



1st Jayewardenepura Computing Symposium (JCoS 2026)

Program & Abstract Book



Theme:

*Computing the Future:
Innovation, Intelligence, and Impact*



Faculty of Computing
University of Sri Jayewardenepura
Sri Lanka



May 2026

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Computing the Future: Innovation, Intelligence, and Impact

Faculty of Computing
University of Sri Jayewardenepura
Sri Lanka
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(JCoS 2026)

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University of Sri Jayewardenepura

19th and 20th May 2026

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Editors:

- Dr. Budditha Hettige
Faculty of Computing, University of Sri Jayewardenepura
- Ms. Vindya Senanayake
Faculty of Computing, University of Sri Jayewardenepura

Message from the Vice Chancellor



It is with great pleasure that I extend my warm greetings and best wishes to the organizers, participants, researchers, and distinguished guests of the Jayewardenepura Computing Symposium 2026 (JCoS 2026), organized by the Faculty of Computing of the University of Sri Jayewardenepura.

JCoS 2026 provides an important academic platform for undergraduate researchers, academics, and industry professionals to exchange innovative ideas, present research findings, and explore emerging developments in the fields of computing and information technology. In an era shaped by rapid technological advancement and digital transformation, forums of this nature play a vital role in encouraging critical thinking, innovation and research-driven solutions to contemporary challenges.

I am particularly pleased to witness the active engagement of our students and young researchers in scholarly inquiry and technological innovation. Such initiatives significantly contribute to strengthening the research culture of the University while nurturing the next generation of professionals, innovators, and academic leaders who will contribute meaningfully to national and global development.

I highly appreciate the commitment and the vision of the Dean of the Faculty of Computing in guiding and supporting the successful organization of this symposium. I also wish to place on record my sincere appreciation to the Symposium Chair, organizing committee, technical program committee, reviewers, academic staff, industry collaborators, and student volunteers for their dedication, professionalism, and hard work in making JCoS 2026 a reality.

The University of Sri Jayewardenepura remains firmly committed to promoting

excellence in education, research, innovation, and interdisciplinary collaboration. Events such as JCoS 2026 reflect the University's continuing efforts to create an intellectually vibrant academic environment that encourages discovery, creativity, and meaningful engagement with society and industry.

I extend my best wishes to all presenters and participants for a productive and inspiring symposium experience. May JCoS 2026 be a great success and a catalyst for future collaborations, innovative research, and technological advancement.

Senior Prof. Pathmalal M. Manage
The Vice Chancellor,
University of Sri Jayewardenepura
Sri Lanka

Message from the Dean



JCoS2026: Cultivating Research Excellence in Computing...

It is my great pleasure to welcome you to the inaugural edition of the Jayewardenepura Computing Symposium (JCoS) 2026, organized by the Faculty of Computing (FoC), University of Sri Jayewardenepura (USJ). JCoS 2026 marks an important milestone in our journey toward fostering a vibrant research and innovation culture within the Faculty and the wider academic community. This symposium has been envisioned primarily as a platform to inspire, encourage, and showcase the scholarly and innovative contributions of our students, particularly those of the Faculty of Computing.

We believe that providing young researchers with opportunities to present their ideas, engage in academic dialogue, and receive constructive feedback is essential for nurturing the next generation of computing professionals, innovators, and researchers. The theme of this year's symposium, "Computing the Future: Innovation, Intelligence, and Impact," reflects the transformative role of computing in addressing contemporary societal, industrial, and global challenges. The papers and projects presented at JCoS2026 demonstrate not only the technical competencies of our students and researchers, but also their creativity, interdisciplinary thinking, and commitment to developing impactful solutions.

I would like to extend my sincere appreciation to all Authors, Reviewers, Keynote Speakers, Resource Persons of JoCS2026 Workshops, Organizing Committee Members, Academic Staff, Industry Collaborators, and All JoCS2026 Volunteers whose dedication and hard work made JCoS 2026 a reality. Your contributions have laid a strong foundation for what we hope will become a flagship annual academic event of the Faculty of Computing.

I also congratulate all the students and researchers whose work has been selected for presentation and publication in these proceedings. Your enthusiasm, perseverance, and intellectual curiosity are truly commendable and represent the promising future of computing research and innovation in Sri Lanka and beyond. I hope that JCoS 2026 will serve not only as a forum for disseminating knowledge, but also as a catalyst for new collaborations, innovative ideas, and meaningful academic and industry partnerships.

Wishing you a successful and enriching symposium experience.

Prof. Prasad M. Jayaweera
Dean, Faculty of Computing
University of Sri Jayewardenepura
Sri Lanka

Message from the Symposium Chair



It is with great pleasure that I welcome you to the 1st Jayewardenepura Computing Symposium (JCoS 2026), organized by the Faculty of Computing, University of Sri Jayewardenepura, Sri Lanka. This symposium marks an important milestone as the Faculty of Computing proudly launches its first-ever undergraduate research symposium with the aim of promoting research, innovation, collaboration, and knowledge sharing among students, academics, and researchers.

JCoS 2026 has received an encouraging response from the academic community. This year, a total of 162 papers were submitted to the symposium, and 77 papers were selected for presentation after a rigorous review process. The accepted papers are presented through 12 technical sessions covering diverse areas of computing and interdisciplinary research. These contributions reflect the growing enthusiasm and research potential of undergraduate students and young researchers.

In addition to the technical sessions, two pre-symposium workshops were successfully conducted to enhance the practical and research knowledge of participants. I would like to extend my sincere appreciation to Prof. Saman Mutukumarana for kindly accepting my invitation and physically visiting Sri Lanka from Canada to conduct a valuable workshop and support JCoS 2026. I also wish to express my gratitude to Dr. Kalani Ilmini for conducting the second workshop and sharing her valuable knowledge and expertise with participants.

I would also like to sincerely thank our keynote speakers, Mr. Heshan Karunaratna from the Computer Society of Sri Lanka (CSSL) and Prof. Saman Mutukumarana, for delivering inspiring keynote speeches and contributing greatly to the success of the symposium.

I take this opportunity to express my sincere gratitude to the Vice Chancellor and the Dean of the Faculty of Computing for their continuous encouragement and support in making this symposium a success. I also extend my appreciation to all

academic and non-academic staff members of the Faculty of Computing for their dedication and contributions.

My special thanks go to Ms. Vindya Senanayake for her exceptional commitment and support as the Symposium Secretary in coordinating numerous symposium activities successfully.

I would also like to express our sincere appreciation to the Sri Lanka Association for Artificial Intelligence (SLAAI) for providing technical co-sponsorship for JCoS 2026. Special thanks are extended to the members of the Technical Program Committee for their valuable effort, commitment, and professionalism in handling the technical review process of the symposium.

I would also like to thank all reviewers for their valuable time, constructive feedback, and dedication in maintaining the academic quality of the symposium. In addition, I sincerely appreciate all technical session chairs and co-chairs for their support in successfully conducting the 12 technical sessions.

Finally, I would like to congratulate and thank all presenting authors for sharing their research contributions and innovative ideas through JCoS 2026. Your participation is the true strength of this symposium and an inspiration for future research and academic excellence.

Dr. Buddhitha Hettige

Symposium Chair

Department of Knowledge Engineering and Communication

Faculty of Computing

University of Sri Jayewardenepura

Sri Lanka

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Pre-Symposium Workshop I



Hands-on Prompt Engineering for Effective Use of Large Language Models

Resource Person: Dr. Kalani Ilmini
Designation: Senior Lecturer
Affiliation: Department of Computer Science
Faculty of Applied Sciences
University of Sri Jayewardenepura
Date: 19th May 2026
Time: 9.00 AM – 12.00 Noon
Venue: E316, 3rd Floor, New Building,
Faculty of Management Studies and Commerce

This workshop provides a practical introduction to prompt engineering techniques for effectively working with Large Language Models (LLMs). Participants will learn core principles of prompt design, iterative refinement strategies, context management, and response evaluation for generating accurate and reliable outputs from modern AI systems. The workshop will cover techniques including zero-shot and few-shot prompting, chain-of-thought reasoning, structured prompting, and practical approaches for improving model performance across diverse tasks. Participants will also explore the integration of LLMs into academic, research, and industry applications, highlighting their potential for intelligent automation and decision support. Through interactive demonstrations and hands-on exercises, participants will gain practical experience in designing effective prompts and utilizing contemporary AI tools for real-world problem solving.

Pre-Symposium Workshop II



Bayesian Computing and Markov Chain Monte Carlo (MCMC) Algorithms

Resource Person: Prof. Saman Muthukumarana
Designation: Senior Lecturer
Affiliation: Professor & Head
Department of Statistics
University of Manitoba, Canada
Date: 19th May 2026
Time: 01.00 PM – 04.00 PM
Venue: E316, 3rd Floor, New Building,
Faculty of Management Studies and Commerce

This workshop provides a practical introduction to Bayesian computing with a focus on Markov chain Monte Carlo (MCMC) algorithms. Participants will learn core principles of posterior simulation, convergence diagnostics, and predictive simulations, with coverage of simulation-based inference for high dimensional data including Metropolis-Hastings and Gibbs sampling algorithms. The workshop will also introduce Bayesian networks and Dirichlet process-based methods and their computing, highlighting their role in flexible modeling of complex data. Through illustrative and hands-on examples, participants will gain practical experience in implementing Bayesian models using modern computational tools for applied problems.

Symposium Agenda

Date: 20th May 2026
Time: 07:50 AM – 04:30 PM
Venue: Sumangala Auditorium

Time	Event
07:50 AM – 08:00 AM	Welcoming Invitees
08:00 AM – 08:10 AM	Lightning of the Oil Lamp
08:10 AM – 08:15 AM	University Anthem
08:15 AM – 08:25 AM	Cultural Event – Pooja Dance
08:25 AM – 08:35 AM	Welcome Address by Symposium Chair
08:35 AM – 08:40 AM	Curtain Raiser Video – JCoS 2026
08:40 AM – 08:55 AM	Address by Prof. Prasad M. Jayaweera Dean, Faculty of Computing
08:55 AM – 09:10 AM	Address by the Chief Guest Senior Prof. Pathmalal M. Manage Vice Chancellor, University of Sri Jayewardenepura
09:10 AM – 10:00 AM	Keynote Speech I Prof. Saman Muthukumarana University of Manitoba, Canada
10:00 AM – 10:10 AM	Dancing Event
10:10 AM – 10:50 AM	Keynote Speech II Mr. Heshan Karunaratne President, Computer Society of Sri Lanka
10:50 AM – 10:55 AM	Vote of Thanks
10:55 AM – 11:00 AM	National Anthem & End of the Inaugural Session
11:00 AM – 11:30 AM	Refreshments - FoC Faculty Complex
11.30 AM – 01.30 PM	Technical Session I (M1 - M6) 3 rd floor, Faculty of Management Studies and Commerce New Building
01:30 PM – 02:30 PM	Lunch - Ground floor, New Building, FMSC
02:30 PM – 04:30 PM	Technical Session II (A1 -A6) 3 rd floor, New Building , FMSC

Technical Program

Session M1: Modern Software Systems: DevOps, Security, and Intelligence

Time: 11:30 AM - 01:30 PM
Location: E304 3rd Floor, New Building,
Faculty of Management Studies and Commerce
Chair: Dr. Gilmini Geethika, Faculty of Computing
Co-Chair: Mr. Nisal Rodrigo, Faculty of Computing

Paper ID	Title & Authors	Time
16	Explainable Commit-Level Vulnerability Intelligence in DevSecOps Pipelines: A Structured Review and Synthesis <i>Don Dasun Sandeepa Wilathgamuwa, Malshani Hettiarachchi, Budditha Hettige</i>	11:40AM-11:55AM
64	Explainable Multi-Objective and Energy-Aware Sequence-Based Automated Refactoring in Open-Source Java: A Systematic Review <i>Amandi Athukorala, Vindya Senanayake, Budditha Hettige</i>	11:55AM-12:10PM
66	Assessing the Industry Need for Autonomous Test Suite Evolution and Modular Architecture: A Survey <i>Imalsha Sathsarani, Vindya Senanayake, Viraj Wijesooriya, Budditha Hettige</i>	12:10PM-12:25PM
108	A Systematic Review of Coordinating Bot Detection Techniques in Real-Time Web and Mobile Applications <i>Kavindu Peiris, Vindya Senanayake, Pubudu Jayasekara</i>	12:25PM-12:40PM
137	A Review on AI-Driven Inventory Control and Sales Forecasting for Small Hardware Retailers <i>Zeenathsharoth Mohamed Yehiya, Vidura Perera</i>	12:40PM-12:55PM
142	Ontology-Based Clinical Decision Support Systems for Breast Cancer Care: A Systematic Review of Architectures, Guideline Modeling, and Implementation Challenges <i>Tharushi Gandarawaththa, Vindya Senanayake, Gilmini Dantanarayana</i>	12:55PM-01:10PM

Session M2: Computational Linguistics and NLP Applications

Time: 11:30 AM - 01:30 PM

Location: E305 3rd Floor, New Building,
Faculty of Management Studies and Commerce

Chair: Prof. RGN Meegama, Faculty of Applied Sciences

Co-Chair: Mr. Vidura Perera, Faculty of Computing

Paper ID	Title & Authors	Time
36	A Systematic Review of Multimodal AI Systems for Early Childhood Development Evaluation and Screening <i>Sarasi Perera, Vidura Perera</i>	11:40AM-11:55AM
71	A Review of AI and NLP Approaches for Sinhala Speech and Text to Sinhala Sign Language Translation Using 3D Avatar Animation <i>Akila Prabath, Shajini Majuran</i>	11:55AM-12:10PM
73	Towards Efficient Long Context Transformers: A Survey of alternative attention mechanisms <i>Yasas Sri Tharuwara, Deepika Senevirathne</i>	12:10PM-12:25PM
80	Separating Vocal Suitability from Singing Difficulty: A Two-Stage Machine Learning Approach <i>Sakith Dewnith, Vidura Perera</i>	12:25PM-12:40PM
84	AI-Powered Chatbots for Mental Health Support: A Systematic Review <i>Janudi Akmeemana, Dilmi Praveena, Budditha Hettige</i>	12:40PM-12:55PM
86	A Review of Intelligent Academic Advisor Chatbots Using Natural Language Processing and Machine Learning <i>Dilan Karunanayake, Budditha Hettige</i>	12:55PM-01:10PM

Session M3: IoT, Sensor Networks, and Smart Applications

Time: 11:30 AM - 01:30 PM
Location: E307 3rd Floor, New Building,
Faculty of Management Studies and Commerce
Chair: Mr. Dilum Perera, Faculty of Applied Sciences
Co-Chair: Mr. Pubudu Jayasekara, Faculty of Computing

Paper ID	Title & Authors	Time
35	A Review and Comparative Analysis of RF-Based Offline Communication Systems and IoT Integration Approaches for Traveller and Hiker Safety <i>Eranga Kavisanka Ariyaratna, Vidura Perera, Pubudu Jayasekara</i>	11:40AM-11:55AM
38	Autonomous School Bus Ecosystem with Predictive Proximity Alerts and Smart Gate Integrated Student Verification <i>Dilum Munasinghe, Vidura Perera</i>	11:55AM-12:10PM
40	A Review of Natural Language to Motion Intent in Autonomous UAV Control and Human–Drone Interaction <i>Yehan Wickramasinghe, Vidura Perera</i>	12:10PM-12:25PM
89	A Comprehensive Systematic Review of Sensor-Based Technologies and Analytical Approaches Used for Early Detection and Risk Assessment of Diabetic Foot Complications. <i>Aruna Sampath, Dilmi Praveena, Deepika Seneviratne</i>	12:25PM-12:40PM
92	Narrative Review of Communication-Efficient TinyML for Distributed IoT Edge Devices <i>Sandaru Wickramasinghe, Pubudu Jayasekara</i>	12:40PM-12:55PM
106	Toward Objective Digital Biomarkers of Bradykinesia: A Technology Centric Review of Finger Tapping Assessment in Parkinson’s Disease. <i>Aashinshana Weerakoon, FHSR Silva, Pubudu Jayasekara</i>	12:55PM-01:10PM

Session M4: Machine Learning and Generative AI Technologies

Time: 11:30 AM - 01:30 PM
Location: E315 3rd Floor, New Building,
Faculty of Management Studies and Commerce
Chair: Prof. TGI Fernando, Faculty of Applied Sciences
Co-Chair: Ms. Romenia Silva, Faculty of Computing

Paper ID	Title & Authors	Time
53	Systematic Review of AI-Based Personalized Diet and Activity Recommendation System for Diabetic Individuals <i>Thathsara Bandara, Vidura Perera, Shajini Majuran</i>	11:40AM-11:55AM
69	A Review of AI-Driven Branch-Level Product Mix and Assortment Optimization for Retail Decision Support <i>Dunith Munasinghe, Thareesha Disanayaka</i>	11:55AM-12:10PM
74	A Review of Deep Reinforcement Learning Approaches for Intelligent Traffic Signal Control with Applications to Sri Lankan Traffic Conditions <i>Mohamed Siyas, Vidura Perera</i>	12:10PM-12:25PM
93	A Review of Neuro-Symbolic AI Integration: Combining Large Language Models and Answer Set Programming for Goal-Driven Conversational Agents <i>Uththara Karunarathna, Dilmi Praveena, Nadeeka De Silva</i>	12:25PM-12:40PM
103	Systematic Review of Machine Learning and Deep Learning Approaches for Tea Leaf Disease Detection <i>Gayana Sajani, Vindya Senanayake, Deepika Seneviratne</i>	12:40PM-12:55PM
125	A Review of Solar Irradiance and Photovoltaic Power Forecasting Using Image Based and Data Driven Methods <i>Lasitha Randima, Pubudu Jayasekara, Tharindu Rangana, Bhagya Senadheera</i>	12:55PM-01:10PM

Session M5: AI-Driven Cybersecurity and Intelligent Threat Detection

Time: 11:30 AM - 01:30 PM

Location: E306 3rd Floor, New Building,
Faculty of Management Studies and Commerce

Chair: Dr. Pasan Maduranga, Faculty of Engineering

Co-Chair: Mr. Kanishka Edirimanna, Faculty of Computing

Paper ID	Title & Authors	Time
28	Zero Trust Architecture and Dynamic Access Control Mechanisms in Modern Cybersecurity Systems <i>Ashan Dissanayake, Malshani Hettiarachchi, Budditha Hettige</i>	11:40AM-11:55AM
33	A Review on Network Intrusion Detection for Passive Attacks on LLMs <i>Amrul Haq Zameer, Malshani Hettiarachchi, Gilmini Dantanarayana</i>	11:55AM-12:10PM
34	Machine Learning Approaches for Software Project and Requirement Risk Prediction <i>Maleesha Weerasooriya, Vidura Perera</i>	12:10PM-12:25PM
56	A Systematic Review of Integrating Explainable AI and Deep Learning for Enhanced Anomaly Detection and Forecasting in Sri Lanka CEB Smart Grid Systems <i>Belani Jayasinghe, Vidura Perera</i>	12:25PM-12:40PM
82	Bridging the Trust-Resilience Gap in Autonomous Network Security: A Systematic Review of XAI, MTD, and Emerging Quantum-Adversarial Threats <i>Hansani Dhanushika, Malshani Hettiarachchi</i>	12:40PM-12:55PM
102	AI-Assisted Cyber Threat Detection, Classification and Mitigation through LLM-Enhanced Security Analytics <i>Usitha Kalyana, Vindya Senanayake</i>	12:55PM-01:10PM

Session M6: Computational Simulation and Modeling

Time: 11:30 AM - 01:30 PM

Location: E316 3rd Floor, New Building,
Faculty of Management Studies and Commerce

Chair: Prof. Saman Muthukumarana, University of Manitoba, Canada

Co-Chair: Ms. Hirusha Wanigasingha , Faculty of Applied Sciences

Paper ID	Title & Authors	Time
24	Bridging the Semantic Gap in Deaf Education: A Review of Virtual Reality Platforms and Knowledge-Based AI Approaches <i>S.I.L. Ratnayake, D.V.D.S. Abeysinghe, H.L.D.P. De Silva</i>	11:55AM-12:10PM
25	Framework for Reducing Skin-Tone Bias in AI Skin Cancer Detection Using XAI-Guided Lesion-Focused Regularization <i>DAN Amasha, Mihiri Sirisuriya, DMAD Bandara</i>	12:10PM-12:25PM
158	A Review of Audio Deepfake Detection Beyond English Benchmarks for Low Resource Conversational Speech <i>Vidusahan Perera, Umada Dikwatta</i>	12:25PM-12:40PM
163	Modelling Misinformation Spread in Social Networks: An Agent-Based Approach with Algorithmic Feed Ranking and Fact-Checking Mechanisms <i>P.L.M.S. Udayashan, P.R.D.B.M. Peramune, B. Hettige</i>	12:40PM-12:55PM
166	Agent-Based Simulation of Grocery Store Checkout Queuing with Dynamic Lane Management, Shift-Based Staffing, and Self-Checkout Integration <i>W.M.K.G.V.B. Wijekoon, H.M.C.Y. Hennayaka, W.D.N.S. Wijekoon, M.P.S. Morais, P.D.R.C. Jayasinghe, B. Hettige</i>	12:55PM-01:10PM
114	A Machine Learning Based Approach for Wedding Cost Prediction and Package Recommendation in Sri Lanka <i>Pasindu Udana, Sanjeewa Sandaruwan, Hashan Hirantha, WP Sudasun, Dilmi Praveena, Nuwan Jayarathna</i>	01:10PM-01:25PM

Session A1: Image Processing and Vision Systems

Time: 02:30 PM - 04:30 PM
Location: E304 3rd Floor, New Building,
Faculty of Management Studies and Commerce
Chair: Dr. Deepika Seneviratne, Faculty of Computing
Co-Chair: Ms. Thareesha Disanayaka , Faculty of Computing

Paper ID	Title & Authors	Time
41	AI-Based Fake User Detection in Online Dating Platforms: A Review of Chat Behavior and Profile Image Analysis Techniques <i>Nishadi Navodya Wickramaarachchi, Malshani Hettiarachchi, Budditha Hettige</i>	02:40PM-02:55PM
47	A Review on AI-Assisted Motion-based Animation and Video Editing techniques <i>Adeesha Indrajaya, Shajini Majuran, Vindya Senanayake</i>	02:55PM-03:10PM
61	A Review of AI-Based Image Measurement and Scene Understanding Techniques for AR-Based Interior Visualization <i>Rushani Sivakumar, Shajini Majuran</i>	03:10PM-03:25PM
76	A Survey-Based Analysis of Video Gaming Addiction and Its Impact Among IT Undergraduates in Sri Lanka <i>Shenal Gunasekara, Vindya Senanayake, Deepika Seneviratne</i>	03:25PM-03:40PM
119	A Review and Comparative Evaluation of Image-Based Ripeness Detection and Grading Techniques for Coconuts <i>Oshini Mihindukulasuriya, Budditha Hettige</i>	03:40PM-03:55PM
124	Computer Vision and Deep Learning for Queue Buildup Prediction in Retail: A Narrative Review of Technical and Operational Challenges <i>Dunith Abeyaratne, Vindya Senanayake</i>	03:55PM-04:10PM
68	Coral Reef Health Monitoring Using Image Classification Techniques: A Systematic Review <i>Chami Dilshika, Vindya Senanayake, Shajini Majuran</i>	04:10PM-04:25PM

Session A2: AI-Driven Multidisciplinary Research and Applications

Time: 02:30 PM - 04:30 PM
Location: E305 3rd Floor, New Building,
Faculty of Management Studies and Commerce
Chair: Dr. Nuwan Jayarathna, Faculty of Computing
Co-Chair: Ms. Praveena Kulugammana, Faculty of Computing

Paper ID	Title & Authors	Time
77	A Comprehensive Review of Predictive Horizontal Pod Autoscaling Driven by Mathematical Workload Patterns <i>Dileesha Perera, Malshani Hettiarachchi, Pubudu Jayasekara</i>	02:40PM-02:55PM
78	A Review On Cost Prediction And Visualization For Kubernetes Resource Management <i>Janith Nanayakkara, Malshani Hettiarachchi, Pubudu Jayasekara</i>	02:55AM-03:10PM
98	Deep Learning-Based Object Detection for Sri Lankan Expressways <i>Yasiru De Silva, Vidura Perera</i>	03:10PM-03:25PM
99	Machine Learning Paradigms for Multi-Scale Polymer Property Prediction: A Systematic Review <i>Venumi Alagoda, Malshani Hettiarachchi, Deepika Seneviratne</i>	03:25PM-03:40PM
128	A Comparative Review of CycleGAN and Diffusion Models for Data Augmentation in RealTime Plant Disease Recognition <i>Amanda Sewwandi, Kanishka Edirimanne, Shajini Majuran</i>	03:40PM-03:55PM
133	Systematic Literature Review of Technical Integration Challenges and Workflow Gaps of Generative AI Tools in Unity-Based Indie Game Development <i>Sachintha Gunasekara, Vidura Perera, Budditha Hettige</i>	03:55PM-04:10PM

Session A3: Computational Linguistics and NLP Applications

Time: 02:30 PM - 04:30 PM
Location: E306 3rd Floor, New Building,
Faculty of Management Studies and Commerce
Chair: Dr. Shajini Majuran, Faculty of Computing
Co-Chair: Ms. Dilki Jayasooriya, Faculty of Computing

Paper ID	Title & Authors	Time
90	AI-Based Personalized Sinhala Font Generation from Handwriting Samples <i>Ravindu Vidurusinghe, Vindya Senanayake</i>	02:40PM-02:55PM
91	A Review of Visual Speech Recognition Models and Their Applicability to the Sinhala Language <i>Tharushima Perera, Kanishka Edirimanne, Shajini Majuran</i>	02:55PM-03:10PM
94	A Review of Data-Driven Sinhala Grammatical Error Correction: Corpora, Models, and Low-Resource Strategies <i>Sahan Perera, Dilmi Praveena, Sachintha Pitigala</i>	03:10PM-03:25PM
95	From Sentiment Polarity to Context-Aware Emotion Detection for Sinhala Text: An Integrative Review of Models, Corpora, and Research Gaps <i>Menura Andrahennedi, Dilmi Praveena, Sachintha Pitigala</i>	03:25PM-03:40PM
105	A Narrative Review of Methods, Effectiveness, and Limitations of Self-Refinement in Large Language Models <i>Ganindu Deshapriya, Budditha Hettige</i>	03:40PM-03:55PM
120	A Systematic Review of AI-Based Learning Content Summarization and Interactive Assessment <i>Disini Wickramasinghe, Tharindu Rangana, Prasad Jayaweera</i>	03:55PM-04:10PM
122	Digital Transformation in Geotechnical Engineering: A Systematic Review of Mobile Systems and AI-Driven Report Generation <i>Vihanga Rathnayake, Vidura Perera, Deepika Senevirathne</i>	04:10PM-04:25PM

Session A4: Information Systems and Enterprise Applications

Time: 02:30 PM - 04:30 PM
Location: E307 3rd Floor, New Building,
Faculty of Management Studies and Commerce
Chair: Dr. Wijendra Gunathilake, Faculty of Computing
Co-Chair: Ms. Jayani Rajakaruna, Faculty of Computing

Paper ID	Title & Authors	Time
29	Smart Travel Planner - A Review of Automated Travel Itinerary Generation Systems for Sri Lanka. <i>Zahara Zahir, Vidura Perera, Wijendra Gunathilake</i>	02:40PM-02:55PM
31	SportAccessSL - A Review of Location-Based Accessibility Analysis for Sports Coaching and Resources <i>Dilupa Shehan, Vidura Perera, Wijendra Gunathilake</i>	02:55PM-03:10PM
49	Digital Game-based Education and Entertainment System for Elementary and Primary School Children <i>Nidhyana Kodikara, Vidura Perera</i>	03:10PM-03:25PM
60	Artificial Intelligence Techniques in Fitness, Wellness, and Rest Management Systems for University Students: A Systematic Review <i>Sasikala Nishadi, Dilki Jayasooriya, Bhagya Senadheera</i>	03:25PM-03:40PM
110	Intelligent Transportation Systems for Bus Arrival Prediction and Commuter Behavior in Decentralized Public Transport <i>HEM Udayanga Srimal, FHSR Silva, Pubudu Jayasekara</i>	03:40PM-03:55PM
130	A Review of AI Enabled Workload Management and Injury Prediction Systems for Cricket <i>Kavindu Nimesh, Dilmi P Kulugammuna, Deepika Senevirathne</i>	03:55PM-04:10PM
136	Mobile Health Interventions for Maternal and New-born Health in Low and Middle Income Countries: A PRISMA Review <i>Chethana Sathsarani, Bhagya Senadheera</i>	04:10PM-04:25PM

Session A5: Bioinformatics and Secure Computing

Time: 02:30 PM - 04:30 PM

Location: E315 3rd Floor, New Building,
Faculty of Management Studies and Commerce

Chair: Dr. Bhagya Senadheera, Faculty of Computing

Co-Chair: Ms. Upeksha Samarasinghe, Faculty of Management Studies and
Commerce

Paper ID	Title & Authors	Time
39	Review of Behavioral and Biometric Approaches for AI Powered Real-Time Cheating Detection in Online Interviews <i>Kavindi Hewawasam, Vidura Perera</i>	02:40PM-02:55PM
51	A Systematic Review of Digital Systems for Upper-Limb Physiotherapy Assessment <i>Rivindu Dulan, Vidura Perera, Bhagya Senadheera</i>	02:55PM-03:10PM
65	Advances in Topological Data Analysis for Biological Sequence Classification: Bridging Persistent Homology and Deep Learning <i>Y. Dinusha Devindi, Dilmi Praveena, Nadeeka De Silva</i>	03:10PM-03:25PM
100	User Perceptions and Requirements for AI-Based Dry Eye and Posture Monitoring Systems: A Survey Study <i>Heshan Bandaranayake, Vindya Senanayake, Pooja Ranasinghe, Vidura Perera, Shajini Majuran</i>	03:25PM-03:40PM
160	A Review of Self-Supervised and Drift-Aware Anomaly Detection for Industrial Data Streams <i>Nethmi Hirunika SuwandaArachchi, Umanda Dikwatta</i>	03:40PM-03:55PM
159	A Review of Eye Region Based Deepfake Detection Under Resolution Degradation and Demographic Bias <i>Heshani Maddage, Umanda Dikwatta</i>	03:55PM-04:10PM
147	A Systematic Review of Adversarial Evasion Attacks on Machine Learning-Based Network Intrusion Detection Systems: An Analysis of the Practicality Gap <i>Thisara Hetti Arachchi, Wijendra Gunathilake, Vindya Senanayake</i>	04:10PM-04:25PM

Session A6: Machine Learning for Multidisciplinary Innovations

Time: 02:30 PM - 04:30 PM
Location: E316 3rd Floor, New Building,
Faculty of Management Studies and Commerce
Chair: Dr. Dhammika Pieris, Faculty of Computing
Co-Chair: Ms. Piyumi Udeshika, Faculty of Applied Sciences

Paper ID	Title & Authors	Time
127	A Review of IoT-Based Plastic Waste Identification Systems Using ESP32 and Near-Infrared Sensors <i>Mohamed Azeem, Thisal Vitharana, Rukshika Fernando, Vindya Senanayake, Pubudu Jayasekara, Dhammika Weerathunga</i>	02:40PM- 02:55PM
129	A Review and Comparative Analysis of Deep Learning Techniques for Plastic Classification Using Near-Infrared Spectral Data <i>Vishishta Dilsara, Thisal Vitharana, Rukshika Fernando, Vindya Senanayake, Pubudu Jayasekara, Dhammika Weerathunga</i>	02:55PM- 03:10PM
132	A Critical Review of Technologies Effectiveness and Claims for IoT Enabled Ultrasonic Mosquito Repellent device <i>Nuhansa Kodithuwakku, Vidura Perera, Deepika Seneviratne</i>	03:10PM- 03:25PM
144	A Review of Real-Time Speech Translation and Streaming Speech Processing Systems for Wearable and Edge-Based Applications <i>Chandira Sugith Induwara, Pubudu Jayasekara</i>	03:25PM- 03:40PM
148	A Systematic Review on Kidney Stone Detection using Explainable AI <i>Ravisha Ranasinghe, Vindya Senanayake, Gilmini Geethika</i>	03:40PM- 03:55PM
152	Smart Waste Management with Reward Tokens and Gamification: A Systematic Review <i>Bodhigamage Malithi Nawodya, Gilmini Dantanarayana, Tharindu Rangana</i>	03:55PM- 04:10PM
156	The Evolution of Web Form Testing: A Review of AI-Driven Test Case Generation [2020-2025] <i>Haritha Perera, Deepika Senevirathne</i>	04:10PM- 04:25PM

Abstracts

Explainable Commit-Level Vulnerability Intelligence in DevSecOps Pipelines: A Structured Review and Synthesis

Don Dasun Sandeepa Wilathgamuwa, Malshani Hettiarachchi, Budditha Hettige

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Abstract

DevSecOps has improved significantly in recent years due to the increasing speed and complexity of modern software delivery through continuous integration and continuous deployment (CI/CD) pipelines. It focuses on integrating security into the DevOps process so that software can be released quickly without compromising security. Deep learning and large language models have shown strong potential for detecting software vulnerabilities; however, in practice, they do not integrate effectively into real DevSecOps pipelines. Most existing techniques operate at the function level and provide limited explanation for why a vulnerability is reported. As a result, developers often struggle to use these outputs during code changes, reducing trust in such tools. This paper presents a structured review of AI-based vulnerability detection approaches, with a particular focus on commit-level analysis and explainability within CI/CD environments. The study is based on approximately 40 papers published between 2018 and 2025, collected from IEEE Xplore, the ACM Digital Library, and SpringerLink. The analysis reveals that fewer than 10% of studies perform commit-level analysis, while nearly 80% provide no explainability, highlighting a critical gap in DevSecOps security integration. Based on these findings, the paper synthesises a conceptual framework that integrates commit-level change analysis, AI-based vulnerability detection, and explainable security mechanisms within CI/CD pipelines. This framework aims to improve developer trust, support faster decision-making, and enhance the practical adoption of AI-driven security in DevSecOps.

Keywords: DevSecOps, Commit-level vulnerability detection, Explainable AI, CI/CD security

Bridging the Semantic Gap in Deaf Education: A Review of Virtual Reality Platforms and Knowledge-Based AI Approaches

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Abstract

The acquisition of language and literacy is a constant challenge for Deaf and Hard of Hearing (DHH) children, mainly due to the core “semantic gap” between visual sign language and the abstract concepts of written text. To address this, this paper’s objective is to review the current domain of digital learning technologies in DHH education in a systematic way, critically analyze their hard-wired limitations, and propose a paradigm shift towards knowledge-based Artificial Intelligence that is imperative. Following the PRISMA framework, this review synthesized literature across immersive technologies, computer vision approaches, and knowledge representation systems. The findings demonstrate that although Virtual Reality (VR) offers highly capable and promising solution for contextual immersion, the applicability of most of the existing systems are undermined by their dependency on fragile, non-semantic Computer Vision (CV) models, which lack the power of true conceptual understanding. A significant gap was identified in the application of robust, reasoning-based AI, such as ontologies and knowledge graphs, a critically underexplored domain altogether. This review concludes that future of effective and unbiased DHH educational technology lies in the combined integration of immersive platforms with ontology-driven AI. This combination is greatly required to move beyond simple pattern recognition and enable the deep semantic reasoning, adaptive feedback, and meaningful learning experiences that is required to ultimately bridge the semantic gap.

Keywords: Deaf Education, Assistive Technology, Virtual Reality (VR), Ontology, Sign Language

Framework for Reducing Skin-Tone Bias in AI Skin Cancer Detection Using XAI-Guided Lesion-Focused Regularization

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Abstract

Skin cancer detection using artificial intelligence has demonstrated dermatologist-level accuracy. However, existing systems shows performance gap of 10–15% against patients with darker skin tones especially on Fitzpatrick types V–VI. Although previous mitigation strategies such as data augmentation, adversarial debiasing, and post-hoc calibration attempt to address this inequity, they fail to target the root cause: during classification, AI models incorrectly focus on background skin tone rather than lesion characteristics. This gap in requires an interpretable, attention-aware bias mitigation approach. This paper proposes a conceptual framework for bias prevention via attention regularization using explainable AI as an active bias prevention mechanism. It integrates this approach directly into model training through lesion-focused regularization (LFR). This framework consists of four conceptual stages: (i) XAI-based bias detection quantifies attention distribution using Grad-CAM, Lesion Focus Ratio (LFR), and Background Attention Ratio (BAR) across Fitzpatrick skin types, (ii) lesion segmentation using ground-truth masks or a pre-trained U-Net for regularization targets, (iii) attention-guided regularization that extends the training loss to penalize background-focused attention, and (iv) fairness-aware evaluation spanning distributional fairness and representational fairness metrics. In contrast to current approaches that sacrifice accuracy by imposing statistical fairness requirements, the suggested approach aims to correct the inherent attentional bias. This approach is expected to keep the accuracy-fairness balance below 2%. Although further validation is needed as part of future research, the proposed methodology creates a theoretical foundation for building AI-based diagnostic algorithms in a transparent and reliable manner that can be generalized from dermatology to other medical imaging applications. This will help ensure health care equality since it will make it possible to accurately diagnose skin cancer in people regardless of their skin color.

Keywords: Skin-tone bias mitigation, Explainable artificial intelligence, Lesion-focused regularization, Fairness-aware deep learning , Grad-CAM attention guidance.

Zero Trust Architecture and Dynamic Access Control Mechanisms in Modern Cybersecurity Systems

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Abstract

With the rapid expansion of cloud computing architecture, remote work and distributed infrastructures, the weaknesses of perimeter-based security have been coming to pass since its emergence has rendered the previously relied-upon models of trust based on a security boundary at the perimeter irrelevant to present-day cybersecurity needs. Zero Trust Architecture (ZTA) represents a security model that removes any trust connections by introducing microsegmentation, contextual access control and continuous authentication to confirm every access request by blocking any security attack. The review of new research studies that concentrate on ZTA, Zero Trust Network Access (ZTNA) and the new design of trust scoring schemes and machine-learning-based score enforcement indicates that organizations now like to apply data-driven information assurance tasks and threat mitigation tasks that have to rely on dynamic operational procedures. These research gaps, as researchers identified, entail three primary issues that must be solved through real-time trust testing and solution validation through testing at scale and solving privacy issues that behavioral analytics applied in continuous monitoring detect user intent and anomaly detection. The review comprises future trends in the development of scalable Zero Trust solutions that can address the needs of enterprises with an adaptive ZTNA architecture that incorporates behavioral analytics and reinforcement learning to enhance accuracy in decision-making and responsiveness of the system. The case study indicates that organizations have to work on the capacity of sharing information on different platforms as they strive to come up with a standardized implementation of trust costs and creation of consistent organizational rules that will operate in a variety of operating environments. Review also helps highlight that organizations should set their operations towards their performance standards of excellence.

Keywords: Zero Trust Architecture, Zero Trust Network Access, dynamic access control, trust scoring, reinforcement learning

Smart Travel Planner - A Review of Automated Travel Itinerary Generation Systems for Sri Lanka.

Zahara Zahir, Vidura Perera, Wijendra Gunathilake

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Abstract

The rise in the complexity of travel planning has inspired interest in the need for more intelligent itinerary planners that can produce viable and customized travel itineraries. The problem discussed in this research revolves around the lack of an integrated itinerary planner system localized to Sri Lanka that considers all aspects, such as preferences, duration of the trip, route optimizations, and cost considerations under one roof. There have been some improvements in the three methods through which such systems have evolved. The recommender-based approach includes tools like TripBuilder (Brilhante et al., 2013) that use crowdsourcing techniques to develop time-constrained tours but only works with generic urban data without any regional adaptability. In contrast, the optimization-based model involves MYVISITPLANNERGR (Refanidis et al., 2016), where ontological reasoning along with demographic profiling is used, but cost, route, and interest aspects were considered separately. However, in recent times, there have been significant advancements in AI-based planners using large language models for conversational access. Nevertheless, recently there have been tremendous breakthroughs in AI planners with large language models for conversation-driven access to travel planning, but, they suffer from problems such as hallucination and weak constraint management, as shown by TripTailor (Shen et al., 2024) and TravelPlanner (Xie et al., 2024). Such drawbacks are especially important in Sri Lanka because feasibility depends on monsoonal periodicity, road conditions, and unique travel behavior patterns that cannot be captured in general-purpose systems. Rathnasekara et al. (2023) demonstrate the potential of machine learning for local tourist support, yet fall short of a fully integrated planning framework. This review identifies key gaps of insufficient localization, unrealistic travel-time estimation, weak cost modeling, and limited real-world evaluation and establishes a foundation for developing a Sri Lanka-specific itinerary planning system that is context-aware, integrated, and practically validated.

Keywords: Personalized Tourism, Route Optimization, Smart Tourism, Sri Lanka, Tourism Recommendation Systems, Travel Itinerary Planning

SportAccessSL - A Review of Location-Based Accessibility Analysis for Sports Coaching and Resources

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Abstract

Unequal access to sports training and facilities is a major concern for balanced participation and effective talent identification in sports, particularly in developing nations such as Sri Lanka. The literature has addressed issues such as geographic accessibility, location-based services, and predictive analytics in sectors including healthcare, education, and urban planning. However, there is a significant lack of literature on accessibility to sports coaching and sports equipment. This review paper critically evaluates current studies on location-based accessibility analysis, spatial distribution of sports facilities and coaches, data driven decision support systems, and predictive modeling techniques. The aim of this research is to identify methodological approaches used in existing studies, patterns of data analysis, and limitations in sports management research, while emphasizing gaps related to regional equity, affordability, and quality in the sports system. The approach adopted is that of a systematic review, based on relevant articles in journals, conference proceedings, and reports published by authoritative sources on spatial analysis and sports resource allocation. The findings of the study show that, despite the popularity of Geographic Information Systems (GIS) and spatial analysis, many studies do not consider important factors such as budget sensitivity, coach quality measures, infrastructure status, and predictive modeling abilities. Further, studies on developing countries with varied regions and limited data are few. This paper forms the basis for the proposed SportAccessSL system by incorporating spatial analysis, affordability, quality evaluation, and predictive modeling. The proposed system is expected to facilitate balanced and data-informed decision-making and help towards a sustainable approach to sports development and systematic talent identification in Sri Lanka.

Keywords: geographic information, Location-based, predictive analytics, resource distribution, sports accessibility, sports coaching

A Review on Network Intrusion Detection for Passive Attacks on LLMs

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Abstract

This review analyzes network intrusion detection approaches to identify passive attacks targeting Large Language Model (LLM) systems, including eavesdropping, traffic analysis, training data extraction, membership inference, model inversion, prompt leakage and dataset inference. These attacks are particularly challenging to detect as they do not actively modify model behavior or network traffic patterns, resulting in weak or indistinguishable signatures in conventional feature spaces. A total of 32 studies published between 2017 and 2025 were systematically synthesized, covering deep learning-based NIDS foundations, transformer and LLM-based detection pipelines, explainability mechanisms, Retrieval-Augmented generation (RAG), and LLM vulnerabilities and robustness considerations. The findings indicate that LLM enhanced detection is most effective when (i) network telemetry is transformed into structured natural language representations, (ii) external knowledge sources are integrated to reduce hallucination and improve detection of rare behaviors, and (iii) model explanations are grounded in evidence retrieved from contextual data. However, several limitations persist, including the lack of realistic passive attack scenarios in publicly available datasets, reduced evaluation reliability under concept drift, computational complexity in real-time deployment, and susceptibility to prompt-based attacks on LLM-integrated pipelines. Based on the reviewed evidence, a practical architecture is proposed that combines flow-to-text transformation, lightweight fine-tuning, and a retrieval layer with short-term traffic memory to support context-aware passive attack inference. Finally, key research directions are identified, including the development of passive attack specific benchmark datasets, standardized evaluation of evidence-grounded explanations, robust prompt defense mechanisms, and continual learning strategies to address evolving network traffic patterns.

Keywords: Passive Attacks, Network Intrusion Detection, Large Language Models, Retrieval-Augmented generation, Flow-To-Text Transformation

Machine Learning Approaches for Software Project and Requirement Risk Prediction

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Abstract

Software project failures are often linked to ineffective risk management, particularly during the requirements engineering phase where issues such as ambiguity, incompleteness, and volatility can significantly impact downstream development. This paper presents a structured review of machine learning (ML) approaches for software risk prediction, with a clear focus on requirement-related risks while situating them within the broader context of software project risk management. The study synthesizes existing literature to examine commonly applied ML techniques, including classification models, ensemble methods, and deep learning approaches, alongside the types of datasets, feature engineering practices, and evaluation metrics used. In contrast to purely descriptive surveys, this review critically analyzes how and why certain techniques perform better under specific conditions and evaluates their generalizability across diverse project environments. The findings reveal several persistent challenges, including the limited availability of standardized datasets such as PROMISE and NASA repositories, inconsistencies in evaluation methodologies, and concerns regarding reproducibility. Additionally, the review identifies a relative lack of focused research on requirement-specific risk prediction compared to general project risks. By clarifying this distinction and providing a more analytical synthesis of prior work, the paper contributes a coherent understanding of current trends and methodological gaps in the field. It further outlines future research directions, emphasizing the need for standardized benchmarks, higher-quality datasets, and more rigorous and transparent evaluation frameworks to improve the reliability and practical applicability of ML-based risk prediction models.

Keywords: Machine Learning, Predictive Modeling, Requirement Risk Prediction, Requirements Engineering, Software Project Risk, Systematic Literature Review

A Review and Comparative Analysis of RF-Based Offline Communication Systems and IoT Integration Approaches for Traveller and Hiker Safety

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Abstract

The rise in popularity of outdoor activities such as hiking and adventure travel has increased the demand for effective safety communication in remote environments. In such settings, traditional communication systems, including cellular networks and internet-based services, are often unreliable due to terrain constraints and environmental conditions. This creates significant safety concerns, particularly during emergency situations where timely information exchange is critical. Radio frequency (RF)-based offline communication systems have been explored as a potential solution, enabling direct multi-hop device-to-device communication without reliance on existing infrastructure. The integration of Internet of Things (IoT) technologies further extends system capabilities by supporting functionalities such as location awareness, environmental monitoring, and emergency alert dissemination. Existing offline communication systems exhibit diverse design choices and trade-offs in terms of communication range, energy consumption, scalability, reliability, and integration complexity. This study presents a review and comparative analysis of RF-based offline communication systems and IoT integration approaches. The approaches are classified based on RF technologies, network architectures, and integration methods, and evaluated using criteria such as communication range, power consumption, scalability, reliability, and applicability. The analysis reveals that sub-gigahertz RF-based communication systems offer significant potential for extended coverage and energy efficiency, particularly when combined with mesh networking to improve fault tolerance. However, no single approach fully satisfies all safety communication requirements, as inherent trade-offs persist among communication range, scalability, latency, reliability, and energy consumption. The findings provide a consolidated understanding of current RF-based offline communication and IoT integration techniques, while highlighting key research gaps, particularly in achieving scalable and energy-efficient solutions under real-world conditions. These insights emphasize the need for adaptive, energy-aware, and robust system designs to enhance safety communication for travellers and hikers in infrastructure-limited environments, while also guiding future research and practical system development.

Keywords: Emergency Communication, Internet of Things, Offline Communication Systems, Remote Safety, RF Communication

A Systematic Review of Multimodal AI Systems for Early Childhood Development Evaluation and Screening

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Abstract

Early childhood assessment is essential at the age of 3-6 years in order to detect developmental delays and provide an intervention in time. The traditional evaluation approaches have some limitations such as subjective observation, schedule constraints of periodicity, and cultural bias especially for bilingual groups in developing countries. Technologies based on Artificial Intelligence (AI) present opportunities of continuous multimodal analysis of speech, motor, cognitive, and social-emotional development. This study presents a systematic review of AI-based assessment applications in early childhood learning, conducted in adherence to PRISMA 2020. Extensive searches through IEEE Xplore, ACM Digital Library, PubMed, Web of Science, Scopus and Google Scholar yielded 1,214 records and 25 studies were eligible according to the inclusion criteria of systematic screening. Five thematic areas were identified: speech and language assessment with 85Major gaps in the research are that cross-cultural validation is little, small datasets (usually $n < 500$), large computational needs, and correlational constraints. The majority of studies are geographically biased to the Western populations with minimal representation of South Asians. The technological shortcomings include lack of robustness to naturalistic settings, a lack of cross-linguistic transfer learning, and inadequate uncertainty quantification mechanisms. The SmartKid Insight platform is proposed as future work to address these gaps with culturally adjusted Sinhala-optimised protocols, offline edge computing, and lean mobile structures in resource-limited environments, contributing toward equitable AI-driven developmental assessment for the global population.

Keywords: Artificial Intelligence, Automated Screening, Deep Learning, Early Childhood Assessment, Multimodal Systems.

Autonomous School Bus Ecosystem with Predictive Proximity Alerts and Smart Gate Integrated Student Verification

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Abstract

Transportation systems in schools are essential in making students safe and keeping the operating systems efficient but, unfortunately, a lot of the current systems continue to rely on manual transportation, fixed schedules and disjointed communication systems. These restrictions usually lead to reluctant information, poor absences administration and high risks to the safety of the students. As the Internet of Things technologies rapidly develop, intelligent school bus systems have become one of the potentially effective solutions to these problems. The review paper includes a critical examination of twenty peer-reviewed articles regarding the area of IoT-enabled school bus tracking, RFID/NFC-enabled student verification, geofencing-based notifications, predictive delay intelligence, and smart transportation technologies. The literature review is performed in terms of the following themes to assess the support of the existing systems to real-time bus tracking, automated attendance monitoring, proximity-based parent notifications, and predictive scheduling. The results show that IoT and GPS-tracking systems can offer real-time information about the bus position and RFID and NFC technologies can be used to enhance the process of student verification when they board and alight. Geofencing systems also provide even more safety as they create an alert system that is sent to parents and school officials in a timely manner. Predictive delay modeling and intelligent decision-making are, however, not fully used and tend to be deployed as a stand-alone feature. In addition, the literature examining the combination of autonomous or autonomous context-sensitive bus functions and smart attendance verification through gateways is very scarce. This review has found out that there are some critical research gaps concerning system integration, predictive intelligence, data security and scalability. It emphasizes the necessity to have an integrated, independent school bus ecosystem that integrates live tracking, proximity warnings, and secured student authentication to enhance the safety, effectiveness, and communication between stakeholders of the contemporary school transportation systems

Keywords:Autonomous School Bus, Geofencing-Based Alerts, Intelligent School Transportation Systems, Internet of Things, Predictive Delay Intelligence, RFID/NFC Student Verification

Review of Behavioral and Biometric Approaches for AI Powered Real-Time Cheating Detection in Online Interviews

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Abstract

Real-time Artificial Intelligence (AI) based cheating detection systems have gained traction in remote job interviews by analyzing candidate behavior and biometrics. Remote interviews bring fresh issues of inequity and honesty as they are subject to impersonation, onscreen assistance, and illegitimate resources. The existing proctoring systems have not been built to work under remote environments. With the help of AI, computer-based cheating can be analyzed on the basis of behavior and identity analysis. This paper systematically reviews 21 recent studies on AI-powered behavioral and biometric cheating detection approaches. Behavioral analysis methods detect abnormal movements such as gaze deviation, excessive head pose variation, response latency, and voice inconsistencies using gaze tracking, head pose estimation, and speech analysis. Face recognition, voice biometrics, deepfake voice detection, and cancellable facial biometrics are discussed as biometric identification methods to verify identity continuously in real-time. The models of Multimodal AI that make use of Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), and machine learning classifiers are discussed to combine audio-visual and behavioral data streams. The considered findings show that deepfake voice detection (a biometric method) has up to 99.3 percent accuracy, whereas CNN-based behavioral models have more than 97 percent accuracy, but with a high cost of calculations. Methods of behavioral-only have moderate accuracy (around 75-89) and are environmentally sensitive. Although the current systems perform well, they have high false-positive rates, privacy issues, biased data, and lack of explainability. This review demonstrates the necessity of lightweight, explainable, privacy-preserving, and bias-aware multimodal frameworks to enhance fairness and reliability in remote recruitment. The results present organized knowledge to inform further studies on the ethical and scalable interview proctoring systems powered by AI.

Keywords: AI-powered cheating detection, behavioral analysis, biometric authentication, online interviews, real-time proctoring

A Review of Natural Language to Motion Intent in Autonomous UAV Control and Human–Drone Interaction

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Abstract

Natural-language control of unmanned aerial vehicles (UAVs) promises more intuitive and effective human–drone interaction, but translating free-form language into safe and reliable motion remains difficult because commands are often ambiguous, environments are dynamic and partially observed, and high-level semantic reasoning must be grounded in low-level control. This review synthesizes recent research on natural language to motion intent for autonomous UAV control and related robotic navigation, covering modular grounding-and-planning pipelines, learning-based end-to-end models, vision-language-action (VLA) frameworks, and multimodal large language model (MLLM)-based task decomposition. Across the literature, modular methods offer interpretability and easier integration with classical planners, whereas end-to-end and VLA models improve semantic grounding, instruction following, generalization, and explainability by coupling perception, language, and action more tightly. MLLM-driven systems further expand capability by decomposing complex missions, coordinating multi-UAV tasks, and enabling higher-level contextual reasoning. The review also highlights a broader shift from waypoint-style command translation toward intent-aware, collaborative, and context-sensitive UAV behavior. However, current benchmarks remain inadequate: UAV-language datasets are limited, fragmented, and often synthetic; spoken-language resources and standardized aerial evaluation protocols are scarce; and many studies rely on simulation, simplified environments, or human assistance. Important limitations also persist in real-time deployment, including heavy data requirements, high computational cost, cloud-dependent inference, sensitivity to perception noise, hallucination risk, and weak robustness in cluttered, unseen, or GPS-denied environments. Overall, the field is progressing from rule-based instruction parsing toward unified multimodal autonomy, but practical voice-controllable UAVs will require larger and more realistic benchmarks, low-latency edge-deployable models, stronger multimodal sensor fusion, interactive clarification mechanisms, spoken-command integration, and broader real-world validation in safety-critical settings.

Keywords: Autonomous UAV Control, Human–Drone Interaction, Multimodal Large Language Models (MLLMs), Natural Language to Motion Intent, Vision-Language-Action Models (VLA)

AI-Based Fake User Detection in Online Dating Platforms: A Review of Chat Behavior and Profile Image Analysis Techniques

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Abstract

Online dating platforms have grown rapidly, allowing people to form more social and romantic relationships. However, this growth has also led to the creation of more fake user accounts for emotional manipulation, harassment, and financial fraud. Recent studies suggest that fake accounts can constitute approximately 20-30% of suspicious accounts detected on large-scale online sites. Chatfishing, where automated conversational agents mimic human interaction, and deepfake-generated profile images, which make fake profiles look more real, have made this problem worse with advances in artificial intelligence (AI). Most current methods for detecting fake profiles focus on one type of data at a time, either text chat behavior or visual profile content. These methods struggle to identify advanced hybrid fake users who use both conversational and visual deception techniques. This review provides a comprehensive analysis of AI-driven methodologies for identifying fraudulent users on online dating platforms, focusing specifically on chat behavior analysis and profile image evaluation. A systematic taxonomy of detection methodologies is proposed, followed by a comparative analysis of traditional machine learning, deep learning, and hybrid approaches across various application domains. Identified key research gaps include the lack of multimodal datasets specific to the dating platform, restricted explainability, and privacy limitations. To support the creation of appropriate, comprehensible, and privacy-preserving fake profile detection systems for the next three to five years, future research directions are outlined.

Keywords: Chatfishing, Deepfake Images, Multimodal Learning, Artificial Intelligence, Online Dating Fraud, Fake Profile Detection.

Digital Game-based Education and Entertainment System for Elementary and Primary School Children

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Abstract

Game-based digital learning has developed rapidly and has become an major tool for children's education, particularly due to the increased availability, affordability, and accessibility of the internet and various digital technologies. With the increasing use of smartphones and computers, children are increasingly exposed to digital environment from an early age. For children in elementary and primary school age, providing education through digital games can be beneficial for cognitive development, academic success, and the promotion of higherorder thinking skills, all while maintaining child engagement and motivation. This article aims to provide a systematic narrative review of recent literature, including foundational works, on digital game-based learning(DGBL) and entertainment for children aged 4-12 years. This article specifically looks at two age ranges for elementary and primary school children focusing on learning outcomes, the development of computational thinking skills, creativity, problem-solving abilities and health considerations. This article shows that DGBL has moderate to large positive effects on children's cognitive thinking, academic success, and problem-solving skills. At the same time, DGBL can be detrimental to children's well-being if poorly designed, excessively used, or lacks proper educational structure. This article aims to identify the gaps in the current literature and propose possible directions to design and conduct DGBL that is healthy and effective for children's education.

Keywords: Computational thinking, Cognitive development, Digital game-based learning(DGBL), educational games, Primary education

A Systematic Review of Digital Systems for Upper-Limb Physiotherapy Assessment

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Abstract

Upper-limb physiotherapy assessment relies on accurate and consistent documentation of clinical parameters such as range of motion (ROM), functional performance, and patient history. However, in many clinical settings, assessment data are still documented manually or stored across different digital tools without a unified system. This limits clinical integration, data reuse, and long-term patient monitoring. To support physiotherapy assessment, various digital health technologies have been developed, including smartphone-based applications, wearable sensor systems, telerehabilitation platforms, and electronic health record (EHR) solutions. These technologies are often implemented as isolated systems, even though they address different aspects of physiotherapy assessment such as measurement through smartphone applications, motion analysis using wearable sensors, remote monitoring through telerehabilitation, and data management using EHR systems.

This study presents a systematic review that examines and integrates evidence on digital systems for upper-limb physiotherapy assessment. The review aims to identify and analyze existing systems, focusing on the types of assessment data captured, validation approaches, and the level of integration with clinical workflows and EHR systems. In addition, the review identifies research gaps and limitations in current solutions to guide future system design.

The analysis shows that although many digital tools can measure individual parameters such as ROM with moderate to high agreement compared to conventional measurement methods, most systems remain limited to isolated functions. They often lack integration with patient demographics, clinical workflows, and centralized documentation, which reduces their clinical usability. Furthermore, limited attention has been given to structured data storage and interoperability with existing EHR systems. Recent trends indicate a movement toward integrated and interoperable platforms that support multimodal data capture and advanced digital health technologies. This review highlights important research gaps and emphasizes the need for integrated digital solutions capable of supporting complete, structured, and clinically reusable upper-limb physiotherapy assessment data.

Keywords: Digital Health, Physiotherapy, Physiotherapy Assessment, Physiotherapy ROM Measurements, Range of Motion, Telerehabilitation, Upper-limb Rehabilitation, Wearable Sensors

Systematic Review of AI-Based Personalized Diet and Activity Recommendation System for Diabetic Individuals

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Abstract

Diabetes is a significant and growing public health problem not only globally but also in Sri Lanka. Sri Lanka has very traditional dietary practices and limited access to personalized management tools to understand this problem. This systematic review focuses on AI-based personalized diet and activity recommendation systems for diabetic patients in Sri Lanka, with a focus on technologies adaptable to environments like Sri Lanka. Using PRISMA guidelines, we analyzed 38 studies (2014–2025) across some domains. AI-driven food recognition, portion estimation, wearable sensor-based health monitoring, glucose prediction, digital twin modeling, and federated learning. Results show us that wearable sensors and predictive analytics give the ability to continuously monitor glucose and forecast, while deep learning models (CNNs and vision transformers) and augmented reality (AR) have a great capacity for precise food recognition and portion estimation. New technologies, such as digital twins and federated learning, make it easy to give nutrition advice that is very personal and confidential. There are, however, significant research gaps in the recognition of meals and patterns that are specific to certain cultures (such as Sri Lankan dishes). Current portion estimation tools are not adapted to local tableware or traditional eating practices. Our review shows that an integrated AI system combining multiple modalities could significantly improve diabetes management by delivering culturally adapted recommendations. For practical implementation in Sri Lanka and similar environments, this review shows culturally adapted food recognition datasets for South Asian cuisines, privacy-preserving federated learning architectures suitable for multi-institutional healthcare networks, and accessible, user-centered system design accounting for digital literacy and local healthcare infrastructure. This review shows us a proper roadmap for developing evidence-based AI systems that address real-world problems to better diabetes care in resource-constrained regions, ultimately supporting improved glycemic control and health outcomes.

Keywords: Calorie Intake Estimation, Digital Twin with federated learning, Food Recognition, Glucose Level Estimation, Portion Size Estimation, Wearable Sensor-Based Monitoring

A Systematic Review of Integrating Explainable AI and Deep Learning for Enhanced Anomaly Detection and Forecasting in Sri Lanka CEB Smart Grid Systems

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Abstract

Accurate anomaly detection is necessary to reduce energy theft, technical losses, and cyberattacks in modern smart grids, especially for Sri Lanka Ceylon Electricity Board (CEB), which faces frequent load shedding and topology changes. This systematic review analyzes 20 research studies (2019-2025) that evaluate deep learning architectures related to time-series anomaly detection, including Long Short-Term Memory (LSTM) Autoencoders, Convolutional Neural Network Long Short-Term Memory (CNN-LSTM) hybrids, XGBoost, and Transformers. Across all studies, models achieved Area Under the Receiver Operating Characteristic Curve (AUROC) values between 0.89-0.96. While LSTM autoencoders perform well in capturing temporal dependencies in electricity consumption, the CNN-LSTM architectures can better extract spatial-temporal features from household and substation data. Research conducted at CEB shows that LSTM models forecast district-level loads with a 2.8% Mean Absolute Percentage Error (MAPE), outperforming traditional statistical methods. However, these models' "black box" nature affects operator trust in critical grid decisions. Explainable AI (XAI) approaches such as Local Interpretable Model-agnostic Explanations (LIME) provide localized explanations, highlighting key features (hour of the day, tariff rate) influencing predictions. Federated Learning is used to maintain substation-level privacy without centralizing data and Streamlit dashboards allow real-time deployment for residential and industrial users. However, gaps remain including lack of district level XAI frameworks, models struggling to adapt during topology changes, load shedding causing false positives and high computational cost from Kernel Shapley Additive Explanations (KernelSHAP). Future research should focus on LSTM-SHAP hybrids that incorporate grid topology physics from GridCAL, optimized Federated Learning, district-specific CEB dashboards, and the development of publicly available datasets covering the post-2022 Sri Lankan energy crisis. This review proposes to create a framework for understanding smart grid anomaly detection methods, identify LSTM-SHAP dashboards as the best approach to improve grid resilience, and assist CEB in performing district-wide anomaly detection.

Keywords: Anomaly Detection, LSTM, SHAP, Smart Grid, Sri Lanka CEB

Artificial Intelligence Techniques in Fitness, Wellness, and Rest Management Systems for University Students: A Systematic Review

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Abstract

The use of artificial intelligence (AI) in digital health systems is rapidly increasing for the improvement of fitness, wellness, and rest management among university students. Many university students are challenged by sedentary lifestyles due to academic pressures and have irregular sleep patterns. This paper provides a systematic review of Artificial Intelligence based fitness, wellness, and rest management systems for university students. Studies were included based on the systematic review method using literature published between 2015 and 2025 from key academic databases, resulting in a total of 23 papers being identified that met the inclusion criteria. The systematic review will evaluate how past work has utilized AI techniques, identified data sources, provided functionality and evaluated the use of AI systems. Ultimately, findings from this review suggest that AI-based systems provide superior personalization and adaptability than traditional rule-based systems; however, most AI-based systems evaluated within this review have remained fragmented, with separate applications for fitness, wellness, and rest. Limitations identified from previous studies included small datasets, short-term evaluation periods, a heavy reliance on self-reported data, no standardized assessment metrics and insufficient attention to privacy and ethical issues. Due to these limitations the generalizability of current AI systems is limited and therefore current AI systems cannot be effectively applied to real life situations. Based on the findings from this review it is evident that a need exists for the development of integrated, adaptive, ethically designed AI systems that adopt a holistic, student-centered approach for promoting lifelong physical and mental health and well-being.

Keywords: Artificial Intelligence, Fitness Recommendation Systems, University Students, Wellness Management, Rest and Sleep Monitoring

A Review of AI-Based Image Measurement and Scene Understanding Techniques for AR-Based Interior Visualization

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Abstract

An accurate understanding of indoor scenes is necessary for applications in interior design, construction inspection, and augmented reality-based visualization. Due to advancements in computer vision, ordinary consumer-grade cameras can also be used to do many things, ranging from indoor measurements to depth estimation to scene understanding. However, the current research being done on these topics is scattered into different research directions: image-based measurement, depth estimation, layout understanding, and AR visualization. This fragmentation makes it difficult to understand how they incorporate with each other and where their limitations lie. The review presents a structured overview of recent vision-based approaches applicable to indoor settings. Papers published within the 2017-2025 timeframe have been collected from digital databases, and based on pre-defined inclusion and exclusion criteria, 25 of those were finalized for this review. The paper examines image-based indoor measurement methods, followed by metric depth estimation approaches, indoor layout understanding, and AR-based interior visualization systems. The results show that image-based measurement provides an affordable method, but accuracy depends on reference objects and the quality of images. Depth estimation methods have improved in terms of scale prediction but are still affected by occlusions, variations in lighting, and cameras. The layout estimation provides a more consistent structural understanding, especially for wall geometry, whereas AR systems enable the interactive visualization, but they face challenges in terms of accurate placement and realism. Overall, the study highlights the need for more integrated and lightweight approaches that combine depth, layout, and AR components for practical indoor visualization applications.

Keywords: Augmented Reality, Computer Vision for Indoor Environments, Image-Based Measurement, Indoor Layout Estimation, Metric Depth Estimation

Explainable Multi-Objective and Energy-Aware Sequence-Based Automated Refactoring in Open-Source Java: A Systematic Review

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Abstract

Refactoring, also known as code refactoring, is the process of improving existing software code without changing its external behavior. Automated refactoring has been recognized as a key concept for enhancing the maintainability, quality, and performance of software systems. Although recent research has explored multi-objective optimization and energy-aware refactoring, most existing approaches perform refactoring independently, providing limited transparency for developer decision-making. Runtime energy consumption has been identified as a neglected area in open-source and large-scale software environments, and only a few studies provide transparent explanations of refactoring effects.

The goal of this systematic review is to investigate different refactoring studies. The review examines 18 papers published between 2007 and 2025. These papers were collected from IEEE Xplore, ScienceDirect, ACM Digital Library, and Google Scholar. The findings indicate an increasing demand for sequence-aware, explainable, and multi-objective optimization-based refactoring approaches. The results show that approximately 13 out of 18 papers apply multi-objective optimization techniques, while around 12 studies consider sequence-aware refactoring. However, only 2 studies explicitly incorporate energy consumption as an optimization objective.

Furthermore, although several approaches provide basic forms of explainability, none offers a unified framework that integrates energy awareness, sequence optimization, and developer-centric explainability. The findings reveal several significant research gaps. First, the impact of refactoring sequences on energy consumption remains largely unexplored. Second, explainable mechanisms that assist developers in understanding trade-offs are still missing. Third, only a few studies integrate multiple objectives within a unified framework.

This review highlights important research gaps and provides directions for future work toward more advanced, energy-efficient, and developer-centric refactoring approaches for sustainable software development.

Keywords: Automated Refactoring, Energy-Aware, Explainable Decision Support, Multi-Objective Optimization, Sequence-Aware Refactoring

Advances in Topological Data Analysis for Biological Sequence Classification: Bridging Persistent Homology and Deep Learning

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Abstract

Biological sequence classification represents a critical problem in bioinformatics with applications in genomics, proteomics, and drug discovery efforts. Traditional alignment-based approaches, as well as recent deep learning methods, demonstrate considerable success. However, these approaches fail to capture the inherent geometric forms in biological sequences. Persistent homology provides a mathematically rigorous structure for Topological Data Analysis (TDA) by capturing multi-scale geometric structures. This review examines the development of Topological Data Analysis (TDA) methods for biological sequence classification with a total of 43 references published between 2010 and 2025. Throughout the review, three phases of evolution were identified; the establishment of computational topology and vectorization methods during 2014-2017, initial integration with machine learning (ML) for biomolecular applications during 2015-2020, and advanced deep learning integration from 2020 to 2025. The review presents a comprehensive comparison of different topological prediction methods and evaluates their respective strengths, limitations, and biological applicability. Furthermore, topological prediction methods are systematically compared with structural prediction approaches, including AlphaFold2 and ESMFold, demonstrating that these paradigms serve complementary rather than competing roles. Nevertheless, critical research gaps were determined; computational scalability limitations, the issue of sequence-to-topology representation, and a lack of theoretical understanding characterize topology-function relationships. In light of these important findings, future directions emphasize equivariant topological architectures, integration with biological foundation models, and multi-modal topological learning. The design of interpretable methods that enable topological feature attribution is an important future direction. The review provides researchers with an organized perspective and practical directions to guide the development of topological methodologies in biological sequence analysis.

Keywords: Biological Sequence Classification, Deep Learning, Machine learning, Persistent Homology, Protein Classification, Topological Data Analysis

Assessing the Industry Need for Autonomous Test Suite Evolution and Modular Architecture: A Survey

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Abstract

Good software quality depends on strong testing strategies. However, keeping automated tests up to date can become expensive and complicated. The rapid adoption of Large Language Models (LLMs) in Software Quality Assurance (SQA) has changed test automation in significant ways, but most tools still focus too much on creating test scripts rather than on keeping them working over time. As software changes, automated tests often break easily, which makes them hard to keep up with, and current LLM tools do not solve this problem well. This research looks at this important "Generation-Evolution Gap" by surveying 67 people in the industry, from manual testers to senior test architects. The study finds three key points that question how AI is being used now. First, it finds an "Experience Paradox," where senior architects have much more trouble maintaining tests than junior engineers, showing that the main problem is not writing new code but handling old, complex test sets. Second, the data show that people do not want unstructured AI-generated scripts; there is a strong need for "Structural Modularity," with professionals wanting AI tools that always follow established design rules, like the Page Object Model, to avoid future problems. Third, a clear "Trust Gap" shows that people do not trust fully automatic "Black Box" solutions, as most want a "Human-in-the-Loop" to check any self-fixing actions. These results show that simple code generators are not useful for big companies and instead show the need for an advanced framework with an architecture process and a Reviewing process that can manage test changes on its own while keeping the system well-organized and trusted by users. A multi-agent architectural approach can be proposed, with an agent to enforce design standards, an agent to detect requirements shifts, and an agent to maintain the Human-in-the-Loop process.

Keywords: Code Modularity, Large Language Models (LLMs), Self-Healing Tests, Software Test Automation, Test Maintenance

Coral Reef Health Monitoring Using Image Classification Techniques: A Systematic Review

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Abstract

Coral reefs can be viewed as the most diverse and complex ecosystems that provide habitats for various types of marine life forms, as well as offering various ecological and economic roles. However, they are now at risk due to the impacts of global warming, ocean warming, pollution, and diseases that cause coral bleaching. Coral reef monitoring techniques using manual observation from divers and visual interpretation are labor-intensive and expensive. In order to solve the aforementioned problems, some researchers have been conducting studies on the automated monitoring of coral reef health by means of image classification algorithms implemented through the help of machine learning and deep learning techniques. This study is based on a systematic review conducted following the PRISMA guidelines. In total, 28 articles from IEEE Xplore, Scopus, and Google Scholar databases have been considered between 2016 and 2025. This study concentrates on image classification methods that can be applied for coral reef health evaluation, including binary classification problems such as identifying healthy or bleached corals. Based on the research results, CNN-based models such as ResNet and EfficientNet lead in the field and usually attain classification accuracies surpassing 85%. The emergence of ViT models and hybrid CNN-ViT models has led to better results regarding classifying complicated underwater conditions. In addition, ensemble learning and image enhancement strategies have contributed to higher accuracy rates and robustness. Despite advancements in the research domain, there has been no application of XAI methods, highlighting a gap in the literature. Concluding, the adoption of deep learning for image classification is one of the remarkable achievements made in terms of monitoring the health status of coral reefs, which is where future research can be focused on.

Keywords: Coral Reef, Deep Learning, Explainable AI, Health Monitoring, Image Classification

A Review of AI-Driven Branch-Level Product Mix and Assortment Optimization for Retail Decision Support

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Abstract

The optimization of product mix and assortment at the retail branch level is becoming more and more a data-driven decision-making process with the help of artificial intelligence. However, the existing literature remains fragmented in the forecasting, optimization, and deployment perspectives. This study is a systematic literature review of peer-reviewed articles from major scholarly databases, published in 2020-2025, selected with the help of clear inclusion and exclusion criteria and then subjected to thematic synthesis. This paper gives a systematic taxonomy of forecasting, choice modeling, and optimization methods, and a review of evaluation practice and implementation trends. The predictive models of demand and sales estimation that are discussed in the review include classical time-series models, machine learning, and deep learning architectures. These models usually include pricing, promotions, seasonality, and local contextual factors. Assortment and product mix decisions in the prescriptive domain are mostly developed as constrained optimization problems. Popular solution methods include mixed-integer programming, robust and stochastic optimization, and heuristic or metaheuristic. Recent studies show that there is a growing interest in decision-oriented learning and reinforcement learning for adaptive decisions in evolving customer behavior. They indicate that there are improvements in the modeling of substitution and complement effects, scaling solutions in multiple branches and stock keeping units, and the integration of operational constraints such as shelf space, budget constraints, service-level objectives and replenishment policies. Despite these advances, major gaps remain, including inconsistent datasets and evaluation criteria, insufficient treatment of uncertainty and concept drift, simplistic constraint modeling, and over-reliance on offline metrics that are not always business outcomes. The results have practical implications on retail decision support systems and point to future research directions of constraint-aware, uncertainty-calibrated, interpretable, and real-time branch-level optimization frameworks.

Keywords: Assortment optimization, Decision support system, Artificial intelligence in retail

A Review of AI and NLP Approaches for Sinhala Speech and Text to Sinhala Sign Language Translation Using 3D Avatar Animation

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Abstract

Sign language translation technologies are used to improve the communication gap between deaf and hearing communities. There are more than 300 different sign languages in the world. Highly resourced sign languages such as American Sign Language (ASL) and British Sign Language (BSL) have achieved great progress, while low-resourced sign languages such as Sinhala Sign Language (SSL) have achieved limited progress. This paper presents a review of recent works on sign language translation systems, with a focus on Sinhala Sign Language and multimodal speech-to-sign and text-to-sign systems.

This review paper shows the analysis of 23 studies published between 2015 and 2025. They are collected from major academic databases including IEEE Xplore, ACM Digital Library, SpringerLink, and Google Scholar. It covers rule-based approaches, machine learning methods, deep learning methods and 3D avatar-based systems. The literature is categorized according to task type (recognition, translation, bidirectional systems), output type (text, video, GIF, 3D avatar), linguistic level (alphabet, word, sentence) and technologies (CNN, LSTM, transformer, multimodal). The presented analysis clearly points towards progress from rule-based systems, going through deep learning, to multimodal systems. It focuses specifically on continuous speech-to-sign language translation systems.

This paper addresses some critical gaps. It includes isolated sign recognition, dependence on small datasets, lack of grammar-aware sentence generation, and 3D avatar animation with facial expressions and lip movements. Only a few systems attempt true sentence-level translation with proper linguistic modelling and multimodal inputs.

Based on these findings, there is a need to develop a mobile-based Sinhala speech-to-sign and text-to-sign translation system with linguistically correct sentence generation, along with real 3D avatar animation. These insights give a clear path for future research and make a unique contribution to the field by addressing a gap between existing technological approaches and the practical needs of Sinhala sign language users.

Keywords: 3D Avatar Animation, Deep Learning, Multimodal Translation, Natural Language Processing, Sign Language Translation, Sinhala Sign Language.

Towards Efficient Long Context Transformers: A Survey of alternative attention mechanisms

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Abstract

Important element of Transformer architectures is the self attention mechanism, which allows for flexible modeling of long range dependencies in a variety of sequence modeling applications. However as models expand to longer contexts and larger deployments a fundamental restriction arises due to the quadratic time and memory complexity of typical softmax attention. This problem has caused a rapidly expanding amount of research on alternate attention mechanisms that seek to increase efficiency while maintaining the expressive power. We present an organized summary of recent developments in effective attention mechanisms in this review. We classify the literature into a logical taxonomy that includes sparse attention mechanisms (like block-sparse and hash-based designs), state space models, hybrid architectures that integrate several paradigms into a single model and linear attention techniques (like kernel-based, low-rank, and gated recurrent formulations).

Our analysis shows that these approaches frequently result in trade offs between efficiency and model performance, with sparse methods heavily rely on predefined attention patterns and linear attention suffering from accuracy reduction. Additionally, hybrid architectures which combine complementary attention mechanisms represent a promising direction for future research. Instead of viewing these methods as distinct approaches, we draw attention to their common abstractions and underlying presumptions.

Keywords: Deep Learning, Transformers, Self attention, Sparse attention, Linear attention

A Review of Deep Reinforcement Learning Approaches for Intelligent Traffic Signal Control with Applications to Sri Lankan Traffic Conditions

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Abstract

Traffic congestion is an important issue that affects the contemporary cities, especially in developing world whose traffic conditions are very dynamic and heterogeneous. Traditional methods of traffic signal control e.g. fixed-time and actuated control are not flexible and usually they are not able to act responsively to real-time changes in the traffic. Over the recent years, deep reinforcement learning (DRL) has been proposed as a promising data-driven method of intelligent traffic signal control by allowing adaptive decision-making with the continuous interaction of the traffic environment. This paper presents a method-based review of DRL approaches in intelligent traffic signal control with specific reference to its applicability to the context of the traffic in Sri Lanka. The review critically examines the current approaches to DRL-based techniques, such as single-agent and multi-agent models, state and reward design methods, scalable learning systems, and advanced reinforcement learning models such as meta-reinforcement learning and multi-objective optimization. These approaches are typically experimented with the assistance of traffic simulation applications such as SUMO that enable one to model complex and mixed traffic. The advantages and disadvantages of these methods along with their trade-offs are compared to find out which are more effective in coordination, scalability and robustness. The review shows that the transition of isolated single-agent models to coordinated multi-agent systems is evident, as they enhance network-level performance, yet raise some issues like non-stationarity and communication overhead. Moreover, the review establishes severe research gaps concerning the assumption of simulations, the limited generalization to mixed traffic situations, and the high reliance on state and reward formulations manual. The results suggest the importance of having scalable, robust, and adaptive DRL-based traffic signal systems that can be deployed in real-world conditions. The learning of this paper forms a basis of coming up with effective DRL solutions that are specific to the resource and complex setting of urban traffic.

Keywords: Deep Reinforcement Learning, Intelligent Transportation Systems, Multi Agent Reinforcement Learning, Smart Cities, Traffic Signal Control

A Survey-Based Analysis of Video Gaming Addiction and Its Impact Among IT Undergraduates in Sri Lanka

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Abstract

Excessive video gaming has become increasingly common among university students, and this has raised concerns about its potential effects on their academic, mental, and social well-being. The present research aims to examine the phenomenon of gaming addiction among undergraduate IT students at the University of Sri Jayewardenepura using survey analysis and examine video game-related behaviors and their effects from a multidimensional perspective. The data were collected using an online survey that consisted of questions on demographic information, video game duration, emotional effects, social effects, sleep impacts, and attitudes toward controlling their video game habits. Since the issue of gaming addiction involves many dimensions, the research was not limited to one type of behavior, and three dimensions of video game addiction, such as behavioral addiction, emotional addiction, and social addiction, were constructed using five items each, with five-point Likert scales. The results showed that the level of video game addiction was found to be moderate in all three dimensions. Behavioral addiction was found to have a positive and significant correlation with video game duration on both weekdays and weekends, indicating that the longer the video game duration, the higher the level of behavioral addiction. Emotional addiction was found to have a significant association with sleep disturbances, indicating that video game addiction may affect the sleep patterns of students. The level of social addiction was found to increase with the frequency of complaints from family members or social groups, indicating that video game addiction has social effects on students. However, no significant association was found between students' willingness to control their video game habits and video game addiction levels, indicating that students, irrespective of their level of video game addiction, tend to show a favorable attitude toward controlling their video game habits.

Keywords: Behavioral addiction, Emotional addiction, Gaming addiction, Social addiction, Survey-based analysis

A Comprehensive Review of Predictive Horizontal Pod Autoscaling Driven by Mathematical Workload Patterns

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Abstract

Predictive Horizontal Pod Autoscaling (PHPA) has emerged as an effective solution for mitigating the limitations of reactive resource management in cloud environments. Traditional Kubernetes Horizontal Pod Autoscaler mechanisms depend on current resource utilization which often leads to delayed responses to changes in workload and performance degradation. Recent studies have proposed predictive and learning-based autoscaling approaches that allow proactive resource provisioning to address these limitations. This review offers a comprehensive analysis of existing PHPA, focusing on prediction techniques, scaling strategies, deployment platforms, datasets and evaluation methodologies. The paper systematically examines statistical, machine learning, deep learning, and reinforcement learning models, including AutoRegressive Integrated Moving Average (ARIMA), Long Short-Term Memory (LSTM), regression, graph neural networks, and Proximal Policy Optimization (PPO). In addition, reactive, proactive, hybrid and learning-based scaling mechanisms are compared with respect to their adaptability, efficiency, and practical applicability. The review also analyses the impact of dataset quality, experimental settings, and evaluation metrics on reported performance. The analysis reveals that deep learning and reinforcement learning approaches achieve high prediction accuracy and enable adaptive control, but they often introduce significant computational complexity and deployment challenges. Comparatively, lightweight statistical and machine learning models offer greater efficiency but perform poorly under highly dynamic workloads. Moreover, most studies rely on controlled testbeds and benchmark datasets, which lack real workload behaviour. Finally, this review shows key research gaps and outlines future directions toward developing scalable, lightweight predictive autoscaling solutions suitable for diverse and resource-constrained environments.

Keywords: Horizontal Pod Autoscaling, Predictive Horizontal Pod Autoscaling, Workload Prediction, Time Series Forecasting

A Review On Cost Prediction And Visualization For Kubernetes Resource Management

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Abstract

Kubernetes has emerged as the primary orchestration platform for managing containerized applications in cloud native environments. However, its dynamic and diverse nature presents significant challenges for efficient resource management and cost control. Traditional approaches often result in resource overallocation, delayed responses to workload changes, and increased operational costs. In response, a growing body of reviews has explored optimization and prediction techniques to improve cost efficiency and resource Consumption in Kubernetes clusters. This paper presents a review and comparative analysis of 25 selected studies focusing on Kubernetes cost prediction and resource management. The literature is analysed thematically across four key domains: swarm intelligence-based optimisation techniques, Kubernetes resource and cost management layers, cost optimization and prediction approaches, and evaluation practices. The review highlights how swarm intelligence algorithms optimize, while machine learning based models allow proactive cost and workload prediction. Nevertheless, existing approaches are mostly fragmented, often handling optimization, prediction, or visualization in isolation and lack support for integrated visualization and long-term cost analysis in Kubernetes environments. Based on the identified trends and gaps, this review emphasizes the need for a solid Kubernetes framework for cost-effective resource management.

Keywords: Kubernetes cost optimization, Kubernetes resource management, Swarm intelligence, Cloud native optimization, Cost prediction

Separating Vocal Suitability from Singing Difficulty: A Two-Stage Machine Learning Approach

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Abstract

The latest developments in the field of machine learning (ML) have enabled automated evaluation of singing performance in music education. These methods overcome the shortcomings of subjective and inefficient traditional assessments. However, current methods often fail to distinguish two fundamentally different concepts: vocal suitability (physiological safety and feasibility) and perceived singing difficulty (subjective performance challenge), which result in unsafe and misleading outcomes in individualized vocal training.

This review examines 23 peer-reviewed studies (2015–2025) from IEEE Xplore, ACM Digital Library, SpringerLink, and ScienceDirect. The studies are grouped into perceptual-acoustic methods, classical ML approaches (Support Vector Machines, k-Nearest Neighbors, XGBoost), and deep learning models (Convolutional and Recurrent Neural Networks). Each study is analyzed based on methodology, performance, applicability, and treatment of vocal suitability and perceived singing difficulty.

Perceptual-acoustic studies provide a baseline showing moderate relationships between acoustic features and perceptual ratings ($r = 0.72$). Classical ML approaches are more interpretable and effective for safety-related evaluations, achieving 82–89% accuracy in activities such as singing-quality assessment, strain detection, and vocal-mode recognition. Deep learning methods exhibit predictive accuracy exceeding 90% and demonstrate strong correlation with expert scoring ($r = 0.91$) in reference-free singing difficulty assessment. However, this improvement, reduces interpretability, increases data dependency, and bias toward Western musical datasets. These findings show that existing methods focus on either interpretability or predictive accuracy, but do not consider vocal safety and perceived difficulty within a single framework.

To overcome this drawback, this review proposes a two-stage ML-based framework for singing evaluation and recommendation. The first stage filters unsafe songs using biomechanical constraints such as vocal range, tessitura, and phonation limits. The second phase predicts individualized singing difficulty based on singer-specific features and the acoustic characteristics of songs. This work provides a foundation for developing safe, interpretable, and personalized systems for singing assessment and recommendation.

Keywords: Machine Learning, Music Information Retrieval, Perceived Singing Difficulty, Singing Assessment, Vocal Suitability

Bridging the Trust-Resilience Gap in Autonomous Network Security: A Systematic Review of XAI, MTD, and Emerging Quantum-Adversarial Threats

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Abstract

The development of autonomous network security has introduced a trust–resilience gap, where AI-driven decisions lack transparency, while existing defenses are no longer sufficient against adaptive adversaries. This paper presents a systematic review of three key pillars required to bridge this gap: Explainable Artificial Intelligence (XAI), Moving Target Defense (MTD), and emerging quantum-adversarial threats. Using the PRISMA methodology and PICOC framework, the study synthesizes findings from recent literature to address four research questions covering explainability, resilience effectiveness, quantum threat models, and governance challenges. The review shows that XAI techniques, such as SHAP (SHapley Additive exPlanations) and LIME (Local Interpretable Model-agnostic Explanations), are essential for transforming opaque Intrusion Detection Systems (IDS) into a more transparent system. In addition, interpretable models like the Enterprise Threat Detection Explainer (ETDE) can explain how subgraphs illustrate complex alert sequences during cloud-network integration. However, trust alone is not effective without resilience. MTD mechanisms, including dynamic IP shuffling and replica-based path activation, introduce resilience by proactively disrupting the reconnaissance phase of the cyber kill chain. Despite their promise, many MTD implementations exhibit static behavior and are vulnerable to hyperparameter leakage, allowing attackers to predict system changes. Furthermore, the emergence of Quantum Machine Learning introduces new attack surfaces, including hardware-level side channels and circuit-level backdoors. This paper highlights the need for a unified threat-modeling approach that accounts for both physical hardware vulnerabilities and algorithmic manipulation. This review identifies key research gaps, including the lack of standardized evaluation metrics for XAI, limited real-world validation of MTD strategies, fragmented quantum security research, and insufficient legal and ethical frameworks. Overall, the study proposes a multi-stage, integrated defense paradigm that combines explainability, adaptive resilience, and quantum-aware security to support trustworthy autonomous network environments.

Keywords: Autonomous Network Security, Explainable AI, Moving Target Defence, Quantum Machine Learning, Cybersecurity

AI-Powered Chatbots for Mental Health Support: A Systematic Review

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Abstract

Globally, the prevalence of mental health conditions is rising, making it one of the most significant issues facing healthcare in the 21st century. These mental illnesses have effects that endure a person's entire life, requiring constant care from both patients and medical professionals. So then, AI-powered chatbots are increasingly being studied as digital mental health systems because they may improve access to psychological support through scalable, anonymous, and ongoing conversations. This review aims to analyze, classify, and compare existing research on AI-powered chatbots for mental health support. It looks at their effectiveness, limitations, and unresolved research gaps. A PRISMA-inspired review method was used to find relevant studies published from 2015 to 2025 in primary healthcare and computational databases. After reviewing 45 records, 27 studies were selected for qualitative synthesis based on their predefined inclusion and exclusion criteria and their relevance, methodological clarity, and focus on AI-powered chatbots for mental health support. The findings indicate that cognitive-behavioral therapy (CBT)-based chatbots demonstrate the strongest evidence for reducing anxiety and depression symptoms, while large language model (LLM)-based systems achieve higher user engagement but raise significant ethical and safety concerns. Common outcome measures include PHQ-9, GAD-7, user engagement, and retention rates. Despite promising results, limitations such as short-term evaluations, lack of clinical validation, and ethical challenges persist. This review contributes by providing a structured comparison of chatbot approaches and highlighting the need for long-term clinical studies, improved safety frameworks, and ethical integration into healthcare systems.

Keywords: AI-powered chatbot, conversational agent, mental health, depression, anxiety, CBT, large language models

A Comprehensive Systematic Review of Sensor-Based Technologies and Analytical Approaches Used for Early Detection and Risk Assessment of Diabetic Foot Complications.

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Abstract

Diabetic foot issues are a significant therapeutic challenge in the management of diabetes since they can lead to ulceration, infection, and lower limb amputation if not detected early. Key diabetic foot risk indicators may now be continuously and non-invasively monitored thanks to recent developments in wearable and sensor based technology. Forty peer-reviewed journal publications and conference papers from Google Scholar, IEEE Xplore, Scopus, ScienceDirect, and PubMed were examined in this systematic review. Based on monitored parameters, sensing technologies, analytical techniques, and system design features, the reviewed research were categorized. While moisture-based monitoring is still underutilized in wearable diabetic foot monitoring systems despite its clinical relevance for preserving skin integrity and lowering infection risk, the review findings show that plantar pressure and foot temperature monitoring are the most thoroughly studied methods for early risk detection. By combining many physiological and biomechanical indications, multi-sensor and hybrid monitoring systems show enhanced risk assessment capabilities; nonetheless, issues with sensor dependability, data integration, and extensive clinical validation still exist. In order to improve early risk diagnosis and preventative management, this review identifies important research gaps and emphasizes the necessity of comprehensive, multi-parameter diabetic foot monitoring systems backed by sophisticated data analytics and useful clinical validation.

Keywords: Diabetic foot complications, sensor-based monitoring systems, plantar pressure analysis, foot temperature monitoring, multi-parameter risk detection.

AI-Based Personalized Sinhala Font Generation from Handwriting Samples

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Abstract

The Sinhala script poses exceptional problems to digital processing with complex character structures, compound glyphs, and visual resemblance between letters. Current studies on Sinhala text processing have primarily been dedicated to Optical Character Recognition, through rule-based, statistical, and deep learning-based methods. Although the recent CNN-based methods are especially more accurate in recognition, by learning features directly from image content. These systems still rely on proper character segmentation and are not applicable to any other task. Generation of font and personalization, necessary to maintain consistency of style and expression of culture, has obtained relatively little discussion in Sinhala language studies. Recent solutions in Generative Adversarial Networks (GANs) have shown to yield promising results in automated font generation of complex scripts, including Chinese and Korean, where the entire font can be generated using only a few examples. Glyph consistency and readability have been further enhanced by component-guided and structure-preserving GAN architectures. Such generative methods are, however, not well explored when applied to the Sinhalese script, especially in the creation of fonts using handwriting. The literature review will examine the current literature on Sinhala OCR, low-resource script deep learning, and font generation methods based on GAN. By means of comparative analysis, important limitations and gaps in the research are determined, including the lack of data, the reliance on segmentation, and a lack of Sinhala-specific generative frameworks. The review highlights the necessity of having a deep learning based system that end to-end, learn the Sinhalese handwriting style with limited data to generate fonts on a large scale with scalability and without human intervention.

Keywords: Deep Learning, Generative Adversarial Networks (GANs), Optical Character Recognition (OCR), Sinhala Font Generation, Typeface Generation

A Review of Visual Speech Recognition Models and Their Applicability to the Sinhala Language

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Abstract

Visual Speech Recognition (VSR) also known as lip reading is a branch of speech recognition where speech is recognized without any audio information. This is particularly important in cases where audio information is poor, such as in noisy conditions, silent speech, whispering, analyzing CCTV videos, and also in speech and hearing impaired individuals.

Recently, Visual Speech Recognition has been growing exponentially, riding on the deep learning bandwagon, which allows end-to-end learning of spatiotemporal patterns directly from videos, primarily focusing on visual features. However, the performance of Visual Speech Recognition has been varying across languages. Although most well-resourced languages have benefited significantly from this area, low resourced languages are yet to be explored. Among these, Sinhala, being an official and national language of Sri Lanka, has yet to find any proper place in Visual Speech Recognition with no proper visual data and research conducted on it.

This review paper analyzes the existing visual and audio-visual recognition models, with a focus on the existing models of deep learning, CNN-RNN, Transformer, Conformer, robust models, datasets, and transfer learning. The paper will also explore the feasibility of using the existing VSR models for the Sinhala language by synthesizing the results of different research articles on speech recognition for the Sinhala language.

The review concludes that, although the existing models have a sound technical base, there is a need to focus on the development of the dataset and language models for effective visual speech recognition in the Sinhala language.

Keywords: Deep Learning, Lip Reading, Low-Resource Languages, Visual Speech Recognition, Sinhala Language

Narrative Review of Communication-Efficient TinyML for Distributed IoT Edge Devices

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Abstract

The rapid growth of Internet of Things (IoT) devices has contributed to the rise of Tiny Machine Learning (TinyML), where learning is performed directly on resource-limited microcontroller (MCU)-based hardware. Distributed approaches such as Federated Learning (FL) allow multiple devices to train shared models without exchanging raw data. However, directly applying these methods to TinyML environments at the MCU scale remains challenging due to strict limitations in memory, energy, and connectivity. In many IoT systems, communication tends to consume more energy than local computation, making it a major bottleneck when applying FL to TinyML devices. Most existing FL frameworks were originally developed for mobile or edge systems with relatively higher resources. As a result, they are not well suited to microcontroller-based environments with intermittent connectivity and limited bandwidth.

This paper reviews communication-efficient distributed learning techniques for TinyML devices, focusing on reducing communication overhead while maintaining model performance. It also explores methods such as sparse updates, model compression, and meta-learning. Several practical challenges are also discussed, including limited memory capacity, unstable network conditions, device heterogeneity, and non-IID data distributions. Additionally, it shows that FL protocols designed for mobile systems often do not adapt well to the constraints of IoT edge devices. The study also points to the gap between theoretical FL models and their practical use in TinyML systems. Based on these observations, several research directions are suggested, including adaptive communication strategies, improved model personalization, and energy-aware aggregation for resource-constrained environments.

Keywords: TinyML, Communication Efficiency, IoT, Distributed Learning

A Review of Neuro-Symbolic AI Integration: Combining Large Language Models and Answer Set Programming for Goal-Driven Conversational Agents

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Abstract

The current systematic review seeks to examine the integration of connectionist and symbolic approaches in Artificial Intelligence, with special focus on the integration of Large Language Models (LLMs) and Answer Set Programming (ASP). LLMs have been seen to exhibit impressive capabilities in natural language understanding, generation, and semantic generalization, among other capabilities. However, LLMs have been seen to have some weaknesses, such as hallucinations, probabilistic inconsistency, lack of formal guarantees, and no explicit reasoning. ASP, on the other hand, has been seen to exhibit impressive capabilities in mathematically based declarative programming, capable of accurate and transparent reasoning but lacking linguistic flexibility and responsiveness to open-ended and noisy information found in the real world. In an attempt to mitigate these weaknesses of LLMs and ASP, the current systematic review will seek to conduct a thorough survey of peer-reviewed research articles that exhibit integration in LLMs and ASP. These approaches will then be compared and evaluated based on their ability to solve different application scenarios, such as automated service composition, medical decision making, and robotic task planning. From these results, it is clear that it is possible to hybridize probabilistic language models and symbolic reasoning systems significantly to reduce neural hallucinations and solve constraint satisfaction problems, as well as alleviating the knowledge engineering problem associated with logic-based systems. In addition, their ability to generate causal proofs and internalize logical consistency during training has also been demonstrated. Future Research Directions: Some of the future research directions include the development of automatic natural language specification transformation into ASP logic, as well as scalability and exploitation of justification tools of ASP for explainable, verifiable, and safe AI systems.

Keywords: Neuro-Symbolic AI, Large Language Models, Answer Set Programming, Conversational Agents, Goal-Driven AI

A Review of Data-Driven Sinhala Grammatical Error Correction: Corpora, Models, and Low-Resource Strategies

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Abstract

Grammatical Error Correction(GEC) has improved for high-resource languages, but Sinhala is considered a low-resource language despite its usage as the primary language in Sri Lanka, because of the lack of annotated data and tools, together with inherent linguistic difficulties, including rich morphology, productive compounding, flexible word order, diglossia between spoken and written forms. To identify what is currently possible for Sinhala GEC and which design choices are effective, we provide a review of 44 studies on Sinhala-based correction, multilingual/low resource GEC, synthetic data generation, identified via SemanticScholar and ResearchRabbit. This review uniquely synthesizes insights across Sinhala-specific and multilingual GEC research to propose a practical, literature-informed design roadmap for Sinhala GEC systems. Our synthesis yields 4 key findings: i) corpus construction needs clear annotation guidelines, a defined target register and a minimal-edit policy, and can be accelerated via model-assisted pre-correction followed by human verification; ii) under limited supervision, both multilingual Sequence-to-Sequence(seq2seq) Transformer models and tag-and-edit approaches are feasible, with pre-trained multilingual encoder-decoders improving as more supervision becomes available while edit-based methods provide efficient baselines; iii) synthetic data is essential for scaling/training, but naïve noise risks distribution shift, controllable/tagged corruption, Mask-Translate and Fill (MTF)-style generation, and confusion-set synthesis are preferable; iv) evaluation for Sinhala should reflect multiple valid corrections, avoid overcorrection by combining reference-based metrics with do-no-harm checks and targeted human judgments of fluency and meaning preservation. We conclude that an effective roadmap for Sinhala GEC is a staged pipeline-normalization for noisy or mixed-script input, synthetic pretraining, fine-tuning on a gold dataset, and conservative decoding-paired with public release of corpora, preprocessing tools, and guidelines, while key problems remain in Sinhala-specific error taxonomies and robust evaluation under limited references.

Keywords: Grammatical Error Correction, Sinhala, Low Resource, NLP, Transformers, Synthetic Data

From Sentiment Polarity to Context-Aware Emotion Detection for Sinhala Text: An Integrative Review of Models, Corpora, and Research Gaps

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Abstract

Advances in emotion detection have shifted away from traditional sentiment polarity classification and enable more fine-grained modeling of human affect in text. However, this transition has presented significant challenges for Sinhala, a morphologically complex and low-resource Indo-Aryan language with an approximate population base of 17 million. The purpose of this study was to conduct a narrative literature review using an integrative synthesis approach to review 31 studies on affective computing for Sinhala across lexicon-based, machine learning, deep learning, and transformer-based models to assess how the field has progressed from sentiment analysis to emotion detection. Even though there have been many advances in methodology, most of the research on affective computing for Sinhala continues to be focused on either binary or ternary sentiment polarity classification rather than discrete or multi-label emotion detection. Additionally, the review found that there are no existing Sinhala-focused studies on emotion intensity prediction, little consideration of contextual and conversational aspects, and limitations in handling both code-mixed and Romanized Sinhala (Singlish) text. Finally, current evaluation methods continue to be out of alignment with international emotion detection benchmarks, therefore, limiting the ability to compare and contrast to state-of-the-art approaches. Based on the conclusions derived from the findings of the review, the primary barrier to develop an advanced emotion detection system for Sinhala is not model capacity, but task formulation, dataset limitations, and benchmark misalignments. Addressing these gaps requires benchmarked datasets, multi-label and intensity-aware modeling, and context-sensitive approaches for Sinhala. This review contributes a structured synthesis of the field's progression and a consolidated gap analysis to guide future Sinhala emotion detection research.

Keywords: Emotion detection, Sinhala NLP, Low-resource languages, Multi-label classification, Affective computing

Deep Learning-Based Object Detection for Sri Lankan Expressways

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Abstract

The rapid expansion of Sri Lanka's expressway network has created a growing demand for automated traffic surveillance systems to replace manual monitoring, which is labor-intensive, error-prone, and inefficient. However, deploying global deep learning-based object detection models in this context presents challenges due to domain-specific constraints such as environmental conditions (e.g., tropical rain and nighttime glare), limited edge-computing resources, and variations in vehicle characteristics relevant to expressway enforcement. This study presents a systematic review and comparative analysis of deep learning-based object detection and tracking techniques for intelligent expressway traffic monitoring. A structured benchmarking of twenty peer-reviewed studies published between 2019 and 2025 was conducted, evaluating single-stage detectors and transformer-based models using performance metrics including detection accuracy, inference speed, and robustness under adverse conditions. Standard datasets such as UA-DETRAC and ACDC were used to assess environmental performance. The results indicate that Scaled-YOLOv4 and Improved YOLOv5s provide an optimal balance between accuracy and real-time inference suitable for edge deployment, while Deformable DETR demonstrates superior performance in detecting small and distant vehicles. However, performance degradation was consistently observed under nighttime and rainy conditions, similar to findings reported in other low- and middle-income country contexts. The study highlights key research gaps, including limited robustness in adverse environments, challenges in accurate speed estimation, and constraints imposed by local infrastructure. Addressing these issues through hybrid model architectures and synthetic data generation can significantly enhance the scalability and reliability of intelligent transportation systems for Sri Lankan expressways.

Keywords: Deep Learning, Deformable DETR, Expressway Traffic Monitoring, Heterogeneous Traffic, Object Detection, You Only Look Once

Machine Learning Paradigms for Multi-Scale Polymer Property Prediction: A Systematic Review

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Abstract

Polymer forecasting has been dependent on the prediction of polymer properties on computationally expensive Density Functional Theory (DFT) calculations and empirical correlations, restraining high throughput material discovery. The new trends in machine learning have made it possible to use data-directed methods that are capable of obtaining the complex structure-property correlation directly through molecular representations, covering novel prospects in designing and analysing polymers. This systematic review synthesizes the current landscape of ML methodologies for polymer property prediction and bond analysis, including supervised learning, deep learning, graph neural networks, and generative models. A comprehensive literature search has been conducted across multiple databases and identified relevant studies published after 2015. The reviewed works are analyzed in terms of learning paradigms, molecular representations, interpretability strategies and target properties. Our analysis highlights the increasing dominance of graph-based architectures, especially Graph Convolutional Neural Networks (GCNN) and Message-Passing Neural Networks (MPNN), which are explicitly capable of modeling covalent bonding and molecular connectivity. Current studies are frequently constrained by limited and biased datasets, with a strong focus on synthetic polymers and comparatively few investigations of natural polymers. Moreover, many existing models remain largely correlational, incorporating limited physics-informed constraints or some causal reasoning. The absence of standard benchmarks and unified polymer data further makes fair model comparison difficult. Future research directions emphasize the integration of physics-informed learning, uncertainty-aware modeling, explainable artificial intelligence and community-driven data standardization. More coupling between machine learning workflows and experimental validation will accelerate reliable polymer materials discovery.

Keywords: Polymer informatics, Machine learning, Graph Neural Network

User Perceptions and Requirements for AI-Based Dry Eye and Posture Monitoring Systems: A Survey Study

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Abstract

Prolonged screen exposure has become an integral aspect of modern digital life, particularly among students, professionals, and computer users. While technology enhances productivity and communication, it also introduces significant health risks, especially dry eye syndrome and musculoskeletal disorders. This study presents a survey of 141 participants to evaluate the prevalence of screen-related health issues, user behavior patterns, and willingness to adopt a deep learning-based system for early detection and prevention. The findings reveal a high prevalence of health concerns, with approximately 87% of participants reporting symptoms of dry eye, including irritation and discomfort associated with prolonged screen use. Additionally, more than 80% reported posture-related issues such as neck, shoulder, and back pain, highlighting the widespread impact of poor ergonomic practices. Further analysis indicates a relationship between prolonged screen time and increased symptom severity, emphasizing the need for timely intervention. Despite high awareness of these risks, only a limited number of individuals actively adopt preventive measures. Furthermore, the study explores user acceptance of AI-based health monitoring solutions, with 66% of participants expressing interest in systems capable of detecting early signs of eye strain and poor posture. Key factors influencing adoption include system reliability, detection accuracy, usability, and privacy considerations, particularly in real-world everyday usage scenarios. To address these needs, the study outlines the design of an AI-based monitoring system incorporating real-time video-based eye strain detection, computer vision-based posture analysis, personalized alerts, and privacy-preserving local data processing. Overall, the findings highlight the potential of intelligent, user-centered monitoring systems to promote healthier screen habits and reduce long-term health risks.

Keywords: Deep Learning, Digital Preventive Healthcare, Dry Eye Syndrome, Health, Posture Detection

AI-Assisted Cyber Threat Detection, Classification and Mitigation through LLM-Enhanced Security Analytics

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Abstract

The ever-evolving nature of the threats and the sophistication of the attacks have made conventional systems of rules-based systems and conventional ML-based intrusion detection systems ineffective. Thus, it has become challenging to effectively respond to the evolving threats. In the current literature, the latest developments in AI-based systems of cybersecurity are explored, with a focus on LLM and its association with conventional ML and DL methods. The publicly available sources of cybersecurity data, feature engineering methods, and the use of hybrid models of AI-based systems of cybersecurity, including the association of LLM with conventional methods of anomaly detection, are also considered. In addition, the evaluation metrics are also considered, with a focus on quantitative metrics such as Precision, Recall, F1-Score, and ROC-AUC, and qualitative metrics such as the recommendations and insights offered by LLM. Ethical, privacy, and safety issues are also considered, with a focus on the risks, issues, and challenges, which are critical to AI-based systems of cybersecurity. In addition, the research gaps are also considered, with a focus on research opportunities, with a focus on adaptive, dynamic, and real-time systems of detecting threats. The current article is aimed at being a useful reference point for researchers and practitioners who are willing to capitalize on the opportunities offered by AI and LLM in enhancing the existing systems of cybersecurity, while also gaining an insight into the use of the hybrid AI systems in enhancing the systems of detecting threats, while also highlighting the limitations, challenges, and opportunities to be addressed to pave the way towards the next-generation systems of cybersecurity.

Keywords: Cybersecurity, Intrusion Detection, Large Language Models, Artificial Intelligence, Threat Intelligence

Systematic Review of Machine Learning and Deep Learning Approaches for Tea Leaf Disease Detection

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Abstract

Tea is one of the most widely cultivated and consumed beverage crops worldwide. It contributes major economic value through export earnings, rural employment, and farmer livelihoods in tea-producing regions. As a result, tea leaf diseases can cause substantial losses. These losses include reduced yield, lower leaf quality and grade, and increased management costs. However, disease monitoring in plantations is still based mostly on manual visual inspection. This process is time-consuming, subjective, and often unreliable under field conditions. Variations in illumination, occlusion, weather effects, and complicated backgrounds increase the difficulty of accuracy. To deal with these limitations, many studies have investigated machine learning (ML) and deep learning (DL) techniques for the image-based detection and classification of tea leaf diseases. This paper aims to conduct a systematic review of the available literature using the PRISMA protocol. The structured search was performed on Google Scholar, IEEEExplore, SpringerLink, and ResearchGate. The search results were obtained from January 2015 to January 2026. A total of 29 papers were obtained from the search results. Out of these results, 15 were chosen as the primary studies. The literature review shows that the tea leaf disease identification methods are currently shifting from conventional approaches towards CNN-based approaches. Transfer learning is now being used to boost the performance of these approaches. Object detection tools like YOLO are not only used to classify the disease but also locate the diseased area of the leaf. Although the results show high accuracy and F1 scores, many experiments have been conducted on private datasets, and the validation methods are inconsistent. Therefore, to address these issues, future research should focus on publicly available benchmark datasets. The focus should be on evaluating plantation conditions, early-stage disease detection, and lightweight models.

Keywords: Convolutional Neural Network, Deep learning, Disease classification, Tea leaf, Machine learning

A Narrative Review of Methods, Effectiveness, and Limitations of Self-Refinement in Large Language Models

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Abstract

Large Language Models (LLMs) have shown impressive performance on an extensive variety of tasks such as reasoning, natural language generation and solving complex problems. Nevertheless, they are vulnerable to factual errors, logical fallacies and hallucinations due to their dependence on single-pass autoregressive inference, which is an important weakness in high stakes applications. Self-refinement has emerged as a compelling inference-time paradigm that enables models to iteratively critique and revise their own outputs without requiring any modification to underlying model parameters. This paper is a structured narrative review of the self-refinement mechanisms in LLMs, which systematically investigate their conceptual basis, architectural designs, evaluation approaches, and their effectiveness in a variety of task domains. The review examines the main aspects of the refinement process to include output-level versus step-level revision strategy, self-critique versus externally grounded verification and fixed versus adaptive iteration control strategy.

While prior studies demonstrate notable improvements in domains with verifiable feedback such as mathematical reasoning and code generation, the analysis highlights persistent limitations. These include unreliable self-evaluation, the rigid stopping criteria, the saturation effect, and substantial computational overhead. This review seeks to close important gaps in adaptivity, efficiency, and interpretability by synthesizing the results of the latest literature to comprehensively limit the practical use of the current methods of self-refinement in real-world settings. The review mainly expects to motivate future research toward more principled, task-sensitive, and controllable self-refinement systems.

Keywords: Large Language Models, Self-Refinement, Iterative Reasoning, Self-Critique, Inference-Time Optimization.

Toward Objective Digital Biomarkers of Bradykinesia: A Technology Centric Review of Finger Tapping Assessment in Parkinson's Disease.

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Abstract

This paper presents a comprehensive technology centric review of finger tapping as an objective digital biomarker for assessing bradykinesia in Parkinson's disease (PD). Finger tapping, a core component of the Movement Disorder Society Unified Parkinson's Disease Rating Scale (MDS-UPDRS), provides a structured motor task that reflects key characteristics of bradykinesia, including reduced speed, diminished amplitude, rhythm irregularities and movement hesitation. Traditional clinical evaluation relies heavily on subjective visual observation, which introduces inter rater variability and limits sensitivity to subtle motor changes. The review synthesizes recent advancements in sensing technologies, categorizing finger tapping assessment systems into three primary modalities: wearable sensors, vision-based systems, and smartphone touchscreen platforms. Each modality offers distinct advantages and tradeoffs in terms of accuracy, accessibility, and environmental robustness. Wearable sensors provide high resolution kinematic data but require calibration and standardized placement. Vision-based approaches enable contactless measurement through computer vision techniques but are sensitive to environmental conditions. Smartphone based systems offer scalable and cost-effective solutions, though they are limited to two dimensional motion capture and subject to device variability. In addition to sensing modalities, the paper examines signal processing and computational pipelines, including preprocessing, feature extraction, and machine learning based classification. Extracted features span temporal, kinematic, and frequency-domain domains, enabling multidimensional characterization of motor impairment. Emerging deep learning approaches further enhance predictive performance by learning representations directly from raw data. Despite promising technological progress, several challenges hinder clinical translation, including lack of standardization, device heterogeneity, limited longitudinal validation, and regulatory constraints. The review highlights future directions such as multimodal sensing, explainable artificial intelligence, and real-world deployment strategies. Overall, this work underscores the potential of finger tapping as a scalable, objective, and data driven digital biomarker for improving PD diagnosis and monitoring.

Keywords: Parkinson's Disease, Bradykinesia, Finger Tapping Assessment, Digital Biomarkers, Machine Learning

A Systematic Review of Coordinating Bot Detection Techniques in Real-Time Web and Mobile Applications

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Abstract

Coordinated bots have emerged as a significant and evolving threat to contemporary web and mobile applications. Unlike traditional solitary bots, coordinated bots operate as groups of interconnected accounts or sessions that mimic human behavior, thereby bypassing conventional defense mechanisms such as CAPTCHAs, IP filtering, rate limiting, and static device fingerprinting. This evolution has enabled large-scale malicious activities, including fraud, spam, data scraping, engagement manipulation, and coordinated platform abuse, highlighting the urgent need for more robust detection strategies. This paper presents a systematic literature review of recent techniques for detecting coordinated bots, with a focus on developments published between 2022 and 2025. The review follows PRISMA guidelines and established systematic review methodologies to ensure transparency and reproducibility. The surveyed approaches are evaluated based on key criteria, including detection accuracy, real-time applicability, computational complexity, scalability, dependency requirements, and resistance to evasion strategies. The analysis reveals that machine learning, deep learning, and group-based behavioral modeling techniques demonstrate high detection effectiveness, particularly in identifying collaborative patterns across accounts. However, these approaches often suffer from significant limitations, including high computational overhead, challenges in real-time deployment, and dependence on large-scale labeled datasets. In contrast, lightweight and heuristic-based methods offer improved efficiency and deployability but lack adaptability to evolving attack strategies. This review further identifies critical research gaps, including the need for hybrid detection frameworks that balance accuracy and efficiency, improved real-time and cross-platform detection capabilities, and more robust evaluation methodologies. By synthesizing current advancements and limitations, this study provides insights to guide the development of scalable, adaptive, and efficient solutions for mitigating coordinated bot threats in modern applications.

Keywords: Anomaly Detection, Behavioral Analysis, Botnets, Coordinated Bot Detection, Deep Learning, Group-based Detection, Machine Learning, Real-time Detection, Web and Mobile Security

Intelligent Transportation Systems for Bus Arrival Prediction and Commuter Behavior in Decentralized Public Transport

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Abstract

Public transportation in developing economies is chronically problematic, characterized by significant uncertainty in bus arrival times, severe congestion, low security level, and high information asymmetry between the passengers and the operators. Although Intelligent Transportation Systems (ITS) offer solutions through GPS tracking and predictive analytics, the current literature is heavily biased toward centralized and resource-intensive transit systems. This overlooks the privately operated, decentralized bus systems common in South Asia, Southeast Asia and Sub-Saharan Africa. To address this gap, this paper presents a systematic review of 78 peer-reviewed publications (2015-2025) on the technological, economic, and social limitations of emerging transit landscapes. The review considers GPS-based tracking, crowd-sensing methods, dynamics of commuter behaviour, and scheduling, as well as deep learning prediction models, particularly Long Short-Term Memory (LSTM) and Bidirectional LSTM (BiLSTM) architectures. A critical content analysis of the selected studies identifies key research gaps: (1) the lack of demand-aware scheduling, which exacerbates overcrowding and unsafe travel practices such as footboard travel; (2) insufficient real-time visibility, exposing passengers to safety risks; (3) persistent bidirectional information asymmetry; and (4) limited validation of low-cost sensing technologies in developing country contexts. The findings indicate that LSTM-based models can effectively estimate bus arrival times, while highlighting the need for economically viable, scalable solutions. Future research should focus on hybrid predictive models that incorporate behavioural variables, the adoption of low-cost IoT technologies, and real-world pilot deployments in countries such as Sri Lanka, Bangladesh, India and Philippines.

Keywords: Intelligent Transportation Systems, Bus Arrival Prediction, LSTM Neural Networks, Commuter Behavior, Information Asymmetry

A Machine Learning Based Approach for Wedding Cost Prediction and Package Recommendation in Sri Lanka

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Abstract

The increasing prices of the services, the peculiarities of the culture, and the ultimately inaccurate system of manual budget planning largely affect the wedding planning process in Sri Lanka. Additionally, the difficulty involved in tailoring wedding packages due to several interconnected variables like number of guests, geographical location, seasonality, and preferred services, poses problems in estimating costs accurately. This research aims to create a machine learning model to predict wedding costs and recommend a wedding package based on past data to overcome these financial intricacies. Specifically, this research presents a machine learning-driven model that estimates the cost of wedding events and recommends optimal service packages. The model is developed using real-world Sri Lankan wedding data collected through planner interviews, wedding fairs, and online service sources. Based on a quantitative experimental research design adopted in the current study, the prediction of wedding costs is performed based on an automated machine learning model, which consists of data gathering from participants, preprocessing, and building different regression models such as Linear Regression, Decision Tree, Gradient Boosting, and Random Forest. In evaluating the performance of each model, some common criteria were used, namely Mean Absolute Error (MAE) and Root Mean Squared Error (RMSE). The results show that the Random Forest model achieved the best performance with the lowest MAE and RMSE, while key cost drivers such as guest count, geographical location, venue type, seasonal timing, and service interactions significantly influence wedding cost prediction in Sri Lanka.

Cultural significance of this research can be seen in the dataset collected and cost differences noted because Sri Lankan weddings normally include culturally determined elements like a large number of guests, extended ceremonies conducted over several days, religious traditions, and social expectations of services such as quality food and decorations.

Keywords: Machine Learning, Wedding Cost Prediction, Package Recommendation, Decision Support System, Regression Analysis, Model Evaluation Metrics

A Review and Comparative Evaluation of Image-Based Ripeness Detection and Grading Techniques for Coconuts

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Abstract

The assessment of coconut ripeness and maturity is an important task for harvesting, grading, and quality control. These factors influence product utilization, market value, and processing efficiency. Accurate assessment is essential for maintaining quality standards and improving economic returns. Until recently, most methods for evaluating coconut maturity were subjective and manual, requiring considerable time and effort. Therefore, there is a strong demand for reliable and efficient automated solutions. In recent years, there has been growing interest in integrated approaches that combine image analysis, machine learning, and deep learning techniques to assess coconut ripeness. This paper presents a systematic review of research on image-based coconut ripeness assessment, covering 21 selected studies. The reviewed studies were classified using a method-based approach. Based on the analysis, deep learning-based methods, including image classification and object detection, demonstrate higher accuracy and robustness than traditional feature-based approaches. These methods also perform better under extreme field conditions. However, several challenges remain. These include limited dataset diversity, real-time implementation constraints, and model generalization issues across different environments. In addition, integrating assessment systems into practical harvesting processes remains a significant challenge. Overall, this review highlights current advancements while identifying gaps that must be addressed to enable effective real-world deployment.

Keywords: Coconut Ripeness Detection, Image Processing, Deep Learning, Convolutional Neural Networks, Object Detection, Computer Vision

A Systematic Review of AI-Based Learning Content Summarization and Interactive Assessment

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Abstract

Educational institutions are increasingly adopting online and hybrid learning models, creating challenges in maintaining student engagement and ensuring effective assessment. Content summarization and interactive evaluation in online educational settings has become an effective prospective application of artificial intelligence (AI). In this paper, the systematic review of 25 articles published in 2016-2026 will be discussed and focused on AI-based strategies to summarize educational content and interactive assessment. The findings indicate that AI-driven summarization helps learners focus on the most key concepts and manage excessive information. Interactive assessment methods, including automated quiz-generation and adaptive interrogation, maintain the learners engaged and offer them instantaneous feedback. Transformer-based models and hybrid models are always more successful in terms of providing the right summaries and personalized evaluations. Despite these advantages, several challenges persist, such as issues of privacy of data, algorithm bias, problems with system integration, and its compatibility with pedagogical design. The analysis of the summarization and assessment methods in the present work is more cohesive than in the previous ones as it demonstrates the influence of the combination of the two methods on the learning outcomes and engagement. The review provides critical research gaps, especially in the multilingual support, multimodal learning integration, and long-term effectiveness. The way forward in this research should be to create responsible, scalable, and pedagogically appropriate AI systems. Overall, the study highlights the opportunities that AI has to revolutionize digital education through enhanced learning efficiency, personalization, and quality of assessment.

Keywords: Artificial Intelligence, Natural Language Processing, Educational Technology, Automated Quiz Generation, Content Summarization, Interactive Assessment.

Digital Transformation in Geotechnical Engineering: A Systematic Review of Mobile Systems and AI-Driven Report Generation

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Abstract

Mobile computing and artificial intelligence (AI) offer transformative potential for geotechnical engineering workflows, yet practical implementation presents significant integration challenges. This systematic review examines the current state of digital transformation across four critical research areas: (1) mobile-first systems for field operations, (2) large language models (LLMs) and AI-driven intelligence, (3) distributed microservices architecture for system integration, and (4) evaluation frameworks for trustworthy AI and automated report validation. Using PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) methodology, we conducted a comprehensive literature search across Web of Science, Scopus, arXiv, and Google Scholar databases, identifying key studies published through mid-2025. Our analysis reveals that mobile systems employing offline-first and Conflict-Free Replicated Data Type (CRDT) architectures successfully achieve real-time data synchronization. Retrieval-Augmented Generation (RAG) systems eliminate AI hallucinations by grounding responses in domain knowledge. Microservices-based architectures deliver 89.5% response time efficiency, while Natural Language Processing (NLP) evaluation metrics address critical shortcomings in AI validation frameworks. However, significant barriers to adoption persist: cost (55% of small and medium enterprises cite high investment), organizational culture (resistance to change), and competence gaps (lack of multidisciplinary expertise). Critical research gaps include mobile-AI-cloud hybrid solutions, geotechnical-specific AI validation protocols, physics-informed AI approaches, and industry-academia collaboration frameworks. Standards alignment with American Society for Testing and Materials (ASTM) and Association of Geotechnical and Geoenvironmental Specialists (AGS) requirements remains unexplored for automated reporting systems. This review synthesizes current findings and proposes detailed future research directions, including domain-specific fine-tuning of LLMs, hybrid reporting systems balancing flexibility with compliance, offline-capable mobile solutions, and deployment case studies demonstrating return on investment. By identifying these critical research gaps and providing a structured framework for mobile-AI integration, this work provides geotechnical engineering practitioners and researchers with actionable insights for advancing digital transformation initiatives.

Keywords: Automated reporting, Digital transformation, Geotechnical engineering,

Computer Vision and Deep Learning for Queue Buildup Prediction in Retail: A Narrative Review of Technical and Operational Challenges

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Abstract

Queue formation in the retail checkout counter affects the customers' satisfaction level and the efficiency of the business process. However, current management techniques have been reactive as they can only act on congestion formation after its occurrence. This review critically assesses the technological environment and applications of computer vision and deep learning algorithms, including object detection, multi-object tracking, and time-series forecasting, in addressing queue formation prediction in retail checkout counters. In comparing object detection architectures, the most accurate architecture with 94% accuracy and 92% recall rate is YOLOv8 at 80 frames per second (FPS). It outperforms other similar models such as YOLOv3, which has a 22% mAP score and works at 35 FPS, and YOLOv5, which achieves a 43% mAP score and operates at 40 FPS. However, the Faster R-CNN model, although almost accurate with an accuracy of about 95%, works at 10 FPS, making it inappropriate for real-time implementation using multiple cameras. For multi-object tracking, Deep SORT reduces identity-switch errors by 45% relative to SORT through Kalman filter motion prediction and deep appearance features, improving identity preservation in crowded scenes. Among forecasting methods, LSTM networks demonstrate 84–87% error reduction over ARIMA on nonlinear retail time-series, while Facebook Prophet achieves 94% accuracy for weekly and seasonal demand patterns. Hybrid Prophet–LSTM models offer the strongest balance of prediction horizon, complexity, and cost, whereas reinforcement learning remains promising yet operationally complex for retail deployment. A critical gap is the absence of cart movement dynamics as a leading checkout demand indicator, a real-time signal largely unmodelled in existing systems. Additional deployment challenges include occlusion, illumination variation, cross-camera identity coordination, and regulatory compliance under GDPR and CCPA. Future research should prioritise multimodal, privacy-aware architectures that integrate cart-flow signals with temporal forecasting pipelines, enabling retailers to transition from reactive intervention toward proactive queue management.

Keywords: Computer vision, Deep learning, Queue prediction, Retail analytics, Multi-object tracking, Time-series forecasting

A Review of Solar Irradiance and Photovoltaic Power Forecasting Using Image Based and Data Driven Methods

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Abstract

The swift integration of solar photovoltaic technologies in modern power grids has driven demands for precise solar irradiance and power generation to ensure efficient grid management. Solar power generation is naturally unpredictable due to dynamic cloud formations. This paper aims to provide an extensive overview of state of the art techniques for solar irradiance and photovoltaic power forecasting with specific emphasis on cloud aware and data driven techniques. To achieve this, 20 peer reviewed articles published between 2017 and 2025 have been reviewed using an adapted Preferred Reporting Items for Systematic Reviews and Meta Analyses protocol. The literature survey encompasses a wide range of techniques, including physical and statistical models, satellite based cloud nowcasting, ground-based sky image/video analysis, Internet of Things based monitoring systems, and machine learning/deep learning techniques. The literature survey reveals an emerging shift from traditional deterministic techniques towards advanced data driven techniques for forecasting solar irradiance and photovoltaic power. Deep learning techniques such as Convolutional and Recurrent Neural Networks attain the highest forecasting accuracy for short term and nowcasting horizon forecasts using sky images, satellite data, and hybrid data inputs. Besides, probabilistic forecasting can further improve the accuracy of predictions based on uncertainty. However, some issues like, the lack of data availability in different climatic zones, generalization, computational complexity, and the ability to be implemented in real time energy management systems. The future work should be directed towards improving generalization, managing multiple sources of data, dealing with uncertainty, and developing light models for practical applications in solar forecasting. This review provides a structured synthesis of the trends, issues, and future research directions, acting as a solar energy forecasting reference.

Keywords: Solar irradiance forecasting, Satellite cloud nowcasting, Data-driven solar energy models.

A Review of IoT-Based Plastic Waste Identification Systems Using ESP32 and Near-Infrared Sensors

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Abstract

The increasing plastic waste problem is becoming increasingly pressing due to inefficient waste segregation and inadequate recycling practices. Despite successful implementation of IoT based smart waste management systems using real-time monitoring and cloud-based solutions, limited progress has been made in material-level plastic waste identification. Existing IoT waste management systems mostly focus on monitoring the process of waste management and its parameters such as fill-level sensing, optimal collection, environment sensing, and other similar parameters without the capacity to identify plastic waste at the material level. In this study, around 23 research papers on smart waste management systems, plastic identification technologies, embedded hardware platforms, and sensing technologies were reviewed. Among the IoT architectures described in these studies, hardware platforms such as ESP32 and Raspberry Pi, communication protocols such as MQTT, and cloud solutions were examined. In addition, several approaches for material-level plastic waste identification, including visual and spectroscopic methods, were analyzed and compared with traditional sensor-based sorting techniques. Material level approaches are mainly based on two sensing technologies: mid-infrared (MIR) and near-infrared (NIR) spectroscopy. MIR spectroscopy provides more accurate identification but has a limited sensing range and system integration capability. In contrast, although NIR is less accurate than MIR, NIR sensors are cost-effective, scalable, and suitable for real-time applications. Both ESP32 and Raspberry Pi hardware platforms are efficient for implementing IoT based waste management systems; however, the ESP32 platform has certain advantages over the Raspberry Pi platform, including lower costs, lower energy consumption, and better scalability for large-scale deployments. A key limitation identified in existing research is the absence of efficient, real-time IoT solutions for material-level plastic waste identification in a cost-effective and scalable manner. This represents a significant research gap in the field.

Keywords: Plastic Waste Management, Internet of Things (IoT), Near-Infrared (NIR) Sensing, ESP32, Embedded Systems

A Comparative Review of CycleGAN and Diffusion Models for Data Augmentation in RealTime Plant Disease Recognition

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Abstract

The rapid advancement of artificial intelligence and computer vision has created transformative opportunities for precision agriculture. Yet real-world plant disease recognition remains hindered by unbalanced and poorly labelled field datasets and domain shift that severely limits the robustness of real-time detectors. This systematic literature review (SLR) evaluates generative adversarial networks (GANs) and diffusion models as data-augmentation techniques to enhance real-time plant disease recognition models for field deployment. Following PRISMA guidelines and Kitchenham quality-assessment protocols (minimum score threshold of 3.0), 37 studies published between 2020 and January 2026 were selected from 500 papers retrieved across major databases, with emphasis on image fidelity (FID, SSIM) and detection performance (mAP, F1-score). CycleGAN and its variants excel in inference speed and edge-device compatibility, making them the preferred choice for unpaired healthy-to-diseased image translation in real-time applications. Diffusion models deliver superior visual fidelity and few-shot performance, though at higher computational cost. Hybrid approaches and latent-space optimisations are identified as promising directions for combining both paradigms while preserving deployability. As a key contribution, this review proposes a strategic framework based on three cascading priorities. First, it emphasises the integration of explainable AI (XAI) to ensure the biological and pathological validity of synthetic samples. Second, it introduces regression-conditional generation for disease severity grading. Third, it highlights the need for large-scale field validation across diverse crops and climates to reduce domain shift. IoT-enabled robotic systems are identified as the deployment platform, enabling the convergence of these priorities in resource-constrained field settings. This review provides an evidence-based roadmap for advancing robust, scalable AI-powered plant disease recognition across diverse real-world agricultural settings.

Keywords: Plant disease recognition, Generative adversarial networks, Diffusion models, Data augmentation, Real-time detection

A Review and Comparative Analysis of Deep Learning Techniques for Plastic Classification Using Near-Infrared Spectral Data

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Abstract

The rising levels of plastic waste have heightened the demand for automated and reliable classification of plastics to facilitate effective recycling. Near-Infrared (NIR) spectroscopy technology has gained prominence as a widely used technique owing to its fast, non-destructive nature and material-specific spectral response. However, classifying plastics based on their NIR spectra poses great difficulty owing to factors such as spectral noise, variability, and overlapping absorption regions caused by similar molecular bonds, e.g., C-H, O-H, N-H, especially when comparing plastics having chemically similar structures such as PET/PVC and HDPE/LDPE. The conventional machine learning and chemometric approach to classify plastics requires significant amounts of manual data pre-processing (such as normalization and smoothing). A comprehensive overview of deep learning techniques, especially the use of CNNs, is performed in this study to determine how effectively these techniques can be used to classify plastics by using NIR spectral information. State-of-the-art deep learning methods for this specific task have been assessed based on several performance evaluation metrics, such as accuracy, precision, recall, F1 score, and other measures. There are some drawbacks in this area, including poor interpretability of models, poor generalization ability to different datasets, and computational complexity for implementing models on mobile devices. The results of this study identify these limitations and suggest directions for further research.

Keywords: Near-Infrared Spectroscopy, Convolutional Neural Networks, Plastic Waste Identification, Spectral Classification, Deep Learning

A Review of AI Enabled Workload Management and Injury Prediction Systems for Cricket

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Abstract

Modern cricket is a very competitive team sport. It is a physically demanding sport that depends on combination of player performances. When considering the player's performance, workload management is a leading factor for players to improve their existing skills and find out their weaknesses. This review paper examines the existing workload management and injury epidemiology in cricket using AI enabled injury prediction models and workload monitoring methods in sports science. Current technologies have the capability to develop predictive injury risk models and workload management systems for an individual player considering relevant factors of each player. This review paper was written by analyzing 26 papers of original research papers and systematic reviews related to sports science and computer science. This paper reviews workload monitoring methods like Acute Chronic Workload Ratio (ACWR) and more sensitive methods like Exponentially Weighted Moving Averages (EWMA). With the collaboration of sports science and computer science, findings on valid internal load metric with the help of combining the Session Rating of Perceived Exertion (sRPE) with Computer Vision (CV) and useful machine learning architectures such as XGBoost, CNN-LSTMs, and Random Forests to predict results. The review identified significant research gap about applying those methods and technologies to domestic cricket in Sri Lanka. There are many uses of these technologies in international cricket, but domestic cricket lacks the usage. When it comes to domestic cricket, it is important to consider some important factors, such as ground hardness. So that can identify gaps in existing systems about expanding them with Ai enabled workload management and injury prediction systems for domestic cricket and integrating multi source data and machine learning techniques to improve injury prevention strategies.

Keywords: Workload, Injury Prediction, Machine Learning, Artificial Intelligence, Domestic Cricket, Computer Vision, sRPE, ACWR, EWMA

A Critical Review of Technologies Effectiveness and Claims for IoT Enabled Ultrasonic Mosquito Repellent device

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Abstract

Mosquito-borne diseases remain a significant global public health problem, with more than 700 million infections and more than one million deaths a year. Conventional chemical-based vector control techniques are increasingly being questioned on grounds of environmental consideration, insecticide resistance and human health risks. This has prompted studies on the development of non-chemical alternatives, in particular ultrasonic repellent technology combined with Internet of Things (IoT) architectures to create smart pest control. The current review evaluates 24 peer-reviewed articles covering the period between 2010 and 2025 and analyses the state of re-search on the topic of IoT-enabled ultrasonic mosquito repellent devices. Some of the thematic considerations encompass a wide variety of hardware implementation solutions based on microcontrollers (NodeMCU ESP8266, Arduino platforms, ATmega328P), operating frequencies largely in the 20-50 kHz range, and more recently integrating with cloud platforms and TinyML to enable autonomous execution. Nonetheless, the critical review has shown that there are significant shortcomings: mixed biological evidence of ultrasonic effectiveness, methodological variability in protocols, a lack of long-term field validation, and significant gaps between laboratory assertions and actual performance. There remain controversies on the underlying bio-logical processes underlying ultrasonic repulsion, with individual studies only having been able to show molecular-level responses at very high frequencies (100 kHz). This review identifies urgent needs for rigorous interdisciplinary validation, standardized testing protocols and evidence based evaluation frameworks to guide future research and inform public health policy decisions.

Keywords: Embedded Systems, Internet of Things, Smart Pest Control, Ultrasonic Mosquito Repellent

Systematic Literature Review of Technical Integration Challenges and Workflow Gaps of Generative AI Tools in Unity-Based Indie Game Development

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Abstract

Generative Artificial Intelligence (GenAI) is rapidly transforming digital content creation, offering significant potential to enhance efficiency and creativity in game development. For indie developers, these tools enable cost-effective and accelerated asset generation across domains such as visual design, animation, and code production. Despite these advantages, integrating GenAI into established development environments—particularly the Unity engine—introduces substantial technical and workflow-related challenges that limit its practical adoption. This study presents a systematic literature review of research published between 2018 and 2025, focusing on the barriers to effective GenAI integration in Unity-based indie game development. A structured methodology based on PRISMA guidelines was employed to identify and select 24 relevant studies from leading academic databases, including IEEE Xplore, ACM Digital Library, SpringerLink, and ScienceDirect. Clear inclusion and exclusion criteria were applied, and a formal quality assessment was conducted to ensure methodological rigor. Potential sources of bias in study selection are also critically discussed. Moving beyond descriptive analysis, this review introduces a classification framework that organizes identified challenges into three key dimensions: technical integration constraints, workflow misalignment, and tool interoperability limitations. Comparative analysis across studies reveals recurring issues such as performance overhead, limited contextual awareness of AI-generated outputs, and fragmentation caused by reliance on external tools. The primary contribution of this work is a structured synthesis of current limitations, alongside a conceptual framework to guide future research and support more seamless integration of GenAI within game development pipelines.

Keywords: Game Development, Generative AI, Indie Games, Systematic Literature Review, Unity Engine, Workflow Integration,

Mobile Health Interventions for Maternal and Newborn Health in Low and Middle Income Countries: A PRISMA Review

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Abstract

Maternal and newborn health issues are still significant global health problems for LMICs because of access barriers and inadequate follow-up care, and weak health systems that lead to preventable mothers and children becoming ill or dying unnecessarily. Given the rapid increase in mobile phone usage globally; mHealth interventions are a viable option to improving the delivery of health care services. This review follows the PRISMA protocol; summarizes findings on the effectiveness of mHealth interventions for providing maternal and newborn health care in LMICs; and identifies areas needing further research.

A systematic search of the available literature was performed in the following databases: PubMed, PMC, BMC, and JMIR databases. After screening for peer review, 20 studies were included in the final analysis. The mHealth interventions studied included SMS reminders, mobile apps, electronic cohorts, and integrated digital platforms used to deliver antenatal, delivery, postnatal, nutritional, and mental health services.

The results of the included studies indicate that using SMS-based reminders can increase the number of women receiving antenatal services from trained personnel, and increase the number of women who use trained personnel for their childbirth, and have increased the number of women receiving postnatal care. Mobile applications helped to improve maternal health-related knowledge, increase self-monitoring (of their pregnancy), promote better nutrition, and enhance the likelihood of using available health care resources. Overall, there were limited amounts of evidence to support mHealth interventions for long-term sustainability, providing mental health support, integrating into existing health information systems, or offering individualized care.

This review indicates the capabilities of mobile health (mHealth) to improve continuity of care and enhance access to healthcare services in low- and middle-income countries (LMICs). Future research should develop scalable, culturally appropriate, multilingual mHealth systems that are integrated with existing primary healthcare systems within LMICs and have a positive impact on maternal and newborn health outcomes.

Keywords: Keywords: mHealth, maternal health, newborn care, antenatal care, SMS reminders, mobile applications, LMICs, PRISMA, digital health

A Review on AI-Driven Inventory Control and Sales Forecasting for Small Hardware Retailers

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Abstract

Despite technological advancements, inventory management remains a major problem faced by small- and medium-sized retail firms due to uncertain demand, limited warehouse capacity, inconsistent supply chain lead times, and manual inventory practices. These factors contribute to understocking and overstocking, which is detrimental to the business in terms of profitability and performance. The challenges mentioned above become even more pronounced within highly competitive business settings in which slight stock management inefficiencies can cause substantial financial problems and lower customer satisfaction. Traditional techniques of inventory management, such as fixed reorder point policies and manual decision-making, are not always effective in dealing with unpredictable customer demand. As a result, small retailers often struggle to maintain optimal inventory levels while balancing customer demand and operational costs. This paper provides a systematic literature review of 20 articles devoted to the use of artificial intelligence (AI) for inventory management, sales forecasting, and automated reorder decision-making. The chosen articles were selected according to specific criteria from major academic databases and cover topics such as decision trees, random forest models, Long Short-Term Memory (LSTM) models, and others. The application of such methods in practice has been growing in popularity over the past few years owing to the capability of these techniques to handle large amounts of data and detect intricate demand patterns. The results show a clear pattern across the examined studies. AI methods improve forecasting and inventory management efficiency compared to conventional approaches. However, these approaches require sufficient quality data and technical infrastructure to operate effectively. Therefore, their application in small retail environments is limited due to constraints in technology and professional expertise.

Keywords: Artificial Intelligence, Inventory Management, Reorder Automation, Sales Forecasting, Small Retail

Ontology-Based Clinical Decision Support Systems for Breast Cancer Care: A Systematic Review of Architectures, Guideline Modeling, and Implementation Challenges

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Abstract

It is crucial to timely recognize the symptoms, refer patients appropriately, accurately diagnose and adequately follow up with those suspected of having breast cancer. Ontology based and clinical guideline based Clinical Decision Support Systems (CDSS) have been advocated for use in evidence-based decision making. While there may be many advantages to these systems, several issues arise when one considers their appropriateness, reusability, adaptability, and user-centeredness in underdeveloped countries. This systematic review is aimed at investigating the current state of literature concerning ontology-based CDSS and breast cancer care navigation systems. A thorough literature search was performed in IEEE Xplore, SpringerLink, PubMed, Association for Computing Machinery (ACM) Digital Library, and ScienceDirect. Twenty-four articles meeting the criteria specified by PRISMA guidelines were selected for qualitative analysis. These articles will be discussed in terms of their knowledge representation methodology, approach to clinical guideline modeling, reasoning technique, validation and usability techniques used, and intended users of the system. The research shows that there exist numerous advantages of ontology-based clinical decision support in breast cancer treatment through structured knowledge representation and better compliance with evidence-based guidelines. Nevertheless, most of the current CDSS is clinician-centered, poorly adapted to patient navigation, and context-bound, which limits its reusability. Moreover, the validation aspect is commonly based on either expert opinion or simulation, with little or no implementation in practice. Despite the recent research into the fusion of ontologies and machine learning for clinical decision support systems, predictive accuracy often prevails over interpretability and practical applicability. This paper outlines the critical areas that require further development within the field of context-sensitive CDSS with ontological knowledge bases applied to breast cancer treatment in underdeveloped healthcare systems.

Keywords: Clinical Decision Support System, Ontology Based CDSS, Clinical Guideline Modeling, Computer Interpretable Guidelines, Breast Cancer, Care Navigation Systems.

A Review of Real-Time Speech Translation and Streaming Speech Processing Systems for Wearable and Edge-Based Applications

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Abstract

Real-time multilingual speech translation has recently received significant attention due to rapid advances in deep learning, largescale speech-language models and low-latency streaming infrastructures. In particular, the increasing demand for wearable and hands-free translation devices has introduced new constraints related to latency, computational efficiency, energy consumption and deployment feasibility. This review paper analyses twenty recent research studies published between 2018 and 2026 focusing on speech-to-text translation, speech-to-speech translation, streaming speech translation, and edge and client-server speech processing architectures. The reviewed literature is systematically grouped into four major themes: direct and cascaded speech translation models, streaming and simultaneous speech translation methods, edge and mobile deployment architectures, and large speech-language model based adaptation frameworks. A comparative analysis highlights the strengths and limitations of current approaches in terms of translation quality, latency, scalability and practical deployability. Finally, major research gaps are identified, particularly the limited focus on wearable platforms, the lack of unified low-power architectures, and insufficient evaluation in real-world conversational environments.

Keywords: Speech translation, streaming speech processing, speech-totext, edge computing, wearable devices

A Systematic Review of Adversarial Evasion Attacks on Machine Learning-Based Network Intrusion Detection Systems: An Analysis of the Practicality Gap

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Abstract

In today's world, Machine Learning-based Network Intrusion Detection Systems have emerged to be of absolute necessity for cybersecurity, but this technology harbors one critical flaw: its vulnerability to adversarial evasion attacks. This systematic review deals with the 'practicality gap' between the theoretical success of an attack in feature-space and practical success in traffic-space. Using PRISMA methods, from 1,155 citations, we chose the top 30 publications from 2014 to 2026. This paper attempts to answer three essential queries. First, despite their high evasion efficiency (above 90%) in feature space achieved by white-box gradient methods (FGSM, PGD, C&W) and GANs, their practical application is heavily limited. Secondly, the reasons behind practicality gaps are because of inverse feature mapping, which is compounded by constraints imposed by the TCP/IP architecture. Adherence to conditions of correct checksum values, stateful flags, and functional payloads often makes theoretically possible evasion routes completely unusable due to a lack of routability on a live network. In the third place, among the various proposed solutions, adversarial training comes out to be the best choice. However, there is one important limitation regarding this methodology, and that is the absence of proper benchmarks for modern-day systems when considering P99 latencies and resource utilization in high throughput scenarios, thereby making many systems vulnerable to resource exhaustion attacks such as the Sponge Attack. Conclusively, our study indicates that whereas the limitations associated with TCP/IP implementation limit the potency of attacks in theory, the lack of latency-based metrics causes significant security vulnerabilities on the part of actual systems. Future studies need to move away from unbounded analysis in feature space towards problem space-based engineering with emphasis on the protocol.

Keywords: Adversarial Machine Learning, Network Intrusion Detection Systems, Evasion Attacks, Practicality Gap, Problem Space Attacks

A Systematic Review on Kidney Stone Detection using Explainable AI

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Abstract

Kidney stones are a critical problem affected for 10% -15% of the global population and have a recurrence rate of 50% in 5 - 10 years. The gold standard of identifying kidney stones is using Computed Tomography (CT) imaging, which has a sensitivity of 94% - 96%. Recently, the application of AI and deep learning has also reached an outstanding detection accuracy of over 90%. This systematic review mainly focuses on the application of explainable artificial intelligence (XAI) in the detection of kidney stones by CT imaging. According to the PRISMA method, we have analyzed 28 peer-reviewed articles (2020-2025). Our results show that although CNN, Vision Transformers, and YOLO models have high accuracy, the application of XAI has increased from 21% in the initial studies (2020-2022) to 67% in the latest studies (2023-2025). However, there are advances in the field, but there also remain critical research gaps that currently impede translation into the clinical setting. Not a single study among all the reviewed articles attempted to validate XAI explanations on practicing radiologists or urologists, and thus, the question of whether these explanations correspond to clinical reasoning or whether they actually facilitate diagnostic decision-making remains unanswered. Moreover, no studies attempted to validate explanation quality using quantitative criteria, there were no real-world prospective clinical studies, and 82% of studies were based on single-center datasets, which preclude generalizability. This review highlights the need for transparent and clinically validated AI systems that foster clinician trust and facilitate effective human-AI collaboration for kidney stone diagnosis and has identified specific research priorities that are critical to ensure responsible clinical translation.

Keywords: Explainable Artificial Intelligence, Kidney stone identification, CT scan, Image classification, Deep Learning

Smart Waste Management with Reward Tokens and Gamification: A Systematic Review

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Abstract

The rising challenges of environmental sustainability and urban waste generation have increased the need for efficient and intelligent waste management solutions. This systematic literature review aims to explore how gamification strategies and reward token mechanisms can be integrated into smart waste management systems to encourage recycling behavior and promote sustainable waste management practices. A total of 22 peer-reviewed studies published between 2021 and 2026 were identified through a comprehensive literature search conducted across several databases, including IEEE Xplore, Springer, Scopus, Google Scholar and repositories like ResearchGate. Peer-reviewed publications were chosen and carefully examined in accordance with the PRISMA guidelines, along with clearly defined inclusion and exclusion criteria in order to ensure reliability, consistency and reduce bias. The review highlights the key technological aspects of intelligent waste management systems, including AI and IoT. While smart waste bins and sensor-based systems optimize waste collection, accurate classification, energy balancing and real-time monitoring, some scalability issues, data security concerns, user adoption barriers and the lack of integration with retail or governmental services remain as challenges. The results demonstrate that reward token mechanisms combined with gamification significantly enhance user participation in waste segregation and recycling activities. This systematic literature review provides a collective understanding of current trends and critical research gaps that help researchers, system designers and policymakers to develop waste management solutions that are secure, scalable, reward-driven and sustainable.

Keywords: Gamification, Internet of Things, Reward Tokens, Smart Waste Classification, Sustainable Waste Management

The Evolution of Web Form Testing: A Review of AI-Driven Test Case Generation [2020-2025]

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Abstract

Web forms represent one of the key web applications in the modern world, as they enable registration, authentication, data input, and online transactions. It is hence imperative to ensure that they are accurate, reliable, and secure. Systematic testing is one of the fundamental tasks of software quality assurance, which allows performing strict validation and identifying critical bugs. The traditional web form testing is usually grounded on manual test cases and rule-based testing tools like Selenium, an automated web testing tool. Nevertheless, these solutions are not only labor-intensive, but also are expensive to maintain, have minimal scalability, and are not flexible enough to accommodate frequent user interface works. In 2020-2025, the academic community has paid more and more attention to the use of Artificial Intelligence (AI) and the ability to reduce the drawbacks of traditional testing and improve the overall performance. The methods reviewed include AI-based methods, including Machine Learning (ML), Deep Learning (DL), Natural Language Processing (NLP), Reinforcement Learning (RL), Large Language Models (LLMs), and hybrid or agent-based systems. Literature is analyzed to find out the trends and new innovations that are emerging, and the empirical evidence shows the strengths and weaknesses. The AI-driven test-generation efforts in related fields, including task-based conversational agents and requirement-based testing models, are briefly discussed. The review demonstrates a change of manual and rule-based web form testing to AI-based techniques, in particular, ML, NLP, RL and LLMs. The types of LLM-based and hybrid methods are superior to traditional methods, although the problems of reliability, scalability, explainability, standardization, and privacy remain. We also outline a number of potential lines of future work that can enable the development of accurate, robust and efficient AI-inspired web form testing solutions consistent with these results.

Keywords: AI-driven test-generation, Web form testing, Test case generation, Software testing, Large Language Models

A Review of Audio Deepfake Detection Beyond English Benchmarks for Low Resource Conversational Speech

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Abstract

Recent advances in neural speech synthesis and voice conversion technologies have enabled the generation of highly realistic synthetic speech, significantly amplifying security threats through audio deepfakes, including sophisticated impersonation attacks, fraud, and misinformation campaigns in voice-based communication systems. The research community has consequently invested significant resources into audio deepfake detection. Nevertheless, the practical usefulness of the state-of-the-art systems is limited. This review presents a systematic and critical analysis of audio deepfake detection literature and identifies three fundamental and recurring gaps (i) a pronounced English-centric bias driven by benchmark datasets such as the ASVspoof series, which restricts cross-lingual generalization, (ii) insufficient robustness under real-world conditions involving codec compression, environmental noise, replay attacks, and channel mismatch and (iii) lack of studies on low-resource conversational and code-switched speech. The review examines the evolution of detection approaches across feature representations, architectural paradigms, which include cepstral features, end-to-end neural design and self-supervised learning design. Finally, the review explains how benchmark-based design decisions veil the instability of systems in practice. Specific focus is given to the artifacts presented by neural vocoders as language-neutral forensic indicators and the way that they could mitigate linguistic reliance on detection pipelines. By comparing the synthesis of the methods of detection, robustness analysis and cross-lingual transfer, the review shows that the current methods struggle significantly with the spontaneous, conversational speech. When investigating low-resource languages like Sinhala, the review highlights the necessity to shift away the benchmark-based development to the robust, artifact-based identification frameworks that are responsive to the real-world, multilingual, conversational settings.

Keywords: audio deepfake detection, synthetic speech detection, text-to-speech, neural vocoder artifacts, low-resource languages, sinhala speech processing

A Review of Eye Region Based Deepfake Detection Under Resolution Degradation and Demographic Bias

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Abstract

Eye-region analysis has emerged as a targeted forensic approach to detect deepfakes due to the involuntary and rich data generated by the eye-region, and the accessibility of such information. This paper aims to critically examine the reliability and real-world applicability of eye-region-based deepfake detection methods under practical constraints. The review discusses how eye-based signals such as pupil geometry, appearance variables, blink behavior, and gaze consistency have been utilized across detection methods, and why they often fail to generalize beyond controlled settings. To achieve this, a narrative review methodology is adopted, where relevant literature is identified through academic databases and screened based on inclusion criteria focusing on visual deepfake detection, eye-region cues, robustness, and demographic analysis. Selected studies are categorized into thematic groups including detection techniques, resolution and compression effects, fairness and demographic bias, and dataset limitations, enabling structured comparative analysis. Coherent patterns of weakness are identified by synthesizing findings across these dimensions. Eye-region signals are shown to be highly sensitive to image quality distortions such as resolution degradation, compression, and illumination variation, leading to significant performance deterioration. These limitations are further amplified by dataset biases, particularly the lack of demographic diversity and underrepresentation of South Asian faces in widely used benchmarks, which obscures subgroup-specific failure modes and challenges claims of general robustness. This review contributes by providing an integrated analysis of robustness, fairness, and evaluation practices in eye-region deepfake detection, highlighting structural limitations that hinder reliable deployment. The findings emphasize the need for resolution-aware evaluation, demographically balanced datasets, and comprehensive benchmarking strategies to support robust and fair deepfake detection systems.

Keywords: Deepfake detection, Eye-region forensics, Resolution degradation, Demographic bias, Computer vision forensics

A Review of Self-Supervised and Drift-Aware Anomaly Detection for Industrial Data Streams

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Abstract

Modern industrial machinery generates high-velocity sensor data. Industries rely on automated anomaly detection to identify faults because manual monitoring of these data streams is impractical. But traditional supervised learning is difficult to implement due to the scarcity of labeled anomalous samples in industrial settings. This implies that anomaly detection in industrial data streams must adapt to concept drift - data distribution shifts caused by machine wear, environmental changes, or material variations - without relying solely on labeled samples. To address this challenge, the field is increasingly adopting unsupervised and self-supervised learning (SSL) for multivariate time-series anomaly detection (MTS-AD). This study analyzes the transition from conventional statistical approaches to advanced SSL methods, specifically evaluating their robustness against concept drift. We provide a dataset-centric comparison of model adaptability, utilizing the sewing industry as a practical case study representing high-speed mechanical production with frequent material transitions. This literature review critically analyzes the traditional statistical methods, autoencoder-based networks, and transformer-based models for industrial anomaly detection. Our findings highlight that while reconstruction-based models can efficiently compute on edge machines, transformer architecture can more readily capture multivariate dependencies. Additionally, we highlight the limitations of traditional benchmark datasets and demonstrate how lightweight, adaptive windowing and continuous learning processes can be combined to reduce false alarms in dynamic environments. Finally, the review outlines important research gaps and offers future opportunities for creating robust, self-sustaining industrial monitoring systems.

Keywords: Anomaly Detection, Concept Drift, Industrial Data Streams, Multivariate Time Series, Self-Supervised Learning

Modelling Misinformation Spread in Social Networks: An Agent-Based Approach with Algorithmic Feed Ranking and Fact-Checking Mechanisms

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Abstract

Misinformation spread in social media platforms can be described as a critical societal challenge, since algorithmic amplification and echo chamber formation continue to accelerate the reach of false content across digital environments. In this paper, an Agent-Based Model is proposed to simulate the dynamics of misinformation spread within a small-world social network, where three types of agents (regular users, influencers, and fact-checkers) interact through an algorithmic feed ranking system. The simulation environment is implemented using NetLogo 7 with 220 agents, and the feed ranking algorithm is designed to incorporate four components: recency, engagement, tie weight, and sensationalism, which collectively determine content visibility in terms of each agent's personalised feed. Since false posts are assigned higher sensationalism scores on average, the algorithm naturally amplifies misinformation even without explicit intent. Further, the model captures echo chamber formation through dynamic tie-weight reinforcement, where repeated interaction with similar content strengthens connections between agents. Fact-checker agents are introduced as an intervention mechanism that can flag false content and reduce its sharing probability. The results obtained from the simulation depict that the net spread of misinformation depends on the competing forces of algorithmic amplification (sensationalism advantage: $+0.40$) and fact-check-driven suppression (flagging effect: -0.77), while echo chambers emerge organically with mean tie weight growing by 51.6% over the simulation period. A four-layer validation framework, consisting of stylized fact reproduction, distributional analysis, parameter calibration, and sensitivity analysis, is employed to evaluate the model in terms of empirical grounding and robustness, and all six stylized facts from the misinformation literature are successfully reproduced. The proposed model provides mechanism-level insights for platform design and policy decisions regarding fact-checking coverage and algorithmic transparency.

Keywords: Agent-Based Modelling, Misinformation, Social Media, Algorithmic Amplification, Fact-Checking

Agent-Based Simulation of Grocery Store Checkout Queuing with Dynamic Lane Management, Shift-Based Staffing, and Self-Checkout Integration

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Abstract

The checkout process is one of the most critical bottlenecks in retail operations, since prolonged customer waiting times directly degrade satisfaction and elevate abandonment rates. Classical M/M/c queueing models rest on simplistic assumptions of identical servers, memoryless interarrivals, and passive customers that poorly characterise modern grocery environments, where lanes are specialised and customers actively switch queues. This paper presents a high-fidelity agent-based simulation in NetLogo 7.0.2 that addresses these limitations by modelling two interacting agent breeds (customers and cashiers) and incorporating seven configurable mechanisms. The model supports four heterogeneous cashier types: cash, card, express, and self-checkout, all governed by strict lane-eligibility rules, and adds behavioural realism through threshold-based jockeying with hysteresis to suppress oscillatory thrashing. Dynamic idle-to-express conversion, express overflow redirection, and adjustable per-shift staffing are coupled with a sinusoidal dual-peak arrival process that produces gradual rather than step-wise demand transitions. Service logic is lane-dependent: regular lanes follow stochastic per-item processing in which cash transactions take roughly 83% longer than card payments, while express lanes use a fixed 60-second service window. The resulting P95-to-mean ratio of $4.94\times$ indicates moderately heavy-tailed waiting behaviour driven primarily by shift-transition transients. Notably, the lean staffing configuration (Shift 2) achieves the highest utilisation without compromising throughput, because adaptive jockeying and lane conversion absorb the transition peaks. These results show that combining heterogeneous lane structures with demand-responsive, shift-based staffing maintains stable operating performance under stochastic demand.

Keywords: Agent-based simulation, Queueing theory, Jockeying, Self-checkout, Shift scheduling

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