



INTELLIGENCE • INNOVATION • IMPACT
Shaping the Future With AI and Engineering

ABSTRACT BOOK

ORGANIZED BY



EVEREST ENGINEERING COLLEGE
Sanepa, Lalitpur-2, Nepal

CO-ORGANIZER



SUPPORTED BY



विश्वविद्यालय अनुदान आयोग
University Grants Commission

KNOWLEDGE PARTNER



RECOGNIZED BY



नेपाल इन्जिनियरिङ्ग परिषद्
Nepal Engineering Council

TECHNICAL SUPPORT BY



Nepal Section



Abstract Book

This is the short version of the booklet for print use. Full abstracts with all authors, references, and figures can be found in the electronic version at
<https://eemc.edu.np/public/aicse/index.html>

Contents

About	6
About IC-AICSE 2026	6
Message from the Chief Guest	9
Message from the CEO	11
Message from the Conference Chair & Principal	12
Message from the Conference Member Secretary	13
Message from the Co-Organizer	14
Distinguished Keynote Speakers	15
Organizing Committee	16
Advisory Board	17
 List of Abstracts – Talks	 19
A Hybrid VAE–GAT–Transformer and Signature-Based Intrusion Detection Framework for Zero-Day Attack Detection in Enterprise and IoMT Networks . .	19
Multimodal Emotion Recognition for Nepali Speakers Using Fused Facial and Audio Convolutional Neural Networks	20
A Regularized Multilayer Feedforward Neural Network for Early-Stage Diabetes Risk Prediction	21
A Unified Deep Learning Framework for Brain Tumor MRI Classification with Domain Adaptation, Ensemble Learning, and Uncertainty Estimation . . .	22
Adaptive Precision Hybrid Binary–Stochastic Neural Network Accelerator with GA-Optimized Stochastic Number Generator Architecture for Energy-Efficient Edge AI	23
Advanced Radiomix-Attention Fusion CNN: A Radiomics-Guided Deep Learning Framework for Uterine Fibroid Detection	24
Agentic Retrieval-Augmented Generation with Knowledge-Graph Memory for Quality-Gated First-Response Orchestration in Enterprise Support Systems	25
AI-Based Wearable Assistive System for Physiotherapy Rehabilitation	26
Computational Modeling and Multi-Objective Particle Swarm Optimization of a Cam-Actuated Dual-Finger Seedling Separation Mechanism for Non-Mat Rice Transplanters	27
Deep Learning to Predict the Nature of Line Charge for Given Potential in Unit Sphere	28
Detecting Protected Health Information (PHI) in Heterogeneous Email Attachments	29
Enhancing Sentiment Analysis of Romanized Code-Mixed Nepali Social Media Text Through Monolingual Transformation	30
Enhancing the AI-Powered Anti-Money Laundering System Using Adversarial Robust Testing	31

Evaluating Google's Open Knowledge Format (OKF v0.1) for Multi-Agent Threat Intelligence	32
Detection and Mitigation in IoT Ecosystems	33
Explainable Multi-Modal Deep Learning for Early Cancer Biomarker Prediction Using Genomic and Multi-Omics Datasets	34
Fiber Anomalies Detection and Localization in Optical Network using GRU-AE and A-BiGRU	35
Phishing Scams in Emerging Digital Economies—Evidence from Nepal	36
Hybrid Variational Quantum-Classical Framework with Adaptive Weighting and Efficiency Assessment	37
Leakage-Aware Temporal Acoustic Representation Learning for Reliable Voice-Based Parkinson's Disease Detection	38
Machine Learning Techniques for Tabular Data Classification and Regression	39
Assessing the Value of Waiting Time at Narayan Gopal Chowk Intersection, Kathmandu	40
Multi-Objective Feature Selection for Enhanced Efficiency in Phishing URL Detection	41
Multiple Access Using LoRa Communication	42
Optimal Siting of Fast Charging Stations along the Prithvi Highway using GIS-based MCDA	43
Plant Pest Identification and Treatment Recommendation Using Deep Learning	44
AI-Based Plant Disease Detection	45
Predicting E- mobility adoption in Nepal: An Analytical Hierarchy Process and System Dynamics Approach	46
Multi-View Anomaly Detection for Black-Box Prompt Injection Defense in Large Language Models	47
Questioning the Benchmarks: Hidden Circularity in AQ-10 Autism Screening Datasets	48
RARE-AI: Intelligent Risk-Aware Routing for Cross-Border Payments Using Explainable Artificial Intelligence	49
Analysing the Direct and Indirect Impacts of Basic Sanitation Initiatives in Nepal	50
A Web-Based GIS and Machine Learning Framework for Grid-Wise Flood Risk Monitoring and Early Warning	51
EdgeQuakeNet: A Federated Transformer Framework for Real-Time Earthquake Early Warning on Resource-Constrained Edge Devices	52
An Ensemble Based Approach for Facial Emotion Recognition	53
NepScript Genesis: Neural Architecture Search for Handwritten Devanagari Digit Synthesis	54
Encoder-Decoder vs. Decoder-Only Transformers for AI-to-Human Text Style Transfer	55
A Preliminary Treatability Assessment of Textile Industry Effluent in Nepal	56
Bridging the Resource Gap: Nepali-Assisted Transfer Learning for Low-Resource Nepal Bhasa–English Neural Machine Translation with NLLB-200 and mBART-50	57

Spatiotemporal, Topographic, and Climatic Analysis of New and Small Glacial
Lakes in Dudhkoshi River Basin 57

A Comparative Evaluation of Traditional and Transformer-Based Approaches
for Detecting Hate Speech in Nepali Political Content 58

Design and Evaluation of Machine Learning Models for Predicting At-Risk Stu-
dents in Universities 59

Legal Divorce Chatbot: A Retrieval-Augmented Generation Based Nepali Legal
Question Answering System 60

Exploring Explainable AI for At-Risk Student Prediction in Education 61

Multi-Objective Deep Reinforcement Learning-Based Spatial Optimization of
Green Infrastructure in High-Density Up-Growing Cities 62

Partner Institutions and Sponsors

About IC-AICSE 2026

The **International Conference on Artificial Intelligence in Computational Science and Engineering (AICSE 2026)** is an international academic forum organized by **Everest Engineering College**, affiliated to **Pokhara University**, Nepal. The conference is scheduled for **7 October 2026** and is expected to bring together more than 200 participants, including researchers, academicians, engineers, industry professionals, innovators, and students.

AICSE 2026 has been conceived to provide a multidisciplinary platform for presenting research, exchanging knowledge, discussing emerging technologies, and developing academic and professional collaborations. The conference recognizes the growing influence of Artificial Intelligence and computational technologies across scientific, engineering, financial, environmental, and digital domains.

The conference welcomes original research papers, review articles, case studies, and applied research contributions addressing contemporary challenges and emerging developments. Its thematic scope includes:

- **Computer Engineering and Information Technology:** Artificial Intelligence, Machine Learning, Deep Learning, Software Engineering, Embedded Systems, Internet of Things (IoT), Computer Networks, Communication, and Cybersecurity.
- **Computational Science:** Applied and Computational Mathematics, Computational Biology and Bioinformatics, Computational Physics, and Computational Chemistry.
- **Cybersecurity and Digital Forensics:** Disk, Memory, and Network Forensics, Digital Forensics and Incident Response (DFIR), Legal Compliance, and Fraud Investigation.
- **FinTech and Applications:** Digital and Neo Banking, InsurTech, and RegTech.
- **Civil Engineering:** Structural Engineering, Transportation Engineering, and Hydropower Engineering.
- **Environmental Science and Engineering:** Environmental Science and Engineering, Climate Change and Environmental Management, Geographic Information Sys-

tems (GIS), and Remote Sensing.

AICSE 2026 places particular emphasis on AI-driven innovation, intelligent systems, computational modelling, sustainable technologies, cybersecurity, and digital transformation. Through keynote sessions, technical paper presentations, panel discussions, and networking activities, the conference aims to facilitate interaction between academia, industry, research institutions, government organizations, and other stakeholders.

The conference also provides an avenue for research dissemination through the publication of accepted and presented papers in the designated **Special Issue of the EAST Journal**, subject to the journal's applicable editorial and publication processes. Published papers are intended to receive **Digital Object Identifier (DOI)** identification, supporting discoverability and citation.

More than a conference, AICSE 2026 seeks to become a platform for building research networks, encouraging interdisciplinary thinking, supporting emerging researchers, and fostering collaborations that can contribute to technological and scientific advancement in Nepal and internationally.

About Everest Engineering College

Everest Engineering College (EEC) is an academic institution located in Sanepa, Lalitpur, Nepal, affiliated with Pokhara University. The college is committed to providing quality engineering education while encouraging innovation, professional development, research, and engagement with emerging technologies.

In an era characterized by rapid technological advancement, engineering education extends beyond the acquisition of technical knowledge. It requires an environment where students and faculty members can explore new ideas, conduct research, develop practical solutions, and respond to the evolving needs of society and industry. Everest Engineering College seeks to contribute to this academic and professional environment through education, research, and collaborative initiatives.

The college recognizes the growing importance of **Artificial Intelligence**, computational science, digital technologies, cybersecurity, sustainable engineering, and interdisciplinary research. By encouraging academic interaction and research-oriented activities, EEC aims to provide opportunities for learners and professionals to engage with contemporary developments in engineering and technology.

The organization of **AICSE 2026** reflects this commitment to research and knowledge exchange. Through the conference, Everest Engineering College provides a platform for researchers, academicians, engineers, industry professionals, and students to present their work, exchange perspectives, and establish professional and academic connections.

The college also values collaboration with other academic institutions, professional organizations, industry partners, and research communities. Such collaboration is essential for developing a stronger research culture and creating opportunities for knowledge transfer and innovation.

With a focus on academic excellence, innovation, professional responsibility, and technological advancement, Everest Engineering College continues to support initiatives that connect education with real-world challenges and emerging opportunities.

Everest Engineering College

Sanepa, Lalitpur-02, Nepal

Tel: +977-9843152917

Email: admin@eemc.edu.np

Message from the Chief Guest



Prof. Chandra Mani Paudel,
PhD

President
Bagmati University

It is my great pleasure to extend my warm greetings and best wishes on the occasion of the **International Conference on Artificial Intelligence in Computational Science and Engineering (AICSE 2026)**.

The rapid advancement of Artificial Intelligence and computational technologies is transforming research, education, industry, and society. For Nepal, strengthening research and innovation is essential for building a knowledge-based and technologically capable society. Conferences such as AICSE 2026 provide an important platform for researchers, academicians, professionals, industry experts, and students to share knowledge, present research findings, and develop meaningful collaborations.

I particularly appreciate the initiative of Everest Engineering College, a private academic institution, in organizing an international research conference of this scale. Such an initiative is significant for strengthening the culture of research and innovation in Nepal. The organization of AICSE 2026 is an important milestone for the college and demonstrates the valuable role that private higher-education institutions can play in promoting research, knowledge exchange, and academic excellence.

Nepal needs stronger collaboration among universities, colleges, research institutions, industries, and other stakeholders to address national challenges. Research and innovation in areas such as Artificial Intelligence, computational science, cybersecurity, digital forensics, FinTech, engineering, environmental science, and other emerging technologies can contribute significantly to sustainable development and the advancement of our society.

AICSE 2026 also provides valuable opportunities for young researchers and students to present their work, receive academic feedback, engage with experts, and build professional networks. Such opportunities are important for nurturing the next generation of researchers, engineers, and innovators in Nepal.

The initiative of a private engineering college to organize an international conference focused on research and emerging technologies is commendable. I hope this conference will encourage further collaboration between academia and industry and inspire other academic institutions to promote similar research-oriented activities.

I would like to express my sincere appreciation to the organizing committee, **Everest Engineering College**, researchers, reviewers, participating institutions, industry partners, and all contributors for their efforts in making AICSE 2026 possible. I warmly welcome all distinguished guests, researchers, presenters, delegates, and participants.

I am confident that the research presentations, discussions, and interactions during the conference will generate valuable ideas and contribute to the advancement of research and innovation in Nepal.

I wish **AICSE 2026** every success and hope that it will be a productive, inspiring, and memorable academic experience for all participants.

Message from the CEO



Mr. Arun Kumar Bhandari

Chief Executive Officer
Everest Engineering College

It is my great pleasure to extend my warm greetings and best wishes on the occasion of the **International Conference on Artificial Intelligence in Computational Science and Engineering (AICSE 2026)**.

The rapid advancement of Artificial Intelligence and computational technologies is transforming the way we understand problems, develop solutions, conduct research, and deliver services across almost every sector. For a developing nation like Nepal, embracing these technologies through meaningful research, innovation, and collaboration is essential for building a resilient and knowledge-driven future.

AICSE 2026 provides an important platform for researchers, academicians, engineers, industry professionals, innovators, and students to share their knowledge, research findings, and practical experiences. The conference brings together diverse fields including Artificial Intelligence, computational science, cybersecurity, digital forensics, FinTech, civil engineering, environmental science, and other emerging areas of technology.

At Everest Engineering College, we believe that quality education must go hand in hand with research, innovation, professional ethics, and social responsibility. Through initiatives such as AICSE 2026, we aim to strengthen connections among academia, industry, research institutions, and other stakeholders, creating opportunities for knowledge exchange and collaborative problem-solving.

I am confident that the discussions, research presentations, and interactions during this conference will generate valuable ideas and encourage further research and innovation. I also hope that AICSE 2026 will contribute to strengthening Nepal's position within the growing global research and technology community.

I extend my sincere appreciation to the organizing committee, researchers, reviewers, participating institutions, industry partners, and all contributors whose efforts have made this conference possible. I warmly welcome all distinguished guests, delegates, presenters, and participants to AICSE 2026.

I wish the conference every success and hope that it becomes a meaningful and memorable academic experience for everyone involved.

Message from the Conference Chair & Principal



Prof. Dr. Hari Krishna Shrestha

Conference Chair & Principal
Everest Engineering College

It gives me immense pleasure to welcome researchers, academicians, professionals, industry experts, and students to the **International Conference on Artificial Intelligence in Computational Science and Engineering (AICSE 2026)**.

We are living in an era in which Artificial Intelligence is no longer confined to computer science laboratories. It is increasingly becoming an integral part of scientific discovery, engineering design, environmental management, financial systems, cybersecurity, health-care, communication, and many other dimensions of modern society. This transformation calls for interdisciplinary research that combines technological innovation with domain-specific knowledge.

AICSE 2026 has therefore been conceived as a forum where diverse academic and professional communities can come together to explore the opportunities and challenges created by intelligent and computational technologies. The conference encompasses a broad spectrum of areas, including Artificial Intelligence and Machine Learning, Software Engineering, IoT, Computer Networks, Cybersecurity, Computational Mathematics, Computational Biology, Computational Physics and Chemistry, FinTech, Civil Engineering, Environmental Science, Climate Change, GIS, and Remote Sensing.

The quality of a conference is ultimately reflected in the quality of ideas exchanged through it. We have therefore encouraged original research, review studies, case studies, and applied research contributions that can advance knowledge and address contemporary scientific and engineering challenges. The peer-review and technical presentation process is intended to promote scholarly discussion and constructive academic engagement.

As Conference Chair, I would like to express my sincere gratitude to the organizing committee, reviewers, authors, partner institutions, and all those who have contributed their time and expertise to AICSE 2026. I particularly appreciate the enthusiasm of young researchers and students whose participation is vital to the future of research and innovation.

I hope this conference will serve not merely as an event for presenting papers, but as a foundation for new collaborations, research partnerships, and ideas that continue beyond the conference itself.

Message from the Conference Member Secretary



Assoc. Prof. Er. Rajan Lama
Member Secretary, AICSE 2026
Everest Engineering College

It is my privilege to welcome you to the **International Conference on Artificial Intelligence in Computational Science and Engineering (AICSE 2026)**. The conference represents a collective effort to create a platform for meaningful academic dialogue, research dissemination, and professional interaction among scholars and practitioners from Nepal and beyond.

The organization of an international conference is a collaborative undertaking. From the submission and review of research papers to technical sessions, participant coordination, and academic networking, every stage requires the commitment of researchers, reviewers, organizers, institutions, and participants. AICSE 2026 has been designed with this spirit of collaboration at its core.

The thematic breadth of this conference reflects the increasingly interconnected nature of modern research. Artificial Intelligence and computational approaches are being applied across engineering, science, cybersecurity, financial technology, environmental management, and digital transformation. Bringing these disciplines together allows us to examine common challenges from multiple perspectives and identify opportunities for interdisciplinary research.

We are particularly pleased to provide a platform for emerging researchers and students to present their work, interact with experienced academics and professionals, and become part of a wider research community. Such interaction is essential for developing research capacity and encouraging a culture of innovation.

I sincerely thank all authors who have contributed their research to this conference, as well as the reviewers and members of the organizing committee for their valuable contributions. I also acknowledge the support of Everest Engineering College and our collaborating institutions in making AICSE 2026 possible.

I hope that every participant will find this conference intellectually stimulating and professionally rewarding, and that the discussions initiated here will lead to sustained academic collaboration and future research initiatives.

Message from the Co-Organizer



Er. Charchit Nagila

*Acting Principal, HIST College
Co-Organizer, AICSE 2026*

It is a matter of great pleasure for **HIST College** to be associated with the **International Conference on Artificial Intelligence in Computational Science and Engineering (AICSE 2026)** as a co-organizing institution.

The pace of technological change has created both unprecedented opportunities and complex challenges for education, research, industry, and society. Artificial Intelligence and computational technologies are becoming powerful instruments for addressing these challenges, but their meaningful application requires collaboration across disciplines and institutions.

Academic institutions have a particularly important role in this transformation. We must encourage students and researchers not only to acquire technical knowledge, but also to investigate real-world problems, develop innovative solutions, and consider the wider implications of emerging technologies. Conferences such as AICSE 2026 provide an important environment for nurturing this culture of inquiry and innovation.

The interdisciplinary scope of AICSE 2026 is especially valuable. By bringing together researchers from computing, computational science, cybersecurity, FinTech, civil engineering, environmental science, and related fields, the conference encourages participants to look beyond traditional disciplinary boundaries.

HIST College is pleased to support an initiative that promotes research communication, knowledge sharing, and institutional collaboration. We believe that partnerships between academic institutions can play a significant role in strengthening Nepal's research ecosystem and creating opportunities for students, faculty members, and professionals.

I extend my sincere appreciation to Everest Engineering College, the conference organizing committee, reviewers, authors, presenters, and all participating institutions for their contributions to this academic initiative.

I wish AICSE 2026 a successful and enriching conference and hope that the ideas exchanged during the event will contribute to further research, innovation, and collaboration.

Distinguished Keynote Speakers



Prof. Dr. Kyoung Y. Bae

*Sogang University
Seoul, South Korea*

Prof. Dr. Kyoung Y. Bae

Prof. Dr. Kyoung Y. Bae is a distinguished academic affiliated with Sogang University, South Korea. His academic and professional expertise contributes to the broader field of computing and emerging technologies. Through his research and academic engagement, he contributes to the advancement of knowledge and innovation in contemporary technology and computational research.

Keynote Focus: Artificial Intelligence, Computational Intelligence, Emerging Computing Technologies, and Intelligent Systems.



**Prof. Dr. Adebayo
Abayomi-Alli**

*Department of Information
Systems
Vilnius Tech
Vilnius, Lithuania*

Prof. Dr. Adebayo Abayomi-Alli

Prof. Dr. Adebayo Abayomi-Alli is a researcher and academic in the field of computing and information technology. His academic background includes Computer Engineering and Computer Science, with research interests that include pattern recognition, machine learning, and intelligent computational systems. He has also been involved in international research, academic, and professional activities.

His work reflects an interdisciplinary interest in the application of computational intelligence and machine learning to practical problems.

Keynote Focus: Artificial Intelligence, Machine Learning, Pattern Recognition, and Intelligent Computational Systems.



Dr. Sojen Pradhan

*University of Technology
Sydney
Sydney, Australia*

Dr. Sojen Pradhan

Dr. Sojen Pradhan is a Senior Lecturer at the University of Technology Sydney. He has more than 25 years of teaching experience and has been involved in academic and community-oriented initiatives. His research focuses on the intersection of social innovation, digital platforms, and community development. His work has addressed a range of social and cultural issues, including innovative approaches to rural tourism and education in developing countries, volunteering opportunities, and the use of digital platforms for community development.

Keynote Focus: Digital Transformation, Social Innovation, Digital Platforms, Community Development, and Technology for Society.

Organizing Committee

The core organizing committee designated to lead the IC-AICSE conference.



**Prof. Dr. Hari Krishna
Shrestha**

Conference Chair
Everest Engineering
College



**Assoc. Prof. Er. Rajan
Lama**

Member Secretary
Everest Engineering
College



Er. Narayan Sapkota
Member

Everest Engineering
College



Er. Mukunda Paudel
Member

Everest Engineering
College



Er. Pradip Paudel
Member

Everest Engineering
College



Er. Romharsh Oli
Member

Everest Engineering
College



**Asst. Prof. Er. Charchit
Nagila**

Member
Himalayan Institute of
Science and Technology



**Asst. Prof. Ram Prasad
Neupane**

Member
Himalayan Institute of
Science and Technology

Advisory Board



Er. Laxmi Nath Nepal
Civil Engineering
Everest Engineering
College
Nepal



Mr. Arun Kumar Bhandari
Mathematics
Everest Engineering
College
Nepal



Prof. Dr. Subarna Shakya
Computer Science
Tribhuvan University
Nepal



Prof. Dr. Arun Kumar Timilsina
Computer Science
Tribhuvan University
Nepal



Prof. Dr. Gajendra Sharma
Computer Science
Kathmandu University
Nepal



Prof. Dr. Daniel Oluwasegun Adams
Mathematics
University of Agriculture
Nigeria



Prof. Dr. Ramkaji Budhathoki
Computer Science
Kathmandu University
Nepal



Assoc. Prof. Dr. Manoj Shakya
Artificial Intelligence
Kathmandu University
Nepal



Assoc. Prof. Dr. Ajay Kumar Jha
Mechanical and Renewable Energy
Tribhuvan University
Nepal



**Assoc. Prof. Dr.
Deepanjal Shrestha**
Computer Science
Pokhara University
Nepal



**Asst. Prof. Dr. Sarbagya
Ratna Shakya**
Artificial Intelligence
Eastern New Mexico
University

List of Abstracts – Talks

A Hybrid VAE–GAT–Transformer and Signature-Based Intrusion Detection Framework for Zero-Day Attack Detection in Enterprise and IoMT Networks

Om Prakash Panjiyar¹, Shambhu Gautam¹

¹ Lord Budha Education Foundation, Asia Pacific University of Technology & Innovation, Kathmandu, Nepal

The rapid growth of smart systems, Internet of Things (IoT), Industrial Internet of Things (IIoT), and cloud computing environments has significantly increased the frequency and complexity of cyberattacks, including advanced persistent threats (APTs), ransomware, zero-day exploits, and polymorphic malware. Traditional signature-based Intrusion Detection Systems (IDSs) achieve high accuracy in detecting known attacks but struggle with previously unseen threats. In contrast, deep learning-based IDS approaches provide improved zero-day attack detection capabilities but often suffer from high false-positive rates, significant computational requirements, and limited adaptability across diverse network environments. This paper proposes HDLTSIDS, a hybrid intrusion detection framework that combines signature-based detection with advanced deep learning techniques to improve the detection of both known and unknown cyber threats. The proposed architecture integrates a Variational Autoencoder (VAE) for unsupervised feature learning and anomaly detection, a Graph Attention Network (GAT) for modelling complex relationships among network traffic instances, and a Transformer Encoder for capturing long-range contextual dependencies in network flows. The signature-based detection module provides reliable identification of known attack patterns while reducing false positives generated by the deep learning component. The proposed framework will be evaluated using enterprise benchmark dataset UNSW-NB15 and Internet of Medical Things (IoMT) benchmark dataset CICIoMT2024 using performance metrics including accuracy, precision, recall, F1-score, Matthews Correlation Coefficient (MCC), Area Under the Receiver Operating Characteristic Curve (AUC-ROC), False Positive Rate (FPR), and inference latency. The proposed approach aims to achieve improved zero-day attack detection, enhanced generalization across different cyber environments, reduced false-positive rates, and a scalable intrusion detection solution for next-generation intelligent network security systems.

Keywords: Cybersecurity, Intrusion Detection System (IDS), Hybrid Deep Learning, Variational Autoencoder (VAE), Graph Attention Network (GAT), Transformer Encoder, Signature-Based Detection, Anomaly Detection, Zero-Day Attack Detection, Internet of Medical Things (IoMT).

Multimodal Emotion Recognition for Nepali Speakers Using Fused Facial and Audio Convolutional Neural Networks

Yaman Sigdel¹, Shubham Pokhrel¹, Bipin Thapa Magar², Sarbagya Ratna Maharjan¹, Shaligram Bhatta¹

¹ Department of Electronics and Computer Engineering, Sagarmatha Engineering College, Lalitpur, Nepal

² Department of Electrical and Computer Engineering, University of Kentucky, Kentucky, USA

Recognizing human emotions in real time is an essential component of natural human-machine interaction; however, accurate emotion understanding remains challenging due to the complexity of human expressions and the limited representation of underexplored languages and cultures such as Nepali. This paper presents a multimodal emotion recognition framework for Nepali speakers that jointly analyzes facial expressions and vocal characteristics to classify five emotional states: neutral, happy, sad, angry, and surprised. The proposed system employs two parallel Convolutional Neural Network (CNN) models, where an audio-based model learns from acoustic features including Zero-Crossing Rate (ZCR), Root Mean Square Energy (RMSE), and Mel-Frequency Cepstral Coefficients (MFCCs) extracted from spectrogram representations, while a facial expression model processes visual information for emotion classification. Both models are trained using a custom Nepali emotion dataset containing more than 35,800 facial images and 2,652 audio samples collected and augmented to represent local linguistic and cultural expression patterns. The outputs of the two models are combined through a reliability-weighted fusion mechanism, assigning approximately 65% contribution to facial information and 35% contribution to audio information based on modality reliability. Experimental evaluation demonstrates facial emotion recognition accuracy of 66% and audio emotion recognition accuracy of 80%, with class-level analysis showing complementary strengths between the two modalities. The fused model effectively integrates visual and acoustic cues, demonstrating the feasibility of culturally localized multimodal emotion recognition systems. The proposed approach provides a foundation for developing more inclusive human-computer interaction systems capable of understanding emotional expressions from underrepresented linguistic communities.

Keywords: Emotion Recognition, Convolutional Neural Network (CNN), Multimodal Fusion, Speech Processing, Facial Expression Analysis, Human-Computer Interaction, Nepali Language Processing, Audio-Visual Learning.

A Regularized Multilayer Feedforward Neural Network for Early-Stage Diabetes Risk Prediction

Avinabh Thakur¹

¹ Department of Electrical and Electronics Engineering, Kathmandu University, Dhulikhel, Nepal

Diabetes mellitus is one of the fastest-growing chronic metabolic disorders worldwide, and its silent progression makes early, low-cost screening essential, particularly in resource-constrained regions where laboratory-based diagnosis may be expensive and difficult to access. This paper presents a regularized multilayer feedforward neural network (MFNN), trained using the error backpropagation algorithm, for binary classification of diabetes risk using the Pima Indians Diabetes Dataset (PIDD). Physiologically invalid zero values in five clinical attributes are treated as missing-at-random and imputed using attribute-wise median values. Nine engineered features, including pairwise interaction terms, second-order polynomial features, a clinically motivated insulin-resistance ratio, and binary risk indicators, are combined with the eight original attributes to create a 17-dimensional feature space that enables the network to capture complex nonlinear relationships between glucose, adiposity, and diabetes risk factors. The proposed network consists of two hidden layers with 64 and 32 rectified linear units, regularized using L2 weight decay, batch normalization, and dropout, followed by a sigmoid output layer. Class-balanced loss weighting, early stopping based on validation area under the curve (AUC), and learning-rate annealing are employed to address class imbalance and reduce overfitting. On a stratified held-out test partition containing 20% of the 768 records, the proposed model achieves 74.68% accuracy, 76.59% balanced accuracy, and an area under the receiver operating characteristic curve (AUC) of 0.810. By selecting the operating threshold using Youden's J statistic, the model achieves 91.1% sensitivity and 74.0% specificity, demonstrating suitability for screening applications where minimizing false negatives is critical. Additionally, an interactive inference widget is demonstrated for point-of-care risk estimation. The results show that the proposed approach provides competitive performance compared with existing backpropagation-based methods on the same dataset.

Keywords: Diabetes Mellitus, Artificial Neural Network, Multilayer Feedforward Neural Network, Backpropagation, Deep Learning, Feature Engineering, Pima Indians Diabetes Dataset, Class Imbalance, Medical Diagnosis, Healthcare Informatics, ROC Analysis.

A Unified Deep Learning Framework for Brain Tumor MRI Classification with Domain Adaptation, Ensemble Learning, and Uncertainty Estimation

Puja Bist¹, Prem Singh Bist², Yagya Raj Pandeya³

¹ Cosmos College of Management and Technology, Pokhara University, Nepal

² Nanyang Technological University, Singapore

³ Department of Artificial Intelligence, Kathmandu University, Dhulikhel, Nepal

Brain tumor classification from Magnetic Resonance Imaging (MRI) remains a challenging task due to limited model generalization across diverse datasets and insufficient estimation of prediction reliability, which restricts the clinical applicability of deep learning-based diagnostic systems. This paper presents a unified deep learning framework for four-class brain tumor MRI classification that integrates ensemble learning, domain adaptation, uncertainty estimation, and model interpretability. The proposed framework combines an ensemble of ResNet50, DenseNet121, and EfficientNetB0 architectures with Deep Correlation Alignment (Deep CORAL) for improving cross-dataset generalization. Temperature scaling is incorporated to enhance prediction calibration, while Monte Carlo Dropout is employed for uncertainty estimation to quantify model confidence. Additionally, Gradient-weighted Class Activation Mapping (Grad-CAM) is utilized to provide visual explanations of model predictions and improve transparency. The proposed framework is evaluated on independent MRI datasets using established classification performance metrics, calibration measures, and uncertainty assessment methods. By integrating complementary techniques within a single pipeline, the proposed approach improves predictive robustness, reliability, and interpretability for brain tumor classification. The framework aims to support the development of trustworthy and clinically deployable artificial intelligence systems for medical image analysis, particularly in resource-constrained healthcare environments.

Keywords: Brain Tumor Classification, Uncertainty Quantification, Model Interpretability, ResNet50, DenseNet121, EfficientNetB0

Adaptive Precision Hybrid Binary–Stochastic Neural Network Accelerator with GA-Optimized Stochastic Number Generator Architecture for Energy-Efficient Edge AI

A Dinesh Babu¹, C Gomathy¹

¹ Department of Electronics and Communication Engineering, SRM Institute of Science and Technology, Chennai, Tamil Nadu, India

The rapid adoption of artificial intelligence (AI) in edge healthcare applications has increased the demand for neural network accelerators capable of achieving high inference accuracy while satisfying strict power, latency, and hardware resource constraints. Although stochastic computing (SC) provides significant advantages in arithmetic simplicity and fault tolerance compared with conventional binary implementations, its practical deployment is limited by stochastic bitstream correlation, high stochastic number generator (SNG) overhead, and increased computation time due to fixed-length bitstreams. This paper proposes an Adaptive Precision Hybrid Binary–Stochastic Neural Network Accelerator incorporating a Genetic Algorithm (GA)-optimized SNG architecture to overcome these limitations. The proposed framework combines binary computation for input feature processing with stochastic arithmetic operations in hidden layers, exploiting the numerical precision of binary computing and the hardware efficiency of stochastic computing. A GA-based optimization strategy is employed to optimize LFSR seed selection, primitive polynomial assignment, and bitstream permutation to minimize stochastic computing correlation (SCC) and mean squared error (MSE) while reducing SNG hardware complexity. Furthermore, an adaptive precision controller dynamically adjusts stochastic bitstream lengths based on prediction confidence, reducing unnecessary computation while maintaining inference accuracy. The proposed architecture targets implementation on a Xilinx Arty Z7 FPGA and is evaluated using the Pima Indians Diabetes Dataset as a representative biomedical inference application. Based on architectural analysis and preliminary design evaluation, the proposed accelerator is expected to achieve classification accuracy exceeding 92%, reduce total power consumption by approximately 25–30%, decrease Look-Up Table (LUT) utilization by nearly 20%, improve inference throughput by 30–40%, and reduce energy per prediction by approximately 35% compared with conventional stochastic implementations while maintaining zero Digital Signal Processing (DSP) utilization. The proposed hybrid architecture establishes a scalable and reconfigurable hardware framework for ultra-low-power edge AI accelerators, enabling applications in wearable healthcare devices, Internet of Things (IoT) platforms, and real-time biomedical decision-support systems.

Keywords: Stochastic Computing, Adaptive Precision, Stochastic Number Generator, Field-Programmable Gate Array (FPGA), Neural Network Accelerator, Edge AI, Low-Power Very Large-Scale Integration (VLSI), Biomedical Hardware Acceleration.

Advanced Radiomix-Attention Fusion CNN: A Radiomics-Guided Deep Learning Framework for Uterine Fibroid Detection

Sangeetha Ilayaraja¹, J Srinivasan¹

¹ Department of Computer Science and Applications, SCSVMV University, Kanchipuram, TN, India

In order to promote gynaecological screening, lessen the burden of diagnosis, and aid in early treatment planning, accurate automated recognition of uterine fibroids from medical imaging is therapeutically crucial. However, uterine lesions may exhibit varied size, shape, texture, boundary visibility, and intensity distribution across imaging settings, making fibroid image classification still difficult. The quantitative texture and morphological information that is crucial for fibroid characterisation may not be explicitly preserved by conventional CNN-based classifiers, even if they can learn helpful visual patterns. This research suggests a Radiomix Attention Fusion Convolutional Neural Network for uterine fibroid diagnosis employing radiomics-guided deep feature integration in order to overcome this constraint. To enhance the classification of uterine fibroid images, the suggested framework combines gated Radiomix feature fusion, channel-spatial attention, radiomics-inspired quantitative descriptor encoding, and CNN feature extraction based on transfer learning. The CNN branch extracts hierarchical visual features from uterine imaging data, whereas the radiomics branch records lesion form, intensity variation, and texture heterogeneity. Before final classification, the Radiomix fusion block improves tumor-relevant representations by adaptively combining both feature streams. Accuracy, sensitivity, specificity, precision, F1-score, and AUC are the performance metrics used to assess the model using the publically accessible classification_fibroid dataset. By enhancing feature discrimination in comparison to CNN-only, radiomics-only, and attention-CNN baseline models, the suggested framework aims to attain classification accuracy above 95%. This work's primary innovation is the combination of attention-refined deep features and radiomics-guided quantitative descriptors into a single uterine fibroid identification framework. The suggested methodology provides a technically scalable and practically relevant AI-assisted method for accurate classification of uterine fibroid images.

Keywords: Convolutional neural networks, radiomics, medical picture categorisation, uterine fibroid identification, Radiomix attention fusion, and artificial intelligence.

Agentic Retrieval-Augmented Generation with Knowledge-Graph Memory for Quality-Gated First-Response Orchestration in Enterprise Support Systems

Sangita Sharma¹

¹ Aqore Software Pvt. Ltd., Kathmandu, Nepal

Service Level Agreement (SLA) breaches remain a significant challenge in enterprise customer support systems due to reactive workflows, fragmented knowledge sources, and delayed response processes that often result in repeated clarification cycles with clients. Although Large Language Models (LLMs) enable automated response generation, many enterprise deployments remain limited to chatbot-style interactions and lack persistent memory, structured reasoning over organizational knowledge, and governance mechanisms for client-facing decisions. This paper presents an Agentic Retrieval-Augmented Generation (RAG) architecture, implemented and evaluated in a production support environment at Aqore, that integrates semantic retrieval and structured knowledge reasoning through a knowledge-graph-powered memory layer. The proposed memory layer combines entity and relationship extraction from unstructured sources, including documentation, previous support tickets, and internal wikis, with structured operational information such as employee, billing, and system records. A parallel vector embedding store enables dense semantic retrieval of relevant unstructured context. The system further incorporates sentiment and intent analysis of client-agent conversation threads to enhance contextual reasoning and identify potential escalation risks. A key contribution of this work is a quality-gated first-response orchestration mechanism, where generated responses are evaluated using grounding evidence, contextual relevance, and confidence scores before initiating client-facing actions. Responses that fail predefined quality thresholds are redirected for internal review under a human-in-the-loop governance framework. The architecture also incorporates a closed-loop knowledge feedback mechanism to identify documentation gaps and continuously improve enterprise knowledge coverage. Evaluation on enterprise support data using metrics including AI First-Response Coverage Rate, Zero-touch Resolution Rate, and Decision Accuracy demonstrates approximately 80% accuracy for well-documented request categories. The findings indicate that effective SLA optimization depends not only on language model capability but also on the integration of memory, retrieval, workflow orchestration, and human oversight within enterprise support systems.

Keywords: Agentic Artificial Intelligence, Retrieval-Augmented Generation, Enterprise Intelligent Customer Support Systems, Human-in-the-Loop, Decision Intelligence

AI-Based Wearable Assistive System for Physiotherapy Rehabilitation

Yogini Borole¹, Kaustubh Walunj¹

¹ Mitramandal's Institute of Technology, Pune, India

Home-based physiotherapy is widely adopted for rehabilitation following musculoskeletal injuries, neurological disorders, and post-operative conditions. However, the lack of continuous therapist supervision often results in incorrect posture, improper joint movement, and unsafe exercise execution, which can reduce rehabilitation effectiveness and increase the risk of secondary injuries. Existing wearable rehabilitation systems primarily focus on motion tracking and provide limited capabilities for adaptive physical assistance and real-time corrective feedback. This paper presents an Artificial Intelligence (AI)-based wearable rehabilitation system integrated with a lightweight adaptive soft exoskeleton to improve posture recognition, movement accuracy, and patient safety during home-based physiotherapy. The proposed system utilizes wearable Inertial Measurement Units (IMUs) and flex sensors to capture joint kinematics and body posture information. Sensor measurements are processed using a Kalman filter to minimize noise and enhance motion tracking accuracy, while machine learning algorithms analyze movement patterns and identify deviations from clinically correct exercise techniques. When incorrect posture or unsafe movements are detected, the system provides real-time haptic feedback through vibration modules and visual guidance through a mobile application. The adaptive soft exoskeleton dynamically modifies assistance levels according to movement quality and rehabilitation progress, helping guide joints along safer movement trajectories. The proposed framework is evaluated using knee flexion, shoulder abduction, and hip extension exercises involving healthy individuals and post-operative patients. Biomechanical modelling and control simulations performed in MATLAB demonstrate improved posture recognition, reduced motion tracking error, fewer unsafe movement patterns, and enhanced exercise performance compared with conventional wearable motion-tracking rehabilitation systems. The integration of artificial intelligence-based movement assessment, Kalman-filter-based sensing, real-time feedback mechanisms, and adaptive soft-exoskeleton assistance provides a practical approach for personalized home-based physiotherapy, improving rehabilitation outcomes, patient confidence, and reducing dependence on continuous therapist supervision.

Keywords: Wearable Rehabilitation System, Soft Exoskeleton, Artificial Intelligence-Assisted Rehabilitation, Physiotherapy, Motion Tracking, Posture Recognition, Kalman Filter, Haptic Feedback, Home-Based Healthcare.

Computational Modeling and Multi-Objective Particle Swarm Optimization of a Cam-Actuated Dual-Finger Seedling Separation Mechanism for Non-Mat Rice Transplanters

Bhupendra Kumar Yadav¹, Ritesh Dev¹, Daan B. Ghartimagar¹, Ganesh B. Singh¹

¹ Department of R&D, National Innovation Center, Nepal

Rice is one of the major agricultural crops in Nepal, and transplantation is a critical farming operation. However, many small-scale farmers continue to rely on manual transplanting methods, particularly for non-mat rice seedlings, which present challenges such as root entanglement, irregular seedling distribution, and damage during picking and separation. This study proposes a computational mathematical modeling approach combined with Multi-Objective Particle Swarm Optimization (MOPSO) for the design and optimization of a cam-actuated dual-finger seedling separation mechanism for manual rice transplanters. A comprehensive mathematical model is developed to describe the kinematic and dynamic behavior of the cam-follower system and dual-finger mechanism, including finger displacement, velocity, acceleration, gripping force, operating torque, and power consumption. The proposed model and optimization framework are implemented in MATLAB for numerical simulation, mechanism analysis, and multi-objective optimization. The performance of the mechanism is evaluated using seedling separation efficiency, seedling damage rate, missed pickup rate, and power consumption as optimization objectives. MOPSO is applied to maximize separation efficiency while minimizing seedling damage, missed pickups, and energy requirements. The optimization variables include cam radius, finger length, finger opening angle, spring stiffness, and operating speed. The resulting Pareto-optimal solutions provide balanced design alternatives and identify suitable operating conditions without extensive experimental trial-and-error. This computational framework aims to support the development of efficient, reliable, and affordable manual rice transplanters for Nepalese agriculture by improving transplanting performance, reducing labour requirements, and advancing precision agricultural machinery.

Keywords: Non-Mat Rice Seedlings, Computational Mathematical Modeling, Multi-Objective Particle Swarm Optimization (MOPSO), Rice Transplanter, Agricultural Machinery, Precision Agriculture, Mechanism Design.

Deep Learning to Predict the Nature of Line Charge for Given Potential in Unit Sphere

Rijan Niraula¹, Ganesh P.S. Kushawa¹

¹ Manmohan Technical University, Budhiganga, Morang, Nepal

This paper presents a deep learning framework for inverse design in electrostatics, enabling the prediction of closed-loop line charge configurations that generate user-specified electric potentials on the surface of the unit sphere. The target potential is discretized over the spherical surface using a grid of 50 divisions along the polar angle (θ) and 50 divisions along the azimuthal angle (ϕ), providing high-resolution boundary conditions. A deep neural network directly maps the discretized potential distribution to the spatial coordinates of a closed-loop line charge, achieving accuracy of around 92%. The network predicts the two-dimensional coordinates of the closed loop with an angular resolution of 7.2° (50 equally spaced points over 360°), lying outside the unit sphere in an annular region. The framework is validated through predictions for (i) equipotential conditions on the unit sphere and (ii) special constant field configurations obtained by linearly scaling canonical harmonic functions to match observed network potential limits, accompanied by quantitative error analysis comparing predicted and target configurations.

Keywords: Inverse design, electrostatics, deep learning, neural networks, line charges, potential theory, electric fields, computational electromagnetics.

Detecting Protected Health Information (PHI) in Heterogeneous Email Attachments: A Systematic Review of Local-First, Edge-AI Frameworks

Sanjesh Panta¹, Khagendra Koirala², Anjan Chandra Paudel³, Bishow Kaji Shrestha⁴

¹ IMS, Tinkune, Kathmandu, Nepal

² St. Lawrence College, Chabahil, Kathmandu, Nepal

³ Institute of Engineering, Tribhuvan University, Lalitpur, Nepal

⁴ Tribhuvan University, Kirtipur, Nepal

The rapid growth of generative artificial intelligence and cloud-based webmail platforms has created a significant privacy challenge for enterprises, where employees frequently transmit sensitive corporate and clinical information, including Protected Health Information (PHI) and Personally Identifiable Information (PII), through outgoing emails. Traditional Data Loss Prevention (DLP) systems primarily rely on cloud-based scanning infrastructures, which introduce concerns related to privacy, data sovereignty, and processing latency. Recent edge-computing approaches address these limitations by deploying lightweight, quantized Small Language Models (SLMs) and Recurrent Neural Networks (RNNs), such as Long Short-Term Memory (LSTM) networks, directly within user environments for detecting plain-text data leakage. However, existing solutions remain limited in their ability to analyze complex email attachments, including scanned documents, images, PDF files, word-processing documents, and spreadsheets. This paper presents a systematic review of privacy-preserving, local-first, edge artificial intelligence (Edge-AI) frameworks for detecting PHI leakage in heterogeneous email attachments. The reviewed approach introduces a privacy-aware browser extension architecture that intercepts outgoing emails, extracts information from diverse attachments through local Optical Character Recognition (OCR) and document parsing pipelines, and analyzes extracted content using lightweight quantized SLMs. By performing data extraction, pattern matching, and model inference entirely on the user's device, the framework ensures enhanced privacy protection and data sovereignty. Furthermore, the approach addresses adversarial evasion threats through intelligent preprocessing mechanisms capable of identifying obfuscated text, unusual encoding patterns, and hidden payloads before model inference. Experimental evaluation scenarios demonstrate that real-time, device-side blocking of unsafe attachments combined with informative user warnings provides an effective strategy for improving enterprise and clinical endpoint security. This work highlights the potential of local-first Edge-AI architectures as a scalable and privacy-preserving alternative for modern healthcare and enterprise data protection systems.

Keywords: PHI, DLP, Edge-AI, Small Language Model, Privacy-Preserving Computing

Enhancing Sentiment Analysis of Romanized Code-Mixed Nepali Social Media Text Through Monolingual Transformation

Safal Sharma¹, Apar Poudel¹, Bidur Devkota¹

¹ Department of Computer Engineering, Gandaki College of Engineering and Science, Pokhara, Nepal

Romanized Nepali has become the dominant script for communication on social media platforms in Nepal. However, existing artificial intelligence models face significant challenges in processing such content due to the script gap created by their primary training on formal Devanagari text. Sentiment analysis of Romanized Nepali social media content is further complicated by inconsistent spelling patterns, word-sense ambiguity, code-mixing, and limited availability of annotated datasets. This paper investigates whether monolingual transformation of code-mixed Romanized Nepali text can improve sentiment classification performance by converting informal social media content into standardized linguistic representations. Two normalization strategies are explored: transformation from Romanized Nepali into Devanagari Nepali and conversion into high-resource English through human annotation. A preprocessing pipeline is developed to remove irrelevant social media noise, normalize informal spellings based on pronunciation patterns, and transform code-mixed content into either standardized Devanagari Nepali or English representations. Transformer-based multilingual models, including XLM-RoBERTa, Multilingual BERT (mBERT), and Multilingual Representations for Indian Languages (MuRIL), are trained and evaluated on more than 10,000 annotated social media posts categorized into positive, negative, and neutral sentiments. Experimental results demonstrate that script normalization and reduction of code-switching improve sentiment classification performance, with XLM-RoBERTa achieving a Macro F1-score of 0.7093 on normalized Devanagari text compared with 0.67 on raw Romanized text. Similar improvements are observed for mBERT and MuRIL, highlighting the importance of script normalization for processing informal and dialectal Nepali text. Although challenges remain in understanding casual slang and idiomatic expressions, this study provides a foundation for future research in online hate speech detection and sentiment analysis across diverse Nepali language variations.

Keywords: Sentiment Analysis, Romanized Nepali, Code-Mixed Text, XLM-RoBERTa, Multilingual BERT

Enhancing the AI-Powered Anti-Money Laundering System Using Adversarial Robust Testing

Apurva Nepal¹, Manoj Pandey¹, Prabhat Acharya¹, Yagya Raj Pandeya²

¹ King's College Kathmandu, Nepal

² Department of Artificial Intelligence, Kathmandu University, Dhulikhel, Nepal

Existing artificial intelligence (AI)-based anti-money laundering (AML) systems primarily focus on improving detection accuracy while often overlooking their resilience against adversarial attacks designed to manipulate transactions and evade detection. This research proposes an enhanced AI-powered AML framework that integrates transaction detection with adversarial robustness testing to improve system reliability and security. In the detection component, the Synthetic Transaction Monitoring Dataset for Anti-Money Laundering (SAML-D), containing 9.5 million synthetic transactions with diverse customer profiles and payment attributes, is utilized. After preprocessing, transaction-level risk scores are generated using the XGBoost algorithm. These transaction representations are then used to construct a graph-based model, where transactions and entities are represented as nodes, and a Graph Neural Network (GNN) is applied to identify complex relationships and suspicious patterns among connected entities. In the security component, adversarially perturbed transaction patterns are generated to evaluate the vulnerability of the detection model and measure the impact of evasion attacks on classification performance. The model is subsequently retrained using adversarial examples that successfully bypass the initial detection system, improving robustness against future attacks. Additionally, SHAP (Shapley Additive Explanations) is employed to interpret feature contributions, justify parameter interactions, and provide transparency in identifying false positive predictions. This research contributes toward developing more secure, explainable, and robust anti-money laundering systems suitable for real-world financial applications.

Keywords: Anti-Money Laundering, XGBoost, Graph Neural Network, Adversarial Robustness, SHAP (Shapley Additive Explanations)

Evaluating Google's Open Knowledge Format (OKF v0.1) for Multi-Agent Threat Intelligence: A Proof-of-Concept in Digital Forensics

Sushant Poudel¹, Rakhee Pandey¹

¹ Department Computer Engineering, Nepal Engineering College, Bhaktapur, Nepal

Large Language Models (LLMs) are reshaping Digital Forensics and Incident Response (DFIR), but the unstructured JSON telemetry these systems still rely on has become a critical bottleneck for autonomous multi-agent threat intelligence pipelines. In high-noise forensic environments, ingesting monolithic data dumps drives context exhaustion, inflates latency, and triggers hallucination rates severe enough to undermine operational integrity. This paper evaluates Google's Open Knowledge Format (OKF v0.1) as a selectively traversable, graph-native alternative to flat serialization. Through a controlled benchmark of 7,680 inference cycles spanning five open-source model architectures and escalating decoy densities, we show that OKF Selective sustains noise-invariant recall (0.94–0.99), cuts token overhead by 33.6%, and suppresses hallucination by more than 80% relative to a JSON baseline. These results establish that semantic knowledge representation is not simply an engineering optimization — it is an architectural prerequisite for trustworthy autonomous cyber defense.

Keywords: Multi-Agent Systems, Digital Forensics, Large Language Models, Open Knowledge Format, Threat Intelligence, Autonomous Cyber Defense

Detection and Mitigation in IoT Ecosystems: An Empirical Study of Physical-Layer Surveillance and Stateful CSI Obfuscation

Sushant Poudel¹, Aashika Pandey¹, Ashish Kr. Jha¹

¹ Department of Computer Engineering, Nepal Engineering College, Bhaktapur, Nepal

Wi-Fi was originally designed for data communication; however, recent advancements have transformed it into a pervasive environmental sensing platform capable of detecting motion, inferring human behaviour, and reconstructing physical activities through signal reflection analysis. The increasing sensing capability of Wi-Fi introduces a significant and largely overlooked attack surface, particularly in Internet of Things (IoT) ecosystems where existing security mechanisms were not designed to address physical-layer surveillance threats. This paper presents an empirical evaluation of covert Wi-Fi sensing attacks under realistic and interference-prone IoT environments. The study demonstrates that a passive adversary equipped with commercially available hardware can extract fine-grained keystroke information, including PIN entry patterns, without network authentication, physical access, or malicious packet injection. Experimental evaluation shows that the attack achieves an F1-score of 85.4% in enterprise line-of-sight environments and maintains 61.2% accuracy through a standard 15 cm drywall barrier, significantly outperforming random classification performance in a ten-class problem. To mitigate this threat, the study introduces RF-Guard, a deterministic and stateful Channel State Information (CSI) obfuscation framework implemented at the firmware level. RF-Guard reduces adversarial classification accuracy to 9.8% across three IoT testbeds, remains effective against adaptive signal-smoothing attacks, and introduces less than 4.2% throughput degradation on ESP32 microcontrollers during continuous 24-hour stress testing. The proposed approach requires no hardware replacement and provides an efficient defence mechanism against covert Wi-Fi sensing attacks in resource-constrained IoT environments.

Keywords: Wi-Fi Sensing, Channel State Information, Physical-Layer Security, IoT Security, Keystroke Inference, Side-Channel Attack, CSI Obfuscation

Explainable Multi-Modal Deep Learning for Early Cancer Biomarker Prediction Using Genomic and Multi-Omics Datasets

Yogini Borole¹

¹ Mitramandal's Institute of Technology, Pune, India

Early cancer diagnosis remains a significant challenge due to the complex interactions among genomic, transcriptomic, epigenomic, metabolomic, and histopathological factors. Conventional deep learning models and statistical biomarker discovery approaches often struggle to effectively integrate heterogeneous biological data sources, resulting in limited interpretability, reduced cross-institutional generalizability, and decreased clinical confidence. This study presents an updated evaluation of explainable multi-modal deep learning frameworks for early cancer biomarker prediction using integrated multi-omics and imaging datasets. The review examines recent advances in transformer architectures, graph neural networks, foundation models, federated learning, and explainable artificial intelligence techniques, including SHapley Additive exPlanations (SHAP) and attention-based feature attribution methods, for transparent biomarker discovery and clinical decision support. The proposed framework emphasizes the integration of genomic profiles, molecular biomarkers, histopathological images, and clinical metadata to improve early-stage cancer detection, cancer subtype classification, survival prediction, and treatment response assessment. Furthermore, privacy-preserving collaborative learning approaches for multi-center healthcare environments are explored to enhance model robustness while maintaining patient data confidentiality. The study also investigates current challenges associated with data heterogeneity, computational requirements, model interpretability, and clinical deployment. The findings indicate that explainable multi-modal deep learning approaches have substantial potential to enable scalable, transparent, and reliable decision-support systems for precision oncology while facilitating the discovery of clinically meaningful early-stage cancer biomarkers.

Keywords: Biomarker Identification, Multi-Omics Integration, Explainable Artificial Intelligence, Transformer Networks, Graph Neural Networks, Federated Learning, Precision Oncology, Genomic Datasets, Multi-Modal Deep Learning, Early Cancer Diagnosis.

Fiber Anomalies Detection and Localization in Optical Network using GRU-AE and A-BiGRU

Belmata Bhandari¹, Sharad Kumar Ghimire¹

¹ Department of Electronics and Computer Engineering, Pulchowk Campus, IOE, Tribhuvan University, Nepal

Optical fiber networks form the backbone of modern telecommunication systems due to their high bandwidth and low latency. However, their physical infrastructure is highly vulnerable to anomalies such as fiber cuts and signal losses, necessitating rapid diagnosis to reduce network downtime. This paper proposes a robust two-stage deep learning framework for the automated anomaly detection and fault localization utilizing Optical Time Domain Reflectometry (OTDR) traces directly accumulated from live DWDM backbone network monitors. We describe a Gated Recurrent Unit-Autoencoder (GRU-AE) that reconstructs fixed-length spatial bins to score anomaly presence, successfully yielding an AUC of 0.9400. Subsequently, an Attention-based Bidirectional GRU(A-BiGRU) models fault location via sharp contextual regression over the fiber sequences, attaining a localization Root Mean Square Error (RMSE) of 0.76 km. The methodologies signify a practical, machine learning-driven approach superseding traditional manual OTDR analyses.

Keywords: Optical Fiber, Anomaly Detection, Fault Localization, GRU-AE, A-BiGRU, OTDR.

Phishing Scams in Emerging Digital Economies—Evidence from Nepal

Ganesh Bhusal¹

¹ Softwarica College of IT and E-Commerce, Kathmandu, Nepal

Banking phishing is the dominant initial-access vector for financial cybercrime in emerging digital economies, where rapid mobile-money adoption has outpaced consumer protection and authentication infrastructure. In Nepal, the mobile wallet user base grew 260% between 2020 and 2024 to reach 22.62 million, and the Financial Intelligence Unit (FIU-Nepal) reports that 64% of fraud-related Suspicious Transaction/Activity Reports (STR/SARs) filed in the first five months of 2024 were cyber-enabled, mostly through OTP harvesting, social-media impersonation, and mule account exploitation. No published framework combines phishing-resistant authentication, machine-learning detection, sector intelligence sharing, and localized awareness in a form suited to emerging-economy constraints. This paper closes that gap with five contributions: (i) empirical characterization of Nepal's attack landscape from 151 sampled FIU-Nepal STR/SARs; (ii) a formal STRIDE+DREAD threat model identifying 14 threats across three trust boundaries, nine rated High severity ($DREAD \geq 11$); (iii) the HBPDF four-layer framework integrating FIDO2/Passkey authentication, a hybrid Gradient Boosting plus Isolation Forest detection pipeline, NFS-ISAC sector intelligence sharing, and branch-anchored localized awareness; (iv) PaySim ML validation yielding $F1 = 0.998$ and $ROC\ AUC = 0.999$, with label-noise robustness testing across 0–10% noise levels ($F1 = 0.981$ at 5%); and (v) a phased implementation roadmap aligned with NIST CSF 2.0 and PCI-DSS v4.0. Grounded in primary regulatory data and validated against a peer-reviewed benchmark, the framework provides a replicable blueprint for comparable mobile money economies in South Asia and Sub-Saharan Africa.

Keywords: banking phishing; cyber-enabled fraud; FIDO2/Passkey; machine learning; Isolation Forest; gradient boosting; STRIDE+DREAD; NFS-ISAC; mobile banking security; Nepal; NIST CSF 2.0; emerging digital economies.

Hybrid Variational Quantum-Classical Framework with Adaptive Weighting and Efficiency Assessment

Dilli Hang Rai¹

¹ Institute of Science and Technology, Tribhuvan University, Kirtipur, Nepal

Hybrid quantum-classical neural networks have emerged as a promising approach for integrating quantum computing capabilities into machine learning while addressing the limitations of current quantum hardware. This paper presents a Deep Quantum Neural Network (DQNN) for handwritten digit classification on the Modified National Institute of Standards and Technology (MNIST) dataset using a hybrid architecture that combines classical feature extraction with a Variational Quantum Circuit (VQC). The proposed framework first reduces high-dimensional image features through a classical neural network and subsequently encodes the compressed representations into an 8-qubit quantum circuit using angle embedding and strongly entangling layers. The resulting quantum measurement expectation values are utilized for final classification. To provide a comprehensive evaluation, the study investigates model reproducibility through multi-seed experiments, evaluates performance across different dataset conditions, including MNIST and low-resource indigenous scripts of Nepal, and analyses the effect of varying training dataset sizes. Additionally, a lightweight interpretability analysis is conducted to examine latent feature representations and quantum measurement outputs. The proposed framework aims to establish an efficient and reproducible benchmark for hybrid quantum machine learning while improving transparency and practical understanding of quantum-enhanced classification models. The study provides insights into the potential of variational quantum approaches for future machine learning applications under evolving quantum computing constraints.

Keywords: Hybrid Quantum-Classical Learning, Deep Quantum Neural Network (DQNN), Variational Quantum Circuit (VQC), Quantum Machine Learning, Handwritten Digit Classification, MNIST Dataset, Quantum Computing, Neural Networks.

Leakage-Aware Temporal Acoustic Representation Learning for Reliable Voice-Based Parkinson's Disease Detection

Ms Pavithra J¹, Mari Kamarasan¹

¹ Department of Computer & Information Science, Faculty of Science, Annamalai University, Chidambaram, India

Voice-based machine learning provides a promising non-invasive approach for screening Parkinson's disease (PD); however, reported performance can be significantly affected by data leakage caused by subject overlap, acquisition-domain variation, and duplicated recordings. This paper presents a leakage-aware robust temporal acoustic representation framework designed for reliable voice-based Parkinson's disease detection. The proposed approach incorporates source-normalized preprocessing, energy-adaptive voice-region selection, 19 frame-level acoustic descriptors, and a 133-dimensional temporal distributional representation. Each descriptor trajectory is summarized using statistical and temporal measures, including median, interquartile range, 10th and 90th percentiles, median and interquartile range of absolute first differences, and lag-1 autocorrelation, enabling the capture of central tendency, variability, distribution characteristics, local dynamics, and temporal persistence without requiring sequence padding. A class-balanced radial basis function Support Vector Machine (SVM) is evaluated under strict validation protocols involving exact-content grouping, de-duplication, subject-disjoint validation, and cross-corpus transfer. The proposed representation achieves 92.42% accuracy, 95.00% sensitivity, 89.90% specificity, and an Area Under the Receiver Operating Characteristic Curve (AUC-ROC) of 0.977 on the de-duplicated primary corpus. In contrast, naïve instance-level validation achieves 98.77% accuracy due to data leakage, where 78.7% of test instances contain identical copies within training folds. Evaluation on a repeated-recording cohort demonstrates that random record-level validation achieves 69.23% accuracy, while subject-disjoint evaluation decreases performance to 55.96%; robust subject aggregation improves performance to 72.50% under nested validation. Additive-noise experiments reveal performance degradation below a 20 dB signal-to-noise ratio, and cross-corpus transfer approaches chance-level performance. The findings highlight the importance of leakage-aware validation and external-domain robustness testing while demonstrating the effectiveness of temporal acoustic encoding for reliable Parkinson's disease voice modelling under controlled conditions.

Keywords: Parkinson's Disease, Speech Analysis, Temporal Acoustic Representation, Leakage-Aware Validation, Voice-Based Disease Detection, Support Vector Machine, Domain Shift, Acoustic Feature Learning.

Machine Learning Techniques for Tabular Data Classification and Regression: A Systematic Literature Review of Traditional and Deep Learning Approaches

Parash Mani Shah¹, Narendra Sharki¹, Dipesh Yadav¹, Mahesh Dahal¹

¹ Department of Graduate Studies, Everest Engineering College, Lalitpur, Nepal

Structured data represented in tabular form remains the dominant data format across domains such as healthcare, finance, cybersecurity, manufacturing, and business analytics. Traditional machine learning algorithms, including Decision Trees, Random Forest, XG-Boost, LightGBM, and CatBoost, have consistently demonstrated strong predictive performance on tabular datasets. More recently, advances in deep learning have introduced specialized architectures such as TabNet, TabTransformer, FT-Transformer, TabPFN, and TabR, designed specifically to address the unique characteristics of tabular data. Despite these developments, a comprehensive and up-to-date systematic comparison of traditional machine learning and modern deep learning approaches for both classification and regression tasks remains limited. This study presents a Systematic Literature Review (SLR) of research published between 2020 and 2026, following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Relevant studies will be identified through comprehensive searches of IEEE Xplore, ACM Digital Library, ScienceDirect, and Google Scholar. The review will examine commonly used algorithms, benchmark datasets, data preprocessing techniques, evaluation metrics, comparative performance, emerging research trends, limitations, and open challenges in tabular machine learning. Furthermore, it will identify research gaps and highlight future directions for developing robust, scalable, and interpretable machine learning models for tabular data. The findings aim to provide researchers and practitioners with a comprehensive reference to the current state of the art in machine learning techniques for tabular data classification and regression.

Keywords: Structured Data, Tabular Data, Classification, Regression

Assessing the Value of Waiting Time at Narayan Gopal Chowk Intersection, Kathmandu: A Stated Preference Case Study

Sandip K.C.¹, Pradeep Kumar Shrestha¹

¹ Department of Civil Engineering, Pulchowk Campus, Institute of Engineering, Tribhuvan University, Nepal

Traffic congestion at signalized intersections can impose substantial time costs on commuters, yet the monetary value travelers place on reducing intersection waiting time remains insufficiently studied in Nepal. This study estimates the Value of Waiting Time (VOWT) at Narayan Gopal Chowk, a congested intersection in Kathmandu, using a stated-preference (SP) choice experiment involving 384 valid respondents from 409 approached. Respondents were categorized by their primary travel mode into two-wheelers ($n = 141$), private cars ($n = 126$), and public transport ($n = 117$). Each respondent completed four binary choice tasks comparing existing waiting conditions with an alternative offering reduced delay at an additional cost. Separate binary logit models, equivalent to McFadden's (1974) two-alternative conditional logit specifications, were estimated for each travel mode, with standard errors clustered at the respondent level to account for the four repeated choices. The estimated VOWT was NPR 230.63/hr for two-wheeler users, NPR 549.47/hr for private car users, and NPR 90.91/hr for public transport users. Coefficient-level significance was assessed using Wald z-tests, while overall model significance was evaluated using Likelihood Ratio tests. A respondent-level bootstrap with 1,000 replications further supported the reliability of the estimates. All coefficients exhibited theoretically expected signs, and the baseline VOWT estimates fell within their corresponding 95% confidence intervals. The findings provide mode-specific estimates of the monetary value travelers place on reducing intersection waiting time and offer useful evidence for evaluating congestion and traffic management measures in Kathmandu.

Keywords: Value of Waiting Time, Binary Logit, Stated Preference, Discrete Choice Modeling, Traffic Congestion, Signalized Intersection.

Multi-Objective Feature Selection for Enhanced Efficiency in Phishing URL Detection

Gayatri Sharma¹, Binod Sapkota¹

¹ Department of Electronics and Computer Engineering, Thapathali Campus, Tribhuvan University, Nepal

Phishing attacks through deceptive URLs remain a significant and financially damaging cybersecurity threat worldwide. However, many existing machine learning-based phishing detection approaches rely on high-dimensional feature sets that require substantial memory and computational resources, limiting their deployment in resource-constrained environments such as browser extensions and mobile applications. This paper presents a multi-objective feature selection framework designed to improve the efficiency of phishing URL detection while maintaining reliable classification performance. The proposed approach formulates feature selection as a bi-objective optimization problem, simultaneously considering detection accuracy and model complexity. By integrating the Extreme Gradient Boosting (XGBoost) classifier with the Non-dominated Sorting Genetic Algorithm II (NSGA-II), the framework systematically identifies optimal feature subsets that achieve a balance between classification performance and reduced feature dimensionality. The proposed method is evaluated using the PHIUSIIL dataset, containing more than 234,624 labelled URL instances, to determine the most discriminative attributes for detecting malicious URLs. Experimental results demonstrate that the evolutionary optimization process converges to a knee-point solution, reducing feature dimensionality by more than 91.30% while maintaining near-baseline detection reliability. Rather than producing a single fixed model, the proposed framework generates multiple non-dominated solutions, enabling practitioners to select models according to specific hardware constraints and performance requirements. This study provides a practical foundation for developing lightweight, fast, and efficient phishing detection systems capable of delivering strong security protection with minimal computational overhead.

Keywords: Evolutionary Computation, Feature Selection, Multi-Objective Optimization, Phishing Detection, Web Security, XGBoost, Non-dominated Sorting Genetic Algorithm II (NSGA-II), Cybersecurity.

Multiple Access Using LoRa Communication

Rajeev Suwal¹, Binay Shrestha¹, Sandesh Machamasi¹, Pratistha Prajapati¹, Sarbagya Buddhacharya¹, Yogesh Bajracharya¹

¹ Department of Electronics, Communication and Automation, Khwopa Engineering College, Purbanchal University, Bhaktapur, Nepal

This study presents the development of a time-coordinated multiple access system using Long Range (LoRa) communication to achieve collision-free packet transmission for multi-node Internet of Things (IoT) applications. The proposed system implements Time Division Multiple Access (TDMA) to enable reliable communication among multiple sensor nodes. The developed framework consists of three ESP32-based transmitter nodes equipped with DHT22 temperature and humidity sensors, SX1278 LoRa transceivers, and DS3231 Real-Time Clock (RTC) modules. These nodes communicate with a Raspberry Pi-based receiver node through a synchronized communication link. The performance of the proposed system is evaluated through one-hour experiments involving three communication links at distances of 450 m, 650 m, and 710 m, where each node transmits environmental data within assigned TDMA slots. The results demonstrate that no inter-node packet collisions occur during TDMA operation, achieving packet delivery rates of 95%, 84%, and 92% for the respective communication links. Furthermore, the study shows that LoRa communication using a spreading factor of 12 (SF=12), coding rate of 4/8 (CR=4/8), and transmission power of 20 dBm can extend the communication range up to 1.3 km. The findings demonstrate that RTC-synchronized TDMA provides an efficient and reliable communication mechanism for multi-node LoRa networks and can support scalable IoT applications requiring low-power and long-range connectivity.

Keywords: Long Range Communication (LoRa), Time Division Multiple Access (TDMA), Internet of Things (IoT), ESP32, Wireless Sensor Networks, Low-Power Wide-Area Networks, Multi-Node Communication.

Optimal Siting of Fast Charging Stations along the Prithvi Highway using GIS-based MCDA

Prajwal Chirague Niroula¹, Bishnu Prasad Devkota²

¹ Department of Transportation Engineering and Management, Nepal Engineering College, Lalitpur, Nepal

² Nepal Electricity Authority (NEA), Kathmandu, Nepal

The rapid adoption of electric vehicles (EVs) in Nepal has outpaced the development of public charging infrastructure, resulting in uneven station distribution, charging deserts, and increased range anxiety during intercity travel. This study identifies optimal locations for public DC fast-charging stations along a 5 km corridor of the Prithvi Highway (Kathmandu–Pokhara) using a Geographic Information System (GIS)-based Multi-Criteria Decision Analysis (MCDA) framework. A mixed-method approach integrated expert knowledge with spatial analysis using six criteria: proximity to electrical grid infrastructure, traffic volume, proximity to existing charging stations, proximity to amenities, land-use suitability, and landslide hazard susceptibility. Criterion weights were determined using the Fuzzy Analytic Hierarchy Process (FAHP) based on expert judgments from 20 multidisciplinary professionals and incorporated into a Weighted Linear Combination (WLC) model in QGIS. Service gap analysis was also conducted to identify underserved highway segments. The FAHP results identified proximity to electrical grid infrastructure (29.66%) and traffic volume (25.17%) as the most influential criteria, followed by proximity to amenities (18.17%), distance from existing charging stations (13.81%), land-use suitability (8.05%), and landslide hazard susceptibility (5.15%). The expert judgment matrix achieved a Consistency Ratio (CR) of 0.096, indicating acceptable consistency. Spatial suitability mapping showed that highly suitable locations are concentrated near existing settlements and major highway intersections with reliable grid access, while environmentally constrained areas showed low suitability. Service gap analysis identified Dhunbesi, Galchhi, and Abu Khaireni as critical underserved sections. The findings demonstrate that integrating GIS with FAHP provides a robust decision-support framework for fast-charging station siting. The study recommends prioritizing identified service gap areas while considering grid accessibility, traffic demand, and traveler amenities. The proposed framework supports evidence-based EV charging infrastructure planning along national highway corridors in Nepal and can be adapted to similar transportation networks.

Keywords: Electric Vehicle (EV), DC Fast Charging Station, GIS-based Multi-Criteria Decision Analysis (MCDA), Geographic Information System (GIS), Fuzzy Analytic Hierarchy Process (FAHP), Spatial Suitability Analysis, Service Gap Analysis, Sustainable Transportation.

Plant Pest Identification and Treatment Recommendation Using Deep Learning

Kyathrin Chemjong¹, Rupesh Chaudhary¹, Prem B. KC²,

¹ Department of Computer Engineering, Lalitpur Engineering College, Institute of Engineering, Tribhuvan University, Lalitpur, Nepal,

¹ Department of Computer Science, Campus, Orchid International College, Nepal

Plant pests contribute substantially to crop losses, while access to timely and reliable pest diagnosis remains limited for many farmers. This study presents a web-based Plant Pest Identifier and Treatment Recommender that combines image classification with actionable pest-management guidance. The system was developed using pest images from the IP102 dataset supplemented with observations collected from iNaturalist. Images were organized by class, resized to 224×224 pixels, normalized, and augmented using geometric transformations. A custom Convolutional Neural Network (CNN) trained from scratch was compared with a fine-tuned ResNet-50 transfer-learning model. Both models were evaluated using validation accuracy, precision, recall, F1-score, loss curves, and confusion matrices. The custom CNN achieved 84.63% validation accuracy after 40 epochs, while ResNet-50 achieved 90.93% validation accuracy after 11 epochs. Although ResNet-50 provided higher classification performance, the custom CNN had lower model complexity and faster inference, making it a practical option for resource-constrained deployment. For each predicted pest, a rule-based mapping retrieves information on descriptions, symptoms, affected crops, and chemical, biological, or cultural control measures. The resulting application supports image uploading, pest prediction with confidence scores, and accessible treatment guidance. The study demonstrates that integrating visual pest recognition with recommendation logic can support earlier pest management and more informed crop-protection decisions. Future work should expand field-image coverage, validate treatment recommendations with agricultural experts, and develop a multilingual mobile interface.

Keywords: Convolutional Neural Network, Deep Learning, Image Classification, Plant Pest Identification, Precision Agriculture, Treatment Recommendation.

PlantDoc: AI-Based Plant Disease Detection App

Nayan Raj Pokharel¹, Sujan Dhungana¹, Ayush Koirala¹, Kiran Bagale¹

¹ Department of CSIT, Madan Bhandari Memorial College, Tribhuvan University, Kathmandu, Nepal

Plant diseases are a major threat to agricultural productivity, causing significant crop losses globally each year. In Nepal, where approximately 65% of the population depends on agriculture for their livelihood, early and accurate disease identification is critical for crop protection and food security. This project presents PlantDoc, an AI-powered mobile application that enables farmers to identify plant diseases in real time using a smartphone camera. The system employs transfer learning with MobileNetV2 as the backbone architecture, trained on 25,191 leaf images covering 15 disease classes across four major crops: Apple, Potato, Strawberry, and Tomato. A two-phase training strategy was adopted, with Phase 1 training the classification layers for 20 epochs while freezing the backbone, achieving 89.26% validation accuracy. Phase 2 fine-tuned the top 100 layers of the MobileNetV2 backbone for 80 additional epochs, achieving a final validation accuracy of 95.71%. Data augmentation was applied to improve model generalization and class balance. The system follows a client-server architecture, with a Flutter-based frontend supporting Android and iOS, and a FastAPI backend serving the trained TensorFlow Keras model through REST APIs. The application provides image capture, disease scan results, scan history, plant tracking, and user profile features, while authentication is managed using JSON Web Tokens (JWT). Scan records are stored in a SQLite database with optional Supabase cloud synchronization. System testing confirmed successful end-to-end operation across major use cases. The proposed system demonstrates that deep learning-based plant disease detection can be effectively deployed as a lightweight mobile application, providing a practical and accessible solution for precision agriculture.

Keywords: PlantDoc, Plant Disease Detection, Deep Learning, MobileNetV2, Transfer Learning, Precision Agriculture, Computer Vision, Flutter, FastAPI, Agricultural Technology.

Predicting E- mobility adoption in Nepal: An Analytical Hierarchy Process and System Dynamics Approach

Roshan Yadav¹, Bishnu Prasad Devkota²

¹ Department of Transportation Engineering and Management, Nepal Engineering College, Lalitpur, Nepal

² Nepal Electricity Authority (NEA), Kathmandu, Nepal

Nepal possesses significant hydropower resources, making the transition to electric mobility a strategic priority for reducing fossil fuel dependence and supporting climate goals. However, EV adoption is influenced by complex economic, technological, social, and policy-related factors. This study aims to identify and prioritize the multidimensional factors influencing electric vehicle (EV) adoption in Nepal using the Analytic Hierarchy Process (AHP). A mixed-method approach was adopted by synthesizing expert judgments from policymakers at the Ministry of Physical Infrastructure and Transport (MoPIT), utility planners from the Nepal Electricity Authority (NEA), academic researchers, and automotive industry leaders. The AHP results identify Economic Factors as the most influential driver of EV adoption, with a weight of 0.565, followed by Technological Factors (0.262), Social Factors (0.118), and Policy and Infrastructure Factors (0.055). Analysis of global weights across the sub-criteria further identifies Purchase Price as the most critical factor overall, with a weight of 0.319, followed by operating and maintenance costs (0.148). These results indicate that high initial vehicle costs remain a major barrier to consumer adoption despite the long-term economic benefits of electric mobility. The findings suggest that technological readiness and social influence play supporting roles, while EV adoption in Nepal is strongly influenced by economic considerations. Addressing the purchase price barrier through consistent and long-term fiscal policies is therefore important for supporting the transition toward electric mobility in Nepal.

Keywords: Electric Vehicles, Nepal, Analytic Hierarchy Process (AHP), EV Adoption, Economic Factors, Technological Factors, Policy and Infrastructure, Sustainable Transportation.

PromptSentinel: Multi-View Anomaly Detection for Black-Box Prompt Injection Defense in Large Language Models

Binod Bhattarai¹, Dipesh Gurung²

¹ Department of Computer Science, Islington College, Kathmandu, Nepal

² Department of Computer Science, Lord Buddha Education Foundation, Kathmandu, Nepal

Large Language Models (LLMs) are increasingly deployed in conversational AI, autonomous agents, and decision-support systems; however, their adoption introduces significant security risks, particularly prompt injection attacks that exploit instruction-following behavior to bypass safeguards, leak sensitive information, or manipulate system behavior. Existing defense mechanisms often depend on supervised attack classification, internal model access, or predefined attack signatures, limiting their effectiveness against evolving unseen threats in black-box environments. This study proposes PromptSentinel, a lightweight multi-view open-set anomaly detection framework for prompt injection defense in black-box LLM systems. The framework integrates semantic embeddings, intent-risk indicators, and structural prompt features to capture complementary attack characteristics, while a deployment-oriented extension, PromptSentinel v2, introduces benign-context suppression to reduce false positives in realistic operational settings. Experimental evaluation against established anomaly detection baselines, including Autoencoder, Isolation Forest, One-Class SVM, Deep SVDD, and DAGMM, demonstrates substantial performance gains, with PromptSentinel achieving a ROC-AUC of 0.858, PR-AUC of 0.591, and F1-score of 0.531. PromptSentinel v2 further reduced hard benign false positive rates from 70.4% to 9.6% while maintaining practical inference latency of approximately 2.6ms per sample. Additional experiments confirmed strong robustness against obfuscated prompt attacks and effective cross-dataset generalization. These findings demonstrate that multi-view anomaly detection offers an effective, practical, and deployable strategy for securing modern LLM applications against prompt injection threats.

Keywords: Large Language Models; Prompt Injection Detection; Open-Set Anomaly Detection; Black-Box Security; Jailbreak Defense; Adversarial Robustness; Cybersecurity.

Questioning the Benchmarks: Hidden Circularity in AQ-10 Autism Screening Datasets

Soham Biren Katlariwala¹, Amina Saeed², Harina Kumari Khati³, Mahdisa Moradi⁴

¹ Department of Computer Engineering, Gujarat Technological University, Ahmedabad, India

² Department of Computer Science and Information Technology, Virtual University of Pakistan, Lahore, Pakistan

³ Department of Computer Science and Information Technology, Padma Kanya Multiple Campus, Kathmandu, Nepal

⁴ Department of Health Science, University of the People, California, USA

Autism Spectrum Disorder (ASD) screening datasets are widely used for developing and benchmarking machine learning models, with numerous studies reporting classification accuracies exceeding 95%. However, such high performance may be influenced by hidden structural biases within commonly used datasets, potentially leading to overestimated model capabilities and unreliable benchmarking results. This paper investigates previously overlooked circularity issues in widely used AQ-10 autism screening datasets and evaluates their impact on machine learning-based ASD prediction. The study examines four traditional machine learning models and two deep learning models, including Logistic Regression, Random Forest, Support Vector Machine (SVM), Extreme Gradient Boosting (XGBoost), FT-Transformer, and TabNet, using three University of California Irvine (UCI) AQ-10 autism screening datasets. To identify and quantify hidden circularity, the study introduces the Circularity Index (CI) and proposes AutoCirc, a domain-independent framework for automated circularity detection based on mutual information analysis. Model performance is evaluated using classification accuracy, comparison against majority-class baselines, and circularity measurement using the proposed CI. Experimental results demonstrate that questionnaire-item-only models achieve 93.2–100% accuracy even after removing the pre-computed result feature, while demographic-only models remain close to majority-class baseline performance, producing a mean CI value of 0.947. Cross-domain validation using the Depression Anxiety Stress Scales-42 (DASS-42) and Rosenberg Self-Esteem datasets indicates that similar circularity issues extend beyond autism screening applications. The findings suggest that publicly available AQ-10 datasets may not provide reliable benchmarks for evaluating predictive machine learning models because target labels are structurally derived from questionnaire responses. This work emphasizes the importance of dataset validation and proposes a foundation for developing trustworthy clinical artificial intelligence systems through automated circularity detection.

Keywords: Autism Spectrum Disorder, Clinical Artificial Intelligence, Dataset Bias

RARE-AI: Intelligent Risk-Aware Routing for Cross-Border Payments Using Explainable Artificial Intelligence

Sudip Subedi¹, Sudipa Subedi¹

¹ Independent Researcher, Bharatpur, Chitwan, Nepal

The development of alternative settlement infrastructures, including stablecoin-based systems, has expanded the available options for cross-border payment processing beyond conventional banking networks. As different payment infrastructures introduce distinct trade-offs in terms of cost, speed, reliability, and risk, cross-border payment execution has increasingly become a routing optimization problem rather than solely a settlement problem. However, existing approaches largely focus on individual payment rails, while operational route selection often depends on static rules, corridor-specific heuristics, and manual decision-making, resulting in inefficient selection of settlement pathways. This paper proposes RARE-AI, an explainable artificial intelligence framework based on Risk-Adaptive Remittance Evaluation for intelligent routing of cross-border payments. The proposed framework models payment execution as a constrained routing problem across three representative settlement rail categories: traditional banking (T), native stablecoin settlement (S), and hybrid settlement rail (H = bank→stablecoin→bank). To enable consistent comparison among heterogeneous payment infrastructures, the study introduces the Risk-Aware Remittance Evaluation (RARE) Score, a composite decision indicator integrating operational efficiency and transaction risk into a unified evaluation framework. The empirical framework utilizes publicly available and reproducible datasets, while policy documents and infrastructure reports guide variable selection and scenario development. RARE-AI applies predictive machine learning and risk-aware optimization using Extreme Gradient Boosting (XGBoost) as the primary predictive model, with Random Forest, Light Gradient Boosting Machine (LightGBM), and Categorical Boosting (CatBoost) used for comparative benchmarking. SHapley Additive exPlanations (SHAP) are incorporated to improve model interpretability and provide transparent routing decisions. Furthermore, a Monte Carlo simulation environment is developed to evaluate the proposed framework against static and rule-based routing approaches. The proposed system provides an implementable, transparent, and reviewer-auditable artificial intelligence-driven payment orchestration framework for improving efficiency and reliability across diverse cross-border settlement infrastructures.

Keywords: Cross-Border Payments, Payment Routing, Stablecoins, Explainable Artificial Intelligence, Risk-Aware Optimization, Extreme Gradient Boosting (XGBoost), SHapley Additive exPlanations (SHAP), Monte Carlo Simulation, Remittance Systems, Financial Technology.

Analysing the Direct and Indirect Impacts of Basic Sanitation Initiatives in Nepal and Citywide Inclusive Sanitation (CWIS) as a Pathway Towards Safely Managed Sanitation Aligned with SDG 6.2

Devendra Kumar Jha¹, Mohit Aggarwal¹, A.K. Mishra²

¹ Department of Civil Engineering, Noida International University, Greater Noida, Uttar Pradesh, India

² Madhesh University, Parsa, Nepal

Nepal has achieved remarkable progress in basic sanitation, reaching 100% coverage in 2019 compared to 43% in 2011 and becoming the first Open Defecation Free (ODF) country in South Asia. This achievement was driven by the Sanitation and Hygiene Master Plan, which emphasized government leadership, community ownership, stakeholder collaboration, and private sector participation. The campaign-based approach effectively mobilized policymakers, political representatives, professionals, and communities to promote toilet construction and sustained usage, contributing to improved health, dignity, and social development. Nepal's total sanitation approach further strengthened accountability across the Water, Sanitation and Hygiene, health, education, and environmental sectors. Between 2015 and 2020, the country increased basic sanitation coverage by 18%, representing significant progress among developing nations. Notably, ODF status was achieved through a no-subsidy approach, maximizing community participation while minimizing public expenditure. The impacts of these initiatives include reduced diarrhoeal diseases, improved girls' school attendance through enhanced menstrual hygiene facilities, cleaner water bodies, and reduced child mortality, as highlighted by the Nepal Demographic and Health Survey 2022. Despite these achievements, sustaining sanitation progress remains a major challenge. Effective management of septic tank waste through treatment and resource recovery is essential to support agriculture, livelihoods, and environmental sustainability. Citywide Inclusive Sanitation (CWIS) provides a pathway towards safely managed sanitation by aligning with Sustainable Development Goal (SDG) 6.2 and promoting non-sewered sanitation value chains, including containment, emptying, transportation, treatment, and reuse within a circular economy framework. The principles of Resource Recovery and Reuse (RRR) highlight the potential of faecal sludge as a source of fertilizer and biogas. Public-private partnerships, climate-resilient infrastructure, and effective regulatory mechanisms are critical for long-term sustainability. Considering the high lifecycle costs associated with centralized sewer systems, CWIS presents a technically, financially, socially, and environmentally viable approach for achieving safely managed sanitation in Nepal.

Keywords: Citywide Inclusive Sanitation (CWIS), Sanitation Campaign

A Web-Based GIS and Machine Learning Framework for Grid-Wise Flood Risk Monitoring and Early Warning

Abiral Gautam¹

¹ School of Engineering, Pokhara University, Nepal

Flooding is a major recurring hazard in Nepal, particularly during the monsoon season, affecting settlements, transportation networks, agricultural land, critical infrastructure, and local livelihoods. Existing rainfall stations, river-level monitoring systems, and flood bulletins provide valuable warning information; however, they are primarily station-based and often lack detailed spatial flood risk information for individual settlements, river corridors, streams, and drainage networks. This study proposes a web-based flood risk monitoring and early warning decision support system that integrates Geographic Information Systems (GIS) and machine learning techniques. The study area will be divided into regular grid cells, and flood-related features, including rainfall, river level, forecast rainfall, elevation, slope, flow accumulation, distance to waterways, land-use type, and historical flood records, will be extracted for each grid. Logistic Regression will serve as the baseline model, while Random Forest and XGBoost will be evaluated for grid-wise flood risk classification. The predicted risk levels—Low, Medium, High, and Danger—will be visualized through an interactive GIS dashboard to support disaster preparedness, risk communication, and evidence-based decision-making by local authorities. The proposed framework aims to improve the spatial resolution and effectiveness of flood early warning systems and contribute to more resilient flood risk management in Nepal.

Keywords: Flood Risk Classification, Geographic Information Systems (GIS), Machine Learning, Grid-wise Risk Classification, Early Warning System, Decision Support System, Random Forest, XGBoost.

EdgeQuakeNet: A Federated Transformer Framework for Real-Time Earthquake Early Warning on Resource-Constrained Edge Devices

Arman Ansari¹

¹ KIST College, Purbanchal University, Nepal

Nepal is located in one of the most earthquake-prone regions in the world, yet it lacks a practical early warning system capable of providing critical seconds of advance notice before strong ground shaking. Existing earthquake detection approaches face challenges including unreliable internet connectivity in rural mountainous regions, dependence on expensive centralized servers, and the difficulty of transmitting large volumes of seismic data to remote processing facilities. This paper presents EdgeQuakeNet, a lightweight Transformer-based neural network framework designed for real-time earthquake P-wave detection on resource-constrained edge devices. The proposed system deploys a compact model on Raspberry Pi 5 devices and integrates federated learning to enable decentralized model training while preserving seismic data privacy. Instead of transferring raw seismic signals to a central server, individual monitoring stations train local models and share only model updates through a federated learning architecture. EdgeQuakeNet is evaluated using the STEAD benchmark dataset and 11,340 real earthquake recordings collected from Nepal's National Seismological Centre between 2018 and 2025. The federated model achieves an F1-score of 0.946 on Nepal-specific seismic data, outperforming several larger conventionally fine-tuned models. The deployed system performs earthquake detection within 83 milliseconds while consuming only 2.1 watts of power, enabling operation on low-power energy sources such as solar panels. The proposed approach achieves a false alarm rate of 1.7%, significantly lower than the 8.9% observed with the traditional STA/LTA method. These results demonstrate the feasibility of affordable, intelligent, and decentralized earthquake early warning systems for regions with limited infrastructure.

Keywords: Earthquake early warning, Federated learning, Transformer neural network, Edge computing, Seismic phase detection, Nepal Himalaya, IoT sensor network.

An Ensemble Based Approach for Facial Emotion Recognition

Samundra Bhandari¹, Rahul Chaudhary¹, Juhi Jha¹, Anish Bhattarai¹, Narayan Sapkota²

¹ Department of Software and IT Engineering, Everest Engineering College, Lalitpur, Nepal
² Department of Graduate Studies, Everest Engineering College, Lalitpur, Nepal

Facial emotion recognition plays a vital role in understanding human behavior and enhancing intelligent human-computer interaction systems. Traditional single-model approaches often face challenges due to variations in facial expressions, lighting conditions, and individual differences. This project proposes an ensemble-based approach for facial emotion recognition using deep learning techniques to improve classification robustness and performance. The proposed system classifies static facial images into six basic emotion categories: happiness, sadness, anger, surprise, disgust, and neutrality. Multiple Convolutional Neural Network (CNN) models are integrated into an ensemble framework to improve overall classification performance. The model is evaluated using accuracy, precision, recall, and confusion matrix analysis to assess performance across different emotion classes. The proposed approach aims to achieve improved emotion recognition accuracy compared to individual CNN models. The developed system can be applied in controlled and semi-real-time environments, including educational tools, healthcare assistance systems, and human-computer interaction applications, demonstrating the potential of ensemble learning for robust facial emotion recognition.

Keywords: Facial Emotion Recognition, Ensemble Learning, Deep Learning, Convolutional Neural Network (CNN), Computer Vision, Human-Computer Interaction.

NepScript Genesis: Neural Architecture Search for Handwritten Devanagari Digit Synthesis

Mausam Gurung¹, Sajjan Acharya¹, Prabin Neupane¹

¹ Independent Researcher, Nepal

This paper introduces NepScript Genesis, a Neural Architecture Search (NAS) framework for automated Generative Adversarial Network (GAN) discovery, applied to conditional Devanagari handwritten digit synthesis. We compare five NAS strategies against a carefully constructed Deep Convolutional GAN (DCGAN) baseline (FID = 332.28). Architecture selection utilizes a two-stage pipeline guided by a novel domain-aware evaluation metric (Enhanced Score). Results demonstrate that Adaptive Exploration achieves the optimal quality-efficiency trade-off, attaining an FID of 79.12; a 76.19% improvement over the baseline, and the highest mode coverage among the NAS strategies (Recall = 0.531) in under one GPU-hour. Furthermore, we demonstrate that incorporating script-specific structural heuristics into the search phase prevents early-stage mode collapse. In a downstream low-resource evaluation, augmenting 250 real training samples per class with GAN-generated digits from the best NAS model improves CNN classification accuracy from 91.0% to 96.5% (+5.5 percentage points), demonstrating that NAS-optimized synthesis produces digits of sufficient quality to benefit practical recognition pipelines when real data is scarce.

Keywords: Neural Architecture Search, GANs, Devanagari, Conditional Image Synthesis, DCGAN, Adaptive Exploration, FID, Inception Score

Encoder-Decoder vs. Decoder-Only Transformers for AI-to-Human Text Style Transfer

Utsav Paneru¹

¹ Department of Computer Engineering, Kathmandu Engineering College, Kalimati, Kathmandu, Nepal

AI-generated text has become increasingly common in academic and professional writing, creating growing interest in methods for detecting machine-generated content. However, comparatively less attention has been given to the reverse task of rewriting AI-generated text so that it more closely resembles naturally written human text. This study investigates AI-to-human text style transfer by comparing encoder-decoder and decoder-only transformer models. A parallel corpus of 25,140 paired AI-generated and human-written text chunks was constructed from a multi-style writing repository. Linguistic analysis identified 11 measurable stylistic markers that distinguish the two types of text. Among these, contraction usage showed a notable difference, with AI-generated text averaging 0.00 contractions per chunk compared with 0.17 in human-written text. Human references also exhibited lower Flesch-Kincaid grade levels, shorter average word lengths, and greater variation in sentence length. Three models were fine-tuned: BART-base (139M parameters), BART-large (406M parameters), and Mistral-7B-Instruct using QLoRA. BART-large achieved the highest similarity to human references across all three evaluation metrics, with a BERTScore F1 of 0.924, ROUGE-L of 0.566, and chrF++ of 55.92. Despite having substantially fewer parameters than Mistral-7B, BART-large also reproduced human-like characteristics more accurately in terms of word length, lexical diversity, and readability. Mistral-7B produced a larger overall shift in linguistic markers, but detailed analysis showed that the shift was not always aligned with the desired human distribution. The model overshoot the human range for five markers and moved comma usage in the opposite direction. These findings suggest that measuring only the magnitude of stylistic change may not accurately reflect the quality of text style transfer. Instead, evaluation should also consider how closely the generated text approaches the intended human linguistic distribution. Overall, the results indicate that BART's denoising pretraining objective can provide an advantage for controlled text rewriting that model scale alone may not overcome.

Keywords: Text Style Transfer, AI-to-Human Rewriting, Sequence-to-Sequence Models, BART, Mistral, Linguistic Markers, BERTScore, Natural Language Generation.

A Preliminary Treatability Assessment of Textile Industry Effluent in Nepal

Pratap Bikram Shahi¹, Sangita Ghimire¹, Kul Bahadur Shahi¹

¹ Aastha Scientific Research Service Pvt. Ltd., Maitidevi, Kathmandu, Nepal

Treating textile industry effluent is challenging due to its complex and variable composition. In Nepal, research integrating different treatment processes while considering their practical feasibility remains limited. This study evaluated a combination of physicochemical and biological treatments for real textile effluent, including pH adjustment, alum coagulation, *Moringa oleifera* as a coagulant aid, anaerobic sludge, Chlorella-dominated non-axenic microalgae, and activated carbon treatments. The results showed that alum and activated carbon achieved 70% and 63% color removal, respectively, while a 1:5 anaerobic sludge treatment achieved 50% COD removal. pH adjustment alone was insufficient for color removal, whereas the addition of *Moringa oleifera* as a coagulant aid improved color characteristics. The continuous-flow UASB showed low COD removal efficiency. Microalgae treatments were more effective in regulating nitrogen but resulted in increased COD levels. Overall, the treatments provided complementary functions rather than effective standalone treatment. Based on laboratory results and techno-economic and spatial considerations, a modified treatment train was proposed comprising an equalization tank, pH adjustment, alum coagulation-flocculation, settling, anaerobic treatment, an activated carbon filter, and an aluminum resin filter. This study provides a preliminary framework for integrated textile effluent treatment in Nepal and supports further pilot-scale validation and optimization.

Keywords: Textile Effluent, Wastewater Treatment, Alum Coagulation, Anaerobic Treatment, Microalgae, Activated Carbon, COD Removal, Color Removal.

Bridging the Resource Gap: Nepali-Assisted Transfer Learning for Low-Resource Nepal Bhasa–English Neural Machine Translation with NLLB-200 and mBART-50

Sarbin Sayami¹, Subarna Shakya²

¹ Central Department of Computer Science and IT, Tribhuvan University, Kathmandu, Nepal

² Institute of Science and Technology, Tribhuvan University, Kathmandu, Nepal

Nepal Bhasa (Newari), a Sino-Tibetan language indigenous to the Kathmandu Valley, is not represented among the languages supported by NLLB-200 or mBART-50, two widely used multilingual neural machine translation systems. This study presents a benchmark for Nepal Bhasa–English neural machine translation (NMT) using both architectures and investigates whether pretrained multilingual models can be extended to a language absent from their training data by leveraging lexical and orthographic contact with Nepali, a geographically and historically connected language supported by both models. A 2,500-sentence Nepal Bhasa–English parallel corpus was constructed, and each base model was evaluated using zero-shot translation, direct fine-tuning on Nepal Bhasa–English data, and joint fine-tuning with additional genuine Nepali–English parallel data. For NLLB-200, three epochs of direct fine-tuning improved chrF from 12.75 to 22.20, while joint fine-tuning further increased chrF to 28.52 with a BLEU score of 7.21. For mBART-50, direct fine-tuning increased chrF from 9.67 to 37.12, while joint fine-tuning achieved a chrF of 36.95 and the highest BLEU score of 14.23. These results show substantially stronger performance for mBART-50 under the evaluated conditions. Analysis of training and validation loss curves further indicates that NLLB-200 remained underfit after three epochs at this data scale, whereas mBART-50 showed early signs of overfitting after the second epoch. The findings demonstrate that multilingual transfer learning, particularly through related-resource augmentation with Nepali, offers a promising approach for developing NMT systems for low-resource languages such as Nepal Bhasa.

Keywords: Nepal Bhasa, Newari, Neural Machine Translation (NMT), Low-Resource Languages, Transfer Learning, NLLB-200, mBART-50, Nepali-Assisted Training, Machine Translation.

Spatiotemporal, Topographic, and Climatic Analysis of New and Small Glacial Lakes in Dudhkoshi River Basin

Mega Maskey¹

¹ Institute of Engineering, Pulchowk Campus, Kathmandu, Tribhuvan University, Nepal

Glacial lakes in the Hindu Kush-Himalaya are expanding under contemporary climate warming, yet the dynamics of small and newly forming lakes remain less understood than those of larger, well-studied lakes. This study presents a multi-temporal inventory of small glacial lakes smaller than 0.05 km² in the Dudh Koshi sub-basin of eastern Nepal, comparing their distribution and physical characteristics between 2017 and 2025 using Sentinel-2 surface reflectance imagery processed in Google Earth Engine. A total of 233 lakes were inventoried across both years, revealing a net increase in total lake area from 0.611 km² to 4.225 km² over the eight-year period. New lake formation was the dominant mode of change, with 198 previously unrecorded lakes identified in 2025, collectively covering 4.076 km². Twenty-six lakes disappeared, six decreased in area, and three expanded relative to their 2017 extents. ERA5 reanalysis data indicate that the study period coincided with predominantly above-average temperatures in the basin, consistent with sustained glacier retreat and the development of topographic and hydrological conditions favorable for lake formation. Further analysis will examine the topographic settings and spatial clustering of newly formed lakes using DEM-derived variables, including slope, aspect, and terminus distance, while spatial statistical methods will be used to assess climate trends. These findings provide a systematic characterization of an underexplored but rapidly evolving component of the Dudh Koshi cryosphere and establish a foundation for future glacial lake outburst flood hazard assessment in the region.

Keywords: Glacial Lakes, Dudh Koshi Basin, Climate Change, Sentinel-2, Google Earth Engine, Glacier Retreat, Remote Sensing, Glacial Lake Outburst Flood.

A Comparative Evaluation of Traditional and Transformer-Based Approaches for Detecting Hate Speech in Nepali Political Content

Pravin Rana¹

¹ Pulchowk Engineering Campus, Tribhuvan University, Nepal

The growing volume of political discourse on social media platforms such as Twitter, YouTube, and Facebook in Nepal has been accompanied by increasing levels of hate speech, offensive language, and toxic commentary. Despite this trend, Nepali remains a low-resource language for hate speech detection, with limited annotated datasets and benchmark studies compared with high-resource languages. This study presents a comparative evaluation of traditional machine learning and transformer-based approaches for detecting hate speech in Nepali political content using a three-class classification scheme: Neutral, Offensive, and Hate. A manually annotated dataset of Nepali and code-mixed political comments was used to train and evaluate two traditional baseline models, Support Vector Machine (SVM) and Naive Bayes, using TF-IDF-based feature representations. On a held-out test set of 1,000 comments, Naive Bayes achieved an accuracy of 69.7% and a macro F1-score of 0.590, while SVM achieved an accuracy of 68.6% and a macro F1-score of 0.561. Both models showed reduced performance on the minority Hate class due to class imbalance. To investigate whether contextual pretrained representations can improve upon these baselines, three transformer-based models, NepBERTa, XLM-RoBERTa, and MuRIL, are being fine-tuned on the same dataset. The evaluation will compare transformer-based models with traditional baselines and assess performance differences among the three transformer models. The annotated dataset is also being expanded, after which the transformer models will be fine-tuned again to examine how performance changes with increased training data. This ongoing study aims to establish an early benchmark for Nepali hate speech detection and provide practical insights into model selection for low-resource and morphologically rich languages.

Keywords: Nepali Natural Language Processing (NLP), Hate Speech Detection, Transformer Models, NepBERTa, XLM-RoBERTa, MuRIL, Political Discourse, Low-Resource Language.

Design and Evaluation of Machine Learning Models for Predicting At-Risk Students in Universities

Dharma Raj Ojha¹, Dr. Akhtar Husain², Dr. Prakash Datt Bhatt³

¹ Department of Computer Science & IT, Faculty of Engineering Technology, Mahatma Jyotiba Phule Rohilkhand University, Bareilly, India

² Department of Computer Science & IT, Faculty of Engineering Technology, Mahatma Jyotiba Phule Rohilkhand University, Bareilly, India

³ Department of Computer Science and Information Technology (CSIT), Siddhanath Science Campus, Tribhuvan University, Nepal

University administrative records contain substantial information about students, but this data is rarely transformed into a systematic process for identifying those at risk of not completing their studies. This study designs, evaluates, and interprets six supervised machine learning models using academic, demographic, and socio-economic data from 3,515 university students to predict at-risk students. Logistic Regression, Naive Bayes, Decision Tree, Random Forest, Support Vector Machine (SVM), and Extreme Gradient Boosting (XGBoost) were evaluated using a common protocol comprising stratified 5-fold cross-validation, synthetic minority over-sampling applied only to training folds, and six metrics appropriate for imbalanced outcomes. SVM achieved the highest overall accuracy (0.663), ROC-AUC (0.713), and Matthews correlation coefficient (0.308), as well as the highest sensitivity (0.764) for identifying at-risk students, while maintaining a precision of 0.726. Random Forest produced the lowest ROC-AUC (0.665), potentially reflecting the interaction between bootstrap aggregation and synthetic oversampling. Model interpretation used three independent feature-importance measures and SHapley Additive exPlanations (SHAP) at global, dependence, and individual levels. Across the analyses, the amount of academic backlog accumulated during the first year emerged as the most influential predictor, with an importance score of 0.271 and a mean absolute SHAP value of 0.638, more than twice that of the second-ranked attribute. Operational risk tiers showed a monotonic increase in observed at-risk rates from 32.1% to 79.4%, compared with an overall cohort rate of 59.2%. These findings indicate that machine learning models with moderate discriminative performance can provide interpretable evidence to support proportionate and systematic allocation of institutional student support.

Keywords: Higher Education, Early Warning Systems, At-Risk Students, Supervised Machine Learning, Explainable Artificial Intelligence, SHAP.

Legal Divorce Chatbot: A Retrieval-Augmented Generation Based Nepali Legal Question Answering System

Bhuwan Prasad Joshi¹, Anshu Bhandari¹, Ishita Bhatta¹, Pradeept Jarur Shahi¹

¹ Department of Computer Engineering, Everest Engineering College, Lalitpur, Nepal

Access to legal information remains a significant challenge in Nepal, particularly for citizens seeking to understand their rights and obligations in sensitive matters such as divorce and domestic violence. Traditional legal consultation can be expensive and time-consuming, while legal documents are often difficult for the general public to understand. This study presents a Nepali legal question-answering chatbot based on Retrieval-Augmented Generation (RAG). The system retrieves relevant passages from the Civil Code and the Domestic Violence (Crime and Punishment) Act, 2009 and provides the retrieved context to a large language model for response generation. The legal documents were processed using semantic chunking and indexed with FAISS for similarity-based retrieval. A total of 62 evaluation questions were prepared, comprising 59 in-scope legal questions and three out-of-scope questions to assess refusal behavior. The four reported RAG metrics were evaluated on the 59 in-scope questions using Gemini 2.5 Flash as an LLM judge. The system achieved an overall LLM-judged RAG Quality Score of 87.3%, with Relevance of 97.10%, Groundedness of 90.00%, Correctness of 89.8%, and Retrieval Relevance of 72.22%. These results indicate that RAG can support legal question answering in low-resource languages such as Nepali by combining document retrieval with language model generation. However, the reported scores represent automated evaluation results and should not be considered a substitute for review or advice from qualified legal professionals.

Keywords: Legal Question Answering, Retrieval-Augmented Generation (RAG), Nepali Language, Legal Chatbot, FAISS, Large Language Models, Natural Language Processing.

Exploring Explainable AI for At-Risk Student Prediction in Education

Sojen Pradhan¹

¹ School of Professional Practice and Leadership, Faculty of Engineering and Information Technology, University of Technology Sydney, Sydney, Australia

Educators play an important role in supporting students who struggle academically, fail courses, or are at risk of dropping out. While artificial intelligence (AI) can help identify students at risk of academic failure, predictions alone are often insufficient for educators who need to understand the factors contributing to those outcomes. This paper presents a supporting machine learning (ML) and explainable artificial intelligence (XAI) pipeline designed to generate predictions and interpretable explanations for an eXplanation User Interface (XUI) targeted at non-technical educators. The study was conducted in two stages. First, a pilot pipeline using a public dataset was developed to investigate data preprocessing, class balancing, machine learning model selection, and the generation of global and local explanations using SHapley Additive exPlanations (SHAP), Local Interpretable Model-Agnostic Explanations (LIME), and partial dependence plots. Second, the pipeline was extended and evaluated using a Saudi dataset. The resulting pipeline generates both global and local XAI representations and converts local SHAP outputs into plain-language narratives using large language models. The developed infrastructure supports multiple forms of explanation within the XUI, enabling educators without technical expertise to better interpret model predictions and understand the factors associated with student risk. The work demonstrates how combining machine learning, explainable AI, and natural-language generation can contribute to more transparent and educator-oriented early warning systems in education.

Keywords: Explainable Artificial Intelligence (XAI), At-Risk Student Prediction, Machine Learning, SHAP, LIME, Partial Dependence Plots, Early Warning Systems, Education, Explainable User Interface (XUI).

Multi-Objective Deep Reinforcement Learning-Based Spatial Optimization of Green Infrastructure in High-Density Up-Growing Cities

Bikram Babu KC¹

¹ Dr. K.N. Modi University, Rajasthan, India; Lecturer, REC, Pokhara University, Nepal

High-density cities experiencing rapid vertical growth face increasing challenges related to microclimatic degradation, intensified Urban Heat Island (UHI) effects, and biodiversity loss. Conventional two-dimensional urban spatial planning approaches are increasingly inadequate for addressing these challenges in vertically developing urban environments. This paper presents an artificial intelligence-based spatial optimization framework for guiding the development of Green Infrastructure (GI) and Blue-Green Infrastructure (BGI) across public and private urban spaces. The proposed framework integrates multispectral remote sensing, high-resolution LiDAR, and three-dimensional urban morphological parameters to address limitations in current urban analytics, including limited 3D bioclimatic integration, model transferability, and ecosystem-service quantification across spatial scales. The methodology employs Deep Reinforcement Learning (DRL) to model the complex relationships among microclimatic cooling, heat-stress reduction, air-quality improvement, and ecological connectivity while incorporating socio-economic considerations of fairness to reduce potential algorithmic bias. The framework further connects spatial optimization outputs with urban governance by translating alternative development scenarios into actionable planning policies and incentives for private-sector implementation. By integrating environmental, spatial, and socio-economic objectives within a unified optimization framework, the proposed approach supports more informed planning of green and blue-green infrastructure in vertically growing cities. The study contributes to sustainable urban informatics by reframing vertical densification as an opportunity for developing climate-resilient, environmentally responsive, and socially equitable urban environments.

Keywords: Green Infrastructure, Deep Reinforcement Learning, Urban Heat Island, Three-Dimensional Microclimate, Spatial Optimization, Algorithmic Fairness, Blue-Green Infrastructure, Urban Morphology.

Partner Institutions and Sponsors



