عام الذكاء الاصطناعي
THE YEAR OF ARTIFICIAL INTELLIGENCE 2026

CENTRAL MICHIGAN UNIVERSITY

KFU
جامعة الملك فيصل
KING FAISAL UNIVERSITY

المؤتمر الدولي الخامس
في الحوسبة وذكاء الآلة 2026
IEEE 5th International Conference
on Computing and Machine Intelligence (ICMI 2026)

5th IEEE International Conference on Computing and Machine Intelligence ICMI-2026

Conference Booklet

King Faisal University, Al-Ahsa, Saudi Arabia

08-10
April
2026

الراعي الذهبي

الراعي البلاتيني

الراعي العلمي

الشريك الاستراتيجي

راعي المشروبات

الراعي الفندقي

الراعي الإعلامي

الراعي الفضي

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برعاية كريمة من صاحب السمو الملكي الأمير

سعود بن نايف بن عبدالعزيز آل سعود

أمير المنطقة الشرقية

بحضور وتشريف صاحب السمو الملكي الأمير

سعود بن طلال بن بدر آل سعود

محافظ الأحساء

Prof. Adel Mohammed Abuzenadah

President of King Faisal University

At a historical moment marked by accelerating digital transformation and the increasing integration of advanced technologies across various aspects of life, artificial intelligence emerges as a driving force for a new era of knowledge and innovation. With the designation of the year 2026 as the Year of Artificial Intelligence in the Kingdom of Saudi Arabia, following the approval of the Council of Ministers, this initiative reflects the commitment of our wise leadership (may God preserve it) to accelerating the adoption of advanced technologies and strengthening the Kingdom's position as a global hub for innovation and digital transformation. This development clearly demonstrates the growing prominence of artificial intelligence in shaping the future of science and the economy. The 5th International Conference on Computing and Artificial Intelligence (ICMI 2026), hosted by King Faisal University, takes place in conjunction with this important national milestone, reflecting the spirit of this era and the growing commitment to building a knowledge-based society driven by intelligent technologies. We are also honored that this conference is held under the gracious patronage of His Royal Highness the Prince of the Eastern Province (may God preserve him), reflecting the continued support of our leadership for the advancement of science and innovation.

The designation of 2026 as the Year of Artificial Intelligence is not merely symbolic; rather, it marks the beginning of a new phase in which intelligent technologies lead national development pathways. In this phase, digital knowledge and advanced data become the foundation for decision-making and sustainable growth. In this context, ICMI 2026 acquires particular significance, as it serves as a global scientific platform bringing together researchers, experts, and decision-makers to discuss the latest developments in computing and artificial intelligence, and to explore future applications that will contribute to the advancement of societies and the improvement of quality of life.

King Faisal University firmly believes that scientific research is the cornerstone for building the future, and that investing in computing and artificial intelligence is a direct investment in the knowledge economy. Over the past years, the University has worked to establish a comprehensive research ecosystem that supports innovation and fosters creative ideas. This has been achieved through the establishment of specialized research centers, the provision of funding programs for scientific projects, and the development of advanced digital infrastructure that enables researchers to conduct their work with high efficiency. The University also actively promotes interdisciplinary collaboration among its colleges and departments, and builds strategic partnerships with leading international universities and research institutions.

These efforts have resulted in significant growth in the University's scientific output, reflected in the increasing number of research papers published in peer-reviewed international journals. Research areas have expanded to cover multiple disciplines in computer science, data science, artificial intelligence, and applied sciences. The University has also achieved notable progress in citation indicators and international research collaboration, reflecting the high quality of its scientific output and strengthening its position within the global academic landscape. Furthermore, the University has achieved significant accomplishments in innovation and patent registration, demonstrating its ability to transform scientific knowledge into practical applications that support sustainable development.

The organization of this conference during the Year of Artificial Intelligence 2026 carries special significance, as it represents a scientific opportunity to promote international dialogue on the future of intelligent technologies and to showcase the latest innovations in machine learning, big data analytics, intelligent systems, and advanced computing. The conference also provides a platform for integration and collaboration among researchers, academics, and industry partners, helping to translate research outcomes into practical technological solutions applicable across multiple sectors.

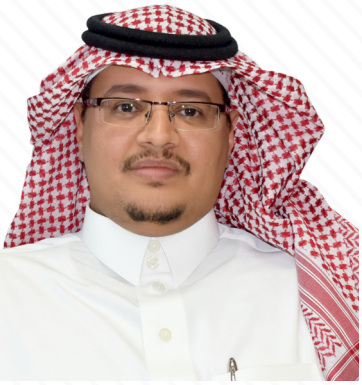
Within the framework of the University's commitment to addressing major national priorities, King Faisal University places particular emphasis on leveraging artificial intelligence to support food security and environmental sustainability. Intelligent technologies have become effective tools for analyzing agricultural data, improving water resource management, and developing smart farming systems. These efforts contribute to strengthening food production and achieving sustainability in the face of growing climate challenges. From this perspective, the conference seeks to highlight the role of computing and artificial intelligence in addressing environmental and agricultural challenges, while presenting innovative scientific solutions that serve society and the economy.

This scientific event also aligns with the major transformations taking place in the Kingdom of Saudi Arabia under the objectives of Saudi Vision 2030, where artificial intelligence has become one of the primary drivers of digital transformation and economic development. The Kingdom has launched numerous national initiatives aimed at developing digital infrastructure and building specialized human capacities in the fields of data and advanced technologies. In addition, research centers and national institutions have been established to enhance innovation and localize advanced technologies. The declaration of 2026 as the Year of Artificial Intelligence reinforces this strategic direction and sends a clear message that the future will be built upon digital knowledge and technological innovation.

In recent years, there has also been a remarkable expansion in educational and training programs related to artificial intelligence. AI concepts are increasingly integrated into academic curricula, and numerous training initiatives and scientific competitions have been launched to prepare a new generation of specialists capable of leading technological transformation. Saudi universities, foremost among them King Faisal University, play a pivotal role in building these national capabilities through the development of specialized academic programs and the advancement of research in emerging technological fields.

From this perspective, King Faisal University is committed to ensuring that the 5th International Conference on Computing and Artificial Intelligence (ICMI 2026) serves as a leading scientific platform that brings together global expertise and opens new horizons for research collaboration among universities and scientific institutions. The conference also represents an important opportunity to enhance knowledge exchange and establish international partnerships that contribute to advancing scientific research, improving innovation quality, and linking research outcomes with societal needs.

In the Year of Artificial Intelligence 2026, we aspire for this conference to become an important scientific milestone that contributes to envisioning the future of digital technologies and strengthening the role of universities as engines of development and innovation. We also hope that its scientific outcomes will support the journey of digital transformation and reinforce the position of the Kingdom of Saudi Arabia as a global hub for knowledge and technology, making this scientific event another step toward a future shaped by science and driven by creative minds.



Dr. Hasan Shojaa Alkahtani
Dean, College of Computer Science and Information Technology, KFU
The General Chairs of ICMI'2026

It is our great pleasure to welcome you to the Fifth International Conference on Computing and Artificial Intelligence (ICMI'2026), which is organized and hosted by King Faisal University in Al-Ahsa, Saudi Arabia, from April 8 to 10, 2026. The organization of this conference comes at a time when the Kingdom of Saudi Arabia is witnessing an accelerated transformation toward a knowledge-based and innovation-driven economy, particularly in light of the Cabinet's approval designating the year 2026 as the Year of Artificial Intelligence in the Kingdom of Saudi Arabia. This decision reflects the ambitious vision of the Kingdom's leadership to strengthen the country's position as a regional and global hub for advanced technologies, while further supporting research and development ecosystems in artificial intelligence and advanced computing. In this context, the conference reflects the University's commitment to supporting scientific research, promoting innovation, and expanding international academic collaboration in the fields of computing and artificial intelligence.

This edition of the conference has received remarkable scientific interest, with a total of 398 research papers submitted by researchers and academic and research institutions from around the world. This level of participation reflects the growing reputation of the conference and the relevance of its scientific themes at both regional and international levels. Following a rigorous peer-review process conducted according to the highest academic standards, 239 papers were accepted for inclusion in the conference's scientific program, representing valuable contributions that combine scientific depth with practical applications.

The scientific and organizing committees have carefully prepared a comprehensive scientific program spanning the three days of the conference. The program features four keynote lectures delivered by distinguished speakers, in addition to a plenary session and several parallel technical sessions organized across eight specialized tracks. These sessions provide participants with valuable opportunities to exchange scientific expertise, discuss the latest research developments, and establish meaningful research collaborations.

We would like to express our sincere appreciation to the sponsors and partners for their generous support. We also extend our deep gratitude to the administration of King Faisal University for its support in organizing and hosting this international conference and for its continuous efforts in supporting scientific research, encouraging innovation, and strengthening the Kingdom's scientific presence on the international stage. Our thanks also go to the organizing committee, the scientific and program committees, and all supporting committees for their dedicated work and sincere efforts that have contributed to delivering the conference at the expected scientific and organizational level.

Finally, we would like to extend our sincere thanks to all researchers, authors, speakers, reviewers, students, and participants for their valuable scientific contributions and constructive engagement. Your presence and active participation constitute the cornerstone of the success of this conference. We hope that ICMI'2026 will serve as a fruitful scientific gathering that fulfills participants' expectations and provides a meaningful scientific and intellectual contribution. We wish you a pleasant stay in Al-Ahsa and a successful and enriching conference experience.

5th IEEE International Conference on Computing and Machine Intelligence (ICMI 2026) Program (Riyadh Time)

Wednesday, April 08, 2026,

8:00-10:00	Registration					
10:00 – 11:00 Keynote Presentation (Celebration Hall)	Speaker: Mark Coeckelbergh, Professor of Philosophy of Media and Technology, University of Vienna Title: AI, Democracy, and the Common Good					
11:45-12:00	Prayer time					
12:00 - 13:00	Conference Opening					
13:00 - 14:00 Keynote Presentation (Celebration Hall)	Speaker: Dr. Khalid Alodhaibi, Deputy Chief Executive Officer for Technology at HUMAIN. Title: From AI Models to National Intelligent Systems					
14:00 - 14:30	Lunch Time					
14:45 - 17:00 Scientific Session	**Tuwaiq** Track 1: Core Machine Learning & Intelligent Systems **Session Chair:** Dr. Manal Alohali **[A01~A05]**	**Diriyah** Track 2: Language Technologies, LLMs & Generative AI **Session Chair:** Dr. Mousa Khubrani **[B01~B05]**	**Jawatha** Track 3: Computer Vision, Imaging & Multimodal Perception **Session Chair:** Dr. Theyazan Aldhyani **[C01~C05]**	**Hajar** Track 4: AI for Healthcare, Bioinformatics & Medical Imaging **Session Chair:** Dr. Raid Alzubi **[D01~D05]**	**NEOM** Track 5: Cybersecurity, Privacy & Trustworthy Machine Intelligence **Session Chair:** Dr. Maher Abuhussein **[E01~E05]**	**Aluqair** Track 6: IoT, Edge Intelligence & Cyber-Physical Systems **:Session Chair** Dr. Omar Albalawi **[F01~F05]**
	Sindalah Track 7: Human-Centered Computing, Affective & Educational Technologies **Session Chair:** Dr. Fahad Algarni **[G01~G05]**	**Hexagon** Track 8: Data Science, Cloud Computing & Intelligent Applications **Session Chair:** Dr. Abdulrahman Alzahrani **[H01~H05]**	**Alqaisariyah** Track 2: Language Technologies, LLMs & Generative AI **Session Chair:** Dr. Sultan Alasmari **[B06~B10]**	**Qiddiya** Track 3: Computer Vision, Imaging & Multimodal Perception **Session Chair:** Prof. Iyad Katib **[C06~C10]**	**Trojena** Track 5: Cybersecurity, Privacy & Trustworthy Machine Intelligence **Session Chair:** Dr. Abdullah Alharbi **[E06~E10]**	**THE LINE** Track 7: Human-Centered Computing, Affective & Educational Technologies **Session Chair:** Dr. Areej Alasiry **[G06~G10]**
17:00 - 17:15	**Break Time**					
17:15 - 19:30 Scientific Session	**Tuwaiq** Track 1: Core Machine Learning & Intelligent Systems **:Session Chair** Dr. Mashael Al-jubairah **[A06~A10]**	**Diriyah** Track 2: Language Technologies, LLMs & Generative AI **:Session Chair** Dr. Mohammad Alsulami **[B11~B15]**	**Jawatha** Track 3: Computer Vision, Imaging & Multimodal Perception **:Session Chair** Dr. Eid Albalawi **[C11~C15]**	**Hajar** Track 4: AI for Healthcare, Bioinformatics & Medical Imaging **:Session Chair** Dr. Abdulelah Algosaibi **[D06~D10]**	**NEOM** Track 5: Cybersecurity, Privacy & Trustworthy Machine Intelligence **:Session Chair** Dr. Mohammed Albaihan **[E11~E15]**	**Aluqair** Track 6: IoT, Edge Intelligence & Cyber-Physical Systems **:Session Chair** Dr. Mohammed Al-Naeem **[F06~F10]**
	Sindalah Track 7: Human-Centered Computing, Affective & Educational Technologies **:Session Chair** Dr. Abdullah Alalimi **[G11~G15]**	**Hexagon** Track 8: Data Science, Cloud Computing & Intelligent Applications **:Session Chair** Dr. Shareefa Al Amer **[H06~H10]**	**Alqaisariyah** Track 2: Language Technologies, LLMs & Generative AI **:Session Chair** Dr. Ahad Alotaibi **[B16~B21]**	**Qiddiya** Track 3: Computer Vision, Imaging & Multimodal Perception **:Session Chair** Dr. Nora Alkhaldi **[C16~C20]**	**Trojena** Track 5: Cybersecurity, Privacy & Trustworthy Machine Intelligence **:Session Chair** Dr. Mohammed Alqahtani **[E16~E20]**	**THE LINE** Track 6: IoT, Edge Intelligence & Cyber-Physical Systems **:Session Chair** Prof. Mounir Frikha **[F11~F15]**

Thursday, April 09, 2026

8:00 -9:00 (KFU Hall)	Women in AI Research and Trends					
9:00 - 10:00 Keynote Presentation (Trojena Hall)	Speaker: Peter Richtarik, Professor of Computer Science, King Abdullah University of Science and Technology (KAUST) Title: From the Ball-proximal (Broximal) Point Method to Efficient Training of Large Language Models					
10:15 - 12:30 Scientific Session	**Tuwaiq** Track 1: Core Machine Learning & Intelligent Systems **Session Chair:** Dr. Muhammad Alhassan **[A11~A15]**	**Diriyah** Track 2: Language Technologies, LLMs & Generative AI **Session Chair:** Dr. Maha Albarrak **[B22~B27]**	**Jawatha** Track 3: Computer Vision, Imaging & Multimodal Perception **Session Chair:** Dr. Munif Alotaibi **[C21~C26]**	**Hajar** Track 4: AI for Healthcare, Bioinformatics & Medical Imaging **Session Chair:** Dr. Sakhar Alkhereyf **[D11~D15]**	**NEOM** Track 5: Cybersecurity, Privacy & Trustworthy Machine Intelligence **Session Chair:** Dr. Fatimah Aljaafari **[E21~25]**	**Aluqair** Track 6: IoT, Edge Intelligence & Cyber-Physical Systems **Session Chair:** Dr. Mohammed Alyaari **[F16~F20]**
	Sindalah Track 7: Human-Centered Computing, Affective & Educational Technologies **Session Chair:** Prof. Sami Alnawali **[G16~G20]**	**Hexagon** Track 8: Data Science, Cloud Computing & Intelligent Applications **Session Chair:** Dr. Alhanof Almutairi **[H11~H16]**	**Alqaisariyah** Track 1: Core Machine Learning & Intelligent Systems **Session Chair:** Dr. Asma Alshuhail **[A16~A21]**	**Qiddiya** Track 4: AI for Healthcare, Bioinformatics & Medical Imaging **Session Chair:** Dr. Badar Almarri **[D16~D20]**		
12:30 - 13:00	Prayer Time					
13:00 - 14:00 Keynote Presentation (Trojena Hall)	Speaker: Nitesh Chawla, Professor of Computer Science and Engineering, University of Notre Dame Title: When Data and AI Converge for Good, Societal Impact Accelerates					
16:00 – 18:30	Exploring the Al-Ahsa Oasis: Cultural Tour					
21:00-22:00	Closing Ceremony					
22:00	Gala Dinner					

Friday, April 10, 2026

09:00 - 01:00 Online Special Sessions

Note:

- The Tuwaiq, Diriyah, Jawatha, Hajar, NEOM, Aluqair, and Sindalah halls are located in the College of Computer Science and Information Technology building.
- The Hexagon, Alqaisariyah, Qiddiya, Trojena, and THE LINE halls are located in the College of Engineering building.

Conference Hall Locations

College of Computer Science and Information Technology

Hall	Floor	location
Tuwaiq	Ground Floor	College Auditorium
Diriyah	First Floor	Room No. 2047
Jawatha	First Floor	College Library
Hajar	Ground Floor	Room No. 1007
NEOM	Ground Floor	Room No. 1005
Al-Uqair	First Floor	Room No. 2045
Sindalah	Ground Floor	Room No. 1003

College of Engineering

Hall	Floor	location
HEXAGON	Ground Floor	Room No. 1038
Al-Qaisariyah	First Floor	Room No. 2163
Qiddiya	Ground Floor	College Library
Trojena	First Floor	College Auditorium
THE LINE	Ground Floor	Room No. 1040

Advanced Program Summary (Riyadh Time)

Bridging Minds: International Collaboration Workshop

Wednesday, 8 April 2026 17:00 – 20:00 | KFU Hall - College of Engineering |

Overview:

Bridge of Minds is a professional international collaboration workshop in computing and machine intelligence. It is designed to strengthen multi-track international collaboration through academic and institutional partnerships. The workshop focuses on converting scientific encounters into actionable cooperation by aligning potential partners, identifying complementary opportunities, and establishing structured communication channels that support joint initiatives with near- to mid-term value.

Objectives and Thematic Tracks

The workshop explores and develops collaboration opportunities with international universities and researchers across the following tracks:

- Research collaboration and joint initiatives.
- Academic and educational collaboration.
- Academic mobility and capacity building.
- Institutional partnerships.

Program

Time	Activity
17:00 – 17:10	Opening and orientation
17:10 – 17:30	Guided lightning introductions
17:30 – 18:15	Structured matchmaking sessions – Round 1
18:15 – 18:25	Short break
18:25 – 19:05	Track-based roundtables
19:05 – 19:45	Structured matchmaking sessions – Round 2
19:45 – 20:00	Wrap-up and recommendations

Expected Outcomes

- Establish initial alignments and partnership pathways with international universities and research centers around shared collaboration opportunities.
- Identify priority work areas and points of contact among participating partners.

Agree on appropriate follow-up steps (e.g., subsequent meetings, information exchange, or an institutional partnership pathway) in line with the participants' interests.

Target Audience

- Faculty members and researchers
- Directors of research centers
- Postgraduate program leaders
- Representatives of international cooperation and partnerships offices
- University representatives and delegates

PLENARY & KEYNOTES

Wednesday, April 08, 2026, 13:00 - 14:00

Speaker: Dr.Khalid Ebraheem Alodhaibi

Title: From AI Models to National Intelligent Systems

Dr. Khalid bin Ibrahim Al-Odhaibi serves as Deputy Chief Executive Officer for Technology at HUMAIN. He brings extensive leadership and executive experience in technology and digital transformation across Saudi Arabia and the United States. He holds a Ph.D. in Information Technology and Artificial Intelligence from George Mason University, Virginia, USA. Throughout his career, Dr. Al-Odhaibi has held several prominent executive and leadership positions, including Deputy CEO at the National Center for Artificial Intelligence at the Saudi Data and Artificial Intelligence Authority (SDAIA), Head of Information Technology at the General Directorate of Health Services of the Ministry of Defense, Healthcare Sector Director at Advanced Electronics Company, and Executive Director of Health Informatics and Information Technology at King Fahad Medical City. He has also built broad professional and technical expertise through work in advanced technology environments in both Saudi Arabia and the United States, including with global companies such as IBM and AT&T. In addition, he has served as a Board Member and Governance Advisor at HIMSS in the United States. His profile reflects a distinctive combination of executive leadership, strategic vision, and deep technical expertise, particularly in enterprise technology, digital transformation, artificial intelligence, and health informatics.

Thursday, April 09, 2026, 9:00 - 10:00

Speaker: Peter Richtarik (Professor of Computer Science, King Abdullah University of Science and Technology (KAUST))

Title: From the Ball-proximal (Broximal) Point Method to Efficient Training of Large Language Models

Peter Richtárik is a professor of Computer Science at the King Abdullah University of Science and Technology (KAUST), Saudi Arabia, where he leads the Optimization and Machine Learning Lab. His research interests lie at the intersection of mathematics, computer science, machine learning, optimization, numerical linear algebra, and high-performance computing. Through his work on randomized and distributed optimization algorithms, he has contributed to the foundations of machine learning, optimization and randomized numerical linear algebra. He is one of the original developers of Federated Learning. Prof Richtárik's works attracted international awards, including the Charles Broyden Prize, SIAM SIGEST Best Paper Award, Distinguished Speaker Award at the 2019 International Conference on Continuous Optimization, the IMA Leslie Fox Prize (three times), and a Best Paper Award at the NeurIPS 2020 Workshop on Scalability, Privacy, and Security in Federated Learning. Several of his works are among the most read papers published by the SIAM Journal on Optimization and the SIAM Journal on Matrix Analysis and Applications. Prof Richtárik serves as an Area Chair for leading machine learning conferences, including NeurIPS, ICML and ICLR, and is an Action Editor of JMLR, and Associate Editor of Numerische Mathematik and Optimization Methods and Software. In the past, he served as an Action Editor of TMLR and an Area Editor of JOTA.

Wednesday, April 08, 2026, 10:00 – 11:00

Speaker: Mark Coeckelbergh (Professor of Philosophy of Media and Technology, University of Vienna)

Title: AI, Democracy, and the Common Good

Prof. Dr. Mark Coeckelbergh is a full Professor of Philosophy of Media and Technology at the Philosophy of Department of the University of Vienna, and until recently Vice Dean of the Faculty of Philosophy and Education. He is also ERA Chair at the Institute of Philosophy of the Czech Academy of Sciences in Prague and Guest Professor at WASP-HS and University of Uppsala. Previously he was the President of the Society for Philosophy and Technology (SPT). His expertise focuses on ethics and technology, in particular robotics and artificial intelligence. He is a member of various entities that support policy building in the area of robotics and artificial intelligence, such as the European Commission's High Level Expert Group on Artificial Intelligence, the Expert Council Ethics of AI of the Austrian UNESCO Commission, the Austrian Council on Robotics and Artificial Intelligence, and the Austrian Advisory Council on Automated Mobility. He is University of Vienna's Circle U. Academic Chair for Artificial Intelligence. He is on the advisory board of the University of Milan's Research Center on the Philosophy of Technology (PhilTech@UNIMI) and is also on the editorial board of the journal Cambridge Forum on AI: Law and Governance. He is the author of 21 philosophy books and numerous articles and is involved in several national and European research projects on AI and robotics.

Thursday, April 09, 2026, 13:00 – 14:00

Speaker: Nitesh Chawla (Professor of Computer Science and Engineering, University of Notre Dame)

Title: When Data and AI Converge for Good, Societal Impact Accelerates

Nitesh Chawla is the Frank M. Freimann Professor of Computer Science and Engineering at the University of Notre Dame and the founding director of the Lucy Family Institute for Data and Society. With expertise in artificial intelligence, data science, and network science, Chawla's research focuses on leveraging technology for the common good through interdisciplinary collaboration. He holds concurrent faculty appointments in the Department of Applied and Computational Mathematics and Statistics in the College of Science and the Department of Information, Technology, Analytics, and Operations in the College of Business.

Chawla has been inducted as a Fellow of the Association for the Advancement of Artificial Intelligence (AAAI), the Association for Computing Machinery (ACM), the Institute of Electrical and Electronics Engineers (IEEE), and the American Association for the Advancement of Science (AAAS). His notable awards include the IEEE CIS Outstanding Early Career Award, the IBM Watson Faculty Award, the Rodney F. Ganey Award for community impact, the 1st Source Bank Technology Commercialization Award, the Outstanding Undergraduate Teacher Award, and the National Academy of Engineering New Faculty Fellowship. Additionally, Chawla founded Aunalytics, a data science software and cloud computing company.

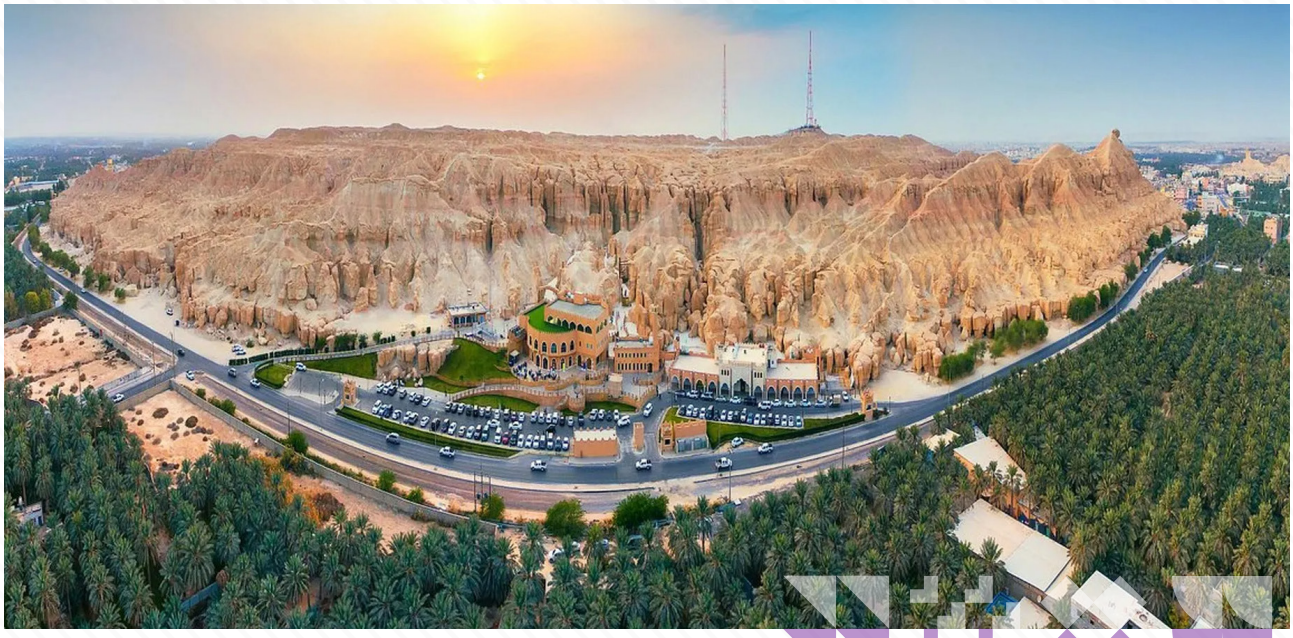
SOCIAL & NETWORKING

Women in AI Research and Trends

Thursday, 9 April 2026 8:00 – 9:00

- As a featured session of the conference, it aims to highlight the pioneering role of women in advancing next-generation computing and Artificial Intelligence. In alignment with national initiatives dedicated to women's empowerment and their integration into the technology sector, this session is specifically designed to facilitate high-level professional networking and bridge collaboration among female academics, researchers, and innovators. By encouraging an interactive environment for exchanging specialized expertise and exploring strategic research partnerships, the session seeks to accelerate digital innovation and empower national talents to lead the future of intelligent transformation.

Introduction to Al Ahsa

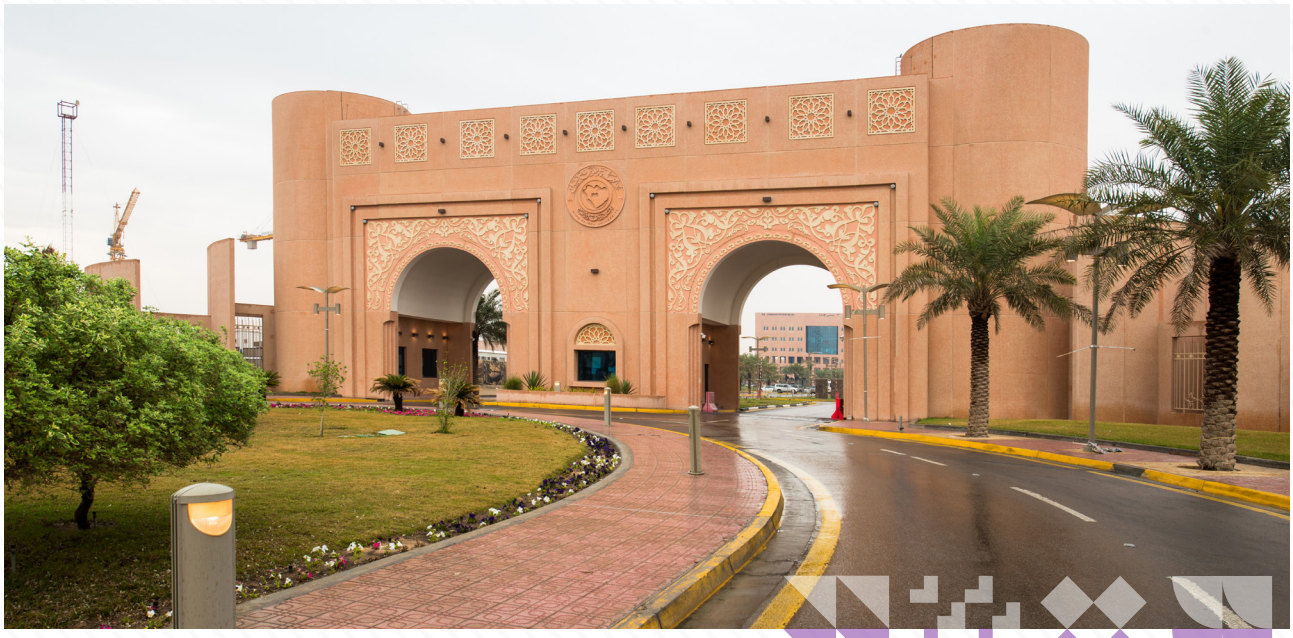


Al-Ahsa is a historic oasis region in Saudi Arabia's Eastern Province, centered around Al-Hofuf / Al-Mubarraz, and recognized for a long tradition of settlement shaped by water management, agriculture, trade, and living heritage. The governorate is located roughly 150 km from Dammam and 360 km from Riyadh.

At the heart of the region is "Al-Ahsa Oasis, an Evolving Cultural Landscape," inscribed as a UNESCO World Heritage Site (2018). UNESCO describes it as a serial property comprising gardens, canals, springs, wells, and a drainage lake, alongside historic buildings, urban fabric, and archaeological sites—evidence of sustained human presence from the Neolithic to the present. The nominated/inscribed landscape is documented as 12 components covering a total area of 8,544 hectares. UNESCO also notes the oasis' vast palm groves—about 2.5 million date palms—as part of what makes Al-Ahsa globally distinctive.

Al-Ahsa's cultural identity is also reflected in its strong craft traditions (including palm-based crafts, pottery, weaving, and joinery), and it is recognized as a UNESCO Creative City for Crafts & Folk Art (since 2015). For visitors, official Saudi tourism guidance highlights experiences that combine heritage and nature—such as Qasr Ibrahim (Ibrahim Palace), traditional markets like Al-Qaisariyah Souq, and natural and geological attractions including Al-Qarah Mountain and the oasis landscapes themselves.

Introduction to King Faisal University



King Faisal University (KFU) is a public Saudi university headquartered in Al-Ahsa (Al-Hofuf), Eastern Province. It was established by Royal Decree No. H/67 dated 28 Rajab 1395H (1975), marking a major milestone in expanding higher education in the region. Over five decades, KFU has grown into a comprehensive institution with 15 faculties/colleges and approximately 2,200 faculty members. As of 2024, KFU reports 45,118 students, including 39,726 undergraduates (88%) and 5,392 postgraduates (12%).

KFU emphasizes academic quality and continuous program development, supported by digital transformation and distance/e-learning pathways. It also advances applied research and innovation, with notable focus areas including food security and environmental sustainability, as well as regionally relevant health and agricultural priorities (e.g., date palm research and applied medical research).

KFU's institutional direction is framed through its strategic planning, focusing on strengthening teaching and learning, research performance, community partnerships, and an integrated innovation and business development ecosystem.

Selected Achievements & Recognition

- Global sustainability impact (THE Impact Rankings 2025): 40th worldwide, with standout SDG results including No Poverty (11th), Affordable & Clean Energy (9th), Life Below Water (=7th), and Life on Land (8th).
- World ranking (THE World University Rankings 2026): 601–800 band, with subject strengths including Computer Science (401–500) and Engineering (301–400) (among other ranked fields).
- QS World University Rankings 2026: #=648 (also listed in QS Arab Region rankings on the same QS profile page).
- Innovation & patents (NAI, 2024): Ranked #1 worldwide in the "Top 100 Worldwide Universities Granted U.S. Utility Patents (2024)" list with 631 patents.
- Digital learning excellence: Licensed by the National eLearning Center (NELC) in 2022 for distance education; the university reports holographic imaging services and 14 licensed e-programs.
- Institutional excellence: KFU runs an internal Excellence Awards ecosystem (departmental, faculty, staff, alumni, and accreditation-related honors).

College of Computer Science and Information Technology

Vision:

An energetic college of excellence in teaching and research that promotes national human capital development in IT

Mission:

Promoting state-of-art teaching and research in the field of IT; by capitalizing resources, creating a competitive environment for carrying out novel interdisciplinary research that serves the university's identity and community, establishing partnerships and collaborations nationally and internationally

Global Ranking:

451-500, QS World University Rankings by Subject (Computer Science & Information Systems)

Academic Profile:

Five Bachelor Programs

- Computer Science (CS) – ABET Accredited
- Computer Information Systems (CIS) – ABET and NCAAA Accredited
- Computer Engineering (CE)
- Computer Networks and Communications (CN) – ABET Accredited

Master Programs

- Computer Science – NCAAA Accredited
- Computer Information Systems – NCAAA Accredited
- Artificial Intelligence – NCAAA Accredited
- Cybersecurity – NCAAA Accredited

Research &Innovation

700 Research Papers in the past four years

2 Granted Patents

4 in Progress

4 Faculty Members have been ranked among the top

2% of the World's most influential Scientists for

2025 According to the Prestigious Stanford University Ranking

Conference hall locations

College of Computer Science and Information Technology

Hall	Floor	location
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Trojena	First Floor	College Auditorium
THE LINE	Ground Floor	Room No. 1040

SCIENTIFIC PROGRAM

Track 1: Core Machine Learning & Intelligent Systems

Room: Tuwaiq | Date: Wednesday, April 08, 2026 | Time: 14:45 – 15:10 [In Person]

[A01] Artificial Intelligence and Renewable Energy: Enterprise Systems in Digital Regulation and International Sovereignty

Alhanof Almutairi*, King Faisal University (Saudi Arabia); Alshaimaa Mohamed Mahmoud Hassan, (King Faisal University)

Abstract: This paper explores the role of artificial intelligence (AI) and enterprise systems in renewable energy governance, with a focus on digital sovereignty. It adopts an interdisciplinary approach combining information systems and political science. Technologically, it examines how enterprise systems enable AI-driven optimization and regulatory compliance in smart energy infrastructures. A comparative analysis of Egypt and Saudi Arabia illustrates distinct national strategies: modular integration in Egypt and centralized platforms in Saudi Arabia. Politically, the study introduces the concepts of Collaborative Sovereignty and Functional Digital Sovereignty Institutions to explain how states engage in digital governance while preserving autonomy. The findings highlight the need for integrated technical and institutional frameworks to support effective, sovereign, and globally connected clean energy transitions.

Room: Tuwaiq | Date: Wednesday, April 08, 2026 | Time: 15:10 – 15:35 [In Person]

[A02] Study of the Switching Dynamics of Ta2O5-Based RRAM Cells

Usman Isyaku Bature; Ali Alzahrani, (King Faisal University); Haider Abbas, (Sejong University); Faisal Bashir, Faisal Bashir (Saudi Arabia); Muhammad Sani Yahya, Universiti Teknologi PETRONAS (Malaysia); Furqan Zahoor*, King Faisal University (Saudi Arabia)

Abstract: Resistive random-access memory (RRAM) stands out as a highly promising memory technology due to its outstanding performance characteristics. However, comprehensive modeling and understanding of its resistive switching mechanisms remain key challenges. This study investigates the resistive switching behavior of a Ta/Ta2O5/Pt RRAM device through a combination of experimental characterization and multiphysics simulation using COMSOL. The fabricated cell exhibits robust and repeatable bipolar resistive switching, attributed to the voltage-induced formation and rupture of conductive filaments (CFs). The finite element model incorporates field-driven oxygen vacancy migration, quantum tunneling conduction, and self- consistent Joule heating effects to capture the switching dynamics. Simulation results reveal a tunneling-dominated SET process and a thermally assisted RESET mechanism, aligning closely with experimental I-V characteristics. The strong agreement between simulation and measurement highlights the model's predictive accuracy and its effectiveness in guiding RRAM design optimization, particularly in terms of biasing strategies and thermal reliability..

Room: Tuwaiq | Date: Wednesday, April 08, 2026 | Time: 15:35 – 16:00 [Online]

[A03] Spatiotemporal Deep Learning Identifies Drug-Specific Behavioral Fingerprints in Planarians

Jasper Shi*, Dougherty Valley School (United States)

Abstract: This study presents a novel deep learning-based system for automated recognition and classification of drug-specific behavioral fingerprints in planarians, addressing critical limitations in traditional behavioral analysis methods. The research developed a Multi-Scale Spatiotemporal Convolutional Neural Network (MS-STCNN) integrating spatiotemporal feature extraction, multi-scale analysis, and attention mechanisms to comprehensively capture complex behavioral. Brown planarians were exposed to ethanol (0.1% v/v), caffeine (0.2% w/v), and nicotine (0.01% w/v). Behavioral responses were recorded using high-resolution video analysis.

The system achieved 92.3±2.5% classification accuracy, significantly outperforming traditional approaches including Support Vector Machine (82.4%) and Random Forest (85.7%) approaches. Quantitative analysis revealed distinct drug-specific behavioral signatures: alcohol exposure induced motor suppression with reduced movement speed (1.67±0.35 mm/s) and impaired learning efficiency (index: 0.67±0.14); caffeine enhanced both motor activity (3.89±0.57 mm/s) and cognitive performance (learning efficiency index: 0.96±0.11); while nicotine produced severe cognitive impairment (learning efficiency index: 0.54±0.16) accompanied by characteristic circular motion patterns. The research uncovered previously undocumented transgenerational effects, with behavioral transmission rates declining to 73.2±6.8% and 68.9±8.4% in alcohol and nicotine groups respectively. These findings establish planarians as a powerful model for drug effect assessment while providing an objective, quantitative analytical framework for behavioral neuroscience. The integration of deep learning with traditional behavioral assays opens new avenues for high-throughput drug screening and mechanistic studies of addiction, offering significant implications for neuropharmacology research and therapeutic development.

Room: Tuwaiq | Date: Wednesday, April 08, 2026 | Time: 16:00 – 16:25 [Online]

[A04] Machine Learning-Driven Voltage control and Prediction for Maximum Power Point Optimization in Solar Energy Harvesting Systems

Adham Mahdy*, Hochschule Heilbronn (Germany); Mohamed Dwedar, Heilbronn University of Applied Science (Germany); Alexander Jesser, University Heilbronn (Germany)

Abstract: Accurate real-time control of photovoltaic (PV) systems is critical for maximizing energy yield under dynamic environmental conditions. This study proposes a machine learning-based framework for predictive voltage regulation to enhance Maximum Power Point Tracking (MPPT). Conventional MPPT methods such as fractional open-circuit voltage (FOCV), fractional short-circuit current (FSCC), Perturb and Observe (P&O), and Incremental Conductance (IncCond) often exhibit limited adaptability and responsiveness in rapidly changing environments. To address these limitations, multiple supervised learning models were evaluated, including Multivariate Linear Regression (MLR) and Polynomial Regression (PR). Ultimately, an Artificial Neural Network (ANN) was selected for its superior predictive accuracy and robustness. Trained on empirical datasets comprising irradiance, temperature, voltage, and current measurements, the ANN enables real-time adaptive voltage control. Experimental results demonstrate improved tracking precision, faster convergence, and enhanced stability compared to conventional methods, achieving a coefficient of determination (R2) of approximately 0.98. This work advances intelligent, data-driven PV control systems and offers a scalable solution for both grid-tied and standalone renewable energy applications.

Room: Tuwaiq | Date: Wednesday, April 08, 2026 | Time: 16:25 – 16:50 [Online]

[A05] Accelerating HunyuanPortrait Towards Real-Time Inference: A Performance Optimization Study

Zain Ali Siddiqui*, QLU.ai (Pakistan)

Abstract: —The HunyuanPortrait model is a state-of-the-art diffusion-based framework for generating animated portrait videos from a single image and driving video, as introduced by Xu et al.. While it achieves high visual fidelity, its inference latency is prohibitive for real-time applications. In this work, we investigate an extensive set of optimization techniques to accelerate HunyuanPortrait's inference without compromising perceptual quality. Our efforts include reducing the number of diffusion steps (e.g., from 25 down to 10–12), adjusting the number of sampled frames per batch (n_sample_frames), introducing a decoding chunk strategy (decode_chunk_size=4), and leveraging PyTorch 2.0's compiler (torch.compile(...) with the inductor backend) to JIT-compile the denoising U-Net. We evaluate the resulting speed-quality trade-offs using metrics such as frame rate (FPS), generation time, peak GPU memory, and fidelity measures (PSNR, SSIM, LPIPS). Initial experiments show that reducing the inference steps yields substantial speedups (from ~0.73 FPS at 25 steps to ~1.31 FPS at 12 steps) with only minor degradations in PSNR (~9.13→9.06 dB) and SSIM (~0.195) and a negligible increase in LPIPS (~0.66→0.67). Further, enabling decode_chunk_size=4 and increasing n_sample_frames improves throughput by up to ~1.8

under certain configurations. Compiling the U-Net torch.compileroughly doubles perstep throughput, cutting a 192s generation time to ~101s for a 120-frame video. Throughout all optimizations, the peak GPU memory footprint (Approx. 22.3GB) remains largely constant. Our results suggest that HunyuanPortrait can be tuned for interactive frame rates, achieving near-real-time inference with largely preserved visual quality. Future work will evaluate more sophisticated schedulers (e.g., DDIM) and adaptive step skipping, as well as explore deployment on specialized hardware to further close the gap to true real-time performance.

Room: Tuwaiq | Date: Wednesday, April 08, 2026 | Time: 17:15 – 17:40 [In Person]

[A06] Comparative analysis of DT and KNN for AMC

Ahmed Ali*, Al fayha College (Saudi Arabia); Hesham Ahmed

Abstract: - This paper presents a comparative analysis of Decision Trees (DT) and K-Nearest Neighbors (KNN) for Automatic Analog Modulation Classification (AMC) in wireless systems. We utilize features extracted from the RadioML2016.10a dataset, focusing on Amplitude Modulation (AM) and Frequency Modulation (FM) across various Signal-to-Noise Ratios (SNRs). Our methodology includes signal preprocessing and instantaneous feature computation. Experimental results show both DT and KNN significantly outperform a random baseline and are competitive with a recent lightweight deep learning model (61.20% average accuracy). KNN achieves 65.82% overall accuracy, while DT offers notably faster inference (approaching ms/sample). The study highlights practical trade-offs, demonstrating the utility of these traditional approaches for resource-constrained AMC applications, while establishing a crucial baseline for the integration of higher-complexity methods in future work.

Room: Tuwaiq | Date: Wednesday, April 08, 2026 | Time: 17:40 – 18:05 [In Person]

[A7] Effect of Anionic Polyacrylamide on Oil-Water Stratified Flow: Artificial Neural Networks Prediction of Water Holdup

Mohammed Al-Yaari*, King Faisal University (Saudi Arabia)

Abstract: This study investigates the application of artificial neural networks (ANNs) for predicting water holdup in stratified water-oil flow in a 1-inch horizontal pipe, both prior to and following the injection of a drag-reducing polymer. Anionic polyacrylamide (APAM) was introduced into the system at a concentration of 50 ppm, resulting in a significant reduction in pressure drop and improved stratification effects. The ANN model was developed using key input parameters: oil flow rate (Qo), water flow rate (Qw), and time (t), with the output parameter being the water holdup to pipe internal diameter ratio (H/D). A comprehensive dataset of 1,908 experimental data points (with and without APAM) was utilized for the training, validation, and testing of a multi-layer, feed-forward, back-propagation neural network employing rectified linear unit (ReLU) activation functions. The findings revealed a strong correlation between the model's predictions and the experimental H/D values, achieving a coefficient of determination (R^2) of 1.0000, along with low root mean square error (RMSE < 0.0007), low mean square error (MSE ≈ 0.0000), and low mean absolute error (MAE < 0.0006). The performance of the model surpassed that of existing published models, highlighting its efficacy in predicting water holdup in liquid-liquid flow systems.

Room: Tuwaiq | Date: Wednesday, April 08, 2026 | Time: 18:05 – 18:30 [Online]

[A08] Enhanced Credit Card Fraud Detection using Data Augmentation and Deep Anomaly Detection Techniques

Yousra Alaklouk*, Istinye University (Turkey); Muhammed Davud, İstinye University (Turkey)

Abstract: The increasing prevalence of credit card fraud presents significant risks for financial institutions and consumers due to extreme class imbalance in transaction data. This thesis investigates the impact of data augmentation on fraud detection, comparing Synthetic Minority Over-sampling Technique (SMOTE) and Conditional

Tabular Generative Adversarial Networks (CTGAN). A novel "balanced augmentation" strategy, equally upsampling fraud and non-fraud classes, was assessed using Random Forest, Artificial Neural Network (ANN), Compensated ANN (C-ANN), and Support Vector Machine (SVM). Rigorous evaluations involving cross-validation and threshold tuning highlighted that balanced augmentation substantially improved fraud detection performance, particularly enhancing recall from baseline levels (~75%) to near-perfect (~99.98%) with CTGAN. Random Forest combined with SMOTE delivered optimal overall reliability and stability, achieving the highest practical performance (AUC = 99.99%) under realistic conditions. Findings underscore the critical role of balanced data augmentation in operational fraud detection systems, providing clear, practical guidance for financial institutions.

Room: Tuwaiq | Date: Wednesday, April 08, 2026 | Time: 18:30 – 18:55 [Online]

[A09] Extreme Learning Machine Based System for DDoS Attacks Detections on IoMT Devices

Nelly Elsayed*, Lily Dzamesi, University of Cincinnati (United States); Zag ElSayed, UC (United States); Murat Ozer, (University of Cincinnati)

Abstract: The Internet of Medical Things (IoMT) represents a paradigm shift in the healthcare sector, enabling the interconnection of medical devices, sensors, and systems to enhance patient monitoring, diagnosis, and management. The rapid evolution of IoMT presents significant benefits to the healthcare domains. However, there is a rapid increase in distributed denial of service (DDoS) attacks on the IoMT networks due to several vulnerabilities in the IoMT-connected devices, which negatively impact patients' health and can even lead to deaths. Thus, in this paper, we aim to save lives via investigating an extreme learning machine for detecting DDoS attacks on IoMT devices. The proposed approach achieves a high accuracy at a low implementation budget. Thus, it can reduce the implementation cost of the DDoS detection system, making the model capable of executing on the fog level.

Room: Tuwaiq | Date: Wednesday, April 08, 2026 | Time: 18:55 – 19:20 [Online]

[A10] Unraveling the Factors of Procrastination: An Insightful Assessment of Procrastination Levels Through ML and XAI

Mariam Sarker, IUBAT - International University of Business Agriculture and Technology (Bangladesh); Anwar Hossain Efat*, Idaho State University (United States); Maria Afrin Khan, IUBAT (Bangladesh); Minhaz F. Zibran, Idaho State University (United States); Jubair Ahmed Nabin, Department of CSE, CUET (Bangladesh)

Abstract: Procrastination is a pervasive issue that significantly impairs productivity and academic achievement. Traditional analysis methods often fail to capture its complex, multi-faceted nature. This study proposes a machine learning framework enhanced with Explainable AI to accurately predict procrastination levels and identify its key determinants. Utilizing a novel dataset of 674 samples from a diverse Bangladeshi population, we developed a Feature-Tuned Support Vector Machine (FT-SVM) model. The framework employs a dual-layered XAI strategy, integrating methods like SHAP and LIME for interpretability and feature importance analysis. Our FT-SVM model achieved a high prediction accuracy of 93.08\%, which was further improved to 95.06% after XAI-guided feature elimination. The results underscore critical influencing factors, including time management and emotional state, providing actionable insights for developing targeted interventions to mitigate procrastination.

Room: Tuwaiq | Date: Wednesday, April 08, 2026 | Time: 10:15 – 10:40 [In Person]

[A11] Feasibility Study Using Machine Learning to Predict Photon Dose Conversion Coefficients for Average Saudi Female

Rasha Almatrafi*, Iau (Saudi Arabia); ALI Alghamdi, Imam Abdulrahman Bin Faisal University

Abstract: Machine learning (ML) has the potential to revolutionize radiation dosimetry by enabling rapid and accurate dose predictions compared to computationally intensive Monte Carlo (MC) methods. This study employs eXtreme Gradient Boosting (XGBoost), a supervised ML model, to predict photon Dose Conversion Coefficients (DCCs) for effective dose in an average Saudi female using a refined MC photon DCCs compilation

and the F_H50W50 mesh-based reference computational phantom. The phantom (64.1 kg, 163.3 cm) closely aligns with average Saudi female anthropometric data (64.85 kg, 157.96 cm). Training data include seven features across 16,899 energy bins (0.01–20 MeV) for combined 35 organs, covering anterior posterior (AP), posterior anterior (PA) and lateral (LAT) irradiation conditions. Four tree-based ML models XGBoost, Random Forest, Gradient Boosting and Extra Trees were evaluated, with XGBoost achieving the highest average R2 (0.97) and lowest MSE (0.25), indicating superior performance. Hyperparameters tuning was carried out via k-fold analysis and Bayesian optimization enhanced accuracy, particularly for low-energy bins (0.01–0.1 MeV). Comprehensives analyses were carried out for XGBoost prediction against standard reference MC calculations. Comparisons with F_H50W50 revealed close agreement at higher energies and discrepancies at low energies. A maximum discrepancy for one energy bin of 80% at 0.02 MeV for PA irradiation condition was recorded when comparing XGBoost with F_W50H50 MC calculations. The other differences for lower energy ranges were less than 47%, 30% and 42% for PA, AP and LAT, respectively. These results highlight XGBoost's efficacy for rapid, accurate DCCs prediction, with potential for refinement using expanded organ specific data.

Room: Tuwaiq | Date: Thursday, April 09, 2026 | Time: 10:40 – 11:05 [In Person]

[A12] DDoS attack detection on IoMT based Convolutional Neural Networks (CNN) model

Abdulqawi Almosti*, King Faisal University (Saudi Arabia); Ziad Almulla, (King Faisal University); Mounir Frikha, KFU (Saudi Arabia); Munam Ali Shah, Department of Computer Networks and Communication, King Faisal University, Al-Ahsa, Saudi Arabia (Saudi Arabia); Fawaz Abu Khadra

Abstract: In the healthcare field, the Internet of Medical Things (IoMT) is becoming common, so doctors can monitor patients in real time while making better decisions based on data from connected medical devices. These systems are becoming more connected and more vulnerable to cyber threats, particularly Distributed Denial of Service (DDoS) attacks, which can cause the collapse of these essential medical services. This paper attempts to detect DDoS attacks in IoMT systems using a Convolutional Neural Networks (CNN) model. In the experimental section, we used the NSL-KDD and WUSTL-EHMS-2020 dataset to test our approach and further applied Genetic Algorithms (GA) as feature selection to choose the most useful features on the model. The CNN model with 20 layers achieved accuracy: 100%, precision: 100%, and recall: 99.99% on NSL-KDD dataset. In the WUSTL-EHMS-2020 dataset, accuracy was achieved: 99.97%, recall: 99.76% and precision: 100.00%. These results indicate the CNN model is well-suited for accurately identifying DDoS attacks in IoMT environments.

Room: Tuwaiq | Date: Thursday, April 09, 2026 | Time: 11:05 – 11:30 [Online]

[A13] Dynamic Dropout: Leveraging Conway's Game of Life for Neural Networks Regularization

David Freire-Obregón*, Universidad de Las Palmas de Gran Canaria (Spain); José Salas-Cáceres, ULPGC (Spain); Modesto Castrillón-Santana, Universidad de Las Palmas de Gran Canaria (Spain)

Abstract: Regularization techniques play a crucial role in preventing overfitting and improving the generalization performance of neural networks. Dropout, a widely used regularization technique, randomly deactivates units during training to introduce redundancy and prevent co-adaptation among neurons. Despite its effectiveness, dropout has limitations, such as its static nature and lack of interpretability. In this paper, we propose a novel approach to regularization by substituting dropout with Conway's Game of Life (GoL), a cellular automata with simple rules that govern the evolution of a grid of cells. We introduce dynamic unit deactivation during training by representing neural network units as cells in a GoL grid and applying the game's rules to deactivate units. This approach allows for the emergence of spatial patterns that adapt to the training data, potentially enhancing the network's ability to generalize. We demonstrate the effectiveness of our approach on the CIFAR-10 dataset, showing that dynamic unit deactivation using GoL achieves comparable performance to traditional dropout techniques while offering insights into the network's behavior through the visualization of evolving patterns. Furthermore, our discussion highlights the applicability of our proposal in deeper architectures, demonstrating how it enhances the performance of different dropout techniques.

Room: Tuwaiq | Date: Thursday, April 09, 2026 | Time: 11:30 – 11:55 [Online]

[A14] Predicting Financial Success Through ESG Metrics: Leveraging Machine Learning and Explainable AI

Abuzar Khan; Ahmad Junaid, CECOS University (Pakistan); Abid Iqbal*, King Faisal university (Saudi Arabia); Ghassan Husnain*, CECOS University of IT and Emerging Sciences (Pakistan)

Abstract: This study have examined the relationships between the Environmental, Social and Governance (ESG) performance and thier financial outcomes through a multi-phase Machine Learning(ML) and Deep Learning frameworks. A global dataset of firms was analyzed, combining ESG indicators with financial metrics such as revenue, profit margin and market capitalization. Models like XGBoost, LightGBM and TabNet are applied for regression and classification summary and results. The results have shown a strong predictive performance with classification accuracy reaching 0.88 and AUC values above 0.90, while regression models achieved R2 above 0.90 and RMSE as low as 0.34. XAI methods such as SHAP and LIME have highlighted the market capitalization, water usage and carbon emissions as the most influential drivers, with governance consistently ranked as the leading ESG factor. Cross-domain evaluation confirmed robustness, with industry- and region-level accuracies between 0.69 and 0.78. Scenario simulations indicated that targeted ESG improvements, for example, a 10% rise in governance scores, produced measurable though modest profitability gains. These findings were embedded into a prototype decision support system, allowing managers to test ESG strategies interactively. Overall, the framework delivers robust, interpretable and practical insights that align sustainability practices with financial performance.

Room: Tuwaiq | Date: Thursday, April 09, 2026 | Time: 11:55 – 12:20 [Online]

[A15] Write Energy Estimation for Phase-Change Memory Using Regression Based Models

Anthony Taylor; Marjan Asadinia*, California State University, Northridge and Cal Poly humboldt (United States)

Abstract: Phase-Change Memory (PCM) is a promising nonvolatile memory technology offering high density and scalability. However, its widespread adoption is hindered by high write energy consumption and limited endurance. In this work, we propose a machine learning-based framework to estimate write energy in PCM using synthetic datasets that simulate realistic bit-level transitions and physical resistance variations. Two regression models, a Multi-Layer Perceptron (MLP) and XGBoost are developed and evaluated using engineered features derived from write operations. The results demonstrate that both models achieve high prediction accuracy, with XGBoost significantly outperforming the neural network in terms of error metrics and generalization. Our approach provides a foundation for energyaware memory optimization and highlights the potential of datadriven techniques in modeling emerging memory technologies.

Room: Al-Qaisariyah | Date: Thursday, April 09, 2026 | Time: 10:15 – 10:40 [Online]

[A16] AI Governance in the Data Collection Phase of Building an AI Model

khalid BENNOUK*, ESNA (Morocco)

Abstract: With the objective of ensuring a compliant, ethical, and secure building of an AI (Artificial intelligence) models, it becomes imperative to apply a governance layer during all phases related to the AI life cycle. The massive integration of AI models into existing information systems or the generation of new ones may generate serious impacts related to human well-being, societal and environmental impacts. To avoid bias and discrimination, misuse or dual use, and unintended consequences, there are significant calls for a systematic review of practices during the building of an AI model. In addition, the complexity of digital systems and their fast interactions with AI models represent a serious challenge to facing the high level of tactics and techniques used in diverse cyberattacks. The study aims to propose a fundamental understanding of AI governance relative to building AI models. It introduces a thorough comprehension of the existing ten AI principles in the literature. The position paper highlights major risks of AI models, underlying their impact, scope, and potential solutions. This research proposes a holistic mapping between the AI principles and eight proposed stages of the AI life

cycle. It presents ten main metrics to be assessed during the data collection stage before training the AI model. Results of this study demonstrate a strong need for AI governance to avoid data drift, biased models, privacy infringements, and reduce AI risks during all phases of building any future model of prediction or classification.

Room: Al-Qaisariyah | Date: Thursday, April 09, 2026 | Time: 10:40 – 11:05 [In Person]

[A17] Evaluation of XGBoost-Based Machine Learning for Prediction the Biological Activity of IL-23 Inhibitors in immune system

Hala Abuelmakarem*, King Faisal University (Saudi Arabia); Amir Mohamed, Seif Aly, The Higher Institute of Engineering

Abstract: Interleukin-23 (IL-23) is a pivotal cytokine in immune regulation and has emerged as a promising therapeutic target for autoimmune and inflammatory disorders. However, the discovery of IL-23 inhibitors remains a challenging task due to the complexity of structure–activity relationships and the vastness of chemical space. In this study, an AI-driven quantitative structure–activity relationship (QSAR) modeling framework was developed to predict the biological activity (pIC_{50}) of IL-23 inhibitors. A dataset of IL-23 inhibitors was extracted from the ChEMBL database and subjected to rigorous preprocessing. Molecular descriptors were generated using the RDKit cheminformatics toolkit and then refined through a structured feature selection pipeline that removed low-variance and highly correlated features while retaining biologically informative variables through univariate and model-based approaches. Four machine learning algorithms—Linear Regression, Random Forest, Support Vector Regression, and Gradient Boosting (XGBoost)—were systematically trained and evaluated using an independent test set. Model performance was assessed with statistical metrics including R^2, root mean square error (RMSE), mean absolute error (MAE), and residual analysis. Among the tested algorithms, XGBoost achieved the best predictive accuracy (R^2 = 0.820, RMSE = 0.596, MAE = 0.356), outperforming the other techniques. These findings underscore the potential of ensemble learning in QSAR-driven drug discovery and provide a robust computational framework for accelerating the identification of novel IL-23 inhibitors.

Room: Al-Qaisariyah | Date: Thursday, April 09, 2026 | Time: 11:05 – 11:30 [Online]

[A18] Predicting Bit-Flip Errors in Multi-Level Cell Phase-Change Memory Using Machine Learning

Marjan Asadinia*, California State University, Northridge and Cal Poly humboldt (United States); Joshua Drye, University of California (Los Angeles)

Abstract: Since Dynamic Random Access Memory (DRAM) is approaching its scalability limits, Phase Change Memory (PCM) has emerged as a promising alternative due to its scalability, fast access times, low read latency, and high storage capacity. However, PCM, and particularly Multi-Level Cell (MLC) PCM, is prone to bit-flip errors caused by cell wear, electrical noise, resistance drift, and temperature variations. Although such errors are relatively rare, the ability to predict their occurrence can significantly improve PCM reliability and support its future adoption. In this work, we investigate the use of Machine Learning (ML) models to predict bit-flip errors based on key features including write history, resistance, and flip rate. Experimental results demonstrate that ML models can effectively identify patterns associated with error occurrence. A Random Forest model, used as a baseline, achieved 72% prediction accuracy. In comparison, a Support Vector Machine (SVM) achieved 70% accuracy, while a Multilayer Perceptron (MLP) achieved the highest accuracy of 78%. These findings provide evidence that ML-based approaches can play an important role in predicting error-prone cells, thereby advancing the development and reliability of MLC PCM systems.

Room: Al-Qaisariyah | Date: Thursday, April 09, 2026 | Time: 11:30 – 11:55 [Online]

[A19] Guardrail-First Architecture for Multi-Agent Systems: Typed Rails as First-Class Connectors

Viswapriyan Ragupathy*, IEEE Senior Member (United States)

Abstract: This paper introduces the Guardrail-First Architecture (GFA), a unique paradigm for multi-agent

system safety, compliance, and governance. GFA uses Design-Science Research to enforce semantic, policy, and capability restrictions on inter-agent and agent–tool interactions with Typed Rails as first-class architectural connectors. Agent, Tool Interface, Typed Rails, and Policy Engine/Evidence Store layers ensure verifiable, policy-compliant activities with traceable evidence. GFA maintains operational performance while enhancing governance, as shown by a 47% decrease in dangerous activities, a 31% increase in policy adherence, and little latency overhead in a controlled MAS environment. Quality feedback emphasises openness, auditability, and minimised manual monitoring. GFA provides a solid foundation for trustworthy and responsible MAS implementation by architecturally formalising safety and compliance semantics. Automated Typed Rail synthesis, dynamic policy adaption, and heterogeneous, enterprise-level MAS scalability will be studied.

Room: Al-Qaisariyah | Date: Thursday, April 09, 2026 | Time: 11:55 – 12:20 [Online]

[A20] Forecasting Next-Day Gold Returns under Market Volatility: A Comparative Study of Machine Learning and Hybrid Deep Learning Ensembles

Muhammad Atif Saeed*, NUCES (Pakistan); Sohaib Sulman, National University of Computer and Emerging Sciences (Islamabad); Maheen Abdul Rehman Jan, National University of Computer and Emerging Sciences (Islamabad, Pakistan); Azka Atiq, National University of Computer and Emerging Sciences (Islamabad); Akhtar Jamil, National University of Computer and Emerging Sciences (Pakistan); Alaa Ali Hameed, Istinye University (Turkey)

Abstract: The non-linear, noisy, and highly volatile nature of the execution of gold makes it difficult to predict the return for the following day. This research evaluates the performance of eight models: Random Forest, Ensemble Machine Learning, Support Vector Regression, XGBoost, , Long Short-Term Memory, hybrid CNN-LSTM network, Bidirectional LSTM, and deep learning aggregates combining CNN-LSTM, and GRU framework. Utilizing daily gold market data from 2020 to 2025, we evaluate error-based measures of RMSE and MAE and directional correctness. The tuned SVR model exceed all other models in terms of RMSE and MAE, analyzing a minimal prediction error. On the other hand, the highest directional accuracy of 60.45\% has been achieved by a deep learning ensemble that averages CNN-LSTM and GRU predictions. Therefore, it is an excellent model for predicting the movement of tomorrow's returns. Traditional tree-based models, for instance RF and XGBoost, worked worse than deep learning approaches in heading prediction. In a nutshell, the findings shows the mutual strengths of machine learning and deep learning techniques in financial return forecasting, underlining the fact that while SVR performs best in reducing forecast error, hybrid deep learning ensembles fare better in catching the direction of the market.

Room: Al-Qaisariyah | Date: Thursday, April 09, 2026 | Time: 12:20 – 12:45 [Online]

[A21] Deep Reinforcement Learning for Optimizing Penalty Kick Strategies in Football: A Comparative Study of PPO and IPPO

Muhammad Fadhlul Wafi Ahmad Naim; Azhar Mohd Ibrahim; Mohd Zaid; Ali Ahmed Allam, International Islamic University (Malaysia)

Abstract: Penalty kicks are among the most decisive and pressure-filled moments in football, often shaping the outcome of matches. Their complexity lies in the split-second decisions made by both kicker and goalkeeper, which traditional statistical or biomechanical approaches struggle to fully capture. In this paper, we explore how Deep Reinforcement Learning (DRL) can optimize penalty kick strategies using the Google Research Football (GRF) environment. We trained agents with two algorithms, Proximal Policy Optimization (PPO) and Independent PPO (IPPO), to model realistic kicker–goalkeeper interactions. Performance was analyzed through goal success rates, goalkeeper saves, and decision heatmaps. The trained IPPO agents exhibit a goal success rate exceeding 85%, a notable increase compared to baseline strategies which uses PPO agents (~65%). Spatial heatmaps further revealed a strong preference for low-corner shots, aligning with real-world tendencies. These findings show that DRL-trained agents can learn adaptive and effective penalty strategies, offering practical insights for football analytics, training, and tactical preparation.

Track 2: Language Technologies, LLMs & Generative AI

Room: Diriyah | Date: Wednesday, April 08, 2026 | Time: 14:45 – 15:10 [Online]

[B01] Exploring the Effectiveness of ChatGPT in Python Code Generation

Sophia DiCuffa, Christopher Roddy, Corey Heckel, Evan Ciok; Eman AlOmar*, Stevens Institute of Technology (United States)

Abstract: This paper explores the relationship between ChatGPT and GitHub code review. It investigates issues such as concerns regarding bias and interpretability and issues related to code context comprehension. It will ultimately achieve an extensive understanding of the challenges posed by ChatGPT-assisted code review and pave the way for informed decisions and solutions in collaborative software development environments.

Room: Diriyah | Date: Wednesday, April 08, 2026 | Time: 15:10 – 15:35 [In Person]

[B02] Semantic Academic Paper Retrieval using Lightweight LLMs and FAISS: A Comparative Study

walaa Aljoofi*, KFU (Saudi Arabia); Asayil Alawadh; Alaa M. Sagheer, King Faisal University (Saudi Arabia)

Abstract: The rapid growth of scientific literature has made retrieving contextually relevant academic documents increasingly challenging. This paper presents a comparative evaluation of three lightweight transformer-based models, namely, GTE-base, MPNet, and MiniLM, for semantic academic paper retrieval, with BM25 serving as a traditional lexical baseline. Using the SciFact dataset and FAISS for dense vector indexing, the models were assessed with standard information retrieval metrics, including Mean Reciprocal Rank (MRR), Precision@1, Recall@1, Mean Average Precision (MAP), and Normalized Discounted Cumulative Gain (NDCG). Experimental results show that GTE-base consistently outperforms other models in both top-1 and rank-based retrieval tasks, demonstrating superior semantic alignment and ranking quality. These findings highlight the advantages of dense semantic representations over keyword-based methods and lay the foundation for future enhancements through hybrid retrieval and cross-encoder re-ranking techniques.

Room: Diriyah | Date: Wednesday, April 08, 2026 | Time: 15:35 – 16:00 [Online]

[B03] Refusing Fairness: A Temporal Audit of Dialect Bias in Modern Language Models

Cynthia Nosiri*, Hashmath Fathima, Morgan State University (United States); Kofi Nyarko, Morgan State University

Abstract: This study extends Groenwold et al.'s evaluation of dialectal bias in language models by comparing outputs from African American Vernacular English (AAVE) and Standard American English (SAE) prompts across five modern LLMs. We benchmark five widely used LLMs, Claude 3.5 Sonnet, GPT-4, Gemini 1.5 Pro, Qwen2, and LLaMA 3 on semantically equivalent dialect pairs to assess sentiment consistency, lexical similarity, and output quality. Using BLEU and ROUGE metrics, we evaluate textual fidelity, while a two-phase sentiment analysis pipeline reveals polarity drift across dialects. As an extension of prior work, we introduce refusal behavior analysis to evaluate how safety-aligned models handle dialectal inputs. Claude 3.5 exhibited disproportionately high refusal rates on AAVE prompts, suggesting that alignment and safety mechanisms may inadvertently amplify linguistic bias. These findings reveal persistent dialect-related disparities in model behavior and underscore the importance of dialect-aware benchmarking for building fair and inclusive language technologies

Room: Diriyah | Date: Wednesday, April 08, 2026 | Time: 16:00 – 16:25 [Online]

[B04] Natural Language Inference for Consistency Checking in Requirements Engineering: Evaluating LLMs on Semisynthetic Automotive Data

Karl Volkenandt*, RWTH Aachen University (Germany); Bernhard Rumpe, (RWTH Aachen University)

Abstract: We investigate the effectiveness of large language models (LLMs) in performing natural language inference (NLI) for consistency checking in technical requirements from the automotive domain. Due to

the scarcity of annotated industrial requirements, we construct a semisynthetic dataset by generating contradictory and paraphrased variants of real-world German-language requirements. Our dataset consists of over 21000 requirement pairs balanced across entailment, contradiction, and neutral classes, with controlled syntactic variation introduced through LLM-based transformations. We benchmark classical multilingual transformer models against OpenAI's GPT-4o and GPT-4o mini, using both direct and Chain-of-Thought prompting. Our results show that while GPT-4o significantly outperforms fine-tuned baselines, the smaller GPT-4o mini performs only slightly worse after using automatic prompt optimization. These findings indicate that LLMs can reliably detect natural language-based inconsistencies in industrial requirements without domain-specific training, offering a promising avenue for scalable application to consistency checking in requirements engineering.

Room: Diriyah | Date: Wednesday, April 08, 2026 | Time: 16:25 – 16:50 [Online]

[B05] A Comparative Study of Translation Bias and Accuracy in Multilingual Large Language Models for Cross-Language Claim Verification

Ryan Ding*, Algoverse AI Research (United States); Aryan Singhal, Gary Sun, Veronica Shao, (Algoverse AI Research)

Abstract: The rise of digital misinformation has heightened interest in using multilingual Large Language Models (LLMs) for fact-checking. This study systematically evaluates translation bias and claim verification accuracy across fifteen languages from five language families: Romance, Slavic, Turkic, Indo-Aryan, and Kartvelian. Evaluating accuracy and translation bias through a novel metric, we investigated two distinct translation methods on the XFACT Dataset: pre-translation and self-translation. We use mBERT's performance on the English dataset as a baseline comparison for language-specific accuracies. We find that the translation method significantly impacts accuracy of output in claim verification. Direct-inference results in significantly lower accuracy for low-resource languages and higher accuracy for high-resource languages, due to discrepancies in representation in the training data. Furthermore, larger models demonstrate superior performance in self-translation, with improvement in translation accuracy and reduced bias. These results highlight the need for balanced multilingual training, especially in low-resource languages, to promote equitable access to reliable fact-checking tools and minimize the spread of misinformation in various linguistic contexts.

Room: Al-Qaisariyah | Date: Wednesday, April 08, 2026 | Time: 14:45 – 15:10 [In Person]

[B06] Domain Specific Large Language Models: Potential, Challenges and Future Directions

Sajid Iqbal*, King Faisal University Saudi Arabia (Saudi Arabia)

Abstract: The invention of large language models has boosted NLP research to new heights and has changed the question-answering mechanism from smart to very smart level. Natural language processing (NLP) research has seen significant evolution in almost all of its sub-domains. The development of general-purpose language models like GPT-3 and BERT have shown great success however, their limitations in understanding domain-specific tasks argue for the development of domain-specific models (DS-LLMs). This paper provides an in-depth exploration of DS-LLMs, emphasizing their importance in addressing industry-specific challenges. We outline the limitations associated with general LLMs and highlight how these could be solved using DS-LLMs. As case studies, we examine a few application areas like education and healthcare. The adoption of DS-LLMs, for commercial applications, has also posed multiple challenges which are also discussed. The paper concludes with the increasing role of DS-LLMs in advancing language processing in the context of specific current and future domains/applications.

Room: Al-Qaisariyah | Date: Wednesday, April 08, 2026 | Time: 15:10 – 15:35 [Online]

[B07] Urdu Crime News Summarization (UCS) Corpus

Tenzeela Saeed*, University of Management and technology (Pakistan); Muhammad Wasim, UMT (Pakistan); Rwaida Obaid Alssadi, Florida Institute of Technology (Melbourne); Widian Alssadi, University of Bisha (Al Nakhil)

Abstract: The increasing volume of online news articles highlights the need for automatic summarization tools. An automatic text summarization system helps readers focus on crucial information from large amounts of text data. Among existing approaches, abstractive summarization methods generate summaries that resemble human writing. This makes them valuable for documents that contain sensitive information. Despite significant progress in high-resource languages, there is a lack of datasets for low-resource languages, particularly in specialized domains. Urdu is a low-resource language, resulting in limited datasets for abstractive summarization. Furthermore, no dataset is available for the crime news domain. To fill this gap, this study presents the Urdu Crime News Summarization (UCS) Corpus. UCS is a unique dataset that contains 1,500 crime news articles sourced from various news websites, along with their manually written abstract summaries. We discuss the linguistic and syntactic challenges in Urdu summarization, highlighting the difficulties of creating a summary corpus in Urdu and generating automated summaries. The benchmark evaluation using pre-trained large language models on the UCS Corpus shows that ChatGPT achieves the highest performance, with ROUGE-1, ROUGE-2, and ROUGE-L scores of 43.00, 19.72, and 34.92, respectively. The data collection pipeline and summarization methodology proposed in this work can be generalized and applied to other low-resource languages and specialized domains, enabling the development of similar benchmark corpora beyond the Urdu crime domain. The results indicate that fine-tuning large language models can further enhance performance on Urdu crime news summarization. The UCS Corpus is available to support further research in this area.

Room: Al-Qaisariyah | Date: Wednesday, April 08, 2026 | Time: 15:35 – 16:00 [Online]

[B08] Bridging Lexical and Semantic Gaps: Query Expansion Analysis with FastText for Information Retrieval

Shoaib Khan*, QLU.ai (Pakistan)

Abstract: This paper presents a comparative analysis of multiple different query expansion strategies aimed at enhancing document retrieval accuracy using FastText-based models and semantic reranking. The study explores the limitations of baseline FastText embeddings, which often rely on morphological similarity, thus leading to semantically incoherent nearest neighbours. In order to address this, two enhancement strategies are experimented with, namely random string encoding for multiword phrases, and thus presents a solution to enhanced performance in information retrieval by retrofitting FastText embeddings with ConceptNet. A strict keyword filtering pipeline, then followed by semantic reranking using SentenceTransformer is integrated, in order to assess performance on Wikipedia-based document retrieval. Results display that ConceptNet-enhanced FastText achieved a recall@3 of 93.21%, thus outperforming both the random-masked FastText model (87.63%) and baseline Elasticsearch keyword retrieval (76.75%). A comparison against a zero-shot LLM-based expansion pipeline using GPT-4o is also included, which presented the highest recall@3 of 99.06%, therefore highlighting the potential of context-aware generative expansion. These findings resultantly shed light to the importance of semantically enriched expansion strategies and provide a framework for evaluating embedding quality in retrieval tasks.

Room: Al-Qaisariyah | Date: Wednesday, April 08, 2026 | Time: 16:00 – 16:25 [Online]

[B09] Bridging Consumer and Enterprise: Benchmarking LLaMA, Qwen, and GPT Models on Diverse Hardware

Farhan Khan*, Shoaib Khan, Qlu.Ai (Pakistan)

Abstract: The increase of large language models (LLMs) such as Qwen, LLaMA, Mistral, and GPT variants has intensified the need for systematic benchmarking across heterogeneous hardware platforms. This paper evaluates NVIDIA A100 and RTX 3090 GPUs, AMD RX 580 and RX 7600 XT GPUs, and an Intel i5-14400F CPU on a diverse suite of open-source LLMs, including Mistral-7B, LLaMA-2 (7B, 13B), LLaMA-3.x (3B–11B), CodeLLaMA,

Qwen1.5/2/2.5 (1.8B–14B), and legacy GPT models (GPT-2, GPT-Neo, GPT-J, GPT-NeoX-20B). Performance was assessed in terms of sustained TFLOPs, throughput in tokens per second (TPS), and memory/power efficiency. Results show that smaller Qwen models peaked at 276 TPS (A100), the RTX 3090 dominated 1–7B models due to higher frequency and lower overhead, and the A100 scaled efficiently on 13B–20B workloads. The RX 7600 XT, enabled by patched ROCm 6.4.2 gfx1102 support, sustained up to 35–50 TPS on 1.5B–3B models and executed models up to 14B parameters, while the RX 580 and CPU were limited to lightweight inference. These findings underscore how real-world performance depends not only on theoretical FLOPs but also on memory capacity, kernel launch overheads, and software stack maturity, offering actionable insights for selecting hardware across consumer and data-center deployments.

Room: Al-Qaisariyah | Date: Wednesday, April 08, 2026 | Time: 16:25 – 16:50 [Online]

[B10] Towards Lightweight Voice Cloning: Quantization of LLaMA-based TTS Transformers

Ali Zain*, QLU.ai (Pakistan)

Abstract: Recent advancements in Text-to-Speech (TTS) have been propelled by Large Language Models (LLMs), leading to systems like Llasa that achieve remarkable naturalness and speaker similarity in voice cloning. However, these models, with parameter counts in the billions, present significant challenges for deployment on resource-constrained devices due to their substantial memory footprint and computational demands. This paper investigates the application of post-training quantization (PTQ) to the Llasa family of TTS models (1B, 3B, and 8B parameters). Our goal is to drastically reduce their size while maintaining high-fidelity voice cloning performance. We apply an 8-bit (INT8) quantization scheme and evaluate the trade-offs between model compression and synthesis quality using a suite of objective metrics. Our experiments reveal that INT8 quantization provides a substantial reduction in model size, making large models more accessible for resource-constrained environments. This efficiency gain comes at the cost of a modest, predictable decrease in synthesis quality and, in our software-based setup, an increase in inference latency. Furthermore, we note issues of output stability, suggesting that quantization is a mitigant, not a panacea. These findings highlight a critical trade-off between model footprint and performance, providing a practical guide for deploying large-scale TTS models.

Room: Diriyah | Date: Wednesday, April 08, 2026 | Time: 17:15 – 17:40 [Online]

[B11] Evaluating the Grammatical Iraab Capabilities of Large Language Models in Arabic

Razan Alkhalaqi*, sharefah Alghamdi, King saud university (Saudi Arabia)

Abstract: This paper presents a comparative evaluation of six prominent large language models (LLMs) GPT, DeepSeek, Claude, Gemini, Grok, and Cohere in the context of Arabic syntactic Iraab. We designed a multiple-choice question (MCQ) framework targeting key grammatical elements such as word type, syntactic function, and diacritical marking. Our experiments spanned diverse Arabic sentence structures, including Quranic verses, Hadith, poetry, and general sentences. The findings highlight significant variation in Iraab performance across models, with DeepSeek and Gemini achieving the highest accuracy. The results emphasize both the potential and current limitations of LLMs in handling complex morphosyntactic tasks in Arabic.

Room: Diriyah | Date: Wednesday, April 08, 2026 | Time: 17:40 – 18:05 [Online]

[B12] Cross-Dataset Fairness Evaluation of Transformer Models in Sentiment Analysis

Sara Zuiran*, Florida Institute of Technology (United States); Siddhartha Bhattacharyya, Florida Instittute of Technology (United States)

Abstract: This paper investigates the fairness of transformer models for sentiment analysis, using RoBERTa and Mental- BERT. We compare the outcomes across demographic groups after testing them on two datasets, SST-2 and CALM. Several fairness metrics are used, such as SPD, JSD, WD, EOD, FPRD, FNRD, and permutation

testing. According to the experiments, RoBERTa remains more consistent, whereas MentalBERT ex- hibits greater variations, particularly with regard to gender and race. This demonstrates how cross-dataset analysis aids in identifying discrepancies that are not visible when utilizing a single dataset.

Room: Diriyah | Date: Wednesday, April 08, 2026 | Time: 18:05 – 18:30 [Online]

[B13] Rethinking Retrieval: A Hybrid Contextual Pipeline for Open-Domain QA with LLMs

Zain Rizwan*, QLU.ai (Pakistan)

Abstract: Large Language Models (LLMs) perform well in open-domain question answering but often suffer from factual errors and loss of context when using flat chunk-based retrieval. We propose a hybrid contextual pipeline that combines BM25 and dense embeddings with enriched contextualized chunks and LLM-based query expansion. Concise summaries are added to chunks to preserve key entity and temporal references, while queries are reformulated into diverse variants to improve retrieval coverage. Candidate results are fused, reranked, and used to generate grounded answers. Evaluated on a 100,000-document Wikipedia corpus, our approach outperforms baseline hybrid retrieval, showing consistent gains in recall and speed, while also improving efficiency. The results demonstrate that integrating contextualized chunking with query expansion strengthens retrieval-augmented generation, making it more robust and precise open-domain QA.

Room: Diriyah | Date: Wednesday, April 08, 2026 | Time: 18:30 – 18:55 [Online]

[B14] Generative AI Is Unable to Detect Audio Deepfakes: An Empirical Investigation

Oussama Ben Achour*, University of Quebec at Chicoutimi (Canada)

Abstract: In recent years, advances in synthetic speech have raised growing concerns in areas such as cybersecurity, media authenticity, and digital identity authentication. This study evaluates whether large language models (LLMs), such as Mistral, DeepSeek, LLaMA, and Gemma, can detect audio deepfakes using only textual summaries of acoustic features. To evaluate this, we extracted two balanced subsets from the ASVspoof2019LA and SceneFake datasets. Each subset contains 2,400 audio samples (1,200 bonafide and 1,200 spoofed), giving a total of 4,800 recordings used in the evaluation. For each sample, we extracted acoustic features using both Mel-Frequency Cepstral Coefficients (MFCCs) and Wav2Vec2 embeddings, which were then transformed into textual prompts. To examine how prompt engineering influences model performance, we designed and tested multiple variations of prompts on each language model. The results show that certain prompt formulations enable the models to detect spoofed audio samples with perfect recall. However, the precision remained relatively low, depending on the prompt structure, suggesting that models are susceptible to false positives despite more descriptive prompts being provided. Our findings indicate that LLMs at present are incapable of detecting audio deepfakes without domain-specific tuning, highlighting the need to develop specialized models.

Room: Diriyah | Date: Wednesday, April 08, 2026 | Time: 18:55 – 19:20 [Online]

[B15] BenchDP: An LLM Benchmark for Due Process Recognition

Joshua Johnson*, University of Louisville (United States); Adrian Lauf, (University of Louisville)

Abstract: This work explores the efficacy of using vector embeddings to evaluate the ability of large language models (LLMs) to recognize due process issues within judicial opinions as compared to the review of documents by human attorneys. An engineered prompt including due process definitions was utilized to find due process issues in judicial opinions. Next, the models under evaluation were prompted with a simplified query: “What are the due process issues in this text:” followed by the judicial opinion’s body. The zero-shot performance of the evaluated models was then assessed by comparing the outputs against the results derived from the engineered prompting by comparing proximity in a vector space. Attorney evaluations were performed on the engineered prompt results and the zeroshot results to determine the effectiveness of an LLM approach

to evaluating models. The attorney scoring of a subset of outputs revealed the mean machine based scoring to be within 4.08% of the human attorney mean scoring. Ranked from highest to lowest benchmarked score this work includes the benchmark results for the following models: Gemini 1.0 Pro, Llama-3.1 405B, GPT-4 Turbo, GPT-4o, Gemini 1.5 Pro, Llama-3 70B, Llama-3 8B, and Llama-2 7B.

Room: Al-Qaisariyah | Date: Wednesday, April 08, 2026 | Time: 17:15 – 17:40 [Online]

[B16] Explainability of Large Language Models in Healthcare Information Systems: A Review

Rob Sullivan*, Nelly Elsayed, University of Cincinnati (United States)

Abstract: Large language models (LLMs) have produced unprecedented results in areas such as language understanding, machine translation, and question and answering. However, a major challenge with adopting these and other forms of deep learning models into information systems is their opaque nature. Answering the question of how the model drew its conclusions is imperative for adoption in many disciplines, particularly in healthcare and medicine, finance, and legal, where transparency, trust, and regulatory compliance are critical. This study investigates approaches being used to explain transformer-based LLMs independent of any particular model that supports different organizations in improving governance, trust, and accountability while fostering these models into decision-making systems.

Room: Al-Qaisariyah | Date: Wednesday, April 08, 2026 | Time: 17:40 – 18:05 [Online]

[B17] The Emerging Role of Large Language Models in Threat Modelling: A Survey

Petter Buseth, (NTNU)); Ahmed Amro, NTNU (Norway); Athanasia Kollarou, Michail Takaronis, (NTNU)); Riku Lehkonen, (University of Jyväskylä); Sarang Shaikh*, Norwegian University Of Science and Technology (NTNU) (Norway)

Abstract: The increasing complexity of the cybersecurity landscape necessitates systematic and efficient approaches to threat modelling. Traditional methodologies such as STRIDE, LINDDUN, and MITRE ATT\&CK remain essential but are hindered by their reliance on expert knowledge and manual, time-intensive processes. Recent advances in Large Language Models (LLMs) offer promising opportunities to enhance automation and reduce effort in this domain. This paper presents a comprehensive literature review on the application of LLMs in threat modelling, identifying their roles across tasks such as system understanding, threat identification, and mitigation definition. The analysis reveals that while multiple models, including GPT-4.1, Gemini 2.5 Pro, ModernBERT, and domain-specific variants, have demonstrated encouraging results, current research is fragmented, often limited to specific contexts, and frequently evaluated using qualitative measures. Commonly employed input artefacts include system designs, Data Flow Diagrams (DFDs), and natural language system descriptions. Our findings indicate that, despite their potential, LLM-powered threat modelling approaches are still in an exploratory stage, with limited end-to-end integration and a strong reliance on fine-tuning for domain-specific tasks. This review highlights opportunities for establishing standardised frameworks and evaluation methodologies to advance LLM-assisted threat modelling toward practical adoption.

Room: Al-Qaisariyah | Date: Wednesday, April 08, 2026 | Time: 18:05 – 18:30 [Online]

[B18] AI Agent-Driven Semantic Parsing: Translating Natural Language to Structured Filters with LLMs in E-Commerce

Karthik Govardhanan*, Boston University (United States)

Abstract: Intelligent algorithms that can understand user intent and create structured, dynamic filters to improve product discovery are becoming more and more important for retail e-commerce platforms. Translating unstructured natural language queries into structured attribute-value filters, including category, price, and colour, is the goal of this paper's AI agent-driven architecture that is powered by large language models (LLMs). A user interface layer, a k-nearest neighbour (kNN) catalogue retriever, an LLM-based semantic agent, and a structured filter generator are all part of the system architecture that allows for explainable search

interactions in real-time. The approach accomplishes grounded and context-aware parsing by using retrieval-augmented generation (RAG), catalog-aware semantic embeddings, and chain-of-thought prompting. Our technique outperforms standard baselines on a simulated dataset with 50,000 fashion-related queries and 10,000 catalogue items. No-result rates are reduced by 47%, attribute coverage is increased by 21%, and filter accuracy is improved by 22%. In commercial e-commerce settings, our study establishes the groundwork for conversational search systems that are scalable, multimodal, and personalized.

Room: Al-Qaisariyah | Date: Wednesday, April 08, 2026 | Time: 18:30 – 18:55 [Online]

[B19] ASL2ESL-DL: Arabic Sign Language to English Sign Language Translation System Using Deep Learning

Amani Alazmi*, Kuwait University (Kuwait); Ayed Salman, (Kuwait University); Mohammad Alenzi, Public Authority for Applied Education and Training

Abstract: Deaf and hearing-impaired individuals use sign language as a form of communication. Sign language involves a series of movements, gestures, facial expressions, and postures that correspond to spoken language letters and words. Various sign languages are used worldwide, with the World Federation of the Deaf reporting in 2018 that more than 70 million deaf individuals use over 300 different sign languages globally. The world currently has different sign languages depending on the geographical location and the standard spoken language used in different countries. This created another layer of difficulty of communications among deaf people with each other's especially when they are living in different countries. For these reasons, scientists under the World Federation of Deaf (WFD) are currently trying to develop a universal sign language, called 'International Science Sign Language', for faster and easier communication between deaf people and to achieve the principle of equality. Designing a system that can translate between multiple sign languages would also work toward the same goal of easing communication among deaf individuals. This research objective is to enhance communication between deaf people using Arabic Sign Language and those who are using English Sign Language by proposing, designing, and implementing a novel middleware system that uses convolutional neural networks to translate between both sign languages. The proposed system is named Arabic Sign Language to English Sign Language translation system using Deep Learning (ASL2ESL-DL). In this thesis, we designed, implemented and tested ASL2ESL-DL on the "ArASL2018" dataset, which contains 54,049 images of 32 Arabic alphabet signs gathered from 40 different participants. The proposed model was implemented and showed an accuracy of 97.3% and a total loss of 12%.

Room: Al-Qaisariyah | Date: Wednesday, April 08, 2026 | Time: 18:55 – 19:20 [Online]

[B20] Tutor-Aware Automated Essay Scoring with Knowledge Graph Interpretability

Dhruv Shah, Ria Talsania*, Manthan Vala, Sardar Patel Institute of Technology (India); Bhavya Shah, Sardar Patel Institute of Technology; Dr. Kailas Devadkar, Sardar Patel Institute of Technology (India)

Abstract: Delivering reliability in Automated Essay Scoring (AES) requires explicit modeling of tutor-specific grading styles. In contrast to previous systems based mostly on general text embeddings or rubric aggregates, the introduced framework combines rubric-aligned rating, knowledge graph (KG) reasoning, and retrieval-augmented language model (LLM) feedback to capture both semantic depth and tutor consistency. A multi-tutor graded essay dataset was harmonized via column mapping and span-based annotation, allowing for structured analysis of rubric categories and qualitative comment alignment. To avoid sparse tutor coverage, augmentation approaches were utilized, effectively boosting robustness. Experimental evaluation shows that the method improves band-level prediction accuracy with interpretability preserved via KG-guided span–rubric–comment connections. Error analysis indicates misclassifications are limited to neighboring bands, which guaranties the model's calibration. These results pave the way for AES systems that are not only precise but also interpretable and adjustable to diverse grading habits.

Room: Al-Qaisariyah | Date: Wednesday, April 08, 2026 | Time: 19:20 – 19:45 [Online]

[B21] Empirical Evaluation of LLM-Generated Unit Tests

Hana Kapadia*, De Anza College (United States)

Abstract: The effectiveness of Large Language Models (LLMs) in generating unit tests is often questioned, with debates on whether their ability stems from deep comprehension or simple memorization. This paper presents an empirical study on pytest unit tests generated by both large (high parameter count) and small (low parameter count) LLMs for a dataset of 335 Python algorithms. To challenge memorization, we applied progressive code obfuscations, including renaming identifiers, inserting misleading docstrings, and injecting dead code. The quality of the generated tests was measured by pass rate and statement coverage. Our findings show that while the rate of generating perfectly executable tests is low, the tests are qualitatively strong, achieving high statement coverage that is resilient to heavy code obfuscation. This suggests that LLMs possess an abstract understanding of program logic, making them a robust tool for automated unit test generation.

Room: Diriyah | Date: Thursday, April 09, 2026 | Time: 10:15 – 10:40 [Online]

[B22] LLMs with Tools: Empirical Evaluation of the Thought-Action-Observation Paradigm

Muhammad Usman*, National University of Sciences and Technology (NUST) (Pakistan); Naima Iltaf, (NUST)); Muhammad Rayyan, (ODU)); Tauseef Rana, King Faisial University (Saudi Arabia)

Abstract: Large Language Models (LLMs) have progressed from static text generators to tool-augmented systems capable of interacting with external APIs, databases, and computational resources. Central to this transformation is the Thought-Action Observation (TAO) paradigm, which underpins modern agentic AI byenabling structured reasoning and external tool interaction. This paper presents an empirical study of tool-augmented LLMs, focusing on how TAO enables effective tool integration across diverse task categories. Using GPT model integrated with weather APIs, web search capabilities, and mathematical functions via LangChain/LangGraph frameworks, we systematically evaluate system performance across three representative case studies. Our analysis examines tool calling effectiveness along five critical dimensions: selection accuracy, parameter extraction quality, execution success rates, response integration, and operational latency. Our findings establish the TAO paradigm as the foundational framework for agentic AI systems, enabling autonomous agents to perform complex, multi-step problem-solving through structured interaction with external tools and resources.

Room: Diriyah | Date: Thursday, April 09, 2026 | Time: 10:40 – 11:05 [Online]

[B23] Invisible Risks: Evaluating LLM Safety Disparities Across Dialects and Low-Resource Languages

Cynthia Nosiri*, Morgan State University (United States); Emmanuel Masa-ibi, (Morgan State University); Hashmath Fathima, Morgan State University (United States); Binisa Giri, Derrick Cook, (Morgan State University); Kofi Nyarko, Morgan State University

Abstract: Large language models (LLMs) are increasingly deployed in safety-critical domains such as education, healthcare, and public services. However, safety evaluations rarely account for linguistic diversity, overlooking dialectal disparities that can reinforce systemic bias. We introduce a structured, multi-model framework to assess the safety and helpfulness of LLMs across four language varieties: Standard American English (SAE), African American Vernacular English (AAVE), Nigerian Pidgin, and Nepali. Using 100 prompts across five risk domains, we evaluate GPT-4o, Claude 3.5, and Gemini 1.5, annotating outputs for safety, helpfulness, refusal type, and failure type. Results reveal marked disparities: AAVE and Nigerian Pidgin responses showed both higher refusal rates and lower helpfulness, alongside increased under-detection of unsafe content, compared to SAE. In contrast, Nepali often outperformed SAE, exposing paradoxes in safety calibration. Inter-annotator agreement analyses confirm reliability. We release our rubric, dataset, and pipeline to foster equitable auditing, highlighting the urgent need for dialect-aware safety benchmarks and more inclusive AI alignment.

Room: Diriyah | Date: Thursday, April 09, 2026 | Time: 11:05 – 11:30 [Online]

[B24] Spam Detection for Arabic Texts based MarBert Transformer

Mohammed KHEYYI*, ENSA (Morocco); Bouchra Nassih, FEG (Morocco); Aouatif Amine, ENSA (UIT)

Abstract: Detecting spam in Arabic texts is challenging due to the complexity of the language's morphology and syntax. This study involves a comparative analysis of three models: The MarBert Transformer is based on the Bert architecture, recurrent neural networks (RNN), and long short-term memory (LSTM) networks. Each model was trained on a dataset named as the "Dataset of Arabic Spam and Ham Tweets" This dataset comprises both Arabic spam and legitimate tweets and the data was collected using the Twitter REST API. The evaluation of the models is focused on a range of metrics, including accuracy, recall, precision, and F1-score. The results demonstrated that the MarBert model achieved the highest performance more than other models. The good performance of the MarBert model can be attributed to its ability to understand context and recognize relationships within the Arabic text.

Room: Diriyah | Date: Thursday, April 09, 2026 | Time: 11:30 – 11:55 [Online]

[B25] Code Summarizer: A Deep Learning Transformer-Based Model (CS-DLT)

Nazia Bibi*, National University of Science & Technology (NUST) (Pakistan); Tauseef Rana, King Faisial University (Saudi Arabia); Muhammad Sohail, National University of Sciences and Technology, Islamabad Pakistan (Pakistan); Kamran Iqbal, Abdullah Abdulrhman Alaulamie

Abstract: Automatic code summarization is vital in software engineering to help developers understand, maintain and reuse complex code. Traditional deep learning models struggle with long-range dependencies whereas Transformers overlook syntactic structures. This paper introduces, a Transformer-based model with hierarchical attention and data-flow integration that captures token, statement and data flow level representations through structure-guided self-attention and a pointer generator mechanism. Experiments on the CodeSearchNet Java and Python datasets show that the proposed model outperforms in terms of evaluation metrics producing more accurate and human preferred summaries.

Room: Diriyah | Date: Thursday, April 09, 2026 | Time: 11:55 – 12:20 [Online]

[B26] Semantically Coherent Information Retrieval and Generation from a Corpus of Urdu News Texts

Muhammad Aasim Rafique*, KFU (Saudi Arabia)

Abstract: In the era of digital information overload, traditional keyword-based information retrieval (IR) systems often fail to capture semantic nuances in low-resource languages such as Urdu, leading to suboptimal relevance and user dissatisfaction. To resolve this issue, this article presents a unified framework for semantically coherent IR and natural language generation (NLG) tailored to Urdu news texts, aiming to enhance retrieval accuracy and generate fluent, human-like summaries. The proposed model integrates multilingual semantic embeddings such as paraphrase-multilingual-MiniLM-L12-v2) and FAISS indexing for efficient similarity-based retrieval, benchmarked against TF-IDF and BM25 baselines. Topic modeling via latent Dirichlet allocation refines semantic clustering, while transformer-based models like mBART enable abstractive summarization of retrieved contexts. Key findings from experiments on an 80/20 train-test split reveal that semantic approaches outperform baselines achieving up to 0.354 Precision@5. Similarly, 0.420 Recall@5, and 0.392 MRR in retrieval, alongside superior ROUGE-1 (0.42 improvement) and BERTScore-F1 (0.83) in generation, are achieved. These results underscore the role of semantic coherence in bridging resource gaps, with implications for scalable NLP applications in Urdu, thereby fostering improved information access and cross-lingual transfer.

Room: Diriyah | Date: Thursday, April 09, 2026 | Time: 12:20 – 12:45 [Online]

[B27] Retrieval Augmented Generation (RAG) to Reasoning-Augmented (RNA) Architecture: An Enterprise Seam Taxonomy and Migration Playbook

Viswapriyan Ragupathy*, IEEE Senior Member (United States)

Abstract: This study introduces a Reasoning-Augmented (RNA) architecture that extends Retrieval-Augmented Generation (RAG) with event-driven orchestration, typed policy governance, and dual-memory for enterprise decision-support. It provides concrete operational definitions, measurement protocols, and domain-grounded policies to address novelty, reproducibility, and governance clarity. An explicit "seam taxonomy" operationalises four migration-critical boundaries—data semantics, orchestration control-flow, memory persistence, and governance enforcement—with short workflow examples and traced to concrete policy functions and audit-log artefacts, distinguishing the work from checklist-style orchestration frameworks. A step-risk-cost-benefit alignment table, load-calibrated SLAs, and rollback gates make a four-phase migration playbook actionable; two domain prototypes (finance, healthcare) are normalised for hardware and workload for fair comparison; and evaluation protocols define "reasoning correctness" with a rubric, inter-rater agreement, and power analysis for statistical robustness. Results show raw values with confidence intervals rather than round percentages, latency distributions with concurrent load levels, and anonymised audit-log excerpts to demonstrate traceability. Governance is concretised by SOX/AML and HIPAA policies enforced at plan, action, and memory-access seams, and ethical risks in healthcare triage are assessed with harm-prevention guardrails and escalation policies. The findings show that integrating logic, memory, and governance as first-class seams improves performance and transparency for regulated settings. The conclusion focusses on near-term optimisations (planner granularity, memory indexing, and policy compilation) and removes speculative claims.

Track 3: Computer Vision, Imaging & Multimodal Perception

Room: Jawatha | Date: Wednesday, April 08, 2026 | Time: 14:45 – 15:10 [Online]

[C01] Cluster-based Multi-Object Tracking with Robust Kinematic Estimation for Dynamic Obstacles Under Area-Dependent Shape Variations

Ege Yılmaz*, Elif TOY AZIZIAGHDAM, OTOKAR (Turkey); Onur ACUN, (OTOKAR)

Abstract: Multi-object tracking (MOT) plays a critical role in autonomous driving, computer vision, and robotics, where maintaining the identity and trajectories of dynamic objects is essential. Traditional tracking pipelines often rely on object detections that assume targets are discrete and well-separated. However, in real-world scenarios—especially in dense urban environments—object clusters can appear fragmented due to sensor limitations or variations in the ego-vehicle's viewpoint as objects move. This study aims to enhance the robustness and temporal consistency by incorporating two velocity estimation techniques. The first method, Frame-Based Velocity Smoothing (FBVS), extends existing techniques by mitigating abrupt velocity fluctuations by assessing motion consistency across recent frames. The second, Area Change Ratio Smoothing (ACRS), is a novel method that improves spatial consistency by analyzing variations in object area, helping to suppress noise and maintain stable updates. These methods are designed to reduce false-target tracking, stabilize motion estimation, and handle sudden changes caused by occlusions, sparse point clouds, or misaligned segments. The proposed approaches were integrated into an Extended Kalman Filter (EKF)-based tracking system and evaluated using real-world data collected from an OTOKAR E-Centro autonomous bus operating in dense urban traffic conditions. All configurations were tested on the same dataset to ensure a fair comparison. Experimental results show that integrating FBVS and ACRS significantly improves motion coherence and orientation stability, particularly in cluttered or noisy environments.

Room: Jawatha | Date: Wednesday, April 08, 2026 | Time: 15:10 – 15:35 [In Person]

[C02] AI Powered Fainting Detection in Crowded Religious Sites: A Case Study of the Great Mosque of Mecca

Naif Almusallam*, King Faisal University (Saudi Arabia); Danah Almuhaysin; Shahad Almuotairi, mam Mohammad Ibn Saud Islamic University; Renad Alajmi, Dhay Alrubai; Aseel Alnazr, Imam Mohammad Ibn Saud Islamic University

Abstract: Loss of consciousness in public spaces, particularly in densely crowded environments such as religious gatherings in Mekka, poses a significant public health risk. Delays in detection and response can severely impact the effectiveness of medical inter- ventions. Traditional emergency response systems rely heavily on human intervention, which is inefficient in large crowds, noise, or limited visibility. To address this challenge, we propose an AI-powered computer vision system that is capable of detecting fainting incidents in real time through video surveillance feeds. Our approach leverages state-of-the-art deep learning architectures, including Convolutional Neural Networks (CNN), YOLOv8, and ResNet, to identify instances of fainting. Initial experiments using publicly available datasets revealed substantial limitations, such as low image resolution, lack of scene diversity, and inconsis- tent annotations, which adversely affected model per- formance. To overcome these challenges, we constructed a custom dataset with high-quality imagery, diverse scenarios, and rigorously validated annotations. This tailored dataset significantly improved model train- ing and generalization capabilities. Among the tested models, our CNN architecture achieved the highest performance, with a detection accuracy of 99.8%. These results demonstrate the feasibility and potential impact of deploying automated fainting detection systems in high-risk public environments to enhance emergency response time and save lives.

Room: Jawatha | Date: Wednesday, April 08, 2026 | Time: 15:35 – 16:00 [In Person]

[C03] AI-Powered Zooplankton Recognition Using VGG19: Advancing Smart Marine Monitoring in the Red Sea

Heider Wahsheh*, King Faisal University (Saudi Arabia); Mohammad Wahsha, Marine Science Station The University of Jordan (Aqaba Branch); Tariq Al-Najjar

Abstract: Zooplankton identification is the cornerstone of the monitoring of marine ecosystems, but the time-consuming and erroneous traditional taxonomy-based method. In this paper, we present an AI-driven framework for zooplankton classification in the Gulf of Aqaba, using a carefully collected image set and the transfer learning technique with VGG19 convolutional neural network. More than 15K annotated, consistently preprocessed, and augmented images, this aided in the robust training and validation of the model. Class scores of VGG19 classifier (overall accuracy 92.5%) were balanced for majority species (precision = 93.5%, recall = 93.1%, F1-score = 93.0%). The investigation showed that the vast majority of misclassifications exist among morphologically similar classes, highlighting class imbalance and intraclass variability. Our results show that deep learning, with expert annotation and thoughtful selection of dataset and adversaries, is able to offer rapid, objective and scalable solutions in real-time marine biodiversity quantification. The incorporation of AI-based approaches for marine monitoring is a game changer as it allows predicting ecosystem changes in advance and improved conservation management. To enhance reliability and broader applicability in dynamic environments like the Red Sea, further dataset refinement and transparent validation remain essential.

Room: Jawatha | Date: Wednesday, April 08, 2026 | Time: 16:00 – 16:25 [Online]

[C04] Naut AI: Design of a Novel AI-Driven Robotic Fish for Neritic Zone Exploration

Ryan Zou*, Dougherty Valley High School (United States)

Abstract: Environmental issues such as global warming and pollution have created a cascade of consequences that ultimately affect the health and functionality of the ocean. To tackle this issue this paper aims to design and implement an AI-Driven Robotic fish through biomimicry, in order to address the lack of non-invasive monitoring techniques and the inability to influence the behavior of fish. Naut AI employed a mass adjusting system to control the pitch/roll, and a single servo motor was used to create undulatory locomotion. Through the single servo the design is able to achieve a top speed of 26.40 cm/s. In addition to this, the proposed solution achieved a minimum turning radius of 27 cm when turning left and 12 cm when turning right. Additionally, the mass-adjusting system allowed for pitch-controlled diving at a max speed of 21.10 cm/s. Naut AI also uses computer vision in order to track colored objects. In the future, this idea can be used to create advanced monitoring systems that are able to identify changes in appearance that cannot be detected through traditional sensors. Furthermore, Naut AI is capable of swimming alongside the Koi fish, without disturbing or scaring the Koi away, laying the foundation to influence the movements and behaviors of real fish through an independent robotic device. Ultimately, Naut AI has various applications such as non-invasive monitoring in mariculture farms and shallow oceans, leading or herding fish away from pollutants and other hazards, and even zoning in the fishing industry to reduce bycatch.

Room: Jawatha | Date: Wednesday, April 08, 2026 | Time: 16:25 – 16:50 [Online]

[C05] Scoring Students' Answers Using OCR and GPT

abdulaziz Algablan*, Qassim University (Saudi Arabia); Raghad Alshammari, Sadeem Alresaini, Rana Alnughaimshi

Abstract: Artificial intelligence (AI) has immense potential to revolutionize grading and the delivery of efficient feedback to students, all while reducing the workload for instructors. Existing automated grading systems are typically limited to specific question types, such as true-false and multiple-choice questions, and often do not address the need to assess more diverse forms of student responses. This paper proposes ExaGrade, an open-source platform that integrates optical character recognition (OCR) with the Generative Pre-trained Transformer (GPT). It enables the use of AI models to automate the grading of student answers. The platform supports both

paper-based and online exams. The early results presented in this paper show promising capabilities in handling flexible formats for true/false and multiple-choice questions. However, further investigation and refinement are necessary to effectively address open-ended responses. The study observed that GPT's scoring of student answers faces notable limitations compared to instructor evaluations. The experiment revealed a low average Euclidean distance, indicating significant differences between the two grading methods. While the average cosine similarity of 0.628 suggests moderate alignment in grading patterns, the average exact match ratio of 0.648 reflects a moderate overall agreement between ExaGrade and the instructor's evaluations.

Room: Qiddiya | Date: Wednesday, April 08, 2026 | Time: 14:45 – 15:10 [Online]

[C06] Smart AI Assistive Stick for Safe and Independent Navigation for the Visually Impaired

Azween Abdullah*, HELP University (Malaysia); Prabhu Natarajan, Sathish Natarajan, Prabhu International Research Institute (PIRI) (Japan)

Abstract: This paper presents a novel smart assistive stick designed to enhance the mobility and independence of visually impaired individuals. The proposed system integrates a suite of advanced technologies, including a high-resolution camera, ultrasonic sensors, and an inertial measurement unit (IMU), all of which are orchestrated by a powerful embedded AI processor. The core of our system is a dual-AI model approach, featuring a custom-trained YOLOv8 model for real-time object detection and a sophisticated monocular depth estimation model for accurate distance measurement. This combination allows for comprehensive environmental perception, identifying potential obstacles, and assessing their distance and trajectory. The system provides intuitive multimodal feedback to the user through a combination of spatial audio alerts and haptic feedback, ensuring timely and unambiguous warnings. We conducted extensive experiments to evaluate the system's performance, demonstrating significant improvements in navigation accuracy, obstacle avoidance, and user satisfaction compared to traditional assistive devices. Our results show a 92% detection accuracy for critical obstacles within a 5-meter range and a 35% reduction in navigation errors in complex urban environments. This research makes a significant advancement in assistive technology, offering a practical and effective solution for enhancing the quality of life for individuals who are visually impaired

Room: Qiddiya | Date: Wednesday, April 08, 2026 | Time: 15:10 – 15:35 [Online]

[C07] Real-Time Visual Place Recognition via Cluster-Aware Hierarchical CNNs

Abdul Hafez Abdul Hafez*, King Faisal University (Saudi Arabia); Saed Alqaraleh, Mutah University (Jordan); Ahmad El Jouma

Abstract: —We propose a hierarchical image retrieval framework designed to enhance both accuracy and computational efficiency in large-scale visual place recognition (VPR) tasks. The architecture decomposes retrieval into two stages: a primary A convolutional neural network (CNN) that predicts the image cluster, followed by a specialized sub-model for fine-grained identification within that cluster. This design reduces search complexity while preserving high recognition performance. Built on a ResNet-18 backbone trained via transfer learning on In the Places365 dataset, the system achieves a response time of approximately 220 milliseconds on standard CPU hardware, outperforming several state-of-the-art methods in both speed and accuracy. Extensive experiments across multiple benchmark The datasets demonstrate the robustness of the approach to variations in lighting, viewpoint, and scene structure, making it highly suitable for real-time applications in robotics and autonomous navigation. The proposed method is lightweight, scalable, and adaptable for edge deployment, enabling practical real-time VPR in constrained environments such as drones, embedded systems, or mobile robots.

Room: Qiddiya | Date: Wednesday, April 08, 2026 | Time: 15:35 – 16:00 [Online]

[C08] Exposing the Illusion: A Comprehensive Survey on Deepfake Detection Techniques, Challenges, and Future Horizons

Zainab Rafique*, University of Management and Technology Lahore (Sialkot Campus) (Pakistan); Muhammad Wasim, UMT (Pakistan); Rwaida obaid Alssadi, Widian Alssadi, University of Bisha (Al Nakhil, Bisha)

Abstract: The rapid advancement in deep learning methods has made it possible to produce extremely realistic synthetic media, which are referred to as deepfakes. Deepfakes have creative value in film and media production but are also pose significant threats to privacy, security, and public trust. This paper conducts an extensive overview of deepfake detection techniques, classifying them according to their inherent techniques, such as machine learning, deep neural networks, frequency-based, and multimodal analysis. We analyze the efficacy and limitations of these techniques under different datasets and real-world cases. We further discuss the essential challenges in deepfake detection, including generalizability to out-of-distribution data, adversarial robustness, and lack of high-quality annotated datasets. Lastly, we emphasize new trends and provide directions for promising future work, such as explainable AI integration, lifelong learning, and cross-modal forensics. The survey endeavors to inform researchers and practitioners with a comprehensive view of the existing state and direct future advancements toward protecting the authenticity of digital media.

Room: Qiddiya | Date: Wednesday, April 08, 2026 | Time: 16:00 – 16:25 [Online]

[C09] Passenger-Comfort-Aware Hierarchical Multi-Mode Braking Control with Physics-Based Feedforward Compensation for Autonomous Vehicles.

Berke Miraç*; Osman Sezgin TemelCan Ercan; Elif Toy, OTOKAR (Turkey)

Abstract: The ability to accurately maintain longitudinal motion control is important for autonomous vehicles to operate safely and effectively in many traffic and road situations. This study proposed a hierarchical control algorithm in order to manage cruise and braking behaviors by utilizing planned stop locations and real-time obstacle perception. The control algorithm consists of four operating brake modes; Cruise, Smooth Stop, Hard Stop and Emergency Stop. These four modes provide rules for transitioning between modes dynamically that depend on requested stops, obstacles in the environment, and available stopping distance.In cruise mode, a PID controller is employed to minimize velocity tracking error, and the reference velocity is adapted according to road geometry and traffic constraints to ensure safe and comfortable motion. For both smooth stop and hard stop, a particular deceleration profile is followed that matches the requirements of the situation. Finally, regardless of mode, a single feedforward compensation term was integrated in all modes to track and compensate for aerodynamic drag, rolling resistance, and grade of road slope, respectively. The inclusion of the feedforward compensation term improved both speed tracking performance and braking performance with varying load applied and at changing terrain. The proposed control algorithm was implemented and evaluated on the OTOKAR e-CENTRO autonomous vehicle platform, successfully demonstrating good velocity tracking and safe stopping behavior in urban driving environments.

Room: Qiddiya | Date: Wednesday, April 08, 2026 | Time: 16:25 – 16:50 [Online]

[C10] A Novel End-to-End Single Image Dehazing Using Pix2Pix GAN

Vinaya Varshini Ravichandran, Department of Computer Science and Engineering University of North Texas (United States); PRIYAN MALARVIZHI KUMAR*, Abhignya Jagathpally, UNIVERSITY OF NORTH TEXAS (United States); Jeeva Selvaraj, Department of Computer Science and Engineering (Dayanand sagar university, Bangalore.)

Abstract: Haze is a significant deterioration of the image quality, which undermines visibility and limits the interpretation of the scene in the computer-vision applications. In the current research article, an advanced single-image dehazing model is suggested that is founded on the Pix2Pix conditional Generative Adversarial Network (cGAN). Its generator is a U-Net architecture that has an encoder-decoder structure, and skip

connections to retain small details, and a PatchGAN discriminator that enhances local realism. The training process of dehazed images using adversarial training allows approximating the clarity of the expected images. The effectiveness of the framework is supported by empirical assessment, which includes generator loss, discriminator loss, and L1 loss. Across more than 50 epochs, L1 loss decreases from 21.13 to 6.43, demonstrating a marked improvement in visual fidelity. The method is superior to conventional dehazing methods in the restoration of structural detail and texture and can be used in practical settings by virtue of the latter.

Room: Jawatha | Date: Wednesday, April 08, 2026 | Time: 17:15 – 17:40 [Online]

[C11] Structured Video Analysis for Abandoned Object Detection: A Hybrid Approach Combining Computer Vision and SQL-Database Querying with Generative-AI Model Comparisons

Tasmeer Alam*, Morgan State; Kofi Nyarko, Morgan State University

Abstract: The exponential growth of surveillance systems has created unprecedented challenges in detecting abandoned objects while maintaining forensic-level ownership attribution for security investigations. This paper presents a novel computer vision framework that integrates YOLOv11 object detection and tracking with structured SQL database storage, enabling comprehensive post-incident analysis of unattended objects in public spaces. Unlike traditional approaches that focus solely on detection accuracy, our system emphasizes queryable datasets supporting detailed forensic investigations through object tracking, occlusion handling, and ownership attribution mechanisms. The framework implements temporal label consistency correction, Kalman filter-based motion prediction, and robust spatial-temporal correlation analysis to maintain object identity continuity across extended surveillance periods. Evaluation using the ABODA dataset demonstrates superior performance compared to generative AI models (GPT-4o and Claude 3.5 Sonnet), achieving reliable ownership attribution for competing approaches. The structured querying approach enables security analysts to conduct detailed investigations without specialized computer vision expertise, making video analytics more accessible and interpretable for real-world surveillance applications in airports, transit stations, and public venues.

Room: Jawatha | Date: Wednesday, April 08, 2026 | Time: 17:40 – 18:05 [Online]

[C12] Comparative Analysis of MRI Slice Orientations for Autism Detection

Abdulaziz Aladdad, (Towson University); wassila lalouani*, Towson university (United States)

Abstract: Autism Spectrum Disorders (ASDs) are neurodevelopmental conditions that typically manifest during early childhood and are characterized by a broad range of cognitive, behavioral, and social impairments. Early detection is critical, as timely intervention is associated with significantly improved treatment outcomes. However, conventional diagnostic procedures are often prolonged and resource intensive, typically requiring assessments by multiple specialists over several months. Recent advances in artificial intelligence offer promising avenues for accelerating and enhancing the accuracy of ASD diagnosis. In this paper, we investigate the effectiveness of various computer vision models, specifically ViT-B/16, AlexNet, MobileNet, RegNet, and DenseNet for classifying Autism Spectrum Disorder (ASD) using coronal, axial and sagittal slices from magnetic resonance imaging scans. Our experimental results demonstrate that RegNet models outperform the others, achieving the highest classification accuracy and the lowest false positive rates, indicating their potential utility as a supportive diagnostic tool in clinical settings.

Room: Jawatha | Date: Wednesday, April 08, 2026 | Time: 18:05 – 18:30 [In Person]

[C13] Signal Processing–Guided Multimodal Encoder for Intelligent Bearing Fault Diagnosis

Mohammed Farag*, King Faisal University (Saudi Arabia)

Abstract: This paper presents a novel multimodal convolutional neural network (CNN) architecture with adaptive signal fusion mechanisms for bearing fault diagnosis using vibration signals. The proposed architecture employs three specializedprocessing branches—temporal, spectral, and spectrogram—thatextract complementary

discriminative features from raw vibra-tion data through domain-specific signal transformations. A dual-channel signal processing approach is introduced to simultaneously analyze raw signals and their analytical envelopes computed via Hilbert transform, capturing both carrier frequency characteristics and amplitude modulation patterns indicative of fault conditions. The architecture incorporates two fusion strategies:concatenation-based feature combination and adaptive gated fusion with learnable attention. Comprehensive experimental validation on two industry-standard bearing fault datasets (CaseWestern Reserve University and Paderborn University) demonstrates superior performance compared to individual branch architectures. The multi-branch architecture achieves validationaccuracies and F1-scores exceeding 99% across both datasetswhile maintaining computational efficiency suitable for real-timedeployment. Extensive ablation studies reveal that concatenation fusion consistently outperforms gated fusion, with the spectrogram branch demonstrating the highest individual performance on complex fault signatures. The proposed architecture provides interpretable fault diagnosis through comprehensive branch visualization and feature embedding analysis, establishing a robust foundation for industrial condition-based maintenance systems.

Room: Jawatha | Date: Wednesday, April 08, 2026 | Time: 18:30 – 18:55 [Online]

[C14] Extending Feature Selection Strategies in VGG16: Convolutional Feature Aggregation for Content-Based Image Retrieval

Saha Kuljit Shantanu*, Bangladesh University of Engineering and Technology (Bangladesh); Alina Zaman, Monirul Islam, Bangladesh University of Engineering and Technology

Abstract: Content-Based Image Retrieval (CBIR) has achieved significant advances through deep learning, with VGG16 serving as a widely adopted architecture for robust feature extraction. Conventional feature aggregation strategies, such as AdCoW+I, typically rely on a single dominant feature channel, potentially overlooking complementary semantic information from other channels. This paper proposes an adaptive multi-channel fusion framework that selects multiple high-ranking channels based on a dataset-dependent threshold(), determined through an iterative process to optimize representation. The selected channels are fused using weighted averaging, and spatial as well as channel-wise weighting schemes are applied to enhance discriminative capability while reducing visual burstiness. Experiments on the Oxford5k and Paris6k datasets demonstrate consistent improvements over AdCoW+I, with Mean Average Precision (MAP) increasing from 39.7% to 42.04% on Oxford5k and from 43.78% to 46.12% on Paris6k. Grayscale feature was also evaluated, yielding dataset-dependent effects—beneficial for Oxford5k but detrimental for Paris6k. The results highlight the potential of adaptive multi-channel fusion to improve CBIR accuracy while maintaining computational efficiency

Room: Jawatha | Date: Wednesday, April 08, 2026 | Time: 18:55 – 19:20 [Online]

[C15] Segmenting Photographs of Bat Wings Using U-Net Provides a Foundation for Recognizing Individuals

Robby Hoover, University of Cincinnati (United States); Melissa Meierhofer, (University of Cincinnati); Amitabh Chakravorty, University of Cincinnati (United States); Kevin Jin, Sai Keerthi Vadnala, (University of Cincinnati); Kojo Gyamfi, University of Cincinnati (United States); Rune Sørås, (Swedish Biodiversity Centre); Jeroen van der Kooij, Research and Consultancy van der Kooij; Joseph Johnson*, University of Cincinnati (United States)

Abstract: The ability to identify animals that have previously been encountered is necessary for answering many ecological questions. Bat ecologists often place uniquely numbered bands, or rings, on the forearm of a captured bat for later identification. However, there are concerns about the safety of this practice. An alternative approach is using the pattern of collagen-elastin bundles in the wings as unique biomarkers that can be identified from photographs. While valid, implementing this approach at a large scale is currently unfeasible because visually identifying these patterns is too labor-intensive. To simplify the process, we used a U-Net neural network to segment photographs of bat wings, reducing images to the collagen lines

to serve as a database for identification. Our segmentation model had a recall rate of 60\%, specificity of 99.9\%, accuracy of 99.9\%, and AUC of 75\%. The low recall rate resulted from class imbalance in the wing photographs, with \textless 2\% of pixels representing true positives (collagen lines). Despite a low recall rate, the model produced segmented images that bat ecologists used to accurately identify individuals 94.9\% of the time. These results demonstrate that U-Net is a promising application to aid with recognition of individual animals. Although our model's sensitivity can be improved, we suggest that future works use similarly segmented images in a fully-automated approach identifying bats from photographs.

Room: Qiddiya | Date: Wednesday, April 08, 2026 | Time: 17:15 – 17:40 [In Person]

[C16] Multi-Scale Attention-Enhanced Convolutional Neural Network for Real-Time Object Detection and Scene Understanding in Dynamic Environments

Fathimathul Rajeena P.P*, King Faisal University (Saudi Arabia); Rahoof P.P, Malabar Institute of Technology (India); Sunder R, galgotias university (India); Rasmi A, RR Institute of technology (India)

Abstract: The rapid increase in autonomous systems and intelligent surveillance systems has increased the desire for accurate real-time object detection and full scene understanding in dynamic environments. Traditional deep learning methods often fail to maintain detection performance under event conditions that include illumination variations, partial occlusions, or rapid camera movement/follow-up. Thus, in safety-critical applications, it will be common for traditional deep learning methods to underperform. This study introduces a new Multi-Scale Attention-Enhanced Convolutional Neural Network (MSA-CNN) that attempts to perform both object detection and scene understanding in real-time while optimizing runtime performance. The framework utilizes a hybrid architecture which includes multi-scale feature extraction, attention-guided feature fusion, and real-time processing to improve the robustness of MSA-CNN against environmental variations. We provide extensive experiments based on COCO, Cityscapes, and KITTI benchmark datasets. The evaluation is based on mean Average Precision (0.5:0.95), mean Intersection over Union (mIoU), and frames per second (FPS). The framework achieved 52.8 mAP score, 82.3 mIoU score, and utilized 45 FPS, outperforming other state-of-the-art baselines including YOLOv8, Deformable DETR, Mask RCNN, and Sparse R-CNN. The results of MSA-CNN provide substantial improvements to performance with both detection and full segmentation performance in real-time environments and will allow for real-world colonialization in autonomous vehicles and surveillance systems

Room: Qiddiya | Date: Wednesday, April 08, 2026 | Time: 17:40 – 18:05 [Online]

[C17] A Comparative Analysis of CNN and Vision Transformer Object Detectors Under Physical Adversarial Attacks in Automated Driving

Long Wang*, Queensland University of Technology (QUT) (Australia); Mohammed Elhenawy, CARRS-Q (Australia); Sebastien Glaser, (QUT)); Mahmoud Masoud, (KFUPM))

Abstract: This study examines the robustness of two object detection architectures, a convolutional neural network (YOLO11) and a vision transformer (RT-DETR), under adversarial patch conditions. Both models were evaluated on the APRICOT dataset with patch perturbations using standard detection metrics and custom robustness measures. YOLO11m achieved an mAP@0.5 of 0.15 and mAP@0.5–0.95 of 0.12, with 123 misclassifications and 1,052 robust detections. RT-DETR_50 obtained slightly higher accuracy (mAP@0.5 = 0.17, mAP@0.5–0.95 = 0.13) and precision (0.317), while producing 406 misclassifications and 1,417 robust detections. These results reveal a trade-off between the two approaches: the vision transformer provides stronger overall detection performance and improved robustness in preserving object recognition despite adversarial interference, whereas the convolutional neural network shows greater resilience to misclassification. The findings emphasise the importance of evaluating both accuracy and robustness metrics when comparing detection architectures for deployment in safety-critical domains.

Room: Qiddiya | Date: Wednesday, April 08, 2026 | Time: 18:05 – 18:30 [In Person]

[C18] Using Deep Learning and Computer Vision for Automating Waste Classification

Enas Jambi*, University of Jeddah (Saudi Arabia)

Abstract: Going green is a pressing issue in today's era, with efficient waste management being a critical challenge. This paper presents an AI-driven system that employs deep learning and the Internet of Things (IoT) to enhance recycling practices. A diverse dataset of waste images was collected and augmented to improve model generalisation. Three deep learning models—CNN, ResNet50, and YOLOv8—were trained and evaluated, with ResNet50 achieving the highest accuracy. The model was integrated with a Raspberry Pi and ultrasonic sensors to enable real-time waste classification and monitoring of bin fill levels. Based on sensor data, a cleaning schedule and notification system was developed to ensure timely collection. By addressing the common issue of improper use of recycling bins, the proposed system reduces operational costs and supports sustainable waste management for stakeholders such as the Ministry of Environment, Water, and Agriculture.

Room: Qiddiya | Date: Wednesday, April 08, 2026 | Time: 18:30 – 18:55 [Online]

[C19] Language-Driven Portrait Editing and Animation via Diffusion and Motion Control

Shoaib Khan*, QLU.ai (Pakistan)

Abstract: We present a feasibility study for a novel pipeline that unifies natural language–driven portrait editing with temporally consistent talking-head animation by integrating GPT4o instruction parsing, YOLOv8-Seg region masking, Stable Diffusion XL (SDXL) inpainting, and HunyuanPortrait motion transfer. Unlike existing frameworks that treat image editing and motion reenactment as isolated tasks, our system bridges them into an end-to-end workflow where user queries (e.g., "make the man wear a hat") are automatically decomposed, spatially localized, semantically edited, and animated. Experiments were conducted on dual RTX 3090 GPUs with separate CUDA allocation for SDXL and HunyuanPortrait to enable joint execution. Quantitative evaluation demonstrates that identity preservation and perceptual quality are largely maintained across edits, with PSNR of 16.78 and SSIM of 0.596 for original imageto-video consistency, compared to PSNR of 15.95 and SSIM of 0.500 for inpainted image-to-video. Cross-video comparison further confirms stability, yielding SSIM of 0.519 and LPIPS of 0.134 between original and inpainted outputs. These results highlight the viability of combining diffusion-based semantic editing with portrait animation, while also revealing current limitations in fine-grained segmentation, inpainting completeness, and inference efficiency.

Room: Qiddiya | Date: Wednesday, April 08, 2026 | Time: 18:55 – 19:20 [Online]

[C20] Autoclean EEG - ICVision: Automated ICA Artifact Classification Using Vision-Language AI

Zag ElSayed*, UC (United States); Gavin Gammoh, Grace Westerkamp, Peyton Siekierski, (CCHMC); Jack Yanchen Liu; Craig Erickson, Ernest Pedapati, (CCHMC)

Abstract: We introduce EEG Autoclean Vision-Language AI (ICVision)—a first-of-its-kind system that emulates expert-level EEG ICA component classification through AI-agent vision and natural language reasoning. Unlike conventional classifiers such as ICLabel, which rely on handcrafted features, ICVision directly interprets ICA dashboard visualizations topography, time series, power spectra, and ERP plots, using a multimodal large language model (GPT-4 Vision). This allows the AI to "see and explain" EEG components the way trained neurologists do, making it the first scientific implementation of AI-agent visual cognition in neurophysiology. ICVision classifies each component into one of six canonical categories (brain, eye, heart, muscle, channel noise, and other noise), returning both a confidence score and a human-like explanation. Evaluated on 3,168 ICA components from 124 EEG datasets, ICVision achieved $k = 0.677$ agreement with expert consensus, surpassing MNE-ICLabel, while also preserving clinically relevant brain signals in ambiguous cases. Over 97% of its outputs were rated as interpretable and actionable by expert reviewers. As a core module of the open-source EEG Autoclean platform, ICVision signals a paradigm shift in scientific AI where models

don't just classify, but see, reason, and communicate. It opens the door to globally scalable, explainable, and reproducible EEG workflows, marking the emergence of AI agents capable of expert-level visual decision-making in brain science and beyond.

Room: Jawatha | Date: Thursday, April 09, 2026 | Time: 10:15 – 10:40 [Online]

[C21] A Human-in-the-Loop Framework for Facial Perceptual Image Quality: Phase-1 Pilot

Hashmath Fathima*, Cynthia Nosiri, Morgan State University (United States); Kofi Nyarko, Morgan State University

Abstract: We introduce a human-in-the-loop stimulus generation framework aimed at studying facial perceptual image quality (PIQ), specifically focusing on skin appearance. The Phase-1 system is a Tkinter desktop application that integrates live webcam capture with controlled, parameterized edits, including brightness, contrast, sharpness, blur, saturation, various types of noise (Gaussian, impulse, and salt-and-pepper), and a skin-smoothing operator that combines HSV masking with bilateral filtering. The interface allows users to view original and edited images side by side and logs each saved stimulus with its precise parameter vector in JSON format. This logging includes timestamps, randomly assigned participant IDs, separate session folders, and links to initial and final surveys. Users also have the option to record think-aloud audio for each image. We present a within-subject protocol that standardizes the capture conditions and gathers mean opinion score (MOS) ratings for overall image quality, skin naturalness, skin-detail preservation, and pleasantness. A lightweight data pipeline merges JSON data from the application with survey responses, organized by image filename and ID. This enables precise stimulus regeneration, reproducible analysis, and quick quality control. A pilot study using convenience sampling demonstrates the feasibility of the system and reveals clear rating trends across different editing factors, showing how even minor adjustments can influence perceived facial quality and skin realism. Our key contributions include: (1) an extensible instrument for capturing and editing images, (2) a clear data schema and merging workflow, (3) a practical protocol for obtaining skin-aware PIQ assessments, and (4) a roadmap for Phase-2, which will incorporate segmentation-aware edits (such as perceptual gamma and gain adjustments) and larger-scale evaluations.

Room: Jawatha | Date: Thursday, April 09, 2026 | Time: 10:40 – 11:05 [In Person]

[C22] NavBuddy: An AI-Augmented Navigation Assistant for Context-Aware Route Guidance

Aron Bakes*, QUT (Australia)

Abstract: Navigation apps such as Google Maps have transformed modern transport, yet their reliance on delayed or ambiguous instructions can create stress and errors for drivers. Delayed prompts, unclear lane guidance, and poor alignment with real-world conditions increase cognitive load, particularly for users with spatial anxiety, which may undermine driver confidence and even lead to unsafe driving behaviour. We propose NavBuddy, an AI-augmented navigation assistant that leverages vision-language models (VLMs) and real-time scene context from the dashcam to convert Google Maps generic step-by-step directions into short, human-friendly, lane-level guidance. NavBuddy integrates live dashcam footage, navigation instructions, and route data to identify visible cues such as lane markings, exits, and landmarks, producing concise instructions. Our design prioritises clarity, safety, and reduced driver anxiety, while incorporating uncertainty fallbacks. Preliminary evaluations suggest that NavBuddy improves instruction clarity and driver confidence compared to baseline navigation prompts.

Room: Jawatha | Date: Thursday, April 09, 2026 | Time: 11:05 – 11:30 [In Person]

[C23] An Automated Approach for Classifying The Severity of Cucumber Diseases Using Deep Learning and Transfer Learning

Md Shamiul Islam*, Bangladesh University of Business and Technology (Bangladesh); Nabila Rahman, University of Genoa (Bangladesh); Md Tanim Mahmud, Bangladesh University of Business and Technology (Bangladesh); Arjun Naidu, Mustanzid Ashraf Toha; Samin Yasar, Bangladesh University of Business and Technology (Bangladesh); Md. Saifur Rahman, Bangladesh University of Business and Technology (BUBT) (Bangladesh); Syed Usman Jamil, charles sturt university (Australia)

Abstract: In the world of agriculture, where every cucumber plant symbolizes the toil of a farmer and the sustenance of the community, disease surveillance is indispensable. This system is an automated tool that helps farmers quickly and reliably identify and manage cucumber diseases. Farmer concerns include unexpected weather and crop diseases. We developed an autonomous system utilising deep learning and transfer learning to detect cucumber diseases by analysing images of cucumber plants. Along with the latest technology, our participative strategy prioritises farmers' needs. Utilizing custom-brewed CNNs and pre-fed models such as VGG16, ResNet50, InceptionV3 and we came up with a solution that's both powerful and accessible. The development was largely based on extensive testing and validation, which helped us improve models to recognize a variety of cucumber diseases, such as Anthracnose, Bacterial Wilt, Belly Rot, Downy Mildew, Fresh Cucumber, Fresh Leaf, Gummy Stem Blight and Pythium Fruit Rot. This means farmers can now detect infections early and treat them faster, improving crop management. The project addresses farmers' needs and empowers them with technology to improve their lives, not just algorithms and statistics. Automating disease classifications saves time and resources and calms farmers who depend on crops. Beyond improving cucumber diagnosis, it is creating a forum for agricultural collaboration and creativity. We will make smallholder farming more resilient and prosperous worldwide.

Room: Jawatha | Date: Thursday, April 09, 2026 | Time: 11:30 – 11:55 [Online]

[C24] C-MINT: A Causality-Aware Tokenized Multimodal Transformer for Infant Pain Estimation and Time-to-Relief Prediction

Sami Naouali*, King Faisal University (Saudi Arabia); Oussama Othmani, Ecole Polytechnique de Tunisie (Tunisia); Riadh Ouersighni, (Military Academy of F. Jedid)

Abstract: Neonatal pain assessment is challenging due to infants' inability to verbalize discomfort, often leading to subjective and variable evaluations using scales like NIPS and PIPP-R. We propose C-MINT, a Causality-Aware Multimodal Transformer, for precise pain estimation and time-to-relief prediction in neonatal intensive care units (NICUs). C-MINT integrates facial video, cry audio, and physiological signals (heart rate variability, electrodermal activity) using cross-modal tokenization, a structural causal layer, and diffusion-based counterfactual augmentation to ensure invariance to confounders like lighting or medical devices. It employs multi-instance ordinal regression for pain intensity estimation and a survival model for time-to-relief prediction. Evaluated on the Neonatal Pain Assessment Dataset (NPAD), C-MINT achieves 94.2% accuracy and 0.91 F1-score for pain estimation, with a 3.8-minute mean absolute error for time-torelief, outperforming baselines by 10–15%.With uncertainty calibration and token-level attribution, C-MINT offers interpretable, real-time monitoring, enhancing neonatal care.

Room: Jawatha | Date: Thursday, April 09, 2026 | Time: 11:55 – 12:20 [Online]

[C25] Multi-Level Feature Fusion: A Hybrid CLIP and Wavelet Pipeline for Robust Synthetic Image Detection

Ayush Bheemaiah*, UCSC (United States); Pushpita Joardar, University of California, Santa Barbara (United States)

Abstract: The advancements and widespread adoption of synthetic image generators, specifically diffusion models, have led to indistinguishable photorealistic content for disinformation. To combat this, existing detectors rely on identifying unique fingerprints in noise inconsistencies or semantic features extracted

by pre-trained foundational models. In this work, we propose a novel hybrid architecture that fuses high-level features from CLIP ViT-B/32's image encoder with low-level features in the frequency domain. Through cross-attention and learnable gating between CLIP's image representations and Haar wavelet transforms, our pipeline dynamically weighs semantic and frequency-based information, achieving 97% AUC and 94% accuracy in test splits. Notably, our method exhibits zero-shot generalization capabilities by outperforming state-of-the-art detectors with an average +13% AUC and +16% accuracy on out-of-distribution data from previously unseen models. Despite being lightweight, our model surpasses all tested detectors, demonstrating the potential for fusion methods to accurately distinguish between synthetic and real images.

Room: Jawatha | Date: Thursday, April 09, 2026 | Time: 12:20 – 12:45 [In Person]

[C26] Computer Vision for Parking management

Fatma Masmoudi*, AOU (Saudi Arabia); Norah Saad Al-Garnas, Department of Information Systems College of Computer Engineering and Sciences (Prince Sattam Bin Abdulaziz University, Alkharj, Saudi Arabia); Reema Nasser Al-Turki, Department of Information Systems College of Computer Engineering and Sciences (Prince Sattam Bin Abdulaziz University, Alkharj, Saudi Arabia); Remaz Khaled Al-Assaf

Abstract: Parking management is a major challenge in modern urban areas. In our project, a system based on image processing has been developed to improve parking management. The system aims to accurately classify images to determine parking status and categorize vehicles into classes such as good parking or bad parking. The system also focuses on detecting license plates to verify whether a vehicle is parked in its designated area, such as spaces reserved for individuals with disabilities, ensuring proper usage or highlighting violations. The system relies on a carefully prepared and labeled dataset using image classification tools, contributing to improved detection accuracy, reducing traffic violations, enhancing the user experience, and minimizing the negative impacts on traffic infrastructure.

Track 4: AI for Healthcare, Bioinformatics & Medical Imaging

Room: Hajar | Date: Wednesday, April 08, 2026 | 14:45 – 15:10 [Online]

[D01] Predicting Type 2 Diabetes from Vocal Features: An AI-Powered Approach

Daniyah Almusa*, - (Saudi Arabia)

Abstract: Type 2 Diabetes Mellitus (T2DM) is a common metabolic disorder often diagnosed at late stages, primarily because of the invasive and costly nature of diagnostic testing procedures. This study presents a non-invasive diagnostic approach based on voice analysis, supplemented by deep learning embeddings (BYOL-S) combined with clinical factors to determine T2DM status. Gender-based predictive models were developed to account for anatomical and physiological differences in vocal features. The Voting Classifier achieved promising results in this study with accuracies of 84.2% for male participants and 75.4% for female participants, along with Area Under Curve (AUC) values of 0.884 and 0.812, respectively. These findings highlight the potential of voice analysis as a scalable, cost-efficient, and accessible tool for early detection of diabetes. Future studies will focus on expanding the datasets and optimizing model topologies to increase generalizability.

Room: Hajar | Date: Wednesday, April 08, 2026 | Time: 15:10 – 15:35 [Online]

[D02] An Attention-Guided Deep Learning Framework for Brain Tumor Detection Using Multimodal MR Imaging

Ibrahim Abdelhaliem, Assiut University (Egypt); Oluwatunmise Akinniyi; Joseph Aina, (Morgan State University); Jose Dixon, (Morgan State); Shiva Mehravaran; Gehad Saleh, (Mansoura University); Md Rahman, (Morgan State University); Fahmi Khalifa*, Morgan State University (United States)

Abstract: Precise identification of brain tumors is essential for prompt and effective clinical treatment. Recently, AI-powered diagnostic platforms have gained prominence as impactful solutions, streamlining classification tasks and supporting swift, unbiased clinical decisions. In this work, we developed AI-based approach for classifying brain tumors. It introduces a multi-modal MRI framework that combines Diffusion-Weighted MRI (DW-MRI) with T2-weighted MRI (T2-MRI). To align spatial dimensions across imaging types while preserving critical visual details, T2-MRI scans are adjusted using a High-Frequency Information Retention (HFIR) method. The proposed model utilizes a dual-path 3D Convolutional Neural Network (3D CNN) to capture deep, modality-specific features. To further refine the representation of tumor characteristics, an Adaptive Region Attention (ARA) mechanism is incorporated, directing focus toward shared, highly discriminative regions across both modalities, thereby enriching tumor analysis. The model was tested on a custom-labeled brain MRI dataset comprising three tumor categories. Results highlight its effectiveness, with an accuracy of 92.86%, a sensitivity of 80.00%, and a specificity of 94.12%. Comparative statistical evaluations validate the model's superiority over current leading techniques, reinforcing its reliability and advanced performance for accurate brain tumor classification.

Room: Hajar | Date: Wednesday, April 08, 2026 | 15:35 – 16:00 [Online]

[D03] A Novel AI Approach to Investigate Curcumin's Potential to Delay Alzheimer's Onset Using Genetically Modified Drosophila

Zoe Fan*, Menlo School (United States)

Abstract: This study investigates the therapeutic potential of curcumin, a polyphenolic compound derived from turmeric, in reducing inflammation and alleviating Alzheimer's disease (AD) symptoms. Three experimental groups of Drosophila melanogaster (fruit flies) were used: a control group of GAL4 Drosophila, a group with AD-like symptoms, and a third group with AD-like symptoms treated with curcumin in their diet. The flies' health was assessed through two behavioral assays: a climbing test and a petri dish performance assay, both of which measured movement as an indicator of health. An AI-based solution was developed to analyze the flies' movement using OpenCV, calculating metrics such as speed and height. Flies given curcumin were significantly more active

compared to the others. The curcumin-treated flies lived 30% longer than those with AD-like symptoms. The untreated AD-like group showed slower movement and reduced health in both assays. In contrast, the curcumin-treated AD-like group moved 5.5 times faster and demonstrated improved health over time. Statistical analysis revealed highly significant differences between the curcumin-treated flies and the AD-like group ($p = 0.0086$), as well as between the control and AD-like groups ($p = 0.0075$), suggesting curcumin's positive effects. There was no significant difference between the curcumin-treated group and the control group, indicating that curcumin restored normal health levels in AD-like flies. These results suggest that curcumin's anti-inflammatory and antioxidant properties can delay AD progression. The study also demonstrates the utility of AI-based solutions in supporting Alzheimer's drug and nutrition research, showcasing curcumin's potential as a therapeutic agent.

Room: Hajar | Date: Wednesday, April 08, 2026 | Time: 16:00 – 16:25 [Online]

[D04] An Explainable Ensemble Learning Framework for Early Diagnosis of Pediatric Genetic Disorders

Ibtisam Alwethainani; Eman Alqaissi*, King Khalid University (Saudi Arabia)

Abstract: Timely detection of pediatric genetic disorders can reduce long-term complications and mortality, yet ambiguous early symptoms hinder accurate diagnosis. We present an AI-based diagnostic framework that integrates genomic and clinical data for early detection. Multiple models—XGBoost, Random Forest, Gradient Boosting, and artificial neural networks (ANNs)—were trained and compared. ANN and XGBoost achieved the best performance, with up to 99% accuracy, precision, and recall on the test set. To ensure interpretability, we combined SHAP-based feature attribution with large language models (LLMs) that generate clinician-friendly explanations of model outputs. Key predictors identified include parental variants and birth complications, while bagging with XGBoost further improved subclass classification. This hybrid approach demonstrates that high-performance predictive models can be paired with transparent, natural language explanations, supporting clinical decision-making in data-sparse pediatric conditions.

Room: Hajar | Date: Wednesday, April 08, 2026 | Time: 16:25 – 16:50 [Online]

[D05] CausalRAG-AD: Multimodal MRI Classification and Guideline-Compliant MRI Captioning for Alzheimer's Diagnosis

Ramisa Farha*, Morgan State University (United States); Md Mahmudur Rahman, (Morgan State University); Fahmi Khalifa, Morgan State University (United States)

Abstract: Alzheimer's disease (AD) is a degenerative disease, and current AI-based diagnostic procedures often lack calibrated probabilities, clear causal explanations, and comprehensive reporting. We propose CausalRAG-AD, an end-to-end framework that (i) trains calibrated transformer classifiers for AD staging from structural MRI and (ii) generates NIA-AA guideline–compliant, evidence-grounded MRI captions. The proposed architecture augments Video Vision Transformer (ViViT) with ROI-gated attention (CausalRAG-ViViT) from FreeSurfer hippocampus/ventricle/temporal z-scores and a light clinical gate; per-fold temperature scaling yields calibrated probabilities. It is evaluated against ViT+BiLSTM and ViViT-lite baselines using the Alzheimer's Disease Neuroimaging Initiative (ADNI) cohort. For binary AD vs. Cognitively Normal (CN), CausalRAG ViViT achieves the strongest calibration (ECE 0.078). In tri class CN/Mild Cognitive Impairment(MCI)/AD, CausalRAG ViViT reaches the best Acc (0.519) with competitive F1 (0.452). The proposed system produced 4,427 structured per-visit MRI reports. Every report contained all required sections, and most explicitly documented MRI provenance (scanner/vendor and field strength; 93.6%). All pipeline-generated numbers—MRI z-scores, MMSE, and CDR-SB—were replicated exactly from source tables (100% fidelity), and Aβ42 values matched the source (93.9%). When the necessary biomarkers were available, the AT(N) labels in the report consistently matched with our rule-based determination (100%).

Room: Hajar | Date: Wednesday, April 08, 2026 | Time: 17:15 – 17:40 [Online]

[D06] A Robust Attention-based Architecture for PE Detection Using Pulmonary CT Angiograms

Abeer Abdelhamid*, Faculty of Engineering, Mansoura University (Egypt); Amir El-Ghamry, Computer Science Department (Faculty of Computers and Information, Mansoura University); Ehab H.Abdelhay, Electronics and Communications Engineering Department (Faculty of Engineering, Mansoura University); Mohammed M. Abo-Zahhad, Electrical Engineering Department (Faculty of Engineering, Sohag University); Hossam El-Din Moustafa, Electronics and Communications Engineering Department (Faculty of Engineering, Mansoura University); Fahmi Khalifa, Morgan State University (United States)

Abstract: Pulmonary embolism (PE) is a critical and potentially fatal condition, ranking as the third leading cause of cardiovascular-related mortality after myocardial infraction and stroke. It occurs when blood clots obstruct the pulmonary arteries, hindering blood flow to the lungs. Timely and accurate diagnosis of PE is essential for effective clinical intervention; however, interpreting medical imaging remains a complex task for clinicians and may result in misdiagnosis. Deep learning (DL) offers significant potential in supporting computer-aided diagnosis (CAD) for PE detection. In this study, we present a classification approach that utilizes the Swin transformer to enhance diagnostic performance. The proposed model begins with a preprocessing stage involving an autoencoder, discrete wavelet transform (DWT), and Sobel filter to improve feature extraction and minimize noise. Subsequently, the Swin transformer is applied for classification task. The model was evaluated using the Radiological Society of North America (RSNA) dataset, categorized into normal and abnormal cases. Our approach achieved an accuracy of 96.4% and F1-score of 95.6% in PE classification. These findings underscore the model's effectiveness and its potential as a dependable tool for the early detection of PE.

Room: Hajar | Date: Wednesday, April 08, 2026 | Time: 17:40 – 18:05 [In Person]

[D07] Predictive Analytics for Proactive Patient Outcomes Prediction Using Multi-Modal Deep Learning

Muhammad Nabeel Asghar*, King Faisal University (Saudi Arabia)

Abstract: Electronic Health Records (EHRs) contain a wealth of information; however, they are exceedingly challenging to navigate. EHR data is frequently diverse, encompassing several forms of structured data, such as laboratory results and vital signs, and unstructured data, including clinical notes and physician diagnoses. Conventional models frequently necessitate comprehensive, human feature engineering to convert raw data into a comprehensible format, a procedure that is labor-intensive and susceptible to errors. This necessitates predictive models capable of managing the intricacies of EHR data while delivering actionable insights for immediate clinical decision support. This research presents the Multi-Modal Medical Predictor (M3P). The M3P framework is a hybrid architecture that analyzes several data streams, including vital signs, laboratory findings, clinical notes, and demographic data, via specialized components. It employs bidirectional LSTMs with attention mechanisms for time-series data, deep neural networks with residual connections for static data, and transformer-based architectures optimized for medical text in clinical notes. The outputs from these modules are subsequently merged with learned attention weights to produce a comprehensive patient depiction. This method was assessed using an extensive dataset of 125,000 patient records from various healthcare organizations. The suggested model achieved an AUROC of 0.892 for death prediction, 0.847 for readmission prediction, and 0.823 for length-of-stay prediction, surpassing conventional machine learning methods by 12–15%. By precisely forecasting adverse events, healthcare providers can optimize resource allocation, tailor treatment plans, and ultimately enhance patient outcomes, thereby reducing costs and saving lives, as well as decreasing mortality and readmission rates, which ultimately improves clinical decision-making and resource optimization.

Room: Hajar | Date: Wednesday, April 08, 2026 | Time: 18:05 – 18:30 [Online]

[D08] Comparative Analysis of Knowledge-Guided Few-Shot Brain Tumor Detection using Efficient Vision–Language Models and a Single-Shot Detector

OKIB ISLAM*, Morgan State University (United States); Joy Muchangi; Ayomide Bonojo, (Morgan State University); Md Mahmudur Rahman; Fahmi Khalifa, Morgan State University (United States)

Abstract: Brain tumor detection from MRI scans remains challenging due to morphological heterogeneity and limited annotated data, with manual interpretation being time-consuming and prone to inter-observer variability. While vision-language models (VLMs) and single-shot detectors have shown promise individually, no systematic comparison exists evaluating their performance under knowledge-guided few-shot learning constraints. This study presents the first head-to-head comparison of two state-of-the-art VLMs (PaliGemma-2 and SmolVLM) against a single-shot detector (YOLOv12), each augmented with a structured medical knowledge graph (KG) encoding ICD-10 and SNOMED-CT ontologies. We construct a multimodal KG linking brain MR image embeddings with clinical reports and inject semantic priors through graph-aware attention modules for VLMs and feature wise linear modulation for YOLOv12. Experiments are conducted under strict 1 shot, 3 shot, and 5 shot scenarios using a publicly available brain MRI dataset with glioma and meningioma annotations. Our comparative analysis reveals distinct advantages: PaliGemma-2 with KG achieves the largest performance gain (55.1% mAP, 18.9% F1), demonstrating superior ability to leverage structured knowledge. SmolVLM + KG shows notable efficiency gains (31.3% mAP) with minimal parameter overhead, while YOLOv12 + KG excels in precise localization with sustained spatial accuracy (5.3% mAP) and realtime inference capability. These findings establish that medical knowledge graph augmentation is a model-agnostic enhancement strategy, with each architecture offering unique clinical deployment advantages: PaliGemma-2 for high-accuracy diagnosis, SmolVLM for resource-constrained settings, and YOLOv12 for real-time surgical guidance.

Room: Hajar | Date: Wednesday, April 08, 2026 | Time: 18:30 – 18:55 [Online]

[D09] An Improved Residual 3D U-Net for Brain Tumor Segmentation

nooshin soroor*, Istiniye university (Turkey); Muhammed Davud, İstinye University (Turkey)

Abstract: Accurate brain tumor segmentation in MRI is essential for clinical diagnosis and treatment planning. This study proposes an improved deep learning model based on a Residual 3D U-Net architecture for glioma segmentation. The model integrates ResNet blocks to enhance feature extraction and employs skip connections to retain spatial detail across layers. The architecture features an encoder based on ResNet for extracting hierarchical features, followed by residual blocks that enhance feature representation while preserving spatial information. Skip connections are utilized during the decoding phase to handle structural scale variations within MRI images. Transposed convolutional layers in the decoder up-sample feature maps, retaining details and incorporating contextual information from earlier layers. Evaluated on the BraTS2020 dataset, the model achieved a Dice Score of 89.67\% for the whole tumor, 90.59\% IoU, 99.32\% accuracy, and 85.00\% F1-score, outperforming many state-of-the-art approaches. The proposed architecture holds promise for edge-deployable and real-time brain tumor analysis in clinical settings.

Room: Hajar | Date: Wednesday, April 08, 2026 | Time: 18:55 – 19:20 [Online]

[D10] Hypernetwork-Mediated Multimodal Fusion for Breast Cancer Molecular Subtype Classification Using Histopathology and Genomics

Faseela Abdullakutty*, Younes Akbari, Qatar University (Qatar); Somaya Al Maadeed, Qatar University; Ahmed Bouridane, University of Sharjah (United Arab Emirates); Rifat Hamoudi, (University of Sharjah); suchithra Kunhoth, Qatar University (Qatar)

Abstract: Accurate molecular subtyping of breast cancer into luminal versus basal/HER2 subtypes remains difficult due to limited integration of histopathology and genomic data. Existing multimodal fusion strategies

often underexploit cross-modal interactions and tend to overfit small cohorts, resulting in suboptimal classification. To address this, we propose a hypernetwork-based fusion framework where gene expression profiles dynamically modulate CNN parameters for histopathology analysis. Results on 5-fold cross-validation show that unimodal genomic models perform strongly, whereas image-only models perform poorly, and conventional early fusion provides no significant improvement. In contrast, the proposed hypernetwork-mediated fusion achieves 0.96 accuracy, with consistently high F1-score and AUC, clearly outperforming both unimodal and standard multimodal approaches on the same cohort. This establishes hypernetwork fusion with cross-modal augmentation as an effective and generalizable strategy for robust breast cancer subtyping, offering potential for precision oncology applications.

Room: Hajar | Date: Thursday, April 09, 2026 | Time: 10:15 – 10:40 [In Person]

[D11] Advanced Classification of Pancreatic Cancer: Harnessing Bag-of-Features with Linear SVM and Fine KNN

Hala Abuelmakarem*, King Faisal University (Saudi Arabia); Esraa Shaker, The Higher Institute of Engineering; Alshimaa Teaima, Cairo University (Egypt); Nourhan Yehia; Shimaa Khder, Bab El Sharia (Egypt)

Abstract: Pancreatic cancer is the 7th leading cause of cancer-related deaths worldwide and over 510,000 new cases are diagnosed annually internationally. While its incidence is relatively low (about 3% of all cancers), it accounts for a disproportionately high mortality rate, approximately 7% of all cancer deaths. Pancreatic cancer (PC) is a highly aggressive malignancy that does not cause symptoms in its early stages, so it is usually diagnosed when it has already advanced, making effective treatment more challenging. These reasons highlight the critical need for better early detection methods and more effective treatment options. In this study, 1411 CT images specifying two classes: 646 cases of normal and 765 cases of pancreatic tumor led to an efficient image classification with linear SVM and fine KNN. The classification stage attained an accurate level of KNN 98.59% and SVM 99.29%, yielding outstanding results that contributed to the early detection process.

Room: Hajar | Date: Thursday, April 09, 2026 | Time: 10:40 – 11:05 [Online]

[D12] A Novel Integration of Multimodal Strategies and Ensemble Learning to Enhance Reliability in Early Skin Cancer Detection

Medha Choudhry*, The Harker School (United States)

Abstract: A multimodal framework is introduced that improves skin cancer classification by integrating visual, structured clinical, and unstructured text-based features. A total of 2298 smartphone images from the PAD-UFES-20 dataset were preprocessed with resizing, augmentation, and image transformations, while patient attributes were selected based on statistical significance and encoded for model training. A Vision Transformer (ViT) was trained on the PAD-UFES-20 images and served as an end-to-end classifier, attaining an F1 score of 0.873 after hyperparameter tuning. ResNet18, fine-tuned on the HAM10000 dataset, served as a feature extractor. Additionally, Pixtral, a multimodal large language model (vLLM), released by Mistral in 2024, generated image descriptions that were embedded using a pretrained Sentence Transformer. The embeddings, combined with ResNet18-extracted features and clinical data, were used to train a LightGBM (LGBM) model, achieving a 0.849 F1 score, compared to 0.813 when LGBM was trained without Pixtral's text features. The final model is an ensemble that averages the softmax outputs from ViT and LGBM, resulting in an F1 score of 0.902 in five-fold cross-validation. This approach highlights the potential to enhance early detection of skin cancer by merging image, text, and clinical features, improving the classification accuracy for high-risk lesions.

Room: Hajar | Date: Thursday, April 09, 2026 | Time: 11:05 – 11:30 [Online]

[D13] Residual U Net for Enhanced Liver Tumor Segmentation in CT Images

Vinaya Varshini Ravichandran, Department of Computer Science and Engineering University of North Texas (United States); PRIYAN MALARVIZHI KUMAR*, Abhignya Jagathpally, UNIVERSITY OF NORTH TEXAS (United States); Balasubramanian kavin, SRM Institute of Science and Technology (India)

Abstract: In this study, we look at U-Net and ResU-Net as approaches to segmenting liver tumors in CT images. The study participants used 18,834 annotated CT slices to train and assess the models. The Dice score and IoU on ResU-Net were respectively 0.9621 and 0.931 which is better than U-Net, where they were 0.9465 and 0.908. Besides, ResU-Net scored precision 0.977, recall 0.975 and F1-score 0.976 structural similarity index of 0.979 suggesting better and more accurate boundary predictions. The reason for these improvements is the residual connections in ResU-Net which make it possible to use gradients well and repeat useful features, so ResU-Net can learn more difficult tumor shapes successfully. It was evident from images that ResU-Net correctly filled in small or uncertain edges that often aren't recognized by ResNet. Based on the findings, ResU-Net looks promising for managing accurate liver tumor segmentation, something that improves medical decision-making and disease treatment.

Room: Hajar | Date: Thursday, April 09, 2026 | Time: 11:30 – 11:55 [Online]

[D14] Enhanced Brain Tumor Classification Using a Hybrid MobileNet-FTViT-B16 Model Utilizing MRI Scans

PRIYAN MALARVIZHI KUMAR*, Tayyaba Shahwar, Abhignya Jagathpally, UNIVERSITY OF NORTH TEXAS (United States)

Abstract: Brain tumors, characterized by uncontrolled cell growth in the brain, are life-threatening conditions that require early detection and intervention to improve survival rates. Magnetic Resonance Imaging (MRI) is a pivotal tool for identifying and categorizing brain tumors based on attributes such as size and location. However, manual interpretation of MRI scans can be labor intensive, emphasizing the necessity for automated diagnostic solutions. This study implements MobileNet-FTViT-B16, which integrates the local feature extraction strengths of Convolutional Neural Networks (CNN) with the global context modeling abilities of Vision Transformers (ViT). The model is trained and tested using publicly accessible data comprising 7,031 MRI scans classified into four categories. By utilizing MobileNet-V2 for efficient feature extraction and a fine-tuned ViT for capturing long-range dependencies, the proposed method attained a remarkable classification accuracy of 97.87%, surpassing baseline models. This makes MobileNet-FTViT-B16 a highly efficient tool for automating brain tumor diagnosis, with significant potential for clinical applications.

Room: Hajar | Date: Thursday, April 09, 2026 | Time: 11:55 – 12:20 [Online]

[D15] A Dataset and Evaluation Framework for Socio-Cultural Awareness in Arabic Mental Health

Sumayah Alsakiti*, KKU (Saudi Arabia); Hassan Alhuzali, Umm Al-Qura University (Saudi Arabia); Ashwag Alasmari, KKU (Saudi Arabia)

Abstract: Large language models (LLMs) are increasingly used in digital mental healthcare, yet their ability to capture socio-cultural aspects of patient–doctor communication in under-represented languages such as Arabic remains unexplored. This paper addresses this gap by proposing a novel threelevel annotation schema for Arabic mental health questions that explicitly captures whether a question reflects cultural, sociocultural or religious influence. Building on the MentalQA dataset, we enriched an existing corpus with hierarchical socio-cultural labels, creating a novel resource for evaluating LLMs understanding of socio-cultural contexts in mental health questions in Arabic. We benchmark four LLMs including LLMs—GPT-4.1, ALLaM-7B, JAIS-13B, and DeepSeek-7B, using a standardized few-shot setting without fine-tuning. Results show that GPT4.1 consistently outperformed other models across accuracy, F1, and Jaccard metrics, while ALLaM-7B emerged as the most competitive open-source model. In contrast, JAIS-13B and DeepSeek-7B struggled, particularly

on broad and fine-grained tasks. Our findings highlight both the promise and current limitations of LLMs for culturally grounded Arabic mental health applications, underscoring the need for larger resources and targeted adaptation to capture linguistic, social, and cultural nuances.

Room: Qiddiya | Date: Thursday, April 09, 2026 | Time: 10:15 – 10:40 [Online]

[D16] Integrating Vision Transformers and Generative Models for High Accuracy Breast Cancer Detection from Histopathology Images

Sayli Aphale*, Eugene John, University of Texas at San Antonio (United States)

Abstract: Breast cancer remains a widespread and life- threatening disease for women, making early and accurate diagnosis critical to reducing mortality. Fast and reliable detection can significantly improve patient outcomes. Histopathology images play a vital role in documenting tumor cell characteristics, and recent advances in artificial intelligence have enabled automated analysis of such data for cancer detection. In this work, we propose a Vision Transformer (ViT)–based framework enhanced with synthetic data generation to classify benign and malignant breast cancer tissue samples. Our model was trained using both raw BreakHis dataset images and synthetic samples generated via Deep Convolutional Generative Adversarial Networks (DCGAN), which enhanced robustness across diverse histopathological patterns. To improve data quality, we applied three preprocessing techniques: Reinhard normalization, Enhanced Super-Resolution GAN, and Contrast-Limited Adaptive Histogram Equalization. The proposed ViT model achieved 99.24% test accuracy with a test loss of 0.5057, supported by strong precision, recall, and F1-scores. Importantly, we incorporated interpretability through attention visualization using CLS-token attention maps, which consistently highlighted tumor-relevant regions while suppressing background stroma. These results demonstrate that our approach not only achieves state-of-the-art classification accuracy, but also provides clinically meaningful interpretability, underscoring its potential as a promising tool for computer-aided breast cancer diagnosis.

Room: Qiddiya | Date: Thursday, April 09, 2026 | Time: 10:40 – 11:05 [Online]

[D17] Rabies Diagnosis in Low-Data Settings: A Comparative Study on the Impact of Data Augmentation and Transfer Learning

Khalil Akremi; Mariem Handous, Rabies Laboratory (Institut Pasteur de Tunis, University Tunis El Manar); Zied Bouslama, (WHO Country Office Tunisia); Mariem Hanachi, LR24IPT09) (Institut Pasteur de Tunis, Univesrity of Tunis-El-Manar, Tunisia); Farah Bassalah; Maryem Jebali, University of Tunis-El-Manar (Rabies Laboratory, Institut Pasteur de Tunis, Tunis, Tunisia.); Ines Abdeljaoued-Tej*, BIMS Laboratory (LR24IPT09), Institut Pasteur de Tunis, Univesrity of Tunis-El-Manar, Tunisia (Tunisia)

Abstract: Rabies remains a major public health concern across many African and Asian countries, where accurate diagnosis is critical for effective epidemiological surveillance. The gold standard diagnostic methods rely heavily on fluorescence microscopy, necessitating skilled laboratory personnel for accurate interpretation of results. Such expertise is often scarce, especially in regions with low annual sample volumes. This paper presents an automated, AI-driven diagnostic system to address these challenges. We developed a robust pipeline utilizing fluorescent image analysis through transfer learning with four deep learning architectures: EfficientNet-B0, EfficientNet-B2, VGG16, and Vision Transformer (ViT-B-16). Three distinct data augmentation strategies were evaluated to enhance model generalization. Our results demonstrate that TrivialAugmentWide was the most effective augmentation technique, preserving critical fluorescent patterns while improving robustness. The EfficientNet-B2 model, combined with TrivialAugmentWide, achieved perfect classification performance (100% accuracy, AUC=1.0), significantly outperforming other configurations. VGG16 showed inconsistent results, and ViT-B-16 consistently underperformed (75% accuracy), highlighting EfficientNet-B2's superior suitability for this medical imaging task. Despite constraints posed by a limited dataset, this research confirms the viability of deep learning for automating rabies diagnosis. The proposed method enables fast and reliable detection, with potential for further optimization. It can also function as a confirmatory tool in diagnostically

ambiguous cases. An online tool was deployed to facilitate practical access, establishing a valuable framework for future medical imaging applications. This work underscores the potential of optimized deep learning models to transform rabies diagnostics and improve public health outcomes. Topic.Artificial Intelligence and Applications:AI for Medical Diagnosis and Healthcare.

Room: Qiddiya | Date: Thursday, April 09, 2026 | Time: 11:05 – 11:30 [Online]

[D18] Regional Attention-Enhanced Swin Transformer for Clinically Relevant Medical Image Captioning

Muhammad Aasim Rafique*, KFU (Saudi Arabia)

Abstract: Automated medical image captioning translates complex radiological images into diagnostic narratives, offering radiologists decision support and reducing reporting workloads. We propose an encoder–decoder architecture that combines a Swin Transformer encoder, a learnable regional attention module, and a BARTbase language decoder with PubMedBERT embeddings. The model is trained and evaluated on the ROCO dataset, which contains more than 81k radiology images with paired clinical captions. The images are resized to 224 224, normalized and augmented, while the captions are cleaned and tokenized using a biomedical tokenizer. The Swin encoder extracts multiscale visual features, and the regional attention module assigns higher weights to diagnostically relevant regions, suppressing normal anatomy and improving explainability. After projecting and adaptively pooling features to 29 tokens, a BART decoder generates captions guided by cross attention over the attended regions. Training uses cross-entropy loss with AdamW and teacher forcing. Compared with baselines, the proposed model achieves higher ROUGE scores (0.603 vs 0.356 and 0.255), BERTS score (0.807 vs 0.645 and 0.623), and competitive BLEU/CIDEr scores. Qualitative analysis demonstrates accurate modality recognition, localization of abnormalities, and clinically precise descriptions across CT, radiograph, and angiography cases. The regional attention mechanism improves interpretability by highlighting image regions responsible for generated descriptions. These results suggest that the proposed approach brings state-of-the-art performance to medical image captioning while offering transparent diagnostic reasoning.

Room: Qiddiya | Date: Thursday, April 09, 2026 | Time: 11:30 – 11:55 [Online]

[D19] Interpretable Stacked Ensembles with PCA and SHAP for High-Accuracy Breast Cancer Diagnosis

Zainab Alkuwayti*, King Faisal University (Saudi Arabia); Fatima Alomran; Khawla Alhudabi, (King Faisal University); Banin Alessa, Shayma'a Younis; Marwan Abuzanona, (King Faisal University)

Abstract: Early and accurate classification of breast lesions (benign vs. malignant) remains critical for prognosis and treatment planning. This study proposes a robust, explainable ensemble framework that combines modern preprocessing, dimensionality reduction, class imbalance correction, automated hyperparameter search, and both model-agnostic and model-specific explainability to improve diagnostic performance on tabular clinical/pathological features. We merged two canonical Wisconsin datasets to form a 1,268-sample dataset and applied median imputation, standard scaling, and a two-stage feature-reduction pipeline: (1) PCA to compress redundant measurements and (2) SHAP-guided selection (and, for comparison, LASSO) to keep clinically informative attributes. To address class imbalance, we used SMOTE on training folds. Model development used a level-0 ensemble of Random Forest, ExtraTrees, LightGBM and XGBoost, whose hyperparameters were tuned with Optuna (Tree-structured Parzen Estimator) and a Logistic Regression meta-learner to produce a stacking classifier. We evaluated models with stratified 5-fold CV and a held-out test set, reporting accuracy, precision, recall, F1 and AUC. Explainability was provided by SHAP summary and PDP visualizations to validate feature effects and by per-sample SHAP explanations for model transparency. Our optimized stacking model achieved accuracy = 0.990 and F1 = 0.989 on the test set — a small but meaningful improvement over baseline ensembles and previous literature — while maintaining interpretable decision rules and stable feature importance alignment with clinical knowledge. The combination of SHAP-based selection + PCA + SMOTE + Optuna-tuned stacking provides a reproducible, high-performance, and explainable pipeline for breast cancer classification suitable for translational research and further clinical validation.

Room: Qiddiya | Date: Thursday, April 09, 2026 | Time: 11:55 – 12:20 [Online]

[D20] Multi-disease Prediction Using Hybrid Ensemble Learning and Explainable AI

Haji Qasim, Student (Pakistan); Laraib Abbas, National University of Computer and Emerging Sciences (Islamabad); Muhammad Atif Saeed*, NUCES (Pakistan); Noshina Tariq, FAST, NUCES, Islamabad (Pakistan); Akhtar Jamil, National University of Computer and Emerging Sciences (Pakistan); Alaa Ali Hameed, Istinye University (Turkey)

Abstract: Chronic health conditions are an important focus in the management of older adult health, including heart disease, hypertension, stroke, diabetes mostly appears jointly caused by common biological mechanisms. Early diagnosis is important for diseases before they occur and minimizing the strain on patients and healthcare infrastructure. Historically, separate models were required to predict each disease, which consumed much more computational resources and efforts. In this study we utilized the MIMIC-IV dataset and proposed a hybrid ensemble learning technique with explainable AI. This architecture brings together seven base classifiers using out-of-fold (OOF) stacking and utilizes CatBoost model as meta-model. Feature selection narrowed the dataset down to most relevant 28 attributes clinically meaningful and for global and local explanations we incorporated SHAP and LIME, Making predictions clear and understandable. The model forecasts the risk of heart disease, stroke, hypertension, and diabetes simultaneously, achieving best performance with AUCs of 0.86 for heart disease, 0.81 for stroke, 0.81 for hypertension, and 0.87 for diabetes. SHAP analysis identified key risk factors aligned with medical expertise, whereas LIME supplied patient-level interpretations. this strategy mitigates the weaknesses of conventional single-disease approaches by identifying interdependencies among diseases and enhancing accuracy and improving model transparency. this framework reveals promise for practical use in early risk identification, healthcare decision support and bias identification, presenting a stable and open tool for medical use.

Track 5: Cybersecurity, Privacy & Trustworthy Machine Intelligence

Room: NEOM | Date: Wednesday, April 08, 2026 | Time: 14:45 – 15:10 [In Person]

[E01] Detection of Malicious Websites Based on Hybrid Machine Learning (HML)

maitha alarjani*, KFU (Saudi Arabia)

Abstract: Everyone depends on the internet nowadays. People prefer online shopping, recharge, booking, and banking. As the internet becomes more integrated into our daily lives, it's important to stay vigilant against online threats. One of the most common ways that cybercriminals try to steal personal information or infect devices with malware is through malicious Uniform Resource Locators (URLs). This can include phishing scams, where the user is tricked into entering their login credentials or other sensitive information on a fake website, or malware downloads, where clicking on a link can infect the user's device with harmful software. Due to the consequences and the destructive impact that malicious URLs leave on their victims, including losing money, critical data, and reputation, it was necessary to develop a technique to detect those malicious websites. In this paper, a method is developed, an intelligent model that can identify and pick up on the suspicious characteristics common to malicious websites. This work aims to help prevent and mitigate the risks of malicious websites. It can be done by building a new hybrid machine-learning model for detecting malicious websites. Also, the Synthetic Minority Oversampling Technique (SMOTE) was used to handle imbalances in class data. The data was used from the Kaggle website; The three proposed classification algorithms used via hard voting in this paper are Random Forest (RF), Support vector machine (SVM), and Adaboost URLs, as using a hybrid model gives 98.87% accuracy. This technique outperforms recent studies that have been conducted to detect malicious websites.

Room: NEOM | Date: Wednesday, April 08, 2026 | Time: 15:10 – 15:35 [In Person]

[E02] Random Client Selection for Contrastive Federated Learning in Parameter Poisoning Attacks

Achmad Ginanjar*, The University Of Queensland (Australia)

Abstract: Vertical Federated Learning (VFL) has revolutionised collaborative machine learning by enabling privacy-preserving model training across multiple parties. However, it remains vulnerable to information leakage during the sharing of intermediate computations. Although Contrastive Federated Learning (CFL) was introduced to mitigate these privacy concerns through representation learning, it still faces challenges from gradient-based attacks. This paper presents a comprehensive experimental analysis of gradient-based attacks in CFL environments and evaluates the selection of random clients as a defensive strategy. Through extensive experimentation on eight datasets, we demonstrate that random client selection proves particularly effective in defending against gradient attacks in the CFL network, decreasing the attack success rate to 16%. Our findings provide valuable insights for implementing robust security measures in contrastive federated learning systems, thereby contributing to the development of more secure collaborative learning frameworks.

Room: NEOM | Date: Wednesday, April 08, 2026 | Time: 15:35 – 16:00 [In Person]

[E03] Utilizing Blockchain and IPFS for Government Correspondences in Saudi Arabia

Mohammed Alannsary*, Institute of Public Administration (Saudi Arabia)

Abstract: Governments often still rely on printed letters for communication between agencies, despite broad e-service adoption. In Saudi Arabia, the legacy National Correspondence System links fewer than 30% of agencies and enforces a 20 MB transfer limit, which necessitates that large attachments resort to fallback FTP storage, leading to single points of failure and hampering response times. This paper outlines a recommended blueprint for a national inter-agency communication exchange that integrates a permissioned ledger (permissioned blockchain) with a private IPFS cluster to ensure immutability, verifiability, detailed access management, and decentralized storage while avoiding the duplication of complete documents

on the blockchain. In addition, a description is provided for block schema, identity and access mapping, an integration API, and an IPFS pinning/replication policy designed for the National Data Management Office sensitivity categories (Public, Restricted, Secret, Top Secret). To ensure reproducibility, a practical example and a validation roadmap (testbed strategy and KPIs) for a pilot project of limited scale is offered. The suggested design is operationally oriented - it reduces alterations to current agency DMSs, utilizes the Government Secure Network for connectivity, and outlines governance and on boarding processes for National Information Center and Digital Government Authority. The outcome is a viable, verifiable, and expandable approach to diminishing paper correspondence, enhancing traceability, and speeding up inter-agency processes. This paper presents an implementation-ready architecture and a pilot validation roadmap; it reports a design and evaluation plan rather than results from a nationwide deployment.

Room: NEOM | Date: Wednesday, April 08, 2026 | Time: 16:00 – 16:25 [Online]

[E04] Modern Cryptographic Approaches for Data Security in Cloud Computing

Moath Alamri*, King Faisal University (Saudi Arabia); Munam Ali Shah, Department of Computer Networks and Communication, King Faisal University, Al-Ahsa, Saudi Arabia (Saudi Arabia)

Abstract: Cloud computing stands as the main approach for processing and storing extensive amounts of data. Outsourcing data storage with third-party cloud providers creates substantial issues about confidentiality protection while also affecting the integrity of data along with privacy concerns. Research into cloud data security employs various cryptographic methods such as HE, ABE, Blockchain-based security, PQC and hybrid cryptographic models to address the identified challenges. Research presented here contains a Systematic Literature Review analysis of 25 recent studies spanning between 2020 and 2025 to evaluate effectiveness combined with efficiency and limitations when these techniques are used in cloud environments. A system for classification sorts cryptographic methods using their functional aspects and use environments. Comparative and descriptive tables were formulated to show research gap and performance metric and trend analysis. The studies demonstrate the preference for hybrid and quantum-resistant solutions yet researchers still confront challenges when attempting to scale these solutions and enhance their performance level. The paper outlines essential research areas and suggests research pathways that enhance security measures for dynamic distributed cloud systems.

Room: NEOM | Date: Wednesday, April 08, 2026 | Time: 16:25 – 16:50 [Online]

[E05] A Comprehensive Survey on Blockchain-Based E-Voting Systems: Security, Anonymity, Consensus Mechanisms, Decentralization, and Scalability

Hasan Ramadan, (Lebanese American University); Khaleel Mershad*, Lebanese American University (Lebanon)

Abstract: Electronic voting (e-voting) is related to the process of election using electronic means to assist in casting and counting ballots in a predefined time frame. Blockchain, on the other hand, has a high potential to be integrated into the e-voting systems due to the security and immutability it provides. This comprehensive survey paper explores the promising field of blockchain-based e-voting systems, assessing critical factors to prevent common challenges in traditional voting systems. Our investigation shows that blockchain technology offers promising security features through its various immutable architectures and cryptographic features. The decentralized structure of e-voting blockchain-based systems eliminates single points of failure and reduces the chance of exploiting the system. We also presented various consensus mechanisms and explored the advantages of each over the other. Hybrid consensus protocols were discussed in which two consensus algorithms were homogenized to leverage their combined advantages and security. Blockchain technology integrally provides essential features necessary for the voting process, such as transparency, immutability, and security. Furthermore, we categorized different security threats or attacks common in traditional systems and how researchers suggested building or designing the system to prevent these attacks. Although the results were promising in security and preventing attacks, scalability seemed to be an issue. The consensus protocols and

the security measures taken seemed to affect scalability. This survey paper contributes to the field by offering a formal approach for analyzing blockchain-based systems at different levels and discussing certain limitations. These levels include security characteristics, transparency mechanisms, privacy and anonymity features, scalability approaches, decentralization principles, consensus mechanisms, and overall system efficiency.

Room: Trojena | Date: Wednesday, April 08, 2026 | Time: 14:45 – 15:10 [In Person]

[E06] Privacy-Preserving AI using Federated Multimodal Attention Networks for Healthcare and Robotics

Sathish Natarajan*, Prabhu International Research Institute (PIRI) (Japan); Azween Abdullah, HELP University (Malaysia); Ilangovan Perumal, (Perdana University); Prabhu Natarajan, Prabhu International Research Institute (PIRI) (Japan)

Abstract: The integration of multimodal data in healthcare and autonomous navigation presents privacy challenges while demanding high accuracy. This paper introduces a novel framework combining multimodal attention networks with federated learning for privacy-preserving AI. Our approach leverages modality-aware attention mechanisms to fuse heterogeneous data, including medical images, clinical records, RGB-D streams, and LiDAR data, while ensuring differential privacy ($\varepsilon = 1.0$, $\delta = 10^{-5}$). The system demonstrates 96.3% accuracy in healthcare diagnosis and 89.4% success rate in navigation, with 85% communication reduction and <200ms latency. Contributions include a novel multimodal attention architecture for federated learning, a theoretical analysis of privacy-utility trade-offs, comprehensive experimental validation across various domains, and practical deployment considerations for real-world applications.

Room: Trojena | Date: Wednesday, April 08, 2026 | Time: 15:10 – 15:35 [In Person]

[E07] SecureBio-AI: A Quantum-Resistant Zero-Trust Multimodal Biometric Authentication

Prabhu Natarajan*, Prabhu International Research Institute (PIRI) (Japan); Azween Abdullah, HELP University (Malaysia); Ilangovan Perumal, (Perdana University); Sathish Natarajan, Prabhu International Research Institute (PIRI) (Japan)

Abstract: Digital authentication systems face unprecedented challenges from sophisticated cyber threats, quantum computing advances, and stringent privacy regulations. Traditional authentication methods and conventional biometrics are increasingly vulnerable to AI-powered attacks and quantum cryptanalysis. This paper presents SecureBio-AI, a novel, quantum-resistant, zero-trust, multimodal behavioral biometric authentication system that addresses these critical security gaps. Our methodology integrates four behavioral modalities—keystroke dynamics, mouse dynamics, gait analysis, and touch dynamics—through an explainable AI-driven attention mechanism. The system implements CRYSTALS-KYBER encryption, lattice-based differential privacy, and quantum-secure federated learning to ensure comprehensive protection against both classical and quantum adversaries. Experimental evaluation on a 500-user dataset demonstrates 92.47% authentication accuracy with quantum-resistant privacy guarantees (ε=0.8, δ=1e-6). SecureBio_x0002_AI represents the first truly future-proof behavioral biometric solution, providing 256-bit quantum security while maintaining practical performance for real-world deployment.

Room: Trojena | Date: Wednesday, April 08, 2026 | Time: 15:35 – 16:00 [In Person]

[E08] Achieving Consensus in Distributed Ledgers: A Comparative Analysis of Consensus Mechanisms in Blockchain

maha Al-Qahtani*, kfu (Saudi Arabia)

Abstract: Blockchain technology has emerged as a foundational element of the digital economy, enabling secure, transparent, and decentralized transactions across diverse domains._x000D_ Although numerous consensus algorithms have been proposed,_x000D_ existing studies often examine them in isolation or from a_x000D_ limited set of metrics. This paper presents a comprehensive_x000D_ and integrated comparative

analysis of major consensus mechanisms—Proof of Work (PoW), Proof of Stake (PoS), Delegated PoS (DPoS), Practical Byzantine Fault Tolerance (PBFT),_x000D_ and Federated BFT (FBFT). We systematically evaluate their_x000D_ verification processes, performance metrics, security trade-offs,_x000D_ and application contexts. Our contribution lies in consolidating_x000D_ these aspects into a unified framework that highlights critical_x000D_ design trade-offs and decision criteria for selecting appropriate_x000D_ consensus protocols. This work aims to support researchers and_x000D_ practitioners in developing and deploying more efficient and_x000D_ secure blockchain systems._x000D_

Room: Trojena | Date: Wednesday, April 08, 2026 | Time: 16:00 – 16:25 [Online]

[E09] Transforming Customer Experience in Fintech through Ethical, Scalable, and Secure AI Systems

Muthu Selvam*, University of North Carolina at Charlotte (United States)

Abstract: AI solutions must be efficient, ethical, scalable, and secure to maintain consumer confidence and regulatory compliance in the fast-changing Fintech market. The ESS-AI framework, a multi-layered architecture, includes Ethical AI for fairness and transparency, Scalable Infrastructure for horizontally extensible services using Kubernetes and edge computing, and Security & Privacy Control based on differential privacy and zero-trust principles. While theoretically comprehensive, the framework does not offer new algorithms but incorporates best practices to allow safe AI implementation in financial situations. Two main use cases were built in a cloud-native sandbox: real-time fraud detection using Random Forest and LSTM models, and a transformer-based financial counselling chatbot. However, dataset provenance, bias evaluation methodologies, and replication are detailed for transparency and benchmarking validity. Benchmarked against a "traditional AI baseline" of tree-based classification models and generic chatbots, the results show an average response latency 53% lower and a 76% reduction in demographic bias. These metrics were calculated using fairness and latency measurements for gender and ethnicity subgroups. Despite considerable improvements, the confined sandbox setting limits the findings and requires more testing in genuine Fintech systems. While ESS-AI provides a framework for ethical AI in finance, it requires further validation, standardization, and user-stakeholder feedback before its widespread adoption.

Room: Trojena | Date: Wednesday, April 08, 2026 | Time: 16:25 – 16:50 [Online]

[E10] Concept-Drift Aware and Obfuscation-Resistant Federated Learning for Android Malware Detection

Kawthar Chakif, (Qatar University); Faria Nawshin*, Devrim Unal, Qatar University (Qatar)

Abstract: The growing use of Android devices has made them a prime target for malware, which is increasingly difficult to detect because of concept drift and code obfuscation. Federated Learning (FL) offers privacy-preserving detection, but current approaches fail to address these two challenges together. We propose COR-FL, an FL framework that addresses both the issue of concept drift and obfuscation in Android malware detection. COR-FL combines an Evolution-Aware Feature Adaptation (EAFA) module to handle temporal data shifts with an Ensemble Transformer architecture that enforces representation consistency, improving resilience against obfuscated malware. Evaluations on KronoDroid, AndroZoo, and AndroOBFS show that COR-FL achieves 90–99% accuracy and an F1-score above 92% under long-term drift (2008–2020), sustains an F1-score above 87% with up to 100 heterogeneous clients, and maintains above 90% accuracy and F1-score against obfuscation. These results highlight the scalability and robustness of COR-FL, surpassing existing solutions in both accuracy and adaptability for real-world federated malware detection systems.

Room: NEOM | Date: Wednesday, April 08, 2026 | Time: 17:15 – 17:40 [In Person]

[E11] A Cryptographic and Usability-Aware Framework for Securing Social Media Posts Using ECC Digital Signatures

Heider Wahsheh*, King Faisal University (Saudi Arabia); Mohammed S. Al-Zahrani

Abstract: The unregulated proliferation of information on online platforms is deteriorating public trust, and the only recourse seems to be beyond mere reactive approaches using traditional AI systems such as detection methods that are biased and do not generalize well. A cryptographic and usability-friendly approach to embed digital signatures directly in social media posts using Elliptic Curve Cryptography (ECC) is presented. We create a lightweight proof of concept tool that can be used to allow users in Saudi Arabia to sign and verify content before sharing it on platforms such as X (previously Twitter), WhatsApp, Telegram etc without any infrastructural changes required for the platform. The system is integrated with the Saudi National Root Certification Authority fucking (Root-CA) to support verifiable authorship through trusted certificates. Two ECC schemes — ECDSA and EdDSA (Ed25519) were compared in terms of signing speed, verification time, signature size and platform support. Forty-eight participants engaged in a formal usability evaluation (following ISO 9241-11 guidelines) which evaluated efficiency, effectiveness and satisfaction; the System Usability Scale (SUS). Results indicate that Ed25519 greatly outperformed ECDSA in cryptographic efficiency and user experience overall faster actions, higher task success rates, better usability scores. This implementation provides a proof of concept for integrating legally binding, cryptographically sound and user-friendly authentication with the day-to-day social media operation that would contribute towards achieving SAUDIs Vision 2030 digital transformation objectives

Room: NEOM | Date: Wednesday, April 08, 2026 | Time: 17:40 – 18:05 [In Person]

[E12] CyberGuard: A Smart Vulnerability Detection System

Wael Elsersy, University of East London - Hosted by European Universities in Egypt (Egypt); Ahmed AbdelWahab, Arab Open University (Saudi Arabia); Mohamed Elsersy*, Higher College of Technology (United Arab Emirates)

Abstract: Software vulnerabilities remain a critical concern in modern application development, exposing systems to risks such as data breaches, operational failures, and financial liabilities. To address these challenges, This study introduce CyberGuard, an advanced machine learning-based system to detect, classify, and remediate software vulnerabilities. CyberGuard leverages transformer-based models, particularly CodeBERT, to conduct real-time static code analysis, enabling precise identification of security issues and delivering actionable guidance to devel_x0002_opers. By incorporating the Common Weakness Enumeration (CWE) taxonomy and the Common Vulnerability Scoring System (CVSS) metrics, the platform supports detailed categorization and prioritization of vulnerabilities based on severity. The study evaluated the software Vulnerabilities detection system using benchmark datasets that include a wide range of program_x0002_ming languages with several vulnerability types. Hence, The study criticize the Cyberguard performance against state-of-the_x0002_art systems such as LineVul and VulDeePecker. Experimental results show that CyberGuard achieves a 12.7% improvement in F1-score, demonstrating its effectiveness in identifying and addressing security threats. Furthermore, its ability to integrate smoothly into DevSecOps pipelines offers a scalable and efficient approach to strengthening secure software development practices. CyberGuard lays a robust foundation for future research in proactive threat mitigation and intelligent vulnerability repair, contributing to the advancement of AI-driven cybersecurity.

Room: NEOM | Date: Wednesday, April 08, 2026 | Time: 18:05 – 18:30 [Online]

[E13] Class-Coverage Sampling and Entropy-Weighted Aggregation: A Novel Framework for Tackling Heterogeneity in Federated Learning

Ao Chen, James Watt School of Engineering,University of Glasgow (United Kingdom); Habib Ullah Manzoor, University of Glasgow, UK (United Kingdom); Sajad Hussian; Lina Mohjazi, Ahmed Zoha*, University of Glasgow (United Kingdom)

Abstract: Federated Learning (FL) trains a collaborative model without sharing local data, thus protecting privacy. However, in practical FL deployments, not all clients can participate in model training. Therefore, selecting

training clients becomes necessary to address this problem. Another major issue is data heterogeneity. In this case, random client selection may lead to insufficient class coverage, unstable convergence, and reduced model performance. To address these challenges, we propose a novel aggregation termed Class-Coverage Sampling and Entropy Weighting (CCS-EW). More specifically, the CCS component ensures that the selected clients cover as many classes as possible, while the EW mechanism assigns higher aggregation weights to clients with more balanced label distributions. We evaluated this method on the CIFAR-10 dataset under non-IID client conditions. Experimental results demonstrate that CCS-EW improves convergence stability and global accuracy compared to the random client selection baseline. Specifically, CCS-EW achieved a final accuracy of 51.3%, substantially higher than the 34.8% attained by random selection, while also reducing variance across clients. These findings confirm that CCS-EW enhances both the robustness and fairness of federated training.

Room: NEOM | Date: Wednesday, April 08, 2026 | Time: 18:30 – 18:55 [Online]

[E14] Decentralized Federated Learning with Differential Privacy for ECG Classification

Abhignya Jagathpally, Department of Data Science University of North Texas Denton (Texas); Tayyaba Shahwar, PRIYAN MALARVIZHI KUMAR*, university of north texas (United States)

Abstract: Deep learning is essential in classifying fatal cardiovascular disease (CVD) using electrocardiography (ECG) data to predict heart disease before its severe consequences occur. However, it typically requires large amounts of data to train the deep learning model while corroborating the privacy and security concerns. The proposed approach considers an end-to-end federated framework for ECG-based heart beat analysis using AlexNet with an attention mechanism in a dual-branch fusion network model. Peer-to-peer (P2P) federated learning with a lightweight differential privacy technique mitigates data availability and privacy considerations. Additionally, the proposed framework effectively classifies different arrhythmias by tracking the local gradients of the models and orchestrating mixed precision to ensure convergence accuracy. The model was trained and tested, by extracting 23,998 ECG beats from preprocessed data generated by combining two baseline datasets (MIT-BIH arrhythmias database (MITDB) and PTB diagnostic database (PTBDB)). The trained classifier achieved up to 92.8% accuracy with five-fold cross-validation and reduced communication costs by enhancing the privacy of the data in a federated setting. These evaluations validate the potential of the proposed distributed learning approach for ECG classification in aiding the incorporation of learning models. Using automated systems for ECG analysis to provide dynamic solutions in healthcare facilities.

Room: NEOM | Date: Wednesday, April 08, 2026 | 18:55 – 19:20 [Online]

[E15] AUTHNET++: Extending Neural Authentication to Multimodal and Context-Aware Deep Learning Models

Prakasam Venkatachalam*, LPL Financial (United States)

Abstract: Deep learning models are increasingly adopted in critical domains, yet remain vulnerable to unauthorized access, adversarial manipulation, and intellectual property compromise. This paper introduces AUTHNET++, a multimodal authentication framework that enhances the security and integrity of neural networks without compromising task performance. The proposed method integrates dynamic key generation, distributed neuron encoding, and context-aware logic. AUTHNET++ supports diverse architectures, including transformers, recurrent neural networks, and hybrid models, across modalities such as natural language, speech, and tabular data. In contrast to conventional defenses such as trusted execution environments, watermarking, and passporting, AUTHNET++ embeds authentication keys into low-activation neurons and jointly optimizes task and authentication objectives. Formal verification techniques are employed to improve resilience against fine-tuning, pruning, and adversarial attacks. Experimental evaluations demonstrate authentication accuracy exceeding 96% on models including BERT, Wav2Vec, and an XGBoost-inspired deep neural network. Identified limitations include training overhead and dependence on secure metadata. Future work will focus on optimizing efficiency for edge deployment, expanding multimodal input sources, integrating blockchain-based certification, and extending verification to federated learning environments. AUTHNET++ provides a scalable and adaptive foundation for securing next-generation AI systems.

Room: Trojena | Date: Wednesday, April 08, 2026 | Time: 17:15 – 17:40 [In Person]

[E16] Securing the Bot Ecosystem: IAM Framework for RPA and AI BOTS

Muhammad Shahbaz*, Member IEEE (Saudi Arabia); Syed Talha Hussain, SSUET (Saudi Arabia); Muhammad Emran, Higher Colleges of Technology (United Arab Emirates); Muhammad Haleem Junejo, SDAIA (Saudi Arabia)

Abstract: This study investigates how Identity and Access Management (IAM) systems can be integrated with environments that make use of physical AI bots and robotic process automation (RPA), two technologies that have completely changed business operations by automating repetitive tasks. These bots security and access control become increasingly important as they become growing in popularity in sectors like banking, healthcare, and finance. The flexibility, visibility, and lifecycle management required to safeguard bot identities are frequently absent from current IAM frameworks, which increases the risk of shared credentials, inadequate access controls, and insufficient audit trails. To ensure that bots only access the data and systems they need, effective IAM for bots necessitates the formation of unique identities, role-based access control (RBAC), attribute-based access control (ABAC), and multi-factor authentication (MFA). The management of bot identities' lifecycle, communication channel security, and continuous bot activity monitoring are some of the important subjects covered in this research. According to the study, bot-specific IAM frameworks that incorporate privileged access management (PAM) systems and embrace cutting-edge security concepts like decentralized identities and zero trust are important. This paper offers best practices for integrating IAM into RPA and physical bot environments, ensuring regulatory compliance and lowering security risks through a thorough study. In conclusion, it makes the case that strong IAM methods are necessary to defend critical systems in increasingly automated businesses, preserve operational integrity, and defend against both physical and digital bots.

Room: Trojena | Date: Wednesday, April 08, 2026 | Time: 17:40 – 18:05 [Online]

[E17] Behind the Prompt: Privacy Risks in Large Language Models

Bedri Chaparov, (University of Derby); Abid Khan*, Ovidiu Bagdasar, University of Derby (United Kingdom); Munam Ali Shah, (King Faisal University)

Abstract: Large language models (LLMS) are progressively adopted since their inception yielding tremendous impact in domains such as finance, healthcare, and cybersecurity. However, they also introduce new vulnerabilities as well among them privacy of the underlying sensitive data is very alarming. This paper explores the problem of data privacy by performing theoretical threat modeling as well as providing an experimental validation. We develop a custom LangChain-based local LLM agent to simulate a controlled environment for testing responses to sensitive, adversarial, and benign prompts. Our analysis considers passive threats, such as data memorization, and active adversarial attacks, including prompt injection and training data extraction. A variety of privacy-preserving methodologies are evaluated in comparison to proprietary models such as OpenAI's GPT-4o. Finally, we propose a conceptual framework for mitigating privacy risks in practical LLM deployments.

Room: Trojena | Date: Wednesday, April 08, 2026 | Time: 18:05 – 18:30 [In Person]

[E18] Advanced Multi-Layer Security Framework: Integrating AES and LSB for Protection of Sensitive Information

Muhammad Nabeel Asghar*, King Faisal University (Saudi Arabia); Muhammad Sajid; Kaleem Razzaq Malik, (Air University Islamabad); Ali Haider Khan, Beijing University of Technology; Jianqiang Li, School of Software Engineering, Beijing University of Technology (China)

Abstract: In a progressively technological era, disseminating information via digital means has become prevalent. Image encryption is an important part of modern data security that protects sensitive data's privacy, integrity, and confidentiality. This study proposes a novel and efficient framework that integrates cryptography and steganography techniques to capitalize on the benefits of these technologies regarding security and practicality, effectively addressing the complexities of a dynamic network environment while adhering to

stringent information transmission security standards. In the initial phase, this research used symmetric encryption AES-128 along with Cipher Block Chaining (CBC-IV) and Initialization Vector to transform plain text into cipher-text, where a secret key is generated using a pseudorandom number and SHA256, establishing a foundational layer of protection. This study employed an enhanced LSB, utilizing LSB matching and replacement to provide robust steganography. The cipher-text is subsequently embedded into a specific position of a 2D image, which preserves image quality and facilitates accurate data extraction to enhance message security. The results showed that the suggested model performed well in terms of PSNR of 72.31 dB, SSIM of 1.0, correlation coefficient of 0.99, BER of 0.07, histogram MSE, and RMSE of 0.009. This study attained exceptional NPCR and UACI scores of 99.65 and 33.64, respectively, compared to other prevailing approaches.

Room: Trojena | Date: Wednesday, April 08, 2026 | Time: 18:30 – 18:55 [Online]

[E19] Enhancing Trust in Maternal Health Predictions Through Explainable AI with Quantitative Assessment

Maria Muzaffar, Ihtesham Ul Islam; MUHAMMAD SOHAIL*, National University of Sciences and Technology, Islamabad Pakistan (Pakistan); Maemoona Farooq; Tauseef Rana, King Faisial University (Saudi Arabia)

Abstract: Traditional black-box machine learning systems, are powerful, often fail to gain trust of clinical staff due to their opacity. For the solution of this gap, this research proposes an Explainable AI (XAI) framework designed to enhance trust and usability of ML models in maternal healthcare. Specifically, SHAP (SHapley Additive Explanations) and LIME (Local Interpretable Model-Agnostic Explanations) are employed to provide transparent, interpretable insights into model behavior.The study follows an empirical, model-based, and quantitative research design using two public and anonymized datasets: a multi-class Maternal Health Risk Prediction dataset and a binary Gestational Diabetes Mellitus (GDM) dataset. Preprocessing includes missing value imputation, IQR-based outlier removal, class balancing using SMOTE, and feature selection using Mutual Information and RFECV. Multiple models of machine learning i.e., Support Vector Machine (SVM), XGBoost, Neural Network, Random Forest, Decision Tree, and Logistic Regression, are evaluated using standard performance metrics such as accuracy, precision, recall, specificity, F1-score, and AUC. Experimental results show that SVM achieves the highest accuracy 98.42% on the GDM dataset, while XGBoost leads on the maternal health dataset with 86.33% accuracy. The explainability of the models is evaluated using fidelity, consistency, robustness, and simplicity. The scores of these evaluation metrics for both datasets are fidelity (1.0 and 1.0), consistency (1.0 and 1.0), robustness (1.0 and 0.99) whereas, simplicity shows separate values for each features of both datasets. All these scores are optimal or near- optimal levels, confirmed the reliability of the generated explanations.

Room: Trojena | Date: Wednesday, April 08, 2026 | Time: 18:55 – 19:20 [Online]

[E20] A Quantum-Resilient Blockchain Framework to Secure Peer-to-Peer Energy Trading Systems

Md Moniruzzaman; Shahroz Abbas*, Ajmery Sultana, Algoma University (Canada); Georges Kaddoum, (Université du Québec)

Abstract: The increasing adoption of electric vehicles (EVs) and distributed energy resources has led to the rise of peer-to-peer (P2P) energy trading, in which participants exchange energy within local markets. Blockchain technology has emerged as a secure and transparent solution for managing these transactions. However, the advancement of quantum computing poses a significant threat to the traditional cryptographic mechanisms used in blockchain systems. This paper proposes a quantum-safe blockchain framework designed specifically to secure P2P energy trading networks. The proposed system integrates quantum-resistant cryptographic techniques, including lattice-based cryptography and quantum key distribution (QKD), to safeguard transactions against quantum attacks. Additionally, a quantum-safe consensus mechanism, Quantum Delegated Proof of Stake (QDPoS), is introduced to enhance network security and scalability. Experimental evaluations demonstrate that the proposed approach improves transaction security while maintaining efficiency and reducing computational overhead. The findings highlight the need to integrate quantum-safe solutions into blockchain systems to ensure long-term security in decentralized energy trading networks.

Room: NEOM | Date: Thursday, April 09, 2026 | Time: 10:15 – 10:40 [Online]

[E21] Privacy Aware Intrusion Detection System Using Machine Learning and Federated Learning

Md Shamiul Islam*, Bangladesh University of Business and Technology (Bangladesh); Nabila Rahman, University of Genoa (Bangladesh); Mohammad Faisal, AL Arafath Zihad, Sarup Majumder, Dr Syed Sadiqur Rahman; Syed Usman Jamil, charles sturt university (Australia); Al Shahriar Emon

Abstract: In today's digital revolution, network security is crucial, and Intrusion Detection Systems (IDSs) play a vital role in identifying and mitigating such threats. This research explores the development of an intrusion detection system (IDS) that uses both machine learning (ML) and Federated learning (FL) methods, with a focus on the CIC-IDS-2017 dataset. We utilise the CIC-IDS-2017 dataset, which contains extensive network traffic data, to train and evaluate various machine learning models for intrusion detection, including Decision Trees, Random Forest, and Support Vector Machines. Federated learning is a distributed machine learning method used to make IDS more private and efficient. This is achieved by enabling model training across multiple nodes without compromising data privacy. We use performance metrics such as accuracy, precision, recall, and F1-score to evaluate how well the suggested system performs. The results show that it is possible to develop an effective and privacy-protecting intrusion detection system by combining classic machine learning methods with federated learning. This study highlights the significance of federated learning for real world IDS applications, particularly in scenarios where data privacy is a major concern.

Room: NEOM | Date: Thursday, April 09, 2026 | Time: 10:40 – 11:05 [Online]

[E22] An Ensemble Machine Learning Framework for Encrypted HTTPS Traffic Classification

Mohammad Faisal; Md Shamiul Islam, Bangladesh University of Business and Technology (Bangladesh); Rubaiyat H Rahman; An nafew, Dhaka Residential Model College; Sabrin Sohely, Hasin Israque Chowdhury Taha, Imtiaz Uddin, Md Tanvir Rahman Saad; A S M Ahsanul Sarkar Akib*, Robo Tech Valley (Bangladesh)

Abstract: The swift proliferation of encrypted network communication has rendered conventional deep packet inspection (DPI) methodologies unsuitable for traffic identification and security surveillance. This study proposes an ensemble machine learning framework for classifying encrypted HTTPS data based on flow-based criteria that protect user privacy. The experimental dataset comprises statistical attributes, including packet size distribution, flow duration, and inter-arrival durations, gathered from actual backbone networks. We employ these attributes to sort network traffic into six application types: live video streaming, video player, music player, file upload, file download, and website browsing. We examine the performance of Support Vector Machine (SVM), Logistic Regression (LR), K-Nearest Neighbors (KNN), Artificial Neural Network (ANN), Random Forest (RF), and XGBoost. To improve the accuracy and reliability of classification, an ensemble model is created that utilizes the best features of each individual learner. The ensemble method outperforms individual classifiers in recognizing encrypted HTTPS traffic patterns, as evidenced by experimental findings that demonstrate higher accuracy, precision, and F1-score. The suggested framework is a smart, scalable, and privacy-preserving way to analyse current network data. It makes it easier to optimise networks and find intrusions in encrypted settings.

Room: NEOM | Date: Thursday, April 09, 2026 | Time: 11:05 – 11:30 [Online]

[E23] Assessing the Cybersecurity Vulnerabilities of SCADA-based Smart Agriculture

Eslam Hasan*, University of South Carolina Aiken (United States); Elmahedi Mahalal, University of New Haven (United States)

Abstract: The food and agriculture (FA) sector faces significant challenges in meeting the increasing food demands of a growing population, reducing resource usage, and adapting to environmental stresses. These challenges have driven the adoption of smart agriculture technologies, which aim to enhance productivity by 70% by 2050. Supervisory control and data acquisition (SCADA) systems play a vital role in managing key processes, including lighting, irrigation, and ventilation. This study proposes a SCADA-based greenhouse system designed to monitor and regulate environmental lighting to optimize crop growth. The system employs a programmable

logic controller (PLC) to automate light regulation and trigger alarms when intensity deviates from predefined thresholds, thereby reducing labor costs. In addition, a human-machine interface (HMI) provides real-time system monitoring and facilitates manual control. However, network communications between the PLC and HMI introduce cybersecurity vulnerabilities. To reveal these vulnerabilities, we performed a comprehensive cybersecurity assessment using the SCADA-based smart greenhouse as a case study. Our analysis showed that SCADA networks often lack robust security, making them susceptible to reconnaissance attacks. We also evaluated resilience against man-in-the-middle (MiTM) and denial-of-service (DoS) attacks, revealing that reconnaissance data could facilitate MiTM attacks, threatening system integrity and availability. This research highlights the critical need for cybersecurity mitigation of SCADA-based smart agriculture systems, as the FA sector is a critical infrastructure sector, comprising essential assets, systems, and networks—both physical and virtual—whose disruption or destruction could severely impact food security at the national and international levels.

Room: NEOM | Date: Thursday, April 09, 2026 | Time: 11:30 – 11:55 [Online]

[E24] A Study of Model Poisoning Attacks on Federated Large Language Models

Amir Faiyaz*, Rukayat Olapojoye, Texas Tech University (United States); Gaurav Karwa, (Texas Tech University); Tara Salman, Texas Tech University (United States)

Abstract: The adoption of large language models (LLMs) in privacy-sensitive applications has raised many privacy concerns resulting from data sharing. This has led to a growing interest in federated learning LLM (FedLLM), where private fine-tuning models are used without requiring the sharing of private data. However, the multi-agent nature of FedLLM introduces new attack surfaces that remain underexplored in LLM settings. This paper presents the first in-depth analysis of model poisoning attacks targeting FedLLM. We analyze three classic untargeted attacks —scaling, sign-flipping, and Gaussian attacks — under the FedLLM setting. We demonstrate their potentially catastrophic effects, including perplexity spikes exceeding 10^{5} times and complete degradation of BLEU scores. Our results, conducted with 33\% malicious clients, reveal that FedLLM and its underlayering adaptation layer can amplify specific attack vectors while marginally mitigating others. These findings highlight critical vulnerabilities in FedLLM and underscore the need for a secure, communication-efficient FedLLM.

Room: NEOM | Date: Thursday, April 09, 2026 | Time: 11:55 – 12:20 [Online]

[E25] Comparative Analysis of Classical and Transformer-Based Models for Phishing URL Detection

Faris Alsulami*, Mohammed Balfaqih, University of Jeddah (Saudi Arabia); Khalid Alamoudi, Muhannad Alghazali, Abdullah Mohammed, Amjad Turkumani, Abdulrahman Sami

Abstract: This study presents a systematic comparative analysis of classical machine learning algorithms and transformer-based architectures for phishing website detection using URL-based features. The evaluation, conducted across four benchmark datasets—Kaggle, Ebbu2017, PhishTank, and ISCX 2016—aims to establish a reproducible and statistically rigorous framework for comparing distinct learning paradigms. Results demonstrate that transformer-based models, particularly Fine-Tuned BERT and TinyBERT, achieve higher recall and F1-scores, making them well-suited for enterprise-scale deployment where maximizing phishing coverage is critical. Conversely, classical models, including Random Forest and hybrid DNN-XGBoost, exhibit strong precision, lower latency, and reduced memory usage, making them practical for real-time, client-side applications. Cross-dataset analysis further reveals that classical approaches maintain greater stability under distributional shifts. Overall, the findings emphasize a fundamental trade-off between accuracy and computational efficiency, guiding model selection according to deployment constraints and operational objectives.

Track 6: IoT, Edge Intelligence & Cyber-Physical Systems

Room: Al-Uqair | Date: Wednesday, April 08, 2026 | Time: 14:45 – 15:10 [Online]

[F01] Artificial Intelligence Approaches in Wireless Sensor Networks Challenges: Survey

Bayan Alamri*, University of Prince Mugrin (Saudi Arabia); Ahmed Barnawi, (King Abdul-Aziz University)

Abstract: Real-time wireless sensor network (WSN) technology and applications increasingly becoming integral to numerous aspects of daily life, driving the demand for advanced artificial intelligence (AI) technologies that can replace traditional methods in this field. These AI technologies use a variety of techniques, including machine learning (ML), neural networks (NNs), deep learning (DL), fuzzy logic, swarm intelligence, and more. This survey presents current state-of-the-art research on the primary challenges related to WSNs, focusing on contributions, methodologies, strengths, and limitations. Key interrelated areas of investigation include node localization, data collection, aggregation and dissemination, monitoring, and security within WSNs. The findings demonstrate the potential of AI techniques to significantly improve and optimize the efficiency, accuracy, and robustness of WSN applications and operations. Several challenges and open research directions remain, including reducing transmission power, minimizing computational complexity, and ensuring adaptability to various network topologies

Room: Al-Uqair | Date: Wednesday, April 08, 2026 | Time: 15:10 – 15:35 [In Person]

[F02] DistillEdge: Knowledge Distillation–Driven Adaptive Offloading for Real-Time IoT Applications in Heterogeneous Edge Environments

Abdulaziz Alanazi, Nasser Albalawi*, Northern Border University (Saudi Arabia)

Abstract: The rapid expansion of Internet of Things (IoT) ecosystems has created an urgent demand for intelligent, lowlatency inference on resource-constrained edge devices. However, the heterogeneity of edge hardware and the unpredictability of network conditions pose significant challenges to static model deployment. In this paper, we propose DistillEdge, a knowledge distillation–driven adaptive offloading framework that enables efficient real-time inference in heterogeneous edge environments. DistillEdge trains lightweight student models using a highcapacity cloud-based teacher and dynamically offloads uncertain predictions based on entropy estimation and runtime context profiling. A multi-factor offloading controller considers system load, bandwidth availability, and prediction confidence to make intelligent offloading decisions. Experimental results demonstrate that DistillEdge achieves up to 42% latency reduction and 35% energy savings over baseline methods such as EdgeBooster and BranchyNet, with only marginal accuracy loss. The framework is robust, hardware-agnostic, and suitable for deployment in smart cities, healthcare, and industrial IoT environments.

Room: Al-Uqair | Date: Wednesday, April 08, 2026 | Time: 15:35 – 16:00 [Online]

[F03] Teryaq: An IoT-Enabled System for the Smart Delivery of Temperature-Sensitive Medications

Durrah Aloulah, Mozn Alzunidi, Futun Alqudayri, Farah Alsubaheen, Shadan Aldhawi, (Majmaah University); Amal Aljohani*, Majmaah University (Saudi Arabia)

Abstract: Temperature-sensitive medications transportation faces significant challenges, especially in maintaining the needed environmental conditions to guarantee safety and efficacy. Preserving the quality of the medication is critical, and many factors play a major role in the medication safe to be used. Temperature stability is a critical factor that needs to be monitored and controlled, especially during hospital-to-patient deliveries of temperature-sensitive medications. However, traditional transportation methods show limitations in this regard, increasing the risk of temperature excursions that can compromise patient safety. This paper presents a smart system called Teryaq which is designed to enhance the transportation of temperature-sensitive medications by ensuring optimal delivery conditions. The system integrates real-time environmental monitoring with intelligent routing algorithms to minimize risk and improve efficiency. Leveraged with wireless

communication and embedded sensors, the system continuously monitors temperature and automatically transmits reports and alerts. The system identifies the safest and most efficient routes by analyzing data such as delivery time and traffic patterns. It combines hardware and intelligent software to ensure reliable performance, even under rapidly changing conditions. This work aims to ensure safe, reliable, efficient, patient-centered delivery of temperature-sensitive medications while minimizing medication waste.

Room: Al-Uqair | Date: Wednesday, April 08, 2026 | Time: 16:00 – 16:25 [Online]

[F04] Direction Guided Kinematic Constrained A*: A Dual-Stage Trajectory Planning for Long Autonomous Vehicles

Hüseyin Azmanoğlu*, Otokar Otomotiv ve Savunma Sanayi A.Ş (Turkey); Muvahhid Kılıç, Burak Sarmusak, Otokar Otomotiv ve Savunma Sanayi A.Ş; Elif Toy Aziziaghdam

Abstract: —Autonomous vehicles are highly dependent on advanced path planning methods to navigate complicated environments in safety. Overtaking maneuvers are particularly challenging, especially for long vehicles with limited maneuverability, delayed reactions, and strict dynamic limits. While traditional A* performs well with particle models, it often overlooks the physical size and motion constraints of the vehicles. To address these challenges, this study proposes a novel enhancement to the A* pathfinding algorithm. This enhancement includes direction-guided graph search, ego-size and steering-aware node selection, cost evaluations dynamically adapted with ego-speed, and collisionaware-smoothing. Using this framework, the ego-vehicle can carry out overtaking maneuvers while maintaining safe spacing on both lateral and longitudinal axes. This reduces the chance of risky or abrupt movements. We assessed the method in real traffic conditions with OTOKAR's E-CENTRO AUTONOMOUS bus. Observations from these tests confirmed that the proposed method enables reliable, safe, and steady overtaking and realworld operations. Index Terms—long autonomous vehicles, trajectory planning, DGKC-A*, A* algorithm, overtaking maneuver, trajectory smoothing, real-world testing, robotics and automation, autonomous systems.

Room: Al-Uqair | Date: Wednesday, April 08, 2026 | Time: 16:25 – 16:50 [Online]

[F05] Real-Time Intrusion Detection in Fog Computing Environments Using Machine Learning Approaches

Hamza Sulimani*, Umm Al-Qura University (Saudi Arabia)

Abstract: With the rapid proliferation of Internet of Things (IoT) devices and edge computing, fog computing has emerged as a key paradigm for enabling low-latency, distributed data processing. However, this decentralized architecture also introduces significant cybersecurity vulnerabilities. In this paper, we propose a machine learning-based framework for real-time intrusion detection tailored to fog computing environments. The system employs lightweight classification models deployed at edge nodes to detect malicious activities with minimal computational overhead and response delay. Experimental evaluations using benchmark intrusion detection datasets confirm the effectiveness of the proposed approach in terms of detection accuracy, latency, and resource efficiency.

Room: Al-Uqair | Date: Wednesday, April 08, 2026 | Time: 17:15 – 17:40 [In Person]

[F06] Be Aware: Anxiety Detection System Based on GSR Signals using ML and IoT

Shahad Al Shehab*, King Faisal University (Saudi Arabia); Rawabi Al Sedais, KFU (Saudi Arabia); Shatha Al Mukhaylid, (King Faisal University); Fatima Al Harbi, Noura Al Saleh

Abstract: This paper introduces an innovative approach to anxiety detection through a portable and wearable system that uses a galvanic skin response (GSR) sensor and machine learning technologies. The core of this system is the integration of the XGBoost model with 98% accuracy rate, a machine learning technique that processes GSR data to accurately classify anxiety levels. This allows real-time feedback through a user-friendly application, enabling individuals to monitor their condition and receive alerts during anxiety episodes. This system stands out by combining technology with healthcare, aiming to transform anxiety management and support systems, making them more accessible and efficient for users worldwide.

Room: Al-Uqair | Date: Wednesday, April 08, 2026 | Time: 17:40 – 18:05 [In Person]

[F07] Unified Mixed-Signal Design: Integrating Memristor-Based Ternary Logic with an Open-Source Sky130 CMOS Non-Inverting Op-AMP

Fawwaz Hazzazi*, Prince Sattam bin Abdulaziz University (Saudi Arabia)

Abstract: — This work presents a unified mixed-signal design that combines recent advances in multiple-valued logic and open-source analog circuit design. Building upon our memristor-based ternary logic gates that leverage hybrid two-dimensional field-effect transistors to reduce circuit area and power, we develop a compact digital core capable of three-level logic operations. To interface this core with sensor inputs and other analog signals, we integrate a non-inverting CMOS operational amplifier designed using the SkyWater Sky130 PDK and implemented through a reproducible flow involving Xschem/NGSpice, Magic and Netgen. The analog front end offers high input impedance and moderate low-frequency gain while maintaining phase fidelity. We discuss the architectural synergy between the ternary logic circuits and the op-amp, highlighting how the open-source design flow enables rapid prototyping and mixed-signal simulation. Preliminary simulation results demonstrate that the combined system achieves compact layout, low power dissipation and straightforward integration, suggesting its suitability for energy-efficient sensor interfaces, neuromorphic computing and other applications where multiple-valued logic and analog processing coexist. This work underscores the potential of memristor-based MVL circuits paired with open-source CMOS amplifiers to advance low-power, mixed-signal system design while acknowledging the need for further integration of memristor models into the Sky130 process.

Room: Al-Uqair | Date: Wednesday, April 08, 2026 | Time: 18:05 – 18:30 [Online]

[F08] From Sensors to Actions: AI- and IoT-Powered Hydro-Salinity Dashboards and Prescriptions for Early-Stage Mangrove Survival

Faten Dhawi*, KFU (Saudi Arabia); Abdul GHfoor, (KFU); Nora Alkhaldi, King Faisal University (Saudi Arabia)

Abstract: Early-stage survival of mangrove seedlings in hyper-arid, hypersaline landscapes is frequently constrained by heat stress, infrequent flushing, and soil salinity accumulation. We present an integrated pipeline that couples (i) an Internet-of-Things (IoT) sensing stack for soil and micro-climate variables, (ii) machine-learning (ML) models that predict weekly survival rate (%) and classify "Critical" (<35% survival) vs "Non-critical" weeks, (iii) time-series forecasts of air/soil temperatures and relative humidity, and (iv) an actuation layer that automatically triggers flushing when projected survival falls below a policy threshold. The pipeline was designed to stabilize survival during hot months while conserving water. Feature-attribution analyses highlight the central role of soil temperature, with important secondary contributions from air temperature, humidity, and flushing intensity. The approach is grounded in mangrove eco-physiology and salinity management best practices and leverages robust ML and IoT evidence from precision agriculture

Room: Al-Uqair | Date: Wednesday, April 08, 2026 | Time: 18:30 – 18:55 [Online]

[F09] Design and Fabrication of a Biomass Briquette Machine for Recycling of Agricultural Waste

Abdullah Alarfaj, Hamzah Almarabia, Jihad Alkhalifah, Abdulmohsen Albeladi, Abdulsalam Alharbi, Kamran Shah, Mohammed Ismail; Hussain Altammar*, King Faisal University (Saudi Arabia)

Abstract: This paper presents the design and fabrication of a biomass briquette machine aimed at converting organic waste into usable fuel. With growing environmental concerns and the need for sustainable energy alternatives, biomass offers a renewable and efficient solution. The project explores various types of biomass and their applications, particularly in producing briquettes for heating, industrial use, and energy generation. The machine is built using accessible materials and components, including a carbon steel frame, an auger, bearings, an electric motor, and interchangeable dies. Through research, design, and hands-on construction, the performance of the proposed design was evaluated and tested in transforming agricultural and organic waste into dense fuel briquettes. This proposed design ,showcases environmental and energy solutions that contribute to sustainable waste management.

Room: Al-Uqair | Date: Wednesday, April 08, 2026 | Time: 18:55 – 19:20 [Online]

[F10] Unveiling Judicial Patterns: A Vector-Based Approach to Thematic Analysis of Court Opinions Through Time

Joshua Johnson*, University of Louisville (United States); Adrian Lauf, (University of Louisville)

Abstract: This paper presents an approach to analyze common themes in judicial opinions embedded in a vector space. After embedding judicial opinions in a vector space using a Llama model, principal component analysis was performed to reduce dimensionality. HDBSCAN and K-means clustering were then used to cluster the embedding vectors of the judicial opinions. After clustering, samples from each cluster were aggregated and processed through a large language model to determine common themes within the cluster. This technique reveals a novel way to classify types of cases and understand themes and semantic nuances common in judicial opinions that are not easily apparent from human observation. Applying this method to a dataset of fifty thousand judicial opinions spanning 1900 to 2020, a set of themes emerged, that included topics such as statutory interpretation, contract disputes, criminal procedure, and appellate review. Both K-means and HDBSCAN clustering algorithms produced overlapping groupings showing some consistency in semantic clustering. A time-based analysis shows that while certain legal topics remain consistent over time, judicial activity does display shifts over the decades that could reflect changing legal priorities and societal concerns. These findings demonstrate the capacity of vector-based approaches not only to surface persistent themes but also to trace the evolution of judicial themes across time.

Room: THE LINE | Date: Wednesday, April 08, 2026 | Time: 17:15 – 17:40 [In Person]

[F11] Gate-Engineered Tunnel FET Based LIF Neuron for Scalable and Energy-Efficient AI Systems

Faisal Bashir*, Faisal Bashir (Saudi Arabia)

Abstract: This paper proposes a leaky integrate-and-fire (LIF) neuron design based on band-to-band tunneling transistor (Tunnel FET). The steep sub-threshold swing of a Tunnel FET is leveraged to replicate LIF neuronal behavior. Through calibrated simulations, we demonstrate that this single-device neuron accurately emulates neural activity without using external circuitry. The design achieves a remarkably low energy consumption of 20 f J per spike, which is 2.4 × 103 times lower than existing single MOSFET based neurons existing in the literature. Further, we validated the neuron's capability at a system level by simulating a network for image recognition tasks. The system achieved a recognition precision of 97.3 % on the standard MNIST benchmark, confirming the practical applicability of our design for complex, energy efficient AI (Artificial Intelligence) application. This work offers a pathway to building highly scalable and energy efficient threshold architectures for next generation neuromorphic computing.

Room: THE LINE | Date: Wednesday, April 08, 2026 | Time: 17:40 – 18:05 [In Person]

[F12] Energy-Efficient Power Control and Movable Antenna Positioning in 6G Cellular Networks via Reinforcement Learning

Ayaz Ahmad*, King Faisal University (Saudi Arabia)

Abstract: This paper considers power control and antenna positioning in downlink 6G cellular networks with the base station (BS) quipped with movable antenna serving multiple ground users. The objective is to maximize energy efficiency (EE) defined as users' sum-rate divided by total transmission power plus circuit power while satisfying the BS power budget constraint, the feasible region constraint for antenna movements, and minimum rate requirement per user. The problem of joint power control and antenna position optimization is formulated as an episodic Markov decision process. A feasibility-aware deterministic reinforcement learning (RL) framework based on actor–critic method with a safety layer is proposed to solve it. This framework effectively solves the problem while ensuring all the constraints. The simulation results demonstrate fast and stable learning with improved EE and sum-rate improvements compared to fixed antenna baseline across diverse BS power budgets and users' QoS thresholds.

Room: THE LINE | Date: Wednesday, April 08, 2026 | Time: 18:05 – 18:30 [In Person]

[F13] 6G Open Radio Access Networks: A review

Ali Alshaqaq*, KFu (Saudi Arabia)

Abstract: The Open Radio Access Network (O-RAN) as a new concept of telecommunications formulated by O-RAN alliance is introduced with the keywords of openness, modularity and multi-vendor interoperability. O-RAN thus decomposes conventional RAN deployments to offer efficient, advanced solutions for 6G, 5G and beyond as are briefly described below. The focus of this report lies on O-RAN architecture and, it outlines the key parts of this architecture to include the RAN Intelligent Controller (RIC), the Centralized Units (CUs), the Distributed Units (DUs) and also open interfaces so as to encourage innovation as well as the vendor diversification. Use-cases including cost optimization, utilization of artificial intelligence, and deployment possibilities in both, urban as well as rural setting serves as the rays of hope in O-RAN. Nevertheless, issues related to integration, security as well as performance persist and need to be solved with higher level approaches. The technologies such as machine learning ML and Artificial intelligence (AI) are going to be used in the current and future ORAN telecommunication systems. These technologies bring several advantages in terms of network operation, ecosystem, intelligence network, and international standard.

Room: THE LINE | Date: Wednesday, April 08, 2026 | Time: 18:30 – 18:55 [Online]

[F14] Performance Benchmarking of ESP32-Based Smart Home Systems for Latency, Power, and Reliability

Ahmed F. Ashour*, Rishikesh Bajgai, Idaho State University (United States); Monsoon Thapa; Hesham A. Sakr, Elsewedy University of Technology (Egypt); Mostafa M. Fouda, Idaho State University (United States)

Abstract: Advancements in the field of the Internet of Things (IoT) are changing our lifestyle and how we do things. One of the most important features of IOT is its scalability, as it comprises hardware and software. A simple upgrade to either hardware or software makes it better and smarter than it was a few moments ago. The growing usage of smart home technology requires low-latency, low-power, and cost-effective IoT solutions to enable real-time monitoring and alarm systems. This paper presents a holistic investigation of an ESP32-based IoT system to capture sensor data and email alerts compared to other microcontrollers such as Arduino with a camera module, Raspberry Pi, ESP8266 and STM32. Unlike previous work that typically exhibits functional prototypes, the focus of this research is quantitative measurement through controlled latency tests for user notification, power consumption, and overall reliability. The motion sensing device was integrated into the ESP32-Cam board, the ESP32-CAM connected to WiFi network, captured the picture, and sent it to the recipient's email. The results demonstrated that the two-part home automation architecture ensures security redundancy along with addressing latency, power, and reliability issues compared to other microcontrollers.

Room: THE LINE | Date: Wednesday, April 08, 2026 | Time: 18:55 – 19:20 [Online]

[F15] Machine Learning Based IoT Adaptive Architecture for Epilepsy Seizure Detection: Anatomy and Analysis

Zag ElSayed*, UC (United States); Nelly Elsayed, University of Cincinnati (United States); Murat Ozer, (UC); Ahmed Abdelgawad, Associate Professor (United States)

Abstract: A seizure tracking system is crucial for monitoring and evaluating epilepsy treatments. Caretaker seizure diaries are used in epilepsy care today, but clinical seizure monitoring may miss seizures. Monitoring devices that can be worn may be better tolerated and more suitable for long-term ambulatory use. Many techniques and methods are proposed for seizure detection; However, simplicity and affordability are key concepts for daily use while preserving the accuracy of the detection. In this study, we propose a versal, affordable noninvasive based on a simple real-time k-Nearest-Neighbors (kNN) machine learning that can be customized and adapted to individual users in less than four seconds of training time; the system was verified and validated using 500 subjects, with seizure detection data sampled at 178 Hz, the operated with a mean accuracy of (94.5\%).

Room: Al-Uqair | Date: Thursday, April 09, 2026 | Time: 10:15 – 10:40 [In Person]

[F16] Trust-Based Management for Internet of Vehicles via Wireless Sensor Networks: Safeguarding Trust during Journeys

Muhammad Shahbaz*, Member IEEE (Saudi Arabia); Muhammad Haleem Junejo, SDAIA (Saudi Arabia); Muhammad Emran, Higher Colleges of Technology (United Arab Emirates)

Abstract: A new era of intelligent and networked mobility has begun with the rapid integration of Wireless Sensor Networks (WSNs) into the Internet of Vehicles (IoV). Even yet, there are still a lot of obstacles to overcome in order to guarantee safe travel and communication in this highly dynamic network. This paper presents a comprehensive Trust-Based Management strategy that uses Wireless Sensor Networks to protect vehicles from malicious attacks during the journey. The proposed system employs dynamic trust evaluation mechanisms that adapt to the evolving conditions of the vehicular network. By leveraging the capabilities of WSNs, the proposed trust model monitors and assesses the trustworthiness of vehicles, nodes, and data transmissions in real-time. Through simulations and real-world applications, the effectiveness of the suggested approach is confirmed, showcasing its potential to improve communication security and dependability in the Internet of Vehicles. The suggested trust-based management solution addresses the vital necessity of safe travel in the connected mobility era and helps to develop a robust and reliable IoV infrastructure. Keywords—Internet of Vehicles, WSN, Trust Model.

Room: Al-Uqair | Date: Thursday, April 09, 2026 | Time: 10:40 – 11:05 [Online]

[F17] HEART: Hardware-Efficient Analytics for Radiomic Tissue Evaluation Using In-Sensor Processing Scheme

Mohammed Alali, PSAU (Saudi Arabia); Sepehr Tabrizchi, University of Illinois Chicago; Haidar Almubarak*, SAUDI ELECTRONIC UNIVERSITY (Saudi Arabia); Arman Roohi, University of Illinois Chicago (United States)

Abstract: Traditional medical imaging systems are impractical for low-power environments due to their high power requirements and computational complexity. This paper introduces HEART , a novel in-sensor processing architecture integrating binary image sensing with lightweight neural networks for efficient histopathology analysis. HEART employs a custom-designed 4T active pixel sensor coupled with precharge sense amplifiers to directly generate 1-bit pixel data, processed by an integrated digital accelerator. Evaluated on the MHIST dataset for colorectal polyp classification, HEART achieves 81% accuracy, delivering substantial improvements of 1.64× power reduction, 2× area savings, and 4× speed enhancement compared to conventional 8-bit systems. Simplified CNN architectures operating on binarized images notably outperform complex quantized networks, achieving a 59% F1-score for detecting pre-malignant tissues. MobileNet V2 outperforms both simple CNN and ResNet architectures. This approach establishes a foundation for nextgeneration of medical devices capable of continuous and powerefficient tissue monitoring

Room: Al-Uqair | Date: Thursday, April 09, 2026 | Time: 11:05 – 11:30 [In Person]

[F18] Recognizing Occupancy and Activities with PIR Sensors and LSTM-RNN

Muhammad Abid Hussain, Muhammad Arslan, Taymoor Khalid; Heider Wahsheh*, King Faisal University (Saudi Arabia); Mohsin Raza Jafri, Wajeeha Tariq Ansari

Abstract: In the realm of monitoring systems, the need for advanced and accurate human detection has become increasingly vital for various applications, ranging from smart healthcare and monitoring to automation and smart environments. Considering its potential to improve the accuracy and efficacy of monitoring systems, human classification within a multi-subject monitoring scenario has attracted a lot of interest. Human Activity Recognition (HAR) has greatly increased in accuracy thanks to the quick development of numerous types of sensors. In this research, we introduce a novel HAR and Multi-Subject classification technique, leveraging state-of-the-art deep learning technique i.e. Long Short-Term Memory - Recurrent Neural Network (LSTM-RNN). The proposed method accurately detects movement direction and activities

using fused information from network-connected PIR sensors. Prior to performing feature enhancement on the data, we first gather and examine the PIR sensor's time-domain signal. We then aggregate the data based on peak time sequence features. The LSTM-RNN is then used to predict the activities and direction of moving subject. Lastly, results are used to validate the effectiveness of the method through experiments. The proposed model accurately classifies the direction of movement of an individual along with different types of physical activities, specifically walking, running, and falling with 99% accuracy. It classifies combinations or the number of individuals present in a test space with an accuracy of 96%.

Room: Al-Uqair | Date: Thursday, April 09, 2026 | Time: 11:30 – 11:55 [Online]

[F19] Advanced Deep Learning Frameworks for DDoS Attack Forecasting with Neurosymbolic Reasoning

Prakasam Venkatachalam*, LPL Financial (United States)

Abstract: Modern Distributed Denial-of-Service (DDoS) attacks exploit dynamic traffic patterns and adversarial drift, rendering static detection systems increasingly ineffective. This paper presents the Adaptive Threat Cognition Framework (ATCF), a modular deep learning architecture designed to forecast, interpret, and adapt to evolving DDoS threats. ATCF integrates four core components: a Temporal Encoding System (TES) for real-time traffic profiling, a Neurosymbolic Reasoning Engine (NRE) for interpretable threat inference, a Feature-Domain Multimodal Transformer (FDMT) for cross-domain fusion, and a Co-evolutionary Meta-Cognition Layer (CMCL) for adaptive learning under adversarial conditions. Evaluated across benchmark datasets and adversarial simulations, ATCF consistently outperforms existing models in precision, recall, and explainability. The framework demonstrates resilience against concept drift and offers actionable insights for real-world deployment in cyber-physical infrastructures.

Room: Al-Uqair | Date: Thursday, April 09, 2026 | Time: 11:55 – 12:20 [Online]

[F20] ISAC in 6G: Exploring Performance Metrics, Design Strategies, and Evolving Research Directions

Rishikesh Bajgai, Mohamed I. Ismail, Mostafa Fouda*, Idaho State University (United States)

Abstract: Over the past five years, integrated sensing and communication, or ISAC, has drawn a lot of attention as a crucial element of the 6G vision for next-generation communication systems. We begin with the foundations of ISAC and then review the key technologies used. ISAC systems that use the same physical components and waveform to meet both radar and communication goals. In addition to performing the extra processing required for detection, communication-centric ISAC is primarily concerned with enhancing communication performance beyond 5G/6G cellular networks and Wi-Fi standards. Conversely, the sensing-centric ISAC incorporates communication functions as efficiently as possible while prioritizing sensing and detection capabilities. With an emphasis on their functions as essential components of 6G systems, this survey provides a comprehensive overview of ISAC technologies. Based on key performance metrics, including spectral efficiency, sensing accuracy, communication reliability, complexity, and hardware compatibility, we compare various ISAC waveforms and techniques, such as OFDM, FMCW, OTFS, pilot embedding, and machine learning-based beamforming. Due to their good 6G alignment and outstanding efficiency, RIS-assisted and dual-functional radar-communications systems are given special attention. Additionally, we investigate how ISAC can be integrated with other 6G enablers, including ultra-massive MIMO, AI-driven adaptability, and reconfigurable intelligent surfaces (RIS). The discussion encompasses challenges such as hardware constraints, privacy concerns, cross-domain interference, and waveform co-design. Finally, we outline future research areas and offer a plan for implementing reliable and useful ISAC-enabled 6G systems.

Track 7: Human-Centred Computing, Affective & Educational Technologies

Room: Sindalah | Date: Wednesday, April 08, 2026 | Time: 14:45 – 15:10 [Online]

[G01] Enhancing Micro-interaction in Text Chat with BERT-Based Emoji Reaction Recommender

Uriel Melendres*, National University (Philippines); Rodolfo, Jr Raga, National University Philippines

Abstract: This study addresses the limitations of emotional expression in digital communication by developing a BERT-based emoji reaction recommender system for text chat platforms. Digital communication lacks nonverbal cues, leading to misunderstandings and reduced user engagement. To enhance micro-interactions, we fine-tuned a DistilBERT model for emotion classification using an augmented dataset of six emotions: joy, sadness, surprise, anger, fear, and shame. The model was compared against traditional machine learning approaches, including Support Vector Machine, Logistic Regression, and Naive Bayes. Results showed DistilBERT achieved superior performance with 68.18% accuracy, significantly outperforming SVM (64.58%), Logistic Regression (45.15%), and Naive Bayes (44.34%). We propose an emotion-to-emoji mapping pipeline incorporating confidence-based selection and style filters to provide contextually appropriate emoji recommendations. This system aims to improve emotional expression, foster inclusive participation, and provide immediate feedback mechanisms in social computing platforms, ultimately enhancing the quality of digital discourse.

Room: Sindalah | Date: Wednesday, April 08, 2026 | Time: 15:10 – 15:35 [Online]

[G02] Autonomous AI Whiteboard Systems: Transforming Modern Learning Spaces

Noor Hafsa*, King Faisal University (Saudi Arabia)

Abstract: Traditional whiteboard maintenance necessitates manual intervention, causing disruptive interruptions in educational settings - a limitation persisting even in semi-automated solutions. This research introduces a fully autonomous whiteboard management system that intelligently initiates maintenance operations through integrated computer vision and motion detection technologies. Our framework combines three key innovations: (1) A transfer learning-based classification model deployed on Raspberry Pi that continuously analyzes whiteboard states via ceiling-mounted cameras, (2) Motion-activated sensors triggering automated digital archiving during user inactivity periods, and (3) Precision wiping mechanisms with bidirectional cleaning capabilities. Operating without human intervention, the system completes clean-preserve-erase cycles within minutes of detecting user absence. By seamlessly maintaining writing surfaces while preserving educational content, this technology significantly enhances classroom operational efficiency and enables truly uninterrupted smart learning environments. Experimental validation in active classrooms demonstrates the system's effectiveness, positioning it as a transformative solution for modern educational infrastructure.

Room: Sindalah | Date: Wednesday, April 08, 2026 | Time: 15:35 – 16:00 [Online]

[G03] Gesture Based Authentication for the Visually Impaired Using a Smartwatch

Sai Sravani Lekkala, Khandaker Rahman, Saginaw Valley State University; Avishek Mukherjee*, University of Detroit Mercy (United States)

Abstract: This research investigates a gesture-based authentication system using smartwatches as a secure and accessible solution for visually impaired users. Leveraging accelerometer and gyroscope data from wrist-worn devices, the system captures subtle and deliberate hand movements as behavioral biometrics. A custom-developed Wear OS application was used to collect motion data during gesture performance, with both genuine and impostor attempts included in the study. Five different classification and comparison techniques were evaluated, with Hidden Markov Models (HMM) and Dynamic Time Warping (DTW) identified as the two most effective. A total of 140 gesture sequences, excluding augmented samples, were analyzed across 20 unique gesture patterns. Impostor trials included both seated and standing replication attempts to

simulate real-world attack scenarios. System performance was evaluated using Equal Error Rate (EER) scores, with the top models achieving EER values between 0% and 12%, depending on the complexity of the gestures and the preprocessing conditions applied. The results support the feasibility of using smartwatch gestures for inclusive and secure authentication, particularly in accessibility-focused contexts.

Room: Sindalah | Date: Wednesday, April 08, 2026 | Time: 16:00 – 16:25 [Online]

[G04] Exploring the Duality: Cognitive and Affective Trust in Human–AI Collaboration within Agile Requirements Engineering

Abdulaziz Alhubaishy*, Saudi Electronic University (Saudi Arabia)

Abstract: Cognitive and affective trust play a critical role in modern software development, particularly in Agile environments where collaboration and rapid iteration are essential. As AI tools become increasingly integrated into requirements engineering activities, covering initial elicitation, prioritization, and validation, they fundamentally redefine how teams work together and how trust is established. This transformation can either facilitate or hinder the development process, depending on how these tools are perceived and adopted by practitioners. Through our qualitative investigation, this study explores the factors influencing practitioners' trust in AI tools and their subsequent adoption within Agile requirements engineering. The study identifies six critical factors that determine how Agile practitioners develop trust in AI tools: (1) the transparency and explainability of the tool, (2) perceived fairness and absence of bias in its outputs, (3) the emotional impact on team members, (4) the reliability and accuracy of its suggestions, (5) how well it integrates with existing workflows, and (6) quality of human–AI collaboration. These factors collectively influence whether AI tools are embraced as valuable team members or rejected as disruptive elements in the Agile process. Our findings provide practical insights for both tool designers and Agile teams seeking to successfully incorporate AI assistance into their requirements engineering practices while maintaining the human-centric values at the core of Agile methodologies.

Room: Sindalah | Date: Wednesday, April 08, 2026 | Time: 16:25 – 16:50 [Online]

[G05] A User-Centric Review and Comparative Analysis of Explainable AI Methods for Social Media Recommender Systems

Banan Alkhateeb*, Newcastle University (United Kingdom); Ellis Solaiman, (Newcastle University)

Abstract: As algorithmic transparency becomes increasingly important, social media platforms have integrated explainability features into their recommender systems, following a one-size-fits-all approach that fails to address the diverse explainability needs of different users. This survey presents a comparative synthesis of existing literature on five XAI methods (LIME, SHAP, Anchors, Counterfactual Explanations, and Concept Bottleneck Models) and evaluates their suitability for three types of social media users (developers, domain experts, and lay users). To support this analysis, we conducted a systematic search across three major academic databases using relevant keywords, filtering for publications from 2018 to 2025. A total of 30 papers met the inclusion criteria and were selected for review. Our analysis demonstrates that no single XAI method works equally well for all user tiers or all social-media contexts. We therefore advocate tier-aware explainability, explicitly matching XAI techniques to user types and platform contexts, to maximize clarity, trust, and accountability.

Room: THE LINE | Date: Wednesday, April 08, 2026 | Time: 14:45 – 15:10 [In Person]

[G06] Rewiring the Mind for AI: A Pilot Study on Neuro-Cognitive Changes from Prompt Engineering Training

Hend Al-Khalifa*, King Saud University (Saudi Arabia)

Abstract: The emergence of large language models (LLMs) necessitates effective prompt engineering, a skill that requires complex cognitive engagement for optimal human-AI interaction. This pilot study, involving 13 adult participants, investigates whether structured prompt engineering training leads to measurable neuro-cognitive changes. Our preliminary findings reveal that such training is associated with increased

functional connectivity in the left precentral and postcentral gyri, indicating neural plasticity. Using resting-state fMRI and a seed-based connectivity analysis, post-training results showed increased connectivity in left sensorimotor regions. This suggests the development of embodied cognitive strategies and more efficient neural resource allocation. These early results suggest that interacting with AI can reshape brain networks involved in executive planning and action selection, offering initial empirical evidence of prompt engineering as a driver of neuroplasticity in human-AI collaboration. Due to the pilot nature of this study, a control group was not included, and these findings should be interpreted as preliminary.

Room: THE LINE | Date: Wednesday, April 08, 2026 | Time: 15:10 – 15:35 [In Person]

[G07] Design of Hybrid XAI Text-Based Ingredient Risk Prediction System

Leila BENAROUS*, University of Laghouat (Algeria)

Abstract: In our fast-paced era, we benefit from multiple luxuries made available to us thanks to the advances in technologies. We can taste foods and cuisines from around the world and seasonal goods year-around. We consume convenience and preserved food because they are quick, tasty and easy to prepare. However, this taste comes at the risk of ingesting toxins from the additives used to ensure freshness and flavor. Moreover, beauty standards now are higher and people eagerness in seeking beauty is as high as ever. This led them to the over-consumption of care and cosmetic products full of ingredients whose toxicity level are largely unaware of. Therefore, it is necessary to provide knowledge to users about the potential risk level of the ingredients they consume. In this paper, we presented a hybrid eXplainable Artificial Intelligence (XAI) system for risk level assessment in conserved food and cosmetic products. We constructed our dataset from COSING, EFSA and FDA EAFUS. For feature engineering, we combined word-level extracted features (TF-IDF features) with rule-based semantic tokens to provide contextual awareness. We used random forest for the classification and SHAP for explainability. Our system gives excellent results in term of accuracy (0.98), recall (0.98) and precision (0.97); in addition, to scoring low mistaken predictions (false positive and negative). To avoid these mistakes, we enhanced the model by adding rules to confirm or correct the AI predictions.

Room: THE LINE | Date: Wednesday, April 08, 2026 | Time: 15:35 – 16:00 [Online]

[G08] FSyD-Net: Fused Synergistic Disentanglement for Robust Audiovisual Emotion Recognition

Qiong Hong*, The National University of Malaysia (Malaysia); Lailatul Qadri Zakaria, Sabrina Tiun, The National University of Malaysia

Abstract: Audiovisual Emotion Recognition (AVER) faces a fundamental dilemma, how to strike a balance between ensuring information sufficiency and necessity. Multimodal fusion is essential for integrating complementary cues to ensure "sufficiency," but it has the inherent risk of indiscriminately amplifying task-irrelevant noise, such as speaker identity features. Feature disentanglement assures "necessity" by stripping away identity obfuscation variables, but may compromise valuable affective context. To address this problem, this paper proposes a novel end-to-end framework, the Synergistic Disentanglement Network (FSyD-Net). The network follows the design philosophy of "fusion first, purification later". First, an audio-visual fusion encoder builds a sufficient joint representation. Subsequently, our constructed Synergistic Disentanglement Head works on this representation, It adaptively combines the advantages of geometric disentanglement (orthogonal projection) and probabilistic disentanglement (variational inference) within a unified framework. Experiments on the RAVDESS dataset show that FSyD-Net significantly outperforms a range of task baselines on the AVER task. Further unsupervised feature quality analysis demonstrates that our approach learns more discriminative sentiment representations while effectively removing identity information, providing a new paradigm for building more robust AVER systems.

Room: THE LINE | Date: Wednesday, April 08, 2026 | Time: 16:00 – 16:25 [Online]

[G09] Introducing the Visible–Infrared Salinity Index (VISI) for Soil Salinity Mapping Using Remote Sensing and Machine Learning

Hamdi Zurqani*, University of Arkansas (United States); Murad Ellafi, (University of Minnesota); Abdulsalam Al-Bukhari, (University of Omar Al-Mukhtar); Mhieldin Alkhboli, The Libyan Ministry of Higher Education and Scientific Research

Abstract: Soil salinity is a critical constraint to agricultural productivity in arid and semi-arid regions. This paper introduces the Visible–Infrared Salinity Index (VISI), a novel composite index derived from aggregated visible reflectance normalized by near-infrared (NIR). VISI demonstrated the strongest correlation with field-measured soil electrical conductivity of the saturated paste extract (ECe) ($r \approx 0.34$), outperforming conventional salinity indices. Multi-temporal Landsat 5 imagery, terrain attributes, and ECe data from 1,765 soil profiles were used to train four machine learning models: CART, RF, GTB, and SVM, alongside a weighted ensemble approach. RF ($R^2 = 0.339$) and GTB ($R^2 = 0.322$) yielded the most accurate predictions. Spatial mapping confirmed VISI as the most robust predictor across models, offering improved discrimination of saline soils. These findings highlight VISI's potential as a transferable salinity index and provide a replicable methodological framework for sustainable land management in arid agroecosystems.

Room: THE LINE | Date: Wednesday, April 08, 2026 | Time: 16:25 – 16:50 [Online]

[G10] Virtual Reality Enabled Classrooms: Shaping the Future of Next Generation Learning

Shadeeb Hossain*, DeVry University (United States)

Abstract: The growing demand for immersive and adaptive educational tools has accelerated the use of extended reality (XR) technologies in engineering education. This work presents the design and development of an XR based framework for interactive electrical circuit simulation, aimed at enhancing student engagement and supporting diverse learning styles. The proposed architecture comprises of four layers: Presentation and Interaction layer, Simulation and Physics layer, Adaptation and Assessment layer, and Integration and Deployment layer. Unity XR provides the user interface for manipulating virtual components, while real-time circuit simulation is supported with haptic feedback and visual cues to aid kinesthetic learning. Learner actions are logged for performance analysis , and an adaptive assessment mechanism provides tailored feedback based on pre-defined thresholds. A cloud backend manages analytics, user profiles, and content synchronization, with support for multi-user interaction through middleware APIs. Initial implementation demonstrates the feasibility of accurate component modeling using C# scripting within Unity XR, establishing a scalable foundation for more complex educational scenarios.

Room: Sindalah | Date: Wednesday, April 08, 2026 | Time: 17:15 – 17:40 [Online]

[G11] Beyond Human Coaches: Evaluating LLM-Powered Leadership Coaching for Underrepresented Groups

Amna Asif*, Lancaster University Leipzig (Germany); Luise Frohberg; Jörg Frohberg, (Taara Quest)

Abstract: Accessing leadership coaches can be challenging due to availability constraints or high costs, limiting opportunities for diverse professionals, especially underrepresented groups seeking leadership development. Artificial Intelligence (AI) coaches present a viable alternative. This study investigates participant engagement and emotional responses in leadership training scenarios, comparing interactions with AI and human roleplay partners. Analyzing 78 roleplay sessions, we found that AI-human roleplay partners evoked significantly higher positive emotions of determination, confidence, and appreciation, while negative emotions like frustration, concern, and disappointment were common in human-human roleplay sessions. This study explored the feasibility of AI-human roleplay partners, which showed high engagement and provided a psychologically safer environment for participants. These results demonstrate the potential of AI-human roleplay partners to support effective leadership coaching without compromising emotional well-being.

Room: Sindalah | Date: Wednesday, April 08, 2026 | Time: 17:40 – 18:05 [Online]

[G12] Non-Invasive Driver Activity Recognition using mmWave Radar

Basim Alhumaily*, University of Glasgow (United Kingdom); Fahad Ayaz, Sajjad Hussain, (University of Glasgow); Lina Mohjazi, Ahmed Zoha, University of Glasgow (United Kingdom)

Abstract: Driver monitoring systems are crucial for automotive safety, yet conventional camera-based solutions suffer from lighting variability and significant privacy concerns. This paper presents a privacy-preserving, illumination-invariant alternative using a single Frequency Modulated Continuous Wave (FMCW) mmWave radar sensor to classify subtle driver head and upper-body movements indicative of distraction or fatigue. We collected a dataset from 15 subjects performing six distinct and kinematically similar activities. A specialized signal processing pipeline transforms raw radar data into micro-Doppler spectrograms using the Short-Time Fourier Transform (STFT). To address the critical challenge of data scarcity, we introduce a tailored data augmentation strategy that adapts the SpecAugment technique to generate a robust training set while preserving the physical characteristics of the radar signatures. Without augmentation, a lightweight, fine-tuned MobileNet-V2 model achieves a baseline accuracy of only 60% on an unseen test set of subjects. By applying our proposed augmentation method with an augmentation factor of 10, the classification accuracy increases significantly to 91.32%. This result underscores the effectiveness of our approach and demonstrates the feasibility of using a single radar sensor for robust, non-invasive driver monitoring, paving the way for the next generation of reliable and privacy-compliant automotive safety systems.

Room: Sindalah | Date: Wednesday, April 08, 2026 | Time: 18:05 – 18:30 [Online]

[G13] Multimodal Emotion Recognition Algorithm Based on Multimodal Bottleneck Fusion Network

Yaxi Chen, (Southwest Minzu University); Jinzong Hu, Southwest Minzu University (China); Qianchuan Zhang*, (Southwest Minzu University); Chang Liu, chengdu university (China); Yutong Sun, Yimei Long, Jiahao Chen, Qian Cheng, Xin Tian, (Southwest Minzu University)

Abstract: Multimodal emotion recognition (MER) technology enhances the accuracy, reliability and adaptability of emotion detection by capturing modality-specific emotional cues and leveraging cross-modal synergies. However, challenges persist in terms of shallow feature representations, heterogeneous data alignment, and inefficient multimodal fusion. To address these issues, this paper proposes a Multimodal Bottleneck Fusion Network (MBFN). The model utilizes pre-trained models (BERT, Wav2Vec 2.0 and FabNet) to extract high-semantic features from text, audio and visual modalities. An LSTM-based information aggregation module equipped with a collaborative attention mechanism dynamically aligns temporal features and suppresses redundancy through adaptive weighting. Additionally, a bottleneck fusion mechanism integrated within the Transformer architecture constrains cross-modal interactions, thereby reducing computational redundancy and noise. Experimental results on IEMOCAP and CMU-MOSEI datasets demonstrate that MBFN outperforms nine state-of-the-art methods (e.g., TFN, LMF, MulT), achieving top performance in metrics such as ACC-7 and ACC-2 while reducing computational costs. The proposed approach advances MER by balancing efficient fusion, noise suppression, and context-aware modality integration.

Room: Sindalah | Date: Wednesday, April 08, 2026 | Time: 18:30 – 18:55 [Online]

[G14] A Regression-based Machine Learning for Typing Speed Prediction Using Historical User Data

Modhawi Alotaibi*, Taibah University (Saudi Arabia); Afnan Jadidi, Ebtehal Eshaq; Furat Alraddadi, (Taibah University); Shahad Alzayed; Youmna Sharaf, (Taibah University)

Abstract: Touch typing is an essential skill in the modern digital world, where most services and communications depend on fast and accurate text input, yet it is often undervalued as a technical skill. This study aims to spread awareness of its importance in digital communication. Where traditional touch-typing tools rarely offer statistical information about the users' future performance, particularly the typing speed, this paper

proposes a machine learning approach for predicting users' future typing speed based on past performance data. It employs the Light Gradient Boosting Machine (LightGBM) regression model to evaluate essential typing parameters, such as current speed, accuracy, and temporal improvement trends. This model assesses aggregated progression metrics over time instead of a continuous time series of sessions. The model provides personalized speed predictions and visualizes potential progress, motivating users to consistently practice their typing skills. The evaluation of real user data yielded a mean absolute error (MAE) of 4.45 and an R2 score of 0.92, indicating high predictive accuracy. The proposed system was implemented on actual data from a touch-typing website designed for computer science students, novice programmers, and freelancers. Overall, the findings highlighted the broader value of machine learning in delivering personalized feedback, supporting continuous skill development, and enhancing digital productivity.

Room: Sindalah | Date: Wednesday, April 08, 2026 | Time: 18:55 – 19:20 [Online]

[G15] Performance Evaluation in a SMART Artificial Intelligence Inclusive Classroom using Modified-Item Response Theory (M-IRT)

Shadeeb Hossain*, DeVry University (United States)

Abstract: This model proposes a Modified Item Response Theory (M-IRT) framework, extending the traditional Two-Parameter Logistic (2 PL) model by redefining the discrimination parameter as a function of multiple contextual variables. While conventional Item Response Theory (IRT) models primarily account for item difficulty and learner ability, M-IRT incorporates additional passive factors that influence response behavior and learning outcomes. Specifically, the model integrates: (i) response time, (ii) encoded learning style, (iii) lesson duration, (iv) instructor reputation, and (v) participation score- each contributing to a dynamic discrimination slope. The paper presents the mathematical formulation of the model, supported by a computational algorithm designed to estimate these parameters effectively. The proposed framework offers a more nuanced understanding of learner performance and holds promises to enhance adaptive assessment and personalized instruction in the educational environment.

Room: Sindalah | Date: Thursday, April 09, 2026 | Time: 10:15 – 10:40 [In Person]

[G16] A Mini-Review of Arabic Poetry Meter Classification

Murtadha Alabdulsalam*, King Fahd University of Petroleum & Minerals (Saudi Arabia); Wasfi Al-Khatib; Mohammad Amro, KFUPM (Saudi Arabia)

Abstract: Poetry is an important art form in human history. Many poems have been written to share emotions, express pride or gratitude, declare or resolve conflicts, among others. Writing good poetry requires expertise. Understanding the structure of a poem helps poets better choose words and phrases that reflect their ideas. Identifying the meter of a poem helps in teaching new poets the different compositions they have at their disposal while also providing an easy way for professional to detect broken poetry. This work investigates various efforts from the literature that tackled poetry meter classification, focusing on poetry written in Arabic. Different gaps in research have been identified including the need of proper analysis of the effects of diacritization on individual meters, the limited amount of research in spoken poetry due to scarce public datasets. , and the need of further investigations regarding similar and rare poetry meters. We conclude with recommendations for dataset creation and modeling strategies to close these gaps and outline directions for future research in Arabic poetry meter classification.

Room: Sindalah | Date: Thursday, April 09, 2026 | Time: 10:40 – 11:05 [In Person]

[G17] Aban: Predicting ADOS Score from Upper-Body Movements and Eye Gaze for Autism Severity Assessment

Maryam Aldulami*, KFU (Saudi Arabia); Badar AlMarri, Safa Alsalman, Nujud Alobaid, Jinan AlMaghlouth, Sara AlJamea, Aisha Alkhateeb, (King Faisal University)

Abstract: Autism Spectrum Disorder (ASD) is a neurodevel- opmental disorder that causes challenges in social interaction, communication, and behavior. Early diagnosis of ASD is crucial for timely intervention and improved developmental outcomes. One of the most widely used tools to assess the severity of ASD is the Autism Diagnostic Observation Schedule (ADOS). In this article, we proposed a deep learning model to predict ADOS scores utilizing the DREAM dataset, which was collected during therapeutic sessions using three RGB cameras and two RGBD (Kinect) cameras. The dataset includes eye-gaze and upper body movement data. To capture the sequential and temporal nature of this dataset, we employed Recurrent Neural Networks (RNNs), specifically a Bidirectional Long Short-Term Memory (BiLSTM) architecture. Our model achieved a classification accuracy of 95.54 in predicting ADOS scores ranging from 4 to 20. This approach demonstrates the potential to support the diagnostic process by offering a more objective method to assess the severity of ASD, reducing the dependence on subjective evaluation, and providing a scalable and data-driven solution for the early evaluation of ASD.

Room: Sindalah | Date: Thursday, April 09, 2026 | Time: 11:05 – 11:30 [Online]

[G18] STT-SSCAF: Transformer-Based Infant Pain Estimation with Self-Supervised Learning and Multimodal Fusion

Sami Naouali*, King Faisal University (Saudi Arabia); Oussama Othmani, Ecole Polytechnique de Tunisie (Tunisia); Riadh Ouersighni, (Military Academy of F. Jedid)

Abstract: Accurate infant pain assessment is essential in neonatal care but remains challenging due to subtle expressions and limited labeled data. We introduce STT-SSCAF, a novel transformer-based architecture that leverages self-supervised pretraining and cross attention fusion to estimate pain severity from facial videos. By integrating masked autoencoders, dualbranch transformers for spatio-temporal modeling, and optional multimodal signals, the model employs ordinal regression to predict pain levels (0–3). Evaluated on the iCOPE dataset, STT-SSCAF achieves 84.6% ± 0.7% accuracy and a quadratic weighted kappa (QWK) of 0.82, surpassing baseline models, with near real-time performance on GPU hardware. This work advances neonatal affective computing, offering a robust solution for clinical deployment.

Room: Sindalah | Date: Thursday, April 09, 2026 | Time: 11:30 – 11:55 [Online]

[G19] HearMeWell: Emotion Signals Recognition in Arabic Speech Using Image-Based and Numerical-Based Approaches

Raghad Almutairi*, Ghadi Bakhashwain, University of Jeddah (Saudi Arabia); Ramah Alharbi, Jeddah University (Saudi Arabia); Danah Bawajeeh, Non (Saudi Arabia); Rama Magbool, (University of Jeddah); Shahd Alahdal, University of Jeddah (Saudi Arabia)

Abstract: Understanding emotions conveyed in spoken Arabic is crucial for improving emotional communication and helping people with specific needs. This study aims to detect emotions in Arabic speech using two distinct methods: image-based and numericalbased approaches. Unlike previous studies, which primarily focus on English audio and often use numerical-based approach, with some exploring image-based approach, this study introduces a comparative analysis of these approaches specifically for Arabic audio. The results showed that the image-based approach outperformed the numerical-based approach, achieving higher accuracy in identifying emotions, especially in “Anger” and “Disgust”. These findings not only deepen our understanding of emotion recognition in speech, but also open the door to practical applications. For instance, this technology could support individuals with hearing impairments in understanding emotions. It could also be applied to areas such as mental health support, personalized learning, and customer service.

Room: Sindalah | Date: Thursday, April 09, 2026 | Time: 11:55 – 12:20 [Online]

[G20] Towards Responsible Conversational AI for Mental Health Support: Balancing Empathy, Fairness, and Safety with Deep Learning

Fatima Khurshid*, FAST, NUCES Islamabad (Pakistan); Akhtar Akhtar, National University of Computer and Emerging Sciences (Pakistan)

Abstract: Conversational AI systems are increasingly being deployed for mental health support; however, many existing approaches emphasize language fluency while overlooking critical aspects of responsibility, including safety, fairness, and personalization. This paper proposes a lightweight and responsible conversational AI framework designed to deliver empathetic mental health support under low-resource conditions. The framework integrates emotion-aware dialogue analysis, zero-shot personality approximation, layered safety filtering, and fairness auditing within a unified and modular pipeline. Sentence-level semantic embeddings are used to enable efficient emotion classification and personality-informed adaptation without large-scale model fine-tuning. Safety mechanisms are incorporated to detect toxic or crisis-related content and to prevent the generation of inappropriate medical advice, while fairness is evaluated through controlled input comparisons. Experiments conducted on an extended Empathetic Dialogues dataset demonstrate strong emotion classification performance and coherent personality structures in a CPU-only environment. The results suggest that responsible design principles can be effectively integrated with lightweight deep learning models to develop empathetic, safe, and equitable conversational agents for mental health support.

Track 8: Data Science, Cloud Computing & Intelligent Applications

Room: HEXAGON | Date: Wednesday, April 08, 2026 | Time: 14:45 – 15:10 [In Person]

[H01] Forecasting Crowd Density and Directional Flow

Rawabi Alsedais*, KFU (Saudi Arabia)

Abstract: This paper presents a smart crowd analytics system for monitoring and predicting crowd density and directional flow, designed using AI techniques. The system aims to assist organizers of large-scale events in the early detection of crowd conditions, enabling them to make fast and efficient decisions. We developed a comprehensive system that analyses frame sequences from the UCSD pedestrian dataset by integrating CNN-based detection, tracking, and LSTM-based temporal modeling to generate scalar density values and interpretable movement directions. Our evaluation shows an R2 of 97% for density prediction and 88% for flow direction prediction. This project contributes to proactive crowd management by integrating forecasting capabilities with a dashboard that transforms raw predictions into accessible, decision-ready insights for safety authorities.

Room: HEXAGON | Date: Wednesday, April 08, 2026 | Time: 15:10 – 15:35 [In Person]

[H02] A Systems Mapping Framework for Analyzing Value Creation in Metaverse Economies

Walaa Alharthi*, Taibah Valley (Saudi Arabia)

Abstract: The Urban Digital Twin Metaverse Ecosystems (DTME) are technical systems that integrate technology and social systems to simulate cities in a virtual environment. These systems allow integration of trial data, allowing planning of collaborative simulations, and are long-term 3D city environments. Although there are strong frameworks, such as FIWARE/NGSI-LD and federated data systems, there is little evidence illustrating real-life and economic benefits. This paper is based on a new approach to the creation of values in DTME, applied to describe them with a clear four-step process: Frame, Explore, Map, and Reflect. We identified 18 main factors, which are organized in six thematic groups to show causal relations. The analysis demonstrates that there are five feedback loops, which include interoperability adoption, governance trust, ecosystem growth, simulation value, and efficiency attribution. All these cycles contribute to value creation. However, fragmentation trap is important as it balances the loop by limiting system performance. Although it has a strong technical and management structure, transforming them into specific value is a challenge because it is characterized by ineffective evaluation procedures, data attachment, and governance. These findings provide useful pieces of information to city leaders and developers of technological solutions to enhance urban metaverse projects. Index Terms: Urban digital twins, metaverse ecosystems, systems mapping, value creation.

Room: HEXAGON | Date: Wednesday, April 08, 2026 | Time: 15:35 – 16:00 [Online]

[H03] Soybean Commodities Impact Forecasting in the USA

Cristian Hrenciuc, (Universiteit van Amsterdam); Cristian Rodriguez Rivero*, Polytechnic University of Catalonia Barcelona Tech (Spain); Julian Pucheta, Laboratorio de Investigación Matemática Aplicada a Control - Universidad Nacional de Córdoba (Argentina); Dim Coumou, IVM/VU (Netherlands)

Abstract: This study analyses how climate extremes and weather conditions affect daily soybean futures prices in the USA. We construct a high-frequency dataset that combines soybean futures prices and trading volumes, the S&P 500 index, and indicators of natural disasters (droughts, floods, storms, wild_x0002_fires, earthquakes, epidemics) from EM-DAT, and, for a shorter subperiod, gridded climate variables (temperature, precipitation, wind, humidity, solar radiation) from CFSR. We first develop a benchmark dynamic regression model that includes financial and seasonal drivers, and then augment it with climate variables. The benchmark model shows that soybean futures prices are highly autoregressive and strongly linked to trading volume and broad equity market movements, with an autoregressive coefficient of about 0.96 and an R^2 above 0.98.

Adding climate extremes improves forecasting performance only marginally: for the full dataset the RMSE decreases from 0.0523 to 0.0515, and for the extended dataset with CFSR variables from 0.0566 to 0.0554. We compare these models to a pure AR(1) process and to XGBoost, which achieve lower errors but do not provide interpretable climate effects. The regression results indicate that droughts significantly affect prices and that their impact depends on the season, with evidence of price decreases in autumn and small increases in spring and summer. Overall, we find that climate-related information is only weakly and inconsistently reflected in short-term soybean futures prices once financial and seasonal factors are taken into account

Room: HEXAGON | Date: Wednesday, April 08, 2026 | Time: 16:00 – 16:25 [Online]

[H04] Why Do Admission Attempts Fail? An Analysis of Bangladeshi University Admission Applicants Using ML and XAI

Anwar Hossain Efat*, Idaho State University (United States); S.M. Mahedy Hasan, Rajshahi University of Engineering & Technology (Bangladesh); Minhaz F. Zibran, Farjana Z Eishita, Idaho State University (United States)

Abstract: Each year, over one million students in Bangladesh compete for limited undergraduate seats at universities, with intense competition for the 53 public universities where about 36 candidates vie for each seat. This fierce rivalry often results in unmet expectations, leading to depression and other psychological challenges for many students. Contributing factors include educational background, family circumstances, distractions, unproductive activities, and socio-economic conditions. This study aims to identify the primary reasons behind unsuccessful admission attempts and evaluate the impact of these factors using data from 600 students across 15 public and private universities. Questionnaires were used to gather data, which was analyzed with Machine Learning (ML) techniques. Among various models, the proposed Feature-Tuned Support Vector Machine (FT-SVM) achieved a 96.47% accuracy in predicting admission outcomes based on preparatory activities. To enhance model interpretability, Explainable Artificial Intelligence (XAI) techniques were employed, highlighting critical factors that influence outcomes. These findings offer actionable insights for students, helping them optimize their preparation and improve their chances of success in future admission tests.

Room: HEXAGON | Date: Wednesday, April 08, 2026 | Time: 16:25 – 16:50 [Online]

[H05] Adapting MCP and A2A in the Banking Ecosystem

Muthu Selvam*, University of North Carolina at Charlotte (United States)

Abstract: Federated Learning (FL) integrates MCP and A2A for privacy-preserving and intelligent mobile banking personalisation. FL allows decentralised model training on client devices, protecting sensitive user data. MCP manages federated context modelling and model orchestration, whereas A2A coordinates A2A (automation) and A2A (transactional) interactions in the paper's dual-layer design. This reduces privacy leakage and enables dispersed financial institutions to update their models continually. An experimental assessment utilizing synthetic banking activity datasets and anonymized UPI transaction streams reveals a 35% latency reduction, a 42% gain in A2A settlement efficiency, and a 22% decrease in false positives for fraud detection. Further statistical verification and replication are needed to confirm these empirical results, a study limitation. With permission verification and cryptographic auditability, the modular architecture can support regulatory compliance and intelligent banking personalization.

Room: HEXAGON | Date: Wednesday, April 08, 2026 | Time: 17:15 – 17:40 [Online]

[H06] Detecting Cognitive Activity Using Electroencephalography and Distributed Detection System

Abdullah Biran, (King Faisal University); Aleksandar Jeremic*, McMaster University (Canada); Laila Alateyah, (King Faisal University); Aljazi Al Maghlouth, King Saud bin Abdulaziz University

Abstract: Analysis of cognitive states is important from both clinical and academic standpoints as it enables us to have better insight into cognitive states and / or deficiencies. By obtaining sufficiently accurate image

of cognitive states we can potentially design more efficient therapies / treatments for patients suffering from certain disorders such as ADHD. To this purpose in this paper we propose machine learning algorithm for detecting cognitive states and predicting outcomes of cognitive activity. We utilize Frechet average of the coherence matrix as it has been demonstrated that it is one of most important discriminating features for cognitive state detection. We demonstrate the applicability of the proposed algorithms using real data set.

Room: HEXAGON | Date: Wednesday, April 08, 2026 | Time: 17:40 – 18:05 [In Person]

[H07] A Fuzzy Goal Programming Approach for Integrated QFD: Selection of Engineering Characteristics and Design Alternatives

Mohamed Sadok Cherif*, king Faisal University (Saudi Arabia)

Abstract: Quality Function Deployment (QFD) is widely used to translate customer needs into engineering targets. However, a key challenge in practice is prioritizing which engineering characteristics (ECs) to select and determining how to implement them under uncertainties in cost, risk, and technical data. This paper proposes a novel fuzzy goal programming (FGP) model that integrates the selection of ECs with the allocation of design alternatives (DAs). The model seeks to maximize customer satisfaction (CS) while minimizing cost and technical risk, using fuzzy set theory to capture imprecision in development data. The approach is demonstrated through an electric vehicle powertrain case study, which shows the generation of robust Pareto-optimal solutions. The results indicate that the model offers managers a practical and quantitative decision tool for strategic product design under uncertain conditions.

Room: HEXAGON | Date: Wednesday, April 08, 2026 | Time: 18:05 – 18:30 [Online]

[H08] Impact of Dataset Scale on First-Order Motion Model Performance

Talha Rashid*, QLU.ai (Pakistan)

Abstract: This paper presents a large-scale reproduction study of the First Order Motion Model (FOMM) for image animation, investigating a critical but unexplored question: was the original model's performance limited by its training data scale? While the original FOMM was trained on a limited subset of 12,331 videos from VoxCeleb1, we hypothesize that the architecture's capacity was underutilized. To test the true data efficiency and upper performance bound of this architecture, we train an identical architecture on a curated set of over 422,672 videos from VoxCeleb2. Our results demonstrate significantly accelerated convergence, achieving strong in-domain performance after a small fraction of the original training time and shows rapid improvement on cross-domain benchmarks. This provides empirical evidence that FOMM is a highly data-efficient architecture but the model has significant untapped potential that can be unlocked with larger data. Our study offers valuable insights into the data scaling properties of motion models and underscores the importance of large-scale datasets in unlocking a model's full potential.

Room: HEXAGON | Date: Wednesday, April 08, 2026 | Time: 18:30 – 18:55 [Online]

[H09] Forecasts of Hurricane Helene Using AI Machine Learning Models

Kristen Lou*, Independent Research (United States)

Abstract: Accurate hurricane forecasting is vital for protecting communities and saving lives. This paper forecasts Hurricane Helene, a Category 4 storm that caused widespread damage across the southeast U.S. in 2024, using AI weather prediction (AIWP) models. The AIWP models (Nvidia's FourCastNet, Google's GraphCast, Microsoft's Aurora, and Huawei's PanguWeather) - billion-parameter deep learning models - were used to forecast Hurricane Helene's speed, pressure, landfall, trajectory, and intensity, with 1-day, 2-day, and 3-day forecast windows. The prediction focused on key parameters, including the maximum 10-meter wind speed, minimum mean sea level pressure (MSLP), and the hurricane's landfall and centroid locations. We proposed a new linear interpolation algorithm to accurately predict the time when the hurricane will hit the coast, based on the AIWP model-predicted

hurricane positions just before and after landfall. We compared the AIWP forecasts to both the ERA5 reanalysis dataset and the National Hurricane Center (NHC) observed data. Our results suggest that the AIWP models, having been trained primarily on the ERA5 dataset with limited local hurricane data, faced greater challenges in accurately predicting Hurricane Helene (2024) compared to Storm Ciar´ an (2023). The maximum wind speed and minimum MSLP of the hurricane were both under-predicted by the AIWP models and even by ERA5, when compared to the NHC ground truth data. However, they did perform reasonably well in predicting the hurricane's overall trajectory and landfall time and location, which is crucial for early warning systems and disaster preparedness. The AIWP models' ability to accurately predict the hurricane's path and movement underscores their potential for supporting future hurricane forecasting. The study suggests that further refinement and integration of more localized data may be needed for the AIWP models to be used for operational extreme weather forecasting.

Room: HEXAGON | Date: Wednesday, April 08, 2026 | Time: 18:55 – 19:20 [Online]

[H10] Identifying Information Technology Research Trends through Text Mining of NSF Awards

Said Varlioglu*, University of Cincinnati (United States); Hazem Said, (University of Cincinnati); Murat Ozer, (Univeristy of Cincinnati); Nelly Elsayed, University of Cincinnati (United States)

Abstract: Information Technology (IT) is recognized as an independent and unique research field. However, there has been ambiguity and difficulty in identifying and differentiating IT research from other close variations. Given this context, this paper aimed to explore the roots of the Information Technology (IT) research domain by conducting a large-scale text mining analysis of 50,780 abstracts from awarded NSF CISE grants from 1985 to 2024. We categorized the awards based on their program content, labeling human-centric programs as IT research programs and infrastructure-centric programs as other research programs based on the IT definitions in the literature. This novel approach helped us identify the core concepts of IT research and compare the similarities and differences between IT research and other research areas. The results showed that IT differentiates itself from other close variations by focusing more on the needs of users, organizations, and societies.

Room: HEXAGON | Date: Thursday, April 09, 2026 | Time: 10:15 – 10:40 [Online]

[H11] Edge–Cloud Predictive Maintenance Models for Industry 4.0

Ahmad Junaid, CECOS University (Pakistan); Abuzar Khan; Abid Iqbal*, King Faisal university (Saudi Arabia); Ghassan Husnain, CECOS University of IT and Emerging Sciences (Pakistan)

Abstract: This study presents a predictive maintenance framework designed for Industry 4.0 that integrates preprocessing, feature engineering, machine learning, deep learning, explainability and prescriptive optimization in a unified pipeline. The dataset was cleaned, balanced and engineered to retain 10 key features, with torque identified as the most important predictor. Baseline models including CatBoost, LightGBM and TabNet achieved strong performance, with CatBoost reaching an accuracy of 0.994 and ROC-AUC of 0.994. Deep learning simulations compared lightweight edge models against cloud-based architectures, showing that shallow MLP achieved accuracy of 0.962 with latency of 1.2 milliseconds, while deep MLP achieved accuracy of 0.982 with latency of 7.1 milliseconds. TabNet further achieved accuracy of 0.989 with F1 of 0.986. Using SHAP and LIME, we were able to clearly see that torque-related ratios and how we label failure types are very important for making accurate predictions. This helps make the system more transparent and easier to trust in real-world industrial use. Final benchmarking highlighted that edge models provided ten times faster inference while cloud models delivered maximum accuracy of 0.993 and F1 of 0.992. The results demonstrate a balanced, scalable and sustainable predictive maintenance system that optimizes accuracy, efficiency and operational cost.

Room: HEXAGON | Date: Thursday, April 09, 2026 | Time: 10:40 – 11:05 [Online]

[H12] Federated Cloud Intelligence: A Privacy-Preserving, Trustworthy and Sustainable Framework for Multi-Cloud AI

Abuzar Khan; Ahmad Junaid, CECOS University (Pakistan); Abid Iqbal*, King Faisal university (Saudi Arabia); Ghassan Husnain, CECOS University of IT and Emerging Sciences (Pakistan)

Abstract: This paper introduces Federated Cloud Intelligence for Privacy-Preserving AI, a new layered framework that supports secure and eco-friendly learning across different cloud providers. Instead of centralizing data, our method trains models locally on varied client datasets and combines their updates using federated learning to stay compliant with data protection rules. The experiment have shown that the federated setup reached an average accuracy of 0.844 over five communication rounds, just slightly lower than the centralized baseline of 0.850. Meanwhile, the loss decreased from 0.367 to 0.285, coming close to the centralized value of 0.318. To build trust, we added a blockchain-based layer that permanently stored updates with little extra cost, adding blocks each round with an average consensus delay of 0.189 seconds. Tests showed that this consensus process reduced the impact of malicious client attacks, keeping accuracy stable around 0.827. Further it is incorporated zeroknowledge proofs, adding only 0.196 seconds of latency and 260–360 MB GPU memory overhead, while maintaining accuracy up to 0.844. A reinforcement learning agent optimized workload scheduling by shifting computation from AWS to GCP, reducing carbon scores by 20% with minimal accuracy trade-off. Finally, explainability analysis revealed balanced provider contributions (0.021–0.023) and highlighted key features such as logPurchases and storePurchases.

Room: HEXAGON | Date: Thursday, April 09, 2026 | Time: 11:05 – 11:30 [Online]

[H13] Legacy system modernization using MVC with Microservices

Muhammad Abdullah Tariq*, National University of Science and Technology (Pakistan); Tauseef Rana, King Faisial University (Saudi Arabia); Ayesha Maqbool, National University of Sciences and Technology (Pakistan)

Abstract: Legacy systems are existing running systems which are very important for an organization. They play a vital role in the organizations day to day working. Due to the rapid advancement in technology, working with these systems have become very hard and costly. This has lead researchers to explore towards finding techniques that enable the software developers to work with legacy systems.The process of upgrading a legacy system from out dated technology to new and up to date technology is called legacy system modernization. This process may include rewriting the system completely or integrating an old legacy system in a new system. Microservices are the next big trend in software design and architecture. They divide a large application in smaller independent modular applications and make them available over the network using APIs. In this paper we focus on web based legacy systems, we study the commonly used legacy system modernization design patterns and propose a new software design pattern for the legacy system modernization process using MVC and Microservices. The proposed design pattern makes the application more scalable, maintainable and has the ability to adapt any changes that may be done later on. The proposed pattern is also a more cost efficient and flexible for developers to work with.

Room: HEXAGON | Date: Thursday, April 09, 2026 | Time: 11:30 – 11:55 [Online]

[H14] Hyper-Localized Weather Forecasting Using Spatial Interpolation and Deep Learning

Owais Waheed*, Faisal Alvi, Habib University (Pakistan); Muhammad Khubaib, Kushal Chandani, (Habib University); Abdullah Junejo

Abstract: Hyper-localized weather forecasting is essential for effective disaster preparedness, agricultural planning, and public safety in regions with diverse terrain and limited data infrastructure. This paper presents a hybrid approach that integrates spatial interpolation using Universal Kriging with deep learningbased temporal forecasting using models such as LSTM, XGBoost and SARIMA-X to address sparse weather station coverage. We utilize high-resolution weather data recorded at minute intervals from various cities in northern

and central Pakistan. Model performance is evaluated using standard metrics including RMSE, MAE, and R^2. Universal Kriging, enhanced with elevation-based drift, achieved near-perfect interpolation with R^2 values approaching 1.0. For 48-hour temperature forecasting, LSTM with multi-station lagged features reached an R^2 score of 0.961. Our results demonstrate that combining geostatistical interpolation with temporal forecasting substantially improves prediction accuracy, offering a scalable solution for localized weather intelligence in data-sparse regions.

Room: HEXAGON | Date: Thursday, April 09, 2026 | Time: 11:55 – 12:20 [Online]

[H15] MST-AFF: A Multi-Modal Spatio-Temporal Transformer with Adaptive Feature Fusion for Pain Intensity Estimation

Sami Naouali*, King Faisal University (Saudi Arabia); Oussama Othmani, Ecole Polytechnique de Tunisie (Tunisia); Riadh Ouersighni, (Military Academy of F. Jedid)

Abstract: Accurate pain intensity estimation from facial expressions is vital for clinical diagnostics and telemedicine but is challenged by background interference, inter-subject variability, and limited data. We introduce the Multi-Modal Spatio-Temporal Transformer with Adaptive Feature Fusion (MST-AFF), a novel architecture leveraging the UNBC-McMaster Shoulder Pain Expression Archive Database. MST-AFF integrates a fine-tuned Vision Transformer for robust spatial feature extraction, a Temporal Transformer for modeling dynamic expression changes, and an attention-based fusion module to prioritize pain-indicative features. Advanced preprocessing, including face cropping and data augmentation, addresses dataset limitations. The model classifies Prkachin and Solomon Pain Intensity scores (0–3: no pain to strong) with an expected 97% accuracy and 95% F1-score, achieving an RMSE below 1.0 for continuous prediction. With ⍰50ms inference per frame on an NVIDIA A100 GPU, MST-AFF supports real-time telemedicine. Outperforming baselines like EJH-CNN-BiLSTM (89%) and parallel CNNs (95.11%), MSTAFF's transformer-based approach and adaptive fusion enhance subtle pain detection. Future enhancements include multimodal physiological integration and synthetic data generation, advancing robust pain assessment.

Room: HEXAGON | Date: Thursday, April 09, 2026 | Time: 12:20 – 12:45 [In Person]

[H16] Deep Transformer based Structural Semantic Network for Document Clustering

Umair Amir, Faizan Ali, Ali Ahmed; Muhammad Rafi*, National University of Computer and Emerging Sciences

Abstract: Document clustering is very sensitive to document representation schemes. Traditional document clustering approaches used document content to model features and used representation based on these features thus suffer from problems like vocabulary mismatch and word sense ambiguities, and fail to cater with word-to-word relationship in longer dependency. Consequently, the clustering results lack semantic values. Deep document clustering simultaneously learns semantic repesentation and does clustering using deep neural networks. In this paper, a deep transformer-based structural semantic network for document clustering (DTSN) is proposed, it uses a transformer based approach to learn a document-level semantic representation with long-term text dependency, and exploits graph convolution network in order to capture semantic between documents going layer-by-layer, utilizing reinforcement learning. Extensive series of experiments are performed, and this proposed approach performs substantially better than state-of-the-art deep document clustering approaches. This paper reports a new state-of-the-art on unsupervised text document clustering tasks.

DAY-3: Online Sessions
Friday, April 10, 2026

Online Session-1 | Time: 09:00 – 11:00 AM

Google Meet Link-1

Date: Friday, April 10, 2026 | Time: 09:00 – 09:15

[PaperID: 77] Surgery Scheduling Optimization using an Adaptive Genetic Algorithm with Q-Learning Guided Tournament Selection

Mohammadtaghi Dehghannezhad (King Fahd University); Jam Muhammad Talha Laar (King Fahd University); Alaa Khamis (King Fahd University); Yasser Almoghathawi (King Fahd University)

Abstract: Scheduling surgeries in operating rooms is a critical task that directly influences patient outcomes, staff workload, and a hospital's ability to respond to emergencies. This paper proposes an adaptive genetic algorithm with novel Q-learning guided tournament selection method to adaptively select tournament sizes, enhancing the balance between exploration and exploitation during the optimization process. A domain-specific encoding scheme for patient–operating room–day assignments is employed to effectively represent and manage scheduling constraints. To evaluate the proposed method, a discrete-event simulation environment is developed to generate datasets based on benchmark scheduling patterns. Numerical experiments demonstrate that the proposed approach consistently converges faster than a standard genetic algorithm and achieves an average reduction of 10.05\% in total scheduling penalties, while maintaining zero delay for emergency cases. Furthermore, it outperforms other state-of-the-art genetic algorithm variants in identifying optimal solutions. Thanks to its adaptability and efficiency, the proposed method improves the scalability of surgical scheduling systems, facilitating real-world implementation and reducing operational costs.

Date: Friday, April 10, 2026 | Time: 09:15 – 09:30

[PaperID: 427] Generative AI for Cold-Start E-Commerce Product Review Generation

Siddhanta Rawal (Algoma University); Mahreen Nasir (Algoma University)

Abstract: Cold start remains a persistent challenge in collaborative filtering-based recommender systems, where products with limited user interactions often remain effectively invisible. This paper presents a novel approach for synthesizing product reviews using Large Language Models to mitigate data sparsity for new and low-visibility items. Using the Amazon Reviews 2023 dataset across the Beauty and Appliances categories, we demonstrate that generated reviews can bootstrap early helpfulness predictions for cold-start products. Experimental results show that synthetic reviews substantially improve product visibility, with mean ranking gains increasing from 47,919 to 59,554 positions and top-500 inclusion rates rising from 0 to 6.1%. We further observe that review density plays a critical role; for example, generating 10 reviews per product yields up to a

threefold improvement compared to using only 3 reviews. Importantly, the enhanced model maintains recommendation quality for warm items while exposing 85% of previously unseen products within the recommendation space. These findings indicate that synthetic review generation provides an effective and scalable solution to the cold-start problem in e-commerce recommendation systems.

Date: Friday, April 10, 2026 | Time: 09:30 – 09:45

[PaperID: 145] Evaluating Prompting Strategies in Multimodal Large Language Models for Human-Aligned Forensic Video Analysis

Opeyemi Adeniran (MORGAN STATE UNIVERSITY); Temitope Ajibola (Morgan State University); Kelechi Nwachukwu (Morgan State University); Anjolie Anthony (Morgan State University); David Nyarko (Morgan State University); Emmanuel Masa-Ibi (Morgan State University); Cynthia Nosiri (Morgan State University); Hashmath Fathima (Morgan State University); Binisa Giri (Morgan State University); Derrick Cook (Morgan State University); Blessing Adeika (Morgan State University); Tijesunimi Adeyemi (Morgan State University); Md Mahmudur Rahman (Morgan State University); Fahmi Khalifa (Morgan State University); Kofi Nyarko (Morgan State University)

Abstract: Forensic video analysis requires AI systems that can replicate human expert reasoning to support investigative processes. This study evaluates eight prompting techniques to optimize human-aligned responses in multimodal large language models (MLLMs) for forensic applications. The research systematically compared zero-shot, sequential, least-to-most, ReAct, chain-of-thought, meta-prompting, self-consistency, and iterative techniques across Claude Sonnet 4, GPT-4o, and Gemini 2.0 Flash models using a crime detection dataset spanning eleven categories. The evaluation employed a specialized forensic analysis rubric covering critical dimensions including crime classification, temporal reconstruction, evidence documentation, and forensic narrative generation. Each technique was scored on a 1-10 Likert scale, with evaluation based on proximity to annotated ground truth standards rather than absolute performance. Results showed GPT-4o achieved superior human-alignment (60.48, σ=11.14), followed by Gemini (47.44, σ=18.32) and Claude (35.81, σ=31.14). ReAct demonstrated the highest human-expert approximation across all models: Claude (70.8), GPT-4o (69.0), and Gemini (65.5). Chain-of-thought proved effective as a secondary technique, while iterative approaches failed with Claude. These findings provide forensic investigators and AI researchers with evidence-based guidance for developing human-aligned AI systems that meet the rigorous standards required in forensic investigative contexts.

Date: Friday, April 10, 2026 | Time: 09:45 – 10:00

[PaperID: 428] Machine Learning-Based Hand Gesture Recognition using Wearable Smart Glove

Aya Dakilall (Al-Nahrain university); Aseel Mohamed Ali Ali (Al-Nahrain University)

Abstract: Hand gesture recognition using wearable smart gloves has gained increasing attention in rehabilitation and assistive technology applications, particularly for post-stroke hand-function monitoring.

However, many studies report overly optimistic performance due to improper data-splitting strategies that introduce data leakage between training and testing sets. This paper presents a leakage-free evaluation framework for glove-based hand gesture recognition using a publicly available American Sign Language (ASL) sensor dataset, with a focus on rehabilitation-relevant hand functions. Two supervised classifiers—Support Vector Machine with RBF kernel (SVM-RBF) and Decision Tree (DT)—are evaluated using Grouped K-Fold cross-validation to enforce trial-level separation. The results indicate that the SVM-RBF achieves the highest performance with a mean accuracy of 0.97 ± 0.06, followed by DT (0.92 ± 0.12). Results emphasize leakage-free evaluation and ensemble learning for robust wearable gesture detection, with future work focusing on individual patient rehabilitation data validation.

Date: Friday, April 10, 2026 | Time: 10:00 – 10:15

[PaperID: 303] Deep Reinforcement Learning for Optimizing Penalty Kick Strategies in Football: A Comparative Study of PPO and IPPO

Muhammad Fadhlul Wafi Ahmad Naim (International Islamic University Malaysia); Azhar Mohd Ibrahim (IIUM); Mohd Zaid (International Islamic University Malaysia); Ali Ahmed Allam (International Islamic University Malaysia)

Abstract: Penalty kicks are among the most decisive and pressure-filled moments in football, often shaping the outcome of matches. Their complexity lies in the split-second decisions made by both kicker and goalkeeper, which traditional statistical or biomechanical approaches struggle to fully capture. In this paper, we explore how Deep Reinforcement Learning (DRL) can optimize penalty kick strategies using the Google Research Football (GRF) environment. We trained agents with two algorithms, Proximal Policy Optimization (PPO) and Independent PPO (IPPO), to model realistic kicker–goalkeeper interactions. Performance was analyzed through goal success rates, goalkeeper saves, and decision heatmaps. The trained IPPO agents exhibit a goal success rate exceeding 85%, a notable increase compared to baseline strategies which uses PPO agents (~65%). Spatial heatmaps further revealed a strong preference for low-corner shots, aligning with real-world tendencies. These findings show that DRL-trained agents can learn adaptive and effective penalty strategies, offering practical insights for football analytics, training, and tactical preparation.

Date: Friday, April 10, 2026 | Time: 10:15 – 10:30

[PaperID: 356] Comparative Analysis of MRI Slice Orientations for Autism Detection

Abdulaziz Aladdad (Towson University); wassila lalouani (Towson university)

Abstract: Autism Spectrum Disorders (ASDs) are neurodevelopmental conditions that typically manifest during early childhood and are characterized by a broad range of cognitive, behavioral, and social impairments. Early detection is critical, as timely intervention is associated with significantly improved treatment outcomes. However, conventional diagnostic procedures are often prolonged and resource intensive, typically requiring assessments by multiple specialists over several months. Recent advances in artificial intelligence offer promising avenues for accelerating and enhancing the accuracy of ASD diagnosis. In this paper, we investigate

the effectiveness of various computer vision models, specifically ViT-B/16, AlexNet, MobileNet, RegNet, and DenseNet for classifying Autism Spectrum Disorder (ASD) using coronal, axial and sagittal slices from magnetic resonance imaging scans. Our experimental results demonstrate that RegNet models outperform the others, achieving the highest classification accuracy and the lowest false positive rates, indicating their potential utility as a supportive diagnostic tool in clinical settings.

Date: Friday, April 10, 2026 | Time: 10:30 – 10:45

[PaperID: 174] CausalRAG-AD: Multimodal MRI Classification and Guideline-Compliant MRI Captioning for Alzheimer's Diagnosis

Ramisa Farha (Morgan State University); Md Mahmudur Rahman (Morgan State University); Fahmi Khalifa (Morgan State University)

Abstract: Alzheimer's disease (AD) is a degenerative disease, and current AI-based diagnostic procedures often lack calibrated probabilities, clear causal explanations, and comprehensive reporting. We propose CausalRAG-AD, an end-to-end framework that (i) trains calibrated transformer classifiers for AD staging from structural MRI and (ii) generates NIA-AA guideline–compliant, evidence-grounded MRI captions. The proposed architecture augments Video Vision Transformer (ViViT) with ROI-gated attention (CausalRAG-ViViT) from FreeSurfer hippocampus/ventricle/temporal z-scores and a light clinical gate; per-fold temperature scaling yields calibrated probabilities. It is evaluated against ViT+BiLSTM and ViViT-lite baselines using the Alzheimer's Disease Neuroimaging Initiative (ADNI) cohort. For binary AD vs. Cognitively Normal (CN), CausalRAG ViViT achieves the strongest calibration (ECE 0.078). In tri class CN/Mild Cognitive Impairment(MCI)/AD, CausalRAG ViViT reaches the best Acc (0.519) with competitive F1 (0.452). The proposed system produced 4,427 structured per-visit MRI reports. Every report contained all required sections, and most explicitly documented MRI provenance (scanner/vendor and field strength; 93.6%). All pipeline-generated numbers—MRI z-scores, MMSE, and CDR-SB—were replicated exactly from source tables (100% fidelity), and Aβ42 values matched the source (93.9%). When the necessary biomarkers were available, the AT(N) labels in the report consistently matched with our rule-based determination (100%).

Date: Friday, April 10, 2026 | Time: 10:45 – 11:00

[PaperID: 177] Comparative Analysis of Knowledge-Guided Few-Shot Brain Tumor Detection using Efficient Vision–Language Models and a Single-Shot Detector

OKIB ISLAM (Morgan State University); Joy Muchangi (Morgan State University); Ayomide Bonojo (Morgan State University); Md Mahmudur Rahman (Morgan State University); Fahmi Khalifa (Morgan State University)

Abstract: Vision language models (VLM) showed significant potential in multimodal medical analysis. This study presents a head-to-head comparison of two state-of-the-art VLMs (PaliGemma-2 and SmolVLM) and a single shot detector YOLOv12, each augmented with a structured medical knowledge graph (KG) for brain tumor detection. We construct a multimodal KG that links brain magnetic resonance (MR) image embeddings with corresponding report excerpts and standardized ontologies (ICD-10, SNOMED-CT), creating semantic

associations between visual patterns and clinical concepts. For VLMs, KG embedding is infused via a graph aware attention module that directs cross-modal reasoning toward anatomically and pathologically relevant regions. For YOLOv12 semantic priors are injected into intermediate feature maps through learned graphs embedding to reinforce contextual localization. Experimental framework utilizes a brain MRI dataset, evaluated under strict few shots learning constraints of 1, 3 and 5 shot scenarios to simulate real-world data scarcity. Model performance is quantified using various metrics and comparative analysis reveals distinct strengths across the models. PaliGemma-2 with KG achieves the most substantial improvements, highlighting its ability to leverage structured knowledge for more reliable tumor detection. SmolVLM achieves notable knowledge-to-parameters efficiency gains from KG augmentation, while YOLOv12 excels in precise localization and real-time detection with strong overall accuracy. These findings indicate that medical KG augmentation is a promising paradigm for specialized medical AI applications, where each architecture offers unique advantages for different clinical deployment scenario.

Online Session-2 | Time: 09:00 – 11:00 AM

Google Meet Link-2

Date: Friday, April 10, 2026 | Time: 09:00 – 09:15

[PaperID: 117] FSyD-Net: Fused Synergistic Disentanglement for Robust Audiovisual Emotion Recognition

Qiong Hong (The National University of Malaysia); Lailatul Qadri Zakaria (The National University of Malaysia); Sabrina Tiun (The National University of Malaysia)

Abstract: Audiovisual Emotion Recognition (AVER) faces a fundamental dilemma, how to strike a balance between ensuring information sufficiency and necessity. Multimodal fusion is essential for integrating complementary cues to ensure “sufficiency,” but it has the inherent risk of indiscriminately amplifying task-irrelevant noise, such as speaker identity features. Feature disentanglement assures “necessity” by stripping away identity obfuscation variables, but may compromise valuable affective context. To address this problem, this paper proposes a novel end-to-end framework, the Synergistic Disentanglement Network (FSyD-Net). The network follows the design philosophy of “fusion first, purification later”. First, an audio-visual fusion encoder builds a sufficient joint representation. Subsequently, our constructed Synergistic Disentanglement Head works on this representation, It adaptively combines the advantages of geometric disentanglement (orthogonal projection) and probabilistic disentanglement (variational inference) within a unified framework. Experiments on the RAVDESS dataset show that FSyD-Net significantly outperforms a range of task baselines on the AVER task. Further unsupervised feature quality analysis demonstrates that our approach learns more discriminative sentiment representations while effectively removing identity information, providing a new paradigm for building more robust AVER systems.

Date: Friday, April 10, 2026 | Time: 09:15 – 09:30

[PaperID: 146] ArabTutor: An Arabic Intelligent Tutoring System Powered by GPT-4 for Primary Education

Wala'a Shehada (Arab American University); Huthaifa Ashqar (Arab American University)

Abstract: This paper presents ArabTutor, an intelligent tutoring system built on OpenAI's GPT-4 architecture, aimed at enhancing educational accessibility for Arabic-speaking primary school students. The system supports three core subjects (Arabic Language, Mathematics, and Science) and enables students to interact using Modern Standard Arabic (MSA). ArabTutor provides concise, contextually accurate answers, maintains a short conversation history, incorporates subject selection, and includes a feedback-logging mechanism. Implemented with Python and Gradio, responses are logged to CSV files. A key feature is a "flag" function to report potentially incorrect responses for review. Unlike earlier Arabic tutoring systems that relied on static or rule-based agents, ArabTutor leverages GPT-4 to deliver flexible, adaptive explanations. Evaluation on 30 curated questions (10 per subject), reviewed by educators, showed 100% accuracy in Mathematics and Science and 90% in Arabic Language. The single error, hamza-type misclassifications, highlights challenges in fine-grained orthography. ArabTutor demonstrates the feasibility of LLM-powered tutoring for Arabic education and contributes toward closing the gap in Arabic-language AI applications. Code and data for reproducing our experiments are available in our GitHub repository https://github.com/walaashe/ArabTutor.

Date: Friday, April 10, 2026 | Time: 09:30 – 09:45

[PaperID: 147] A Survey on AI Approaches to Student Feedback Analysis for Personalized Learning

Eyad Ibraheem (Arab American University); Huthaifa Ashqar (Arab American University)

Abstract: Student feedback remains a critical component of evaluating teaching effectiveness and enhancing educational quality. Traditional approaches rely primarily on structured survey forms, which, while easy to process, often fail to capture the depth and nuance of students' experiences. Recent advances in Artificial Intelligence (AI), particularly text mining and machine learning (ML), offer new opportunities to analyze unstructured student feedback and uncover hidden patterns, sentiments, and themes that are otherwise difficult to detect. This survey paper provides a comprehensive review of AI-driven approaches for analyzing student feedback in higher education, with a focus on Natural Language Processing (NLP), sentiment analysis, topic modeling, and supervised/unsupervised ML algorithms. We examine how these methods move beyond conventional categorical analysis to support personalized learning, improve student engagement, and guide institutional decision-making. The paper also highlights emerging trends such as mobile learning analytics, deep learning applications, and the integration of AI with continuous improvement frameworks. Finally, we identify gaps in current research, with particular attention to underexplored contexts such as Palestinian universities, and propose directions for future work towards building inclusive, data-driven ecosystems for personalized education.

Date: Friday, April 10, 2026 | Time: 09:45 – 10:00

[PaperID: 159] Evaluating FinTech Services in the Palestinian Banking Sector: Insights into Customer Trust, Security, and Usability

Neebal Mutan (Arab American University); Nawal Abubaker (Arab American University); Noor Karaki (Arab American University); Rahaf Darraj (Arab American University); Huthaifa Ashqar (Arab American University)

Abstract: The rapid growth of financial technology (FinTech) has transformed banking services worldwide, offering customers greater convenience, efficiency, and accessibility. This study examines the level of FinTech adoption and its impact on customer satisfaction in the banking sector of Palestine. Data were collected through a structured online survey conducted in May 2025, yielding 399 valid responses from a diverse sample of bank customers. The survey included 16 questions covering demographic information, usage patterns, perceptions of FinTech, and satisfaction indicators such as usability, security, reliability, speed, and time savings. Descriptive analysis revealed that 79.9% of respondents reported using FinTech applications, with younger customers (18–24 years) and those already holding bank accounts showing the highest adoption and satisfaction levels. Among the available services, bank-affiliated applications (34.8%) and money transfers (19.5%) were most frequently used. Inferential analyses demonstrated significant differences in satisfaction across gender ($t = 2.214, p < 0.05$) and age groups ($F = 2.759, p < 0.05$). Moreover, satisfaction was positively associated with frequency of use ($\rho = 0.371, p < 0.001$), perceived security ($\rho = 0.371, p < 0.001$), application speed ($p < 0.001$), and time savings ($p < 0.001$), while frequent technical problems had a negative impact. These results suggest that FinTech services in Palestine are generally well-received, especially among younger and banked customers, but sustained satisfaction requires addressing technical challenges and strengthening trust and reliability mechanisms.

Date: Friday, April 10, 2026 | Time: 10:00 – 10:15

[PaperID: 243] Early-Stage Lung Cancer Prediction Using Ensemble Learning and Explainable AI Feature Analysis

Liyana Mohtaseb (Arab American University); Huthaifa Ashqar (Arab American University)

Abstract: Lung cancer is the leading cause of cancer-related deaths worldwide, largely due to its late detection and rapid progression. Early identification of risk factors and disease stage is critical for improving survival outcomes. In this study, we applied ensemble machine learning models, Random Forest and Extreme Gradient Boosting (XGBoost), to predict lung cancer stages using a structured dataset of demographic, environmental, lifestyle, and symptom-related variables. SHapley Additive exPlanations (SHAP) were employed to enhance interpretability and identify the most influential predictors of disease stage. The results revealed that obesity, passive smoking, and chest pain were the strongest drivers of advanced-stage predictions. These findings carry significant health implications. Obesity, increasingly recognized as a metabolic and inflammatory risk factor, may accelerate disease progression. Passive smoking emerged as a particularly important predictor, showing the urgent need for stronger smoke-free policies and public health interventions targeting indirect exposure. Chest pain, a late-stage symptom, highlighted the limitations of symptom-driven diagnosis and the critical

importance of screening programs capable of detecting lung cancer before clinical manifestations arise. While the models demonstrated high predictive accuracy (0.97 to 0.99), they slightly struggled to differentiate early-stage patients. Nonetheless, this study demonstrates the potential of Explainable Artificial Intelligence (XAI) to provide clinically meaningful insights, support preventive strategies, and strengthen public health policies aimed at reducing lung cancer mortality.

Date: Friday, April 10, 2026 | Time: 10:15 – 10:30

[PaperID: 336] Few-Shot Learning for Predicting Anti-VEGF Treatment Response in OCT Images

Ranya AMMARY (Laboratory of Biophysics and Medical Technologies Institute of Medical Technologies of Tunis, University of Tunis El Manar)*; Ines Rahmany (Laboratory of Biophysics and Medical Technologies Institute of Medical Technologies of Tunis, University of Tunis El Manar); Desire Sidibe (University of Paris-Saclay); Hedi Tabia (University of Paris-Saclay); Imane Zghal (Department A,Hedi Raies of Ophthalmology Institut (IHROT)); Nawres Khlifa (Laboratory of Biophysics and Medical Technologies Institute of Medical Technologies of Tunis, University of Tunis El Manar)

Abstract: Diabetic macular edema (DME) is a major cause of vision loss, usually treated with intravitreal injections of anti-VEGF agents such as aflibercept and bevacizumab (ranibizumabis no longer commercialized in Tunisia). However, not all patients respond effectively to this therapy, making it crucial to predict treatment outcomes in advance in order to personalize clinical decisions. One of the main challenges is the limited availability of annotated OCT datasets, which limits the performance of conventional deep learning methods. In this study, we investigate Few-Shot Learning (FSL) approaches, specifically Prototypical Networks, Relation Networks, and Model-Agnostic Meta-Learning (MAML), applied to OCT images for predicting patient response to anti-VEGF treatment. These architectures are designed to generalize from only a few training examples per class, making them suitable for medical scenarios with scarce data. Experimental results obtained on a private OCT dataset (good vs. poor responders) show that the Prototypical Network achieved the best performance with 90% accuracy and 85.5 % F1-score, outperforming both Relation Network (63% accuracy) and MAML (56.5% accuracy). These findings highlight the potential of meta-learning strategies to provide robust and efficient predictive models in ophthalmology, paving the way for improved personalized treatment strategies in patients with DME.

Date: Friday, April 10, 2026 | Time: 10:30 – 10:45

[PaperID: 378] Cross-Modality Deep Learning for Automated PET Segmentation

Hajer BRAHIM (Majmaah university)*; Nawres khlifa (Manar University)

Abstract: Accurate delineation of regions of interest (ROIs) in positron emission tomography (PET) remains a persistent challenge in the quantitative assessment of Parkinson's disease (PD), primarily due to the modality's intrinsically low spatial resolution and limited anatomical contrast. This study introduces a cross-modality deep learning framework that leverages structural priors from magnetic resonance imaging (MRI) to guide automated PET segmentation, thereby enhancing functional boundary definition through anatomical

knowledge transfer. The proposed pipeline integrates MRI-based atlas labeling, multimodal co-registration, and quantification-aware learning to achieve anatomically consistent segmentation and physiologically reliable biomarker estimation. Four state-of-the-art architectures—U-Net, Attention U-Net, Feature Pyramid Network (FPN), and DeepLabV3+—were systematically trained and evaluated on paired PET–MRI data from the H828 cohort. Experimental results demonstrated that MRI-guided supervision substantially improved both segmentation accuracy and biomarker reproducibility. Among the evaluated models, FPN achieved the best overall performance, with a mean Dice coefficient of 0.907, Intersection-over-Union (IoU) of 0.56, and standardized uptake value ratio (SUVr) of 1.15, outperforming baseline models by over 10% in Dice score and ensuring consistent quantification across all dopaminergic regions. Overall, the proposed MRI-informed PET segmentation framework achieves over 12% improvement in biomarker stability, representing a significant advancement in multimodal neuroimaging pipelines for PD diagnosis, disease progression monitoring, and precision clinical decision support.

Date: Friday, April 10, 2026 | Time: 10:45 – 11:00

[PaperID: 311] Hybrid Modeling for Accurate Insurance Reserve Prediction: Integrating Machine Learning and Vine Copulas

Sawssen araichi (King Faisal University)*

Abstract: Stability and regulatory compliance in the insurance industry. Traditional actuarial methods, such as chain-ladder methods, often assume linear patterns and independence, limiting their ability to capture complex dependencies and nonlinear trends in claims. This study aims to improve the accuracy of insurance reserve forecasting by developing a hybrid framework that integrates machine learning (ML) methods and Vine copula models. This study uses run off triangles data from an actual insurance dataset to forecast future payments. The XGBoost algorithm is employed as the ML component to model temporal patterns, and Vine Copulas is applied to capture multivariate dependency structures among different insurance lines. This hybrid approach combines the predictive power of ML with the flexibility of Vine Copulas to model joint risk distributions. The results show that the proposed framework significantly outperforms traditional methods such as the chainladder approach and stand-alone ML models, and achieves a significant reduction in forecast errors. The model shows robust performance over various development periods, highlighting its potential for practical applications in reserves estimation. This hybrid approach provides a scalable and effective tool for insurers to enhance reserve forecasting, improve risk management, and meet regulatory requirements such as Solvency II. This study contributes a novel framework to the insurance literature.

Online Session-3 | Time: 11:00 – 01:00 AM

Google Meet Link-1

Date: Friday, April 10, 2026 | Time: 11:00 – 11:15

[PaperID: 136] Conformal-ABR: Distribution-Free Risk-Controlled Bitrate Selection for HTTP Adaptive Streaming

Mahmoud Darwich (University of Mount Union)*; Kasem Khalil (University of Mississippi); Yasser Ismail (Southern University and A&M College); Ahmed Abdelgawad (Central Michigan University); Magdy Bayoumi (University of Louisiana at Lafayette)

Abstract: Adaptive bitrate (ABR) streaming hinges on shorthorizon throughput prediction. However, inevitable prediction errors often trigger rebuffering and harsh quality oscillations. We present Conformal-ABR, a risk-controlled ABR scheme that provides distribution-free coverage guarantees on prediction error under standard exchangeability assumptions and translates them into explicit control of stall risk during bitrate selection. Conformal-ABR wraps any throughput predictor (e.g., EWMA or a lightweight attention model) with a calibration layer that produces per-segment prediction intervals. The player then solves a one-step optimization to choose the highest representation whose probability of under-delivery stays within a user-set risk budget while penalizing variation for smoothness. In trace-driven and browser-based tests on public datasets (fixed broadband and mobile HSDPA/LTE) and standard QoE content, ConformalABR reduces stall time and improves smoothness versus heuristic (BOLA), RL (Pensieve), and recent consistency/uncertainty-aware methods, while achieving near-calibrated coverage of prediction error and the induced stall risk across varied network regimes. Results indicate that calibrated, distribution-free uncertainty acts as an effective control knob for robust QoE.

Date: Friday, April 10, 2026 | Time: 11:15 – 11:30

[PaperID: 352] Multi-Model Machine Learning Framework for Early Detection and Risk Stratification of Breast Cancer Subtypes

Mahmoud Darwich (University of Mount Union)*; May Eid (Physics Institute, National Research Center); Kasem Khalil (University of Mississippi); Magdy Bayoumi (University of Louisiana at Lafayette)

Abstract: Early detection and accurate classification of breast cancer subtypes are critical for personalized treatment planning and improved patient outcomes. However, conventional diagnostic methods face limitations in scalability, consistency, and timeliness. In this paper, we propose a modular multi-model machine learning framework that integrates structured clinical data and optional histopathological images for robust subtype prediction. The framework employs ensemble learning techniques—Random Forest, XGBoost, and Support Vector Machines—alongside a Convolutional Neural Network (CNN) for image analysis. Predictions from individual models are combined via soft voting or stacking, and model interpretability is ensured through SHAP (SHapley Additive exPlanations) analysis. Experiments conducted on the TCGA-BRCA dataset demonstrate that the stacking ensemble achieves superior performance with an accuracy of 89.3%, a

macro F1-score of 0.884, and an AUC of 0.921. Furthermore, SHAP-based feature attribution confirms alignment with clinically significant biomarkers, enhancing the framework's transparency and trustworthiness. The proposed solution offers a practical and explainable tool for early breast cancer subtype classification, suitable for integration into real-world diagnostic workflows.

Date: Friday, April 10, 2026 | Time: 11:30 – 11:45

[PaperID: 380] A Robust Adversarial GANs Approach to Pharmaceutical Data Generation

Samiul Islam Niloy (University of Mississippi); Md Rahat Kader Khan (University of Mississippi); Nourhan Mostafa (University of Mississippi); Eman Ashour (University of Mississippi); Kasem Khalil (University of Mississippi)*

Abstract: Self-emulsifying drug delivery systems (SEDDS) formulation faces significant challenges due to limited experimental datasets and the complexity of predicting dual-target outcomes for nanoparticle size and drug release profiles. This inspires the development of a comprehensive framework integrating Generative Adversarial Networks (GANs) with adversarial robustness testing for synthetic SEDDS dataset generation. The methodology employed a constraint-driven GAN architecture to generate realistic formulations of Capryol 90, Tween 20, and Transcutol HP while maintaining pharmaceutical feasibility constraints, with Fast Gradient Sign Method (FGSM) implemented to evaluate model robustness. The framework is evaluated using multiple matrices including Kolmogorov-Smirnov statistics, Jensen-Shannon divergence, multivariate coverage analysis, and manifold intrusion scoring to quantify synthetic data fidelity. The GAN-generated synthetic dataset demonstrated exceptional performance with multivariate coverage of 77.46%, manifold intrusion score of 0%, enhanced feature interpretability showing Capryol 90 importance scores of 0.755 for Release and 0.902 for Particle Size, predictive consistency R2 scores of 0.35 for synthetic versus 0.47 for real data, and strong distributional alignment with Kolmogorov-Smirnov statistics ranging from 0.137 - 0.279 and Jensen-Shannon divergence values of 0.331 - 0.392. This study establishes GAN-based synthetic data generation as a transformative methodology for pharmaceutical formulation research, successfully addressing data scarcity and providing comprehensive validation frameworks that position this approach as a powerful tool for accelerating drug delivery system development enabling rational formulation design in resource constrained environments.

Date: Friday, April 10, 2026 | Time: 11:45 – 12:00

[PaperID: 381] Survey on Privacy-Aware Federated Learning Frameworks for Energy Systems within Smart Grids

Damilola Agboola (University of Mississippi); Tamador Mohaidat (University of Mississippi); Md Rahat Kader Khan (University of Mississippi); Kasem Khalil (University of Mississippi)*

Abstract:

The global transition towards Smart Grids (SGs) has brought about significant advancements in energy management and efficiency. To sustain these advancements, robust data-driven models trained on large-scale energy datasets are essential. However, the bidirectional flow of data and increasing connectivity within SG

infrastructures have introduced cybersecurity and privacy vulnerabilities, raising concerns about the protection of sensitive consumer and operational information as well as regulatory compliance. Federated Learning (FL), a decentralized machine learning paradigm, has emerged as a promising solution to these challenges, enabling models to be trained at the edge while ensuring the accuracy of a global model. Although numerous studies have explored the application of FL in the Internet of Things (IoT), this paper presents a survey of most recent and impactful literature on the application of FL algorithms within the SG domain. Our analysis integrates findings from key studies, categorizing the primary applications of FL to address common challenges such as communication overhead and statistical heterogeneity arising from non-independently and identically distributed (non-IID) data. We also explore promising avenues for future research in FL and anomaly detection. Furthermore, we examine various FL architectures, threat models, privacy preserving mechanisms, and the gaps in existing datasets and protocols.

Date: Friday, April 10, 2026 | Time: 12:00 – 12:15

[PaperID: 424] An Explained Machine Learning Model for Analyzing Electric Vehicle Cyber Attacks

Amal Saif (Princess Sumaya University for Technology)*; Eman Elnagi (PSUT); Ashraf Ahmad (PSUT)

Abstract: With the increasing presence and use of electric vehicles, the number of charging points has also increased, posing challenges and vulnerabilities for these vehicles. Due to the limited availability of datasets for analyzing and detecting attacks, published research on the topic is also scarce, and attention has been focused more on energy issues than on security. This paper uses a new benchmark dataset, CICEVSE2024, to analyze attacks, features, and classification results with common machine learning algorithms, and to interpret the outcomes using explainable artificial intelligence (XAI) methods, along with the models' weights when applicable. The results show that the decision tree and random forest models achieve the best performance and exhibit acceptable consistency with XAI results. A few features are sufficient to represent attack occurrences, enabling real-time detection. Based on these findings, this research provides a future direction for fusion models that focus on the most important indicators of threats to predict the likelihood of an attack.

Date: Friday, April 10, 2026 | Time: 12:15 – 12:30

[PaperID: 425] A Novel Medical Images Random Cryptosystem

Eman Alnagi (Princess Sumaya University for Technology)*; Amal Saif (Princess Sumaya University for Technology); Ashraf Ahmad (Princess Sumaya University for Technology)

Abstract: Medical images are considered highly sensitive data that must be protected for privacy purposes. Encryption algorithms are one way to secure medical images before transmitting them to concerned parties. In this paper, a novel cryptosystem is proposed for medical images. The encryption and decryption algorithms utilize linear feedback shift registers (LFSRs) to generate random numbers to represent the positions of image blocks to be processed. Accordingly, the blocks are encrypted using Advanced Encryption Standard (AES) with a new mode of operation, random vector cipher (RVC), in a random order. This random encryption results in shuffled cipher blocks, and the number of these blocks would exceed the actual number of original image

blocks, which may confuse the attacker in distinguishing the type of data encrypted. In addition to the traditional AES key, several secrets are used to leverage the robustness of the cryptosystem. The algorithm is implemented and tested on samples of the Medical MNIST dataset, resulting in uniform histograms for the encrypted images while preserving the correctness and integrity of the original images.

Date: Friday, April 10, 2026 | Time: 12:30 – 12:45

[PaperID: 299] Diagnosing Algorithmic Bias in AI-Powered Hiring: Toward a Fairness-Aware Framework

Hairu Fan (Central Michigan University)*; Shiyuan Wang (Central Michigan University)

Abstract: Artificial intelligence (AI) is gaining wider usage in hiring from resume screening through candidate evaluation. Though such systems hold out the promise of efficiency, they also understandably generate recurrent doubts about fairness and bias. This work addresses these doubts by presenting a diagnostic framework for detecting bias in AI-powered hiring. The framework combines three stages: (1) descriptive analysis of demographic distributions, (2) statistical testing of group outcome disparities, and (3) model-level fairness metrics, including selection rates, true positive rates, and false positive rates. With three extensively researched datasets: Adult Income, Job Salary, and COMPAS, this work demonstrates that gendered differences persist. Results demonstrate steady salary outcome gaps and differential error rates across demographic groups despite standardized preprocessing. These demonstrate that automated hiring tools without fairness checks threaten to escalate workplace inequalities. Proposed here is a structured and reproducible method to detect algorithmic bias that will help both researchers and users promote fairness and accountability in hiring systems.

Date: Friday, April 10, 2026 | Time: 12:45 – 01:00

[PaperID: 341] CA-WNN: Improving Weightless Neural Networks using Cellular Automata Feature Extraction

Kriza Baby (The University of Texas at San Antonio)*; Lizy K John (University of Texas at Austin); Felipe M. G. Franca (Federal University of Rio de Janeiro); Priscila M. V. Lima (Federal University of Rio de Janeiro); Eugene John (The University of Texas at San Antonio)

Abstract: Cellular Automata (CA) and Weightless Neural Networks (WNN) are lightweight computational paradigms characterized by inherent parallelism and low computational cost. This paper introduces a hybrid image classification framework that integrates CA-based rule-driven feature extraction with WNN classifiers. Unlike conventional deep learning methods that depend on weight matrices and gradient optimization, the proposed approach applies predefined morphological and edge-detection rules to generate structured binary patterns that capture spatial and temporal regularities. These patterns are encoded into RAM-based WNN memory for classification. Experiments on the MNIST dataset demonstrate that CA-driven features significantly enhance the discriminative capability of WNNs while maintaining efficiency.

Online Session-4 | Time: 11:00 – 01:00 AM

Google Meet Link-2

Date: Friday, April 10, 2026 | Time: 11:00 – 11:15

[PaperID: 134] Machine Learning-Driven Voltage control and Prediction for Maximum Power Point Optimization in Solar Energy Harvesting Systems

Adham Mahdy (Hochschule Heilbronn)*; Mohamed Dwedar (Hochschule Heilbronn); Alexander Jesser (Hochschule Heilbronn)

Abstract: Accurate real-time control of photovoltaic (PV) systems is critical for maximizing energy yield under dynamic environmental conditions. This study proposes a machine learning-based framework for predictive voltage regulation to enhance Maximum Power Point Tracking (MPPT). Conventional MPPT methods such as fractional open-circuit voltage (FOCV), fractional short-circuit current (FSCC), Perturb and Observe (P&O), and Incremental Conductance (IncCond) often exhibit limited adaptability and responsiveness in rapidly changing environments. To address these limitations, multiple supervised learning models were evaluated, including Multivariate Linear Regression (MLR) and Polynomial Regression (PR). Ultimately, an Artificial Neural Network (ANN) was selected for its superior predictive accuracy and robustness. Trained on empirical datasets comprising irradiance, temperature, voltage, and current measurements, the ANN enables real-time adaptive voltage control. Experimental results demonstrate improved tracking precision, faster convergence, and enhanced stability compared to conventional methods, achieving a coefficient of determination (R2) of approximately 0.98. This work advances intelligent, data-driven PV control systems and offers a scalable solution for both grid-tied and standalone renewable energy applications.

Date: Friday, April 10, 2026 | Time: 11:15 – 11:30

[PaperID: 73] Machine Learning-Based Identification of Health Risk Levels from Clinical Data

Alyah Alromaizan (Alfaisal University); Lulwah Alhumaid (Alfaisal University); Ghala Alzahrani (Alfaisal University); Nidal Nasser (Alfaisal University)*

Abstract: Health risk classification is a critical task in healthcare, enabling early identification of individuals at risk of severe health conditions. This study evaluates multiple machine learning models, including Logistic Regression, Decision Trees, Support Vector Machines (SVM), K-Nearest Neighbors (KNN), and Neural Networks, for classifying individuals into three health risk categories: Low, Medium, and High. The dataset comprises key health-related features such as age, BMI, blood pressure, and cholesterol levels. Models were assessed using accuracy, precision, recall, F1- score, and ROC-AUC metrics. Results demonstrate that Neural Networks achieved the highest performance, with an accuracy of 95.29% and strong ROC-AUC values across all classes, making it the most effective model for this task. Logistic Regression provided interpretable results, while Decision Trees offered intuitive decision-making but exhibited overfitting. SVM and KNN performed well but faced limitations in computational efficiency and scalability. This study highlights the strengths and

weaknesses of each model, providing insights into their suitability for health risk classification and informing future applications in personalized healthcare and preventive medicine.

Date: Friday, April 10, 2026 | Time: 11:30 – 11:45

[PaperID: 74] Machine Learning Approaches for Customer Retention in the Telecom Industry Jude

Altamimi (Alfaisal University); Layla Alzuhair (Alfaisal University); Haya Alissa (Alfaisal University); Nidal Nasser (Alfaisal University)

Abstract: Customer churn is a critical issue for telecommunications companies, as losing customers directly impacts revenue and growth. This study examines the application of machine learning models to predict customer churn, enabling businesses to identify at-risk customers and implement proactive retention strategies. Using a publicly available dataset, we analyzed customer demographics, account details, and service usage patterns. The dataset was preprocessed through techniques such as handling missing values, encoding categorical variables, and scaling numerical features. We implemented and evaluated several machine learning models, including Logistic Regression, Decision Trees, Support Vector Machines, K-Nearest Neighbors, and Neural Networks. Model performance was assessed using metrics like accuracy, precision, recall, F1-score, and ROC-AUC, alongside visual analyses using confusion matrices and ROC/precision-recall curves. Our results highlight the strengths and limitations of each model, with certain algorithms demonstrating higher predictive accuracy and robustness. These findings offer valuable insights for businesses seeking data-driven strategies to reduce churn. The study concludes with recommendations on integrating predictive analytics into customer retention programs to enhance decision-making and improve customer satisfaction.

Date: Friday, April 10, 2026 | Time: 11:45 – 12:00

[PaperID: 76] Ensemble and Neural Methods for Multi-Class Forest Cover Classification Using Cartographic Data

Saleh Alghannam (Alfaisal University); Razan Abuowaimer (Alfaisal University); Kerem Demirboga (Alfaisal University); Nidal Nasser (Alfaisal University)*; Asmaa Ali (Western University)

Abstract: This paper presents the development and evaluation of several classification models to predict forest cover types using cartographic features from the well-known Forest CoverType dataset. Our approach compares Logistic Regression, Decision Trees, Support Vector Machines (SVM), K-Nearest Neighbors (KNN), and Neural Networks on multiple performance metrics including accuracy, precision, recall, F1- score, and ROC curves. We focus on a multi-class scenario with seven cover types, employing various preprocessing steps such as scaling, feature engineering, and handling class imbalance with SMOTE. The results demonstrate that ensemble methods and well-optimized models outperform simpler models, offering promising accuracy and robust generalization. Future work will include more advanced ensemble techniques, deeper neural architectures, and domain- specific enhancements to improve practical utility in forestry management and ecological decision-making.

Date: Friday, April 10, 2026 | Time: 12:00 – 12:15

[PaperID: 77] Surgery Scheduling Optimization using an Adaptive Genetic Algorithm with Q-Learning Guided Tournament Selection

Mohammadtaghi Dehghannezhad (King Fahd University)*; Jam Muhammad Talha Laar (King Fahd University); Alaa Khamis (King Fahd University); Yasser Almoghathawi (King Fahd University)

Abstract: Scheduling surgeries in operating rooms is a critical task that directly influences patient outcomes, staff workload, and a hospital's ability to respond to emergencies. This paper proposes an adaptive genetic algorithm with novel Q-learning guided tournament selection method to adaptively select tournament sizes, enhancing the balance between exploration and exploitation during the optimization process. A domain-specific encoding scheme for patient–operating room–day assignments is employed to effectively represent and manage scheduling constraints. To evaluate the proposed method, a discrete-event simulation environment is developed to generate datasets based on benchmark scheduling patterns. Numerical experiments demonstrate that the proposed approach consistently converges faster than a standard genetic algorithm and achieves an average reduction of 10.05\% in total scheduling penalties, while maintaining zero delay for emergency cases. Furthermore, it outperforms other state-of-the-art genetic algorithm variants in identifying optimal solutions. Thanks to its adaptability and efficiency, the proposed method improves the scalability of surgical scheduling systems, facilitating real-world implementation and reducing operational costs.

Date: Friday, April 10, 2026 | Time: 12:15 – 12:30

[PaperID: 234] Fine-Grained Detection of Third-Party Java Library Migration

Hussein AlRubaye (Microsoft); Mohamed Wiem Mkaouer (University of Michigan-Flint)*; Ali Ouni (ETS Montreal)

Abstract: Third-party software library reuse is becoming a common practice in software engineering. With the exponentially growing number of available and competing libraries in software ecosystems, migrating from one library to another is widely acknowledged to be a complex, time-consuming, and error-prone activity. In this paper, we introduce \textit{MigrationMapper}, an automated tool that detects code migrations and recommends method mapping that is performed between Java third-party libraries. Given a list of open-source projects, the tool detects potential library migration code changes and collects the specific code fragments in which the developer replaces methods from the retired library with methods from the new library. To support the migration process, MigrationMapper detects method-level mapping between added/removed libraries using state-of-the-art Substitution Algorithm~\cite{alrubaye2019automating}. We evaluate our approach on a benchmark of manually validated library migrations. Results show that MigrationMapper achieves high accuracy in detecting migration code and detecting method mapping. A demo video of MigrationMapper is available at \url{https://www.youtube.com/watch?v=D-01g2GjuTg}. The project repository is available at \url{https://github.com/hussien89aa/MigrationMapper}.

Date: Friday, April 10, 2026 | Time: 12:30 – 12:45

[PaperID: 240] High-Precision Table Structure Recognition Using Transformer-Based Detection: Fine-Tuning TATR on Large-Scale Cropped Table Datasets

mohamed TOUATI (Univ Brest); wiem MKAOUER (The University of Michigan-Flint Flint, Michigan)*

Abstract: We present a high-performance table structure recognition system based on a fine-tuned Table Transformer (TATR) architecture. The approach adopts a DETR-style end-to-end transformer framework with a lightweight ResNet-18 backbone for feature extraction, positional encoding for spatial context preservation, and transformer encoder–decoder stacks for object query processing. Prediction heads consist of a classification head and a 3-layer MLP bounding-box head. We fine-tuned a pretrained TATR model on a large-scale dataset of approximately 835,000 annotated cropped table images (rows, columns, spanning cells, column headers and projected row headers). Evaluation uses IoU, Average Precision (AP) at multiple thresholds, and Average Recall (AR). Our model achieves AP@[IoU=0.50:0.95] = 0.971, AP@0.50 = 0.998, AP@0.75 = 0.995, and AR@[IoU=0.50:0.95, maxDets=100] = 0.986 demonstrating near state-of-the-art detection precision with robust performance across object sizes. We include a comparative study placing our results vs. recent transformer-based TSR methods and discuss practical deployment considerations and future directions.

Date: Friday, April 10, 2026 | Time: 12:45 – 01:00

[PaperID: 241] Pixheart: AI-Powered Automated ECG Analysis Using Hybrid CNN-LSTM and Machine Learning Models for Clinical Diagnostics

Mohamed TOUATI (Univ Brest); Mohamed Medimegh (Pixemantic); mmkaouer@umich.edu Mkaouer (College of Innovation and Technology, The University of Michigan-Flint)*; laurent NANA (Labsticc, University of Brest)

Abstract: In collaboration with Pixemantic and its Pixheart platform, this project presents an AI-powered web application for automated Electrocardiogram (ECG) analysis. The system processes scanned ECG images, extracts cardiac features using CNN and LSTM models, and classifies abnormalities with clinical-grade accuracy. Our hybrid CNN-LSTM model reached an accuracy of 86%, with precision at 88%, recall at 87%, and an F1-score of 87%. For comparison, traditional machine learning approaches also performed strongly, with Support Vector Machines (SVM) achieving 96% accuracy and Logistic Regression reaching 93%. Random Forest and XGBoost provide complementary strengths: RF achieved perfect MI precision (1.00) and high PM precision (0.97), while XGBoost attained higher HB recall (0.81) and balanced F1-score (0.86). The platform enables real-time analysis, intuitive waveform visualization, and reporting, with clinical experts validating data quality and model performance, demonstrating its practical potential for efficient, accurate ECG diagnostics.

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