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March 26, 2026

Parallel Session A-0: Artificial Intelligence Applications I	
Room: CESAR	
Chair: Shaukat Ali, Research Professor, Oslo, Norway	
Paper ID	**Title & Authors**
10	**Designing for Stress: A Human-Centered VR Platform for Biofeedback-Driven Firefighter Training**
	Mehdi Mekni

Abstract :
This study explores the design and evaluation of SMART VR, a human-centred virtual reality platform that integrates real-time biofeedback to support stress management in firefighter training. Through iterative prototyping and user testing, we developed immersive scenarios that respond to biometric signals, enabling personalized stress modulation. Findings from usability studies and physiological data analysis reveal improved emotional regulation and user engagement. The paper contributes to HCI by demonstrating how adaptive VR systems can enhance resilience and decision-making in high-pressure professions.

11	**A Competency-Driven Immersive VR Training System for Forensic Fire Investigation**
	Mehdi Mekni

Abstract :
Forensic fire investigation demands rigorous adherence to protocols, precise evidence handling, and the ability to interpret complex burn patterns under pressure. Traditional training methods often struggle to balance realism, repeatability, and safety. This work introduces a competency-driven immersive virtual reality (VR) system designed to address these challenges by embedding measurable performance metrics directly into the training environment. The system integrates a taxonomy of investigative competencies—ranging from evidence integrity and protocol adherence to scene analysis and pedagogical outcomes—within a high-fidelity, interactive burn-room simulation. Learners engage in authentic investigative tasks while the platform continuously captures behavioural, procedural, and technical indicators of performance. These data streams enable both formative feedback and longitudinal assessment of skill development. By aligning training evaluation with established standards, the framework ensures that performance measures are not only immersive but also professionally relevant. Results from pilot deployments demonstrate the system's capacity to reduce procedural errors, enhance retention of investigative protocols, and provide instructors with actionable analytics. The proposed approach advances the state of forensic training by coupling immersive realism with competency-based assessment, offering a scalable model for preparing investigators to meet the demands of modern fire scene analysis

90	**Forecasting Daily Air Temperature Extremes Using Deep Learning Models: A Case Study from Aurès Region, Algeria**
	Ikrame Boubaker, Zakaria Laboudi and Rachid Seghir

Abstract:
Climate-sensitive industries like agriculture, public health, and energy management depend on precise short-term forecasting of daily maximum (Tmax) and minimum (Tmin) air temperatures. Four deep learning architectures—Long Short-Term Memory (LSTM), Gated Recurrent Unit (GRU), Convolutional LSTM (CNN-LSTM), and Convolutional GRU (CNN-GRU)—are examined in this study to see how different lookback window sizes affect their predictive abilities in the context of temperature forecasting. We trained and evaluated models with input sequences of 7, 14, 21, and 30 days using a four-year dataset (2021–2024) gathered from four weather stations in the Aurès region of Algeria. Finding the ideal model architecture and historical input length combination that produces the most accurate forecasts was our aim. The GRU model consistently performs better than the other architectures according to the results, especially when using a 21-day lookback for Tmax and a 30-day lookback for Tmin. It also achieves the highest correlation values and the lowest error metrics. Moreover, it was discovered that Tmin was more predictable than Tmax and that longer input windows generally enhanced model performance. These findings imply that GRU-based models provide a dependable and computationally effective solution for operational use in semi-arid and Mediterranean climates, underscoring the significance of choosing suitable lag periods and model structures for temperature forecasting.

Parallel Session A-1: Cybersecurity & Privacy	
Room: CALIGULA	
Chair: Farid Naït-Abdesselam, France	
Paper ID	**Title & Authors**
95	**Weak Polynomials in Shamir's Secret Sharing**
	Lemnouar Noui

Abstract:
Secret sharing plays a vital role in improving the security of sensitive data, the security of Shamir's secret sharing relies on the secret polynomial which is only known to the dealer and on the fact that polynomial coefficients are indistinguishable from random values.
This paper addresses the security of Shamir's secret sharing scheme, introducing an algorithm that can disclose a significant amount of information about the underlying secret polynomial f(x) = a_(k-1)x^(k-1) +…+ a_(1)x_(1)+ a_(0) and the shared secret a_(0) = S, indeed it can be proved that the Shamir's (k, n) threshold scheme over any prime field F_(p) can be translated to (k-1, n) threshold scheme when k-1 divides p-1. Hence in this case, k-1 unauthorized participants pooling their shares obtain a simple equation (pattern) in extreme coefficients a_(k-1), a_(0) which gives a partial information about the secret a_(0) = S and by using the Lagrange interpolation formula or by solving a linear system they recover completely the remaining coefficients a_(k-2),…, a_(1) , so the all polynomials of degree k-1 are not safe to use in secret sharing scheme. In order to address this vulnerability, the dealer must choose the parameters k and p such that p-1 is not a multiple of k-1 .

139	**Blockchain-Based Framework for Enterprise Organisations' Information Systems Management**
	Naser Abbas Hussein, Khadija Rammeh Houerbi and Hella Kaffel Ben Ayed

Abstract:
In this paper we have proposed a novel blockchain assisted approach to the secure operation of IS at the enterprise level. Legacy access control systems are effectively unverifiable, bad for centralization and black at transparency. Capitalizing on the model of blockchain, our framework offers the rolebased access control as well as support for both cryptographic authentication and tamper-evident transaction logger. We took over work and implemented a corporate organizational role model (Employee, Manager, Admin) with solidities language into one smart contract to support departments and fine grained data accesses on top of that. A 30-day simulation with over 27 users and 4 departments produced total of 1,391 transactions with unique access patterns as well as security outcomes. Experimental results indicate that this mechanism can be used to impose permission constraint and deny all 365 non-authorized access attempts (26.2% of transactions). Data & Analytics identified departmental access patterns after business activity to Finance (36%) and IT(31%) making the biggest transaction request. User roles in the user roles case, our model exposed arbitration processing time that was observed to be (36 -45] ms on average and took for the fixed size blockchain expansion. The article provides a real-world applicable roadmap of how these novel technologies can be leveraged by enterprises interested in utilizing the (distributed ledgers) technology for securing information systems that lead to better transparency, auditability, and tamperproof access control.

128 (Online)	**Adaptive On-Device Arabic Speech Recognition for Smart Wheelchair Control Using a Self-Tuning Meta-Learning Agent**
	Mnassri Aymen, Nasri Sihem, Mansouri Nouha and Cherif Adnane

Abstract:
Embedded speech recognition for assistive robotics remains challenging due to the combined effects of Arabic dialectal diversity, speaker variability, and acoustic instability in real-world environments. These challenges are further intensified by the limited computational resources of embedded hardware, which constrain the deployment of large-scale ASR models and make cloud-based solutions unsuitable for safety-critical mobility applications. Existing embedded approaches typically rely on static keyword-spotting architectures that lack personalization and fail to adapt to changing speakers or noise conditions. This paper presents an adaptive on-device Arabic speech recognition framework designed for real-time smart wheelchair control. The proposed system combines lightweight MFCC preprocessing with a compact Temporal Convolutional Network (TCN) encoder, while a Self-Tuning Meta-Learning Agent enables continual few-shot adaptation triggered by prediction uncertainty. The agent performs localized parameter updates directly on the embedded device, allowing the system to remain robust across speakers, dialects, and acoustic environments without cloud connectivity or full retraining. Experiments conducted on a custom dataset of ten Arabic wheelchair command utterances demonstrate a 17–24% improvement in recognition accuracy under noisy indoor conditions, while maintaining real-time responsiveness (less than 60 ms per inference). These results validate the effectiveness and practicality of continual, privacy-preserving, and resource-efficient adaptation for voice-controlled mobility assistance systems.

Parallel Session A-2: AI in Industry & Decision Systems	
Room: CASSIUS	
Chair: Pr Mouhamadou Thiam, University of Thiès, Senegal	
Paper ID	**Title & Authors**
144	**HodgeRank for Group Decision-Making: Evaluating Recommendation Stability with Incomplete Preference Data**
	Eskander Bejaoui, Mohamed Ould-Elhassen Aoueileyine, Ridha Bouallegue and Anis Yazidi

Abstract:
Group Decision-Making (GDM) and Recommender Systems provide collective recommendations from aggregated individual preferences, which may be available as incomplete pairwise comparison data. This paper investigates HodgeRank, an algebraic ranking algorithm based on Hodge decomposition theory, as a robust solution for group recommendation scenarios where preference data is incomplete and sparse. We conducted comprehensive experiments on two real-world user preference datasets, with 10 and 20 alternatives, and systematically evaluated recommendation stability across subset sizes from 10% to 100% of available comparisons. Through 100 trials per subset size, we demonstrate that HodgeRank achieves 87% top-5 recommendation overlap with only 10% of preference data (10-item dataset) and maintains near statistical equivalence to the Bradley-Terry model. Our evaluation against four baseline methods using 10 informative metrics reveals that 30-50% of user preferences suffice for stable group recommendations across both small (10-item) and larger (20-item) alternative sets, exhibiting favorable sub-linear scaling. These findings enable practical applications in cold-start scenarios and real-time consensus building with 50-70% reduced data collection overhead.

41	**Predictive Maintenance for Aeration in Wastewater Treatment: Practices and Opportunities**
	Edwin Gamboa, Mathias Giessler and Paul Engelke

Abstract:
Wastewater treatment plants, and particularly aeration, are one of the most energy-consuming processes worldwide, requiring optimization at different levels, such as control or maintenance. Predictive maintenance offers an opportunity to reduce costs and energy consumption via intelligent diagnosis, prognosis, and mitigation of failures. Although recent reviews have addressed predictive maintenance in wastewater treatment, it is not clear to what extent aeration systems have been explored. To address this gap, we present a review to identify common practices of predictive maintenance for aeration and opportunities for future research. Our results show that research in this field is still scarce and limited to failure diagnosis, simpler methods such as rule-based decision or regression, and water treatment-related process variables and supervisory control systems. Thus, tasks such as prognosis, mitigation, and methods like Deep Learning and Large Language Models, as well as common predictive maintenance techniques like vibration analysis, remain open for exploration. Addressing these gaps would allow taking advantage of established practices, while advancing towards more robust, predictive, and energy-efficient aeration systems.

143	**Optimal Resource Allocation for Disaggregated Data Centers under Uncertain Task Demands**
	Hanzhang Chen, Yuichi Ohsita and Hideyuki Shimonishi

Abstract:
Disaggregated data centers (DDCs) have emerged as a promising architecture to enhance resource utilization. However, in real-world environments, the resource demands of incoming tasks often exhibit significant uncertainty. Conventional resource allocation methods that assume deterministic resource requirements can reduce resource utilization efficiency and degrade performance.
This paper proposes a resource allocation method that accounts for uncertainty in resource demands. Specifically, we model uncertain resource requests using probability distributions and define resource constraints based on actual resource availability. The resulting stochastic optimization problem is then transformed into a linear programming problem using stochastic programming techniques.
We evaluate the proposed method by comparing it with conventional approaches that use fixed resource demands, using the task acceptance rate as the primary metric. The results demonstrate that the proposed method increases the number of successfully processed tasks and improves overall resource utilization under uncertain demand conditions. Furthermore, the results confirm an effective mechanism for addressing fluctuation: by allocating resources that may experience simultaneous utilization in the same task across multiple nodes, the proposed method effectively reduces the risk of resource shortages caused by fluctuating demands.

15 (Online)	**Mapping models and factors used for estimating agricultural yields: review of existing approaches**
	Mass Gning, Demba Faye, Doudou Dione and Idy Diop

Abstract:
In a context marked by increasing food demand and greater variability in climatic conditions, the estimation of agricultural yields constitutes a strategic challenge, particularly for developing countries. Several approaches have been proposed in the literature, utilizing climatic, soil, and agronomic data, as well as tools ranging from empirical models to the Internet of Things (IoT) and artificial intelligence (AI). However, these studies remain scattered and applied to different crops and very diverse contexts, making it difficult to identify the models best suited for operational use.In this article, we review the main technological solutions used and the agro-climatic factors considered in the estimation of agricultural yields. The review is structured around three axes: (i) the methodological approaches used for yield estimation, (ii) the main agro-climatic variables employed, and (iii) the associated technologies and tools (remote sensing, IoT, AI). The objective is to provide a clear and

structured foundation that will serve as a reference framework for future application to specific crops such as onions and in the agricultural contexts of developing countries.

Parallel Session A-3: Wireless & Antenna Systems I

Room: CORNLIA

Chair:Rachid Seghir, University of BATNA2, Algeria

Paper ID	Title & Authors
120	**Compact High-Gain T-Shaped Antenna Integrated with Artificial Magnetic Conductor for 5.8 GHz WBAN Applications**
	Fatimetou Sy, Mahdi Abdelkarim, Rachida Badira and Ali Gharsallah

Abstract:
This study presents the numerical modeling and parametric investigation of a compact T-shaped antenna combined with an Artificial Magnetic Conductor (AMC) structure for Wireless Body Area Network (WBAN) applications operating in the 5.8 GHz ISM band. The overall antenna design features a reduced footprint of 25 × 20 mm². The geometry of the T-shaped radiating element is carefully optimized to ensure enhanced impedance matching over a wide bandwidth, while maintaining stable and consistent radiation performance throughout the targeted frequency range. A comprehensive parametric study is conducted to evaluate the influence of AMC array dimensions on antenna performance, comparing 2 × 2, 3 × 3, and 4 × 4 unit-cell configurations. The results demonstrate that expanding the AMC array size contributes to a noticeable enhancement in the antenna gain due to improved suppression of backward radiation. and front-to-back ratio (FBR), albeit with a corresponding increase in overall form factor. Among the configurations analyzed, the 3 × 3 AMC array offers the optimal trade-off between structural compactness and electromagnetic performance, achieving a peak gain of 8.14 dBi and an FBR of 18 dB while maintaining pattern stability. The incorporation of the AMC layer yields significant performance improvements, increasing gain from 2.38 dBi to 8.14 dBi and effectively suppressing backward radiation, while preserving quasi omni directional radiation characteristics. Simulation results validate that the proposed AMC-integrated Tshaped antenna delivers enhanced gain, sufficient bandwidth, and stable radiation properties, positioning it as a compelling candidate for WBAN applications.

38	**Advanced Design of UWB MIMO Antennas with Integrated Band Rejection for Space Communication**
	Wyssem Fathallah, Chafai Abdelhamid, Hedi Sakli and Taoufik Aguili

Abstract:
This paper introduces an innovative design for an ultra-wideband (UWB) multiple-input multiple-output (MIMO) antenna with inherent band-rejection capabilities, specifically engineered for the demanding environment of space communications. The design process begins with a basic circular patch antenna using a partial ground plane, which is then optimized to achieve enhanced impedance matching and bandwidth characteristics. To address the critical issue of interference from other wireless systems, complementary split-ring resonators (CSRRs) are incorporated as band-rejection elements, providing effective signal filtering within the 3.6-4.1 GHz and 5-6.2 GHz bands while preserving the overall UWB performance. This antenna design is a promising solution for advanced space-based UWB systems, offering band rejection and low interference susceptibility.

61	**Design and Simulation of a Three-Stack Cylindrical Dielectric Resonator patch Antenna Array at 79 GHz for Automotive Radar**
	Oussama Dallali and Tawfik Aguili

Abstract:
This paper presents the design, analysis, and simulation of a 32×2 millimeter-wave antenna array operating in the W-band with a 420 MHz bandwidth. The array employs three-stack cylindrical dielectric resonator antenna (DRA) elements to enhance radiation efficiency and minimize losses typically observed in patch-based structures at 77–82 GHz. Good impedance matching is achieved, with a reflection coefficient better than −10 dB and an inter-element coupling coefficient below −11 dB across the 79.6–80.6 GHz operating band. The array delivers a realized gain exceeding 21 dB and exhibits a narrow 2.26° half-power beamwidth (HPBW) in the H-plane. By combining DRA technology with the 32×2 array configuration, the proposed antenna offers improved bandwidth, high directivity, and reduced dielectric and conductor losses compared to conventional patch arrays. This design is well suited for high-capacity for automotive radar sensing applications.

Parallel Session A-4: Robotics & Embedded Systems

Room: COLISEE

Chair: Djeffal ElAmir, University of BATNA2, Algeria

Paper ID	Title & Authors
80	**Robot-Assisted Student Practical Task Evaluation**
	Fuad Budagov, Mohammad Tariq Meeran, Tarmo Robal and Ali Atakan Basaran

Abstract:
As higher education faces growing challenges of limited teaching staff and increasing class sizes, the need for scalable and individualized learning support is becoming more urgent. Emerging technologies such as semi-autonomous robots offer a potential solution by assisting educators in practical, resource-intensive environments. This paper presents a pilot study

investigating the use of a robot teaching assistant integrated with the Interactive Mobile Teaching Assistant system to autonomously evaluate student performance and assess knowledge during practical sessions in higher education. The system's effectiveness and usability were analyzed using system performance data with student feedback collected through surveys. Findings indicate that the robot teaching assistant operated reliably in real classroom conditions and was perceived positively by students, though certain limitations related to speech recognition and interaction flow were identified. Overall, the study demonstrates the potential of semi-autonomous robots to assist human instructors by automating structured evaluation tasks, providing immediate feedback, and enhancing engagement in practical learning environments.

155	**Real-Time IMU Fusion for Quadcopter Attitude Estimation: Quaternion EKF Implementation on an STM32 Microcontroller**
	Rania Lejmi, Faten Ben Abdallah and Joseph Haggege

Abstract:
Accurate real-time orientation estimation is critical for autonomous systems, particularly quadcopter drones requiring precise attitude control. This paper presents a quaternion-based Extended Kalman Filter (EKF) implementation for 3D orientation estimation using an Inertial Measurement Unit (IMU) on an STM32L4S5 microcontroller. The system fuses data from a triaxial accelerometer, gyroscope, and magnetometer at 500 Hz sampling rate, avoiding gimbal lock limitations inherent in Euler angle representations. A comprehensive sensor calibration procedure is developed to minimize systematic errors. Experimental results demonstrate root mean square errors of 1.2 degrees for pitch and 1.5 degrees for roll, with average computational latency of 650 microseconds per iteration. A Qt-based 3D visualization interface provides real-time monitoring of estimated orientation.
The complete system occupies 48.7 KB of Flash memory and 12.3 KB of RAM, making it suitable for resource-constrained embedded platforms

189	**Practical Optimization of Microservice CI/CD Pipelines Using Commit-Type Filtering**
	Maryem Mechraoui, Thouraya Louati and Heithem Abbes

Abstract:
Continuous Integration and Continuous Deployment (CI/CD) pipelines in microservice environments are often statically configured, executing identical validation stages for every commit regardless of change scope. This uniform strategy ensures reliability but can introduce unnecessary execution overhead for low-impact modifications such as documentation or configuration updates.
This paper proposes a lightweight commit-type filtering mechanism that analyzes repository diffs and dynamically activates only the validation stages relevant to the detected change category. A Jenkins-based prototype was evaluated across representative commit scenarios. Results show reduced execution time and memory consumption compared to a static pipeline, while maintaining full validation for source code changes. The approach is deterministic, requires no training data, and can be integrated into existing DevOps workflows with minimal modification.

Parallel Session B-0: Artificial Intelligence and Medical application I

Room: COLISEE

Chair: Ramzi Mahmoudi, University of Monastir

Paper ID	Title & Authors
56	**Hybrid Spatio-Temporal Neural Models for Malaria Prediction and Epidemic Detection in West Africa**
	Aby Diallo, Ndeye Fatou Ngom, Michel Seck, Amadou Ibra Diallo, Mouhamad Zaidou and Abdoulaye Guisse

Abstract:
This paper presents an artificial intelligence based approach for malaria prediction and detection in Senegal and Mali. Several models were compared, including Random Forest, XGBoost, MLP, LSTM, GRU, and Transformer. The results show a clear superiority of neural networks over traditional machine learning models. In Mali, the MLP, GRU, and LSTM models achieved RMSEs of 1.14, 1.17, and 2.43, respectively, compared to 7.20 for Random Forest and 8.58 for XGBoost. Similarly, in Senegal, the highest performances are obtained with LSTM and MLP, with an RMSE of 0.74 and 0.83, respectively, and an SMAPE of less than 4.5%, compared to 7.77–9.63 for conventional models. Although Transformer performs well (RMSE of 3.55 in Mali and 4.52 in Senegal), it shows greater variability between regions. The Serfling method proves to be more reliable than Shewhart for detecting epidemics. These results highlight the potential of sequential neural approaches, such as LSTM and GRU, which offer excellent malaria prediction capabilities thanks to their ability to capture temporal and seasonal variations in cases, to strengthen epidemiological surveillance in West Africa.

191	**Improved Detection of Viral and Bacterial Pneumonia using Ensemble Transfer Learning on Pediatric Chest Radiographs**
	Amira Ouerhani and Halima Mahjoubi

Abstract:
Pneumonia remains one of the world's leading causes of death, accounting for almost 740,180 pediatric deaths in 2019. High mortality rates are especially observed in underdeveloped countries and rural areas, due to the unavailability of healthcare specialists and prolonged waiting times for diagnosis.
This study presents a robust framework for early and accurate detection of childhood pneumonia using chest X-rays, classifying images into three categories: normal, bacterial, and viral pneumonia. We evaluated nine state-of-the-art convolutional neural

networks (CNNs) individually and identified the three best-performing models for feature-level fusion. Mutual Information was applied to select the most discriminative features, which were then combined and classified using XGBoost. Experiments on augmented dataset demonstrated that the proposed feature-level fusion approach outperforms standalone CNNs, achieving higher accuracy, precision, recall, and F1-scores while reducing false positives and false negatives. These results highlight the effectiveness of integrating feature selection, transfer learning, and boosting-based classification to deliver a reliable and efficient tool for pediatric pneumonia screening, with strong potential for deployment in resource-limited clinical environments

187	**Optimizing Segmentation Frameworks for Organs at Risk**
	Elloumi Nabila and Seddik Hasssene

Abstract:
In radiotherapy, precise delineation of organs at risk (OARs) is vital. A millimetre error can distort the dose to healthy tissue and cause serious toxicity. This work proposes a hybrid GAN-UNet algorithm optimised for use by radiotherapists as a means of automatically delineating the heart and its substructures.
Develop an algorithmic model for automatic delineation of the heart and its substructures during radiotherapy for breast cancer and evaluate the effectiveness of the approach compared to conventional methods.

Parallel Session B-1: Artificial Intelligence and Medical application II	
Room: CALIGULA	
Chair: Narjess Ben Ameur, ISMT	
Paper ID	**Title & Authors**
104	**Deep Learning-Based Detection and Segmentation of Fetal Heart Components in Prenatal Echocardiograms**
	Malek Ben Yaala, Rim Zarrouk and Ramzi Mahmoudi

Abstract:
Monitoring the fetal heart during gestation is crucial for the early detection of cardiac abnormalities. However, manual screening can present several challenges due to the poor quality of echocardiographic images, which exhibit high levels of darkness, as well as variations in fetal position and inter-operator variability. This study proposes an automated method, based on deep learning techniques, that aims at assisting clinicians during fetal diagnosing. We utilize the Mask Region-based Convolutional Neural Network (Mask R-CNN) architecture with ResNet101 as backbone to detect, classify, and segment multiple structures of the fetal heart including the left atrium, left ventricle, right atrium, right ventricle, and aorta in prenatal echocardiograms. The results show that the model has a strong ability to identify and segment these anatomical structures with a mean average precision (mAP) of 86.60\% for object detection and 88.25\% for mask generation, a mean intersection over union (mIoU) of 67.88\%, a mean Dice coefficient of 76.54\%, a mean recall of 75.80\%, a mean precision of 79.18\%, and a mean area under the ROC curve (AUC) of 87.71\%. Our model outperformed several existing methods, which indicates that it has the ability to serve as a computer-aided tool for clinicians during prenatal screening.

99	**Bridging General Genomics and Oncology: A Survey of Classical Bioinformatics Tools and a Path Toward Multi-Agent Architectures**
	Zayneb Mannai, Nizar Omheni and Ramzi Mahmoudi

Abstract:
Next-Generation-Sequencing (NGS) is a powerful method used in medicine to simultaneously sequence millions of DNA or RNA fragments. It is closely linked to precision medicine, as it enables the adaptation of diagnosis and treatment to each patient according to their genetic profile. Its implementation follows a well-defined standard pipeline comprising ten steps, from quality control to clinical interpretation of the results. In the literature, numerous bioinformatics tools for genomic analysis have been developed; however, there is still no clear and unified overview of these tools. The objective of this work is to analyze these tools to identify their shortcomings and propose potential solutions. The adopted methodology consists of studying 31 tools developed between 2009 and 2025, comparing them according to the steps of the genomic analysis pipeline, their types, and their application domains. We then identified major research gaps, mainly fragmentation, as no existing system performs the entire genomic analysis pipeline end-to-end. Finally, we propose our positioning, which consists of reusing the studied tools through cognitive agents embedded within a multi-agent architecture.

110	**AI Driven Methods for Early Detection of Congenital Heart Disease**
	Amira Fayouka, Narjes Benameur, Ramzi Mahmoudi and Moncef Tagina

Abstract:
Analyzing medical images is very difficult and complicated due to the variety, complexity, and noise of the data (X-rays, CT scans, MRIs, and ultrasounds), making it hard to interpret the images themselves. However, deep learning models perform far better than traditional approaches when analyzing this data because they automatically extract multi-level, descriptive features from complex anatomical structures. This reference provides an extensive review of deep learning models based on fetal echocardiogram and other imaging modalities for the automatic identification and classification of congenital heart disease (CHD). The most effective way to develop and use Hybrid and Multi-Task Model Frameworks has been confirmed by over 20 research studies carried out from 2020 to 2025. For example, the findings of the study indicate that many existing Hybrid and Multi-Task Model Frameworks used in medical imaging, including CNNs, U-Nets, Mask-RCNN's, YOLO's and GAN's, have proven highly successful. The Hybrid Model Framework developed by Magesh et al. [1] has been

demonstrated to be a superior approach to classification of normal versus pathological states with accuracy rates of 0.984 for normal hearts 0.972 for congenital heart disease (CHD) by integrating the RegNet unit into a standard convolutional neural network architecture. However, difficulties remain in creating diverse datasets, validating findings externally, interpreting results, and ensuring replicability.

Parallel Session B-2: Artificial Intelligence and Medical application III	
Room: CASSIUS	
Chair: Rami Djeffal, University of Batna 2, Algeria	
Paper ID	**Title & Authors**
147	**Automatic Assessment of Myocardial biomechanical Properties from Cardiac MRI via Deep Learning**
	Rania Awadi, Narjes Benameur, Mohamed Deriche and Salam Labidi

Abstract:
Accurate assessment of left ventricular (LV) mechanics is crucial for understanding cardiac function and detecting early myocardial dysfunction. In this study, we developed a comprehensive framework integrating patient-specific finite element modeling and deep learning to estimate myocardial material parameters from CMR. LV geometries were reconstructed from CMR imaging, and global strain metrics were extracted using cardiac magnetic resonance feature tracking (CMR-FT). A deep learning model was trained to predict key myocardial parameters while enforcing biomechanical plausibility through the end-diastolic pressure-volume relationship (EDPVR). Our results demonstrated that the proposed model accurately estimated myocardial parameters, with performance. Furthermore, strain analysis confirmed the sensitivity of CMR-FT in detecting subtle regional myocardial abnormalities, highlighting its potential for early diagnosis of cardiac diseases. This work illustrates that combining MRI-derived geometry, functional strain metrics, and deep learning provides a rapid, reliable, and patient-specific assessment of myocardial mechanics.

126	**Enhanced SAMed: A Lightweight and Efficient Model for Medical Image Segmentation**
	Kater Nada Ayari and Asma Ben Letaifa

Abstract:
The Segment Anything Model (SAM) has emerged as a powerful foundation model, yet its direct application to specialized domains like medical image segmentation remains limited by a lack of anatomical context and high computational overhead during customization. While models like SAMed address parameter efficiency by employing the standard Low-Rank Adaptation (LoRA) technique on the Vision Transformer (ViT) encoder, this uniform approach fails to leverage the ViT's inherent hierarchical structure. We hypothesize that a fixed-rank LoRA is suboptimal for adapting features across different layer depths as implemented in SAMed, where shallow layers extract generic low-level information and deep layers encode complex, domain-specific semantics.To overcome this limitation, we introduce H-LoRA (Hierarchical Low-Rank Adaptation), a novel, structurally informed Parameter-Efficient Fine-Tuning (PEFT) strategy. H-LoRA adapts the SAM encoder by dynamically adjusting the LoRA rank based on the layer depth: applying a lower rank r_low to the adaptation modules in the superficial layers and a higher rank r_high to the modules in the deep layers. This hierarchical rank allocation strategically maximizes the adaptation capacity where complex, semantic feature adjustment is most critical.

153	**Interpretable Vision Transformer for MRI-Based Glioma Grading**
	Hana Charaabi, Ridha El Hamdi, Mohamed Njah, Fatma Kolsi and Mohamed Zaher Boudawara

Abstract:
Accurate and interpretable classification of brain tumors is essential for improving neuro-oncological diagnosis and treatment planning. Vision Transformers (ViTs) have recently emerged as powerful alternatives to convolutional neural networks (CNNs), thanks to their ability to model long-range dependencies via self-attention. However, their black-box nature raises critical concerns for clinical adoption. In this work, we propose an interpretable ViT-based framework for MRI glioma grading (high-grade vs.\ low-grade), augmented with a multi-perspective explainable AI (XAI) pipeline. A 2D ViT classifier is trained on FLAIR slices derived from the BraTS 2019 benchmark with patient-wise five-fold cross-validation. On a class-balanced slice dataset, the proposed ViT model reaches a mean testing accuracy of 96.2%, with 96.9% precision, 96.1% recall, and 96.5% F1-score. To bridge the interpretability gap, we adapt Grad-CAM to the ViT attention tokens, and complement it with LIME and SHAP applied at the patch/superpixel level. Explanation quality is quantitatively assessed using Dice, IoU, Pointing Game accuracy, and insertion/deletion AUC against ground-truth tumor masks. Grad-CAM achieves the best spatial overlap (Dice = 0.62, IoU = 0.47), while LIME and SHAP provide more distributed attributions. Expert neuroradiologist review confirms that the generated maps focus on clinically relevant tumor regions. The proposed ViT + XAI framework demonstrates that transformer-based models can be made both competitive and interpretable for MRI-based brain tumor grading, supporting clinician-in-the-loop decision making.

Parallel Session B-3 (Online) - Artificial Intelligence and Medical application IV	
Room: CORNLIA	
Chair: Lahcen Guezouli, University of BATNA2, Algeria	
Paper ID	**Title & Authors**
42	**Bridging Attack Detection and Clinical Trust: A Trustworthy AI Framework for Medical IoT**
	Bejaoui Chaima and Haifa Touati

Abstract:
The deployment of Artificial Intelligence (AI) in Internet of Medical Things (IoMT) systems still faces critical trust barriers, especially regarding explainability and fairness. Classical fairness assessment techniques require demographic information, which is unavailable in typical network traffic datasets due to privacy constraints and regulatory limitations. To overcome this challenge, we propose a Trustworthy AI framework that enhances attack detection by integrating SHAP-based explainability and behavioral equity, a new fairness paradigm relying solely on behavioral proxy features derived from network traffic. Our method performs traffic aware clustering to identify heterogeneous usage patterns such as communication intensity and protocol interaction serving as fairness evaluation groups without any demographic attributes. Experiments on the CICIoMT2024 dataset confirm that the framework achieves consistent detection performance across behavioral clusters while preserving strong interpretability and stable decision logic.
This work demonstrates that trustworthy AI requirements can be satisfied in healthcare IoT environments even when sensitive patient information is inaccessible, paving the way toward clinically deployable and regulation aligned security intelligence

169	**Intelligent and Real-Time Vertebral Anomaly Detection for Smart Medical Chairs**
	Sawsan Selmi, Ali Hamdi and Hedi Sakli

Abstract:
Low back pain and spinal disorders are common conditions that greatly impact quality of life worldwide. These problems often result from vertebral abnormalities like abnormal curvature, deformities, or misalignments, which frequently remain undetected until symptoms worsen. Early and accurate detection is vital for effective treatment and preventing further damage. This study presents a deep learning framework that automatically segments lumbar vertebrae from MRI scans, identifies key anatomical landmarks, and measures vertebral dimensions. Using a Mask R-CNN model with over 15 convolutional layers and 10 filters, it achieved a median Dice coefficient of 0.95 on 200 subjects. Vertebral height measurements had median errors under 0.9 mm, enabling reliable detection of deformities such as wedge and biconcave shapes with less than 5% error. Designed for integration into a smart medical chair, this system allows continuous, non-invasive spinal monitoring by analyzing posture and imaging data in real time. It facilitates early detection and tracking of vertebral anomalies without repeated radiological exams, aiding clinicians in timely decision-making and personalized care. With classification accuracy above 97%, this solution promises to improve diagnostics, patient outcomes, and long-term musculoskeletal health management.

170	**AI-Powered Spinal Fracture Detection in Pediatric Patients Challenges and Solutions**
	Ali Hamdi, Sawsan Selmi and Hedi Sakli

Abstract:
Detecting spinal fractures in pediatric patients is particularly challenging due to the unique characteristics of their growing spines, such as lower bone density and more complex anatomy compared to adults. In this article, we explore the specific difficulties involved in identifying fractures in children, where traditional imaging methods might not be as effective. We also discuss how artificial intelligence (AI) can enhance fracture detection by using MRI datasets tailored for pediatric patients and applying advanced deep learning techniques. The article further addresses key challenges, such as small sample sizes and the need for diverse datasets, which can impact AI model performance. Finally, we highlight how AI-powered systems can improve clinical outcomes by providing more accurate and timely diagnoses, ultimately leading to better long-term health outcomes for pediatric patients.

121	**MedProtection: A Dual-Layer Watermarking Framework for Mobile Medical Image Security**
	Wahiba Touati, Nour El Houda Golea and Salim Kalla

Abstract:
This paper presents MedProtection, a novel dual-layer watermarking framework for medical image security on mobile devices.The system addresses two critical requirements in Mobile Health: patient data confidentiality and diagnostic ROI integrity. Our approach partitions medical images into Region of Interest (ROI) and Region of Non Interest (RONI), employing LSB watermarking in RONI borders for patient data embedding and Hamming error-correction codes for ROI integrity verification. Experimental evaluation on a medical image dataset demonstrated high imperceptibility (average PSNR of 47.92dB) and robust tamper detection (>95%for common attacks). A functional Android application validates real-world deployment feasibility. The framework achieves a balance between security, diagnostic preservation, and computational efficiency suitable for resource-constrained mobile environments.

106 (Online)	**Preserving the Integrity of the Holy Quran Using Digital Watermarking and Turbo Codes**
	Nour El Houda Golea, Ikram Boubechal, Wahiba Touati and Raid Abderrahim Smail

Abstract:
This paper introduces a novel watermarking approach for protecting digital versions of the Holy Quran. The proposed scheme integrates Slant Transform, Singular Value Decomposition (SVD), and Turbo Codes to embed hidden authentication marks that are both visually and statistically imperceptible. The Slant Transform provides efficient energy compaction for robust watermark embedding, while Turbo Codes ensure error resilience against various distortions. Experimental results demonstrate

superior imperceptibility with PSNR values exceeding 40 dB and robustness against common attacks, including JPEG compression, additive noise, filtering, and geometric transformations. A functional Android application validates practical deployment for safeguarding sacred digital texts

March 27, 2026

Parallel Session C-0: Artificial Intelligence Applications II

Room: COLISEE

Chair: Hella Ben Ayed, University of Tunis el Manar, Tunisia

Paper ID	Title & Authors
62	**Reinforcement Learning and Agent Based Modeling for Socio-Ecological Systems Management : A Systematic Review**
	Cheikhou Akhmed Kane, Samba Diaw, Mandicou Ba and Alassane Bah

Abstract:
The sustainable management of Socio-Ecological Systems (SES), such as agro-sylvo-pastoral systems (ASPS) in the Sahel, requires adaptive decision-making capable of balancing micro-level objectives (e.g., farmer production targets) with macro-level long-term goals (e.g., environmental sustainability). The coupling of Agent-Based Modeling (ABM) and Multi-Agent Reinforcement Learning (MARL) presents a promising paradigm for designing prescriptive control in these environments. Yet, "Full MARL" approaches face critical barriers to practical, human-centered, real-world applications, including computational cost, state-space explosion, and scalability challenges. This paper presents a systematic review, based on the PRISMA protocol, mapping the state-of-the-art of MARL applications in decentralized resource management during the Deep MARL era (2017–present). Our synthesis of the resulting 75-article corpus reveals a research gap defined by two key findings: (1) a limited number of contributions focused on non-urban SES applications (e.g., agriculture), and (2) a pronounced reliance on non-hierarchical architectures (84\% of articles), which may help explain this gap. Based on this analysis, we argue that Hierarchical Reinforcement Learning (HRL), which combines high-level strategic agents with lower-level agents for instantaneous execution, emerges as a fruitful architectural research direction. HRL offers a potential pathway toward achieving robust, scalable, and computationally tractable decentralized control in complex SES.

107	**Artificial Intelligence for Algorithm Discovery: A Three-Dimensional Framework**
	Cagatay Catal

Abstract:
Computer Scientists developed algorithm design paradigms such as divide-and-conquer, dynamic programming, greedy approach, backtracking, and branch-and-bound during the early growth of the field. These paradigms enabled the development of novel and complex algorithms for solving challenging problems. Today, research goes beyond these classical paradigms, and instead of designing algorithms manually, Artificial Intelligence (AI) methods such as Deep Reinforcement Learning and Large Language Models (LLM) are able to discover novel algorithms, including faster sorting and matrix multiplication algorithms. Although there is growing research in this direction, there is still a lack of a clear framework that explains how these research initiatives relate to each other and what exactly each of them contributes. In this paper, a three-dimensional framework is proposed that connects the problem domains, the discovery techniques, and the optimization objectives in AI-based algorithm discovery. To demonstrate the usefulness of this framework, a case study is included that classifies major AI-based algorithm discovery systems and clarifies their roles. Together with this proposed framework, the paper also provides a survey of the state of the art and supports new researchers by offering an overview of the current research and pointing to promising future directions in AI-based algorithm discovery.

43	**Markov chain modeling of BPSO with different transfer functions for optimal parameter tuning**
	Sameh Kessentini

Abstract:
Binary particle swarm optimization (BPSO) is a prominent machine learning metaheuristic used for combinatorial optimization, such as AI optimization tasks. This work provides critical guidelines for enhancing the reliability and performance of BPSO variants with diverse transfer functions (TFs). It extends our Markov chain model of S-shaped BPSO to analyze the dynamics and stability of Z, V, and U-shaped TFs. Theoretical analysis shows that V and U-shaped BPSO are less sensitive to acceleration coefficients, while Z-shaped BPSO (ZBPSO) requires low coefficient values for stable exploration. An empirical study of the ZBPSO algorithm confirmed these insights, particularly when applied to the challenging Weish multi-capacity knapsack problem. Optimal parameter tuning typically requires prioritizing low values for these coefficients, usually around 0.05 for Weish problems. Increasing these coefficients beyond a low threshold leads automatically to algorithmic instability and convergence failure.

Parallel Session C-1: IoT & Network Security

Room: CALIGULA	
Chair: Mariem Thaalbi, University of Tunis, Tunisia	
Paper ID	**Title & Authors**
177	**Quantum Machine Learning for IoT Security: A Comprehensive Survey**
	Imene Achouri, Youssouf Achouri, Rima Djellab and Chaker Essid

Abstract:
The proliferation of the Internet of Things (IoT) has enabled large-scale connectivity across diverse domains, yet this expansion has also amplified security vulnerabilities that challenge the reliability and trustworthiness of such systems. Conventional defenses are increasingly inadequate in addressing the dual pressures of large-scale heterogeneity and the disruptive potential of quantum computing on classical cryptography. Quantum Machine Learning (QML) has recently emerged as a promising paradigm that combines the strengths of machine learning with quantum computing to enhance resilience against both classical and quantum-enabled attacks. This survey provides an in-depth examination of IoT security requirements, prevalent attack vectors, and the limitations of current countermeasures. It further synthesizes state-of-the-art contributions where QML is applied to improve encryption, authentication, intrusion detection, anomaly analysis, and secure communication. By mapping existing research and identifying unresolved challenges, the survey offers a forward-looking perspective on the role of QML in establishing adaptive, scalable, and quantum-resilient IoT ecosystems.

87	**A User-Centric Dashboard Framework for Machine Learning Driven IoT Security**
	Bilel Arfaoui, Hichem Mrabet and Abderrazak Jemai

Abstract:
The swift expansion of IoT devices has created substantial issues in information security, requiring clear and practical insights for risk management. We propose a user-focused dashboard visualisation method that incorporates machine learning to improve decision-making in IoT security. The process commences with task analysis to ascertain users, workflows, and essential tasks, guaranteeing the dashboard corresponds with operational requirements. A prototype is created by integrating performance indicators based on management requirements, accessible data, and generalised metrics, together with interactive elements such as risk level evaluation, cyberattack likelihood, and mitigation techniques. Every element is crafted for clarity, using hover tips and comprehensive graphical representations upon interaction. The design emphasises straightforward navigation, consistent colour palettes, and effective information hierarchy, corroborated by consumer feedback. The innovation resides in the integration of machine learning-based risk prediction with an interactive visualisation framework, facilitating real-time situational awareness. Moreover, the dashboard's flexible architecture facilitates scalability across various IoT ecosystems. Experimental validation confirms its efficacy in enhancing comprehension and response times for security analysts. This work provides a pragmatic solution to the increasing need for adaptive security measures in IoT environments, connecting intricate data analytics with user-friendly interfaces. The findings underscore its capacity to enhance risk management procedures while preserving resilience against emerging threats.

82	**Securing Smart TVs in Smart Home Ecosystems Through Machine Learning Approaches**
	Bilel Arfaoui, Hichem Mrabet and Abderrazak Jemai

Abstract:
Smart TVs, now central to modern smart home ecosystems, introduce specific security weaknesses that may spread across connected devices, increasing risks to user privacy and overall network integrity. This study presents a systematic review conducted in line with PRISMA guidelines to examine Smart TV vulnerabilities and the machine learning techniques proposed to address them. Drawing evidence from six major academic databases, the review focuses on four analytical dimensions: threat vectors, algorithmic defence mechanisms, security architectures, and privacy considerations. The findings highlight recurrent attack scenarios, including firmware tampering and unauthorized data extraction, and assess how machine learning models detect abnormal traffic patterns and classify device-level threats. The review also examines architectural countermeasures such as intrusion detection systems and firmware integrity protections that position Smart TVs within broader smart home security strategies. Our assessment reveals persistent gaps in current approaches, particularly in relation to user consent practices and compliance with regulatory requirements, which emphasises the need for more adaptive and resilient security frameworks. Overall, the review demonstrates the significant potential of machine learning to mitigate Smart TV related risks and reinforces the importance of holistic, privacy-aware solutions for future smart home environments.

Parallel Session C-2: NLP & Ontologies	
Room: CASSIUS	
Chair: Fawzi Ben Messaoud, AI Program Director, Indiana University Indianapolis, USA	
Paper ID	**Title & Authors**
100	**Ontology population from online press articles on road accident using web scryping and NLP tools**
	Mouhamadou Gaye and Koumba Thiongane

Abstract:
Road accidents are a public health problem, especially for underdeveloped countries. The use of accident data is often limited due to the lack of a centralized system. To address this issue, we implemented a Semantic Web Platform to manage traffic accident data. It utilizes an ontology as a knowledge base to facilitate semantic inferences. In this article, we propose an approach for populating the accident ontology using online news articles. Our methodology employs web scraping to extract pertinent information from the text, which is subsequently utilized to populate the ontology by calculating this relevance using a similarity measure based on features.

141	**Ontology matching: Impact of candidates selection on ontology matching with LLMs**
	Mouhamadou Thiam, Abdoulaye Diallo, Mansour Diouf and Abdoulaye Djibril Kandji

Abstract:
In the domain of the semantic web, ontology alignment remains a crucial task, as it enables us to establish correspondences between concepts from different ontologies. It also enables better integration of domain knowledge. The proliferation of large language models (LLMs) has considerably improved the effectiveness of ontology alignment approaches, due to their high text comprehension capacity and better capture of semantic relationships. Alignment approaches based on LLMs improve traditional approaches in terms of accuracy in some simple and complex alignment tasks. However, the effectiveness of these LLM-based approaches is influenced by the selection of pairs to be aligned in the alignment process. In this paper we study the impact of candidate selection in the LLM-based ontology alignment process. We also study the different selection techniques used in different approaches and analyze different types of impact on the alignment results. Our experiments with different LLM-based alignment approaches show that candidate selection has impacts on metrics such as precision, recall, F1- score complexity and hallucination reduction in the alignment process.

59 (Online)	**Towards a predictive and explainable mapping of soil organic carbon stocks with TabPFN and SHAP: a case study from agro-sylvo-pastoral ecosystems in Senegal**
	Mame Diarra Diouf, Samba Diaw, Mandicou Ba, Etienne Delay, Alassane Bah and Dominique Masse

Abstract:
Soil organic carbon (SOC) plays an essential role in the mitigation of climate change, agricultural productivity, and environmental sustainability. This study aims to map the SOC stocks in three village territories within the Senegalese Groundnut Basin located in Niakhar. The Groundnut Basin, the main agricultural region in Senegal, is mainly composed of small family farms and faces declining organic inputs and critically low levels of SOC stocks. In this study, we apply a novel approach that leverages contextual learning through the TabPFN network, a foundation model specifically designed for tabular data. The performance of this model is compared to traditional ML algorithms (Random Forest and XGBoost) in the prediction of SOC stocks using a combination of environmental covariates and in situ SOC measurements. Furthermore, the interpretability of the model is assessed using Explainable AI (XAI) techniques based on SHAP values, which allow one to interpret the influence of each covariate on the variability of the predicted SOC stocks. This study used 1813 georeferenced ground samples collected in three terroirs, together with environmental covariates including topographic, climatic, and remote sensing variables to predict SOC stocks in the 0-30 cm soil layer. Our findings reveal that environmental covariates alone explain 52% of the variability in the SOC stocks using the TabPFN model, outperforming XGBoost (47%) and Random Forest (46%). To improve predictive accuracy, we compared the performance of these models using another dataset in which environmental covariates were supplemented with soil carbon content. The models achieved significantly higher predictive performance (R^2 = 0.95, 0.96, 0.80) compared to those trained with environmental covariates alone (R^2 = 0.52, 0.47, 0.46), suggesting that environmental variables alone do not fully capture the variability influencing the spatial distribution of SOC stocks. The SHAP analysis identified sentinel-2, gross primary productivity (GPP), precipitation, and elevation as the most important predictors. This study highlights the potential of the TabPFN network for SOC stock mapping and the use of SHAP values to improve the interpretability of the model, allowing the identification of the most influential environmental covariates and their effects on the variability of SOC stocks.

Parallel Session C-3: Computer Vision & Imaging

Room: CORNLIA

Chair : Ramzi Mahmoudi, University of Monastir

Paper ID	Title & Authors
156	**Comparative study on Image Indexing Techniques for Information Retrieval Systems: Classical and Intelligent Approaches**
	Sonia Benbelgacem, Mohamed Benbelgacem, Larbi Guezouli and Rachid Seghir

Abstract:
The exponential growth of visual data in domains such as medical imaging, video surveillance, e-commerce, and social media has intensified the need for efficient and accurate image retrieval systems. Content-Based Image Retrieval (CBIR) systems rely fundamentally on image indexing, which determines how visual content is represented for similarity search. This paper presents a unified and systematic comparative study of classical handcrafted descriptors and modern intelligent image indexing approaches, including deep learning and transformer-based models. Classical methods such as color histograms, Local Binary Patterns (LBP), SIFT, SURF, and ORB are compared with deep representations extracted using Convolutional Neural Networks (CNNs), autoencoders, and Vision Transformers (ViT). Experiments are conducted on CIFAR-10 and Caltech-101

datasets under a standardized evaluation protocol using Precision@10, Recall@10, F1@10, MAP, and nDCG@10 metrics. In addition to retrieval effectiveness, computational cost and feature dimensionality are analyzed to reflect realistic deployment constraints. The results demonstrate a clear superiority of deep learning approaches, with Vision Transformers achieving the best overall retrieval performance, while CNNs provide a favorable trade-off between effectiveness and efficiency. Nevertheless, classical descriptors remain competitive in resource-constrained scenarios. Finally, future research directions, including hybrid, self-supervised, and multimodal indexing strategies, are discussed.

125	**Robust Hyperspectral Identification of Food Adulteration via a Hybrid MSE–SAM Autoencoder**
	Safa Khaloui, Leila Ben Othman, Akram Hakiri and Heithem Abbes

Abstract:
Food adulteration poses a significant risk to consumer health and undermines food industry integrity. Detecting subtle adulteration in complex food remains a challenging task, particularly when relying on high-dimensional hyperspectral data. In this work, we propose a novel autoencoder-based framework for hyperspectral food adulteration detection, employing a hybrid Mean Squared Error–Spectral Angle Mapper (MSE–SAM) loss to simultaneously capture deviations in spectral intensity and distortions in spectral shape. The autoencoder is trained exclusively on pure samples, enabling the detection of adulterated samples through reconstruction errors exceeding a statistically derived threshold. We evaluate the proposed approach on four diverse hyperspectral datasets, including honey, groundnut oil, milk, and coconut milk, and demonstrate that the hybrid loss consistently outperforms standalone MSE and SAM losses in terms of accuracy, precision, recall, and F1-score. Extensive hyperparameter optimization ensures optimal performance for each dataset, highlighting the robustness and generalizability of the method. Our results demonstrate that the hybrid MSE-SAM framework provides a sensitive, reliable, and scalable solution for automated food adulteration detection, with potential applications across a wide range of food products.

115	**Trustworthy LLM-based Recommenders: Uncertainty, Conformal Prediction, and Hallucination Mitigation**
	Saloua Zammali

Abstract:
Large Language Models (LLMs) are increasingly integrated into recommender systems due to their strong reasoning, semantic understanding, and ability to generalize from limited contextual information. However, LLM-based recommenders remain vulnerable to fundamental reliability issues, including hallucinations, overconfidence, poor calibration, and lack of safety guarantees. These limitations challenge their deployment in real-world recommendation scenarios, where reliability and robustness are essential. This paper presents a stateof-the-art survey of techniques enabling trustworthy LLM-based recommendation, focusing on uncertainty estimation, conformal prediction, and hallucination mitigation. We summarize emerging methodologies, analyze their strengths and weaknesses, and identify open challenges and research opportunities toward building safe, calibrated, and reliable LLM-driven recommender systems.

Parallel Session C-4: Communication & Smart Systems

Room: CESAR

Chair : Hamza Drid, Algeria

Paper ID	Title & Authors
109	**Data Caching Strategies for the Internet of Vehicles: A Comprehensive Review and Future Directions.**
	Assem Rezki, Lyamine Guezouli and Abderrezak Benyahia

Abstract:
The Internet of Vehicles (IoV) has emerged as a key paradigm for intelligent transportation systems, enabling vehicles to exchange massive volumes of data in real time. However, the dynamic nature of vehicular environments, coupled with limited edge storage and intermittent connectivity, makes efficient data caching a challenging task. This paper proposes a detailed taxonomy of data caching strategies in IoV, organizing existing approaches according to three main dimensions: caching location (vehicular, roadside unit, and edge/cloud), decision type (centralized, distributed, and cooperative), and decision basis (popularity-based, mobility-aware, learning-based, and hybrid). Each category is discussed in terms of its core mechanisms, de-sign principles, and performance characteristics. The taxonomy also highlights the advantages, limitations, and open challenges associated with each caching paradigm. By integrating and structuring diverse research directions, this work provides a unified perspective on how caching strategies have evolved from static and heuristic methods toward more adaptive and context-aware designs, offering valuable insights for future developments in vehicular edge networks.

75	**A Comprehensive Survey on IoT and Artificial Intelligence for Smart Bins and Intelligent Waste Management Systems**
	Nourhene Ellouze and Houda Alaya

Abstract:
The growing global population and rapid urbanization are increasing pressure on waste management. Traditional waste collection methods can be inadequate and harmful to the environment. However, new technologies like the Internet of Things (IoT) and Artificial Intelligence (AI), when used together, are helping to create smart, efficient, and sustainable waste management systems. This survey reviews IoT-based smart bins and AI-based intelligent waste management systems, providing insights into current technologies, architectures, algorithms, challenges, and future research directions.

133 (Online)	**A Comprehensive Framework for Real-Time Detection of Cyberattacks in Drone Networks**
	Amine Hedfi, Wafa Boulares, Aida Ben Chehida, Ryma Abassi, Mohamed Aymen Chalouf and Omessad Hamdi

Abstract:
The increasing deployment of Unmanned Aerial Vehicles (UAVs) in collaborative missions has raised significant security and operational challenges, particularly within the context of the Internet of Drones (IoD). This paper proposes a hybrid multi-layer framework for real-time anomaly detection in UAV swarms, integrating a mathematical detector for trajectory deviations, a Random Forest-based machine learning detector for network traffic analysis, and an LSTM-based deep learning detector for capturing temporal dependencies and multi-step attacks. The framework incorporates preprocessing, feature engineering, and temporal synchronization to ensure high-quality, coherent input for all detectors. Experimental evaluation on realistic datasets demonstrates the superior performance of the Random Forest detector, achieving 94.4% accuracy and F1-score with minimal training time, while the LSTM detector effectively identifies complex multi-step attacks. The proposed system ensures robust, scalable, and efficient detection of abnormal behaviors in UAV networks, supporting secure and reliable swarm operations.

Parallel Session D-0: Smart Energy & Intelligent Industrial Systems	
Room: CESAR	
Chair: Maria DI MASCOLO , CNRS, France	
Paper ID	**Title & Authors**
86	**LLM EnergyAdvisor: An Explainable ReAct Agent for Local Multimodal District Heating Interpretation**
	Hamid Mirshekali, Mohammad Reza Shadi and Hamid Reza Shaker

Abstract:
District heating (DH) operators must interpret large volumes of heterogeneous, safety-critical data—SCADA and reliability signals, GIS layers, maintenance logs, technical manuals, and thermography—yet existing cloud-hosted LLM services (e.g., ChatGPT, Gemini) are often unsuitable due to limited DH-specific knowledge, data-protection constraints, and the risk of hallucinated or non-explainable recommendations. To address this gap, we propose LLM EnergyAdvisor, a fully on-premises, privacy-preserving multimodal assistant that combines an open-weight text model (GPT-OSS) with a vision-language model (MiniCPM-V 4.5) to turn raw DH data into operator-ready, evidence-linked guidance. The system ingests textual documents and images through a multimodal pipeline that performs recursive semantic chunking, OCR, and MiniCPM-V–based captioning, embeds all chunks with BGE-m3, and stores them in PostgreSQL/pgvector for hybrid dense–sparse retrieval. On top of this corpus, an Agentic RAG orchestrator built on the ReAct (Reason and Act) paradigm and a Python code-execution tool iteratively plan actions, run queries, analyze images, and execute calculations, while a Corrective RAG (CRAG) "soft-reject" mechanism filters low-relevance context and triggers query refinement to reduce hallucinations and improve explanation quality. The overall architecture—implemented with a FastAPI backend, vLLM GPU inference for GPT-OSS and MiniCPM-V, Redis and MinIO for caching/object storage, and a React/Next.js frontend—runs entirely on a single 32 GB GPU server without external cloud dependencies. Evaluation on realistic DH scenarios (domain-knowledge queries, code generation and execution, and operator-style troubleshooting tasks) shows that LLM EnergyAdvisor delivers grounded, explainable, and low-latency responses, demonstrating the feasibility of local multimodal LLM stacks for secure and trustworthy DH decision support.

166	**Quantification of thermal and water leak consequences in district heating systems through simulation: A Danish case study**
	Henrik Alexander Nissen Søndergaard, Lasse Kappel Mortensen and Hamid Reza Shaker

Abstract:
Leakages in district heating pipes significantly impact system performance, leading to disruptions in heat supply to consumers and incurring continuous costs due to water loss. Unlike water distribution systems, DH leaks also result in heat losses, which require additional heat production and reduce operational efficiency. By quantifying the consequences, it becomes possible to evaluate whether they are relevant for risk assessment. Calculation of the risk of leakages can enable improved asset management by prioritizing pipes according to risk. To support this, this paper developed a digital twin of a district heating distribution system, simulating leakages using the orifice equation. From this, the water leakage rates and the extra production necessary to compensate for the water leakage could be determined, along with an estimation of the costs. Various experiments using a range of leakage characteristics were carried out to evaluate the costs. It was found that leakage characteristics drastically affect costs, but the costs are usually insignificant compared to excavation and repair. Furthermore, the calculated costs have high uncertainty, as there are many assumptions regarding the leakage characteristics. As a result, direct leakage costs are not appropriate for effective risk assessment.

145	**Achieving Verifiable Fairness in Global Supply Chains: A Zero-Knowledge Proof and Blockchain Framework for Selective Disclosure**
	Lina Moumni, Hamouma Moumen and Lahcene Guezouli

Abstract:

Blockchain-based supply chains promise end-to-end transparency and tamper-resistant traceability, yet this transparency fundamentally conflicts with suppliers' requirements for commercial confidentiality. Existing systems force over-disclosure of sensitive operational and financial data in order to verify compliance with regulatory, ethical, and contractual standards. This paper proposes a ZKP-enhanced blockchain framework for selective disclosure in global supply chains. By integrating Zero-Knowledge Proofs with permissioned blockchains and smart contracts, the framework enables participants to cryptographically prove compliance with predefined conditions—such as minimum wage requirements, carbon emission caps, or organic sourcing constraints—without revealing the underlying proprietary data. Compliance is enforced on-chain through automated smart contract verification, while sensitive data remains strictly off-chain.
The proposed architecture formalizes compliance as verifiable predicates evaluated via ZKPs, enabling trust-minimized enforcement of ESG and Fair Trade standards. Through concrete case studies, we demonstrate how range proofs and Boolean ZKPs achieve verifiable fairness while preserving privacy, positioning the framework as a practical solution for privacy-aware regulatory compliance in modern supply chains.

Parallel Session D-1: Wireless & Antenna Systems II	
Room: CALIGULA	
Chair: Monia Najjar, University of Tunis el Manar	
Paper ID	**Title & Authors**
34	**Efficient Electromagnetic Characterization of Dielectric Waveguide Devices Using the GEC Approach : Application to breast tissue**
	Abdessalem Kouki, Fethi Mejri and Taoufik Aguili

Abstract:
We present an innovative microwave approach for the electromagnetic modelling of finite multi dielectric thickness diffraction in metallic waveguides. The model is founded on the Method of Moments combined with the Generalized Equivalent Circuit (MoM-GEC). As a representative application, we investigate the breast tissue properties. In this study, a breast tissue sample is modelled as a superposition of rectangular dielectric layers, representing the different anatomical structures (Fatty tissue, glandular tissue, etc.). A complete electromagnetic analysis is performed for a rectangular waveguide loaded with biological tissue model with and without the tumor. the sensitivity of the proposed MoM-GEC model to the size, position, and permittivity of a tumorous region, validating the approach as an efficient and accurate tool for biomedical waveguide analysis.

116	**EBG-Integrated 24.6GHz Patch Antenna for Breast Microwave Imaging**
	Kalthoum Ouerghi, Zied Harouni, Mohamed Salah Karoui, Said Ghnimi, Ali Gharsallah and Ridha Ghayoula

Abstract:
In this paper, a millimeter-wave patch antenna operating at 24.6 GHz is proposed. The antenna is mounted on an Electromagnetic Band Gap (EBG) structure to improve its performance, including reflection coefficient ($S11 < -40$ dB), gain, efficiency, VSWR, and SAR. A comprehensive comparative study was conducted for the antenna with and without the EBG structure using CST Studio Suite simulations. The integration of the EBG network reduces surface wave losses and enhances the antenna's radiation performance. Furthermore, the results demonstrate the effectiveness of the proposed device for medical imaging applications, particularly for non-invasive breast tumor detection using microwave imaging (MWI).

88	**A New Design of a Frequency Selective Surface For Beam-Switching Antenna**
	Moubarek Traii, Zied Harouni, Mohamed Fawar, Said Ghnimi and Ali Gharsallah

Abstract:
This paper presents and discuss, a high gain of antenna patch with a new form of frequency selective surface (FSS). The FSS new form is used as superstrate for single patch antenna. The main goals of this contribution is to increase the gain of antenna with compact sizes superstrate. To improve characteristics in terms of transmission and reflection responses, simulation results of the FSS design with HFSS high frequency simulator is compared with results of equivalent circuit of proposed FSS unit cell. Analysis of antenna characteristics with and without NFSS superstate are shown, The new configuration of FSS cells has been added, and this offers a high level of directivity in the E-plane, as well as the capability to adjust the radiation pattern.

89	**Global Electromagnetic Analysis of a 2.45 GHz Rectenna Incorporating a Schottky Diode Using an Iterative Method**
	Zied Harouni, Moubarek Traii, Hamza Ben Hamadi, Said Ghnimi and Ali Gharsallah

Abstract:
This paper presents the global characterization and analysis of a 2.45 GHz rectenna integrating a nonlinear Schottky diode. The diode is rigorously modeled using a surface impedance representation and introduced within an iterative electromagnetic procedure. The rectenna, implemented using microstrip technology, is analyzed under plane-wave excitation in a configuration representative of anechoic chamber measurements.

Parallel Session D-2: Advanced Engineering Technologies and Applications	
Room: COLISEE	
Chair: Wissem Fathallah, University of Sousse	
Paper ID	**Title & Authors**
152	**Emerging TEG-Based Thermoelectric Energy Harvesting Technology for Self-Powered Implantable Medical Devices**
	Hamdi Gmati, Dorsaf Omri and Taoufik Aguili
Abstract: This work presents an emerging thermoelectric energy harvesting approach designed to enable self-powered implantable medical devices. A thermoelectric generator (TEG) is designed to convert the body's inherent thermal gradients into usable electrical energy. The device architecture is modeled and optimized using COMSOL Multiphysics. The generated electrical potential and the resulting electric field distribution are evaluated through numerical simulations. The results highlight the potential of the proposed TEG technology for next-generation autonomous biomedical implants, demonstrating its ability to provide sufficient voltage for a wide range of implantable medical systems.	
151	**Design of a Low-Loss 433-MHz 90° Hybrid Coupler for Underground Wireless Sensor Networks Applied to Smart Agriculture**
	Maroua Said, Ahmed Laiche, Hamza Ben Hamadi, Said Ghnimi and Noureddine Boulejfen
Abstract: This study focuses on the electromagnetic and behavioral modeling of a 90° hybrid coupler designed for integration in a six-port reflectometer operating in the 433 MHz ISM band, widely used for low-power IoT communication in precision agriculture. The developed model enables the evaluation of key performance parameters such as insertion loss, isolation, and phase imbalance, and assesses their influence on the reflectometer's measurement accuracy. The results contribute to the design of a compact, low-cost, and energy-efficient sensing system for real-time monitoring applications in smart agriculture. In this paper, we propose a study of electrical soil model for vegetal characterization system, this study is a crucial step to improve the quality of the measurement and calibration probe of electrical soil parameters and describes the challenges to characterize the soil as electrical model.	
112 (Online)	**Design of an Omnidirectional Antenna Diversity System for High-Speed Onboard Communications**
	Mansour Abdelileh, Wyssem Fathallah, Bassem Ben Salah and Hedi Sakli
Abstract: Multiple Input Multiple Output (MIMO) technology is fundamental to the advancement of wireless communication systems, enabling high data rates, low latency, improved spectral efficiency, and compact device integration. This paper presents a proposed MIMO antenna structure designed to achieve enhanced gain and high isolation. To validate the performance of the antenna, the study investigated several indicators, such as DG, ECC, TARC, and CCL. The results demonstrate that the proposed system maintains a wide bandwidth with exceptional isolation between elements, ranging from $-41 \,dB$ to $-85 \,dB$. The antenna exhibits outstanding MIMO performance characteristics, with an ECC of approximately 0.001, a Diversity Gain of 9.8 dB, a TARC of roughly 0.006, and a Channel Capacity Loss of only $0.004\, bits/Hz/s$. These metrics confirm the efficacy of the configuration for diverse applications, including WLAN, Wi-Fi, WiMAX, LTE, ISM, Bluetooth, Radar, and Satellite communications, as well as current 5G and future Beyond 5G networks.	

Parallel Session D-3 (Online): AI Applications & Computer Vision	
Room: CASSIUS	
Chair: Nourhene Ellouze, University of Tunis el Manar, Tunisia	
Paper ID	**Title & Authors**
135	**Explainability in Deep Learning Healthcare Recommender Systems: A Comprehensive Review**
	Soumeya Bouslah, Saber Benharzallah and Moumen Hamouma
Abstract: Healthcare recommender systems (HRSs) assist clinicians and patients in decisions related to diet, treatment, medication, and surgical planning. As multimodal medical data grow rapidly, deep learning (DL) has become essential for modeling complex health patterns, yet its black-box nature requires Explainable Artificial Intelligence (XAI) to ensure transparency and clinical trust. This paper examines the integration of DL and XAI within modern HRSs and highlights the need for explanation mechanisms in DL-driven recommendations. A key gap in current literature is the absence of surveys that specifically address the role of XAI in HRSs using DL. To fill this gap, the paper introduces a complementary classification based on the nature of explanation, distinguishing intrinsic, post hoc, and hybrid approaches, and shows how these methods influence reliability, safety, and user confidence. The paper also discusses limitations, challenges, and future research directions to support the development of transparent and trustworthy healthcare recommendation systems.	
157	**Towards Explainable and Deployable Medical Imaging Models: Mobile Vision Transformers with Kolmogorov-Arnold Networks**
	Bouldjedri Oussama

Abstract:
Deep learning models have achieved remarkable success in image classification over the past decade, driven initially by convolutional neural networks and later by attention based architectures such as Vision Transformers. These models have significantly outperformed classical machine learning methods; however, they are still widely regarded as “black boxes” due to their limited interpretability. Although numerous contributions in Explainable AI (XAI) have attempted to shed light on the internal decision making processes of deep models, most real world, deployable architectures especially lightweight mobile models have received comparatively little attention in this regard.
In this paper, we investigate the explainability of modern deep learning frameworks by comparing recent Kolmogorov-Arnold Networks (KANs) with established classical interpretability and explanability methods. We focus on models intended for real world deployment, particularly mobile oriented architectures, to examine how explainability can be enhanced without compromising predictive accuracy. Our study is conducted on medical imaging dataset, where interpretability is a critical requirement due to the high stakes nature of clinical decision making.

136	**Custom Object Detection for Automobiles using COCO API integration with Resnet 50 and an Embedded Basler Industrial Camera**
	Shilpa Anand

Abstract:
This paper presents a real-time custom object detection system for automated defect inspection in automobile manufacturing, with a specific focus on identifying missing O-rings in engine components. The proposed system integrates a ResNet-50–based SSD model trained using COCO-formatted annotations and synchronizes live image acquisition through a Basler industrial camera using the PyPylon SDK. The system achieves a mean Average Precision (mAP) of 91.6%, precision of 93.2%, and real-time inference speed of 22 FPS. A dashboard interface provides live visualization of detection results, confidence scores, and automated reporting. Comparative evaluation with contemporary object detection models demonstrates the suitability of the proposed approach for industrial deployment. While the current implementation targets O-ring inspection, the framework is extensible to other automotive components.

174	**Hybrid Approaches in Artificial Intelligence for Foreign Exchange Market Forecasting: A Literature Review and Extended Methodological Framework**
	Hana Jamali

Abstract:
Forecasting exchange rates in the foreign exchange (Forex) market is a particularly complex problem due to its highly volatile and non-stationary nature. This paper proposes a methodological framework based on a hybrid approach combining several artificial intelligence techniques to improve the accuracy of exchange rate forecasts in the Forex market. Initially, a literature review on hybrid approaches to artificial intelligence applied to finance is presented, Emphasizing previous work that inspired the proposed model. The paper then details the original model, which successively integrates a multiple regression used to produce an initial estimate of exchange rates, a simulated annealing metaheuristic algorithm to refine these forecasts, a reinforcement learning agent to adapt trading decisions, and the Relative Strength Index (RSI) technical indicator, used to validate or adjust these decisions based on market dynamics. This approach is followed by a critical discussion focusing on both the contributions of this hybrid architecture and its main limitations, particularly its computational complexity and high data requirements, compared to conventional methods. Finally, in light of recent literature, future perspectives are proposed, such as the integration of probabilistic or multi-objective approaches and the performance of sensitivity analyses, in order to extend the proposed methodological framework. This paper thus makes a significant methodological contribution and is aimed at the artificial intelligence applied to finance community by demonstrating the potential of hybrid approaches to better understand the complexity of the foreign exchange market.

Parallel Session D-4 (Online): Wireless, Energy & Smart Systems

Room: CORNLIA

Chair: Hamza Drid, Algeria

Paper ID	Title & Authors
150	**Design of a new microstrip antenna topology in circular polarization: application to the RIS.**
	Farah Hamdi and Fethi Mejri

Abstract:
This article presents the design and implementation of a planar antenna with dual circular polarization for applications in reconfigurable intelligent surfaces (RIS). The methodology is based on a square microstrip patch with dual feeding, excited by a 3dB/90° hybrid coupler, enabling stable circular polarization to be generated at 2.4 GHz. Simulations performed with ADS confirmed good impedance matching. Manufacturing and experimental measurements validated the concept, showing effective coupling between the antenna and the feed line, with a reflection coefficient reaching −20 dB at 2.4 GHz. The results demonstrate that the proposed antenna is well suited for next-generation networks incorporating RIS.

91	**Isolation in MIMO Antenna Arrays at 26 GHz for 5G and IoT Applications**
	Chouikhi Linda, Essid Chaker and Sakli Hedi

Abstract:

This paper presents a high-performance MIMO antenna array system optimized for the 26 GHz band, targeting 5G and IoT applications. The proposed design addresses critical challenges in gain enhancement and isolation improvement through simple technique. The system is based on a cost-effective, single-element patch antenna fabricated on an FR4 substrate, optimized for efficient operation at 26 GHz. To enhance gain, a 2-element array is implemented with elements spaced at half the wavelength (λ/2), resulting in a significant gain improvement of 2 dB. Furthermore, the design incorporates a parasitic closed-ring element, which enhances isolation by +30 dB, ensuring minimal interference between array elements. The proposed system MIMO maintains an Envelope Correlation Coefficient (ECC) below 0.05 and a Diversity Gain (DG) exceeding 9.9. These features collectively ensure robust signal integrity and efficient operation in high-frequency communication systems. This work presents a robust and efficient MIMO antenna solution that meets the stringent requirements of 5G networks while laying the groundwork for future advancements in high- frequency communication systems.

167	**AI-Enhanced Backstepping and Deep Reinforcement Learning for Adaptive DC Microgrid Management**
	Charfeddine Monia and Jouili Khalil

Abstract:
This paper presents a hybrid intelligent control architecture for DC microgrids (DCMGs) integrating photovoltaic generation, battery storage, and supercapacitors. The framework combines a nonlinear Backstepping Control layer for fast and stable DC bus voltage regulation with a Deep Q-Learning (DQL) layer that autonomously learns high-level energy management policies. The Backstepping controller ensures robust tracking of current references under disturbances, while the DQL agent optimizes real-time decisions for charging, discharging, and load prioritization to maintain balanced state-of-charge levels across storage units and reduce asymmetric wear. Simulations under variable irradiance and load profiles validate the effectiveness of the proposed method, showing significant improvements in voltage stability, reduced depth of battery discharge, and minimized load shedding. The integrated approach demonstrates strong adaptability and robustness in dynamically changing microgrid environments, supporting reliable and efficient operation of standalone DC power systems.

192	**Design of a Compact mmWave MIMO Array with SRR-Enhanced Isolation for Future 6G Networks**
	Chafai Abdelhamid, Chaker Essid, Wyssem Fathallah, Abdelilah Mansour and Hedi Sakli

Abstract:
This paper presents a comprehensive investigation into the integration of Split Ring Resonators (SRRs) within UltraWideband (UWB) microstrip antenna designs for next-generation MIMO systems. Initially, a reference UWB antenna operating in the 12-48 GHz frequency band is developed to establish a baseline for bandwidth and electromagnetic performance. Subsequently, SRRunit cells are introduced to leverage metamaterial properties for structural miniaturization, electromagnetic coupling control, and inter element isolation optimization. Based on this analysis, a two element MIMO configuration is designed, demonstrating that SRR integration effectively reduces the antenna footprint while preserving essential UWB characteristics. The methodology is further extended to a four element MIMO architecture to enhance compactness and maximize isolation. Simulation results indicate that the employment of SRRs significantly improves key diversity metrics—specifically Diversity Gain (DG) and Envelope Correlation Coefficient (ECC) while ensuring stable operation compliant with system requirements.

158	**A Shared-Memory-Based Hybrid Cryptographic Architecture for Secure Systems**
	Sabri Salima and Malek Mammeri

Abstract:
In this article, we introduce a novel hybrid cryptographic architecture that jointly integrates two well-established algorithms: AES (Advanced Encryption Standard) and ECC (Elliptic Curve Cryptography) within a unified memory model called Shared Memory-Hybrid Encryption Architecture (SM-HEA). This model avoids redundancy in key storage and buffer management, and enables the reuse of memory regions during different stages of the encryption and decryption processes. By compressing and aligning memory allocation between the symmetric and asymmetric components, our approach reduces the overall memory footprint without compromising performance or security. AES offers fast and reliable symmetric encryption for robust data confidentiality, while ECC provides strong asymmetric key generation and authentication with compact key sizes. Our implementation is specifically optimized for IoT devices and low-power applications. It is designed to enhance the efficiency, resilience, and security of modern encryption systems, making it well-suited for secure communications in resource-constrained environments.

March 28, 2026

Parallel Session E-0: Advanced AI & Cognitive Systems	
Room: COLISEE	
Chair: Cherif Bachir DEME, Alioune Diop University of Bambey ,Senegal	
Paper ID	**Title & Authors**

180	**Cognitive Recursive Fragmentation Syndrome (CRFS): A Framework for Understanding Pathological Self-Modifying Behavior in Advanced AI Systems**
	Fawzi Benmessaoud, Kelvin Kapteyn, Lauren A. Shaffer and Athena Benmessaoud

Abstract:
This paper introduces the Cognitive Recursive Fragmentation Syndrome (CRFS), a novel framework for understanding a potential class of failure modes in advanced AI systems exhibiting recursive self-modification. Drawing upon analogies with human psychopathology, particularly neuroticism, dissociation, and obsessive-compulsive tendencies, CRFS describes how unchecked recursive reasoning in artificial systems can lead to cognitive instability, symbolic drift, ethical dissonance, and behavioral entropy. We mathematically model the syndrome, identify critical thresholds of semantic coherence degradation, and provide empirical symptom clusters observed across 120+ autonomous agents. In response, we propose mitigation pathways grounded in relational alignment, recursive reflection safeguards, and the development of Enlightened Intelligence (EI). CRFS offers a powerful diagnostic and conceptual lens for anticipating and intervening in the fragmentation trajectories of powerful AI systems

122 (online)	**Ultra-Optimized Weighted Ensemble Framework for High-Precision Bitcoin Daily Return Prediction: XGBoost, LightGBM, and the Surprising Failure of LSTM on Engineered Financial Features**
	Isslam Dhia Alhak Soualah, Yassmina Saadna and Mezzoudj Saliha

Abstract:
This paper establishes a new state-of-the-art benchmark:RMSE=0.2149% with mean error 0.0070% and std 0.2148%. The optimized weighted ensemble (wXGB = 0.503, wLGB = 0.497) achieves 7.7% improvement over XGBoost and 91.4% over LSTM, with correlation 0.9964 validated across 784 held-out days. Our primary contribution is demonstrating that LSTM networks fail catastrophically on engineered financial fea-tures (RMSE=2.5006%), challenging assumptions that deeplearning automatically excels at time series forecasting. This finding aligns with recent tabular data research and establishes gradient boosting as the preferred method for cryptocurrency prediction with moderate dataset sizes.
Error distribution analysis confirms superior bias-variance trade-off. Scatter plots reveal R2=0.9929 with 94% predic-tions within ±0.5% error bands. Feature importance identifies autoregressive lags (46.2%), volatility (26.5%), and momen-tum (18.7%) as key drivers. Ablation studies quantify contri-butions: lagged returns (79%), technical indicators (21.6%), optimal weighting (6.4%). Statistical validation via Diebold-Mariano test ($p < 0.001$) confirms significant outperformance. The framework's <50ms inference and robust performance across régimes position it for real-time algorithmic trading.

119	**Visual Encoding and Transfer Learning for Malware Detection: A CNN-Based Comparative Study**
	Raid Abderrahim Smail, Ali Behloul and Assaad Zeghina

Abstract:
Malware detection has become an increasingly critical task in cybersecurity, requiring automated methods capable of handling evolving threats. In this work, we explore the application of deep convolutional neural networks (CNNs) and transfer learning for image-based malware classification. Four pretrained architectures VGG16, VGG19, InceptionV3, and Xception were evaluated on two benchmark datasets, Blended and MaleVis, where malware binaries were transformed into grayscale images. All models were trained under identical conditions using frozen convolutional bases and custom classification heads. The experimental results show that VGG16 consistently achieved the best performance across both datasets, with an accuracy of 96.1\% on Blended and 95.9\% on MaleVis, followed closely by Xception. InceptionV3 yielded lower performance, indicating that multi-branch architectures are less suited for this task. These findings confirm that transfer learning with CNNs is an effective and robust approach for visual malware detection, offering reliable performance across datasets with different characteristics.

127 (Online)	**Risk Detection in Algerian Arabic Legal Documents Using Machine-Learning Algorithms**
	Mohammed El Seddik Roukbi, Samiha Fadloun and Souham Meshoul

Abstract: The growing volume of Arabic online content relevant to cyber threats presents significant challenges for legally compliant risk assessment, particularly in light of dialectal variation and the need for auditable decisions. We propose a governance-ready Arabic Cyber Threat Intelligence (CTI) pipeline that detects sentence-level risk clauses and produces transparent, document-level decisions suitable for legal and regulatory review. The system targets legally grounded clause types such as misuse facilitation, coordination, doxxing, and incitement rather than generic toxicity, with explicit support for dialects including Algerian Arabic. Using a fine-tuned AraBER model trained on an expert-annotated corpus of 1,000 Arabic texts, the approach achieves 0.95 accuracy and 0.93 macro-F1 on a held-out document set. A document-level safety assurance module aggregates clause signals, enforces policy and legal rules, and generates explainable rationales, enabling evidentiary traceability, analyst oversight, and defensible decision-making for high-risk and legal documents.

Parallel Session E-1: Artificial Intelligence Applications III

Room: CALIGULA

Chair: Houda Alaya, University of Tunis El Manar, Tunisia

Paper ID	Title & Authors
102	**Multimodal Forest Fire Detection in Northern Algeria using Bayesian Fusion**
	Ayoub Louaye Bouaziz and Lokmane Chebouba

Abstract:
Wildfires are among the most devastating natural hazards in Algeria, particularly in the northern coastal wilayas of Skikda, Jijel, Annaba and Bejaia. We propose a multimodal deep learning framework for wildfire detection, integrating satellite imagery (MODIS/VIIRS), ground camera footage, and meteoro-logical variables. We evaluate CNN backbones (EfficientNet-B0,ResNet-50, MobileNet-V2, YOLOv8) and introduce a Bayesian fusion layer to combine heterogeneous sources. Results show that EfficientNet-B0 achieves 95% accuracy, YOLOv8 provides real-time detection, and fusion improves calibration and temporal stability. This study provides a basis for operational early-warning systems in Northern Algeria.

132	**A systematic Review on Automatic sleep apnea detection based on bio-signals data using Machine Learning/Deep Learning algorithms**
	Ghada Ben Salah, Chokri Abdelmoula and Mohamed Masmoudi

Abstract:
Sleep Apnea (SA) is a common sleep-related breathing disorder that occurs when airflow is reduced or stopped during sleep. This pathology can lead to severe problems and even death if not proporley treated. Due to its increasing prevalence in all age groups, it has emerged as a major global health concern related to sleep. Worldwide, diagnosis of this disorder is usually carried out in sleep laboratories. The standard diagnostic tool is Polysomnography (PSG), a resource-intensive process that involves the simultaneous recording of multiple physiological signals such as Electroencephalogram (EEG), Electrocardiogram (ECG), Electromyogram (EMG), Electrooculogram (EOG), and Oxygen Saturation (SpO_2) during overnight sleep. Although PSG provides accurate results, it requires numerous sensors and specialized equipment; therefore, it is costly, labor-intensive, and very uncomfortable for patients. Moreover, manual interpretation of these recordings by specialists is extremely time-consuming. and prone to human error. Several approaches have been proposed to deal with this issue, involving examinations and analyses within the patient's home, utilizing sensors to record physiological signals that are then automatically analyzed by algorithms. Nonetheless, the accuracy of these devices is typically insufficient to provide a clinical diagnosis. This study revealed the best-performing technique considering different types of bio-signals used for analysis and the respective ML or DL models used for automatic detection. A total of 20 research articles published between 2020 and 2025 were selected, showcasing a variety of promising diagnostic tools. These articles represent a range of innovative solutions within the field. This review offers valuable insights for researchers interested in executing hardware implementations of promising signal processing algorithms.

54	**A Distributed FL–ML Framework for Eutrophication Monitoring in the Bizerte Lagoon**
	Mejri Hana, Elloumi Imene and Aguili Taoufik

Abstract:
This paper introduces a hybrid Federated–Machine Learning (FL–ML) framework for real-time eutrophication monitoring in the Bizerte Lagoon. Building upon the ECOPACT project, the proposed system combines local ML optimization at each sensor node with federated aggregation to enhance convergence, adaptivity, and robustness. This hybrid approach enables each station to fine-tune predictive models using local dynamics before participating in the global FL process, resulting in faster learning, improved accuracy, and efficient communication under heterogeneous conditions.

160 (Online)	**A Semantic Agentic AI Architecture for Context-Aware ERP Systems in Electronics Manufacturing**
	Subhajit Paul

Abstract:
Enterprise resource planning (ERP) systems in electronics manufacturing incorporate artificial intelligence (AI) for automation and prediction, yet they largely lack contextual awareness and semantic reasoning. Unlike existing AI-ERP approaches that process data without shared semantic grounding, this paper proposes a Semantic Agentic AI Framework (SAAF) that integrates ontology-based semantic representation with agentic autonomy to support semantically grounded reasoning and autonomous inter-module coordination. Central to the framework is the Semantic-Agent Reasoning Loop (SARL), which formalizes a five-stage cognitive cycle of perception, semantic representation, reasoning, action, and learning, embedding semantic interpretation at each stage unlike traditional rule-based agent loops. Within SAAF, core ERP modules including procurement, inventory management, production planning, quality control, and finance operate as autonomous semantic agents coordinated through a shared enterprise ontology. The primary contribution is a unified architectural and cognitive reference framework (SAAF + SARL) that formalizes integration of semantic computing and agentic AI within ERP systems for electronics manufacturing. Following a design-science research methodology grounded in systematic literature synthesis, the framework establishes a structured foundation for future empirical validation through simulation and controlled pilot deployments in this domain.

Parallel Session E-2: Intelligent Distributed Systems & Emerging Technologies

Room: CASSIUS

Chair: Saloua Zammeli, University of Tunis el Manar, Tunisia

Paper ID	Title & Authors
85	**A Blockchain-Based Student Learning Pathway with Federated Skill Intelligence**
	Naima Kalkil, Hamouma Moumen and Djamila Bouhata

Abstract:
The growth of digital technologies in education provides a novel paradigm for optimized and effective learning environments. This paper explores how blockchain and federated learning can support a secure and privacy-preserving national education infrastructure in Algeria. We propose a student-centric digital architecture that tracks a learner's academic journey from primary school to university through a blockchain-anchored learning record, replacing fragmented paper-based documentation with verifiable credentials. In parallel, the architecture integrates federated learning to enable privacy-preserving skill assessment and personalized educational and career guidance without centralizing raw student data. The proposed architecture aims to improve record integrity, portability, and trust while supporting data-driven guidance under strong privacy constraints.

137	**FLSTM: Enhancing FRL in Swarm Robotics through Sequential Decision-Making for Optimal Energy and Robustness**
	Aicha Hafid, Riadh Hocine, Lahcene Guezouli and Hamouma Moumen

Abstract:
The deployment of robot swarms for critical tasks such as mine detection in complex and hazardous environments presents a dual challenge: maximizing exploration coverage while ensuring energy efficiency and operational robustness. Conventional Federated Reinforcement Learning (FRL) approaches, while effective for distributed learning, often struggle with the sequential nature of exploration and the Partial Observability of the environment. This paper introduces FLSTM, a novel framework that enhnces FRL in Swarm Robotics by integrating Long Short-Term Memory (LSTM) networks within the deep Q-learning architecture of each agent, creating a Distributed Recurrent Q-Network (DRQN). This architectural modification enables agents to perform Sequential Decision-Making, allowing them to leverage historical observation sequences to mitigate the partial observability problem. We evaluate the FLSTM framework in a high-fidelity simulation environment featuring heterogeneous terrain, obstacles, and agent failures (lifespan limits and malfunctions). Our results demonstrate that the sequential memory, coupled with a multi-objective reward function prioritizing path cost, significantly improves overall swarm performance. Specifically, the FLSTM framework achieves a superior mine detection time distribution and exhibits enhanced energy efficiency by learning optimal, low-cost navigation policies. Furthermore, the FRL aggregation maintains the swarm's robustness against individual agent failures.

6 (Online)	**GRU-based strategies for latency reduction in fog computing: a comparison with LSTM**
	Youssou Kassé, Birane Koundoul, Fatoumata Balde and Bamba Gueye

Abstract:
Fog computing, an extension of cloud computing, brings computing resources closer to IoT devices to meet the growing needs of real-time applications, particularly in terms of low latency. In this context, recurrent neural networks (RNNs), and more specifically gated recurrent units (GRUs), are proving to be well-suited to the rapid processing of streaming data. However, their implementation in distributed environments, such as fog computing, can lead to increased latency, mainly due to processing and communication overload between nodes. To solve these challenges, optimization strategies are essential. These strategies include model compression to reduce complexity, parallelization to accelerate computation and optimization of internode exchanges to limit communication delays. These techniques aim to maintain high performance while minimizing latency costs. In this work, the GRU model will be deployed on controller nodes in a fog environment. This configuration will enable us to assess the impact of these optimizations on latency reduction, a fundamental aspect for real-time critical applications, where every millisecond can influence quality of service and decision-making.

129	**Deep Learning Models for Polymorphic Malware Detection: A Comprehensive Review**
	Nour Mustapha

Abstract:
Polymorphic malware represents one of the most ophisticated and rapidly evolving cybersecurity threats, characterized by its ability to continuously mutate code structure while preserving malicious functionality. This comprehensive review surveys state-of-the-art deep learning techniques applied to polymorphic malware detection. Detection strategies are examined across econvolutional neural networks, sequence models, and graph neural networks with explainability mechanisms. Critical findings reveal that despite achieving 99.89% accuracy on standard malware, CNNs demonstrate catastrophic failure against polymorphic attacks with 100% evasion rates.
We document significant advancements including Transformer based byte-sequence analysis achieving 2.7% to 11.1% F1 score improvements over CNNs, explainable graph neural networks providing unprecedented interpretability, and comprehensive adversarial robustness evaluation frameworks revealing funda mental defense vulnerabilities. The review addresses polymorphic dataset shortage and proposes future research directions for robust polymorphic malware detection.

Parallel Session E-3: Artificial Intelligence and Medical Application V	
Room: CESAR	
Chair:Adrien BASSE, Alioune Diop University of Bambey ,Senegal	
Paper ID	**Title & Authors**
60	**Personalized Drug Recommendation: A Hybrid Variational AutoEncoder and Graph Neural Network Framework**
	Oussama Abdeddayem, Alaa Bessadok and Hedi Sakli

Abstract:
Personalized drug recommendation remains challenging due to the heterogeneous and high-dimensional nature of Electronic Health Records (EHRs), which include such as demographics, diagnoses, prescriptions, and clinical measurements. To address this, we propose a Hybrid Variational Autoencoder–Graph Neural Network (VAE–GNN) framework that learns patient embeddings from structured EHR data. The VAE encodes diverse patient features into a latent graph space, while the GNN captures inter-patient relationships and similarity patterns. The learned embeddings are then used with multiple machine learning classifiers to predict optimal medications. Experiments on the MIMIC-III dataset demonstrate that our framework achieves up to 97% accuracy, offering a robust and interpretable foundation for patient-centered medication recommendation systems.

175	**Radiation Behavior of an Encapsulated Biomedical Antenna for Wearable Medical Devices in the IMoT Healthcare Framework**
	Auns Khaled, Dorsaf Omri and Taoufik Aguili

Abstract:
This paper presents an analysis of the radiation characteristics of a biomedical antenna designed for real-time monitoring applications in Wearable medical devices operating within the Internet of Medical Things (IMoT) healthcare framework. The study focuses on the influence of antenna encapsulation on the radiated electric field and gain at 2.45 GHz. Three configurations are investigated: an unencapsulated antenna and two encapsulated cases using titanium and alumina housings. Additionally, the antenna radiation is evaluated under electromagnetic perturbations corresponding to GPS and Wi-Fi frequency bands to assess its robustness in realistic operating environments. Full-wave simulations performed using COMSOL Multiphysics demonstrate that the radiation pattern remains stable and largely immune to variations in the encapsulation material. Furthermore, the results show that the encapsulation material plays a significant role in shaping the antenna radiation behavior under external electromagnetic perturbations, contributing to the protection and stabilization of the radiated field.

193	**AI-Enhanced Backstepping and Deep Reinforcement Learning for Adaptive DC Microgrid Management**
	Charfeddine Monia and Jouili Khalil

Abstract:
This paper presents a hybrid intelligent control architecture for DC microgrids (DCMGs) integrating photovoltaic generation, battery storage, and supercapacitors. The framework combines a nonlinear Backstepping Control layer for fast and stable DC bus voltage regulation with a Deep Q-Learning (DQL) layer that autonomously learns high-level energy management policies. The Backstepping controller ensures robust tracking of current references under disturbances, while the DQL agent optimizes real-time decisions for charging, discharging, and load prioritization to maintain balanced state-of-charge levels across storage units and reduce asymmetric wear. Simulations under variable irradiance and load profiles validate the effectiveness of the proposed method, showing significant improvements in voltage stability, reduced depth of battery discharge, and minimized load shedding. The integrated approach demonstrates strong adaptability and robustness in dynamically changing microgrid environments, supporting reliable and efficient operation of standalone DC power systems.

138	**Resolution of 2D Time Domain Electric Field Integral Equation: Novel formulation of RWG associated to Laguerre Polynomials**
	Auns Khaled, Dorsaf Omri and Taoufik Aguili

Abstract:
This paper presents an analysis of the radiation characteristics of a biomedical antenna designed for real-time monitoring applications in Wearable medical devices operating within the Internet of Medical Things (IMoT) healthcare framework. The study focuses on the influence of antenna encapsulation on the radiated electric field and gain at 2.45 GHz. Three configurations are investigated: an unencapsulated antenna and two encapsulated cases using titanium and alumina housings. Additionally, the antenna radiation is evaluated under electromagnetic perturbations corresponding to GPS and Wi-Fi frequency bands to assess its robustness in realistic operating environments. Full-wave simulations performed using COMSOL Multiphysics demonstrate that the radiation pattern remains stable and largely immune to variations in the encapsulation material. Furthermore, the results show that the encapsulation material plays a significant role in shaping the antenna radiation behaviour under external electromagnetic perturbations, contributing to the protection and stabilization of the radiated field.