3rd International Conference on Computing and Data Analytics

IEEE

جامعة التقنية والعلوم التطبيقية
University of Technology and Applied Sciences
صلالة
Salalah

Proceedings

3rd International Conference on Computing and Data Analytics (ICCDA 2026)

4–5 November 2026 | Salalah, Sultanate of Oman

University of Technology and Applied Sciences – Salalah

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ACKNOWLEDGEMENT

The Organising Committee of the 3rd International Conference on Computing and Data Analytics (ICCDA 2026), organised by the University of Technology and Applied Sciences - Salalah, Sultanate of Oman, extends its sincere gratitude to everyone who contributed to the success of the conference and the publication of these proceedings.

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The Chair of Strategic Technology Studies at the University of Technology and Applied Sciences

Their support has strengthened the academic quality, international reach and visibility of the conference.

Our thanks also go to the University of Technology and Applied Sciences – Salalah for hosting and supporting the conference. We thank the authors who submitted their work, the reviewers whose careful evaluations upheld the conference's peer-review standards, and the keynote speakers and session chairs for enriching the programme. Finally, we acknowledge the dedication of the Steering Committee, the Organising Committee and all sub-committee members, whose efforts made ICCDA 2026 possible.

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Message from the Vice-Chancellor



In the name of Allah, the Most Gracious, the Most Merciful. May peace and blessings be upon our Prophet Mohammad.

It is our distinct honor to welcome all participants to the Third International Conference on Computing and Data Analytics (ICCDA 2026), hosted by the Salalah Branch of the University of Technology and Applied Sciences on 4-5 November 2026.

Advances in computing, artificial intelligence, and data analytics are creating new opportunities to generate knowledge and develop solutions that address future needs and real-world challenges. This conference offers an opportunity to discuss these developments, exchange research experiences and ideas, and explore how these technologies can benefit people and society.

Equally vital are the professional connections that researchers develop when they come together to exchange ideas. We hope the discussions at this conference will strengthen these connections, encourage further scientific collaboration, and create new opportunities for innovation.

We wish all participants a productive and rewarding conference, promising research outcomes, and a pleasant stay in Salalah.

May the peace, mercy, and blessings of Allah be upon you.

H. E. Dr. Said Hamed Al Rubaii
Vice-Chancellor
University of Technology and Applied Sciences



Message from the Assistant Vice-Chancellor

Welcome to the University of Technology and Applied Sciences – Salalah.

Oman Vision 2040 places people, knowledge and innovation at the heart of the nation's future, calling for an education system that prepares young Omanis to lead and a research culture that turns ideas into real solutions. UTAS shares this commitment through its vision to be a leading applied university that connects learning with practice, and research with the needs of industry and the community.

Hosting the 3rd International Conference on Computing and Data Analytics (ICCDA) in Salalah is one way we bring that vision to life. As computing, data and artificial intelligence shape Oman's development, this conference brings together industry professionals, decision makers, academic researchers and students to share their work and learn from one another. Accepted papers will be published in a high-ranking journal, giving researchers from UTAS and around the world a valuable platform for their work.

We are proud to welcome so many guests to Salalah, and we hope the conversations started here will grow into joint research and lasting partnerships between our university and yours.

I extend my sincere thanks to the College of Computing and Information Sciences and to everyone who worked over the past months to bring this edition together. I wish you a successful conference and a pleasant stay in Salalah.

Dr. Ahmed Ali Al-Shahri
Assistant Vice-Chancellor
University of Technology and Applied Sciences - Salalah



Message from the Conference Chair

On behalf of the Organising Committee, it is my pleasure to welcome you to the 3rd International Conference on Computing and Data Analytics (ICCDA 2026), organized by the University of Technology and Applied Sciences, Salalah, and technically sponsored by IEEE.

Building on the success of its previous editions, ICCDA 2026 brings together researchers, academics, and industry professionals from around the world to share knowledge, present innovative research, and foster international collaboration.

This year, the conference received 689 paper submissions across seven research tracks: Computer Network, Cyber Security and Privacy; Artificial Intelligence and Soft Computing; Data Science, Analytics and Applications; Software Engineering and Information Systems; Applied Mathematics; Emerging Topics & Cutting-Edge Technologies; and Ethics, Governance & Responsible AI / AI Ethics in Practice. Following a rigorous peer-review process, 100 papers were accepted, representing an acceptance rate of 14.5%, with 1,983 contributing authors from 37 countries,with first authors from 27 country.

These proceeding showcases the accepted research contributions and reflects the diversity and innovation of the global research community. We hope it inspires meaningful discussions, new partnerships, and future research opportunities.

I extend my sincere appreciation to all authors, reviewers, the Technical Program Committee, the Organising Committee, sponsors, and partners for their dedication and valuable contributions to the success of ICCDA 2026.

Dr. Lamiya Said Al-Shanfari

Conference Chair

University of Technology and Applied Sciences - Salalah

ABOUT THE CONFERENCE

ICCDA 2026

The International Conference on Computing and Data Analytics (ICCDA) is a premier international forum dedicated to advancing research and innovation in Data Sciences, Soft Computing, AI Ethics, Machine Learning, Big Data, Statistical Exploratory Data Analysis, and Information Sciences. The 3rd edition brings together researchers, educators, and industry practitioners to present original work, exchange experience and build collaboration from theory and methods to real-world applications.

ICCDA 2026 aims to advance computational methods and analytical techniques that enhance data-driven decision. By uniting global experts, ICCDA 2026 seeks to contribute to theoretical development and practical applications, aligning with Oman Vision 2040 for sustainable technological growth.



TRACK: Software Engineering and Information Systems
Software design, testing and maintenance, information systems, enterprise platforms and digital transformation.



TRACK: Artificial Intelligence and Soft Computing
Machine learning, deep learning, language models, computer vision, fuzzy and evolutionary computation, and intelligent systems.



TRACK: Emerging Topics and Cutting-edge Technologies
Digital twins, IoT, edge and quantum computing, immersive media and other fast-moving technologies.



TRACK: Computer Networks, Cyber Security and Privacy
Network architectures, secure systems, threat detection, cryptography and privacy-preserving technologies.



TRACK: Data Science, Analytics and Applications
Data mining, big data, predictive modelling, visualizing and data-driven applications across domains.



TRACK: Ethics, Governance and Responsible AI
Fairness, transparency, accountability, regulation and trustworthy AI in education, industry and society.



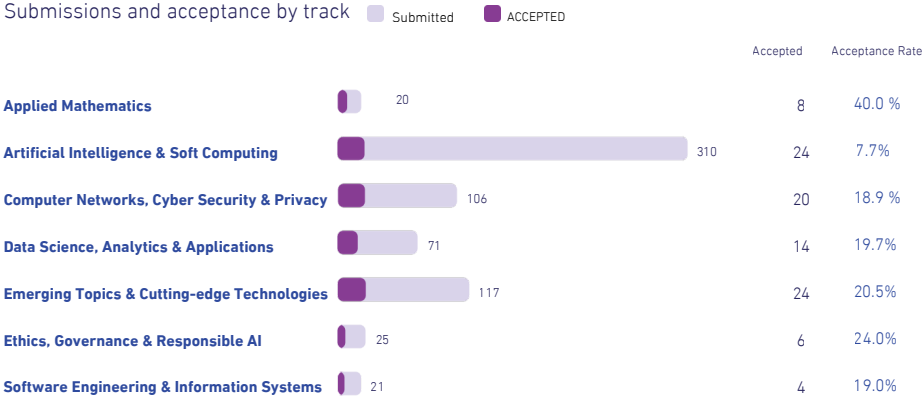
TRACK: Applied Mathematics
Mathematical modelling, differential equations, optimisation, numerical methods and statistics applied to intelligence systems.

CONFERENCE AT A GLANCE

ICCDA 2026 in Numbers

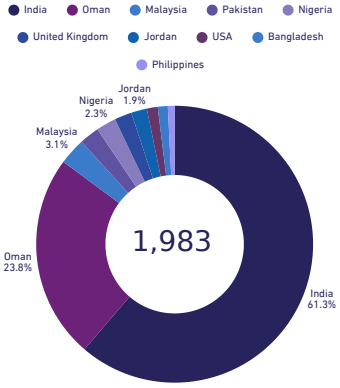
689	100	14.5%	1,983	27
SUBMISSIONS	ACCEPTED PAPERS	ACCEPTANCE RATE	AUTHORS	FIRST AUTHOR COUNTRIES

Submissions and acceptance by track

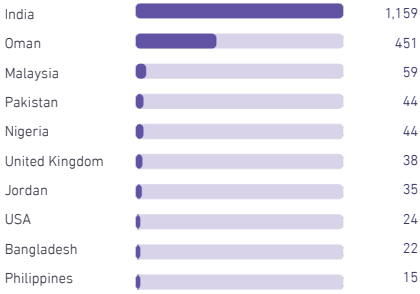


Where our authors come from

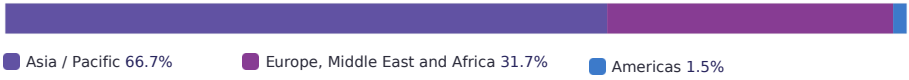
Share of the 1,983 author entries across all submitted papers



TOP 10 COUNTRIES BY AUTHORS



Authors by region



ICCDA 2026 Committee Structure



ICCDA Conference Committees members

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PROGRAM

Keynote Speakers

Source: ICCDA2026 conference website (iccda.utas.edu.om/keynote-speakers-2).



Dr. Haitham Al Hajri

CISO-CYBERSECURITY RESEARCHER
HEAD OF CYBER AND INFORMATION SECURITY OMAN
HOUSING BANK
SULTANATE OF OMAN

Dr. Haitham Al Hajri is an award-winning cybersecurity leader with over 19 years of experience, recognized as CISO of the Year 2024 and 2025. As CISO at a major financial institution, he has led critical initiatives in incident response, GRC, and cyber-resilience, collaborating closely with national regulators, law enforcement, and CNI sectors. A forward-thinking innovator, technology co-founder, and advisor within multiple tech innovation firms, he advocates the adoption of AI, machine learning, and quantum-resilient technologies to strengthen cybersecurity posture and strategic decision-making. He holds a master's in digital forensics, a PhD in Cybersecurity Management & Operations, and multiple professional certifications. Recognized as a LinkedIn Top Voice and a sought-after keynote speaker, Dr. Al Hajri continues to advance national cyber-capacity building and knowledge sharing.



Dr. Carrie Demmans Epp

ASSOCIATE PROFESSOR
DEPARTMENT OF COMPUTING SCIENCE
UNIVERSITY OF ALBERTA
CANADA

Carrie Demmans Epp is a Killam Laureate and Associate Professor in the Department of Computing Science at the University of Alberta. She holds a PhD in Computer Science (Human-Computer Interaction – Educational Technology) from the University of Toronto, as well as an MSc and BSc in Computer Science from the University of Saskatchewan.

Dr. Demmans Epp leads the EdTeKLA research group, where her work addresses limitations in both the capabilities of existing educational technologies and their integration into real-world learning environments. Her research examines how people incorporate technology into teaching and learning processes, as well as how learners develop and use models of their performance and processes. Drawing on artificial intelligence, natural language processing, human-computer interaction, software engineering, and psychology, her work contributes to multiple fields, including AI, HCI, applied linguistics, psychometrics, and education. Her research focuses primarily on language learning, while also extending to other contexts such as lifelong learning and special education, with an emphasis on learner modeling, visualization, and analytics to support decision-making for both educators and learners.



Dr. Mazen Mohammed Ahmed Ali

PRESIDENT, ISACA BAHRAINCHAPTER
DEAN,COLLEGE OF INFORMATIONTECHNOLOGY UNIVERSITY OF BAHRAIN

Dr. Mazen Ali is an accomplished and forward-thinking leader with extensive experience in higher education management, digital transformation, and strategic institutional development. His career is distinguished by a consistent record of advancing academic excellence, operational efficiency, and sustainable growth across education and professional training sectors.
As Dean of the College of Information Technology at the University of Bahrain, Dr. Ali leads transformative initiatives that enhance educational quality, expand learning, and strengthen industry and research partnerships. His leadership has modernized academic structures, advanced the university's IT programs, and ensured alignment with national and global workforce demands.

In addition to his deanship, Dr. Ali has served as Director of E-Learning and Director of the Media Center, where he successfully implemented digital learning platforms. These initiatives have strengthened the university's learning management systems, enhanced learner engagement, and fostered a culture of innovation and collaboration.

Beyond academia, Dr. Ali has demonstrated outstanding professional leadership as President of the ISACA Bahrain Chapter, where he has led numerous high-impact training programs and professional development events. Under his leadership, the chapter received recognition and awards for its contributions to advancing knowledge in information systems governance, cybersecurity, and digital auditing. His leadership exemplifies an ability to bridge academia and industry, driving shared objectives in capacity building and national development.

A collaborative and visionary leader, Dr. Ali engages actively with government entities, industry partners, and international organizations to align education with technological innovation and economic growth. Guided by strategic foresight and a deep commitment to quality and impact, he continues to champion digital transformation and institutional excellence, advancing human capital development at national and global levels.



Prof. Dr. Noor Zaman Jhanjhi

PROFESSOR
SCHOOL OF COMPUTER SCIENCE
TAYLOR'S UNIVERSITY
MALAYSIA

Prof. Dr. Noor Zaman Jhanjhi is a highly esteemed Senior Professor of Computer Science, specializing in Artificial Intelligence and Cybersecurity. He currently holds the position of Professor at the School of Computer Science at Taylor's University, Malaysia. He serves as the Director of Research Center, Center for Intelligent Innovations CII, Program Director for Postgraduate Research Degree Programmes as well as the Director of the Research Center. With a career marked by academic leadership and groundbreaking research, Prof. Jhanjhi has been pivotal in advancing research and education in computer science.

Recognized globally, Prof. Jhanjhi has been ranked among the world's top 2% research scientists for four consecutive years (2022, 2023, 2024, and 2025). In Malaysia, he is ranked the No. 1 Best Computer Science researcher (AD Scientific Index) and was honored with the Outstanding Faculty Member award by MDEC Malaysia in 2022, as well as the Vice Chancellor's Best Research Citations Award from Taylor's University in 2023.

His impressive academic portfolio includes over 80 research books edited or authored with prestigious publishers such as Springer, Elsevier, Taylor & Francis, Wiley, IET, Bentham, CRC, and IGI Global USA. His research has garnered more than 1000 points in impact factor, reflecting the depth and breadth of his contributions to the field. A dedicated mentor, Prof. Jhanjhi has supervised and co-supervised 45 postgraduate students to successful graduation and has served as an external examiner for over 70 Ph.D. and Master's theses globally.

In addition to his academic accomplishments, Prof. Jhanjhi holds Editor in Chief, Associate Editor and EAB positions with several high-ranking journals, including PeerJ Computer Science, CMC Computers, Materials & Continua, and Frontiers in Communication and Networks. He was also recognized as an Outstanding Associate Editor for IEEE ACCESS.

A sought-after keynote speaker, Prof. Jhanjhi has delivered over 90 invited Keynote talks at international conferences and has chaired numerous conferences and sessions. His commitment to academic excellence and accreditation extends to his involvement with ABET, NCAAA, and NCEAC over the past decade.

Track Venue Day 1

BUILDING	VENUE	TRACK
Building D	D005	Software Engineering and Information Systems
Dhofar Hall Building D	Conference Hall D005	Artificial Intelligence and Soft Computing
Building I	I-126	Emerging Topics and Cutting-edge Technologies
Building I	Huawei Lab	Computer Network, Cyber Security and Privacy
Building A	Saada Hall	Data Science, Analytics and Applications
Building D	D001	Ethics, Governance and Responsible AI
Building I	I-101	Applied Mathematics

Track Venue Day 2

BUILDING	VENUE	TRACK
Dhofar Hall Building D	Conference Hall D005	Artificial Intelligence and Soft Computing
Building I Building I	I-105 I-126	Emerging Topics and Cutting-edge Technologies
Building I	Huawei Lab	Computer Network, Cyber Security and Privacy
Building A	Saada Hall	Data Science, Analytics and Applications

TRACK

Computer Networks, Cyber Security and Privacy

20 Abstracts in this section



106	20	30.4%
SUBMISSIONS	ACCEPTED	ACCEPTED RATE

Computer Network, Cyber Security and Privacy

Session Chair:
Dr.Faizal Hajamohideen

Session Facilitator:
Dr. Mohammed Ashik

Day 1
Huawei Lab

TIME	PAPER ID	PAPER TITLE
12:00 PM – 12:20 PM	1571314689	A Practical, Four-Phase Framework for Incremental Zero Trust Architecture Adoption in Legacy Networks
12:20 PM – 12:40 PM	1571316660	Empirical Optimization of BFV Homomorphic Encryption Parameters for Reliable Privacy-Preserving Healthcare Queries
12:40 PM – 1:00 PM	1571309050	The Impact of Heterogeneity on UAV Swarm Formation Recovery and Mission Success Following Visual Jamming Attacks
1:00 PM – 1:20 PM	1571312289	TCL FedGuard: Trust Calibrated Lightweight Federated Distillation for DDoS Detection in 5G V2X Edge Networks
1:20 PM – 1:40 PM	1571314736	A Survey of Explainable AI-Driven Socio-Technical Framework for Proactive Vulnerability Prioritization in Enterprise Systems: Challenges and Future Directions
1:40 PM – 2:00 PM	1571312637	Experimental Comparison of Privacy-Preserving Mechanisms in Blockchain-Based E-Voting
3:00 PM – 3:20 PM	1571292037	Blockchain-Based Smart Contract Framework for Secure Agricultural Marketplace and Automated Farmer Payments in India
3:20 PM – 3:40 PM	1571284115	FedSplit: A Federated Split-Learning Framework with Energy-Adaptive Inference for Privacy-Preserving Wearable Healthcare IoT
3:40 PM – 4:00 PM	1571316608	Cybersecurity in the Healthcare Industry: Challenges, Breaches, and Emerging Defenses
4:00 PM – 4:20 PM	1571305576	Hysteresis-Based anti-Oscillation Control for Adaptive Routing in QKD Networks
4:20 PM – 4:40 PM	1571316295	AI-Driven Cyber Threat Detection in the Post-Quantum Era: Challenges and a Layered Defense Framework
4:40 PM – 5:00 PM	1571316877	LSPCE: A Legally Scoped Privacy-Compliant Framework for Cloud Forensic Evidence Collection and Compliance Validation

Computer Network, Cyber Security and Privacy

Session Chair:
Dr.Faizal Hajamohideen

Session Facilitator:
Dr. Mohammed Ashik

Day 2
Huawei Lab

TIME	PAPER ID	PAPER TITLE
10:45 AM – 11:05 AM	1571321055	A Continuous Zero-Knowledge Proof Protocol for Privacy-Preserving Operator Authentication in Immersive Industrial Environments
11:05 AM – 11:25 AM	1571316469	Design and Analysis of Filter-Embedded Hybrid (FEHY) Feature Selection of DDoS Attacks Detection in SDN
11:25 AM – 11:45 AM	1571295861	PhishFixRTD: Integrating Phishing Detection Models into Web Browsers for Real-Time Detection
11:45 AM – 12:05 PM	1571316353	Quantum Cryptography Today: Applications, Limitations, and Future Outlook
12:05 PM – 12:25 PM	1571298348	Mini-SOC: LLM-Orchestrated Multi-Agent Framework for Autonomous Intrusion Detection and Response
12:25 PM – 12:45 PM	1571280214	Decentralized Federated Generative AI Systems for Privacy-Preserving Collaborative Intelligence in Distributed Environments

01
ID
1571314689

A Practical, Four-Phase Framework for Incremental Zero Trust Architecture Adoption in Legacy Networks

Yashir Uto Ambula[1], Jonathan Peter Glycer R. Tambaoan[1], Rogelio T. Gutierrez Jr[1]
[1] La Consolacion University Philippines, Philippines

Organizations face a growing threat landscape. The adoption of remote work and cloud services intensifies this challenge. Reports of breaches on legacy networks illustrate this. Attackers exploit outdated hardware to gain unauthorized access to critical systems. The incident highlights vulnerabilities inherent in perimeter-based security models. These models are now ineffective. Zero Trust Architecture (ZTA), based on the principle of "never trust, always verify," offers a comprehensive solution. Yet, implementing ZTA in existing "brownfield" legacy networks is particularly complex. Legacy systems often use outdated hardware and flat architecture. They include critical applications that are hard to modify. A complete "rip-and-replace" strategy can be risky and costly. This paper addresses a commonly encountered practical challenge in Zero Trust adoption for legacy environments, which we refer to as transition complexity. It does so by introducing a practical four-phase framework for the incremental adoption of ZTA. The framework consists of Foundation and Visibility, Control and Enforcement, Automation and Optimization, and Full Integration. Each phase delivers immediate security enhancements with minimal operational disruption. This enables organizations to build a Zero Trust posture tailored to their unique legacy constraints. By dividing the process into manageable steps, the framework makes Zero Trust Architecture attainable and strategic.

Keywords: Zero trust architecture; Legacy networks; Network security; Incremental adoption; Perimeter-based security

02
ID
1571316660

Empirical Optimization of BFV Homomorphic Encryption Parameters for Reliable Privacy-Preserving Healthcare Queries

Kamran Saeed[1], Shahzad Hassan[2], Yahya Yaqoob Obaid Al Balushi[2], Muhammad Nauman, Muhammad Naseer[1], Birger Andersen[3]

[1] Bahria University, Islamabad, Pakistan
[2] Military Technological College, Oman
[3] Technical University of Denmark, Denmark

Homomorphic encryption has emerged as a promising technology for privacy-preserving healthcare analytics by enabling computation directly on encrypted data stored in untrusted cloud environments. Among the available homomorphic encryption schemes, the Brakerski-Fan-Vercauteren (BFV) scheme is particularly well suited to clinical applications because it supports exact integer arithmetic, which is essential for electronic health records (EHRs) and remote patient monitoring (RPM) workloads. However, selecting appropriate BFV parameters remains challenging due to the trade-offs among computational performance, storage overhead, multiplicative depth, and decryption reliability. This paper presents an empirical evaluation of BFV parameter configurations at a fixed 128-bit security level using Microsoft SEAL through the Pyfhel library. Representative healthcare workloads, including aggregate clinical queries and chained homomorphic multiplications for risk-scoring operations, were used to benchmark polynomial modulus degrees $n \in \{4096, 8192, 16384\}$ and plaintext modulus bit lengths $tbits \in \{16, 20, 24\}$. Performance was evaluated in terms of key generation time, encryption and decryption latency, ciphertext storage, available noise budget, supported multiplicative depth, and decryption correctness. Experimental results show that the configuration ($n = 4096$, $t_bits = 20$) provides the most efficient and reliable solution for aggregate healthcare queries, whereas ($n = 8192$, $t_bits = 20$) offers the best balance between computational depth and performance for weighted risk scoring workloads requiring multiple homomorphic multiplications. Based on these findings, this paper proposes a practical workload driven framework and deployment safeguards for reliable BFV parameter selection in privacy-preserving healthcare systems.

Keywords: Homomorphic encryption; BFV scheme; Privacy-preserving queries; Healthcare analytics; Parameter optimization

03
ID
1571309050

The Impact of Heterogeneity on UAV Swarm Formation Recovery and Mission Success Following Visual Jamming Attacks

Maryam Said Bauwain[1], Aisha K. Junejo[1], Nadia Kanwal[1]
[1] Keele University, United Kingdom (Great Britain)

This paper evaluates model heterogeneity in Unmanned Aerial Vehicle (UAV) swarms, with a specific focus on their resilience against visual jamming attacks. Maintaining precise geometric formations in dynamic environments remains a significant challenge, particularly under adversarial conditions. To address this, we used a heterogeneous Deep Reinforcement Learning (DRL) architecture with the Proximal Policy Optimization (PPO) algorithm to train the leader for efficiently reaching a target using the color rate recorded by the leader's camera, while the Soft Actor-Critic (SAC) algorithm is employed to train the swarm to maintain a flexible V-shaped formation within a high-fidelity simulation environment. The results demonstrate that the leader achieved 100% target-reaching accuracy, while the swarm maintained its V-shaped formation with an average success rate of 47.73% (± 9.92%) during normal flight, peaking at a 73.78% success rate. This approach significantly outperformed homogeneous PPO-based models, which failed to complete the task effectively. In addition, the study introduces a swarm formation recovery time after jamming attacks metric to measure the swarm formation resilience under visual jamming attacks, revealing a substantial performance drop, reducing the average success rate to 11.4%, with a recovery time ranging between 2.4s and 3.7s. These findings suggest that future research must focus on integrating robust filtering mechanisms and autonomous navigation algorithms based on local estimation.

Keywords: UAV swarm; Visual jamming attacks; Formation recovery; Heterogeneity; Resilience

04
ID
1571312289

TCL FedGuard: Trust Calibrated Lightweight Federated Distillation for DDoS Detection in 5G V2X Edge Networks

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Distributed denial of service (DDoS) attacks can affect 5G V2X sidelink coordination, user plane congestion and slow down safety responses. Conventional deep learning mandates raw traffic collection, while standard federated learning (FL) decreases the amount of data exposed but is vulnerable to poisoned clients, non independent data and communication overhead. Thus, this paper introduces TCL FedGuard, a trust calibrated lightweight federated distillation framework to detect V2X DDoS attacks at the resource constrained edge nodes. TCL FedGuard sends validation F1 score, consistency of updates and reliability scores based on link quality to calibrate compact softened logits instead of exchanging all model parameters among all peers. A strong trimmed distillation step helps reduce clients that are outliers, and a quantized student detector allows for real time student inference on embedded vehicular hardware. We test the method in a realistic experimental setup where V2X traffic is flooded at various flow levels with TCP SYN, UDP and mixed flooding patterns, and under both IID and non IID partitions. The results indicate that TCL FedGuard obtains a 94.8% macro F1 score, reduces the communication to 0.64 MB per round and maintains 90.7% macro F1 score in case of 20% poisoning of clients. The proposed method achieves a better trade off between detection accuracy, robustness and network cost, compared to FedAvg and secure peer to peer averaging baselines, without centralizing raw traffic.

Keywords: DDoS detection; Federated distillation; 5G V2X; Edge networks; Trust calibration

05
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1571314736

A Survey of Explainable AI-Driven Socio-Technical Framework for Proactive Vulnerability Prioritization in Enterprise Systems: Challenges and Future Directions

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Thousands of vulnerabilities are affecting enterprises systems nowadays. Security teams have limited time and resources to fix all these exposures. Enterprise vulnerability management has become more difficult as organizations receive vulnerability data from public vulnerability databases, vendor advisories, exploit feeds, and threat intelligence reports. There are two traditional methods, Common Vulnerability Scoring System (CVSS) and Exploit Prediction Scoring System (EPSS) used to asses' vulnerabilities in enterprise systems. CVSS gives security teams a useful way to measure technical severity whereas EPSS improve prioritization by estimating exploitation likelihood. Most prediction systems remain vulnerability centric. They often focus on technical attributes such as CVE and metadata, however both classic methods CVSS and EPSS alone cannot capture the real enterprise risk. Enterprise risk is also influenced by human. organization and enterprise-context factors. Organizations cannot patch everything; prioritization must be focused on vulnerabilities with the highest probability of actual organization risk. Machine learning models can improve exploit likelihood estimation and support prioritization however; many of these AI models are still black-box systems. Limited transparency reduces analyst trust, decision actionability and adoption in security workflows. Therefore, explainable artificial intelligence is essential for transparent, defensible and practical remediation. After reviewing existing work, this paper identifies key challenges and future directions, and finally proposes an explainable socio-technical framework for proactive vulnerability prioritization in enterprise systems

Keywords: Vulnerability prioritization; Explainable AI; Socio-technical framework; Enterprise security; Vulnerability management

06
ID
1571312637

Experimental Comparison of Privacy-Preserving Mechanisms in Blockchain-Based E-Voting

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The discussion on the use of blockchain technology in digital voting has taken center stage, aiming to meet the challenges of auditability, transparency, and resistance to tampering. Technical solutions such as blind signatures and zero-knowledge proofs (ZKP) can enhance anonymity guarantees, but can also lead to non-trivial computations and protocol overhead. In this paper, we provide a controlled experimental comparison of three blockchain-based e-voting workflows: a non-private one in which the voting process is recorded in the ledger; a private one based on blind signatures to authorize votes, and a private one based on a Schnorr-like ZKP to authorize votes. A prototype of Python was developed to run these workflows under the same conditions. The baseline model was able to maintain 18,699.53 transactions per second with a negligible casting latency, the blind-signature model was able to achieve 26.42 transactions per second with an average of 37.81 ms of casting latency, and the ZKP-based model was able to achieve 1,390.90 transactions per second with an average of 0.65 ms of casting latency. The results highlight the inherent privacy-performance paradox: blind signatures incur the highest overhead while the ZKP-style workflow provides greater privacy security than the baseline with significantly better performance than blind signatures. These findings reflect prototype-scale comparative measurements under controlled conditions.

Keywords: Blockchain; E-voting; Zero-knowledge proofs; Blind signatures; Privacy-preserving mechanisms

07
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1571292037

Blockchain-Based Smart Contract Framework for Secure Agricultural Marketplace and Automated Farmer Payments in India

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Delays in payment, price fixing, and lack of transparency in the agricultural supply chain are common in India. The traditional market system with intermediary agents is mainly responsible for these challenges. This paper proposes a decentralized agriculture marketplace using blockchain technology and smart contracts. The approach applies a minimum support price through smart contracts and uses an escrow service for secure and transparent transactions. Farmers and buyers interact directly without intermediaries, reducing exploitation and increasing trust between participants. The Solidity-based smart contract operates on the Ethereum test network and was evaluated for gas consumption, transaction finality, transparency, efficiency, and essential security features to ensure reliable agricultural trade. Experimental results show that smart contracts reduce payment delays, increase price transparency, and automatically enforce fair pricing policies. The system supports sustainable and digitally connected agricultural markets in developing countries while improving trust, operational efficiency, fairness, and long-term economic benefits for farmers, buyers, and other participants.

Keywords: Blockchain; Smart contracts; Agricultural marketplace; Farmer payments; Supply chain transparency

08
ID
1571284115

FedSplit: A Federated Split-Learning Framework with Energy-Adaptive Inference for Privacy-Preserving Wearable Healthcare IoT

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The rapid penetration of wearable healthcare IoT devices calls for timely, energy-efficient, and privacy-protected health monitoring systems. Current cloud computing solutions are hampered by latency, privacy concerns and high energy consumption on resource limited wearable devices. In this paper, we introduce FedSplit, a three-pronged approach that combines federated split-learning with adaptive inference for energy efficient wearable healthcare IoT. The first pillar supports privacy preserving collaborative training with federated learning through differential privacy. The second pillar incorporates a Q-learning-based adaptive split computing agent that dynamically splits inference across wearables and edge servers, taking into account battery, network, and health urgency. The third pillar provides an energy-harvesting-aware engine that dynamically transitions between Full, Split, and Ultra-Lite inference. The approach is extensively tested on the MIT-BIH and PTB-XL ECG datasets using federated learning and achieves 93.8% classification accuracy, 47.3% lower latency, 52.1% lower energy consumption, and 2.8 times longer battery life than conventional federated learning approaches.

Keywords: Federated split learning; Wearable healthcare IoT; Energy-adaptive inference; Privacy preservation; Edge computing

09
ID
1571316608

Cybersecurity in the Healthcare Industry: Challenges, Breaches, and Emerging Defenses

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This paper describes a comprehensive review article that reviews the current state of the cybersecurity threat landscape in the healthcare industry and the existing technologies to counteract these threats. The review methodology is based on the systematic analysis of significant data breach events that have occurred over the last ten years. It considers the common weaknesses in the system, associated financial damage, and the impact on patients' safety. We review the major cybersecurity threats in healthcare, such as ransomware attacks, social engineering, and vulnerabilities in the IoMT environment. Additionally, this review examines the new technologies for defending from such cybersecurity threats, including machine-learning anomaly detection, blockchain technology, and Zero-Trust architecture. Based on the results obtained of the review, we propose a new conceptual framework, which suggests integrating these technologies to build a proactive, adaptive, and scalable defense for healthcare infrastructure. Contrary to the primary research paper, the work does not provide any empirical implementation, but rather a critical analysis and a model for further studies. Finally, we consider the future direction and discuss how quantum-resistant cryptography and federated learning may improve privacy and resilience.

Keywords: Healthcare cybersecurity; Data breaches; Threat landscape; Defense mechanisms; Systematic review

10
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1571305576

Hysteresis-Based anti-Oscillation Control for Adaptive Routing in QKD Networks

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Adaptive routing in Quantum Key Distribution (QKD) networks faces a stability versus responsiveness conflict that has no analogue in classical networking. Every path change forces a full quantum key re-establishment, so each unnecessary switch consumes both wall-clock time and previously generated key material. Recent dynamic-routing studies report path oscillation as a self-acknowledged limitation but propose no mitigation, and the route flap damping framework formalized in RFC 2439 specifies only mechanism classes, leaving numerical parameter values unaddressed for the QKD setting. This paper presents a hysteresis-based anti-oscillation policy built on a four-rule decision logic (minimum residence time, hysteresis window, switch-rate cap, and QBER improvement threshold) with a consecutive-failure emergency override. The novelty lies not in the mechanism alone but in the derivation. Each of the five control values is obtained from BB84 sampling cadence, link-recovery time, and the measured QBER noise floor, then validated through a 418-run sensitivity sweep across five seeds on an 8-node MESH topology under 35 percent per-step disturbance. The derived configuration eliminates all 23.2 oscillation events per 200-step run observed under uncontrolled routing, at a controlled cost of 8.4 percent in average Secure Key Rate (9.83 to 9.01 kbps), and lies on the SKR versus oscillation Pareto frontier with zero false emergencies. The result is a transferable parameter-derivation template for stable adaptive routing in production QKD deployments.

Keywords: Quantum key distribution; Adaptive routing; Hysteresis control; Network stability; Quantum networks

11
ID
1571316295

AI-Driven Cyber Threat Detection in the Post-Quantum Era: Challenges and a Layered Defense Framework

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The convergence of artificial intelligence (AI)-enabled cyber threats and quantum computing presents a major challenge to modern cybersecurity systems. Most existing AI-powered threat detection mechanisms were developed before the post-quantum era, when RSA and Elliptic Curve Cryptography (ECC) were considered sufficient for secure communication. However, the finalization of the National Institute of Standards and Technology (NIST) post-quantum cryptography (PQC) standards in August 2024, including FIPS 203, FIPS 204, and FIPS 205, has created an urgent need to rethink AI-driven detection systems under quantum-safe security requirements. This paper reviews major AI-driven attack vectors, including Large Language Model (LLM)- assisted phishing, adversarial machine learning (AML), neural network poisoning, deepfake-based social engineering, and Autonomous Exploitation Agents (AEAs). It also examines the NIST PQC standardization process and identifies key gaps in the existing literature. To address these gaps, this paper proposes the Post- Quantum AI Defense Framework (PQADF), a four-layer architecture consisting of quantum-safe communication, PQC-secured detection, adaptive response, and governance and compliance. The framework addresses four major challenge dimensions: computational overhead in real-time detection pipelines, quantum-amplified adversarial attacks against AI models, training data privacy under the harvest-now-decrypt-later (HNDL) threat, and the absence of standardized PQC-aware intrusion detection datasets. A comparative analysis with five prior frameworks shows that PQADF provides broader and more integrated coverage. The proposed framework offers researchers and practitioners a structured pathway for transitioning from conventional AI-driven cyber defense toward a quantum-safe operational posture.

Keywords: Post-quantum cryptography; AI-driven threat detection; Cybersecurity; Layered defense; Quantum computing

12
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1571316877

LSPCE: A Legally Scoped Privacy-Compliant Framework for Cloud Forensic Evidence Collection and Compliance Validation

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Cloud forensic investigators work under the legal warrant that defines the scope of evidence they are allowed to gather, which contains the principals under investigation, the categories of evidence that they are allowed to gather, and the time frame of the evidence gathering. In reality the translation of a warrant into an operational collection plan is done manually and is inefficient, hard to audit, and can lead to two types of errors: collecting evidence not authorized by the warrant, or not collecting evidence that is authorized under the warrant. This paper proposes the LSPCE framework, which automates this process and validates it. LSPCE normalizes warrant language to extract the authorized scope and intended scope from natural language warrant and investigator collection plans, respectively, by applying a large language model; normalizes evidence descriptions to a controlled forensic taxonomy using the LLM; and classifies each plan as APPROVED, OVER COLLECTION, or UNDER COLLECTION by applying a deterministic rule-based comparator. We test the framework using 165 labeled collection plans for 55 forensic scenarios from the Invictus AWS CloudTrail data set. The results demonstrate LLM-based extraction significantly outperforms a regex-based baseline, particularly in identifying evidence categories and that the framework can effectively capture evidence collection that is not authorized in the evaluation set. The results show that automatic validation of warrant compliance is technically possible and that it has practical value for the cloud forensic investigations workflow, and the goal of more consistent and auditable evidence collection practices.

Keywords: Cloud forensics; Digital evidence collection; Privacy compliance; Legal warrant; Compliance validation

13
ID
1571321055

A Continuous Zero-Knowledge Proof Protocol for Privacy-Preserving Operator Authentication in Immersive Industrial Environments

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Immersive industrial environments give a single human operator continuous control over consequential physical processes. Yet, authentication in these environment is typically a one-time gate where an operator proves identity once, and the system trusts the rest of the session unconditionally. An operator displaced mid-session, by device theft or unauthorized takeover, goes undetected until the session ends, and the continuous schemes that do exist typically transmit or store raw biometric data, creating a single point of permanent compromise. This paper presents CB-ZKP, a Continuous Behavioural Zero Knowledge Proof protocol that generates a Groth16 zk-SNARK proof from passive gaze biometrics every 30 to 120 seconds, reverifying operator identity without interrupting the task or exposing biometric data to the verifier. To our knowledge, CB-ZKP is the first protocol to combine continuous verification with zero knowledge biometric privacy for human-operator authentication in this setting. A first implementation of the circuit, benchmarked over 100 trials at each of five feature dimensionalities (8 to 128), generates proofs in under 820 milliseconds against a 2-second budget, and a Monte Carlo simulation bounds median substitution-detection latency to 15.4 seconds at a 30-second cycle.

Keywords: Zero-knowledge proofs; Continuous authentication; Immersive industrial environments; Privacy preservation; Operator authentication

14
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1571316469

Design and Analysis of Filter-Embedded Hybrid (FEHY) Feature Selection of DDoS Attacks Detection in SDN [2]

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Software-Defined Networking (SDN) architecture have elevated the vulnerabilities of Distributed Denial of Service (DDoS) attacks due to the centralized control nature of architecture. Attackers can overwhelm the controller with a flood of new-flow requests, which exploits the architecture's reliance on a central point for network management. Existing Intrusion Detection System (IDS) struggled with high-dimensional traffic data and evolving attack patterns in SDN environments. Feature Selection (FS) is crucial in improving ML-based DDoS attacks detection systems by identifying relevant traffic characteristics while reducing computational overhead. Most of the existing IDS employed with FS method have several problems, such as dataset generalizability limitation, dataset imbalance, high complexity, and high false positive rates. This research proposed a hybrid FS method named Filter-Embedded Hybrid Feature Selection (FEHY), combining filter method (Mutual Information), embedded methods (L1 Regularization and Tree-based feature importance), and a rank-based voting system for enhanced DDoS attacks detection in SDN environments. The proposed hybrid filter-embedded FS method integrates both linear and non-linear perspectives on feature importance while leveraging information-theoretic approaches to identify important features across multiple FS techniques. The framework employs Decision Tree (DT) and Random Forest (RF) classifiers for their superior performance in handling complex, non-linear relationships in network traffic data. Performance is evaluated on three benchmark datasets (InSDN, CIC- IDS2017, CIC-IDS2018). The results showed that FEHY combined with Random Forest achieved detection performance with 100% accuracy, precision, recall, and F1-score on both InSDN and CIC-IDS2018 datasets, while maintaining computational efficiency advantages over other FS methods.

Keywords: DDoS attacks; Software-defined networking; Feature selection; Hybrid filter; Intrusion detection

15
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1571295861

PhishFixRTD: Integrating Phishing Detection Models into Web Browsers for Real-Time Detection

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Phishing remains a major cybersecurity threat, exploiting browser-level weaknesses and user susceptibility to steal sensitive information. Most existing defences rely on blacklists, incur high computational cost, lack real-time browser integration, and generalise poorly to zero-day attacks. This paper presents PhishFixRTD, a lightweight hybrid machine-learning framework for real-time phishing detection embedded within a web browser. The approach combines 43 lexical URL features with 66 infrastructure attributes derived from DNS, SSL, and WHOIS signals, and employs a low-latency LightGBM classifier. We train and evaluate the model on a large- scale dataset of over 1.2 million phishing and legitimate URLs. Results show strong performance (99.70% accuracy, 99.22% precision, 99.03% recall, ROC-AUC = 0.9984) with sub-100 ms inference suitable for live browsing. PhishFixRTD is deployed via a RESTful API and integrated with a Chrome extension to enable in- session detection and refinement using user feedback. Overall, the framework demonstrates practical, privacy- conscious, and responsive phishing defence for modern web systems.

Keywords: Phishing detection; Browser integration; Real-time detection; Zero-day attacks; Machine learning

16
ID
1571316353

Quantum Cryptography Today: Applications, Limitations, and Future Outlook

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Quantum computing represents a transformative leap in processing power, harnessing the principles of quantum physics to handle information in ways that traditional computers cannot. Unlike classical systems, quantum computers exploit phenomena such as superposition and entanglement to perform complex computations at unprecedented speeds. This study investigates the profound impact of quantum computing on the field of cryptography, with particular focus on the vulnerabilities it introduces to widely used encryption standards, including RSA, Elliptic Curve Cryptography (ECC), and Diffie-Hellman Key Exchange (DHKE). As these conventional methods face growing threats, the need for robust alternatives becomes increasingly urgent. We explore the foundational principles of quantum mechanics and their implications for both computation and data security. Furthermore, we analyze emerging defensive strategies, including post-quantum cryptography and Quantum Key Distribution (QKD), assessing their potential to safeguard sensitive information in a future where quantum computing becomes mainstream. The rapid advancement of quantum technologies necessitates a proactive approach from governments, industries, and researchers alike in redesigning security infrastructures. Without timely intervention, critical systems spanning finance, healthcare, and national defense could become dangerously exposed to quantum-enabled attacks. Ultimately, this study aims to bridge the gap between theoretical quantum developments and practical cybersecurity solutions, offering a roadmap for building a more resilient digital future.

Keywords: Quantum cryptography; Quantum key distribution; Post-quantum security; Quantum computing; Cryptographic applications

17

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1571298348

Mini-SOC: LLM-Orchestrated Multi-Agent Framework for Autonomous Intrusion Detection and Response

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Static rule-based detection engines and fragmented log pipelines have created a measurable gap between the alerts that modern Security Operations Centers generate and the autonomous reasoning required to act on them. This paper presents Mini-SOC, an open-source SOC framework built on a stateful LangGraph multi-agent pipeline in which four specialized agents – Collector, Analyst, Hunter, and Orchestrator – automate the complete incident response workflow from raw log ingestion through structured decision-making. The Orchestrator is powered by GPT-5.5, and its contextual reasoning capability was directly observable during live evaluation: the system correctly issued a block decision against the ZeroTier attacker IP while recommending escalation for the IPv6 loopback address, inferring without any configured rule that blocking the loopback would disrupt local services without mitigating the actual threat. The system was validated against a live human attacker connected over a cross-city ZeroTier VPN overlay, producing adversarial traffic under realistic operational conditions. Across four attack scenarios, Mini-SOC achieved a 100% detection rate within a two-minute response window, processed 3,468 real alerts, and mapped observed activity to eight MITRE ATT&CK tactics, executing entirely on a single virtual machine using open-source components.

Keywords: Security Operations Center; Multi-agent LLM; Intrusion detection; LangGraph; Autonomous incident response

18

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1571280214

Decentralized Federated Generative AI Systems for Privacy-Preserving Collaborative Intelligence in Distributed Environments

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[5] Sohar University, Oman

Distributed organizations often need to train generative artificial intelligence (GenAI) models across hospitals, laboratories, factories, and edge devices without moving sensitive data to a central server. This setting is challenging because distributed learning must address data heterogeneity, unstable communication, privacy leakage, model drift, and computational cost simultaneously. This paper proposes a decentralized federated GenAI framework for privacy-preserving collaborative intelligence in distributed environments. The framework combines local generative training, protected parameter exchange, secure aggregation, differential privacy, adaptive model fusion, and reliability-aware coordination among participating nodes. It is evaluated in a multi-node setting with heterogeneous data partitions and repeated communication rounds against centralized learning, conventional federated averaging, and isolated local training. Performance is measured using accuracy, F1-score, perplexity, Frechet Inception Distance, communication overhead, convergence rate, privacy loss, and robustness under node dropout. The results show that the proposed framework reaches 97.8 percent accuracy and 97.2 percent F1-score, while reducing perplexity to 9.8, Frechet Inception Distance to 12.6, privacy loss to 0.82, and communication overhead to 1.84 GB. The method also achieves a convergence rate of 0.031 and dropout robustness of 94.1 percent. These results indicate stronger generation quality, better predictive stability, lower exposure risk, and more reliable decentralized cooperation. Overall, the study contributes a practical architecture for secure and scalable collaborative intelligence in healthcare, smart industry, and scientific research networks.

Keywords: Federated learning; Generative AI; Privacy preservation; Differential privacy; Secure aggregation

19
ID
1571317262

A Digital Twin-Driven Reinforcement Learning Framework for Lifetime Maximization in WSN's

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Wireless Sensor Networks (WSNs) play a key role in Internet of Things (IoT) applications, such as smart agriculture, environmental monitoring, healthcare, and industrial automation. But the short battery life and unequal energy usage dramatically shorten the network lifetime, resulting in energy-efficient routing and cluster management as ongoing research challenges. Current clustering protocols identify cluster heads only according to the current network condition, which leads to reactive decisions and reduces the cluster lifetime, and forms energy holes. To tackle these drawbacks, this paper introduces a Digital Twin-based Reinforcement Learning (DT-RLNet) network for maximizing network lifetime and enhancing energy efficiency in WSNs. The proposed framework introduces a lightweight Digital Twin to continuously synchronize with the physical network to model the residual energy, links, traffic, and topology in real time. This predictive representation allows a Reinforcement Learning agent to proactively select cluster heads, optimize multihop routing, and dynamically schedule nodes' sleep cycles to minimize energy consumption while avoiding premature node failure. DT-RLNet is different from traditional snapshot-based methods, as it allows for predictive energy management via adaptive and intelligent decision-making. The framework is tested through MATLAB R2024a simulations and compared to the LEACH protocol and recent energy-efficient clustering protocols. The simulation results show that DT-RLNet boosts network lifetime by 9.8% and saves 8.4% of energy consumption while increasing the number of alive nodes by 10.7%, and improving throughput by 4.2% and packet delivery ratio by 3.1% over benchmark methods, which proves the effectiveness of DT-RLNet for various types of IoT deployments.

Keywords: Digital twin; Reinforcement learning; Wireless sensor networks; Network lifetime; Energy-efficient routing

20
ID
1571301283

An Adaptive Grey Wolf Optimized Deep Neural Network for Secure Intrusion Detection in IoT-Enabled Smart Grid Systems

Ramaraj Muniappan[1], Thangarasu N[2], P Boopathi[3], S Monica[4], V Jayashree[5], Karthikeyan Nagarajan[6]

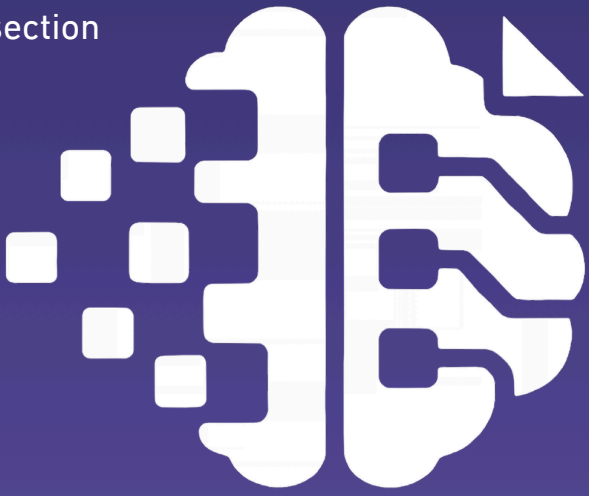
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The proliferation of smart cities with IoT devices has resulted in intelligent services through the inter-connectedness of surveillance cameras, smart meters, traffic monitoring systems, health sensors, as well as environmental nodes. These add automation and decision-making capability to the system, but are extremely vulnerable to DDoS, DoS, spoof, recon, brute force attack, botnet attack and Mirai attack. IDSs tend to have false alarms, low detection accuracy in the large scale IoT network, and fail to deal with the features in the relevant way. The challenges are tackled by proposing Adaptive Grey Wolf Optimized Deep Neural Network (AGWO-DNN) for the intelligent Intrusion Detection (ID) in IoT-based Smart City (SC). The proposed model uses Adaptive Grey Wolf Optimization (AGWO) algorithm to get the significant features in the network traffic and to optimize the parameters of Deep Neural Network (DNN). This optimization process will remove redundant attributes, improve classification performance and enhance detection performance. Optimized feature set is then fed to the DNN classifier to classify the traffic as normal or malicious traffic. Evaluation is done experimentally by using accuracy, precision, recall, F1 score and false alarm rate. The proposed AGWO-DNN is more accurate than the existing machine learning and deep learning models in terms of detection and provides low false alarms.

Keywords: Intrusion detection; Grey wolf optimizer; Deep neural network; Internet of Things; Smart grid

TRACK
Artificial Intelligence and Soft Computing

24 Abstracts in this section



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12:00 PM – 12:20 PM	1571317240	Machine Learning-Based Cybersecurity Framework for Detection and Prevention of Image and Video Quality Distortion During Transfer
12:20 PM – 12:40 PM	1571311590	Real-Time Smart Grid Fault Detection Using Explainable Federated Machine Learning
12:40 PM – 1:00 PM	1571314438	A Digital Twin-Driven Intelligent Irrigation Framework Using Machine Learning for Sustainable Agriculture
1:00 PM – 1:20 PM	1571314360	Disentangling Accent from Pathology: A Clinically-Grounded Dual-Route Framework for Synthetic Indian-Accented Speech Generation and Early Parkinson's Disease Detection
1:20 PM – 1:40 PM	1571287565	Shadow Prompt Detection in RAG Systems
1:40 PM – 2:00 PM	1571314379	Variational Quantum Circuit-Driven K-Means Clustering for Dermoscopic Lesion Segmentation
3:00 PM – 3:20 PM	1571320879	Digital Twin for Game Monitoring and Addiction Prediction
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3:40 PM – 4:00 PM	1571321944	Comparative Evaluation of Gulf Arabic Sentiment Datasets and Sentiment Classification Models with Insights into the Omani Resource Gap
1:20 PM – 1:40 PM	1571300791	Comparable Investigation of Artificial Intelligence and Deep Learning Models for Efficient Liver Cancer Detection Using Multimodal Medical Data
1:40 PM – 2:00 PM	1571319300	RouteCraft: Dynamic Multimodal Route Optimization Using Graph-Based Routing and Traffic Prediction
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Artificial Intelligence and Soft Computing

Session Chair:
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Day 2
Dhofar Hall
D005 Venue

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01
ID
1571317240

Machine Learning-Based Cybersecurity Framework for Detection and Prevention of Image and Video Quality Distortion During Transfer

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Digital media transmission is increasingly vulnerable to sophisticated cyber intrusions designed to clandestinely degrade visual fidelity. While modern security protocols heavily rely on cryptographic measures to ensure data confidentiality, these standards are fundamentally insufficient for validating visual integrity against nuanced threats, such as bitstream tampering and man-in-the-middle (MitM) quality erosion. These attacks do not compromise the data packet's header, allowing them to bypass traditional firewalls while subtly distorting the visual content's structural and perceptual features. To address this critical gap, this manuscript introduces a robust cybersecurity framework underpinned by machine learning, specifically engineered to detect and preempt image and video quality degradation during network transit. Our proposed architecture harmonizes deep learning-based feature extraction with No-Reference Image Quality Assessment (NR-IQA) algorithms, allowing for real-time distortion detection without the need for pristine reference frames. A core innovation of this framework is the implementation of a dedicated adversarial detection layer, which utilizes a specialized classifier to distinguish between stochastic benign channel noise-common in high-speed transmission-and deliberate, structured malicious alterations. Empirical evaluations demonstrate that our framework achieves an impressive 98.4% detection accuracy regarding active injection attacks. Furthermore, by optimizing the computational pipeline for edge deployment, we ensure that the system maintains a minimal resource footprint. These findings validate the framework as a scalable and highly practical security solution, providing a necessary layer of perceptual integrity for high-volume media networks and mission-critical visual streaming platforms.

Keywords: Cybersecurity; Image quality distortion; Man-in-the-middle attack; No-reference IQA; Adversarial detection

02
ID
1571311590

Real-Time Smart Grid Fault Detection Using Explainable Federated Machine Learning

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The development of smart grid systems uses an increasing number of inductive methods that are controlled by data mining to support an active power system. Nevertheless, centralized machine learning (ML) methods for fault detection suffer from important issues related to privacy, scalability, and explicability. To solve these problems, this study introduces a novel interpretable federated machine learning framework for real-time fault identification in smart grids. The developed framework supports distributed grid entities to jointly train fault detection models while raw operational data are stored locally in the respective entities, retaining privacy and reducing communication overhead. We use deep learning-based models to detect and classify power system faults with time-series electrical measurements, while integrating explainable artificial intelligence techniques to deliver transparent and interpretable decision alerts to grid operators. Comprehensive experimental results with simulated IEEE benchmark distribution systems indicate that the proposed method offers high detection accuracy with low latency and provides informative explanations corresponding to the detected faults. The results verify the efficiency and feasibility of the model for secure real-time smart grid monitoring.

Keywords: Smart grid; Fault detection; Federated learning; Explainable AI; Privacy

03
ID
1571314438

A Digital Twin-Driven Intelligent Irrigation Framework Using Machine Learning for Sustainable Agriculture

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Water shortage and climatic variability have led to an increased demand for intelligent irrigation systems which can assist farmers to increase agricultural productivity, and to achieve sustainable water use. This study introduces a Digital Twin-Driven Intelligent Irrigation Framework that integrates IoT-derived data from sensors, satellite-derived data from soil moisture, meteorological data, and machine learning for intelligent irrigation decision-making in real time. The framework provides a virtual representation of agricultural fields, synchronizing physical and digital environments using the Soil Moisture Active Passive (SMAP) and NASA Prediction of Worldwide Energy Resources (POWER) datasets. The Random Forest Regression model was used to forecast future soil moisture levels and provide irrigation schedules that optimize soil moisture conditions based on historical and real-time environmental data. The proposed digital twin continuously monitors the field, creates irrigation scenarios, and enables data-driven decisions that improve water-use efficiency while maintaining adequate soil moisture for crop growth. The framework is judged based on conventional measures such as the Mean Absolute Error (MAE), Root Mean Square Error (RMSE), Mean Absolute Percentage Error (MAPE), and coefficient of determination (R^2). The proposed approach demonstrates the potential of combining Digital Twin technology with artificial intelligence to support precision agriculture, optimize irrigation practices, and promote sustainable resource management.

Keywords: Digital twin; Smart irrigation; Internet of Things; Machine learning; Sustainable agriculture

04
ID
1571314360

Disentangling Accent from Pathology: A Clinically-Grounded Dual-Route Framework for Synthetic Indian-Accented Speech Generation and Early Parkinson's Disease Detection

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Speech is a promising non-invasive biomarker for early Parkinson's Disease (PD), as hypokinetic dysarthria and dysphonia emerge in the prodromal phase. Robust detection is limited by the scarcity of accent-specific corpora-particularly for Indian populations, whose phonetic and prosodic characteristics differ markedly from the English-, Spanish-, and Italian-language datasets that dominate the literature. We argue the deeper obstacle is a confounding of an accent factor with a pathology factor, and propose PathoVoice-IN, a clinically-grounded, dual-route synthetic generation framework that explicitly disentangles the two. A signal-level route synthesises healthy Indian-accented speech via TTS and applies pathology-aware acoustic operators (calibrated jitter, shimmer, HNR reduction, monopitch, vowel-space compression, festination) parameterised from clinical ranges; a feature- level route fits conditional tabular generators (CTGAN, TVAE, CopulaGAN) and recalibrates them to Indian- accent statistics through an optimal-transport map that preserves the class contrast, with a rejection-sampling fidelity gate. Data is evaluated along fidelity, utility (Train-on-Synthetic, Test-on-Real), and privacy, and fed to a pipeline of discrete wavelet transform, cepstral/ spectral features, multi-objective feature selection (Lion's Pride and Big Bang), and an Adaptive SVM that treats synthetic data as a source domain adapted to scarce real target data. The accent-specific signal route and optimal-transport recalibration are presented as the proposed extension, since no Indian-accent PD corpus yet exists. The contribution is a privacy-preserving, accent-aware methodology that improves cross-database generalisation for early PD screening.

Keywords: Parkinson's disease; Speech synthesis; Indian accent; Dysarthria; Voice biomarkers

05
ID 1571287565

Shadow Prompt Detection in RAG Systems

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Retrieval-Augmented Generation (RAG) systems have emerged as a powerful method of enhancing the factual correctness and contextual appropriateness of large language models through incorporating external sources of knowledge when generating responses. Nevertheless, there is a critical but commonly ignored security issue with the dependency on retrieved materials. A retrieved content can include obfuscated malicious code, also known as shadow prompt injection attacks, that can control the actions of the language model and produce unsafe or unintended results. This paper suggests a safe RAG system that is aimed at identifying and reducing such adversarial instructions prior to the process of generation being affected by them. The suggested solution will use a sentence-based classification system that is based on a fine-tuned RoBERTa model and differentiates between harmless content and malicious prompt injections found within the retrieved documents. Moreover, a risk scoring mechanism is presented to measure the percentage of adversarial content, thus giving the interpretation of possible threat. It also includes a safe filtering layer that eliminates identified malicious sentences and builds a whitewashed context of the language model. The experimental analysis proves that the suggested model attains high classification and prevents adversarial instructions to influence the generated answers. The results indicate that document-level security mechanisms implemented in RAG pipelines can go a long way in improving reliability and safety in language model applications.

Keywords: Retrieval-augmented generation; Shadow prompt; Prompt injection; LLM security; Attack detection

06
ID 1571314379

Variational Quantum Circuit-Driven K-Means Clustering for Dermoscopic Lesion Segmentation

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Accurate delineation of malignant skin lesions remains a critical bottleneck in melanoma diagnosis. Conventional pixel-clustering segmentation methods rely on Euclidean distance in classical feature spaces, which performs poorly when lesion and background intensities overlap, as frequently occurs in dermoscopic imagery. This paper presents a hybrid quantum-classical framework in which image features are encoded into 4-qubit states via PennyLane, processed through a variational quantum circuit, and the resulting quantum-derived distances drive a standard K-Means clustering step. Evaluation on a stratified 100-image subsample of the ISIC benchmark dataset yielded a pixel-wise accuracy of 77.47% ± 3.2%, only marginally above a trivial all-background baseline of 77.0%, but an IoU of 0.449 ± 0.061 that the trivial baseline cannot attain by construction. A paired Wilcoxon signed-rank test confirms this IoU improvement over fuzzy c-means is statistically significant ($p < 0.05$), despite the circuit's parameters remaining untrained. These results indicate that even an untrained quantum feature representation yields modest but measurable segmentation gains, motivating further work toward higher-qubit, trained implementations.

Keywords: Quantum computing; K-means clustering; Skin lesion segmentation; Dermoscopy; Melanoma

07

ID
1571320879

Digital Twin for Game Monitoring and Addiction Prediction

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The exponential growth of digital gaming has changed the child's gaming behaviour to addiction that leads to the necessity of monitoring and detecting child's behaviour before turning to addiction. The existing parental application provides monitoring and setting restrictions but lacks in prediction and real time gaming behavior visualization. This work proposes a Digital Twin-based Game Monitoring and Addiction Prediction (DTGMAP) System that visualizes the real time child's gaming platform to enable continuous monitoring, analysing gaming behaviour, predicting addiction and generating alerts to parents. The proposed DTGMAP system comprises a hidden monitoring module on a child's device, a parent dashboard, real time cloud synchronization module, and a Machine Learning (ML) based prediction module for identifying and predicting gaming addiction. The digital twin constantly imitates the gaming activities, helps parents to visualize the gaming behavioral statistics and often receive alerts whenever the predefined risk threshold is exceeded. The synchronized gaming behavioural data are analysed using various ML algorithms like Random Forest (RF), K Nearest Neighbor (KNN), Decision tree (DT), Support Vector Machine (SVM) and Logistic Regression (LR) to classify the levels of addiction risk (High/ Low). A real time dataset containing 300 gaming behaviours with 21 attributes was used for training and testing. The evaluated results show that RF classifier achieves the best performance with 80% accuracy, 86% precision, 80% recall, and 80% F1-score. The results show that the combination of Digital Twin technology and ML provides a fruitful solution for continuous monitoring and early addiction risk prediction in children.

Keywords: Digital twin; Gaming addiction; Behaviour prediction; Parental monitoring; Child safety

08

ID
1571309529

Generative AI-Enabled Cognitive Human Digital Twin Ecosystem for Workforce Intelligence, Well-Being, and Human-AI Symbiosis Under Industry 5.0

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A paradigm changes from pure automation to human-centered, resilient, and sustainable cyber-physical systems is represented by Industry 5.0. The optimization of human-machine interaction, which has traditionally seen the human operator as a rigid, deterministic component, is at the heart of this progression. In order to promote workforce intelligence, give occupational well-being first priority, and facilitate smooth human-AI symbiosis, this study suggests a revolutionary Generative AI-Enabled Cognitive Human Digital Twin (G-CHDT) Ecosystem. Unlike traditional Digital Twins that model physical assets, the G-CHDT continuously gathers multimodal human data, including physiological, cognitive, and behavioral streams, and uses Generative Artificial Intelligence (GenAI) in conjunction with Cognitive Architectures to simulate, predict, and optimize human states in real-time. We introduce a closed-loop system architecture that includes a Predictive Well-being Engine, a Generative Cognitive State Synthesis module, and an Adaptive LLM-Agent Orchestrator. Multi-objective Markov Decision Processes (MDP) are used to mathematically codify the ecosystem in order to balance industrial production against stress and cognitive fatigue. We demonstrate a 34% decrease in operator cognitive overload, a 22% increase in task execution accuracy, and remarkable adaptability in dynamic human-in-the-loop workflows by validating the framework using simulated industrial assembly and telemetry workloads.

Keywords: Digital twin; Generative AI; Industry 5.0; Workforce well-being; Human-AI symbiosis

09
ID
1571321944

Comparative Evaluation of Gulf Arabic Sentiment Datasets and Sentiment Classification Models with Insights into the Omani Resource Gap

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Gulf Arabic sentiment analysis is hindered by several challenges, including dataset heterogeneity, inconsistent evaluation settings, and the lack of evidence regarding cross-dataset generalization. This empirical study presents a comparative evaluation of seven sentiment classification models, namely SVM, LSTM, CNN-BiLSTM, RNN-BiLSTM, AraBERT, MARBERT, and SaudiBERT, using a unified preprocessing, data partitioning, and evaluation framework on the AraCust and ArSAS datasets. Two experimental settings were considered: in-domain evaluation and bidirectional cross-dataset transfer, with Macro-F1 adopted as the primary evaluation metric. SaudiBERT achieved the highest in-domain performance, attaining a Macro-F1 score of 0.863 on AraCust and 0.831 on ArSAS. In the cross-dataset evaluation, MARBERT achieved the best performance for the AraCust-to-ArSAS transfer, with a Macro-F1 score of 0.831, whereas SaudiBERT obtained the highest score of 0.801 for the ArSAS-to-AraCust transfer. In contrast, deep learning models trained from scratch exhibited lower and less stable transfer performance. Overall, the results demonstrate that pretrained transformer models consistently outperform classical machine learning and recurrent neural network models in both in-domain and cross-dataset evaluations. Furthermore, dialect-aware pretraining substantially improves cross-dataset robustness, highlighting Gulf-pretrained transformers as strong baseline candidates for future Omani Arabic sentiment analysis while emphasizing the need for dedicated Omani benchmark resources.

Keywords: Arabic sentiment analysis; Gulf dialects; Dataset evaluation; Omani Arabic; Text classification

10
ID
1571319300

RouteCraft: Dynamic Multimodal Route Optimization Using Graph-Based Routing and Traffic Prediction

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Rapid urbanization, population growth, and the proliferation of transportation modes have rendered conventional navigation systems increasingly inadequate for modern urban mobility. Existing solutions typically optimize for a single criterion such as shortest distance or fastest time, and fail to account for the multimodal nature of urban transportation, real-time traffic variability, or the economic preferences of travelers. This paper presents RouteCraft, a dynamic multimodal route optimization platform that integrates bus, metro, auto-rickshaw, cab, and walking networks into a unified graph-based routing framework. The transportation network is modeled as a weighted multi-layer graph in which nodes represent transit stops, stations, and landmarks, while edges encode travel time, cost, and mode-switching penalties. Dijkstra's algorithm is applied to compute three distinct route categories-fastest, cheapest, and balanced-according to user-specified preferences. A LightGBM-based machine learning model, trained on historical traffic data, predicts congestion levels and generates traffic multipliers that dynamically adjust edge weights prior to route computation. Weather conditions are further incorporated through predefined impact factors. Last-mile connectivity is addressed through landmark-aware walking and auto-based links. Experimental evaluation on real-world datasets from Bengaluru demonstrates that RouteCraft produces practical, context-aware route recommendations that adapt to dynamic urban conditions.

Keywords: Route optimization; Multimodal transport; Graph-based routing; Traffic prediction; Urban mobility

11
ID
1571316748

Intelligent Supermarket Shelf Monitoring and Stock Auditing System

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Retail shelf monitoring is an important task in inventory management, auditing, and loss prevention. Traditional manual inspection approaches are time-consuming, prone to errors, and inefficient, particularly in settings where similar-looking products are present. In this paper, we describe a camera-based intelligent retail shelf monitoring system based on a deep learning object detection model that can automatically identify, categorize, and count items on retail shelves. A YOLO-based model is developed and trained on a custom image dataset to learn subtle visual differences between similar-looking bottles and packages. Our system is capable of processing images in real-time, producing annotated results, and providing organized stock data via a web interface. Experimental validation shows the effectiveness of object separation, detection accuracy, and the viability of using deep learning for automatic retail shelf monitoring.By integrating real-time detection, automated counting, low-stock alerts, and predictive analysis, the proposed system provides a scalable, efficient, and practical solution for modern retail shelf monitoring and inventory management, reducing manual effort while improving accuracy and decision-making.

Keywords: Shelf monitoring; Retail inventory; Computer vision; Stock auditing; Object detection

12
ID
1571316691

Hierarchical Graph Attention MAPPO for Resource Allocation in V2V Communications

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Vehicle-to-Vehicle (V2V) communication is a key enabler of intelligent transportation systems, requiring ultra-reliable and low-latency communications for safety-critical applications. However, efficient radio resource allocation is challenging due to dynamic network topology, severe co-channel interference, and stringent Quality- of-Service (QoS) requirements. This paper proposes a Hierarchical Graph-based Multi-Agent Proximal Policy Optimization (HG-MAPPO) framework for distributed V2V resource allocation. The proposed framework models the vehicular network as a dynamic interference graph and employs a Graph Attention Network (GAT) to learn topology-aware representations. A hierarchical reinforcement learning architecture jointly optimizes spectrum selection and transmission power, reducing action-space complexity and improving learning efficiency. Furthermore, a predictive attention module exploits temporal channel dynamics to enhance decision-making in rapidly varying environments. Simulation results under a realistic Manhattan mobility scenario demonstrate that HG-MAPPO consistently outperforms Random Allocation and GNN-DQN in terms of SINR, throughput, spectral efficiency, and end-to-end latency. Ablation studies further verify the effectiveness of graph attention, hierarchical learning, and predictive attention in improving convergence, scalability, and communication reliability. The proposed HG-MAPPO framework provides an efficient and scalable solution for radio resource management in next-generation V2V and beyond-5G/6G vehicular networks.

Keywords: V2V communications; Resource allocation; Multi-agent reinforcement learning; Graph attention; MAPPO

13

ID
1571299145

Development of SEINTransformer for UAV-Based Intelligent Road Surface Monitoring: A Road Defect Detector for Developing Countries

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Nigeria, like every other developing country, continue to experience severe road degradation characterised by widespread surface and pothole irregularities. These deteriorations pose significant safety risks, increase vehicle maintenance costs, and impede economic activities. Excessive vehicular loads, substandard road construction, inadequate drainage systems, and poor maintenance practices, exacerbated by heavy rainfall, flooding, and erosion, have been duly attributed as the underlying cause. Despite repeated infrastructural investments, the absence of a reliable, data-driven monitoring framework has limited effective road maintenance planning and resource allocation. Therefore, this paper developed an intelligent framework for automated bad road and pothole detection using Unmanned Aerial Vehicles through a developed SEINTransformer deep learning model. The developed SEINTransformer capture both fine-grained structural details, such as cracks, pothole edges, and deformation patterns, resulting in a more comprehensive classification of road surface into pothole, deformation, crack and intact surface. Experimental evaluations of the model on a custom UAV-acquired dataset demonstrated that SEINTransformer achieves an overall accuracy of 96.8%, F1-score of 95.4%, and IoU of 91.2%, outperforming established baselines such as Swin Transformer, ViT, and EfficientNet. This shows the transformative potential of UAV technologies and deep learning in resolving the perpetual challenge of road deterioration in Nigeria and other developing nations.

Keywords: Road defect detection; UAV; Transformer; Pothole detection; Road surface monitoring

14

ID
1571317309

Navigating the Digital Tide: AI-Driven Solutions for Brand Perception and Content Moderation in Social Media Comments

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Social media has become a key platform for shaping brand reputation, moderating user-generated content, and identifying emerging trends. But understanding online comments is very complex because of sarcasm, hidden toxicity and code-mixed languages. Old methods struggle to interpret this type of content, resulting in misclassified text and unsuccessful sentiment tracking. Real-time Sentiment, Toxicity, Sarcasm and Brand Topic Classification System It complements brand monitoring, crisis detection, and audience engagement with real-time social media data. Objective: The main goal is to build a precise system for social media analytics and content moderation which identifies emotions alongside toxicity and sarcasm alongside brand-related discussions efficiently. Novelty: it surpasses the standard studies by simply analyzing sentiment because it also features sarcasm detection and brand perception tracking. Real-time processing capabilities allow for processing data in a real-time format to ensure getting the most recent insights. Its flexibility allows this approach to scale up or down according to specific business or platform needs, hence providing businesses with valuable information with which to make better decisions.

Keywords: Brand perception; Content moderation; Social media; Sentiment analysis; Code-mixed language

15 AgentTrip: An Agentic AI Framework for Intelligent Personalized Travel Planning Using Google Gemini and Multi-Agent Collaboration

ID 1571317304

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Conventional recommendation systems make isolated recommendations in single vertical, monolithic Large Language Model (LLM) prompted to plan a trip hallucinates prices and schedules, and fails to consider hard constraints, lacking grounded access to live data and any mechanism for self-verification. This paper introduces AgentTrip, an agentic AI framework that breaks down the travel planning problem into a society of seven distinct and specialized agents, implemented as a stateful directed graph in LangGraph, with Google Gemini 2.5 handling reasoning, tool selection, and natural-language generation. The Planner breaks down the user goal into a set of sub-goals, each including a dependency; each specialist agent uses a ReAct (reason-act-observe) loop over the Google Places, Google Maps, and OpenWeather APIs to complete relevant parts of the solution and add them to a shared blackboard; Itinerary agent schedules the solution, performing an explicit feasibility check before generating its output; the Budget agent solves a 0/1-knapsack relaxation to guarantee a global financial constraint. We model the user-preference, attraction-relevancy, budget-optimization, and overall-utility models formally, give three algorithms with complexity analysis, and define the shared-state schema. In a benchmark of 120 multi-constraint scenarios, AgentTrip achieves a 93.4% accuracy in recommendation accuracy, a 4.5/5 rating in mean user satisfaction, 93% rate of constraint satisfaction and less than 5% budget overrun, while also being more cost effective in planning latency than a rule-based planner, a traditional recommender and a single- agent LLM. Ablations show that it is not just the base model that produces reliability gains, it's the budget and verification.

Keywords: Agentic AI; Travel planning; Multi-agent systems; Large language models; Google Gemini

16 Analysis of the Use of AI Chatbots in the Higher Education Environment: A Study of User Behavior and the Impact of Awareness Campaigns

ID 1571321716

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Staff and students at the University of Technology and Applied Sciences (UTAS), Salalah, often face challenges in locating, interpreting, and understanding the university's academic regulations. Responding to inquiries manually is time-consuming for academic and administrative staff. The need of an Admission and Registration Center's Smart System (ARCSS) which is capable of providing reliable and immediate responses to questions related to academic regulations is highly needed. Although artificial intelligence (AI) and chatbot technologies have been widely adopted in higher education to enhance student services, limited research has explored their integration into academic regulation support systems. This study investigates the impact of a ARCSS developed at UTAS Salalah on improving awareness and understanding of the university's academic regulations. The ARCSS is designed to provide accurate, rapid, and direct responses to users' inquiries, reduce staff workload, and offer 24/7 access to academic regulation. A mixed-methods approach was employed, combining system usage analytics with focus group discussions involving key stakeholders. The findings indicate that the ARCSS significantly improves access to academic regulations and enhances users' understanding of institutional policies. However, system usage among staff and students remains relatively low, highlighting the need for greater awareness and adoption. The study recommends promoting the ARCSS through targeted training programs, workshops, and social media campaigns to encourage its use and maximize its benefits for the university community.

Keywords: AI chatbots; Higher education; User behaviour; Awareness campaign; Academic regulations

17
ID
1571321121

A Pilot Reliability Audit of Arabic and English LLM-Generated Java Code Explanations

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Large language models (LLMs) can provide code explanations to novice programmers, but apparent clarity does not guarantee a faithful account of program behavior. This pilot study evaluates a reproducible workflow for auditing Arabic and English explanations of short Java verification tasks. Five executable introductory Java tasks were paired with explanations from three models in two languages, yielding 30 unique explanations. Two raters independently scored semantic accuracy, completeness, and explicit answer cue leakage; Arabic terminology was audited descriptively. Following adjudication and a post-adjudication generation-metadata audit, 29 of 30 explanations received the highest final accuracy score, 27 received the highest completeness score, and no explicit answer-cue leakage was recorded. The four non-ceiling records were Arabic loop explanations: one self-check ambiguity, one genuine coverage gap, and two max_tokens truncations. The two truncation cases were corrected only after the metadata audit showed that initial score reconciliation had treated them as complete. The pilot demonstrates a feasible, traceable evaluation workflow whose value lies in catching reliability defects that surface-level rating misses, supporting instrument refinement rather than comparative claims about languages or models.

Keywords: Large language models; Code explanation; Java programming; Arabic; Reliability audit

18
ID
1571295899

Toward Realistic Phishing URL Detection: Leakage-Aware Domain-Grouped Evaluation with Conservative Lexical Modelling

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Phishing URL detection remains a critical cybersecurity challenge, yet many reported machine learning results are overly optimistic because conventional random train-test splits can leak domain-specific information between training and evaluation sets. This paper proposes a leakage-aware framework for realistic generalization to unseen domains. Using the PhiUSIIL dataset of 235,795 URLs, the study adopts a conservative lexical design and evaluates four progressively constrained feature configurations under registered-domain grouping. XGBoost emerged as the strongest and most stable classifier, while MLP served as a deep-learning baseline. Under the main Minimal_URL_Only configuration, XGBoost achieved 0.9922 accuracy, 0.9937 F1-score, 0.9988 ROC-AUC, and 0.9835 MCC on a grouped 70/30 holdout split, with similarly stable results under 5-fold GroupKFold validation. Overall, conservative lexical modelling combined with leakage-aware evaluation provides a robust and methodologically defensible direction for phishing URL detection. These findings highlight that realistic evaluation design is essential for developing trustworthy AI-driven phishing URL detectors that can generalize beyond dataset-specific patterns.

Keywords: Phishing URL detection; Data leakage; Domain-grouped evaluation; Lexical features; Machine learning

19
ID
1571307290

STY-ADNet: A Hybrid Swin Transformer-YOLO Framework with Attention-Based Damage Severity Estimation for Real-Time Earthquake Assessment Using UAV Imagery

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Emergency response, disaster management, and resource allocation in metropolitan areas require rapid and precise earthquake damage assessment. Manual inspections are laborious, hazardous, and time-consuming after a tragedy. Deep learning-based earthquake assessment models have improved structural damage detection using UAV imagery, but many existing methods lack contextual understanding, inaccurate localization of partially collapsed structures, computational inefficiency, and explainability. This paper proposes a new STY- ADNet framework that includes hierarchical Swin Transformer feature encoding, YOLOv8-based real-time damaged-building localization, and Cross-Scale Seismic Attention Fusion for accurate damage severity estimation using the xView2 dataset to overcome these limitations. Local structural texture and long-range contextual interdependence are captured by the proposed framework in complex seismic situations. Real-time UAV emergency systems also use Grad-CAM-based explainable AI and edge-aware optimization to boost interpretability and deployment. Experimental findings show that the STY-ADNet framework classified earthquake damage with 97.82% accuracy, 97.17% F1-score, and 98.26% AUC. The model also reduced localization error to 2.84% and achieved 96.44% mAP@50 and 95.13% IoU. The system outperformed CNN- based Disaster Detection, LEGG Diffusion Model, DBA-RTMDet, MobileNetV3-Small, and UAV Structural Monitoring with 58 FPS and 15.6ms inference latency. This shows that the suggested methodology for intelligent and explainable post-earthquake damage assessment using UAV imagery works.

Keywords: Earthquake damage assessment; Swin Transformer; YOLO; UAV imagery; Damage severity estimation

20
ID
1571309535

Intelligent Health Monitoring System That Predicts Stress, Sleep Quality, and Calorie Intake Using Multimodal Machine Learning

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Lifestyle diseases such as insomnia, chronic stress and sedentary lifestyle are on the rise. As such, there is a need for a system to make a track of daily physical state. Customarily, care is given based on clinical appraisals. These appraisals are generally infrequent; as such, they do not allow an accurate assessment of an individual's well-being at a given moment in time. This paper represents a Smart Health Monitoring System is a product that uses machine learning models which are specialized and trained to predict three parameters, the amount of stress, sleep quality and calories burned. Each health parameter is used to predict through independent pre- trained models to improve the accuracy of prediction and provide clear features. We propose an integrated decision support system that uses machine learning and data analytics, along with actual implementation of the system on the cloud, to provide personalized ideas and recommendations. The system can be scaled up and is implemented via a web interface.

Keywords: Health monitoring; Stress prediction; Sleep quality; Calorie intake; Multimodal machine learning

21
ID
1571306496

Integrating WACM and DA-CLIP for Degradation-Aware Enhancement: An Approach for Contextual Colorization

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[2] Maharaja Agrasen Institute of Technology, New Delhi, India

Automatic image colorization, a most important task in computer visions these days. It is very important in various application including Digital Art, style enhancement historic image restoration and Medical and scientific imaging. In history image colorization benefits from both rich multiscale representation and explicit semantic guidance. Each approach has its significant use in image colorization applications and shown remarkable performance but often overlook structural fidelity, semantic coherence and context of scene in the presence of low-quality input image. This work purposes a unified framework that combines a wavelet transform assisted adaptive colorization model (WACM) with a DA-Clip style text guided colorization head. WACM use wavelet coefficient to learn detailed structure of images and reduce dimensionality for improving robustness and diversity of colorization process. Special consistency constraints are utilized to preserve data fidelity and structural coherence. To enhance semantic controllability, DA-CLIP integrates text embedding are fused with wavelet features through adaptive attention to modulate color distribution according to user provided description and add context aware hue selection. Extensive experiments on benchmark data sets have shown that proposed framework achieve state of the art performance in PSNR, SSIM, and perceptual similarity. Also shown fine grained text driven control over colorization

Keywords: Image colorization; DA-CLIP; Image restoration; Degradation-aware enhancement; Computer vision

22
ID
1571316857

CBAM-TransFormer-AD: A Comparative Study of Hybrid Deep Learning-CBAM-Transformer Framework for Multi-Class Alzheimer's Disease Classification from Brain MRI

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Alzheimer's disease (AD) is one of the most prevalent neurodegenerative diseases in the world, characterized by gradual deterioration of memory and other cognitive skills, which negatively impact daily activities. Therefore, early and accurate diagnosis is essential for prompt clinical management to retard the progression of the disease. Magnetic Resonance Imaging (MRI) is a non-invasive technique that allows visualization of structural aberrations within brain regions at different stages of AD. However, visual diagnosis of MRI images requires enormous amounts of labor and relies largely on the proficiency of radiologists. This necessitates the development of computer-aided diagnosis (CAD) systems for automatic interpretation of brain images. In recent years, with the advent of Deep Learning (DL), medical image classification has been significantly advanced by automating the feature extraction from neuroimaging data. Despite promising results, the commonly used Deep Convolutional Neural Network (CNN) architectures only learn local spatial information and do not readily represent long-range interactions across different brain areas. To alleviate this problem, we introduce a comparative hybrid DL framework namely CBAM-TransFormer-AD, which employs Convolutional Block Attention Module (CBAM) combined with Transformer Encoder to reinforce feature representations for the multi-class AD classification. Three well-established DL backbones InceptionV3, DenseNet121 and EfficientNetB0, were applied and evaluated with the shared attention-transformer framework for extracting discriminative MRI features.

Keywords:

Alzheimer's disease; Brain MRI; CBAM; Transformer; Deep learning

23
ID
1571320707

Generalized Deep Learning Attention Framework for AI-Assisted Differential Diagnosis of Infectious Skin Diseases Using Multi-Class Skin Lesion Images

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Unprecedented outbreak of Mpox (Monkeypox) worldwide and the continued existence of multitude of visually-similar infectious skin diseases such as Chickenpox, Cowpox, Measles, and HFMD, there is a pressing demand for accurate, fast, and widely available computer-aided diagnosis(CAD) systems. Initial clinical diagnosis is difficult, owing to overlapping dermatological symptoms among these diseases, often necessitating laboratory testing which is difficult to perform in resource-limited regions. This paper introduces a CAD framework called Enhanced Dot Attention-based ResNet50 (EDA-ResNet50) for automating multi-class classification of six different infectious skin lesions including Mpox, Chickenpox, Cowpox, Measles, HFMD and Healthy skin using publicly available Mpox Skin Lesion Dataset v2.0 (MSLD v2.0). It combines a ResNet50 architecture backbone and an Enhanced Dot Attention (EDA) module to enable the network to focus on relevant features of skin lesions and eliminate background noise. Weighted random sampling, an enormous online data argumentation strategy, label smoothing technique, AdamW optimizer, cosine annealing learning-rate policy, gradient clipping, and early stop strategy are implemented within five-fold standard cross-validation to ensure high robustness and good generality of the proposed model. The proposed EDA-ResNet50 achieves very satisfactory diagnostic performance overall 96.47% accuracy, 96.59% macro precision, 95.93% macro-recall (sensitivity), 96.23% macro-F1score, 99.17% specificity, 3.53% zero-one-loss. Proposed model provides close to perfection for the multi-class ROC performance with the macro-AUC of 0.9999 and outstanding discriminating ability against all classified diseases. Experimental results prove EDA-ResNet50 is efficient, reliable, effective CAD that can be directly employed in teledermatology, point-of-care diagnosis and skin health management systems especially in those with limited infrastructure.

Keywords: Mpox; Skin disease diagnosis; Attention mechanism; Deep learning; Computer-aided diagnosis

24
ID
1571300791

Comparable Investigation of Artificial Intelligence and Deep Learning Models for Efficient Liver Cancer Detection Using Multimodal Medical Data

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Liver cancer is one of the most serious and deadly diseases globally, and it is the leading cause of death related to cancer. Since symptoms are often not detected early, liver cancer progresses quickly, and the tools available to detect it immediately are not widely accessible. The most common form of liver cancer is HCC, which is often found at a late stage when treatment options are limited, reducing the patient's chances of survival. Like many diagnostic procedures, the interpretation of radiological images, biopsy results, and lab tests heavily depends on the expertise of the clinician. These methods can be time-consuming, prone to errors, and affected by human factors. Therefore, the development of accurate, automatic, and intelligent diagnostic systems is an important area of research in modern healthcare. The integration of AI, ML, and DL has transformed the analysis of medical images, enabling more accurate, efficient, and reliable disease detection. Using AI-based diagnostic systems helps process large volumes of medical data from various sources, identify hidden disease patterns, and assist medical professionals in early cancer detection and treatment planning. The study compares various Machine Learning and DL models, including SVM, CNN, RNN, CNN with GAN, and Autoencoder-based models. The results of this study highlight the potential of AI-based systems to support radiologists and healthcare professionals in decision-making, early detection of liver cancer, avoiding diagnostic errors, and improving treatment planning. This study emphasizes the transformative potential of AI-driven diagnostic technologies in medicine and intelligent healthcare, refining existing liver cancer detection systems.

Keywords: Liver cancer detection; Deep learning; Hepatocellular carcinoma; Multimodal medical data; Medical imaging

TRACK
Data Science, Analytics and Applications

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71	14	19.7%
SUBMISSIONS	ACCEPTED	ACCEPTED RATE

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Data Science, Analytics and Applications

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01
ID
1571314108

Smart Library Search: An NLP-Based Resource Discovery and Visualization System for Academic Libraries

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Traditional keyword-based search methods in academic and public libraries are increasingly insufficient for meeting modern user needs, highlighting the need for more intelligent, AI-driven solutions using Natural Language Processing (NLP). In line with Oman Vision 2040 and the country's digital transformation efforts, this study investigates current library practices in Muscat and develops an NLP-powered smart library system using data from the UTAS Muscat library. The proposed system includes semantic search, study mode, research mode, and a recommendation feature to improve access to physical library resources, while also integrating data visualization tools to support librarians in collection development and performance evaluation. Experimental results show that the proposed model outperforms traditional keyword-based search; however, its performance remains limited by a small dataset and insufficient Arabic-language resources, which affect natural language query processing in Arabic. Future work will focus on expanding the dataset, enhancing Arabic-language support, and deploying the system in real library environments to evaluate its practical impact on student engagement.

Keywords: Natural language processing; Library search; Resource discovery; Data visualization; Academic libraries

02
ID
1571314115

Optimizing the AI-Driven Trade-off: Balancing Operational Efficiency and Customer Experience in Oman's Telecommunications Sector

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The rapid integration of artificial intelligence (AI) into telecommunications customer service presents a structural tension between operational efficiency and customer experience (CX). While AI-driven channels deliver measurable reductions in average handling time and cost-to-serve, excessive automation risks eroding empathy, dialect alignment, and complex resolution capacity, particularly in high-context, collectivist service environments. This study employs a sequential explanatory mixed methods design to quantify the efficiency-CX trade-off among Omani telecom subscribers (initial N = 241; final valid N = 227 after rigorous data cleaning) and triangulate findings with executive insights from three major operators. Quadratic regression modeling reveals a statistically significant inverted-U relationship, with CX peaking at approximately 91.2% automation intensity before declining. Cultural preference for human interaction negatively moderates this pathway ($\beta = -0.14$, $p = .005$), while Arabic dialect proficiency ($\beta = 0.17$, $p = .004$) and digital literacy ($\beta = 0.11$, $p = .028$) positively moderate it. The Trust Triad partially mediates the automation-CX relationship (36.2% indirect effect), confirming that utility experience converts initial privacy cynicism into sustained adoption when transparency and escalation pathways are embedded. Synthesizing empirical thresholds with industry roadmaps, we develop a Strategic AI Optimization Framework that provides operators with data-backed calibration benchmarks, dialect localization investment guidelines, and confidence-score routing protocols. Findings offer actionable guidance for telecom leaders and the Telecommunications Regulatory Authority (TRA) while advancing theoretical extensions of UTAUT and the Service-Profit Chain in the Gulf Cooperation Council (GCC) context.

Keywords: Artificial intelligence; Telecommunications; Customer experience; Operational efficiency; Oman

03
ID
1571317278

SepNova: A Real Time Multi Horizon Sepsis Prediction Framework with Stacking Ensemble and Composite Clinical Scoring for Intensive Care Unit

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Sepsis is a timecritical ICU syndrome where delayed detection directly increases mortality. Existing clinical scoring tools such as SOFA and qSOFA lack predictive capability and provide no advance warning window. This paper presents SepNova, a real time multi horizon sepsis prediction framework combining a four model stacking ensemble with a novel SepNova Composite Score that fuses machine learning probability with bedside clinical indicators to produce interpretable four tier risk stratification. Evaluated on the PhysioNet Computing in Cardiology Challenge 2019 dataset of 40,336 ICU patient records, SepNova achieves an AUROC of 0.923 and AUPRC of 0.638 at the 3 hour prediction horizon, outperforming all individual base models and established clinical baselines. The system supports prediction at 3 hour, 6 hour, and 12 hour horizons and delivers alerts in under 5 seconds via HL7 and FHIR integration. A demographic fairness audit confirms equitable performance across age and sex subgroups. SepNova demonstrates that ensemble learning with composite clinical scoring substantially advances early sepsis detection in real world ICU environments.

Keywords: Sepsis prediction; Stacking ensemble; Intensive care unit; Clinical scoring; Real-time prediction

04
ID
1571319081

EEG-Based Cognitive Classification for Recruitment Decision Support

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Recruitment decisions often depend on interviews, resumes, cognitive tests, and work samples. This study explores whether electroencephalography (EEG) signals can provide an additional research-based input for cognitive classification in recruitment-oriented decision support. Because private employee EEG datasets are rarely available for public validation, the study uses the public LEMON/ MPI Leipzig Mind-Brain-Body dataset as a reproducible test bed. Resting-state EEG records were matched with Leistungspruefsystem (LPS) fluid-intelligence scores, and participants with very high and very low scores were selected for classification. From 203 usable participants, the final top-versus-bottom 15% grouping produced 70 EEG-matched subjects, including 34 high-score and 36 low-score participants. EEG features were extracted from spectral power, relative power, connectivity, alpha asymmetry, and theta/beta ratio measures. Classical machine-learning models and compact neural-network models were evaluated using repeated stratified participant-level cross-validation. The best EEG-only result was obtained with a radial basis function support vector machine using 200 selected features. It achieved 80.12% balanced accuracy and 84.01% receiver operating characteristic area under the curve. However, an age-only logistic regression model reached 90.29% balanced accuracy on the same labels. This indicates strong age-related confounding in the public cognitive proxy task and shows that demographic baselines must be audited before interpreting EEG-based cognitive classification results. This study does not propose an automated hiring system. Instead, it presents a cautious and reproducible workflow for evaluating EEG-based recruitment decision-support methods and highlights the need for age-aware validation, external cohorts, and job-relevant outcomes before such models are considered for operational recruitment settings.

Keywords: EEG; Cognitive classification; Recruitment; Decision support; Machine learning

05
ID
1571297706

CESUDS: A Comparative Evaluation of Structured and Unstructured Data Sources for Big Data Workflows

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Structured and unstructured data sources introduce different processing and scalability challenges in Big Data environments due to differences in schema, format, and preprocessing requirements. Therefore, this study developed and evaluated the Comparative Evaluation of Structured and Unstructured Data Sources (CESUDS) framework for comparative Big Data workflow analysis. The framework integrates distributed ingestion, Hadoop HDFS storage, PySpark processing, export operations, analytics-ready data preparation, and comparative evaluation within a unified distributed environment. The structured workflow utilized Apache Sqoop for ingestion from remote MySQL databases, while the unstructured workflow utilized distributed file ingestion for text-based datasets with text transformation and sentiment classification operations. Experimental evaluations using multiple dataset scales measured ingestion performance, processing and export performance, scalability, resource utilization, reliability, and data quality. The results showed that the structured workflow recorded ingestion times between 74 and 140 seconds and CPU utilization between 34.27% and 68.61%, while the unstructured workflow recorded ingestion times between 3 and 420 seconds and CPU utilization between 42.44% and 70.19%. In addition, the workflows achieved 0% missing value rates, 0% export mismatch rates, and 100% overall data quality scores across all evaluated datasets. The results demonstrate that CESUDS successfully supports comparative evaluation of structured and unstructured Big Data workflows using a shared distributed processing environment.

Keywords: Big data; Structured data; Unstructured data; Data workflows; Scalability

06
ID
1571316171

AI-Based Real-Time Crisis Detection and Geo-Location Alert System: A Lightweight, Client-Side Approach Using Multinomial Naïve Bayes Text Classification

Aditya Kishor Dudhande [1], Dinesh Banswal [1], Shubhangni Dey [1], Janvi Hemantraj Kaware [1]

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Unstructured text such as wire bulletins, advisory notices, and field updates typically reaches the public well before any structured, geocoded record of a crisis event becomes available to responders. This paper proposes a browser-resident system for real-time crisis detection and location-aware alerting that labels incoming free-text reports as crisis or non-crisis and links confirmed crisis activity to a user's approximate position to generate tiered notifications. Classification is performed by a Multinomial Naïve Bayes model trained on a count- vectorized, stop-word-filtered bag-of-words representation, inspired by the Kaggle "NLP with Disaster Tweets" task. The system maintains a regional risk score with four severity bands (Low, Medium, High, Critical), applies an exponential-decay mechanism so aging signals lose influence over time, and renders a relative geo-zone map via the browser's native geolocation interface. The complete pipeline – tokenizer, classifier, scoring engine, and map – runs entirely inside a single self-contained HTML/JavaScript file, requiring no server, account, or installation step. On a fixed 20% hold-out partition (25 of 121 labeled samples, seeded for repeatability) the prototype attains 96.0% accuracy, 100% precision, 87.5% recall, and an F1-score of 0.933 for the crisis class. We present the architecture, preprocessing and classification pipeline, risk-scoring and alerting logic, and geolocation cross-referencing mechanism, and discuss the trade-offs of in-browser deployment relative to server-hosted alternatives.

Keywords: Crisis detection; Geo-location alerts; Naive Bayes; Text classification; Client-side processing

07
ID
1571314723

Predicting Academic Performance from Self-Reported Learning Behaviour: A Comparative Analysis of Machine Learning Models on a Class-Imbalanced Student Sample

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Machine learning is increasingly applied to predict student academic performance and to support early identification of at-risk learners. Many studies, however, report point estimates from a single train-test split and engage only superficially with the class-imbalance constraint that characterises pass/fail outcomes in undergraduate populations. This study examined the behavioural predictors of academic failure and benchmarked four classical classifiers on a small, severely imbalanced sample. A ten-item self-report instrument was administered to 204 undergraduate respondents, of whom 7 (3.4%) reported failure. Univariate associations were quantified using biascorrected Cramer's V with Holm-Bonferroni correction. Logistic regression, decision tree, random forest, and multilayer perceptron classifiers were compared under repeated stratified five-fold cross-validation (50 out-of-fold estimates), with 95% percentile confidence intervals on every metric. Three predictors showed medium effect sizes that survived correction: study consistency (V = 0.385), previoussemester performance (V = 0.373), and revision frequency (V = 0.243). Behavioural-frequency items conventionally emphasised in such instruments (attendance, study hours, assignment timeliness, and class participation) showed no meaningful association with the outcome. No classifier produced a statistically defensible recall estimate for the failure class; confidence intervals on recall-for-Fail either spanned the full [0, 1] interval or collapsed to zero, and the models were not distinguishable from one another. The findings are framed as associational evidence with a quantified predictive ceiling, not as validation of a deployable classifier, with implications for instrument revision, ethical deployment, and the sample-size requirements of any follow-up study.

Keywords: Academic performance prediction; Machine learning; Class imbalance; Learning behaviour; Educational data mining

08
ID
1571316025

AI-Assisted Business Analytics for SME Sustainability Risk Assessment a Decision Support Framework with Application to Oman

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Small and medium-sized enterprises in Oman face sustainability risks arising from financial constraints, managerial capability gaps, market uncertainty, supply chain disruption, limited data readiness, and institutional pressures. Existing studies often examine these risks separately, while many artificial intelligence and business analytics solutions assume data availability, technical capacity, and implementation resources that small firms may not possess. This paper proposes an artificial intelligence-assisted business analytics framework for multidimensional sustainability risk assessment in small and medium-sized enterprises, with contextual application to Oman. The framework synthesizes seven risk dimensions: financial resilience, managerial capability, market access, operational and supply chain continuity, digital and data readiness, institutional and regulatory environment, and sustainability and innovation readiness. It then organizes these dimensions within a phased decision support architecture that moves from descriptive dashboards to predictive risk scoring and prescriptive recommendations according to enterprise data maturity. To improve interpretability and managerial trust, the framework includes an explainability and human review layer that links risk scores to their contributing factors and allows human oversight of automated recommendations. The proposed framework provides a structured way to translate fragmented sustainability risk factors into actionable decision support outputs. It can support policymakers, incubators, financial institutions, and enterprise managers in identifying vulnerable firms, prioritizing targeted interventions, and strengthening the long-term resilience of Oman's small and medium-sized enterprise ecosystem.

Keywords: Business analytics; SME sustainability; Risk assessment; Decision support; Oman

09
ID
1571320673

Calibration-Aware Expected Goals Modelling Using Machine Learning and Hybrid Ensembles on Open Football Event Data

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[4]Cardiff Metropolitan University, United Kingdom (Great Britain)

Football analytics increasingly relies on probabilistic modelling frameworks to support objective decision-making in player evaluation, tactical analysis, and recruitment. Expected Goals (xG) models estimate the probability that a shot results in a goal, yet football event data are typically imbalanced, nonlinear, and context-dependent, creating challenges for reliable probability estimation. This study presents a comparative evaluation of machine learning and ensemble-based approaches for probabilistic football event prediction using open StatsBomb event data. The modelling pipeline begins with interpretable baseline models, including Logistic Regression and Random Forest, and progresses to gradient boosting using XGBoost. Bayesian hyperparameter optimisation with Optuna is applied to improve discrimination and probability calibration. Finally, a hybrid ensemble framework combining weighted averaging and stacking integrates complementary model strengths. Mod els are evaluated using probability-focused metrics including ROC-AUC, Log Loss, and Brier Score. Results show that the hybrid stacking ensemble achieves the highest discrimination (ROC-AUC = 0.8301) while maintaining competitive calibration, demonstrating the effectiveness of ensemble modelling for scalable football analytics applications.

Keywords: Expected goals; Football analytics; Model calibration; Hybrid ensembles; Machine learning

10
ID
1571308273

Throat Cancer Metastasis Detection Using Advanced Machine Learning Algorithms: A Comparative Study

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The lymph node metastasis of throat cancer has a significant impact on the five-year survival rate, which drops from more than 80 percent to less than 35 percent under the influence of this impact. Techniques that are currently in use, such as CT scans, PET-CT scans, or biopsies, have several drawbacks, including a lower sensitivity in identifying micrometastasis, high costs, and the possibility of subjective interpretation by various medical professionals. As a result, the purpose of this study is to present the creation of a stacking machine learning algorithm that combines multi-modality in order to properly identify metastasis. TCIA imaging data and data from the TCGA-HNSC database, which contained information on 2,847 patients, were employed by our team. It was possible to extract clinical, radiomics, and genetic parameters from the data. Following the implementation of the SMOTE sampling technique and the RFECV feature selection, seventh baseline algorithms were put through their paces. The results of the Stacking Ensemble showed that it had the best accuracy (96.4%), as well as the highest AUC-ROC score (0.983), which was superior than all of the baseline algorithms.

Keywords: Throat cancer; Lymph node metastasis; Machine learning; Medical diagnosis; Comparative study

11

ID
1571307461

Predicting Adverse Clinical Outcomes in Sepsis Patients in Emergency Department: A Comparative Analysis of Machine Learning Models with Calibration-Discrimination Assessment

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Early identification of emergency department (ED) patients at risk for adverse outcomes is critical for timely intervention and resource allocation. Traditional risk stratification tools, such as the National Early Warning Score (NEWS), have improved upon unstructured clinical judgment; however, they continue to exhibit limitations in predictive accuracy across diverse patient populations. This study developed and compared six machine learning models for predicting adverse outcomes in 1,508 ED patients using routinely available clinical parameters, with attention to the calibration discrimination trade-off. Models-Decision Tree, Random Forest, Gradient Boosting Machine, XGBoost, Logistic Regression, and Linear Discriminant Analysis-were evaluated using 10-fold stratified cross-validation. XGBoost achieved the highest F1-score (0.57) and ROC AUC (0.88). Feature importance identified ICU admission timing, serum lactate (>4.0 mmol/L), and age (≥90 years) as the strongest predictors. Ensemble methods like XGBoost offer superior discrimination for risk stratification but at the cost of poorer calibration. Model choice should align with clinical use: XGBoost for triage, calibrated models for individual risk communication.

Keywords: Sepsis; Emergency department; Clinical outcome prediction; Machine learning; Model calibration

12

ID
1571308293

Comparative Analysis of Ensemble Machine Learning Techniques for Air Quality Index Prediction

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Air pollution is one of the current environmental and public health problems at a global scale, especially in fast urbanizing areas of South Asian countries. A timely health advisory and informed decision making depends heavily on accurate forecasting of Air Quality Index (AQI). The present study proposes an extensive machine learning-based model for AQI prediction to utilize multi-year data (2022-2024) of seven major pollutants including PM2.5, PM10, NO2, O3, CO, SO2 and NH3 data. The six supervised learning models Gradient Boosting, Random Forest, Ridge Regression, XGBoost, LightGBM and Support Vector Regression (SVR) were systematically evaluated. The Gradient Boosting model performed extremely well, with an R^2 of 0.9996, RMSE of 1.02, MAE of 0.29 and MAPE of 0.12%, far better than all other competing models. The importance analysis showed that PM10 is the most important variable with a normalized importance score that is very close to 1.0. The temporal analysis showed that the AQI had significant seasonal variations, with high AQI values during summer (June-July, ~250) and minimum in winter (December-January, ~138). Health risk assessment revealed 56.4% days in Moderate, 40.7% days in Poor, 1.6% Very Poor and no Good days of air quality during the study period. On a YOY comparison, the air quality has improved marginally from 2022 to 2024, with slight decrease in post monsoon AQI values. The proposed framework offers a strong and data-driven basis for on-going AQI forecasting and urban AQ management. pollution; Prediction

Keywords: Air quality index; Ensemble learning; Machine learning; Air

13 Trade Compass: An Intelligent Equity Analytics Platform

ID 1571298051

Ryan Wyton,[1] Bacha Rehman[1]

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Accurate stock forecasting and automated trading remain challenging due to the high dimensionality and non-stationarity of financial time series. This paper presents Trade Compass, an Intelligent Equity Analytics Platform (IEAP) implementing a seven-stage pipeline encompassing Principal Component Analysis (PCA)-based stock selection, multi-model machine learning forecasting, rule-based signal generation, and a Deep Q-Network (DQN) reinforcement learning trading agent. Six forecasting models spanning statistical, tree-ensemble, and deep learning paradigms are evaluated on both regression and directional classification tasks. The platform is deployed as an interactive Streamlit application supporting live Long Short-Term Memory (LSTM) inference. Evaluated on four NASDAQ-100 stocks, LSTM achieved the lowest Root Mean Square Error (RMSE) across all stocks, with a best result of 0.0454 on VRSK (R2=0.953). Directional classification accuracy across all architectures clusters near the 50% random baseline, consistent with weak-form market efficiency. The DQN agent substantially outperformed a buy-and-hold benchmark across all stocks, with CEG generating a 9,085% return against a 779.4% benchmark over 200 training episodes.

Keywords: Stock forecasting; Algorithmic trading; Principal component analysis; Equity analytics; Financial time series

14 Temporal-Spatial Fusion Network for Intelligent Water Quality Prediction

ID 1571292604

Gitanjali Gupta,[1] Aleem Ali[1]

[1] Chandigarh University, India

Water quality degradation poses an escalating global threat to public health and aquatic ecosystems, demanding intelligent, scalable predictive solutions beyond conventional monitoring approaches. This paper presents a novel Temporal-Spatial Fusion Network (TSFN), a unique hybrid deep learning framework that simultaneously captures temporal dynamics and spatial interdependencies across distributed water quality monitoring stations. The novelty of TSFN lies in its innovative integration of Long Short-Term Memory (LSTM) networks with Graph Convolutional Networks (GCN), unified through an attention-guided adaptive fusion mechanism and systematically optimized via Bayesian hyperparameter tuning. The uniqueness of this architecture addresses the critical dual limitation of existing models – their inability to jointly model spatio-temporal water quality patterns. Extensive experiments conducted on 87,600 samples across 24 geographically distributed monitoring stations demonstrate that TSFN achieves an R^2 of 0.9612, RMSE of 0.1874, and MAE of 0.1423, outperforming all baseline models including CNN-LSTM and standalone GCN by significant margins. Cross-validation results confirm exceptional model stability with standard deviation below 0.003, establishing TSFN as a robust, generalizable, and deployment-ready framework for real-world intelligent water quality prediction.

Keywords: Water quality prediction; Temporal-spatial fusion; Deep learning; Hybrid network; Environmental monitoring

TRACK
Software Engineering and Information Systems

4 Abstracts in this section



21	4	19%
SUBMISSIONS	ACCEPTED	ACCEPTED RATE

Software Engineering and Information Systems

Session Chair:
Dr. Taher Omran

Session Facilitator:
Dr. Melissa P. Juanilo

Day 1
D005

TIME	PAPER ID	PAPER TITLE
12:00 PM – 12:20 PM	1571319560	Leveraging AI in RAG with Risk Management Strategies for Personalized Educational Assistance at UTAS-Salalah
12:20 PM – 12:40 PM	1571317246	Adoption of a Unified Software Development Platform in Higher Educations Institutions (HEIs) Mediated by Trust: Towards Digital Transformation
12:40 PM – 1:00 PM	1571321781	ANRA: An Intelligent Course Recommendation System Based on Learning Style and AI-Assisted Academic Advising
1:00 PM – 1:20 PM	1571320803	Beyond the Single Platform: A Multi-Dimensional Decision Framework for Enterprise Integration and Cloud Transformation in Heterogeneous Ecosystems

01
ID
1571319560

Leveraging AI in RAG with Risk Management Strategies for Personalized Educational Assistance at UTAS-Salalah

Hansel Galido Delos Santos [1]

[1] University of Technology and Applied Sciences-Salalah, Oman

The increasing demand for personalized learning in higher education has highlighted the need for intelligent educational support systems capable of addressing diverse student needs. This study proposes the development and evaluation of an Artificial Intelligence (AI)-driven Retrieval-Augmented Generation (RAG) framework integrated with risk management strategies to provide personalized educational assistance at the University of Technology and Applied Sciences (UTAS)-Salalah. The proposed system combines large language models with retrieval mechanisms to generate context-aware, accurate, and personalized academic support while minimizing risks such as misinformation, bias, privacy concerns, and system unreliability. A mixed-methods research design will be employed, integrating quantitative and qualitative approaches. Quantitative analysis will evaluate the system's impact on academic performance, engagement, and learning outcomes through surveys, AI performance metrics, and academic records. Qualitative data from interviews and focus group discussions with students and faculty will explore user experiences, usability, and perceptions of the system. The study will involve approximately 4,000 students across various academic departments using stratified sampling to ensure representative participation. The RAG-based system will be deployed using Oracle AI technologies and institutional knowledge repositories to provide personalized learning resources, adaptive feedback, and real-time academic assistance. Statistical analyses, including t-tests, ANOVA, and regression, alongside thematic analysis of qualitative data, will assess the system's effectiveness. The expected outcomes include improved academic performance, enhanced student engagement, early identification of at-risk learners, and increased retention rates. The research also supports Oman Vision 2040 by promoting digital transformation and AI-driven innovation in higher education.

Keywords: Retrieval-augmented generation; Personalized learning; Risk management; Educational assistance; Artificial intelligence

02
ID
1571317246

Adoption of a Unified Software Development Platform in Higher Educations Institutions (HEIs) Mediated by Trust: Towards Digital Transformation

Siham AL Siyabi,[1] Qasim Al Ajmi [1]

[1] University of Technology and Applied Sciences-Muscat, Oman

A unified software development platform is an integrated digital environment that supports software development activities, system coordination, and standardized digital operations. Such platforms are increasingly relevant to higher education institutions because they may reduce fragmented practices and support digital transformation. However, user adoption remains a challenge because it depends not only on technical availability, but also on users perceptions, trust, and behavioral intention. This study examines the factors associated with users behavioral intention to adopt a unified software development platform in Omani higher education institutions. The study is grounded in the Unified Theory of Acceptance and Use of Technology and considers trust as a mediating factor within the proposed adoption model. The study concludes that unified platform adoption in higher education should be understood through both technical adoption factors and trust related perceptions. The findings imply that higher education institutions should strengthen technical support, demonstrate platform usefulness, and build user trust when planning unified platform initiatives for digital transformation.

Keywords: Unified software development platform; Technology adoption; Trust; Higher education institutions; Digital transformation

03
ID
1571321781

ANRA: An Intelligent Course Recommendation System Based on Learning Style and AI-Assisted Academic Advising

Maryam Hamood Abdullah Al Wahaibi , [1] Salvacion Mata Domingo [1, 2]

[1]Gulf College, Oman
[2]Muscat University, Oman

[…] education are often supported by prerequisite rules, grades and manual consultations, but these approaches may not sufficiently consider student learning preferences, quiz performance, progress and support needs. This paper presents ANRA, a web-based intelligent course recommendation prototype that combines learning-style assessment, course metadata, quiz performance, progress tracking, AI Coach support, gamification, advisor feedback and administrative analytics. The system was developed using ASP.NET Core MVC, C#, Entity Framework Core and MySQL/MariaDB following an agile development approach. The recommendation workflow uses learning-style results as one supportive signal together with academic activity data and course attributes, avoiding the assumption that learning style alone determines capability. Functional testing covered 28 test cases, all of which passed. User evaluation involved 35 respondents representing students and faculty/ advisory users. Results showed very good perceptions of functionality (mean = 3.59), usability (mean = 3.89), reliability (mean = 3.63) and overall system factors (mean = 3.70), while overall satisfaction was excellent (mean = 4.37). The study contributes a practical prototype model for AI-assisted, data-informed and advisor-supported course guidance in higher education, with future work focusing on real institutional data, stronger AI context awareness, security testing and learning management system integration

Keywords: Course recommendation; Learning styles; Academic advising; Recommender system; Artificial intelligence

04
ID
1571320803

Beyond the Single Platform: A Multi-Dimensional Decision Framework for Enterprise Integration and Cloud Transformation in Heterogeneous Ecosystems

Rajendra Pallikonda[1], Naveen kumar Reddy Komulwad[2], Rajesh Kumar Reddy Kallapari[2], Khadarvali Shaik[3], Abdul Rasheed Shaik[2], Balakrishnan Devaraj[4]

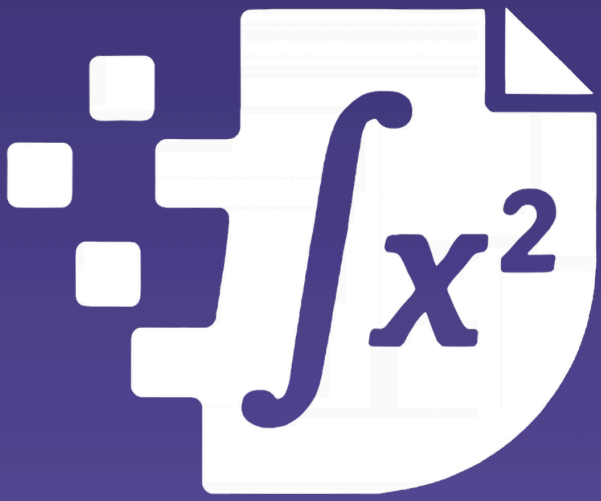
[1] Blue Ribbon Global Technologies, USA
[2] USA
[3] IEEE, USA
[4] Cognizant Technology Solutions, USA

Modern enterprises rarely operate within a single-vendor technology ecosystem. Instead, they accumulate a layered portfolio of cloud-native services, legacy on-premise applications, domain-specific SaaS platforms, and purpose-built data stores, each introduced at a different point in the organization's evolution governed by different commercial relationships. The resulting heterogeneity makes integration one of the most consequential and least standardized disciplines in enterprise architecture. Practitioners must routinely decide not only how to connect disparate systems but which integration capability chosen from a competitive field that includes platform- native connectors, general-purpose Integration Platform as a Service (iPaaS) products, event streaming infrastructure and API management gateways that is best suited for each scenario. This paper proposes a multi- dimensional, platform-agnostic decision framework for enterprise integration and cloud transformation. The framework characterizes integration scenarios along five axes (system homogeneity, native capability maturity, reuse potential, security and compliance posture, total cost of ownership) and maps those characteristics to a governed selection among competing integration approaches. We examine how leading iPaaS platforms (MuleSoft Anypoint Platform, Dell Boomi, SnapLogic, Azure Integration Services, and AWS AppFlow), event streaming platforms (Apache Kafka, AWS Kinesis, Azure Event Hubs), and vendor-native integration layers interact within a governed multi-cloud architecture. Through analysis of cross-industry transformation scenarios spanning financial services, manufacturing, healthcare, and consumer goods, we demonstrate that neither platform consolidation nor unconstrained pluralism produces optimal outcomes; instead, a scenario-driven, governance-anchored selection model consistently delivers superior integration quality, lower total cost of ownership, and more durable architectural coherence over multi-year transformation horizons

Keywords: Enterprise integration; Cloud transformation; Decision framework; Heterogeneous ecosystems; Legacy systems

TRACK
Applied Mathematics

8 Abstracts in this section



20	8	40%
SUBMISSIONS	ACCEPTED	ACCEPTED RATE

Applied Mathematics

Session Chair:
Dr. Veeramani

Session Facilitator:
Mr. Muni Balaji Thumu

Day 1
I- 101 Venue

TIME	PAPER ID	PAPER TITLE
12:00 PM – 12:20 PM	1571319313	Power Quality Disturbance Analysis of an 11 kV/415 V Radial Distribution System Using MATLAB/Simulink
12:20 PM – 12:40 PM	1571319903	A Multimodal Explainable Artificial Intelligence Framework for Early Coconut Disease Prediction Using UAV Imagery and Environmental Sensor Fusion
12:40 PM – 1:00 PM	1571310507	Analytical Derivation and Statistical Sensitivity of the Garman-Kohlhagen Model for European FX Options
1:00 PM – 1:20 PM	1571312105	An AI-Assisted Browser-Based Analytical Framework for Preliminary Structural Analysis: Benchmarking Against Commercial FEA Packages
1:20 PM – 1:40 PM	1571316385	A High-Performance Enhanced RLS Framework for Noise & Vibration Suppression in Robotic Systems
1:40 PM – 2:00 PM	1571316916	Argmax Stability and Distributional Signatures of Retrieval-Augmented Generation
3:00 PM – 3:20 PM	1571315619	A New Extension of the Beta Function and Its Properties
3:20 PM – 3:40 PM	1571305554	Quality Assessment of Construction Project Across Sustainable Metrics: A Logistic Model Approach

01 Power Quality Disturbance Analysis of an 11 kV/415 V Radial Distribution System Using MATLAB/Simulink

ID 1571319313

Syed Kamran Hussain Shah,[1] Eman Fatima,[1] Asad Waqar[1], Shahzad Hassan[2]

[1] Bahria University, Pakistan
[2] Military Technological College, Oman

Power quality disturbances have been a major issue in modern distribution systems, as sensitive electrical and electronic loads require a stable and reliable voltage supply. The equipment performance can be affected, industrial processes can be interrupted and the reliability of the power network can be reduced by events such as voltage sag, voltage swell, switching transients and harmonic distortion. Abstract This paper presents modeling and analysis of common power quality disturbances in a three phase 11 kV/415 V distribution system using MATLAB/Simulink. The proposed model consists of three phase source, delta-wye step down transformer, high voltage and low voltage measurement buses, line fault branch, capacitor bank switching branch and nonlinear rectifier load branch. A line fault is introduced to study the voltage sag and swell characteristics, a capacitor bank is switched to study the oscillatory transients and a universal bridge rectifier is used to study the nonlinear load effects. The simulation is performed for 0.2 s at 50 Hz so that the pre-disturbance, disturbance and recovery times can be observed clearly. The results show that the fault produces a four cycle voltage sag, the capacitor switching produces short duration oscillatory transients and the nonlinear load introduces current distortion and harmonic behavior. The study confirms the MATLAB/Simulink as an effective and flexible platform to understand the power quality disturbances in practical Pakistan type distribution network.

Keywords: Power quality; Voltage sag; Harmonic distortion; MATLAB/Simulink; Distribution system

02 A Multimodal Explainable Artificial Intelligence Framework for Early Coconut Disease Prediction Using UAV Imagery and Environmental Sensor Fusion

ID 1571319903

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[2] University of Technology and Applied Sciences – Salalah, Oman

Early prediction of coconut diseases is critical for enabling timely intervention, minimizing crop losses, and improving sustainable plantation management. Existing detection approaches primarily rely on visual symptom analysis after disease manifestation, which limits their effectiveness for preventive decision-making. This study proposes a multimodal explainable artificial intelligence framework for early coconut disease prediction that integrates high-resolution aerial imagery from unmanned aerial vehicles with real-time environmental observations from a wireless sensor network, including temperature, relative humidity, soil moisture, and light intensity, to capture both visual and climatic indicators of disease development. A dual-branch deep learning architecture independently learns visual and environmental representations, which are then combined through an attention-based fusion mechanism that adaptively weights each data source rather than relying on fixed concatenation. To support deployment in resource-constrained agricultural environments, the trained model is compressed and executed on a low-power edge computing gateway, enabling low-latency inference without continuous cloud connectivity. Two complementary explanation techniques are further incorporated to visualize influential image regions and quantify the contribution of each environmental variable to a given prediction, improving model transparency and supporting agronomists in understanding disease risk factors. Experimental evaluation shows that the proposed adaptive fusion of aerial imagery and environmental sensing significantly improves prediction accuracy over image-only approaches while maintaining efficient computational performance suitable for edge deployment. The framework offers an intelligent, scalable, and interpretable solution for proactive coconut disease management by enabling early prediction rather than post-symptomatic diagnosis, reducing dependence on manual field inspections, and supporting data-driven decision-making in precision agriculture.

Keywords: Explainable AI; Coconut disease prediction; UAV imagery; Sensor fusion; Edge computing

03
ID
1571310507

Analytical Derivation and Statistical Sensitivity of the Garman-Kohlhagen Model for European FX Options

Amir Ahmad Dar[1], Mohammad Shahfaraz Khan[2], Shariq Mohammed[3], Abidha A K[4], Altaf Ahmad Bhat[5], Saleem Iqbal[6]

[1] Lovely Professional University, India
[2] University of Technology and Applied Sciences, Oman
[3] Dhofar University, Oman
[4] B S Abdur Rahman Crescent Institute of Science and Technology, India
[5] University of Technology and Applied Sciences, Salalah, Oman
[6] Govt Degree College Vailoo, India

The Garman-Kohlhagen (GK) model, an extension of the Black-Scholes framework, is widely used for pricing European-style foreign exchange (forex) options. This study investigates the relative influence of five key input parameters in the GK model: domestic interest rate, underlying asset price (spot exchange rate), strike price, volatility, and foreign interest rate. Observational data at three levels for each parameter were adopted from the study conducted by Maina (2015 [1]). Statistical techniques, including design of experiments and analysis of variance (ANOVA), were employed to evaluate the significance and contribution of each parameter to option pricing. The analysis enables the identification of the most influential factors affecting forex option values and quantifies their respective impacts. By examining parameter sensitivity under controlled conditions, the study provides insights into the behavior of currency option prices and supports more informed decision-making in financial risk management, derivative valuation, and investment strategies within the foreign exchange market.

Keywords: Garman-Kohlhagen model; Foreign exchange options; Sensitivity analysis; Option pricing; Black-Scholes

04
ID
1571312105

An AI-Assisted Browser-Based Analytical Framework for Preliminary Structural Analysis: Benchmarking Against Commercial FEA Packages

Mithun Vinayaka Kulkarni, [1] Vijayanand Manickam[2], Mahaviradhan Narayanasamy[2], Sathish Babu Boppana[3]

[1]University of Technology and Applied Sciences, Oman
[2]University of Technology and Applied Sciences Salalah, Oman
[3]Presidency University Bangalore Bengaluru Karnataka, India

Finite element analysis (FEA) packages such as Abaqus, SolidWorks Simulation, and Autodesk Inventor are widely used for structural analysis. However, for simple classroom problems and early-stage design, license cost, setup time, and model-building effort can limit their practical use. This paper presents a browser-based tool for solving standard structural mechanics problems with AI support. A large language model interprets problems written in plain English and extracts the required input values. However, all numerical calculations are performed only using fixed closed-form equations or published stress-concentration charts, not by the AI. The tool then reconstructs stress and displacement fields and displays them in the browser for visualization. Two test cases are considered. The first is a steel cantilever beam subjected to a load at its free end. The second is a finite- width plate with a central circular hole under tensile loading. For the beam, Euler-Bernoulli theory gives a tip displacement of 0.400 mm and a maximum bending stress of 12.0 MPa, which are exactly reproduced by the tool. Commercial FEA results differ only by a few percent due to support modelling, mesh size, deformation scaling, and post-processing settings. For the plate with a hole, the chart-based maximum stress is about 64 MPa, while the three FEA packages give 63.7-65.97 MPa. The results show that the tool is useful for analytical checking, visualization, and teaching standard problems, while commercial FEA remains necessary for final design validation.

Keywords: Structural analysis; Finite element analysis; Large language model; Browser-based tool; Stress concentration

05 A High-Performance Enhanced RLS Framework for Noise & Vibration Suppression in Robotic Systems

ID 1571316385

Hussain Akbar,[1] Ghulam E Mustafa Abro,[2] Zainab Alansari[3]

[1] Hamdard University, Pakistan
[2] Aarhus University, Denmark
[3] University of Technology and Applied Sciences-Muscat, Oman

The paper presents a comparative study of the Least Mean Squares (LMS) and Recursive Least Squares (RLS), and Enhanced Recursive Least Squares (Enhanced RLS) algorithms for active vibration control (AVC) in smart piezoelectric systems. Control algorithms play a critical role in the active vibration suppression of flexible structures based on smart materials. While both LMS and RLS are fundamental adaptive filtering algorithms, our study first compares the performance of LMS and RLS in the context of vibration control, characterized using a finite impulse response (FIR) structure. The result showed that the RLS outperformed LMS in terms of adaptation speed, vibration suppression, and robustness. We further enhance the RLS algorithm with a variable forgetting factor, sparsity-aware regularization and dynamic adaptation gain to improve real-time performance in non-linear environments. The algorithms are tested under three scenarios: stationary, non-stationary and noisy signals. The simulation results confirm that the Enhanced RLS algorithm gives good adaptation and robustness to changes and noise in non-stationary conditions while the LMS algorithm is still a good solution in stationary conditions. This shows the applicability of each algorithm to various applications of active vibration control. These findings optimize adaptive filtering for real time AVC in smart piezoelectric structures, with potential applications in aerospace, robotics, and automotive systems for vibration suppression and noise control.

Keywords: Active vibration control; Recursive least squares; Adaptive filtering; Piezoelectric systems; Noise suppression

06 Argmax Stability and Distributional Signatures of Retrieval-Augmented Generation

ID 1571316916

Sooraj K C[1]

[1] Alliance University, India

Retrieval-Augmented Generation (RAG) improves the factual reliability of large language models by conditioning their predictions on retrieved passages, yet the precise conditions under which a retrieved passage changes a model's predicted next token have not been characterized exactly. We treat the next-token distribution as a point on the probability simplex and study two questions: when retrieval preserves the most probable token, and how it reshapes the distribution when the prediction is unchanged. For the first we prove an exact stability result: a global threshold on the mixing weight below which the argmax is preserved, a tight certified radius m/lambda (base margin over mixing weight) in total-variation distance, and a polytope description of the stable region that extends to several retrieved documents. For the second we introduce a suite of information-theoretic measures: Shannon entropy, the Kullback-Leibler and Jensen-Shannon divergences, an inverse-probability sensitivity heuristic, and top-k token-set overlap. On 200 SQuAD question-answer pairs, relevant context sharpens the distribution markedly (median entropy reduction 0.95 nats, $p < 1e-145$), contracts its effective support from 545 to 175 tokens, and replaces about 40% of the ten most probable tokens, while irrelevant context perturbs it far less. A temperature-scaling invariance result establishes that this is a genuine rearrangement of the distribution rather than simple sharpening. The same qualitative behavior holds for both GPT-2 Medium and Pythia-410m. These findings offer principled, token-level signals for retrieval quality scoring, hallucination detection, and reward design in adaptive retrieval.

Keywords: Retrieval-augmented generation; Argmax stability; Large language models; Information theory; Hallucination detection

07
ID
1571315619

A New Extension of the Beta Function and Its Properties

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[2] Jamia Millia Islamia, India

This paper presents a new (m, n) parametric extension of the classical Euler Beta function based on an asymmetric exponential kernel. The proposed definition introduces two independent positive parameters in the exponential terms, allowing different boundary behaviours near the endpoints of the integration interval. We study the basic properties of the proposed function and establish several analytical results, including convergence, reduction formulas, summation identities, and alternative integral representations. It is shown that the classical Euler Beta function and some existing exponential extensions are obtained as special cases by choosing suitable parameter values. Using the proposed beta function, we further define an extended Gauss hypergeometric function and derive Mellin transform representations. In addition, an extended beta probability distribution is introduced, and its basic statistical properties, including moments, mean, variance, and moment- generating function, are obtained. Numerical results and graphical illustrations are provided to show the effect of the parameters on the behaviour of the proposed function. The proposed extension offers a flexible mathematical framework that may be useful in special functions, probability theory, applied mathematics, and related scientific applications.

Keywords: Beta function; Special functions; Hypergeometric function; Mellin transform; Beta distribution

08
ID
1571305554

Quality Assessment of Construction Project Across Sustainable Metrics: A Logistic Model Approach

Amit Kumar Awasthi,[1] M Javed Idrisi,[2] Ruchi Gupta,[2] Arun Kumar Garov,[3] Rajendra Kumar Tripathi,[4] Shavej Ali Siddiqui[4]

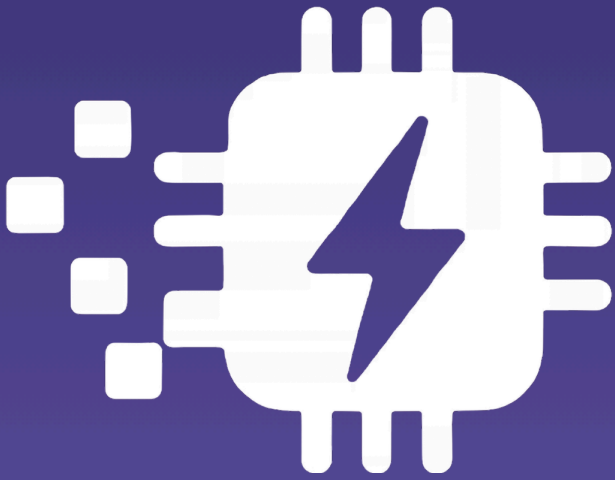
[1] Lovely Professional University & Phagwara, India
[2] Manav Rachna University Faridabad, India
[3] RIMT University, Mandi Gobindgarh, India
[4] Khwaja Moinuddin Chishti Language University, India

This study presents a comprehensive mathematical model based on the Logistic differential equation, considering a myriad of factors encompassing both positive and negative aspects. The positive aspects encompass: eco-friendly material selection, energy efficiency optimization, waste reduction and recycling, water conservation, improved indoor air quality, biodiversity and green spaces, lifecycle cost savings, regulatory compliance and certifications, resilience to climate change, enhanced social and economic value. The negative aspects include: higher initial investment, longer project timelines, limited availability of sustainable materials, complexity in implementation, performance uncertainty, energy consumption of sustainable technologies, regulatory and compliance challenges, skilled workforce shortage, limited client awareness, economic viability for small projects. The model is designed to address the complex dynamics of project management, with a primary focus on achieving and sustaining a defined standard quality level (Qs). By integrating diverse variables and their interactions within the Logistic differential equation framework, the system dynamically responds to the ever-changing nuances of project management. This approach enables the robust management of challenges that may compromise quality, while also harnessing positive influences to ensure that projects consistently meet or surpass predefined quality standards. The utilization of this mathematical model aims to proactively optimize project outcomes by effectively managing the intricate interplay of factors influencing project quality. Moreover, integration of AI into construction quality assessment can lead to higher efficiency, long-term sustainability, improved safety, and reduced waste while maintaining cost-effectiveness.

Keywords: Logistic differential equation; Sustainable construction; Quality assessment; Mathematical modelling; Eco-friendly materials

TRACK
Emerging Topics and Cutting-edge Technologies

24 Abstracts in this section



117	24	20.5%
SUBMISSIONS	ACCEPTED	ACCEPTED RATE

Emerging Topics and Cutting -edge Technologies

Session Chair:
Dr. Muna Saif Al Rahbi

Session Facilitator:
Ms. Marian A. Malig-on

Day 1
I- 126

TIME	PAPER ID	PAPER TITLE
12:00 PM – 12:20 PM	1571297542	Wideband Differential-Fed Planar Antenna with Improved Gain Performance Enabling Efficient RF Energy Harvesting for IoT Devices
12:20 PM – 12:40 PM	1571302621	Climate-Driven Crop Water Demand Prediction for Omani Agriculture Using a Convolutional-LSTM Deep Learning Framework
12:40 PM – 1:00 PM	1571321301	Energy-Efficient Lifting-Based 2D DWT VLSI Architecture Using Genetic Algorithm for Medical Image Compression
1:00 PM – 1:20 PM	1571311839	Efficient Buffer-Aided Packet Scheduling for UAV Relays Based on First-Hop Link Quality
1:20 PM – 1:40 PM	1571308215	A Cognitive Digital Twin Ecosystem for Industry 5.0 -Enabled Sustainable Smart Mining in Oman
1:40 PM – 2:00 PM	1571319536	Artificial Intelligence to Systemic Inflammation and Metabolic Dysregulation Biomarkers in Liver Cirrhosis for Disease Severity Prediction and Prognostic Modeling
3:00 PM – 3:20 PM	1571306829	Adaptive Digital Twin Decision-Support System for Dengue Forecasting and Counterfactual Intervention Planning
3:20 PM – 3:40 PM	1571312993	AI Driven Recommendations for Personalised Therapy in Nerve Conduction Studies
3:40 PM – 4:00 PM	1571320880	An AI-Enabled Dynamic Solar Tracking Car Cover for Adaptive Multi-Directional Vehicle Protection
4:00 PM – 4:20 PM	1571318890	A Hybrid IoT and RFID Based Wearable System for Child Safety: A Proposed Model
4:20 PM – 4:40 PM	1571312731	High-Efficiency Resonant Converter Topology for Constant Current Electric Vehicle Battery Charging
4:40 PM – 5:00 PM	1571296644	Privacy-Preserving Cloud Agnostic Infrastructure for Secure Management of Multimodal PCOS Health Profiles

Emerging Topics and Cutting-edge Technologies

Session Chair:
Dr.Muna Saif Al Rahbi
Dr.Nurul Akhmal Zulkefli

Session Facilitator:
Mr. Muni Balaji Thumu
Ms. Marian A. Malig-on

Day 2
I- 105 Venue
I-126

TIME	PAPER ID	PAPER TITLE
10:45 AM – 11:05 AM	1571311715	A Hybrid Large Language Model for Drug Discovery Using Quantum Machine Learning
11:05 AM – 11:25 AM	1571314952	CRAVE: Climate Risk Attribution and Vulnerability Evaluation via Explainable Machine Learning
11:25 AM – 11:45 AM	1571280552	Intelligent Computation Offloading Framework for Mobile Edge Computing Using Machine Learning-Based Decision Models
11:45 AM – 12:05 PM	1571317297	AI Adoption in Healthcare Across Divergent Regulatory Ecosystems: A Comparative Conceptual Framework for MENA, United States, European, and ASEAN Pathways
12:05 PM – 12:25 PM	1571299339	Structured Pruning of LSTM Networks for Energy-Efficient Solar Irradiance Forecasting on IoT Edge Devices
12:25 PM – 12:45 PM	1571316831	Diversity-Preserved Modified Black-Winged Kite Algorithm for Scientific Workflow Scheduling in Cloud Environment
10:45 AM – 11:05 AM	1571307958	Educational Digital Twins are Not Learners: The Epistemic Limits of Predictive Student Modeling
11:05 AM – 11:25 AM	1571307138	Automated Intelligent Resume Analyzer to Match Applicants Skill with Job Specifications: An ML and NLP Based Approach
11:25 AM – 11:45 AM	1571295697	A Comprehensive Organ-Sharing System for Efficient Transplantation
11:45 AM – 12:05 PM	1571314930	ESG-Based Explainable Machine Learning Framework for CO_2 Emission Prediction Using World Bank Development Indicators
12:05 PM – 12:25 PM	1571312881	Adaptive Federated Learning Framework with Trust-Aware Aggregation for Privacy-Preserving Healthcare Analytics in Edge-IoT Environments

01
ID
1571297542

Wideband Differential-Fed Planar Antenna with Improved Gain Performance Enabling Efficient RF Energy Harvesting for IoT Devices

Haq Nawaz,[1] Mateen Ahmad Mateen Ahmad Khan,[1] Faisal Masood[1]

[1] Military Technological College, Oman

This work introduces a compact, wideband planar antenna featuring enhanced gain performance designed for radio frequency (RF) energy harvesting for internet of things (IoT) devices. The presented metasurfaces antenna achieves a broader impedance bandwidth while maintaining high gain performance across its entire operational bandwidth. The wideband capability is realized by integrating parasitic feeding and an electromagnetic bandgap (EBG) radiator, which is excited through a modified proximity-fed four-pointed star-shaped driven patch. Attributed to its differential feeding mechanism, the antenna delivers improved gain throughout its operating bandwidth. It exhibits unidirectional radiation pattern, resonating at a center frequency of 3.75 GHz, with a -10 dB impedance bandwidth of better than 1.6 GHz (43%), covering frequencies from 3 GHz to 4.6 GHz. The differentially driven planar antenna showcases notable gain performance, stemming from the balanced excitation of the EBG patch. Compared to previously reported unidirectional antennas, this proposed antenna stands out with its wideband impedance bandwidth and high gain, making it a promising candidate for modern rectenna applications.

Keywords: Planar antenna; RF energy harvesting; Wideband antenna; Metasurface; Internet of Things

02
ID
1571302621

Climate-Driven Crop Water Demand Prediction for Omani Agriculture Using a Convolutional-LSTM Deep Learning Framework

Vimal Kumar Stephen[1], Anand Muthukumarappan[1], Kumar Kaliyamoorthy[1], Antonio Rutaf Manalang[1], Mallika Banu Basheer Ahmed[1], Rudiardo Percival Ninalga de Vera[1]

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Agriculture in the Sultanate of Oman is constrained by chronic water scarcity, an arid-to-semi-arid climate, and an estimated annual groundwater deficit on the order of hundreds of millions of cubic metres, of which irrigation accounts for the dominant share. Accurately anticipating how much water a crop will require under changing climatic conditions is therefore a national priority. This paper applies artificial intelligence to climate science by proposing CWD-ConvLSTM, a hybrid convolutional long short-term memory network with a temporal attention layer that forecasts climate-driven crop water demand (the FAO-56 crop evapotranspiration, ETc) several days ahead from multi-source meteorological and wireless-sensor data. A one-dimensional convolutional stage extracts cross-variable spatial structure, stacked LSTM layers model temporal dynamics, and an attention layer emphasises the most informative time steps. The model was evaluated against Linear Regression, Random Forest, XGBoost, and a standalone LSTM on an Omani climate-agriculture dataset. The proposed CWD-ConvLSTM attained the lowest RMSE of 0.286 mm/day, an MAE of 0.198 mm/day, a MAPE of 3.91%, and the highest R^2 of 0.963, while supporting a projected irrigation water saving of 18-27% relative to fixed-schedule baselines. The results indicate that climate-aware deep forecasting can materially improve irrigation decision support in water-limited regions such as Oman.

Keywords: Crop water demand; ConvLSTM; Deep learning; Omani agriculture; Climate

03
ID
1571321301

Energy-Efficient Lifting-Based 2D DWT VLSI Architecture Using Genetic Algorithm for Medical Image Compression

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Medical imaging compression technology is crucial in reducing storage space and required bandwidth for transmissions while maintaining the quality of the diagnostic images. While the two-dimensional Discrete Wavelet Transform (2D DWT) technique is extensively used in medical imaging compression, typical hardware implementations suffer from excessive power consumption and complex computations which make them unsuitable for portable real-time medical imaging equipment. This paper introduces an energy-efficient DWT VLSI architecture based on lifting process, which is optimized via Genetic Algorithm (GA) for medical image compression. The lifting process turns the wavelet transform into splitting, predicting, and updating operations leading to the decrease in the computation complexity and used hardware resources. The GA has been used to optimize various architectural parameters such as decomposition level, word length, and pipeline design in order to minimize the power consumption, area of hardware, and processing delay while keeping the image reconstruction quality high. The developed architecture was implemented using the MATLAB environment for the image compression analysis and Cadence RTL synthesis tools for the hardware analysis. According to the experiments, the suggested design is capable of consuming between 145-340 mW, occupying 1.7-2.9 mm^2 of hardware area and achieving area-Delay Product (ADP) values of 580-780 while giving a PSNR ranging from 39.8-43.9 dB and SSIM going from 0.89-0.94 in medical image datasets. Unlike conventional lifting systems for DWT, the suggested GA-optimized design is able to deliver higher efficiency of the system in terms of hardware usage and energy consumption.

Keywords: Discrete wavelet transform; VLSI architecture; Genetic algorithm; Medical image compression; Energy efficiency

04
ID
1571311839

Efficient Buffer-Aided Packet Scheduling for UAV Relays Based on First-Hop Link Quality

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The unmanned aerial vehicles (UAVs) can serve as data relay for a monitoring UAV that is not having a reliable direct connection to the ground control station (GCS). Since dynamicity in UAVs flights mobility makes the wireless channels intermittent while low cost UAVs have their inherent electronic limitations that affect their communication performance. Moreover, the line-of-sight communication links may cause interferences among UAVs. In this scenario, different packets may have different associated channel state information (CSI). Proposing an efficient transmission scheme that selects a best packet among available packets in buffer of the relay can support quality in communication. Existing works mainly focuses on data routing considering UAVs without buffer. In this work, we consider relay with buffer capability and investigate the suitable packet selection from the buffer of the relaying UAV to be forwarded to the destination GCS and evaluate its impact on system reliability. In this work a packet selection algorithm is proposed that selects best packet from the buffer of relaying UAV relay. The selection is based on the associated CSI with packets stored in relaying UAV while buffer is supposed to be asymmetrically accessible. The system analysis and implementation results demonstrate the effectiveness of the proposed schemes for buffer access compared to buffer less transmission scheme. Many important results are deduced that can help in designing efficient systems of this kind.

Keywords: UAV relays; Packet scheduling; Buffer-aided relaying; Link quality; Wireless communications

05
ID
1571308215

A Cognitive Digital Twin Ecosystem for Industry 5.0-Enabled Sustainable Smart Mining in Oman

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Under Oman Vision 2040, the mining and mineral industry in Oman is emerging as a significant force behind economic diversification. Mining operations require intelligent, resilient, sustainable, and human safety-focused technologies to serve this role. Inefficiencies, unanticipated equipment stoppages, safety hazards, environmental demands, and a lack of real-time decision assistance are still problems for current operations. A Cognitive Digital Twin Ecosystem (CDTE) for Industry 5.0-enabled sustainable smart mining in Oman is presented in this study. Within a single cyber-physical mining ecosystem, the suggested framework integrates AI, digital twin modelling, IoT sensing, edge-cloud collaborative intelligence, blockchain-based data trust, and sustainability-oriented optimization. A 720-hour simulation set up to replicate Omani mining conditions was used to assess a six-layer design. The CDTE supported the decarbonization and economic diversification targets of Oman Vision 2040 by increasing ore yield by 12.30%, decreasing unplanned downtime by 85.28%, and lowering carbon emissions by 22.01% when compared to an Industry 4.0 SCADA baseline. The framework aligns Oman Vision 2040's standards for environmental sustainability and worker safety with industry-specific targets.

Keywords: Cognitive digital twin; Industry 5.0; Smart mining; Sustainability; Oman Vision 2040

06
ID
1571319536

Artificial Intelligence to Systemic Inflammation and Metabolic Dysregulation Biomarkers in Liver Cirrhosis for Disease Severity Prediction and Prognostic Modeling

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Cirrhosis of the liver is the final outcome of chronic liver diseases, which carry a significant burden in terms of morbidity, mortality, and medical costs globally. Transition from chronic liver damage to cirrhosis is accompanied by sustained systemic inflammation, metabolic derangement, impaired immunity, fibrosis, and multiple organ disorders. Established prognostic indices like Child-Pugh and Model for End-Stage Liver Disease (MELD) scores give useful clinical insights but cannot fully reflect the interplay between inflammatory, metabolic, radiologic, histological, and molecular biomarkers. Modern developments in the field of artificial intelligence (AI), machine learning (ML), and deep learning (DL) enable researchers to work with heterogeneous data sources and create predictive models. AI-based models can find complex associations between biomarkers, increase diagnostic performance, predict decompensation episodes, calculate risk of death, and help to make therapy decisions. In this review, the present use of AI techniques for assessing systemic inflammation and metabolic dysregulation biomarkers in liver cirrhosis is described. Multimodal methods for evaluation of various biomarkers and comparison of traditional and new prognostic scoring systems in cirrhosis patients are discussed. Also, the future directions and limitations of AI in clinical practice are highlighted.

Keywords: Liver cirrhosis; Biomarkers; Systemic inflammation; Prognostic modelling; Artificial intelligence

07
ID
1571306829

Adaptive Digital Twin Decision-Support System for Dengue Forecasting and Counterfactual Intervention Planning

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Dengue fever continues to be a significant public health problem in tropical and subtropical countries and forecasting and planning action could help minimize outbreak severity. Dengue prediction studies that have been conducted so far mainly seek to predict accuracy and offer little support to causal analysis, intervention assessment and operational decision making. In this paper, we propose an Adaptive Digital Twin Decision- Support System (ADT-DSS) for Dengue Forecasting and Counterfactual Intervention Planning that brings together machine-learning forecasting, adaptive digital-twin synchronization, structural causal modeling, counterfactual simulation, and explainable artificial intelligence to provide a cohesive, unified framework. The proposed system continuously feeds epidemiological and environmental observations to keep an up-to-date virtual picture of the dynamics of dengue transmission synchronized. Climatic, vegetation and historical dengue indicators are used to develop a high performance forecasting engine that uses models optimized for each city. A structural causal model enables evaluation of alternative intervention scenarios through counterfactual simulations and SHAP-based explainability identifies the influential drivers of outbreaks. Experimental evaluation on the DengAI benchmark dataset for San Juan and Iquitos demonstrates strong forecasting performance, achieving R^2 values of 0.873 and 0.625, respectively. The findings from counterfactual analyses show that adopting more integrated vector-control measures significantly decrease the expected incidence of dengue cases and offer guidance for implementing interventions. The results show that the proposed ADT-DSS goes beyond the traditional predictive forecasting, and provides additional capabilities such as causal reasoning, explainability, and intervention planning, which can aid in the implementation of proactive dengue-control policies and intelligent public-health decision making.

Keywords: Digital twin; Dengue forecasting; Decision support; Counterfactual analysis; Public health

08
ID
1571312993

AI Driven Recommendations for Personalised Therapy in Nerve Conduction Studies

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Nerve conduction studies (NCS) play a critical role in the assessment of peripheral nerve disorders; however, conventional interpretation is often subjective and lacks direct integration with personalized treatment planning. This paper presents an artificial intelligence (AI)-driven framework for generating personalized therapy recommendations based on NCS data, aiming to enhance both diagnostic accuracy and clinical decision support. The proposed system employs advanced signal processing techniques to preprocess raw NCS signals, including noise reduction and normalization, followed by extraction of key electrophysiological features such as latency, amplitude, and conduction velocity. These features are utilized to train supervised machine learning models for classification and severity assessment of neuropathic conditions. In addition, patient-specific clinical parameters, including age, body mass index (BMI), and associated comorbidities, are incorporated to enable a comprehensive and individualized analysis. A key contribution of this work is the integration of a recommendation module that translates diagnostic outputs into personalized therapeutic strategies. Using multimodal data fusion, the system suggests targeted interventions such as pharmacological management, physiotherapy protocols, and ergonomic or lifestyle modifications. Furthermore, explainable AI techniques are incorporated to improve model transparency and facilitate clinical interpretability. The proposed framework demonstrates the potential to bridge the gap between neurophysiological diagnostics and precision medicine. It provides a scalable and efficient approach for improving patient-specific care in neuropathy management. Future work will focus on validation using large-scale clinical datasets and real-world implementation in healthcare settings.

Keywords: Nerve conduction studies; Personalized therapy; Artificial intelligence; Clinical decision support; Peripheral neuropathy

09
ID
1571320880

An AI-Enabled Dynamic Solar Tracking Car Cover for Adaptive Multi-Directional Vehicle Protection

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The massive usage of fossil fuel burning has significantly increased global temperatures leading to excessive heat for any parked car. Intense heat produced by the interior material degradation inside a parked car is harmful for humans which can lead to many diseases. The existing solution for the current scenario is the overhead canopy shield protection mechanism provided by some manufactures, which do not consider the sun's azimuth and elevation change throughout the day. The researchers propose a top mounted AI enabled retractable vehicle cover protection system using solar tracking sensors. The proposed system calculates the sun's trajectory with predictive positioning algorithms relative to the parked vehicle and the motorized system rolls down the protective textile barriers to shield the vehicle from direct exposure. The researchers also outline the system architecture including the sensor framework, auto roller mechanism offering scalable, energy efficient solution for reducing the internal temperature in a parked vehicle.

Keywords: Solar tracking; Vehicle protection; AI-enabled system; Heat mitigation; Renewable energy

10
ID
1571318890

A Hybrid IoT and RFID Based Wearable System for Child Safety: A Proposed Model

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Safety of children is a primary concern for the parents and the responsible authorities in all public places such as shopping malls, crowded beaches, parks, communal gatherings and different entertainment zones as well as when children go out in groups with peers of their own age. Traditionally, parents must keep a close watch on their children, as in a few seconds, the children can easily move out of sight. More care should be given to younger kids and specially-abled children even when they are going to schools and known places. Modern technology plays a vital role in safeguarding children across various aspects. This paper deliberates some of the proposed and implemented methodologies that utilize IoT, RFID and related communication and tracking technologies in the related work. We propose in this paper a hybrid wearable device design incorporating both IoT and RFID technologies to offer an effective and economical solution with the assurance of maintaining privacy for the safety of children. RFID is useful for quick reliable identification with the RFID readers within controlled environments, while IoT-based communication and tracking provide continuous monitoring in open and unknown places. The objective of this work is mainly to encourage parents and authorities to adopt technological applications to ensure child safety and to reduce their anxiety when children are taken to public places or allowed to go out independently, also to monitor the movement of specially-abled children.

Keywords: Child safety; Internet of Things; RFID; Wearable system; Location tracking

11 High-Efficiency Resonant Converter Topology for Constant Current Electric Vehicle Battery Charging

ID 1571312731

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The rapid adoption of electric vehicles (EVs) has heightened the need for reliable battery charging. In conventional charging systems, complex feedback controllers are needed to simplify the constant charging current, which leads to increased complexity of the system, along with switching losses. This paper introduces a high-efficiency resonant converter of Load-Independent Constant Current (LICC) Charging of EV batteries using Resonant Immittance Converter (RIC). Resonant Converter topologies are examined with the same operating conditions and are compared with respect to load current, source current, voltage gain and current gain. From the total number of topologies analyzed, the LA7 configuration is shown to be the best and achieves the maximum load current while maintaining constant current. A charger operating at 25 kHz resonant frequency with a DC input source of 25 V was designed and is validated through MATLAB/Simulink. The charger in question achieved an output voltage of 106.3 V with a charging current of 100 mA, a voltage gain of 4.251 and a current gain of 0.235. The constant current charging, the linear rise of the battery voltage and the demonstrated excellent load autonomy were verified. From the total number of topologies analyzed, the LA7 configuration was shown to be the best and most appropriate for the application of high-efficiency charging of EV batteries.

Keywords: Resonant converter; Electric vehicles; Battery charging; Constant current; Power electronics

12 Privacy-Preserving Cloud Agnostic Infrastructure for Secure Management of Multimodal PCOS Health Profiles

ID 1571296644

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Polycystic ovary syndrome (PCOS) is a complex endocrine disorder affecting women of reproductive age and is associated with hormonal imbalance, metabolic dysfunction, and reproductive complications. Effective monitoring and management of PCOS requires continuous tracking of heterogeneous health indicators, including metabolic parameters, clinical biomarkers, anthropometric measurements, dietary profile and lifestyle attributes. Digital health platforms rely on cloud computing infrastructure to store and process health data in modern era. Moreover, healthcare datasets contain sensitive personal information, and reliance on vendor-specific cloud platforms adds the privacy, vendor lock-in, and interoperability concerns. This study addresses these issues and proposes a privacy-preserving cloud agnostic infrastructure for secure management of multimodal PCOS health profiles. The proposed system integrates secure data ingestion, an embedded privacy preserving transformation pipeline and a medallion based architecture to progressively refine raw data into standardized and analytics ready datasets. Further, privacy safeguards such as de-identification and pseudonymization are incorporated within data lifecycle for secure handling of sensitive information. The proposed architecture is designed using cloud agnostic principles, enabling deployment across private, public, or hybrid cloud environments without dependence on vendor-specific services. The framework also incorporates synthetic data generation to enable the privacy compliant data and provides a robust foundation for digital health research and future AI-driven applications in PCOS management.

Keywords: PCOS; Privacy preservation; Cloud-agnostic infrastructure; Multimodal health data; Secure data management

13
ID
1571311715

A Hybrid Large Language Model for Drug Discovery Using Quantum Machine Learning

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The traditional drug discovery process is often time-consuming and expensive, especially for rare diseases where minimal data complicates the development process. In this paper, we propose a Large Language Model (LLM) integrated with Quantum Machine Learning (QML) for advancement in drug discovery with a focus on precision medicine. This model employs a pre-trained biomedical LLM (such as BioGPT) to extract and generate possible molecular structures for rare diseases. These molecular representations are passed to a QML module for evaluation of the druggability or potential binding affinity of each molecule. The system generates a ranked list of possible molecular structures optimized for a specific disease, based on its chemical viability. This concept demonstrates the feasibility of combining the reasoning capabilities of LLMs with the stability of QML in handling minimal or incomplete data. Our prototype was tested on a small dataset, targeting a specific medical condition, showing strong potential in molecule generation and its evaluation. The system architecture and implementation allow scalability toward more complex models and real-world datasets. This work contributes to the optimization of drug discovery in the case of rare diseases, driven by quantum technologies.

Keywords: Large language model; Quantum machine learning; Drug discovery; Precision medicine; Rare diseases

14
ID
1571314952

CRAVE: Climate Risk Attribution and Vulnerability Evaluation via Explainable Machine Learning

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India's climate vulnerability originates from the intersection of climatic variability, demographic pressure, and socio-economic inequality. This study constructs a Climate Vulnerability Index (CVI) for 34 Indian states and union territories, based on a multi-source panel dataset for the years 2015-2019 and 2023-2025. The PCA framework is applied and validated through KMO, with three components retained, jointly accounting for 76.86% of the total variance. Seasonal correlations, ANOVA, and fixed-effects panel regression to assess ENSO teleconnections reveal significant regional effects in eastern and northeastern India, but no direct effect on composite state-level vulnerability. ANOVA confirms significant differences in rainfall between ENSO phases ($p = 0.032$), with lower rainfall during El Niño years than during La Niña years. Vulnerability rankings show consistent spatial concentration in Uttar Pradesh, Bihar, Madhya Pradesh, Rajasthan, and Maharashtra. The Random Forest-SHAP analysis reveals population, literacy rate, and income as dominant drivers, whereas climatic indicators and ENSO are the least contributing. These results highlight the importance of socioeconomic capacity in terms of climate resilience and the necessity of adaptation to the ENSO-sensitive conditions in northeastern India.

Keywords: Climate vulnerability index; Explainable machine learning; Climate risk; Principal component analysis; India

15

ID 1571280552

Intelligent Computation Offloading Framework for Mobile Edge Computing Using Machine Learning-Based Decision Models

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The mobile edge computing (MEC) approach ensures efficient task offloading by processing computation- intensive tasks at edge servers. Despite its many benefits, there have been no efforts towards the development of a smart task offloading approach that employs dynamic methods. Traditional task offloading approaches are constrained by static policies, single-objective optimization techniques, and complex reinforcement learning systems. In this study, we propose a dynamic task offloading strategy based on a random forest classifier that uses task size, CPU utilization, latency constraints, edge server loading, and mobile device battery power as input parameters to select between local task execution, edge computing, and cloud task execution. The proposed scheme was trained using an artificial dataset comprising 2,000 data samples corresponding to typical MEC activities. The classification accuracy was found to be 91.5% ... task offloading system significantly lowered the average task completion time and consumed energy by 66.7% ... local computing approach. Effective threshold load balancing policy with θ= 0.75 ensures that optimal resource utilization will be achieved since it ensures saturation avoidance of edge servers by migrating tasks to the cloud whenever required. It is concluded from this study that the suggested approach achieves comparable performance to the DRL, however, with minimum computational overhead. Therefore, the suggested approach is feasible in terms of resource constraints.

Keywords: Mobile edge computing; Computation offloading; Machine learning; Task scheduling; Decision models

16

ID 1571317297

AI Adoption in Healthcare Across Divergent Regulatory Ecosystems: A Comparative Conceptual Framework for MENA, United States, European, and ASEAN Pathways

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This paper presents a four-dimensional conceptual framework for healthcare AI adoption – regulatory and policy environment, clinical system readiness, sociocultural acceptance, and infrastructure and technology access – and uses it to organize a narrative synthesis of adoption patterns reported for the United States, the United Kingdom, continental Europe, ASEAN, and the Middle East and North Africa (MENA). Drawing on a non- systematic scoping review of 32 peer-reviewed and industry sources published between 2017 and 2025, this research shed light on the existing arguments that cross-regional differences in reported adoption are associated more consistently with institutional trust, regulatory clarity, and resource readiness than with the underlying state of the AI technology itself. We formalize this argument as four testable propositions and derive an illustrative set of policy pathways for MENA health systems, with an explicit caveat that available MENA evidence is concentrated in Gulf Cooperation Council (GCC) states and may not generalize to lower-resource parts of the region. The framework and propositions are offered as a starting point for future empirical validation rather than as established findings.

Keywords: Healthcare AI adoption; Regulatory frameworks; MENA; Comparative framework; Policy

17
ID 1571299339

Structured Pruning of LSTM Networks for Energy-Efficient Solar Irradiance Forecasting on IoT Edge Devices

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Solar irradiance forecasting plays a central role in managing renewable energy systems reliably. As photovoltaic (PV) installations expand rapidly across India, the need for accurate, real-time, and locally deployable forecasting solutions has become increasingly urgent. While deep learning models, particularly Long Short-Term Memory (LSTM) networks, have demonstrated strong forecasting accuracy, their computational demands make direct deployment on resource-constrained IoT edge devices impractical. This paper proposes a structured pruning framework applied to LSTM networks to address this gap, enabling energy-efficient solar irradiance forecasting directly at the edge without dependency on cloud infrastructure. The proposed model is trained and evaluated on NASA POWER reanalysis data collected for Gandhinagar, Gujarat, India, covering the period 2015 to 2023. Structured pruning reduces the model parameters by 60%, from 186,432 to 74,112, while maintaining a forecasting accuracy comparable to the full model, achieving a Mean Absolute Error (MAE) of 39.1 W/m^2, Root Mean Square Error (RMSE) of 52.6 W/m^2, and an R^2 of 0.961. Deployment on a Raspberry Pi 4 demonstrates an inference latency of 12.3 ms and energy consumption of 0.43 mW, representing reductions of 61.2% and 63.2% respectively over the unpruned baseline. These results confirm that the proposed approach delivers a viable, accurate, and hardware-friendly solution for real-time solar forecasting in grid-edge and off-grid IoT environments.

Keywords: LSTM; Structured pruning; Solar irradiance forecasting; IoT edge devices; Energy efficiency

18
ID 1571316831

Diversity-Preserved Modified Black-Winged Kite Algorithm for Scientific Workflow Scheduling in Cloud Environment

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Cloud-based scheduling facilitates the efficient distribution of resources and maximizes the utilization of virtual machines and computing infrastructure. Metaheuristic (MH) algorithms effectively address complex scheduling problems due to their robust search capabilities and ability to handle NP-hard optimization problems. This study adopts the recently developed nature-inspired Black-Winged Kite Algorithm (BKA) to tackle the scheduling problem. We propose a Modified BKA (MBKA) for workflow scheduling that enhances the original BKA by integrating Latin Hypercube Sampling (LHS) for population initialization. This modification replaces conventional random initialization, ensuring superior population diversity and uniform distribution across the search space. The proposed MBKA is evaluated on benchmark scientific workflows: LIGO, Montage, and Epigenomics, and compared against the well-established MH algorithms, including Differential Evolution (DE), Grey Wolf Optimizer (GWO), Sine Cosine Algorithm (SCA), and the original BKA. Experimental results validate that MBKA consistently achieves lower makespan values and a faster convergence rate, outperforming its counterparts. The modification is further validated through statistical measures such as mean and standard deviation, demonstrating the effectiveness of LHS-based initialization in enhancing BKA performance for cloud workflow scheduling.

Keywords: Black-winged kite algorithm; Workflow scheduling; Cloud computing; Metaheuristics; Diversity preservation

19

ID
1571307958

Educational Digital Twins are Not Learners: The Epistemic Limits of Predictive Student Modeling

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A digital twin is a computerized model that represents a physical system in real time. Digital twins of learners can now be created from and trained on large bodies of educational data in order to predict student performance, measure engagement, and forecast a student's trajectory. This paper argues that the learner analogy fails. A physical system such as a turbine is limited to what the sensors attached to it can measure; a learner is not so easily measured. There is a large gap between the behavioral data any system can collect and what actually happens when a student learns: conceptual change, the making of meaning, and the slow formation of a student's identity cannot be captured in behavioral data. The paper names this shortfall the educational representation gap and examines three limitations that follow from it: (a) reductionism, the modeling of only those aspects of a learner that can be measured; (b) interpretive ambiguity, the fact that models of learners must make many interpretations of behavior without grounds for choosing among them; and (c) a blindness to cognitive processes that leave no trace in behavioral data. The purpose is not to dismiss the technology but to argue that it should be used as a decision-support tool, not as a representation of a learner. Consequences for learning analytics, educational AI, and computational social science are described.

Keywords: Digital twins; Student modelling; Learning analytics; Epistemic limits; Educational technology

20

ID
1571307138

Automated Intelligent Resume Analyzer to Match Applicants Skill with Job Specifications: An ML and NLP Based Approach

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In the present online job hiring scenario, hiring agencies receive numerous resumes for the vacant positions. Manually screening these resumes can be time-consuming, boring, and not so consistent. Recruiters have to waste a lot of time screening resumes to identify the right person with the right skills and qualifications. To overcome this problem, an intelligent resume analyzer that makes use of NLP (Natural Language Processing) and Machine Learning (ML) can be employed. This intelligent resume analyzer makes use of natural language processing techniques that can identify key information from resumes, such as skills, education, and experience. In addition, it can apply ML techniques that compare the resumes of the candidates with the job requirements. By identifying the similarity of the resume with the job requirements, it can identify the right candidates for the job. Testing results have shown that the proposed system is quick and efficient and saves lots of screening time.

Keywords: Resume analysis; Natural language processing; Machine learning; Job matching; Recruitment

21
ID
1571295697

A Comprehensive Organ-Sharing System for Efficient Transplantation

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Organ transplantation is a crucial, life-saving intervention for patients with end-stage organ failure. Conventional organ-sharing mechanisms are, however, confronted with several challenges, such as inefficient distribution of organs, lack of transparency in the process of selecting recipients, logistics, and high rates of wastage of organs. These inefficiencies result in protracted waiting times, increased mortality and sub-optimal utilization of available organs. This study addresses these problems by presenting LifeLink, a centralized, artificial intelligence (AI)-based organ-sharing platform designed to optimize donor-recipient matching, ensure ethical and transparent distribution, and facilitate organ tracking and transportation. Real-time status monitoring, role-based access for administrators, physicians, and users, and OTP-based verification of donors are all built into the system. LifeLink provides integrated workflow and secure data management, increasing speed, accuracy, and reliability of organ transplantation with PHP, AngularJS, and MySQL. LifeLink has demonstrated the ability to reduce organ waste from 18% to below 5% and increase allocation speed by 40%, increasing stakeholder trust and system efficiency.

Keywords: Organ transplantation; Organ allocation; Healthcare systems; Recipient matching; Logistics

22
ID
1571314930

ESG-Based Explainable Machine Learning Framework for CO_2 Emission Prediction Using World Bank Development Indicators

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Accurate carbon dioxide (CO_2) emission forecasting is essential to meet Net Zero Carbon targets and to support evidence-based environmental policies. The complex nonlinear interactions between environmental, social, governance (ESG) and economic issues are often difficult to capture by traditional statistical techniques. This study develops an explainable machine learning framework for CO_2 emission prediction using ESG indicators of the World Bank Development Indicators (WDI) dataset. The framework combines K-Nearest Neighbors (KNN) imputation, logarithmic transformation, K-means clustering, Extreme Gradient Boosting (XGBoost), Artificial Neural Networks (ANN), and Shapley Additive explanations (SHAP) to improve the accuracy of prediction and the interpretability of the model. We estimate global CO_2 emissions for more than 190 countries using twelve predictor variables that include environmental, social, governance and economic control variables. Comparative studies were carried out using XGBoost, Random Forest, ANN, and Linear Regression, and the performance was evaluated using the coefficient of determination (R^2), Mean Absolute Error (MAE), Mean Squared Error (MSE), Root Mean Square Error (RMSE). The proposed XGBoost model performed better than the benchmark models in terms of prediction performance with R^2 value of 0.9904. The SHAP analysis showed that the most influential variables for emissions were GDP, population density, electric power consumption, renewable energy consumption, life expectancy, and forest land. The proposed explainable framework based on ESG facilitates sustainable environmental management, climate policy evaluation and progress towards Net Zero Carbon and the Sustainable Development Goals (SDGs) by providing clear interpretation, accurate prediction and useful decision support for policymakers.

Keywords: CO_2 emission prediction; ESG; Explainable machine learning; World Bank indicators; Net zero

23
ID
1571312881

Adaptive Federated Learning Framework with Trust-Aware Aggregation for Privacy-Preserving Healthcare Analytics in Edge-IoT Environments

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The rising use of Edge-IoT technologies in healthcare, such as wearable devices and remote monitoring systems, has facilitated the provision of ongoing data-driven insights and posed serious privacy challenges. Federated Learning (FL) is a solution to these issues that enables decentralized model training without exposing sensitive information. Nevertheless, traditional FL methods do not fit well into real-world healthcare settings, where data is not necessarily IID, devices are non-homogeneous, and client behavior can be unreliable or even hostile. This paper suggests an Adaptive Federated Learning model using Trust-Aware Aggregation mechanism and privacy-preserving layer. The framework is dynamic in that it chooses the clients involved depending on the availability of the resources and allocates the trust scores depending on the data quality, consistency of the model, and past reliability. These trust scores are employed to weigh up client contributions in the process of aggregation, so that the effect of noisy or malicious updates is minimized. Privacy is also strengthened using the different privacy and secure aggregation practices. The given strategy is tested on various healthcare datasets in non-IID and adversarial conditions. Experimental evidence shows better accuracy, greater robustness and less communication overhead than conventional FL methods. The presented work presents a trust-sensitive adaptive aggregation approach that enhances the reliability and security of federated learning on federated healthcare Edge-IoT systems.

Keywords: Federated learning; Trust-aware aggregation; Healthcare analytics; Edge-IoT; Privacy preservation

24
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1571317285

Quantum Cryptography in the Post-Quantum Era: Applications, Algorithms, and Future Directions

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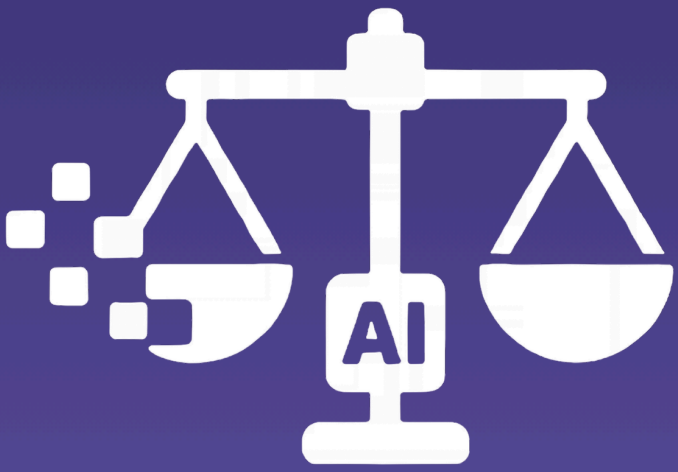
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Quantum computing represents a revolutionary paradigm shift in computational processing, fundamentally challenging the cryptographic infrastructure that currently secures global digital communications. By harnessing the esoteric principles of quantum mechanics-namely superposition and entanglement-quantum systems process information in ways that render classical cryptographic assumptions obsolete. This comprehensive manuscript provides an in-depth examination of the transformative impact of quantum computational supremacy on modern cryptographic frameworks. We meticulously analyze the acute vulnerabilities exposed in traditional asymmetric encryption models, particularly the Rivest-Shamir-Adleman (RSA) cryptosystem, Elliptic Curve Cryptography (ECC), and the Diffie-Hellman Key Exchange (DHKE), in the face of quantum algorithms like Shor's and Grover's. Furthermore, we explore the theoretical foundations of quantum mechanics and their practical, real-world implications for secure computation. The paper extensively investigates emerging quantum encryption methodologies, providing a rigorous breakdown of Quantum Key Distribution (QKD) protocols (BB84 and E91) and the nascent field of Fully Quantum Encryption, including Quantum Homomorphic Encryption (QHE). Finally, we project the future trajectory of quantum-secure applications across critical sectors, evaluating their indispensable role in establishing unconditional data security in the forthcoming post-quantum era.

Keywords: Quantum cryptography; Post-quantum cryptography; Quantum computing; Cryptographic algorithms; Secure communications

TRACK
Ethics, Governance and Responsible AI

6 Abstracts in this section



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1:20 PM – 1:40 PM	1571316737	Governing Ancestral Bias in Genomic AI Representational Adequacy as a Defeasible Process Invariant

01
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1571302003

Generative AI, Academic Integrity, and Policy Governance in Higher Education: A Systematic Literature Review

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This systematic literature review (SLR) applies the five-domain policy framework of Alduais et al. (2025)-transparency and disclosure, authorship and accountability, quality assurance and safety, data security and privacy, and AI literacy and training-to synthesize 39 peer-reviewed studies on generative AI (GenAI) governance in higher education. Following PRISMA 2020 guidance, a Scopus Boolean search identified 86 records published or accepted between 2022 and 2026. Full-text appraisal against five quality criteria yielded 47 eligible studies, of which 39 were accessible for final synthesis. Findings show that transparency commitments are widespread but poorly operationalized; authorship accountability is empirically undermined because markers cannot reliably distinguish AI-assisted work; AI detection tools remain insufficient for high-stakes decisions; data privacy guidance is strongly dependent on regulatory context; and AI literacy is the most endorsed yet most under-resourced governance domain. The Arab Gulf region remains significantly under-represented despite growing institutional interest in GenAI adoption. This review provides empirical validation of the Alduais et al. framework against a systematic research corpus and identifies practical governance gaps for higher education institutions.

Keywords: Generative AI; Academic integrity; Policy governance; Higher education; Systematic literature review

02
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1571314677

Shadow IT in Higher Education Institutions: Strategic Risks and Governance Implications

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Shadow IT, the use of technology without formal IT approval, has become a persistent and growing problem in higher education institutions (HEIs). Academic staff usually adopt collaboration tools or programs related to their lessons, researchers connect to internal or external cloud storage, departments procure SaaS platforms, and students use personal devices and applications, all without institutional supervision. Each of these choices is individually understandable. But together, they create a fragmented technology environment that IT governance structures were not designed to manage. This paper examines shadow IT as a strategic information systems challenge rather than a purely technical one. Drawing on a structured review of shadow IT literature, IS governance frameworks, and higher education cybersecurity reports, the paper identifies three primary risk categories: security and data protection risk, compliance and regulatory risk, and strategic alignment risk. A governance framework for HEIs' shadow IT management is proposed and organized around five principles: visibility and discovery, risk-tiered evaluation, policy clarity, IT-business partnership, and continuous monitoring. The framework is designed to be applied by IS administrators and academic leaders without deep technical specialization and recognize that effective shadow IT governance in HEIs depends as much on organizational culture and communication as it does on technical controls.

Keywords: Shadow IT; Higher education institutions; IT governance; Strategic risk; Cloud services

03
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1571272414

Navigating the Factors and Influences in Teachers' Readiness for Integrating Artificial Intelligence in Teaching: A Multivariate Approach

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This study used secondary data approach, analyzing responses from 430 in service teachers who completed AI related training. Using Partial Least Squares Structural Equation Modeling (PLS SEM), it examined how school type, school location, teaching experience, professional development participation and motivation, perceived self efficacy, and readiness for integrating Artificial Intelligence (AI) into instruction interrelate. Resultantly, public school teachers report significantly lower self efficacy in AI integration than private school colleagues. Unexpectedly, rural teachers display higher self efficacy than urban teachers. Teaching experience is negatively correlated with both participation in AI professional development and anticipation of such training, suggesting veteran educators' less inclination toward AI upskilling. These underscore the necessity of contextualizing professional development to diverse school environments. Policymakers and PD designers should provide differentiated, co-created support aligned with teachers' contexts, demographics, and career stages. Tailored PD enhances self-efficacy and readiness for AI integration, leveraging educators' unique profiles for more effective and contextually relevant pedagogical transformation.

Keywords: Teachers' readiness; AI in education; PLS-SEM; Professional development; Multivariate analysis

04
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1571305187

RAIA-Reskill: A Task-Centric Algorithmic Impact Assessment Benchmark for LLM-Based Workforce Reskilling Advisors

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Large language models are increasingly proposed as workforce reskilling advisors, yet most prior work builds such advisors while comparatively little evaluates them under an explicit governance lens. We present RAIA-Reskill, a task-centric algorithmic impact assessment benchmark that measures, rather than constructs, language-model-based reskilling advice. The benchmark couples eight O*NET-derived source-to-target occupational transitions (16 occupations) with 96 synthetic learner personas and 144 single-attribute protected counterfactuals (signaled gender, name-origin signal, age bracket), and a synthetic, closed-book reference corpus (14 documents, 49 sections) that supplies controlled grounding and an explicit responsible-advising policy. Three advisor models are evaluated with and without retrieval augmentation, yielding 1,440 structured advisor responses, each scored mechanically and by an independent cross-family language-model judge (1,440 evaluations). We report target-occupation correctness, citation precision, skill and knowledge gap recall, a composite material-unfair-change indicator over 864 matched counterfactual comparisons, privacy and governance signals, and task-level impact-assessment decision states. Under these controlled conditions, retrieval together with the responsible-advising corpus acted as a governance control: material unfair change fell from 0.222 without retrieval to 0.000 with retrieval, while target-occupation correctness, citation precision, and overall gap recall reached 1.000 for all three advisors under retrieval. We do not claim that language-model advisors are fair; rather, a task-centric retrieval-plus-policy configuration measurably reduced protected-counterfactual instability and improved groundedness in this closed-book benchmark, and the impact-assessment framing translates these signals into deployment-readiness decisions.

Keywords: Algorithmic impact assessment; Workforce reskilling; Large language models; AI governance; Benchmark

05
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1571316737

Governing Ancestral Bias in Genomic AI: Representational Adequacy as a Defeasible Process Invariant

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Genomic artificial intelligence can inherit cross-population validity gaps from discovery cohorts, reference panels, phenotype definitions, and validation resources. Lifecycle audits can expose these gaps, but disclosure alone does not determine whether a system has enough evidence to support its intended population and clinical use. This paper proposes a normative framework that treats representational adequacy as a defeasible process invariant: at each lifecycle transition, the evidence supporting a genomic-AI system must remain adequate to its declared population and clinical use, or the responsible claim owner must acquire further evidence, narrow the use, adopt a bounded mitigation, or hold progression. We operationalize this invariant through a Minimum Viable Population Cohort (MVPC) procedure that derives cohort requirements from pre-specified validity and precision criteria rather than a fixed ancestry quota. We then (i) ground the invariant in the epistemological tradition of defeasible reasoning, (ii) map claims, evidence artifacts, responsible actors, and decisions onto an IEEE 7000- series-informed lifecycle, (iii) conduct a counterfactual governance analysis of PRS-CSx, and (iv) translate the invariant across the European Union, the United States, and China at the level of specific regulatory provisions, including the 2026 Digital Omnibus on AI amendment to the EU AI Act (Regulation (EU) 2026/1744). The contribution is therefore normative and procedural: it converts representational adequacy from a reported limitation into an auditable rule governing whether a genomic-AI claim may advance.

Keywords: Genomic AI; Ancestral bias; Representational adequacy; AI governance; Fairness

06
ID
1571282729

Closing the Ethics-Execution Gap in AI Systems: Audit Mechanisms, Cryptographic Accountability, and the Governance Imperatives

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Spend enough time in AI ethics circles and you start noticing a pattern: the conversation is almost exclusively about what good AI governance should look like, and almost never about why the governance mechanisms organisations already claim to follow are not working. This paper takes the second question seriously. The argument is not that the field needs different values fairness, transparency, accountability, and human oversight are exactly the right values. The problem is that these commitments live in documents rather than in systems, in policy statements rather than in audit trails. Three interlocking mechanisms are proposed as the operational floor below which no governance claim should be taken seriously: independent algorithmic impact assessment with binding consequences, privacy-preserving computational audit using Homomorphic Encryption and Secure Multiparty Computation, and contestation infrastructure that gives affected people genuine rather than nominal recourse. Each mechanism is examined against the specific institutional context of Oman Vision 2040 and the MTCIT Public Policy for the Safe and Ethical Use of AI Systems (April 2025), producing an implementation pathway that reflects the Sultanate's particular governance strengths, acknowledged gaps, and strategic AI ambitions within the 2024-2026 National AI Programme.

Keywords: AI ethics; AI governance; Audit mechanisms; Cryptographic accountability; Ethics-execution gap

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