CSCE 2025 BOOK of ABSTRACTS

The 2025 World Congress in Computer Science, Computer Engineering, and Applied Computing
CSCE 2025

https://www.american-cse.org/csce2025/
July 21-24, 2025
Luxor Hotel (MGM Property), 3900 Las Vegas Blvd. South, Las Vegas, 89109, USA

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Note that the titles of papers, the authors' names and the abstracts that appear in this book ("Book of Abstracts") were extracted from the papers that were submitted to the EVALUATION web portal (i.e., extracted from the first draft submissions). The official published proceedings/book will have any and all changes/revisions that authors may have done.

KEYNOTE ADDRESSES

(The Keynote lectures are open to all participants)

CONGRESS WELCOME REMARKS

Professor Emeritus Hamid R. Arabnia
(Chair, Steering Committee & Coordinator), School of Computing, University of Georgia, USA;
Editor-in-Chief, The Journal of Supercomputing (Springer Nature);
Editor, Transactions of Computational Science & Computational Intelligence
Fellow, Center of Excellence in Terrorism, Resilience, Intelligence & Organized Crime Research (CENTRIC)

KEYNOTE TITLE:

Empowering Cyber Defense: The UCS Ecosystem of Data, Tools, and Awareness

Dr. Arash Habibi Lashkari
Canada Research Chair and Associate Professor in Cybersecurity
Founder and Director of the Behavior-Centric Cybersecurity Center (BCCC)
Co-founder and Director of the Cybersecurity Cartoon Award (CSCA)
York University, Toronto, Canada

Abstract - Data has become the cornerstone of intelligent, proactive cybersecurity in today's threat landscape. This talk explores how high-quality, purpose-built datasets fuel the development of AI-powered threat detection, classification, and response systems. Drawing on the open-access resources of the Understanding Cybersecurity Series (UCS) developed at York University's Behaviour-Centric Cybersecurity Center (BCCC), we will showcase the design and application of novel cybersecurity datasets and analyzers, including encrypted traffic, memory snapshots, and logs, crafted to train and evaluate machine learning models in real-world scenarios. We will also highlight tools like NTLFlowLyzer, VolMemLyzer, and SCsVulLyzer, which support advanced profiling and zero-day threat detection. By bridging data engineering, explainable AI, and community access, UCS provides a unique platform for researchers, educators, and industry to advance threat intelligence capabilities. The session will conclude with insights into best practices for dataset development and an open call for collaboration across the cybersecurity ecosystem.

PANEL DISCUSSION:

Artificial Intelligence: Pros, Cons, and Implications

Panelist: Prof. Leonidas Deligiannidis
Professor of Computer Science
School of Computing and Data Science
Wentworth Institute of Technology, Boston, MA, USA

Panelist: Dr. Salem Othman
Associate Professor of Computer Science
School of Computing and Data Science
Wentworth Institute of Technology, Boston, MA, USA

Panelist: Dr. John N. Carbone
Senior Technical Director, Adjunct Professor
Everfox LLC, Baylor University, Texas, USA

Moderator & Panelist: Prof. Hamid R. Arabnia
Professor Emeritus, Computer Science
School of Computing
The University of Georgia, Georgia, USA

Abstract - NA

INVITED LECTURE:

The Future is Integrated: Predictive Intelligence for Semiconductor Supply Chains

Deepshikha Shekhawat
Business Intelligence Program Manager, AMD, Inc.
Affiliated with Fortune 500 Companies, including AMD and Applied Materials.

Abstract - In the fast-paced semiconductor industry, fragmented data across teams hampers efficiency and decision-making. This session explores how to break down these silos using smart data architecture and predictive analytics to streamline supply chains and reduce time-to-market. Drawing from 12+ years of experience, I'll share real-world strategies to unify critical data, define effective KPIs, and enable real-time insights into supplier performance, lead times, and costs. Attendees will gain actionable guidance on building robust, cross-functional data infrastructure that enhances forecasting, boosts transparency, and empowers all levels of the organization to make faster, data-driven decisions that drive measurable business outcomes.

The 9th International Conference on Applied Cognitive Computing (ACC'25: July 21-24, 2025; Las Vegas, USA)

https://american-cse.org/csce2025/conferences-ACC
https://american-cse.org/csce2025/

Moving Beyond Arbitrary Augmentations: K-Hop Connectivity for Robust Augmentation in Graph Contrastive Learning

Tonni Das Jui, Mary Lauren Benton
Baylor University, Waco, Texas, USA

Abstract - Graph Contrastive Learning (GCL) methods primarily employ random augmentations, such as node and edge dropping and feature masking, to generate contrasting views. However, these perturbations often lead to arbitrary information loss, disrupt structural integrity, and degrade the quality of representation. Although recent adaptive augmentation techniques aim to address these limitations, they introduce substantial computational overhead and reinforce dataset-specific biases, thereby restricting generalization. To overcome these challenges, we propose a neighborhood commonality-based augmentation strategy that captures critical node and edge information while aligning node representations by preserving both local and global structural dependencies. Our method achieves a favorable trade-off between computational efficiency and performance, avoiding the complexities of adversarial or eigen-decomposition-based augmentation strategies. Furthermore, we provide a rigorous theoretical justification for our approach and empirically validate its effectiveness through experiments.

Digital Activity Recognition and Cybersecurity Procedural Task Extraction with Video LLMs: A Cognitive Computing Framework

Terry Traylor, Ben Bernard, Pann Ajjimaporn
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Abstract - Extracting procedural workflows from instructional videos is an emerging challenge at the intersection of video understanding, human activity recognition (HAR), screen-based task modeling, and domain-specific training, such as cybersecurity. Unlike conventional HAR, which focuses on physical actions, procedural extraction requires symbolic reasoning across multimodal inputs—command-line interfaces, GUIs, and narration. Current video-language models like struggle in these contexts due to limited symbolic grounding, weak task hierarchy modeling, and insufficient domain-specific data. To address this, we define the Digital Activity Recognition (DAR) problem class and implement it through the DAR Research Infrastructure Layer (DRIL). DRIL is validated on curated cybersecurity training videos, supporting DAR as a foundational task in multimodal AI through a reusable infrastructure for systematic experimentation.

Intelligent Shading Classification for Smart Reconfigurable Photovoltaic Panels in Residential Solar Systems

Varun Yedavilli, Akshat Desai, Jonathan Olivares, Sachin Lodhi, Robert Cruz, Santiago Monofre, Kevin Huang, Kanika Sood, Jaya Dofe, Rakeshkumar Mahto
Department of Electrical and Computer Engineering, California State University, Fullerton, California, USA;
Department of Computer Science, California State University, Fullerton, California, USA;
Department of Technology and Engineering, Fullerton College, Fullerton, California, USA;
Troy High School, Fullerton, California, USA

Abstract - Partial shading affects the performance of photovoltaic (PV) systems since it reduces performance and system reliability. A smarter PV panel that can reduce the impact of partial shading conditions through machine learning (ML) and transistor-embedded PV panels is desirable for a wider acceptance of the residential PV panels. To achieve it, this paper presents an ML-based approach to classify the shading conditions of PV panels to enable real-time detection and reconfigurability of transistor-embedded PV panels. A dataset consisting of over 24 million datapoints was generated using a MATLAB Simulink model of a 60-cell PV panel operating under varying environmental conditions, including irradiance, temperature, and shading levels. Features such as voltage, current, power, and engineered ratios were used to train and evaluate five ML classifiers: Logistic Regression, k-Nearest Neighbors (KNN), Random Forest (RF), XGBoost, and LightGBM. Among these, ensemble-based models, Random Forest and XGBoost, demonstrated superior performance, achieving classification accuracies of 96.8% and 96.4%, respectively. A detailed analysis of precision, recall, F1-score, and feature importance reveals that engineered features and configuration parameters significantly influence classification accuracy. The proposed methodology holds promise for enabling adaptive control in smart PV panels for residential applications.

Emotion Analysis in Speech Based on Audio-Visual Fusion

Zou Zhitao, Gulanbaier Tuerhong, Mairidan Wushouer, Tian Liwei
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Abstract - This paper introduces a deep learning-based emotion analysis method utilizing audio and video data, achieving enhanced accuracy in emotion recognition through comprehensive exploration of both modalities. For audio processing, this paper employed a combination of multi-path fusion convolutional neural networks and channel attention mechanisms to extract emotional features from audio data.. The attention mechanism emphasizes the significance of key channels, capturing emotionspecific information more precisely. In the context of video analysis, this paper utilize the R(2+1)D network, which effectively captures temporal relationships, enabling superior extraction of emotional features from video data. To holistically leverage audio and video information, this paper introduce a cross-modal attention mechanism to merge the two types of features. This fusion method aids in integrating information from different modalities, thereby enhancing the accuracy of emotion analysis. By focusing on the correlation between audio and video, this paper successfully elevate the performance of emotion recognition. Experimental results demonstrate significant advancements on a publicly available datasets (RAVDESS), achieving higher accuracy compared to previous methods. The success of this method lies in the comprehensive utilization of audio and video features and the introduction of a cross-modal fusion mechanism. this paper firmly believe that this approach holds significant research and practical value in the field of emotion analysis, providing a new perspective for a more comprehensive and accurate understanding and analysis of emotional information.

Harnessing Deterministic Chaos for Adaptive Gradient Optimization

Kenneth Brezinski, Ken Ferens, Witold Kinsner
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Abstract - This paper systematically investigates deterministic chaos as a source of structured gradient perturbations for modern optimisers. Seven chaotic maps—including cubic, logistic, single- and multiparametric tent, Hénon, Ikeda and Baker—are projected to bounded, zero-mean signals and injected at principled loci within SGD, Adam and RMSProp. We log each optimiser's internal state—momentum_buffer, first and second moments, and square_avg—to explain how chaos reshapes exploration and variance control. Experiments on a synthetic regression task show that cubic-map noise accelerates momentum build-up in SGD, Hénon noise yields faster damping of RMSProp's variance estimate, and tent-map perturbations modulate Adam's learning rate without destabilising convergence. Parameter sweeps reveal that small chaos scales can even reduce adaptive-variance inflation below the clean baseline. Our analysis highlights the importance of map choice, invariant-measure bias and injection locus, providing concrete design guidelines and opening a path toward chaos-aware optimisation on complex deep-learning benchmarks.

TruCrisisAware: Integrating Naturalistic Decision Making into AI for Enhanced Disaster Response

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Department of Computer Science, Iowa State University, Ames, Iowa, USA

Abstract - In high-stakes disaster scenarios, timely, context-aware decisions are essential for survival. Traditional AI systems deliver speed and scale but often lack the intuitive reasoning and adaptive cognition exhibited by human experts. This study presents TruCrisisAware, a mobile AI framework grounded in DualProcess Theory (DPT) and the Recognition-Primed Decision (RPD) model. By combining heuristic (System 1) and deliberative (System 2) reasoning, and dynamically switching between them based on situational demands and inferred user trust, the system emulates expert decision-making under uncertainty. Implemented as a smartphone app, TruCrisisAware fuses sensor data (e.g., smoke, heat, visual obstruction) with triangulated positioning to provide realtime evacuation guidance. The decision engine is trained via imitation and reinforcement learning. Six simulated fire scenarios in Unity ML-Agents evaluate the system on Task Success Rate (TSR), Route Optimality (RO), Decision Robustness (DR), and Trust Calibration Index (TCI). Results show that TruCrisisAware outperforms single-mode agents, maintaining high performance and trust alignment under complex conditions. The system offers a human-centered decision support model that bridges speed and cognition to enhance safety, coordination, and resilience in disaster contexts.

The 26th International Conference on Bioinformatics & Computational Biology (BIOCOMP'25: July 21-24, 2025; Las Vegas, USA)

https://american-cse.org/csce2025/conferences-BIOCOMP
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Robust Unsupervised Classification of Drosophila Cell Dynamics Using DTW and Feature-Based Cluster Consensus

Tim Rogalsky, Lia Campbell-Enns, Matthaeus Dyck, Nicolas Malagon
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Abstract - Understanding the spatio-temporal dynamics of cell development is a key step toward early detection of abnormal growth patterns, including cancer. In this study, we classify size oscillation patterns of epithelial cells in the developing foreleg of Drosophila melanogaster using unsupervised machine learning. We began by clustering raw delta-area time series using Dynamic Time Warping (DTW), which revealed three distinct dynamic patterns of size change. Building on this, we engineered interpretable time series features and applied two dimensionality reduction techniques - Principal Component Analysis (PCA) and Non-negative Matrix Factorization (NMF) - each followed by hierarchical and k-means clustering. Finally, we evaluated clustering agreement and performed omnibus tests with effect size ranking to identify the most discriminative features of cell behavior. The results highlight recurring developmental motifs and point to a reproducible structure underlying the cell dynamics. These methods and findings establish a computational baseline for future comparisons to pathological data.

Neural Network Benchmarking on ECG Classification

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Universidad Nacional Autonoma de Mexico, Mexico

Abstract - This study presents a comparative analysis of the performance of neural network models for the classification of electrocardiograms (ECG), evaluating the impact of different variable selection strategies. Eight models were implemented using variables related to heart contraction and expansion, the heart rate variable, and a subset of variables selected using the Random Forest algorithm. The models were evaluated in terms of accuracy, Kappa index, AUC-ROC, and other performance indicators, demonstrating that the model using all predictive variables achieved the best overall performance (AUC = 94.59%), followed by the model based on the four most important variables identified by Random Forest (t_axis, qrs_axis, qrs_end, qrs_onset), which achieves an optimal balance between simplicity and performance (AUC = 93.44%). The addition of the heart rate variable improved the sensitivity of the models, indicating that incorporating this variable enhances the model's discriminatory capability. These findings suggest that appropriate variable selection can optimize the performance of ECG prediction models, facilitating the implementation of automatic systems for detecting cardiac anomalies.

Risk Factors for the Development of Early Onset Cancers

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Department of Behavioral Science, Athens State University, Athens, Alabama, USA

Abstract - Cancers previously considered "cancers of old age" are making a statistically significant shift toward younger diagnoses. Termed Early Onset Cancers (EOC's), EOC's are particularly concerning because current medical research has been unable to identify a reason for this shift. Identifying risk factors for the development of EOC is an area of critical need. Given the unclear clinical application of extant literature, this study applies data clustering, heat maps, and data analysis to EOC data using clinical and genomic data from the publicly available PANCAN project. The study focus is to provide novel insights to elucidate risk factors that contribute to the development of EOC's, which will help inform preventative measures to potentially reduce the risk of EOC's.

Integrating Pharmacokinetics and Pharmacodynamics Modeling with Quantum Regression for Predicting Herbal Compound Toxicity

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University of Texas Southwestern Medical Center, Dallas, Texas, USA;
University of Nebraska Medical Center, Omaha, Nebraska, USA

Abstract - Herbal compounds present complex toxicity profiles that are often influenced by both intrinsic chemical properties and pharmacokinetics (PK) governing absorption and clearance. In this study, we develop a quantum regression model to predict acute toxicity severity (LD_{50}) for herbal-derived compounds by integrating toxicity data from NICEATM with pharmacological features from TCMSP. We first extract molecular descriptors (e.g., logP, polar surface area) alongside PK metrics such as oral bioavailability, combining them into a unified feature set. A quantum linear systems algorithm is then applied to solve the regression problem in a high-dimensional quantum state space, capturing multifaceted feature interactions efficiently. Comparative evaluation against classical models, including linear regression and random forest, shows that the quantum model achieves lower prediction errors and higher explanatory power. Analysis of learned coefficients reveals the importance of PK features for modeling toxicity, highlighting that well-absorbed, lipophilic compounds display heightened risk. We further demonstrate the model's utility by predicting toxicity for additional herbal compounds lacking experimental data, identifying several high-risk candidates. This work underscores the potential of integrating pharmacokinetics into quantum machine learning to elucidate toxicity mechanisms, offering a more comprehensive approach to herbal compound safety assessment.

BlurFisheye: A Technique for Enhanced Biological Network Visualization

Hanin Alzahrani, Sara Fernstad
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Newcastle University, UK

Abstract - Complex biological networks are complex systems that mirror essential life processes, from interactions at the molecular level in an individual cell to communication between organs in multicellular organisms. Full working knowledge of these networks improves the treatments given to patients; however, their complex nature and voluminous nature of their data can impede visualization and interpretation. On that note, this research merged the fisheye view with the blur effect to improve the ease of use and data clarity of the network, which then produced the Blurfisheye visualization tool. The blurfisheye technique allows users to put full concentration on certain details without compromising on the whole network context. Therefore, it allows users to effectively sift through the complex biological datasets. In evaluating the blurfisheye technique, usability data were collected using combined data collection approaches such as surveys and interviews with domain experts. Heuristic metrics and the Insight, Confidence, Essence, and Time (ICET) factors were utilized for the evaluation. Quantitative feedback assessed the technique's usability, while qualitative insights captured expert opinions on its application value. Findings indicate that Blurfisheye

significantly improves network exploration by facilitating the identification of drug discovery targets, uncovering research clusters, and enhancing educational engagement. The technique meets users' expectations by providing an adaptable and user-centered interface capable of adjusting to varied analysis needs while maintaining data clarity. Furthermore, the research highlights possible areas for improving tools to enhance biological network analysis. Overall, this study shows how Blurfisheye improves biological network visualization, leading to greater insights and promoting a better understanding of intricate biological systems.

Leveraging Local LLMs for Taxonomy-Aware Analysis of STRING-Supported Species

Hanin Alzahrani
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Abstract - Large Language Models (LLMs) are now widely used in research. They can help with tasks like summarizing information and analyzing data. However, using LLMs with structured biological data is still a challenge. One major problem is hallucination. This happens when the model gives incorrect or made-up answers. In biology, such errors can lead to wrong conclusions. This study proposes a reproducible, taxonomyaware prompt engineering framework for local LLMs that significantly reduces hallucinations and improves factual accuracy in biological dataset analysis. It explores how local LLMs, like LLaMA 3.1 and Phi 4, can be used safely to analyze species data from the STRING database. The aim is to guide these models using well-designed prompts to reduce hallucination and improve accuracy. The method involves creating clear system and user prompts. These prompts were tested on three tasks: counting species flags, grouping by genus, and finding duplicate IDs. Each result was compared to the correct answers generated using Python. The results show that prompt engineering helps the model produce better answers. Hallucinations were reduced, and output became more reliable. Also, LLaMA 3.1 performed better than Phi 4, especially on larger datasets. This study shows that local LLMs, when guided with clear prompts, can support accurate analysis of structured biological data.

A Neural Network Approach for Predicting Cancer-Linked Transcriptional Activity from Epigenetic Signature

Riyan Jain, Anel Turgambayeva
Illinois Mathematics and Science Academy, Aurora, Illinois, USA;
Department of Biological Sciences, Brock University, St. Catharines, ON, Canada

Abstract - Gene transcription is central to biological function and cellular processes. The multitude of proteins created from the transcription of their coding genes controls all crucial cellular functions, both directly and indirectly. Epigenetics seeks to understand how DNA methylation, histone modifications, and genomic imprinting allow the genome to store information beyond the DNA sequence. Genes are characterized by their DNA sequence; however, whether a particular gene is transcribed into proteins or not in a specific cell type is governed by the cell's epigenetic landscape. Thus, epigenetic alterations can contribute to potential carcinogenesis, as enhancement or silencing of the "wrong" genes may cause tumor proliferation. Understanding the principles behind the epigenetic control of gene transcription is crucial for identifying cancer-causing differences. To address this, we developed six neural network models using deep learning to predict transcriptional activity (mRNA expression) based on epigenetic signals (ChIP-seq interactions). Our results show that a model trained on the epigenetic signals of a human cell line can predict that cell line's transcriptional activity with a reasonably high accuracy (79%). Moreover, a model trained on multiple cell lines can be effectively generalized to predict the transcriptional activity of a new cancerous cell line with reasonable accuracy (from 68% to 76% as the number of cell lines used for training increases). This demonstrates underlying patterns in the relationship between the epigenetic signals and resulting transcriptional activity, including shared patterns across normal and tumor cells. Thus, our model is a valuable tool for exploring epigenetic landscapes from a cancer context.

Simulation Study of Optical Phase Conjugation Light Refocusing with Constant Amplitude Information

Sheng-Chun Yao, Jake W. Liu, Snow H. Tseng
Graduate Institute of Photonics and Optoelectronics, National Taiwan University, Taipei, Taiwan

Abstract - We aim to investigate the effectiveness of OPC refocusing in biological tissues with and without amplitude information. Hence, we apply the pseudospectral time-domain (PSTD) method to model the OPC refocusing process and compare the results with and without the presence of amplitude information. Research findings show that while the reconstruction efficiency is higher than 90% for the phase-only approach, the signal-to-noise ratio increases by 25.81% with the amplitude information, indicating a lower noise light refocusing process. Therefore, we conclude that the phase information determines light propagation, while the amplitude information determines the focused light intensity distribution.

The 11th International Conference on Biomedical Engineering & Sciences (BIOENG'25: July 21-24, 2025; Las Vegas, USA)

https://american-cse.org/csce2025/conferences-BIOENG
https://american-cse.org/csce2025/

Real-Time Pose Evaluation and Health Feedback System for Fitness Using AI

Given Mark Garcia, Jasper Liu, Yuliang Zhao, Carol Yan, Reiniery Villalta, Heng Wu
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Software Development, Google Developer Group, Fremont, California, USA;
Obra D. Tomkins High School, Houston, Texas, USA;
Diamond Bar High School, Diamond Bar, California, USA;
Computer Science and Computer Engineering Department, University of La Verne, La Verne, California, USA

Abstract - As interest in health and wellness continues to grow, exercise and fitness play an increasingly important role in overall well-being. This paper presents a novel AI-powered system that uses computer vision and deep learning to evaluate posture and provide personalized health feedback in real time. We integrate CNN-LSTM models with real-time pose tracking on mobile platforms to improve training outcomes and minimize injury risk. The system captures and processes motion images to extract key features and movement patterns. Using deep learning and pattern recognition, it evaluates posture, motion, and physical condition during exercise. Based on these evaluations, the system generates personalized health recommendations. Experimental results show that the proposed approach accurately assesses exercise form and physical state, helping to improve training effectiveness, reduce injury risk, and enhance overall workout quality.

Federated Lung Nodule Segmentation Utilizing Hybrid Transformer-Unet Architecture

Sapthak Mohajon Turjya, Mulham Fawakherji
Kalinga Institute of Industrial Technology, Bhubaneswar, India;
North Carolina Agricultural and Technical State University. Greensboro, North Carolina, USA

Abstract - Lung nodule segmentation is vital for early lung cancer detection, but traditional deep learning models often struggle with generalization due to data privacy restrictions and institutional silos. This study proposes a federated segmentation framework using a hybrid TransformerU-Net, which captures both local and global features without requiring data sharing. Trained among decentralized clients, the model preserves privacy while achieving segmentation accuracy comparable to centralized approaches, demonstrating strong generalizability and clinical viability in pulmonary imaging.

Streamlining Breath Analysis Methods for Rapid and Low-Cost Diabetes Detection and Dataset Collection

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Department of Electrical and Biomedical Engineering, University of Nevada Reno, Reno, Nevada, USA;
Department of Computer Science, University of Houston - Downtown, Houston, Texas, USA

Abstract - The diagnosis of early stages of diseases such as lung cancer or diabetes is challenging, as these diseases do not have many noticeable symptoms. However, human breath contains many volatile organic compounds (VOCs) that could be used as a clue to conduct the proper test. This study explores the technology required to develop a device for rapid, non-invasive disease detection with the use of the human breath print. The architecture for rapid and low-cost sensing is described, and how it could be employed in the future. The process of finalizing the sampling device and the data flow architecture will be described, along with important factors to consider when designing a breath analysis device. Index Terms—Diabetes; Volatile Organic Compounds.

Novel Composite Nerve Guidance Conduits with Controlled Degradation and Drug Release for Peripheral Nerve Regeneration

Deepak Khare, Jiaying Wang, Xiaojun Yu
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Abstract - Peripheral nerve injury (PNI) refers to the situation where the peripheral nervous system is broken due to trauma, inflammation and other reasons. Due to the weak regeneration ability of nerves, nerves cannot repair themselves in large-interval nerve injuries. Although the traditional treatment methods of autologous transplantation and allogeneic transplantation have good efficacy, they are limited by insufficient donors, inflammation, and complications. The nerve guide catheter (NGC) has become a potential solution for the treatment of PNI. In this study, a new type of NGC was developed using solvent casting and ion cross-linking methods. Polycaprolactone (PCL) and chitosan were used as materials to make a PCL-chitosan hybrid catheter with a spiral structure. The morphology, porosity, degradation and mechanical properties of this NGC were tested, and in vitro bovine serum albumin (BSA) release and Schwann cell biocompatibility were studied. The results showed that compared with pure PCL-NGC without chitosan, PCL-chitosan NGC showed better biocompatibility, drug release characteristics and degradability, and met the mechanical strength requirements required for transplantation. This shows that PCL-chitosan NGC has the potential to become one of the good materials for the treatment of PNI. This study proves the feasibility and better effect of the synergistic use of PCL and chitosan and provides new ideas for material design in the field of peripheral nerve repair.

Traffic Signal Detection System For The Visually Impaired Using Deep Learning

Aaron Jiwei Bai, Chris Cheng Zhang
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Abstract - This project created a YOLOv8 model powered product that automatically recognizes red, yellow, and green traffic lights then displays and verbalizes this information to enable people with color blindness to drive more safely. The machine learning dataset was created with Computer Vision Annotation Tool (CVAT) for image labeling and a python-based training program called You Only Look Once (YOLO) v8 for the training process. This model was then used to make a tool that was able to detect traffic signals and transform their colors into colors distinguishable by those with colorblindness while vocally relaying information to drivers. The model achieved an accuracy rate of 96% in traffic light detection and 93% color signal recognition. The AI model was then integrated into a Raspberry Pi. Integration into a Raspberry Pi makes the AI model mobile and internet-free. This approach also holds promise for broader applications in marine and aviation sectors, potentially revolutionizing transportation safety for individuals with colorblindness.

The 23rd International Conference on Scientific Computing (CSC'25: July 21-24, 2025; Las Vegas, USA)

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A Hybrid Statistical-Machine Learning Framework for Assessing Structural Accuracy in Predicted Protein Models

Niharika Pandala, Katherine G. Brown, Homayoun Valafar
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University of South Carolina, Columbia, South Carolina, USA

Abstract - Reliable evaluation of predicted protein structures is essential for their application in drug discovery and functional genomics. We present a hybrid statistical–machine learning framework that assesses residue-level accuracy using Ramachandran-space circular distances and φ/ψ torsional features derived from sequence-contextual distributions via PDBMine. These features, integrated with unsupervised clustering and supervised classifiers—including a neural network achieving an F1-score of 0.93—enable high-resolution structural validation beyond traditional RMSD-based metrics. This approach uncovers structurally unreliable regions and supports confident deployment of predicted models in structurally complex and biologically sensitive systems.

Machine Learning and Data Analysis Method for Predicting an Efficient Algorithm for Heterogeneous Multicore Scheduling

Imad Assayakh, Imed Kacem, Giorgio Lucarelli
LCOMS, Universite de Lorraine, Metz, France

Abstract - We propose a machine learning method to predict an efficient algorithm for scheduling tasks on hybrid CPU-GPU platforms with precedence constraints. The prediction is also based on data analysis, with the aim of identifying the influencing parameters in the input. Each task has processor-dependent processing times, and the objective is to construct a feasible non-preemptive schedule that minimizes the makespan. We define 129 features and benchmark seven state-of-the-art scheduling heuristics on synthetic instances generated using controllable DAG and processing time generators. The collected performance data are then used to train multi-output regression models, which predict the makespan and scheduling runtime of each heuristic for new instances. At runtime, the heuristic minimizing a weighted combination of these two predicted metrics is automatically selected. Experimental results demonstrate that this approach, combining efficient prediction models and systematic instance generation, substantially improves scheduling performance compared to relying on any single heuristic alone.

Synchronous Blocking Data Transfer Over Wi-Fi Using Java Fork-Join Versus Virtual Threads and Structured Concurrency

Anil L. Pereira
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Abstract - Java fork-join, virtual threads and structured concurrency API are combined with synchronous blocking TCP sockets and compared with traditional multithreading for data transfer between devices with multicore CPUs over WiFi. Fork-join, a task-based processing framework performs better than traditional multithreading for parallel computation on multicore CPUs, especially for divide and conquer algorithms. Virtual threads are light weight user-mode threads that can execute concurrently in large numbers with less scheduling overhead than multithreading. Structured concurrency allows for creating relationships between tasks and subtasks executing on different virtual threads, thus reducing program latency and wastage of resources. Performance evaluation shows that fork-join combined with synchronous blocking TCP sockets perform better overall with respect to throughput, scalability and heap memory occupancy.

Example of Non-Linear Map with Non-Unique Transition to Dynamic Chaos

Peter Chtcheprov, Andrei Chtcheprov
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Independent Researcher, Chapel Hill, North Carolina, USA

Abstract – The paper presents a parameterized version of the previously introduced onedimensional discrete chaotic map with pre-defined invariant distribution function. A novel parametric model is explored for a broad range of map parameters and transitions from non-chaotic dynamic patterns to chaotic regimes are studied. Generated bifurcation diagrams and plots of Lyapunov exponent reveal a remarkable property of the system: non-uniqueness of dynamic routes to chaos and their strong dependence on initial conditions. Observed transition regimes occur because a trivial stable fixed point co-exists with either another stable fixed point or other irregular dynamic patterns. Computed invariant distribution functions are compared with empirical distributions and review of ergodic property of the dynamic system is conducted.

Enhancing Network Security in Multi-Cloud Environments through Adaptive Threat Detection

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Tshwane University of Technology, Pretoria, South Africa

Abstract - Multicloud environments have become indispensable in modern organizational operations and offer unparalleled flexibility, scalability and cost-effectiveness. However, this widespread adoption has created a series of security challenges that need immediate attention. This paper addresses the critical need to increase security in multicloud environments by applying adaptive threat detection techniques powered by machine learning and software-defined networks (SDN). The proliferation of multicloud architectures has enabled organizations to optimize resource use and achieve unprecedented operational agility. However, the heterogeneity of multi-cloud platforms and the rapidly evolving cyber threats landscape expose organizations to advanced persistent threats, zero-day vulnerabilities and data violations. These challenges require innovative solutions capable of providing proactive and adaptable defense. Adaptive threat detection leverages the power of machine learning to analyze network traffic patterns and establish baselines of normal system behavior. Through supervised and unsupervised learning techniques, deviations from these baselines are identified as potential threats. The dynamic capabilities of SDN complement this approach by enabling real-time reconfiguration of network policies, ensuring a robust and responsive defense mechanism against detected threats. The integration of these technologies provides a scalable solution that addresses both known and emerging security challenges. This paper explores the principles of adaptive threat detection in multi-cloud environments. It discusses the limitations of traditional security systems, the complexities of managing heterogeneous cloud infrastructures, and the necessity of advanced security measures. Core components, such as machine learning model selection, anomaly detection mechanisms, and SDN-based adaptive responses, are elaborated. The study delves into algorithms suitable for threat detection, including supervised methods

for known threats and unsupervised techniques for anomaly detection, highlighting their application in strengthening multi-cloud security. Enhancing security in multi-cloud environments through adaptive threat detection powered by machine learning and SDN is crucial to safeguarding critical infrastructure and maintaining the integrity of cloud ecosystems. By addressing the unique security challenges of multi-cloud platforms and implementing robust detection and mitigation strategies, organizations can proactively fortify their defenses against an evolving threat landscape. This paper serves as a comprehensive guide for advancing security in multi-cloud environments, empowering organizations to embrace digital transformation while ensuring their critical assets remain protected.

Crypto-Agility in Post-Quantum Cybersecurity with AI-Driven Dynamic Key Management

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Abstract - The increasing reliance on digital financial services necessitates robust cryptographic solutions capable of resisting emerging quantum threats. Traditional cryptographic methods, such as RSA and ECC, are vulnerable to quantum algorithms, underscoring the urgency of adaptive security measures. This research introduces an AI-driven crypto-agile framework designed to dynamically manage cryptographic keys, effectively responding to both classical and quantum-inspired cyber threats. Utilizing a dataset of 1.85 million credit card transactions, the proposed framework integrates classical feature extraction, deep learning algorithms, and specialized quantum threat heuristics. Results demonstrate superior performance with over 92% F1-score in detecting sophisticated threats. Despite introducing a modest 12–15% increase in handshake latency, the system effectively balances security and operational performance, significantly enhancing financial cybersecurity resilience.

Variational Quantum Biosimulation to Decipher Protein Interaction Networks for Autism Spectrum Disorder

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Abstract - This study introduces a variational quantum machine learning (QML) approach to model protein–protein interactions (PPIs) associated with Autism Spectrum Disorder (ASD). Classical machine learning techniques face challenges in handling the intricate, high-dimensional interactions within ASD-related protein networks. Using variational quantum circuits, this research demonstrates enhanced predictive accuracy and identification of previously unrecognized protein interactions involving critical ASD-linked proteins such as GRIA2, GABRA1, and GRIN2B. Comparative analysis against classical methods indicates the superior ability of QML to capture complex molecular interactions, offering greater precision, recall, and F1-scores. The proposed quantum-enhanced framework thus provides deeper insights into the molecular mechanisms underlying ASD, paving the way for targeted therapeutic interventions and advanced network-level diagnostics.

Lattice-Based Encryption in Building Post Quantum-Resistant Algorithms for Next-Generation Security

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Abstract - The rapid expansion of digital healthcare services and complex data exchanges demands advanced security measures, as quantum computing poses threats to conventional cryptographic methods. This research introduces a framework integrating quantum key distribution (QKD) into healthcare standards like HL7 FHIR. Leveraging quantum mechanics, QKD securely generates and distributes cryptographic keys, ensuring unparalleled privacy and authenticity. The framework addresses interoperability, scalability, and regulatory compliance, integrating seamlessly with emerging post-quantum cryptography solutions. Our approach demonstrates successful QKD implementation within standard data workflows, providing quantum-safe environments. This work establishes a flexible, robust infrastructure to future-proof sensitive patient information, facilitating secure and globally scalable healthcare information exchange, thereby supporting widespread adoption and long-term sustainability.

AI-Sensing Neuromorphic Computing for Cybersecurity in Healthcare Data Lakes

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Abstract - Quantum computing threatens classical encryption and long-term data confidentiality, particularly in healthcare data lakes. Post-quantum cryptographic (PQC) methods provide quantum-safe alternatives but require effective integration of advanced key management and threat detection. This paper introduces an AI-sensing–driven quantum dynamic key management framework combining CRYSTALS-Kyber cryptographic parameters with a transformer-based liquid neural network for anomaly detection. Using synthetic datasets derived from MIMIC-III, the system dynamically escalates cryptographic parameters upon detecting anomalous user behaviors, achieving over 97% detection accuracy and an 85% reduction in attack window. The resulting system maintains acceptable latency and overhead for clinical workflows, demonstrating feasibility of an integrated, AI-driven adaptive PQC solution that proactively protects healthcare data against quantum threats.

Quantum-Resilient Edge Computing Cryptography for Resource-Limited Medical IoT

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University of Texas Southwestern Medical Center, Dallas, Texas, USA;
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Abstract - The The evolution of quantum computing challenges conventional cryptography in healthcare, particularly in the Internet of Medical Things (IoMT). Although quantum-resistant algorithms are rapidly advancing, integrating them into resource-limited medical devices remains difficult. This paper proposes a conceptual multi-layered framework designed for wearables, implantables, and real-time monitoring systems, combining lightweight post-quantum cryptographic primitives, edge computing, robust key management, side-channel mitigation, and regulatory compliance. By segmenting functionalities into device,

communication, security, and management layers, the architecture facilitates incremental adoption and flexibility. Although empirical evaluation is not provided, extensive literature informs the framework, promoting future implementation. This holistic approach aims to secure sensitive patient data, enhance healthcare trust, and ensure robust interoperability against quantum-era threats.

A Material Interface-aware Method for Diffusion Equation

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Abstract - A numerical method is developed for two- and three-dimensional time-dependent diffusion equations in numerical simulations involving mixed cells. The focus of the development is on the formulation for large time steps, second order accuracy in time, the correct treatment of the discontinuity in diffusion coefficient, the handling of mixed cells, and its simplicity compared with the previous interface-aware method. The discontinuity in material diffusion coefficient is correctly treated based on the conservation of energy flux. For mixed cells, material interface reconstruction is applied. In the previous interface-aware method, the global linear system includes all the clean cells (each of which contains only one material) and material polyhedrons resulted from interface reconstruction, and the geometry connectivity needed to form the global linear system includes those between clean cells and material polyhedrons and between material polyhedrons thermally connected in all the simulation domain. The proposed method is simpler through two stages. The first stage is based on volume homogenization without interface reconstruction and material polyhedrons. In the second stage, the temperatures of the materials in each mixed cell are corrected locally. Compared with the existing interface-aware method, the proposed method is simpler in forming required linear systems. The correctness and features of the method are demonstrated through numerical examples.

Quantum-Enhanced Intrusion Detection: A Novel Hybrid Approach Using Quantum Deep Learning

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Abstract - Intrusion Detection Systems (IDS) are critical for modern cybersecurity, yet traditional machine learning-based IDS models face several challenges including computational inefficiencies, vulnerability to adversarial attacks, and inadequate detection of complex intrusions. This paper presents a hybrid quantum-enhanced intrusion detection system (QIDS) integrating Quantum Machine Learning (QML) with classical models. We demonstrate improved detection accuracy and robustness, a scalable hybrid Intrusion Detection (ID) architecture, security evaluations, and comparative analysis showing superior performance over traditional systems by leveraging quantum computing's capacity for parallelism and enhanced pattern recognition.

Preserving Medical Meaning Across Languages: A UMLS-Driven Approach with Small Language Models

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Ilse Karena De-Anda-Garcia, Sabur Butt, Miguel Gonzalez-Mendoza, Gilberto Ochoa-Ruiz,
Hector Gilbran Ceballos-Cancino
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Abstract - This study introduces an innovative framework integrating Small Language Models (SLMs) with concept-based analysis to evaluate medical translation accuracy. Using medical concept embeddings (Cui2vec) and Unified Medical Language System (UMLS) identifiers, we assessed English-to-Spanish translations beyond traditional metrics. Our comparison of similarity measures revealed that cosine similarity and Pearson correlation best preserved semantic accuracy. Domain-specific models (Meditron, Meerkat) demonstrated superior semantic consistency compared to general-purpose models like Llama-2. These findings establish SLMs as efficient alternatives to Large Language Models for medical translation evaluation, particularly beneficial for low-resource languages. By focusing on conceptual meaning preservation rather than lexical equivalence, this approach enhances cross-lingual medical communication while maintaining clinical precision.

Evaluating Large Language Models for Explaining Insecure Code and Identifying Vulnerabilities in Java and Python

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Abstract - This study evaluates how accurately four large language models (GPT4, Claude, Gemini, and DeepSeek) explain insecure Java and Python code and identify security vulnerabilities. Using a dataset of 211 code samples spanning 25 CWE categories, we conducted a comprehensive manual evaluation of model responses. Our findings reveal that while models excel at explaining code functionality (98-99% accuracy), their vulnerability detection capabilities vary (95- 100%). However, 73%–86% of responses included hallucinated or fabricated content. Our findings highlight the importance of human oversight in AI-assisted security workflows, as LLMs often hallucinate, misjudge critical vulnerabilities, and express misleading confidence, particularly in complex real-world code.

Heart Valvular Disease Detection Using Image-based Time Series and Transfer Learning

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Abstract - Cardiac auscultation is a noninvasive, affordable, and practical diagnostic tool for detecting heart valve diseases (HVD), offering the potential for early identification of abnormalities. However, its effectiveness is highly dependent on the cardiologist's expertise. In this study we leverage transfer learning by employed VGG-16 model for the detection of HVD, aiming to provide reliable diagnostics in clinical settings with limited computational resources. Heart sound signals, captured as time-series data, are transformed into image-based representations to align with the architecture of VGG-16, a convolutional neural network (CNN) optimized for accuracy and efficiency. The model was trained and evaluated on Phonocardiogram (PCG) recordings from the Yaseen2018 dataset to distinguish multi and binary class. The five heart valvular conditions are: normal, Aortic Stenosis (AS), Mitral Regurgitation (MR), Mitral Stenosis (MS), and Mitral Valve Prolapse (MVP). For multiclass classification, it attained an accuracy of 99.3% and an F-score of 99.5%, while for binary classification, it achieved an accuracy of 99.1% and an F-score of 99%.

Zero-Shot Perception and Spatiotemporal Transformers for Automated Gait and Footpad Score Classification

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School of Computing, The University of Georgia, Athens, Georgia, USA;
Institute for Artificial Intelligence, The University of Georgia, Athens, Georgia, USA;
Institute for Integrative Precision Agriculture, The University of Georgia, Athens, Georgia, USA;
College of Animal Science & Technology, Henan University of Animal Husbandry and Economy,
Zhengzhou, Henan, China

Abstract - Manual assessment of broiler chicken gait and footpad condition is subjective, labor intensive, and inefficient for large scale welfare monitoring. This study introduces an automated pipeline using RGB D video data captured by an Intel RealSense L515 camera as chickens traverse a platform. It simulta neously predicts gait quality and footpad condition using quantized scores (0–2). The proposed pipeline uses multiple zero shot models, including YOLOE for detection, SAM2 for segmentation/tracking, and RAFT for optical flow. Decoupled X , Y , and Z axis motion streams feed a dual scale Transformer based classifier (CNN TimeSformer) with adaptive gating for optimal feature fusion. The pipeline achieves promising accuracy (gait: 88.9%, footpad: 81.5%), demon strating potential for objective and comprehensive poultry welfare assessment.

Representation of Multidimensional Chaotic Models with Closed-Form Invariant Distributions as Compositions of Symmetric Functions

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Abstract – The paper presents a mathematical and computational framework to study a special case of multidimensional discrete chaotic models with known closed-form invariant distribution functions. The dynamic process is viewed as a realization of a multidimensional stochastic sequence of random variables. To construct chaotic models, distributions are formulated first without prior knowledge of chaotic maps and then map functions are derived. The paper shows that the multidimensional dynamic system can be represented as a set of one-dimensional stochastic processes with new generating maps that are compositions of the original map functions. It is demonstrated that constructed composition models preserve the distribution invariance property. The paper presents examples of two-dimensional chaotic systems with closed-form distributions and explores ergodic property.

Formulation of Voltage Stability Second Order Governing Equation and Arithmetic Moving Average for Transmission Line Prediction and Improvement

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Abstract – The Nigeria 330kV integrated power system currently consists of the existing network, national independent power projects (NIPP), and independent power producers (IPP). This network consists of generating stations, transmission lines, and buses. Consequently, the Nigerian power system is gradually transforming into a complex interconnected network of different components. This complexity is because of the deregulation of the electricity industry and the expansion of the network by the National Independent Power Project (NIPP) and Independent Power Producers (IPP) to meet the increasing energy demand. A balance between active and reactive power will ensure a reliable electric power system for the consumer at the receiving end. For low power factor of the system essentially indicates inefficient delivery of active power to the load due to reactive power losses. This paper study considered the application of predictive optimizers with the view to assess various voltage stability indices (VSI), particularly fast voltage stability index (FVSI), line stability index (LMN), line stability factor (LQP), voltage stability index (LD) and novel line stability index (NLSI), are presented to predict the proximity of the line close to voltage collapse. Following the predictive pattern, three (3) predictive indices (NLSI, LMN, FVSI) captured the voltage collapse behaviour in their respective predictive order, while voltage stability (LD) and line stability factor (LQP) are far from capturing predictive behaviour for voltage collapse, because of its slow dynamic response capacity to the system at abnormal conditions or violations. The mean absolute percentages error (MAPE) indicates NLSI as better and faster in terms of performance capacity, followed by line stability index (LMN) and fast voltage stability index (FVSI) as the slow predictive index for voltage stability under study. While five (5) yearly moving average techniques captured 11 numbers of voltage collapse for the year 2021-2024,10 numbers of voltage collapse for the year 2025-2029. The indices, NLSI, LMN and FVSI show predictive behaviour for system voltage collapse. The Novel line stability index (NLSI) has better and faster predictive characteristics capacity for determining voltage instability especially, Shiroro (generator-bus), Okpai (generator–bus) Kumbotso (load bus), Jos (load-bus), Markudi (load-bus) Damaturu (load-bus), Ikeja-west (load-bus), Ikot-Ekpene (load bus. The research paper also introduced the application of artificial neural network (ANN), to measure system parameters performance, correlation, and validation with input data (FVSI, LMN, LQP, LD, NLSI). The obtained quantitative of R = 0.9993 while the validity value was 0.9993 which agrees with the data input for parameters relationship. [1,2]

Voltage Collapse Instability Prediction of Nigerian 330kV Transmission Network Using Predictive Optimizer and Arithmetic Moving Average Technique for Enhancement

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Nkpolu-Oroworukwo, Port Harcourt, Nigeria

Abstract – The Nigeria 330kV integrated power system currently consists of existing network, national independent power projects (NIPP), and independent power producers (IPP). This network consists of generating stations, transmission lines, and buses. Consequently, the Nigerian power system is gradually transforming into a complex interconnected network of different components. [1] A balance between active and reactive power will ensure a reliable electric power system for the consumer at the receiving end. Low power factor of the system indicates inefficient delivery of active power to the load due to reactive power losses. Voltage collapse incidence may be the resultant effect of voltage instability in the power system network (PSN). This paper considered the application of predictive optimizers with the aim to assess various voltage stability indices (VSI), particularly fast voltage stability index (FVSI), line stability index (LMN), line stability factor (LQP), voltage stability index (LD) and novel line stability index (NLSI), are presented to predict proximity of the line close to voltage collapse. The line voltage stability indices are based on active and reactive power injections into network configuration Five (5) predictive indices [2, 3] examined the predictions of voltage collapse profile for the 330kv transmission network under investigation. Following the trend of the predictive pattern are three (3) indices (NLSI, LMN, FVSI) captured for voltage collapse behaviour in their respective order, especially voltage stability (LD) and line stability factor (LQP) prediction behaviour for voltage collapse, because of its poor dynamic response to system abnormal conditions which indicates that the mean absolute percentages error (MAPE) was used to indicates NLSI has better and faster response terms of performance capacity, followed by line stability index (LMN) and fast voltage stability index (FVSI). The application of Arithmetic Moving Average (AMA) determined the number of voltage collapse in the following years, 2024, 2025, 2026, 2027 and 2028 to be 11, while the expected villages collapses become 10 in the year 2029 – 2032, using Five (5) years moving average technique. It is observed that the number of voltage collapse from 2021 – 2024 was 11 while the year 2025 – 2029 was 10 numbers. The indices, NLSI, LMN and FVSI show high predictive behaviour for yearly system voltage collapse, particularly the Novel line stability index (NLSI) which has better and faster predictive characteristics capacity for determining voltage instability especially, Shiroro (generator-bus), Okpai (generator–bus) Kumbotso (load bus), Jos (load-bus), Markudi (load-bus) Damaturu (load-bus), Ikeja-west (load-bus), Ikot-Ekpene (load bus), Ayede (load bus) Aja (load bus) Egbin (generator bus). The research paper also introduced application of artificial neural network (ANN), to measure system parameters performance, correlation, and validation with input data (FVSI, LMN, LQP, LD, NLSI). The result shows the obtained quantitative value of R = 0.9993 while the validity value was 0.9993 which agrees with the (FVSI, LMN, LQP, LD, NLSI) set parameters relationship. [4, 5]

Comparative Analysis of Scheduling Algorithms Relative to O(n) Characteristics

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Abstract - This study investigates the performance of various scheduling algorithms through an O(n) analysis, emphasizing their computational efficiency and effectiveness in managing process execution in operating systems. The study includes a detailed examination of fundamental algorithms such as First-Come, First-Served (FCFS), Shortest Job First (SJF), and Round Robin (RR), alongside more advanced methods like Priority Scheduling, Improved Round Robin, and Lottery Ticket Scheduling, etc. Each algorithm is assessed based on its time complexity, with a focus on how the algorithms scale with increasing numbers of processes. Key performance metrics such as turnaround time, waiting time, and response time are analyzed in relation to their O(n) characteristics, providing a clear understanding of the trade-offs involved in selecting appropriate scheduling strategies. The findings underscore the importance of O(n) analysis in evaluating algorithm performance, ultimately contributing to the development of more efficient process management techniques in modern operating systems.

Parallel and Sequential Algorithms for Detecting Sparse Binary Squares with Three Ones

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Department of Mathematics, Computer Science and Engineering, Perimeter College,
Georgia State University, Atlanta, Georgia, USA

Abstract - This paper explores the set of odd positive integers m for which m^2 has exactly three ones in its binary expansion, specifically of the form $m^2 = 2^a + 2^b + 1$, where $a > b > 0$. To address this problem computationally, we design and implement both sequential and parallel algorithms in Java, capable of exhaustively searching up to one novemquadragintillion (10^{150}). The algorithms systematically iterate over valid exponent pairs (a, b), compute the candidate square, and verify its square root using a custom BigInteger binary search method. The parallel version distributes the search range across multiple threads, achieving an 8.33× speedup compared to its sequential counterpart. The results suggest a compelling conjecture: the complete solution set includes the finite set {5, 7, 9, 17, 23} and an infinite family of the form $m = 2^u + 1$ for $u \geq 5$. This work contributes new insights into the structure of sparse binary squares and demonstrates the power of parallel computation in large-scale number-theoretic searches. The algorithms and empirical findings lay the groundwork for future studies in digital representations and additive number theory.

Causal Inference for Observational Studies: Deep Learning Approaches to Counterfactual Generative Modeling

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Abstract - Causal inference from observational data remains one of the most formidable challenges in science and medicine, largely due to the absence of randomized treatment assignment and the pervasive influence of confounding variables. At the heart of this challenge lies the estimation of counterfactual outcomes—hypothetical scenarios that reveal what would have happened under alternative interventions. The rise of artificial intelligence (AI), particularly deep learning, has ushered in a transformative shift in how we approach this problem. By uncovering complex, high-dimensional latent structures and capturing non-linear relationships, deep generative models now offer powerful tools for counterfactual reasoning. This paper presents a comprehensive synthesis of traditional causal inference strategies and cutting-edge AI methodologies, including Variational Autoencoders (VAEs), Generative Adversarial Networks (GANs), Normalizing Flows, and Diffusion Models. We explore how these frameworks can be harmonized with classical causal theory to improve robustness, scalability, and personalization. Our analysis spans benchmark datasets and real-world applications in high-stakes domains such as coronary artery disease (CAD) and Alzheimer's disease and related dementias (ADRD), where observational data is abundant but difficult to interpret causally. Finally, we emphasize the imperative of ethical deployment, transparency, and fairness—arguing that deep counterfactual modeling is not merely a technical advance but a foundational capability for the future of precision medicine and equitable healthcare policy.

Evaluation of the Impact of Preprocessing and Selection of Characteristics on the Classification of Feelings

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Abstract - Currently, the identification of psychological disorders such as depression through the analysis of unstructured texts has gained relevance in the field of natural language processing and machine learning. In particular, the use of models such as decision trees has proven to be a useful tool for classifying unstructured texts that show signs of depression. The present research work focuses its efforts on the realization of a system capable of identifying depression making use of three machine learning methods based on decision trees: Random Forest, J48 and Decision Tree, using some preprocessing techniques in conjunction with two types of classification scenarios in order to identify the conditions in which the best performance of the system is obtained.

Density of States of Triangular Antiferromagnetic Ising Models of Finite Size

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Abstract - The density of states of antiferromagnetic Ising model on finite triangular lattices in a one dimensional ladder like arrangement are analyzed. It is show that the density of states is approximately gaussian and the peak height varies with one over the square root of system size, and the width of the gaussian grows linearly with system size. Yet the ground state alternates from non-degenerate to highly degenerate when the number of spins changes from even to odd. Thus the bulk density of states is not sensitive to the variation in the ground state degeneracy. Ground states must be found via exhaustive enumeration of states.

Academic Risk Prediction: An Artificial Intelligence-Based Approach Using Psychoeducational Variables

Ruth Yalena Zuleta Torres, Pedro Javier Lopez Perez, Ethel de la Hoz, Dixon Salcedo Morillo
Universidad de la Costa, Barranquilla, Colombia

Abstract - This study presents an academic information management model based on Artificial Intelligence (AI) for early predicting school failure risk. It integrates classical statistical techniques, such as multiple regression and correlation analysis, with advanced machine learning methods, including K-means clustering and Principal Component Analysis (PCA). This methodological combination enables a comprehensive analysis of data related to cognitive skills, executive functions, physical and mental health, emotional well-being, and sociodemographic factors. The model was applied to a sample of 190 students aged 8 to 12 from vulnerable communities in Colombia, with data collected at three key points: mid-school year, end of the cycle, and the beginning of the following academic year. The analysis achieved a predictive accuracy of 85%, highlighting the importance of mental health indicators, especially depression and anxiety, in predicting academic performance and reading comprehension. Significant interactions between emotional and cognitive variables were found, underscoring the need for integrated approaches when designing effective educational interventions. This approach allows for more targeted preventive actions and supports ongoing evaluation of the model's stability over time. Incorporating more sophisticated AI techniques, such as deep neural networks and boosting models, is proposed as a future direction to enhance the model's predictive capacity and broaden its applicability across diverse educational contexts.

Reinforced ArCHitEcture Learning (RACHEL): A Reinforcement Learning-Driven Neural Architecture Search Framework for Efficient Ensemble Learning

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Department of Computer Science, Missouri State University, Springfield, Missouri, USA

Abstract - Neural Architecture Search (NAS) automates model design but often requires prohibitive computation, especially Reinforcement Learning (RL) methods needing thousands of GPU hours. We introduce Reinforced ArCHitEcture Learning (RACHEL) to address this barrier. RACHEL integrates an actor-critic RL agent and ensemble learning featuring a stability-ensuring safety net. Utilizing mixed-precision and XLA optimizations, RACHEL demonstrates exceptional efficiency on CIFAR-10. It achieved significantly higher accuracy than Adanet on binary tasks in under 2 hours and a competitive accuracy on the full dataset in under 8 GPU hours on an NVIDIA L4. RACHEL provides competitive performance at a drastically reduced computational cost compared to established NAS techniques.

OTDOA-based Positioning Approach for Indoor Factory (InF) Settings Using 5G New Radio

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Abstract - Positioning has significant importance, particularly in the context of indoor environments where the global positioning system does not work. With the envisioned Industry 4.0 and beyond, and future smart factories, locating robots precisely is crucial for safety and productivity. With the 5G new radio (NR) positioning reference signal (PRS), higher bandwidth offers the opportunity for a more accurate indoor position. This study performs simulations for the indoor factory (InF) settings as defined by the 3GPP release and analyzes the efficacy of 5G NR for locating mobile devices in the InF environment. Different use cases are considered for both line-of-sight (LoS) and non-line-of-sight (non-LoS) scenarios. In addition, simulations are performed using different bandwidths to extensively investigate the influence of bandwidth on positioning accuracy.

SESSION: Military and Defense Modeling and Simulation

Chairs: Douglas D. Hodson (Chair), Michael R. Grimaila** (Co-Chair), Torrey J. Wagner*** (Co-Chair)*
**Professor, Computer Science and Engineering Department, the US Air Force Institute of Technology, USA;*
***Professor & Head, Systems Engineering and Management Department, the US Air Force Institute of Technology, USA;*
****Assistant Professor of Data Analytics supporting the AFIT/EN Data Analytics graduate certificate program, USA*

Classifying Seismic Events: A Machine Learning Approach to Identifying Earthquakes, Explosions and Other Rare Events

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Data Analytics Certificate Program, Air Force Institute of Technology, Wright-Patterson AFB, Ohio, USA;
KBR Inc., Wright-Patterson AFB, Ohio, USA

Abstract - Seismic event classification can differentiate between natural and human-caused geophysical events in near-real time, which has numerous potential applications. Using a dataset of 30,000 seismic events from the United States Geological Survey (USGS), machine learning (ML) models were developed and evaluated to automate the classification of earthquakes, explosions, or other events. Key features were identified as depth, magnitude, latitude, and longitude. A Random Forest (RF) model achieved the best performance, with 99.8% accuracy, F1-score of 0.97, and recall of 0.95, which performed better than a trivial majority-class model 90.6% accuracy. Classification of explosions or other rare geophysical events posed a challenge for all models because the dataset was severely imbalanced, with 90.6% of the data classified as earthquakes. RF models incorporate an ensemble approach and place higher class weights across rarer events, making them better for classification of minority events. Neural networks (NN) were also explored. They achieved 98.8% accuracy but underperformed in minority class recall compared to the RF model. The NN highlighted the importance of addressing class imbalances to improve performance, so Synthetic Minority Oversampling (SMOTE) was applied to assist the NN achieve better predictions of rarer seismic events. The classical ML and NN results demonstrate the utility of these models to enhance capabilities by enabling accurate, real-time seismic event classification, potentially contributing to treaty compliance, battlefield awareness, and disaster response applications.

Cost Estimation of DoD ACAT 1 Software Programs: Statistical Regression vs. Neural Networks

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Graduate School of Systems Engineering & Management, Air Force Institute of Technology, Wright-Patterson AFB, Ohio, USA;
Graduate School of Mathematics and Statistics, Air Force Institute of Technology, Wright-Patterson AFB, Ohio, USA;
AFLCMC/FZCE, Air Force Life Cycle Management Center, Wright-Patterson AFB, Ohio, USA

Abstract - Accurately estimating software costs is crucial for Department of Defense (DoD) projects to avoid budget overruns and resource misallocation. This study compares the effectiveness of statistical regression techniques and neural network models for cost estimation, using 306 records with ESLOC, SLOC, and project attributes. A baseline model had an MAE of 1.35 and MSE of 2.82. The refined Ordinary Least Squares (OLS) regression model achieved an R2 of 0.58, Adjusted R2 of 0.57, PRESS R2 of 0.57, MAE of 0.85, and MSE of 1.20, focusing on key predictors such as ESLOC and development hours. In contrast, the bestperforming neural network achieved an R2 of 0.54, MAE of 0.88, and MSE of 1.27, with L2 regularization reducing overfitting but lowering R2 to 0.48. The findings highlight the strengths of OLS regression in small-sample scenarios, where its transparency and reliability make it better suited to DoD cost analysis than neural networks, which often require extensive tuning and face instability. These results underscore the value of statistical methods in providing actionable insights for refining cost estimation frameworks and guiding resource management in Agile and traditional DoD environments.

Airfoil Selection Tool Development Using the Cross-Industry Standard Process for Data Mining

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Data Analytics Certificate Program, KBR Inc., Wright-Patterson AFB, Ohio, USA

Abstract - This work aims to streamline the process of selecting airfoils based on geometric and aerodynamic characteristics. This project integrates an extensive airfoil database with automated preprocessing routines to standardize and analyze airfoil geometries. The tool employs XFOIL to generate aerodynamic coefficients for various airfoil geometries, enabling engineers to make informed design choices efficiently. A robust graphical user interface (GUI) facilitates user interaction, allowing airfoil selection based on performance criteria or geometric similarity. Comparative validation against experimental and high-fidelity computational fluid dynamics (CFD) benchmark data confirmed the tool's predictive reliability within XFOIL's operational envelope. Despite some discrepancies in drag prediction at high lift coefficients, the tool effectively supports airfoil selection for preliminary aircraft design. Future enhancements include integrating higher-fidelity aerodynamic solvers, expanding the airfoil database, and refining geometric analysis capabilities.

Early Fault Detection and Remaining Useful Life Prediction in CMAPSS Engines

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Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio, USA

Abstract – NA

Solar Storm Effects on Quantum Communication Network Performance

Brett M. Martin, Michael K. Seery, Douglas D. Hodson, Torrey J. Wagner, Michael R. Grimaila,
Anne Marie Richards, Wayne McKenzie
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Abstract - While previous studies have shown that local weather predictors can accurately model time synchronization errors in quantum networks within the strict tolerances required by critical quantum networking protocols, the chaotic behavior of these systems makes precise modeling difficult. To investigate whether additional factors further explain the variance in synchronization errors, we examine space weather data from periods of increased solar activity—specifically, X-ray flux and geomagnetic disturbance data taken during the April–May 2024 solar storm. Correlation analyses and predictive machine learning models are used to assess predictive accuracy. Our findings show that the variance in model residuals explained by space weather is negligible, suggesting solar storms have minimal impact on precision distributed timing.

MADFACTs:A Meta-learning Augmented Defense Framework for Adversarial Cyber Techniques

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Army Cyber Institute, USA

Abstract - Adversarial examples are functional data examples that fool machine learning classifiers. Network intrusion detection systems are not typically designed with resilience to adversarial attacks. Recent research demonstrates that generative adversarial attacks allow malicious cyber packets to bypass network intrusion detectors at 69% success rate. This alarming penetration rate opens the door for cyber-kinetic attacks that risk damage to infrastructure and loss of life. A novel framework incorporates meta-learning and adversarial training to enhance the detection of generative adversarial examples. Our results show 100% detection rate against known variants of adversarial attack. Detection of adversarial examples is a critical component of securing cyber networks and in turn protecting infrastructure.

The 24th International Conference on e-Learning, e-Business, Enterprise Information Systems, & e-Government (EEE'25: July 21-24, 2025; Las Vegas, USA)

https://american-cse.org/csce2025/conferences-EEE
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EduRAG: Improving AI Teaching Assistants with Retrieval-Augmented Generation

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Abstract - This paper addresses the emerging need for AI-driven teaching assistants to deliver personalized, effective and responsive educational assistance. Although large language models (LLMs) like GPT-3, GPT-4 generate human-responsive text, these models suffer from domain accuracy. One potential solution was identified as the Retrieval-Augmented Generation (RAG). These problems can be addressed by fusing the generative capability of LLMs with modern retrievals that allow it to refer to well-curated knowledge bases in that domain, thus making the responses more accurate and appropriate. This study develops RAG as an AI teaching assistant. This reduces the gap between general knowledge and subject-specific expertise, thus providing information that is not only relevant to the context but also customized to the unique requirements of students.

Future Multimedia Integrated Learning Methodologies and its Applications in Digital Education

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Abstract - In underdeveloped nations, obtaining high-quality education continues to be a significant obstacle. Many approaches, including the exploitation of multimedia technology, have been considered in attempts to provide access to the vast majority of learners in developing countries. Exploration of the future multimedia integrated learning methodologies and its usage in digital education is the central goal of this article. In addition, the study determines how multimedia technologies have shown to be an adequate end-to-end approach for closing the access gap to high-quality digital education. We examined a number of scientific literatures to investigate how significant the tools of multimedia are in the educational processes. The research exhibited that the technologies currently in deployment include multimedia features, namely, audio, video, 3D, animation, text and pictures. According to the study's findings, digital education can make use of a variety of multimedia technologies. As a result, the findings of this study can be furtherly used as reference for educators and administrators to help them choose multimedia resources and technologies for use in the classroom at schools and other higher education institutions.

Using Data Mining for Effective Customer Relations in Retail Sector

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Abstract - Integrating data mining into retail customer service has revolutionized how businesses understand and interact with consumers, driving personalized experiences and operational efficiency. By analyzing vast datasets, retailers uncover patterns in customer behavior, optimize service delivery, and mitigate risks, ultimately fostering loyalty and competitive advantage. The data mining technology in Customer Relationship Management (CRM) can make classification, clustering, and association analysis of customer behaviors according to set models to convert the data into useful information to support operating decision-making. This paper discusses a few aspects of how data mining has impacted business operations and its transformative role in retail customer service.

A Proposed Model for Resource Consumption Optimization within Inter-Organizational Business Process Execution

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Abstract - The inter-process collaboration can be quantified as a cost based on the multiple exchanges between the web services which execute the business process tasks. This cost can be calculated by using interoperability criteria. The objective of the paper is to provide the formal definition of the resource consumption optimization problem within inter-organizational business process execution. We have defined and tested the model by studying the process of the brand image creation for a customer in an enterprise network. The results show that the overall cost of resource consumption is greater than one thus, the resources are over-used, and removing the unnecessary web services can optimize the utilization of resources during the execution of the inter-organizational business process instances.

The 23rd International Conference on Embedded Systems, Cyber-physical Systems, & Applications (ESCS'25: July 21-24, 2025; Las Vegas, USA)

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Cognitive Software Defined Radios for Embedded Systems and 7G Mesh Applications

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Abstract - This paper presents the design, implementation, and evaluation of advanced cognitive software defined radio (SDR) platforms intended for next-generation wireless networks and mesh applications. Two SDR prototypes were developed: a compact 2×2 MIMO system based on an AMD/Xilinx Kria systemon-module, and a high-performance 4-channel SDR utilizing Xilinx Zynq UltraScale+ RFSoC technology. Both platforms integrate Gallium Nitride (GaN) power amplifiers, support high-order modulation up to 4096-QAM, and employ artificial intelligence (AI) and machine learning (ML) techniques in their digital signal processing pipelines for dynamic scheduling, LDPC decoding, and channel equalization. Laboratory measurements confirm that these SDRs achieve high fidelity in 1024-QAM and 4096-QAM transmissions, low-latency decoding, and robust real-time performance. Building on these validated platforms, we develop and analyze a cognitive mesh networking architecture suitable for UAVs and embedded systems, featuring multi-band operation, AI-driven routing, and resilience to interference and adverse conditions. Simulation and testbed results demonstrate improved throughput, adaptability, and reliability compared to conventional approaches. The findings highlight a practical pathway to implementing adaptive, high-capacity wireless mesh networks for future applications in distributed and autonomous systems.

Adaptive Per-Tree Canopy Segmentation and 3D Reconstruction via Multi-Sensor Fusion in Structured and Unstructured Orchards

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Department of Computer and Information Science, University of Pennsylvania, Pennsylvania, USA

Abstract - Accurate and automated per-tree canopy segmentation is critical for large-scale orchard monitoring, especially in environments with variable planting geometries. We present a system for adaptive segmentation and 3D reconstruction of individual tree canopies using mobile LiDAR data and UAVderived point clouds. The system integrates LiDAR-inertial odometry, density-based clustering, and graph-based refinement to operate across both structured (pistachio) and unstructured (almond) orchard environments. A multi-stage clustering pipeline dynamically combines DBSCAN with spectral clustering to resolve overlapping or irregularly spaced canopies. Additionally, we introduce a multi-scale ICP-based point cloud fusion method to align UAV and LiDAR data, enhancing structural completeness and canopy continuity. Field experiments in two commercial orchards demonstrate the system's robustness, achieving 93% segmentation success in structured layouts and 80% in dense, overlapping environments. This work introduces scalable, geometry-aware tree canopy mapping pipeline enabling robust, geometry-aware segmentation for diverse orchard types and serving as a foundation for scalable, tree-level analytics.

Energy-Aware Scheduling In Dvfs-Enabled Mixed-Criticality Systems

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Abstract - In this paper, we propose an energy-aware task scheduling algorithm for mixed-criticality systems, where a task can operate in multiple operating modes on a heterogeneous multiprocessor system. Given a latency constraint, our approach minimizes energy consumption by first scheduling at maximum frequency to ensure feasibility, then selectively adjusting to lower frequencies for energy savings. The experimental analysis shows the algorithm generates significant improvements on energy use compared to the HEFT schedule. Future work involves exploring different options for selecting the energy-focused critical path and expanding the scope of the algorithm to handle the critical frequency.

TruRescue: A Federated Learning Based Drone Driven Road Emergency Assistant with Generative AI

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Abstract - In real-world traffic accident scenarios, visual perception systems often face challenges such as motion blur, low illumination, and environmental occlusion, which significantly impair image clarity and hinder timely emergency response. To address these limitations, we propose TruRescue, a multi-UAV visual assessment system that integrates Federated Learning (FL) and Generative Artificial Intelligence (GenAI) for robust, privacy-preserving image reconstruction and risk estimation. Each UAV captures degraded images of accident scenes and participates in decentralized model training via FL, while a generative module fuses multi-view inputs to reconstruct high-fidelity images. A novel CDVbased risk assessment framework, incorporating Clarity gain (C), Damage severity (D), and Visibility level (V), is introduced to quantify incident risk and support intelligent decision-making. Simulation experiments using AirSim demonstrate that TruRescue significantly improves image quality (e.g., PSNR +8.7 dB, SSIM +0.20), achieves high risk scoring accuracy (up to 91%), and accelerates model convergence with tolerable communication overhead. These results validate the effectiveness and deploy ability of TruRescue in edge-based, uncertain disaster environments, providing a practical pathway toward trustworthy AIdriven emergency response systems.

Container Performance in Secure Space Systems

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Abstract - Embedded systems running critical applications, such as spacecraft flight software, demand high reliability, efficiency, and real-time responsiveness. As Linux and container technologies gain traction in these domains, understanding their performance implications becomes essential, particularly when enhanced with Mandatory Access Control (MAC) Linux security modules (LSMs) like SELinux and AppArmor. This study evaluates the performance impact of enabling SELinux and AppArmor on application and container workloads running on a Raspberry Pi 4. We examine both native and containerized execution environments under various security configurations, analyzing CPU, memory, disk I/O, and runtime latency. Our results show that enabling MAC LSMs introduces minimal performance overhead across most metrics, suggesting that security enforcement through SELinux or AppArmor can be achieved without significantly compromising system performance.

Openness and Adaptability in Cybersecurity: A Hierarchical Approach to Robust Defense

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Abstract - Cybersecurity systems are increasingly essential and broadly deployed across a wide range of applications and domains. This paper investigates the generalization and adaptability of defense mechanisms for AI-based defenders in environments characterized by uncertainty and openness. We critically analyze the limitations of existing machine learning-based approaches, emphasizing their diminished performance in unpredictable scenarios. To address these shortcomings, we introduce a heuristic hierarchical framework designed to enhance defender adaptability. Empirical results demonstrate that our proposed method surpasses the widely adopted Proximal Policy Optimization (PPO) algorithm in open-system settings. These findings offer valuable insights into the development of more robust, generalized, and adaptive cybersecurity defense strategies tailored for dynamic and uncertain environments.

Design and Evaluation of a Servo-Potentiometer Actuation System for SCARA Robots

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Corpus Christi Catholic, Secondary School, Burlington, ON, Canada;
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Middle School Taiyuan, Shan'Xi, China;
A.R. MacNeil Secondary School, Richmond, BC, Canada;
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Abstract - With the rapid rise of AI, the demand for a diverse range of robotic systems is increasing at an unprecedented rate. A critical component of any robotic system is its actuator, which must provide precise motion. However, many actuators are complex, expensive, and difficult to manufacture. This paper addresses these challenges by presenting a SCARA robot arm equipped with two actuators, each integrating a high torque servo motor and a potentiometer, housed in a compact and easy- tomanufacture 3D design. This paper presents the design and static performance evaluation of this actuator, demonstrating its potential as an affordable and simple solution for precise motion control in educational or lightweight SCARA robot arms, with key metrics on accuracy and repeatability presented.

Design of an Automated Pet Nourishment System and Embedded Microcontroller

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Abstract - This paper presents the design and implementation of an adjustable embedded microcontroller in an automated pet nourishment system. The automated system addresses common challenges faced by pet owners, offering adjustable feeding and watering solutions alongside its cleaning functionalities. The system will be designed with features that include: a customizable feeding regimen, allowing users to input specific feeding quantities per serving, serving frequency, and feeding times; a water dispensing component that incorporates a self-cleaning mechanism, where the user can opt for continuous water supply, timed refills, and scheduled cleanings; and a mobile application that enables remote monitoring and control. This paper will describe the design, implementation, and results of each of the listed objectives.

The 21st International Conference on Foundations of Computer Science (FCS'25: July 21-24, 2025; Las Vegas, USA)

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Language Foundations for HPC Array Structures

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Abstract - Data types such as lists, trees and graphs have well-understood theories that support declarative programming, program correctness and complexity analysis. But array types are not so well formalized and implemented, which is one explanation for the absence of HPCspecific software engineering. There are open basic questions about arrays: does the shape belong to the type or value? are 2D arrays of the same type as 3D arrays? what is a recursive array programming definition ? What is an empty array ? What does an empty shape mean ? We settle those pending questions by applying mathematical domain theory (”Scott domains”) to produce a semantic space for the recursive definition of array operations and their efficient execution.

Design and Analysis of Recursive Algorithms - A Modern Perspective

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Abstract - With the recent advancement in computing technologies, the price of the computing hardware has sharply declined, whereas the performance of the two essential computing resources - CPU processing speeds and RAM or Main Memory storage space have drastically increased. With these advancements in computing, the price of the Main Memory or RAM has been rapidly declining, making recursive algorithms a viable choice for algorithm design for many practically oriented problems. Recursion with previous personal computer or workstation models presented a bottleneck due to limitations in main memory capacity. This paper explores recursive approaches to algorithm design and analysis that also incorporate common sorting, searching, and exponential power computing algorithm design, and explores recursion as a powerful tool for the algorithm design and analysis in Java. Java as a relatively recent object-oriented programming language offers many enhanced features that are useful in recursion, and recursive algorithm design. One such important feature is the introduction of the length field with arrays and the length() method with the String class. Recursion is usually less efficient compared to its iterative counterpart in algorithm design. However, recursion and recursive algorithms could be designed to be more efficient that surpasses the efficiency of the related iterative counterparts. Some such recursive algorithms are considered in this paper together with the design enhancements. Some of the algorithms considered are tail-recursive algorithms. With tail recursive algorithms, the recursive call is usually the last statement in the recursive method, which uses the same stack area repeatedly for performance improvement.

Enhanced Pneumonia Detection in Chest X-rays via KPCA and Multi-Kernel SVM

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Department of Statistics and Finance, University of Science and Technology of China, China;
Department of Economics, Kurume University, Japan

Abstract - This study presents an improved and resource-efficient method for classifying chest X-ray images, specifically targeting the distinction between ”No Finding” and ”Pneumonia” cases. In our previous research, we employed Principal Component Analysis (PCA) for dimensionality reduction followed by Kernel Support Vector Machine (KSVM) classification, which achieved a precision of 71%. Building upon this, we now propose a refined approach using Kernel Principal Component Analysis (KPCA), as it more effectively captures the essential and intricate features of medical images, and combined with a Multiple-Kernel SVM(MKSVM) model, integrating Laplacian, RBF, and Exponential kernels. This updated method significantly increases the classification precision to 89.17%. Importantly, the system remains computationally lightweight, requiring neither GPU acceleration nor large memory, and is capable of running on standard PCs. This makes it a viable and scalable solution for small clinics and resource-constrained healthcare environments, particularly in developing countries.

Counting Nonisomorphic Magic Venn Diagrams

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Abstract - A Magic Venn Diagram (MVD) is a Venn diagram where given regions are labeled such that the labels of the regions of each set add up to the same magic sum. MVDs establish a framework that encompasses various magic figures, like magic squares and magic graphs. One problem that arises in the study of Magic Venn Diagrams is counting the number of non-isomorphic MVDs for a given number of sets and given regions. A previously implemented branch-and-bound search determines all isomorphic, but not non-isomorphic MVDs. We have developed and implemented a preprocessor that detects specific regional structures. The result of the preprocessor is used to speeds up the solution process if one of the known regional structures is present. In all scenarios, human intervention is not necessary anymore to determine the number of non-isomorphic MVDs.

Network-Scale Fault Tolerant Computing - A von Neumann Multiprocessor Architecture

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Abstract - Effective networked computing has been an open challenge for system designers. The main difficulty is the scalability in performance, reliability and security at the same time. The “scaling dilemmas” has plagued infrastructures to date. This paper reports a network-scale reconfigurable multiprocessor architecture inspired by von Neumann’s statistic multiplexing principles. The multiprocessor reconfigurability is enabled by a proposed Active Content Networking protocol and a kernel extension for dynamic runtime resource mapping. Together, they deliver fault tolerant dynamically reconfigurable multiprocessors for arbitrary workflows without scaling limits. This effort will complete the high-performance computing software stack including the customizing compilers under MLIR framework.

Generalized Anti-Symmetry

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Abstract – Anti-symmetric variable pairs have been used to speed up logic simulation. Traditionally, the techniques used to identify anti-symmetric variable pairs are difficult to extend to larger symmetries because antisymmetric variable pairs are not transitive. Orbit-based methods, such as those used by the universal symmetry detection algorithm can be used to extend anti-symmetry to multiple inputs and can be used to identify antisymmetries of many different kinds. These symmetries can be exploited to simplify the simulation of digital logic. The techniques are more involved that those for variable pairs, but significant improvements can be made. Exploitation of auto-symmetries can be added to the array of other types of symmetries available for simulation speed-up.

High Performance Algorithms for Network Routing using In-Memory Computing

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Abstract - Data processing in in-memory computing occurs directly from memory instead of disk storage which results in lower data-access latency and faster processing speeds. Network routing operations reach their highest performance potential through this paradigm which matches Software-Defined Networking needs. We developed parallel algorithms for many-core GPU processing using CUDA which optimize in-memory computing capabilities. Our system achieves three-order-of-magnitude speedup through new computational methods and optimized memory access coordination and shared memory conflict prevention. The system provides scalable performance for large networks by processing big graphs beyond GPU memory capacity and enabling multiple GPU support. Keywords: Multi-core, Multi-threaded Algorithms, Routing Algorithms.

Investigating the Use of Quantum Computing and Quantum Machine Learning in Speech Recognition Systems: A Comprehensive Survey of Recent Advancements

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Abstract - Since the emergence of quantum computing (QC) and quantum machine learning (QML), the world has witnessed a significant advancement in speech recognition systems in the field of Natural Language Processing (NLP). This paper presents a comprehensive overview of some cutting-edge research works where quantum algorithms have been used for improved analysis, understanding, and classification of audio data. During this study period, we have found that quantum neural networks, quantum kernel frameworks, and quantum genetic algorithms have been used in research for enhanced automatic speech recognition (ASR) systems. Using quantum machine learning, we also explored some novel data privacy technologies for audio-visual data. These advancements underline the potential of QC and QML in addressing complex computations in developing ASRs and make the way for the following novel applications in this field.

FCS9632
Generalized Hierarchical Symmetry

Peter M. Maurer
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Abstract – The concept of the group-theoretic wreath product can be used to extend the concept of hierarchical symmetry. This paper shows how this is done.

The 21st International Conference on Frontiers in Education: Computer Science & Computer Engineering
(FECS'25: July 21-24, 2025; Las Vegas, USA)

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Python Pioneers: A K-12 Just-in-Time, Culturally Relevant, Computational Thinking Based Python Learning Experience

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Abstract - This regular research paper presents the results of an innovative five-day educational approach designed to expose middle and high school students to Python and its applications across various fields. These fields include Data Science, Machine Learning, Artificial Intelligence, Cybersecurity, and Information Age Technology, along with computational thinking and Python programming. The camp was designed to be engaging and accessible for middle and high school students, employing a just-in-time teaching approach. This method included information dissemination, hands-on projects, complex analysis at a K-12 level, theoretical examination, and practical real-world application. The emphasis on informal and justin-time learning allowed students to apply newly acquired theoretical knowledge to practical contexts, thereby reinforcing their understanding and retention. Feedback from the study highlights increased engagement, improved understanding, and heightened interest in programming concepts and activities among the participants. The camp demonstrated increased engagement and confidence among students, serving as a model for integrating just-intime learning, cultural relevance, and AI into K -12 education.

BugTor: A Feedback-Driven Static Analysis Tailored for Novice Java Programmers

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Abstract - A common challenge among novice programmers is interpreting runtime error stack traces and manually detecting logic and style errors in their Java code, resulting in inefficient debugging and poor coding practices. This study presents BugTor—a static analysis and feedbackgeneration tool designed to help novice programmers identify and resolve a wide range of common programming errors. Our preliminary evaluation results reveal that BugTor effectively identifies targeted errors and provides

formative feedback, helping students pinpoint issues in their code and offering guidance on how to fix them. BugTor also offers students insights into their performance through weighted error densities compared to submission-wide averages. For instructors, BugTor highlights patterns in common student difficulties, supporting data-driven curriculum improvements.

Integrating Virtual Reality and Research Methods into an Undergraduate Computer Science Elective Course

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Abstract - This paper presents a case study on developing a research-oriented computer science undergraduate elective course. We present and discuss our experience in integrating human-computer interaction research elements into an elective course on virtual reality (VR). Teaching VR application design and corresponding software development exposes students to cutting-edge technologies and offers opportunities to explore emerging trends and advanced programming techniques in computer science. It also allows students to engage in research projects, explore novel VR applications, and contribute to the advancement of interaction and application knowledge in VR. We strived to make this new course a high-impact, research-oriented undergraduate elective. In this paper, we introduce the course design, discuss teaching methodologies, present a sample student group research project, discuss the course outcomes, and propose directions for future course development. In this case study, we aim to address two research questions: 1) Is a VR-focused course a suitable candidate for integrating research elements as an elective? 2) What types of research elements or activities are most appropriate to incorporate into such a course? We conclude that integrating research elements into an undergraduate elective, focusing on virtual reality and human-computer interaction research methods, has been a rewarding experience, with students greatly benefiting from the research-oriented approach.

Collaboration, Flipped Classrooms and the Challenge of Board Tutorials in Mathematics Education

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School of Mathematics and Statistics, University of New South Wales, Sydney, Australia

Abstract - The study investigates effects of a change in teaching of problem-solving classes in first-year Discrete Mathematics in an Australian university. Traditionally, students had two small-group tutorials a week, led by a tutor presenting solutions, in response to questions or to illustrate a particular point. One was replaced by a larger tutor-led class and the other by a board tutorial, in which students collaborated in small groups, working on a board, with a tutor available to answer questions. Achievement scores came from examination scripts. Students from the last year of traditional tutorials were compared with students from the first year of board tutorials, with a split motivated by previous results of the authors, into domestic and international subgroups. Significant results favoured traditional tutorials and domestic students. No significant gender-related differences were found in the collaborative groups.

Generating Educational Interactive Fiction Games Using ChatGPT

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Abstract - We propose an automatic method for generating educational interactive fiction games using ChatGPT. Our method builds on previous research in narrative generation, aiming for consistency by constructing a complete story flowchart before producing individual scenes. Academic content is integrated into the generated interactive narratives to enhance learning and immersion. User studies including questionnaires and pre-/post-tests were conducted to evaluate the method effectiveness. In trials performed by the authors, the quiz performance showed a negligible change. However, in experiments with external participants, the average number of correct answers increased from 6.5 to 9.0, demonstrating a notable educational impact. The evaluation scores varied depending on the story content and progression, suggesting that structured generation can improve both the learning outcomes and narrative quality.

Engaging First and Second Year Undergraduates with Parallel and Distributed Computing: Lessons from Unplugged and Game-Based Activities

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Abstract - This paper discusses the use of unplugged activities and game-like visualizations to introduce fundamental PDC concepts to earlystage undergraduate students in a Python programming course. We designed and implemented a set of interactive exercises—including a flagcoloring activity, and animations to help students visualize and understand basic principles of parallelism. Following these activities, students explored parallel programming constructs in Python to reinforce concepts through hands-on coding. Our targeted audience included students from diverse majors with foundational programming knowledge (in C++ and Python). This paper discusses the design rationale, classroom implementation, and reflections on student engagement and conceptual understanding. We also position this work within the broader landscape of PDC education and propose future directions to deepen student learning.

AI Catalysing and Reformulating Innovation-Driven Education in ICT Engineering

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Abstract - The global business and innovation environment is rapidly evolving due to the rise of the platform economy, digital transformation, and the shift towards remote and hybrid work emphasizing personal innovation and entrepreneurship. Artificial intelligence is challenging students ability to innovate, learn and renew. In this paper, we concentrate on how AI is catalyzing and reformulating university learning from innovation perspective causing major attitudinal change throughout the whole engineering education. Our study consists of three core elements: innovation entrepreneurship, integrated innovation learning model and co-creation. The key idea is not teaching mechanically innovation process in single courses, we systematically feed students innovations throughout the curriculum in order to boost their ability to innovation with competitive attitude, but still co-creative manner.

Integrating Edge AI and Embedded Systems into Computer Architecture with Raspberry Pi

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Abstract - In recent years, computer architecture instruction has increasingly adopted project-based approaches to bridge the gap between theory and practical applications. This paper presents two hands-on learning activities using the Raspberry Pi platform to introduce students to real-time object detection and GPIO-based hardware control. These projects emphasize the integration of software and hardware, aligning with key concepts in embedded systems and edge artificial intelligence (AI). Students implement live video processing and physical feedback using lightweight tools such as Python, OpenCV, and YOLOv8. These projects, embedded in a computer architecture course, help students apply architectural concepts while tackling real-world challenges in deploying AI on resource-constrained devices. Informal feedback and classroom observations suggest increased engagement, improved confidence in embedded programming, and a deeper understanding of software-hardware interaction. This work offers a scalable, low-cost model for integrating embedded and AI topics into engineering curricula.

Improving Student Persistence by Studying Course Withdrawal Data

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Abstract - Studying student course withdrawal data can provide important insights into factors impacting student success. However, institutions rarely analyze the student-reported reasons that accompany withdrawal requests. In this work, we analyzed 114 electronic withdrawal requests for CS301 (Data Structures & Algorithms) at California State University, East Bay, during Fall 2020–Spring 2025. Open coding and statistical tests were applied and correlations between reasons and GPA were examined. Time management was the most cited reason for withdrawal, followed by inadequate preparation, personal/family issues, and work. This analysis provides actionable steps Computer Science departments can implement, including improving data collection practices, targeted student advising, and more flexible course scheduling. These recommendations are particularly relevant for STEM programs serving similar highly diverse student populations.

Buddy, Not Crutch: Ethical Use of Zero-Shot Prompting with Public LLMs for Software Engineering Technical Interview Preparation

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Abstract - Preparing for technical interviews can feel like a solo sport, especially for students without access to mentors, mock interviews, or insider advice. In this practice-based report, we explore how publicly available LLMs (e.g., ChatGPT, GitHub Copilot) can be harnessed via zero-shot prompting, not as a shortcut to answers, but as collaborative scaffolds that reinforce genuine skill development. Building on an equity-focused framework for interview preparation, we introduce five responsible prompting patterns that guide students to: (1) restate and validate problems, (2) generate clarifying questions, (3) brainstorm alternative solutions, (4) verify Big-O analyses, and (5) perform self-code reviews without an IDE. We argue that, when used responsibly, LLMs have the potential to amplify student agency, reduce interview anxiety, and democratize access to high-quality preparation.

Integrating Programming Beyond CS to Foster Inclusive Computing Literacy

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Abstract - This paper presents our approach to designing a General Education (GE) Mathematics/Quantitative Reasoning course launched in Fall 2022 to equip non-CS students with Python programming skills relevant to their disciplines. The course addresses the growing need for foundational programming knowledge and pathways to a diverse set of careers, including Data Science (DS), Artificial Intelligence (AI), and other computing-related areas. Underrepresented groups face barriers to DS and AI education due to economic, educational, and cultural disparities, making inclusive learning essential. Despite attracting a diverse student base, equity gaps persist, with higher DFW (Drop, Fail, Withdrawal) rates among minority students. This paper presents insights from pre- and post-course student surveys that examine students' motivations, challenges, and overall perceptions of the course while analyzing student demographics and success rates between Fall 2022 and Fall 2024, to identify disparities between underrepresented minority (URM) students and other groups. Additionally, we provide an in-depth look at the course structure and how it addresses gaps in DS education for non-computing majors. Beyond our institution, fostering computing literacy across disciplines is essential, particularly in universities without GE requirements, such as outside of North America. Embedding programming modules into non-CS courses is an effective way to foster computing literacy, particularly in universities without GE requirements. We share strategies for seamless integration and propose targeted interventions for equity gaps, including adjusting course content and pacing, providing extra instructional support, and enhancing feedback. Our goal is to improve outcomes and promote equitable DS and AI education.

Development of Interdisciplinary Computing-Based Programs for Democratizing Computing Workforce

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Abstract - This paper considers the fast growth of Artificial Intelligence (AI), Machine Learning (ML) and Data Science (DS) in recent years, which has sparked an urgent need for skilled workers in these highly-related areas, subject to the growing calls for a diverse, inclusive technology workforce. This paper presents an innovative approach to rapidly designing and developing interdisciplinary, computing-focused degree programs emphasizing AI, ML, and DS, while providing foundations for domain-specific applications. Prevailing stereotypes about the computer workforce often suggest that women and minorities lack the ability to succeed in the field. To challenge these stereotypes, we have reached out and developed interdisciplinary programs with majors that traditionally attract more women and minorities. This paper outlines how we quickly developed a computing-based BS in Data Science within one year, followed by the concurrent creation of a BS and MS in Computer Science and Linguistics with the Department of Linguistics the next year, then a BS and MS in Computer Science and Geology with the Department of Geology in the subsequent year, and the ongoing development efforts with the Department of Biology. The paper outlines the approaches to curricular development, incorporates ethical and social-awareness elements, and highlights the unique aspects and success factors. Preliminary data show an increase in enrollment of women in these programs. We believe that this paper will serve as a model initiative for rapidly developing a diverse technology workforce everywhere that meets the needs of emerging AI, ML and DS industries.

The Role of AI in AR and VR for STEM Education: A Systematic Review of Cognitive Learning Outcomes

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GO4IR Talent Academy, Pretoria, South Africa;
Faculty of Applied Science and Technology, Koforidua Technical University, Koforidua, Ghana;
School of Governance, IT and Management, University of KwaZulu Natal, Durban, South Africa;
Faculty of Accounting and Informatics, Durban University of Technology, Durban, South Africa

Abstract - The educational landscape is seeing a significant upheaval due to the incorporation of Artificial Intelligence (AI), Augmented Reality, and Virtual Reality.These technologies are transforming the delivery of STEM disciplines, transcending traditional teaching methods to provide dynamic, interactive, and individualized learning experiences.The domains of Science, Technology, Engineering, and Mathematics (STEM) have garnered considerable global attention in policy discourse, especially regarding progress in industry, academic research, higher education enrollment, and curriculum creation in educational institutions To analyze and understand the impact of AI-enhanced AR/VR on higher STEM education, emphasizing its impact on cognitive learning systematic literature review was conducted. The study focused on 2017 to 2025 published studies , limiting a comprehensive relevance of the results. The reviews are uneven in design and quality, with some being exploratory and small-scale lacking strong statistical analysis. There was limited standard technique to determining cognitive learning outcomes, making it difficult to measure the exact extent of cognitive enhancement related to AI and other technologies. The lack of comprehensive reporting on how AI was precisely utilized within AR and VR systems also posed a limitation to the review. The geographical scope of the review was limited to developed countries with advanced structure and resources in respect to artificial intelligence and STEM education, leaving Africa and other regions with little research. The systematic review revealed that AI-enhanced AR/VR platforms offer significant educational value, particularly in fostering comprehension, engagement, critical thinking, and problem-solving abilities among STEM students.

Enhancing Granular Sentiment Classification with Chain-of-Thought Prompting in Large Language Models

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Queensland Academy for Science Mathematics and Technology, Australia;
Research Spark Hub Inc., California, USA

Abstract - We explore the application of Chain-of-Thought (CoT) prompting with large language models (LLMs) to enhance the accuracy of granular sentiment categorization in app store reviews. Traditional methods often rely on numeric ratings or basic polarity (positive, negative, neutral), missing the nuanced sentiment in user feedback. Our approach captures these subtleties through step-by-step reasoning. We evaluated this by analyzing 2,000 Amazon app reviews, comparing sentiment labels from CoT prompting to those from single step prompting, with human annotations as the gold standard. CoT prompting improved classification accuracy from 84% to 93%. This demonstrates that reasoning based prompts not only increase interpretability but also lead to more accurate and context-aware sentiment analysis.

Analysis of the Correlation Between Education and Social Advancement through Pseudonym Information Combination

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Abstract - A great deal of data is being produced and accumulated in relation to education, from elementary education, secondary education, higher education, and even lifelong education. The Ministry of Education is generating information from these data and using it to establish effective education policies and make decisions based on data. To provide customized education to students and pursue stable social advancement through education, it is important to confirm what kind of social advancement path an individual who received secondary education takes after going through higher education. In this paper, we propose a model that creates new information by combining pseudonymized information, which is the sensitive part of personal information, with a salt key applied to the combined key. We applied this model to university graduate data and school advancement and employment data to confirm which university each graduate went to or which company he or she was employed at, and which graduates did not go on to school or get a job even though they graduated from university. To combine pseudonymized information, a legal basis such as the "Personal Information Protection Act" must be established, and data from a public database such as a public database must be easy to utilize.

Integrating Generative AI into Blockchain and Marketing Education at HBCUs: A Proposed Framework

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Department of Mathematics, Computer Science, and Engineering Technology,
Elizabeth City State University, Elizabeth City, North Carolina, USA

Abstract - This paper presents a conceptual framework for integrating Generative Artificial Intelligence (GenAI) and blockchain technologies into marketing education at Historically Black Colleges and Universities (HBCUs). Using a qualitative meta-synthesis of literature published between 2019 and 2025, the study examines how these emerging technologies can enhance curriculum design, faculty development, and student engagement. The framework addresses challenges specific to HBCUs, such as limited resources and digital equity, while promoting culturally responsive and scalable educational models. By embedding GenAI tools for automated feedback, simulations, and analytics, and incorporating blockchain modules focused on consumer data transparency, digital rights management, and loyalty programs, the model prepares students for future industry demands. Emphasizing equity, accessibility, and alignment with institutional missions, the framework positions HBCUs as leaders in inclusive technology adoption. The paper concludes with recommendations for pilot implementation and empirical validation to assess the framework's effectiveness in transforming business and marketing education in underrepresented academic contexts.

A Spotlight on the Role of Functional Programming & Haskell in Computing & Software Development

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Abstract - This paper casts a spotlight on the role of functional programming, using Haskell as an exemplar, in shaping modern computing and software development education, with particular attention to its foundational mathematical abstractions derived from type theory. Through a systematic review of twenty-eight empirical studies spanning 2015-2025, we examine how Haskell's emphasis on purity, composability, immutability, and declarative semantics serves as an ideal medium for illustrating core software design principles in mathematically rigorous yet pedagogically meaningful ways. Our analysis reveals three critical themes: educational effectiveness demonstrates mixed but promising outcomes when functional programming concepts are integrated rather than taught in isolation; mathematical reasoning and abstract thinking development show consistent benefits across multiple longitudinal studies; and transfer learning to mainstream object-oriented languages exhibits selective effectiveness requiring targeted pedagogical support. We explore how Haskell's abstractions—including polymorphic types, algebraic data types, type classes, functors, and monads—relate to concepts implemented in mainstream languages such as generics, interfaces, inheritance, polymorphism and programming with side-effects, offering practical strategies for easing the teaching and learning curve in multi-paradigm programming environments. In an era where AI tools increasingly generate code, our findings suggest that functional programming education becomes more rather than less critical, as it develops the mathematical reasoning and abstract thinking capabilities essential for effective human-AI collaboration in software development. The evidence demonstrates that Haskell serves not only as a powerful functional programming tool but also as a conceptual bridge enabling students to master mainstream programming languages while developing principled approaches to software construction, requirements analysis, and system design that remain fundamentally human competencies.

Assessing Academic Success and Proficiency of Non-Computing Students in Foundational Computing Courses

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Abstract - Non-computing majors often perceive computing courses as unnecessary and irrelevant to their fields of study leading to less interest, reduced participation and below par performance. However, in today's digital era, computing skills are fundamental for academic success and workforce readiness across all disciplines. This study investigates the proficiency levels of non-computing majors in computing fundamental courses in the context of Botswana. Specifically, it explores whether proficiency levels vary across faculties, whether students are exiting with adequate computing skills and which concepts practical or theoretical are more effectively grasped by students. The study used the quantitative methods in particular non-parametric tests. The findings revealed that students exit computing course with moderate proficiency. Social sciences appear to perform better than their counterparts in Education. Students performed better in theoretical concepts. Findings from this research will provide insights into disparities in computing proficiency, inform curriculum development to better address the needs of non-computing majors and guide strategies to enhance engagement and performance. This study contributes to improving digital literacy and workforce preparedness in Botswana.

Pedagogical Barriers to AR and VR Integration in Computing and Engineering Higher Education: A Systematic Review

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GO4IR Talent Academy, Pretoria, South Africa;
Faculty of Applied Science and Technology, Koforidua Technical University, Koforidua, Ghana;
School of Governance, IT and Management, University of KwaZulu Natal, Durban, South Africa;
Honorary Research Fellow, Faculty of Accounting and Informatics, Durban University of Technology, Durban, South Africa

Abstract - The study investigates the evolving direction of computing and engineering education, emphasizing a growing emphasis on hands-on learning and practical involvement, facilitated by the integration of augmented reality (AR) and virtual reality (VR). This research is motivated by the growing significance of AR/VR as educational tools, despite persistent barriers in their efficient adoption into teaching methods. The researchers employed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) methodology to conduct the investigation. A preliminary collection of 512 papers was compiled from prominent scholarly databases, such as IEEE, Web of Science, and Scopus. The articles underwent a comprehensive screening process, resulting in the selection of studies considered suitable for this further evaluations. The analysis provides insightful perspectives on navigating challenges and implementing optimal strategies for integrating AR and VR into computing and engineering education. The review reveals that these technologies can promote interactive and immersive educating environments, enhancing students' comprehension and practical skills through virtual laboratories, simulations, and contextual learning settings. The findings provide guidance for educators, researchers, and decision-makers seeking to reform educational practices in accordance with emerging technologies.

Tensor Decomposition Optimization for Student Success Prediction Modeling in Hands-on Cybersecurity Exercises

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The Evergreen State College, Olympia, Washington, USA

Abstract - EDURange, a hands-on cybersecurity education platform, is implementing a student success prediction model to identify struggling students so instructors can quickly reach out and assist. Because obtaining sufficient high-quality data to train this model through classroom testing is difficult, we are employing the existing 3DG framework to create synthetic data to supplement. This paper is an in-depth exploration of the tensor decomposition aspect of the 3DG methodology by offering a thorough explanation of tensor decomposition, creating a new optimization strategy, and trying the process on our new dataset. We found that for the EDURange dataset, our optimization method of adding reasonable attempts before decomposition decreased the accuracy of our results, but improved their usefulness.

Numerical Solution for the One-Dimensional Schrodinger Equation and Allowed Energies of Quantized Systems

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Abstract - This paper aims to teach the reader or provide more tools that a professor can use to help teach quantum mechanics to whomever they need to teach, or for someone to use for self-studies, by providing a set of tools to make quantum mechanics easier to understand via numerical methods code that can anyone to graphs any wavefunction and teaches the reader to use the WKB approximation to either the exact or approximate allowed energy states for some system.

The 21st International Conference on Grid, Cloud, & Cluster Computing (GCC'25: July 21-24, 2025; Las Vegas, USA)

https://american-cse.org/csce2025/conferences-GCC
https://american-cse.org/csce2025/

Safeguarding Critical Data in High-Volume Transaction Processing Cloud Services

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Electrical Engineering and Computer Science Department, University of Arkansas, Fayetteville, Arkansas, USA

Abstract - Cloud computing, given its numerous advantages, has excited many organizations, including those managing critical information systems, to move their data and applications to cloud-based systems. At the same time, given the stash of sensitive data along with the weaknesses in security protocols, it has attracted cyber criminals to steal data from, and sometimes damage data in cloud databases. If a cyberattack on a cloud system succeeds in affecting the critical data, the damage spreads through the database rapidly due to the interdependent nature of such data. Therefore, it is vital to devise a mechanism to minimize the damage caused by the attack by restraining it to a limited number of data items in the database. In order to achieve that, we have proposed a mechanism to classify data and restrict access depending on data classification. We have presented an access methodology and a simple algorithm to implement our policy.

On Adaptive Metric-Driven Load Balancing for Specialized Clusters: A Case on Using NGINX

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Abstract - Cloud computing has become an essential part of today's digital world. It allows scalable, cost-efficient, secure access to computing resources, including data and applications. Many traditional load-balancing approaches lack the adaptability to dynamic workloads, and many newer load-balancing algorithms work mainly on cloud simulators. This paper proposed an adaptive, metric-driven, two-tier load-balancing system that uses NGINX and Prometheus to optimize resource allocation in specialized cloud clusters. The proposed framework is built to give great performance and flexibility and runs on Google Kubernetes Engine (GKE), but it may also be deployed in local cloud environments for added security. The first tier of the proposed framework uses an NGINX-based load balancer to route incoming requests based on content type, sending traffic to hardware-optimized clusters to process requests through specialized hardware. The second tier dynamically modifies the load distribution throughout each cluster by calculating pod weights based on CPU, memory, and network consumption on a regular basis. This adaptive weight distribution maximizes resource consumption and responsiveness, outperforming existing fixed-weight systems. In comparison to typical multi-component solutions, our system's lightweight architecture minimizes configuration and management overhead while scaling fluidly to address dynamic traffic patterns. Its modular design paves the way for seamless integration with existing cloud architectures, providing organizations with a simple, yet highly effective solution for handling variable, unpredictable workloads. Performance evaluation shows that the proposed system improves throughput by approximately 74% and almost doubles the number of requests processed per second while being a simple, scalable, adaptable solution. We believe that the proposed solution may be a practical, effectual building block for a complex cloud systems, and would contribute significantly to the future cloud systems.

On Simulation of Multiple-Row Generalized Pipeline Cellular Array

Ihfaz Islam, Harpreet Singh, Lubna Alazzawi, Kaveh Abani, Bhupinder Mavi, Gurveer Singh Kalsi
Electrical and Computer Engineering, Wayne State University, USA

Abstract - There is an increasing interest in array computing these days because of the requirement of speed, accuracy, chip area, and wearable electronics. Advanced arithmetic computation has always been the interest of researchers in computing. A generalized pipeline array has been the topic of research for the last few decades. The literature was limited to 5 rows cellular array. In this paper, a generalized pipeline array has been extended to 7 rows and 9 rows. The simulation of this design has been done using Xilinx Vivado in the paper. The pipeline arrays were written using the Verilog hardware language. The approach can be extended to any number of rows of the pipeline array and thus resulting in more advanced arithmetic computations. It is hoped that this research work will result in more fruitful advanced computer architecture.

The 11th International Conference on Health Informatics & Medical Systems (HIMS'25: July 21-24, 2025; Las Vegas, USA)

https://www.himscsce.org/hims25/
https://american-cse.org/csce2025/

From Respiration to Heart Sounds: A Comparative Review of Three Radar Systems for Unobtrusive Monitoring

Aref Smiley, Joseph Finkelstein
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Abstract - This paper presents a comparative evaluation of three radar systems— ViRa24, X4M06, and IWR1443BOOST—for contactless physiological monitoring. These systems, based on continuous-wave (CW), ultra-wideband (UWB) impulse, and frequency-modulated continuous-wave (FMCW) radar principles respectively, were assessed for their ability to detect respiration, cardiac motion, heart sounds, and heart rate variability (HRV). Detailed analysis of their hardware architecture, signal processing pipelines, software tools, and practical deployment was performed. Each system offers unique advantages aligned with specific applications in telemedicine, rehabilitation, and human-computer interaction. The results provide insights into the strengths and trade-offs of each radar modality, guiding future deployment in clinical and research environments.

Benchmarking of Sentence Transformers in Text-Based Drug-Drug Interaction Classification

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Department of Computer Engineering, Ankara University, Ankara, Turkey

Abstract - The detection of drug-drug interactions (DDIs) has become a key research focus due to its significant impact on healthcare and drug safety. Various machine learning methods have been proposed for DDI identification and classification, while most studies focus on drug chemical properties, with few considering the impact of textual data. This study investigates these influencing factors to assess their contributing and compromising effects on DDI identification and classification. To this end, the impact of chemical features and the most accurate representation of the textual data has also been assessed, and several experiments have been performed to obtain a fair comparison. The results indicated that text embeddings significantly enhanced DDI classification capabilities compared with models relying solely on chemical features.

Enhancing Language Assessment in Traumatic Brain Injury: A Situational Approach to Data Precision and Stability Detection

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Instituto Nacional de Astrofisica Optica y Electronica (INAOE), Mexico

Abstract - This study concerns a situational approach requiring precise and intelligible processes and results. The perspective copes with inexorable constrained data conditions, making room for secondary examination routes. This study is designed to grow the evidence of a previously introduced technique focused on alternative methods that showed encouraging results. The objective

is to recognize subtle modifications that likely indicate potential innerconnection adjustments of language structures, analyzing samples from individuals affected by traumatic brain injury. This can contribute to recognizing sharper patient language dynamics and integrating more effective strategies. The reported results support the soundness of the approach, which will be addressed in depth in the comprehension aspect as an inherent need for the circumstances in the studied question.

Smart Home-Based AI Medicine Recognition System for Elderly Care

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Lunghwa University of Science and Technology, Taiwan;
Division of Neurosurgery, Department of Surgery, Far Eastern Memorial Hospital, Taiwan

Abstract - As the population ages and the need for telemedicine continues to grow, smart home technologies play a key role in enhancing care for seniors. This study proposes an AI-integrated smart home system that can identify prescription drugs through camera-based image detection. The system provides instant feedback and displays medication information directly on the touch screen interface, ensuring better medication compliance and user safety. The implementation focuses on practical interaction design, usability for elderly users, and lightweight AI model deployment. The result is a streamlined and reliable solution that can be expanded to a wider range of applications such as cognitive training and rehabilitation.

Exploring IoT Architecture for Home-Based Physical Telerehabilitation

Aref Smiley, Joseph Finkelstein
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Abstract - Telerehabilitation systems that integrate real-time monitoring and personalized exercise guidance have the potential to improve adherence and outcomes for patients engaging in home-based therapy. This paper presents an implementation of a low-cost, scalable telerehabilitation platform that combines cycling exercises with physiological monitoring and clinician oversight. The system incorporates two custom-built Internet of Things (IoT) devices: the C-box, which wirelessly streams heart rate and oxygen saturation data from a Nonin 3150 pulse oximeter, and the iBikE, which captures real-time cycling speed via a magnetic sensor. Both devices utilize ESP32 microcontrollers to collect, transmit, and synchronize data through Firebase and a secure backend SQL database. A web-based clinician portal enables remote configuration of exercise prescriptions and real-time performance review. The hardware design includes LED indicators, dual-microcontroller architecture, and automated session management to enhance usability and reliability. Real-world tests confirmed seamless BLE communication, real-time cloud data synchronization, and accurate feedback delivery. This system provides a clinically viable solution for remote rehabilitation, supporting personalized therapy while enabling continuous monitoring and scalable deployment.

Using Mobile Technology to Assist in Classification of Potential carpal Tunnel Syndrome Patients

Wei Zhang, Feng Gu, Ali Mohamed
The City University of New York, College of Staten Island, Staten Island, New York, USA

Abstract - NA

Artificial Intelligence as an Assistant for Pregnancy Journey

Ala Saleh Alluhaidan, Marwan Alluhaidan
Princess Nourah bint Abdulrahman University, Saudi Arabia

Abstract - NA

Heart Attack Prediction Using Machine Learning: A Comparative Model Evaluation

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Department of Business and Economics at the School of Business and Information Systems,
The City University of New York, York College, Jamaica, New York, USA

Abstract - NA

Random Forest-Based Classification of Critical ECG Rhythms for the Detection of Life-Threatening Cardiac Events

Herson Armando Martinez Partida, Daniela M. Martinez, Irma Uriarte Ramirez,
Norma Alicia Barboza Tello, Paul Medina Castro
Universidad Autonoma, de Baja California, Mexico

Abstract - NA

Early Prediction of Bladder Cancer Diagnosis Using Structured Claims Data and Machine Learning

Wanting Cui, Joseph Finkelstein
The University of Utah, Salt Lake City, Utah, USA;
Columbia University, New York, USA

Abstract - NA

Early Detection of Interstitial Lung Disease Using Machine Learning and Pre-Diagnostic Clinical Features

Xingyue Huo, Joseph Finklestein
The University of Utah, Salt Lake City, Utah, USA

Abstract - NA

Correlating Daily Activities and Life Satisfaction to Promote Health Behaviors of Older Adults in the Community

Susumu Shibusawa, Toshiya Watanabe
Ibaraki University, Japan

Abstract - NA

ALFABEATS: A Machine Learning Based Decision Support Platform for Biomedical Time Series Analysis

Sasa Kendjel, Nikolina Frid, Eda Kalafatic, Kresmir Jozic, Alan Jovic
Faculty of Electrical Engineering and Computing, University of Zagreb, Croatia;
JANAF Plc, Sisak, Croatia

Abstract – NA

Benchmarking Classic Machine Learning Models for Diabetes Diagnosis: A Performance Evaluation Framework Using Confusion Matrices and ROC Analysis

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Abstract - NA

Hybrid Stacked and Tuned Ensemble Models for Enhanced Coronary Heart Disease Classification: A Multi-Dataset Study

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Abstract - Still a major worldwide health burden, coronary heart disease (CHD) calls for accurate, cheap, and efficient diagnostic systems. This work presents a high-performance classification framework based on advanced ensemble and hybrid models applied to six benchmark clinical datasets obtained from the UCI and Kaggle repositories for early CHD detection and classification. Applied and generally assessed were classification algorithms including Random Forest (RF), XGBoost, AdaBoost, Logistic Regression, and Support Vector Machine (SVM). Processes including feature selection, normalization, and imputation greatly enhanced model performance, with further performance gains achieved through hyper-parameter tuning and ensemble stacking techniques. Notably, the stacked model attained a peak accuracy of 99.7% and near-perfect AUC-ROC on the Hungarian two-class dataset. ROC-AUC scores, precision-recall curves, and F1-score assessments provided other insights. Results provide useful direction for clinical decision support systems and confirm the superiority of ensemble classifiers in CHD diagnostics.

Machine Learning-Based Breathing Phase Classification of Respiratory Sounds for Pulmonary Health Assessment

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Purdue University, West Lafayette, Indiana, USA

Abstract - Respiratory sound analysis is emerging as a noninvasive and scalable approach for pulmonary health assessment. This work-in-progress paper presents a machine learning framework for the classification of inhalation and exhalation phases from respiratory audio recordings. By leveraging signal processing techniques and deep neural networks, the system aims to improve the accuracy and efficiency of respiratory phase detection, a foundational step in diagnosing conditions such as asthma and chronic obstructive pulmonary disease (COPD). The proposed methodology includes time–frequency feature extraction, heuristic segmentation, and supervised learning-based classification. We anticipate promising results across various respiratory sound datasets. After full model development and analysis, future work will focus on incorporating abnormal sound classification, enhancing model generalization, and conducting validation in real-world clinical settings.

Applying Business Intelligence to Cancer Incidence Analysis in a Population-Based Registry

Ricardo Timaran Andrea Bravo, Luisa Bravo, Fredy Vidal,
Arsenio Hidalgo, Anivar Chaves, Colombia

Abstract - NA

MRI-based Deep Learning for Brain Tumour Prediction

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College of Computer Science and Engineering, Department of Information System and Technology, University of Jeddah, Jeddah, Saudi Arabia;
College of Medicine, Internal Medicine Department - Radiology, University of Tabuk, Tabuk, Saudi Arabia

Abstract - NA

EEG-Based Stress Detection and Personalised Music Recommendation System for Stress Relief

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Cal Poly Pomona, Pomona, California, USA

Abstract - NA

Estimating Fall Risk in Older Adults Using Postural Sway Parameters and Machine Learning

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University of North Texas Health Science Center at Fort Worth, Texas, USA

Abstract - NA

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

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Informatics and Computer Systems, King Khalid University, Abha, Saudi Arabia;
Unit of Technical and Engineering Majors, King Khalid University, Abha, Saudi Arabia

Abstract - Early diagnosis of genetic disorders in pediatric can significantly reduce long-term health complications and mortality. However, these disorders often present with ambiguous early symptoms, making clinical detection difficult. This study proposes an AI-based framework for the early identification of pediatric genetic disorders using a public genomic-clinical dataset. Multiple models were evaluated including XGBoost, Random Forest, Gradient Boosting, and Artificial Neural Networks (ANNs). SHAP values and locally hosted language models were incorporated for explainability. XG- Boost and ANN achieved accuracy, precision, and recall of up to 99%. SHAP-based interpretability highlighted critical predictive features such as parental mutations and birth complications. XGBoost enhanced by bidding improved subclasslevel predictions. The model demonstrates strong potential for integration into early pediatric diagnostic pipelines, particularly in under-resourced or data-scarce environments, by combining high accuracy with clinical transparency.

Home Physical Telerehabilitation System for Patients with Postural Orthostatic Tachycardia Syndrome

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Department of Neurology, University of Utah, Salt Lake City, Utah, USA

Abstract - Postural Orthostatic Tachycardia Syndrome (POTS) is a chronic autonomic nervous system disorder characterized by an abnormal increase in heart rate upon standing, leading to debilitating symptoms that impair daily functioning. Exercise training has been shown to improve autonomic regulation in POTS patients; however, traditional rehabilitation programs often face challenges of accessibility, adherence, and cost. To address these barriers, we developed and evaluated a home-based telerehabilitation system tailored for patients with POTS and other autonomic disorders. The system integrates an IoT-enabled exercise device (iBikE) designed for supine cycling, a clinician portal for remote exercise prescription and monitoring, and real-time cloud-based data synchronization. We conducted a single-group pretest–posttest usability study with 10 participants completing three tasks: login, survey completion, and supine exercise using the system. Usability was assessed using task performance metrics, the System Usability Scale (SUS), and heuristic evaluations. Participants completed all tasks with 100% success and high efficiency. The system achieved a mean SUS score of 89.5 (SD = 15.6), indicating excellent perceived usability. Heuristic ratings were consistently high, particularly for system visibility, consistency, and error recovery. Participants rated the system as easy to use, efficient, and intuitive, though aesthetic appeal of the exercise interface was slightly lower. These findings demonstrate the feasibility and acceptability of the HAT platform as a home-based telerehabilitation solution for POTS patients, with potential to improve adherence and reduce access barriers to regular physical exercise.

Analyzing Speech Impairments: A Machine Learning Approach to Dysarthria Detection

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Abstract - Dysarthria includes dysfunction in the nerves and muscles controlling speech, leading to unclear spoken words. While many studies have been carried out to examine speech impairment, the variation of this problem among people with a similar dysarthria diagnosis has necessitated the need for more research in this area. The particular type and severity of the impairment are essential to monitor the progress of dysarthria and make effective therapeutic interventions. This project describes a Convolutional Neural Network (CNN) model for dysarthria detection, where several acoustic features are extracted in the form of zero crossing rates, Mel Frequency Cepstral Coefficients (MFCCs), spectral centroids, and spectral roll-off. Using the TORGO database of speech signals, training the model, and testing it for its efficiency has shown much promise in the early diagnosis of dysarthric speech. The numerical results indicate that the model design provides an efficiency of nearly 95%, which is higher than previous model architectures. This model aims to identify the condition early and help improve the management of dysarthria through timely and accurate diagnosis.

Negative Effects of Alcohol: Software for Educating the Public while Determining Public Awareness

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Abstract - The objective for this project was to create software to educate the public on the negative effects of alcohol while determining public awareness of the negative effects of alcohol. The survey software determined that there is good public awareness of the effects of alcohol. For 25 questions with 1 point per question, the mean score was 22.31 (89.24%), the confidence interval was +/- 0.47 (+/-2.1%) for a confidence level of 95%, the median was 22 (88%), and the mode was 23 (92%). People were effectively educated on the negative effects of alcohol using an online quiz.

Radiomic Biomarker Discovery and Lung Cancer Staging Using Gradient Boosted Decision Trees

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Abstract - Imaging biomarkers, known as Radiomics, an emerging field within medical imaging, involves the quantitative extraction of tumor-related features from radiological scans, thereby providing an objective assessment of neoplastic morphology and heterogeneity. These high-dimensional imaging biomarkers encompass a diverse array of attributes, including lesion shape, texture, and intensity patterns. This study leveraged radiomics, by extracting structured and quantitative tumor features through medical imaging such as CT scans. Class of Gradient Boosted Decision Tree (GBDT) algorithms have demonstrated efficacy in handling complex, nonlinear relationships in medical datasets. These models run through iterative training, wherein sequentially generated decision trees refine the predictive performance of the ensemble by minimizing the residual error of prior iterations. A GBDT algorithm was implemented for biomarker identification and lung cancer classification into different cancer stages. This approach moves beyond traditional imaging- based assessments, allowing for an objective, data-driven evaluation of tumor characteristics.

A Multivariate Sparse Group Lasso (MSGL) for Lung Cancer Stratification

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Abstract - This study implemented a Multivariate Sparse Group Lasso (MSGL) survival analysis technique to identify significant imaging biomarkers and compare their predictive power against conventional clinical factors, including stage, age, and gender. Data were obtained from a cohort of lung cancer patients, with imaging-derived radiomic features extracted and analyzed. To assess the robustness of imaging biomarkers as prognostic indicators, stratified analyses were conducted within age and gender subgroups. The study then evaluated whether incorporating imaging biomarkers into prognostic models led to improved survival prediction compared to traditional clinical factors alone. Results: The findings using the proposed MSGL indicate that imaging biomarkers provide significantly stronger stratification of survival probabilities than traditional prognostic indicators such as stage, age, and gender. Kaplan-Meier survival curves demonstrate that patients with specific imaging biomarker patterns exhibit markedly different survival outcomes compared to those without, suggesting that these features effectively capture tumor heterogeneity associated with prognosis. Stratified subgroup analyses further reveal that imaging biomarkers remain dominant predictors of survival across different age and gender groups, whereas stage alone provides limited differentiation. These results underscore the potential of imaging biomarkers in enhancing lung cancer prognostication beyond conventional clinical parameters.

The 27th International Conference on Artificial Intelligence (ICAI'25: July 21-24, 2025; Las Vegas, USA)

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Multi-task Parallelism for Robust Pre-training of Graph Foundation Models on Multi-source, Multi-fidelity Atomistic Modeling Data

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Abstract - Graph foundation models using graph neural networks promise sustainable, efficient atomistic modeling. To tackle challenges of processing multi-source, multi-fidelity data during pre-training, recent studies employ multi-task learning, in which shared message passing layers initially process input atomistic structures regardless of source, then route them to multiple decoding heads that predict data-specific outputs. This approach stabilizes pre-training and enhances a model's transferability to unexplored chemical regions. Preliminary results on approximately four million structures are encouraging, yet questions remain about generalizability to larger, more diverse datasets and scalability on supercomputers. We propose a multi-task parallelism method that distributes each head across computing resources with GPU acceleration. Implemented in the open-source HydraGNN architecture, our method was trained on over 24 million structures from five datasets and tested on the Perlmutter, Aurora, and Frontier supercomputers, demonstrating efficient scaling on all three highly heterogeneous super-computing architectures.

Explainable Feature Selection using Feature Weighted Self-Organising Maps

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Abstract - Feature selection is a fundamental data preprocessing step that significantly influences the performance of machine learning (ML) models by reducing irrelevant features. Although recent advancements in ML techniques have achieved high predictive accuracy, many operate as black boxes lacking explainability and requiring manual efforts for hyperparameter tuning and feature selection. Additionally, conventional feature reduction methods often perform poorly on structurally complex data. This research seeks to address some of these limitations by improving Feature Weighted SelfOrganising Map (FWSOM), an interpretable and low-compute model capable of autonomous learning. FWSOM hypothesis is extended to support both clustered and path-based data, enabling automatic identification of relevant features in a transparent and computationally efficient manner, thereby facilitating more trustworthy and scalable AI systems.

Modular AI-Powered Interviewer with Dynamic Question Generation and Expertise Profiling

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Abstract - Automated interviewers and chatbots are widely used in research, recruitment, and education. However, most existing systems rely on static question sets, rigid rules, and limited personalization. This leads to repetitive conversations and low engagement. As a result, they restrict their effectiveness in complex qualitative research settings that demand adaptability, context awareness, and ethical sensitivity. To address this gap, this study proposes an AI-powered interviewer that dynamically generates a coherent flow of contextually appropriate and expertisealigned questions across interview sessions. Built on a locally hosted large language model (LLM), the system ensures coherent dialogue while preserving data privacy. It integrates real-time expertise profiling, responsedriven question generation, and transition-aware messaging to simulate human-like interviews in a secure and controlled environment. A modular prompt engineering pipeline underpins these capabilities, enabling flexible, adaptive, scalable, and semantically rich interactions. The proposed AI-powered Interviewer was evaluated across diverse users, and it achieved high engagement, satisfaction, and contextual relevance. The system achieved high satisfaction (M = 4.45), strong engagement (M = 4.33), and significant predictive value (R 2 = 0.249, p = 0.004). Proposed AI-powered interviewer marks a significant advancement in AI-assisted qualitative data collection, offering a scalable and privacy-conscious solution for diverse applications.

A Prompt-Based Framework for Loop Vulnerability Detection Using Local LLMs

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Abstract - Loop-related vulnerabilities pose serious risks in software development. They can cause infinite executions, resource exhaustion, and logic errors that degrade performance and security. Traditional static analysis tools often fail to detect these issues due to their reliance on syntactic patterns. They struggle with identifying semantic flaws, especially those embedded in complex loop logic. Large Language Models (LLMs) offer new potential for vulnerability detection through contextual code understanding. Local LLMs address privacy, latency, and dependency concerns by enabling secure and efficient offline analysis. This study proposes a prompt-based framework that uses local LLMs to detect loop vulnerabilities in Python 3.7+ code. The framework targets three categories of loop issues: control and logic errors, security risks inside loops, and resource management inefficiencies. This study implements a generalized structured, prompt-based framework for local LLMs, such as LLaMA and Phi, by guiding the models' behavior through iterative prompt engineering and validating outputs against a manually established ground truth. The prompt-based framework design included key safeguarding features such as language-specific awareness, code-aware grounding, version sensitivity, and hallucination prevention. The LLM results were validated against the manual baseline ground truth. Validation results show that Phi consistently outperforms LLaMA in precision, recall, and F1-score. These findings highlight the importance of prompt-guided local LLMs for secure and accurate code vulnerability analysis.

Performance of LLM-Generated Code

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Abstract - Coding is becoming more crucial across numerous scientific fields. The ability to code is increasingly vital for scientists because it enables them to analyze and explore their data in new ways and develop innovative solutions, often much faster than traditional methods. However, many scientists lack competent coding skills. Large Language Models (LLMs) may help bridge

this skill gap by helping scientists generate functional, performant code. Our goal was to explore whether or not a scientist who is not familiar with programming can reasonably use an LLM to generate their simulation code. We asked five LLM chatbots to write code to solve a numerical benchmark problem with which we have previously worked, and we measured the performance of the output. We did this across five languages with four versions of the code for both sequential and parallel implementations. We found that the current LLMs are still lacking. Only 47 of the 100 versions created actually compiled and ran with sufficient accuracy for us to proceed with performance testing. Only 31 of the 100 were accurate enough to be considered usable for scientific work. Most of those are significantly slower than the human-written versions. We also used a vibe-coding approach in Cursor to try to optimize the human-written code using parallel kD-trees for each of the five languages. This was more successful with speed boosts seen in three of the five languages.

Local Language Models for Context-Aware Adaptive Anonymization of Sensitive Text

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Abstract - Qualitative research often contains personal, contextual, and organizational details that pose privacy risks if not handled appropriately. Manual anonymization is time-consuming, inconsistent, and frequently omits critical identifiers. Existing automated tools tend to rely on pattern matching or fixed rules, which fail to capture context and may alter the meaning of the data. This study uses local Large Language Models (LLMs) to build a reliable, repeatable, and context-aware anonymization process for detecting and anonymizing sensitive data in qualitative transcripts. We introduce a Structured Framework for Adaptive Anonymizer (SFAA) that includes three steps: detection, classification, and adaptive anonymization. The SFAA incorporates four anonymization strategies: rule-based substitution, context-aware rewriting, generalization, and suppression. These strategies are applied based on the identifier type and the risk level. The identifiers handled by the SFAA are guided by major international privacy and research ethics standards, including the GDPR, HIPAA, TCPS2, and OECD guidelines. This study followed a dual-method evaluation that combined manual and LLM-assisted processing. Two case studies were used to support the evaluation. The first includes 82 face-to-face interviews on gamification in organisations. The second involves 93 machine-led interviews using an AI-powered interviewer on LLM awareness and workplace privacy. We deployed two local models, LLaMA and Phi, to evaluate their performance. The results show that the LLMs identified more sensitive data than the manual reviewers. Phi achieved a higher recall but produced slightly more errors. Phi achieved over 91% recall and preserved 94.8% sentiment alignment, demonstrating both high accuracy and minimal impact on downstream qualitative analysis.

MoIST: Mixture of Intellectuals via Student-Teachers

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Abstract - In this work, we introduce MoIST (Mixture of Intellectuals via Student-Teachers), a novel framework that combines Knowledge Distillation (KD) and Mixture of Experts (MoE) to improve model efficiency. MoIST distills knowledge from a large teacher model into multiple smaller, specialized student models, which are then routed to handle specific subsets of the dataset. This routing mechanism, inspired by MoE, improves computational efficiency while maintaining model performance. We explore various architectural configurations for both the student models and the routing mechanism, demonstrating that MoIST can achieve accuracy comparable to the teacher model while significantly decreasing computational cost. Our results show that MoIST provides a promising approach to training an extra-efficient model, particularly in environments with limited resources.

Beyond the Black Box: Deep Regression with Insight for More Accurate and Interpretable Supply Chain Forecasting

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Abstract - Demand forecasting remains a persistent challenge in supply chain management due to nonlinear dynamics, high-dimensional input features, and the demand for model transparency. While deep learning models offer superior accuracy, their opaque nature limits operational trust. This paper proposes an interpretable deep regression framework that combines SHapley Additive exPlanations (SHAP), Predictive Power Score (PPS) filtering, and correlation to enhance both accuracy and explainability. A systematic hyperparameter tuning strategy is employed to optimize model convergence and robustness, balancing loss terms and regularization. Empirical evaluations demonstrate that our approach achieves high predictive performance while delivering clear, actionable insights, making it well-suited for deployment in data-driven supply chain decision making and forecasting environments.

Deep Learning-based Time-Series Prediction of Traffic Speed Using NPMRDS Dataset

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Abstract - Accurate traffic speed prediction has become essential for mitigating congestion and improving mobility, thereby contributing to safety, public health, and economic benefits. This study presents a comprehensive evaluation of deep learning models for short-term traffic speed forecasting using a time-series dataset from the National Performance Management Research Data Set (NPMRDS), focused on a selected road segment or Traffic Message Channel (TMC) in Connecticut state, USA, over seven years (2017–2024). We pre-process the data to ensure consistent hourly intervals and evaluate nine deep learning architectures: Recurrent Neural Network (RNN), Long ShortTerm Memory (LSTM), Gated Recurrent Unit (GRU), EncoderDecoder LSTM, attention-based sequence to sequence, transformer, Convolutional Neural Network (CNN), CNN-LSTM, and Temporal Convolutional Network (TCN) under various input feature (univariate, bivariate, and multivariate) combinations. Additionally, we implement a Seasonal AutoRegressive Integrated Moving Average with eXogenous factors (SARIMAX) model as a statistical baseline. Experimental results demonstrate that all deep learning models outperform SARIMAX, with GRU achieving the best univariate Mean Absolute Error (MAE) of 1.74 miles per hour (mph) and CNN achieving the best overall performance (MAE = 1.798 ± 0.026 mph).

Modeling the Impact of Partial Shading on Photovoltaic Panels via Large-Scale Simulation and Regression

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Abstract - Partial shading on photovoltaic (PV) systems is a significant challenge, causing severe power loss and potential panel damage, while existing detection methods are expensive or unreliable. This research presents a low-cost, data-driven approach to accurately quantify shading percentage using electrical I-V curve data alone. In this work, we develop a comprehensive, high-

fidelity dataset of over 24 million data points, using a custom physics-based simulation, encompassing a wide range of irradiance levels (200-1000 W/m²), temperatures (10-50°C), and 60-cell panel configurations. A core contribution is our novel contextual feature engineering strategy, which normalizes voltage, current, and power measurements into scale-invariant ratios, enabling a single machine learning model to generalize across diverse system architectures. We employ regression analysis using an XGBoost model trains on these engineered features to predict shading levels from 0% to 100%. The model demonstrates exceptional performance, achieving an R-squared (R^2) value of 0.937, a Mean Absolute Error (MAE) of 5.19%, and a Root Mean Squared Error (RMSE) of 7.76%. The results validate our methodology to accurately predict partial shading without relying on expensive external sensors. This work provides a foundational framework for developing intelligent, scalable, and cost-effective solutions for performance monitoring and optimization in solar energy systems.

Does Embodiment Still Matter? Comparing User Experience With LLM-Powered Agents

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Abstract - Conversational Artificial Intelligence (AI) is increasingly integrated into various aspects of human life, yet creating truly natural and engaging interactions remains a challenge. The role of physical embodiment in shaping user experience, particularly when coupled with advanced AI capabilities, requires further investigation. This study aims to investigate the impact of embodiment on user experience by comparing interactions with an embodied conversational agent (Pepper robot) versus a non-embodied agent (Laptop AI), both powered by the same sophisticated Large Language Model (LLM), Ollama Llama 3.2 7B. A within-subjects experiment (N=32) was conducted where participants interacted with both the embodied and non-embodied agents in a counter-balanced order. The agents utilised the Ollama Llama 3.2 7B model and Google Text-to-Speech. Post-interaction questionnaires assessed user experience on 5-point Likert scales. Results revealed significantly higher user ratings for the embodied Pepper robot across multiple dimensions, including perceived naturalness ($p=.001$), conversation flow ($p=.010$), understanding of agent responses ($p=.005$), relevance of responses ($p=.027$), user engagement ($p<.001$), perception as a social entity ($p=.002$), sense of connection ($p<.001$), and comfort ($p=.024$). Participants expressed a unanimous and strong preference for the embodied agent. Crucially, self-rated tech savviness did not significantly correlate with these core interaction metrics for either agent type. Furthermore, the embodied agent met user expectations for naturalness, whereas the non-embodied agent did not ($p=.002$). Findings demonstrate that physical embodiment, when combined with an advanced LLM, substantially enhances user experience, fostering more natural, engaging, and socially resonant interactions compared to an equivalent non-embodied system, largely independent of user tech-savviness.

Baylor Environmental AI Research System (BEARS): An Agentic AI Project to Combat Climate Change

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Abstract - Agentic AI architectures, long theorized but limited by compute, have regained feasibility with large language models. Here we present the Baylor Environmental AI Research System (BEARS), an autonomous multi-agent pipeline in which nine collaborating agents exchange structured JSON via a shared key–value store to generate, assess, and rank deep learning research ideas addressing climate change. Agents perform tasks such as literature retrieval, idea generation, evidence synthesis, feasibility analysis, carbon auditing, impact estimation, risk evaluation, utility scoring, and control, iterating until defined thresholds are met. BEARS illustrates how modular agentic design can deliver transparent, reproducible, and ethically aware AI-driven research workflows.

Designing Multi-Objective CNN Architectures for SQL Query Modeling with Evolution Strategies

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Abstract - Automated evaluation of open-ended student work remains a challenge in educational technology. In the context of SQL query assessment, existing models often rely on rigid heuristics or underfit architectures that fail to generalize. Here we present a multi-objective neural model whose architecture and hyperparameters are optimized using evolution strategies (ES). Our model jointly predicts query correctness, diagnostic remarks, and numerical grades from raw student submissions. We show that this approach improves classification accuracy and robustness across underrepresented feedback classes, while maintaining interpretability. These findings demonstrate the utility of ES in discovering high-performing configurations for complex assessment tasks.

From Data to Insight: Using Support Vector Machines to Identify Key Poverty Determinants

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Abstract - This study investigates the multifaceted nature of poverty in the United States by applying machine learning models based on Support Vector Machines (SVMs) to a large, cross-sectional dataset drawn from the IPUMS database. The primary aim is to identify and rank the significance of social, demographic, economic, and geographic factors influencing poverty. Three SVM models were trained using categorized variables—predisposing, socio-demographic, and socio-economic—and evaluated using cross-validation and performance metrics such as accuracy, AUC, and F1 score. Sensitivity and Variable Effect Characteristic (VEC) analyses further highlighted the dominant influence of total personal income, employment status, and educational attainment on poverty status. Additionally, racial, and geographic factors also played substantial roles, underlining systemic disparities. The findings reinforce the importance of using complex, multi-variable models to understand poverty and support the formulation of more comprehensive, equity-focused policy interventions.

A Unified Framework Incorporating AW-TRBAC and Semantic Variational Autoencoders for Dynamic Threat Detection and Access Control

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Abstract - This paper presents a composite framework to enhance cyber resilience in Cyber-Physical Systems (CPS) against advanced persistent threats. It integrates Dynamic Access Control, specifically Authorizing Workflow and Task-Role-Based Access Control (AW-TRBAC), with Semantic Variational Autoencoders (SVAEs) for Intrusion Detection Systems (IDSs). AW-TRBAC offers context-aware access control with dynamic Segregation of Duties, while SVAEs improve anomaly detection. This multi-layered approach focuses on preventing threats and enabling real-time adjustments to access policies. The framework's probabilistic learning allows in-depth analysis of CPS access flows. Simulations in water treatment CPS scenarios validated its effectiveness, demonstrating improved security with minimal false positives and enhanced access control. This research contributes a proactive, adaptable security solution for the unique challenges in CPS environments.

Towards Smarter IT Compliance Audits: Leveraging Artificial Intelligence

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Abstract - Due to technological advancements, Information Technology (IT) compliance audits have evolved from labor-intensive, manual procedures to efficient, data-driven processes. This transformation has streamlined the audit process, enabling more accurate and follow the compliance with regulations and standards. This paper is based on System Dynamics (SD) principles to the automation of IT compliance audits using AI-powered tools. The growing complexity of digital environments and the growing quantity of facts have made normal audit processes inadequate. This paper investigates how the National Institute of Standards and Technology and Artificial Intelligence Risk Management Framework (NIST) (AI RMF) can be utlised as a basis for automating and improving IT compliance audits. We proposed a conceptual framework that integrates the NIST AI RMF with automation-unique capabilities, which includes anomaly detection and live tracking, to create a dynamic and adaptive audit method to create a dynamic and adaptive audit process. The paper uses a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis of the NIST AI RMF to identify key leverage points for improving adoption strategies. The study also presents a threat assessment model to highlight potential internal and external threats to AI-driven audit processes, such as implementation challenges, rapid technological advancements, and a lack of understanding. The findings demonstrate that AIpowered tools, like CoCAF and EY Helix GLAD, can significantly improve audit efficiency, accuracy, and regulatory compliance. However, ethical challenges, for instace algorithmic bias and data transparency, must be carefully addressed. The study recommends a phased implementation approach, encouraging ethical considerations, and the use of blockchain technology to improve data security and transparency.

A Type-3 Fuzzy-Fractal Stage Classification of Retinal Pathology

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Abstract - This paper offers an approach for classifying different retinal pathologies based on a combination of type-3 fuzzy logic (T3FL) and the fractal dimension (FD). Due to the fractal nature of retinal blood vessels, the retinal FD is a logical metric to explore its use as a potential diagnostic tool. Based on these facts, a T3FL system is used to represent expert knowledge in retinal pathologies by using the FD values. In this case, T3FL helps in modeling uncertainty for enabling medical classification. Results for retinal cases illustrate the effectiveness of the proposal.

textAuthor, An AI-Based Text-Authorship Classifier

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Abstract - textAuthor is a data-driven, artificial-intelligence (AI)-based text-authorship classifier. When trained on user-supplied text/author pairs, the classifier attempts to identify the authors of user-supplied texts (whose authorship may be unknown) that are not in the training set. This paper describes the implementation of textAuthor and shows an example of its use. The example trains the classifier on the full texts of two works written by each of seven authors. textAuthor then assesses who wrote each of a set of test cases (works) that are not in the training set of the example. The classifier robustly identifies the author of each of the test cases whose authors are represented in the training cases.

Sensitivity Parameter Analysis in the Brainstorm Optimization Algorithm

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Abstract - In this work, a sensitivity analysis of the parameters was carried out, using mathematical benchmark functions, for the Brainstorm Optimization (BSO) algorithm. This algorithm is inspired by emulating the collective behavior of humans in problem-solving-specifically, the brainstorming process and is based on swarm intelligence, which is characteristic of evolutionary algorithms. Simulation results highlight which parameter of BSO has more impact on the results. This article is structured as follows: Section 1 defines the Brainstorm Optimization algorithm, its methodology, and governing equations. Section 2 presents the result tables from tests conducted using benchmark mathematical functions. Section 3 provides the sensitivity analysis of the parameters with in the BSO algorithm.

Datasets for Hash-based Homomorphic AI with Variable Compression Rate

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Abstract - We present datasets produced by a new approach in data security, known as HbHAI (Hash-based Homomorphic Artificial Intelligence). This disruptive approach enables processing data under their encrypted form without the limitations and drawbacks that exist for conventional homomorphic data analysis techniques to date (CKKS and BFV schemes). HbHAI is based on a new class of key-dependent hash functions presented in [3] that naturally preserve the similarity properties, most AI algorithms rely on. The HbHAI techniques are not yet public as they are in the process of being protected industrially. However, to enable an initial public assessment, this paper presents several datasets which will be published in a very near future. Among its many features, HbDAI techniques can reduce the size of data at a compression ratio of at least 3. While strongly preserving data security and privacy, this reduces storage space and computing time for native, “off-the-shelf” AI algorithms.

From Data to Decision: Ethical Responses to Bias in AI Systems

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Abstract - As Artificial Intelligence (AI) systems become increasingly integrated into decision-making processes across sectors such as healthcare, finance, and law enforcement, concerns about algorithmic bias and its ethical and societal consequences have grown. This paper investigates the root causes of AI bias, including historical data imbalances, algorithmic design choices, and user interaction patterns. It explores the real-world implications of these biases and highlights existing efforts in policy, regulation, and ethical frameworks aimed at mitigating harm. The study further evaluates current research in bias detection, explainable AI, and privacy-preserving methodologies. Through case studies and analysis of ongoing initiatives, this paper emphasizes the importance of designing AI systems that are fair, transparent, and inclusive. It concludes by outlining future directions for ethical AI development, including interdisciplinary collaboration, public engagement, and the establishment of accountability mechanisms to ensure equitable outcomes.

Labeling Data Using a Rule-Based Voting Ensemble, Fuzzy Sets, and Fuzzy Clustering

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Abstract - Data labeling is a critical—and often costly—step in building supervised machine learning models, especially in domains like road traffic safety, where only a small subset of observations can be manually annotated, and class imbalance is severe. We propose a hybrid, semi-supervised labeling pipeline that combines three strategies: (1) a rule-based voting ensemble, in which domain experts define attributespecific threshold rules (weak classifiers) whose outputs are aggregated by majority vote over a small manually labeled seed set, (2) fuzzy cmeans clustering to assign soft labels in a complementary, unsupervised manner, and (3) fuzzy sets, in which a fuzzy inference system based on threshold rules and penalty values is built to determine the risk level of a single observation. To remedy label sparsity, we augment rare classes with synthetic examples following expert-driven risky patterns and balance the final annotations via SMOTE. On a real-world driving dataset (23,152 synthetically enriched observations; 21,172 unlabeled), our voting ensemble achieves 82% labeling accuracy on held-out expert labelspreserving the expected "descending" class distribution from low to very high risk—while fuzzy clustering often misclassifies high-risk cases. Our approach yields a fully labeled, balanced dataset of 50,612 instances ready for downstream training with minimal manual effort and clear interpretability.

Improving Retail Sales Forecast Accuracy Using XGBoost: A Machine Learning Approach

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Abstract – Sales forecasting is critical to business success, laying the foundation for anticipating future demand and improving inventory management and marketing strategies. Recognizing the importance of sales forecasting, this project leverages a dataset from Kaggle's "Walmart - Recruitment Prediction Competition" covering weekly sales from February 5, 2010, to November 1, 2012, and uses XGBoost, a powerful machine learning algorithm known for its efficiency and accuracy, combined with optimization techniques to achieve optimal performance. We aim to deliver a scalable and accurate sales forecasting solution that supports data-driven decision-making in the retail industry and beyond. The accuracy achieved in our project significantly outperformed the top-performing models from the Kaggle competition using the same dataset.

Efficient Real-Time Object Detection Using Deep Neural Networks: A Comparative Analysis on Low-Power Devices

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Abstract - We present a comparative study of real-time object detection models optimized for low-power devices, specifically the Raspberry Pi 3B and 4B. We evaluated multiple deep learning models including SSD MobileNet V2[1], EfficientDet-D0, and the YOLO[3]v5/v8/v11 series under both FP32 and INT8 quantized settings. Using a custom dataset with only 977 images across three object classes, we fine-tuned each model and measured inference speed (FPS), latency, and mean average precision (mAP). Our findings show that models such as YOLOv11 and SSD-MobileNet-v2-FPNLite maintain high accuracy even after quantization, making them highly suitable for deployment on low-power edge devices.

Assessing Applied Behavior Analysis Provider Effectiveness with Gradient Boosting

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Abstract - Applied Behavior Analysis (ABA) is a research-based approach to behavior modification used in therapeutic interventions for people with developmental and behavioral disorders. A critical component of ABA therapy is therapeutic consistency, which can be hampered by provider-related factors such as punctuality, attendance, and engagement. This paper uses a Gradient Boosting Classification Model to assess ABA provider effectiveness using multidimensional features derived from a novel dataset. We explore how machine learning, particularly Gradient Boosting, may help create a more predictive model for evaluating provider performance.

Preliminary Results of LLM Vulnerability Testing in Less Common Languages

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Abstract - This study investigates the vulnerabilities of Large Language Models (LLMs), specifically focusing on currently leading ChatGPT and Gemini families of models through uniquely crafted adversarial prompts. The models are tested across multiple low-resource less-common languages to assess their ability to handle ethically and legally complex queries in such languages, comparing English with French and Haitian Creole. A total of over twenty prompts, iteratively modified based on model responses, are used to systematically evaluate the models' security measures and responsiveness. Additionally, the response speed of each model is analyzed to identify performance variations. This research builds on previous extensive studies and expands the dimensions of the Adversarial Response Scoring System (ARSS), designed to measure the models' security awareness and judgment further. The findings uncover substantial weaknesses in LLM security and raise an alarm on AI safety.

Agentic AI Guidance Using Simon's Framework for Management Science

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Abstract - The rise of agentic Artificial Intelligence (AI) provides a rich envionment for the design, development, test, and deployment of AI agents. Alignment of the agentic AI capabilities for various decision-making and communication tasks can benefit from the framework for management science developed in the late 1960's by Nobel Laureate Herbert A. Simon. This poster session will employ his concepts of bounded rationality and decision-making model (Intelligence-Design-Choice) to guide and recommend agentic AI design and implementation.

Conversational AI for Healthcare: A Smart Chatbot For Breast Cancer Awareness

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Abstract - Breast cancer remains one of the most prevalent and life-threatening diseases globally, emphasizing the critical need for accessible, reliable, and comprehensive information for patients, caregivers, and the general public. This research presents development of an AI-powered question-answering chatbot designed to provide accurate, interactive, and user-friendly information on various aspects of breast cancer, including symptoms, diagnosis, treatment options, and risk factors. The chatbot integrates stateof-the-art Natural Language Processing (NLP) techniques, utilizing Transformer-based models such as DistilBERT for questionanswering and Sentence Transformers for context-aware information retrieval, ensuring precise and contextually relevant responses. A structured knowledge base was meticulously curated from verified medical sources, ensuring the credibility and reliability of the information provided. To enhance the chatbot's performance, a context-aware retrieval system was implemented, designed to mitigate response repetition, maintain coherence across interactions, and deliver diverse yet consistent answers based on the user's queries. Furthermore, the chatbot was developed with a modern and intuitive user interface (UI) using Streamlit, incorporating interactive elements such as follow-up question suggestions, a structured conversation flow, and a welcoming introduction page to improve user engagement and accessibility. The research involved iterative enhancements to address key challenges such as response redundancy, relevance optimization, and UI accessibility, ensuring an informative and seamless user experience. The chatbot serves as a valuable educational and informational tool that enables users to obtain quick, structured, and reliable insights into breast cancer-related concerns. This study contributes to the ongoing efforts in healthcare AI, demonstrating how NLP-driven chatbots can play a pivotal role in bridging the gap between medical knowledge and public awareness, ultimately empowering individuals with timely and reliable health information.

A Real-World Dataset of Ingredient Images for Food Computing

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Abstract - Computing technologies for food analysis have recently attracted significant attention due to their potential to support applications that promote healthier lifestyles, such as diet monitoring and food recommendation systems. These tools can help reduce the risk of diet-related diseases. A key component in developing such applications is the automatic recognition of food images, which alleviates the need for users to manually log consumed or available ingredients. While numerous datasets exist for prepared food, there are few publicly available resources that focus specifically on food ingredients. In this work, we present a dataset comprising approximately 4,000 densely annotated images of food ingredients and food products, intended to support the development of food-related applications. Each image includes instance segmentation annotations, capturing food items as they might appear on refrigerator shelves or tables, thus providing rich contextual information for recognition tasks. We present a detailed analysis of the dataset's composition. Then, to assess its quality and utility, we report experimental results using several neural network models for instance segmentation.

SPAR: Scalable Prioritized Agent Routing for Multi-Agent Networks

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Abstract - We introduce SPAR (Scalable Prioritized Agent Routing), a novel communication protocol for coordinating tasks in a decentralized graph of autonomous AI agents (with optional human participants). SPAR evolves from the Social Online Routing (SOR) protocol originally developed for human social networks, generalizing its concepts to multi-agent systems. Like SOR, SPAR enables decentralized, peer-to-peer request propagation without centralized brokers, but it is redesigned for AI agents by incorporating dynamic priority queues at each node to manage tasks at scale. We adapt SOR's I-Need, I-Have, and I-Thank

message framework to agent networks and integrate SPAR with emerging agent communication standards, complementing protocols such as Anthropic's Model Context Protocol (MCP) [3], Google's Agent2Agent (A2A) [4], and the open Agent Network Protocol (ANP) [5]. An experimental evaluation in simulated agent networks demonstrates that SPAR's prioritized, queue-based routing achieves significantly lower end-to-end delays and message overhead than baseline flooding approaches, without sacrificing success rates. We also discuss practical applications of SPAR—from collaborative problem-solving among AI assistants to human–AI teamwork—and consider limitations around security, privacy, and open-network scalability, along with future directions to improve and standardize SPAR in the broader AI agent community.

The Geometry of Bias in Contrastive Embeddings: A Spectral Analysis

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Adrien Belcastro, Ray Huang, Vijay Panchal
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Abstract - This paper introduces a spectral method to measure and reduce representational bias in embedding models when supervision is minimal or absent. The method builds similarity graphs from embeddings, which it uses to perform spectral clustering to identify subgroup disparities through eigenvector analysis. Our method demonstrates competitive accuracy and substantial reduction in fairness gaps in CelebA and CheXpert datasets compared to supervised and heuristic baselines during experiments. Our method allows fairness evaluation without full label supervision while providing a scalable and interpretable solution for responsible representation learning.

Mamba and Reformer Training on Minute-Level Stock to Compare Sentiment Signals from Top 10 Large Language Models

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Abstract - The stock market is extremely difficult to predict in the short term due to high market volatility, changes caused by news, and the nonlinear nature of the financial time series. This research proposes a novel framework for improving minute-level prediction accuracy using semantic sentiment scores from ten different large language models (LLMs) combined with minute interval intraday stock price data. We systematically constructed a time-aligned dataset of AAPL news articles and 1-minute Apple Inc. (AAPL) stock prices for the dates of April 4 to May 2, 2025. The sentiment analysis was achieved using the DeepSeek-V3, GPT variants, LLaMA, Claude, Gemini, Qwen, and Mistral models through their APIs. Each article obtained sentiment scores from all ten LLMs, which were scaled to a [0, 1] range and combined with prices and technical indicators like RSI, ROC, and Bollinger Band Width. Two state-of-the-art such as Reformer and Mamba were trained separately on the dataset using the sentiment scores produced by each LLM as input. Hyper parameters were optimized by means of Optuna and were evaluated through a 3-day evaluation period. Reformer had mean squared error (MSE) or the evaluation metrics, and it should be noted that Mamba performed not only faster but also better than Reformer for every LLM across the 10 LLMs tested. Mamba performed best with LLaMA 3.3–70B, with the lowest error of 0.137. While Reformer could capture broader trends within the data, the model appeared to over smooth sudden changes by the LLMs. This study highlights the potential of integrating LLM-based semantic analysis paired with efficient temporal modeling to enhance real-time financial forecasting.

A Multimodal Multi-Agent Framework for Radiology Report Generation

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Abstract - Radiology report generation (RRG) automatically generates diagnostic reports from chest X-ray images to support clinical workflows and reduce radiologists' workload. Recent methods using multimodal large language models (MLLMs) and retrieval-augmented generation (RAG) have shown promise but still struggle with factual inconsistency, hallucination, and cross-modal misalignment. We propose a multi-agent framework aligned with clinical reasoning, where specialized agents handle distinct tasks including retrieval, drafting, refinement, visual analysis, and synthesis. Experimental results show that our approach consistently outperforms strong baselines in both automatic metrics and LLM-based evaluations, producing more accurate, structured, and interpretable reports. This work highlights the potential of clinically aligned multi-agent frameworks to support explainable and trustworthy clinical AI applications.

Leveraging Transformer Models for Extractive Question Answering in Criminal Report Analysis

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Abstract - Transformer-based models have significantly advanced Extractive Question Answering (EQA) in Natural Language Processing (NLP); yet their adaptation to legal document analysis remains understudied. This paper proposes a domain-adapted BERT model for Question Answering (QA) on Spanish-language robbery case reports from Ecuador's Prosecutor's Office (Fiscalía General del Estado), where the volume of reports and the complexity of legal language pose significant challenges for manual analysis. Our methodology employed Generative Artificial Intelligence (GAI) to synthesize a SQuAD-formatted questionanswering dataset tailored to robbery case reports. We first evaluated the baseline performance of a pre-trained BERT model on this domain-specific dataset before conducting fine-tuning to adapt the model to the unique characteristics of legal documentation. The fine-tuned model demonstrated improved capability in processing criminal case information, achieving a final F1-score of 82.88, which represents a measurable enhancement over the baseline performance. These results demonstrate the effectiveness of fine-tuning transformer-based models for EQA tasks in legal language processing and underscore their potential to optimize information retrieval within the justice system. This could help to provide better service to the community in the near future by leveraging workloads.

Prompt Engineering Approaches to Reducing the Costs in LLM-Based Automated Test Case Generation

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Abstract - Large language models (LLMs) automate test case generation but require lengthy prompts to reach 100% code coverage, increasing token usage and API costs. We compare two prompt engineering strategies: removing docstrings and compressing prompts with LLMLingua-2. Across Python projects using Claude 3.7 Sonnet, Gemini 2.5 Pro Preview, and GPT-4.1. LLMLingua-2 reduce API costs by 6.8% while keeping 100% code coverage. Docstring removal achieved savings only on GPT-4.1. For Claude, the coefficient of variation was 19.5% with docstrings and 32.7% without. This is indicating more stable performance when docstrings is retained. Therefore, these findings reveal that the need for docstrings depends on the model and demonstrate that prompt engineering can deliver predictable cost saving, advancing the deployment of economical LLM-based test case generation.

Multi-domain Feature Extraction and Comparative Evaluation of Classification Accuracy for Punching Motions in Mass Boxing

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Abstract - Subjective judging in mass boxing has raised concerns, emphasizing the need for objective evaluation methods. We propose an AIbased system that digitizes punch motions and scores them based on predefined criteria. As a step toward this goal, we developed a punch classification system using accelerometer data. Unlike previous studies that excluded preparatory motions by inserting static states, we collected data reflecting natural pre- and post-punch movements to better simulate real match conditions. Features from time, frequency, and time-frequency domains were extracted and used to train a Random Forest classifier. Results showed that time-frequency features achieved the highest accuracy (0.997). The findings highlight the effectiveness of time-frequency analysis for punch classification and its potential to support objective judging in mass boxing.

An EEG Based High Accuracy CNN for Emotional Health Detection

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Abstract - Millions of individuals across all ages, genders, and demographics in the U.S. experience mental and emotional health issues every year. Protracted persistence of negative emotional health significantly influences mental health and can lead to severe mental health illnesses. Traditional methods for assessing emotional health primarily rely on evaluations conducted by mental health professionals through clinical interviews, standardized questionnaires, and physical or neurological examinations. With advancements in deep learning (DL), techniques such as Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs) have been increasingly utilized to analyze physiological signals, including Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Heart Rate Variability (HRV), and Galvanic Skin Response (GSR), which reflect the body's response to emotional stimuli. This research aims to develop a high-accuracy CNN model for detecting and classifying emotional states using a publicly available EEG dataset. The proposed CNN classifier is designed to distinguish between negative, neutral, and positive emotional states. To evaluate its performance, key metrics such as accuracy, F1-score, precision, recall, and confusion matrix were analyzed. The model achieved an inference accuracy of 99.77%, demonstrating its potential for enhancing emotional health assessment through AI-driven analysis.

Exploring Spam Classification with Open-Source Language Models and Real-World Gmail Data

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Abstract - Unwanted emails, widely known as spam, pose a significant and persistent problem in daily digital lives. Spam can carry security risks such as phishing attacks, making effective detection crucial. While machine learning (ML) has driven advancements in spam filtering, a key challenge remains: most publicly available datasets for training these filters are outdated. These datasets do not reflect the complex mix of "ham" (legitimate) and spam emails encountered today. To address this, a current dataset was built from scratch using real Gmail data. To truly understand the effectiveness of traditional ML models, which have evolved over the years, they need to be tested against real-world scenarios. Simultaneously, recent breakthroughs in artificial intelligence, particularly with Large Language Models (LLMs), are fundamentally changing how information is interacted with. These powerful models offer new possibilities for understanding and classifying text. This paper presents a direct comparison that evaluates the performance of several established traditional ML models, including Naive Bayes, Support Vector Machines (SVM), and XGBoost. The capabilities of these models are then compared against three distinct LLMs. This work aims to provide clear insights into the capabilities of open-source LLMs in detecting spam in contemporary email environments.

Benchmarking Aircraft Detection using Pretrained Models

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Abstract - Airplane detection through computer vision offers promising opportunities to enhance aviation safety by providing additional layers of monitoring and situational awareness. This study benchmarks the performance of several popular deep learning-based object detection models on the task of airplane detection. Different deep learning based models are evaluated using an available dataset of airplane images under diverse conditions. The research goal is to systematically assess performance, identifying models that are best suited for practical deployment in aviation-related applications. By comparing these architectures, this research aims to inform future efforts in integrating computer vision into airport operations, and surveillance, ultimately contributing to safer and more efficient operations.

SensTrans: An AI Model for Generating Wearable Sensor Time-Series Signals to Improve Human Activity Detection

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Abstract - Wearable devices like smartwatches offer great promise for real-time activity tracking and personalized healthcare. However, small organizations often lack access to large-scale, high-quality sensor data. This paper addresses this challenge by leveraging a Sensor Transformer model for synthetic time-series data generation. By learning temporal patterns, the model generates additional data to augment training for activity recognition tasks. Experiments using benchmark datasets—WISDM, HARTH, and PAMAP2—demonstrate that synthetic data improves classification performance across models such as SVMs, CNNs, and LSTMs. This approach enhances model robustness and generalization, enabling accurate recognition even with limited data. Future work includes real-time generation, dynamic validation, and scaling to more complex activities and sensors, offering an accessible path for startups in health monitoring innovation.

LLM-Based Benchmarking and Performance Assessment of Paraphrased Sentences

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Abstract - Understanding how similar two sentences are, semantically, not just lexically, is a central challenge in natural language processing (NLP). Whether it's detecting paraphrases, powering semantic search engines, or enabling intelligent question-answering systems, measuring semantic similarity plays a vital role. Recent advances in transformer-based language models like BERT, RoBERTa, and MPNet have significantly improved our ability to capture meaning in text. However, not all models perform equally well in every application, and there remains uncertainty around which model and similarity approach offer the most accurate results for real-world tasks like paraphrase identification. This study explores and compares the capabilities of three state-of-the-art transformer models, BERT (bert-base-uncased), RoBERTa (all-roberta-large-v1), and MPNet (allmpnet-base-v2), in detecting paraphrased sentence pairs from the well-established Microsoft Research Paraphrase Corpus (MRPC). The goal was not only to evaluate which model performed best, but also to better understand how the choice of similarity metric and decision threshold influences outcomes in practical scenarios.

Collaborative Time Series Forecasting Models to Predict Solar Energy

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Abstract - Accurate time series forecasting is vital for solar energy planning and smart grid optimization. This study compares statistical models (ARIMA, SARIMA) and deep learning models (GRU, LSTM) for predicting Global Horizontal Irradiance (GHI) in Tunisia using over 11 years of meteorological data. We evaluate model performance in both univariate and multivariate contexts, integrating key features like temperature and humidity. Monte Carlo simulations are applied to quantify forecast uncertainty and enhance long-term prediction reliability. The results show that while ARIMA and SARIMA offer solid baselines, GRU and LSTM better capture non-linear patterns, especially with proper data preprocessing. This work highlights the value of deep learning and uncertainty modeling in improving long-term solar forecasting.

Model Construction for Complex Systems Using Systems Dynamics Aware Neural Networks

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Abstract - In this extended abstract, we present our research directions on model construction for complex systems, particularly building Systems Dynamics (SD) models from data. In our previous work, we introduced Systems Dynamics Aware Neural Networks (SDANN) that facilitate incorporating known dynamics of systems into neural network training by following a very flexible programming pattern. We also extended our work to address parameter estimation problem by considering the systems where the dynamics among variables are known in general and could be modeled with SD or differential equations but the parameter values are not known. We argued that SDANN could offer a powerful and flexible way to tackle parameter estimation problems for complex systems. Our next challenge is the application of SDANNs for model construction, that is to identify the stock variables, flows and parameters of the underlying systems dynamics model from data. Approaches exist for identifying the underlying model behavior for dynamical and physical systems, and building the governing differential equations using available data. Main difference between existing work and our research direction is the larger complexity in yielding not just the underlying model behavior or the governing differential equation but additionally building candidate SD models with stock variables, flows and parameters that fit the data. Our research direction considers a set of supported behavior patterns between each pair of stock variables, and tries to find the best matching pattern from the data. Then an SD model pattern is identified as the best match to the identified behavioral patterns among the stock variables. With the application of SDANN on model construction, partially known dynamics can be incorporated via coding the difference equations or by specifying the known behavior patterns among stock variables from the set of pre-programmed behavior patterns.

Evolving Generators Using Policy Gradients With Parameter-Based Exploration for InfoGAN Training

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Abstract - Previous work showed that embedding cultural knowledge into evolutionary optimization improved MNIST handwritten-digit classification. We therefore ask whether policy gradients with parameter-based exploration (PGPE), in the absence of a cultural layer, can successfully train generative adversarial networks (GANs) for image synthesis.. Classical GANs trained with backpropagation are prone to mode collapse, vanishing gradients and unstable dynamics. Evolutionary search, being gradient-free, could in principle alleviate some of these issues. InfoGAN encourages disentangled latent variables by explicitly maximising the mutual information between a latent code and the generated sample. This property could inspire a new attention

mechanism in an InfoGAN-style transformer. We therefore build a hybrid InfoGAN: the discriminator and auxiliary Q-network are trained with back-propagation, while the generator is evolved with PGPE. PGPE approaches, but does not fully reach, convergence on a generator that yields consistently high-quality, disentangled digits. The main bottleneck is converting the multi-objective feedback available during GAN training into the scalar fitness signal that PGPE requires. We evaluate three scalarization strategies—normalization, weighted sums and non-dominated sorting. Each reveals different aspects of PGPE's search dynamics yet ultimately restrains convergence. In future work we will re-incorporate cultural knowledge to drive dynamic objective weighting during evolution and will extend the framework to deeper architectures and more diverse datasets.

Augmenting Agricultural Human Capital through Agentic AI: Personalizing Support for Small Farmers in Labor-Scarce Rural and Agri Industry Ecosystems

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Abstract - Persistent rural-to-urban migration and generational labor shifts have left global agriculture and dairy sectors with critical human capital deficits, particularly among smallholder farmers. This paper presents a novel framework for deploying Agentic AI—self-governing digital agents capable of learning farmer preferences, regional agronomic contexts, and value chain characteristics—to address labor shortages, enhance knowledge dissemination, and boost productivity in under-resourced agricultural systems. Our solution leverages modular, multilingual AI agents embedded on mobile and edge platforms, designed to operate in low-bandwidth rural environments. The economic impact is significant: according to the World Bank and FAO, labor shortages in agriculture contribute to $56 billion USD in annual productivity loss globally, with smallholders representing the majority of affected stakeholders. In our analysis, Agentic AI - by improving decision accuracy in areas like crop selection, irrigation timing, and input management - can contribute to 5–15% yield increases, representing $12–20 billion USD/year in potential economic gains worldwide. Our approach includes value chain integration, voice-driven interfaces for semiliterate populations, and adaptation of local practice, making it a culturally contextualized solution. This work argues for a paradigm shift where AI agents are not merely tools, but cognitive collaborators - learning, adapting, and extending the reach of traditional agricultural extension services. This vision positions Agentic AI as essential digital infrastructure in building resilient, inclusive food systems.

The Impact of Generative AI (ChatGPT) on Constructivist Learning Outcomes in Higher Education: A Mixed-Methods Study

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Abstract - The study underscores the potential of ChatGPT to support constructivist learning principles while also addressing challenges such as over-reliance on AI and ethical considerations. By providing empirical evidence on the benefits and limitations of ChatGPT, this research paves the way for the responsible integration of AI tools in higher education, aligning with broader strategic goals such as Saudi Vision 2030.

Convolutional Neural Networks for Accurate Medical Clamp Identification in Hospital Settings

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Abstract - This study focuses on classifying surgical forceps using deep learning to improve inventory management in medical settings. It targets specific types—such as Allis (curved and straight), Babcock, ring, field, Kelly, and Mixter forceps—using a custom photographic dataset. ResNet101 proved to be a feasible and accurate model for this task, showing strong potential for real-world application. This approach helps reduce equipment mismanagement and enhances operational efficiency. Future work will explore advanced architectures like Encoder-Decoder models, BLIP, YOLO, LSTM, and GRU to further improve classification accuracy and support deployment on devices with limited computational resources.

Missile Command Reimagined: Formulation of a Reinforcement Learning Based Approach for Resource-Constrained Defense

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Abstract - This work investigates the use of reinforcement learning (RL) for missile defense asset allocation in a modified version of the classic Missile Command game. The environment has been extended to support heterogeneous interceptor types, varied threat profiles, and configurable resource constraints, transforming the engagement into a tractable resource allocation problem. By abstracting away spatial targeting, the scenario isolates asset selection as the primary decision variable, enabling focused evaluation of RL methods in mission-relevant conditions. Proximal Policy Optimization (PPO) was applied to train an agent in this setting; however, the resulting policy did not converge, suggesting that the current reward structure does not provide sufficient learning signal. Future work will focus on reward function redesign and feature engineering, which are expected to significantly improve learning outcomes and policy effectiveness. This effort serves as a foundation for further exploration of AI-assisted decision support in tactical defense planning.

Deep Learning for Detection of Frosty Pod Rot in Cacao Pods: A Comparative Analysis

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Abstract - Frosty Pod Rot (FPR), caused by Moniliophthora roreri, poses a significant threat to global cocoa production, especially in Colombia, where cacao cultivation is vital for rural economies. Traditional manual inspection methods for detecting FPR are labor-intensive and often ineffective at identifying early-stage symptoms. This study investigates the application of five deep learning models—Custom Convolutional Neural Network (CNN), MobileNetV2, MobileNetV3, ResNet18, and ResNet50 for automated, image-based FPR detection. Using a diverse dataset of cocoa pod images collected from Colombian farms and public sources, we applied image preprocessing techniques including HSV color enhancement, manual cropping, and normalization. Evaluation across accuracy, precision, recall, and F1-score demonstrates that MobileNetV2 outperforms both shallow and deeper architectures, achieving high accuracy and stable learning behavior with low computational demand. The findings support the use of lightweight, transfer-learning-based models for practical, low-cost disease detection in resource-constrained agricultural environments.

Machine Learning-Based Crop Yield Prediction: State-of-the-Art, Challenges, and Future Directions

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Abstract - In recent years, advancements in Machine Learning (ML) have greatly enhanced agricultural practices, drawing significant attention to crop yield forecasting and prediction. With the rising global population and the increasing impact of climate change on agricultural productivity, accurate crop yield prediction has become crucial for ensuring food security and optimizing resource allocation. As a result, this paper presents a comprehensive overview of ML-based crop yield prediction, detailing the models employed, their applications, and the challenges encountered. This paper seeks to take stock of state-of-the-art (SOTA) on such technical developments in crop yield prediction. Our attention focuses on relevant ML-based crop yield prediction schemes that have been published from July 2024 to March 2025 from the Scopus, MDPI, Scientific Reports, Taylor & Francis, WILEY, and ScienceDirect databases. Our contribution lies in the analysis, synthesis, and summarized alignments of these schemes toward overcoming crop yield prediction challenges across the globe. Finally, the review highlights a number of future research directions deduced from recently proposed crop yield prediction schemes.

An Intelligent Emotion-based Mechanism to Predicting Domestic Violence in Public Online Posts

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Centre for Instructional Technology and Multimedia, Universiti Sains Malaysia, Penang, Malaysia

Abstract - Domestic violence (DV) incidents against women are on the rise worldwide. This study proposed a machine learning model to predicting DV from Microblogs. The proposed model was based on the classification of different types of emotions and tweet polarity. The Latent Dirichlet Allocation algorithm was used to identify the latent topics shared among the collected tweets based on certain DV-emotional and -physical features. The results showed that DVrelated topics were associated with emotions of anger, disgust, fear, and sadness. Three classifiers (K-nearest neighbor, multinomial logistic regression, and LogitBoost) were used to classify DV-related topics. The results of the Logistic classifier achieved the highest classification accuracy (97.71 %) in predicting DV incidents against women. Outcomes from this study can offer health and wellbeing decision makers a timely and cost-effective way to predict DV against women. This includes the feasibility of integrating different sentimental features in classifying DV incidents.

Unveiling Gender Disparities in Neurodegenerative Disease Diagnosis on Microblogs

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Abstract - Recent research highlights how biological sex may influence the development of neurodegenerative conditions such as Parkinson's disease (PD). Early and accurate diagnosis of PD symptoms can play a key role in extending life expectancy and enhancing quality of life. This study presents a novel model to predict PD using gendered data from X (Twitter). We analysed PD-related tweets to identify user gender, extract hidden topics and sentiments, and applied multi-label classification. The classification results showed the potential of genderbased sentiment in predicting PD at 85.64% accuracy. Emotional patterns differed by gender, with males showing anger and surprise, and females expressing disgust, fear, sadness, and trust. The proposed approach offers new possibilities for enhancing online PD diagnosis and personalized healthcare.

Early Detection of Poultry Infectious Disease Using Deep Learning

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College of Computer Science and Engineering, Department of Information System and Technology, University of Jeddah, Jeddah, Saudi Arabia;
College of Medicine, Internal Medicine Department - Radiology, University of Tabuk, Tabuk, Saudi Arabia

Abstract - Epidemiological poultry illnesses, including Coccidiosis, Salmonella, and Newcastle, are notorious for decimating poultry populations and jeopardizing white meat supplies, adversely impacting chicken production and leading to considerable economic losses for farmers. Furthermore, it presents a significant threat to human health. Farmers and veterinarians may now detect these diseases by visual and auditory monitoring. They can analyze photos of chicken feces to determine whether the birds are healthy or afflicted by one of the previously stated diseases. Nonetheless, the detection process is laborious and time-consuming when conducted on a large scale. To address the identified constraints, we offer a solution consisting of an image multi-class classifier utilizing six models: baseline CNN, VGG16, InceptionV3, MobileNetV2, Xception, and MobileNetV3. The initial five models were employed by the cutting-edge solutions. MobileNetV3, the most recent model, has not been utilized for the detection of these disorders and was recommended by us. We selected MobileNetV3 because to its superior performance compared to all other models. For instance, it is at least twice as quick as the other models during the training phase. This complements the attainment of exceptional accuracy of approximately 98%. We utilize diverse data sets to illustrate the efficacy of the proposed method. The datasets comprise 2057 fecal photos of healthy poultry, 376 fecal images of poultry infected with Newcastle disease, 2276 fecal images of poultry infected with Salmonella, and 2103 fecal images of poultry infected with Coccidiosis, totaling 6812 images.

Enhancing Incident Root Cause With Confidence Using Zebraai

Christopher Allen, Xin Bai, Juan Quintana, Mason Torres, Pramila Padmanabhan
The Microsoft Corporation, Redmond, Washington, USA

Abstract - NA

RIASEC GPT Chatbot and Eye Tracking: Conscious vs. Subconscious Vocational Interest Inventory

Jennifer Mei-ling Chun, Nada Attar, Sayma Akther, Luke Liu
San Jose State University, San Jose, California, USA;
Santa Clara University, Santa Clara, California, USA

Abstract - Vocational Interest Inventories (VIIs) recommend suitable career categories to users based on their work activity interests. Utilizing advanced chatbot software and eye-tracking technology may glean additional conscious and subconscious data from users that may improve VIIs. By applying the RIASEC model (Holland's Codes) of VIIs to Generative Pre-trained Transformer (GPT) multimodal multi-bot chatbots and image-based comparison programs incorporating background eye-tracking in three related experiments, alternative methodologies of VII career category and career recommendation prediction are conducted, compared, and proposed for future vocational research studies. This is the first VII project that explores diametrically opposite RIASEC career category comparison, GPT applications (speech-to-text, text-to-speech, and image generation through GPT-4), and eye-tracking technology to efficiently predict user interest in RIASEC's career categories.

Artificial Intelligence in Cybersecurity

Matthew N. O. Sadiku, Matthais Oteniya, Janet O. Sadiku
Roy G. Perry College of Engineering, Prairie View A&M University, Prairie View, Texas, USA;
Juliana King University, Houston, Texas, USA

Abstract - Artificial intelligence (AI) is an area of computer science that emphasizes on the creation of intelligent machines that work and perform tasks like humans. AI is being introduced to just about every facet of life these days. Cybersecurity is a place AI can have a significant impact. AI and cybersecurity are increasingly interconnected, with AI playing a significant role in enhancing cybersecurity measures. Artificial intelligence in cybersecurity refers to the deployment of AI algorithms to detect, prevent, and respond to cyber threats. AI technologies leverage machine learning models, natural language processing, and other analytics to improve cybersecurity measures. The recent advances in AI have led to an explosion in interest around AI-powered cybersecurity capabilities. Artificial Intelligence is revolutionizing the field of cybersecurity, empowering organizations to combat the ever-evolving threat landscape effectively. This paper highlights the challenges and risks of using AI in cybersecurity.

Evaluating the Impact of Local Knowledge Document File Types on the Performance of Large Language Models

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Abstract - Large Language Models (LLMs), such as GPT-4, are increasingly being integrated into document-based question-answering systems to help users extract meaningful insights from their own materials. These models are especially valuable in environments like Microsoft Copilot Studio, where users can upload documents and interact with AI agents to retrieve answers grounded in those documents. However, while LLMs are powerful, their performance may be influenced by factors that are often overlooked, such as the file format of the uploaded documents. Despite the widespread use of formats like .TXT, .DOCX, .PDF, and .XML, there has been limited research into how these formats might affect the efficiency and quality of the system's responses. This study set out to explore whether document format has any measurable impact on GPT-4's response time, answer length, and content consistency.

A Study on the Context-based Trustworthiness to Decrease Confirmation Bias and Improve Evenness of the Generated Content

Hyun Jung Lee
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Abstract - In this era, it is popularized to use the generated contents by generative AIs, even if the purpose and intention may different. The other way around, the veracious and informative generated contents have become important issues. As is already known, there are plausible issues like hallucination, fake news, and so on. For instance, one of the critical issues is related to confirmation bias. To decrease the unintended side effects, it is important to guarantee and increase the trustworthiness of the generated content. To do this, it is necessary to discuss how to increase the trustworthiness of the veracity of the generated contents. In this research, trustworthiness is examined by evenness of the content and diversity of associated sources. The evenness is depending on the consistency among contents and it is possible to ensure objectivity of information through diversity the associated sources. So, the evenness present consistent content and balanced sources that are used to generate contents by generative AIs. To measure the trustworthiness of the generated contents, the knowledge graph is adopted to measure the contextual distance and biased among components of the generated content. In addition, the diversity as a wide range of sources is adopted to examine the trustworthiness of the generated contents.

SESSION:
XXV Technical Session on Applications of Advanced AI Techniques to Information Management for Solving Company-Related Problems

Co-Chairs:
Dr. David de la Fuente, University of Oviedo, Spain &
Dr. Jose A. Olivas, University of Castilla - La Mancha, Spain

Evaluating the Impact of Algorithmic Complexity on Recommender Systems: A Comparative Study of Rating and Ranking Models

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Escuela Politecnica de Ingenieria Gijon, Campus de Viesques s/n, Gijon, Asturias, Spain

Abstract - NA

Digital Twins in Supply Chain Management: An Overview of the Literature

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Abstract - NA

Analyzing Stock Market Recovery for G20 Countries in Critical Events using Elastic Patterns

A. Lorenzo, R. Rodriguez-Cardos, J. A. Olivas
Department of Business Intelligence, Castilla-La Mancha Government, Spain

Abstract - NA

Policy Deployment: Process-Centric Adoption as a Key Factor of Success

Costas J., Pastor R., Fernandez-Vazquez S., Fernandez I., Puente J.
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Abstract - NA

How to Manage Supply Chain Bill of Materials through Artificial Intelligence?

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Research Centre on Production Management and Engineering (CIGIP), Universitat Politecnica de Valencia, Alarcon, Alcoy, Alicante, Spain

Abstract - NA

The 21st International Conference on Data Science
(ICDATA'25: July 21-24, 2025; Las Vegas, USA)

https://icdatascience.org/
https://american-cse.org/csce2025/

Utility AI for Explainable Decision-Making in Six-DoF Simulation Environment

Indu Shukla, Aberahim Salhi, James E. Ross, Gary J. Briggs
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United States Army Corps of Engineers, RAND Corporation, Santa Monica, California, USA

Abstract - Reinforcement Learning (RL) agents show promise in air combat simulation but often operate as black boxes, limiting their usability in complex and mission-critical environments. This work introduces a utility-based interpretability and explainability framework for offline RL in a six-degree-offreedom (6-DoF) aerial environment. We visualize utility scores over time, unpack decision logic through feature-based considerations, and apply diverse scoring curves to reveal how input variables shape agent behavior. A contextual importance heatmap further illustrates how tactical priorities shift with engagement range. Together, these tools provide actionable insights into agent reasoning, enhancing transparency and confidence in autonomous systems.

Conditional Wasserstein Generative Adversarial Network Transformers with Gradient Penalty (CWGANSFORMER-GP) with Multi-Modal Data

Rose Atuah, Khalil Almakrami, Michael McGuire
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Abstract - This study proposes a novel model-Conditional Wasserstein Generative Adversarial Network Transformer with Gradient Penalty (CWGANSFORMER-GP), to improve the accuracy and reliability of tropical cyclone(TC) intensity and track forecasting. The model leverages the Conditional Wasserstein Generative Adversarial Network with Gradient Penalty (CWGAN-GP) to address the problem of data imbalance and the Transformer architecture for improved predictive capability. Consequently, this research aims not only to enhance the accuracy of TC track and intensity forecast but also to ensure model robustness and reliability by contributing to advancements in meteorology and disaster risk reduction. Our key contribution is threefold: Training and evaluating the proposed model on multimodal data to enhance robustness, generalization, and understanding of the complex nature of TC forecasting; employing the synergistic integration of CWGAN-GP and Transformer to build a hybrid model tailored for imbalanced datasets; and demonstrating through empirical results that the proposed CWGANSFORMER-GP model not only complements but outperforms previous state-of-the-art methods.

Reinforcement Learning Explainability Using Decision Tree in Combat Environment

Indu Shukla, Aberahim Salhi, James E. Ross, Gary J. Briggs
United States Army Corps of Engineers, Vicksburg, Mississippi, USA;
United States Army Corps of Engineers, RAND Corporation, Santa Monica, California, USA

Abstract - This study focuses on advancing Multi-Agent Reinforcement Learning (MARL) by exploring dynamic environments where multiple agents interact in both cooperative and competitive scenarios. The complexity of these interactions is progressively increased by utilizing well-established MARL scenarios, providing a comprehensive and robust framework for testing and evaluation. By simulating various agent behaviors, the study aims to capture a wide range of decision-making processes and interaction patterns, ensuring a thorough examination of MARL systems in diverse conditions. A key component of this research is the implementation of explainability techniques to make agent interactions more transparent and interpretable. To achieve this, advanced policy visualization methods, such as heatmaps and decision trees, are applied to clearly illustrate agent behavior across different regions of the state space. These visualizations provide valuable insights into how agents make decisions and respond to environmental changes, making the system more accessible to human understanding and enabling better analysis of agent strategies. By enhancing both the complexity of agent interactions and the interpretability of their decision-making processes, this study aims to push the boundaries of MARL development and evaluation.

Multistage Stress Classification and Cognitive Capacity Analysis Using EEG

Abdul Waleed, Nusrat Jahan Nitu, Carol Fung
Concordia University, Montreal, Canada;
University of Dhaka, Bangladesh;

Abstract - NA

Task Scheduling with Various Security Level Requirement in Financial Cloud Environment

Xianmei Hua, Xinrong Zhan
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Abstract - The proliferation of multi-cloud infrastructures in the financial sector presents new challenges in executing security-sensitive and quality-of-service (QoS)-constrained workloads. Traditional scheduling methods often fall short in addressing the conflicting objectives of execution efficiency and inter-cloud communication overhead. In this paper, we propose a hybrid task scheduling framework that integrates a communication-aware clustering strategy with a multi-objective Non-dominated Sorting Genetic Algorithm II (NSGA-II) to optimize financial workflow execution across multi-cloud environments. The proposed method first employs a DAG-based clustering algorithm to identify groups of interdependent tasks with high data exchange, aiming to minimize inter-cloud traffic. These clusters are then used to guide both the initialization and evolutionary operators of NSGA-II, enabling efficient exploration of the solution space while ensuring security-level compliance and resource feasibility. Simulation results demonstrate that our approach achieves superior performance in terms of makespan reduction and communication cost minimization when compared with others approaches. The proposed framework offers a scalable and adaptive solution for QoS-aware financial task scheduling under heterogeneous cloud environment.

DP-WGAN-GP for Privacy Protection in Medical Data

Bo Yu, Hao Huang, Yiyu Shan, Guoqiang Zhao, Hemn Barzan Abdalla
Wenzhou-Kean University (WKU), Wenzhou, Zhejiang, China;
Kean University, New Jersey, USA

Abstract - This paper proposes a privacy protection data generation model that combines Wasserstein generative adversarial networks with gradient penalty (WGAN-GP) and differential privacy (DP). This approach effectively addresses the dual challenges of generating high-quality synthetic medical data and protecting sensitive information. By combining residual blocks, gradient clipping, and fixed Laplacian noise injection, the WGAN-GP framework ensures training stability and data fidelity for realistic data generation and robust privacy protection. Comparative experiments highlight the advantages of fixed noise in enhancing model performance, and Laplacian noise is superior to Gaussian noise in privacy protection. The proposed DP-WGAN-GP model preserves the main features of the original data while protecting privacy, making it suitable for applications requiring strict privacy standards. Compared to other privacy protection models, our approach performs well in maintaining an accurate distribution of classified data and generating synthetic data that approximates real healthcare data. The experimental results further prove that the DP-WGAN-GP model can closely replicate real medical data and maintain a balance between data utility and privacy, providing a powerful solution for big data medical data protection.

Beyond the Hype: The Efficacy of Simpler Models for Water Level Forecasting Compared to Deep Learning Architectures

Edgar Ceh-Varela, Sarbagya Shakya, David Schmith
Eastern New Mexico University, New Mexico, USA

Abstract - Accurate river level forecasting is crucial for water resource management, emergency planning, and log-term conservation efforts, particularly in drought-prone regions. Realworld hydrological datasets often contain significant noise and outliers, which can severely compromise predictive model performance. This study investigates one-day-ahead water level forecasting using a USGS dataset from the Ruidoso river in New Mexico. We leveraged a comprehensive approach, including initial outlier detection (Z-score analysis), extensive model selection using LazyRegressor, and fine-tuning of top-performing traditional machine learning models. Crucially, we compared the best traditional model (RANSAC) against deep learning architectures, namely Long Short-Term Memory (LSTM) and Transformer models, which were also rigorously hyperparameter tuned. Contrary to common expectations that complex deep learning models would yield superior performance, the RANSAC regression model consistently outperformed both LSTM and Transformer models across all evaluation metrics, including R 2 , MAE, MSE, and RMSE. RANSAC achieved an R 2 of 0.9672 and an MAE of 0.0322, significantly outperforming LSTM (R 2 0.8877, MAE 0.0694) and Transformer (R 2 0.8028, MAE 0.0932). Our results strongly suggest that the inherent robustness of RANSAC to outliers, which were prevalent in the dataset, played a decisive role in its superior performance. This work highlights that for time series data with noise or outliers, simpler, robust traditional machine learning models can offer more reliable and accurate predictions than complex deep learning architectures, providing valuable insights for practical hydrological forecasting applications.

Classification Based on Dynamic Skyline Objects

Yoshiaki Okubo
Hakodate Campus, Hokkaido University of Education, Japan

Abstract - We propose a novel parameter-free classification method inspired by the fundamental idea of the k-nearest neighbors (k-NN) algorithm. Our method defines a new notion of neighborhood based on the Dynamic Skyline with respect to a query object and predicts its label via majority voting. In order to improve classification quality, we also explore weighted voting schemes using distance-based and rank-based weights, both of which require no parameter tuning. Experimental results on benchmark and synthetic datasets demonstrate that the proposed method achieves classification performance comparable to or even better than k-

NN. These observations suggest the potential of Dynamic Skyline-based classification as a practical and robust alternative to k-NN without requiring any user-defined parameter.

How Students Tackle Coding Tasks in Formative Assessment

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University of Washington, Seattle, Washington, USA

Abstract - Computer science has become a fundamental skill for success in the 21st century, and open-ended coding tasks are widely used to assess students' programming abilities. These tasks often involve solving problems using various programming concepts, such as loops, branching, and data manipulation. However, despite their prevalence, there is limited psychometric research on how to accurately measure item difficulty—especially in assessments that allow unlimited attempts. This study investigates item difficulty in programming assessments by analyzing both product data and process data. Using a dataset collected from college students completing 21 programming tasks, we applied classical test theory, cognitive diagnostic modeling, and cluster analysis to classify item difficulty levels. We found that expertbased difficulty classifications could be refined using data-driven methods, revealing clearer distinctions among item difficulty levels. Additionally, we examined students' coding behaviors through keystroke feature and keystroke burst analysis. Results showed that harder items were associated with longer, more continuous typing bursts and fewer pauses, indicating deeper cognitive engagement. In contrast, easier items showed more fragmented typing and frequent pauses, suggesting lower cognitive demand or trial-and-error strategies.

Machine Learning-Based Viscosity Prediction of Ionic Liquids Using Random Forest Regression

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School of Polymer Science and Polymer Engineering, The University of Akron, Akron, Ohio, USA

Abstract - In this study, random forest regression models were developed to predict the viscosity of ionic liquids using an enhanced dataset generated via the cheminformatics toolkit RDKit. The curated dataset included over 22,000 experimental observations across 2,068 unique ionic liquids, with inconsistent or uncertain entries removed. Feature extraction expanded the original four features to 126 molecular descriptors, capturing properties such as molecular weight, charge, and structural attributes. To manage high dimensionality, Principal Component Analysis preserved 95% of variance, followed by feature refinement using SelectKBest, Recursive Feature Elimination, and a novel Bayesian Feature Selection approach. Model optimization was performed through Bayesian hyperparameter tuning and validated using 10-fold cross-validation. An ensemble of random forest models was autonomously generated and evaluated across varying feature sets and hyperparameters. The final model achieved an average R^2 of 0.96 on the training set and 0.76 on the test set, indicating strong predictive performance. This work demonstrates the power of combining advanced feature engineering, dimensionality reduction, and machine learning to predict ionic liquid viscosity, providing valuable tools for the rational design and industrial deployment of ionic liquids.

Age-Related Differences and Implications for Development of Advanced Driver Assistance Systems

Shabnam Shabani, Michael Bauer
Department of Computer Science, The University of Western Ontario, London, Ontario, Canaada

Abstract - Vehicles continue to be instrumented with more advanced technology to enhance safety and support drivers. As the population ages, understanding the differences in driving characteristics between older and younger drivers is crucial for developing effective driver support systems. This paper reports on a study to identify behavioral and performance variables that show significant age-related differences and could serve as potential indicators for future driver behavior modeling. Using data

from a high-fidelity driving simulator, we analyzed driving behavior across multiple scenarios for 22 older adults (Age > 65) and 12 younger adults (Age 18–40). A broad set of metrics was extracted, focusing on those characterizing driving behaviors to identify candidate features for modeling. The Mann–Whitney U test was applied to determine key variables that show significant differences between age groups. These are then used to identify related age-relevant metrics appropriate for use in driver behavior modeling and assistance technologies.

Behavioral Analysis via Tabular-to-Image Transformation for Proactive Threat Detection

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Universidad Popular Autonoma del Estado de Puebla (UPAEP), Departamento de ingenierias,
Facultad de Tecnologias de Informacion y Ciencia de Datos (FTIyCD), Puebla, Mexico;
Universidad Popular Autonoma del Estado de Puebla (UPAEP),
Facultad de Tecnologias de Informacion Ciencia de Datos (FTIyCD),
Secretaria de Ciencia, Humanidades, Tecnologia e Innovacion (SECIHTI), Puebla, Mexico;
Universidad Popular Autonoma del Estado de Puebla (UPAEP),
Facultad de Tecnologias de Informacion Ciencia de Datos (FTIyCD), Puebla, Mexico

Abstract - This study explores Network Behavior Analysis (NBA) by transforming captured traffic data into images optimized for machine learning models focused on detecting network threats, particularly DDoS attacks. Building on previous anomaly detection research, this work incorporates behavioral science variables for a deeper analysis of user behavior. Using the publicly available BCCC-Dataset, tabular data were processed with one-hot encoding, and images were generated using NEighborhood Dependencies (Refined), DeepInsight, and Tabular Convolution (TAC) techniques. Deep learning models based on Convolutional Neural Networks (CNNs) were then applied to predict potential threats. The results show effective detection of suspicious patterns, reducing response times and operational costs. This study highlights the importance of combining machine learning and behavioral analysis for proactive threat management.

Text Mining Analysis for Traditional Dance Songs

Toshiyuki Maeda, Masumi Yajima, Akiyoshi Wakatani
Department of Management Information, Hannan University, Japan;
Department of Economics, Meikai University, Japan;
Faculty of Intelligence and Informatics, Konan University, Japan

Abstract - As an example of the application of AI and data science technologies to the field of performing arts, we present and discuss text mining analysis for Japanese traditional dance songs (Kouta and Jiuta). In this study, clustering analysis have been conducted on lyrics of Kouta and Jiuta to verify the possibility of extracting and classifying trends by lyricist and dance schools. We are convinced that the application of AI and data science technologies to the field of performing arts has great potential, and we look forward to its further development in the future.

Machine Learning and Explainable Artificial Intelligence for Network Intrusion Detection

Madison Ngafeeson, Oluwatimileyin Favour Obagbuwa
Sol Plaatje University, South Africa

Abstract - NA

CPU-Based Parallelization of BDAC: Enhancing k-Clique Approximation

Belgin Ergenc Bostanoglu, Busra Calmaz
Izmir Institute of Technology, Turkey

Abstract - NA

Using Generative AI and Multi-agent LLM Architectures for Topic Summarization and Segmentation for Long Lists of Educational Videos

Oscar Yllan Garza, Luz Maria Gonzalez Urena, Francisco J. Cantu
Tecnologico de Monterrey, Mexico

Abstract - NA

A Computational Approach to Improving Fairness in K-means Clustering

Guancheng Zhou, Haiping Xu, Hongkang Xu, Chenyu Li, Donghui Yan
University of Massachusetts Dartmouth, Massachusetts, USA

Abstract - NA

Optimizing Mobility: A Scalable Real-Time Warehouse for Intelligent Transportation Analytics

Buddhi Ayesha Rathnayaka Hewa Kirindage Don, Uthayasanker Thayasivam, Umashanger Thayasivam
Rowan University, USA

Abstract - NA

Multi-Dimensional Summarization Agents with Context-Aware Reasoning over Enterprise Tables

Amit Dhanda
Amazon, USA

Abstract - NA

Feature Engineering for Classical and Quantum Unsupervised Machine Learning in Short Time Series of Bird Strike Incidents

Mohammed Syed, Mark Slagle, Paul Garcia
The Boeing Company, USA

Abstract – NA

Is the Indian Social Sector Data Science Ready?

Satender Rana, Sanchita Mukherjee, Swetha Prakash, Sreya Menon
Indian School of Development Management, India

Abstract - NA

Machine Learning for B2B Sales Prediction: A Comparative Study

Guilherme Pires, Carina Pimentel, Luis Miguel Matos
University of Minho, Portugal

Abstract - NA

Disputing Facts: A Glimpse into Voting-Related Conversation on TikTok

Mohamed Ahmed, Helge Marahrens, Lisa Singh, Pleasant Ballenger, Diego DiMattina, Kenedy Ducheine, Aiden Ehrenreich, Caroline Field, Kylie Griffiths, Lucy Olander, Katie Wilson
Georgetown University, Washington, D.C., USA

Abstract - NA

Validating DataOps CI/CD Pipelines with a Three-Layer Testing Framework

Dmytro Valiaiev
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Abstract - The industry shift from extract-transform-load (ETL) to extract-load-transform (ELT) through DataOps practices has made continuous integration and continuous deployment (CI/CD) pipelines central to transforming raw SQL models into governed data assets. However, practical guidance on how to test these pipelines remains limited. This study introduces a threelayer framework (white-box, gray-box, and black-box) integrated into GitLab CI for a data-warehouse codebase. The framework runs 23 automated controls per commit. An evaluation of real merge requests shows that the gate prevents faulty submissions and releases compliant code without manual review. The results demonstrate that rigorous, yet lightweight, DataOps pipeline validation is achievable and cost-effective while ensuring productiongrade quality assurance.

Semantic Risk Scoring of Aggregated Metrics: An AI-Driven Approach for Healthcare Data Governance

Mohammed Omer Shakeel Ahmed
University of Texas at Arlington, Texas, USA

Abstract - Large healthcare institutions typically operate multiple business intelligence (BI) teams segmented by domain, including clinical performance, fundraising, operations, and compliance. Due to HIPAA, FERPA, and IRB restrictions, these teams face challenges in sharing patient-level data needed for analytics. To mitigate this, A metric aggregation table is proposed, which is a precomputed, privacy-compliant summary such as “Average Patient Wait Times by Department” or “Donor Conversion by Campaign.” These abstractions enable decision-making without direct access to sensitive data. However, even aggregated metrics

can inadvertently lead to privacy risks if constructed without rigorous safeguards. A modular AI framework is proposed that evaluates SQL-based metric definitions for potential overexposure using both semantic and syntactic features. Specifically, the system parses SQL queries into abstract syntax trees (ASTs), extracts sensitive patterns (e.g., fine-grained GROUP BY on ZIP code or gender), and encodes the logic using pretrained CodeBERT embeddings. These are fused with structural features and passed to an XGBoost classifier trained to assign risk scores. Queries that surpass the risk threshold (e.g., > 0.85) are flagged and returned with human-readable explanations (e.g., "Metric may overexpose sensitive groupings like gender or ZIP"). This enables proactive governance, preventing statistical disclosure before deployment. This implementation demonstrates strong potential for cross-departmental metric sharing in healthcare while maintaining compliance and auditability. The system also promotes role-based access control (RBAC), supports zero-trust data architectures, and aligns with national data modernization goals by ensuring that metric pipelines are explainable, privacypreserving, and AI-auditable by design. Unlike prior works that rely on runtime data access to flag privacy violations, the proposed framework performs static, explainable detection at the query-level, enabling pre-execution protection and auditreadiness.

SELENE: A Deep Learning Model for Predicting Lunar Absorbed Radiation Dose Rates

Sai Srikar Tummala, Mittansh Bhatia, Robert Chun
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Abstract - Lunar exploration faces major challenges because the Moon lacks a magnetic field and atmosphere, exposing astronauts to harmful radiation from galactic cosmic rays and solar energetic particles. Traditional radiation models rely on computationally intensive physics simulations, which are often slow and require significant resources. This study introduces SELENE (Space Environment Lunar Exposure Neural Estimator), an artificial neural network designed to rapidly predict lunar surface radiation dose rates using space weather data. SELENE is trained on over 27,000 data points collected from the CRaTER instrument aboard the Lunar Reconnaissance Orbiter, enabling fast and accurate radiation forecasting essential for protecting astronauts on future lunar missions.

Machine and Deep Learning for AI Text Detection

Li-jing Arthur Chang
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Abstract - The study compared several deep learning and machine learning algorithms to see their performance in detecting AI-generated text. Results showed the RoBERTa algorithm has the highest accuracy, followed by its deep learning counterparts like BERT, LSTM, and Bi-LSTM. The performance of these deep learning algorithms excelsthat of the machine learning algorithms tested such as support vector machine, logistic regression, Naïve Bayes, and random forests.

Kinematic Analysis of Ball Speed in Volleyball Spikes using Pose Estimation and Object Detection

Deniz (AJ) E. Mergen, S. Ayca Erdogan
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San Jose State University, San Jose, California, USA

Abstract - This paper presents a low-cost method for analyzing volleyball spiking performance using only a single smartphone camera. We employ pose estimation and object detection to automatically extract key temporal metrics from video, including approach time and jump time. These metrics, along with the player's arm style, are then used in a regression model to predict ball speed and investigate the significance of their effects on ball speed. For model development and validation, a radar gun is used to collect the ground-truth speed data. Our regression model ($R^2 = 0.67$) provides preliminary evidence for a significant interaction between approach time and arm style, indicating a potential dependency between approach time and ball speed that is determined by the player's swing technique.

A Survey of Vulnerabilities and Emerging Defenses in GANs, VAEs, and Transformers

Jothsna Praveena Pendyala, Aman Goyal
Clark University, USA;
Carnegie Mellon University, USA

Abstract - The rapid proliferation of Generative Artificial Intelligence technologies spanning Generative Adversarial Networks, Variational Autoencoders, and Transformer based language models has unlocked novel capabilities across industries. However, this progress has been paralleled by growing concerns around security vulnerabilities, including prompt injection, model inversion, training data leakage, and adversarial perturbations. This poster paper presents a structured review of architectural attack surfaces in leading Generative Artificial Intelligence frameworks and synthesizes existing defense mechanisms such as adversarial training, latent regularization, watermarking, and ensemble filtering. We introduce two conceptual contributions- a proposed Generative Artificial Intelligence Robustness Index for evaluating models across attack coverage, defense overhead, and output quality and a Dual-Layer Defense strategy that integrates training time hardening with inference time safeguards. While empirical benchmarks are beyond the current scope, this work lays the foundation for a comprehensive and systematic framework to advance Generative AI security research and deployment best practices.

Open-source and Institution-specific Research Impact Evaluation via Unsupervised Ranking

Maria Tomasso, Emon Nooruddin, Melinda Villagran
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Department of Computer Science, Texas State University, San Marcos, Texas, USA

Abstract - Evaluation of the impact of research works and identification of high-impact projects allows for researchers and institutions to allocate resources more efficiently and improve research dissemination strategies. Although some proprietary tools for research impact assessment exist, we seek an institution-specific model that is open-source, explainable, and actionable. We frame this task as an unsupervised ranking problem and develop three methodologies to identify high impact works. We build a pipeline to collect a training data set of 25,000 articles published between 2000 and 2024 with at least one author affiliated with a specific institution. Using our framework, we identify three sets of high impact papers using a composite percentile score, Pareto front ranking, and cluster-based ranking. We compare the results of each methodology and conclude with a recommendation for an ensemble approach to the detection of high-impact research papers.

Interpretable, Adaptive, and Robust Online Machine Learning for Data Streams - An Overview and Update

Zhong Chen
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Abstract - In this survey, I will summarize our recent representative research studies towards interpretable, adaptive, and robust online machine learning for data streams with multiple streaming natures, such as skewed distributions, concept drifts, and streaming or mix-typed features, which are four vital components towards intelligent online machine learning. I will also discuss some potential streaming applications for online anomaly detection, and future work on online semi-supervised learning, online label shift learning, online continuous learning, and large language model enhanced online machine learning for data streams.

Explainable AI for Anomaly Detection in Financial Transactions: A Temporal-Pattern-Based Approach for Regulatory Compliance

Bharat Chaturvedi
Independent Researcher, USA

Abstract - The world of financial regulations is getting tougher all the time, and that means we absolutely must ensure transparency in how AI makes decisions for monitoring transactions. This paper introduces a new kind of framework that brings together time-series anomaly detection with explainable artificial intelligence (XAI). The goal? To pinpoint suspicious patterns in financial transactions. We've built a hybrid system that combines Temporal Convolutional Networks (TCNs) and Transformer-based models. These work together to learn how transactions typically behave over time and then spot any deviations that could signal fraud or compliance issues. To tackle that tricky "black box" problem often associated with AI, we've systematically integrated SHAP (SHapley Additive exPlanations) and counterfactual explanations. This lets us interpret what the model is doing, so human analysts and auditors can actually trace why an alert was triggered. We validated our system using both synthetic and semi-real financial datasets, and it showed not only superior detection accuracy but also maintained high interpretability. Our proposed approach is designed to be scalable, robust even when transaction patterns subtly change over time, and can be directly applied to real-time compliance pipelines in financial institutions.

The 4th International Conference on Emergent Quantum Technologies (ICEQT'25: July 21-24, 2025; Las Vegas, USA)

https://qmexico.org/ICEQT2025/
https://american-cse.org/csce2025/

Quamtum Approximate Optimization Algorithm: Applications, Limitations and Enhancement

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Abstract - The Quantum Approximate Optimization Algorithm (QAOA) is a promising quantum algorithm for solving combinatorial optimization problems. However, its efficiency can be limited by the large search space that needs to be explored. This paper proposes an enhancement to QAOA by modifying the initial state to a semi-superposed state, combining prior knowledge and heuristics to collapse some qubits to specific values while leaving others in superposition. This modification reduces the search space, focusing the algorithm on more promising regions of the solution space. We detail the preparation of the semi-superposed state and the application of QAOA operators, including the phase and cost Hamiltonians. We then discuss the benefits of this approach, such as faster convergence, improved solution quality, and reduced computational cost. Performance improvements are evaluated in terms of search space reduction, convergence behavior, and solution quality. The results show that the enhanced QAOA algorithm can find high-quality solutions more efficiently, making it a promising approach for solving large-scale optimization problems on near-term quantum devices.

Quantum-Inspired Clustering Techniques for Malware Detection in Supply Chain Networks

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Abstract - The increasing sophistication of cyber threats targeting supply chain communications in critical sectors like healthcare and manufacturing necessitates advanced detection mechanisms. This paper investigates the application of quantum clustering algorithms for identifying malware within these communication networks. We compare classical clustering techniques (Spectral), classical clustering enhanced with a precomputed quantum kernel, and a novel quantum circuit-based clustering approach. Our methodology leverages the unique capabilities of quantum computing to potentially uncover subtle and complex malware patterns that may be missed by classical methods. We evaluate the performance of these approaches using real-world supply chain communication dataset, highlighting the potential advantages and challenges of quantum clustering in bolstering cybersecurity within these vital industrial hubs.

A Practical Tutorial on Implementing Shor's Algorithm

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Abstract - Wentworth Institute of Technology provides educational programs at the baccalaureate and master's degree levels. The School of Computing and Data Science offers Bachelor of Science degrees in Applied Mathematics, Computer Science, Computer Networking, Information Technology, Cybersecurity, and Data Science, all characterized by a hands-on, skills-focused curriculum.

Recognizing the critical importance of security, all computing programs incorporate relevant coursework. A recent addition to our curriculum is a course dedicated to Quantum Computing with specific emphasis on its security implications. Quantum Computing, leveraging the principles of quantum mechanics, holds the potential to significantly accelerate computations for certain problems, exceeding the capabilities of classical supercomputers. Notably, our course explores Shor's algorithm, among others, which provides an exponential speedup for factoring large numbers compared to classical methods. However, the intricacies of Shor's algorithm present pedagogical challenges when demonstrated in a classroom setting, leading to numerous student inquiries. This paper addresses the theoretical and implementational complexities associated with teaching Shor's algorithm and provides illustrative examples that educators can use, as a guide, to effectively teach and present Shor's algorithm in the classroom.

Quantum Vehicular Ecosystem: Analysis of Emerging Applications and Security Implications

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Abstract - Today's security deployments and implementations heavily rely on cryptographic systems and their underlying infrastructures. In particular, the application of quantum principles is emerging as a significant paradigm in security communication. This manuscript conducts a comprehensive investigation of quantum technologies, specifically focusing on automotive cybersecurity and their numerous applications within a proposed Quantum Vehicular Ecosystem (QVE)—emphasizing the critical need for enhanced security measures and specialized quantum applications in the context of vehicles. This work addresses a significant gap in the existing literature by shedding light on QVEs. We provide valuable insights, including the importance of quantum-like modeling approaches and solutions that can improve vehicular security and their relevant applications.

Hybrid QNN (H-QNN) for Intrusion Detection

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Abstract - Deep learning has been applied to Network intrusion detection. With the advent of quantum technology, quantum neural networks (QNNs) have become the focus of research. Quantum circuits with parameters can extract rich features from raw data. Quantum neural networks (QNNs) is being widely applied to many different areas. This paper proposes a hybrid QNN (H-QNN) model designed for intrusion detection that capitalizes on the strengths of quantum computing and classical neural networks. Our H-QNN model uses a compact, two-qubit quantum circuit integrated with a classical architecture. Our H-QNN model significantly enhances classification accuracy, achieving a ACC of 97.50%, a RE of 87.90%, a PR of 98.71% and a F1 of 97.98% on intrusion detection. The obtained quantitative results exhibit the generalization of our H-QNN for intrusion detection tasks. and makes H-QNN a valuable tool for practical applications.

The 26th International Conference on Internet Computing & IoT (ICOMP'25: July 21-24, 2025; Las Vegas, USA)

https://american-cse.org/csce2025/conferences-ICOMP
https://american-cse.org/csce2025/

A Framework for Improving Network Topology Based on Graph Theory in Software-Defined Networking

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Abstract - This paper presents a novel approach to network topology improvement in Software-Defined Networking (SDN) environments by developing a comprehensive mathematical framework for critical node identification. We introduce the Network Node Significance Index (NNSI), a new mathematical integration of multiple centrality metrics to provide a more accurate assessment of node criticality based on functional significance rather than topological scale. Through extensive experimental evaluation on 261 network topologies from the Internet Topology Zoo dataset, we demonstrate that NNSI consistently outperforms existing methods in identifying truly critical nodes, with an average improvement of 7.61% across all networks and up to 72% in very large networks. Building on this improved critical node identification capability, we develop a topology improvement framework that strategically reconfigures network connections to improve resilience, reduce latency, and improve network resource utilization. Our approach achieves significant improvements across multiple performance metrics, demonstrating its practical utility for network administrators seeking to optimize their infrastructure with minimal changes.

Efficient Non-Linear Primitives for Secure Multi-Party Computation among IoT Devices

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Abstract - Secure multi-party computation (secure MPC) has indeed sparked considerable interest, leading to the development of various algorithms and application ideas. However, its deployment remains limited primarily due to performance bottlenecks inherent in its distributed nature and the associated overhead of data encryption. With the proliferation of Internet of Things (IoT) devices– many of which are resource-constrained–there is an urgent need to revisit secure MPC for practical applications in IoT and edge environments. This paper proposes lightweight and simplified secure MPC primitives specifically designed for these resource-constrained devices, aiming to serve as foundational building blocks for more complex algorithms in the future. We focus on baseline primitives that address critical non-linear operations, including comparison and equality testing, which are known to be significant bottlenecks in secure MPC. Through theoretical analysis, we demonstrate that our proposed protocols exhibit substantial improvements in efficiency, making them suitable for deployment in resourceconstrained settings while ensuring security against semi-honest adversaries. The results indicate that these lightweight primitives not only mitigate performance limitations but also enable secure computations across a variety of applications in IoT and edge environments. We envision that this work will pave the way for the broader adoption of secure MPC in scenarios where computational resources are limited, making secure collaborative computation a viable option for a diverse range of IoT uses.

Visualization and Monitoring System for Autonomous Vehicles

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Abstract - The advent of Autonomous Vehicles (AV's) brought a new dimension to the field of automobile industry. The present-day technologies like IoT, Vehicular Ad Hoc Networks (VANET) are shaping the future of self-driving cars. Autonomous cars are aiming at navigating and drive through the cities and roads without drivers. Self-driving cars visualize the roads from the data images captured by the cameras and the sensors. However, weather conditions and obstacles where the vision is not clear can challenge the self-driving cars in harsh conditions. We propose using Inertial Navigation Systems (INS) to navigate safely and securely the AVs to manage with most conditions. The INS technologies are used in the submarines and even in flights for navigation purpose where there is no visual images are available. We propose using similar techniques for AVs. We investigated whether this approach could be used and be integrated with VANETs to communicate among other autonomous on the roads to achieve clear visualization of the traffic. The integration of IoT with VANETs in self-driving cars with INS monitoring could assist most potential scenarios on the roads, like accidents, traffic congestion, and sudden obstacles and share the information with the fleets of vehicles. This clustered sharing of the data and diagnostics assist the control systems to navigate the self-driving cars safely under adverse conditions.

SLO-FEI: A Novel Secure and Lightweight Offloading Approach for Fog-Edge Federation-Based IoT

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Abstract - The Internet of Things (IoT) has rapidly evolved into a fundamental technology in modern life. However, IoT devices often struggle with computationally intensive tasks due to limited processing capabilities. Offloading such tasks to fog or edge nodes can alleviate this burden,s but ظintroduces significant computational and communication costs. Moreover, the inherent vulnerabilities of wireless communication channels expose IoT systems to active and passive security threats during the offloading process. We propose SLO-FEI, a lightweight and secure offloading approach designed for IoT environments to address these issues. The approach utilizes Elliptic Curve Cryptography (ECC) to provide mutual authentication and secure session key establishment between communicating entities, ensuring data confidentiality and integrity during task delegation. We evaluate the SLO-FEI approach's security using formal methods and informal analysis. The results demonstrate strong resistance to a wide range of potential attacks. Additionally, we compare SLO-FEI with a related existing approach in terms of computational and communication overhead and security features. Our findings indicate that SLO-FEI achieves enhanced security with reduced overhead, making it a cost-effective and reliable solution for secure offloading in resource-constrained and wireless-vulnerable IoT scenarios.

Carbon Flexing for Individual Households - A Study Based on Electrical Carbon Data

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Abstract - De-carbonising our electricity should be one of the leading steps to overcome climate changes and positively impact the environment in which we operate in the twenty-first century. This topic, which was widely explored by the production sector, has been outside the reach of individual households. Due to the high costs, decarbonisation could only happen through significant investments such as solar panels. This paper explores the possibility of reducing carbon usage not via high investments but via shifting the electricity load to less carbon-intensive grid electricity hours. Therefore, it enhances the fact that electricity on the grid can come from various sources at any given time, and it is better to use high-renewable intensive loads. The project explores

both the social willingness to participate in such a shift, the response to automation, and the quantitative potential that could arise from such practices. This study aims to assess the quantitative potential and user willingness to participate in carbon reduction of individual households. The carbon reduction, that was measured, is achieved by flexing user usage to times during the day when grid energy comes from primarily renewable sources. The mixed method with user-centered study used data that was collected via questionnaire and quantitative assessment of pre-exited dataset. Carbon flexing potential quantified between 5-11%. Overall, there is a high willingness to participate in carbon flexing. This study underscores the importance of integrating automated approaches to flexing energy consumption. By ensuring the convenience of automated adjustments, households can achieve significant carbon savings. The findings contribute valuable insights into the design of effective carbon reduction strategies and highlight the role of user participation in achieving sustainability goals.

A Systematic Literature Review on Secure Extraction of Multiple Features for Privacy Protection in Wearable Medical Devices

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Abstract - Wearable medical devices and technologies are widely accepted and increasingly employed for continuous authentication and monitoring, with electrocardiograms (ECG)-based biometrics emerging as a reliable method in telehealth and telemedicine. This study reviews current advancements in electrocardiogram-based biometric authentication applications, with a primary focus on deep learning methods, privacy-protection frameworks utilising federated learning, and self-supervising approaches. A systematic literature review was conducted, gathering studies from IEEE Xplore, MDPI, and Google Scholar databases, using PRISMA guidelines. The findings reveal significant enhancements in method accuracy and performance, despite challenges in real-time deployments, privacy considerations, data inconsistencies, and the computational limitations of edge devices. The review also identifies research gaps and suggests potential areas for developing secure, effective, and generalisable biometric systems for wearable medical devices and technologies.

Edge Fluent: How AI, IoT, and Small Language Models (SLMs) Are Powering Inclusive ESG Platforms for a Sustainable Future

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Hanumayamma Innovations and Technologies PVT Limited, Hyderbad, India;
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Abstract - This paper presents a novel Environmental, Social, and Governance (ESG) - centric IoT Edge architecture that integrates lightweight natural language processing models - specifically a fine-tuned, multi-label DistilBERT - to enable inclusive, real-time decision support for smallholder farmers in the agri-dairy sector. Addressing one of the most pervasive barriers to sustainability - language accessibility - the system empowers non-English-speaking and low-literacy farming communities with context-aware, regionally adapted insights across environmental, social, and governance (ESG) domains. By deploying the DistilBERT model on resource-constrained edge devices co-located with IoT sensors, the platform can classify ESGrelevant queries, translate regulatory or agronomic knowledge into local dialects, and support actionable interventions such as methane tracking, feed optimization, animal welfare monitoring, and climate resilience strategies. The architecture is optimized for offline inference, low-power environments, and multimodal sensor inputs, ensuring operational viability in underserved rural areas. This approach not only democratizes access to ESG intelligence for marginalized populations but also enables data harmonization and traceability required for Scope 1, 2, and 3 emissions reporting, sustainable certification, and precision agriculture. The solution has been validated through real-world deployments in dairy farms with multilingual farmer interfaces and Class 10 veterinary sensors. Ultimately, the ESG IoT Edge with DistilBERT redefines sustainability by embedding AI-driven language inclusion at the core of climate-smart agriculture, advancing both technological equity and the achievement of UN Sustainable Development Goals (SDGs).

Placement of Distributed Machine Learning Services for AI and Smart Grid Enabled IoT Platform

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Abstract - Artificial intelligence, fog computing, and smart grids allow for better energy management and personal data control. However, such a heterogeneous platforms complexify service placement due to hardware and network heterogeneity. This paper proposes a distributed machine learning service for fog computing platforms model, and two new algorithms that aim to reduce time and energy consumption. The first algorithm groups services geographically, while the second places services vertically in the topology to reduce network usage. The Batsim simulator have been used to deploy distributed AI applications for measuring their duration and energy usage of the fog architecture. Results show that the first algorithm induces higher time and energy consumption than the second one, which outperforms multiple baseline algorithms for both metrics.

Energy Consumption of TinyML-based Intrusion Detection System for Nano-Sized UAVs

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Abstract - With the growing integration of nano-sized Unmanned Aerial Vehicles (UAVs) into Internet of Things (IoT) applications, ensuring their security against cyber threats under limited computational and energy resources has become a significant challenge. This work empirically investigates the feasibility and energy consumption of deploying an Intrusion Detection System (IDS) on the Crazyflie 2.1 using Tiny Machine Learning (TinyML). Supervised Machine Learning (ML) models are trained using Python's Scikit-learn library and converted into efficient C code using the emlearn framework for embedded deployment. The converted models are integrated into the Crazyflie firmware to enable real-time, on-device inference without relying on external communication or cloud resources. Energy consumption is estimated based on the inference times of the deployed ML models. The results demonstrate the viability of TinyML-based security mechanisms for enabling real-time, energy-efficient intrusion detection on nano-sized UAVs.

Design and Verification of a CanSat Rover Remote Control System Using Cloud and MQTT Communication

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Abstract - The purpose of this study is to design and develop a remote-control system for a CanSat rover utilizing cloud technology and MQTT communication. MQTT, a lightweight protocol with excellent real-time performance, is employed to enable bidirectional communication—transmitting data collected from GPS and onboard sensors while receiving control commands based on that data. Field experiments were conducted on a university futsal court to evaluate the system's performance in terms of navigation accuracy toward a designated goal and communication stability.

Deep Reinforcement Learning for Resource Management in 5G-Enabled IoT Networks: A Comprehensive Survey

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Abstract - The rapid adoption of 5G-enabled Internet of Things (IoT) devices has created substantial challenges in resource management due to the diverse range of applications and massive connectivity requirements. Efficient resource allocation is crucial to ensure high-quality service, reduce latency, and maintain sustainable IoT network operations, especially in complex and dynamic environments. This paper explores how reinforcement learning (RL) techniques, particularly deep reinforcement learning (DRL), can address these challenges by optimizing resource allocation in 5G-enabled IoT networks. By reviewing existing research, this study identifies key challenges, evaluates current solutions, and proposes potential future directions. It highlights the significant potential of DRL to enhance resource efficiency and cater to the evolving demands of 5G-powered IoT ecosystems.

Express Dialer 2

Dwight Deugo
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Abstract – As we age, our cognitive abilities can both improve and decline. Declines can include the abilities of reasoning, attention span, memory and processing speed, each having different impacts on how we are able to complete tasks. Older mobile devices users often find these declines make it difficult to use their devices. Given a major use of mobile devices is the ability to call other people, the goal of this work is to simplify the mobile dialing application and hardware to enable an aging population to make a make a call quickly and easily.

Blockchain in Agriculture

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Abstract - Blockchain is a distributed ledger system for recording and storing transactions. At its core, blockchain is simply a software which creates a ledger of accounts, also known as a database, whose transaction history is very difficult to change. Blockchain technology, once solely associated with cryptocurrencies, is now being hailed as a game-changer for the agricultural industry, offering the potential to enhance transparency, traceability, and efficiency in supply chains. Blockchain technology in agriculture allows for secure and verifiable record-keeping of agricultural transactions, helping to build trust and reduce fraud. It offers farmers a way to improve transparency, streamline operations, and access new markets. The blockchain can bring transparency to agricultural financial transactions, credit history, and financial agreements for smallholders who want to invest in farming. This paper explores the integration of blockchain technology in the agriculture industry.

ICM9220
Societal Impact of Technology on Wellbeing and Cohesion

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Abstract - Several challenges such as cyberbullying, digital divides, and erosion of traditional community structures are introduced by digital advancements in the enhancement of information connectivity and accessibility. The multifaceted effects of technological advancement on societal wellbeing and cohesion were explored in this paper. Likewise, both the positive and negative impacts of technological advancement on individual wellbeing and social dynamics were examined in the paper by drawing on specific insights and global studies from Africa. Moreover, this paper is prepared and intended as a foundational summary of the societal impact of technology on wellbeing and cohesion.

The 24th International Conference on Wireless Networks (ICWN'25: July 21-24, 2025; Las Vegas, USA)

https://american-cse.org/csce2025/conferences-ICWN
https://american-cse.org/csce2025/

AODV-M: The AODV Modified with Link Quality Prediction for WSN

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Abstract - With the expansion of wireless IoT networks, efficient data routing has become essential to ensure optimal performance. The Ad hoc On-Demand Distance Vector (AODV) protocol is used for routing in ad hoc networks but has certain limitations, particularly its reliance on hop count for route selection. This issue, known as the data routing problem, is exacerbated by many factors, including frequent link breaks. Therefore, improving routing stability becomes crucial. In this work, we propose an enhanced version of the AODV protocol by integrating link quality prediction into the data routing process. The proposed Modified AODV protocol (AODV-M) operates through five key stages. The link quality prediction model is incorporated into the data routing process to improve route selection. The simulation results show that AODV-M manages higher traffic volumes with higher packet delivery rates, and the jitter increases slowly compared to the standard AODV protocol. We conclude that AODV-M is suitable for high-mobility networks with better quality of service.

Designing a Biorobotic Wireless Sensor Paradigm for Soil and Crop Monitoring

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Abstract - This paper introduces a novel biorobotic wireless sensor paradigm designed for advanced soil and crop monitoring in precision agriculture. By integrating bio-inspired sensing—mimicking plant roots and insect antennae—with autonomous mobile robotics, the system achieves real-time, non-invasive environmental assessment. It measures soil moisture, nutrients, temperature, and plant health while intelligently adapting through machine learning. Wireless data transmission supports cloud-based analysis and decisionmaking. Field trials validate its ability to deliver high-resolution, spatiotemporal insights essential for efficient irrigation, fertilization, and crop care. This paradigm offers a sustainable, adaptive alternative to conventional sensors and sets the stage for biologically inspired, scalable technologies in smart farming. Future developments will expand biosensing diversity and robotic collaboration.

Sensor Data Synchronization in Wireless Sensor Networks with Unsynchronized Local Clocks

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Abstract - In a wireless sensor network, sensor nodes transmit sensor data with information about detected events including local clock values at times when occurrences of the events are detected to a fusion center. The sensor data is stored in a database and analyzed. Since local clocks in wireless sensor nodes are usually not synchronized precisely due to unexpectable transmission delay of control messages for clock synchronization which requires high communication overhead, this paper proposes sensor data synchronization which adjust the local clock values associated to stored sensor data. For local clock value adjustment, this paper proposes a novel method based on estimation of relative skew and offset between local clocks in neighbor wireless sensor node whose observable areas are overlapped. Here, estimation of commonly detected events by the wireless sensor nodes is a key technique. By our proposed method, with no additional communication overhead, local clock values are consistently adjusted to analyze their temporal relations such as precedence ones.

A Base Station Energy Saving Strategy Integrating Multi-Agent Reinforcement Learning and Load Balancing

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Abstract - With the rapid increase in network usage, the number of base stations has risen sharply, leading to a significant rise in energy costs. As a result, network energy efficiency has become a growing concern. This paper uses Multi-Agent Reinforcement Learning (MARL) to make base station switching decisions, turning off base stations during low traffic periods to reduce power consumption. Additionally, a load balancing mechanism is introduced based on the switching decisions, further optimizing the overall network energy consumption.

Segment-Based Protection Techniques in Segment Routing

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Abstract - This study proposes a segment-level protection mechanism based on Segment Routing (SR) to improve failure recovery in ultra-low latency networks, addressing the limitations of traditional IP Fast Reroute (IPFRR) at the Point of Local Repair (PLR). Unlike conventional methods, our approach applies protection to each segment of the end-to-end path and considers node failures. Simulation results show that increasing the Segment List Depth (SLD) effectively reduces packet loss by up to 28.61% and reduces path length by up to 8.59%, demonstrating enhanced network resilience and resource efficiency.

Bandwidth Slicing Analysis under Abnormal Traffic using a Digital Twin Framework

Tai-An Wu
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Abstract - This study implements a network simulation system that integrates Digital Twin (DT) and Network Slicing (NS) technologies. By synchronizing physical network traffic into a Mininet environment on a virtual machine, users can simulate and analyze network behavior without affecting physical devices. The system captures ICMP packets, converts them into JSON format, and transfers them to the DT virtual machine, where the traffic is reproduced. Users can customize abnormal traffic patterns, such as packet size and count, and apply different NS configurations to compare network performance. This approach allows realistic traffic simulation and helps identify optimal bandwidth allocation strategies, enhancing network management and user experience.

The 24th International Conference on Information & Knowledge Engineering (IKE'25: July 21-24, 2025; Las Vegas, USA)

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https://american-cse.org/csce2025/

Ontology Driven Fake News Detection for Post Disaster Management

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Abstract - Fake news during disaster events can cause public panic, erode trust in authorities, and trigger misinformation-driven responses. Traditional credibility-based detection models rely on social credibility metrics such as source reputation, user behavior, and content popularity, but often lack semantic fact-checking and the ability to detect contextually paraphrased misinformation. This paper presents an enhanced hybrid model that incorporates ontology-based semantic validation into the Veracity architecture. The algorithm extracts structured knowledge from a domain-specific disaster ontology and computes semantic similarity using Sentence-BERT embeddings. This validates whether incoming messages align with factual disaster events. Using a balanced dataset of real and fake disaster news, the model achieved 86% accuracy with high recall for real messages and high precision for fake messages.

Secure Password Management System (SPMS) using One-Time Pad (OTP)

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Abstract - This study is focused on the development of a highly Secure Password Management System (SPMS) through the utilization of advanced cryptographic techniques aimed at enhancing password management, security, and storage. Static encryption keys have been relied upon by traditional password managers, rendering them vulnerable to data breaches and cryptographic attacks. In this research, Argon2 hashing is implemented for master password authentication, HMAC-SHA256-based One-Time Pad (OTP) key generation is applied for unique password encryption, and XOR encryption is employed to improve storage efficiency. Confidentiality, integrity, and robust protection against brute-force attacks are ensured by this combination of cryptographic methods. Additionally, efficient storage and retrieval of encrypted passwords are provided by employing a lightweight NoSQL keyvalue storage system (Replit Database). The effectiveness of the system is demonstrated through simulated implementation, with the security and usability of the proposed password manager being confirmed. Also, the performance analysis shows that the proposed system outperforms three other existing systems as compare in terms of encryption and computational overhead and estimated time require to evade regular GPU-based attached. Future improvements are expected to include the development of a graphical user interface (GUI) and the enhancement of performance for larger dataset.

A Quality-Focused Performance Evaluation of SQL over Large Language Models

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Abstract - Large Language Models (LLMs) have revolutionized how we explore large unstructured data using Natural Language prompts. They have been shown capable of supporting a variety of tasks in the database domain. However, LLMs are not designed to process data directly from the database. In this paper, we address the problem of evaluating SQL queries using a DB-first approach that provides seamless access between SQL and LLMs data sources. Our main contribution, called Galileo, combines Retrieval-Augmented Generation, a divide-and-conquer planning strategy, heuristic optimizations, and operator-cost estimation to generate and execute optimized SQL query plans across LLMs and traditional relational databases. We performed an experimental study on the ATIS (Airline Travel Information System) benchmark considering different query complexities. The results show that Galileo achieves higher precision and recall than a state-of-the-art solution when evaluating SQL queries over LLMs. Galileo improves the overall quality of the results by providing more relevant contextual information and the query plan.

Multi-LLM Record Linkage: A Comparative Analysis Framework for Co-Residence Pattern Discovery

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Abstract - Record linkage or Entity resolution for co-residence pattern identification presents unique challenges that often exceed the capabilities of traditional approaches, particularly when dealing with poor data quality and format heterogeneity. This paper introduces an innovative multi-LLM framework that leverages the complementary strengths of three state-of-the-art large language models—Gemini 2.0, GPT-4o, and Mistral Large—to identify household movement patterns with unprecedented accuracy. Our system employs a meta-evaluation architecture where a fourth "judge model" critically assesses and synthesizes individual outputs, enabling significant reductions in both false positives (62%) and false negatives (41%) compared to the average of individual models. Experimental results on the challenging s12px dataset demonstrate that our approach achieves 92.4% accuracy, outperforming the best single model by 4.8%. This research directly extends previous work on entity resolution with LLMs by addressing the reliability limitations identified in single-model approaches. While currently implemented as a research prototype with scale, the architecture could be adapted for enterprise environments using locally deployed models to maintain data sovereignty. The framework represents a significant advancement in computational social science methodology, with implications for demographic research and public health applications requiring precise household movement discovery.

Visualizing Human Trafficking and Criminal Networks: A Systematic Mapping Study

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Abstract - Human trafficking is a widespread global crime characterized by decentralized and hidden networks. Addressing this challenge requires not only identifying key individuals but also understanding the structural and temporal dynamics of trafficking operations. This systematic mapping study reviews existing visualization techniques and tools designed to support the analysis of

human trafficking data. From an initial set of 519 records, 15 primary studies were selected for a detailed analysis. These studies were examined in three dimensions: data types, visualization approaches, and tool functionalities. Our findings indicate a strong reliance on graph-based and spatio-temporal visualizations, but also reveal significant gaps in data integration, usability, and empirical evaluation. The results underscore the need for more interoperable, accessible, and useroriented visualization solutions to enhance investigative and preventive efforts.

LOD (Level Of Detail) Based Optimized Privacy-Preserving Navigation

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Abstract - This study proposes an integrated framework based on LOD (Level of Detail) to simultaneously achieve personal privacy protection and efficient data processing in drone navigation systems. The core of the framework is to minimize unnecessary personal information collection by differentially processing landmarks in high resolution (LOD 4) and surrounding areas in low resolution (LOD 0-2) through a dynamic LOD allocation algorithm. For route optimization, *A algorithm extension** is applied to perform route planning that reflects privacy risk (λ=1.5) in the cost function. In terms of communication security, lightweight hybrid encryption is introduced to hierarchically apply AES-256-GCM and ChaCha20 according to data importance, and HMAC-SHA256-based integrity verification is integrated. The proposed system automatically limits the LOD level when the remaining battery level is less than 30% through a real-time dynamic adjustment mechanism, thereby ensuring resource efficiency.

Multilingual Customer Record Linkage: A Novel Approach Using LLMs for Cross-Lingual Entity Resolution

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Abstract - This paper presents a novel approach to multilingual customer record linkage using Large Language Models (LLMs), specifically Google's Gemini model. The system addresses the challenge of identifying duplicate customer records across different languages, a critical problem in global enterprises with international customer bases. By leveraging the advanced semantic and syntactic understanding capabilities of LLMs, our approach performs entity resolution across language barriers without requiring explicit training on bilingual dictionaries or parallel corpora. Gemini and similar modern LLMs can understand more than 80 languages covering nearly every major language globally, enabling unprecedented coverage for cross-lingual entity resolution. The system is implemented as an interactive web application using Streamlit, allowing users to upload customer data and query potential matches in realtime across multiple languages, with demonstrations focusing on English, Spanish, Mandarin, and Arabic. Our experimental results suggest LLMs can effectively serve as cross-lingual entity resolution tools with up to 95% accuracy in identifying cross-language duplicates, offering a flexible and comprehensive alternative to traditional record linkage systems that typically struggle with multilingual data.

Data-Driven Transformation: The Role of Analytics and Visualization Champions in Organizational Digital Maturity

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Abstract - The article looks into how crucial champions of analytics and visualization are to achieve higher digital maturity in organizations. Through a mixed-methods approach, including case studies and surveys, the study investigates how leadership in analytics and visualization fosters an organization's ability to leverage data for strategic decision-making, process optimization, and enhanced innovation. Based on the results, organizations with people focused on analytics and visualization improve their

decision-making, become more efficient, and agile. Champions close the gap between big data and the rest of the organization by propagating the use of data and integrating latest analytics tools in how workers do their jobs. In addition, the study points out that not everyone is eager to change and that there are not enough skilled experts, which keeps data-driven transformation from fulfilling its full potential. It is recommended in the article that empowering analytics and visualization leaders is vital for any group working towards being more digitally advanced, providing suggestions for improvement.

The 29th International Conference on Image Processing, Computer Vision, & Pattern Recognition (IPCV'25: July 21-24, 2025; Las Vegas, USA)

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Enhancing Time Series Clustering and Classification via Order-Preserving Wasserstein Distance, Local Fourier Approximations, and Ensemble Learning

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Abstract - Time series clustering and classification remains a fundamental problem in many scientific and industrial domains, where the goal is to classify temporal patterns effectively and robustly. In this work, we introduce a novel approach, OPW-FA, an optimal transport based distance measure, which integrates the global alignment capabilities of Order Preserving Wasserstein distance with binned Fourier approximation of subsequences to capture both global and local temporal characteristics of time series data. We further propose an ensemble variant, EnOPW-FA, which aggregates multiple OPW-FA distances with diverse parameter settings to an ensemble classifier via majority voting, enhancing robustness across datasets with different characteristics. Through experiments on a subset of 30 datasets from the UCR Time Series Classification Archive, we demonstrate that OPW-FA achieves competitive accuracy compared to state-of-the-art methods such as ShapeDTW, BOSS, and standard OPW, while the ensemble variant further improves performance. A sensitivity analysis of OPW-FA's parameters, such as bin sizes, window size ratios, step size ratios, and the number of Fourier coefficients, provides practical guidance for parameter tuning.

Morphological Component Analysis for Micro-Doppler Signal Decomposition in Outdoor Environments

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Abstract - With the growing frequency and diversity of threats targeting critical infrastructure, rapid and reliable intrusion detection has become essential. While video surveillance systems such as CCTV are widely used, radar-based solutions offer key advantages, including longrange detection and robustness to poor visibility conditions. Among these, micro-Doppler (mD) signature classification has gained significant attention, primarily focusing on binary human detection using either feature-based or deep learning approaches. However, such methods often lack generalizability and adaptability to complex environments or diverse object types. This study introduces a hybrid knowledge-based framework for mD signature interpretation. The approach commences with a morphological decomposition of mD signals in outdoor environments, thereby enabling the identification of sub-signal components.

Comparing Human Fall Detection Algorithms of Millimeter-Wave Radar Among MobileViT, RepLKNet and tinyViT Networks

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Abstract - The contactless detection of human falls utilizing millimeter-wave radar has gained considerable attention due to its advantages of convenience and high efficiency. This technology holds substantial promise for applications in smart home technologies and intelligent medical systems, and has recently emerged as a key research area. This paper investigates the precise detection of human falls by employing feature spectrograms derived from millimeter-wave radars. Specifically, the IWR1843 radar board captures radar echoes resulting from human falls and conducts a detailed time-frequency analysis of these echoes. Through rigorous data preprocessing, distance-time motion (RTM) and Doppler-time motion (DTM) spectrograms are extracted to furnish a comprehensive representation of human movement characteristics. An innovative integrated feature spectrogram (DTM-RTM) is then formulated to discriminate between six distinct human movements, including three types of falls and three non-fall activities. The performance of three convolutional neural network models—MobileViT, RepLKNet, and TinyViT—was assessed, with each model achieving an outstanding accuracy rate exceeding 98%.

Evaluating Open-Source Pretrained Models for Natural Disaster Response

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Abstract - Natural disaster response generates large amounts of unstructured visual and text data. This data is often underutilized due to the lack of structured metadata and automated indexing mechanisms. This presents a significant issue during an active disaster response, when time is severely limited and personnel must rapidly find relevant information to make time sensitive decisions. The rapid rise in the application of multi-modal artificial intelligence has led to a flourishing of many open-source models aimed at addressing this challenge. This paper evaluates the performance of four open-source generative models for generating text descriptions of disaster imagery collected over several years of U.S. disaster response. Through a comparative analysis across this dataset, this study highlights the strengths and limitations of each model and discusses their potential to enhance situational awareness, improve knowledge management, and support real-time decision-making in disaster environments.

An Empirical Study on Underwater Image Enhancement for Robust Instance Segmentation

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Abstract - Underwater vision is critical for applications such as marine engineering, aquatic robotics, and environmental monitoring. However, severe image degradation—caused by light absorption, scattering, and backscattering—often hampers visual recognition tasks. While underwater image enhancement (UIE) is intuitively expected to improve recognition by restoring visual quality for human perception, the extent of its actual impact on automated computer vision, particularly segmentation, remains underexplored. This study systematically evaluates a range of UIE algorithms, spanning both traditional methods and state-of-the-art (SOTA) deep learning approaches, to assess their effects on underwater instance segmentation. We applied these enhancement techniques to the UIEB benchmark dataset and conducted comprehensive qualitative and quantitative analyses of the enhanced images. Subsequently, a widely used segmentation model, Fishial.AI, was employed to evaluate segmentation performance on both raw and enhanced image sets. Experimental results reveal that existing UIE methods yield promising

improvements in segmentation accuracy. These findings provide valuable insights into the role of image enhancement in underwater vision and highlight important considerations for the design of future enhancement algorithms.

Multi-Classification for Specifying the Gender for Adults and Children Using the Resnet-18 Architecture

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Abstract - Image classification is one of the basic primary keys in computer vision tasks. As classification techniques continue to evolve, classifiers need to accurately classify into multiple classes. This study examines the performance of Residual Network (ResNet) for multi-class image classification using an augmented dataset of 2,500 images across six categories: adult, male, female, child, boy, and girl. The model was designed to assign multiple class labels to a single image, which may contain one or more objects, thereby facilitating multi-class classification. The ResNet18 model was trained for 50 epochs and achieved an accuracy of 0.82 for multi-class predictions. However, the model faced challenges in certain scenarios due to limitations within the dataset. The evaluation demonstrated that the classifier performed reasonably well, but it struggled with ambiguous cases, resulting in errors. The ResNet-18 model developed in this study can be effectively combined with smaller or more compact object detection algorithms to classify detected objects into multiple classes without affecting the real-time performance.

Low-light Video Enhancement Using Attention-based Deep Neural Networks

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Abstract - In this study, a low-light video enhancement approach using attentionbased deep neural networks is proposed, which consists of encoder, feature propagation module, decoder, look-up table (LUT) generation module, intensityaware transformation module, and denoising module. Encoder is utilized to extract spatiotemporal information from low-light video frames, feature propagation module is utilized to capture long-term spatiotemporal correlations, decoder is utilized to decode propagation feature maps into intensity maps, LUT generation module is utilized to generate transform tables, intensity-aware transformation module is utilized to perform finer color transformation, and denoising module is utilized to further enhance the quality of video frames. Based on the experimental results obtained in this study, in term of two objective performance metrics and subjective evaluation, the performance of the proposed approach is better than those of four comparison approaches.

Optical Flow Estimation Using Transformer-based Deep Neural Networks

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Abstract - In this study, an optical flow estimation approach using transformerbased deep neural networks is proposed, which consists of spatial feature extraction module, recurrent feature extraction module, matching feature module, coarse matching module, context feature encoding module, context attention module, and recurrent module. Two feature extraction modules extract spatiotemporal features from video frames, matching feature module enhances extracted spatiotemporal features for computing pixelwise correspondences, coarse matching module estimates the initial optical flow, and context feature encoding module and context attention module extract object-level features and propagate motion features to occluded regions, respectively. Finally, recurrent module performs iterative optical flow refinement and generates the final optical flow by upsampling. Based on the experimental results obtained in this study, in terms of three objective performance metrics and subjective evaluation, the performance of the proposed approach is better than those of six comparison approaches.

Appearance-Based Gaze Estimation with Deep Learning for Interactive Digital Signage

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Abstract - The human gaze is a powerful cue for determining the subject of a person's attention. Therefore, the process of estimating a gaze is a crucial component of many human-machine interfaces, providing a more interactive and personal experience. Recent research has demonstrated that deep learning-based approaches to gaze estimation remain highly accurate across a wide range of subjects in unconstrained environments, allowing the technology to be used in a wide range of applications that traditional gaze estimation methods struggle with. One such application for this technology is the growing digital signage industry. This paper proposes the use of real-time deep learning-based gaze estimation in digital signage applications to create a more engaging user experience.

Advanced Anomaly Detection in PV Solar Cells: Leveraging Vision Transformers (ViT) and Machine Learning for Enhanced Fault Diagnosis

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Abstract - Rapid adoption of photovoltaic (PV) solar cells necessitates robust methods for anomaly detection and fault diagnosis to ensure optimal performance and longevity. This paper presents a comprehensive approach to identifying anomalies in PV solar cells using a combination of deep learning and machine learning techniques. We used a comprehensive data set comprising 1,91 validated images in two classes to train our model. We employ a Vision Transformer (ViT) model, specifically the ViT-B16 architecture, to extract high-dimensional features from images of PV cells, achieving a training accuracy of 100% and a validation accuracy of 88.89%. Furthermore, we explore the efficacy of the Decision Tree classifier, which shows exceptional performance with testing accuracies of 99.16%. Our results, validated through t-SNE visualizations and confusion matrices, highlight the potential of these methods to accurately detect and classify anomalies in PV systems. This study not only advances the field of photovoltaic anomaly detection but also provides a scalable and efficient framework for real-world applications.

Smart Computer Vision System for Real-Time Monitoring of Car Parking Duration Using YOLOv7 and Deepsort

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Abstract - Object detection is a critical field in computer vision that focuses on recognizing and locating various objects within images or video streams. This study utilizes the advanced object detection model You Only Look Once version 7 (YOLOv7) to identify vehicles in a designated parking area. To enhance this capability, we integrate a tracking algorithm known as Deep Simple Online and Realtime Tracking (DeepSORT), which allows for continuous monitoring of parked cars and supports the detection model in maintaining identification for as long as necessary. The YOLOv7 model has been trained with data augmentation techniques, achieving an impressive evaluation score of 0.86 in vehicle detection accuracy. The DeepSORT algorithm is responsible for tracking any cars entering the parking zone, triggering a timer that records the duration of each vehicle's occupancy in the parking space. The system provides a clear display of information by indicating the status of each parking space in the upper right corner of the video feed. This displayed information specifies whether each space is occupied or available. A help function has been incorporated, enabling users to capture coordinates of any pixel within the video to assist in accurately mapping parking spots. Evaluation results reveal that the system effectively detects and tracks parked cars for up to 200 seconds across two distinct scenarios. Additionally, to assess real-time performance, we provide an Average Frames Per Second (Avg FPS) metric displayed in the upper left corner, with the system recording a remarkable 32.1 FPS. This comprehensive approach combines robust detection and tracking capabilities, resulting in an efficient and user-friendly parking management solution.

Detecting Canine Cataracts: A Deep Learning and Clustering Approach

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Abstract - Canine cataracts, which are caused by factors such as genetic predisposition and metabolic irregularities, can lead to complete blindness if not diagnosed early. The project simplifies the diagnosis through photos, helping dog owners. Despite the varied clustering techniques explored during the project, the 3-cluster test showed promising results in cataract identification. It is crucial to note that definitive diagnoses should always be performed by specialists. In the material and methods section, a heterogeneous dataset of dog eye images was used, employing the Ultralytics library and the YOLOv8n model for training. The process included cropping eyes, resizing images, and extracting features with a pre-trained VGG16 model. Principal Component Analysis (PCA) reduced dimensionality, and the K-Means clustering algorithm categorized the data. The results show that the eye extraction process achieved 99.7% precision and 97.4% recall. Evaluation through the Elbow Method and Silhouette Analysis identified the three-cluster configuration as the most effective in distinguishing visual patterns within the dataset. The discussion emphasizes the feasibility of employing Deep Learning for cataract detection, though acknowledging the need for further precision refinement. The project has potential as a tool for dog owners, pending clinical application refinement.

Near Real-Time Dust Aerosol Detection with 3D Convolutional Neural Networks on MODIS Data

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Abstract - Rapid identification of dust storms is vital. We present a near real-time system using MODIS Terra and Aqua multispectral data. Preprocessing applies min–max normalization and local imputation for missing values. Our 3D convolutional network uses three blocks with batch normalization, pooling, and a weighted MSE loss emphasizing high-intensity regions. The optimized variant employs memory-mapped I/O, precomputed index sampling, large batches, torch.compile and mixed precision, achieving a 21× training speedup on A100 GPUs. Evaluated on 17 granules, 3DCNN+ attains 0.92 accuracy and an MSE of 0.014. This pipeline enables scalable pixel-level monitoring of dust events and lays groundwork for transformer extensions.

Deep Learning Approach for Detection of Facial Emotional Recognition

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Abstract - In recent years, Facial Emotional Recognition (FER) has garnered significant attention for its pivotal role across various applications, including human-computer interaction, healthcare, and sentiment analysis. This study is motivated by the need to enhance the accuracy and efficiency of FER systems, with a particular focus on leveraging Convolutional Neural Networks (CNNs) featuring dense architectures. Charles Darwin's groundbreaking work on facial expressions as indicators of human emotional states inspires this research, which aims to elevate FER systems for applications spanning therapy, human-machine interactions, and diverse domains like healthcare, education, and entertainment. While previous studies have recognized CNNs' ability to improve FER accuracy through intricate feature extraction, the evolving nature of the field calls for exploring novel CNN architectures and techniques to further enhance precision and efficiency. In this study, we develop and implement a deep learning model capable of

classifying images into seven discrete emotion categories, representing universal human emotions. This objective is achieved by implementing a five-block CNN-based learning algorithm consisting of 44 layers designed to progressively capture complex facial features and expressive patterns. The CNN model performed well on FER and FERG datasets, with accuracy rates of 0.97 and 0.98, showcasing proficiency in facial expression classification. Comparative analysis highlighted its competitive accuracy, emphasizing the importance of feature extraction and architecture design. This research advances facial emotion recognition, offering potential real-world applications like affective computing and human-computer interaction.

R-C-P Method: An Autonomous Volume Calculation Method Using Image Processing and Machine Vision

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Abstract - Incorporating 3D sensors into the system results in increased power consumption, larger volumes of data, and physical space. This study was motivated by a desire to obtain real-time volumetric data and study information with multiple 2D cameras. Two cameras were used to measure the dimensions of a rectangular object in real time. The row-column-pixel (R-C-P) method was presented using a 2D camera and three rectangular surfaces at the same distance. The R-C-P method also detects discontinuous edge volume. The relationship between the actual dimension and the dimension output by the R-C-P method is established as the distance gradually increases. The results obtained best illustrated the R-C-P method, providing equations to calculate the rectangular object's surface area dimensions.

Measuring Light Attenuation via Paper Materials Using Image Processing, and an Application Concept

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Abstract - Energy loss prevention in buildings continues to be an important subject as it impacts climate control and cost associated with used energy necessary to maintain the desired temperatures in closed spaces. Despite insulation methods used during permanent construction, highest energy loss occurs through windows. Materials research and design inventions have improved energy conservation through windows; however, some of the existing implementations may still be relatively costly. For example, double/triple-glazed windows in buildings, to polarization-controlled windows now seen on some aircrafts serve as effective insulators, but are expensive to install. The purpose of this project was to investigate the use of layers of paper as a potential material for use for variable absorbance levels of light energy, showing a potential application and design that could be implemented, for example, as an affordable insulating material over windows for variable-light attenuation. The experiments involved using a cellphone camera to image the amount of light transmitted through up to five layers of paper of four different colors placed over a light bulb. MATLAB programming tool was used to quantify the amount of transmitted light from images based on pixel brightness levels and quantify the energy attenuation, avoiding the need for expensive camera technologies like hyperspectral imaging for data acquisition and analysis. Light attenuation follows Beer-Lambert's law with the constant material but simulated changing thickness or optical path. This experiment has shown that paper can absorb light energy following Beer Lambert law in a controlled manner, and, with some other considerations, paper can be used as an insulator to block light energy. A design concept that could serve as a variable attenuation-control shade for windows or as an awning is also presented as a potential application.

Computation-Efficient Hierarchical Tensor Train Convolutional Architectures for Diffusion-Based Medical Image Segmentation

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Abstract - Diffusion models have rapidly emerged as a leading approach in generative modeling, recognized for their strong theoretical framework and wide-ranging applications, from image synthesis and 3D scene rendering to medical image segmentation. In particular, diffusion-based approaches have achieved great success in generating accurate masks for medical image segmentation tasks. However, despite advancements, diffusion models remain computationally intensive, requiring large memory, long inference times, and complex operations, which lead to significant challenges for real-time deployment in clinical settings. In this paper, we introduce a Hierarchical Tensor Train (HTT) method that captures the structural characteristics of the denoising process within diffusion models to enable efficient compression and improved computational efficiency. With the HTT, the per-layer model size is reduced by up to 500× while maintaining compression rate and similar accuracy to conventional tensor train decomposition. Compared to traditional compression approaches that incur an additional ∼2 GFLOPs per layer, the HTT reduces the per-layer computational load to approximately one-tenth of the original, leading to an overall computational reduction of about one-third across the entire model. This approach offers a promising path toward developing lightweight, scalable diffusion models suitable for diverse real-time applications, including those in clinical and resource-constrained environments.

A Transformer-CNN Hybrid Autoencoder for Accurate and Unsupervised Plant Disease Localization

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Abstract - Early detection of plant leaf diseases is crucial for ensuring high agricultural productivity. Traditional supervised methods require large amounts of annotated data, which is often expensive and time-consuming to acquire. In this work, we propose a semi-supervised anomaly detection framework for plant disease detection based on a modified autoencoder architecture that integrates a Vision Transformer (ViT) as its encoder backbone. The model is trained exclusively on healthy leaf images, learning to reconstruct them with high fidelity. Diseased regions are then identified as anomalies due to reconstruction failures. Our approach demonstrates robust performance across multiple plant disease datasets and outperforms traditional CNN-based autoencoders, especially in generalizing to unseen disease types.

Uncovering Crime Patterns: A Geospatial Clustering Approach

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Abstract - According to the National Institute of Statistics and Geography (INEGI), the state experienced a notable increase in criminal incidents during the year preceding its September 2024 report on victimization and public perception of security—surpassing figures from the previous three years. Considering this trend, it is imperative for public security institutions to formulate strategic responses based on historical data that reveal when, where, and how crimes occur. In this regard, this article analyzes crime patterns in Tamaulipas, Mexico, as one of the most pressing social challenges. Utilizing the K-Means clustering algorithm, this study identifies latent patterns within crime data to classify neighborhoods in the state's principal municipalities according to their levels of criminal activity. The analysis yields a detailed and well-defined segmentation of these clusters, incorporating both criminal and socioeconomic variables. The primary contribution of this research is the development of an information system featuring an interactive map that enables geospatial visualization of crime clusters at the neighborhood level. This tool is designed to assist public security authorities in the effective allocation of resources and the formulation of targeted crime prevention strategies.

Robust DDoS-Attack Classification with 3D CNNs Against Adversarial Methods

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Abstract - Distributed Denial-of-Service (DDoS) attacks threaten critical infrastructure in the modern world of networking systems as they can often evade traditional cyberattack detection mechanisms through subtle traffic manipulation. To address this challenge, we propose a system using hive plot image sequences of network traffic that applies a 3D convolutional neural network (3D CNN) for robust DDoS classification. There are three parts to this project. First, we will leverage the spatial-temporal encodings of the hive plots to set a baseline for pattern recognition, secondly, we will incorporate adversarial training (FGSM and PGD) alongside augmentations (rotation, shear, zoom, noise) to strengthen the model against evasion attempts, and third, we perform a frame-wise no-context evaluation to identify the most predictive time steps for classification. Our contributions include a lightweight 3D CNN architecture specialized for sequence-based hive-plot inputs. This adversarial training regime mixes clean, augmented, and adversarial examples within each batch and several evaluation scripts that can quantify the model's robustness when faced with clean, augmented, FGSM, and PGD perturbations. Our experiments on a pre-classified benchmark dataset of DDoS and normal traffic demonstrated that adversarial retraining increases Augmented-attack accuracy from 50% to 99%, PGD accuracy from 55% to 99%, and FGSM accuracy from 55% to 93.25% all while maintaining clean data performance. We also found that time steps 3 and 4 (out of 8) yield peak classification accuracy, indicating that early detection of DDoS attacks using these models is beneficial. These findings validate that hive plot sequences are effective representations of network traffic data for early DDoS detection as they establish a reproducible, GPU-accelerated framework for adversarially robust network security.

Depth Perception Control Using Camera Focus Control and Foveated Rendering in the Visual System of an Avatar Robot

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Abstract - This study presents a visual system for an avatar robot. The system uses eye-tracking data that are obtained from a head-mounted display (HMD) to perform camera focus control and foveated rendering on images that are captured by a stereo camera. Gaze information measured by the HMD is used to measure the point of fixation and control the distance between the two cameras. In the experiment, the operator wore the HMD, and virtual reality (VR) sickness was evaluated using subjective assessment methods: the Simulator Sickness Questionnaire, VR Sickness Questionnaire, and Fast Motion Sickness Scale. The superiority of the camera focus control with foveated rendering of the image was evaluated using the Wilcoxon signed-rank test. Most values of the test (p-values) were less than 0.05, indicating that the proposed method is effective in reducing visual fatigue and mitigating VR sickness. This advancement enhances depth perception, reduces VR sickness, and improves immersion during operation.

Vision: A Deep Hybrid Architecture for Real-Time Face Recognition in Automated Attendance Systems

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Abstract - Educational systems heavily depend on classroom attendance because it aids both engagement tracking and administrative efficiency and service distribution. Vision utilizes real-time face recognition technology to track enrollment engagement and provides administrative management as well as grading processes and policy execution and resource distribution functions. The process includes grading the students together with policy implementation and resource management. Previous methods of attendance tracking involved both manual roll calls and RFID- Traditional based student systems usually have performance issues along with mistakes as well as scalability challenges which require the implementation of complex automated solutions. The paper describes Vision which functions as a deep hybrid architecture designed to automate real-time face tracking processes. recognition in automated attendance systems. The core value of Vision lies in its unique integration approach. ArcFace is employed as the primary technology for accurate facial detection and recognition, while a lightweight auxiliary model is used to optimize overall algorithm performance. The system performs feature extraction in a way that ensures both high detection accuracy and reduced processing requirements. The system's The modular design of the system creates scalable benefits because it allows easy database integration with cloud platforms. The system maintains reliability throughout diverse conditions like diverse lighting conditions, camera angles, and classroom environments because of its combination of detection and retrieval methods. The performance of Visual attendance tracking system gets better through model quantization along with GPU acceleration features and data pipeline optimization. The implementation of Vision provides fast practical and reliable attendance tracking that meets modern attendance needs.

The 22nd International Conference on Modeling, Simulation & Visualization Methods (MSV'25: July 21-24, 2025; Las Vegas, USA)

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Predicting Trends in Domain Name Registrations Using a VAR Model

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Abstract - This study proposes a method for forecasting domain name registration trends under country-code top-level domains (ccTLDs) using socio-economic indicators specific to each country and a Vector Autoregressive (VAR) model. We focused on 11 publicly available indicators and evaluated several dimensionality reduction techniques to address strong multicollinearity. Experiments using JP domain name data demonstrated that feature selection alone is insufficient, while Principal Component Analysis (PCA) effectively reduced dimensionality and improved forecast accuracy. Our results highlight the relationship between economic conditions and domain registration trends, offering insights that support sustainable registry management. Furthermore, the proposed approach enables objective forecasting without relying on confidential registry data. Applying the same framework to other ccTLDs may also facilitate cross-country comparative analysis.

Implementation of a Digital Twin for the TCP-100 Parabolic Trough Collector Research Facility

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The Alan Turing Institute, British Library, London, England, UK

Abstract - This article discusses the design, implementation, and virtual commissioning of a digital twin (DT) for the TCP-100 parabolic trough collector (PTC) research facility located at the Plataforma Solar de Almería (PSA) experimental installation in Spain. For these tasks, we have selected the following technologies: SIMATIC S7 1500 PLCs (programmable logic controller) for an IEC 61131-3 controller implementation, Dymola for an object oriented Modelica implementation of the TCP-100 behaviour simulator, Message Queuing Telemetry Transport (MQTT) broker bridging with a Linux Mosquitto broker for communication between the controller and simulator, and WinCC Unified to create the Human Machine Interface (HMI) for the system operator.

A Method for Detecting Changes in the Thermal Losses of a Parabolic Trough Collector

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Information Processing and Telecommunications Center,
Universidad Politecnica de Madrid, Madrid, Spain;
Departamento de Automatica, Universidad de Alcala (UAH), Alcala de Henares, Spain;
Plataforma Solar de Almeria, CIEMAT, Tabernas, Spain

Abstract - In this paper, a fault detection scheme is developed, based on a simplified model of a Parabolic Trough Collector that uses water as a heat transfer fluid. The model assumes some simplifications that allow the construction of a Luenberger-type observer-based residual, so that an alarm is activated when the absolute value of such residual surpasses a preestablished threshold. The threshold is computed in order to avoid false alarms, so that when the residual surpasses such threshold, this implies that the absolute thermal losses to the environment have exceeded some established maximum admissible value. Two possible threshold values are proposed, depending on the assumptions considered: the first one is conservative since its computation is solely grounded on the modeling assumptions; the second one is computed by including an additional assumption which provides a less conservative result. Simulations with different fault sizes illustrate the sensitivity of the detection scheme with both thresholds.

Experiment Evaluation-Testing and Validation of a Bio-Inspired Probabilistic Graphical Model for Root Cause Detection in an e-Commerce Application

Kapila Molri, Majid Shaalan
CISC Department, Harrisburg University of Science and Technology, PA, USA

Abstract - In this paper we are going to present the testing and validation of a bio-inspired fault detection and root cause analysis framework based on probabilistic graphical models for e-commerce application. The proposed method draws inspiration from biological systems to identify and diagnose faults in complex systems as was proposed in an earlier paper[1], leveraging the adaptability and resilience inherent in natural processes. A probabilistic graphical model (PGM) was designed to represent system variables and their dependencies, enabling robust inference for fault detection and localization.The experimental setup involved testing the framework on synthetic and real-world datasets, simulating various fault scenarios in industrial and computational systems. Key metrics, including accuracy, precision, recall, and computational efficiency, were used to evaluate the model's performance. The results demonstrated the framework's ability to identify faults and trace their root causes with high accuracy, even in noisy and uncertain environments.Future work will explore extending the framework to more complex systems and real-time implementations. This study provides valuable insights into the practical utility of bio-inspired probabilistic models in industrial diagnostics.

A Framework for Simulating Resilient Cloud-Edge AI Tasking for Geospatial Operations in Contested Environments

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US Army Engineer Research and Development Center (ERDC),
Information Technology Laboratory, Vicksburg, Mississippi, USA

Abstract - The increasing reliance on edge-cloud computing architectures to support geospatial decision-making and battlefield analytics introduces a critical vulnerability in Denied, Degraded, Intermittent, and Limited-bandwidth (DDIL) environments. This paper proposes a potential reinforcement learning-based simulation framework that models taskaware resilience across variable data availability, network conditions, and compute heterogeneity. Using operationally relevant geospatial datasets, the framework will evaluate dynamic AI tasking strategies—such as data offloading, model compression, and adaptive routing under degraded conditions.

Simulation-Based Problem Solving: Enhancing Productivity and Decision-Making Across Diverse Real-World Applications

Bahram Asiabanpour
Ingram School of Engineering, Texas State University, San Marcos, Texas, USA

Abstract - This paper explores the integration of simulation-based course projects into a senior-level engineering curriculum as a means to address real-world productivity challenges across diverse domains. Through the application of discrete event simulation tools, students analyze, model, and optimize systems in areas such as sports team scheduling, automotive service operations, and aquaponic agriculture. The paper details the course structure, project methodology, and key pedagogical strategies, highlighting the role of simulation in developing students' technical, analytical, and problemsolving skills. Results demonstrate significant performance improvements and the successful implementation of circular economy principles within complex system models. The findings support the broader adoption of simulation education as a powerful approach to bridging theoretical instruction with industry-relevant practice.

Center-Surround Improves Multimodal Learning

Marc Estafanous, Evan Mattson, Erhan Guven
Johns Hopkins University, Baltimore, Maryland, USA

Abstract - Evolution has had millions of years to experiment with sensory processing. In vertebrates, visual information is processed first through a commonly themed, fixed pre-processing, i.e. centersurround processing (CSP), before final learned processing. Center-surround (CSP) processing has been found in retinal bipolar cells, and cells that receive auditory signals [9][11]. Visual CSP was first found by Kuffler [6] in mammalian, and in non-mammalian vertebrates by Bartlow [2]. The same preprocessing was also found in invertebrates, such as horseshoe crabs [12] and drosophila flies [8]. CSP, or analogous lateral inhibition processing, has also been found in somatosensory processing [10].

Manufacturing Process Improvement using Discrete Events Simulation

Abdu Shaalan, David Baglee, Ben Hartop
University of Sunderland, Sunderland, UK

Abstract - Manufacturing process improvement has been a hot topic for decades since the introduction of lean applications to increase performance, quality, and reduce cost across various industries. Lean practices introduced multiple tools that supported such needs over the centuries and have proven efficiency in improving the process in numerous areas of the manufacturing process and various industries. Discrete events simulation (DES), as a modern tool, was introduced to help apply various lean tools to test them in a simulation format to test the impact of such applications before they take place. This research evaluates the performance of the DES simulation on the manufacturing process of modular housing. The paper investigates different scenarios backed up with lean thinking in reducing various sources of waste within the manufacturing process

The 31st International Conference on Parallel & Distributed Processing Techniques & Applications (PDPTA'25: July 21-24, 2025; Las Vegas, USA)

https://american-cse.org/csce2025/conferences-PDPTA
https://american-cse.org/csce2025/

A Simulator for Next Generation SSDs with Networked Backend Architecture

Amir Mirzaei, Fatemeh Serajeh Hassani, Atiyeh Gheibi-Fetrat, Mina Zabihi,
Sina Ghorbani-Jabbehdar, Mahmoud Reza Kheyrati-Fard, Ahmad Javadi Nezhad,
Seyed Mohammad Hosseini, Ahmad Javadi Nezhad, Negar Akbarzadeh, Arash Tavakkol,
Jeong-A Lee, Hamid Sarbazi-Azad
Sharif University of Technology, Iran;
ApplyBoard, Inc, Kitchener, Kitchener, Canada;
Institute for Research in Fundamental Sciences (IPM), Iran;
Chosun University, Gwangju,Gwangju, South Korea

Abstract - Solid-state drives (SSDs) have revolutionized non-volatile storage technology for computer systems and have become widely used in today's digital systems. This is due to SSDs offering high performance with lower power consumption compared to traditional hard disk drives. While data sizes and the demand for higher-capacity storage systems grow, SSDs haven't seen considerable growth in capacity, mainly because it is extremely difficult to scale up the current architecture of SSD devices with reasonable performance. A revolutionary idea is to use a network to network flash chips to solve the scalability issue. Partly due to the absence of an integrated, accurate, and extensible simulator, research on such architectures as the most viable structure for next-generation SSDs has been limited. In this paper, we present MQSimNet, an open-source integrated simulator for SSDs with networked flash chips, offering ease of operation and the possibility of low-effort extensibility.

GPU Accelerated GMRES Solver for Efficient Sparse Linear Systems

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Department of Computer and Information Science, University of Mississippi, Oxford, Mississippi, USA;
Department of Electrical & Computer Engineering, Jackson State University, Jackson, Mississippi, USA

Abstract - The Generalized Minimal Residual (GMRES) algorithm is a cornerstone for solving sparse linear systems in scientific and engineering applications. However, traditional CPUbased implementations struggle to meet performance demands as the scale of these systems increases. In this paper, we focus on how to implement the CUDA-based GMRES algorithm to take advantage of the massive parallelism of the architecture of modern GPUs. The porting shall optimize key computations such as matrix vector multiplication and orthogonalization. Performance analysis has shown significant speed ups compared to CPU implementations, especially in the case of large, sparse matrices. For instance, a 23,052 × 23,052 matrix has the execution time reduced from 283 seconds on CPU to 70 seconds on GPU. The results also show that while the GPU implementation has longer execution time on small matrices due to initialization and memory transfer cost, it outperforms the CPU implementation consistently as the matrix size grows.

Accelerating TVM LLM Inference via Paged KV-Cache and Customized Kernels on RVV

Shou Chen Chiu, Chun Lin Huang, Meng Shiun Yu, Ming Zhang Huang, Jenq Kuen Lee
Department of Computer Science, National Tsing Hua University, Hsinchu, Taiwan, ROC

Abstract - This paper proposes a method to accelerate large language model (LLM) inference on CPUs using the TVM compiler and MLCLLM framework. By tensorizing TVM's TensorIR into RISC-V Vector (RVV) intrinsics, we automatically generate efficient vectorized kernels for key operators. Leveraging recent TVM improvements, our framework significantly boosts throughput, during the prefill phase. Experiments show up to 18× speedup in attention and 2.6× more tokens-per-second.

Design and Evaluation of a Cost-Aware Dynamic Load Balancer for Distributed Environments

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Department of Computer Science, Framingham State University, Framingham, MA, USA;
Department of Electronics & Communication Engineering, SRKR Engineering College, AP, India

Abstract – In modern distributed and cloud-native systems, minimizing the cost of compute-intensive workloads has become a critical objective, especially under usage-based pricing models. This paper presents a dynamic, cost-aware load balancing strategy designed to reduce the monetary cost incurred by users for utilizing shared computational resources. The approach is based on a central-server node model that includes communication costs when transferring jobs to remote processing nodes. The proposed dynamic strategy is evaluated against existing static load balancing methods through simulations conducted across varied system configurations. Results demonstrate that the dynamic approach adapts more effectively to changing workloads and system conditions, achieving greater cost-efficiency.

Quantifying HPC Productivity: A Comprehensive Evaluation of High-Level Programming Abstractions versus MPI in Parallel Computing Applications

Arne Hendricks
Department of Computer Science, Friedrich Alexander University, Erlangen, Germany

Abstract - High-Performance Computing (HPC) applications have traditionally relied on low-level programming models like MPI, which offer fine-grained control but impose significant cognitive burden on developers. This paper presents a comprehensive quantitative study comparing developer productivity between MPI and AllScale, a high-level task-based programming model designed for extreme-scale computing. Through controlled experiments with 24 participants implementing three representative HPC kernels (stencil computation, particle simulation, and adaptive mesh refinement), we demonstrate that high-level abstractions can reduce code size by 60-80%, decrease programming errors by 87%, and cut development time by 65% while maintaining 92-105% of hand-tuned MPI performance. We provide detailed implementation analysis of the AllScale Data Item Manager, runtime system architecture, and distributed data structures that enable these productivity gains. Our analysis reveals that the productivity improvements stem primarily from automated data distribution, implicit communication patterns, tuple-space inspired runtime interface, and higher-level algorithmic expression. The study includes extensive case studies from real HPC applications including iPIC3D plasma simulation and AMDADOS adaptive mesh codes. These findings suggest that modern HPC programming models can dramatically improve developer productivity without sacrificing performance, potentially accelerating scientific discovery by enabling domain scientists to focus on algorithms rather than parallel programming mechanics.

International Workshop on Mathematical Modeling and Problem Solving (MPS)

Co-Chairs:
Prof. Miho Chiyonobu, Prof. Masahito Ohue, Prof. Nobuaki Yasuo*, Prof. Masami Takata**
** Shiga University, Japan*
*** Institute of Science Tokyo, Japan*
**** Nara Women's University, Japan*

Employment Method of Regression Machine Learning to Forecast Cherry Blossoms

Miho Chiyonobu, Masami Takata
Nara Women's University, Nara, Japan

Abstract - NA

The Proposal of the Operational Model of an Autonomous Delivery Mobility System Utilizing Medium-Accuracy Maps Generated from Driving Trajectories

Eriko Toma, Katsuyuki Kamei, Masami Takata
Advanced Technology R&D Center, Mitsubishi Electric Co., Amagasaki, Hyogo, Japan

Abstract - NA

Correction Method for Text Errors in Early-Modern Japanese Books Using BERT

Hiyori Kanetaka, Miho Chiyonobu, Yuki Takemoto, Yu Ishikawa, Masami Takata
Nara Women's University, Nara, Japan

Abstract - NA

Efficient Implementation of the QR Algorithm for Complex Matrices

Miho Chiyonobu, Masami Takata, Kinji Kimura, Yoshimasa Nakamura
Shiga University, Shiga, Japan

Abstract - NA

GraphBioisostere: General Bioisostere Prediction Model with Deep Graph Neural Network

Sho Masunaga, Kairi Furui, Apakorn Kengkanna, Masahito Ohue
Institute of Science Tokyo, Kanagawa, Japan

Abstract - NA

GBDT-based Model and Web Tool for Prediction of Blood-Placental Barrier Permeability of Small Molecules

Masahito Ohue, Kairi Furui
School of Computing, Institute of Science Tokyo, Kanagawa, Japan

Abstract - NA

Visualizing Phishing Email Features Through Sentiment Analysis

Takeshi Matsuda, Michio Sonoda
Department of Information Science, Hannan University, Japan

Abstract - NA

Hardware/Software Co-Design for a Multi-Core Post-Quantum Cryptography CRYSTALS-Kyber Accelerator

Kien Tran-Hoang, Hironori Nakajo
Tokyo University of Agriculture and Technology, Tokyo, Japan

Abstract - NA

SESCA: An Enhanced Sine-Cosine Algorithm with Sigmoid-based Nonlinear Mapping for Optimization

Yang Cao, Xingbang Du, Rui Zhong, Jun Yu, Masaharu Munetomo
Hokkaido University, Sapporo, Japan

Abstract - NA

Incorporating Angular Information into GNNs for Protein-Protein Interaction Re-ranking

Yukinobu Matsuno, Nobuaki Yasuo, Masakazu Sekijima
School of Computing, Department of Computer Science, Institute of Science Tokyo, Japan

Abstract - NA

Growth Monitoring of Mini Tomatoes Using Color Analysis and Cumulative Temperature to Predict Maturity Degree

Yan Lyu, Kyuki Shibuya, Yoshiki Gama, Yoshiki Hatanaka, Warut Timprae, Poltak Sandro Rumahorbo, Shinya Yamanaka, Shinya Watanabe
Muroran Institute of Technology, Muroran, Hokkaido, Japan

Abstract - NA

MPIcam: A Deep Learning Based Real-Time Medicinal Plant Identification System for Rural Healthcare in Bangladesh

Shabnur Anonna Akhy, Hayaru Shouno, Mayen Uddin Mojumdar, Tahir Hussain, Md Bilayet Hossain, Shah Md Tanvir Siddiquee, Narayan Ranjan Chakraborty
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Abstract - NA

The 24th International Conference on Security & Management
(SAM'25: July 21-24, 2025; Las Vegas, USA)

http://sam.udmercy.edu/sam25/
https://american-cse.org/csce2025/

The Human Factor in Cybersecurity: A Conceptual Model Integrating Cognitive Biases

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Universidad San Francisco de Quito, Colegio Politecnico, Quito, Ecuador;
Universidad de Lusofona, Lisboa, Portugal;
Departament d'Enginyeria de la Informacio i de les Comunicacions,
Universitat Autonoma de Barcelona - UAB Barcelona, Spain

Abstract - NA

Rethinking Privacy Laws for Subscriptions: A Consumer Harm Perspective

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Department of Cybersecurity, State University of New York at Canton, New York, USA

Abstract - Consumers spend billions of dollars annually on online subscriptions, a trend that continues to grow. Despite the implementation of major privacy laws, significant gaps remain in how these laws protect consumers' personal data within subscription-based models. This analysis examines consent within the CCPA and GDPR privacy laws to highlight the oversight of insufficient interpretation and consent mechanisms that expose individuals to consumer harm in subscriptions. Using a privacy-defining framework, publicized privacy conflicts between consumer and business entities are examined for application and interpretation of privacy laws to identify consumer vulnerabilities specific to subscription-based models. Businesses that participate in subscription models are using exploitative data handling practices that are in conflict with modern data privacy laws and inflict consumer harm. Consumer research reflects consumers' desire for greater control over their personal data while participating in subscriptions. A proposed solution provides updates to consent mechanisms and default handling procedures to provide consumer control and transparency throughout the subscription life cycle, aligning with the intent of consumers and modern privacy laws.

Competency-Based Cybersecurity Education: Developing Industry-Aligned Curriculum Modules

Major Houston, Jing Chen, Darren Waldrep
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Department of Management, Athens State University, Athens, Alabama, USA

Abstract - This paper aims to develop competency-based education (CBE) modules for cybersecurity at Athens State University, focusing on risk management, encryption, and communications security management. Aligned with industry standards like those

from NIST, the competencies emphasize hands-on learning and performance-based assessment to better prepare students for real-world cybersecurity roles. Survey feedback from academic and industry participants supports the relevance and effectiveness of these competencies, while also suggesting the inclusion of areas like the Privacy Framework and end-user awareness. This paper lays a foundation for ongoing academic-industry collaboration and future curriculum integration. The findings address the cybersecurity skills gap and highlight the need for continuous curriculum refinement in response to evolving threats and workforce demands.

Composing Cyberattacks: Sequential Composition with Communication

Ke'Asia Fearn, Katia Maxwell
Athens State University, Athens, Alabama, USA

Abstract - The rapid development of technology has established cybersecurity as a fundamental field for research and development. The use of modeling and simulation tools including Petri Nets and their extension Petri Nets with Player, Strategies, and Costs (PNPSC) are used to analyze different cyberattack scenarios. While it is easy to focus on a single cyberattack and analyze its impact on a system and organization, in today's day and age an extensive system attack which focuses on more than a single cyberattack can be debilitating to an organization. PNPSC models have been studied to be composed together in the means of parallel compositions and sequential composition to represent a more comprehensive system attack that goes beyond a single cyberattack. This study expands on the sequential composition method. The theoretical structure of the method is discussed along with a proof of concept based on a practical walkthrough exercise.

Branch-Commit-Validate: A Git-Inspired Workflow for Autonomous Red-Team Agents

Chinmay Shringi, Alon Hillel-Tuch, Sariya Rizwan
Department of Computer Engineering, New York University, Brooklyn, New York, USA;
Lubin School of Business, Pace University, Brooklyn, New York, USA

Abstract - Red-team penetration testing is critical for uncovering vulnerabilities and strengthening defenses. Automating these complex engagements requires traversing vast, dynamic attack spaces and adjusting to real-time target changes, an area where existing search-based planners and deep reinforcement-learning (RL) agents struggle due to combinatorial explosion and prolonged training requirements. This paper presents Branch, Commit and Validate, a Git-inspired workflow that orchestrates specialized agents through parallel hypothesis exploration (Branch), metadata-rich recording of CPU-hours and operator-interaction time (Commit), and automated reliability and performance validation before integration (Validate). We intend to test the framework in a multi host, multi service simulated enterprise setting, gauging gains in decision delay, exploration efficiency, and validated coverage.

Formal Security Verification of Messaging Layer Security Protocol Using ProVerif

Takehiko Mieno, Hiroyuki Okazaki, Kenichi Arai, Yuichi Futa
Graduate School of Medicine, Science and Technology, Shinshu University,
EPSON AVASYS CORPORATION, Shimonogo Otsu, Ueda City, Nagano, Japan;
Graduate School of Science and Technology, Shinshu University, Japan;
Graduate School of Integrated Science and Technology, Nagasaki University, Japan;
School of Computer Science, Tokyo University of Technology, Japan

Abstract - NA

Enhancing IT Competitiveness for Adaptive Strategy and Threat Response

Suaad Al Fahdi, Zainab Al-Abri, Abdul Khalique Shaikh
Department of Information Systems, Sultan Qaboos University, Muscat, Oman

Abstract - NA

Mitigating Ransomware and Data Breaches in Mobile Health Applications: An Encryption and Integrity-Based Approach

Sarah Dziobak, Valerie Nielson, Brendon Wolfe, Rui Zhu, Huirong Fu
Oakland University, USA;
Kettering University, USA

Abstract - NA

AI-Driven Deepfakes: Exploring Exploitation Risks and Cybersecurity Responses

Brianna Geiger, Mei Li, Anjali Desai, Rui Zhu, Huirong Fu
Oakland University, USA;
Kettering University, USA

Abstract - NA

Harnessing Machine Learning and Artificial Intelligence in Cyber Security: A Deep Dive into Threat Detection, Anomaly Detection, Intrusion Detection, and Malware Analysis

David Dorsaima, Lisa Kovalchick, Weifeng Chen
Pennsylvania Western University, Pennsylvania, USA

Abstract - NA

Multi-Party Computation for IoT Environments: Evaluating Information Checking Protocol-Based Verifiable Secret Sharing Under Resource Constraints

Jaishnoor Kaur, Levent Ertaul
California State University East Bay (CSUEB), California, USA

Abstract - NA

Fraudulent Digital Fingerprint: Developing a Dynamic Scam Detection Tool Through Machine Learning and Network Analysis

Ed Pearson III, Daniel Lambo
Alabama A&M University, Normal, Alabama, USA

Abstract - NA

Bridging the Gap to Enhance Critical Infrastructure Security through Data Analytics and Public-Private Partnerships

Edwin Figueroa Perez, Isaac Osunmakinde, Cheryl Hinds
Computer Science Department, Norfolk State University, Norfolk, Virginia, USA

Abstract - NA

CMR Vulnerabilities and Enhancing Game Payment System Protocols

Pratham Khanal, Farjana Eishita
Idaho State University, Pocatello, Idaho, USA

Abstract - Collaborative Mixed Reality is the combination of Virtual Reality (VR) and Augmented Reality (AR), with the primary application of allowing users to interact with digital objects in its real environment. Like its name suggests, Collaborative Mixed Reality Environment is about enabling more than one user to have an interaction with digital objects that are shared in real time. This paper is an investigation on Cybersecurity Vulnerabilities in a Collaborative Mixed Reality Environment on game payment system using real-time experiment, and research on improving security systems protocols.

Assessing the Impact of Access Control Policies on Data Accessibility in Distributed NoSQL Environments

Abanisenioluwa Orojo, Emmanuelli El-Mahmoud, Greg Speegle
Baylor University, Waco, Texas, USA

Abstract - NoSQL databases have emerged as a scalable and adaptable solution to manage large, unstructured data sets in distributed systems. However, NoSQL data stores lack robust mechanisms for assessing the impact of fine-grained access control policies on database resources in distributed environments. In this study, we introduce a refined framework for evaluating access control mechanisms in NoSQL databases, proposing enhancements to address major challenges in distributed settings. We introduce techniques to integrate node identity into access control evaluation paths, enabling context-aware analysis across distributed data partitions. We develop a dynamic approach capable of managing intricate, multi-layered resource hierarchies to allow for more flexible and scalable evaluations. Our experiments across various datasets confirm the effectiveness and efficiency of our access control evaluation framework. In addition, we propose new metrics that quantify the effects of policies on data accessibility, offering practical insights for policy refinement.

Dynamic ARP Cache Poisoning Detection and Enhanced Prevention in Virtual Networks Using SDN and Real-Time Traffic Analysis with Scapy

Ala'a Alsheikh Ali, Ken McGarry, David Baglee, Neil Eliot
School of Computer Science, Faculty of Technology, University of Sunderland, UK;
School of Engineering, Faculty of Technology, University of Sunderland, UK

Abstract - Addressing critical vulnerabilities in network security, this study presents an advanced detection and mitigation framework against ARP spoofing—a major threat exploiting authentication gaps in the ARP protocol. Leveraging Scapy integrated with Software-Defined Networking (SDN) technologies, including the Ryu controller and Open vSwitch, the research introduces a custom ARP cache poisoning script that covertly reroutes network traffic to an attacker-controlled node with precision and control. Deployed in a virtualized environment, the script was evaluated against tools like Ettercap and Bettercap, achieving superior manipulation capabilities and a 100% ARP table compromise rate. The tailored SDN-based detection tool further demonstrated impressive performance, identifying 98.33% of spoofing activities with a low detection latency of 0.024 seconds and minimal CPU usage, ensuring network efficiency. This research sets a new benchmark in ARP spoofing mitigation and paves the way for future enhancements such as ARP table pre-population and broader protocol support, strengthening defenses in virtualized environments.

Blockchain-Based Health System Development: Challenges, Architecture, and Trends

Given Mark Garcia, Jasper Liu, Carol Yan, Eduardo Colmenares-Diaz, Irvin Velazco, Heng Wu
Software Development, Google Developer Group, La Verne, California, USA;
Software Development, Google Developer Group, Fremont, California, USA;
Diamond Bar High School, Diamond Bar, California, USA;
Department of Computer Science, Midwestern State University, Wichita Falls, Texas, USA;
Computer Science and Computer Engineering Department, University of La Verne, California, USA

Abstract - This paper presents a scalable blockchain architecture for healthcare data management, addressing key challenges in interoperability, regulation compliance, and data security. We propose a hybrid blockchain model that integrates AI-based analytics and quantum-resistant encryption. The architecture is validated through layered system analysis and application scenarios, offering a practical roadmap for adoption. This paper explores the development of scalable blockchain architectures for healthcare data management, addressing interoperability with EHR systems and compliance with HIPAA/GDPR. The architecture is validated through layered analysis and application scenarios, providing a roadmap for future adoption.

3Body Problem: Can it be used for Cryptographically Secure Pseudorandom Number Generator (CSPRNG)?

Lara Su Ertaul
Columbia University, USA

Abstract - NA

ACLR: A Stacked Deep Learning Approach for Botnet Detection Using Network Traffic Analysis

Srinija Reddy Kotla, Xinli Wang, Vijay Bhuse
College of Computing, Grand Valley State University, Allendale, Michigan, USA

Abstract - NA

A Study on Integrated Framework for Copyright Protection based on Multi-Signature in NFT

Hye-Young Kim
School of Games, Hongik University, South Korea

Abstract - NA

Typosquatting Detection at Scale: A Review of DNS-Focused Approach to Domain Abuse

Serra Uysal, Mehmet Tahir Sandikkaya
Department of Computer Engineering, Istanbul Technical University (ITU), Turkey

Abstract - NA

A Secure and Private Food Recommendation Framework Using Game-Theoretic Adversarial Learning

Sai Akshaya Banda, Raihana Tasnim, Madhuri Siddula, Olusola T. Odeyomi, Sajad Khorsandroo
North Carolina A&T State University, Greensboro, North Carolina, USA

Abstract - Personalized food recommendation systems, due to their reliance on centralized data storage, often suffer from privacy and security vulnerabilities. This research proposes a privacy-preserving framework integrating functional encryption and adversarial learning to safeguard sensitive user information while maintaining recommendation accuracy. Additionally, Fernet encryption is used for data encryption. A data poisoning attack is simulated to assess system resilience by injecting adversarial noise into encrypted datasets. Data imbalance is addressed using the Synthetic Minority Oversampling Technique (SMOTE) to enhance model fairness. Experimental results demonstrate that the proposed system effectively mitigates adversarial threats, preserves user privacy, and achieves robust performance across various metrics. This work advances secure and privacy-aware recommendation systems, offering a practical approach to defending against data manipulation attacks.

A Comparative Analysis of Taint Analysis Tools: Enhancing Security Through Combined Static Analysis Approaches

Young Lee, Mohammed Tausif Ansari, Jeong Yang
Texas A&M University - San Antonio, San Antonio, Texas, USA

Abstract - NA

Machine Learning-Based Framework for Cyberattack Analysis and Detection in Smart Grids

Mais Nijim, Viswas Kanumuri, Waseem Al-Aqqad, Hisham Al-Bataineh, Ayush Goyal, David Hicks, George Toscano
Department of Electrical Engineering & Computer Science, Texas A&M University - Kingsville, Texas, USA;
Department of Electrical and Computer Engineering, West Virginia University, Morgantown, West Virginia, USA;
Department of Physics and Geosciences, Texas A&M University - Kingsville, Kingsville, Texas, USA

Abstract - NA

Experimental Evaluation of Security Attacks on Self-Driving Car Platforms

Abhishek Vishwakarma, Purva Vijayvargiya, Nathan Lee, Mohammad Husain
Computer Science, Cal Poly Pomona, Pomona, California, USA

Abstract - NA

CryptoKeys: Another Keyboard-Centric Approach to End-to-End Encryption

Kanwaljit Ahluwalia, Mikhail Gofman, David Medina Dominguez
Computer Science Department, California State University, Fullerton, California, USA

Abstract - NA

NFC-PUF Three-pass Authentication for Supply Blockchains

Norbert Olah, Tamas Giraszi, Mate Vajda, Andrea Huszti
Faculty of Informatics, University of Debrecen, Debrecen, Hungary

Abstract - NA

The 23rd International Conference on Software Engineering Research & Practice (SERP'25: July 21-24, 2025; Las Vegas, USA)

https://american-cse.org/csce2025/conferences-SERP
https://american-cse.org/csce2025/

Automation Innovation - AI's Impact on Software Development Lifecycle

Max Dombrowski, Katia Maxwell
Athens State University, Athens, Alabama, USA

Abstract - As Artificial Intelligence (AI) continues to evolve, its integration into the Software Development Life Cycle (SDLC) offers opportunities to streamline workflows, reduce errors, and accelerate development. Despite these benefits, many organizations lack awareness of AI's potential, resulting in slower product development and increased costs. This study explores how AI enhances each SDLC phase and examines associated risks and mitigation strategies to maintain software security. Key research questions address workforce perceptions of AI, its major benefits and drawbacks, and which SDLC phases gain the most from its adoption. By answering these questions, the study provides insight into AI's impact on software development and evaluates industry readiness for AI-driven transformation.

An Empirical Study on the Evolution and Vulnerabilities of Maven Artifacts

Nirajan Bhattarai, Riley Stratton, Minhaz Zibran
Department of Computer Science, Idaho State University, Idaho, USA

Abstract - Frequent new releases are expected to address security and compatibility issues, but may result in security breakages in return while increasing maintenance cost and system complexity. We conduct an empirical study on the ecosystem-wide evolution of the Maven Central Dependency Graph and the maintenance status of its artifacts, with the ultimate goal of educating the developer community about the evolution and maintenance levels within the Maven Central ecosystem. We examine the growth patterns of library releases over time, focusing on frequency, rhythm, and speed, to understand the influence of project management methodologies such as Agile, security vulnerabilities, and open-source contributions on the evolution of the Maven Central ecosystem. Similarly, we also measure the maintenance level of artifacts in the ecosystem based on various factors such as popularity, missed releases, and whether vulnerabilities have been addressed or not. Rapid growth between 2004 and 2005 aligned with emergence with agile methodologies, followed by a gradual increase up to 2021, after which it started plateauing or stabilizing, which may be attributed to the emergence of new technologies such as AI. In contrast, the growth of vulnerabilities across all severity types experienced a rapid decline after 2021, possibly indicating an increased emphasis on security and improved library maintenance within the community. We found that only 5.21% of all libraries are fully maintained. The study suggests the need for further in-depth research on the most prevalent vulnerabilities in the Maven Central ecosystem, and a well-validated metric system for assessment of combined vulnerability and maintenance level in the Maven Central Dependency Graph.

A Non-Functional Quality Framework for Blockchain Software: ISO/IEC 25010 Revisited

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Abstract - As distributed ledger technology matures from niche innovation to core infrastructure across financial, healthcare, and governmental domains, evaluating its non-functional quality remains an unresolved challenge. A systematic review shows that critical attributes.decentralised governance, regulatory and ethical compliance, fairness, and socio-technical trust.lie beyond the scope of ISO/IEC 25010. This work proposes an extension, ISO/IEC 25010 + BQ, which adds the characteristics Decentralisation & Governance and Regulatory & Ethical Compliance together with a cross-cutting Trust dimension. Indicative metrics and a stepwise assessment workflow are provided. The extended model affords practitioners a structured basis for specifying, evaluating, and certifying blockchain quality.

Remaining Agile with Hybrid Work Models

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Abstract - This study explores the impact of the COVID-19 pandemic and hybrid work models on Agile Software Development (ASD). By comparing pre- and post-pandemic practices, it highlights shifts in priorities such as quality, communication, and organizational culture. A mixed-methods approach—surveys based on the Goal Question Metric (GQM) framework and follow-up interviews—was used to gather data from diverse software organizations. The analysis examines how hybrid work affects ASD compared to remote and in-person models, referencing challenges from Global Software Development (GSD). The goal is to offer actionable insights to enhance productivity, collaboration, and well-being in hybrid Agile environments.

The Role of Provenance Modeling in Tracing and Reproducing Explainable AI Pipelines

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Abstract - Provenance data captures and provides a detailed lineage of datasets, models, and analytical pipelines, ensuring end-to-end traceability. In the explainable AI (XAI) process, recent techniques, including LIME and Grad-CAM, provide local explanations for deep learning models. However, achieving trustworthy AI requires synergizing these local explanations with the global observability and traceability of entire XAI pipelines. Many factors introduce substantial complexity at both local and global levels, generating a vast combinatorial space for experimental tuning to improve model quality. Ensuring the reproducibility of these experiments is critical for maintaining AI performance amidst subtle variations and large-scale changes. In this paper, we propose a provenance network model for cloudbased XAI pipelines. The provenance graph data is stored in the graph database. We demonstrate our model's implementation in cloud environments, validating its effectiveness in enhancing observability, traceability, and reproducibility. Our approach is tested across multiple cloud platforms and open-source models.

Best Practice of Scenario-Based Modeling for Humanoid Software Validation

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Abstract - Recent advances in adapting artificial intelligence technology have revolutionized the field of humanoid robots. The intelligence of robots is based on reinforcement learning and AI models. However, due to the nature of robot software that continuously learns and reacts through interaction with the real environment, it isn't easy to validate safety, reliability, and accuracy using only existing software testing methodologies. To address these issues, we apply scenario-based modeling in software validation to humanoid robot software, incorporating reinforcement learning models. In particular, the 'mode selection' function of humanoid robots is presented as an application case, and a systematic procedure is performed from requirement analysis to scenario creation, refined scenario-based test case creation, and scenario execution and verification using a behavior tree. This is expected to contribute to maintaining the stability of humanoid robot systems by systematically detecting unpredictable behaviors in humanoid software and enhancing efficiency and reliability by validating the decision-making process of AI models using scenario-based modeling based on behavior trees.

The Use of ChatGPT to Teach Coding Inhibits Software Development or Supplements Coding Education

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Abstract - This study emphasizes the true driving factors behind the adoption of AI technology specifically for coding applications. We conducted a survey targeting faculty members in technology, information systems, computer science, and cybersecurity departments across all universities in the state of Maryland. For this investigation, the Technology Acceptance Model was selected as the guiding framework. Five key factors were examined as influences on the acceptance of ChatGPT use within Maryland universities: (1) Inhibit software development and (2) Provide coding education. In this quantitative research, we identified several factors that influence the intended use of ChatGPT for coding purposes. A survey was conducted with a sample of 330 faculty members specializing in computer-related and technology fields, using Google Forms and Microsoft Forms platforms. We examined the impact of each factor on the adoption of advanced AI technologies within Maryland universities. Using SPSS and PLS statistical software for analysis, the findings revealed that faculty members in Maryland considered only one out of the two model variables to be significant. Specifically, one independent variable — serving as a valuable providing coding education — showed a positive correlation with the intention to adopt ChatGPT. The other factor — inhibiting software development was not found to be significant in influencing the decision to implement ChatGPT as a coding tool in the classroom. This study highlights that while ChatGPT offers notable advantages, it also presents certain challenges within the coding education environment. Further investigation into how students are engaging with ChatGPT could provide additional valuable insights.