absolute Error (MAE). The results highlight the importance of integrating technical indicators with appropriate machine learning methods to improve the robustness and accuracy of stock market forecasting

Keywords: Stock market prediction, technical indicators, machine learning, price

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Advancing Volatility Forecasting in Financial Indices : From GARCH to Deep Learning and Multifractal Analysis

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The integration of Deep Learning with traditional econometric models has shown increasing potential in enhancing volatility forecasting. This study proposes a hybrid modeling framework that combines GARCH-type models with recurrent neural networks-specifically Long Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU)-to model and predict the volatility of Islamic stock indices, with a particular focus on the Dow Jones Islamic Market Index (DJIMI). GARCH-type models are first employed to capture linear volatility dynamics, and their outputs are used as features for LSTM and GRU networks to extract nonlinear and time-dependent patterns. Empirical results confirm that the hybrid models significantly outperform both standalone GARCH and standalone deep learning models in forecasting accuracy. In addition to predictive modeling, we conduct a multifractal analysis of DJIMI volatility using Multifractal Detrended Fluctuation Analysis (MF-DFA). The findings clearly reveal a multifractal structure in the volatility series. To investigate the origin of this multifractality, we apply both shuffled and surrogate data tests. Results indicate that the multifractality stems mainly from long-range dependencies and nonlinear temporal structures, rather than from fat-tailed distributions alone. These insights highlight the limitations of conventional GARCH-type models in capturing such complex dynamics and motivate the use of more sophisticated multifractal models in future research to better characterize the inherent complexity of Islamic financial markets.

Keywords: Volatility forecasting, Deep Learning, Hybrid Models, Multifractal Analysis

*Speaker

Identifying Key Drivers of Supply Chain Resilience for Modeling Using AI and Hybrid Predictive Models

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This paper aims to identify the key factors that significantly influence resilience within a supply chain and to develop a predictive model using these variables. Resilience, an increasingly prominent concept in both academic research and industrial practices, refers to the adaptability of the supply chain and its ability to manage and recover from disruptions. It has become a critical priority as organizations face in- creasing disruptions from global uncertainties, natural disasters, and market volatility. It reflects a supply chain's ability to adapt, absorb shocks, and recover quickly, ensuring continuity and competitive advantage. The use of artificial intelligence is increasingly recognized as a powerful enabler of resilience in supply chains. AI improves an organization's ability to anticipate, detect and respond to disruptions by leveraging vast amounts of data and transforming it into actionable insights. In addition to AI, emerging technologies such as Cyber-Physical Systems, and Digital Twins play a vital role in enhancing real-time visibility, and scenario planning, thus strengthening overall supply chain resilience. These technologies contribute to a more integrated and responsive system, allowing for timely decision-making and adaptive responses to changing conditions. Furthermore, key strategic pillars such as digitalization, sustainability, and agility are identified as critical components for maintaining resilient supply chains. Digitalization fosters end-to-end visibility, automation and autonomy, sustainability ensures long-term operational viability and risk reduction, while agility enables a quick adaptation to minor changes in the market demand. Our study includes both qualitative and quantitative analyzes, drawing insights from case studies, and a rich data set comprising various KPIs, strategic insights, technology adoption data, and resilience measurements expressed as percentages across multiple companies. A detailed exploratory data analysis was performed to extract meaningful features from the dataset, which were then used to train and evaluate various predictive models. The objective was to identify the most accurate model with high target accuracy. To achieve this, we performed a comparative analysis of several machine learning, deep learning algorithms, and an advanced hybrid method using an ensemble-based architecture, which combines the strengths of multiple models to improve overall prediction performance and robustness. These models yielded promising results, with notably high accuracy scores. The insights derived from this analysis provide a solid foundation for building a predictive framework capable of identifying key drivers of supply chain resilience. Ultimately, this enables organizations to adopt the right practices and technologies, fostering a highly responsive and adaptive supply chain.

Keywords: resilience, supply chain, prediction, emerging technologies, sustainability, agility.

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†Speaker

Q-Learning-Assisted Simulated Annealing for TSP Optimization

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Simulated Annealing (SA) is a powerful metaheuristic for combinatorial optimization. It is a stochastic metaheuristic that was introduced in 1983 (1) inspired by the annealing process in metallurgy, where a material is heated and then gradually cooled to minimize defects and reach a stable crystalline structure. In combinatorial optimization, SA aims to find a global minimum of an objective function $f : S \to R$ by accepting both improving and worsening solutions according to a temperature-dependent probability. This empowers the SA with the ability to escape from local optima. Still, fixed neighborhood strategies and cooling plans affect its performance. Recent advancements in optimization suggest that the integration of Q-learning with metaheuristics has significantly improved the adaptability and performance of optimization algorithms. Q-learning is a model-free, value-based method that enables an agent to learn optimal action-selection policies by iteratively updating Q-values using rewards obtained through exploration of the environment (2). For instance, Q-learning was integrated into an Iterated Greedy algorithm for flowshop scheduling by Karimi-Mamaghan et al. (5), who showed enhanced convergence and robustness. More recently, Ming et al. (6) achieved better results on benchmark problems by using deep Q-networks to direct operator selection in constrained multi-objective evolutionary algorithms. These and other Q-learning-based metaheuristics are highlighted in a thorough survey by Yang et al. (4), which emphasizes their increasing influence on a variety of combinatorial and continuous optimization problems. In this work, we include Q-learning into the SA framework to improve its flexibility. The suggested approach directs the search toward more promising areas by dynamically choosing a leader solution from a predefined set of potential solutions that are updated during iterations, using a learned Q-policy. Adaptive exploitation of successful guides is made possible by updating the Q-values based on the relative improvement each leader offers over time. Experimental results have been obtained on reference instances of the Traveling Salesman Problem from TSPLIB95 (3), and the results showed that the Qlearning- guided SA achieves better solution quality than the classical SA. These results demonstrate how experience-driven decision-making in reinforcement learning can enhance the performance of metaheuristics.

Keywords: Simulated annealing, Traveling Salesman Problem, Qlearning

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Generalized weak ϵ-subdifferential and applications

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This paper is focused on a new class of approximate subdifferentials called generalized weak ϵ-subdifferential, adapted to vector mappings. We develop some theorems, properties and various calculus rules. Then we apply this calculus to derive optimality conditions for a constrained vector optimization problem for the difference of two vector valued mappings.

Keywords: Generalized weak ϵ, subdifferential, Calculus rule, Optimality condition, Vector optimization problem

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Management Approaches for Hybrid Energy Systems in Microgrids

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The growing complexity of microgrids integrating photovoltaic, wind, and battery systems necessitates efficient energy management strategies to ensure reliability and economic performance. This study reviews optimal energy management systems (EMS) tailored for hybrid energy systems (HES) in microgrids, with a focus on intelligent control and optimization methods. Various EMS approaches are compared, including rule-based logic, model predictive control (MPC), and artificial intelligence techniques such as genetic algorithms and reinforcement learning. Uncertainty quantification techniques-such as probabilistic forecasting and robust optimization-are also explored to address renewable energy variability and demand fluctuations. The study critically evaluates centralized, decentralized, and distributed control strategies and reviews cost-effective EMS deployment considering communication technologies and hardware-software integration. This review serves as a technical foundation for developing scalable, adaptive, and optimal EMS solutions for renewable-based hybrid systems.

Keywords: Microgrids, energy management system, hybrid energy systems, optimization, uncertainty quantification, intelligent control.

*Speaker

Benchmarking Metaheuristics for CNN Optimization: A Comprehensive Study

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The fundamental concept of Artificial Neural Networks (ANNs) originated with the pioneering work of McCulloch and Pitts in 1943 [1]. They laid the groundwork for a mathematical model inspired by neuronal function. Years later, in 1958 [2], Frank Rosenblatt significantly advanced this idea by introducing the Perceptron, a simplified neural network consisting of two layers of "nerve cells" capable of classifying multi-dimensional data.
However, these early ANN models, often restricted to linear architectures, were quickly found to be incapable of solving complex non-linear problems. This limitation significantly hindered their adoption until pivotal advancements emerged. It was in this context that researchers like Rumelhart, Hinton, and Williams 1986 [3] popularized the backpropagation algorithm, an effective method for training Multi-Layer Perceptrons (MLPs), thereby enabling neural networks to learn non-linear relationships.
Training neural models relies on various optimization methods aimed at adjusting network weights to minimize error. Common approaches include adaptive algorithms like Adam, Adadelta, and Adagrad, as well as Stochastic Gradient Descent (SGD). SGD is widely used due to its implementation simplicity and speed, especially during the initial training phases.
Despite its popularity, SGD has limitations. It can suffer from stagnation, particularly in the high-dimensional spaces generated by the increasing number of connections and weights in deep networks. This stagnation manifests as a slowdown in error rate reduction, leading to lower accuracy in classification tasks or higher error values in regression problems.
In response to these challenges, metaheuristic algorithms have demonstrated their effectiveness in solving complex optimization problems, whether discrete, binary, or continuous and high-dimensional. Prior research has already highlighted the advantage of metaheuristics over SGD-based approaches for training Deep Neural Networks (DNNs) [4].
In this vein, our work aims to present a rigorous comparative study on the training of a Convolutional Neural Network (CNN). We will explore the efficacy of five different metaheuristics for optimizing this type of network, thereby highlighting the superior potential of metaheuristics in the learning process.

Keywords: Convolutional Neural Network, Deep Learning, Metaheuristics.

*Speaker

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A new improved Bat Algorithm for traveling salesman problem

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The Bat Algorithm is an evolutionary computational method inspired by the echolocation behavior of microbats when searching for prey, and is used to perform global optimization. this algorithm was developed by Xin-She Yang in 2010. It has been widely applied to various optimization problems due to its simple structure, whether in continuous, discrete or binary search spaces, and several variants have been developed in recent years, particularly for combinatorial problems such as the traveling salesman problem (TSP).
In this study, we propose an improved version of this algorithm. This improvement also incorporates techniques from artificial intelligence (AI) to improve the diversification and intensification of the search process.
The proposed method has been validated on several standard TSP instances taken from the TSPLIB library.

Keywords: Bat algorithm, metaheuristics, raveling Salesman Problem

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Modeling and optimization of a flotation chain to improve product quality and equipment reliability

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Improving the quality and reliability of mining processes is essential for achieving industrial competitiveness. Effectively balancing conflicting objectives such as improving product quality, reducing impurities, and minimizing production interruptions while ensuring sustainable and optimized industrial performance remains challenging. In this paper, we propose an optimization model for a mining process. Our goal is to improve product quality, reduce downtime, and minimize impurities simultaneously. We use Lasso (least absolute shrinkage and selection operator) regression to model the relationships between operating parameters and performance criteria. Due to the multi-objective nature of the mathematical model, we apply the MGWO (Modified Grey Wolf Optimizer) algorithm to solve the optimization problem. To demonstrate the applicability and effectiveness of the mathematical model, a real-life case study was conducted. The computational results demonstrate the benefits of the proposed model.

Keywords: Multi, criteria optimization, Lasso regression, MGWO (Modified Grey Wolf Optimizer), Mining processes, Product quality.

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Extraction of Single-Diode Photovoltaic Model Parameters Using Monte Carlo Optimization and Real Experimental Data

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The precise modeling of the photovoltaic (PV) modules is necessary for performance forecasting, diagnostics, and the design of control systems. In this paper, we propose a Monte Carlo-based optimization method for estimating the parameters of a single-diode PV model using experimental current-voltage (I-V) data. The method takes advantage of stochastic sampling to explore large parameter spaces and determine the best parameters that provide the least error on assumed versus measured data. Among other parameters, the optimized values yielded the following results: photocurrent Iph was 0.77483 A, reverse saturation current I0 was estimated as 6.57 × 10 A, ideality factor n of 1.606, series resistance Rs of 0.084 Ohm while shunt resistance Rsh was 74.64 Ohm. the model generated yielded remarkable results in comparison to experimental data achieved maximum simulated power output of 0.2920 W at 0.414 V, a coefficient of determination R^2 was recorded as 0.9722 and low error values of RMSE = 0.0503 A and $MAE = 0.0376A$. Residual analysis validated the lack of systematic bias while parameter sampled histograms displayed stable convergence behavior. Researchers using traditional heuristic optimization strategies will notice that Monte Carlo methods are more straightforward and considerably more robust; these methods are advantageous for noisy datasets. The results confirm the applicability of the method.

Keywords: Photovoltaic Modeling, Monte Carlo Simulation, Single, Diode Model, Parameter Optimization, Maximum Power Point Tracking (MPPT), Experimental I, V Data.

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Rapid stabilization of parabolic coupled system

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This paper considers the problem of stabilizing a class of non-scalar coupled parabolic equations controlled by a single multiplicative control. We show that if the associated linear system is null controllable, then the solution of the considered system can be locally superexponentially stabilized towards specific trajectories, referred to as eigen-trajectories. To resolve the null controllability issue, we reformulate it as a moment problem and apply two separate sets of assumptions on the eigenvalues. Some applications are presented to illustrate the obtained results.

Keywords: Multiplicative controls, Stabilization, Null controllability, Coupled parabolic systems

*Speaker

SmartCrows: An Adaptive Metaheuristic for Structural Design Problems

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The Crow Search Algorithm is a metaheuristic inspired by the foraging behavior of crows in nature (1). It utilizes a population of virtual crows to represent candidate solutions. The algorithm mimics the hun ting behavior of crows, where individuals search for food by exploiting information from both local and global sources (1). In this paper, we provide an overview of this algorithm, and propose a new modified version (MoCSA). The study presents experimental results obtained by applying MoCSA to select test problems. We ana lyze the algorithm's performance in terms of solution quality and compare the results with those of the basic CSA and other metaheuristics (CSA (1), PSO (2), GA (3)). The applicability of our algorithm is demonstrated by applying it to structural optimization problems (Welded beam design problem, Gear train design, Tension compression spring problem) (4), and the findings shall be compared to methods of references ((1), (2), (3), etc). The results clearly illustrate the robustness of the proposed method.

Keywords: Meta, heuristic, Crow Search Algorithm, Constrained optimization

*Speaker

Secure and Compliant Identity Management Using Blockchain, Cryptography, and Machine Learning

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As digital infrastructures become increasingly decentralized and interconnected, protecting sensitive data and ensuring reliable user authentication have become key challenges. Centralized identity and data management systems often suffer from critical vulnerabilities, including single points of failure, limited transparency, and increased exposure to cyberattacks. This research aims to develop secure and efficient blockchain-based systems tailored to data protection and decentralized authentication. By leveraging blockchain's inherent properties-immutability, trans- parency, and distributed consensus-we propose a modular architecture that addresses key security and scalability challenges in modern digital ecosystems. The work focuses on two main aspects : (1) Data protection, through secure, verifiable, and distributed storage leveraging permissioned or hybrid blockchain networks ; and (2) Authentication, using decentralized identity frameworks (DIDs), attribute-based models, and advanced cryptographic techniques such as zero-knowledge proofs and selective disclosure. To ensure feasibility in resource-constrained environments such as IoT and edge computing, lightweight consensus mechanisms-like Proof of Authentication (PoAh)-are explored to minimize energy consumption and latency while preserving trust. The paper also examines the integration of blockchain with existing authentication standards like OpenID Connect and Verifiable Credentials, and discusses practical implementation using tools such as Solidity, Truffle Suite, and MetaMask on Ethereum-compatible platforms. This work contributes to the advancement of trustworthy digital systems that enhance data privacy, support secure identity verification, and overcome the limitations of centralized architectures

Keywords: Blockchain, Decentralized Identity, Data Protection, Authentication, Smart Contracts, Zero, Knowledge Proofs, Edge Computing .

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Global dynamics of an HBV infection model described by fractional partial differential equations

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In this work, we analyze the global stability of hepatitis B virus (HBV) infection model described by fractional partial differential equations (FPDEs). The model incorporates adaptive immune responses as well as spatial diffusion, through the use of the regional fractional Laplacian operator. Moreover, our model takes into account two modes of transmission : bacterium-to-cell and cell-to-cell, as well as two types of immune responses : lytic and non-lytic. We determine the equilibrium points and perform a stability analysis of these points using an innovative method for constructing a Lyapunov function adapted to FPDEs. Finally, our results are illustrated through numerical simulations.

Keywords: Global stability, Fractional Laplacien operator, Lyapunov function, HBV.

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Effect of Chemical Composition on the Dielectric and Piezoelectric Behavior of PIN–PMN–PT Crystals

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A variety of Pb(In1/2Nb1/2)O3–Pb(Mg1/3Nb2/3)O3–PbTiO3 ternary ferroelectric crystals with different compositions have been grown using the top-seeded solution growth method to systematically investigate this ternary system in single crystal form. The study examined compositional segregation and the dependence of electrical properties on composition for selected samples near the morphotropic phase boundary (MPB) region. All samples display a perovskite structure with rhombohedral symmetry at room temperature. The lattice parameter (a), Curie temperature (TC), and the rhombohedral–tetragonal phase transition temperature (T rh–te) gradually increase with rising PIN content. All samples exhibit high piezoelectric performance. Notably, the crystal with a composition of 0.48PIN-0.27PMN-0.25PT shows excellent electrical properties, such as TC = 180 ◦C, T rh–te = 130 ◦C, k33 = 90.9

Keywords: PIN–PMN–PT, ferroelectric crystals, morphotropic phase boundary, piezoelectric

*Speaker

Modeling the dynamics of sheep populations in response to price fluctuations using Hattaf fractional derivative

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IIn this study, we conduct a comprehensive analysis of the dynamics governing sheep populations under the influence of fluctuating market prices. To achieve this, we construct a mathematical model that incorporates the Hattaf fractional derivative, a tool particularly well-suited for capturing the hereditary and memory-dependent characteristics inherent in biological systems. The use of fractional calculus, and specifically the Hattaf fractional derivative, enables us to describe complex temporal behaviors that traditional integer-order models often fail to represent adequately. By adopting this advanced mathematical framework, we aim to deepen our understanding of the intricate interactions between economic variables-such as the variation of livestock prices and biological processes, including reproduction and mortality rates. The memory effect introduced by the fractional derivative reflects the realistic assumption that the current state of the population is influenced not only by present conditions but also by its historical trajectory. First, we establish the well-posedness of the proposed model by proving the existence and uniqueness of its solutions. We then examine all equilibrium points and derive the necessary conditions for their existence. Finally, we analyze the stability of these equilibria and explore the conditions under which they may become unstable.

Keywords: Dynamics price, equilibrium points, Hattaf Fractional derivative, stability analysis

*Speaker

On the Use of 3D Modeling, Reconstruction and Printing Techniques for the Development of an Anatomical Simulator of Lumbar Disc Herniation: A Case Study in Medical Education

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Abstract: A herniated disc is one of the most common and disabling spinal pathologies, characterized by the displacement of the nucleus pulposus of an intervertebral disc, compressing neighboring nerve structures. This condition, often painful and complex, requires a detailed understanding of spinal anatomy and mechanical interactions to be properly managed. However, teaching of this pathology often remains limited to theoretical supports, lacking realism and opportunities for practical manipulation.
It is in this context that our project is set, which aims to actively contribute to the improvement of medical training through the development of an anatomical simulator of a herniated disc that is within reach, realistic, accessible and directly usable.
Our study, conducted at the Abulcasis International University of Health Sciences, in its Medical Simulation Center, relies on cutting-edge reconstruction, modeling and 3D printing technologies to transform anatomical complexity into a tangible educational tool.
Thanks to advances in the fields of reconstruction, modeling, and 3D printing, we were able to design an accessible, realistic, and functional anatomical simulator. The modeling was carried out using real medical images of a patient, derived from DICOM data, which ensured optimal anatomical fidelity. This simulator, which conforms to the biomechanical characteristics of the spine, aims to facilitate the concrete visualization of a herniated disc, while strengthening the understanding of this complex pathology.
This simulator represents a concrete step forward in the field of biomedical training: it allows direct experimentation, encourages the anchoring of knowledge, and prepares students for a better clinical approach to spinal pathologies.
Keywords: Key words: Anatomical Simulator of a Herniated Disc, Spine, Intervertebral Discs, Nerve Roots, Spinal Cord, 3D Modeling, 3D Reconstruction, 3D Printing Technologies.

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Efficiency Analysis and optimization of a Buck Converter for Electric Vehicle Charging

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This paper presents an analysis of a buck converter design for electric vehicle (EV) charging applications, specifically addressing the challenge of minimizing output voltage and current ripple while achieving compact size for key components. The paper analyses the traditional buck converter design, highlights its limitations, and proposes two modifications of the converter scheme aiming to reduce the overall size without compromising efficiency. The paper also discusses the trade-offs between size, efficiency, and ripple performance for each approach, demonstrating the potential benefits of the proposed solutions for EV charging applications.

Keywords: Buck Converter, Electric Vehicle Charging, Ripple Reduction, Optimization, filter, Efficiency

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Mathematical analysis of a financial model through the generalized Hattaf fractional derivative

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In this work, we propose a mathematical analysis of a financial model involving the new generalized
Hattaf fractional derivative (GHF). First, we prove that our financial model is mathematically and financially well-posed. Additionally, we study the existence of equilibria. Furthermore, the stability analysis
of the financial model is carefully studied. Finally, numerical simulations are presented to illustrate our
theoretical results.

Keywords: Financial model, Hattaf fractional derivative, stability analysis

*Speaker

Life Cycle Assessment of Lithium-ion Batteries: A Critical Review

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Abstract: Lithium-ion batteries (LIBs) are central to the global energy transition, powering applications from portable electronics to electric vehicles and renewable energy storage. While their high energy density and long service life contribute to reducing greenhouse gas emissions, concerns remain regarding their full environmental impacts. Existing research has used Life Cycle Assessment (LCA) to evaluate these effects; however, significant variability in methodologies limits the comparability and reliability of results. This review aims to identify the main sources of methodological discrepancies and propose a standardized approach to strengthen future assessments.

A systematic literature review was conducted to evaluate current LCA practices applied to LIBs. The analysis focused on methodological aspects such as goal and scope definition, system boundaries, functional units, data quality, and impact categories.

Results indicate wide inconsistencies across studies, particularly in the treatment of raw material extraction, energy inputs, and end-of-life processes. Variations in assumptions and datasets significantly influence the reported environmental impacts, leading to conflicting conclusions about the sustainability of LIBs.

These findings highlight the urgent need for harmonized LCA guidelines specific to battery technologies. A standardized framework would enhance transparency, comparability, and decision-making.

In conclusion, developing consistent LCA methodologies is vital to accurately assess and improve the environmental sustainability of LIBs.

Keywords: Lithium, ion batteries, review, Life Cycle Assessment, sustainability.

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The Textile industry: Environmental impact Towards a circular economy

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Abstract: The textile industry has expanded rapidly over the past few decades, primarily driven by fast fashion and mass consumption patterns. This acceleration causes a substantial growth in textile waste generation, in consequence posing severe environmental problems. Despite previous studies having explored the environmental impact of textile production, there remains a necessity to consolidate knowledge particularly around waste management and recycling strategies in order to promote sustainability efforts.
This paper aims to provide a structured review of existing scientific research and statistical data to emphasize critical environmental impacts and emerging solutions. The methodology encompasses a targeted review of relevant literature and statistical reports, focusing on the environmental consequences of textile waste, as well as current recycling innovations. Results indicate that the textile industry is a major contributor to the depletion of natural resources, greenhouse gas emissions, water and soil pollution and also the accumulation of non-biodegradable waste. The production process's textile products is highly resource-intensive, requiring substantial amounts of energy, water and land. Improper disposal methods, such as incineration and landfilling, exacerbate global warming and environmental degradation, while recycling rates remain extremely low.These findings underscore the critical need to improve textile waste management. Circular economy models, innovative recycling technologies, and stronger regulatory mechanisms offer promising avenues to reduce the textile sector's environmental footprint.
Nevertheless, challenges such as technological immaturity, lack of investment, and disjointed coordination among stakeholders hinder large-scale adoption of sustainable solutions.The study, as a whole, indicates that improving recycling capabilities of the textile industry stands as a necessary priority, to offset textile's environmental effects, and stronger collaboration between scientists and industry is needed to trigger systemic change towards sustainable textile production and waste management.

Keywords: Textile industry, Environmental impact, solid waste, water pollution, climate change, air pollution, circular economy.

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