CSCI 2023 BOOK of ABSTRACTS

The 2023 International Conference on Computational
Science and Computational Intelligence (CSCI'23)

https://www.american-cse.org/csci2023/
December 13-15, 2023
Luxor Hotel (MGM Property), 3900 Las Vegas Blvd. South, Las Vegas, 89109, USA

Table of Contents

Message from Program and General Co-Chairs

It gives us great pleasure to introduce this collection of papers to be presented at The 2023 International Conference on Computational Science and Computational Intelligence (CSCI'23), December 13-15, 2023, Las Vegas, Nevada, USA.

The CSCI'23 International Conference includes papers from diverse communities, including researchers from: universities, corporations, and government agencies. Accepted papers are published by Conference Publishing Services (CPS). The full proceedings/book will be published soon after the conference (like prior years). Papers published in the proceedings present solutions to problems in many important areas of computational science and computational intelligence.

Computational Science (CS) is the study of addressing problems that are impossible to solve (or difficult to solve) without computers. CS can be considered to be the bridge between computer science and other sciences. The field is interdisciplinary by nature and includes the use of advanced computing capabilities to understand and solve complex problems. In short, CS is the science of using computers to do science. Computational Intelligence (CI) is the study of computational methods in ways that exhibit intelligence. These methods adapt to changing environments and changing goals. There is a significant overlap between the fields of CI and Artificial Intelligence (AI). However, there is also a difference: in general AI techniques often involve top-to-bottom methods (i.e., methods to the solutions are imposed from the top) whereas CI techniques often involve bottom-up methods (i.e., solutions emerge from unstructured beginnings). An important part of CI includes a set of Nature-inspired computational approaches to address complex problems to which traditional methods are infeasible. Computational Science and Computational Intelligence, both share the same objective: finding solutions to difficult problems. However, as stated earlier, the methods to the solutions are different.

Considering the above broad outline, the International Conference on Computational Science and Computational Intelligence (CSCI'22) is composed of the following Research Tracks: Computational Science (CSCI-RTCS); Computational Intelligence (CSCI-RTCI); Computational Biology (CSCI-RTCB); Cyber Warfare, Cyber Defense, & Cyber Security (CSCI-RTCW); Artificial Intelligence (CSCI-RTAI); Smart Cities and Smart Mobility (CSCI-RTSC); Big Data and Data Science (CSCI-RTBD); Education - CS & CE (CSCI-RTED); Health Informatics and Medical Systems (CSCI-RTHI); Mobile Computing, Wireless Networks, & Security (CSCI-RTMC); Software Engineering (CSCI-RTSE); Internet of Things & Internet of Everything (CSCI-RTOT); Social Network Analysis, Social Media, & Mining (CSCI-RTNA); Cloud Computing and Data Centers (CSCI-RTCC); Parallel & Distributed Computing (CSCI-RTPD); and Signal & Image Processing, Computer Vision & Pattern Recognition (CSCI-RTPC).

The main objective of the CSCI Conference is to facilitate increased opportunities for cross-fertilization across CS and CI. The CSCI Conference is committed to encouraging diversity and eliminating discrimination in both its role as a conference and as a provider of services. CSCI aims to create a culture that respects and values each others' differences, that promotes dignity, equality and diversity, and that encourages individuals to develop and maximize their true potential. We are committed wherever practicable to organizing a conference that broadly reflects the international community. We hope that we have achieved these important objectives.

The Steering Committee and the Program Committee would like to thank all those who submitted papers for consideration. The conference had paper submissions from 64 countries. About 58% of the submissions were from outside the United States. Each submitted paper was peer-reviewed by at least two experts in the field for originality, significance, clarity, impact, and soundness. In cases of contradictory recommendations, a member of the conference program committee was charged to make the final decision; often, this involved seeking help from additional referees. In addition, papers whose authors included a member of the conference program committee were evaluated using the double-blinded review process. One exception to the above evaluation process was for papers that were submitted directly to chairs/organizers of sessions/workshops; in these cases, the chairs/organizers were responsible for the evaluation of such submissions. The overall paper acceptance rate for regular and short

papers was 18%; and 26% of the remaining papers were accepted as extended abstract (poster) papers (at the time of this writing, we had not yet received the acceptance rate for three research tracks.)

We are very grateful to the many colleagues who offered their services in organizing the conference. In particular, we would like to thank the members of the Program Committee and the Steering Committee of CSCI'23. The members of the committees will be requested (after the conference) to provide their expertise and services for selecting papers for publication (extended versions) in various research book series (to be prepared for publishers including: Springer, Elsevier, De Gruyter, and others). We would also like to thank the main sponsor of the conference: American Council on Science & Education.

We express our gratitude to all speakers and authors - the list of speakers appears in the conference schedules. We would also like to thank the followings: the staff of the Luxor hotel (Conference division); and Conference Publishing Services of IEEE Computer Society production editors and managers: Javier Gurrola, Patrick Kellenberger, Jennifer Carruth, and Tricia Yamaguchi.

We present the proceedings of CSCI'23.

Professor Hamid R. Arabnia - Editor-in-Chief, The Journal of Supercomputing (Springer Natgure); Fellow & Adviser of Center of Excellence in Terrorism, Resilience, Intelligence & Organized Crime Research (CENTRIC); Professor Emeritus of Computer Science, The University of Georgia, Georgia, USA

Professor Leonidas Deligiannidis - Professor, School of Computing and Data Science, Wentworth Institute of Technology, Boston, Massachusetts, USA

Professor Fernando G. Tinetti - Facultad de Informatica, Universidad Nacional de La Plata, La Plata, Argentina; Researcher CIC Prov. Bs. As., Argentina; Recipient of the NSF-TCPP Early Adopter Award, NSF/IEEE-TCPP Curriculum Initiative on Parallel and Distributed Computing

Professor Quoc-Nam Tran – Department of Computer Science, Southeastern Louisiana University, Louisiana, USA

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Conference Organization – CSCI 2023

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Professor Leonidas Deligiannidis - Professor, School of Computing and Data Science, Wentworth Institute of Technology, Boston, Massachusetts, USA

Professor Fernando G. Tinetti - Facultad de Informatica, Universidad Nacional de La Plata, La Plata, Argentina; Researcher CIC Prov. Bs. As., Argentina; Recipient of the NSF-TCPP Early Adopter Award, NSF/IEEE-TCPP Curriculum Initiative on Parallel and Distributed Computing

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Note that the title of papers and authors' names that appear in the "Book of Abstracts" were extracted from the papers that were submitted to the EVALUATION web site. The official published proceedings/book will have any and all changes/revisions that authors may have done to the title and/or authors lists in the final version of their manuscripts.

KEYNOTE LECTURES

Collaborative Attacks and Defense

Prof. Bharat Bhargava
IEEE Fellow
Purdue University
Department of Computer Sciences, West Lafayette, Indiana, USA

Abstract – Flying Ad Hoc Networks (FANETs) are becoming increasingly crucial in a variety of civil and military applications, including wildfire monitoring and suppression, search and rescue operations in hazardous scenarios, and transport of supplies or personnel to remote locations. Going beyond protecting FANETs from single forms of attacks, we address collaborative attacks (CA) within these networks. A collaborative attack occurs when attackers synchronize their malicious actions against a target FANET. The collaboration can occur simultaneously, where multiple attackers attempt to compromise the system at the same time or split in time where one attacker gathers the information about the network and subsequently another attacker executes the actual exploit. We are developing a systematic understanding of the threats imposed by collaborative attacks along with the formulation of intelligent and effective defenses.

Integrating Advanced AI Algorithms with Scientific Articles; Large Language Models (LLMs) and Beyond

Dr. Soheyla Amirian
Faculty Fellow, The Institute for Artificial Intelligence;
Faculty Lecturer, School of Computing, University of Georgia;
Director, Applied Machine Intelligence Initiatives & Education (AMIIE) Lab.;
2023 IEEE Atlanta Section Outstanding Educator awardee;
The University of Georgia, School of Computing, Athens, Georgia, USA

Abstract - Scientific articles are truly a treasure trove of information, thus extracting meaningful facts and insights from the large columns of such data is critical for scientific progress and innovation. Leveraging advanced artificial intelligence (AI) algorithms is now transforming the way we interact with vast repositories of scientific literature. Large Language Models such as ChatGPT- along with advanced word embedding strategies have revolutionized the way we understand and interact with that text data, enabling tasks like automated summarization, named entity recognition, question answering, and content generation. This talk aims to explore the integration of Large Language Models (LLMs) and word embeddings with large-scale scientific articles, focusing on a case study in healthcare using data from PubMed, unlocking the full potential of scientific articles to advance clinical research.

The Future is Here: Towards an AI driven Operating System Using Object Messaging and Intelligent Objects (OMIO)

Massoud Alibakhsh
Co-Founder & CEO
OMADEUS
Atlanta, Georgia, USA

Abstract—The proliferation of AI tools, such as ChatGPT and other Large Language Models (LLMs), has raised expectations regarding their widespread adoption and the future of automation. The hype and expectations suggest futuristic and truly intelligent machines with which humans interact using only natural language and thereby ending the need for traditional UIs where users have to direct and manage information processing. The current market trajectory suggests that most financial and expert human resources are focused on improvements of LLMs (more parameters and faster processing) towards achieving this goal. However, this talk delves into the limitations and shortcomings of LLMs which makes achieving this goal highly unlikely if not impossible. We discuss and base this conclusion mainly on the lack of reliability of the generative part of LLMs and the challenges of adopting workflows. Instead we present a new model where a collection of intelligent agents/programs based on OMIO with focused access to constrained datasets such as a person's banking information or a diet plan are arranged within an OMIO based operating system. This is similar to current mobile platforms but the apps will be rewritten with OMIO and the OS is also OMIO based. In this way, the operating system can communicate with the user and the installed apps using natural language. The OS executes the user's wishes using available specialized apps on its platform. The Object Messaging and Intelligent Objects paradigm offers an elegant path for deep integration of LLMs and software applications with structured data, while optimizing communication among humans in the workplace producing human and AI collective intelligence.

Explaining and Applying Grover's Quantum Algorithm

Prof. Leon Deligiannidis
Wentworth Institute of Technology, Boston, Massachusetts, USA

Abstract - Quantum Computing is a groundbreaking technology that exploits the laws and properties of quantum mechanics. It can dramatically speed up computations of certain problems and surpass the computation power of modern supercomputers. One notable quantum algorithm that is used to search an unstructured database is Grover's algorithm. It provides quadratic speedup compared to its classical counterpart. In this tutorial we will explain and illustrate the theoretical and implementational challenges and provide examples and solutions.
Code Repository: https://github.com/Leon-WIT/Grover

CSCI-RTAI: ARTIFICIAL INTELLIGENCE

A Siamese Network for Autonomous Classification of Battlefield Ground Vehicles Using Acoustic Data

Yao Houkpati, Kenneth M'.Bale, Marvin Conn, Geoffrey Goldman, Tung-Duong Tran-Luu, Sreenivasan Ramasamy Ramamurthy, Darsana Josyula
Department of Computer Science, Bowie State University, Bowie, Maryland, USA;
US Army Research Laboratory, DEVCOM, Adelphi, Maryland, USA

Abstract—Ground vehicle detection and classification are vital tasks in traffic monitoring and military surveillance. Acoustic emissions from vehicles are often used to classify the type of vehicle that produces them. Nevertheless, acoustic signals are susceptible to environmental factors, such as temperature, terrain, wind conditions, and vehicle characteristics. Such variations introduce substantial uncertainties that can undermine the effectiveness of classification algorithms. One approach to address these challenges is by extracting distinctive patterns from acoustic emissions recorded under various environmental conditions. However, this hinges on the availability of large and diverse training datasets, which most often are not available. This paper proposes a Siamese neural network (SNN) model trained with limited data for ground vehicle classification. Mel Frequency Cepstral Coefficients (MFCC) computed from the time domain acoustic signals are used as inputs to carry out training and inference with the SNN. Results obtained using the Acoustic-seismic Classification Identification Data Set (ACIDS) demonstrate that our proposed model outperforms previous work, with an accuracy of over 97%.

Examining GPT-4: Capabilities, Implications and Future Directions

Edward Y. Chang
Computer Science Department, Stanford University, California, USA

Abstract—This study provides a comprehensive analysis of large language models (LLMs), specifically emphasizing the architectural innovations in GPT-4. As epitomized by GPT4, LLMs have brought transformative changes to the domain of natural language processing, demonstrating exceptional performance in various tasks like machine translation, question answering, analysis, and text summarization. Initially, this paper explores the distinctive features of GPT-4, highlighting its "polydisciplinary" and "polymodal" representations, the balance between pre-training and post-training for human-value alignment, and the synergistic relationship between human expertise and data. Subsequently, we introduce proposals to harness the full potential of LLMs in establishing a "consciousness layer" for knowledge discovery, reasoning, validation, and critical evaluation. In particular, we introduce our layer, SocraSynth, which is a collaborative committee of humans and LLM-agents. Within this setup, they engage in discussions, debates, and formulate resolutions under human oversight and direction. The impressive capabilities exhibited by LLMs, coupled with the innovative SocraSynth platform we have devised for rigorous reasoning, present invaluable insights for the wider AI community. These insights underline the potential of developing collaborative humancomputer multi-agent systems to push the boundaries of our current knowledge base.

Large Language Model-Based Representation Learning for Entity Resolution using Contrastive Learning

Bi T. Foua, John R. Talburt, Xiaowei Xu
Department of Computer Science, University of Arkansas at Little Rock, Arkansas, USA;
Information Science Department, University of Arkansas at Little Rock, Arkansas, USA

Abstract— Representation learning has been a transformative force in computer vision and information extraction, offering a paradigm shift in how we understand and process data. In this study, we introduce TriBERTa, which, to the best of our knowledge, marks the first representation learning approach tailored meticulously for entity resolution (ER). TriBERTa is engineered to learn representations that inherently group similar entities together while separating dissimilar ones, forming a foundational asset that can be leveraged across all steps of the ER process, including entity matching, data blocking, and data resolution. Although our evaluation is centered around entity matching, the essence of our approach demonstrates the versatility and applicability of representation learning to all facets of ER. Our empirical evaluations span multiple datasets, each with its unique challenges, providing a robust platform for assessing TriBERTa's efficacy. TriBERTa's learned representations not only set new benchmarks in entity matching but also consistently outperform state-of-the-art representations, including those derived from large language models and conventional Term Frequency-Inverse Document Frequency (TF-IDF). Furthermore, when compared with dedicated end-to-end entity matching crossencoders models, TriBERTa's representations exhibit heightened robustness, consistently delivering superior performance across various datasets. It's paramount to emphasize that our primary contribution lies in the realm of representation learning, with the entity matching results serving as a testament to its efficacy, versatility, and potential applicability in broader entity resolution tasks.

Microarchitecture Characterization and Analysis of Emerging Neuro-Symbolic A.I. Workloads

Patrick M. Stockton, Cory Davis, Eugene B. John
The University of Texas at San Antonio, San Antonio, Texas, USA

Abstract—The emergence of neuro-symbolic A.I. (NSAI) workloads introduces a new and powerful approach to artificial intelligence by combining deep learning techniques with traditional rules-based approaches. Dedicated research to better understand and enhance these NSAI models is needed as they are emerging as a major field in AI. Examples of NSAI models analyzed in this paper are the Neural Logic Machine (NLM) and the Logic Tensor Network (LTN). Given that neuro-symbolic models are still an evolving research area, the performance characteristics remain insufficiently understood. Conducting an analysis of the performance characteristics of NSAI workloads offers valuable insights into potential avenues for accelerating and enhancing the performance of these models. By examining the microarchitecture performance characteristics of the NSAI models, including compute workload, memory workload, schedule statistics, warp state statistics, and executed instruction mix, a deeper understanding of the internal mechanisms of these NSAI models can be gained. The obtained performance characteristics have the potential to facilitate improvements in L1 and L2 cache hit rates, issue latency, execution latency, IMC and scoreboard stalls, and other microarchitecture opportunities. In this paper, we explore the promising acceleration design opportunities of the NLM and LTN through the analysis of their microarchitecture performance and characterization.

Enhancing Drug Safety Documentation Search Capabilities with Large Language Models: A User-Centric Approach

Jeffery L. Painter, Olivia Mahaux, Marco Vanini, Vijay Kara, Christie Roshan, Marcin Karwowski, Venkateswara Rao Chalamalasetti, Andrew Bate GlaxoSmithKline, Durham, North Carolina, USA; GlaxoSmithKline, Wavre, Belgium; GlaxoSmithKline, London, UK; GlaxoSmithKline, Poznan, Poland

Abstract—Integrating Large Language Models (LLMs) to enhance complex business document retrieval represents an emerging field known as retrieval-augmented generation (RAG). In highly regulated domains like drug safety (pharmacovigilance), its application has remained largely unexplored. This technology brings numerous advantages, including expedited staff onboarding, enhanced comprehension of contextual queries, and swift information retrieval through natural language inquiries, surpassing conventional keyword searches. This study delves into various operational tasks, such as locating regulatory process guidance, navigating intricate scenarios for advice, and ensuring the LLM's competence in recognizing uncertainties to prevent misinformation. LLMs empower users to engage with documentation using natural language, markedly improving search efficiency. The case study underscores LLM's effectiveness in delivering prompt guidance within pharmacovigilance and adverse event processing and reporting, offering a user-centric solution that streamlines the search for intricate business documentation.

Train Once, Match Everywhere: Harnessing Generative Language Models for Entity Matching

Bi T Foua, Xingqiao Wang, John Talburt, Xiaowei Xu
Department of Computer Science, University of Arkansas at Little Rock, Arkansas, USA;
Information Science Department, University of Arkansas at Little Rock, Arkansas, USA

Abstract— Generative Large language models (LLMs), such as OpenAI's GPT-3, have demonstrated remarkable success in various natural language processing (NLP) tasks by generating human-like content. One significant advantage of these models is their ability to generalize across different domains without further fine-tuning. This paper investigates the applicability of Generative LLMs for entity matching, a crucial task for entity resolution and data quality. We initiated our study by aligning our methods with traditional research protocols: training and testing LLMs, specifically OpenAI's base GPT-3 (ada) and DataBricks opensource model Dolly 2.0, on domain-specific datasets. In this conventional approach, both models showcased commendable performance, exceeding that of other established methods in many tasks. In the paper's innovative pivot, we introduced a unique approach: training the model on a single dataset and then testing its applicability across a spectrum of different domain datasets. This approach yielded noteworthy results, marking a pioneering step in the domain of entity matching research. Although the outcomes didn't consistently outperform traditional domain specific models, they underlined the potential versatility of LLMs in entity matching. Additionally, we delve into a detailed analysis of the differential performance across datasets, shedding light on factors that contributed to varying results. Our findings suggest that the proposed approach has the potential to significantly impact the field of entity matching by providing a robust and scalable solution that can be applied across multiple domains.

An Endless Outpainting Tool Based On Stable Diffusion

Peter Garrity, Leonidas Deligiannidis
School of Computing and Data Science, Wentworth Institute of Technology, Boston, Massachusetts, USA

Abstract - We developed a tool that utilizes the capabilities of machine learning to explore the possibilities of image outpainting. Our tool is built around an image generation model based on Stable Diffusion and provides an easy-to-use command-based interface. The command-line interface allows us to generate an endless set of images.

It starts with a given image, and after the outpainting process, it feeds the generated image as input to the next iteration. To preserve the original image's dimensions, before feeding an image as input to the next iteration, we scale it down so that the generated images are the same dimensions as the original image. By using several iterations like this, we can repeatedly create new details around the edge of an input image.

Mid-Term Seasonal Arctic Sea Ice Concentration Forecasting Based on CNN-ConvLSTM and Wavelet Multi-Scale Deep Learning Algorithms

Andrew Li, Xiaodi Wang
Western Connecticut State University, Danbury, Connecticut, USA

Abstract—Mid-term seasonal Arctic sea ice concentration forecasts are vital for navigation routing, policy-making, and predicting cetacean migrations for safety reasons. The accuracy of such predictions typically declines with extended lead times. Notably, forecasting during the melting season presents more challenges than the freezing season, due to sea ice thinning. In this research, we try to address these challenges by employing convolutional neural networks (CNN) and convolutional long shortterm memory networks (ConvLSTM) in M-band wavelet domain and integrating three-dimensional spatio-temporal climate and sea ice data for enhancing mid-term sea ice concentration (SIC) forecast. Our experimental results revealed that ConvLSTM consistently surpassed CNN. Moreover, the inclusion of climate variables, expanded historical data, and pre-processing of our spatial data with M-band wavelet transform further enhanced model efficacy.

The Challenge of Partial Grounding in Constraint Compliance

Steven Jones, Robert E. Wray
Center for Integrated Cognition, IQM Research Institute, Ann Arbor, Michigan, USA

Abstract—Autonomous AI systems that act and interact in human environments must generally comply with systems of rules, laws, norms, and moral principals that humans are expected to abide by. One of the core challenges of maintaining compliance of such systems of constraints is that the current situation (as perceived and experienced by an agent) may be insufficient for immediately determining whether the agent is in compliance with any one of its (often many) individual constraints. We term this problem partial grounding of constraint specifications: in many situations, an agent will only be able to partially ground its evaluation of constraints. We define this problem, describe some requirements for mitigating it, and present a specific computational approach. The approach enables an agent to anticipate potential grounding issues when constraints are introduced. The anticipatory processing then allows an agent to more quickly respond to novel instances of partially-grounded constraint specifications when/as they arise in execution. The approach is assessed in the context of an analytic tool proposed to help researchers compare and evaluate various approaches to grounding in intelligent systems.

Offline Multi-Agent Reinforcement Learning in Custom Game Scenario

Indu Shukla, William R. Wilson, Althea C. Henslee, Haley R. Dozier
United States Army Corps of Engineers, Vicksburg, Mississippi, USA;
Louisiana Tech University, Ruston, Louisiana, USA

Abstract—Offline reinforcement learning (RL) has received considerable attention in recent years due to its attractive capability of learning policies from offline datasets without environmental interactions. The goal of this research is to establish a proof of concept for offline Multi-Agent Reinforcement Learning (OMARL) for combat simulations. Although MARL has made some impressive progress in recent years, OMARL is still a relatively

under explored area. Here in this paper we researched if we can apply OMARL in custom game environment and if we can transfer this learning to pre-collected dataset from combat simulation for a very simplified scenario with no further environmental interaction. To get a complete understanding of how the OMARL works, we first worked on custom multi-agent grid environment for 2 agents where during the learning process, each agent needs to identify the environment dynamics as well as cooperate with other agent and agent are expected to learn a new policy from a single static dataset of previously collected data generated by random actions. Real world Mission planning is complex and involves multi-agent system therefore, our precollected dataset mission were restricted to motion and actionplanning in discrete grid environment.

Creation and Analysis of a Natural Language Understanding Dataset for DoD Cybersecurity Policies (CSIAC-DoDIN V1.0)

Ernesto Quevedo, Ana Paula Arguelles, Alejandro Rodriguez, Jorge Yero,
Dan Pienta, Tomas Cerny, Pablo Rivas
School of Engineering and Computer Science, Department of Computer Science,
Baylor University, Waco, Texas, USA;
Business School, Department of of Business, University of Tennessee, Tennessee, USA;
School of Engineering and Computer Science, Department of Computer Science,
University of Arizona, Arizona, USA

Abstract—Recent studies in Legal NLP showed the lack of structured data to train Deep Learning models in several tasks. With the increased importance of privacy policies in the current digital world, the research community released multiple datasets related to privacy policies in the last few years. However, other empirical studies have shown the lack of transferability between domain-specific language models in a legal subdomain to other more separate subdomains. With the focus on privacy policies, models are not tested on other policies. In this work, we release the CSIAC-DoDIN V1.0 dataset, focused on cybersecurity policies, responsibilities, and procedures of the organizations involved. This first version offers classic Legal NLP tasks such as several Multiclass Classification tasks and text co-occurrence. Furthermore, we also provide a baseline for this dataset and tasks with experiments using classic transformer-based language models such as BERT, RoBERTa, Legal-BERT, and PrivBERT.

The Utility of Feature Reuse: Transfer Learning in Data-Starved Regimes

Rashik Shadman, M.G. Sarwar Murshed, Edward Verenich, Alvaro Velasquez, Faraz Hussain
Clarkson University, Potsdam, New York, USA;
Air Force Research Lab, Rome, New York, USA;
University of Colorado Boulder, Boulder, Colorado, USA

Abstract - The use of transfer learning with deep neural networks has increasingly become widespread for deploying well-tested computer vision systems to newer domains, especially those with limited datasets. We describe a transfer learning use case for a domain with a data-starved regime, having fewer than 100 labeled target samples. We evaluate the effectiveness of convolutional feature extraction and fine-tuning of overparameterized models with respect to the size of target training data, as well as their generalization performance on data with covariate shift, or out-of-distribution (OOD) data. Our experiments demonstrate that both overparameterization and feature reuse contribute to successful application of transfer learning in training image classifiers in data-starved regimes. We provide visual explanations to support our findings and conclude that transfer learning enhances the performance of CNN architectures in data-starved regimes.

A Deep Reinforcement Learning based Approach for Bridge Health Maintenance

Divija Swetha Gadiraju, Surya Rajalakshmi Muthiah, Deepak Khazanchi
University of Nebraska at Omaha, Nebraska, USA

Abstract—This work proposes an DRL based solution to the bridge health monitoring problem to determine cost-effective and hazard-reducing repair methods for deteriorated bridges. There is a need for efficient maintenance schedules that utilize the available offline data. To address this, a deep reinforcement learning (DRL)-based model is introduced to enhance Nebraska bridge maintenance throughout the bridge life-cycle. The DRL agent utilizes the provided offline data to predict optimal maintenance activities. By considering budget limitations, the DRL algorithm generates an optimized maintenance plan, aiming for maximum cost-effectiveness. This approach incorporates structural degradation and the impact of maintenance operations over time by employing probabilistic models to simulate the stochastic process. We propose an algorithm using reinforcement learning for bridge maintenance. We leverage Double Deep Q-Learning Network with Dueling Architecture called D3QN for our DRL approach. The results show that the best maintenance techniques learned are within the specified budget limits and maximize the life-cycle cost-effectiveness of maintenance operations. Furthermore, the proposed D3QN outperforms traditional techniques like Dueling Deep Q networks (DDQN) and heuristic algorithms. D3QN can achieve faster reward convergence and can achieve 75% better life cycle cost utilization compared to the heuristic algorithm.

A Novel Use of Reinforcement Learning with Thompson Sampling for Predicting Click-Through Rates in Online Advertising

Beytullah Yildiz, Umair Haider
Atilim University, Ankara, Turkey

Abstract—Click-through rate (CTR) prediction plays a vital role in online advertising, influencing advertisement display and advertiser cost. However, traditional methods struggle to encapsulate user preference dynamics and advertisement relevance. To address this limitation, reinforcement learning (RL) algorithms, such as Thompson Sampling, offer a promising solution by effectively balancing the exploration of new strategies with the exploitation of successful ones. In this research, we introduce a novel RL-based approach for CTR prediction which involves a custom OpenAI Gym environment to simulate real-world advertisement impressions and clicks, and an implementation of Thompson Sampling to estimate CTR dynamically, addressing the continuous evolution of user preferences and advertisement relevance. Results showed that Thompson Sampling demonstrated superior performance in CTR prediction, outperforming other RL strategies. Notably, the algorithm exhibited a confidence level nearly 10% higher than other methods. Our findings suggest that leveraging RL algorithms, particularly Thompson Sampling, can significantly enhance online advertisement selection processes, leading to higher CTRs and potentially increased revenue for publishers.

LSTM-CNN: Network for Audio Signature Analysis in Noisy Environments

Praveen Damacharla, Hamid Rajabalipanah, Mohammad Hosein Fakheri
KineticAI Inc., The Woodlands, Texas, USA;
Electrical Engineering, Iran University of Science and Technology, Tehran, Iran

Abstract—There are multiple applications to automatically count people and specify their gender at work, exhibitions, malls, sales and industrial usage. Although current speech detection methods supposed to operate well, in most situations in addition to genders, the number of current speakers is unknown and the classification methods

are not suitable due to many possible classes. In this study, we focus on a Long-Short-Term Memory Convolutional Neural Network (LSTM-CNN) to extract the time- and/or frequency-dependent features of the sound data for estimating the number/gender of simultaneous active speakers at each frame in noisy environments. Considering the maximum number of speakers as 10, we have utilized 19000 audio samples with diverse combination of males, females, and background noise in public city, industrial situations, malls, exhibitions, work places, nature for learning purpose. This proof of concept shows promising performance with training/validation MSE values of about 0.019/0.017 in detecting count and gender.

A Method for Recovering on Unsupervised Domain Adaptation Models Compression

Shou-Ping Wang, Erh-Chung Chen, Meng-Hsuan Yang, Che-Rung Lee
Department of Computer Science, National Tsing Hua University, HsinChu, Taiwan

Abstract—Unsupervised domain adaptation (UDA) aims to transfer learned knowledge from a source domain with labeled data, to a target domain with unlabeled data. For practical uses, UDA models are usually compressed to fit into smaller devices. However, previous work on UDA compression cannot obtain satisfactory accuracy after the compression and fine tuning. Our study shows one of the major reason is the increases of domain discrepancy during the fine tuning process. To recover the model accuracy for the target domain data, we propose a two-step fine-tune strategy: the first step is like ordinary tuning process whose goal is to reduce the classification error; the second step is designed to suppress the growth of domain discrepancy. We propose a sampling technique to estimate domain discrepancy of the pruned model, and use it in the loss function of the second step. We validated the performance of our method on ImageCLEF-DA, Office-31 and Office-home datasets. The results show that our method reaches higher average accuracy than previous work, especially for the unbalanced dataset, such as Office-31.

Leadership Challenges and Strategies in the Era of AI Transformation

Satpreet Singh
National University, San Diego, California, USA

Abstract - In an era characterized by rapid technological advancements, the integration of artificial intelligence (AI) into organizational landscapes has emerged as a transformative force. This research paper examines the intricate relationship between leadership and AI-driven transformations, shedding light on the challenges and strategies that leaders must navigate to harness the potential of AI while ensuring sustainable growth. The paper identifies the shifting role of leadership in AI-integrated environments, emphasizing the importance of adaptive leadership that can effectively respond to dynamic technological shifts. Leaders who are implementing AI-driven changes face several challenges, including addressing concerns related to job displacement, promoting ethical decision-making in AI systems, and managing the balance between human and AI collaboration. To help leaders tackle these challenges, the article suggests several strategies, such as fostering a culture of continuous learning, developing ethical AI guidelines, building transparency and trust in AI decision-making processes, and improving emotional intelligence to manage human-AI interactions.

Three-way Clustering: An Advanced Soft Clustering Approach

JingTao Yao
Department of Computer Science, University of Regina, Canada

Abstract—Clustering is a machine learning technique that assigns unlabelled data points into different groups based on similarity of data. However, in many cases, we are unable to confidently assign some data points to

particular clusters. Soft clustering introduces a probability of the data point belonging to different clusters. Three-way clustering is a recent development of soft clustering based on three-way decisions. In particular, each data point is assigned a value to represent if it is inside, outside, or partial inside a cluster. There are two types of three-way clustering techniques, namely evaluation-based approaches and operation-based approach. The evaluation-based approaches rely on a membership function to calculate the degree of a data point belonging to a cluster. The operator-based approaches use a pair of operators to construct a three-way cluster from a hard two-way cluster. We will introduce, review, and analysis various three-way clustering techniques in this paper. In addition, history of threeway clustering and future development of three-way clustering will also be discussed.

A Transfer Learning-Based New User Recognition for Minimizing Retraining Time in Edge Deep Learning

Dong Hyuk Heo, Soon Ju Kang
School of Electronic and Eletrical Engineering, Kyungpook National University,
Daegu, Republic of Korea

Abstract—Manually adding new users can ensure high accuracy, but it is a cumbersome process. Recent research is focused on methods for automatically detecting and adding new users. Researchers consider high-performance servers essential because they utilize massive deep learning models to ensure accuracy. Moreover, obtaining a substantial amount of new user data requires both the edge node and the server to consume a significant amount of time during data exchange. To address this, researchers have explored various methods, such as conducting online learning on the edge node. However, there are many constraints due to the resource limitations of the edge node. Thus, this paper suggests a system where learning takes place on the server, and all other functions are carried out on the edge node. The proposed system suggests the use of the transfer learning method to minimize the time required for adding new users with a high similarity foot pressure dataset. Through this method, the required amount of new user data for retraining was reduced by 25%. Additionally, a system was developed to dynamically update the deep learning model received from the server in realtime on the edge node. As a result, using a model trained on the existing 10 users as a basis, retraining 10 new users with 140 training data each achieved a recognition performance of 86% for 20 users. Additionally, it was shown that by reducing the training data, it is possible to add a new user within 7.7 minutes, which is an 80% decrease in time.

Classification of Information Display Types using Graph Neural Networks

Yuehan Yin, Michael P. Mcguire, Yahya Alqahtani, Jinjuan Heidi Feng, Joyram Chakraborty
Department of Mathematics and Computer Science, La Salle University, Philadelphia, PA, USA;
Department of Computer and Information Sciences, Towson University, Towson, Maryland, USA;
College of Computer Science and Information Technology, Jazan University, Jazan, Saudi Arabia

Abstract—Eye-tracking technology has been applied in many studies, such as visual behavior and usability studies. The collected eye-tracking data has been increasingly utilized with deep learning techniques to solve various machine learning tasks. The aim of this study is to classify eye-tracking data collected from two visual information processing studies using graph neural networks (GNNs) to identify three types of information display. Additionally, data-preprocessing and feature engineering techniques are applied to convert the eye-tracking data into graphs with a certain number of features. This study also explores how feature engineering affects the evaluation metrics of the neural network models used in the study. The best results came from our GNN model trained using feature engineered input, which achieved a test accuracy of 90.14%, a precision total of 90.92%, a recall total of 88.97%, and an F1 scoretotal of 89.82%. Furthermore, it demonstrates the promise of GNNs in eyetracking data analysis by allowing the classification of large numbers of eye-tracking results.

Toward Gamification Design of Molecular-Level Filters through Reinforcement Learning of Blackjack

Ron Coleman, Bashir Dahir
Computer Science Department, Marist College, Poughkeepsie, New York, USA

Abstract—In this paper, we study reinforcement learning of optimal Blackjack strategies on the GPU as an initial step in the gamification design of molecular-level filters for the desalination/depollution problem. We show that through running approximately 30 billion heads-up games, this approach achieves linear speedup greater than 1,000X with computational efficiency exceeding 99%. The data furthermore indicates that the evolved composite Blackjack strategy favorably compares with the known optimal solution.

An Evaluation of Tiered Machine Learning Framework to Predict Science Achievement among Singapore Students

Khanh Linh Nguyen, Ta'Rhonda Mayberry, Yang Liu, Myint Swe Khine, Vivek K. Pallipuram School of Engineering and Computer Science, University of the Pacific, Stockton, California, USA; Shanghai Maritime University, Shanghai, China; Curtin University, Bentley, Australia

Abstract—There is a significant interest in the education community to use machine learning (ML) techniques to model students' achievement as a function of non-cognitive factors. In this research, we present a tiered machine learning framework designed for educators to apply ML and classify student achievement. The framework comprises three components including SMOTE balancer, a council of selectors, and a suite of learners. The SMOTE balancer removes any data imbalances, thereby reducing ML bias. The council of selectors collectively votes to elect the top three features for effective model training. The suite of classifiers comprises popular ML models that train using the selected features. The suite of classifiers also includes a combiner, which uses ML performance metrics and users' analysis preferences to select an effective model for classification. Using the Trends in International Mathematics and Science study (TIMSS) data on Singapore students, we evaluate the framework and achieve up-to-par prediction results, despite the low correlation between the dependent variable and features. Our goal is to offer educators an easy-to-use ML framework that assists with the analysis of large education data.

Neural Network Structure for Tracking the Climate Temperature Change

Irina Topalova, Pavlinka Radoyska
Department Information Technology, University of Telecommunication and Post, Sofia, Bulgaria

Abstract— Tracking temperature changes in certain geographic regions is a current task in modern research on Earth's climate changes. One of the global problems in solving this task is related to the large volume of measured data and the search for appropriate methods for effective determination of changes. The purpose of this research is to track climate temperature changes using a machine learning-based automated change detection method. The presented method includes training of a two-level structure of neural networks, with measured temperatures for a ten-year period of time for a certain geographical region. In the testing phase, the neural structure classifies measured temperatures for two three-year periods, before and after the ten-year time period, respectively, for the same geographic region. An algorithm was developed to visualize the studied regions by creating an interactive map with their geographic coordinates. The classification results in the neural structure outputs are presented and analyzed as possible temperature changes. Suggestions for continuing and expanding the research in the future are discussed.

Enhancing the K-means Algorithm Using Cluster Adjustment

Fadi Yamout
Computer Science and Information Technology, Lebanese International University, Beirut, Lebanon

Abstract— Clustering algorithms are employed to identify patterns within datasets. One widely recognized clustering technique is the k-means algorithm, which divides objects into k distinct clusters. An improved k-means algorithm variant is kmeans++ and DK-means, incorporating a heuristic approach to determine the initial centroids. This paper introduces IDK-means, which aims to enhance the process of deriving the initial centroids for the k-means method. The IDK-means algorithm is derived from the DK-means algorithm, with the key modification of improving information collection within a cluster. Additionally, it employs a heuristic approach to find the optimal centroids. The new technique is evaluated against the baseline on datasets of varying sizes and types of transactions.

Leveraging Chatbots for Mental Health Enhancement

Anthony Diaz, Daehan Kwak
Department of Computer Science and Technology, Kean University, Union, New Jersey, USA

Abstract—The Covid-19 pandemic has disrupted work, education, health care, the economy, and relationships, with some groups more negatively impacted than others. Many find themselves needing mental health help and advice, but they may run into issues getting help due to their location or a lack of funds. Mental health treatment can move to a virtual setting using an Emotional Assistant Chatbot to provide a supportive presence to service users, engaging them with a conversation at times when they feel low. The proposed chatbot would take a voice journal from the user daily and convert speech to text, as well as apply natural language processing techniques to provide the user with a mental health report and mental health advice. This is a tool that could also be used to track the mental health status of their patients to offer more accurate treatments. The user's speech is analyzed and associated with ten emotions such as anger and happiness, saved on a journal CSV file to create a mental health report. This study will conduct a literature review of current academic research regarding chatbots for mental health use and proposes the implementation of the mental health chatbot system.

Prediction of Credit Defaults based on Weight Dimensionality Reduction Neural Network and M-Band Discrete Wavelet Transform

Alejandro Mayorga, Letian Wang, Xiaodi Wang, Wenke Sun
Western Connecticut State University, Danbury, USA;
Dalian University of Technology, Dalian, China

Abstract— Credit defaults of companies affect many people and firms such as investors that include the individuals and entrepreneurs looking to find the next Apple or companies looking to support small companies. These defaults can be predicted and analyzed using financial information and statistics. However, to perform a careful analysis of each one of the companies in the world is a big challenge. A system which is already trained and takes financial information and returns a credit default is the best for this task. In this research, we propose a novel weight dimensionality reduction neural network (WDR-NN) to better suit such task. We first implemented M-band discrete wavelet transform (MDWT) to decompose our dataset into M different frequency components to discover some hidden information we would not get otherwise. We then used dimensionality reduction techniques such as Uniform Manifold Approximation and Projection (UMAP), Wavelets, PCA, convolutions and Max Pooling to generate a new neural network and then pass relevant information that is in a reduced dimension but preserves the overall structure of the network's weights. In our research, two Datasets were used: England Companies Binary Classification of whether the company went bankrupt at some point and Moody's and Fitch Credit Defaults using binary classification to see if their rating by the agency was higher than a given threshold.

The results have shown that our WDR-NN model outperformed a regular neural network by yielding a 13% accuracy increase in predicting Company fraud as binary classification. We also utilized Shapley Values on our WDR-NN and find that Operating Cash Flow Share and Days of Sales outstanding are the two most important features in determining a company's default. Our WDR-NN model beats traditional methods such as Least Discriminant Analysis, Logistic Regression, Decision Trees and Support Vector Machine in various metrics on both datasets.

Voice Signature Recognition for UAV Pilots Identity Verification

Mokhles M. Abdulghani, Wilbur L. Walters, Khalid H. Abed
Jackson State University, Jackson, Mississippi, USA

Abstract—Employing deep learning as a soft computing tool encouraged researchers to design intelligent systems that mimic human behavior. Speaker identification is a computing task to validate the user claimed identity using features extracted from his voices. These unique features allow researchers to identify a human's voice using different machine learning techniques that are proved to be efficient in the areas of voice recognition, especially for security purposes. Unmanned Aerial Vehicles (UAVs) have gained noticeable attention in recent years for a variety of applications. Simplifying the UAVs control system by adding a voice recognition add-on will allow larger segment of people to enjoy and benefit from such a practical technology. However, a designer should take care of the security and privacy of the user and make sure that the voice recognition system responds only to the voice of the owner. Therefore, we propose, in this paper, a speaker identity verification add-on for security and privacy of voice-controlled UAVs using a small size dataset. The speaker identity verification was implemented in two stages: extracting features from short time recorded audio clip by computing Mel-Frequency Cepstral Coefficients (MFCCs) and applying a feature matching. The results showed a high identity verification accuracy, which makes the proposed approach is a practical add-on to be used for the security purposes of voice-controlled UAVs.

Spatio-Temporal Attention Graph Neural Network for Remaining Useful Life Prediction

Zhixin Huang, Yujiang He, Bernhard Sick
Intelligent Embedded Systems, University of Kassel, Kassel, Germany

Abstract—RUL prediction plays a crucial role in the health management of industrial systems. Given the increasing complexity of systems, data-driven predictive models have attracted significant research interest. Upon reviewing the existing literature, it appears that many studies either do not fully integrate both spatial and temporal features or employ only a single attention mechanism. Furthermore, there seems to be inconsistency in the choice of data normalization methods, particularly concerning operating conditions, which might influence predictive performance. To bridge these observations, this study presents the Spatio-Temporal Attention Graph Neural Network. Our model combines graph neural networks and temporal convolutional neural networks for spatial and temporal feature extraction, respectively. The cascade of these extractors, combined with multihead attention mechanisms for both spatio-temporal dimensions, aims to improve predictive precision and refine model explainability. Comprehensive experiments were conducted on the CMAPSS dataset to evaluate the impact of unified versus clustering normalization. The findings suggest that our model performs state-of-the-art results using only the unified normalization. Additionally, when dealing with datasets with multiple operating conditions, cluster normalization enhances the performance of our proposed model by up to 27%.

Scalable Actions in CNN-based Deep Reinforcement Learning in Finance

Sina Montazeri, Akram Mirzaeinia, Haseebullah Jumakhan, Amir Mirzaeinia
University of North Texas, Denton, Texas, USA

Abstract—The published MLP-based DRL in finance has difficulties in learning the dynamics of the environment when the action scale increases. If the buying and selling increase to one thousand shares, the MLP agent will not be able to effectively adapt to the environment. To address this, we designed a CNN agent that concatenates the data from the last ninety days of the daily feature vector to create the CNN input matrix. Our extensive experiments demonstrate that the MLP-based agent experiences a loss corresponding to the initial environment setup, while our designed CNN remains stable, effectively learns the environment, and leads to an increase in rewards.

Methodologies for Email Spam Classification using Large Language Models

Alejandro De La Noval, Diana Gutierrez, Jayesh Soni, Himanshu Upadhyay, Alexander Perez-Pons
College of Engineering and Computing, Florida International University, Miami, Florida, USA

Abstract—Email spam classification is an issue that has been around almost since the inception of the email. These tricky emails fool individuals into giving them money, personal information, and more. Several models, such as text classification and Machine Learning, have been used for spam email classification. Despite their beneficial and widespread use, Deep Learning models, which are capable of better understanding the nuances of language, have shown incredible promise in this field; they use a transformer architecture that allows the model to grasp complex language concepts and make relationships and patterns for the data presented. Three methods for email scam classification were demonstrated in this work. Here, we compare class explain ability results from zero-shot summarization, model interpretation via feature importance extraction, and model fine-tuning.

CNN-DRL with Shuffled Features in Finance

Sina Montazeri, Akram Mirzaeinia, Amir Mirzaeinia
University of North Texas, Denton, Texas, USA

Abstract—In prior methods, it was observed that the application of Convolutional Neural Networks agent in Deep Reinforcement Learning to financial data resulted in an enhanced reward. In this study, a specific permutation was applied to the feature vector, thereby generating a CNN matrix that strategically positions more pertinent features in close proximity. Our comprehensive experimental evaluations unequivocally demonstrate a substantial enhancement in reward attainment.

Evaluating Ensembled Transformers for Multilingual Code-Switched Sentiment Analysis

Saurav K. Aryal, Howard Prioleau, Gloria Washington, Legand Burge
Computer Science Department, Howard University, Washington DC, USA

Abstract—Sentiment analysis is essential for understanding human-authored texts, especially in multilingual communities where code-switching is common. Most existing research focuses on single-language pair sentiment analysis. We introduce a threestep approach for sentiment analysis on code-switched data: translating the code-switched data into English at word and sentence levels, training on Transformer models, and utilizing a stacking

classifier to ensemble the models for sentiment classification. We establish a performance benchmark for binary and ternary sentiment classification by applying this to five datasets featuring English mixed with Spanish, Tamil, Telugu, Hindi, and Malayalam. Our method emphasizes the potential of ensembled Transformer models in this domain, paving the way for future advancements.

Benchmarking Current State-of-the-Art Transformer Models on Token Level Language Identification and Language Pair Identification

Howard Prioleau, Saurav K. Aryal
Computer Science Department, Howard University, Washington DC, USA

Abstract—With the rise of internet usage, code-switching, where multiple languages or dialects intermingle, has surged. Traditional linguistic analysis struggles with this mixed text, as they're typically monolingual-focused. This paper delves into two core tasks for analyzing code-switched data: Token Level Language Identification (LID) and our newly proposed Language Pair Identification (LPI). We benchmarked and compared current state-of-art transformer models across both tasks to gauge their applicability to the tasks. Our results showed that state-ofthe-art multilingual transformer models could achieve state-ofthe-art performance on both tasks. The impressive performance on LPI suggests that this will be the first step to utilizing Language Pair Identification to assist in various facets related to Code-Switched corpora and classification performance.

SOCIALBERT - A Transformer Based Model used for Detection of social Engineering Characteristics

Michael Abobor, Darsana P. Josyula
Department of Computer Science, Bowie State University, Bowie, Maryland, USA

Abstract—Security threats have escalated in recent years based on social engineering attacks. In these attacks, bad actors target organizations, businesses, and private individuals by luring them into clicking on a link either in a text message, email message, or a document. Social Engineering is the act of using psychological tricks to gain the trust of humans leading to the release of sensitive information which can be used for various nefarious activities by the bad actors. These types of attacks have proven to be the genesis of most of the malicious attacks launched against both physical and virtual IT systems by tricking humans into allowing these attacks. It is scarce to find widely established machine learning techniques specifically designed for identifying social engineering features in messages. To help tackle this problem, this research paper aims to explore the detection of social engineering tactics in text messages by fine-tuning a pre-trained Machine Learning Transformer model, BERT to produce our model called SOCIALBERT. SOCIALBERT (Social Engineering Detection Bert) achieves a 97.55 percent accuracy as compared to DistilBERT, Bert-Base multilingual, and Naive Bayes Models which achieved 55.40 percent, 60.23 percent, and 95.58 percent accuracies respectfully.

Scoping Review on Image-Text Multimodal Machine Learning Models

Maisha Binte Rashid, Pablo Rivas
School of Engineering & Computer Science, Department of Computer Science,
Baylor University, Waco, Texas, USA

Abstract—Multimodal Machine Learning (MMML) has emerged as a promising topic with the ability to jointly utilize data from several data modalities to improve performance and address difficult real-world problems. Large-scale multimodal datasets and the availability of powerful computing resources have sped up the development of

sophisticated deep learning architectures that are designed for multimodal data. In this paper, we conducted a systematic literature review focusing on the deep learning architectures used in MMML that combines image and text modalities. The objective of this paper includes looking at various models and deep learning architectures used in MMML with image and text data, learning about the fusion techniques used to combine both modalities, datasets that are used to train the models and limitations of these models. For this purpose, we have garnered 341 research articles from 5 digital library database and after an extensive review process, we have 89 research papers that allow us to thoroughly assess MMML. Our findings from these papers shed light on providing new directions for further study in this evolving and interdisciplinary domain.

Advancing Classification with Limited Training Data: Harnessing Generative Adversarial Networks and Latent Space Clustering

Gofur Halmuratov, Arnost Vesely
Department of Information Engineering, Czech University of Life Sciences, Czech Republic

Abstract - In the realm of deep learning, where the prowess of algorithms in classification tasks is undeniable, a critical challenge arises when confronted with a scarcity of training data. Conventionally, the remedy involves enlarging the dataset through techniques like data augmentation, demanding substantial computational resources and often proving impractical. In our research, we present an innovative strategy to confront the constraints of limited training data. Rather than relying solely on dataset augmentation, our approach employs Generative Adversarial Networks (GANs) to craft distributions representing distinct categories. The classification of an unknown element is then executed by comparing it with distributions generated by trained GAN networks. We introduce one method that assess the unknown element against those produced by GANs, establishing estimates of conditional probabilities for the unknown element belonging to specific categories. These probabilities form the basis for classifying the unknown element into distinct categories. Crucially, our methodology empowers informed decision-making, yielding precise classification outcomes even in the face of restricted training data. By harnessing the generative capabilities of GANs and incorporating latent space clustering (GMM), our approach pioneers a nuanced paradigm for robust classification in resource-constrained scenarios. This study, an extension of our prior work [1], incorporates latent space clustering for enhanced classification in limited training data scenarios (Halmuratov & Veselý, 2023).

Decoding the Obfuscated: Advanced NER Techniques for Online Escort Advertisements

Alejandro Rodriguez Perez, Pablo Rivas, Javier Turek, Korn Sooksatra,
Ernesto Quevedo, Gisela Bichler, Tomas Cerny, Laurie Giddens, Stacie Petter
School of Engineering & Computer Science, Department of Computer Science,
Baylor University, Waco, Texas, USA;
Intel Labs, Intel Corporation, Portland, Oregon, USA;
School of Criminology & Criminal Justice, California State University, San Bernardino, California, USA;
College of Engineering, Department of Systems and Industrial Engineering,
The University of Arizona, Arizona, USA;
Information Technology & Decision Sciences Department, G. Brint Ryan College of Business,
University of North Texas, Texas, USA;
School of Business, Management of Information Systems,
Wake Forest University, Winston-Salem, North Carolina, USA

Abstract—Online Escort Advertisements (OEAs) present unique challenges for Named Entity Recognition (NER) due to their complex and often obfuscated textual content. This paper thoroughly evaluates state-of-the-art language models and tokenization techniques, focusing on their efficacy in the NER task within the context of OEAs. Our results indicate that the Longformer model, equipped with byte-level BPE tokenization, outperforms

other models regarding precision, recall, and F1 score. The study also uncovers specific areas for improvement, offering avenues for future research. Our findings have significant implications for the automated analysis and monitoring of OEAs, contributing to developing more robust and transparent online ecosystems.

Text Summarization Evaluation using Semantic Probability Distributions

Anh Le, Fred Wu, Lan Vu, Thanh Le
Henry M. Gunn High School, Palo Alto, California, USA;
Department of Computer Science, West Virginia State University, West Virginia, USA;
UEH University, Hochiminh City, Vietnam

Abstract—Most popular methods for evaluation of automatic text summarized content employ some protocol that requires goldstandard summary, usually made by human, for validating the summarized text content based on some content comparison. These evaluation methods are however unable to function in case human-made summaries are not available, or improperly functioning when these summaries are in poor quality. In this paper, we proposed SESP, a novel evaluation method using content based approach. SESP implements new text tokenizing methods together with semantic based similarity metrics to generate semantic probability distributions that best describing the text content. Probability distributions are then used in validation of text summarized content against the original text document. We showed that SESP functions without a need for gold-standard summaries, but yet achieving better performance compared with the state of the art methods that require humanmade summaries.

Attribution Scores of BERT-Based SQL-Query Automatic Grading for Explainability

Korn Sooksatra, Bikram Khanal, Pablo Rivas, Donald R. Schwartz
School of Engineering and Computer Science, Department of Computer Science,
Baylor University, Waco, Texas, USA;
School of Computer Science & Mathematics, Department of Computing Technology,
Marist College, Poughkeepsie, New York, USA

Abstract—Automated grading of SQL queries poses a challenge due to the complexity of the SQL language and the numerous ways in which one can achieve the same results. While recent advancements in machine learning-based automated grading systems have demonstrated remarkable accuracy, there remains a critical need for providing students with meaningful explanations for the grades assigned by these machines. To address this need, our study focuses on a specific recent work in automated grading for SQL queries. We have developed a comprehensive workflow that leverages machine learning models trained in that work. Our objective is to gain insights into the behavior of the machine learning model, particularly in terms of how it assigns grades to SQL queries. Through our analysis, we have observed that our workflow performs effectively, producing valuable attribution scores for important tokens within SQL queries. These attribution scores shed light on which query components are considered significant by the machine learning model, thus enhancing our understanding of the grading process and facilitating more meaningful feedback for students.

Using Deep Learning for Spatial and Temporal Analysis of Wildfire Start and Progression

Pratyush Muthukumar, Janmesh Kalra, Shaurya Pathak, Dawn Comer,
Navid Amini, Jeanne Holm, Mohammad Pourhomayoun
Department of Computer Science, California State University Los Angeles, California, USA;
City of Los Angeles, Los Angeles, California, USA

Abstract— Wildfires pose a significant threat to ecosystems, public safety, and property, and understanding the spatial and temporal patterns of their occurrence is of paramount importance for mitigating their devastating impacts. In this study, we address the critical task of wildfire start and progress prediction by leveraging cutting-edge deep learning techniques. We obtain data from remote-sensing and ground based input sources to analyze patterns for next 24 hours using past 24 hours of data. Real time wildfire prediction requires a multi dimensional model, that is able to learn and retain information from our data set. Our approach employs a novel deep learning architecture, which captures both spatial and temporal dependencies in wildfire data, grants us results that provide substantial breakthroughs in using ML to predict wildfire start and progress.

Improving Public Health Policies with Indoor Air Quality Predictive Models

Ariel Isaac Posada Barrera, Laura Margarita Rodriguez Peralta, Eldman de Oliveira Nunes,
Paulo Nazareno Maia Sampaio, Fabian Leonardo Cuesta Astudillo
Universidad Popular Autonoma del Estado de Puebla (UPAEP), Departamento de ingenierias,
Facultad de Tecnologias de Informacion y Ciencia de Datos (FTIyCD), Puebla, Mexico;
Universidade de Salvador (UNIFACS), Bahia, Brazil

Abstract - Indoor air quality is important for public health. This study was designed to develop predictive models focusing on indoor air quality, specifically targeting levels of CO2, TVOC, PM2.5, and PM10. Implementing and training the Machine Learning Models—Regression Forest Model and Gradient-Boosted Tree Model—on a dataset from Puebla and Morelos states in Mexico. The dataset incorporated various environmental variables, including pollutant levels, temperature, relative humidity, people density, and ventilation characteristics, all of which were found to significantly influence the presence of indoor air contaminants. These findings are instrumental in formulating policies for mitigating poor indoor air quality. Moreover, the study suggests it is feasible to predict when contaminants will reach harmful levels by monitoring changes in these variables.

Artificial Intelligence in Cybersecurity: A Dual-Nature Technology

Abdulrahman Yarali, Evan Rodocker, Christie Gora
School of Engineering, Murray State University University, Kentucky, USA;
Computer Information Technology, University of Cumberlands, Williamsburg, Kentucky, USA

Abstract— Artificial Intelligence (AI) is undoubtedly one of the most promising information age developments. AI has emerged as a transformative technology, reshaping various sectors, including cybersecurity. As digital threats evolve in complexity and scale with a higher potential for vulnerabilities, traditional cybersecurity measures often need help to keep pace. With its ability to learn and adapt, AI offers promising solutions to these challenges. Traditional cybersecurity measures, which often rely on predefined rules and signatures, must be equipped to manage novel threats. AI presents a promising alternative with its ability to learn from data and adapt to the latest information. However, integrating AI into cybersecurity has its challenges when cyber adversaries use it as an AI-powered Cyber-attack tool to their advantage in a threat landscape that is constantly evolving. This paper discusses the future trends in self-learning AI technology to combat novel threats and new attack techniques by explaining why AI/ML is crucial to cybersecurity, its best use, and what is the future of AI. The paper also, reviews how

cybersecurity frameworks can mitigate the exploitation of AI systems, making them safe and reliable by taking precautions and suitability-testing steps before their implementation. We will draw on various sources, providing a balanced and in-depth perspective on the rise of AI as a dual-nature technology and its applications and challenges in the ever-expanding attack surface in cyberspace.

Systematic Literature Review of Machine Learning for IoT Security

Prathibha Kiran Yemmanuru, Jones Yeboah, Khakata Esther N. G.
School of Information Technology, University of Cincinnati, Cincinnati, Ohio, USA

Abstract—Internet of Things or simply called IoT are growing exponentially, and they are predicted to double by 2030. Companies are rushing to release their IoT products into the market to gain a competitive edge. This is causing security lapses in IoT devices and luring attackers to hack the data easily. Machine learning (ML) can detect and mitigate attacks. In this systematic literature review, primary studies are conducted on ML algorithms used for IoT security and they are analysed. Primary studies are classified into five categories (to detect attacks, intrusions, DDoS attacks, Malware and ransomware detection). Research conducted is mentioned in detail in this paper and the scope for future work is also discussed.

A Comparative Study of Machine Learning Techniques for Nuanced Weather Prediction

Prashanth Reddy Gangula, Jones Yeboah, Isaac Kofi Nti
School of Information Technology, University of Cincinnati, Ohio, USA

Abstract— Given the steadily increasing demand and the need to account for uncertainties, there is an obvious requirement for more advanced and precise weather forecasting technologies. The purpose of this work is to develop a weather prediction model that forecasts detailed weather conditions using machine learning algorithms. The methodology employed for this purpose is the data science method with Machine Learning and Data Visualizations. Five machine learning algorithms namely Decision Tree (DT), Support Vector Machine (SVM), Random Forest (RF), Gradient Boosting (GB) and K-Nearest Neighbors (KNN) were compared and the one with higher prediction accuracy was used as the final model. The RF outperforms other algorithms with an accuracy of 75%. It can be inferred that due to the intricacy and chaos of atmospheric systems, as well as the increased variances and classifications of weather situations, accurately predicting more nuanced weather conditions can be challenging.

Opinion Mining of Online Shopping Products Reviews Using Machine Learning

Aashritha Arra, Jones Yeboah, Isaac Kofi Nti
School of Information Technology, University of Cincinnati, Ohio, USA

Abstract— In the realm of electronic commerce, the impact of consumer sentiments on product selections is indisputable. This research introduces a strong and technically sound method for harnessing machine learning's capabilities in analyzing sentiments within online product reviews. Given the exponential expansion of online shopping platforms, comprehending customer sentiments has become of utmost importance for enterprises striving to elevate product quality and customer contentment. Our approach encompasses various stages, including data gathering, data preprocessing, feature extraction, and the utilization of cutting-edge machine learning algorithms. Through extensive experimentation and assessment, we illustrate the effectiveness of our method in accurately categorizing sentiments expressed in product reviews. The investigation uncovers valuable insights into the critical determinants that shape customer viewpoints and highlights the potential for enterprises to utilize these insights in

strategic decision-making processes. As the digital marketplace continues to evolve, our research offers an asset for enterprises seeking a competitive advantage. Our approach equips organizations to extract meaningful insights from vast repositories of online product reviews, ultimately facilitating well-informed product development and marketing strategies.

Smart Temperature Management in Buildings using Predictive Analysis by Machine Learning Algorithms

Ritika Dharmkar, Jones Yeboah, Isaac Kofi Nti
University of Cincinnati, Cincinnati, Ohio, USA

Abstract—In the contemporary world, energy management stands as a critical environmental imperative, necessitating a balanced approach that addresses both ecological and economic considerations. In the scope of this research paper, we employ machine learning techniques to tackle a specific facet of this challenge: temperature and energy management within buildings. Our primary objective is to predict the heating and cooling loads of buildings using different regression models, namely linear regression, decision tree, and random forest. We examine the performance of our models with open-source data from Kaggle based performance metrics such as Mean Absolute Error, Mean Squared Error, and R-squared. Our findings demonstrate that all three machine learning algorithms perform effectively in predicting Heating and Cooling Loads. Notably, the decision tree regressor and random forest regressor surpass the linear regression model, exhibiting superior accuracy, as indicated by their lower Mean Absolute Error and Mean Squared Error, along with higher R-squared values. Consequently, the decision tree-based algorithm emerges as the most suitable choice for this particular dataset.

Text Stream Classification: Literature Review and Current Trends

Najet Medssia, Minyar Sassi Hidri, Ali Frihida
RISC Laboratory, National Engineering School of Tunis, University of Tunis El Manar, Tunis, Tunisia;
Computer Department, Deanship of Preparatory Year and Supporting Studies, Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia

Abstract—Text stream classification is the task of assigning labels to a sequence of text data as it arrives in real time. This is a challenging task because the data is often incomplete and noisy, and the labels may change over time. In this paper, we review the state-of-the-art in text stream classification models. We discuss the different types of models that have been proposed, as well as the strengths and weaknesses of each approach. We also identify some of the open challenges in text stream classification, and suggest directions for future research.

Explainable LightGBM Approach for Predicting Myocardial Infarction Mortality

Ana Leticia Garcez Vicente, Roseval Donisete Malaquias Junior, Roseli A. F. Romero
Computer Science Department, University of Sao Paulo, Sao Carlos, Brazil

Abstract—Myocardial Infarction is a main cause of mortality globally, and accurate risk prediction is crucial for improving patient outcomes. Machine Learning techniques have shown promise in identifying high-risk patients and predicting outcomes. However, patient data often contain vast amounts of information and missing values, posing challenges for feature selection and imputation methods. In this article, we investigate the impact of the data preprocessing task and compare three ensembles boosted tree methods to predict the risk of mortality in patients with myocardial infarction. Further, we use the Tree Shapley Additive Explanations method to identify relationships among all the features for the performed predictions, leveraging the entirety of the available data in

the analysis. Notably, our approach achieved a superior performance when compared to other machine learning approaches existing, with an F1-score of 91,2% and an accuracy of 91,8% for LightGBM without data preprocessing.

Students' Flexibility in Online Education Using Machine Learning

Narendra Thokala, Jones Yeboah, Isaac Kofi Nti
University of Cincinnati, Cincinnati, Ohio, USA

Abstract—Since COVID-19 spread over the world, "online education" has become a more common phrase. Most schools have moved their activities online even though it took underdeveloped countries like Bangladesh a long time to establish fully online education at all levels. Students also faced difficulties when first introduced to online learning. Decision-makers at educational institutions need to understand the efficacy of online education so that they may take steps to enhance it for students. The aim of this paper is to explore the elements that predict a student's level of adaptability in online learning and contribute to the flexibility of pupils. A dataset downloaded from Kaggle website will be used for this paper. The dataset will be processed, described, visualized, trained, tested and evaluated. This research examines online education's benefits and drawbacks for students. Online education affects students' schedules, learning styles, and academic experience, and technology facilitates remote study. The report also investigates how online education can help geographically or financially disadvantaged students access higher education. The report concludes that online education offers flexibility but also poses unique obstacles that must be considered and adapted to achieve success.

Generative and Responsible AI - LLMs Use in FinTech Cyber Security

Atif Farid Mohammad, Ram Agarwal, Tony Colombo, Jess Vigorito
Global Technology Solutions, USA

Abstract— Generative AI techniques are widely used to extract valuable insights from data, which can be used to expand into new markets or save money by changing existing structures. However, there is a lack of innovation in the compliance area of financial transactional platforms, which can lead to money laundering. Standard Generative AI algorithms, specifically the use of Responsible AI within the realm of LLMs, have the potential to build robust detection systems to capture money laundering transactions. Additionally, refined AI predictions can be used to improve the response time of compliance users in deciding whether a transaction is suspicious. This paper focuses on using Generative AI algorithms, anomaly detection, and network analysis to detect suspicious transactions and improve the overall risk rating assessment using hypothetical dataset. We have proposed a dataset to simulate real scenarios and anomalies.

Leveraging Large Language Models for Web3D: Applications, Challenges, and Future Directions

Vinayak Tanksale
Department of Computer Science, Ball State University, Muncie, Indiana, USA

Abstract—Large language models have emerged as powerful tools for natural language processing tasks, offering a wide array of applications in various domains. This paper explores the potential of leveraging large language models for Web3D applications, focusing on their role in content generation, natural language interaction, personalization, and knowledge integration. We examine the benefits and challenges associated with the integration of large language models in Web3D environments, along with ethical considerations. Furthermore, we discuss future directions and potential research avenues for advancing the utilization of large language models in the context of Web3D.

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Predicting Elliott Flat and Zigzag Internal Shapes by Statistical Learning on Fibonacci Ratios

Rafael Ribeiro Dos Santos, Vanderlei Bonato, Geraldo Nunes Silva
Institute of Mathematics and Computer Sciences (ICMC), University of Sao Paulo (USP), Sao Carlos, SP, Brazil;
Institute of Biosciences, Letters and Exact Sciences (IBILCE), Sao Paulo State University (UNESP), Sao Jose do Rio Preto, SP, Brazil

Abstract—Elliott waves and Fibonacci proportions can be used to estimate the price behavior of an asset since they can describe the patterns and relationships from time series of an asset historical price. The challenge is projecting future patterns from a sequence of patterns already mapped from historical data. This paper presents a way to predict the internal shape of the Flat and the Zigzag patterns that happen in Elliott waves. The results show that our model was able to reduce the error 4 times when compared to a solution that is guessing the length only by respecting Elliott wave rules.

MLMVN as a Frequency Domain Convolutional Neural Network

Igor Aizenberg, Alexander Vasko
Computer Science Department, Manhattan College, Riverdale, New York, USA;
Department of Systems Analysis and Optimization Theory, Uzhhorod National University, Ukraine

Abstract — In this paper, a multilayer feedforward neural network (MLMVN) is employed as a frequency domain convolutional neural network (CNN). MLMVN is a complexvalued neural network. Thus, processing such data as a Fourier transform of a signal is natural for this network. With this regard, it is suggested that to solve the image recognition problem by employing convolutions to extract image features, as is common in CNNs, it is also possible to use convolutions in the frequency domain. Hence, it was suggested that Fourier transforms of images to be recognized should be used as sources of inputs. Pooling, whose main goal is to reduce the number of inputs through downsampling, is implemented by selecting Fourier coefficients corresponding to certain low and possibly middle frequencies as the actual inputs of MLMVN. Then, a network should be trained. Its first hidden layer is a dual-purpose layer. It performs a convolution by component-wise multiplication of the inputs, which are low to medium frequencies coefficients of the input image Fourier transform, with weights. These complex-valued weights of each neuron resulting from the learning process should be treated as a frequency domain convolutional kernel, that is, as a Fourier transform of a corresponding spatial domain convolutional kernel. Thus, all neurons from the first hidden layer implement the Convolution Theorem by finding a component-wise product of Fourier transforms of an image and a respective convolutional kernel. Then, neurons from the first hidden layer process this product in a regular way. This approach was tested. It shows results compatible with the best results for regular CNNs while, at the same time, it is computationally more efficient, requiring fewer operations, and demonstrating fast convergence with the batch learning algorithm.

A Smart Particle Filter Technology for Battery State Estimation and Life Prediction

Mohamed Ahwiadi, Wilson Wang
Department of Mechanical and Mechatronics Engineering, Lakehead University,
Thunder Bay, ON, Canada

Abstract—Lithium-ion (Li-ion) batteries are commonly employed in a wide range of industrial and household applications. However, the performance of Li-ion batteries degrades over time due to the aging process, which is difficult to measure using general sensors. Although particle filter (PF) technique can be used for modeling the nonlinear degradation features of battery system, it suffers sample degeneracy and impoverishment problems that limit its ability to accurately capture the electrochemical behaviors of a battery system in state estimation. This paper proposes a smart particle filter (SPF) technique to address these problems and improve the performance of PFs. The proposed SPF technique includes two innovative aspects. Firstly, a sample degeneracy detection method is suggested to identify the low-weight particles associated with sample degeneracy. Secondly, a mutation approach is proposed to adaptively explore the posterior probability density function (PDF) and process the low-weight particles to tackle sample degeneracy. Simulation tests have been conducted to verify the effectiveness of the proposed SPF technique. It is also implemented for predicting the remaining useful life (RUL) of Li-ion batteries. The results of the tests indicate that the proposed SPF technique can effectively capture a system's dynamic behavior and track system characteristics.

Artificial Intelligence - Enabled Deep Learning Model for Diabetes Prediction Using Deep Belief Network with Bayesian Optimization

Jide Ebenezer Taiwo Akinsola, Sunday Adeola Ajagbe, Emmanuel Ajayi Olajubu, Azeezat Oluwayemisi Lawal, Ganiyu Adesola Aderounmu, Matthew Olusegun Adigun
Department of Computer Sciences, First Technical University, Ibadan, Nigeria;
Department of Computer and Industrial Engineering, First Technical University, Ibadan, Nigeria;
Department of Computer Science and Engineering, Obafemi Awolowo University, Ile-Ife, Nigeria;
Department of Computer Science, University of Zululand, Kwadlangezwa, South Africa

Abstract—Diabetes is one of the major health issues that affect more than 10.5 percent of the adult population across the globe. This study applied deep learning techniques of deep belief network (DBN), long short-term memory (LSTM) and recurrent neural network (RNN) with Bayesian optimization on a diabetes dataset to forecast patients with diabetes. A splitting ratio of 80:20 was used for model performance evaluation. DBN model had the lowest mean absolute error in comparison to the other two models with 95.79 accuracy, 0.0331 mean absolute error, 0.0709 mean squared error, 0.1204 loss function, 0.9458 precision, 0.1819 RMSE, and 0.5307 recall. The results from this study validate that the DBN model can be used on a larger dataset to reduce variance and model overfitting, thereby achieving a better accuracy score.

Using Explainable AI and Genetic Algorithms to Drive the Discovery of Novel Antiviral Molecules

Vishakha Singh, Ritesh Sharma, Sushant Kumar, Sanjay Kumar Singh
Department of CSE, IIT (BHU) Varanasi, Varanasi, India;
Department of ICT, Manipal Institute of Technology, Manipal, India

Abstract—The COVID-19 pandemic has prompted the scientific community to expedite therapeutic drug discovery. The partnership between biomedical scientists and artificial intelligence (AI) specialists has resulted in the creation of several computational tools for the preliminary assessment of antiviral drugs. One such category comprises antiviral peptides (AVPs) that are an integral component of an organism's initial immune response to viral invasion and infection. The models that were developed to identify AVPs do not offer any insight into the characteristics that have a significant contribution to their antiviral nature. So, a thorough analysis is needed by a domain expert to find the AVPs from the set output by such models before they can be synthesized and experimentally validated. This work aims to accelerate this process by proposing a fully automated in silico tool that not only identifies AVPs in antiviral protein chains but also optimizes them using the objectives identified after analyzing the existing AVPs using an explainable machine learning model. This model has been built using the extreme gradient boosting algorithm and has an accuracy of 90%, which is better than the existing classifiers. The two objectives found by this model are found to be conflicting, and non-dominated sorting genetic algorithms have been used to find the Pareto-optimal front by establishing a trade-off between them. To evaluate the efficacy of the suggested framework, we found and optimized the AVPs present in some well-known antiviral proteins. The AVPs from the Pareto-optimal front were identified and proposed for synthesis and validation of antiviral activity. Lastly, a free online app has been deployed at https://avpdesign.anvil.app .

Improving Ensemble Regression Models Using Hybrid General Optimization Algorithm and Weighted Schema Based on Proportionate Selection

Faisal Alkhateeb
University Of Bahrain, Bahrain;
Yarmouk University, Irbid, Jordan

Abstract—Optimization algorithms can be employed to solve both continuous and discrete optimization problems. Several works used optimization search algorithm with regression models for selecting the most appropriate features and tuning the hyber-parameters, and thus improve their accuracy score. This paper proposes a hybrid general model that combines a hybrid optimization search algorithm, which is a modified version of previous proposed framework, to iteratively improve its score. Data engineering techniques are applied including: normalization, selecting the proper list of features, inserting new feature/columns using polynomial kernel. The experimental results show that modified hybrid optimization search algorithm, based on well known benchmark functions, is a competitive one. Also, the hybrid proposed regression model provides the best score compared to well-known models (i.e, Linear regression, KNN regressor, Support Vector Machine regressor, XGBOOST Regressor).

Multi-Agent Reasoning with Large Language Models for Effective Corporate Planning

Wen-Kwang Tsao
Trend Micro AILAB, Inc., USA

Abstract—Large Language Models (LLMs) have demonstrated significant capabilities in natural language processing tasks. In this paper, we explore the application of LLMs within a business context. Specifically, we employ LLMs to devise a sales strategy geared towards maximizing customer values (benefits and satisfaction). This sales plan encompasses five iterative stages: market landscape survey, customer profiling, product usage analysis, sales strategy formulation, and crafting persuasive pitches and materials. We leverage LLMs to supplement the limited data available to the company, aiming to enhance the efficacy of each stage and optimize KPIs, including the value-oriented sales conversion and profitability. Due to confidentiality and trade secret concerns, we blend artificial data with genuine data to ensure customer anonymity and protect sales playbooks. Despite these precautions, we effectively demonstrate our methodology of harnessing LLMs to refine the sales planning procedure.

Water Quality Index (WQI) Prediction Using Machine Learning Algorithms

Kunyanuth Kularbphettong, Phanu Waraporn, Nareenart Raksuntorn,
Rujijan Vivhivanives, Chanyapat Sangsuwon
Computer Science Program, Suan Sunandha Rajabhat University, Bangkok, Thailand;
Robotics Engineering Program, Suan Sunandha Rajabhat University, Bangkok, Thailand;
Faculty of Science and Technology, Suan Sunandha Rajabhat University, Bangkok, Thailand

Abstract— Water resources used by human activities ranges typically from personal and household, agricultural, industrial, recreational to environmental pursuits. The effects of these water utilizations are actually of great concerns by many due to various threats created by human functions and the nature itself, for instance, climate change, pollution, scarcity, and even conflicts. To mitigate these threats, implementation of water quality management based on recognized standards and guidelines not only will they provide solid framework and benchmark used in relation to the assessment of the water quality but will also enable the identification of corresponding classification indicated by the water quality index (WQI) pertinent and relevant to the surface water dataset. This paper aims at applying selected predictive modeling techniques that are highly optimized for use in semi-automating the work of the water quality classification (WQC) and the water quality index (WQI) that subsequently can be used in assisting the planning, problem-solving and/or decision-making processes. The preliminary results obtained are quite satisfactory as follow: predicting WQI using neural network model (NN) outperforms both the Multiple Linear Regression (MLR) and the Support Vector Machine (SVM) based on a mean absolute error (MAE) lower than the two models and predicting WQC using SVM, and ANN models based on accuracy score with SVM returns a favorable accuracy score higher than two others.

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Quantum Neural Network Classification Based Cyber Threat Detection in Virtual Environment

Sarvapriya Tripathi, Himanshu Upadhyay, Jayesh Soni
Electrical and Computer Engineering, Florida International University, Miami, Florida, USA

Abstract— Quantum computing is an upcoming research area that applies quantum properties of the materials, eg superposition and entanglement, to information processing. The probabilistic nature of this computation allows some unique capabilities that are not available in classical computing. Quantum Information Processing (QIP), the area of computation using quantum devices, promises to speed up computing significantly as compared to classical processing. QIP has been extended to Artificial Intelligence / Machine learning (AI/ML) in what is referred to as Quantum Artificial Intelligence (QAI) / Quantum Machine Learning (QML). Whereas the classical ML algorithms efficiently identify patterns from datasets, QML tries to implement algorithms that utilize both, classical computing in handling the datasets and quantum computing for quantum-specific algorithms. In this paper, we attempt to implement QML in Cyber Security. We will demonstrate an advanced method of attack vector recognition using virtual machine memory introspection using quantum neural networks.

Practical Quantum Search by Variational Quantum Eigensolver on Noisy Intermediate-scale Quantum Hardware

Chen-Yu Liu
Hon Hai Research Institute, Taipei, Taiwan;
Graduate Institute of Applied Physics, National Taiwan University, Taipei, Taiwan

Abstract—Grover search is a renowned quantum search algorithm that leverages quantum superposition to find a marked item with quadratic speedup. However, when implemented on Noisy Intermediate-scale Quantum (NISQ) hardware, the required repeated iterations of the oracle and diffusion operators increase exponentially with the number of qubits, resulting in significant noise accumulation. To address this, we propose a hybrid quantum-classical architecture that replaces quantum iterations with updates from a classical optimizer. This optimizer minimizes the expectation value of an oracle Hamiltonian with respect to a parameterized quantum state representing the target bit string. Our parameterized quantum circuit is much shallower than Grover search circuit, and we found that it outperforms Grover search on noisy simulators and NISQ hardware. When the number of qubits is greater than 5, our approach still maintains usable success probability, while the success probability of Grover search is at the same level as random guessing.

Endurance-Aware Deep Neural Network Real-Time Scheduling on ReRAM Accelerators

Shi Sha, Xiaokun Yang, Trent Szczecinski, Daniel Whitman, Wujie Wen, Gang Quan
Wilkes University, Pennsylvania, USA;
University of Houston-Clear Lake, Texas, USA;
North Carolina State University, North Carolina, USA;
Florida International University, Florida, USA

Abstract—Achieving accurate multi-modal Deep Neural Networks (DNN) testing often requires operating rich model parameters under limited computing and memory resources. The low cost Resistive Random-Access Memory (ReRAM)-based DNN accelerator is a promising solution for such an application thanks to its inherent processing-in-memory capability. However, its lifetime, which is crucial for applications with strict reliability standards such as self-driving cars, can be significantly limited due to: 1) the need of frequently switching weights among different models for real-time streaming applications; 2) ReRAM device's orders of magnitude lower endurance than DRAM. This work proposes an Endurance-Aware multi-modal DNN Scheduling (EAS) strategy to address this issue using real-time techniques. First, a pre-processing methodology transforms a DNN to an end-to-end execution sequence for resource partitioning. Then, a periodic real-time scheduling method is developed via data reusing for extending ReRAM programming cycles under deadline constraints. The experiment results show that our EAS approach can extend the baseline ReRAM accelerator's lifetime from 0.98 years to 3.14 years on average, at a computational cost of less than 1ms.

Improved Implementation and Analysis of an Algorithm to Count Graphical Partitions

Kai Wang
Department of Computer Science, Georgia Southern University,
Statesboro, Georgia, USA

Abstract—We present a simple and improved implementation of Kohnert's algorithm that computes the number g(n) of graphical partitions of a given even integer n. Two main ingredients of the improvement are: (1) a more precise formula for g(n); (2) an efficient way to compute the four-variate function p(m, k, n, l) introduced by Kohnert. We further show that the algorithm can be easily adapted to compute the g(i) values with all $i \leq n$ for any given n in a single run. A theoretical analysis is given to show that the new implementation to compute all g(i) values for $i \leq n$ is of runtime and space complexity $O(n^3)$. To the best of our knowledge, this is the first analysis to show that g(n) can be computed in $O(n^3)$ time. Experimental evaluations show that our implementation appears to be faster and more space efficient than Kohnert's original implementation.

Data Clustering and Visualization with Recursive Goemans-Williamson MaxCut Algorithm

An Ly, Raj Sawhney, Marina Chugunova
Institute of Mathematical Sciences, Claremont Graduate University,
Claremont, California, USA

Abstract—In this article, we introduce a novel recursive modification to the classical Goemans-Williamson MaxCut algorithm, offering improved performance in vectorized data clustering tasks. Focusing on the clustering of medical publications, we employ recursive iterations in conjunction with a dimension relaxation method to significantly enhance density of clustering results. Furthermore, we propose a unique vectorization technique for

articles, leveraging conditional probabilities for more effective clustering. Our methods provide advantages in both computational efficiency and clustering accuracy, substantiated through comprehensive experiments.

Understanding the Computational Complexity of Diverse Classes of Turing and Super-Turing Computational Models

Ghada Abdelmoumin, Chunmei Liu, Danda Rawat
Department of Information and Engineering Technology,
Northern Virginia Community College, Annandale, Virginia, USA;
Department of Electrical Engineering and Computer Science, Howard University,
Washington, DC, USA

Abstract—The need to solve scientific problems using automated means and hence analyze the performance and measure the complexities of their algorithmic solutions had led to the realization of various computational models. The underlying of these computational models are the mathematical models that provide intuitions for the problems in question and formally describe the problem(s) to be solved by a particular model. In the heart of these models of computations is the Turing Machines abstractions model, a mathematical model of computation that formed the basis of successive models of computations and provided the theoretical foundation of computability. In this paper, we explore various classes of computational models and intuitively understand their computational complexity. We focus on different Turing and super-Turing models of computations and study their complexity in terms of space and time. We provide a comparative analysis of infinitary, fuzzy, hyper and superTuring models using computational characteristics pertinent to Turing computational models in general. Further, we show the conjectured relationships of the four models to the Turing machines and universal Turing machine.

Modeling and Simulation of Dynamic Roadwheel Relationships for Tracked Vehicles using Machine Learning

Jeremy Mange, Jacob Brendle
US Army, Ground Vehicle Systems Center, DEVCOM GVSC, Warren, Michigan, USA

Abstract—Within the context of modeling and simulation (M&S), there is often a trade-off between simulation fidelity and computational run time, with more accurate simulations requiring longer run times, and real-time applications sacrificing fidelity for the sake of speed. This paper presents a method for using the high-fidelity CREATE-GV M&S tool to produce a set of training data, which is then used with machine learning algorithms to train a fast surrogate model for the prediction of tracked vehicle road wheel displacements. This surrogate model could then be used within applications such as autonomous vehicle simulations with real-time requirements, while maintaining a high level of physics fidelity.

New Methods to Solve Difference Equations Automatically

Jun Zhang, Willie Brown, Ruzong Fan
Department of Computer Science and Engineering Technology,
University of Maryland Eastern Shore, Princess Anne, Maryland, USA;
Department of Engineering and Aviation Sciences, University of Maryland Eastern Shore,
Princess Anne, Maryland, USA;
Department of Biostatistics, Bioinformatics, and Biomathematics,
Georgetown University, Washington, DC, USA

Abstract—Difference Equations appear very often in discrete mathematics and computational science, as they describe how the future values of a system depend on their past values. Solving such equations is a very important

task; Laplace transform has a long history and was used for solving difference equations. Although Laplace transform is useful in that regard, it suffers a serious drawback, which is the calculation of inverse Laplace transform. Such kind of inverse calculation is problematic or simply impossible in general. Sumudu transform is an integral transform which was introduced recently, with new and powerful features. In this work, we will explain that Sumudu transform can be used to solve difference equations in the same manner as Laplace transform. More importantly, new computational methods will be proposed to solve difference equations, differential-difference equations, and integro-differential-difference equations; these new methods combine both Laplace transform and Sumudu transform such that there is no calculation of the inverse transform. Demonstration code is provided to show that the methods can be implemented in computer algebra systems such as Maple to solve a wide range of equations automatically.

Accelerating the Convergence in the Identification of PV Cells Parameters

Carmen Elena Stoenoiu, Lorentz Jantschi
Department of Electric Machines and Drives, Technical University of Cluj-Napoca, Cluj-Napoca, Romania;
Department of Physics and Chemistry, Technical University of Cluj-Napoca, Cluj-Napoca, Romania

Abstract—The current trend in energy sources is towards the large-scale use of small-scale photovoltaic (PV) systems for local energy supply. The today's common commercial PV systems today include PV cells of various manufactures and origins based mostly on a large-area p-n junction made of silicon. The characteristic equation describes the non-linear dependence between current and voltage and the parameters values of the characteristic equation define the working regime of the PV system. Parameters identification involves a series of iterations in which the sum of squared errors is minimized (and thus the chance of observation is maximized). A large number of iterations are required if the optimization follows the usual course from the solution proposed by the vertical offsets to the perpendicular offsets. In the present work, an intermediate solution is used to speed up the convergence.

The Traveling Salesman Problem on the Hyperbolic Plane

D. Ficzere, G. Hollosi, A. Franko, P. Varga, J. Biro
Department of Telecommunications and Media Informatics,
Faculty of Electrical Engineering and Informatics,
Budapest University of Technology and Economics, Budapest, Hungary

Abstract—This paper is concerned with the traveling salesman problem (TSP) on the two-dimensional hyperbolic space. We provide an efficient heuristic to find near optimal tour along the cities, where the distance measure is the hyperbolic distance between the points (cities) placed randomly and uniformly on a hyperbolic disk. Our approach is mainly experimental, that is for a large number instances of points randomly generated on hyperbolic disks with different size are performed and statistics on our TSP heuristic are provided and compared to the results of standard TSP solvers. Nevertheless, we also show analytical approximations on the expected tour length in our heuristic solution of the TSP. We also perform an application possibility of our TSP solution for designing optimal address space of hopby-hop routing in hyperbolic complex networks.

An Efficient Dynamical Programming Algorithm for Bin Packing Problem

Catherine Huyghe, Stephane Negre, Melanie Fontaine
University of Picardie Jules Verne (UPJV), Amiens, France

Abstract—In this paper, we propose a very efficient algorithm to solve the 2 dimensional bin packing problem. The algorithm can automatically place thousands of objects in bins using less than 1 minute with very near optimal results on big size instances even if orientation of the objects is free.

Simulation and Visualization of Intelligent MIMO-ANFIS-Based Control System in Virtual Reality using MATLAB and V-Rep

Mokhles M. Abdulghani, Wilbur L. Walters, Khalid H. Abed
Jackson State University, Jackson, Mississippi, USA

Abstract—The noteworthy increase in processing power of computers with the excess of open software and hardware standards has significantly changed the landscape in the field of 3D virtual robotics simulation platforms. Employing software computing tools, such as fuzzy logic, neural networks, and genetic algorithms, encouraged researchers to design intelligent systems that mimic human behavior. Designing a Multiple-Input Multiple-Output (MIMO) control system using Adaptive Nuero-Fuzzy System (ANFIS) offers easy and reliable solutions to generate the desired outputs without the need for a complex mathematical model. This paper shows a MATLAB-based MIMO ANFIS control system for two different robotic systems: a two-wheel drive (2WD) mobile robot and a sixdegree of freedom (6DOF) robotic arm. The Virtual Robot Experimentation Platform (V-Rep) has been used to test the designed systems through a direct interface with the MATLAB Simulink. The results showed an acceptable error value of 0.002% in generating the desired outputs of the 2WD robot. On the other hand, the performance of the implemented ANFIS controller for the 6DOF robotic arm showed a high error value of 30% if the proposed method is used to design MIMO-ANFIS control system.

Augmented Reality-Based Visualization and Simulation of Autonomous Unmanned Aerial Vehicle Control System

Mokhles M. Abdulghani, Wilbur L. Walters, Khalid H. Abed
Jackson State University, Jackson, Mississippi, USA

Abstract—Although the incorporation of sensing, actuators, and controllers make robots powerful systems, simulating them is a big challenge. While it is possible to assemble a simulator from the innumerable graphics, kinematics, physics and libraries, the architecture and control procedure are crucial to shaping the interaction of these elements and consequently the general performance of the robotic system. This paper reviews the capability of two different robotic simulation platforms to simulate different robotic systems that allow for direct interface of various control techniques implemented in MATLAB. This direct interface with Augmented Reality (AR) and simulation models allows more accessibility to test and evaluate the designed control systems to a general-public by reducing the model operation complexity. Using AR simulators reduces the cost, strengthens productivity, and increases the quality of design by offering a flexible diagnostic and evaluation method using AR.

Positive and Negative Effects of Muscle Force Assistance on Muscle Metabolic Cost During Normal Walking

Oh-Seok Kwon, Sang-Ho Lee, Dong-Ha Lee
Division of Intelligent Robot, DGIST, Daegu, Republic of Korea

Abstract—In this study, we investigate the positive and negative effects of the lower limb muscle force assistance on the lower limb muscle metabolic cost during normal walking. To investigate this study, we perform the mathematical analysis and the simulation. The results of this study show that muscle force assistance can have positive or negative effect on muscle metabolic cost, and that a certain muscle force assistance can have positive or negative effect on a certain muscle metabolic cost, and the extent of this effect. Through this study, we can grasp the positive and negative effects of muscle force assistance on the muscle metabolic cost and the extent of these effects. In this way, we can acquire systematic and effective muscle force assistance fundamental technology that can increase the positive effect and reduce the negative effect on muscle metabolic cost.

Time and Space Tradeoffs in Point Location

Mounika Gonuguntla, Yijie Han
School of Science and Engineering, University of Missouri at Kansas City,
Kansas City, Missouri, USA

Abstract— We preprocess the input subdivision with n points on the plane in $O(n\sqrt{\log n})$ time and store them in O(n/t) space to facilitate point location in O(logt) time, where t is an adjustable parameter. When t is a constant we get O(n) space and constant time. When t=O(n) we get constant space and O(logn) time.

Generating Pell Numbers

Weizheng Gao, Julian Allagan, Shanzhen Gao, Jianning Su, Olumide Malomo,
Ephrem Eyob, Adeyemi Adekoya
Department of Mathematics, Computer Science and Engineering Technology,
Elizabeth City State University, North Carolina, USA;
Department of Computer Information Systems, Reginald F Lewis College of Business,
Virginia State University, Virginia, USA;
Perimeter College, Georgia State University, Georgia, USA

Abstract - If you google ìPell numbersî, you will see about 26,300 results. There are around 857 items on Pell numbers in the On-Line Encyclopedia of Integer Sequences. Mathematicians and Computer Scientists love Pell numbers because they seem to be very easy, but they are related to many challenging topics. We will discuss some properties, algorithms, and Python programs used to generate Pell numbers, conjectures, and applications of Pell numbers.

LSU Factorization

Gennadi Malaschonok
Faculty of Computer Science, National University of Kyiv-Mohyla Academy,
Kyiv, Ukraine

Abstract—Matrix LU factorization algorithm is one of the fundamental algorithms of linear algebra. We propose a generalization of the LU and LEU algorithm to the case of a commutative domain and its field of quotients. This algorithm decomposes any matrix A into a product of three matrices A=L*S*U, where each element of the triangular matrices L and U is a minor of matrix A, and the number of non-zero elements of the matrix S is equal to rank(A) and each of them is the inverse of the product of some pair of matrix A minors. The algorithm has the complexity of matrix multiplication.

CSCI-RTCB:
RESEARCH TRACK ON COMPUTATIONAL BIOLOGY

Deep Learning on Hi-C Contact Data Predicts Biological Replicates

Alejandro Rodriguez Perez, Mary Lauren Benton
Department of Computer Science, Baylor University, Waco, Texas, USA

Abstract—High-throughput sequencing-based assays and imaging techniques have enabled the mapping of 3D chromatin architecture at multiple scales and resolutions, with Hi-C being particularly useful in providing a genome-wide measure of chromatin interaction frequency. However, evaluating the reproducibility of Hi-C data remains challenging due to systematic biases in the data. This paper proposes a data-driven neural network approach to predict whether two fragments of Hi-C contact matrices correspond to biological replicates. Our models, trained using multiple resolutions, normalization approaches and cell types, are able to predict this target with an average of 95.92% accuracy. We expect that this work will lead to more robust measurements of Hi-C reproducibility and pairwise similarity in the future.

Deep Sensitivity Analysis for Objective-Oriented Combinatorial Optimization

Ganga Gireesan, Nisha Pillai, Michael J. Rothrock, Bindu Nanduri,
Zhiqian Chen, Mahalingam Ramkumar
Mississippi State Univeristy, Mississippi State, USA;
USDA-ARS, Athens, Georgia, USA

Abstract—*Pathogen control is a critical aspect of modern poultry farming, providing important benefits for both public health and productivity. Effective poultry management measures to reduce pathogen levels in poultry flocks promote food safety by lowering risks of foodborne illnesses. They also support animal health and welfare by preventing infectious diseases that can rapidly spread and impact flock growth, egg production, and overall health. This study frames the search for optimal animal management practices that minimize the presence of multiple pathogens as a combinatorial optimization problem. Specifically, we model the various possible combinations of animal management settings as a solution space that can be efficiently explored to identify configurations that optimally reduce pathogen levels. This design incorporates a neural network feedback-based method that combines feature explanations with global sensitivity analysis to ensure combinatorial optimization in multiobjective settings. Our preliminary experiments have resulted in promising results when applied to two real-world agricultural datasets. While further validation is still needed, these early experimental findings suggest the potential of the model to derive targeted feature interactions that adaptively optimize pathogen control under varying real-world constraints.*

Parameter Estimation in Biochemical Models Using Moment Approximations

Kannon Hossain, Roger B. Sidje
Department of Mathematics, The University of Alabama, Tuscaloosa, Alabama, USA

Abstract—Biochemical processes exhibiting stochastic fluctuations can be mathematically modeled using the chemical master equation (CME). Because of the natural randomness of the molecular interactions, it is important to infer the model parameters from experimental or synthetic data to ensure that the biochemical process being modeled accurately represents the intended system. Methods for estimating model parameters that require solving the CME are computationally expensive due to its large and potentially infinite size. By contrast, in moment-based approximations, the objective function can be stated as a least squares estimator that avoids solving the CME, thus becoming significantly faster to optimize. We demonstrate the usefulness of this approach by applying it to two case studies from systems biology, also showing that the estimation is accurate with very low relative errors.

Machine Learning-Based Artifact Detection for Long-Read Sequencing Data

Felix Mbuga, Kathy Lam, Wendy Lee
Department of Computer Science, San Jose State University, San Jose, California, USA

Abstract—A major goal of cancer diagnostics is to be able to detect the presence of cancer in the earliest stages when it is most curable. Doing this using minimally invasive methods such as liquid biopsy which analyzes tumor material shed into bodily fluids is particularly attractive. Liquid biopsy methods that employ next-generation sequencing (NGS) of circulating tumor DNA (ctDNA) face a challenge due to the low signal-to-noise ratio, where sequencing artifacts introduce noise at a similar level to ctDNA. To address this, we propose utilizing machine learning (ML) and deep learning (DL) techniques, leveraging Genome in a Bottle (GIAB) truth sets and data from the National Center for Biotechnology Information's Sequence Read Archive (NCBI SRA) database, to robustly identify sequencing artifacts. This approach holds promise for enhancing the accuracy and reliability of liquid biopsy-based cancer diagnostics.

Physiological Responsiveness to VR and Non-VR Environments

Alfia Pervez, Sakina Rao, Arshia Khan
Department of Computer Science, University of Minnesota Duluth, Duluth, Minnesota, USA

Abstract - Researchers have delved into the advantages and potential applications of virtual reality (VR) in a variety of scenarios, which has recently generated notable interest in research circles. However, there remains a lack of substantial quantitative evidence supporting the extent of physiological immersion in virtual reality experiences. This study seeks to compare and analyze the physiological responses of participants engaged in gaming using a VR headset versus a non-VR device. Key physiological parameters including Electrodermal Activity (EDA), Heart Rate (HR), Blood Volume Pulse (BVP), Temperature, and Blood Pressure were meticulously monitored using the E4 Empatica Sensor and Omron device. In addition, a qualitative survey was conducted to assess secondary outcomes, encompassing factors such as Calmness, Energy Level, and Ease of Use. The findings suggest that significant alterations in EDA, BVP, and HR occurred within the VR environment when compared to baseline measurements, whereas no notable changes were observed in the non-VR setting. Furthermore, feedback from user surveys indicates that individuals experienced a greater sense of calmness and increased energy levels when using a VR headset. In summary, this study underscores that users tend to undergo pronounced physiological responses within a VR environment, signaling a heightened sense of immersion compared to traditional non-VR settings.

An AI Interface System to NCBI SRA Experiment Data to Support Computational Biology Research

Anh Le, Lan Vu
Gunn High School, Palo Alto, California, USA;
VMware, Inc., Palo Alto, California, USA

Abstract—Human language question to relational database interface allows flexible but effective way of querying data because it not only allows people, even with no SQL knowledge to retrieve information from the database, but also make possible the use of human language in data querying. In this research, we developed an AI interface to SRA database, the meta data of throughput next-generation sequencing data publicly available by NCBI. This system accepts user's data query in natural language, then translates the query into SQL statement using IRNet Deep Learning method which is combined with a Text-based Question Answering method using summary information of large text contents in SRA database. Our system allows computational biologists to query SRA database and retrieving the RNA-seq data for their research without a need for SQL knowledge.

A Deep Learning-Based Model for Gene Regulatory Network Inference

Jialu Ma, Nathan Epperson, John Talburt, Mary Qu Yang
Department of Information Science, University of Arkansas Little Rock, Arkansas, USA;
Department of Psychology, University of Arkansas Little Rock, Arkansas, USA

Abstract—Gene regulatory networks (GRNs) model the transcriptional regulations in biological organisms, offering essential dissections of cellular processes and functions. A wide range of approaches has been developed to reconstruct GRNs from gene expression data. The molecular interactions between regulators and downstream target genes are indicated by nodes connected with edges in the GRNs. Due to the complexity of regulatory mechanisms, GRN inference remains challenging. In this study, we propose a novel deep-learning-based method for network inference. We compared our model with four state-of-the-art GRN inference approaches, including GENIE3, GRNBoost2, KBoost, and DeepSEM. Five datasets from the DREAM4 challenge were used in comparisons. We assessed the model performance according to the weight matrix generated by each method and the golden standard networks. The weight matrix represented the predicted probability of regulations between transcription factors (TFs) and target genes. Then, the area under the receiver operator curve (AUROC) was computed and use for the performance assessment. The results demonstrate that our model achieves comparable performance to the best-performing model. This work establishes a novel network inference method for enhancing our understanding of gene regulations.

Analysis of Single-Cell RNA Sequencing Data Unveils Novel Immune Prognostic Biomarkers

Wenjuan Zhang, Alex Lee, Mary Qu Yang
Information Science Department, University of Arkansas Little Rock, Arkansas, USA;
MidSouth Bioinformatics Center and Bioinformatics Graduate Program, University of Arkansas Little Rock, Arkansas, USA;
University of Arkansas for Medical Sciences, Little Rock, Arkansas, USA;
Biology Department, University of Arkansas Little Rock, Arkansas, USA

Abstract—The immune system plays a central role in recognizing and eliminating cancerous cells. The activity and functionality of immune cells within the tumor microenvironment can significantly impact the prognosis of cancer patients. Leveraging single-cell RNA sequencing technology, we conducted an in-depth investigation into single-cell-based gene signatures for predicting cancer patient survival. The study utilized single-cell RNA sequencing data from breast cancer patients, encompassing over 14,875 immune cells. Gene signatures from major

innate immune cell types, including Natural Killer (NK) cells, Macrophages, and Neutrophils, as well as adaptive immune cells, including Cytotoxic T Lymphocytes (T cells) and B lymphocytes (B cells), were identified. To elucidate their relationship in breast cancer patients, we constructed Cox proportional hazard regression models for predicting patient survival, utilizing the concordance index as a measure of prediction model performance. The evaluation incorporated three independent breast cancer patient cohorts: TCGA (The Cancer Genome Atlas Program), METABRIC (Molecular Taxonomy of Breast Cancer International Consortium), and UK breast cancer data. Our results showed that the T cell-based signature model outperformed the NK cell-based and Neutrophilbased prediction models. Moreover, the T cell-based signature model exhibited robust performance across independent patient datasets. These findings suggest that gene signatures derived from cells of the adaptive immune system have a better survival prediction value than those derived from the innate immune system, underscoring the potential clinical relevance of harnessing the adaptive immune response for refining prognostic assessments in breast cancer. These insights contribute to advancing our understanding of the complex interplay between immune cells and cancer prognosis, paving the way for more tailored and effective therapeutic interventions.

Investigation into the Impact of Varying Inulin Levels on the Survival of Probiotic Microorganisms

Jaruwan Chutrtong, Kunyanuth Kularbphettong, Supatchalee Sirichokworrakit
Department of Industrial Microbiology, Faculty of Science and Technology,
Suan Sunandha Rajabhat University, Bangkok, Thailand;
Department of Biology, Faculty of Science and Technology,
Suan Sunandha Rajabhat University, Bangkok, Thailand;
Department of Food Science and Technology, Faculty of Science and Technology,
Suan Sunandha Rajabhat University, Bangkok, Thailand

Abstract— The objective of this research was to investigate the impact of inulin, a prebiotic substance, when added to 100% milk containing three types of probiotic lactic acid bacteria (Lactobacillus acidophilus, Bifidobacterium sp., and Lactobacillus casei) at concentrations ranging from 0% to 4%. These mixtures were incubated at 37 ± 0.5°C until the pH reached 4.5, after which they were stored at 4°C for a duration of 2 weeks, during which the surviving microorganism counts were monitored. The outcomes of this experiment indicate that the addition of inulin to the group of probiotic lactic acid bacteria has a beneficial effect in enhancing the resilience and survival of these microorganisms. It further demonstrates that, when stored at 4°C over a period of 2 weeks, the microbial population can increase in number. The most substantial increase in bacterial count was observed with the addition of 4% inulin. Also, machine learning techniques were applied to assess and compare the influence of varying inulin content on the survival of a mixed strain of probiotics, which included Lactobacillus acidophilus, Bifidobacterium sp., and Lactobacillus casei. The results revealed that the accuracy of SVM was more than 87%.

Gender Differences in Emotional Responses to Stress During Problem Solving

Yagna Manasa Boyapati, Arshia Khan
Department of Computer Science, University of Minnesota Duluth,
Duluth, Minnesota, USA

Abstract - Gender differences in emotional responses are evident, as each individual reacts uniquely to various situations and expresses emotions distinctively. Gender can be one of the contributing factors to these differences. Consequently, this paper aims to investigate the subtle distinctions in how men and women experience emotional stress while engaging in problem-solving activities.

The Most Frequencies of Gene Trees Reveal Insights into Supporting Lungfish as the Closest Living Relative of Land Vertebrates

Yunfeng Shan, Luwei Tang, Xiaoliang Wang, Yongsheng Xie, Youjun Zhou
College of Mathematics and Computer Sciences,
Guangxi Science and Technology Normal University, Laibin, China;
Department of Genomics, iREG, Toronto, Ontario, Canada

Abstract - Whole-genome data provide all genetic information and good chance for reconstructing a species tree. The one of remaining major challenges is to find a proper method for reconstructing a species tree. However, Incongruent evolutionary relationships of land vertebrates, lungfishes, and coelacanths are inferred using the concatenation or coalescent-based method with the previous five genome-scale data. To resolve the controversy for decades, we use the most frequent gene tree approach to estimate a species tree from single-gene trees. Our findings consistently support lungfishes as the closest living relatives of land vertebrates with statistically significant differences in the first and the second most frequencies of individual gene trees with five previous datasets from transcriptomes of lungfishes. Further analyses demonstrate that the top three most frequent trees correspond to the three hypotheses on phylogenies of land vertebrates, lungfishes, and coelacanths and reveal insights into the three hypotheses, which are not arbitrary guesses but supported by the three largest numbers of genes.

CSCI-RTBD:
RESEARCH TRACK ON BIG DATA AND DATA SCIENCE

Towards Federated Decentralized Querying on Knowledge Graphs

Siraj Munir, Stefano Ferretti
Department of Pure and Applied Sciences, University of Urbino Carlo Bo, Urbino, Italy

Abstract—Recent innovations in research and development have enabled us to observe the world from different dimensions. Thanks to the technologies that helped us to achieve these objectives efficiently. Often in the real world, we need to find a suitable trade-off. However, the selection of suitable and reasonable trade-offs is an art within itself. While modeling semantics, we often require a hierarchical or relational (triples) representation. Decentralized systems fail to model semantic interoperability implicitly. To fill this gap the proposed work introduces a semantic federated querying scheme for decentralized systems. The proposed approach utilizes state-of-the-art graph technology to model decentralized Knowledge Graphs. Furthermore, we discussed different scenarios where the proposed methodology leads to a reasonable conclusion.

CENSUS-HWR: A Large Training Dataset for Offline Handwriting Recognition

Chetan Joshi, Lawry Sorenson, Ammon Wolfert, Mark Clement, Joseph Price, Kasey Buckles
Department of Computer Science, Brigham Young University, Utah, USA; Department of Economics, Brigham Young University, Utah, USA; Department of Economics, University of Notre Dame, Indiana, USA

Abstract—Progress in Automated Handwriting Recognition has been hampered by the lack of large training datasets. Nearly all research uses a set of small datasets, which can cause models to overfit. We present CENSUS-HWR, a new dataset consisting of full English handwritten words in 1,812,014 grayscale images. A total of 1,865,134 handwritten words from a vocabulary of 10,711 unique words in the English language are present in this collection. This dataset is intended to serve handwriting models as a benchmark for deep learning algorithms. This huge English handwriting recognition dataset has been extracted from the US 1930 and 1940 censuses taken by approximately 70,000 enumerators each year. The dataset and the trained model with their weights are freely available to download.

Efficient Crop Classification Using Optical and Radar Big Data: A Time and Cost Reduction Approach

Hashim Abu-Gellban, Essa Imhmed
Department of Computer Science, Grand Canyon University, Phoenix, Arizona, USA;
Department of Mathematical Sciences, Eastern New Mexico University, Portales, New Mexico,USA

Abstract—The ability to accurately estimate crop numbers for various varieties of vegetables makes crop classification an essential component of agriculture. In order to meet the anticipated demand in the future, dealers can predict the number of crops sold on the market. For crop classification, scientists have recently used a variety of data sources, including optical (Polarimetric) and radar sensing imaging. They have, however, run into difficulties when working with huge, high-dimensional, and imbalanced datasets. Some researchers have used a 3-stacked generalization strategy to address these issues. This approach was difficult to train and tackling massive data and imbalanced data concerns head-on. They were able to get an F1-score of 85% with this technique. We used the regression feature selection technique and data sampling in our work, using only 20% of the total data as the training dataset. The effectiveness of our classification methods was significantly improved and the training time was much decreased by these preprocessing techniques. We specifically acquired a remarkable F1-score of 99% after just 42 seconds of training utilizing the Random Forest algorithm. We also achieved a respectable F1-score of 97% in under 7 seconds using Linear SVC. We also demonstrate that good performance may be achieved by using one day's worth of radar data with only 38 features to cut costs and time. The results show that we can use only 16 features to get high performance. In our research, we found that employing radar data produces outcomes that are higher performing and more accurate than using optical data. We have conducted extensive experiments to show the potency of our methods.

A Markov-Based Economic Recession Modeling Through Financial Outcomes: Before and During the COVID-19 Pandemic

Ray R. Hashemi, Omid M. Ardakani, Daniel Bekker, James D. Griffith
Department of Computer Science, Georgia Southern University, Savannah, Georgia, USA;
Department of Economics, Georgia Southern University, Savannah, Georgia, USA

Abstract−We analyze, design, implement, and validate a stochastic model for the economic recession using the financial outcomes of yield spread, crude oil price, and stock market indices (volatility index and Wilshire 5000 total market index). The proposed model: (a) entertains "what-if" questions about the recession status for sudden increase in one of the financial outcomes, (b) forecasts the value of the financial outcomes for a specific date in future and predicts the recession for that day using the forecasted values, and (c) identifies the impact of the COVID-19 pandemic on the recession by modeling the recession for two eras: "before" and "during" the pandemic. The data boundary detection between the two eras is challenging because such boundary does not follow the World Health Organization (WHO) announcement of a pandemic.

Intent Classification: French Recruitment Chatbot Use Case

Nadira Boudjani, Viviane Colas, Azade Fotouhi
SogetiLabs, Paris, France

Abstract—Intent classification is an important task for the chatbot to understand and interpret the user's message. For the proper functioning of the chatbot, it's essential to choose an effective intent classifier. In this paper, we propose a comparative study between three intent classifier models for a French recruitment chatbot: DIETClassifier (Rasa), Wit.ai Classifier and CamemBERT Classifier. First, We constructed a French dataset with intents in a recruitment chatbot context and trained all three classifiers on this dataset. According to our results CamemBERT is the best intent classifier for our chatbot.

Big Data in Healthcare: Acquisition, Management, and Visualization Using System Dynamics

Ashiat Ashake Adeogun, Misagh Faezipour
College of Basic and Applied Sciences, Healthcare Informatics,
Middle Tennessee State University, Murfreesboro, Tennessee, USA;
Department of Engineering Technology, Middle Tennessee State University,
Murfreesboro, Tennessee, USA

Abstract—Integrating big data, electronic health records (EHR), and health information systems (HIS) has yielded transformative benefits in healthcare. However, it has also introduced critical risk factors. These risks encompass data privacy and security concerns, necessitating robust encryption techniques and adherence to regulations like the Health Insurance Portability and Accountability Act (HIPAA). Additionally, data inconsistencies stemming from human behavior and decision-making can compromise data quality, urging strict data quality management and governance. Data fragmentation, primarily due to disparate data storage systems and limited interoperability, challenges comprehensive data integration. The accuracy of data in extensive datasets poses another challenge, with adaptations of quality management techniques required. Re-identification risk, wherein supposedly anonymous data can be traced back to individuals, underscores privacy breaches. Lastly, the evolving landscape of healthcare data governance presents its unique challenges. Using system dynamics in big data analytics can significantly improve healthcare management, decision-making, and patient outcomes. System dynamics is a modeling technique that helps understand complex systems, such as healthcare systems, by representing them as interconnected feedback loops and variables. When applied to big data in healthcare, it can provide valuable insights and support evidence-based decision-making. Addressing these risk factors is imperative to ensure big data's success and ethical use in healthcare through system dynamics.

Analyzing and Modeling Riyadh's Human Mobility Patterns

Alnefaie Musharraf E. Meshal, Ivica Kostanic
Department of Electrical Engineering and Computer Science,
Florida Institute of Technology, Melbourne, Florida, USA

Abstract—Human mobility patterns within Riyadh, Saudi Arabia, are studied using crowd-sourced data. Metrics based on location and distance are examined. The results are presented across three observation periods. This information has the potential to assist leaders in making informed decisions and contribute to the achievement of Saudi Vision 2030 goals. The established mobility metrics provide a set of standards, making the human mobility patterns in Riyadh comparable to other studies.

Crime Data Visualization Using Virtual Reality and Augmented Reality

Sri Chandra Dronavalli, Rishitha Reddy Pesaladinne, Maruthi Prasanna Chellatore, Sharad Sharma
Department of Information Science, University of North Texas, Denton, Texas, USA

Abstract— Crime data visualization is a crucial aspect of understanding and addressing criminal activities. By combining the capabilities of Virtual Reality and Augmented Reality, users are immersed in a three-dimensional environment that enables them to interact with crime data in unprecedented ways. The focus of this paper is on leveraging the unique features of HoloLens 2 and Oculus Quest Pro to develop intuitive and comprehensive visualizations of crime data. These technologies allow users to compare crime data across different cities, visualize crime patterns in both spatial and temporal dimensions, and uncover hidden connections within the data. By immersing users in an environment, virtual reality enhances understanding and facilitates the identification of crime hotspots, trends, and potential intervention strategies. This innovative approach empowers police officers,

analysts, and researchers to immerse themselves in crime data, enabling them to gather valuable insights, make informed decisions, and develop effective crime prevention strategies. This advancement in crime data visualization can improve the effectiveness of law enforcement efforts, aid in proactive crime prevention, and foster better collaboration and information sharing among relevant parties. Overall, this paper demonstrates the potential of utilizing HoloLens 2 and Oculus Quest Pro to transform the visualization of crime data. It highlights the benefits of an immersive and interactive approach, paving the way for advancements in crime analysis and facilitating evidence-based decision-making in the field of law enforcement.

New York City Mobility Analytics Index and the Relationship with Economic Activity

Kyle Whitt, Anasse Bari
Department of Economics, New York University, New York, USA;
Courant Institute of Mathematical Sciences, New York University, New York, USA

Abstract— Alternative data sources, such as transit data and Google searches, can be used to quantify the physical movement of populations within a region. We hypothesize that an increase in mobility in New York City is correlated with an increase in economic activity as measured by traditional economic data sources. By aggregating and analyzing data from multiple alternative data sources, an index that quantitatively demonstrates the amount of movement within New York City can be constructed. A model that tracks with established data published by the Federal Reserve can be created through this mobility index and could lead to identifying trends in the city. Experimental results indicate that there is an inverse relationship between the number of people utilizing public transit and the unemployment rate. This initial discovered relationship suggests that additional data sources may further strengthen the forecasting of economic activity through a predictive model. These results could be valuable to city officials, policymakers, and businesses to inform decision-making and planning in that they take advantage of innovative data sources that have not previously been used in this context to provide better insight into mobility and the economy of New York City.

Morocco's Football Triumph in the 2022 FIFA World Cup: A Data-Driven Analysis of Sociocultural Impact Using Big Data Analytics

Anasse Bari, Edward Hou, Caitlyn Cui, Emos Ker, Charles Wang,
Nawaf Alabdullah, Kelly Lawlor, Sebastian Straesser, Advait Abrol, Alex Manko
Department of Computer Science, New York University, New York, USA

Abstract—In the 2022 Federation Internationale de Football Association (FIFA) World Cup, Morocco's National Football Team achieved a historic fourth-place finish, garnering global attention on platforms like Reddit, Meta, and Instagram. This study presents a preliminary descriptive analytics framework, establishing a set of Morocco Indices through alternative data and natural language processing. These Indices exhibit a surge in positive sentiment about Morocco and Africa, specifically a 400% average increase in global Google search volumes related to Morocco's cuisine, culture, and attractions during and after the World Cup. Specifically, there was a significant increase in Google searches and Reddit posts semantically related to the city of Casablanca, the Atlas Mountains, as well as searches similar to "best time to visit Morocco", "Visa to Morocco", "Moroccan couscous", "Tagine", and "Morocco Travel" during and after the World Cup, among other results. The analytics tools in this study can allow organizations like FIFA and sports academies better monitor sentiment and the socio-cultural impact of sports on nations.

Data Exploration, Preparation, and Pilot Studies for Building a Knowledge Model of the Cayo Santiago Rhesus Monkeys

Martin Q. Zhao, Mehakpreet Kaur, Soumik Kundu, Qian Wang
Department of Computer Science, Mercer University, Macon, Georgia, USA;
School of Engineering, Mercer University, Macon, Georgia, USA;
Department of Biomedical Sciences, Texas A&M University School of Dentistry, Dallas, Texas, USA

Abstract--The Cayo Santiago rhesus, established and maintained for 85 years, has evolved into a valuable resource for researchers across various disciplines. This research paper outlines an ongoing NSF project aimed at developing a comprehensive database and user-friendly software application, CSViewer, to uncover hidden knowledge. Using a big data approach, the paper focuses on key events in the colony's population dynamics, emphasizing gender-specific analyses. It also explores data exploration and preparation processes, along with the application of the genealogy model in inbreeding analysis and genetic tracing. Future efforts, including the expansion of CSViewer's functions, are also addressed.

Data Imputation Under Similarity Rule Constraints Using Fuzzy Multi-Objective Programming

Mohammadreza Safi, Saeed Mozaffari, Majid Ahmadi, Shahpour Alirezaee Department of Electronic and Computer Engineering, The University of Windsor, Windsor, Canada

Abstract— Missing or incomplete data is a prevalent problem during data collection for forecasting, estimating, and decision making. Since data quality exerts profound impacts on machine learning algorithms performance, in data imputation, the process of replacing missing data with substituted values, is pivotal in many applications. Considering possible dependencies between attributes of data leads to more reliable imputation. In this paper, we take fuzzy relaxation in differential dependencies (DDs) between attributes into consideration and propose a novel fuzzy multi-objective linear (FMOL) model to reach maximum imputation performance. The proposed model seeks an imputation with maximum possible filling as well as minimum summation of violations from the crisp DDs. The Improved Zimmermann Method is used to solve the related FMOL model. Experimental results on Kaggle dataset show the proposed approach outperforms the existing methods in terms of imputed fields and imputation accuracy.

Not as Simple as It Looked: Are We Concluding for Biased Arrest Practices?

Murat Ozer, Halil Akbas, Ismail Onat, Fatih Bastug, Arif Akgul, Nelly Elsayed, Zag Elsayed
University of Cincinnati, Cincinnati, Ohio, USA;
Troy University, Troy, Alabama, USA;
University of Scranton, Scranton, Pennsylvania;
Indiana State University, Indiana, USA

Abstract - This study examines racial disparities in violent arrest outcomes, challenging conventional methods through a nuanced analysis of Cincinnati Police Department data. Acknowledging the intricate nature of racial disparity, the study categorizes explanations into types of places, types of persons, and a combination of both, emphasizing the impact of neighborhood characteristics on crime distribution and police deployment. By introducing alternative scenarios, such as spuriousness, directed policing, and the geo-concentration of racial groups, the study underscores the complexity of racial disparity calculations. Employing a case study approach, the analysis of violent arrest outcomes reveals approximately 40 percent of the observed variation attributed to

neighborhood-level characteristics, with concentrated disadvantage neutralizing the influence of race on arrest rates. Contrary to expectations, the study challenges the notion of unintentional racism, suggesting that neighborhood factors play a more significant role than the racial composition in explaining arrests. Policymakers are urged to focus on comprehensive community development initiatives addressing socioeconomic inequalities and support the development of robust racial disparity indices. The study calls for nuanced explorations of unintentional racism and future research addressing potential limitations, aiming to enhance understanding of the complexities surrounding racial disparities in arrests.

Enhancing Data Quality with Label Noise Detection

Wanwan Zheng
Graduate School of Humanities, Nagoya University, Nagoya, Japan

Abstract—Data is a key component of machine learning performance in general. In particular, if the data has been mistakenly labeled, called label noise, the regularity of the data is difficult to determine, which may result in a reduction in inference accuracy and biases in the interpretation of the results. In order to detect such label noise, classifier-based methods are currently the most commonly used. However, there is a lack of consistency in this kind of method, since noise detection results vary depending on the classifier used. Additionally, it is computationally intensive, resulting in a delay in processing. A noise detection method was proposed in this study, whose performance is independent of classifiers, and the removal of identified noises led to the highest overall classification accuracy.

Time Expression Normalization with Meta Time Information

Mengyu An, Chenyu Jin, Xiaoshi Zhong, Erik Cambria
School of Computer Science and Technology, Beijing Institute of Technology, China;
School of Computer Science and Engineering, Nanyang Technological University, Singapore

Abstract—Time expression (short as timex) normalization is fundamental for many downstream applications. Previous researches mainly develop deterministic rules and machine learning methods for the end-to-end task of timex recognition and normalization (TERN). However, deterministic rules heavily depend on specific domains while machine-learning methods are somewhat unexplainable. To better understand the task, we analyze three diverse datasets for characteristics of timex types and values. According to these characteristics, we propose a rule-based method termed MetaTime with three kinds of meta time information to normalize timexes into standard formats. MetaTime is independent of specific domains and textual types. Experimental results on three diverse datasets show that MetaTime outperforms four representative state-of-the-art methods.

Automatic Speech Recognition in Diverse English Accents

Hashir Mohyuddin, Daehan Kwak
Department of Computer Science and Technology, Kean University, Union, New Jersey, USA

Abstract—As progress speeds ahead for automatic speech recognition systems, issues still arise when it is forced to deal with accented speakers. Automatic Speech Recognition (ASR) systems have become a staple in modern life. Starting with the first mainstream system, these voice assistants have introduced a paradigm shift in how we are able to swiftly interact with these machines. However, not all individuals interact with these systems effortlessly. In particular, accented speakers often encounter challenges using ASR technologies without deliberately modifying their pronunciations. The purpose of this study is to compare leading ASR models in their

ability to transcribe speech from accented speakers of various nationalities against their native American English-speaking counterparts. We use the L2-ARCTIC (L2A) and Speech Accent Archive (SAA) speech corpus for our speakers which will be our 'clean' audio. From there, we create two additional files that contain background noise audio – the 'noisy' audio. These files are then fed into each model using their respective APIs, as applicable, to retrieve the transcribed text. Finally, the transcribed text is then compared to the original text to extract the Word Error Rate (WER) for the speaker and model. The primary objective of this study is to highlight the challenges faced by people of color when using this type of technology. By highlighting these issues, we aim to encourage proactive measures on taking steps towards their resolution. We believe it emphasizes the importance of fostering a more equitable and inclusive user experience.

CSCI-RTNA:
RESEARCH TRACK ON SOCIAL NETWORK ANALYSIS, SOCIAL MEDIA, & MINING

A Study of User Perceptions of News Media Labeling to Limit the Spread of Misinformation

Jessica Sietsema, Khalil Ghoseyni, Chase Condron, Kimberly Saks, Matthew Spradling
College of Innovation and Technology, University of Michigan - Flint, Michigan, USA;
College of Arts and Sciences, University of Michigan - Flint, Michigan, USA

Abstract—Disinformation is a growing problem in an increasingly online society. Several proposals have been made to provide 'nutritional facts'-style labeling of online content. OpenLabel implements just such a labeling schema as a Chromium extension. We conducted a behavioral intervention to evaluate the impact that OpenLabel had on participant (n=62) beliefs about news media. We note several correlative relationships from respondent's partisanship, ideology, and political knowledge to their responsiveness to OpenLabel. While exposure to the software itself did not appear to have a significant impact on respondent beliefs, we conversely found no evidence of the backfire effect. Several key conclusions are drawn to impact future development on OpenLabel and further research interventions.

The Influence of Social Media on Body Image

Fadi Yamout, Alia Ghaddar
Computer Science & Information Technology,
Lebanese International University, Beirut, Lebanon

Abstract— Digital devices have become increasingly integrated into our daily lives since society relies much on them for communication. Digital devices are primarily used for social media, which has positive benefits, such as contacting friends and sharing memories. Social media turned out to be the opposite of its purpose. It gradually progressed into setting beauty standards and has started to impact people's self-esteem, as well as their tendencies to depression and anxiety because of body image dissatisfaction. The reason is that the brain treats information about oneself as a reward, and many people are sensitive to self relevant information and social image. They consider this information as an assessment of their social rank and reputation. This paper aims to investigate the influence of social media on body image dissatisfaction among women and how it influences their self-confidence and decision-making. We also aim to check whether women are more prone to have addictive tendencies toward social networking sites and applications than males.

Emotion Analysis on COVID-related Twitter Tweets

Maliha Haider, Daehan Kwak
Department of Computer Science and Technology, Kean University, Union, New Jersey, USA

Abstract—As COVID-19 pandemic cases begin to escalate at an alarming rate, causing more people to get sick every day, it is important to monitor the public's reaction to the crisis. The purpose of this study is to gain an understanding of how peoples' emotions have changed over the course of the pandemic. Understanding how people have responded to COVID-19 will help society have a clearer view of peoples' emotions and how they have been handling the pandemic. Social media has become a common way that the public tends to communicate their thoughts and opinions, thus, this study focuses on detecting emotions on Twitter tweets that were posted during the pandemic. 364,254 tweets are collected, processed, and associated with eight basic emotions (anger, anticipation, disgust, fear, joy, sadness, surprise, trust) along with two sentiments (negative and positive).

Experimental Predictive Analytics Tools to Help Detect Fake News: A Survey

Sana Sajjad, Anasse Bari
Department of Computer Science, Courant Institute of Mathematical Sciences,
New York University, New York, USA

Abstract— Fake news can warp our perspective of reality, controlling the decisions we make as individuals and as a collective. The rise of social media and the fall of professional journalism has made the uproar of fake news stronger. Additional studies, literature, and research are essential in battling this predicament. Thus, this paper's ambitions are to contextualize the detrimental impact of fake news, providing valid arguments for its presence, and running through the traditional non-technological methods of fact-checking. Upon doing so, this study presents a survey of fact-checking algorithms, providing an overview and areas for deeper understanding and improvement. We conclude with suggestions and room for future exploration.

Sentiment Analysis of Twitter Posts on Global Conflicts

Ujwal Sasikumar, Ank Zaman, Abdul-Rahman Mawlood-Yunis, Prosenjit Chatterjee
School of Workforce Development, Conestoga College ITAL, Kitchener ON, Canada;
Department of Physics and Computer Science, Wilfrid Laurier University, Waterloo, ON, Canada;
Department of Computer Science & Cyber Security, Southern Utah University, Cedar City, Utah, USA

Abstract—Sentiment analysis of social media data is an emerging field with vast applications in various domains. In this study, we developed a sentiment analysis model to analyze social media sentiment, especially tweets, during global conflicting scenarios. To establish our research experiment, we identified a recent global dispute incident on Twitter and collected around 31,000 filtered Tweets for several months to analyze human sentiment worldwide. In this research, the training models comprised of Na¨ıve Bayes Algorithm (NBA) and Neural Networks (NN). The trained model achieved 80% and 100% accuracy in predicting the sentiment of the tweets using Naive Bayes and Neural Network models, respectively. A confusion matrix was created to evaluate the model's performance, indicating that the model correctly classified many positive and negative tweets. This study contributes to developing sentiment analysis models for analyzing social media data related to various events and topics. The findings can be helpful for researchers and practitioners interested in understanding public sentiment about the country-wide conflict on social media. In this document, Twitter is referring to its new name X.

Challenging Traditional Polls: 2023 Ecuadorian Regional Elections, Could Shameful Votes be Uncovered Through Sentiment Analysis?

Ruben Pacheco-Villamar, Carlos Chiriboga-Calderon, Joaquin Lopez-Chavez,
Jose Lopez-Fierro, Sariah Lopez-Fierro
Universidad Espiritu Santo, Ecuador; Soluciones Wandarina S. A., Ecuador;
Universidad Catolica de Cuenca, Ecuador

Abstract—Elections serve as a fundamental mechanism for citizens to express their political preferences in democratic societies. However, traditional polls have raised concerns regarding their effectiveness in capturing the complete spectrum of voter sentiment, particularly when it comes to neglected and shameful votes that often remain hidden. This paper focuses on the 2023 Ecuadorian Regional Elections and explores how sentiment analysis techniques and ChatGPT can uncover shameful votes that have been overlooked by conventional polling methods.

A Topic Clustering Method to Identify Online Threats against Soft Targets

Marco San Biagio, Marco Cipolla, Ernesto La Mattina, Vito Morreale
Digital Technologies Research and Innovation Lab,
Engineering Ingegneria Informatica S.p.A., Palermo, Italy

Abstract— Nowadays with the ever-evolving digital landscape and the continual pervasively of the AI-based technologies, safeguarding soft targets from potential threats is of paramount importance. Soft targets, encompassing a wide range of public spaces and institutions, are highly susceptible to several kinds of security risks, making it imperative to design and deploy proactive monitoring strategies. The goal of this work is to propose an AIbased application for supporting intelligence analysts and investigators to timely identify potential security threats from social media platforms. Based on a topic modelling trained algorithm on an extensive terrorism related activities dataset, the tool will suggest hot topics useful to support the monitoring phase to get more precise data from social media platforms. The proposed approach empowers security practitioners and decision makers, regardless of their familiarity with the subject, to gain valuable insights to enhance Public Space and Soft Target Protection. Results obtained on a newly created dataset confirm the efficiency and effectiveness of the solution presented in this paper.

Evaluating Uber Customers' Perception on Twitter: A Case Study in Ecuador

Maria Becerra-Salas, Henry N. Roa
Facultad de Ingenieria, Pontificia Universidad Catolica del Ecuador, Quito, Ecuador

Abstract— This study analyzes the perception of Uber users through Twitter, currently known as X, using the CRISP-DM methodology in Python. We collected data from the last twelve years to accomplish this study. The data set is divided into training and testing, processing them using natural language processing and classifying them as neutral, positive, and hostile. Classification algorithms such as Logistic Regression, Support Vector Machines (SVM), and Naive Bayes are applied, with SVM being the most effective in predicting user sentiments. This approach leverages Twitter accessibility and data analytics to understand the public perception of Uber.

Cybersecurity Risks in the Deployment and Use of Digital Business Cards: Implications for Organizations and End-Users

Dale Rutherford, Ningning Wu
Department of Information Science, University of Arkansas at Little Rock, Arkansas, USA

Abstract— The digital transformation of business networking through digital business cards has brought about unprecedented convenience and efficiency. This research paper scrutinizes the cybersecurity risks associated with digital business cards, impacting individual users, companies, and organizational leaders like CIOs and CPOs. It explores specific cyberattacks such as phishing, malware injection, and database exploits. The paper emphasizes the collective responsibility of mitigating these risks through multi-layered strategies, including software updates, strong authentication, and employee training. By offering actionable insights, this study aims to enhance cybersecurity measures, safeguarding both individual and organizational stakeholders in the realm of digital networking.

An Analytics Framework for Analyzing Social Network News

Fu-Shing Sun, Miao Guo
Computer Science Department, Ball State University, Muncie, Indiana, USA;
Department of Digital Media and Design, University of Connecticut, Storrs, Connecticut, USA

Abstract - We present an analytics framework for analyzing news posts available on Instagram. There are four major components in this framework including data collection, data processing, data analytics, and data visualization. The data collection module is responsible for collecting the news posts from the Instagram website. Data cleaning, filtering, and parsing unstructured data are done in the data processing module. The data analytics module computes the desired analytics in various domains, and finally the data visualization module displays meaningful findings to the users. We also demonstrate how the framework works with real-world online news samples in this paper.

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Detect & Adapt: A Resiliency Enhancement Mechanism for Space Computing Platforms

Shafkat Islam, Nagender Aneja, Ruy de Oliveira, Sandhya Aneja,
Bharat Bhargava, Jason Hamlet, Chris Jenkins
Purdue University, West Lafayette, Indiana, USA;
Federal Institute of Mato Grosso - IFMT, Brazil;
Marist College, Poughkeepsie, New York, USA;
Sandia National Laboratory, USA

Abstract—Over the years, space systems have evolved considerably to provide high-quality services for demanding applications such as navigation, communication, and weather forecast. Modern space systems rely on extremely fast commercially available off-the-shelf (COTS) processing units, with built-in GPU, DSP, and FPGA in light-weight, energy-efficient hardware. Since such devices are not necessarily designed with security features as a priority, there must be an adaptive controller to protect this mission-critical space system from potential malicious attacks, such as memory leaks, packet drops, algorithmic trojans, and so on. These attacks can lead the system to substantial inefficiency or complete failure. Considering the hardware diversity in current space systems, we propose a framework to explore both diversity and redundancy not only of hardware but also of software to make the overall system fault-tolerant. Our approach deploys mechanisms for monitoring and orchestrating actions of redundancy, diversity, and randomization to render the system resilient unpredictably dynamic, and optimize efficiency as much as possible during abnormalities. Yet, we use rule-based and adaptive engines to keep track of the various computing units to learn the best strategies to take when the system is under attack. The robustness of our approach lies in the fact that it makes the system highly unpredictable to potential attackers and tolerates attacks to some extent, which is crucial for any mission-critical application.

Obfuscated Ransomware Family Classification Using Machine Learning

William Cassel, Nahid Ebrahimi Majd
Department of Computer Science and Information Systems,
California State University San Marcos, California, USA

Abstract— The recent rise of ransomware attacks, average ransom demands, average ransom payments, and average ransomware recovery time has made ransomware a serious threat for businesses and individuals. Obfuscated ransomware is a more threatening variation that is more complicated to detect. Designing accurate ransomware detection systems is essential to protect networks from harmful consequences of a ransomware attack. In this research, we propose a machine learning based ransomware classification framework and study five machine learning algorithms and four feature selection techniques to detect the class of an obfuscated ransomware vs. benign. We studied different feature selection techniques that remove noise and highly correlated features to get the most efficient model. We also studied the impacts of different techniques to combat data imbalance. Our results indicate that Random Forest with LightGBM feature selection technique outperforms other models with 89.4% accuracy.

Covert, Secure and Private Communications in Software Defined Networking

Artrim Kjamilji
Department of Cybersecurity, Istanbul Ticaret University, Istanbul, Turkey

Abstract—Covert and private communications are an essential part of the modern Internet. While there have been several works on these topics, almost all of them have one or more drawbacks, which are unacceptable in modern requirements of Software Defined Networking (SDN). To this end, initially, we propose and adopt a few secure buildings block, such as secure bit stream match, secure longest prefix match, secure header replication, etc. On top of them we propose covert and secure end-to-end generalized forwarding protocols used in SDN over busy routers. Besides covert communications, communication privacy is a by-product of the proposed protocols. The proposed schemes are proven to be secure under the semi-honest model, whereas the experimental evaluations show their computation and communication efficiency.

Named Entity Recognition from Biomedical Data

Maged Refaat, Ahmed Rafea, Nada Gaballah
Computer Science and Engineering Department, American University in Cairo, Egypt

Abstract— Vast amounts of textual data are now available digitally. Consequently, automated tools are needed to extract relevant meaningful information. Named entity recognition (NER) is the task of identifying text referring to named entities, and classifying them into predefined categories. Although there exist numerous NER methods, biomedical domain name entity recognition is under-studied. The objective of this research paper is to introduce an efficient approach for NER tasks from biomedical data. The investigated approach uses pre-trained models like BERT and its variances SciBERT and BioBERT, and deep learning technologies. Our hypothesis is that applying the training phase on textual data after being preprocessed will enhance the model performance. Therefore, we will investigate the effect of adding basic preprocessing rules like dropping out punctuation and white spaces and well-known stop words like articles, pronouns, prepositions, and conjunctions. We will also investigate removing irrelevant parts of text based on part-ofspeech tagging such as verbs and adjectives. The effect of text preprocessing on model performance will be monitored. Our model outperforms vanilla BERT, and BioBERT where Precision reaches 66.20%, Recall reached 98.96%, F1 scored reached 79.33%.

Understanding Cyber Threats: Patterns, ISP Characteristics, Industry Targets, and Geographic Correlations

Surya Rohith Akella, Divya Lalitha Vydula, Murat Ozer, Yasin Kose,
Fatih Bastug, Nelly Elsayed, Zag Elsayed
University of Cincinnati, Cincinnati, Ohio, USA;
Friedrich-Alexander-Universitat, Erlangen-Numberg, Erlangen, Germany;
University of Scranton, Scranton, PA, USA

Abstract- Using data from the FireHol Project, this study explores the complex landscape of cyber threats to uncover critical insights into their evolution, internet service provider (ISP) characteristics, industry-specific targets, and geographical correlations. The analysis of ISPs provides a nuanced understanding of their roles in cyber threat scenarios, enabling enhanced risk mitigation strategies. Industry-specific insights illuminate sectors frequently under siege by malicious activities, aiding organizations in crafting tailored defense strategies. Geographic correlations shed light on the connection between IP location and the likelihood of malicious activities, fostering regional threat awareness and international cooperation. By comprehensively addressing these dimensions of cyber threats, this study not only advances the understanding of evolving cybersecurity challenges but also equips stakeholders with actionable knowledge to fortify their defenses in an interconnected digital world. Its implications span cybersecurity practices, policymaking, public awareness, and international collaboration, contributing to the ongoing effort to safeguard the digital realm from malicious actors.

Defending Quantum Neural Networks against Adversarial Attacks with Homomorphic Data Encryption

Ellen Wang, Helena Chaine, Xiaodi Wang, Avi Ray, Tyler Wooldridge
Department of Mathematics, Western Connecticut State University, Danbury, Connecticut, USA;
Department of Mathematics, New York University, New York, USA

Abstract—Several studies have shown that quantum neural networks are susceptible to adversarial attacks, which pose a significant threat to the accuracy of quantum neural networks. Adversarial attacks may exploit the input data of a network by feeding incorrect data to a model while manipulating one that has already been trained, which may cause erroneous results. In this research, we propose a novel defense model to protect quantum neural networks against adversarial attacks by using homomorphic data encryption. Homomorphic encryption allows computations to be processed on encrypted data that has not yet been decrypted by converting the data into ciphertext, which allows the data to be handled in its original form without any risks of privacy breach. By incorporating homomorphic data encryption into quantum neural networks, our proposed model tries to reduce adversarial attacks that may perturb network outputs. Taken together, our approach sheds light on the future of quantum computing and the preservation of sensitive information.

Advancements in Fake News Detection Using Machine and Deep Learning Models: Comprehensive Literature Review

Bushra Alkomah, Frederick Sheldon
Computer Science Department, University of Idaho, Moscow, Idaho, USA

Abstract - In the age of digital technology, the exponential spread of fake news has become a significant issue for society. In response to this issue, considerable advances have been made to identify fake news using machine learning models. This literature review investigates the current state of research on detecting fake news. It emphasizes the use of machine learning models such as TF-IDF, Naive Bayes, and Random Forest, as well as deep learning models such as Convolutional Neural Networks (CNNs), Long Short-Term Memory (LSTM) networks, and Transformer-based models such as BERT. The review concisely summarizes the essential findings and discusses the potential future implications of fake news identification. It also emphasizes the need for additional research to address numerous challenges, such as effective multimedia content management, protection against adversarial attacks, attainment of model generalizability, facilitation of real-time detection, and adherence to ethical standards when developing detection systems. This review is a resource for researchers and practitioners seeking to develop effective methods for addressing the perpetually expanding problem of detecting fake news.

A Machine Learning Approach to Threat Hunting in Malicious PDF Files

Haydar Teymourlouei, Vareva E. Harris
Department of Technology & Security, Bowie State University, Bowie, Maryland, USA;
School of Advanced Studies, University of Phoenix, USA

Abstract—This paper investigates the effectiveness of machine learning models for cyber threat hunting. Four distinct machine learning algorithms are used: Support vector machine (SVM), knearest neighbors (KNN), multi-layer perceptron (MLP), and random forest (RFC). We also analyze the behavioral patterns associated with cyber threats, which can achieve an insight for improving threat hunting systems. The dataset used in the work is specific to threats associated with malicious PDF files. The ML models were tasked with classifying benign and malicious PDFs. The behavior analysis investigates patterns related to the general and internal structure of the PDFs. In the

results, we demonstrate the RFC classifier had an accuracy over 99% and loss below 0.05. The other classifiers had at least 95% accuracy and less than 0.2 loss. When using the full dataset, the MLP model had significantly larger computational overhead than the others. The method presented here has the potential to enable real-time threat hunting for a variety of cyber-security applications.

VoIP Steganography using iLBC Start State Residuals

Ting-Xiao Miaw, Quincy Wu
Department of Computer Science and Information Engineering,
National Chi Nan University, Nantou, Taiwan

Abstract—In this paper, we propose a novel approach for information concealment within speech signals encoded using the iLBC codec. Our method leverages the start state's residual samples. We explore the utilization of the 3-bit quantized start state residual signal as an information hiding field. By strategically selecting specific quantization table indices based on the hidden bits, we achieved a remarkable four-fold enhancement in information hiding capacity while maintaining a high level of Perceptual Evaluation of Speech Quality (PESQ). This method offers a flexible balance between capacity and imperceptibility, allowing adaptation according to varying real-world scenarios. This adaptability empowers customization of information hiding techniques, making it highly applicable in diverse contexts.

A Literature Survey and Analysis of Defending Cyber Attacks Targeting Iot in Critical Infrastructure

Ali Al-Sinayyid, Kadiyala Sasidhar, Md Julifiker Ali Jewel, Venkatesh Mannuru
Department of Mathematics and Computer Science,
West Virginia State University, Institute, West Virginia, USA

Abstract—In an era defined by the relentless advancement of technology, the critical infrastructure that sustains our daily lives has become increasingly reliant on complex digital systems like Internet of Things (IoT). While these complex digital systems have brought convenience and efficiency to critical infrastructure, they have also become prime targets for malicious parties seeking to exploit vulnerabilities, raising concerns across vital sectors like energy, healthcare, transportation, and beyond. Through systematic literature review, historical incident analysis, and examination of recent attacks, this paper aims to deepen our understanding of the evolving threat landscape, emphasizing the urgency of strengthening defenses, particularly in the IoT realm to secure the foundations of modern society. This literature survey encompasses a spectrum of defending technologies and methodologies, including Artificial Intelligence (AI)-based defenses, and anomaly-based intrusion detection systems. Analyzing variations techniques and evaluates their efficiency and complexity.

Fortifying Network Security: Pioneering Digital Twin Technology for Proactive Anomaly Detection

Patrick Ansah, Sumit Tetarave, Jyoti Kumari, Caroline John
Department of Cybersecurity, University of West Florida, Florida, USA;
School of Computer Applications, Kalinga Institute of Industrial Technology, Bhubaneswar, India;
Section of Director Teacher, Byjus FutureSchool, Maharashtra, India

Abstract—Amidst the growing cybersecurity challenges of our digital age, this study leverages Digital Twin technology to fortify network security. We've meticulously developed a Keras-based Digital Twin model to replicate complex network behaviors within a simulated environment. In a landscape where cyber threats evolve rapidly, this endeavor is pivotal. It addresses current cybersecurity trends and offers proactive digital realm

protection. The model enables real-time anomaly detection, empowering organizations to strengthen their digital infrastructure. Rigorous evaluation, employing the confusion matrix, highlights exceptional performance. The model boasts an Accuracy of 99.43%, a Precision of 85.36%, a Recall of 99.58%, and an F1 Score of 91.93%. These metrics accentuate its precision and effectiveness in identifying network anomalies. Additionally, it achieves a remarkable True Positive count of 134,694, effectively detecting positive cases while maintaining low False Positives (Type-I Error) at 774. It also has a False Negative (Type II Error) count of 19 and a True Negative count of 4,514. This success underscores Digital Twin technology's potential to revolutionize network security, providing pre-emptive defense against dynamic threats. Our work signifies a transformative leap towards a safer, resilient digital landscape fortified by cutting-edge technology.

Information Security Paradigm Shift for a Connected World

Choong-Hee Han, Jae-Woo Lee, Adhikari Naresh
Chonnam National University, South Korea; Korea Power Exchange, South Korea;
Dongguk University, South Korea; Slippery Rock University, Pennsylvania, USA

Abstract—The coronavirus pandemic has highlighted the fact that the world is interconnected in real time. We have clearly seen that outbreaks of infectious diseases spread rapidly around the world. With the spread of cloud computing, artificial intelligence, and smart cities, various data are much more connected enormously than before. For example, the electric power industry, which has traditionally been operated as a closed network, is evolving into a domain connected via the Internet owing to the explosive increase in renewable energy generators. However, the philosophy and methodology for information security has not changed substantially since it was established around the 1970s. Information security philosophy and methodologies established in the 1970s are ill-equipped to respond appropriately to various cyber incidents in the connected age. Going forward, determining what needs to be supplemented and improved in the philosophy and methodology of information security will be essential. In this paper, we present the definition, philosophy, methodology, and other aspects of existing information security. We also review recent studies that aim to improve information security. Through this, an updated philosophy and methodology of information security for a connected world will be proposed.

Cyber Extortion Unveiled: The Evolution, Tactics, Challenges, and Future of Ransomware

Salahaldeen Duraibi, Chamandeep Kaur, A. B. Pawar
College of Computer Science and Information Technology, Jazan University, Jazan, Saudi Arabia;
Department of Computer Engineering, Sanjivani College of Engineering, Kopargaon
Savitribai Phule Pune University, Pune, India

Abstract—The adaptability and malicious efficiency of ransomware, a sort of malicious software that encrypts files or restricts system access until a ransom, frequently in the form of cryptocurrency, is delivered to the attacker, is unmatched by other computer dangers. This article covers ransomware's unrelenting evolution, from its historical roots to sophisticated modern varieties that use cutting-edge encryption and the ominous "double extortion" tactic. Attacks with ransomware offer serious risks, including financial hardships, breaches of data privacy, interruptions of vital infrastructure, and psychological effects on victims. The paper explores encryption methods, such as the AES and RSA algorithms, and finds common entry vectors for ransomware, including social engineering, phishing emails, and software weaknesses. It highlights difficulties in ransomware mitigation, including dangers in the supply chain, human weaknesses, resource limitations, ransomware's dynamic nature, encryption and evasion strategies, data exfiltration, and cryptocurrency transactions. Application whitelisting, behavioral analysis, and threat intelligence are all examples of mitigation methods. Response strategies like data backups and incident response plans are examples of mitigation strategies. The efficacy analysis highlights the necessity for a comprehensive strategy by highlighting strengths and shortcomings. The review advocates for interdisciplinary integration to combat the evolving ransomware threat landscape by outlining promising

approaches and future research needs, such as multi-modal authentication techniques, resilience-centric security measures, ransomware attribution techniques, and user-centric security designs.

Detecting Cyber Threats with Limited Dataset using Generative Adversarial Network on SCADA System

Chol Hyun Park, Ju-Yeon Jo, Yoohwan Kim
Department of Computer Science, Univesrity of Nevada Las Vegas, Nevada, USA

Abstract—Cyber-attack and threat pose a significant risk to critical infrastructure especially in Supervisory Control and Data Acquisition (SCADA). These are essential to manage energy, water and industrial manufacturing processes. Detecting cyber-attack on SCADA systems is very important to keep the integrity and security of SCADA systems. However, currently the biggest challenge in SCADA cybersecurity is limitation of dataset. There is very limited public dataset, and generating realistic simulation data is challenging. Therefore, finding or create a dataset to training robust detection model is not easy. We propose to use Generative Adversarial Network (GAN) to address this challenge. GAN is one of the well-known deep learning algorithms that generate synthetic data that resembles real data; therefore, GAN is useful when training data is limited. We research to find the best model and layer structure to detect cyber-attack. Our test result shows higher than 97% accuracy. This paper details what GAN is, browsing dataset, experimental and result.

Machine Learning Systems for Connected Vehicles

Allen Austen Riffee, Ben Cyphers, Guillermo Francia, III, Dallas Snider
Center for Cybersecurity, University of West Florida, Pensacola, Florida, USA;
ACES SFS Program, University of West Florida, Pensacola, Florida, USA;
IT Department, University of West Florida, Pensacola, Florida, USA

Abstract—This paper presents on-going research on machine learning (ML) systems for connected vehicle security. It proposes the application of various ML techniques that are applied to Basic Safety Message (BSM) test datasets, both on normal operation and anomalous behavior. The BSM test datasets conform with the SAE J2735 Standard on message sets that support vehicle-to-everything (V2X) communications systems. The purpose of the study is to determine the suitability of ML systems in identifying and classifying normal and anomalous BSM messages in a network of connected vehicles and the V2X systems.

Analytical Study for Cybersecurity Attacks and Defenses Characteristics

Ali Al-Sinayyid, Kadiyala Sasidhar, Md Julifiker Ali Jewel, Venkatesh Mannuru
Department of Mathematics and Computer Science,
West Virginia State University, Institute, West Virginia, USA

Abstract—As technology continues to advance rapidly, society becomes increasingly reliant on digital systems. The cybersecurity landscape becomes progressively intricate and fraught with challenges. This paper conducts an in-depth exploration of the contemporary cybersecurity threat landscape, charting its evolution and examining the defensive strategies in play. By synthesizing insights from a broad spectrum of literature and presenting real-world cases, this work comprehensively analyzes the key characteristics of various threat categories, including malware, phishing, ransomware, and denial-of-service attacks, among others. As a conclusion, this paper strongly advocates the adoption of a multi-faceted and multi-layered defense approach to yield a high accuracy and efficient cyber defense.

Defending Characteristics and Attribution Analysis for Phishing Attacks

Ali Al-Sinayyid, Kadiyala Sasidhar, Md Julifiker Ali Jewel, Venkatesh Mannuru
Department of Mathematics and Computer Science,
West Virginia State University, Institute, West Virginia, USA

Abstract—Nowadays, Phishing cyber-attacks have been widespread cyber threats to people, governments, private sectors, service providers, and internet users globally. Attackers gather personal information about the targeted victims through the use of emails or fake websites, such as user account login details, bank card numbers, etc. The victim is persuaded using a mix of technical and social engineering techniques. This paper provides a review of recent existing research on various phishing attacks, including HTTPS phishing, spare phishing, whale phishing, pop-up phishing, and email spoofing hacking. As well as how to identify such attacks using Artificial Intelligence (AI) techniques, including Machine Learning, Deep Learning. Besides, investigates the benefits and drawbacks of different defending approaches and provides an overview of the problems with phishing attack detection and future research goals.

Attack Target Detection Using Machine Learning on SCADA Gas Pipeline Data

Michelle Buslon, Chol Hyun Park, Yoohwan Kim, Ju-Yeon Jo
Computer Science Department, University of Nevada, Las Vegas, Nevada, USA

Abstract - Supervisory Control and Data Acquisition (SCADA) architecture is at the core of industrial organizations, such as factories and power plants. Within the SCADA system is a network of devices gathering and monitoring data. As the number of devices or components increases, so does the number of potential attack points. It is crucial to prevent and mitigate attacks on SCADA systems in order to stop a complete loss of the system to an attacker. Detecting the specific target point of the attack will allow for quicker isolation and mitigation without requiring the shutdown of the whole system. This paper explores the use of machine learning models, particularly Random Forest (RF), Gradient Boosting Classifier (GB), AdaBoosted Classifier (AB), a Deep Neural Network (DNN), and other previously proposed models, comparing their performance in identifying the attack target in a SCADA environment for gas pipeline data.

Ensuring Data Security in eLearning: Challenges and Solutions

Shirin Jorayeva, Mohammad Eyadat
Information systes and Operations Management,
California State University, Dominguez Hills, California, USA

Abstract - Data security issues have gotten more and more attention as eLearning becomes more and more popular. There is a chance that private information will get into the wrong hands when instructional content is delivered through technology and the internet. The Internet is eventually necessary for the execution of eLearning, a novel approach to education. A new set of unlawful activities have found a home on the Internet, posing challenges to the e-learning environment. This paper examines the problems with authentication, encryption, and the use of third-party platforms that eLearning presents for data security. In addition, the study offers recommendations for eLearning data security, such as the usage of multi-factor authentication, secure communication protocols, and data encryption. This paper offers insights into how eLearning providers may safeguard their users' data and make sure that learning environments are secure through an analysis of current trends and best practices in data security.

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RESEARCH TRACK ON MOBILE COMPUTING, WIRELESS NETWORKS, & SECURITY

Simulation Model for a Bent Pipe Satellite Network using DVB-S2/RCS2 Standards

Gustavo Chafla, Nelson Salgado, Juan Chafla
Engineering Faculty, PUCE, Quito, Ecuador

Abstract— GEO satellite communications have several advantages, such as their wide coverage, easy installation and are a solution for hard-to-reach areas where terrestrial communication infrastructure simply does not exist or is too expensive. DVB-S2 and DVB-RCS are open satellite standards developed by ETSI which can resolve the interoperability of terminals. This paper presents an NS simulation tool of a bent pipe GEO satellite network based on the DVB-S2 and DVB-RCS2 standards to transport IP traffic taking into the account the multiframe TDMA structure for multiple access and capacity requests mechanisms proposed in both standards.

Wireguard: An Efficient Solution for Securing IoT Device Connectivity

Haseebullah Jumakhan, Amir Mirzaeinia
University of North Texas, Denton, Texas, USA

Abstract—The proliferation of vulnerable Internet-of-Things (IoT) devices has enabled large-scale cyberattacks. Solutions like Hestia and HomeSnitch have failed to comprehensively address IoT security needs. This research evaluates if Wireguard, an emerging VPN protocol, can provide efficient security tailored for resource-constrained IoT systems. We compared Wireguard's performance against standard protocols OpenVPN and IPsec in a simulated IoT environment. Metrics measured included throughput, latency, and jitter during file transfers. Initial results reveal Wireguard's potential as a lightweight yet robust IoT security solution despite disadvantages in raw throughput performance likely due to experimental limitations. With further testing, Wireguard's simplicity and low overhead could enable widespread VPN adoption to harden IoT devices against attacks. The protocol's advantages in setup time, performance, and compatibility is promising for integration even on weak IoT processors and networks.

A 5G/6G Infrastructure for Secure, High-Performance, Low-Latency Application Services

Jeffrey Wallace, Angelica Wallace, Miroslav Vukovic, Toni Karimovic,
Srdjan Kovacevic, Boris Snajder, William Edwards, Junaid Islam
Rocket Technology Systems LLC, Washington, DC, USA

Abstract—The evolution of wireless communication technologies has been marked by significant advancements, with 5G and its successor, 6G, at the forefront of this transformative journey. 5G, the fifth generation of wireless technology, can revolutionize connectivity by delivering ultra-fast data speeds and low latency, enabling a plethora of applications, from augmented reality to autonomous vehicles. The integration of mobile edge computing (MEC) in 5G networks can further augment network performance by bringing computation closer to the data source, facilitating real-time data processing and minimizing latency. Network slicing, a key feature of 5G, allows the creation of customized virtual network segments to segregate traffic based upon user requirements. 6G, the forthcoming sixth-generation technology, is set to build upon these foundations and redefine the possibilities of wireless communication. It is poised to deliver unparalleled data rates, and MEC will continue to play a pivotal role in 6G. Moreover, 6G will introduce radio access network slicing, allowing for even more granular customization of network resources, ensuring that diverse services. In summary, 5G and 6G, coupled with mobile edge computing, network slicing, and radio access network slicing, represent an evolution that promises to reshape the way we connect, communicate, and compute in an increasingly digital world.

Active Admission Control in a P2P Distributed Environment for Capacity Efficient Livestreaming in Mobile Wireless Networks

Andrei Negulescu, Weijia Shang
Computer Science and Engineering Department, Santa Clara University,
Santa Clara, California, USA

Abstract— In this study, the Active Control in an Intelligent and Distributed Environment (ACIDE) media distribution model solution and algorithms are proposed for livestreaming in capacity efficient mobile wireless networks. The elements of the ACIDE model are a base station and a cluster formed by a number of peers able to establish peer to peer communications. The cluster peers are selected from a group of users interested in livestreaming the same media. The ACIDE model solution minimizes the bandwidth allocated to a cluster of n peers such that an uninterrupted media play for all peers is guaranteed. The livestream media is sent to the peers in packages and every media package is divided into n blocks. The blocks are distributed to the n peers of a cluster in two phases, such that the base station bandwidth is utilized during first phase only. The allocated bandwidth, the amount of bandwidth the base station has to allocate to a cluster, is minimized and its lower bound is equal to the bandwidth required for multicasting. In this study, the ACIDE model is used to address the problem of how to find the maximum number of peers n, chosen from a group of N users, that can be admitted to a cluster knowing the given allocated bandwidth, the amount of bandwidth that a base station allocates to a cluster in advance, prior to admitting users. When users become peers of an ACIDE cluster, the network capacity, the total number of users who are able to access live media, increases meaning that network resources are used more efficiently. The problem of finding the maximum number of peers n is addressed as an optimization problem, with the objective of having the entire given allocated bandwidth used by the peers admitted to the cluster. This problem is NP-complete and a non-optimal solution is proposed for peers' selection such that all admitted peers play media continuously.

CSCI-RTOT:
RESEARCH TRACK ON INTERNET OF THINGS & INTERNET OF EVERYTHING

Data Protection and Recovery Plan for Securing Home IoT Domain

Syed Rizvi, James Davis, Shane Reigert, Mark Ihnat
College of Information Sciences and Technology,
Pennsylvania State University, Pennsylvania, USA

Abstract— The proliferation of Internet of Things (IoT) devices in residential settings has exposed individuals to increased vulnerabilities. However, the residential environment often lacks sufficient security measures to effectively address these risks. This research aims to explore methods for securing IoT devices in homes by implementing a proposed risk management framework and utilizing the Business Impact Analysis (BIA) to mitigate potential challenges posed by malicious actors. To demonstrate the practical application of the risk management framework and BIA, a hypothetical yet realistic case study of a home network is created. Subsequently, a comprehensive data recovery plan will be developed. By employing this framework, we can effectively address various aspects of the BIA, leading to the formulation of contingency policies and recommendations that establish a resilient IoT network.

IoT Lightweight Session Key Exchange to Improve Security Scheme

Ahmad AlKurdi, Sa'ed Abed
Computer Engineering Department, Kuwait University, Kuwait City, Kuwait

Abstract—As IoT systems proliferate throughout many different sectors, such as healthcare and safety, additional work is required to ensure that these systems are adequately secured. Networks such as these must ensure that users have access to services in a timely matter. An important mechanism by which we can enable secure communication between nodes in IoT is user authentication. A Banerjee study described a new lightweight user-authenticated session key exchange method for IoT deployment, in which a user's smart card, password, and biometric authentication are used in conjunction. This paper found that the Banerjee system is insecure against attacks, affecting the cardholder's smart card and stolen verifier. We proposed a new methodology with the shortfalls of the Banerjee plan. To better demonstrate our scheme's security, we offer informal security analysis. The Banerjee scheme is employed to discover the security level that our method provides, which indicates that our method is more secure than it. In addition, our solution includes no authentication storage table on the gateway side.

Processing Model for Fog Computing Applied to Internet of Medical Things (IoMT)

Leonardo Juan Ramirez Lopez, Engler Ramirez Maldonado, Wilson Mauro Rojas Reales
Telecommunications Engineering, Universidad Militar Nueva Granada, Bogota DC, Colombia;
Informatic Engineering, Universidad de Salamanca, Salamanca, Spain

Abstract—Internet of Things (IoT) platforms are software systems that connect and manage IoT devices, applications, and data. IoT platforms act as intermediaries between devices and applications, providing a common framework for them to communicate with each other. Furthermore, in fog computing architecture, the fog layer refers to the layer of computing infrastructure that is located between the edge devices and the cloud data center. Therefore, fog layer is comprised of inter-mediate nodes, which are computing resources that are located closer to the edge devices than the cloud data center. With the premise that fog layer allows to improve the efficiency and reduce the latency of data processing by bringing computing and storage closer to the devices that generate and use data. This study presents a new model of real-time data processing in the fog layer to take advantage of own resources instead of sending data to a centralized cloud data center for processing. The method used was the supervised machine learning creates as a model that makes predictions based on evidence in the presence of uncertainty and their application in e-health, using intermediate nodes within an Internet of Things (IoT) platform used for heartbeat anomaly detection. The evaluation used was a set of statistical validation metrics was selected. The findings can identify important criteria for choosing appropriate machine learning techniques, which may include the ML methods' statistical and inherent effectiveness or their adaptability to intermediate nodes within an IoT platform. The less resource-intensive methods like Simple Linear Regression, Logistic Regression, and K Nearest Neighbors are suitable for intermediate nodes, as they demand minimal processing and storage. Consequently, adopting a cognitive network approach for intermediate nodes in IoT platforms reduces the cloud computing processing costs and shifts the burden to the fog layer.

ISAC: IoT-Enabled Smart Attendance Check

Alana Cedeno, Zachary Biernat, Reema Alotaibi, Andrew Jung
Department of Computing Sciences, University of Hartford,
West Hartford, Connecticut, USA

Abstract— In today's society, there have been advancements with technology, especially in the IoT field, which has made many contributions to make people's daily lives more convenient and easier by allowing them to work smarter. In this project, we focus on developing an accurate time-tracking smart attendance system to help instructors and students to enhance participation in class. Our proposed system utilizes a Raspberry Pi, cameras modules, RFID cards, and an RFID reader placed in a classroom to uniquely identify each student that enters and leaves the room, as well as count the number of students that are present to solve the problems of using the attendance sheets such as the time it takes and the impreciseness of it. The system will then send the student attendance information to the instructor's phone via a mobile app in real-time. When testing our system in a real environment, it was found that it can correctly sign in students with the RFID scanner and store the data in the database, as well as detect the number of people in the room using computer vision.

An Enhanced Lightweight Hash-Chain-Based Multi-Node Mutual Authentication Algorithm for Large and Dense IoT Networks

Shengli Yuan, Randy Phan-Huynh, Tyler Thornton
University of Houston-Downtown, Houston, Texas, USA

Abstract - IoT is rapidly revolutionizing the global communication network with billions of new devices deployed and connected with each other. Many of these devices collect and transfer sensitive or mission critical data, making security a top priority. Compared to traditional Internet, IoT networks often operate in open and harsh environment, and may experience frequent delays, traffic loss and attacks; Meanwhile, IoT devices are often severally constrained in computational power, storage space, network bandwidth, and power supply, which prevent them from deploying traditional security schemes. Authentication is an important security procedure that can be used to prevent unauthorized devices or users from accessing a network. Due to resource constraints of IoT devices, it is highly desirable for the authentication scheme to be lightweight while still being effective. In this paper, we developed and evaluated a hashchain-based multi-node mutual authentication algorithm. All trusted nodes in a network share a common secret key. They broadcast to other nodes in range a message containing an authentication hashchain. They can also add to the hash chain and rebroadcast the messages, which will be used to authenticate all nodes in the network. Computer simulations were performed to validate the algorithm.

CSCI-RTSC:
RESEARCH TRACK ON SMART CITIES AND SMART MOBILITY

Situational Awareness and Feature Extraction for Indoor Building Navigation using Mixed Reality

Rishitha Reddy Pesaladinne, Maruthi Prasanna Chellatore, Sri Chandra Dronavalli, Sharad Sharma
Department of Information Science, University of North Texas, Denton, Texas, USA; Department of Computer Science, University of North Texas, Denton, Texas, USA

Abstract— Indoor navigation in complex building environments poses significant challenges, particularly for individuals who are unfamiliar with their surroundings. Mixed reality (MR) technologies have emerged as a promising solution to enhance situational awareness and facilitate navigation within indoor spaces. However, there is a lack of spatial data for indoor environments, including outdated floor plans and limited realtime operational data. This paper presents the development of a mixed-reality application for indoor building navigation and evacuation. The application uses feature extraction for location sensing and situational awareness to provide accurate and reliable navigation in any indoor environment using Microsoft HoloLens. The application can track the user's position and orientation and give the user-specific information on how to evacuate the building. This information is then used to generate navigation instructions for the user. We demonstrate how this mixed reality HoloLens application can provide spatially contextualized 3D visualizations that promote spatial knowledge acquisition and situational awareness. These 3D visualizations are developed as an emergency evacuation and navigation tool to aid the building occupants in safe and quick evacuation. Experimental results demonstrate the effectiveness of the application, providing 3D visualizations of multilevel spaces and aiding individuals in understanding their position and evacuation path during emergencies. We believe that adopting mixed reality technologies, such as the HoloLens, can greatly enhance individuals' ability to navigate large-scale environments during emergencies by promoting spatial knowledge acquisition and supporting cognitive mapping.

Algorithm for Concept Drift Detection in Autonomic Smart Buildings

Mikhail Genkin, J. J. McArthur
Department of Computer Science and Information Systems, Trent University, Peterborough, Canada; Department of Architectural Science, Toronto Metropolitan University, Toronto, Canada

Abstract—In order to support the self-awareness, selfconfiguration, self-description, and self-optimization autonomic properties, autonomic systems need to be able to detect concept drift in their external environment and in their internal operating characteristics. For some autonomic systems, such as smart buildings, this is a very difficult problem because their state is described by multivariate time-series data containing thousands of features generated by thousands of building sensors. Data generated by each sensor typically contains trend, seasonality, and cycles, as well as a significant amount of noise. In this paper we present a new statistical ensemble algorithm for detecting changes in noisy multivariate time-series data. Our algorithm can detect concept drift with up to 100% accuracy, and important change points with up to 92% precision, and 8% false-positive rate. Our algorithm was observed to reduce required features up to 5.4x, reducing the required on-line computational effort.

Blockchain-based Zero Trust on the Edge

Cem Bicer, Ilir Murturi, Praveen Kumar Donta, Schahram Dustdar
Distributed Systems Group, TU Wien, Vienna, Austria

Abstract—Internet of Things (IoT) devices pose significant security challenges due to their heterogeneity (i.e., hardware and software) and vulnerability to extensive attack surfaces. Today's conventional perimeter-based systems use credential-based authentication (e.g., username/password, certificates, etc.) to decide whether an actor can access a network. However, the verification process occurs only at the system's perimeter because most IoT devices lack robust security measures due to their limited hardware and software capabilities, making them highly vulnerable. Therefore, this paper proposes a novel approach based on Zero Trust Architecture (ZTA) extended with blockchain to further enhance security. The blockchain component serves as an immutable database for storing users' requests and is used to verify trustworthiness by analyzing and identifying potentially malicious user activities. We discuss the framework, processes of the approach, and the experiments carried out on a testbed to validate its feasibility and applicability in the smart city context. Lastly, the evaluation focuses on non-functional properties such as performance, scalability, and complexity.

Efficiency and Fairness in P2P Transactions with Variable Pricing for Electricity

Eiichi Kusatake, Norihiko Shinomiya
Graduate School of Science and Engineering, Soka University, Tokyo, Japan

Abstract—With the promotion of renewable energy projects, there has been a growing emphasis on decentralized models in the electricity trading system instead of centralized transactions. One of the models gaining attention in decentralization is Peerto-Peer (P2P) trading. By leveraging P2P trading, not only power utilities but also general consumers participating in the market can secure effective benefits. In this study, using P2P trading, we propose an optimal method considering fairness to ensure improvement in the interests of each consumer without monopolization of benefits within the market. The methodology covers both single-objective and multi-objective optimization. For multi-objective optimization, we will employ evolutionary algorithms. Additionally, as a differentiation from prior research, we approach the electricity unit cost as real-world data, utilizing it as a variable data.

Sustainability of Nature Parks by Changing Tourist Behavior Using Donations and Generative AI

Riku Sato, Yoshiaki Shimazaki, Takayasu Yamaguchi
Akita Prefectural University, Japan

Abstract— Nature parks are one of the most popular tourist destinations in the world. Still, they are sometimes abandoned with little use despite their elegant landscapes, or they can be damaged by the influx of people who come for localized and temporary promotions, so it is necessary to ensure that a certain number of tourists continue to visit in a dispersed manner. While theme parks that charge admission fees may control the number of tourists by setting dynamic prices, this approach is not suitable for nature parks that are free of charge. Some nature parks collect donations, but this is not directly aimed at controlling the number of tourists. Therefore, we propose a system to boost and control the number of tourists by providing information to lure tourists to the best spots scattered throughout the vast nature park and offering unique amusement in return for their donations. We developed a smartphone application that amuses response to tourists' donations. In addition, we provided a tourist guide reflecting the status of sightseeing spots in realtime, and 89.6% of the subjects positively evaluated the guide. Furthermore, we observed that having the AI suggest ideas for making sightseeing spots more attractive had the effect of imagining the actions tourists would want to take at those spots.

Utilizing a Spatial Grid for Automated Parking Space Vacancy Detection

Tristram Dacayan, Eric Ponte, Kuan Huang, Daehan Kwak
Department of Computer Science and Technology, Kean University, Union, New Jersey, USA

Abstract—In primarily populated areas, locating available parking can take time and effort, posing an environmental problem. Depending on the time of day, many drivers may face this issue due to the high volume of other drivers attempting to find parking. In most instances, urban drivers are forced to search for available street parking or vacant spaces in public parking lots. This behavior can often lead to traffic jams in local areas, often seen in populated cities such as Los Angeles and New York. Solutions to this public parking problem introduced the idea of smart parking systems. In this research, we propose a novel approach to video-based parking space detection by utilizing a spatial grid to introduce localization to the scene. Our approach essentially utilizes a spatial grid that serves as a map of the scene, including only the road as cells within the grid. Once the grid is established, it encompasses the entirety of the parking lot, allowing our approach uses a network specialized in Monocular 3D Object Detection to map each vehicle's location more accurately within the scene with respect to the available parking spots identified during grid generation. To leverage the use of our system, we also built a demo application using a database to record the status of each parking space. By leveraging the duration of occupancy of each space, our system also has access to historical occupancy data, which can be used in tandem with other factors, like time of day and day of the week, to provide more valuable predictions and information that can assist drivers in finding parking more efficiently. We plan to continue thoroughly evaluating the accuracy and reliability of our system's predictions through comprehensive testing and comparisons with existing state-of-the-art systems to ensure its practicality in real-world scenarios.

Digital Technological Innovation in the City of Santo Domingo - Ecuador

Nelson Salgado-Reyes, Gustavo Chafla, Jaime Meza
Pontifical Catholic University of Ecuador, Ecuador

Abstract— Focuses on the analysis and description of the technological advances and digital transformation that the city of Santo Domingo, located in Ecuador, has experienced. Through a detailed study, the key aspects of the implementation of digital technologies in infrastructure, public administration and citizen services are explored. The impacts, benefits and challenges that this technological innovation has brought with it, both for residents and for the sustainable development of the city, are examined. This article sheds light on how digital innovation is influencing the evolution of Santo Domingo, contributing to its growth and improvement in various aspects.

CSCI-RTCC:
RESEARCH TRACK ON CLOUD COMPUTING AND DATA CENTERS

A Hybrid Intrusion Detection System Leveraging XGBoost and RNNs for Enhanced Anomaly Detection in Cloud Data Centers

Asaad Althoubi, Hassan Peyravi
Department of Computer Science, Kent State University, Kent, Ohio, USA

Abstract—With the rapid growth of cloud computing, securing cloud data centers against potential security threats has become a critical concern. In this research paper, we propose a novel hybrid intrusion detection system (IDS) that combines the power of the gradient boosting algorithm, specifically XGBoost, with the capabilities of Recurrent Neural Networks (RNNs). The objective of the proposed IDS is to effectively predict and detect temporal patterns in network traffic, thereby enhancing the security posture of cloud data centers. By fusing these techniques, the IDS aims to achieve a holistic view of network behavior, enabling the identification of subtle anomalies that may indicate intrusion attempts. To evaluate the performance of the proposed system, extensive experiments were conducted on real-world network traffic data collected from a cloud data center environment. Evaluation metrics encompass accuracy, precision, recall, and F1-score, providing a comprehensive assessment of the system's effectiveness. The experimental results illustrate the system's efficacy in predicting temporal patterns of network traffic. The hybrid IDS effectively captures sudden shifts in traffic behavior, as well as long-term trends that may indicate evolving threats. Furthermore, the system's ability to adapt to changing network conditions enhances its resilience to dynamic attack strategies.

Fusing SynerGATE for Improved Anomaly Detection in Cloud Data Centers

Asaad Althoubi
Department of Computer Science and Software Engineering,
Miami University, Oxford, Ohio, USA

Abstract—As cloud computing advances, safeguarding cloud data centers from security threats takes precedence. Enter SynerGATE, a novel hybrid intrusion detection system. SynerGATE combines LSTM and GRU networks, aiming to predict temporal patterns within network traffic. SynerGATE's core architecture features dual LSTM and GRU layers, trained using the cross-entropy loss function. These algorithms uncover long-term feature dependencies, with extracted features classified by the Adam classifier. This fusion provides a holistic understanding of network behavior, exposing intrusion attempts. Real-world experiments in live cloud data centers evaluated SynerGATE, using metrics like accuracy, precision, recall, and F1-score. Results highlight its ability to predict network patterns, swiftly detect traffic shifts, and identify evolving threats in dynamic conditions. SynerGATE excels in adapting to ever-evolving attack strategies, enhancing security in the cloud.

SDN-Based Critical Infrastructure Resilience: A Smart Grid Perspective

Steve C. Chiu
Department of Electrical and Computer Engineering,
Idaho State University, Pocatello, Idaho, USA

Abstract− Software-defined network (SDN) systems in their recent development have enabled innovative methods and systems to facilitate control of large and complex infrastructures critical to both regional and national interests. The advent of cloud computing allows the convergence of operation and information aspects of the traditional industrial control systems (ICS), forming the core functionalities of many critical infrastructures ranging from energy, transportation, communication to supply chains. Resilience and the mitigation of natural, manmade and cyber-based attacks are at the center of these infrastructures given the vast amount of data (both friendly and malicious) encountered in the systems. To address these issues, a holistic approach to examine the major subsystems of the infrastructure is thus essential. This paper provides a cross-sectional study of the cloud-based Smart Grid, which utilizes policy-based network management methods in runtime monitoring and operation at both the control and data-plane levels. This paper also examines the currently prevailing categories of cyberattacks, which impact both the infrastructure's resilience and reliability, and proposes promising approaches to counter these prevailing attacks proactively or with minimal latency. We also present an experimental 5G simulation platform that connects a network of SDN embedded 5G devices with a PLC network via classical Ethernet as Internet of Things (IoT). Basic functionality of this experimental platform is verified, along with performance and scalability for future extension in system complexity.

Enhancing Cloud Service Failure Prediction via Temporal Relationship Distillation

Sharmen Akhter, Md. Imtiaz Hossain, Md. Delowar Hossain, Nosin Ibna Mahbub, Eui-Nam Huh
Computer Science and Engineering, Kyung Hee University, Yongin-si, South Korea

Abstract—Deep learning-based task failure prediction methods have achieved significant performance gains in ensuring high service reliability and availability at the core cloud by predicting task failure probability. With the increasing complexity of the deep-learning-based task failure prediction models, the number of service requests, and software and hardware failures, the ability to quickly detect and predict failures becomes essential for minimizing downtime and optimizing resource allocation. However, fast and lightweight deep learning-based task failure prediction models perform poorly in predicting failure occurrence probability compared to the highly parameterized deep learning models. These failed tasks demand large amounts of resources, time, and cost to be recovered. Predicting task failure probabilities quickly before occurrence with high accuracy may increase reliability, and reduce wastage. Inspired by the aforementioned issue we propose a knowledge distillation-based learning approach that empowers the lightweight architectures to achieve improved performances during inference. The proposed approach leverages the representational capacity of the highparameterized best-performing deep learning-based task failure prediction models considered as a teacher to the lightweight student. To extract the temporal pattern we focus on a Bidirectional Long Short Term Memory (Bi-LSTM) based distillation approach where the teacher is the large and heavy architecture that transfers the predictive distribution as the regularization term to the tiny Bi-LSTM student network by analyzing past system message logs and identifying the relationship between the data and the failures. The proposed method achieves a state-ofthe-art complexity-vs-accuracy trade-off in task failure prediction at the core cloud. Extensive experiments and ablation study depicts the superiority of our technique on large-scale standard benchmark dataset.

On Premise Data Center vs Cloud

Mihail Gaianu
West University of Timisoara, Continental Automotive Romania, Timisoara, Romania

Abstract—Cloud computing services recently revolutionized the world. The rise of cloud systems, powered by Amazon Web Services, Google Cloud Platform and Microsoft Azure, persuaded many companies, both large and small, that hosting their data in the cloud is more cost-effective, secure and convenient than maintaining an IT infrastructure on-premises. If you are still unsure which option—cloud versus on-premises—best fits your business needs, explore this comparison for computing, storage and database. This article could be handy for final decision-making. Both on-prem and cloud computing can provide your business with the IT infrastructure it needs. The final choice of the cloud versus on-premises model will likely depend on your business-specific use cases for data use and storage, the level of security required in order to meet compliance standards and the cost structure you prefer.The services modern cloud providers offer are cosmic. For instance, Amazon Web Services has a wide array of ready-to-use cloud computing solutions for an affordable price. So, what is the use of building your own rocket on-premises in case you can entrust its launch and management to an experienced space agency, aka cloud provider.

CSCI-RTPD:
RESEARCH TRACK ON PARALLEL & DISTRIBUTED COMPUTING

Steady-State Thermal Modeling for Embedded Artificial Intelligent Applications

Sarah Azaizeh, Olivia Marsh, Robert Taylor, Shi Sha
Electrical Engineering, Wilkes University, Pennsylvania, USA

Abstract—The ever-increasing application complexity drives a higher level of hardware integration in the embedded and mobile systems' design, which causes soaring power density and rising temperature onboard. To this end, a series of numerical and analytical system-level power and thermal modeling methodologies have been developed for thermal analysis on different system scales and architectures. In this work, we study the steady-state temperature modeling problem for embedded system-on-chip architectures. First, we study the commonly used RC-lumped thermal models for single-core and multi-core platforms. Then, we develop a practical power and temperature measurement testbed using Xilinx ZYNQ Z7 system-on-chip platforms. Next, we extract the thermal prediction parameters using different combinations of synthetic benchmarks, system speed levels and system utilization. At last, we verify the temperature prediction accuracy by comparing it with the onboard sensor readings using convolutional neural network applications. The experimental results show that our steady-state temperature modeling is highly effective with 0.62◦C prediction deviation and 2.79% error on average.

Hands-on Quantum Programming Labs for Beginners

Janche Sang, Chansu Yu
Department of Computer Science, Cleveland State University, Cleveland, Ohio, USA;
Department of Electrical and Computer Engineering, Cleveland State University, Cleveland, Ohio, USA

Abstract—Quantum parallelism arises from the ability of quantum qubits to exist in multiple states simultaneously due to superposition. It enables quantum computers to explore a vast number of possibilities in parallel, potentially solving complex problems exponentially faster than classical computers. Recently, there has been an increasing demand for skilled professionals with expertise in quantum computing and programming. This paper presents a practical approach to teaching quantum computing to Electrical Engineering & Computer Science (EECS) students through dedicated hands-on programming labs. The labs cover a diverse range of topics, encompassing fundamental elements, such as quantum gates and circuits, as well as quantum algorithms. As educators, we aim to share our teaching insights and resources with fellow instructors in the field. This article elucidates the rationale behind the design of each experiment, enabling a deeper understanding of quantum computing.

Accelerated Gauss-Huard Algorithm on Hybrid GPU-CPU: Look-Ahead with the Delayed Algorithm Approach

Hisham G. Elzayyadi, Wafaa S. Sayed, Mona A. El Naggar, Maha A. Hassanein (& may be Eslam Ali)
Engineering Mathematics and Physics Department, Faculty of Engineering, Cairo University, Egypt

Abstract—In this paper, we tackle a significant bottleneck - the panel factorization step - in the Gauss-Huard algorithm through a novel parallel computing approach. We address the open question in the literature regarding the feasibility of applying look-ahead in this context. Our strategy combines the use of the delayed Gauss-Huard algorithm with random butterfly transformations instead of the traditional partial pivoting. The proposed technique not only allows for the application of look-ahead but also enhances the overall efficiency of the Gauss-Huard algorithm in a parallel computing environment, presenting possibilities for further optimizations.

Continuous Integration and Continuous Delivery with Microcontrollers Applications

Fernando G. Tinetti, Alejo A. Santi, Mariano Mendez
Facultad de Informatica, UNLP, CIC Provincia de Buenos Aires, La Plata, Argentina;
Facultad de Informatica, Universidad Nacional de La Plata, La Plata, Argentina;
Facultad de Ingenieria, Universidad de Buenos Aires, Ciudad Autonoma de Bs. As., Argentina

Abstract- This paper presents an approach to streamline the software development process using microcontrollers via a popular practice of recent years: CI/CD (Continuous Integration/ Continuous Delivery or Deployment). Essentially, this practice involves automating different stages of the development process to save time, such as building, testing, and subsequent deployment. By doing so, a system is created to work smoothly and continuously, partially relieving developers of tasks that can be automated. Our approach involves the design and implementation of a compact server for interacting with various agents/tasks related to microcontrollers-based applications development. Thus, the created system is capable of automating at least a portion of the software development process, ultimately providing significant advantages for microcontrollers applications programmers.

Enhancing Blockchain Network Scalability Through Parallelization and Aggregation Techniques: A Survey

Ruth Olusegun, Bo Yang
Department of Computer Science, Bowie State University, Bowie, Maryland, USA

Abstract— Blockchain technologies have gained attention in academia and industry recently. While blockchain has the potential to create high transparency, decentralization, and unprecedented security levels, scalability remains a significant challenge for its wide adoption. The scalability challenge of blockchains results in high transaction fees, slow throughput, and low latency. To handle this bottleneck, several scaling solutions have been proposed. There are, however, some limitations to their wide adoption. The hybridization of some scaling solutions has been the subject of recent research, paving the way for major scaling innovations. This article analyzes how parallel and aggregated scaling methods can be integrated to achieve exponential scalability in blockchain networks. We examine the fundamental concepts, techniques, implementation strategies and propose ZKShard, a paradigm based on zero-knowledge proofs and sharding. We discussed parallelization, communication, aggregation, compression, user experience, and interaction in the proposed model. We also discussed ZKShard applications in domains such as Decentralized Finance (DeFi), New Financial Technologies (NFTs), and Supply Chain Management. Finally, research challenges and future directions based on security, crossshard communication, data availability, smart contracts, and consensus mechanism compatibility were discussed.

Access Pattern Characterization of Last-level Cache for Effective Replacement

Shafayat Mowla Anik, Byeong Kil Lee
Department of Electrical and Computer Engineering, The University of Colorado, Colorado Springs (UCCS), Colorado, USA

Abstract— Based on our analysis, numerous aspects should be considered to achieve the best solutions because cache line eviction is not influenced by only a single aspect. Cache lines may occasionally be accessed repeatedly during programming loops. Suppose the same cache goes to writeback, then has long-distance access, then again goes to a small writeback distance, then again to a long distance, and so on. The same cache line can be a sequence of short and long distances or any order of short and long distances. So, we refer to it as an access pattern. By maintaining the cache line when a short distance is expected in the future and discarding it when a long distance is anticipated, we may take advantage of certain access patterns. With the concept of the access pattern of the cache, we can enhance the performance of the last-level cache. In this paper, we characterize the access pattern of the last-level cache and provide the implications of how to increase cache performance by anticipating and training access patterns. Also, we will discuss the cases where some applications do not have any access patterns.

Implementation of a Hardware Accelerator with FPU-Based Euler and Modified Euler Solver for an Ordinary Differential Equation

Soham Bhattacharya, Dwaipayan Chakraborty
Department of Electrical and Computer Engineering, Rowan University, New Jersey, USA

Abstract—Ordinary differential equations are generally used to simulate dynamical models. As a result, solving these equations is an important task in the high-performance computing (HPC) domain. In this paper, the design of the hardware accelerators for two numerical methods - Euler and modified Euler methods, for solving ODEs has been demonstrated with the help of VHDL language in Xilinx Vivado Environment. The accelerators have been designed using single-precision floating point IP support, generated by Xilinx. Power and timing analysis has been discussed in this study. The accelerators have been deployed on the Zynq ZC702 FPGA evaluation board.

CSCI-RTPC:
RESEARCH TRACK ON SIGNAL & IMAGE PROCESSING, COMPUTER VISION & PATTERN RECOGNITION

DeepCT-SI: Deep Learning Algorithm for Computed Tomography Source Identification

Farid Ghareh Mohammadi, Ronnie Sebro
Department of Radiology, Center for Augmented Intelligence, Mayo Clinic, Jacksonville, Florida, USA

Abstract—Large multicenter publicly available computed tomography (CT) datasets are important for artificial intelligence (AI) research. However, one CT scanner may create images that are of inadequate quality and identifying images from a given CT scanner can be a significant challenge. We propose DeepCT-SI, a deep learning-based algorithm for CT Source Identification. DeepCT-SI utilizes a four-layered convolutional neural network and a three-layered fully connected neural networks. Our study involves a cohort of 2107 patients (mean age: 61.82, SD:16.64) representing both sexes (male: 49%, female: 51%). We randomly partitioned the dataset into training/validation (n=1303, 80%) and test (n=361, 20%) datasets based on patients with no leakage of patient data between data partitions. We utilize 18 different physical CT scan machines, including four distinct manufacturers and eight distinct models. This diverse set of machines represented a broad range of imaging technology commonly employed in clinical practice. DeepCT-SI demonstrates superior prediction performance on the training dataset, achieving an accuracy of 99.75%, AUC of 99.17%, a precision of 98.49%, specificity of 98.88%, and sensitivity of 98.47%. DeepCT-SI evaluated on the test dataset, achieving accuracy of 97.37%, AUC of 90.79%, precision of 83.16%, specificity of 98.47%, and sensitivity of 83.10%.

Robust Image Watermarking based on Cross-Attention and Invariant Domain Learning

Agnibh Dasgupta, Xin Zhong
Department of Computer Science, University of Nebraska Omaha, Omaha, Nebraska, USA

Abstract—Image watermarking involves embedding and extracting watermarks within a cover image, with deep learning approaches emerging to bolster generalization and robustness. Predominantly, current methods employ convolution and concatenation for watermark embedding, while also integrating conceivable augmentation in the training process. This paper explores a robust image watermarking methodology by harnessing cross-attention and invariant domain learning, marking two novel, significant advancements. First, we design a watermark embedding technique utilizing a multi-head cross attention mechanism, enabling information exchange between the cover image and watermark to identify semantically suitable embedding locations. Second, we advocate for learning an invariant domain representation that encapsulates both semantic and noise-invariant information concerning the watermark, shedding light on promising avenues for enhancing image watermarking techniques.

Linear Transformations in Masked Face Recognition: Bridging the Representation Gap

Eslam Ali, Ahmed Elsheikh, Maha A. Hassanein
Mathematics and physics Department, Cairo University, Cairo, Egypt

Abstract—Amid the COVID-19 pandemic, the ubiquity of masks revealed the limitations of face recognition systems in accurately identifying individuals with occluded faces. This issue goes beyond pandemics and applies to circumstances where face coverings are compulsory, such as in healthcare establishments or industrial locations. Optimizing face recognition performance for masked faces is imperative for ensuring security and safety in diverse environments. Earlier endeavors to overcome this challenge faced hurdles such as limited datasets of masked faces, which made it arduous to adjust existing face recognition models to the exclusive traits of masked faces. This study introduces a cutting-edge empirical linear transformation technique for face recognition, modifying embedded vector representations of unmasked faces to correspond with masked faces and vice versa. The study's outcomes show a firm linear relationship between masked and unmasked face embeddings, emphasizing the potential for knowledge exchange between these two facial conditions. Furthermore, this innovative linear transformation strategy offers an efficient and effective solution for masked face recognition systems, eliminating the need for retraining on extensive masked face datasets.

Combined Medical Image Super-Resolution and Modality Translation using GAN Transformer-based Model

Melika Abdollahi, Heidar Davoudi, Mehran Ebrahimi
Faculty of Science, Ontario Tech University, Oshawa, Ontario, Canada

Abstract—*Image super-resolution and modality translation are critical tasks in medical image processing and computer vision. In recent years, Generative Adversarial Networks (GANs) and transformer-based models have emerged as powerful techniques for achieving high-quality image modality translation and superresolution. In this paper, we propose a GAN transformer-based model that leverages the strengths of both GANs and transformers to achieve state-of-the-art results in image translation and super-resolution. Our model employs a generator network that utilizes a transformer architecture to capture global context and long-range dependencies in the input image, and a discriminator network that distinguishes between real and fake images. We evaluate our model on the Brats2018 dataset, given a lowresolution T1-weighted image, we aim to enhance the resolution and recover a plausible corresponding T2-weighted image. We demonstrate its superiority over existing methods in terms of quantitative metrics including Peak Signal-to-Noise Ratio (PSNR) and Structural Similarity Index (SSIM), as well as qualitative visual results. Our code will be made publicly available on GitHub. Our approach can be easily adapted to other imaging datasets. Our GAN transformer-based model demonstrates superior results in image super-resolution and modality translation, surpassing existing methods with both quantitative metrics and qualitative visual outcomes.*

StainSegNet: Stain Normalization and Segmentation – Driven Colorectal Tumor Tissues Classification

Ponnarasee B K, Lalithamani N
Department of Computer Science and Engineering, Amrita School of Computing, Coimbatore, Amrita Vishwa Vidyapeetham, India

Abstract—A prevalent type of cancer that affects the colon and rectum is colorectal cancer, which can be detected and treated with the help of medical imaging procedures. Pathology-based medical image analysis provides a detailed evaluation of the tissue structure of cancerous cells and their microenvironment, which plays a vital role

in diagnosis, prognosis, and therapy planning. This study presents a stain normalization and segmentation-driven colorectal Tumor tissue classification by integrating the deep learning approaches. Reinhard normalization has been used for stain normalization, where it obtained 0.97, outperforming Vahadane and Macenko. StarDist segmented the cellular structures in pathology images and performed well in obtaining the post-processed mask. A comparative study of four popular CNN models, VGG19, ResNet152, and DenseNet169, efficientnet_b0, with two distinct datasets for the task of tumor tissue classification, is implied and the results show that the ResNet152 model outperforms all other models in terms of its performance consistently in both datasets. Overall study demonstrates the limitations and importance of each process involved and highlights its potential for use to assist the pathologist.

Thermal Face Image Classification using Deep Learning Techniques

Prosenjit Chatterjee, ANK Zaman
Department of Computer Science and Cyber Security, Southern Utah University, Cedar City, Utah, USA;
Department of Physics and Computer Science, Wilfrid Laurier University, Waterloo ON, Canada

Abstract—Thermal images have various applications in security, medical and industrial domains. This paper proposes a practical deep-learning approach for thermal image classification. Accurate and efficient classification of thermal images poses a significant challenge across various fields due to the complex image content and the scarcity of annotated datasets. This work uses a convolutional neural network (CNN) architecture, specifically ResNet-50 and VGGNet-19, to extract features from thermal images. This work also applied Kalman filter on thermal input images for image denoising. The experimental results demonstrate the effectiveness of the proposed approach in terms of accuracy and efficiency.

Comparative Study of Data Augmentation Approaches for Improving Medical Image Classification

Khadija Rais, Mohamed Amroune, Mohamed Yacine Haouem, Issam Bendib
LAMIS Laboratory, University of Larbi Tebessi, Tebessa, Algeria

Abstract—In recent years, data augmentation has advanced to the point where it no longer relies on traditional photometric or geometric image processing techniques like rotation, scale, and filtering, but instead has turned to deep learning-based approaches such as variational autoencoder (VAE) and generative adversarial network (GAN). This has made data augmentation a crucial discipline for improving artificial intelligence models that may need a lot of data for training, especially in medical fields where collecting labeled data is difficult and expensive. This study focused on using data augmentation approaches to improve CNN classification accuracy. These approaches, including geometric modifications, color space transformation, and generative techniques, are used to augment the BraTS20 (Brain tumor segmentation 2020) dataset. After comparing the accuracy of convolutional neural networks (CNNs) with and without the augmented dataset, we found that GANs had the highest accuracy of all techniques; GANs produced images that closely resembled BraTs20 compared to other techniques.

Semantic Similar Image Search: A Command-Line Tool Based on CLIP

Yurij Mikhalevich
Lightning AI, Dubai, United Arab Emirates, UAE

Abstract—This paper introduces a practical and scalable approach for implementing a similar image search engine using Contrastive Language-Image Pre-Training (CLIP), OpenAI's model. The method provides a Command-Line Interface (CLI) and utilizes a cache layer powered by SQLite, a relational database, to enable efficient repetitive

searches within large image databases. The effectiveness was evaluated on ImageNet-1k using a metric described in the paper, achieving 48.32% accuracy. Scaling tests showed indexing time increases linearly with the number of images, while search time rose only slightly – for example, indexing over 1 million images took 26.36 times longer on an M1 Max CPU than indexing 50,000, but querying the larger set took just 2.75 times more. This approach would particularly benefit industries managing vast visual data volumes, such as media, security, manufacturing, and healthcare.

Realtime Sign Language Recognition Using Computer Vision and AI

Gabriel Serrano, Daehan Kwak
Department of Computer Science and Technology, Kean University, Union, New Jersey, USA

Abstract—Promoting inclusive communication is essential and sign language plays a crucial role in achieving this goal. In this research, a system is developed capable of making it easier for those who primarily communicate through sign language to interact with those who are unable or may not be knowledgeable in the language. This has the potential to help bridge the communication gap between those who are fluent in sign language, and those who may be struggling to learn or are not knowledgeable. In its current state, our system is capable of recognizing two forms of sign language, namely: American Sign Language and British Sign Language. The system also is capable of performing facial expression analysis to account for nonverbal inflections expressed by the user. These tasks are accomplished by making use of computer vision provided by the OpenCV Python library. It also uses various machine learning models and the MediaPipe library. We explore two approaches for sign language recognition: contour-based recognition and landmark-based recognition. Additionally, facial landmarks for facial expression analysis are investigated which can be used to detect expressions and inflections from a user's face alone. The next steps of this research will consist of working with more complex words and phrases and investigating gesture recognition.

Deblurring ICF Images using Hybrid Iterative Regularization Techniques

Tuwanda McKenzie, Naima Naheed
Department of Biology, Benedict College, Columbia, South Carolina, USA;
Department of Mathematics, Benedict College, Columbia, South Carolina, USA

Abstract—Image deblurring poses a formidable challenge within image processing, as it seeks to restore crisp and aesthetically pleasing visuals from blurry or degraded counterparts. This research is focused on images captured from Inertial Confinement Fusion (ICF) with high-speed X-ray cameras. It is observed that no model fits the noise characteristics of ICF images. As a result, we initiated our work with a synthetic image in which we simulated blur and noise. Our primary objective is to recover the original image from the distorted synthetic version. To accomplish this, we utilized four distinct Iterative Hybrid Regularization methods. SSIM score allowed us to compare the performance of the restored image against our synthetic image.

Real-Time Object Detection to Identify Adults and Children Using YOLO Algorithm

Abdulghani M. Abdulghani, Mokhles M. Abdulghani, Wilbur L. Walters, Khalid H. Abed
Jackson State University, Jackson, Mississippi, USA

Abstract—Mobile devices such as drones or small-size robots are widely used nowadays because they are affordable and can be equipped with a light Graphics Processing Unit (GPU). However, these devices need light-weight algorithms to perform object detection. For this purpose, the YOLO algorithms come in handy with different structures that support light, small, medium, and large devices like YOLO-tiny and YOLO-small. The aim of this research is to use a lightweight version of YOLO algorithms with high accuracy to detect and recognize three objects, namely child, female, and male, in real-time. To achieve this, we have used the YOLOv6-small and YOLOv7-tiny algorithms to detect the three objects. We have also included data augmentation techniques to enhance the detection accuracy and evaluation metrics (precision, recall, and MAP@.5). The results have been promising with the YOLOv6-small augmented model showing a +6% increase in MAP@.5 for the child object and a +4% increase for the female object. On the other hand, we have managed to reduce wrong detection in some cases using the YOLOv7-tiny algorithm.

LF-YOLOv7: Improved YOLOv7 Based on Lightweight Modules and Novel Feature Fusion for Object Detection on Drone-Captured Scenarios

Wangyu Jiang, Le Wang, Fayaz Ali Dharejo, Guojun Mao
Faculty of Computer Science and Mathematices,
Fujian University of Technology, Fuzhou, Fujian Province, China;
Department of Electrical Engineering and Computer Science, Khalifa Univeristy,
Abu Dhabi, UAE

Abstract—Object detection is a critical component in the task of computer vision, especially for perceiving and identifying small objects in unmanned aerial vehicle (UAV) aerial images. However, such drone-captured images involve small-sized objects, dramatic scale variation, intricate backgrounds, and real-time demand. In order to address these challenges, we propose a novel object detection model LF-YOLOv7 by two lightweight modules and a novel feature fusion design for recognizing and classifying small even tiny objects in aerial images. Firstly, we rebuild the detection head structure by adding an indispensable large-scale head for small objects, allowing for more accurate assignment of multiple anchor boxes of different sizes and aspect ratios for objects in UAV images. Secondly, because large receptive fields could subject the network to more sensitivity to background information, we reduce the size of the receptive field in the backbone by pruning the last downsampling layer and the ELEN structure of the backbone of YOLOv7 to maintain higher spatial resolution, thereby preserving more fine-grained details to enhance the accuracy of small object detection while lightweighting the network. Moreover, we propose a new feature fusion module, called SM-BiFPN, which effectively integrates shallow details through cross-layer connections and enables the model to obtain more feature information related to small objects. The extensive experimental results conducted on the VisDrone2019 and Tinyperson datasets demonstrate that our model LF-YOLOv7 surpasses the original YOLOv7-Tiny by 6.2% and 10.5% in mAP50, meanwhile reducing parameters by 18% on the two datasets, respectively. The ablation experiment and analysis also show the effectiveness and superiority of the proposed model, enabling better small object detection in UAV images.

The Reverse-Transition Weighting Filter for Effective Edge Detection for Noisy Color Images

Seth T. Richey, Luke J. Hand, Owen C. Burton, James B. Perdue, Penelope Prochnow, Jason Shin, Seongjai Kim
Department of Mathematics and Statistics, Mississippi State University, Mississippi State, Mississippi, USA; Department of Mechanical Engineering, Mississippi State University, Mississippi State, Mississippi, USA; Department of Electrical Engineering, Mississippi State University, Mississippi State, Mississippi, USA; Data Science, Mississippi State University, Mississippi State, Mississippi, USA; Department of Supply Chain Logistics, Mississippi State, Mississippi, USA

Abstract—Edges in a digital image provide important information about the objects in the image since they constitute boundaries between objects. Most edge detection algorithms are sensitive to noise and attempts to remove noise often weaken not only noise but also the edge strength. This article proposes an innovative denoising method called the reverse-transition weighting (RTW) filter, which can suppress noise without weakening the edge strength. Such a property of preserving the edge strength is unique to the RTW denoising filter. The new filter is analyzed for its stability and convergence and adopted for the denoising step of the Canny edge detection algorithm, replacing the conventional Gaussian smoothing filter. We also compare gradient-fusion methods which combine the RGB gradients into one. Our goal is to formulate a robust edge detection algorithm for color images, particularly for heavily noisy images. Various examples are given to show the effectiveness of the new denoising filter.

Satellite Images Analysis and Classification Using Deep Learning-Based Vision Transformer Model

Adekanmi Adegun, Serestina Viriri, Jules-Raymond Tapamo
School of Mathematics, Statistics and Computer Science, School of Engineering, University of KwaZulu-Natal, Durban, South Africa

Abstract—Analysis and classification of satellite images from diverse sources, including remote sensing and satellite devices, have been explored to understand the dynamics of land use. However, due to their high complexity and multi-resolution, multi-spectra, and multi-scale nature, traditional machine learning classifiers have limitations in their analysis. In this research, an advanced machine learning technique, a deep learning-based vision transformer model, which leverages the benefits of selfattention mechanisms to overcome the challenges of analyzing complex features in satellite images, is proposed for efficient classification. Experimental evaluation on the publicly available EuroSAT satellite imagery dataset demonstrates promising results, achieving an accuracy of 98%.

Automatic Fruit Grading Using Recurrent Neural Networks

Jo-Neil Naicker, Serestina Viriri
School of Mathematics, Statistics and Computer Science, School of Engineering, University of KwaZulu-Natal, Durban, South Africa

Abstract - Automatic fruit quality grading is a complex problem. Fruit grading is the process whereby a fruit is judged based on a multitude of factors to determine the quality of said fruit. There are a vast number of factors that affect fruit grade, such as size, weight, colour, etc. Being able to grade fruits has many benefits for suppliers, as higher-grade fruits can be sold for higher prices, and lower grade fruits that are inedible can be utilised elsewhere. Most of this is done manually in present day times, which is incredibly time-consuming, prone to error, and expensive. This is where automated grading comes in. Automatic fruit grading uses computer vision and machine learning techniques to identify fruit features and categorise them based on those features. This has been tackled many times before through the use of Fuzzy logic, Artificial Neural Networks, Linear Discriminant Classifiers, Nearest Neighbour's classifier and Support Vector Machines, providing high accuracies above 80% on small subsets of fruits. This proposal aims to explore the different ways of highlighting the features of fruits and categorising them with deep learning techniques.

Ultrasound Imaging Based on Mean and Standard Deviation

Cuijuan Lou

Key Laboratory of Grain Information Processing and Control
(Henan University of Technology), Ministry of Education, Zhengzhou, China;
Henan Key Laboratory of Grain Photoelectric Detection and Control,
Henan University of Technology, Zhengzhou, China;
Department of Artificial Intelligence, Henan University of Technology, Zhengzhou, China

Abstract—Resolution and contrast are two important indicators for evaluating the quality of ultrasound imaging. In order to improve both indicators of ultrasound imaging, the ultrasound imaging method based on mean and standard deviation are proposed. Through simulation results of multiple scattering points at different depths, the proposed method achieves a lateral resolution of 50.50% compared to delay and sum (DAS) and 36.17% compared to square-neighborhood robust signal mean-to-standard-deviation factor imaging (SNRSMSF). Through the simulated anechoic and hyperechoic regions results, the contrast improvement of the proposed method can reach up to 0.36dB, compared to DAS and SNRSMSF.

GERRS: Removing Ghost Effects from Real-World Scenarios in 3D Pose Estimation via Zero-Shot Inference Approach

Md Imtiaz Hossain, Sharmen Akhter, Md Nosin Ibna Mahbub, Md Delowar Hossain,
Sungjun Yang, Choong Seon Hong, Eui-Nam Huh
Computer Science and Engineering, Kyung Hee University, Yongin-si, South Korea;
SIGONGtech, Bundang-gu, Seongnam-si, Gyeonggi-do, South Korea

Abstract—In the realm of computer vision, 3D pose estimation algorithms have achieved remarkable proficiency in controlled benchmark datasets. However, their performance often falters when confronted with the complexities of real-world monocular video scenarios. One of the most formidable challenges in this context is the presence of intricate and unpredictable backgrounds. These backgrounds, due to their uncertain textures, are frequently misinterpreted as human subjects, giving rise to the persistent and vexing "ghost effect." This phenomenon not only distorts the accuracy of pose estimation but also hinders its applicability in various practical settings. In response to this conundrum, we present GERRS, a plug-in-play and innovative zero-shot technique designed to address the "ghost effect" problem by effectively managing uncertain textures. GERRS integrates four core components: moving human detection, motion detection, background texture pre-processing, and 3D pose estimation. This comprehensive approach has been subjected to rigorous validation, which has conclusively demonstrated its unparalleled efficacy in mitigating the ghost effect. Our method brings a remarkable enhancement to the accuracy of 3D pose estimation in real-world monocular RGB videos, marking a significant stride towards the realization of robust and reliable pose estimation in dynamic and unpredictable environments. The proposed approach can be incorporated with any existing 3D pose estimation approaches to enhance the performance of the pretrained approach. By tackling the "ghost effect" headon, GERRS holds the promise of revolutionizing the field of computer vision, opening doors to more precise and dependable applications in a wide range of domains, from augmented reality to robotics.

Steganalysis of Medical Radiographs for Radiographic Machine Identification

Farid Ghareh Mohammadi, Ronnie Sebro
Department of Radiology, Center for Augmented Intelligence, Mayo Clinic Jacksonville, Florida, USA

Abstract—Large online databases with radiographs from different institutions are being increasingly used in biomedical research consortiums. Radiographs from one machine at a single site may be suboptimal or corrupted. Steganalysis can be used to quality assurance of radiographs. Here, we use a deep learning framework for source identification of radiographs by predicting the exact radiographic machine (manufacturer and model) using a single rich model. A convolutional neural network architecture is applied to extract high-level contentfree features, and three fully connected neural network layers are used to predict the radiographic machine source of the radiographs. Potential change in pixel information in medical images can be detected using steganalysis. Steganalysis contributes to maintaining trust in medical systems and ensures the accurate diagnosis and treatment of patients. Patients with cervical (n=2028 patients; 3905 radiographs) and chest (n=1499 patients, 2725 radiographs) radiographs obtained at Mayo Clinic from 01/01/2010 to 12/31/2021 were analyzed. Data was randomly split by patient into training/validation (n=80%) and test (n=20%) datasets respectively. The accuracy in the test dataset was 99.50% (AUC=99.72%) and 96.86% (AUC=98.23%) for cervical and chest radiographic machine identification respectively.

Blood Cell Detection Using Deep Learning on Mobile Platforms

Nihar Jain, Fahim Hasan Khan
University of California Santa Cruz, California, USA

Abstract—Blood cell counting is an important medical test for successful diagnosis of many diseases. Traditional blood cell counting tasks are tedious, time-consuming and depend a lot on the skill of the equipment operator. Therefore, there is a need to automate this process and deep learning can be an effective solution. In this paper, 2 deep learning models are deployed to detect RBCs, WBCs, and platelets in blood smear images. You look only once (YOLO) and EfficientDet were trained on annotated blood smear images from three different publicly available datasets and the performance of the models is evaluated and compared. These trained models were also able to detect all the 3 types of blood cells on random blood smear images from other datasets, proving that they are generalized. Next, mobile applications were created in order to perform cell detection in real time. The results show that the process of blood cell count can be automated and this process can be much faster and more efficient in the future with the help of Computer-Aided Diagnosis (CAD) models.

Real-Time Suspicious Activity Detection on ATMs Using Multimodel YOLO Object Detection

Akshith Simha Katragada, Kavya Vuribindi, Varick L. Erickson
Department of Computer Science, California State University East Bay, California, USA

Abstract—ATM theft, including use of card skimming, card trappers, and other means to steal from ATMs, is becoming increasingly common and increasingly harmful to both banks and consumers. While financial institutions have employed tools such as surveillance cameras and security guards, these methods are often costly to implement and are subject to human error, staffing challenges, maintenance, and other issues. In the present work, we leverage You Only Look Once (YOLO) object detection algorithms to significantly improve upon the limitations of traditional surveillance cameras. We demonstrate how YOLO detection algorithms can be used to proactively detect potential threats (such as card skimmers, card trappers, hammers or iron rods) with up to 99% accuracy. Such threat detection could alert security or law enforcement earlier and with greater accuracy about potential threats. Additionally, the models required only 1,200 images for training, and could be updated to detect

new threats with as few as 200 training images. These YOLO models are therefore a promising and low-cost solution to improve the accuracy and effectiveness of ATM security. With proper training data, these models could be adapted to benefit other applications as well, including public safety, retail, and manufacturing.

Biometric Authentification Comparison: Toward Secure Human Recognition

Fatma Mallouli, Nesrine Khelifi, Aya Hellal, Imen Ferjani, Nada Chaabane, Imene Gmach, Houda chamakhi
Deanship of Preparatory Year and Supporting Studies,
Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia;
Business Administration Department, The Applied College,
Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia;
Computer Science Department, The Applied College,
Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia;
Department of Quantitative Methods, College of Business Administration,
Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia

Abstract—Since the pandemic's announcement, covid-19 has hit almost all businesses. Regular office jobs and commercial meetings are changed and adopt the fully online new technology tools. To avoid coworkers' interaction with each other in all departments and face-to-face contact in person, all sectors of industry and all vital domains adopt the fully digital approach. The extreme need for new technology based on information systems leads users to adopt secure tools to face the pandemic. to protect the integrity and confidentiality of data. Biometric Technologies are rapidly becoming the ideal solution to solve lots of problems including human identification. Biometrics are declared to offer the security and accuracy of human being identification and authentication. However, each biometric check involves a series of processes that are interspersed with choices and contingencies on several levels. Additionally, there are underlying normative presumptions about human anatomy that have extremely severe effects on how biometric systems work. Several Recent research analyses have clarified gendered and racist prejudices as the cause of biometric system failures. The production, usage, and problematization of bodily differences during the research and design stages of biometric systems, as well as during their use, are highlighted by a more nuanced understanding of how biometrics and bodily differences intersect. Yet, every biometric check consists of a process with many intermediate steps, introducing contingency and choice on many levels. In addition, there are underlying normative assumptions regarding human bodies that affect the functioning of biometric systems in highly problematic ways. In recent social science studies, the failures of biometric systems have been interpreted as gendered and racialized biases. A more nuanced understanding of how biometrics and bodily differences intersect draws attention to how bodily differences are produced, used, and problematized during the research and design phases of biometric systems, as well as in their use. However, a biometric system such as the iris, ear, retina, voice, and fingerprint uses human body characteristics. This work demonstrates how biometrics works and compares different techniques to understand the most secure and accurate biometric system.

KALI: A Hand Gesture Based Approach to Control PowerPoint Presentation

Tathagata Bhattacharya, Akil Kumar Vujjini, Vinay Alsa
Department of Computer Science and Information Management Systems,
Auburn University at Montgomery, Alabama, USA

Abstract—A PowerPoint presentation is an effective way of delivering a message to the audience. As a part of the presentation, using traditional devices such as a mouse, keyboard, touchscreen, or pen are common scenarios. Hand gesture is a common mean of controlling computer vision in the modern era. Using hand gestures for controlling the activities will simplify PowerPoint presentations. We developed a novel hand gesture-based application KALI, that can swiftly help the presenter to change their slides, zoom in and zoom out the contents of

the slide, and draw and erase on the slide. We use machine learning algorithms and openCV to bolster our application and provide the users with a pro-interactive experience to ease their jobs and provide a high level of user satisfaction and user-friendliness. This paper presents a review of the current state of the art in hand gesture systems for PowerPoint presentations. This research discusses the different types of hand gesture systems that have been developed, as well as the advantages and disadvantages of each approach. The paper also discusses the challenges that need to be addressed in order to make hand gesture systems more widely adopted. We have surveyed the students of Auburn University at Montgomery and figured out the user needs. This survey helped us make a concrete application that will overcome the burden of using a keyboard, clicker, or mouse while teaching in class. Finally, we also discuss how we are going to add more features like video streaming, volume control, and a better auditory impact on the users and the audience to strengthen our novel gesture-based application KALI.

Research on Real-Time Image Stitching for Wafer Defect Inspection

So-Young Kwon, Young-Hyung Kim, Dong-Soo Jung, Yong-Hwan Lee Department of Electronic Engineering, Kumoh National Institute of Technology, South Korea;
Department of IT Convergence, Kumoh National Institute of Technology, South Korea;
Syisolution, South Korea;
School of Electronic Engineering, Kumoh National Institute of Technology, South Korea

Abstract— Recently, with the development of the 4th industrial revolution technology, the importance and demand for memory semiconductors have increased rapidly, and the semiconductor market is expected to continue to expand in the future. One of the important processes in the semiconductor industry is wafer production, and since wafer yield is directly related to a company's competitiveness, improving wafer yield is a very important issue. Therefore, it is important to accurately detect and analyze wafer defects during semiconductor production. A predictive system is used to determine the cause of defects, in which vision camera and scope equipment is used. The prediction system currently in use perform manually when combining multiple photographic images into one image, which increases the time required to analyze defects and has the potential to result in production disruption. In this paper, we discuss an algorithm that automatically combining multiple photographic images and a method of implementing it with FPGA for real-time processing.

Design a Hardware Applying Fog Removal Algorithm using Median Dark Channel Prior for Autonomous Driving Car

Chang-yong Lee, Heon-bin Jang, Young-seok Kim, Yong-hwan Lee
Department of Electronic Engineering, Kumoh National Institute of Technology, South Korea;
School of Electronic Engineering, Kumoh National Institute of Technology, South Korea

Abstract— Autonomous driving cars are required image processing functions. Depending on the driving environment of the car, there may be cases where a clear image is not received, and as a result, the accuracy of autonomous driving may decrease. One of the factors that is affected by the driving environment is fog, and you can have clear images by using a preprocessing algorithm that removes fog. The dark channel method is used to remove fog, but in this paper, the median dark channel method was used considering the blocking phenomenon, which is a disadvantage of the dark channel. To design this with Verilog HDL, the number of comparators was reduced to reduce resources and process in real time. Line buffers were used to increase memory usability.

3Describe-Creating Tangible AR (Augmented Reality) Objects using Depth Camera

Kevin Zhang, Mike Tianci Ye, Chris Cheng Zhang
Department of Research and Development, Canada Youth Robotics Club, Vancouver, BC, Canada;
Saint George's School, Vancouver, BC, Canada;
University of British Columbia, Vancouver, BC, Canada

Abstract—With the rise of online classes using platforms like Zoom whether its because of Covid-19 or to teach students from long distances, many students find these ways of learning to be disengaging with the absence of some interaction. To combat that issue and make distance learning more interactive, this project aims to create a baseline model of AR (augmented reality) cubes that can be touched with hands using a depth camera. By doing so, we can potentially apply this project to more complex 3D objects where instructors and students can interact with.

Localization of Left Ventricular Epicardium and Endocardium Using Convolutional Neural Network and Transfer Learning

A. F. M. Saifuddin Saif, Trung Duong
Department of Computer Science and Information Systems,
West Virginia University Institute of Technology, Beckley, West Virginia, USA;
School of Engineering, Colorado State Univeristy Pueblo, Colorado, USA

Abstract— Localization of Left Ventricular Epicardium and Endocardium is a virtual imaging strategy to empower clinical application. In any case, automatic localization of the ventricular epicardium and endocardium is still challenging due to the complex nature of heart images and precision. This research proposes an efficient method for localizing Left Ventricular Epicardium and Endocardium using transfer learning approach with InceptionV3 CNN model. Experimental validation was done using the Cardiac MRI dataset, where the proposed method can localize the epicardium and endocardium with less error, which is expected to lead to faster and more accurate detection and treatment of cardiovascular disease.

Object Localization Using Vision Transformer with a Loss Function Based on IOU and Mean Squared Error

Hong Cheng, Wen Cheng
Department of Math and Computer Science, Southern Arkansas University, Magnolia, Arkansas, USA

Abstract - In this paper, we present a novel methodology employing a Vision Transformer coupled with a loss function derived from Intersection over Union (IOU) and Mean Squared Error (MSE) for precise object localization or bounding box regression. Through experimentation on two distinct datasets, we have observed that our custom loss function enhances the performance of ViT compared to alternative loss functions like Mean Square Error (MSE), LIoU, or LGIoU.

Simplex Projection Based Dimension Reduction for Multiclass Classification

Hong Zhang
Department of Computer Science, Georgia Southern University, Savannah, Georgia, USA

Abstract—We propose a novel dimension reduction method for classification problems with multiple classes based on the orthogonal projection to the simplex of class centers. The method is numerically stable and leads to a natural, fixed dimensionality. It is shown that the simplex projection method incurs no information loss in special cases of Gaussian distributions. Experimental results using a high dimensional data set showed good performance of the dimension reduction method.

Wavelet Features Greedy Clustering for Remotely Sensing Identification

Zhaohui Wang
Department of Computer Systems Technology, North Carolina A&T State University, Greensboro, North Carolina, USA

Abstract—The wavelet transform can capture the abrupt features from the accurate description of the spectral abrupt features, while the wavelet correlation coefficient can be used to evaluate the similarity or distance between remotely sensed samples in the super dimensional space. The remote sensing identification is to search the pixels with the lowest correlation, and the best clustering centers with the lowest redundancy can be achieved through greedy searching within the boundaries of wavelet correlation coefficients. This wavelet features greedy clustering algorithm is unsupervised without the knowledge of the number and distribution of classes corresponding to various land covers. Its favorable identification results were achieved on the Landsat TM images and AVIRIS hyperspectral images.

Generative Adversarial Networks in Image Generation and Recognition

Anoushka Popuri, John Miller
Francis Howell School District, O'Fallon, Missouri, USA

Abstract—Generative Adversarial Network (GAN) is a class of Generative Machine Learning frameworks, which has shown remarkable promise in the field of synthetic data generation. GANs consist of a generative model and a discriminative model working in a game like contest to generate data with high levels of accuracy. This paper delves into the applications of GANs in the field of Image Generation and Recognition. We look into the advantages and challenges of using GANs, and the ongoing areas of research and improvements, and potential breakthroughs.

Enhanced Database Training to Enhance Small Object Detection

Chia-Ying Chang
National Pingtung University of Science and Technology, Taiwan

Abstract—To effectively detect orchard pests in large volume of interest, small object detection technique is improved via enhanced database training. The recognition rate of orchard pests is greater than 90% in the volume of $50 \times 50 \times 50$ cm^3. Because the outdoor environment has a lot of variables, I want to use deep learning technology for outdoor pest detection. However, in deep learning, a large number of databases are required to strengthen its

robustness, but we cannot comprehensively collect the database in a short time. Therefore, this paper focuses on analyzing the background complexity, the size of the detected objects and the accuracy rate of the database used in the establishment of the database. In order to achieve the target system that can be detected in HD images with a horizontal viewing angle of 67 degrees, 2~5 cm pests can be detected at a depth of 50~70 cm, and the method of small object detection is used to enhance the availability and robustness of the system.

CSCI-RTHI:
RESEARCH TRACK ON HEALTH INFORMATICS AND MEDICAL SYSTEMS

A Machine Learning Pipeline to Analyse Multispectral and Hyperspectral Images

Damiano Azzolini, Alice Bizzarri, Michele Fraccaroli, Francesco Bertasi, Evelina Lamma
Dipartimento di Scienze dell'Ambiente e della Prevenzione, University of Ferrara, Ferrara, Italy;
Dipartimento di Ingegneria, University of Ferrara, Ferrara, Italy

Abstract—Machine Learning is a branch of Artificial Intelligence with the goal of learning patterns from data. These techniques fall into two big categories: supervised and unsupervised learning. The former classify data based on a given set of examples whose classification is known (hence the name supervised), while the latter try to group the data without knowing a priori the possible classes. Neural Networks and clustering algorithms are two of the most prominent examples of the two aforementioned categories. In this paper, we develop a machine learning pipeline to analyse multispectral images. Our approach first adopts neural networks to identify relevant pixels and then applies a clustering algorithm to group the pixels according to two different criteria, namely intensity and variation of intensity.

Well-being of Sedentary Workers: A Novel Approach based on Circadian Rhythms Monitoring

Sawsen El Hadj, Yasmina Berkani, Solene Le Bars, Rodrigo Balp
Capgemini Engineering, Meudon, France

Abstract—The human body follows an approximate 24-hour periodicity that is centrally governed by the Suprachiasmatic Nucleus. This 24-hour rhythmicity may be seen as an internal clock and is commonly referred to as Circadian Rhythm (CR). The synchronization of these endogenous rhythms is therefore vital for healthy bodily function. It is well known that misalignment or disruption of CRs has a negative influence on the body, which can lead to cancer, type-2 diabetes, or obesity among others. In this preliminary study, we propose a protocol for monitoring CRs of healthy, office-hours volunteers to determine to what extent their CRs are physiologically disrupted, while gathering behavioral information via standard questionnaires. Circadian activity and circadian temperature physiological data will be processed to extract well-known circadian biomarkers. These biomarkers will then be analyzed jointly with the subjective, questionnaire-based data. We expect to shed some light into the disruption of CR of healthy workers and their link to their well-being and everyday life behavior. The final goal of this study is to provide relevant information on CRs to prevent illness.

Autonomous Emergency Triage Support System

Ol'Tunde Ashaolu, William Lyons, Ioannis Stefanakos, Radu Calinescu,
Ibrahim Habli, Victoria Hodge, Chiara Picardi, Katherine Plant, Beverley Townsend
York and Scarborough Teaching Hospitals, NHS Foundation Trust, Hull-York Medical School, York, UK;
Department of Computer Science, University of York, York, UK;
Faculty of Engineering and Physical Sciences, University of Southampton, Southampton, UK

Abstract—Medical staff shortages and growing healthcare demands due to an ageing population mean that many patients face delays in receiving critical care in the emergency departments (EDs) of hospitals worldwide. As such, the use of autonomous, robotics and AI technologies to help streamline the triage of ED patients is of utmost importance. In this paper, we present our ongoing work to develop an autonomous emergency triage support system intended to alleviate the current pressures faced by hospital emergency departments. By employing a combination of robotic and AI techniques, our solution aims to speed up the initial stages of ED triage. Its preliminary evaluation using synthetic patient datasets generated with ED medic input suggests that our solution has the potential to improve the ED triage process, supporting the timely and accurate delivery of patient care in emergency settings.

The Impact of Family History Technology on Social and Emotional Well-being

Mark Clement, Joseph Price, Kasey Buckles, Nat Poulson, Joseph Steed, Emma Ausman,
Ammon Quackenbush, Lawry Sorenson, Kymberly Larson, Brandon Southwick
Department of Computer Science, Brigham Young University, Provo, Utah, USA;
Department of Economics, Brigham Young University, Provo, Utah, USA; Department of Economics, University of Notre Dame, Notre Dame, Indianna, USA; Family History Technology Laboratory, Brigham Young University, Provo, Utah, USA

Abstract—Many people suffer from social and emotional problems. These problems are especially difficult for those who are blind or visually impaired, homeless, without family or community support, or incarcerated. We have developed several family history technology applications with an aim of helping these disadvantaged groups. We aim to show that family history technology has a high potential to improve social and emotional wellness for people, especially those who belong to these disadvantaged groups. In particular, we found that surveyed users of RelativeFinder reported that the application helped them feel more connected to their community and had a positive impact on their emotional well-being.

TransONet: Automatic Segmentation of Vasculature in Computed Tomographic Angiograms Using Deep Learning

Alireza Bagheri Rajeoni, Breanna Pederson, Ali Firooz, Hamed Abdullahi,
Andrew K. Smith, Daniel G. Clair, Susan M. Lessner, Homayoun Valafar
Computer Science & Engineering, University of South Carolina, Columbia, South Carolina, USA; Biomedical Engineering, University of South Carolina, School of Medicine, Columbia, South Carolina, USA; Surgery, Vanderbilt University, Nashville, Tennessee, USA;
Cell Biology & Anatomy, University of South Carolina, School of Medicine, Columbia, South Carolina, USA

Abstract—Pathological alterations in the human vascular system underlie many chronic diseases, such as atherosclerosis and aneurysms. However, manually analyzing diagnostic images of the vascular system, such as computed tomographic angiograms (CTAs) is a time-consuming and tedious process. To address this issue, we propose a deep learning model to segment the vascular system in CTA images of patients undergoing surgery for

peripheral arterial disease (PAD). Our study focused on accurately segmenting the vascular system (1) from the descending thoracic aorta to the iliac bifurcation and (2) from the descending thoracic aorta to the knees in CTA images using deep learning techniques. Our approach achieved average Dice accuracies of 93.3% and 83.4% in test dataset for (1) and (2), respectively, highlighting its high accuracy and potential clinical utility. These findings demonstrate the use of deep learning techniques as a valuable tool for medical professionals to analyze the health of the vascular system efficiently and accurately. Please visit the GitHub page for this paper at https://github.com/pip-alireza/TransOnet.

Advancing Child and Maternal Health: A System Dynamics Exploration of Policy Interventions to Tackle Socioeconomic Disparities

Ashiat Ashake Adeogun, Misagh Faezipour
College of Basic and Applied Sciences, Healthcare Informatics,
Middle Tennessee State University, Murfreesboro, Tennessee, USA;
Department of Engineering Technology, Middle Tennessee State University,
Murfreesboro, Tennessee, USA

Abstract—This study delves deep into the multifaceted child and maternal health domain, focusing on policy interventions to mitigate socioeconomic disparities. Utilizing a system dynamics approach, we have integrated various factors such as “Universal Healthcare Access”, “Income Support Programs”, and “Education Equity Initiatives”. We have meticulously analyzed the complex relationships among these elements by investigating dynamic feedback loops. The striking results show the potential for well-designed policy interventions to improve maternal and child health significantly and the reduction of health disparities. Our findings underline the necessity of holistic and multipronged approaches to address socioeconomic disparities within the healthcare system, thus promoting the well-being of both mothers and children. This research provides valuable insights for policymakers, researchers, and healthcare professionals seeking effective strategies for achieving equitable child and maternal health outcomes.

Evaluating and Reducing AI Model Group Disparity: An Analysis of COVID Test Outcomes in Children

Alexander Libin, Jonah Treitler, Yijun Shao
AIM AHEAD Consortium, Medstar Research Health Institute,
Georgetown University, Washington, D.C., USA;
Thomas Jefferson High School for Science and Technology,
Alexandria, Virginia, USA;
Department of Clinical Research and Leadership,
George Washington University, Washington D.C., USA

Abstract—AI fairness in healthcare has attracted significant attention due to the potential risk of perpetuating health disparity. This study assessed the group parity of a set of machine learning (ML) models trained on the National Health Interview Survey data, with COVID test result as the outcome. We also experimented with the use of synthetic data to reduce group disparity. Our results suggest that group disparity is prevalent in ML models though often not statistically significant, and the use of synthetic data can sometimes enhance group parity.

Health Informatics for Contact Tracing in a Pandemic Response: A Perspective

Lateefat Amao, Misagh Faezipour
College of Basic and Applied Sciences, Healthcare Informatics,
Middle Tennessee State University, Murfreesboro, Tennessee, USA;
Department of Engineering Technology, Middle Tennessee State University,
Murfreesboro, Tennessee, USA

Abstract—This paper delves into the pivotal role of health informatics in pandemic response, focusing on the recent COVID19 pandemic as a real-world case study. Contact tracing emerges as a crucial non-pharmaceutical strategy for containing infectious disease outbreaks, especially for highly contagious asymptomatic diseases like COVID-19. While experts agree on its potential to curb disease spread, assessing the effectiveness of traditional contact tracing methods can be challenging. In this study, we embark on a comprehensive journey through peer-reviewed literature to explore how health informatics seamlessly integrate into the contact tracing process. We meticulously analyze its impact, from data collection and modeling to the delivery of healthcare services. By doing so, we shed light on the transformative role that health informatics plays in reshaping pandemic response and management. This paper offers a fresh perspective on the remarkable potential of health informatics in pandemic research and management, seeking to clarify its pivotal role.

Follow-up Evaluation to Explore Disparities between Android and iOS users Utilizing the TrackYourTinnitus Ecological Momentary Assessment Platform

Michael Winter, Winfried Schlee, Thomas Probst, Michael Stach, Rudiger Pryss Institute of Clinical Epidemiology and Biometry, University of Wurzburg, Wurzburg, Germany;
Institute for Information and Process Management,
Eastern Switzerland University of Applied Sciences, St. Gallen, Switzerland;
Division of Psychotherapy, Department of Psychology,
Paris Lodron University Salzburg, Salzburg, Austria

Abstract—The collection of data via smartphones for medical purposes has reached an established place. Concepts such as Patient-reported Outcomes (PROs) or Ecological Momentary Assessments (EMAs) have shown that when operationalized with smartphones, medically relevant outcomes can be achieved. For example, there are studies showing that PROs can be used to increase cancer survival rates. Interestingly, the use of smartphones also opens up entirely new possibilities. For example, if a study offers a smartphone app on Android and iOS, the operating system can be used as a variable to identify medically relevant differences. We have already done this in a 2018 study for our longstanding platform TrackYourTinnitus (TYT). TYT collects daily data from tinnitus patients using EMA and PROs to learn more about their variations. Since tinnitus is still unclear in its origin, but there is a large heterogeneity between patients, longlasting and daily measurements can provide interesting insights, which will be done again in the present study using the differences between Android and iOS users. Because more than 5 years have now passed since the last study, a follow-up analysis is presented. A large part of the results continue to be confirmed and individual aspects have also emerged due to the larger database which we report on in this article.

An Improved Time-Based Encryption Key Rotation Scheme for Healthcare Databases

Ellie Pin-Yu Chen, Quincy Wu, Meng-Shuo Shen
Department of Computer Science and Information Engineering,
National Chi Nan University, Puli Township, Taiwan;
Puli Christian Hospital, Puli Township, Taiwan

Abstract— The practice of encrypting sensitive and critical data has led to the development of many mature cryptosystems that almost guarantee the confidentiality of encrypted data. However, many organizations still suffer security issues caused by poor key management. Some scenarios indicate that encryption keys have not been changed for several years. In that case, former employees still possess valid keys to access the system. Many systems adopt key rotation as countermeasures, but it is difficult to find a balance between security and efficiency. This paper shares the experience in Puli Christian Hospital with key rotation by proposing an improved algorithm with enhanced security and higher performance over a previous time-based key rotation system. It is demonstrated that the new mechanism is more suitable for healthcare database systems to store sensitive data.

One vs All Approach for Nested Named Entity Recognition in the French Medical Text

Hocine Kadi, Mathieu Boyer
Research and Innovation Department, Capgemini Engineering, Illkirch-Graffenstaden, France

Abstract— Named entity recognition (NER) is a fundamental natural language processing task that focuses on identifying and classifying named entities in text. In the context of medical texts, NER plays a key role in automatically recognizing and categorizing medical entities, including diseases, symptoms, treatments, drugs, and other relevant terminology associated with medical conditions. The 2020 version of the French Text Mining Challenge (DEFT 2020) presented a task related nested NER in french medical narrative texts. DEFT 2020 proposes to extract ten categories of information from the medical domain, from a corpus of French clinical cases. In this work, we explore "One vs all" classification strategy with Bert models to extract and identify medical entities proposed in DEFT 2020. The "One vs all" approach makes it possible to train and optimize one model per class. We trained CamemBERT-base and DrBERT for each of the classes of the DEFT 2020 dataset. The best global model based on CamemBERT evaluated on the DEFT 2020 dataset test obtained 95.25% of F1-score, surpassing the state-of-the-art.

Detection Transformer for Teeth Detection, Segmentation, and Numbering in Oral Rare Diseases: Focus on Data Augmentation and Inpainting Techniques

Hocine Kadi, Theo Sourget, Marzena Kawczynski, Sara Bendjama, Bruno Grollemund, Agnes Bloch-Zupan
Research and Innovation Department, Capgemini Engineering, Illkirch-Graffenstaden, France; Department of Computer Science Universite Rouen Normandie, Rouen France;
Reference Center for Rare Oral and Dental Diseases, Hopitaux Universitaires de Strasbourg (HUS), Strasbourg, France

Abstract— In this work, we focused on deep learning image processing in the context of oral rare diseases, which pose challenges due to limited data availability. A crucial step involves teeth detection, segmentation and numbering in panoramic radiographs. To this end, we used a dataset consisting of 156 panoramic radiographs from individuals with rare oral diseases and labeled by experts. We trained the Detection Transformer (DETR) neural network for teeth detection, segmentation, and numbering the 52 teeth classes. In addition, we used data

augmentation techniques, including geometric transformations. Finally, we generated new panoramic images using inpainting techniques with stable diffusion, by removing teeth from a panoramic radiograph and integrating teeth into it. The results showed a mAP exceeding 0,69 for DETR without data augmentation. The mAP was improved to 0,82 when data augmentation techniques are used. Furthermore, we observed promising performances when using new panoramic radiographs generated with inpainting technique, with mAP of 0,76.

Image Compression and Decompression Framework Based on Latent Diffusion Model for Breast Mammography

InChan Hwang, MinJae Woo
School of Data Science & Analytics, Kennesaw State University, Kennesaw, Georgia, USA

Abstract—This research presents a novel framework for the compression and decompression of medical images utilizing the Latent Diffusion Model (LDM). The LDM represents advancement over the denoising diffusion probabilistic model (DDPM) with a potential to yield superior image quality while requiring fewer computational resources in the image decompression process. A possible application of LDM and Torchvision for image upscaling has been explored using medical image data, serving as an alternative to traditional image compression and decompression algorithms. The experimental outcomes demonstrate that this approach surpasses a conventional file compression algorithm, and convolutional neural network (CNN) models trained with decompressed files perform comparably to those trained with original image files. This approach also significantly reduces dataset size so that it can be distributed with a smaller size, and medical images take up much less space in medical devices. The research implications extend to noise reduction in lossy compression algorithms and substitute for complex wavelet-based lossless algorithms.

Allergic Contact Dermatitis Detection with Machine Learning

Kyriakos S. Panagiotidis, Ioannis A. Vezakis, George K. Matsopoulos
National Technical University of Athens, Athens, Greece

Abstract— Allergic contact dermatitis (ACD) is a prevalent immune-mediated skin condition, affecting million people worldwide. Significant diagnostic challenges occur due to the subjectivity inherent in the current diagnostic approach, which involves skin patches. To address this limitation, the present study explores the potential of machine and deep learning algorithms in automating ACD diagnosis, thereby facilitating more objective and accurate assessments. A dataset comprising 1579 skin patch images from 200 patients was collected, to train and evaluate the proposed diagnostic models. The dataset underwent extensive feature extraction, resulting in 732 distinct features. These features were utilized to train classical machine learning models, such as Random Forest, Support Vector Machines, and XGBoost, with the objective of identifying correlations related to ACD. To another approach, Convolutional Neural Network (CNN) architectures were evaluated in recognizing patterns in different image types, such as Texture and Redness, correlated with ACD cases. The results have indicated that machine algorithms can achieve a success rate of 83% in ACD detection, with the fusion algorithm of two approaches boosting the success rate to 85%. The significance of this research lies in the enhancement of overall diagnostic accuracy achieved through the combination of information from various sources. It highlights that machine learning and CNNs can automate ACD diagnosis, making it more objective and efficient. This advancement can greatly assist clinical diagnosis, and benefit regions with limited medical resources and many patients worldwide.

Predicting the Blood Glucose Level using Transformers

Edgar Acuna, Roxana Aparicio
Mathematical Science Department, University of Puerto Rico at Mayaguez, Mayaguez, Puerto Rico;
Industrial Engineering Department, University of Puerto Rico at Mayaguez, Mayaguez, Puerto Rico

Abstract— In this paper, we explore the use of Transformer, a novel deep learning model, to predict blood glucose levels in type 1 diabetes patients. We also evaluate the impact of two preprocessing steps: data imputation and smoothing. We benchmark the Transformer against two other models—XGBoost and a one-dimensional convolutional neural network (1D-CNN)— using the OhioT1DM dataset to forecast blood glucose levels 30 minutes ahead based on a 60-minute historical timeframe. Additionally, we assess four methods for addressing missing time series data during training: hourly mean, linear interpolation, cubic interpolation, and spline interpolation, along with two smoothing approaches: Kalman smoothing and smoothing splines. Our tests indicate that the Transformer outperforms both XGBoost and 1D-CNN when relying solely on continuous glucose monitoring (CGM) as a predictor. Moreover, it holds its own against XGBoost when both CGM and meal-induced carbohydrate intake are predictors. Our findings demonstrate higher accuracy than previously reported in existing literature.

Amazing Power of DINOv2 for Automatic Diagnosis of 12-Lead ECG

Kushal Pal Singh, B. Chandra, Prem Kumar Kalra, Rajiv Narang
ANSK School of Information Technology, Indian Institute of Technology Delhi, New Delhi, India;
Department of Computer Science and Engineering, Indian Institute of Technology Delhi, New Delhi, India;
Department of Cardiology, All India Institute of Medical Sciences, New Delhi, India

Abstract - Heart diseases are the leading cause of death globally. Electrocardiograms (ECGs) can detect several heart anomalies. However accurate interpretation requires skilled professionals. Automatic diagnosis of heart disease from ECG can enable timely treatment. The proposed method uses a Visual transformer for ECG diagnosis. This method proposes to finetune the DINOv2 model, which is trained on many real-world object images, with ECG images. This finetune model is used for extracting relevant features to be used by classification for anomaly detection. The main aim of this paper is to classify the widely known CODE15% dataset, which is 15% of data from a larger dataset known as the CODE dataset. This 12 Lead ECG dataset has six heart conditions: 1dAVb, RBBB, LBBB, SB, AF, and ST. The model was finetuned for 10 epochs and a test accuracy of 96.30% was achieved. The heart conditions 1dABB, AF, SB, LBBB, ST, and RBBB have been classified with 93%, 94%, 95%, 96%, 97% and 98% accuracy, respectively. We achieved this with 2 seconds of ECG data only. Ribeiro et al. (2020) have tried to classify the entire CODE data and have been able to achieve an average precision of 92.37%. In this paper, we have achieved an increase in accuracy to the tune of 3.3% with a smaller dataset.

Vision Health Monitoring System for Pilots

Abdulrahman M. Abdulghani, Mokhles M. Abdulghani, Wilbur L. Walters, Khalid H. Abed
Jackson State University, Jackson, Mississippi, USA

Abstract—Maintaining optimal vision health among pilots during high-altitude flights is paramount for aviation safety. Vision disturbances, often attributed to retinal refraction deviations and fluctuating blood glucose levels, can compromise a pilot's ability to operate an aircraft safely. Diabetic Retinopathy (DR), a serious eye condition, poses a particular concern as it can lead to irreversible vision impairment if not promptly diagnosed and treated. In this study, we introduce an innovative solution tailored to aviation professionals. Leveraging IoT integration and deep learning methodologies, we present a hybrid approach designed for precise and real-time identification of diabetic retinopathy among pilots. Our methodology harnesses the power of deep Convolutional Neural

Networks (CNNs) for feature extraction from fundus images, further enhancing accuracy through optimization with the Grey Wolf Optimizer (GWO) algorithm. Additionally, we incorporate Internet of Things (IoT) devices for continuous monitoring and immediate diabetic retinopathy identification. Experimental evaluation using publicly available datasets demonstrates the effectiveness of our approach, achieving an exceptional accuracy rate of 98.6%. Our research addresses a critical need within the aviation industry by providing a robust mechanism for accurate and instantaneous detection of diabetic retinopathy in pilots. This advancement is poised to significantly enhance aviation safety and the well-being of aviation professionals operating at high altitudes.

Exploring Concepts for Pipeline-Driven Mobile Health Data Dashboards: Insights from Personal Projects and Github Contributions

Carsten Vogel, Michael Stach, Johannes Allgaier, Jens Scheible, Fabian Hofmann, Rudiger Pryss
Institute of Clinical Epidemiology and Biometry, University of Wurzburg, Wurzburg, Germany;
Institute of Databases and Information Systems, Ulm University, Ulm, Germany

Abstract—In recent years, mobile healthcare (mHealth) has experienced tremendous growth, enhancing data collection through patient-reported outcomes (PROs) and/or Ecological Momentary Assessments (EMAs) conducted via smartphones, wearables and, other mobile devices. In addition, Mobile Crowdsensing (MCS) technologies are often integrated into EMAs and PROs, alongside emerging trends such as the adoption of Digital Phenotyping (DP). This shift has shown promise, such as improving cancer survival rates through PROs. However, challenges arise when collecting data over longer study periods. User engagement wanes, necessitating early trend detection for researchers and user awareness of the data. Effective visualization, especially through dashboards, meets both needs. For users, for example, studies have shown that appropriate visualization can increase motivation to use an mHealth app. For researchers, they can use visualizations to detect trends early on or identify new ideas for data analysis. Therefore, our research group is actively working on implementing a flexible dashboard feature for ongoing projects. In this paper, we will outline our development idea based on a flexible pipeline concept. Furthermore, we will show what a recent search in the literature and on GitHub has revealed about existing projects in this context.

Mobile Wellness Program for Nurses with Rotating Shifts Using Social Messenger Service: A Proposed Design

Sang-Ho Lee, Sanghun Yun, Dong-Ha Lee, Oh-Seok Kwon, Jinung An
Division of Intelligent Robot and Convergence Research Advanced Centre for Olfaction, DGIST, Daegu, Republic of Korea;
Division of Electronics and Information System, DGIST, Daegu, Republic of Korea;
Division of Intelligent Robot, DGIST, Daegu, Republic of Korea

Abstract— Nurses with rotating shifts face unique challenges in maintaining their wellness. This paper proposes a mobile wellness program for nurses with rotating shifts using a social messenger service. The program is designed to be accessible, convenient, and engaging for nurses with busy and unpredictable schedules. The program will focus on four key areas of wellness: physical health, mental health, nutrition, and sleep. Nurses will be able to access information and resources on these topics through the social messenger service. They will also be able to connect with other nurses in the program to share tips and support each other. The program will be evaluated using a mixed-methods approach. Quantitative data will be collected on nurse participation and engagement. Qualitative data will be collected through interviews with nurses to learn about their experiences with the program and its impact on their wellness. This proposed mobile wellness program has the potential to make a significant contribution to the well-being of nurses with rotating shifts. By providing nurses with access to information, resources, and support, the program can help them to improve their physical and mental health, nutrition, and sleep.

Prediction of Genetic Biomarkers from RNA-Seq Dataset of Colon Cancer

Tijesunimi Adeyemi, Deborah Ezekiel, Sergio Diaz, Felix Sabb,
Abdullah Abdul, Fitzroy Nembhard, Roshan Paudel
Department of Computer Science, Morgan State University, Baltimore, Maryland, USA;
Department of Physics, University of Maryland Baltimore County, Maryland, USA;
Baltimore County Public School, Baltimore, Maryland, USA;
L3Harris Institute for Assured Information (L3HIAI), Florida Institute of Technology,
Melbourne, Florida, USA

Abstract—This study focuses on the critical role of genetic biomarkers in diagnosing, treating, and preventing the development of colon cancer. The identification of these biomarkers enhances the precision of colon cancer diagnosis and classification. Detecting specific genetic mutations makes distinctions among various colon cancer types feasible. Analyzing upregulated and down-regulated genes aids in identifying individuals at higher risk of colon cancer development. Employing a machine learning approach, this research predicts genetic biomarkers linked to colon cancer, revealing LASP1 as an overexpressed and ICA1 as an under-expressed gene. Additionally, the study predicts seven genetic biomarkers associated with colon cancer, including WNT16, MAD1L1, TMEM176A, M6PR, CYP26B1, ICA1, and LASP1.

Ensembling and Modeling Approaches for Enhancing Alzheimer's Disease Scoring and Severity Assessment

Saurav K. Aryal, Ujjawal Shah, Howard Prioleau, Legand Burge
Computer Science Department, Howard University, Washington D.C., USA

Abstract—With an increasing elderly population and the expected surge in Alzheimer's disease (AD) cases, there is a pressing need for efficient AD detection tools. This study harnessed natural language processing and machine learning for predictive modeling of the Mini-Mental State Examination (MMSE). Our LightGBM model achieved state-of-the-art results, surpassing existing benchmarks by 37% in test RMSE. We also introduced an ensemble strategy, which further enhanced performance by 60%. Our novel AD severity classification approach also showed lightgbm and SVM as top performers. These advancements underscore significant strides towards practical AD detection applications.

SocraHealth: Enhancing Medical Diagnosis and Correcting Historical Records

Jocelyn J. Chang, Edward Y. Chang
Tufts Medical School, Massachusetts, USA;
Computer Science, Stanford University, California, USA

Abstract—This study presents SocraHealth, an innovative approach that harnesses Large Language Models (LLMs) for medical diagnostics, focusing on enhancing accuracy and correcting historical record inaccuracies. SocraHealth utilizes patient data, deploying LLM-based agents in structured debates to refine diagnoses and rectify past errors documented in medical records. The case study, involving two experiments with GPT-4 and Bard, underscores the efficacy of this methodology in generating logical debates devoid of hallucinatory content. By tapping into LLMs' vast knowledge, SocraHealth represents a significant leap beyond conventional diagnostic methods, demonstrating the transformative potential of LLMs in healthcare, particularly in improving diagnostic precision and addressing historical diagnostic inaccuracies.

ECGformer: Leveraging transformer for ECG heartbeat arrhythmia classification

Taymaz Akan, Sait Alp, Mohammad Alfrad Nobel Bhuiyan
Department of Medicine, Louisiana State University Health Sciences Center, Shreveport, Louisiana, USA;
Department of Computer Engineering, Erzurum Technical University, Erzurum, Turkey

Abstract— An arrhythmia, also known as a dysrhythmia, refers to an irregular heartbeat. There are various types of arrhythmias that can originate from different areas of the heart, resulting in either a rapid, slow, or irregular heartbeat. An electrocardiogram (ECG) is a vital diagnostic tool used to detect heart irregularities and abnormalities, allowing experts to analyze the heart's electrical signals to identify intricate patterns and deviations from the norm. Over the past few decades, numerous studies have been conducted to develop automated methods for classifying heartbeats based on ECG data. In recent years, deep learning has demonstrated exceptional capabilities in tackling various medical challenges, particularly with transformers as a model architecture for sequence processing. By leveraging the transformers, we developed the ECGformer model for the classification of various arrhythmias present in electrocardiogram data. We assessed the suggested approach using MIT-BIH and PTB datasets. ECG heartbeat arrhythmia classification results show that the proposed method is highly effective.

Interpretable Data Driven Classifiers: A Proposal for Autism Diagnosis of Children using Ensemble Learning

Abdulhamid Alsbakhi, Joan Lu
School of Engineering, Applied Science & Technology, Canadian University Dubai, UAE;
School of Computing and Engineering, University of Huddersfield, UK

Abstract - Autism Spectrum Disorder (ASD) is a significant healthcare concern due to the large number of cases detected annually, and the massive resources required to support individuals on the spectrum and their families. Data mining and artificial intelligence (AI) techniques have shown promising results in research on healthcare applications, including ASD diagnosis, by providing accurate diagnosis. However, most data models developed by these intelligent techniques, a) do not provide details behind the diagnostic decision to the stakeholders such as clinicians, patients, and caregivers, and b) are criticised for being biased to a single data model rather a group of models. A model that can interpret results involved in the diagnostic process is advantageous offering digital knowledge to healthcare professionals besides adhering to the General Data Protection Regulation (GDPR) terms primarily 'results derived by automated decision-making methods' like AI techniques. More essentially, when the prediction is performed by a group of models this can reduce the decision bias of the diagnosis. This article fills these gaps by proposing a framework based on ensemble learning where a rule-based classifier develops interpretable data models for ASD diagnosis.

Exploring Permanence and Uniqueness of EEG Brain Signals as a Biometric Signature, Part-I: Template-based Techniques

Omer Muhammet Soysal, Muhammed Esad Oztemel
Department of Computer Science, Southeastern Louisiana University, Hammond, Louisiana, USA;
Division of Electrical and Computer Engineering, Louisiana State University Baton Rouge, Louisiana, USA

Abstract - The utilization of electroencephalography (EEG) as a potential biometric tool has been garnering significant attention, leveraging the distinct signatures embedded in human brain activity. The effectiveness of such characteristic patterns, however, hinges on their stability over time. In this study, we aim to explore the permanence and the uniqueness of patterns extracted from neural EEG signals. A comprehensive comparison is

conducted on a spatio-temporal space across various stimuli protocols. In addition, we investigate the effectiveness of Event-Related-Potential signals in contrast to individual response signals. Summarizing our findings regarding the agreement of different time-series techniques for measuring intra- and inter-subject similarity, we present our approach and outcomes in two parts. In this first part, we employed two template-based time series similarity measures, namely normalized Discrete-Time-Warping, and normalized Cross-Correlation. Additionally, we enhance our analysis by applying two time-domain filters− Adjusted Laplacian of Mean and Laplacian of Gaussian− for the extraction of specific spectral neural activity.

Exploring Permanence and Uniqueness of EEG Brain Signals as a Biometric Signature, Part-II: Statistical Techniques

Muhammed Esad Oztemel, Omer Muhammet Soysal
Department of Computer Science, Southeastern Louisiana University, Hammond, Louisiana, USA;
Division of Electrical and Computer Engineering, Louisiana State University Baton Rouge, Louisiana, USA

Abstract - The utilization of electroencephalography (EEG) as a potential biometric tool has been garnering significant attention, leveraging the distinct signatures embedded in human brain activity. The effectiveness of such characteristic patterns, however, hinges on their stability over time. In this study, we aim to explore the permanence and the uniqueness of patterns extracted from neural EEG signals. A comprehensive comparison is conducted on a spatio-temporal space across various stimuli protocols. In addition, we investigate the effectiveness of Event-Related-Potential signals in contrast to individual response signals. Summarizing our findings regarding the agreement of different time-series techniques for measuring intra- and inter-subject similarity, we present our approach and outcomes in two parts. In this second part of our study, we continue our exploration of EEG-based biometric authentication by employing both parametric (T-test) and non-parametric (Mann-Whitney U test) statistical techniques to measure the similarity of time-series signals. After filtering stimuli response signals, we employed two distinct normalization techniques− Forward-Backward-Slope-Normalization and Median-Referenced-Normalization. Additionally, two time-domain filters− Adjusted Laplacian of Mean and Laplacian of Gaussian− are applied for extraction of specific spectral neural activity. Through this multifaceted approach, we aim to enhance our understanding of the robustness and effectiveness of EEG-derived biometric signatures, offering valuable insights for future applications in this promising field.

Medical Care Application Development Through Android Studio

Jason Lee, Nada Alsallami
Department of Computer Science, Worcester State University, Massachusetts, USA

Abstract - Background and aim: Healthcare applications have emerged as important tools to empower patients in partaking in their healthcare journey and streamlining the interaction between patients and healthcare providers. The aim of this work is to create a simple and efficient medical care application that provides multiple beneficial features for the user as well as using sensors to help collect useful data. Methodology: Java programming language through Android Studio is used to create the application. The application has some helpful pages like an appointment page, quick access to authorities in case of an emergency, a health goals list, and a list of sensors to calculate the user's heart rate, light exposure, step count, and temperature.
Results: The application collects data from some sensors and returns useful information to the user. It displays the user's current heart rate in beats per minute. The light exposure page helps the users to avoid high levels of light exposure by displaying the current lux value, it vibrates and displays a warning message if the light threshold is exceeded. The step count page helps the users to track their daily step count. The accelerometer sensor in tandem with the gyroscope sensor is used for the step count implementation. Also, the temperature page displays the current ambient temperature. Conclusion: The creation of this medical care application represents a step towards user empowerment and provides an easier way for the users to keep track of their own health. More sensors might be involved in the future to reach this goal.

Wearable Technology for Fall Prevention-Data Collection Method and Hardware Optimization

Chris Cheng Zhang, Mark Yining Liu, Kevin Zhang (Xinrui Dai)
Department of Research and Development, Canada Youth Robotics Club, Vancouver, BC, Canada;
Sir Winston Churchill Secondary School, Vancouver, BC, Canada;
University of British Columbia, Vancouver, BC, Canada

Abstract—One of the most severe health risks to elderly populations is the risk of falling. Falls can lead to acute injuries, correlating with a decline in physical health. Recognizing the significance of this issue, the Fall Prevention Project aims to develop a method that can accurately predict and prevent falls in elderly demographics. Data collection is essential to understanding and predicting falls. This article addresses the data collection methods used in the Fall Prevention Project. For this project, a gyroscope and accelerometer sensor embedded in a watch records data. By collecting information to train a machine learning algorithm, patient stability can be modeled to reduce the likelihood of injuries and fatalities in at-risk patients. Recently, notable advancements have taken place in the development of prototypes for both the software and hardware components of the watch utilized in the Fall Prevention Project. Changes to the watch's hardware include replacing the previous microcontroller with a controller that requires less power, decreasing the overall size of the watch, and adding a power switch. Changes in software include formatting improvements, the implementation of Excel to store data, and the removal of errors. These developments mark significant progress in refining the technology and functionality of the watch prototype.

Impact of MBSR Therapy on Stress in People with Cognitive Impairments, a Prisma Guided Review

Alfia Pervez, Arshia Khan
Department of Computer Science, University of Minnesota Duluth, Duluth, Minnesota, USA

Abstract - Mindfulness-Based Stress Reduction (MBSR) is a well-established program with a strong evidence base, renowned for its rigorous mindfulness training tailored to assist individuals coping with stress, anxiety, depression, and pain. In this comprehensive review, our primary focus centers on assessing the impact of MBSR on stress reduction. Additionally, we delve into secondary outcomes, including its influence on depression, cognitive function, quality of life, and its potential advantages for individuals grappling with cognitive impairments, particularly Mild Cognitive Impairment, Subjective Cognitive Decline, Alzheimer's Disease, and related forms of dementia. Our analysis encompasses fifteen studies that employ a diverse range of evaluation methods, encompassing stress measurement scales, assessments of hippocampal volume, analysis of HPA axis activity, and EEG measurements, to scrutinize the effects of MBSR. The collective findings strongly indicate that MBSR functions as a versatile intervention capable of mitigating chronic stress and depression, augmenting cognitive function, and enhancing overall well-being. To gain a deeper understanding of these effects, future research endeavors should explore the underlying mechanisms, account for individual variations, and assess the sustained, long-term benefits of MBSR.

Statistical Analysis of Cross-Correlation Index for Identifying Abnormal EGC Signals

Joana Florescano Olguin, Daniela M. Martinez, Norma A. Barboza Tello, Irma Uriarte Ramirez
School of Sciences of Engineering and Technology, Autonomous University of Baja California, Mexico

Abstract—In this work we propose to perform statistical analysis to cross-correlation index for a given electrocardiogram (ECG) signal in order to rapidly identify if the signal corresponds to a healthy heart. This information can be considered as a fast triage for patients complaining of chest pain in order to quickly discard the presence of a heart disease. Results demonstrate that the proposed algorithm was able to correctly classify up to 80% of the normal jointly with up to 85% of the abnormal signals for a particular parameters configuration. This means that it can effectively detect the presence of abnormal signals.

Brain-Inspired Visual Odometry: Balancing Speed and Interpretability through a System of Systems Approach

Habib Boloorchi Tabrizi, Christopher Crick
Department of Computer Science, Oklahoma State University, Oklahoma, USA

Abstract— Here we present a system consisting of traditional visual odometry (VO) enhanced by a fully connected network (FCN). Our primary objectives are speed and interpretability. We modified the FCN to address each degree of freedom individually and to emphasize causal inference. The relative pose error (RPE) is described by modules for each degree of freedom. This RPE highlights differences in parameters and movement variations across scenes. The accuracy of our system often exceeds the performance of other approaches despite its focus on speed. There was even a five percent reduction in RMSE in some cases, which bridges the accuracy and speed gap in VO studies.

A Visualiztion Model for Classification of Human Personality through Bioelectircity Pattern Analysis

Janghwan Kim, Woosung Jang, R. Young Chul Kim
Software Engineering Laboratory, Hongik University, Sejong, Korea

Abstract— Modern medicine is studied based on standardized figures obtained through Medical and scientific methods with one equality of all humans. Through this, the disease's measurement, analysis, and treatment are quantified. Traditional Korean medicine, on the other hand, aims to maintain a healthy human life by solving the fundamental problem of disease based on each different one of all humans. However, our traditional Korean medicine may not fit with modern times due to its long accumulation of a priori knowledge-based records. We are working in a software engineering lab. Because of no medical doctor, we just focus on the number values of human bioelectricity We propose a method of identifying the human constitution with how to apply bioelectricity pattern signals based on traditional Korean medical theory. Through the proposed method, it will expect to care for health conditions.

Early Detection of Pressure Ulcers: Considering Dynamic Phenomena and Temperature

Nicolas Gillard, Pauline Coignard, Jacques Kerdraon, Willy Allegre
Direction R&I, Capgemini Engineering, Saint Jacques De La Lande, France;
Centre Mutualiste de Reeducation et de Readaptation Fonctionnelles de Kerpape, Ploemeur, France;
CoWork'HIT, Ploemeur, France

Abstract—Pressure ulcers are a major disability that can take a long time to heal if discovered late. In this study we examine how early pressure ulcer detection algorithms perform when continuous measurement is implemented. We employ a simulation of a human buttocks that we generated from MRI images to mimic its response to pressure and temperature to detect pressure ulcers early on. The simulation uses the most recent research on muscular stiffening, reperfusion phenomenon, and the effects of temperature on blood flow. For detection, we simulate temperature and pressure sensors on the exterior buttocks interface. Using the pressure readings from the previous two hours, we compute the optimal threshold on the measured instantaneous pressures, which we compare to novel techniques. We showed that considering the evolution of pressure can improve the early detection of pressure ulcer.

A Systematic Review on Machine Learning (ML) and Artificial Intelligence (AI) in UNDERSTANDING and ASSESSING women's health

Jones Yeboah, Sophia Bampoh, Foster Addo Yeboah, Isaac Kofi Nti
University of Cincinnati, Cincinnati, Ohio, USA;
Cleveland Clinic Florida, USA

Abstract—While depression remains a prominent health concern with its associated difficulties, recent years have witnessed the utilization of artificial intelligence (AI) and machine learning (ML) to analyze extensive datasets, thereby enhancing the detection and diagnosis of women's health risks. We conducted a systematic review of AI and ML applications in the context of women's health. This review was carried out using various databases, including PubMed, Scopus, ACM Digital Library, Web-of-Science, and IEEE Explore Digital. We employed specific search terms related to mental health and ML, supplementing our database searches with manual exploration. Our inclusion criteria encompassed articles in English published between 2010 and 2022, focusing on machine learning and artificial intelligence applications and algorithms in the domain of women health, particularly in relation to depression among women. Initially, we identified a total of 495 records based on abstract searches. After removing duplicates, 425 unique reports remained, of which 380 were subsequently excluded following abstract screening. We then assessed 45 full-text articles for eligibility, revealing a wide range of methodologies and outcomes. Notably, the results indicated a high level of accuracy in risk classification, exceeding 90%. Our findings provide valuable perspectives on the implementation and application of AI and ML within the domain of women's health. These insights underscore the potential of these technologies to propel advancements in interventions related to women's health. In summary, we present initial insights and propose future pathways for harnessing AI and ML technologies to tackle depression challenges to enhance women's health on a global scale.

An Approach with Machine Learning for Heart Disease Risk Prediction

Fathe Jeribi, Chamandeep Kaur, A. B. Pawar
College of Computer Science and Information Technology, Jazan University, Jazan, Saudi Arabia;
Department of Computer Engineering, Sanjivani College of Engineering, Kopargaon Savitribai Phule Pune University, Pune, India

Abstract—This in-depth review's goal is to examine how machine learning has fundamentally changed how heart disease is predicted and treated. The need for precise risk assessment, early identification, and individualized treatment options has never been more pressing given the rising worldwide burden of cardiovascular diseases. We identify and address significant obstacles and limits, such as data quality, model interpretability, and bias mitigation, that must be overcome in order to improve healthcare, via the perspective of machine learning. We discover the substantial influence these technologies are having on patient care by looking at the present landscape of machine learning applications in clinical practice, including risk assessment models, early detection techniques, and individualized treatment regimens. We also explore new trends that have enormous potential for future developments, like tailored medicine, explainable AI, and continuous monitoring through wearable technology. With the help of this review, researchers, medical professionals, and policymakers will be better equipped to predict, prevent, and manage heart disease in the future, which will ultimately improve patient outcomes and lower the burden of cardiovascular diseases worldwide.

CSCI-RTSE:
RESEARCH TRACK ON SOFTWARE ENGINEERING

A Method For ODD Specification and Verification with Application for Industrial Automated Driving Systems

Adina Aniculaesei, Christian Schindler, Christoph Knieke, Andreas Rausch, Daniel Rohne, Andreas Richter
Institute for Software and Systems Engineering, Technische Universitat Clausthal, Clausthal-Zellerfeld, Germany;
ADMT-GP/O, Volkswagen AG, Hannover, Germany

Abstract—Various legislative initiatives see the operational design domain (ODD) as the starting point of a development of automated driving systems (ADSs). An ODD describes a set of operating conditions under which a given ADS or feature thereof is specifically designed to function. Therefore, it is important to develop a self-consistent ODD, i.e., there are no contradictions between the ODD constraints, which can be used to check which situations are safe for the operation of the ADS. Standard verification tools, e.g., solvers for satisfiability modulo theories (SMT), could be used to verify the consistency of an ODD specification as well as to check which driving situations fulfill the ODD constraints. However, the usage of a given verification tool requires extensive knowledge of the formal specification language used by the respective tool. Current standardization efforts recommend the specification of an ODD through semi-formal languages (based, e.g., on YAML) in order to address also stakeholders that do not necessarily have a background in formal methods. Thus, we propose a concept for the specification of ODDs, which bridges the gap between the semi-formal languages proposed through current standardization efforts and the standard formal language needed for the interpretation and verification of the ODD. We demonstrate our concept on an example provided by an automotive OEM and report on our results and lessons learned.

Identifying Code Quality Issues for Undergraduate Students Using Static Analysis and NLP

Essa Imhmed, Edgar Ceh-Varela, Scott Kilgore
Department of Mathematical Sciences, Eastern New Mexico University, Portales, New Mexico, USA

Abstract—This research paper presents a detailed analysis of coding standards in the context of university-level programming courses. Focusing on the challenges faced by students in understanding and applying these standards, the study utilizes the CheckStyle tool for Java programming and natural language processing (NLP) techniques such as Doc2Vec for error categorization. The analysis reveals common issues such as spacing problems and non-compliance with naming conventions, exacerbated by factors like tight schedules and limited grading emphasis. Importantly, this paper serves as an exploratory study utilizing advanced natural language processing methods, shedding light on the complexities faced by students in coding standard adherence.

We're Drowning in Errors

Max Maurer, Peter M. Maurer
IBM Corporation (Retired), Gardener, New York, USA;
Department of Computer Science, Baylor University, Waco, Texas, USA

Abstract - This paper discusses the problem of software testing and debugging. Several new error classification schemes are discussed with suggestions for detecting various types of errors.

Utilizing Reusable Test-Ready Models of Smart Home Systems for Testing KNX Devices

Nouf Aljaffan, Lamees Alhazzaa, Afnan Albahli
Department of Computer Science and Engineering, King Saud University,Saudi Arabia;
College of Computer and Information Sciences,
Al-Imam Mohammad Ibn Saud Islamic University, Saudi Arabia;
Department of Information Technology, Princess Nourah Bint Abdulrahman University, Saudi Arabia

Abstract - Smart homes are integral to modern living, offering convenience, energy efficiency, and enhanced security. As these systems evolve and encompass diverse devices, ensuring seamless integration and functionality is paramount. We propose adopting Albahli and Andrews [4] Reusable Test-Ready Models of Smart Home Systems (RTM-SHS) to enhance the efficiency and effectiveness of testing KNX devices. With increasing complexity and the need for interoperability, a streamlined testing process is crucial. RTM-SHS provides reusable, adaptable, and realistic models of smart home environments, enabling rigorous and efficient testing of KNX devices. This approach ensures reliable integration and optimal performance of smart home systems.

Evaluation of Software Security based on Antipatterns Approach

Roberto Andrade, Jenny Torres, Denis Araque, Johanna Molina
Facultad de Ingenieria en Sistemas, Quito, Ecuador;
Universidad de las Fuerzas Armadas Espe, Ecuador

Abstract— Traditional security evaluation of software focuses on detecting and patching known vulnerabilities, in this study we propose the evaluation of security based on antipatterns approach shifts the attention to broader architectural and coding practices. This methodology identifies common design or implementation patterns that may lead to security vulnerabilities. By recognizing and rectifying suboptimal practices, it aims to prevent security issues before they arise and encourages secure coding principles. This paper introduces the foundational framework for this innovative security assessment, highlighting its potential to software security.

Converting WOX Objects to YAML Documents

Vivian P. Reynoso-Sanchez, Betzabet Garcia-Mendoza, Carlos R. Jaimez-Gonzalez, Wulfrano A. Luna-Ramirez
Departamento de Tecnologia de la Informacion, Universidad Autonoma Metropolitana, Unidad Cuajimalpa, Mexico City, Mexico

Abstract—Interoperability refers to the capability of enabling communication between applications developed in different programming languages. This communication is achieved by exchanging data, typically using a standardized format. To solve the challenge of interoperability, one approach involves the implementation of serializers that transform objects into standard formats, which can subsequently be transformed back into any programming language. This paper introduces a converter as a solution to tackle the interoperability issue,

particularly focusing on text-based formats. The converter presented in this paper allows to transform objects written in the XML format generated by WOX to documents written in the YAML format. The paper explores object representations in WOX and YAML, and provides examples of the transformations obtained. A comparative analysis of some existing tools similar to the developed converter is carried out and their most relevant features are described.

DEF-PIPE: Domain Specific Language Visualization for Big Data Pipelines

Amirhossein Layegh Kheirabadi, Vlado Mitrovic, Khoa Dinh, Yilin Chang, Mihhail Matskin
Department of Computer Science, Royal Institute of Technology, KTH, Stockholm, Sweden

Abstract—The complexity of Big Data analysis requires a combination of different software components into a pipeline performing different steps of the analysis. Supporting such pipelines requires different expertise provided by different actors: domain experts and technical/computing experts. The main objective of this work is to support domain experts with a tool for pipeline description, which does not require deep technical knowledge about the deployment and execution of Big Data pipelines. We present a solution to visualize Big Data pipeline description using the DEF-PIPE tool. The solution shows that the process of pipeline description is simple and intuitive for users who are not experts in computing. At the same time, DEF-PIPE automatically generates a textual description of the described data pipelines, which contains the necessary information for simulation, adaptation, deployment, and resource management of the described pipeline. In this case, a separation of concerns between the design and runtime phases of the Big Data pipeline lifecycle is supported. This solution allows us to bridge the gap between domain experts and technical experts. Providing libraries of steps and pipelines also allows the reuse of previously developed solutions.

Modeling MAC Permissions Using Trust-Based Access Control and Actions

Marcel Danilescu, Laura Danilescu
ASWIC Ltd., Galati, Romania;
Department of Computers and Information Technology,
"Dunarea de Jos" University of Galati, Galati, Romania

Abstract— Social life involves the existence of various forms of organization of society members into interaction groups, according to their interests. Some of these organizations are economic structures, while others are military or governmental. Within these, various categories of classified information can be circulated, forming the basis of their activities. Depending on the members' training and their position within the group, the information they circulate has different levels of classification. This paper proposes an implementation model for controlling the permissions granted to organization members regarding its information, based on trust while adhering to the conditions imposed by the Bell-LaPadula model.

Manoel: Automatic Approach to the Execution of Manual Tests

Lorena P. de Figueiredo, Thiago T. Gavanski, Jonathan P. Gomes, Dinara M. Araujo, Rene L. de Almeida,
Welton de A. Seabra, Andre F. Da Cruz, Erick C. Bezerra
SIDIA R&D Institute, Manaus, Brazil

Abstract—Android is an open-source operating system based on Linux that was initially developed for smartphones and tablets. To use a custom Android version with extra Google services, Google Mobile Service, it's necessary to test applications and services that use these packages and provide evidence to generate the

necessary certification for the target build. Part of this test process is not automated. Hence, this work presents Manoel, a software program developed to automate the manual portion of the tests. A case study that compares manual execution and the proposed automated approach is presented. The test cases were evaluated by execution time. Later, a survey was applied to identify the user's perceptions based on experience and productivity. The proposed solution, Manoel, resulted in a reduction of time spent in the test process.

Web System for Visualizing and Executing Methods on Web Objects in XML

Betzabet Garcia-Mendoza, Jose M. Hernandez-Salinas, Carlos R. Jaimez-Gonzalez
Departamento de Tecnologia de la Informacion, Universidad Autonoma Metropolitana, Unidad Cuajimalpa, Mexico City, Mexico

Abstract—This paper presents a web system that allows to display and execute methods on objects created with the Web Objects in XML (WOX) framework, where the user can provide values for each of the method parameters through a web interface. The paper also reviews some existing systems with similar functionality and shows some of their relevant features. The interface of the system is presented, along with some examples that demonstrate its functionality, in particular, the paper shows how a user can display and execute methods on WOX objects. It should be noted that WOX is a framework that allows the creation of object-based distributed applications, which are interoperable among different object-oriented programming languages. WOX uses XML as the format representation for objects, and it uses HTTP as its transport protocol.

Defending the Heap: Diagnosing Undefined Behavior in Dynamic Memory with jkmalloc

Jakob Kaivo, Thomas Devine
Lane Department of Computer Science and Electrical Engineering, West Virginia University, Morgantown, West Virginia, USA

Abstract—Undefined behavior in C programs is a major cause of software vulnerabilities. While the literature contains a substantial amount of work using static analysis to diagnose syntactic undefined behavior, papers diagnosing undefined use of standard library functions are lacking. This paper introduces jkmalloc, a first step toward safe use of the C standard library, targeting the dynamic memory functions. Testing shows jkmalloc effectively inhibits seven types of undefined behavior related to dynamic memory by terminating the program, to prevent undesired execution, and reporting detailed information about the behavior, without requiring modification to existing programs.

Development of a Data Sonification Tool to Transcend Standard Visualization Analyses

Jacob Elbirt, Ali Al-Faris
Computer Science Department, Worcester State University, Worcester, Massachusetts, USA

Abstract— Data manipulation and analysis are critical for companies, researchers, and universities to identify trends and aggregate additional information from existing numerical data. Data normalization and logarithmic transformations are standard alterations used to improve data readability in graphs, charts, and other representations. Spreadsheet applications like Microsoft Excel, Google Sheets, and Apple Numbers provide tools for addressing these tasks but quickly become cumbersome and timeconsuming, requiring considerable

understanding and experience with spreadsheet applications, data formatting and chart generation. While visual representations with their complications are common in spreadsheet applications, audio analysis and representation are largely untapped resources in this capacity. This work presents an approach to sonifying numerical datasets received in spreadsheet format and transforms the data into audio representation that plays during chart generation. The approach involves developing software in the Java programming language. This software is also important in providing a unique opportunity to express datasets and trends to individuals who are blind or otherwise visually impaired.

A Prompt-Based Approach for Software Development

Mohammed Hamdi, Lewy D. Kim
Department of Computer Science and Engineering, Oakland University, Rochester, Michigan, USA;
Stoney Creek High School, Rochester Hills, Michigan, USA

Abstract—Generative language-based AI models have drawn significant interest in a wide range of fields including software engineering. There has been increasing interest in leveraging Gen-LBAI models in various areas of software engineering for efficient software development. Successful adoption of AI models can save time by generating various types of software artifacts, which lets the developer focus on more critical and creative tasks. In this paper, we present a prompt-based approach for software development using an AI model. The approach presents a set of guidelines for designing prompts and discusses where and how AI models can be used in software development for improved efficiency. The approach is evaluated in a case study using ChatGPT-4 and compared with manual development. The evaluation shows that the approach increases 41% in efficiency compared to manual development.

A Survey of Agile vs. Traditional Methods on Project Risk Management

Ibrahim Ibaad Syed, Vishal Goud Uppunuthula, Soma Datta
University of Houston-Clear Lake, Texas, USA

Abstract - This study investigates the influence of traditional and agile project management methodologies on risk management in software development projects. It overviews the relationship between risk management and project management methods by examining prior research on risk management processes, tools, and techniques in traditional and agile software development projects. The study analyses various peer-reviewed articles on risk management. The study's results suggest that the impact on risk management varies between traditional and agile project management methodologies. Agile project management methods are more effective in handling Risk in software development projects that are complex and uncertain. In contrast, traditional project management methods are better suited for projects with precise requirements and low uncertainty. The study emphasizes the importance of choosing the appropriate project management approach based on the project's unique characteristics to effectively manage Risk effectively in software development projects.

Cartoon Extraction Mechanism via UML Models based on Natrual Language Requirement Specs

Janghwan Kim, Chansol Park, Woosung Jang, R. Young Chul Kim
Software Engineering Laboratory, Hongik University, Sejong, Korea

Abstract - Recently, research on the development of artificial intelligence, and in particular generative AI, has been active around the world. This research is mainly focused on generating various types of outputs (text, image,

video, etc.) from textual inputs, but defining and understanding the form and meaning of these prompts remains a challenge. In this paper, we propose a mechanism for extracting natural language-based UML Models and mapping Cartoons from UML properties to address these issues in the software engineer domain. The proposed mechanism combines approaches from linguistics and software engineering to highlight the importance of linguistic applications in natural language analysis, to extract cartoon information from natural language. It brings together linguistics and software engineering from natural language to natural language processing and Cartoons.

Efficacy of Static Analysis Tools for Software Defect Detection on Open-Source Projects

Jones Yeboah, Saheed Popoola
School of Information Technology, University of Cincinnati, Cincinnati, Ohio, USA

Abstract - In software practice, static analysis tools remain an integral part of detecting defects in software and there have been various tools designed to run the analysis in different programming languages like Java, C++, and Python. This paper presents an empirical comparison of popular static analysis tools for identifying software defects using several datasets using Java, C++, and Python code. The study used popular analysis tools such as SonarQube, PMD, Checkstyle, and FindBugs to perform the comparison based on using the datasets. The study also used various evaluation metrics such as Precision, Recall, and F1-score to determine the performance of each analysis tool. The study results show that SonarQube performs considerably well than all other tools in terms of its defect detection across the various three programming languages. These findings remain consistent with other existing studies that also agree on SonarQube being an effective tool for defect detection in software. The study contributes to much insight on static analysis tools with different programming languages and additional information to understand the strengths and weaknesses of each analysis tool. The study also discusses the implications for software development researchers and practitioners, and future directions in this area. Our research approach aim is to provide a recommendation guideline to enable software developers, practitioners, and researchers to make the right choice on static analysis tools to detect errors in their software codes. Also, for researchers to embark on investigating and improving software analysis tools to enhance the quality and reliability of the software systems and its software development processes practice.

Mobile Application Development for Required Daily Nutrition Intake Calculation for Thai Elderly

Nuntaporn Aukkanit, Shutchapol Chopvitayakun, Supatchalee Sirichokworrakit,
Jaruwan Chutrtong, Kunyanuth Kularbphettong
Suan Sunandha Rajabhat University, Bangkok, Thailand

Abstract - This research explores the challenges of an aging society, where the elderly population is on the rise in many countries, including Thailand. Technological products and services are crucial to address the unique needs of this aging population. Mobile applications offer a promising avenue to improve the quality of life for the elderly, especially those living alone. However, existing apps fall short in calculating specific nutrient values, leaving a gap in their utility. To bridge this gap, this research developed a specialized mobile application catering to Thai elderly individuals over the age of 60. The app leverages data from the Thai food composition table and dietary reference intakes to serve as a dietary guide for daily cooking. This study aims to not only develop a nutritional mobile app but also assess its effectiveness and propose dietary guidelines for the elderly.

CSCI-RTED:
RESEARCH TRACK ON EDUCATION

Towards a Task Mining Recording Tool for the Automated Generation and Recording of xAPI Statements for Virtual Learning Environments

Ramona Srbecky, Matthias Hemmje
Department of Multimedia and Internet Applications, University of Hagen, Hagen, Germany

Abstract - Using xAPI statements, learner interactions can be tracked in virtual learning environments. Many educational software providers now incorporate xAPI interfaces for collecting valuable behavioral learning data. However, challenges exist, as not all manufacturers support xAPI statement generation, and not all educational software is open source. Additionally, the software may not consistently produce sufficient xAPI data or accurately capture all interactions. Educators often lack the necessary software development skills, particularly with open-source software, to implement effective xAPI tracking. In this CSCI-RTED track paper, we present a solution enabling xAPI statement generation from software, irrespective of source code access or vendor support. In this short paper, we give an overview of the corresponding State of the Art for User Interaction Recording with task mining and capturing, demonstrate our solution's integration in a digital university teaching scenario, provide an overview of implementation, and offer a partial evaluation.

Student Mastery or AI Deception? Analyzing ChatGPT's Assessment Proficiency and Evaluating Detection Strategies

Kevin Wang, Seth Akins, Abdallah Mohammed, Ramon Lawrence
Department of Computer Science, University of British Columbia, Kelowna, BC, Canada

Abstract—Generative AI systems such as ChatGPT have a disruptive effect on learning and assessment. Computer science requires practice to develop skills in problem solving and programming that are traditionally developed using assignments. Generative AI has the capability of completing these assignments for students with high accuracy, which dramatically increases the potential for academic integrity issues and students not achieving desired learning outcomes. This work investigates the performance of ChatGPT by evaluating it across three courses (CS1,CS2,databases). ChatGPT completes almost all introductory assessments perfectly. Existing detection methods, such as MOSS and JPlag (based on similarity metrics) and GPTzero (AI detection), have mixed success in identifying AI solutions. While instructors and teaching assistants use heuristics to distinguish between student and AI code, their detection is not sufficiently accurate. These observations emphasize the need for adapting assessments and improved detection methods.

Design of an Introductory Java Parallel Programming Course for Non-Java Students

Xuguang Chen
Saint Martin's University, Lacey, Washington, USA

Abstract - This paper introduced the design of a course on parallel programming for the students who have not learned Java but have learned another object-oriented programming language. Topics include an introduction to Java, parallel computing theories, and several Java parallel programming techniques widely used today. As an introductory course, it primarily introduces the basic operations of each parallel programming model and their implementation in Java. Its instructional approaches are closer to student-centered and teamwork approaches. Its coursework is project-based, so students will gain hang-on parallel programming experiences through various projects comprehensively applying what they have learned. The design will be implemented in the summer of 2024 as a pilot.

Undergraduate Service Course Research Infusion

Muhittin Yilmaz
Electrical Engineering and Computer Science Department,
Texas A&M University-Kingsville, Kingsville, Texas, USA

Abstract—This study presents a hands-on research experience for an undergraduate junior-level service course, i.e., Circuits and Electromagnetics Devices, for non-Electrical Engineering students and its goal is to demonstrate major research methodologies as well as technical writing principles. The students have learned and investigated scientific research process, literature review sources as well as approaches, technical writing and blind-review principles, and conducted hands-on research on electrical circuit characterization and analysis for an autonomous/electric vehicle operations and a heating, ventilation, and air-conditioning system operations to investigate the contemporary engineering as well as social trends such as smart/green homes or vehicles. In addition, a practical autonomous vehicle set was utilized to explore the team research outcomes. The final student team outcomes as well as feedback and the corresponding surveys, evaluated by the project administrators, indicate the success of the effective research component inclusion in an undergraduate service course.

Teaching and Learning Sorting Algorithms Using Animation

Yong Daniel Liang
Department of Computer Science, Georgia Southern University, Savannah, Georgia, USA

Abstract - *Sorting is a fundamental task in computer programming. Many sorting algorithms have been developed. Sorting algorithms are taught in the programming, data structures, and algorithms courses. The common sorting algorithms introduced in these courses are selection sort, insertion sort, bubble sort, merge sort, quick sort, and heap sort. We have created the animations to visually demonstrate how these sorting algorithms work. The animation is developed using HTML5, CSS, and JavaScript. It is platform independent. It can be viewed from a browser on any device. The animations are useful tools for teaching and learning sorting algorithms. This paper presents these animations.*

Using Assignment Incentives to Reduce Student Procrastination and Encourage Code Review Interactions

Kevin Wang, Ramon Lawrence
Department of Computer Science, University of British Columbia, Kelowna, BC, Canada

Abstract—Procrastination causes student stress, reduced learning and performance, and results in very busy help sessions immediately before deadlines. A key challenge is encouraging students to complete assignments earlier rather than waiting until right before the deadline, so the focus becomes on the learning objectives rather than just meeting deadlines. This work presents an incentive system encouraging students to complete assignments many days before deadlines. Completed assignments are code reviewed by staff for correctness and providing feedback, which results in more student-instructor interactions and may help reduce student use of generative AI. The incentives result in a change in student behavior with 45% of assignments completed early and 30% up to 4 days before the deadline. Students receive real-time feedback with no increase in marking time.

Resources for Encouraging Academically Challenged Students and Their Impact

Dewan Tanvir Ahmed
Department of Computer Science, University of North Carolina at Charlotte,
Charlotte, North Carolina, USA

Abstract - Identifying academically challenging students can be a valuable endeavor for educators and institutions. These students often demonstrate a strong desire for learning, excel in their studies, and may benefit from more advanced or specialized educational opportunities. Supporting academically struggling students is a crucial part of an educator's role. These students may face various challenges that hinder their academic progress. In this study, a set of tools has been used to help these students such as Differentiated Instruction, Encourage Self-Advocacy, Positive Reinforcement, Extra Help Sessions, Create a Supportive Environment and Patience and Empathy. One of the focuses in the study is being flexible and accommodation toward adverse circumstances can motivate students by creating a more compassionate, inclusive, and supportive learning environment. It acknowledges the real-life challenges students face and helps them navigate these challenges while staying engaged with their education. This, in turn, can lead to improved academic performance and a more positive and motivated student body. This paper underscores the significance of these resources in ensuring equal educational opportunities for all students. The class has employed an array of learning methods, motivational resources, and incentives for participation to establish an atmosphere in which students are encouraged, assisted, and actively involved in their learning.

Design and Delivery of Online Scaffolding Support in Quantitative Subjects

Mary Ruth Freislich, Alan Bowen-James
University of New South Wales, Sydney, Australia;
Crown Institute of Higher Education, Sydney, Australia

Abstract – Learning outcomes among statistics students in two Australian higher education institutions were compared. The two institutions delivered online business statistics units consisting of very similar topics which were assessed at similar levels of difficulty. Both sets of students were offered practice material consisting of a set of examples, designed by teaching staff and covering the full syllabus, with solutions that could be accessed. Institution 1 had all assessments marked by teaching staff. Institution 2 had class tests obtained from an online assessment and homework system linked to the textbook used and were offered bonus points for good results on

homework quizzes afforded by the same system. The intention of introducing the online system was to improve learning through unlimited formative feedback. However, the system and its implementation had inappropriate features. The online system sometimes gave misleading feedback, and online tests locked students out if they gave certain normally harmless computer commands. Multiple tests and demanding rules for bonus points made students' workload heavy, and the linking of the system to the textbook occasionally diverted attention to irrelevant material. Comparison of final examination performance showed significantly higher achievement for students from Institution 1.

A Data Governance Literature Review in Education Sector

Maassoumeh Javadi Baygi, Mandy S. M. Chung, Nushin G. Fard, Mohammed Miskat
School of Public and Global Affairs, Fairleigh Dickinson University, Vancouver, BC, Canada

Abstract - This study examines data governance in the education sector, reviewing its status, challenges, and proposed actions. It begins with a comprehensive literature review, offering an overview of the knowledge base on education data governance. To assess data governance development from 2007.2017 to 2018.2022, a comparative analysis is conducted, comparing results with a 2017 study by Benfeldt Nielsen. The research highlights trends in data governance publication patterns, identifying areas needing attention. Recommendations include engaging stakeholders and educational institutions, promoting ethical data practices, adopting a design science approach for data privacy tools, and conducting experiments to identify best practices. Overall, the study aims to enhance data governance in education, ensuring responsible data handling and privacy protection.

Leveraging LLMs and MLPs in Designing a Computer Science Placement Test System

Yi Li, Riteng Zhang, Danni Qu, Maira Marques Samary
Department of Computer Science, Boston College, Chestnut Hill, Massachusetts, USA

Abstract - Introductory Computer Science (CS) programs at higher education institutions include a variety of introductory courses that are commonly known as CS1, CS2; some institutions offer even a bigger variety (e.g., CS0, CS1.5). Accurate placement of students in these courses is vital for students. success. This paper introduces a machine learning-based CS placement test system using LLMs and classifiers, incorporating a concept inventory (CI) assessment. Five LLMs were evaluated, and the best one was chosen to generate questions. The questions are stored in a database, allowing customized placement tests through an interactive assessment system. After the test, students' performance data were used to train three simple MLP classifiers, achieving over 83% accuracy in a case study with 46 participants.

Student Dropout Prediction in High Education, using Machine Learning and Deep Learning Models: Case of Ecuadorian University

Gonzalo Davila, Juan Haro, Alexandra Gonzalez Eras, Omar Ruiz, Daniel Guaman
Universidad Tecnica Particular de Loja Faculta de Ingenierias y Arquitectura,
Departamento de Ciencias de la Computacion y Electronica, Ecuador

Abstract— This work addresses the problem of student dropout in the university environment, where students abandon their studies at any phase of their career, for reasons ranging from personal and economic factors to academic dissatisfaction. This results in the student not starting the degree, or dropping out in early cycles and in some cases in the final cycles, affecting the continuity of the study program, and at the same time the students do not reach their profession. With the help of Artificial Intelligence, it is possible to find patterns that allow us to avoid these scenarios early, providing universities with useful information to establish mitigation strategies. This

research proposes a prediction model for student dropout in critical subjects, using classic Machine Learning techniques and advanced Deep Learning algorithms, integrated under the KDD method, for analysis of the academic information of the Computer Science degree of a 2-year period. The results of the model allow us to identify the techniques and algorithms with greater precision and at the same time recognize patterns that establish the dropout trend in core and pre-professional subjects.

ChatGPT Implications on Higher Education: Educational Apocalypse or Educational Reboot? A Developing Countries Perspective

Olalekan Samuel Ogunleye
School of Computing and Mathematical Science,
University of Mpumalanga Mbombela, South Africa

Abstract— Artificial intelligence has disrupted many industries, and education is no exception. ChatGPT, a Large Language Model (LLM), has emerged as a promising tool for boosting learning experiences and altering traditional teaching methods in higher education. ChatGPT can be considered a combination of chat and a language model. This article investigates ChatGPT's effects on higher education, focusing on the opportunities and obstacles that may arise. This paper tries to answer whether ChatGPT will lead to an educational apocalypse or a much-needed reboot in higher education by assessing the influence of ChatGPT on educators' usage, student involvement, individualised learning, and administrative operations. In its conclusion, the article explores the prospects of incorporating ChatGPT into higher education and offers some ideas on how to do so successfully.

An Extended Framework of Factors Across CAPE that Support K-12 Computer Science Education

Monica M. Mcgill, Isabella Gransbury, Sarah Heckman, Jennifer Rosato, Leigh Ann Delyser
CSEdResearch.org;
North Carolina State University, North Carolina, USA;
University of Minnesota Twin Cities, Minnesota, USA;
CSforALL.org

Abstract—Motivation. Within K-12 computing education, the building blocks that contribute to student success and equitable outcomes are broadly captured in the CAPE framework (i.e., capacity, access, participation and experience). However, these broad components provide limited detail on the important factors that can influence academic achievement, particularly within each component. Our research question for this study was: What are factors comprising each component of CAPE that impact academic achievement among K-12 CS students? To answer this question, we first created an a priori set of factors based on previous research findings that have been found to contribute to academic achievement. After organizing these factors within each CAPE component, we conducted the systematic mapping review of K-12 CS education research articles (2019-2021) (n = 196) from publicly available, peer-reviewed articles from the K-12 CS Education Research Resource Center. Through this mapping, we identified an additional set of factors that have been studied by CS education researchers and added these to our set of factors. More importantly, we found that capacity was the component most frequently investigated and access was the least. There are many areas (or categories) within each component that remain unstudied (i.e., dual credit offerings, career guidance), even though they play a role in computing education. The expanded CAPE framework is now publicly available and can be used to inform researchers and practitioners on what each CAPE component comprises. These factors are accompanied by descriptions of each factor. Not only does it surface the many factors to be considered when designing and delivering computing education to K-12 students, it also provides a solid framework for future research that synthesizes or analyzes homogeneous factors or explores how various factors may be correlated.

Improving the Accessibility of Online Training: A Usability Evaluation of NetAcad Training for Users with Disabilities

Heba Mahmoud Ismail, Ahmad Jasim Jasmy, Mohammad Bilal Mohammad Rasool
Department of Computer Science and Information Technology,
Abu Dhabi University, Abu Dhabi, United Arab Emirates, UAE

Abstract - This study evaluated the usability of NetAcad, a web-based engineering educational platform, among users with disabilities. A survey questionnaire was distributed to 42 participants, including users with visual impairment, motor disabilities, ADHD, and normal users. The collected data was analyzed using quantitative methods to determine the most and least accommodated heuristic principles in NetAcad. Users with visual impairment and motor disabilities found it most challenging to use the NetAcad platform. The study identified specific difficulties faced by users with disabilities when interacting with the platform, such as the need for a popup that dismisses automatically for feedback, displaying course progress properly by showing a percentage that can break down course progress, and the use of voice assistant features. A one-sample t-test showed that users with disabilities (vision impairment, M=2.6; ADHD, M=2.5; motor disability, M= 2.9) had a significantly lower user experience when compared to normal users (M=3.4) considering the target value (M=5). To improve the accessibility and usability of educational platforms, the study recommends incorporating design features that accommodate users with disabilities.

RecPlugin: New Functionality for Learning Resources Recommendation

Mohamed Rekik, Corinne Amel Zayani, Leila Ghorbel, Ronan Champagnat
Faculty of Sciences of Sfax, Sfax University, Tunisia;
MIRACL Laboratory, Sfax University, Tunisia;
L3i Laboratory, La Rochelle University, France

Abstract—Since Corona Virus pandemic, most supervisors are oriented to teach online. Learners follow learning Resources (LR) not only those provided by their supervisors but also those available on different platforms (LMS, MOOC, SPOOC, youtube etc.). In this respect, learners may be disoriented and face cognitive overload. The tremendous volume of available LR poses significant challenges to learners in selecting LR that satisfy their interests (courses, activities, webinars, etc.) and that are complementary to their training. For this reason, we are interested in this paper, in enhancing Moodle by integrating a new plugin for learning resource recommendation. The most prominent challenge of this work is to provide to academics and researchers a plugin that is entirely free, improvable and shareable.

Tokenization of Digital Assets for Ethical and Unbiased Model Training in an AI-based Proctoring Application

Dragan Boscovic, Mahdi Eghbali, Kashish Khullar, Pooja Bharathi Oguri,
Pratyush Pandey, Mike Olsen, Milan Dordevic
Fulton School of Engineering, School of Computing and Augmented Intelligence,
Arizona State University, Tempe, Arizona, USA;
Economics Department, W. P. Carey Business School,
Arizona State University, Tempe, Arizona, USA;
Proctorio Inc., Scottsdale, Arizona, USA

Abstract— The emergence of the COVID-19 pandemic has instigated a transformative shift across various sectors. In particular, the realm of education has witnessed significant changes, with online platforms becoming

the predominant mode of learning. This transition has also extended to the administration of examinations, which have migrated from traditional in-person settings to online environments. To ensure the integrity of online exams, AIpowered proctoring tools have gained prominence, effectively detecting dishonest practices. However, the adoption of these tools prompts certain concerns regarding ethics, potential biases, data reliability, and the inclusivity of AI models embedded within them. In light of these concerns, this paper proposes an architecture aimed at addressing the issues inherent to online proctoring services, utilizing blockchain technology as a robust solution. Our approach introduces a mechanism that incentivizes the collection of authentic user data through crowdsourcing, rewarding contributors with crypto tokens. Our model champions decentralization by employing a voting process to establish the credibility of labels assigned by annotators for sets of user images, with winning contributors receiving the same crypto tokens. Further, our methodology underscores user privacy by allowing users to revoke access to their contributed images. This action prompts the removal of images from backend servers and triggers the retraining of the model that employed them in its training phase. To amplify accessibility, our trained models are extended as a service through a layered API structure built atop these models. Interested clients can access these models by utilizing crypto tokens, which in turn grant them access to the APIs for seamless integration within their applications.

Development of Skills in Learning a Foreign Language Under a STEAM Approach

Nestor Andres Diaz Ortiz, Martha Jeannette Diaz Pena, Flor Emelida Hortua Mora
Fundacion Universitaria del Area Andina, Bogota, Colombia

Abstract—STEAM is applied as a tool that, through active learning, improves the teaching-learning processes. This work presents the results obtained from the students of the Maranata Christian School in the city of Florencia, department of Caquetá – Colombia. The Focus Group is used as a tool, comparing traditional methods with the application of new didactic tools. The simple difference impact evaluation method was implemented in two groups, with a confidence level of 95% and a margin of error of 5%. The results show an improvement of 80% in relation to existing results.

Examining the Potential of Micro-Aerial Vehicles for Tree Inspections as Climate Change Education Tools

Thomas Menkhoff, Benjamin Gan, Foong Shaohui
Lee Kong Chian School of Business, Singapore Management University, Singapore;
School of Computing and Information Systems, Singapore Management University, Singapore;
Singapore University of Technology & Design, Engineering Product Development, Singapore

Abstract - The objective of our research endeavour is to examine the impact of aerial tree inspections with micro-aerial vehicles (in short: micro drones) on students. climate education. Climate change threatens the health and survival of trees and forests. Aerial tree inspections represent an important climate change education approach to explain the urgency of climate change adaptation and climate solutions to draw down greenhouse gases as well as the technical components of micro drones such as external proximity sensors for obstacle avoidance, the fully enclosed propulsion system that allows flight inside dense jungle canopy or the macro-focused high-definition video feed with onboard 10W illumination so that dark areas can be inspected (with such a system, arborists no longer need to manually climb and scale trees). Our main research goal is to examine the impact of climate education with micro-aerial vehicles for tree inspections on achieving important learning outcomes such as catalyzing students. climate action. We regard micro drones as quality climate change teaching & learning tools that can improve students. engagement with climate change and increase their capacity to adapt to climate change by enhancing sustainability-related competencies and motivating them towards more pro-environmental, carbon offsetting behavior in the context of climate action.

Introducing Automatic Verification Strategy in Online Study of Computational Science

Jun Zhang, Ruzong Fan, Fangyang Shen
Department of Computer Science and Engineering Technology,
University of Maryland Eastern Shore, Princess Anne, Maryland, USA;
Department of Biostatistics, Bioinformatics, and Biomathematics,
Georgetown University, Washington, DC, USA;
Department of Computer Systems Technology, New York City College of Technology,
City University of New York, Brooklyn, New York, USA

Abstract—Online study is a very powerful method for global education, as it is available anywhere for anyone with internet access. It is getting more and more important, especially during the pandemic. Computational science is relatively new but very important. It is considered as the third pillar for scientific research, which advances all sciences and technologies in a new dimension. More and more institutes offer online courses or programs in computational science. Unfortunately, almost no rigorous educational study was publicly available towards online computational science education. In this paper, the authors shall introduce a new Automatic Verification Strategy (AVS) in online study of computational science by using Sumudu transform as an example to undergraduate or graduate students in computational science related courses. AVS is a set of programs to provides interaction and verification during the learning process. AVS will reduce cognitive load and support both synchronous and asynchronous learning. Once the AVS is implemented, it is sustainable and can be used any number of times anywhere anytime, like students have private teachers helping them anytime anywhere.

Implementing AI in Physics Lessons in the High School

Nikos Bessas, Eleni Tzanaki, Dionisios Vavougios, Vassilis P. Plagianakos
Department of Computer Science and Biomedical Informatics, University of Thessaly, Lamia, Greece;
Department of Physics, University of Thessaly, Lamia, Greece

Abstract—ChatGPT is a relatively recent application, free to the general public, released at the end of November 2022 and rooted in artificial intelligence. The educational community is still debating how such an application could be used in the teaching and learning area, with the facilities it offers and the risks it entails. The purpose of this paper is to present how such an application responds to physics topics at the high school level, and to suggest ways to use it properly. In order to cover the issue comprehensively, it is approached from both the teacher's and the student's point of view.

A Computer Based Evaluation System: Design, Implementation and Results on General Chemistry

Carmen Elena Stoenoiu, Lorentz Jantschi
Technical University of Cluj-Napoca, Cluj-Napoca, Cluj, Romania

Abstract—A computer based multiple choice multiple answers evaluation system has been designed, implemented, posted online and used to evaluate students on general chemistry for the last 10 years. In this paper, the design, implementation, and some results regarding the students' performances are presented and discussed.

Curriculum for a New Five-Year Academic Program in Intelligent Systems Engineering and Software Engineering

Ashu M. G. Solo
Maverick Trailblazers Inc. Wilmington, Delaware, USA

Abstract—This research paper proposes a curriculum for a five-year bachelor's degree in intelligent systems engineering and software engineering with courses in knowledge-based systems, fuzzy logic, neural networks, evolutionary computation, machine learning, image processing, computer vision, pattern recognition, data science, control systems, intelligent control systems, robotics, digital signal processing, software development, calculus, algebra, other mathematics, physics, biology, etc. This degree will allow graduates to have a good understanding of all of the main branches of intelligent systems engineering and software engineering as well as other relevant subjects in electrical and computer engineering.

M-Learning Excellence: Personalized Mobile Learning for University Students via an Android App

Shutchapol Chopvitayakun, Danucha Khamsakdee, Nuntaporn Aukkanit
Saun Sunandha Rajabhat University, Bangkok, Thailand

Abstract - Technology is having an increasingly profound impact on education, with mobile applications playing a leading role in this transformation. These applications can help to bridge gaps in accessibility, offer new and innovative learning approaches, and optimize time management. This research explores the many benefits of mobile applications for both students and educators, focusing on their role in personalizing learning experiences, enhancing engagement, and revolutionizing higher education through the principles of mobile learning (m-learning). While m-learning has the potential to make education more flexible and accessible, its successful implementation requires motivated learners, user-friendly systems, and integration with existing educational structures. This study investigates the potential of m-learning to create a dynamic, equitable, and effective educational landscape.

Analysis for Information Security in Virtual Environments for a Higher Education Institution

Carmita Ines Huerta Suarez, Segundo Moises Toapanta Toapanta, Eriannys Zharayth Gomez Diaz, Angel Ernesto Huerta Velez, Carmen Ines Suarez, Marcelo Zambrano Vizuete
Research Department, Instituto Tecnologico Superior Ruminahui, Sangolqui, Ecuador;
Education Department, Instituto Tecnologico Superior Ruminahui, Sangolqui, Ecuador

Abstract - Problems in information security for access in virtual environments are persistent, for the use of technological resources available online; One of the causes is inadequate means of communication, IT infrastructures without meeting any TIER, physical security does not meet national and international standards, among others. The objective of this research is to identify solutions in virtual learning environments for Higher Education Institutions. The deductive method and exploratory research were used to analyze the information. It turned out basic elements for security in virtual learning environments, Impact of the Solutions of virtual learning environments and Advantages of the situation of virtual environments. It was concluded that, to mitigate the risks, vulnerability threats for the use of virtual environments, it is necessary in a first phase to identify the basic elements for security in virtual learning environments, Impact of the Solutions of virtual learning environments and Advantages of the situation of virtual environments as an alternative to mitigate the risks, threats and vulnerabilities in virtual learning environments for a higher education institution.

Embracing ChatGPT in the Teaching and Learning of Finite Element Analysis in Engineering Courses

Qiang Xu, Joan Lu
School of Computing and Engineering, University of Huddersfield, Huddersfield, UK

Abstract - This paper is to discuss a recent emerging research area in AI related application in the domain of engineering education. The background study demonstrates the importance and significance of the research to be conducted. The research questions are proposed. Methods and expected outcome are discussed. Finally, the paper is ended with the possible benefits and impact on the application domain in near future.

Understanding Teamwork in Dynamic Contexts: A Study in a Software Engineering Project Course

Sergio F. Ochoa, Maira Marques Samary, Luis Silvestre, Roc Messeguer
Computer Science Department, University of Chile, Santiago, Chile;
Computer Science Department, Boston College, Chestnut Hill, Massachusetts, USA;
Computer Science Department, University of Talca, Curico, Chile; Department of Computer Architecture, Universitat Politecnica de Catalunya, Barcelona, Spain

Abstract - More complex, diverse and innovative is the new norm in software products. To handle that, teams need to be heterogeneous and capable of performing teamwork. This challenge to higher education that needs to understand what factors motivate or demotivate team-members. This article explores willingness and motivation of students to perform teamwork in a dynamic context scenario. After analyzing the team behavior in 60 real-world software projects, conducted in a software engineering course, we identified the factors that influence teamwork in such a dynamic context. These factors were used to create a model that can be reused by other instructors.