THE 12TH INTERNATIONAL CONFERENCE ON WIRELESS NETWORKS AND MOBILE COMMUNICATIONS

25-27 Nov. 2025

Organized and Hosted by

Arab Open University, Riyadh, Saudi Arabia

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Prince Abdulaziz Bin Talal Bin Abdulaziz Al Saud

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WINCOM 2025 PROGRAM MATRIX

Tuesday, November 25, 2025			
08:30 - 15:00	Registration		
10:00 - 10:30	Official Opening under the patronage of His Royal Highness Prince Abdulaziz Bin Talal Al Saud		
10:30 - 11:30	**Keynote Speaker 1:** Professor Mohamed-Slim Alouni, KAUST **Title:** Tapping into the full potential of the Stratosphere **Chair:** Dr. Bandar Alrami, Arab Open University		
11:30 - 12:30	**Keynote speaker 2:** Mr. Wuhan, Deputy CEO, Huawei Tech Investment Saudi Arabia **Title:** Strategic Talent Development for Tomorrow's Leaders **Chair:** Prof. Khaled Suwais, Arab Open University		
12:45 - 14:00	Coffee Break		
14:00 - 16:00	**TS1** **Chair:** Dr. Marwane Ayaida	**TS2** **Chair:** Dr. Sultan Alasmari	**TS3** **Chair:** Dr. Suad Alramouni
16:00 – 16:20	Coffee Break		
16:20-18:00	**TS1** **Chair:** Dr. Ahmed Drissi	**TS2** **Chair:** Yassine Ben Aboud	**TS3** **Chair:** Mouna El Machkour

Wednesday, November 26, 2025				
09:00 - 16:00	Registration			
09:00 - 11:00	**TS4** **Chair:** Dr.Abd-Elhamid Taha	**TS5** **Chair:** Prof. Nidal Nasser	**TS6** **Chair:** Dr. Mohamed El Kamili	**TS7** **Chair:** Dr. Ahmed Sawalmeh
11:00 - 11:30	Coffee Break			
11:30 - 12:30	**Keynote speaker 2:** Prof. Pascal Lorenz, University of Haute-Alsace, France **Title:** Architectures of Next Generation Wireless Networks **Chair:** Dr. Abdellatif Kobbane, Mohammed V University in Rabat, Morocco			

12 30 – 13:30	**Huawei High-Quality Higher Education Network Solution – Special Session** Eng. Ehab Maher: Huawei Network Specialist and Architecture Designs				
13:30 - 14:30	Coffee Break				
14:30 - 16:00	**TS8** **Chair:** Dr.Mohamed Djemai	**TS9** **Chair:** Dr. AbdulAziz Al-Helali	**TS4** **Chair:** Dr. Khalil Ibrahimi	**TS5** **Chair:** Dr. Imane Daha	**TS6** **Chair:** Dr. Ismail Berrada
20:00 - 23:00	Gala Dinner (Awards)				

Thursday, November 27, 2025 (Online)

11:00 - 13:00	**TS7** **Chair:** Dr. Youssou Fay	**TS8** **Chair:** Dr. Omar Ait Oualhaj	**TS9** **Chair:** Dr. Yasmine Ghazlane
13:00 - 15:00	**TS10** **Chair:** Dr. Anas Barodi	**TS11** **Chair:** Dr. Ousmane Diallo	**TS12** **Chair:** Dr. Jamal Elhachmi
16:00 - 18:00	**TS13** **Chair:** Dr. Idriss Moumen	**TS14** **Chair:** Dr. Meryeme Ayache	

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KEYNOTE SPEAKERS

Speaker 1

Professor Mohamed-Slim Alouini, King Abdullah University of Science and Technology

Talk title: Tapping into the full potential of the Stratosphere

KAUST

Speaker 2

Professor Pascal Lorenz, University of Haute-Alsace, France, France

Talk title: Architectures of Next Generation Wireless Networks

UNIVERSITÉ HAUTE-ALSACE

Speaker 3

Mr. Wuhan, Deputy CEO, Huawei Tech Investment Saudi Arabia Co. Ltd

Talk title: Architectures of Next Generation Wireless Networks

HUAWEI

TOPICS OF INTEREST

WINCOM 2025 solicits high-quality and original contributions in ubiquitous networking, but not limited to, the following tracks:

1. Wireless Networks and Mobile Communications
2. Security, Privacy, and Cybersecurity
3. IoT, Smart Cities, and New Applications
4. ML & AI in Communications network

SPECIAL SESSIONS AND WORKSHOPS

In addition to the main conference, WINCOM 2025 will showcase a lineup of engaging half and full-day special sessions and Workshops. These exclusive sessions at WINCOM 2025 will spotlight the latest trending topics in wireless mobile networking.

Workshop 1
1st International Workshop on Machine Intelligence and Next-Generation Data Technologies (MIND 2025)

Special session 1
Digital Transformation and Disruptive Technologies: Innovating Business Models and Shaping the Future of Industries

Special session 2
Advances in Cybersecurity and Resilience against Cyberattack in Wireless Networks

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- Dr. Cheng Li, Memorial University, Canada
- Dr. Lynda Mokdad, University of Paris-Est, Creteil, France

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- Dr. Abdellatif Kobbane, ENSIAS, Mohammed V University, Rabat, Morocco
- Dr. Essaid Sabir, University of Quebec at Montreal, Canada

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- Dr. Bandar Alrami, Arab Open University, Saudi Arabia
- Prof. Khaled Suwais, Arab Open University, Saudi Arabia
- Prof. Nidal Nasser, Alfaisal University, Saudi Arabia
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- Dr. Marwane Ayaida, University of Reims, Champagne-Ardenne, France
- Dr. Sultan Alasmari, Riyadh Elm University, Saudi Arabia
- Dr. Suad Alramouni, Prince Sultan University, Saudi Arabia
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- Dr. Yassine Ben-Aboud, Mohammed V University in Rabat, Morocco
- Dr. Mouna El Machkour, Mohammed V University in Rabat, Morocco
- Dr. Imane Daha, Mohammed V University in Rabat, Morocco
- Dr. Omar Ait Oualhaj, INPT, Morocco
- Dr. Youssou Fay, University Assane Seck of Ziguinchor, Senegal
- Dr. Idriss Moumen, Hassan II University of Casablanca, Morocco
- Dr. Yasmine Ghazlane, Hassan II University of Casablanca, Morocco
- Dr. Anas Barodi, Hassan 1 University of Setatt, Morocco
- Dr. Ousmane Diallo, University Assane Seck of Ziguinchor, Senegal
- Dr. Jamal Elhachmi, Mohammed V University in Rabat, Morocco
- Dr. Khalid Nafil, Mohammed V University in Rabat, Morocco
- Dr. Meryeme Ayache, INPT, Morocco
- Dr. Ismail Berrada, UM6P, Morocco
- Dr. Mohamed Djemai, QUARTZ Laboratory, France

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STATISTICS

Authors by Country and Region (All Papers)

Country	Total Number of Authors	%	Total Number of Papers	%
Morocco	393	56.2	125	57.1
Saudi Arabia	37	5.3	9	4.1
France	30	4.3	5	2.3
Canada	27	3.9	5	2.3
USA	24	3.4	10	3.6
United Kingdom	19	2.7	3	1.4
Malaysia	18	2.6	7	3.2
Bangladesh	17	2.4	5	2.3
Taiwan	15	2.1	5	2.3
Botswana	12	1.7	4	1.8
China	12	1.7	4	1.8
Indonesia	11	1.6	5	2.3
Egypt	7	1.0	3	1.4
Morocco	7	1.0	2	0.9

Pakistan	7	1.0	3	1.4
Senegal	6	0.9	2	0.9
Italy	6	0.9	1	0.5
Japan	5	0.7	2	0.9
Algeria	5	0.7	3	1.4
Finland	4	0.6	1	0.5
Tunisia	3	0.4	1	0.5
Burkina Faso	3	0.4	1	0.5
Australia	3	0.4	0	0.0
Ireland	3	0.4	1	0.5
United Arab Emirates	3	0.4	2	0.9
Vietnam	3	0.4	1	0.5
New Zealand	2	0.3	0	0.0
Jordan	2	0.3	2	0.9
Norway	2	0.3	1	0.5
Iraq	2	0.3	1	0.5
Turkey	2	0.3	1	0.5

Libya	2	0.3	1	0.5
Estonia	1	0.1	1	0.5
India	1	0.1	0	0.0
Nigeria	1	0.1	0	0.0
Lebanon	1	0.1	1	0.5
Qatar	1	0.1	0	0.0
Philippines	1	0.1	1	0.5
Mexico	1	0.1	0	0.0
Total	699		219	

Authors Counts by Region

Region	% of Authors
Middle East and Africa	69.2
Asia/Pacific	13.6
Europe	9.3
Canada	3.9
United States	3.4
Latin America	0.6

Authors by Country and Region (Accepted Papers)

Country	Total Number of Authors	%	Total Number of Papers	%
Morocco	231	53.2	66	55.5
Saudi Arabia	26	6.0	6	5.0
Canada	25	5.8	5	4.2
France	24	5.5	4	3.4
USA	19	4.4	5	4.2
United Kingdom	15	3.5	2	1.7
China	12	2.8	4	3.4
Taiwan	9	2.1	3	2.5
Botswana	8	1.8	2	1.7
Malaysia	8	1.8	2	1.7
Pakistan	7	1.6	3	2.5
Senegal	6	1.4	2	1.7
Egypt	6	1.4	2	1.7
Italy	5	1.2	1	0.8

Bangladesh	4	0.9	1	0.8
Finland	4	0.9	1	0.8
Ireland	3	0.7	1	0.8
Japan	3	0.7	1	0.8
Burkina Faso	3	0.7	1	0.8
Tunisia	3	0.7	1	0.8
Indonesia	3	0.7	1	0.8
United Arab Emirates	2	0.5	1	0.8
New Zealand	2	0.5	0	0.0
Norway	2	0.5	1	0.8
Jordan	2	0.5	2	1.7
India	1	0.2	0	0.0
Lebanon	1	0.2	1	0.8
Total	434		119	

SHAPING THE FUTURE, ONE STEP AT A TIME

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LIST OF ACCEPTED PAPERS

Compact Low SAR X-Band Planar Inverted F Antenna for Wearable Application

Sahar Saleh (Atlantic Technological University, Ireland & Aden University, Yemen); Tale Saeidi and Nick Timmons (Atlantic Technological University, Ireland); Faroq Razzaz (Prince Sattam Bin Abd, Saudi Arabia)

A compact planar inverted-F antenna (PIFA) operating in the X-band is developed for wireless mobile applications. The antenna is mounted on an extended FR4 substrate mimicking the dimensions of a typical mobile phone and positioned on a realistic head phantom in a talk scenario to replicate actual usage conditions. Initial design optimization is performed in free space to determine the final dimensions, followed by additional tuning for enhanced compactness and performance. The full FR4-based antenna is then tested on the head phantom to assess potential detuning and performance degradation. Detailed parametric analysis, considering both the phantom and substrate, yields a compact PIFA with dimensions of 36 × 24 × 1.6 mm, offering wide bandwidth coverage across the entire X-band and part of the Ku-band (9.09-12.23 GHz), with S11 < -11.98 dB, a peak gain of 6.19 dBi, and radiation efficiency between 50-65%. To ensure user safety, the specific absorption rate (SAR) is evaluated at the resonant frequencies and found to be within the limits set by the European Union Council and FCC. Simulations are conducted using CST software based on the Finite Integration Technique (FIT).

Hybrid Malware Classification Using Static and Dynamic Features with Machine Learning

Mohammed Ibrahim El-hajj (Arab Open University - Lebanon (AOU), Lebanon)

The escalating sophistication of malware threats necessitates innovative detection strategies that combine complementary analysis paradigms. This paper presents a hybrid machine learning framework for malware classification that integrates static and dynamic features through hierarchical fusion, achieving robust detection against evolving threats. Leveraging the Microsoft Malware Classification Challenge, VirusShare, and Malimg datasets, our methodology combines PE header analysis, byte n-grams, and API call sequences with dynamic behavioral traces from sandbox execution. The proposed attention-based fusion strategy demonstrates superior performance (92% accuracy, 0.96 AUC-ROC), outperforming static-only (87% accuracy) and dynamic-only (83% accuracy) approaches while maintaining practical computational efficiency (32ms inference latency). Feature importance analysis identifies byte-level patterns (35%) and system call sequences (28%) as critical discriminators, enabling targeted defense optimizations. Despite challenges in adversarial evasion resistance (8% undetected samples) and memory footprint (7.5GB RAM), the framework provides a foundation for next-generation detection systems, particularly through its open-source implementation and modular architecture. These findings advance hybrid analysis as a pragmatic balance between detection efficacy and operational feasibility in enterprise security environments.

Graph-Based Analysis of Brain Connectivity Alterations Induced by Tumors

Fatiha Lamaallaoui (Mohammed V University in Rabat, Morocco); Dounia Lotfi (Mohammed V University in Rabat & Faculty of Sciences, LRIT Associated Unit with the CNRST, Morocco); Sara Laghmati (Mohammed V University, Morocco)

Brain tumors cause major alterations in connectivity by disrupting the anatomical and functional networks of the brain. These disruptions can lead to significant changes in brain communication, affecting both local and global network properties. Better treatment planning and early diagnosis depend on an understanding of these structural changes. In this study, we suggest a new graph-based method for examining the structural alterations in brain connections brought on by malignancies. We describe the brain as a network, where nodes stand for various brain regions and edges indicate anatomical or functional relationships. We quantify and characterize tumor-induced alterations in network topology using sophisticated graph theory metrics, including degree centrality, between centrality, modularity, and clustering coefficients. There are notable differences in the patterns of connection between brains with tumors and those without. Notably, global measurements like as modularity and clustering coefficients show abnormalities in the general structure of the brain network, while regions close to tumors frequently display aberrant centrality values. These results demonstrate the promise of graph-based techniques as a quantitative and systematic tool for identifying changes in brain connection associated with tumors, providing important information for clinical evaluation and early detection.

A Comprehensive Survey on AI-Based Diagnosis of Gallbladder Disease

Jawaher Badr Alotibi, None (Shaqra University, Saudi Arabia); Samia Dardouri (Shaqra University, Saudi Arabia & Innov Com Laboratory, Tunisia)

Gallbladder diseases, including gallstones, cholecystitis, and gallbladder cancer, remain critical global health concerns that demand accurate and timely diagnosis to optimize treatment outcomes. The emergence of Artificial Intelligence (AI), particularly through Machine Learning (ML) and Deep Learning (DL), has significantly advanced diagnostic methodologies. This survey presents a comprehensive review of AI-based techniques for diagnosing gallbladder diseases, synthesizing findings from 20 recent studies. Notably, deep learning models such as MobileNet and ResNet have demonstrated accuracy rates reaching 98.35% in ultrasound-based diagnostic tasks. Moreover, hybrid architectures and Generative Adversarial Networks (GANs) have shown strong potential in overcoming data scarcity and enhancing diagnostic performance. Despite substantial progress, challenges persist, including data limitations, computational demands, and model interpretability. This paper consolidates recent advancements, identifies critical limitations, and outlines future directions emphasizing the importance of data quality, model transparency, and clinical integration for effective AI deployment in gallbladder disease diagnostics.

Adaptive Fuzzy Energy-Efficient Clustering and Energy Optimization Protocol for Underwater Wireless Sensors Networks

Hamza Zradgui (Ibn Tofail University, Morocco); Khalil Ibrahimi (University of IBN Tofail, Morocco & Tofail University, Morocco); Mohamed El Kamili (Higher School of Technology, Hassan II University, Morocco)

Research on underwater wireless sensor networks (UWSNs) has been significant for applications such as forecasting adversity and disaster, hydrological and military surveillance, seepage monitoring, and underwater triangulation. These networks however, face challenges like significant delay spread, soaring interference, noise, jarring environments, poor connectivity, and restricted battery life. They also cause significant problems in terms of energy efficiency and network longevity. Nodes in UWSNs are subject to additional limitations, including fluctuating ambient conditions, large propagation delays, and limited energy supplies. Designing routing protocols for UWSNs is a promising solution to overcome these issues. The Adaptive Fuzzy Energy-efficient Clustering and Energy Optimization (AFECEO) protocol, proposed especially for UWSNs, is thoroughly evaluated in this study in comparison to six popular clustering protocols: GEC, LEACH, PEGASIS, DCHS, DEEC, and LGCA. The fuzzy logic-based adaptive clustering process used by AFECEO dynamically chooses cluster heads by taking into account variables including distance to the sink, node residual energy, and underwater communication difficulties such as acoustic signal attenuation. According to simulation data, under various underwater settings, AFECEO performs better than its competitors in a number of critical performance parameters, such as average remaining energy, dead node count, and network longevity. Notably, AFECEO outperforms conventional protocols in terms of residual energy by up to 45% and dead node reduction by 60%, guaranteeing improved energy optimization and dependable data transfer in UWSNs. This study demonstrates how well AFECEO works as a reliable option for energy-efficient communication in submerged settings, opening the door for more advanced monitoring and exploration uses.

Towards Proactive Cybersecurity in Smart Grids: Behavioral Advanced Persistent Threat Detection via Adversarial and Autoencoder Architectures

Lahcen Hassine (Hassania School of Public Works (EHTP), Morocco); Yassine Loukili (Sidi Mohamed Ben Abdellah University, Morocco); Hasna Chaibi (ENSIAS, Morocco); Younes Ledmaoui (Hassania School of Public Works, Morocco); Saadane Rachid (EHTP, Canada & SIRC LaGeS EHTP, Morocco); Abdellah Chehri (Royal Military College of Canada, Canada)

Smart grids are confronted with growing cybersecurity threats by Advanced Persistent Threats (APTs) targeting vulnerabilities of cyber-physical systems with stealthy, multi-stage attacks. Conventional signature-based rule-driven detection mechanisms cannot detect these advanced threats. This paper presents an active behavior detection system using Generative Adversarial Networks and Autoencoders for benign network behavior modeling and anomaly detection characteristic of APTs. Tested on actual smart grid data, our hybrid solution is 96.5\% accurate and has an F1-score of 96.59\%, surpassing baseline MLPs and state-of-the-art techniques. The main innovations are adversarial training for generating attack patterns and Autoencoder reconstruction for anomaly detection. Experiments show the framework's robustness to stealthy APTs with few false positives. This research propels adaptive defense technologies for critical infrastructure, bridging the gaps in scalability and dynamic threat modeling.

ML-Based UAV Routing with Dynamic Geofencing Using 5G NEF and CAMARA APIs

Wassim Kribaa (University of Vaasa, Finland); Miloud Bagaa (UQTR University, Canada); Ibrahim Afolabi (Aalto University, Finland & Fingletek, Finland); Adlen Ksentini (Eurecom, France); Mohammed Salem Elmusrati and Petri O Välisuo (University of Vaasa, Finland)

In dense urban environments, traditional GNSS-based navigation for Unmanned Aerial Vehicles (UAVs) suffers from multipath interference and signal obstructions, compromising positioning accuracy and increasing risks of collisions and airspace violations. This paper proposes a novel machine learning-based system architecture for autonomous UAV parcel delivery, leveraging standardized 5G Network Exposure Function (NEF) and CAMARA Device Location API to achieve sub-meter location precision. Our approach integrates dynamic geofencing and predictive rerouting at the network edge, powered by a Random Forest-based collision prediction model that proactively adjusts UAV trajectories to avoid restricted zones in real time. Through simulations of six UAVs navigating dynamically updated no-fly zones, we demonstrate that our system significantly reduces time spent in restricted areas to near zero, compared to GNSS-only and rule-based methods, while limiting path-length inflation to approximately 30% for five of six flights. These results underscore the potential of combining 5G-enabled location services with edge intelligence to enhance safety and compliance in urban UAV operations.

IoT Applications Management Approach for Universal Container-Based Gateway Using Webservices

Abdulkadir Dauda (University of Reims Champagne-Ardenne, France); Olivier Flauzac (Université de Reims, France); Florent Nolot (Université de Reims Champagne-Ardenne & Lab-I, France)

Recent advancements in sensors and related technologies have enhanced the ability of Internet of Things (IoT) devices and systems to transmit and receive data of enormous variety. However, the multiplicity of communication standards and protocols used for data exchange among these devices has increased system heterogeneity. This complexity necessitates using gateways and middleware to enable interoperability among disparate devices and systems. While these approaches have improved the handling of heterogeneity, challenges related to dynamic management, scalability, and application orchestration persist. This work proposes a web service management approach for a dynamic, container-based IoT edge gateway that supports multi-protocol and multi-application environments using low-cost hardware and open-source software solutions. The proposed gateway architecture leverages containers to isolate distinct applications and functions, ensuring execution safety and security. It employs Message Queue Telemetry Transport (MQTT) for inter-component communication and utilizes JavaScript Object Notation (JSON) as the application model. The gateway is designed to operate near connected devices, supporting both IP and non-IP protocols. Experimental results demonstrate the gateway's capability to concurrently run multiple applications, with each application's execution safety being maintained independently.

Gain Improvement of a Monopole Antenna for WiMAX /WLAN 5G/6G Applications Using AMC Technique

Tarik EL arrouch (FST, Morocco); Najiba El Idrissi El Amrani (University of Sidi Mohamed Ben Abdellah & Signal, System and Componant Laboratory - Faculty of Science and Technology - FST, Morocco); Mohamed Chaibi (University of Moulay Ismail, Morocco & Team of Renewable Energy, Morocco); Sudipta Das (IMPS College of Engineering and Technology, India); Karim Errajraji (Moulay Ismail University of Meknes, Errachidia, Morocco)

In this work; a new miniaturized broadband patch antenna using the AMC structure is presented. The proposed antenna; powered by a 50 Ohm Microstrip line; resonates at 5.8GHz for WiMAX (3.6/4.8GHz) and WLAN (5.1GHz/5.825GHz) 5G applications. The proposed antenna consists of three layers: a partial ground having a thickness of 0.035mm, a dielectric substrate FR4-Epoxy, with dielectric constant 4.4, thickness of 1.6mm and loss tangent 0.025, and on the top layer the radiating element which is a rectangular patch and parasitic elements with elliptical slot, to achieve the desired impedance bandwidth of 3.03GHz, with a compact size of (26.5 x 29 x 1.6) 〖mm〗 ^3. A novel AMC structure is designed and analyzed to applied at 5.8GHz for WiMAX and WLAN 5G applications. The AMC structure is integrated with 4 x 4-unit cell on the back of antenna, to suppress the back-radiation lob, which improve the antenna gain. the total antennas size of (40 x 40 x 10.4) mm^3. The results, shows that the antennas operate with wide impedance bandwidth around 5.8GHz from 3.62GHz to 6.65GHz. Moreover, that antenna has Hight gain of 8.5dB at 5.8GHz with a maximal value of 10dB at 6GHz. The results show that antenna is suitable choice for WiMAX (3.6GHz/4.8GHz) and WLAN (5.1GHz/5.825GHz) 5G applications.

Design of a Solar-Powered Automated Dip Spray System for Small Stock Farmers in Remote Areas in Developing Countries

Sajid Mubashir Sheikh, Karabo Lindiwe Sithole, Keleboane Tsamaase, Theo Motlhatledi and Thabang Seeketso (University of Botswana, Botswana)

This study describes the design, implementation, and proposed integration of a mobile, solar-powered automated dip spray system designed especially for small livestock, like sheep and goats. The main goal is to address the ongoing difficulties that farmers in isolated and off-grid areas of Botswana face, especially with regard to ticks and other ectoparasite control. The conventional methods of treating livestock, such as applying tick grease and manually spraying, are frequently labor-intensive, inconsistent, and inefficient at guaranteeing full-body coverage. An Arduino Nano microcontroller was used to create a prototype that automated the spraying mechanism in order to address these issues. The system incorporates a solar-powered pump for the dispersion of an anti-parasitic solution, servo motors for gate control, a capacitive sensor for dip level monitoring, and ultrasonic sensors for animal detection. This paper presents the system's technical development and performance analysis, as well as a comprehensive future roadmap that includes integrating animal weight sensors for customized treatment, upgrading to an ESP32 microcontroller for wireless connectivity, and enabling real-time cloud data logging and mobile application interfacing. The system will become an all-inclusive smart livestock management solution that is appropriate for smallholder farmers in sub-Saharan Africa with these future enhancements.

UAV-Assisted Surface Hole Detection and Volume Estimation for Construction Site Monitoring

Sabella Millicent Sefho, Sajid Mubashir Sheikh and Ali Akbar Firoozi (University of Botswana, Botswana)

Construction site monitoring in rapidly urbanizing regions is hindered by the limitations of traditional ground-based inspections, which are often slow, labor-intensive, and lack coverage in hazardous areas. While UAV-integrated systems offer improved aerial perspectives, many existing solutions fall short in real-time volumetric estimation and rely on lightweight CNNs that sacrifice accuracy for speed. To address this gap, we propose a UAV-based, multisensor hole detection and measurement system powered by a custom deep convolutional neural network called HoleDimNet. Unlike lightweight models, HoleDimNet is optimized for high-precision volumetric regression. Experimental evaluation involved handcrafted test holes measured at three UAV altitudes across four terrain types, with each condition repeated three times. HoleDimNet consistently delivered more accurate area and volume predictions than its lightweight counterpart, achieving lower Mean Absolute Error and showing resilience to variable geometry and elevation. Our approach combines affordable drone hardware with advanced deep learning, offering a modular and scalable solution for real-world construction environments. The HoleDimNet model thus, presents a reliable tool for enhancing excavation planning, safety compliance, and autonomous site auditing.

UAV-Assisted Surface Hole Detection and Volume Estimation for Construction Site Monitoring

Aki Nagano (Japan)

The study of human-AI interaction is gaining traction across various fields. As indicated by past research, effective interaction relies on user trust, which hinges on the technical capabilities of AI systems and the overall interaction process. The process of gaining human trust in AI is closely tied to the persona of the AI agent. This research aims to establish design frameworks for developing suitable AI personas within the business environment. Based on the analysis results, this study presents four frameworks for the personas of business AI agents. Specifically, strengthening both cognitive and emotional trust is crucial for business AI personas. Establishing a sense of security and comfort enhances emotional trust, while addressing negative perceptions of technological threats and fears is essential. Developing stereotypical personas for AI agents, particularly for global companies, presents problems. Creating AI personas that align with business objectives is critical. Illustrating these personas based on the goals requires integrating insights from diverse perspectives, including not only designers but also users, managers, academics, and digital experts. Managers and designers are responsible for imbuing AI agents with personas, instilling a sense of humanity that enhances interaction between humans and AI agents.

A Hybrid Semi-Supervised Learning Approach Based Dimensionality Reduction for Emerging IoT Cyber Attack Analysis

Youssra Baja (University of Ibn Tofail, National School of Applied Sciences (ENSA) Kenitra, Morocco); Khalid Chougdali (Ibn Tofail University, National School of Applied Sciences (ENSA) Kenitra, Morocco)

With internet connectivity's dynamic development and network communication escalating, an upward trend in advanced threats and cyber attack crimes is being witnessed, targeting sensitive data and critical systems. As the number of connected devices continues to increase, more opportunities are provided for malicious actors to exploit these vulnerabilities. Therefore, the attack surface expanded, particularly within the Internet of Things (IoT), reinforcing the necessity to design a suitable and adaptable security model for protecting data and minimizing the damage caused by network system intrusions and attacks. Machine learning is a swift and flexible way to develop a cybersecurity model. Clustering and other unsupervised learning techniques are frequently used to find hidden patterns or anomalies without needing labeled data. Still, they are limited in accurately distinguishing between normal and malicious behaviors, particularly when dealing with emerging attacks (such as zero-day attacks). This paper provides a hybrid semi-supervised classification-based clustering approach model to distinguish malicious emerging cyber-attacks. Initially, unsupervised clustering methods were implemented to group related data points and find underlying patterns to the reduced data dimensionality under Principal Component Analysis (PCA). Then, the pseudo-labels generated by clustering were used in supervised tasks with a Support Vector Machine (SVM) for classification. The experiments have been carried out on two IoT datasets, namely MQTTset and IoTID20, and the results confirm that the hybrid strategy is a viable and effective approach to dealing with IoT security issues in complicated and real-world situations.

A SVM-GWO-Based Prediction Method in a Smart Home with a Security-Conscious Data Model

Marran Al Qwaid (Shaqra University, Saudi Arabia)

The integration of Artificial Intelligence (AI) into medicine is rapidly transforming clinical decision-making processes, particularly in critical scenarios involving life and death. This paper examines the ethical, practical, and philosophical challenges posed by AI in end-of-life care and critical medical judgments. It explores the evolution of AI technologies such as machine learning and deep learning, highlighting their growing influence in diagnosis, prognosis, and treatment planning. Drawing on bioethical principles and ethical theories as determinants of human decision making, it exposes the limitations of AI technology to be lacking in ethical and moral compass, hence incapable of solely or self-determine clinical decisions, especially as it involves life and death. While AI offers unprecedented accuracy, efficiency, and data-driven insights, it also introduces complex dilemmas around transparency, accountability, bias, and the erosion of human-centered care, posing a grave consequence of delegating life-altering decisions to non-humanistic systems. The paper also reflects on the role of the physician in this evolving landscape, arguing that for an AI system to be entrusted with life-and-death decisions, it must be humanistic enough to embody the Personified Perfect Physician (PPP) who balances technological inputs with ethical reflection and patient-centered compassion.

Real-Time Sybil Attack Detection in Vehicular Networks Using Simulation-Based Machine Learning

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Vehicular Ad Hoc Networks (VANETs) play a vital role in enabling Intelligent Transportation Systems (ITS) by allowing communication between vehicles and between vehicles and infrastructure. However, these networks are vulnerable to various attacks that can threaten the integrity and safety of the network. One major attack is the Sybil attack, where malicious actors create multiple fake identities to confuse the network and disrupt normal communication and activities. In this work, we develop a real-time detection framework based on machine learning (ML) that processes data generated in real time from simulations using OMNeT++, Veins, and Simulation Urban Molity frameworks. Our approach leverages four ML models: Random Forest, Gradient Boosting, XGBoost, and LightGBM, along with a stacking ensemble model to enhance detection accuracy. The proposed models are periodically trained on batches of data collected during the simulation, enabling continuous learning. Adaptive training strategies and a web-based dashboard enable continuous monitoring and effective detection of Sybil attacks. Notably, the simulation successfully replicates realistic Sybil attack scenarios and yields a new labeled dataset, which can support future research in this area. Our results demonstrate that the framework effectively detects Sybil attacks in dynamic vehicle networks, highlighting its potential to enhance security in ITS.

AI-Enhanced Routing Optimization for SDN/NFV Architectures in Large-Scale IoT Networks

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The integration of Software Defined Networking (SDN) and Network Function Virtualization (NFV) with the Internet of Things (IoT) offers scalable, programmable, and efficient network infrastructures. However, traditional routing mechanisms in such environments often fail to adapt to the dynamic and heterogeneous nature of large-scale IoT networks. In this paper, we propose an AI-based routing optimization method leveraging Deep Q-Networks (DQN) to enhance the routing efficiency in SDN/NFV architectures. Our approach considers real-time parameters including latency, bandwidth, memory availability, and processing load to make adaptive routing decisions. Simulation results on a large-scale IoT topology demonstrate significant improvements in Packet Delivery Ratio (PDR), end-to-end latency, and load distribution when compared to conventional routing algorithms.

EcoFL: Resource Allocation for Energy-Efficient Federated Learning in Multi-RAT ORAN Networks

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Federated Learning (FL) enables distributed model training on edge devices while preserving data privacy. However, FL deployments in wireless networks face significant challenges, including communication overhead, unreliable connectivity, and high energy consumption, particularly in dynamic environments. This paper proposes EcoFL, an integrated FL framework that leverages the Open Radio Access Network (ORAN) architecture with multiple Radio Access Technologies (RATs) to enhance communication efficiency and ensure robust FL operations. EcoFL implements a two-stage optimisation approach: an RL-based rApp for dynamic RAT selection that balances energy efficiency with network performance, and a CNN-based xApp for near-real-time resource allocation with adaptive policies. This coordinated approach significantly enhances communication resilience under fluctuating network conditions. Experimental results demonstrate competitive FL model performance with 19% lower power consumption compared to baseline approaches, highlighting substantial potential for scalable, energy-efficient collaborative learning applications.

Credit Card Fraud Detection Model Based on Explainable TabNet-Based Feature Selection

Karima El Hachimi, Ghizlane Orhanou and Lahoucine Ballihi (Mohammed V University in Rabat, Morocco)

Financial losses and sensitive data breaches are the most popular risks of credit card fraud in this modern society. Advanced deep learning algorithms have shown outstanding performance regarding fraud detection in this field. However, the proposed models still suffer from the imbalance class problem and the high rate of false positives and negatives. To overcome these challenges, we introduce in this paper a new approach based on TabNet-based feature selection and a sequential hybridization of Random Forest and optimized deep learning algorithm. This model outperformed its rivals in detecting complex fraudulent patterns with confidence while minimizing false negatives. Our powerful performance is achieved by combining TabNet feature selection, outlier removal using Z-score and IQR, and strong classification of RF-DL. The imbalance issue was handled using random oversampling. The results of the experiment demonstrated that our model achieved 100% accuracy, 100% precision, and 1.00 recall regardless of the dataset used which proved its generalization.

Modeling and Automated Code Generation of the Backend of Tourism Applications

Adnane Souha, Charaf Ouaddi and Lamya Benaddi (GL-ISI Team, FST Errachida, UMI-Meknes, Morocco); Jakimi Abdeslam (GLISI Teams, Morocco & Moulay Ismail University, Morocco)

The development of tourism applications requires specialized tools capable of capturing the domain's specific characteristics while reducing technical complexity for developers. This paper presents an approach based on a domain specific language (DSL) and code generation templates aimed at accelerating the design and implementation of applications in the tourism sector. The proposed framework enables the modeling of tourism-related entities through a graphical tool and automatically generates structured, maintainable code that aligns with modern software architectures. The generated code constitutes the backend of the tourism application and supports the management of CRUD functionalities. Additionally, a concrete case study demonstrates the effectiveness of this solution, particularly in terms of reducing development time and improving the quality of the generated code.

Performance and Security in AI-Driven mHealth: A Comparative Evaluation of PostgreSQL, MongoDB, and Firebase for Endometriosis Management

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Mobile health (mHealth) applications transform healthcare for chronic conditions like endometriosis. This paper compares Firebase Firestore, MongoDB, and PostgreSQL for "PainCare", an mHealth application developed for endometriosis symptom tracking and AI-driven predictive analysis. We evaluated these systems on backend performance (using ApacheJMeter with up to 100 users), application security (MobSF static, Burp Suite dynamic), and Random Forest AI model integration (trained on a 10,000-instance Kaggle dataset) for endometriosis likelihood prediction. Our findings show PostgreSQL exhibited superior performance and stability under load (28-32ms avg. response, 0% error). Firebase enabled rapid development but faced Firestore performance testing limitations due to SSL errors, alongside a critical vulnerability from an exposed API key. All implementations received "Medium Risk" MobSF security scores (Firebase: 50/100, MongoDB: 44/100, PostgreSQL: 48/100), highlighting common weaknesses like debug configurations. MongoDB offered flexibility for the AI integration, where the Random Forest model achieved approximately 63.27% accuracy. With 63% accuracy, the AI model cannot be used for clinical diagnosis, but can serve as an awareness or preliminary triage tool, helping direct patients to medical consultation. Future improvements are needed to strengthen its reliability and applicability. This study provides empirical evidence and practical considerations for DBMS selection in AI-enabled mHealth, highlighting the essential relationship between performance, security, AI feasibility, and robust application-level security practices while supporting global smart connectivity for decentralized healthcare systems.

Approaches of Deep Learning for Diagnostic Use on Cone Beam CT Imaging in Dentistry: A Review

Jamila El moubaraki (Chouaib Doukkali University, Morocco); Omar Boutkhoum (University Chouaib Doukkali, Morocco); Hamid El Byad (Dental Clinic, Casablanca, Morocco)

Deep learning (DL) has fundamentally transformed the analysis of cone beam computed tomography (CBCT) images in dentistry, a field where its importance is steadily growing for the detection, diagnosis, and surgical treatment of dental pathologies. DL, particularly based on convolutional neural networks (CNNs), is applied to improve the detection and classification of oro-maxillofacial pathologies. Studies show that using CBCT images analyzed with DL can provide superior diagnostic performance for detecting certain odontogenic cystic lesions compared to panoramic radiographs. Precise detection of these lesions is especially critical because they can lead to bone defects, requiring guided bone regeneration (GBR) or bone grafting interventions to fill the void. Beyond pathologies, DL plays a key role in assessing bone quality, particularly after regenerative procedures such as GBR. It notably enables accurate segmentation of critical bone structures like the mandibular canal using CNNs such as U-Net and its 3D variants, improving efficiency while reducing errors compared to semi-automatic methods. Moreover, DL is employed to classify bone density measured in Hounsfield units (HU) from CBCT images, using approaches based on 3D/2D CNNs, offering speed and precision. Evaluating bone density at the implant site is especially essential as it conditions the primary stability of the implant and directly impacts long-term treatment success. These advances mark a major evolution in radiological analysis, enabling a more objective and reliable assessment of bone density, crucial for implant planning. This survey paper presents an overview of several deep learning algorithms currently applied in diagnostic dentistry and implantology, highlighting their visualization of dental and bone structures, thus facilitating inpotential to optimize clinical workflows and improve patient outcomes.

Comparative Radiation Analysis of Vertical and Circular Disk Monopole Antennas for 433 MHz LoRa IoT Applications Using Method of Moments

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The 433 MHz frequency band plays a pivotal role in long-range (LoRa) wireless communication due to its favorable propagation characteristics within the Industrial, Scientific, and Medical (ISM) spectrum. This study investigates and compares the radiation performance of two antenna configurations-circular disk monopoles (CDMs) and vertical monopoles (VMs)-operating at this frequency. Both antenna types are simulated using the Method of Moments (MoM) implemented in MATLAB, with identical ground plane dimensions and material properties to ensure a fair comparison. Key performance metrics, including the two-dimensional (2D) elevation (E-plane) pattern and the three-dimensional (3D) radiation pattern, are analyzed. The findings provide valuable insights into the relative advantages of each monopole structure in LoRa applications requiring directional and omnidirectional radiation characteristics.

TransUNet++: A Multiscale CNN-Transformer Hybrid Framework for Multi-Modal Brain Tumor Segmentation

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Accurate brain tumor segmentation from multimodal MRI scans remains a difficult task due to the wide variability in tumor morphology and the complexity of brain anatomy. To tackle these challenges, we present TransUNet++, a hybrid CNN-Transformer model that integrates convolutional feature extraction with hierarchically organized multi-scale attention pathways. This design allows the network to capture detailed local structures while simultaneously modeling global contextual dependencies. To address boundary ambiguity and class imbalance, we employ a composite loss that combines focal loss, multi-scale structural similarity (MS-SSIM), and the Jaccard index. In addition, an attention-guided decoder is used to filter out irrelevant background signals and refine segmentation accuracy. We evaluated TransUNet++ on the BraTS 2021 benchmark and a clinical dataset from CHU Hospital. The model achieved Dice scores of 0.92 for whole tumor, 0.87 for tumor core, and 0.85 for the enhancing region. These results demonstrate the effectiveness of TransUNet++ and its strong potential for supporting clinical neuro-oncology workflows, particularly in diagnosis and surgical planning.

S-Cup: a Security Protocol for Self-Reconfiguration by Clustering on Programmable Matter Based Modular Robots

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Programmable matter in the context of microrobots is like mobile microcomputers with size of a millimeter, which can move around each other, communicate to form different shapes. Current challenges are as much theoretical as technological. The main research challenges in computer science focus on clustering, synchronization time, decision-making, analysis of detected data, security and the autoconfiguration process, which today remains the most fundamental. When the number of modules is very high, the self-reconfiguration challenge becomes more crucial for applications requiring rapid transition between two forms. Clustering can enable parallel transitions by allowing geographically close modules to make intra-cluster transitions, thus reducing reconfiguration complexity, the number of transitions and the time required. Clustering-based autoconfiguration solutions are available, but they do not include the security aspect. In this paper, we propose a security protocol for clustering-based self-reconfiguration solutions. This solution relies on resource-efficient cryptographic mechanisms to implement a robust authentication solution that underpins a flexible key management mechanism coupled with a confidential data exchange of the resulting structure.

LRAE: a Low-Rank Autoencoder for Real-Time Efficient CAN Bus Intrusion Detection

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This study introduces an innovative Low-Rank Autoencoder (LRAE) for anomaly detection in automotive Controller Area Network (CAN) systems, demonstrating significant advancements over traditional Standard Autoencoders (SAEs). By factorizing weight matrices into compact subspaces (rank \(\leq\)16), the LRAE achieves a 91.3 % reduction in parameters (2,010 vs. 23,198) and a 9 times lower memory footprint (0.01 MB vs. 0.09 MB), enabling efficient deployment on resource-constrained Electronic Control Units. Training dynamics reveal LRAE converges 50 % faster (5 vs. 10 epochs) with a validation loss stabilizing at 0.35, compared to SAE's at 0.05. Evaluated on the SynCAN dataset, LRAE outperforms SAE with a 1,233 % higher recall (0.04 vs. 0.003) and 1,440 % higher F1-score (0.077 vs. 0.005) in continuous attacks, a 148.4 % recall gain (0.226 vs. 0.091) in suppress attacks, and a 48.1 % higher Precision-Recall Area Under the Curve (PR-AUC) (0.228 vs. 0.154) in plateau scenarios. Despite minor trade-offs in flooding (2.7 % lower PR-AUC, 0.741 vs. 0.761) and playback (22.2 % lower F1-score, 0.112 vs. 0.144), LRAE's accelerated convergence and enhanced specificity position it as a pioneering advancement. These results highlight LRAE's potential to revolutionize automotive cybersecurity, blending efficiency with state-of-the-art detection performance.

Blockchain-Enabled Smart Tourism: Key Benefits and Systemic Comparison with Centralized Models

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Recently, smart tourism marks a significant evolution in the tourism industry, driven by the adoption of cutting-edge digital technologies. Yet, it continues to grapple with persistent issues such as centralized data control, reliance on intermediaries, and challenges to digital sovereignty. Blockchain technology has several core characteristics that make it uniquely capable of handling the in-built challenges of smart cities -specifically smart tourism-. This paper examines the potential of blockchain technology to address these issues through its decentralized, secure, and transparent infrastructure. By analyzing both the foundations and limitations of the current smart tourism model, the study outlines how blockchain can contribute to a more robust, disintermediated, and user-centric tourism ecosystem. It also explores the technical, legal, and organizational barriers to blockchain implementation, and proposes directions for its sustainable and responsible integration into the sector.

A Robust Optimal Patient Distribution Enforced by Blockchain

Ahmed Khoumsi (University of Sherbrooke, Canada)

Emergency health care should be provided as carefully and efficiently as possible. We consider patients in a city who are in an emergency condition and need to be distributed across the city's hospitals using an ambulance service A. Patients are characterized by the type of care they need and the city's area where they are located. The costs of hospitalization and transportation of a patient obviously depend on these two characterization elements. We present a method to optimally distribute patients, i.e. we choose which hospital each patient is sent to so that hospital and ambulance capacities are not exceeded and the total cost to be paid to A and hospitals is minimal. A pricing model is developed to determine payments to hospitals and A. Machine learning is suggested to predict the number of patients in each city's area. The management of our optimal patient distribution is carried out using a publicly reliable smart contract in blockchain. This ensures that patient transport and hospitalization, as well as corresponding payments, are recorded in blockchain in a secure, immutable, transparent and decentralized manner. Finally, we suggest how to make patient distribution robust by handling faulty behaviors of hospitals and A and imperfect patient number predictions (PNPs) in city's areas. To this end, we develop a method to detect faulty behaviors and compute corresponding financial penalties, which is particularly difficult with imperfect PNPs.

Reinforced-2GSeg: a Dual-Generator cGAN Enhanced with Channel and Spatial Attention for Accurate and Resource-Efficient Medical Image Segmentation

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Accurate medical image segmentation is crucial for early cancer diagnosis and effective treatment planning. Deep learning methods have significantly advanced segmentation quality, but achieving high precision often comes with increased computational complexity and resource demands, limiting their deployment in many clinical environments, especially those with constrained hardware. Conversely, reducing model complexity to ease resource requirements frequently sacrifices segmentation accuracy, creating a challenging trade-off. To address this balance, we propose Reinforced-2GSeg, a novel dual-generator conditional generative adversarial network (cGAN) architecture enhanced with channel and spatial attention mechanisms. Our design strategically fuses the complementary strengths of two generators, while attention modules focus on the most informative features across channels and spatial regions. This approach enables the model to improve segmentation precision while significantly reducing the number of parameters and computational load. Reinforced-2GSeg was evaluated on multiple medical image datasets, including lung, spleen, and heart images across both CT and MRI modalities. The model consistently outperformed state-of-the-art methods in segmentation accuracy, while also demonstrating low computational complexity and reduced memory usage. These results confirm its effectiveness and efficiency for deployment in resource-constrained clinical environments.

On Convolutional Neural Networks for Mini UAV Swarms

Ryan McCarthy (Steven Institute of Technology, USA); Noor Ahmed (RITA-UARC Howard University, USA & Stevens Institute of Technology, USA)

The combination of Convolutional Neural Networks (CNNs) and small Unmanned Aerial Systems (UAS/UAV) presents a powerful capability of instantaneous in-flight image classification. However, commercial grade mini UAVs lack the computational and power resources needed to perform full CNN inference onboard. This paper presents a dynamic, distributed inference system that fragments CNN model into separate layers deployed across a representation of a swarm of mini-UAV nodes to collectively classify images while dealing with nodes dropping off the network. This is achieved with a combination of Docker swarm for seamless replica/node recovery and replacement, and a checkpoint-based system using Redis as a distributed data store for synchronizing inference data. We develop a prototype built as a Docker swarm on Ubuntu virtual machines then we deploy on Raspberry Pis to illustrate the practicality of our solution scheme on a resource constraint platforms. The preliminary results of classifying 100 images across the UAV swarm of 4 Rasspbery Pis show that distributed inference with Redis-based check-pointing built-on Dockerized swarm maintains inference integrity and system robustness by design.

Parametric analysis of a rectangular microstrip antenna array resonating at 5.8 GHz for a microwave power transfer system.

Ilham Salhane (Hassan II University, Casablanca Morocco & Laboratory RITM/ESTC, Morocco); Hanae Terchoune (ESTC, Hassan II University of Casablanca, Morocco)

Artificial intelligence (AI) and the Internet of Things (IoT) are increasingly being incorporated into daily life. The seamless collaboration of these technologies often obscures the challenges associated with ensuring uninterrupted operation of wireless devices, such as Radio Frequency Identification (RFID) and Unmanned Aerial Vehicle (UAV). Traditional power supply techniques (using batteries or cells) sometimes require periodic replacements or even human intervention to ensure their autonomy. However, this can cause inconveniences such as temporary device shutdowns and unavailability of the device for a certain period. Moreover, for some applications (rural environments, agriculture and even in the military field, for example), access to these devices remains limited, which complicates battery replacement. An innovative approach is necessary to provide continuous and reliable energy. Intelligent solutions will be required to power connected devices in a targeted manner (by directly focusing on them) while taking into account their mobility. To address this issue, Microwave Power Transfer (MPT) has emerged as a promising solution to power IoT devices wirelessly. The MPT system is made up of two main components: a transmission antenna and a rectifying antenna (rectenna), which is an essential element of the system. The rectenna consists of a reception antenna, an HF filter, and a DC filter. This study focuses on improving overall system performance by optimizing the antenna reception component. In the context of our study, we have chosen to conduct a parametric analysis on a rectangular antenna array resonating at a frequency of 5.8 GHz. Our objective is to enhance the system's efficiency by designing a 1x2 antenna array. A gain of approximately 3 dB was achieved for a bandwidth of 200 MHz.

Review of AI Methods for Intelligent Photovoltaic Systems in Smart Grids: Forecasting, Sizing, MPPT, and Fault Diagnosis

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The growing integration of photovoltaic (PV) energy into smart electrical grids presents significant challenges related to intermittency, fault detection, system sizing, and real-time control. This review provides a comprehensive analysis of recent advancements in Artificial Intelligence (AI), particularly Machine Learning (ML) and Deep Learning (DL), for optimizing the operation and management of PV systems within smart grids. The study categorizes and compares AI-based methodologies in energy forecasting, fault detection and diagnosis, intelligent PV system sizing, and optimization of Maximum Power Point Tracking (MPPT) techniques. Through a critical evaluation of recent literature (2020-2025), the review highlights the complementary roles of classical ML models and advanced DL architectures, including LSTM networks, Transformer models, and hybrid approaches combining physics-based knowledge with data-driven learning. Moreover, heuristic optimization algorithms such as Particle Swarm Optimization (PSO) are discussed for their contribution to enhancing convergence speed and accuracy in MPPT and diagnostic applications.

This review not only synthesizes state-of-the-art AI strategies but also identifies key technical gaps related to data availability, computational complexity, and model interpretability. Emerging solutions such as federated learning, edge computing, and Explainable AI (XAI) are discussed as promising pathways toward scalable, trustworthy, and autonomous PV energy systems. The study aims to support researchers and practitioners in designing robust, real-time AI-based frameworks for next-generation renewable energy integration.

Performance Evaluation of MQTT and ZeroMQ Messaging Protocols for UAV Applications

Yufei Liu (Stevens Institute of Technology, USA); Noor Ahmed (RITA-UARC Howard University, USA & Stevens Institute of Technology, USA)

Unmanned Aerial Vehicles (UAVs) increasingly rely on machine learning (ML) for tasks such as environmental monitoring and disaster response, requiring efficient communication protocols to support real-time data exchange. This paper evaluates MQTT and ZeroMQ - two widely used messaging protocols - in UAV-based networks running data-intensive ML applications. We develop a UAV communication framework, dubbed MQLink, and analyze key performance metrics including transmission time, error rate, and CPU usage. A prototype of MQLink is developed and deployed on Raspberry Pi de- vices to demonstrate the system's effectiveness. Experimental results reveal how workloads of different sizes affect protocol performance, highlighting trade-offs in reliability, latency, and resource consumption. These findings provide valuable insights for selecting the most suitable protocol for UAV applications based on computational workload and network conditions.

A Flexible Architecture for the Management and Security of Transactions and Data Flows for Connected Objects in the Context of the Smart Home

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The Internet's evolution seeks to bridge the virtual and physical worlds via the Internet of Things (IoT), enabling better access to real-world resources. Advances in wireless networks have fueled IoT applications in surveillance, security, healthcare, smart homes, cities, and logistics. This work addresses cybersecurity challenges in smart home environments. We analyze key threats from IoT literature and propose a flexible architecture to manage transactions and data flows. Our system combines centralized and decentralized models and integrates application-layer protocols for efficient flow control, minimizing computation in resource-limited devices. At the base layer, security protocols mitigate vulnerabilities in machine-to-machine (M2M) systems. Experimental results confirm the system's effectiveness in reducing eavesdropping and malware threats while lowering computational overhead for low-energy devices.

A Multi-Agent DDQN-Based Joint Spectral and Energy-Efficient Resource Allocation in D2D-Assisted Heterogeneous 6G Networks

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Device-to-device (D2D)-assisted sixth-generation (6G) wireless networks necessitate intelligent resource management and power control to improve the overall system performance. Additionally, D2D underlay communication, a key enabler for improving spectral efficiency, is often hindered by interference, which adversely impacts the quality of service (QoS) for cellular users (CUs) and also degrades the performance of D2D users (DUs). Considering this, we propose a deep reinforcement learning-based method for resource management and power allocation in D2D-assisted heterogeneous networks (HetNets). A joint optimization problem integrating power control and channel selection is formulated for maximizing the system's spectral energy efficiency (SEE). Specifically, a multi-agent, double-deep Q-network (DDQN) algorithm is proposed in which each user equipment (UE) is trained as an action selection and target estimation agent. These agents dynamically optimize transmit power levels and channel selection to meet the QoS requirements of both CUs and DUs. Simulation results indicate that the proposed approach achieves significant improvement in average SEE by 19.84%, 35.27%, and 69.37% compared to the advantage actor-critic (A2C), deep Q network (DQN), and random allocation (RA) methods, respectively. This highlights the robustness of the proposed method in enabling efficient resource management for D2D communication, contributing to the development of self-sustainable networks.

INSPIRING MINDS, LEADING FUTURES

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A Strategy of Guaranteed Information Freshness for Several Receivers Under Jamming

Andrey Garnaev (Rutgers University, USA); Wade Trappe (WINLAB, Rutgers University, USA)

The shared and open access nature of wireless technologies makes wireless networks susceptible to interference, such as jamming, that could lead to delays in communication and result in delays with corresponding timely information updates. Such delay in information updates might be crucial when an operator controls mobile objects since their untimely updates might lead to drastic consequences. Specifically, we consider an operator communicating with drones performing a joint mission in a protected zone. The protector employs a spherical jamming signal to jam the communication of the operator with the drones to fail their joint mission. To design anti-jamming strategyin such scenario involvingagents, the operator and the protector, with different objectives, game theory is employed. Traditionally, in such background, anti-jamming strategy aims to minimize the total information freshness reflected by the total delay in information update. A con of such a traditional approach is that, due to limited resources, the operator might have to sacrifice the delay in information update for some drones to minimize the total delay. This could fail the joint drones mission since some drones might follow outdated commands. In this paper, motivated by this observation, we suggest using the guaranteed information freshness metric as a cost function for the operator. Under this metric, we specify the maximal time passed since the last data update for each of the drones. Anti-jamming strategy is derived and its advantage in comparison with minimizing total information freshness strategy is illustrated.

Intrusion Detection in IoT Networks Using Hybrid Feature Selection

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With the fast growth of the Internet of Things (IoT), the potential of cyber attacks has also increased. Consequently, Intrusion Detection Systems (IDS) are now essential for protecting IoT systems. Traditional IDS models are impacted by large-dimensional, imbalanced, and noisy traffic data. Feature selection is a central requirement to minimize computational overhead and maximize detection precision in low-powered IoT devices. A novel feature selection method based on a joint approach that integrates Symmetrical Uncertainty (SU) and Trace Ratio Criterion (TRC) is proposed in this paper. The feature sets of dual-ranked rankings are combined through average rank aggregation to produce a compact and informative subset. Experimental testing, using the IoTID20 dataset, shows that combining SU with TRC significantly boosts attack detection, improves overall accuracy, and reduces false positives compared to individual algorithms such as TRC and SU.

Long-Term Hybrid MRC with Imperfect CSI for Distributed MU-MIMO Systems

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We propose low-complexity long-term two-stage beamforming techniques for uplink distributed MU-MIMO systems. Stage one involves analog (A) or digital (D) maximal ratio combining (MRC), followed by long-term decoding (LT) in stage two, denoted as A-LT and D-LT. We derive an approximate expected signal-to-interference-plus-noise-ratio (SINR) for A-LT and D-LT, considering correlation, channel estimation errors, and various base station layouts. These novel analytical results can be used to evaluate the performance of wireless communication systems under different scenarios without the need for extensive simulations or experiments. Our findings indicate that as the number of antennas increases, the performance gap between A-LT, D-LT, and A-D, D-D diminishes. A-D and D-D necessitate accurate channel state information (CSI), while A-LT and D-LT solely rely on channel statistics, significantly alleviating the channel estimation overhead. This suggests that A-LT and D-LT show promise for scalable, cost-effective massive distributed MU-MIMO systems.

Mathematical Modeling and Metaheuristic Optimization of IoT Task Scheduling in Distributed Flow Shop Edge Networks

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In this paper, we address the critical challenge of scheduling IoT tasks in distributed edge computing environments. These tasks often require fast and continuous processing across multiple stages, which makes the scheduling process more complex. In order to address the problem more effectively, we model it as a Distributed Flow Shop Scheduling Problem (DFSSP) with no-wait constraints, where each task must be executed without delays between stages. The objective is to minimize the maximum tardiness, which represents the longest delay of any task beyond its due date. Because the problem is NP-hard, exact methods are not suitable for large instances. To solve it efficiently, we propose three metaheuristic approaches: Variable Neighborhood Search (VNS), a population-based Iterated Local Search (ILS), and Iterated Greedy with Simulated Annealing (IGSA). Experimental results on benchmark instances prove the effectiveness of our approaches in reducing maximum tardiness while maintaining low computation time.

Federated Learning for DDoS Attack Detection in SDN: a Privacy-Preserving Approach

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The main objective of this contribution is to provide an in-depth analysis of the vulnerabilities present in the various layers of the SDN environment as well as to propose a novel solution to detect distributed denial-of-service (DDoS) attacks, as they pose a serious threat to the stability and availability of software-defined networks. In addition, a federated learning framework is introduced to identify DDoS attacks in SDN environments, which simultaneously protects privacy while maintaining high detection accuracy. Our proposed solution reduces the risk of data breaches and protects the confidentiality of sensitive data by training models locally. We have used FL to train three classifiers: Deep neural networks (DNN), convolutional neural networks (CNN) and (LSTM) Long Short-term memory to classify two categories of DDoS attacks, namely: UDP Flood, TCP SYN. Achieving 99.99% accuracy and a 99.99% F1-score on TCP SYN floods, alongside 99.94% and 99.97% on UDP floods, our federated CNN not only exceeds the most robust centralized benchmarks but also outperforms our own federated DNN and LSTM models, establishing a new benchmark for SDN DDoS detection while ensuring complete privacy of raw traffic within each domain.

Hybrid Deep Reinforcement Learning for Joint Resource Allocation in Multi-Active RIS-Aided Uplink Communications

Mohamed Magdy Hamed Shalma, Engy Aly Maher and Ahmed E. El-Mahdy (German University in Cairo, Egypt)

Active Reconfigurable Intelligent Surfaces (RIS) area promising technology for 6G wireless networks. This paper investigates a novel hybrid deep reinforcement learning (DRL) framework for resource allocation in a multi-user uplink system assisted by multiple active RISs. The objective is to maximize the minimum user rate by jointly optimizing user transmit powers, active RIS configurations, and base station (BS) beamforming. We derive a closed-form solution for optimal beamforming and employ DRL algorithms-Soft actor-critic (SAC), deep deterministic policy gradient (DDPG), and twin delayed DDPG (TD3)-to solve the high-dimensional, non-convex power and RIS optimization problem. Simulation results demonstrate that SAC achieves superior performance with high learning rate leading to faster convergence and lower computational cost compared to DDPG and TD3. Furthermore, the closed-form of optimally beamforming enhances the minimum rate effectively.

Securing Microservices: Risk-Adaptive gRPC Access Control Policies

Rami Alboqmi and Rose Gamble (University of Tulsa, USA)

There is an increased adoption of Google Remote Procedure Call (gRPC) as one of the key communication protocols in microservice architecture (MSA) applications. This adoption leads to extending the need for runtime adaptive access control policies through the service mesh to reduce the risks of compromised microservices reaching other microservices. A service mesh, as a layer within the orchestration solution, provides features, such as secure communication, within a deployed MSA application. However, it lacks the mechanisms for adaptive gRPC access control policies to meet the zero-trust principle of always verifying and never trusting. This paper introduces a novel mechanism that extends our previous work on risk-adaptive access control to the use of gRPC through the service mesh. We demonstrate our approach and show how gRPC adaptive access control policies can be applied dynamically at runtime for deployed microservices. We use Kubernetes as the orchestration solution and Istio as the service mesh platform in a model MSA application called Online Boutique hosted on the CloudLab scientific computing platform.

MDP-Based Modeling of TSN Switches Under Stochastic Flow Behaviors

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Existing performance analyses and transmission policy designs under Time-Sensitive Networking (TSN) typically assume that all data flows are periodic and deterministic. However, in real-world scenarios, various sources of uncertainty -- such as device failures, environmental variations, or upstream congestion -- can lead to unexpected packet arrivals or losses, introducing non-deterministic behaviors into the network. This work develops a stochastic model based on Markov Decision Process (MDP) to capture the dynamics of TSN switch transmission under such conditions. To address the inefficiency caused by stale packets blocking fresher and more valuable ones, we propose a stale packet skipping policy to enhance the transmission efficiency. Specifically, a stale packet is discarded if a newer packet of the same flow is injected into the queue or if its deadline can no longer be met. This paper presents a detailed model description of the stochastic packet behaviors, the transmission system, and the stale packet skipping policy.

Boosting IoT Intrusion Detection with Hybrid Federated Learning

Salah El Hajla and Elmahfoud Ennaji (Sultan Moulay Slimane University, Morocco); Yassine Maleh (UMS, Morocco); Soufyane Mounir (Sultan Moulay Slimane University, Morocco)

IoT network security faces dual challenges: effectively detecting intrusions while safeguarding user privacy. This paper introduces HFEL (Hybrid Federated Ensemble Learning), an innovative approach integrating tree-based algorithms with neural networks in a privacy-preserving federated architecture. By combining Random Forest and XGBoost with a Federated Multi-Layer Perceptron, our framework maintains data locality while enhancing detection capabilities through ensemble techniques. HFEL uniquely addresses the performance initialization issues common in federated learning systems through its hybrid design. Experimental validation on BoT-IoT and Edge-IIoT datasets demonstrates HFEL's exceptional performance, achieving detection accuracies of 99.94% and 97.53% respectively. Comparative analysis reveals substantial improvements over both traditional federated approaches and current state-of-the-art methods. This research advances the field by demonstrating how ensemble strategies can overcome key limitations in federated intrusion detection without compromising privacy constraints.

AI-Driven Diabetes Management: a Retrieval-Augmented Conversational Approach

Mahmoud El Hamlaoui (ENSIAS, Mohammed V University in Rabat, Morocco); Anass Bengmah and Abdelhakim Khaouiti (ENSIAS, Morocco); Bouchaib Bounabat and Rdouan Faizi (Mohammed V University in Rabat, Morocco)

This paper presents Diabot, a specialized conversational chatbot designed to assist individuals managing diabetes. The development of Diabot addresses a critical need for accurate, accessible, and empathetic diabetes information in a digital format. Three approaches were explored to enhance the chatbot's capabilities: prompt engineering, fine-tuning of Large Language Models (LLMs), and Retrieval-Augmented Generation (RAG). The implementation focuses on contextual filtering, specialized LLM utilization, and an intuitive user interface. The RAG approach emerged as the most effective solution, overcoming hardware limitations and resource constraints while maintaining response accuracy. The system architecture, implementation challenges, and future improvements are discussed, including the integration of calculation capabilities for precise numerical responses. Diabot demonstrates the potential of specialized conversational AI in healthcare, particularly for chronic condition management like diabetes.

Combating Neural Network Adversaries in Autonomous Vehicles: a 6G-Ready Defense Framework

Mohammad Javaad Akhtar, Rishabh Jain and Iqra Batool (University of Western Ontario, Canada); Mostafa M Fouda (Idaho State University, USA); Mohamed I. Ibrahem (Augusta University, USA); Sherief Hashima (Research Scientist & RIKEN-AIP Japan, Japan); Zubair Md Fadlullah (University of Western Ontario, Canada)

The escalating integration of deep neural networks(DNNs) in autonomous vehicles underscores the urgency of fortifying them against adversarial attacks. This paper presents a novel approach to enhance the robustness of convolutional neural networks (CNNs) in self-driving cars through a combination of adversarial mitigation techniques: They are randomization, image padding, and most uniquely, the addition of random Gaussian noise after convolution layers. Our specialized neural network demonstrates consistent steering control under various attack scenarios, avoiding the over-steering or under-steering issues observed in standard models. As 6G networks emerge with their ultra-reliable low-latency communication capabilities, our research contributes. to the security foundation necessary for autonomous vehicles in this coming era, where resilience against adversarial manipulation will be crucial for maintaining safety in increasingly connected transportation ecosystems. Our open-sourced model provides a benchmark for real-time attack-resistant systems applicable to 6G-enabled autonomous driving technologies.

EYE-DEX: Eye Disease Detection and EXplanation System

Youssef Sabiri (Al Akhawayn University, Morocco); Walid Houmaidi (Al Akhwayn University, Morocco); Amine Abouaomar (Al Akhawayn University in Ifrane, Morocco)

Retinal disease diagnosis is critical in preventing vision loss and reducing socioeconomic burdens. Globally, over 2.2 billion people are affected by some form of vision impairment, resulting in annual productivity losses estimated at $411 billion. Traditional manual grading of retinal fundus images by ophthalmologists is time-consuming and subjective. In contrast, deep learning has revolutionized medical diagnostics by automating retinal image analysis and achieving expert-level performance. In this study, we present EYE-DEX, an automated framework for classifying 10 retinal conditions using the large-scale Retinal Disease Dataset comprising 21,577 eye fundus images. We benchmark three pre-trained Convolutional Neural Network (CNN) models-VGG16, VGG19, and ResNet50-with our fine-tuned VGG16 achieving a state-of-the-art global benchmark test accuracy of 92.36%. To enhance transparency and explainability, we integrate the Gradient-weighted Class Activation Mapping (Grad-CAM) technique to generate visual explanations highlighting disease-specific regions, thereby fostering clinician trust and reliability in AI-assisted diagnostics.

PFANS: an Intelligent 6G Framework for Dynamic Autonomous Vehicle Learning

Iqra Batool (University of Western Ontario, Canada); Mostafa M Fouda (Idaho State University, USA); Mohamed I. Ibrahem (Augusta University, USA); Muhammad Ismail (Tennessee Tech University, USA); Sherief Hashima (Research Scientist & RIKEN-AIP Japan, Japan); Zubair Md Fadlullah (University of Western Ontario, Canada)

Autonomous vehicles generate massive sensor data daily but operate as isolated intelligence units due to privacy constraints and network limitations. Current centralized machine learning approaches face critical barriers including compliance issues, high bandwidth costs, and latency constraints preventing real-time safety decisions. While Federated Learning (FL) enables collaborative training without raw data sharing and 6G networks promise ultra-low latency, a fundamental mis- match exists between FL's dynamic computational demands and 6G's static resource allocation mechanisms. This paper presents PFANS, a Predictive FL-Aware Network Slicing framework that integrates real-time convergence modeling with proactive 6G slice reconfiguration for autonomous vehicle networks. PFANS predicts FL computational demands multiple training rounds in advance and automatically reconfigures network slices before bottlenecks occur. Experimental results demonstrate superior resource utilization efficiency, significantly faster convergence compared to baseline approaches, and excellent handover success rates with minimal context migration times. The framework achieves state-of-the-art prediction accuracy while introducing negligible network overhead, establishing effective adaptive resource management for next-generation vehicular networks.

AttriGen: Automated Multi-Attribute Annotation for Blood Cell Datasets

Youssef Sabiri (Al Akhawayn University, Morocco); Walid Houmaidi (Al Akhwayn University, Morocco); Fatima zahra Iguenfer (Al Akhawayn University, Morocco); Amine Abouaomar (Al Akhawayn University in Ifrane, Morocco)

We introduce AttriGen, a novel framework for automated, fine-grained multi-attribute annotation in computer vision, with a particular focus on cell microscopy where multi-attribute classification remains underrepresented compared to traditional cell type categorization. Using two complementary datasets: the Peripheral Blood Cell (PBC) dataset containing eight distinct cell types and the WBC Attribute Dataset (WBCAtt) that contains their corresponding 11 morphological attributes, we propose a dual-model architecture that combines a CNN for cell type classification, as well as a Vision Transformer (ViT) for multi-attribute classification achieving a new benchmark of 94.62% accuracy. Our experiments demonstrate that AttriGen significantly enhances model interpretability and offers substantial time and cost efficiency relative to conventional full-scale human annotation. Thus, our framework establishes a new paradigm that can be extended to other computer vision classification tasks by effectively automating the expansion of multi-attribute labels.

Accelerating Cerebral Diagnostics with BrainFusion: a Comprehensive MRI Tumor Framework

Walid Houmaidi (Al Akhwayn University, Morocco); Youssef Sabiri (Al Akhawayn University, Morocco); Salmane El Mansour Billah and Amine Abouaomar (Al Akhawayn University in Ifrane, Morocco)

The early and accurate classification of brain tumors is crucial for guiding effective treatment strategies and improving patient outcomes. This study presents BrainFusion, a significant advancement in brain tumor analysis using magnetic resonance imaging (MRI) by combining fine-tuned convolutional neural networks (CNNs) for tumor classification -including VGG16, ResNet50, and Xception-with YOLOv8 for precise tumor localization with bounding boxes. Leveraging the "Brain Tumor MRI Dataset", our experiments reveal that the fine-tuned VGG16 model achieves test accuracy of 99.86%, substantially exceeding previous benchmarks. Beyond setting a new accuracy standard, the integration of bounding-box localization and explainable AI techniques further enhances both the clinical interpretability and trustworthiness of the system's outputs. Overall, this approach underscores the transformative potential of deep learning in delivering faster, more reliable diagnoses, ultimately contributing to improved patient care and survival rates.

No-Reference Image Quality Assessment Using FPLBP Features with Laplacian of Gaussian

Yassine Benhlal (Chouaib Doukkali University, Morocco); Khadija Marzagui (University of Chouaib Doukkal, Morocco); Abdelkaher Ait Abdelouahad (LAROSERIE, Chouaib Doukkali University, Morocco); Abdellatif Dahmouni (LAROSERI, Chouaib Doukkali University, Morocco)

The image quality assessment (IQA) process seeks to determine how people perceive the quality of an image it remains necessary for many image processing and computer
vision applications. In this paper, we propose a novel noreference IQA method based on quality-aware texture descriptors constructed using Four-Patch Local Binary Patterns (FPLBPs). Our First, to improve the description of local textures typically affected by visual distortions, we propose modeling them using a multiscale approach. In which, each image is rendered on several subscales using Laplacian-Gaussian (LoG) filters at varying frequency bandwidths. Second, obtained subband images are then used to calculate the FPLBPs descriptors. Second, we calculate the FPLBP descriptors for each of the subband images. In fact, FPLBP consists of modeling the spatial structure based on local intensity variations across each patch, defining local texture representations as local histograms, and generating the global feature vector by concatenating these local histograms.
This reflects the overall perceived image quality. Lastly, we train a Support Vector Regressor (SVR) to estimate the Mean Opinion Score (MOS) directly from the feature vectors. Evaluation using a benchmark for IQA, shows that our method has strong associations with subjective quality scores.

Seizure Detection Using Reduced Temporal EEG Channels: a Performance-Driven Approach

Mohsin Khalil, Raheel Asif and Muhammad Amir Tahir (National University of Sciences and Technology, Pakistan); Muhammad Nasar Jamal (NUST, Pakistan)

Electroencephalography (EEG) is integral to diagnosing brain disorders, particularly epilepsy. As research advances, there is a significant shift towards mobile and ambulatory EEG systems, necessitating the simplification of traditional setups that typically involve numerous electrodes, thereby increasing cost and complexity. Mohsin Khalil, Raheel Asif and Muhammad Amir Tahir (National University of Sciences and Technology, Pakistan); Muhammad Nasar Jamal (NUST, Pakistan) Electroencephalography (EEG) is integral to diagnosing brain disorders, particularly epilepsy. As research advances, there is a significant shift towards mobile and ambulatory EEG systems, necessitating the simplification of traditional setups that typically involve numerous electrodes, thereby increasing cost and complexity. This study harnesses time domain features within EEG recordings, proposing the exclusive use of temporal channels to enhance device practicability.

A Hybrid CNN-LSTM Architecture for Multiclass Intrusion Detection in IoT Networks

Mehdi Moucharraf (Hassan II University, Morocco); Mohammed Ridouani (Hassan 2 University Casablanca - ESTC, Morocco); Fatima Salahdine (University of North Carolina at Charlotte, USA); Naima A Kaabouch (University of North Dakota, USA)

As cyber threats against Internet of Things (IoT) environments have become more diverse and complex. Therefore, there is increased demand for accurate and intelligent Intrusion Detection Systems (IDS). Conventional machine learning techniques fall short in defining the inherent spatial-temporal patterns typically found in network traffic. This paper introduces a hybrid deep learning methodology that integrates one-dimensional Convolutional Neural Networks (CNN) with Long Short-Term Memory (LSTM) layers to perform multiclass learning. The model was trained and assessed using the UNSW-NB15 dataset, which includes a variety of attacks. The preprocessing pipeline was comprehensive and covered missing value handling, categorical encoding, feature scaling, and categorical label transformation. The input data, once reshaped through a preprocessing pipeline, was fed to a stacked CNN-LSTM architecture for local feature representation learning and sequential dependence learning. The model produced a test score of 97.81% for accuracy, 98.97% precision, and 97.00% recall when identifying both common and complex attack categories. Given the model has relatively few trainable parameters, it can deliver a high performance whilst remaining computationally efficient- the ability to use the CNN-LSTM architecture could enable the deployment of security solutions in real-time for IoT security frameworks.

A Novel Hybrid XGB-RF BlendStack Model for Traffic Flow Prediction

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Accurate short-term traffic flow prediction is crucial in the realm of Intelligent Transportation Systems (ITS), driving effective planning and management. Existing methodologies often falter in capturing the intricate nonlinearities within traffic flow dynamics, resulting in suboptimal prediction accuracy. Addressing this, our study introduces a novel hybrid deep learning and ensemble model harnessing Long Short-Term Memory (LSTM), Gated Recurrent Unit (GRU) networks, as well as Random Forest (RF) and XGBoost algorithms. his fusion is supposed to help automatically extract the important contents from the traffic flow features. Ensemble methods, renowned for combining diverse model strengths to bolster overall performance, have steered attention within predictive modeling. Our proposed hybrid technique unites two prominent ensemble algorithms, namely RF and XGBoost, within a stacked ensemble framework. Initially trained on a UCI Machine Learning Repository public dataset, individual Random Forest and XGBoost models merge their predictions through a stacking strategy. Subsequently, a linear regression model synthesizes insights gleaned from these base models using the stacked features. Empirical experimental results reveal that the XGB-RF BlendStack model achieved a remarkable performance with a Mean Absolute Error (MAE) of 114.52, a Root Mean Square Error (RMSE) of 0.03, a Mean Absolute Percentage Error (MAPE) of 66.18%, and an R-squared (R^2) value of 0.99. These values not only demonstrate the superiority of the XGB-RF BlendStack model over standalone RF and XGBoost models but also underscore the efficacy of our hybrid approach in significantly improving predictive accuracy for short-term traffic flow forecasting.

Tifinagh Handwritten Word Recognition Using CNN Algorithm

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The recognition of handwritten Tifinagh words represents an unexplored research area, due to the similarities between character shapes and the rich morphology of this alphabet. To the best of our knowledge, no previous work has specifically addressed the automatic recognition of Tifinagh words. In this context, we propose the first approach based on Convolutional Neural Networks (CNN) for the identification of handwritten Tifinagh words. The experiments conducted achieved an accuracy rate exceeding 98.46% on a set of 65 distinct words from a database of 32,500 samples, while maintaining optimized execution time. These results highlight the promising performance of our method, which stands out for its accuracy and efficiency.

Performance Modeling of Recursive Networks with PEPA: Quantitative Insights and Scalability Challenges

Peyman Teymoori (University of South-Eastern Norway, Norway); Toktam Ramezanifarkhani (Kristiania University of Applied Sciences, Norway)

Recursive layering is re-emerging in 5G-Advanced and 6G--from network slicing to O-RAN disaggregation--yet we still lack a quantitative understanding of how bottlenecks propagate across these stacked control/data loops. We model such systems with the Performance Evaluation Process Algebra (PEPA) and take the Recursive InterNetwork Architecture (RINA) as a canonical example. Eight scenarios capture typical wireless deployments: single- and multi-layer stacks, shared-buffer contention, feedback-controlled retransmission, and soft-failure repair. Exact steady-state analysis of the resulting continuous-time Markov chains yields, for instance, a \textbf{55% throughput collapse} (22.3 pkt/s to 9.8 pkt/s) when the bottleneck shifts from the lower to the upper layer, and quantifies how buffer overflows propagate upward. The study also exposes two methodological limits: (i) state-space size grows super-linearly (36 to 1296 states with one extra layer), exhausting mainstream PEPA tools, and (ii) exponential timing distorts closed-loop dynamics by up to 18% versus phase-type approximations. These findings signal the need for scalable, non-Markovian formalisms-or hybrid analytic/simulation workflows-to keep pace with 6G recursion.

Application of Blockchain Technology in International Maritime Logistics: Case of Smart Bill of Lading

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The Bill of Lading (BoL) is the most important commercial document in the entire in international transport, particularly maritime transport. It has three main functions: it contains proof of the contract of carriage, serves as a receipt for the goods, as well as the title to the goods, but is generally issued in the form of a physical paper document signed and stamped by the carrier or from PDF files. However, both methods have serious disadvantages such as the risk of fraud, high costs, production, administration and storage times, as well as significant environmental impacts. Our goal in this article is to make the BoL electronically smart using blockchain technology by replacing the traditional paper document by ensuring full traceability of all logistical operations and events. Our Smart BoL proposal using a private cloud blockchain can only be transferred between connected and registered companies that become users (shipper, carrier, consignee, as well as other stakeholders). The connection can only be accepted or initiated through the published address book of these users. An intelligent BoL will serve as an immutable audit trail, absolute transparency of business events and unbreakable confidentiality between business partners.

A Novel Approach to Test Case Generation in Software Testing Using Pre-Trained Large Language Models

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the emergence of Large Language Models (LLM) has revolutionized software engineering due to their ability to understand and generate natural language. Current approaches to test case automation using LLM, relying solely on focal methods or text, struggle to capture expected behaviors, edge cases, and errors, and are poorly suited for Test-Driven Development (TDD). In this context, we propose an approach that combines text and focal methods for test case generation, using comments within the code alongside the logic of the target method. By leveraging the LLaMA 3-8Bmodel, prompt engineering techniques, and evaluation with an LLM acting as a judge, our method aims to automate and improve test case generation. Tested on open-source projects, it successfully generated 7,606 test cases, achieving a 97% syntax correction rate.

ECHO: an Explainable Cooperative Highway Operator for Human-Centric ADAS

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ECHO is a next-generation advanced driver-assistance system (ADAS) that integrates multi-modal perception, cooperative V2X communication, and an agentic large language model (LLM) for explainable, human-centric support. Unlike traditional ADAS, ECHO does not directly control the vehicle but interprets real-time data from sensors, infrastructure, and driver state, producing transparent natural language guidance and standardized V2X intent messages. Extensive evaluation in both simulation and real-world settings shows that ECHO reduces reaction times to V2X events by over 40%, decreases near-miss incidents by 60%, and significantly enhances cooperative maneuver success compared to conventional ADAS. These results demonstrate the potential of agentic, explainable AI to advance connected mobility with improved safety, trust, and driver engagement.

UAV-Assisted Federated Learning: Elevating Decentralized Training to Optimal Heights

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Federated learning (FL) has recently emerged as a tool for efficient distributed learning. In edge-assisted internet of things (IoT) paradigm, FL can achieve a promising speed of convergence in the learning process while preserving privacy. To overcome the inherent wireless network connectivity challenge in FL based IoT networks, unmanned aerial vehicles (UAVs) can play a vital role in offloading the learned models to a central learning server or play as a flying learning server. In this paper, we investigate the physical layer aspects of harnessing UAVs as flying FL server for the distributed model averaging. In particular, we study the effect of the UAV-to-ground communication model in the convergence of the model accuracy and loss curves using well-known benchmark datasets to illustrate the effects. We illustrate the effect of altering the deployment geometry of IoT clients simultaneously with the trajectory design of the UAVs.

Investigating Cyber Attacks on Linux: a Lightweight Forensic Toolkit

Wiame Bouhali (Inpt, Morocco); Elmostafa Belmekki (National Institute of Posts and Telecommunications, Morocco); Mostafa Bellafkih (INPT, Morocco)

Cybersecurity threats are becoming more frequent, complex, and harmful, constantly putting organizational infrastructures at risk, especially when critical services are hosted on Linux-based systems. When an attack occurs, having a solid incident response process is essential not only for analyzing the breach afterward but also for detecting threats early and helping contain them in real time. Incident response plays a key role before, during, and after an attack, from preparation and detection to containment and post-incident analysis. Traditionally, forensic investigations rely on tools like FTK Imager and Autopsy, which create and analyze full disk images. While powerful, these tools are often slow, resource-intensive, and not ideal for live systems, requiring significant CPU, memory, and storage resources. This makes them difficult to use during urgent or ongoing incidents. To overcome these limitations, our research introduces a lightweight and modular forensic toolkit tailored specifically for Linux systems. Unlike traditional approaches, our toolkit is designed to work in scenarios where speed, minimal overhead,
and targeted analysis are essential. It directly addresses the challenges of heavy resource usage, delayed execution, and the need for automation in incident response. The toolkit works through two main approaches. First, it sends system logs to a SIEM (Security Information and Event Management) platform, where visual dashboards, queries, and detection rules help quickly identify attack techniques. Second, it includes a custom script with two components: a collector that gathers key Linux system artifacts, and an analyzer that analyzes them to reconstruct a detailed attack timeline. A major advantage of this toolkit is its ability to deliver fast, structured, and automated forensic analysis, significantly reducing response time while preserving investigation quality. It allows analysts, IT personnel, and system administrators to act quickly and confidently even in high-pressure scenarios without relying on bulky traditional tools.

W-RPC: a Weighted Reducer Placement and Coflow Scheduling Scheme

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Coflow scheduling and reducer placement are key to minimizing job completion times in data-parallel clusters. The RPC framework jointly addresses these tasks but assumes all coflows have equal importance, neglecting priority differentiation in practical workloads. This paper extends RPC by introducing a weighted scheduling mechanism that computes a score for each coflow based on its waiting time and priority, enabling priority-aware placement and bandwidth allocation. An efficient online algorithm minimizes these scores to favor high-priority coflows. Simulation results show that our approach significantly improves completion times for critical coflows and enhances overall fairness compared to baseline RPC.

Hierarchical Federated Learning for Crop Yield Prediction in Smart Agricultural Production Systems

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In this paper, we present a novel hierarchical federated learning architecture specifically designed for smart agricultural production systems and crop yield prediction. Our approach introduces a seasonal subscription mechanism where farms join crop-specific clusters at the beginning of each agricultural season. The proposed three-layer architecture consists of individual smart farms at the client level, crop-specific aggregators at the middle layer, and a global model aggregator at the top level. Within each crop cluster, clients collaboratively train specialized models tailored to specific crop types, which are then aggregated to produce a higher-level global model that integrates knowledge across multiple crops. This hierarchical design enables both local specialization for individual crop types and global generalization across diverse agricultural contexts while preserving data privacy and reducing communication overhead. Experiments demonstrate the effectiveness of the proposed system, showing that local and crop-layer models closely follow actual yield patterns with consistent alignment, significantly outperforming standard machine learning models. The results validate the advantages of hierarchical federated learning in the agricultural context, particularly for scenarios involving heterogeneous farming environments and privacy-sensitive agricultural data.

vChainNet: Accurate and Scalable End-to-End Slice Modeling for 5G and Beyond Networks

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The need for accurate and scalable modeling of 5G and beyond networks has recently emerged, driven by the reliance on virtual network functions (VNFs) and network slicing. Unfortunately, traditional network modeling approaches fail to capture 5G network behavior since they disregard the domain-specific challenges of modeling 5G networks. We propose vChainNet, the first end-to-end network modeling framework that provides accurate, scalable, and generalizable per-VNF and slice-level modeling for 5G and beyond networks. vChainNet introduces a modular, sequence-to-sequence deep learning architecture that models each VNF independently and composes the per-VNF models for end-to-end slice delay prediction. Our system design overcomes key domain-specific challenges in modeling 5G networks, including the functional variability of VNFs, VNFs' stochastic behavior, and the scale introduced by network densification. To address these challenges, vChainNet tunes a lightweight model composed of over 95% fewer parameters than state-of-the-art models, fuses domain-specific manually-engineered features with automatic feature extraction, and optimizes a distribution-based loss function during model training. Our results show that vChainNet achieves an accuracy improvement up to 10.86% compared to state-of-the-art traditional network models, while providing a speedup of up to 53.33 times over common packet-level simulators. Furthermore, vChainNet's reliance on tuning a lightweight model allows it to generalize to unseen VNF types without extra hyperparameter tuning efforts. These results demonstrate the accuracy, scalability, and generalization ability of vChainNet for modeling 5G and beyond networks.

An Integrated Mobile Application with Tangible Assistive Device for Braille Quranic Studies

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Braille Quranic education presents unique challenges for blind students, but with advancements in assistive technology and widespread use of mobile devices, new opportunities exist for enhancing their learning experience. An integrated, tangible touch-tactile assistive technology with a mobile application is designed to deliver an innovative solution for braille Quranic education. A usability test was conducted with blind participants to evaluate the effectiveness of the solution and to gather insights into the impact of this integration on their learning experience. The results of the study showed positive learning experiences and acceptance among the participants and provide valuable information for future developments in the area of Braille Quranic education for blind students

Optimized Threshold Selection for Client Participation in IoT-Based Federated Learning

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Implementing Federated Learning (FL) in IoT environments presents notable challenges, primarily due to variations in both clients' local model performance and the reliability of their communication links, often indicated by received signal strength (RSS). In this study, we introduce a deterministic and lightweight selection mechanism that filters participants based on predefined thresholds for local model accuracy (LMA) and RSS. The thresholds are analytically optimized to maximize the probability of selecting exactly m suitable clients. Theoretical analysis is complemented by parameter-specific insights to better illustrate the system's behavior. Comprehensive experiments using the MNIST dataset demonstrate that our approach consistently surpasses strategies that rely solely on LMA or RSS, validating its effectiveness for FL in resource-limited IoT contexts.

The Effectiveness of Prompt Engineering for Arabic Aspect Category Polarity Analysis

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Large language models (LLMs) have significantly advanced natural language processing (NLP) by breaking through a variety of tasks like summarization, text generation and sentiment analysis. This study addresses aspect-based sentiment analysis (ABSA) for Arabic, a low-resource language. ABSA, which identifies aspect categories and their sentiment polarity, comprises subtasks like aspect category detection (ACD) and aspect category polarity (ACP). Focusing on the aspect of category polarity, we investigate zero-shot, few-shot, and chain-of-thought (CoT) prompting strategies using the Gaza Reviews and HAAD Book Reviews datasets. Our experiments demonstrate that CoT prompting outperforms other methods, achieving F1-scores of 70% on the Gaza Reviews dataset and 67% on the HAAD Book Reviews dataset.

Bridging Digital Divide for Participants of Videoconferencing Sessions with Unequal Access to Mobile Internet: a MEC-Based Approach

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In spite of the unprecedented opportunities carried out by the 5G standard to catch up with the technological digital divide in developing countries, we are increasingly witnessing a cohabitation with 4G, 3G and 2G and that with different territorial coverage rates accentuating the technological digital divide within the same country. In this paper, we looked at how to upgrade the performance of a 4G network to that of 5G for a more comfortable use of the videoconferencing application in a scenario where some participants use 5G while others only have access to 4G. We built on the 5G MEC-enabling technology to design an architecture where distributed videoconferencing servers are hosted on MEC and in close proximity to users' equipments. Simulations run using the Simu5G simulator show an end-to-end delay performance gain over remote cloud-based architectures.

EHKEA: A Lightweight and Secure Authentication Protocol for Healthcare IoT Systems in 5G Networks with Enhanced Resistance to Emerging Threats

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Secure authentication remains a critical challenge in healthcare IoT (H-IoT) systems, where constrained devices must ensure data integrity, privacy, and resilience despite limited resources. This paper proposes EHKEA, a lightweight mutual authentication and key establishment protocol designed specifically for H-IoT environments. EHKEA relies solely on symmetric cryptographic primitives and ephemeral randomness to provide mutual authentication, forward secrecy and resistance to common attacks such as replay, impersonation, and man-in-the-middle intrusions. We formally verify EHKEA in the Tamarin prover under the Dolev-Yao adversary model, proving key security properties including injective agreement and session key secrecy. A detailed informal analysis further confirms its robustness against desynchronization, insider threats, and key compromise impersonation. Comparative analysis with recent H-IoT protocols demonstrates that EHKEA achieves superior efficiency while offering stronger security guarantees, making it well-suited for deployment in real-time healthcare monitoring applications.

Zero-Shot YOLOv8 Descriptors for Low-Latency Object Tracking

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Object tracking in real-time applications often relies on the tracking-by-detection paradigm, where object localization and temporal association are decoupled. While methods such as DeepSORT integrate a detector like YOLO with additional CNN-based ReID module for appearance matching, the ReID network imposes significant computational and memory burdens, especially on edge or CPU-only systems. This work explores the use of zero-training appearance descriptors extracted directly from YOLOv8's internal multi-scale feature maps (P3, P4, P5), used individually as lightweight alternatives to conventional ReID embeddings. Our method selects a feature scale based on object size and retrieves a fixed-length feature vector via a simple center-cell lookup. On the MOT20 train benchmark, our fastest configuration, (i.e. based on the P3 feature map) achieves more than 90% of the HOTA score of the standard DeepSORT with ReID, while reducing tracking time per frame from 0.279 s to 0.035s on a CPU. These results demonstrate that YOLOv8's native features hold sufficient discriminative power for training-free, real-time object association, eliminating the need for costly ReID networks in resource-constrained deployments.

Optimizing Firewall Policy Rule Ordering Using Discrete Cuckoo Search Algorithm

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The exponential growth of modern network infrastructures has significantly increased the complexity of firewall configuration, often leading to rule conflicts and inefficient performance. Firewall rule ordering, a known NP-hard problem, is critical to ensuring accurate traffic filtering and preserving security policy semantics. Traditional deterministic approaches to packet classification often neglect traffic dynamics, limiting their adaptability. In this study, we propose a metaheuristic-based solution using the Discrete Cuckoo Search (DCS) algorithm to optimize firewall rule ordering. Inspired by natural behavior, DCS offers simplicity, global search capabilities, and computational efficiency. Our approach maps the rule ordering task to a job scheduling problem, achieving improved accuracy and performance compared to existing techniques. Experimental results validate the effectiveness of the proposed method in enhancing firewall efficiency.

Impact of Interference on the Performance of Integrated Sensing and Backscatter Communications

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This paper is concerned with the performance of integrated sensing and backscatter communication system in the presence of arbitrary co-channel interference (CCI). New accurate expressions are derived for the communication ergodic rates that account for the mutual correlation between sensing and communication channels. The accuracy of the newly derived expressions is validated through Monte Carlo simulations. Numerical results reveal the adverse influence of CCI on both communication and sensing rate performance. It is also shown that these adverse effects can be mitigated by increasing the number of transmit antennas.

A Zone-Based LoRa Deployment for Agriculture Area Monitoring

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Recent technological advances have opened up new possibilities in the field of wireless sensor networks. One such advancement is LoRa (Long Range) technology, which enables long-range transmission of data with reduced power consumption. This technology has attracted increasing interest in many fields such as urban management, smart agriculture, logistics and many others. The deployment of LoRa devices is a very important issue in the case of large-scale networks. Indeed, the various Spreading Factors (SF) can be sources of interference that significantly impact the performances of a LoRa network. One of the most well-known deployment techniques in LoRa networks is circular deployment around the gateway. LoRa nodes are deployed in circular bands and are assigned spreading factors based on their distance from the gateway. This type of deployment, while interesting, has its limitations when the network scales up. Indeed, in this case, Co-SF interference can severely impact network performance. The main objective of this paper is to find an efficient and optimal deployment of LoRa nodes in a large multi-agricultural area. The deployment follows the same principle of SF allocation as in the case of circular deployment. The major innovation is the division of the area into vertical zones corresponding to crops. Thus, depending on the monitoring requirements of each crop area, LoRa nodes can be activated periodically and independently.The objective is to minimize co-SF interference, optimize energy consumption byenabling selective activation of zones based on environmental conditions. This approach allows for more efficient allocation of resources, rapid response to environmental changes and minimization of interference. We evaluate the proposal in terms of DER, collisions number to determine the optimal number of zone to active in a given moment.

Hybrid IDS for IoT Approach Combining Deep Extraction and Robust Classification

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The rapid adoption of the Internet of Things (IoT) has significantly increased security risks, exposing networks to advanced cyber threats. In this paper, a structured analysis of the IoT architecture has been provided to identify vulnerabilities and attack vectors for each layer. To address these challenges, we developed a deep learning-based intrusion detection system, evaluated on the ToNIoT dataset. The experimental results confirm its effectiveness in detecting intrusions with high precision, demonstrating its potential to improve IoT security. This work highlights the potential of deep learning to improve IoT network security and resilience, providing a robust framework for future research and practical applications.

LiteMixer: Scalable, Low-Overhead Multi-Scale Mixing for Time Series Forecasting

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Deep learning models for time series forecasting increasingly face a critical trade-off between accuracy and computational efficiency especially in mobile, wireless, and edge
computing scenarios. While state-of-the-art architectures like TimeMixer achieve strong performance through multi-scale decomposition, their large parameter footprints limit real-world deployment. In this paper, we propose Efficient Hybrid TimeMixer, a novel architecture that combines TimeMixer's decompositional strengths with lightweight, conditionally-applied enhancements derived from TimesNet. Our approach introduces three key innovations: (1) conditional processing to apply computationally intensive modules only when necessary; (2) parameter-efficient fusion mechanisms to integrate components without overhead; and (3) adaptive scale processing to allocate resources based on temporal complexity. Extensive experiments on five benchmark datasets show our model achieves up to 14.56% fewer parameters while maintaining or surpassing eleven competitive baselines forecasting accuracy. Specifically, on the ETTm2 dataset with a 96-step horizon, our model surpasses TimeMixer's using only 2.00M parameters.

Towards Transparent IoT Malware Detection: A ML/DL and XAI-Based Multi-Class Classification Approach

Mohamed Elsersy (Higher Colleges of Technology, United Arab Emirates); Ahmed Abdelwahab (Arab Open University, Saudi Arabia)

The rapid growth of Internet of Things (IoT) devices has introduced significant security risks due to limited processing power and weak protection mechanisms. This paper presents a machine learning and deep learning-based framework for multi-class classification of IoT malware traffic. Using the CTUIoT dataset, we evaluate Random Forest, XGBoost, Fully Connected Neural Networks (FCNN), and Recurrent Neural Networks (RNN). XGBoost achieved the highest performance with a weighted F1-score of 94.1% and a macro-averaged ROC-AUC of 96.3%. To enhance model transparency, explainable AI techniques such as SHAP and LIME were applied, providing insights into feature contributions. The proposed framework effectively identifies various types of malicious traffic, demonstrating its potential for real-world cybersecurity applications in IoT environments.

Device- and Location-Aware Client Clustering for Heterogeneous Federated Learning

Maryam Ben driss (UQAM, Canada & ENSEM, Morocco); Essaid Sabir (TELUQ University, Canada & University of Quebec, Canada)

The rapid growth of decentralized data requires innovative approaches to address data heterogeneity, resource limitations, and client privacy. Federated learning (FL) offers a solution for training models across multiple clients without centralizing their data. However, non-IID data and variations in device capabilities pose significant challenges, decreasing model accuracy and training efficiency. This paper introduces a fast and energy-efficient FL framework that uses data distribution, device type, and geographic location for client clustering. Our solution significantly improves the convergence time, reduces loss, and improves accuracy. We implement random, round-robin, and accuracy-based client selection methods. Experimental results show substantial improvements: up to 1.09% reduction in loss, 2.8% increase in accuracy, 20.6% reduction in training time, 30.8% reduction in communication overhead, and 25.5% improvement in energy efficiency compared to conventional methods. These results underscore the importance of incorporating device type and location in client clustering to accelerate convergence and optimize energy consumption.

Alignment-Free DNA Sequence Clustering Using Deep Siamese BiLSTM and Attention Mechanisms

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Clustering of genomic sequences is critical for elucidating biological relationships, yet unsupervised methods often compromise between accuracy, generalizability, and biological interpretability. We propose a Siamese Bidirectional Long Short-Term Memory (BiLSTM) network with an attention mechanism, trained via contrastive loss to learn biologically meaningful representations of DNA sequences, entirely without supervision, augmentation, or hand-crafted k-mer features. We evaluate our model on a challenging benchmark of Betacoronavirus genomes. The resulting embeddings capture both sequence-level similarity and evolutionary patterns. When paired with standard clustering algorithms, these embeddings yield high-quality partitions: silhouette score of 0.814, Adjusted Rand Index (ARI) of 0.713, and purity of 0.864. Our model also reduces intra-cluster embedding variance by 2-4× compared to baselines, aligning closely with known taxonomic subgenera. Overall, this framework offers a scalable, interpretable, and unsupervised solution for genomic sequence clustering, with strong potential in comparative genomics and evolutionary biology.

A Multi-Layered Architecture for AI-Enhanced Learning in the Edu-Metaverse

Chaimae Illi and Azeddine El hassouny (ENSIAS, Mohammed V University in Rabat, Morocco)

The Edu-Metaverse presents a transformative approach to digital learning, integrating immersive environments, artificial intelligence, blockchain, and learning management systems to create dynamic, interactive, and personalized educational experiences. This paper presents a multi-layered architecture for implementing the Edu-Metaverse, addressing the critical components needed for an effective digital learning ecosystem. The proposed architecture is divided into User, Application, and Data Layers, integrating Virtual Learning Environments (VLEs), AI-driven tutors, Learning Management Systems (LMS), and blockchain-secured credentialing. A potential small-scale prototype is discussed to validate the feasibility of this approach. Additionally, we propose and evaluate a policy synchronization mechanism inspired by federated learning that allows AI tutors across different virtual classrooms to share knowledge without compromising user data. This system is tested using Unity-based simulations and shows promising results in generalization and policy adaptation. Finally, we analyze adoption challenges and future directions.

A Unified Framework for Decentralized Identity and Trust Management in IoT Using Self-Sovereign Identity and IOTA

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The growing scale and complexity of IoT networks demand robust security models that provide both secure identity authentication and reliable trust evaluation. While Self-Sovereign Identity (SSI) enables decentralized and user-centric authentication, ensuring the ongoing trustworthiness of participating nodes remains a challenge. This paper presents an integrated framework that combines SSI-based decentralized authentication with IOTA-ledger-assisted trust evaluation to form a holistic security architecture for IoT systems. Our approach ensures that only authenticated nodes can participate in the network while continuously assessing their behavior and trustworthiness through immutable and tamper-resistant trust scores.

Leveraging Transformer-Based Models for Cyberbullying Detection in the Moroccan Arabic Dialect

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Cyberbullying is an increasing threat on social media, with serious consequences for mental health, particularly among young people. Despite growing global efforts to address this problem, developing accurate detection systems remains challenging for low-resource languages in both text and audio modalities, such as Arabic and its dialects. This paper presents a binary-labeled dataset for cyberbullying detection in Moroccan Darija. The dataset merges over 4,000 newly collected YouTube comments with the OMCD corpus of 8,024 comments, originally labeled for offensive language. To better reflect the nature of cyberbullying, the entire corpus was reannotated from scratch, clearly distinguishing between bullying and non-bullying content, including subtle forms like sarcasm, shaming, and indirect aggression. Several Arabic transformer models were fine-tuned and evaluated using standard classification metrics. The results show that dialect-specific models, particularly DarijaBERT, achieve the best performance, underlining the importance of context-aware annotation and in-domain pre-training for cyberbullying detection in low-resource settings.

Ranking Large Language Models with Human Preferences: a Game-Theoretic and Bayesian Comparative Study

Adil Haouas and Abdellatif Kobbane (ENSIAS, Mohammed V University in Rabat, Morocco); Hamidou Tembine (UQTR, Canada)

The rapid growth of large language models (LLMs) has created a demand for reliable, interpretable, and scalable ranking systems capable of comparing models based on human preferences. Traditional benchmarks often fail to capture qualitative nuances in open-domain dialog, where subjective judgments play a central role. In this work, we conduct a comparative
study of six prominent ranking algorithms Elo, Glicko, TrueSkill, Bradley-Terry, Markov Chain-based ranking, and a novel Hawas-Rank algorithm applied to the Chatbot Arena dataset containing 244,978 pairwise human preference comparisons. HawasRank is a divergence-based, game-theoretic ranking method inspired by Bregman optimization frameworks, designed to improve convergence speed, transitivity preservation, and computational efficiency in human-in-the-loop LLM evaluations. In this study, we carefully compare these algorithms based on several important criteria, such as predictive accuracy, the occurrence of transitivity violations, sensitivity to hyperparameters, convergence behavior, and CPU resource consumption. The findings of our analysis reveal the trade-offs that exist between different ranking approaches and offer practical guidance for choosing appropriate algorithms, especially in large-scale and evolving LLM evaluation environments.

AgriTwin-Sim: An Interactive Digital Twin Framework for AI-Driven Smart Farming

Yassine Ben-Aboud and Abdellatif Kobbane (ENSIAS, Mohammed V University in Rabat, Morocco)

Modern agriculture faces unprecedented challenges requiring innovative solutions for enhanced productivity and sustainability. Digital Twins (DTs), coupled with Artificial Intelligence (AI) and the Internet of Things (IoT), offer a transformative paradigm for creating dynamic virtual replicas of agricultural systems. This paper introduces an advanced interactive web-based Digital Twin framework designed to bridge the gap between virtual sensor data and intelligent, actionable insights for smart farming. The framework integrates a high-fidelity simulation core, encompassing sophisticated mathematical models for environmental dynamics and plant biophysiology, with a robust AI engine capable of complex analysis, prediction, and decision support. Simulated data from a virtual sensor network feeds the DT, enabling the AI to perform real-time assessments, identify anomalies, predict future states, and recommend optimized management actions. The entire system is exposed through an intuitive and visually rich web interface that facilitates interactive exploration, scenario analysis, and direct visualization of the DT's evolution and the AI's reasoning. We demonstrate the framework's architecture, the formal underpinnings of its key components, and its utility as a powerful tool for research, development, and operational management in next-generation agriculture, showcasing a seamless pathway from data acquisition to intelligent intervention.

Where 6G Stands Today: Evolution, Enablers, and Research Gaps

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As the fifth-generation (5G) mobile communication system continues its global deployment, both industry and academia have started conceptualizing the 6th generation (6G) to address the growing need for a progressively advanced and digital society. Even while 5G offers considerable advancements over LTE, it could struggle to be sufficient to meet all of the requirements, including ultra-high reliability, seamless automation, and ubiquitous coverage. In response, 6G is supposed to bring out a highly intelligent, automated, and ultra-reliable communication system that can handle a vast number of connected devices. This paper offers a comprehensive overview of 6G, beginning with its main stringent requirements while focusing on key enabling technologies such as terahertz (THz) communications, intelligent reflecting surfaces, massive MIMO and AI-driven networking that will shape the 6G networks. Furthermore, the paper lists various 6G applications and usage scenarios that will benefit from these advancements. At the end, we outline the potential challenges that must be addressed to achieve the 6G promises.

LSTM-Based Channel Estimation for OFDM System

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In this paper, we propose a deep learning method for channel estimation in OFDM systems over WINNER II channel. The approach is based on a Long Short-Term Memory (LSTM) network that takes advantage of the temporal and frequency correlation across OFDM blocks. The model is trained to predict the full channel frequency response at each block using only pilot observations from current and previous blocks. We evaluate the performance of the proposed estimator under various signal-to-noise ratio (SNR), numbers of pilot subcarriers, and temporal window sizes. Simulation results demonstrate that the LSTM-based approach consistently outperforms both LS and recent deep learning models based on super-resolution. The results show that the LSTM model achieves lower estimation error across different SNR values, making it a strong candidate for reliable channel estimation in dynamic wireless environments.

OASIS: Optimized Active Sampling for Intrusion Detection in IoT Systems

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Intrusion detection in Internet of Things (IoT) environments is a critical yet challenging task due to the heterogeneous nature of devices and the complex attack landscape. Traditional machine and deep learning models often suffer from limitations such as poor class balance, irrelevant or redundant features, suboptimal classification accuracy, ineffective hyperparameter tuning, and scarcity of labeled data. To address these challenges, we propose an enhanced intrusion detection system model. Variance threshold is applied to select informative features, while the proximity weighted random affine shadow sampling technique is used to balance the dataset effectively. Capsule Network (CapsNet) is employed for robust classification due to its ability to capture spatial hierarchies in data. To further optimize CapsNet, we implement the Reptile Search Algorithm (RSA), resulting in the Reptile-Optimized Cap sule Network (ROC-Net). ROC-Net is further enhanced using Margin-Based Active Learning (MBAL), forming Marginal Active-learning with Reptile-optimized Capsule Network (MARCO-Net), which efficiently annotates the most uncertain samples from the unlabeled pool. Experimental results show that the proposed ROC-Net and MARCO-Net significantly outperform traditional models, achieving improvements of 8.75% and 12.5% in accuracy, 13.75% and 11.25% in precision, 1.19% and 9.52% in recall, 7.41% and 11.11% in F1-score, 11.94% and 20.90% in Matthews Correlation Coefficient, and 13.64% and 22.73% in Cohen's Kappa. Additionally, there is a reduction of 36.84% and 52.63% in hamming loss, and 75.86% and 82.70% in log loss, respectively. These findings demonstrate the effectiveness of the proposed system for accurate and efficient intrusion detection in IoT environments.

Cyberattack Detection in Multi-Agent System

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In this paper, we investigate the secure consensus problem for multiple-input-multiple-output (MIMO) linear multi-agent systems (MASs) under false data injection (FDI) attacks, where an adversary corrupts the output measurements exchanged among agents. To mitigate the effect of such attacks, we design an unknown input observer (UIO) that relies only on relative output information and reconstructs the consensus error while filtering out the injected malicious signals. Based on this observer, a resilient consensus controller is developed. Using a common Lyapunov function (CLF) and linear matrix inequality (LMI) techniques, we show that secure consensus can still be achieved despite the presence of FDI attacks, provided certain observability and robustness conditions are met.

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Real-Time IoT Intrusion Detection Using Deep Learning with Uncertainty and Optimization Mechanism

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The increasing complexity and interconnectivity of Internet of Things (IoT) ecosystems have heightened the need for robust and intelligent intrusion detection mechanisms. However, the development of effective detection models is impeded by challenges such as imbalanced data distributions, limited availability of labeled samples, and the difficulty of tuning deep learning architectures to accommodate diverse threat patterns. In response to these challenges, this paper introduces two novel DenseNet-based frameworks, DN UBSand DN-GBO, for advanced IoT intrusion detection. The proposed approach begins by applying a variance threshold technique on RT-IoT2022 dataset, to eliminate low-variance features, followed by synthetic minority oversampling technique to alleviate class imbalance and enhance minority class representation. DN-UBS integrates an uncertainty-based sampling strategy to iteratively select the most ambiguous instances for annotation, reducing labeling effort while improving model discriminability. In contrast, DN-GBO incorporates a gradient based hyperparameter optimization using the hyperband strategy, allowing for automatic adjustment of network depth, learning rate, and regularization parameters. The DN-GBO achieved superior detection performance with an improvement of 7% in accuracy, 4% in F1 score, 12.8% in precision, 6% in recall, 3% in Receiver Operating Characteristic-Area Under the Curve (ROCAUC), and 17.6% in Matthews Correlation Coefficient (MCC). Similarly, DN-UBS also delivered high efficacy with an improvement of 5.3% in accuracy, 3% in F1 score, 3% in precision, 4.6% in recall, 4% in ROC-AUC, and 10.1% in MCC, while minimizing reliance on labeled data. These findings highlight the effectiveness of the proposed models in delivering scalable, adaptive, and data-efficient solutions for securing IoT infrastructures against intrusive threats.

An Intelligent Intrusion Detection Framework for IoT Using Active Learning and Metaheuristic Optimization

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The rapid expansion of Internet of Things (IoT) networks has made them increasingly vulnerable to diverse cyber threats, necessitating the development of efficient Intrusion Detection Systems (IDS). Traditional models for IDS often face challenges such as data imbalance, scarcity of labeled samples, and suboptimal performance due to manual hyperparameter tuning. To address these issues, we propose a comprehensive IDS framework comprising three key components. First, we mitigate data imbalance using the proximity weighted synthetic oversampling technique, which enhances class distribution, followed by the use of Pointer Network (PtrNet) for classification due to its ability to model variable-length sequential data. Second, to handle the scarcity of labeled data, we introduce an entropy-based active learning strategy on PtrNet, termed Entropy based Active Learning Pointer Network (EAL-PNet). Finally, we optimize model performance through harris hawk optimization applied to PtrNet, resulting in Hawk Pointer Attention Network (HPA-Net). Experimental results demonstrate that the proposed models significantly outperform traditional approaches. EAL-PNet achieves a performance improvement of 9.30% in accuracy, 8.14% in F1-score, 8.14% in precision, 9.30% in recall, 3.16% in Receiver Operating Characteristic- Area Under the Curve (ROC-AUC), 13.92% in Matthews Correlation Coefficient (MCC) and Cohen's Kappa, and 45.71% reduction in log loss. Similarly, HPA-Net shows a 10.47% gain in accuracy, 10.47% in F1-core, 9.30% in precision, 10.47% in recall, 2.11% in ROC-AUC, 15.19% in MCC and Cohen's Kappa, and 51.43% decrease in log loss. These findings validate the effectiveness of the proposed framework in enhancing intrusion detection for IoT environments.

MALOS-IoT: a Multi-Stage Advance Learning and Optimization Framework for IoT Intrusion Detection

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The Internet of Things (IoT) has transformed modern technology by interconnecting physical devices to enable intelligent automation and real-time data exchange. However, securing IoT environments remains a critical challenge due to device heterogeneity, resource limitations, and vulnerabilities in lightweight communication protocols. Traditional Intrusion Detection Systems (IDS) often struggle with issues such as imbalanced datasets, suboptimal classification accuracy, difficulty in tuning hyperparameters, and a scarcity of labeled data. To address these limitations, we propose a novel IDS framework that integrates multiple advanced techniques. Initially, categorical labels are transformed using Label Encoding to facilitate effective model training. To mitigate data imbalance, the Localized Random Affine Shadowsampling (LoRAS) technique is applied, enhancing minority class representation. A Monte-Carlo Active Learning approach implemented on the DaNet architecture, termed MALD, is introduced to improve data efficiency by selectively querying the most informative samples. Additionally, we propose Elephant Herding Optimization applied to DaNet named EHODA to autonomously tune hyperparameters and maximize classification performance. Experimental results demonstrate that the proposed MALD and EHODA models significantly outperform conventional and state-of-theart methods, achieving up to 93% in Accuracy, Precision, Recall, and F1-Score, along with superior values in AUCROC of 0.98 and PR-AUC of 0.93. These findings affirm the effectiveness of our proposed framework for robust and adaptive intrusion detection in IoT environments.

Financial Factor Returns and Portfolio Optimization: from Forecasting to Investment Strategy Using Temporal Fusion Transformers and Genetic Algorithms

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This paper presents a comprehensive quantitative investment framework that addresses the fundamental challenge of systematically identifying and exploiting time-varying factor premiums in equity markets. Traditional factor investing approaches assume static factor relationships that fail to capture the dynamic nature of financial markets, where factor premiums fluctuate based on economic cycles, market regimes, and structural changes. We develop an innovative system that integrates Temporal Fusion Transformers (TFT) for factor return prediction with genetic algorithm-based portfolio optimization to create a robust, institutional-grade investment strategy. Our methodology combines cutting-edge machine learning techniques with established academic finance principles through a three-component framework: (1) TFT models trained on 35 years of daily factor returns and macroeconomic indicators, (2) a hybrid weighting system integrating ML predictions with academic literature-calibrated factor weights, and (3) genetic algorithm-based portfolio construction handling complex multi-constraint optimization problems. Our empirical validation over a 14-month out-of-sample period demonstrates exceptional performance, with the strategy achieving 29.21% total returns compared to the S&P 500 benchmark's 9.12%, generating substantial outperformance of 20.09 percentage points. The strategy exhibits superior risk-adjusted performance with a Sharpe ratio of 2.46 versus the benchmark's 0.98, an information ratio of 1.91, and maximum drawdown of -4.46% compared to the benchmark's -7.94%. The TFT model demonstrates robust predictive accuracy with a correlation of 0.1746 between predicted and actual factor returns, representing exceptional forecasting power in financial markets. This study demonstrates how advanced machine learning architectures can be effectively adapted for financial factor prediction while maintaining theoretical rigor and practical implementability for systematic portfolio management.

Toward Dynamic Risk Assessment: Machine Learning and LLMs in Software Vulnerability Prioritization

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The rapid growth of software vulnerabilities demands advanced prioritization beyond static scoring systems. Recent works (2020-2025) have applied machine learning (ML) and large language models (LLMs) to predict and rank the risk of vulnerabilities based on features such as CVSS metrics, exploit presence, context and natural language descriptions. This review surveys supervised, unsupervised, and hybrid ML approaches-including neural networks, ensemble classifiers, graph-based models-and LLM-based NLP methods. We examine various model types (e.g. Random Forest, XGBoost, CNN, DistilBERT), data sources (NVD/CVE descriptions, exploit databases, OSINT, telemetry), evaluation metrics (accuracy, F1-score, MSE), and quantitative results. Performance trends indicate ML can improve on CVSS baselines (e.g. ~83% accuracy, whereas LLMs require domain adaptation to perform well. Finally we discuss gaps in research, such as limited real-world validation and the need for dynamic, context-aware models.

From Structure to Strength: a Deep Learning Approach to Edge Weighting in Graph-Based Community Detection

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Complex networks analysis requires a full comprehension of the interconnection between the nodes and how these interconnections give rise to community structures. This is done by finding clusters of nodes that are well connected within the cluster but relatively poorly connected with the rest of the network. Out of the many methods conceived to make this task easier, edge weighting has become an indispensable tool, allowing one to quantify the strength of connection in terms of the importance or level of interaction between the nodes. In this work, we propose a new mechanism of edge weighting based on representation learning using autoencoders. The model is trained using the network's adjacency matrix to learn latent structural aspects of the nodes in the network, which are then used as a basis of calculating pairwise similarities using an amplified Gaussian similarity function. As a methodology, this allows us to capture some of the more subtle structural patterns that cannot be identified through traditional local heuristics. Due to the experimental results, we show that our method can give the same performance in a community detection task to popular similarity-based weighting strategies such as Jaccard, cosine similarity, and the Adamic-Adar index, thus proving that learned representations may find success in these kinds of collaborations.

Zero Knowledge Proof in Vehicular Networks

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In the need for high-security mechanisms, Trust Management Systems (TMSs) are implemented in vehicular networks such as Vehicular Ad Hoc Networks (VANETs) and the Internet of Vehicles (IoV) to ensure reliable interactions between vehicles. These systems nowadays are a key factor in building up security by evaluating and managing trust relationships among network participants. However, TMSs are inherently very vulnerable to Trust Manipulation Attacks (TMA), where we find malicious nodes attempting to deceive trust models by exploiting their evaluation mechanisms. One critical variant of this attack involves malicious nodes creating multiple fake identities, a strategy known as the Sybil attack, to falsely reinforce their trustworthiness. This deception will totally mislead legitimate vehicles, manipulates the decision-making processes, and at the end compromises the overall security and reliability of the network. To address this challenge, we propose a Zero-Knowledge Proof (ZKP)-based trust authentication scheme that ensures each vehicle can prove its legitimacy without exposing sensitive information such as private keys or identity-related details. Our approach prevents attackers from fabricating multiple identities or colluding with other malicious entities to manipulate trust values. By integrating cryptographic authentication with trust management, our method significantly strengthens security and ensures that only legitimate vehicles can participate in trust-based evaluations. Through a lot of simulations to evaluate, we demonstrate the effectiveness of our proposed solution in mitigating identity-based trust manipulation attacks, reducing the risk of Sybil-based exploits, and preserving the accuracy of trust assessments in dynamic Vehicular environments. The results indicate that our approach not only enhances security but also maintains efficient trust computation, making it a viable solution for real-world vehicular networks.

Hybrid Deep Learning for Intrusion Detection in IIoT Networks: a CNN-LSTM-Attention Approach

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The Industrial Internet of Things (IIoT) provides an interconnected outline of devices and connected systems to the industrial and building sectors in order to accelerate operational efficiency, automation, and decision-making, among others, but this growth of interconnectivity makes them more vulnerable to cyberattacks than ever before. Specially, the equation concerning an intrusion detection system for IIoT support systems really presents new challenges. In this paper, we introduce a hybrid deep learning network, Convolutional neural network (CNN) combined with Long Short-Term Memory (LSTM) networks by attention mechanism, to detect and classify network intrusions in IIoT systems. In order to balance the WUSTL-IIoT-2021 dataset with its intrinsic class imbalance, the synthetic minority oversampling technique (SMOTE) is leveraged so that the model is able to learn the patterns well enough across all types of attacks.Furthermore, Random Search is employed for hyperparameter optimization, improving the model's overall performance. The WUSTL-IIoT-2021 dataset is used for training and testing to undermine realistic industrial scenarios with different types of attacks mixed with normal traffic. The preliminary results show the high accuracy and representation of this model, especially in dealing with class imbalance.

Advancements in Leaf Recognition Technologies: a Comprehensive Review

Khaled Suwais (Arab Open University, Saudi Arabia); Sally Almanasra (Prince Sultan University, Saudi Arabia)

An important area of research in the scientific community is plant leaf recognition, which involves identifying leaves through image processing techniques. To achieve the highest accuracy, several different strategies using various algorithms have been developed. This study aims to offer an analytical evaluation of the numerous methods employed in image processing for plant recognition based on their leaves. These methods facilitate the extraction of valuable information for botanists to use in comprehending the medicinal properties of these leaves, as well as for other environmental and agricultural applications. Additionally, we provide insights and a thorough evaluation of the different methods researchers use to analyze various attributes and classifiers. To enhance the accuracy of classification systems, specific attributes and classifiers are being studied for their capabilities. Notably, Convolutional Neural Networks and support vector machines emerge as prominent contenders for their superior accuracy, as corroborated by our research findings.

Semantics Driven Multi- Agent Artificial Intelligence Framework for Adaptive Resource Management in 6G Mobile Edge Networks

Nada M Sallam and Samah Mohamed Osman (Arab Open University, Saudi Arabia)

The argumentative progress of heterogeneous data traffic and latency sensitive applications in 6G networks necessitates intelligent and adaptive resource management. Traditional resource allocation mechanisms, based on syntactic information fail to capture the underlying meaning and intent of user tasks. To address this, we propose a Semantics Driven Multi-Agent Reinforcement Learning (SD-MARL) framework that leverages semantic context including user intent, application type, and quality-of-experience (QoE) expectations for an adaptive decision-making among distributed edge nodes. Each edge server is modeled as an autonomous agent cooperating via decentralized learning and optimized for both local performance and global system efficiency. We integrate a semantics-aware encoder with a lightweight attention-based policy network to capture high-level task features. This allows to dynamically adjust computational and communication resources. To enhance sample efficiency and convergence, a shared federated critic is employed for multi-agent coordination without violating data privacy. Simulation results over a realistic 6G edge environment demonstrate significant improvement in task completion latency, energy savings, and enhanced fairness as compared to conventional MARL and non-semantic baselines. Comparative results show a consistent reduction in task completion latency by 20-35% with semantic variant achieving up to 40% faster policy stabilization compared to non-semantic implementations. This work advances an intelligent edge orchestration for next-generation wireless networks.

Federated Learning Meets Cybersecurity: Aggregation Strategies Using UNSW-NB15 Dataset

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Federated Learning (FL) is a machine learning technique that uses a decentralized approach to train a model across several servers or devices. In contrast to centralized machine learning approaches, where all nodes or devices share data at a central location for training, FL implies that each device retains its data locally and does not share it with the server. In FL, the server functions as a central coordinator that gathers model parameters and updates from individual client devices, combines them into a unified model, and redistributes the updated model to the clients. Our research involved comparing different federated learning approaches for detecting malware in network traffic. To implement and train the machine learning model, we utilized the Flower framework.

This research focused on comparing several aggregation methods: FedAvg, FedProx, and FedYogi. These aggregators were applied to the UNSW-NB15 dataset. Among them, FedProx produced the best results.

Custom Image-to-Graph Transformation Strategies for Object Detection with GATs on the KITTI Dataset

Rabab Benfouina (University Mohammed V, Morocco); Ahmed Drissi El Maliani (University Mohammed V in Rabat, Morocco)

Object detection in autonomous driving scenarios represents a critical challenge in computer vision, traditionally dominated by Convolutional Neural Networks (CNNs). This paper presents a comprehensive investigation of Graph Attention Networks (GATs) as an alternative approach for object detection, focusing on three distinct image-to-graph transformation methods. We evaluate: (1) PCA-based patch flattening, (2) PCA with positional enrichment, and (3) advanced textural descriptors including Local Binary Patterns, GLCM, and entropy measures. Our study utilizes the KITTI dataset with 7,841 annotated images, segmented into 32×32 pixel patches treated as graph nodes. To address the significant class imbalance (81% Background and Car classes), we examine three dataset variants: original distribution, GraphSMOTE balancing, and hybrid image augmentation with graph balancing. Results demonstrate that Method 2 (PCA with positional enrichment) achieves superior performance with a weighted F1-score of 0.5924 and 25.75% exact match accuracy on the original dataset, highlighting the critical importance of preserving spatial information during graph transformation. While GAT-based approaches show inferior performance compared to established CNN methods, the progressive improvement observed across transformation strategies and the exceptional enhancement in minority class detection (Cyclist: 0.013→0.406, Person sitting: 0.005→0.980) reveal promising optimization directions for graph-based object detection systems in autonomous driving applications.

A Comparative Analysis of Edge Computing and Fog Computing in Decentralized Networks: Performance and Scalability

Adnan Hnaif (Al-Zaytoonah University of Jordan, Jordan)

The rapid expansion of the Internet of Things (IoT) and the growing need for real-time data processing have accelerated the development of decentralized computing paradigms. This paper presents a detailed comparative analysis of edge computing and fog computing architectures, exploring their distinct roles in modern decentralized networks. By evaluating architectural differences and performance metrics, we assess the advantages and limitations of each approach. The proposed methodology combines theoretical analysis with comparative frameworks. Our findings indicate that edge computing excels in ultra-low-latency applications with minimal infrastructure, while fog computing offers greater scalability and efficient resource management for complex distributed systems. We conclude that the choice between edge and fog computing depends on application-specific requirements, with hybrid models emerging as a promising solution for future decentralized networks. This study enhances the understanding of decentralized computing architectures and provides actionable insights for system designers and network architects.

Reconfigurable Ring-Enhanced Circular Patch Antenna for 5G and Dual-Band WiFi Applications

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The development of new wireless technologies has increased the demand for innovative patch antenna designs capable of operating across multiple frequency bands. In this work, we propose a compact and reconfigurable ring-enhanced circular patch antenna optimized for sub-6 GHz 5G mobile communication and WiFi standards, including WiFi 2.4 GHz and WiFi 6E. The proposed antenna adopts a compact circular patch geometry, facilitating its integration into wireless systems and components. Frequency reconfigurability is ensured through the use of a PIN diode that acts as a switching element. The antenna structure is designed and analyzed using CST Studio Suite, and is implemented on an FR4 epoxy substrate with a relative permittivity of 4.4 and a thickness of 1.6 mm.

TRCP-SSG: a Tamper-Resilient Cryptographic Protocol for Secure Smart Grids

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Smart grids integrate advanced communication and computing technologies to improve the efficiency and reliability of power systems. However, their growing complexity and reliance on distributed infrastructure make them vulnerable to sophisticated threats such as algorithm substitution attacks (ASAs) and cryptographic subversion. Traditional cryptographic methods are often inadequate in detecting or mitigating such attacks. This paper proposes a tamper-resilient cryptographic framework that combines Certificateless Proxy Re-encryption(CL-PRE) with the concept of a Cryptographic Reverse Firewall (CRF). The TRCP-SSG scheme securely distributes encrypted data from smart meters to users via smart grids and resists data exfiltration and ciphertext forgery, even if compromised. The analysis demonstrates that the proposed approach is lightweight, scalable, and well-suited for securing smart grid communications against CPA and ASA adversarial models.

Early UAV Motor-Fault Prediction Using Classical Machine Learning on RflyMAD

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Propulsion-fault anticipation is vital for multirotor-UAV safety. We formulate motor-fault prediction as a 3s early-warning binary task and evaluate three lightweight classifiers-Logistic Regression (LR), Random Forest (RF) and Gradient Boosting (GB)-on a curated subset of the public RflyMAD corpus (34 252 sliding windows, 8.1 % faults). Each window is summarised by 64 statistical features (mean, standard deviation, minimum, maximum) derived from 16 telemetry channels and standardised on the training split only. A leak-free GroupKFold (k = 3) protocol ensures flight-wise separation; class imbalance is corrected with RandomOverSampler, and a 15 % validation slice sets the F_1-optimal threshold. On the outer test folds RF delivers the best compromise, achieving $F_1 = 0.850 \pm 0.003$, ROC-AUC = 0.994 ± 0.000 and a false-alarm rate (FAR) = 21 ± 14 h^{-1}, while issuing alerts 3.67 ± 2.88 s before failure. GB follows closely ($F_1 = 0.832$; FAR = 25 h^{-1}), whereas LR trails ($F_1 = 0.649$; FAR = 64 h^{-1}). All three models satisfy the 3-s warning criterion, but tree-based ensembles offer a superior recall-to-false-alarm balance and sub-millisecond inference, meeting edge-deployment constraints without deep-learning complexity. These findings support the use of certifiable classical models for on-board UAV fault prognostics and motivate future validation on real flights and multi-fault scenarios.

Enhanced Cooperative UAV Swarm Search via LoPSO Integration and Adaptive Sequential Stopping Strategy

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An in-depth analysis and extension of a hybrid approach, combining Local Particle Swarm Optimization (LoPSO) and an optimal stopping strategy inspired by the Secretary Problem, is presented for the search and validation of mobile targets by Unmanned Aerial Vehicles (UAVs). The mathematical foundations of the system model, communication primitives, the LoPSO optimization algorithm, and robust sequential decision strategies are detailed. Furthermore, recent advances in intelligent UAVs, specific LoPSO topologies, and challenges related to swarm coordination and decision-making in constrained environments are incorporated. Key additions include a detailed energy model, a formal communication model, pseudocode for all algorithms, complexity analysis, comparative tables of hardware platforms, and a plan for future experimentation. Finally, ethical and regulatory considerations are discussed, and directions for real-world implementation.

CodeWisp: AST Guided Retrieval Augmented Generation for Code Generation and Completion

Hamza El Atrassi, Yasmina El Idrissi and Yahya Benkaouz (FSR, Mohammed V University in Rabat, Morocco)

In the context of software development, code completion has become an essential functionality that helps speed up coding and reduce syntax errors. Most previously proposed code completion modules are based on rule-based techniques that utilize language grammar to suggest code. Recently, with the rise of LLMs, several code completion assistants have been made publicly available. While demonstrating strong performance, these assistants
raise several concerns related to latency, privacy and data security due to their cloud-based nature.
In this work, we present CodeWisp, a local code assistant based on the Retrieval-Augmented Generation (RAG) paradigm. CodeWisp combines LLM inference with context-aware retrieval using Abstract Syntax Tree (AST)-guided segmentation and semantic indexing. To validate the effectiveness of the proposed AST-guided chunking approach in enhancing semantic retrieval and code generation quality, CodeWisp was evaluated using two embedding models on a dataset of source files spanning four programming languages. In Python CodeWisp's retreiver achieved a recall of 0.96 with nomic-embed-text and a Mean Reciprocal Rank (MRR) of 0.95.

Dual Parameters of Influence: Unveiling a Novel Centrality Measure for Social Media Networks

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This study introduces a novel centrality metric designed to identify influential actors in social media networks, based on two key parameters: relative degree superiority (x over y) and the minimization of shared neighbors. Unlike traditional centrality measures that primarily consider direct connections, our metric incorporates both direct influence and indirect relationships that shape network dynamics. We conducted theoretical analyses and empirical validations across various datasets to compare our metric against existing measures, highlighting its unique advantages in understanding network influence. Our findings indicate that this metric enhances the accuracy of influence assessment in social media networks, advancing our understanding of structural and dynamic properties in real-world systems.

A Bibliometric Analysis of Machine Learning in Maritime Industry as Part of Industry 4.0/5.0

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Machine learning approaches have become increasingly integrated into maritime operations, which drive substantial changes in operational management practices. Generally, the maritime industry benefits from innovative solutions through such technologies, which optimize fleet management while improving maritime safety and operational efficiency in complex dynamic environments, particularly in the context of Industry 4.0/5.0. This research work analyses the publications and citation patterns of machine learning applications in maritime operations throughout the period 2015-2024. This research focuses on the main components of the bibliometric analysis, such as most productive authors/ countries, most cited works, keywords distribution, clusters of research topics/ fields. The Web of Science (WoS) database served as the source for extracting data through an extensive and detailed search approach. The software tools VOSviewer and HistCite have been used to perform the bibliometric analysis, statistics and visualizations. The research methodology revealed 822 documents, which build the main core of the study. The study shows a continuous increasing number of publications in this research area, with a clear dominating leadership of China. Furthermore, research subjects about "Ship Classification and Detection" are dominating the research clusters, followed by "Adaptive Control and Energy Efficiency". This study presents a complete bibliometric evaluation, which combines productivity metrics with citation data to deliver a deep understanding of maritime industry with use of machine learning research.

Enhancing Security and Anomaly Detection in IoMT Systems Using Autoencoders and Blockchain

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Health care is undergoing transformation with the Internet of Medical Things (IoMT) interconnecting physiological sensors to keep track of patients around the clock. In decentralized, resource-challenged environments, maintaining data security, traceability and reliability is an ongoing effort. In this paper we put forward a hybrid architecture that combines neural autoencoders for anomaly detection and blockchain technology to ensure data integrity and make records auditable. This hybrid architecture represents a combination of trust and reliability that had hardly been seen before. In a simulated experiment using the physiological features of heart rate, temperature, signal strength and battery level, our model achieves F1-Score 0.97 and AUC-ROC 0.999. With simulated data fallback under network degradation, robustness is maintained. This approach lays the groundwork for secure, transparent Internet of Medical Things.

Cyberattack Detection in a Robotic Network Using the LPV Kalman Filter Approach

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Coordinating a network of robots to achieve consensus is crucial for collaborative tasks. However, identifying faults within such a network is even more critical. This paper investigates a formation of Wheeled Mobile Robots (WMR) organized in a master-slave architecture, with their interactions modeled through graph theory. The goal is to enable the diagnosis of faults within the robots, allowing faulty units to be removed from the formation while ensuring the task continues uninterrupted. To achieve the goal, the LPV Kalman Filter (LPVKF) is utilized to assess each robot's state, generate residuals, and determine the presence of faults. The effectiveness of this approach is demonstrated using a Matlab simulator.

Reinforcement Learning for Hemodialysis Management: Framework, Simulation, and Evaluation

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The treatment of hemodialysis remains complicated and operator-dependent due to the need to adjust machine settings continuously. This need comes to respond to changing patient situations and avoid complications like intradialytic hypotension. Existing systems do not have adaptive control and are not dynamically customized so that treatment can change on-the-fly. The purpose of this study is to provide a RL framework that facilitates patient-specific hemodialysis treatment management. This article suggests a simulation environment designed for clinical purposes that recreates both machine mechanics and patient physiology. Therefore, it encompasses machine-level state that can reach up to a 20-dimensional vector and another continuous action space that regulates critical machine dynamics. The agent is encouraged to learn stable and effective treatments through a hierarchical reward function that adheres to medical safety guidelines. The performance of the three RL algorithms, including Proximal Policy Optimization (PPO), Soft Actor-Critic (SAC), and Deep Deterministic Policy Gradient (DDPG), were compared in terms of cumulative reward, alarm frequency, and physiological stability. The results indicate that DDPG demonstrates better performance in terms of smoother controlled policies and alleviated number of safety violations. This study shows the promise of using Reinforcement Learning as a potential tool for modeling and optimizing dialysis treatment in a dynamic yet safe way. The discussion also covers limitations that exist when it comes to clinical integration, simulation of fidelity, safety guarantee, and interpretability. It appears that the methodology presented is a promising scheme for future intelligent dialysis systems that can provide personalized care while minimizing clinician workload.

Knowledge Distillation or Efficient Attention? A Systematic Benchmark of Compact Transformers for ESG Text Classification

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Automated assessment of textual disclosures along the Environmental, Social, and Governance (ESG) pillars demands language models that are at once lightweight and transparent. We deliver the first systematic comparison of two compact transformer families-knowledge-distilled models (Tiny Bidirectional Encoder Representations from Transformers and Distilled BERT) and efficient-attention models (Fourier Network and Longformer)-on three balanced datasets of 2 000 documents each, separately targeting the Environmental, Social, and Governance dimensions. All models are fine-tuned on a single 8 gigabyte Graphics Processing Unit and judged on predictive accuracy, inference latency, token-level interpretability obtained with SHapley Additive exPlanations, and concise resource indicators such as per-epoch training time and peak memory consumption. Distilled transformers achieve the best classification performance while offering significant speed-ups and memory savings relative to a BERT-base reference, whereas efficient-attention models become appealing only when inputs exceed four thousand tokens. Attribution analysis reveals that distillation focuses explanatory mass on domain-specific terms such as "diversity" and "emissions", whereas efficient-attention diffuses importance across generic words. These findings position knowledge distillation as the most practical route for production-ready ESG text classification under tight compute and audit constraints, and establish baselines to steer future adaptations of efficient-attention architectures to this domain.

Knowledge Distillation with Enhanced Lightweight STGCN for Gait Disorders Recognition

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Gait recognition is essential for the early diagnosis and monitoring of movement disorders such as Knee Osteoarthrtis (KOA) and Parkinson's Disease (PD). This study presents a new method for skeleton-based gait recognition. Our approach combines Spatio-Temporal Graph Convolutional Networks (STGCN) and Long Short-Term Memory (LSTM) layers to analyze movement data. The STGCN blocks capture spatial and temporal relationships between human joints, while the LSTM layers enhance the model's ability to recognize long-term gait patterns. By incorporating knowledge distillation, our method effectively transfers insights from a complex teacher model to a streamlined student model, improving both accuracy and computational efficiency. We conducted our evaluations on two public datasets for KOA and PD. The results show that our approach outperforms state-of-the-art performance, offering a reliable tool for the clinical assessment and monitoring of gait-related disorders.

Decentralized Privacy-Preserving Federated Learning Using Additive Secret Sharing

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Federated Learning (FL) allows multiple clients to collaboratively train a machine learning model without directly sharing their raw data. While federated learning provides a degree of data privacy, model updates are still susceptible to various inference attacks. This paper presents FLASS, a lightweight and decentralized federated learning framework that leverages additive secret sharing within a multi-server architecture. Each client encodes its local model update into additive shares and shares them with several non-colluding servers, which execute secure aggregation without gaining knowledge of individual contributions. FLASS does not rely on heavy-weight cryptography or a trusted authority. The security analysis and experiments demonstrate the effectiveness and efficiency of the suggested scheme. The analysis indicates that, while achieving the same accuracy as conventional FL schemes, FLASS ensures robust privacy protection with acceptable computational and communication overhead.

A Hybrid Approach for Threat Detection in Social Networks Using Graph Metrics and GANs

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Social networks have become a fertile ground for malicious behavior, ranging from fake profiles to coordinated misinformation campaigns. In this paper, we present a hybrid detection framework that leverages graph-based metrics and generative adversarial networks (GANs) to identify suspicious accounts. User interactions are modeled as a directed graph, and centrality-based features are extracted to capture behavioral patterns. A GAN is then trained on these features to generate synthetic profiles and refine the detection of anomalies. Our experiments, conducted on real-world Twitter data, demonstrate that combining topological analysis with adversarial learning improves detection performance and highlights hidden anomalies often missed by traditional methods.

Optimizing Post-Quantum Blockchain Performance Through Compression Integration

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Falcon and other post-quantum cryptographic algorithms were introduced to counter the critical threats posed by quantum computing to conventional security systems. At the same time, blockchain infrastructures continue to face challenges in maintaining performance and efficiency when adopting
these heavier cryptographic primitives. This work investigates how data compression can be integrated into post-quantum blockchains to alleviate computational stress and improve scalability, particularly in fluctuating load environments. Our results indicate that, while compression introduces a slight overhead during data encoding, it significantly reduces memory consumption and improves latency stability under pressure. For example, our experiments reveal that compression reduces average transaction latency by 34% under normal conditions and lowers memory usage by 22% during peak CPU loads. These findings contribute to the growing research on enhancing the efficiency of postquantum blockchain systems, offering a lightweight and practical optimization technique.

NLP-Assisted Requirements Traceability Pipeline: Multimedia System Use Case

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Requirements traceability is handled to help stakeholders understand existing dependencies between requirements and development artifacts. However, it is hard to infer trace links between them because requirements are often expressed independently from their origin and implementation. The complexity and heterogeneity of requirements are particularly challenging in the context of multimedia systems, where the integration of diverse modalities (e.g., text, audio, video) and real-time constraints complicate the ability to ensure complete traceability from informal statements to formal implementation artifacts. Building on our previous work on the domain-specific language ReqDL which is designed to formalize and manage requirements traceability, this paper extends our model-driven approach by introducing an intelligent NLP-enhanced pipeline. A pipeline that semi-automatically converts informal multimedia requirements into structured, model-based representations. To guarantee semantic consistency and traceability across abstraction levels, the proposed pipeline combines preprocessing, formalization, semantic analysis, and model transformation phases. As a case study, we present a real-time video content moderation system and demonstrate how a high-level requirement is progressively refined, formalized, and linked to system models through ATL-based transformations. The approach generates traceability links such as Satisfy and Verify, supporting impact analysis and model consistency. Experimental results indicate that the pipeline improves modeling efficiency and reduces ambiguity in system requirements. Future extensions include the integration of transformer-based models (e.g., BERT) and applying the method to additional domains such as IoT and e-learning platforms.

Impact of RIS Orientation on Throughput in UAV-Assisted Wireless Systems

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This paper investigates the impact of Reconfigurable Intelligent Surface (RIS) orientation on the throughput performance of Unmanned Aerial Vehicle (UAV)-assisted wireless communication systems. Specifically, we study how physical rotation of the RIS, through controlled azimuth and elevation adjustments, influences the effective channel and data rate. A UAV-mounted RIS enables directional alignment to serve ground users in scenarios where the direct Base Station (BS)-to-user path is blocked. Using the SimRIS Channel Simulator, we analyze the system under various rotation angles and present performance heatmaps that highlight optimal RIS orientations. The results show that properly aligning the RIS can significantly enhance the achievable rate, particularly in indoor environments. This work emphasizes the importance of orientation control in practical RIS deployments

Comparative Analysis of Series YOLO Models for Loose Fruits Palm Oil Detection: A Comprehensive Performance Evaluation

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Automated detection of loose fruits has become a critical factor in minimizing harvest losses in oil palm plantations. This study aims to evaluate and compare the performance of four generations of YOLO models (YOLOv5, YOLOv8, YOLOv9, and YOLOv11) for detecting loose fruits palm oil, focusing primarily on accuracy and inference speed. A total of 20 different model scales were tested using a carefully annotated plantation image dataset resized to 640x640 pixels. Model performance was evaluated based on precision, recall, mean average precision (mAP), and inference time (milliseconds) on both GPU-based systems and edge devices. Results showed that lightweight models such as YOLOv5s and YOLOv8s achieved mAP scores around 0.83 with inference times below 340 ms, making them suitable for real-time applications. Conversely, YOLOv9m and YOLOv11m achieved the highest accuracy with mAP scores exceeding 0.86, but their inference times were longer, surpassing 800 ms, making these models more appropriate for server-based inspection applications. The largest models in each generation provided only slight improvements in accuracy but were accompanied by significant increases in inference time, highlighting a saturation point in the trade-off between model complexity and performance. Consequently, this study offers a comprehensive performance map, serving as a practical guide for selecting appropriate YOLO-based loose fruit detection models tailored to specific application requirements. The key contribution of this research lies in providing a scientific basis for choosing detection models that effectively balance accuracy and computational efficiency, thereby accelerating the integration of computer vision technologies into smart agricultural practices.

Advanced Self-Supervised Learning for Enhanced Heart Disease Prediction

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Cardiovascular diseases (CVDs) persist as the foremost cause of mortality globally, responsible for approximately one in every three deaths, as reported in the 2024 American Heart Association (AHA) Statistical Update [1]. This enduring health crisis underscores the critical demand for early detection and scalable diagnostic tools. Among the available techniques, electrocardiograms (ECGs) are recognized as one of the most cost-effective, non-invasive, and widely utilized methods for identifying cardiac abnormalities, including arrhythmias, myocardial infarction, and heart failure. Despite their clinical significance, traditional ECG interpretation methods heavily depend on expert annotation and extensive labeled datasets, posing substantial scalability challenges in diverse healthcare environments. The manual annotation process is not only time- consuming and resource-intensive but also restricts the applicability of deep learning models in real-world deployments. Therefore, innovative approaches are needed to learn from limited labeled data while ensuring high diagnostic accuracy.

Trust Verification in Connected Vehicles Using Unsupervised Variational Autoencoder

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Only the chairs can edit Cooperative Intelligent Transport Systems (C-ITS) are of great importance in our daily lives. They offer additional means for safer roads thanks to exchanged data between actors (i.e., vehicles and Road Side Units (RSU)). Signatures (that are computed using various Pseudonym Certificates (PC)) are included in all the sent messages. Each vehicle periodically sends application beacons (denoted by CAM (Cooperative Awareness Message)). The integration of the signature and certificate in each transmitted CAM could consume a considerable portion of the communication channel bandwidth. In this study, we propose a new lightweight authentication mechanism using an unsupervised variational autoencoder. Instead of exhaustive authentication, our approach allows vehicles to authenticate each other once and then send only unsigned CAMs based on the trust established during authentication. In order to check this trust level, we proposed to use an unsupervised deep learning mechanism, which continuously measures the variation of the neighbor's behavior. When this variation reaches an unacceptable level, the vehicle assumes that the sender may be compromised. As a result, it proceeds to the authentication of the sender. We have implemented these mechanisms over the OMNET++ network simulation environment. Our simulation study shows that the proposed approach reduces the overhead generated by the authentication algorithms by around 48.9%.

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