



ICTer 2023

Book of Abstracts



23rd ICTer International Conference

8th & 9th November
Colombo, Sri Lanka
<https://www.icter.lk>



23RD ICTer INTERNATIONAL CONFERENCE (ICTer) - 2023

BOOK OF ABSTRACTS

08th and 09th of November 2023

UNIVERSITY OF COLOMBO SCHOOL OF COMPUTING,
Colombo, Sri Lanka.

<https://icter.lk/conference/>



ISSN: 3021-6796

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Abstracts of 23rd ICTer International Conference (ICTer 2023)

Conference Website: <https://icter.lk/conference/>

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ISSN: 3021-6796

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MESSAGE FROM THE DIRECTOR

As the Director of the University of Colombo School of Computing (UCSC), it is my great pleasure to extend a warm welcome to all participants, researchers, and practitioners in the field of Computing at the ICTer International Conference 2023.

The ICTer International Conference is a legacy that stems from the renowned International Information Technology Conference (IITC), which has been a pivotal event in the landscape of Computing conferences in Sri Lanka since its inception in 1998. Building upon this rich history, ICTer now emerges as its successor, reaffirming our commitment to fostering innovation, sharing knowledge, and pushing the boundaries of technology.



In a world where the pace of technological advancement is relentless, it is vital that we create a platform for the exchange of ideas, insights, and research findings. ICTer aims to be precisely that platform. It is a unique opportunity for both seasoned researchers and emerging scholars to present their groundbreaking research results, innovative ideas, and practical deployments that are shaping the computing domains.

One of the distinguishing features of ICTer is the opportunity it offers for high-quality papers to be considered for publication in the esteemed Journals of the National Science Foundation (JNSF) and ICTer journal. This opens up a pathway for authors to share their work with a broader audience and contribute to the body of knowledge that is driving the technological landscape forward.

As we gather for the ICTer International Conference, I encourage all participants to take full advantage of this unique opportunity. Engage in the presentations, contribute to discussions, network with your peers, and foster new collaborations.

In conclusion, I look forward to witnessing the stimulating discussions, the knowledge sharing, and the collaborative spirit that will define the ICTer International Conference. Together, let us shape the future of technology and contribute to a world that is smarter, more connected, and better informed.

Dr. Ajantha Atukorale

Director, University of Colombo School of Computing.

MESSAGE FROM THE CONFERENCE CO-CHAIRS

ICTer conference, managed and hosted by the University of Colombo, has a history of 24 years. It is the successor of the International Information Technology Conference (IITC) started in 1998. In 2007, IITC was rebranded as the International Conference on Advances in ICT for emerging regions (ICTer).



This year's conference features seven keynotes, and four tech talks from the industry in addition to presentations of research papers. Starting this year all papers selected to be presented at ICTer will be published in either a special issue of the Journal of the National Science Foundation or the ICTer Journal. Therefore, all submissions have been subjected to a rigorous review process by an international review panel.

ICTer 2023 is not just an academic conference. In the computing domain, industry is also in the forefront of innovation and research. ICTer recognizes industry innovations and provided space within the conference venue, Innovation Studio, for the industry partners to showcase their technology and innovations.

We hope that the blend of participants from the industry and academia at ICTer 2023 sparks innovations.

***Dr. Chamath Keppitiyagama & Dr. Damith Sandaruwan
Conference Co-Chairs, ICTer 2023.***

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KEYNOTE SPEAKERS

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When Machines Go Rogue: The Risks and Rewards of AI Hallucination

Dr. Ruvan Weerasinghe

Senior Lecturer,

University of Colombo School of Computing, Sri Lanka.

➤ KEYNOTE 2

Fairness in Artificial Intelligence

Prof. Timothy Baldwin

Department Chair of Natural Language Processing,

Mohamed bin Zayed University of Artificial Intelligence.

➤ KEYNOTE 3

LibreOffice Technology, a FOSS platform for personal productivity

Prof. Italo Vignoli

LibreOffice Marketing & PR.

➤ KEYNOTE 4

Lessons from twenty years of working with (administrative) Big Data

Prof. Peter Christen

School of Computing, Australian National University.

➤ KEYNOTE 5

All Your Language Are Belong to Us: Implications and Effects of Large Language Models for Cybersecurity

Mr. Mike Willburn
MITRE Corporation.

➤ KEYNOTE 6

Infrastructuring Participatory Citizenship

Prof. Patrick Olivier
Director of Action Lab,
Faculty of Information Technology, Monash University.

➤ KEYNOTE 7

Towards In-Body, Battery-Free Internet of Things

Prof. Thiemo Voigt
Professor of Computer Science,
Department of Electrical Engineering, Uppsala University.

CONFERENCE DAY 1 - AGENDA Wednesday, 8th November 2023 (Location: Vidya Jyothi Professor V. K. Samaranayake Auditorium, UCSC)	
07.30 AM	Registration
08.00 AM	Inauguration and Introduction of ICTer 2023
08.30 AM	Welcome address by the Conference Chair
08.35 AM	Address by the UCSC Director
08.40 AM	Address by the Vice Chancellor
08.50 AM	Address by the Chief Guest
09.00 AM	Keynote - Dr. Ruvan Weerasinghe (UCSC) When Machines Go Rogue: The Risks and Rewards of AI Hallucination
10.00 AM	Tea Break
10.30 AM	Tech Talk (Cambio Software Engineering) (Cambio: Where Innovation Meets Collaboration)
10.50 AM	Paper Presentations (Session 01)
11.50 AM	Tech Talk (Altria Consulting & WIA Systems Inc) (Cloud ERP: The Benefits and Challenges of Adopting Cloud-Based Solutions)
12.10 PM	Keynote - Prof. Timothy Baldwin (Mohamed bin Zayed University of Artificial Intelligence) Fairness in Artificial Intelligence
01.10 PM	Lunch Break
02.10 PM	Tech Talk (Softlogic Information Technologies (Pvt) Ltd & Dell Technologies) (The dynamics of today's IT)
02.30 PM	Paper Presentations (Session 02)
03.35 PM	Keynote - Italo Vignoli (Associazione LibreItalia) LibreOffice Technology, a FOSS platform for personal productivity
04.35 PM	Tea Break and Reception

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07.30 AM	Registration
08.00 AM	Commencement
08.10 AM	Paper Presentations (Session 03)
08.50 AM	Keynote - Prof. Peter Christen (Australian National University) Lessons from twenty years of working with (administrative) Big Data
09.50 AM	Tech Talk (London Stock Exchange Group) (Beyond general purpose computing)
10.10 AM	Tea Break
10.40 AM	Keynote - Mike Willburn (MITRE Corporation) All Your Language Are Belong to Us: Implications and Effects of Large Language Models for Cybersecurity
11.40 AM	Paper Presentations (Session 04)
12.20 PM	Keynote - Prof. Patrick Olivier (Monash University) Infrastructuring Participatory Citizenship
01.20 PM	Lunch
02.20 PM	Keynote - Prof. Thiemo Voigt (Uppsala University) Towards In-Body, Battery-Free Internet of Things
03.20 PM	Tea Break
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KEYNOTE SPEAKERS

When Machines Go Rogue: The Risks and Rewards of AI Hallucination

Dr. Ruvan Weerasinghe

Senior Lecturer,

University of Colombo School of Computing, Sri Lanka.



In an age where artificial intelligence is rapidly advancing, it's imperative to explore the intriguing yet complex phenomenon of AI hallucination. This talk will delve into the remarkable capabilities of Generative AI and their ability to generate creative content, be it in art, literature, or even scientific research. These AI hallucinations blur the line between human and machine creativity. The talk will navigate the uncharted territories of the risks associated with AI hallucination. We'll consider instances where AI-generated content challenges our perceptions of reality, from deepfake videos to the spread of misinformation. As technology pushes the boundaries of what AI can create, we are confronted with ethical dilemmas and the need for responsible AI use.

Yet, amidst these risks lie extraordinary opportunities. AI hallucination has the potential to revolutionize industries, elevate human creativity, and spark innovation. It promises to be a powerful tool in the hands of artists, scientists, and creators, unlocking novel possibilities that enhance our lives. The talk expects to inspire a thought-provoking dialogue on the delicate balance between the rewards and risks of AI hallucination. As IT professionals, academics, and researchers, we have a pivotal role in shaping the future of AI. It is a future where machines can go rogue, but it's our wisdom, ethics, and innovation that will determine whether this journey takes us to the heights of human potential or the depths of uncertainty.

Fairness in Artificial Intelligence

Prof. Timothy Baldwin

*Department Chair of Natural Language Processing,
Mohamed bin Zayed University of Artificial Intelligence, United Arab Emirates.*



Artificial intelligence (AI) has made truly impressive progress in recent years and is being deployed in an ever-increasing range of user-facing settings. Accompanied by this progress has been a growing realization of: (a) inequities in the performance of naively trained NLP models for users of different demographics, with minorities typically experiencing lower performance levels; and (b) the potential risks associated with large language models, in terms of the harms that outputs can cause. In this talk, I will illustrate the nature and magnitude of the problem and outline a number of approaches that can be used to train fairer and safer AI based on different data settings, without sacrificing overall performance levels.

LibreOffice Technology, a FOSS platform for personal productivity

Prof. Italo Vignoli

LibreOffice Marketing & PR.



LibreOffice was announced in 2010 to relaunch innovation of the already stagnant OpenOffice project. Since 2011, LibreOffice has evolved from a single desktop product to a technology platform supporting applications for the desktop, the cloud and mobile. All products share the same engine, which provides superior consistency.

This has been achieved in stages, following the evolution of the office suite market. First, it has been necessary to pay the technical debt inherited from OpenOffice. Then, source code has been refactored, with the introduction of new technologies to replace legacy ones. Third, the user interface has been modernized and made more flexible, with options for users migrating from proprietary software.

Today, the LibreOffice Technology platform is based on the same software engine for all modules, based on a clean and refactored source code, with a focus on code quality and consistency, and supported by easy and extensive APIs.

LibreOffice consistency represents a strong advantage over the "siloe" approach of all other office suites, where there is a different software engine for each application and each platform. The result is a lack of consistency for files, which are also different by platform.

LibreOffice Technology is the best opensource platform for personal productivity, and is tightly integrated on desktop, mobile and cloud.

Lessons from twenty years of working with (administrative) Big Data

Prof. Peter Christen

School of Computing, Australian National University.



The last twenty years have seen a massive increase in the collection of data about people by businesses and governments. Such databases are mostly collected for administrative purposes, for example to manage the patients in a hospital. The wealth of knowledge that can be gained from analysing such administrative databases and the resulting value to organisations has led to the widespread use of data science technologies across both the private and public sectors.

However, administrative databases can also be used for research that is aimed at improving the social good, and to facilitate population studies across numerous domains. Known as Population Data Science, the use of administrative databases has various challenges that need to be considered. These include data quality and the human and social nature of how personal data are being collected, processed, and potentially integrated, as well as privacy aspects that need to be considered when working with databases that contain (possibly sensitive) personal information.

In this talk I will first provide an overview of what administrative data are, and give examples of how such data can be used for research to improve the social good. Then I will highlight some misconceptions that are commonly made when administrative data are used for analysis or research. I will also touch upon the challenges of accessing real administrative databases, and conclude with a set of lessons learnt and recommendations for anybody who is working with administrative Big Data.

All Your Language Are Belong to Us: Implications and Effects of Large Language Models for Cybersecurity

Mr. Mike Willburn

MITRE Corporation.



The emergence of large language models (LLMs) like ChatGPT has been the focus of much news since late 2022. The ease of use of the platforms has made these powerful tools available to most people on the planet. LLMs have since been used to generate college papers, write screenplays, create very convincing chatbots, and write computer code. Generating these artifacts is relatively simple, requiring the user to “prompt” the LLM by simply asking a question. These activities have implications for privacy and cybersecurity that span a wide range of topics. The focus of this presentation is the use of LLMs for software development and what that means to the future of cybersecurity. LLMs have been shown to be good at writing nearly error free code. Though they have been used for writing larger programs, most of the code has been relatively few lines, hereafter called a “snippet”, that perform specific functions. However, the level of technical knowledge required to generate these snippets is also much lower than it has been to write code historically. We will present a game that we wrote using an LLM in C#, a language that the authors do not have extensive experience with. We demonstrate that relatively complex code can be written with little training in any programming language. For cybersecurity this lowers the barrier to entry for bad actors to write malware, develop social engineering campaigns, and conduct illegal activities. For defenders, this could be leveraged to write monitoring scripts, network defense programs, and augment staff that are stretched thin for time and expertise.

Infrastructuring Participatory Citizenship

Prof. Patrick Olivier

Director of Action Lab,

Faculty of Information Technology, Monash University.



In this presentation, I will outline “what” it means to “infrastructure participatory citizenship”, that is, new relational models of digitally enabled public services, and “how” to realise these models. Will start by unpicking the notion of the “user”, and what it means for technologists and designers to think in terms of “citizens” and design digital technologies with and for citizens that move away from traditional “transactional models” of government and third sector services to create more “relation” citizen- and community-oriented services. Rather than getting too conceptual, I’ll develop my arguments by reference to a trajectory of my group’s digital service designs (all fully deployed) in the area of digital health and community technologies, from Feed-Finder (a community-led breastfeeding advocacy service) and App Movement (a community commissioning platform for Apps) to Paroli (a telephony-based collaboration service for low-resource settings) and Limitless (a video-based global youth innovation program). I will also present my views on how best to engage in this area of research as a university. Unsurprisingly, it means doing things “differently”, a view that I hope will resonate with the Monash University Malaysia business and management research community. By “different” I mean different ways we can design digital services; different ways of engaging communities, NGOs, government and businesses in the design of those services; and, different ways of doing research as a researcher and research group.

Towards In-Body, Battery-Free Internet of Things

Prof. Thiemo Voigt

Professor of Computer Science,

Department of Electrical Engineering, Uppsala University.



In this talk, I present Fat-IBC, a novel approach for in-body communication that uses the human body's adipose (fat) tissue as a communication channel for radiofrequency-based communication. Situated between layers of skin and muscle that act as a wave guide, the fat tissue allows for energy-efficient communication inside the body. Fat-IBC enables multi-hop Internet of Things (IoT) networks inside the body that allow to transfer data from deeply embedded places in the body to a place where it is easy to couple signals in and out. The relatively high bandwidth Fat-IBC enables supports interesting applications such as bionic arms and exoskeletons without cables. I further present some recent work on backscatter communication. Backscatter communication enables a drastic reduction of energy consumption by outsourcing the energy-hungry task of generating the radio wave. This reduction of energy usage enables devices to run on harvested energy rather than on batteries. However, to ensure application progress also when there is no energy to harvest, state must be saved on non-volatile memory. I show how the combination of these two approaches enables a high data yield for sensing applications even when energy and a carrier wave are not always present. We believe that these technologies will also pave the way for battery-free IoT inside the body.

Taekwondo Poomsae Movements Evaluation Using Skeleton Points

W.M.U. Fernando¹, K.D. Sandaruwan¹, A.M.K.B. Athapaththu¹

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Abstract— Taekwondo is a widely practiced martial art and an Olympic sport. In Taekwondo, Poomsae movements are essential, as they form the foundation of the sport and are fundamental for success in competitions. The evaluation of Poomsae movements in Taekwondo has been a subjective process, relying heavily on human judgment. This study addresses the above issue by developing a systematic approach to evaluate Poomsae movements using computer vision. An LSTM-based ML model was developed and evaluated for its effectiveness in Poomsae movement evaluation. The study also aimed to develop this model as a self-evaluation method, that enables Taekwondo players to enhance their skills at their own pace. For this study, a dataset was created specially by recording Poomsae movements of University of Colombo (UOC) Taekwondo players. The technical infrastructure used to capture Skeleton joint data was cost-effective and easily replicable in other settings. Small video clips containing Taekwondo movements were recorded using a Mobile Camera and the skeleton joint data was extracted using the MediaPipe Python library. The model was able to achieve 61% of accuracy when compared with the domain experts' results. Overall, the study successfully achieved its objectives of defining a self-paced approach to evaluate Poomsae and remove human subjectivity in the evaluation process. The feedback of domain experts' was also considered to fine-tune the model for better performance.

Keywords— human action recognition, taekwondo, poomsae, computer vision, MediaPipe, machine learning, LSTM, deep neural networks, skeleton points, movements classifications

An Evaluation of Multipath TCP with Highly Asymmetric Subflows

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Abstract— Multipath TCP (MPTCP) is an extension of the Transmission Control Protocol (TCP) that allows the simultaneous use of multiple available network interfaces to transmit and receive data. MPTCP can improve the throughput, lower the latency, and provide higher resilience to network failures. MPTCP creates a number of network connections (subflows) between the destination and presents a single endpoint to the application. MPTCP schedulers multiplex data over subflows based on their end-to-end path metrics. In this study, we found that the presence of asymmetric links within an MPTCP connection can lead to suboptimal performance. We explored the architecture of the Linux implementation of MPTCP and identified the design choices that lead MPTCP to underperform in the presence of highly asymmetric links. To test the behaviour of MPTCP an emulation testbed was built using the Mininet emulator. We conducted comprehensive experiments in this controlled environment to analyze MPTCP behavior under asymmetric subflows in terms of bandwidth and latency. We designed a novel scheduling algorithm tailored to mitigate the impact of asymmetric subflows and implemented it in the Linux kernel. Building a scheduling algorithm for MPTCP in the Linux kernel is not a straightforward task. Several iterations of the algorithm had to be investigated in order to develop a practically deployable algorithm. The proposed algorithms were implemented in the Linux Kernel and were tested in the testbed. These algorithms were tested for their suitability to be used over highly asymmetric links under several test scenarios. Finally, we proposed the “Extended Dynamic Scheduler Algorithm” which observes the MPTCP connection and adjusts its subflows to limit the effect of asymmetric subflows in the MPTCP connection. The algorithm also has its own kickback policy where the throughput of the connection starts to improve when the asymmetry of the subflows decreases.

Keywords— Multipath TCP, Asymmetric Subflows

Skeletal Point Analysis to Determine the Accuracy of Forehand Smash Shots Played by Badminton Players

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Abstract—This study aims to address the scarcity of scientific research on badminton performance analysis, specifically the accuracy of forehand smash shots. The authors propose the use of a skeletal coordinates-based technology to analyze a badminton player's biomechanics. To achieve this, specific techniques such as formulating a quantitative description of badminton smash biomechanics based on the available literature, collecting video footage of badminton rallies and processing them using a MediaPipe-powered Python program, were followed. Three main approaches were considered for the analysis, defining a dynamic mathematical model, creating a player-to-player comparison model and developing a machine-learning model. Preliminary results suggest that the use of three-dimensional points in comparison to two-dimensional points provides more accuracy in detecting the angle between three skeletal points from any camera perspective. This research also proposes a novel approach to compare two players and evaluate their skills based on a set of key parameters. The study explores the integration of machine learning algorithms to classify and predict player performance accurately. All three proposed methods enable coaches and players to identify and improve upon their weaknesses, enhancing their overall performance as these findings has the potential to reduce subjectivity in measuring shot accuracy during training and to provide players with a more objective means of evaluating their performance. The proposed methodology and results contribute to a better understanding of badminton biomechanics and have implications for future research in this field.

Keywords— Biomechanical and Shot Analysis, Badminton Forehand Smash, Mathematical Model, Machine Learning, MediaPipe

TAMIL: Shorthand Romanized Tamil to Tamil Reverse Transliteration Using Novel Hybrid Approach

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Abstract— Transliteration from Tamil to the Roman script holds a crucial place in the realms of effective communication, educational accessibility, and the seamless integration of digital technology. However, this process encounters a significant challenge due to the disparity in the number of vowels between the Tamil script, which encompasses a rich set of 12 vowels, and the Roman script, which is limited to just 5. This incongruity poses a substantial impediment when attempting ad-hoc transliteration of Tamil into the Roman script, especially when vowels are omitted. This paper aims to make a significant academic contribution by conducting an extensive literature review of recent developments in Romanized Tamil to Tamil transliteration, with a particular focus on addressing the absence of vowels. The review involves a meticulous examination of a wide array of methodologies proposed in recent years, ranging from rule-based systems to context-based strategies and machine learning-based approaches. In response to the challenges inherent in Tamil to Roman transliteration, this research work introduces a novel and innovative solution. This solution incorporates a Reverse Transliteration module, which leverages N-gram analysis and a rule-based model. The utilization of a trained trie structure is a key component of this approach, enabling word suggestions that effectively resolve ambiguities during the transliteration process. Remarkably, the proposed solution outperforms existing character-level transliteration methods, achieving an impressive character-level accuracy rate of 0.93. The practical implications of this research are substantial, particularly concerning the fulfilment of the linguistic and transliteration needs of native Tamil speakers within the digital platform, where such accuracy is of utmost importance.

Keywords— Hybrid Recommendation, N-gram, Rule-based, Suggestion, Transliteration

Multi-Hop Question Answering over Knowledge Graphs

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Abstract— Multi-Hop Question Answering over Knowledge Graphs (MHQA-KG) plays a pivotal role in various applications, including but not limited to Question Answering, Recommendation Systems, and Semantic Search. Nevertheless, current models for MHQA have limitations in their ability to grasp all the information included in the question, resulting a reduction in accuracy when producing answers. In order to mitigate this limitation, this paper proposes a novel Multi-Hop Question Answering over Knowledge Graphs approach. It mainly utilizes question and path embedding to answer multi-hop questions, significantly improving accuracy. This approach effectively captures auxiliary information that may present in the question. The experimental findings provide evidence that the suggested methodology outperforms the current state-of-the-art models, achieving highly accurate outcomes with improvements.

Keywords— Question Answering, Knowledge Graphs, Multi-Hop, Embedding, Sentence Embedding

Comparing the Performance of Machine Learning Algorithms for Emotion Classification on Tweets

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Abstract— The rapid increase in the availability of textual content due to Industry Revolution 4.0 has made sentiment analysis an important area of machine learning research. This study aims to develop a mechanism to identify the hidden emotions in textual content, beyond the three basic sentiments of positive, neutral, and negative. Several machine learning approaches to emotion classification, including Naive Bayes classifiers, Support Vector Machines, Regression, Decision Trees, and Random Forests have been explored. The experiments show that simple linear models can achieve high accuracy (up to 90.5%), suggesting that complex algorithms are not always necessary for effective emotion classification. The performance of the models was evaluated using a variety of metrics, including accuracy, weighted F1-score, and efficiency. The findings suggest that machine learning approaches can be used to effectively identify emotions in textual content, even with simple models. This has potential applications in a variety of domains, such as social media analysis, customer service, and healthcare.

Keywords— emotion detection, sentiment analysis, machine learning, supervised learning, text classification

Detecting the Severity of Depression in Online Forum Data by Leveraging Implicit Semantic Inferences

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Abstract— Depression, a prevalent mental health disorder with global implications, exerts a profound negative influence on individuals' lives. While the prediction of depression (as a binary classification task) is a well-established research area, depression severity detection is a new research direction withpp limited studies. In the context of detecting the severity of depression through online forum data, this research endeavors to offer two distinct solutions by employing Ada embeddings, GPT 3.5 Turbo, and LIWC as feature engineering techniques, while AutoSklearn serves as the ensemble learning algorithm. Notably, the outcomes of this study significantly outperform existing state-of-the-art models on both depression severity annotated datasets used in this research. The results also showcase the potential reuse nature of the proposed models in diverse data sources due to their high performance in both datasets. Furthermore, as a valuable practical outcome, a software prototype has been developed, capable of providing the depression severity level, along with associated symptoms and keywords, upon inputting an online forum post.

Keywords— Depression, Language Models, Natural Language Processing, Machine Learning, Deep Learning

Applicability of End-to-End Deep Neural Architecture to Sinhala Speech Recognition

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Abstract— This research presents a study on the application of end-to-end deep learning models for Automatic Speech Recognition in the Sinhala language, which is characterized by its high inflection and limited resources. We explore two e2e architectures, namely the e2e Lattice-Free Maximum Mutual Information model and the Recurrent Neural Network model, using a restricted dataset. Statistical models with 40 hours of training data are established as baselines for evaluation. Our pretrained end-to-end Automatic Speech Recognition models achieved a Word Error Rate of 23.38% by far the best word-error-rate achieved for low resourced Sinhala Language. Our models demonstrate greater contextual independence and faster processing, making them more suitable for general-purpose speech-to-text translation in Sinhala.

Keywords— Speech Recognition, Deep Learning, Transfer learning

Emotion-Based Movie Recommendation System

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Abstract— This study presents a novel approach for a movie recommendation system that uses the emotions of a user to recommend movies. To detect user emotions, the system uses both facial expressions and text analysis. To detect facial expressions, several types of pre-trained models were re-trained and evaluated using benchmark datasets (FER2013). The ResNet50 model which has the highest accuracy of 73% was selected as the final model. For text analysis, several classical machine learning models (SVM, RF, MNB) and deep learning models (LSTM, Bi-LSTM, BERT, BERT+CNN) were trained and evaluated for their effectiveness in classifying emotions (using ISEAR). The BERT+CNN model with an accuracy of 78% was ultimately chosen for its high accuracy and efficiency in handling textual data. Final emotion derived by applying soft voting ensemble technique to the results of facial expression model and the text analysis model. For making the recommendations, the study incorporated content-based and collaborative filtering techniques to recommend movies based on the users' emotional state. Both methods were combined and adjusted based on the user's emotional state, resulting in more personalized movie recommendations. To assess the efficiency of the proposed system, feedback was collected from ten users and analyzed. The final system received positive feedback from seven of the ten users. This indicated that the proposed system has the potential to enhance user experience by providing more personalized and relevant movie recommendations based on their emotional state.

Keywords— Machine Learning, Deep Learning, Image processing, NLP, Recommendation systems

Enhancing Social Media Content Analysis with Advanced Topic Modeling Techniques: A Comparative Study

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Abstract— Topic modeling, a pivotal unsupervised machine learning approach, serves as a valuable tool for uncovering latent themes within vast document repositories. It aids in the organization, comprehension, and simplification of extensive textual data while revealing distinctive underlying themes across a corpus of documents. The intrinsic characteristics of social media content, marked by brevity, text-heavy nature, and a lack of structure, often pose methodological challenges in data collection and analysis. In an effort to bridge the realms of computer science and empirical social sciences, this research aims to assess the effectiveness of three distinct topic modeling methodologies: Bidirectional Encoder Representations from Transformers (BERTopic), Non-negative Matrix Factorization (NMF), and Latent Dirichlet Allocation (LDA). While NMF relies on a matrix factorization paradigm and LDA employs a probabilistic framework, BERT-based techniques, which utilize sentence embeddings for topic generation, represent a contemporary innovation. In this study, BERTopic is evaluated with multiple pre-trained sentence embeddings, and the outcomes are rigorously compared with those derived from LDA and NMF methodologies. The study leverages C_V and U_MASS, two vital coherence measures, to evaluate the efficacy of these topic modeling strategies. The research delves into the analysis of various algorithms, elucidating their strengths and limitations within the context of social sciences, using YouTube comments as a benchmark dataset. Notably, this investigation sheds light on the utility of BERTopic and NMF for evaluating YouTube video content disclosure based on specific attributes, thereby enhancing the analysis process, and addressing performance concerns.

Keywords— Topic Modeling, Social media analysis, BERTopic, Comparative Study

Reinventing Real Estate: Exploring the Dynamic Landscape of Prop-Tech driven Digital Transformation in the Residential Sector – Lessons for Sri Lanka

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Abstract— This article presents a comprehensive narrative review of published articles focusing on the digital transformation of the residential real estate sector driven by PropTech (Property Technology). The study aims to provide insights into the current state of digitalisation within residential real estate, examining the technological advancements and their impact on various aspects of the market. The review employed a narrative review approach, analysing scholarly articles, industry reports, and reputable online sources that explore the intersection of real estate and technology. The findings highlight the revolutionary effect of PropTech on the residential real estate sector, fundamentally changing traditional practices and enhancing operational efficiency. The study identifies key areas where PropTech has made significant strides in the residential real estate sector. These advancements have reshaped the market dynamics, fostering transparency, reducing energy consumption, and increasing access to information for all stakeholders. In conclusion, this narrative review underscores the transformative impact of PropTech on residential real estate, shedding light on its potential to reshape industry practices and improve overall efficiency. The findings provide valuable insights for researchers, practitioners, policymakers, and industry players seeking to understand and leverage technology in residential real estate.

Keywords— Prop-Tech, Smart Residential Sector, Smart building technology, Internet of Things

Enhancing Neural Machine Translation for the Sinhala-Tamil language pair with limited resources

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Abstract— Neural Machine Translation has emerged as a promising approach for language translation. Transformer-based deep learning architectures have also significantly enhanced translation performance across various language pairs. However, several language pairs with limited resources face challenges in adopting Neural Machine Translation because of their data requirements. This study investigates methods for expanding the parallel corpus to enhance translation quality. We establish a series of effective guidelines for enhancing Tamil-to-Sinhala machine translation based on cutting-edge Neural Machine Translation techniques like fine-tuning hyperparameters and data augmentation through both forward and backward translation. We validate our methods empirically using standard evaluation metrics. Based on our conducted experiments, we observed that Neural Machine Translation models trained on larger sets of back-translated data outperform other methods of synthetic data generation in Transformer-based training settings. We investigated if we could effectively use the Transformer architecture in the limited-resource context of translating Tamil to Sinhala. Our research demonstrated that Transformer models can surpass the top Statistical Machine Translation models, even in language pairs with limited resources. We achieved an improvement of 3.43 BLEU points in translation quality compared to the statistical translation models.

Keywords— Neural Machine Translation, Low Resourced Languages, Back translation, Hyper-parameters, Sinhala, Tamil

POSTERS

A Context-Aware Clothing Design & Recommendation System Using a Deep Generative Model for Young Females

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Abstract— The fashion industry is currently experiencing a significant transformation, driven by rapid advancements in technology, particularly in the fields of artificial intelligence (AI) and machine learning (ML). This evolution is fueled by a growing population segment, namely young females, who are deeply engaged in fashion trends and seek personalized clothing recommendations that not only reflect their age but also their unique personal preferences, local climate conditions, and individual styles. However, traditional recommendation systems often fall short in catering to the distinct needs of the mentioned demographic. In order to address this problem, authors propose an innovative context-aware clothing recommendation system designed for young females. Central to this system is the utilization of a Conditional Generative Adversarial Network (GAN) model, a neural network that enables the generation of custom clothing designs tailored to the preferences and requirements of each user. By considering the skin tone, weather condition, type of occasion, and body type, the proposed model is capable of generating a unique clothing design customized to the user. The system consists of a skin tone segmentation model that captures the skin tone group of the specific user from an image uploaded by the user. In addition to skin tone, our system requires users to provide the date and geographical location of the event for which they desire an outfit recommendation. Using this information, the system interfaces with a weather data API to determine the relevant weather category, ensuring that the recommended outfit is suitable for the prevailing climate. With the generated final outfit, the system also browses selected clothing e-commerce sites to recommend outfits similar to the one generated. The proposed model supports consumers of the fashion industry to make informed fashion choices and supports clothing designers to produce unique designs. Our study presents a proof-of-concept prototype that is being developed and evaluated using clothing data meticulously labeled by fashion designers. The research aims to bridge the gap between the fashion industry and the distinctive fashion requirements of the selected demographic, ultimately providing them with a more personalized clothing recommendation system.

Keywords— Context-aware, Conditional Generative Adversarial Network, Skin Tone Segmentation, API

AgrOM: A Hybrid Model for Plant Disease Detection through Ontology and Machine Learning

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Abstract— The effective and accurate prediction of plant diseases plays a crucial role in assisting farmers in the agriculture domain to make informed decisions to optimize their cultivation practices. Monitoring the plant diseases during the production life cycle is essential as it significantly affects the crop yield, leading to food security in a country. Distinguishing plant diseases accurately on time is required to provide correct control measures and improve plant health for effective disease management. The existing research heavily relies on visible leaf symptoms. However, diseases also show various ‘extra symptoms’ such as non-leaf symptoms (on other parts of the plant) and non-capturable symptoms such as odor symptoms. Hence, the main objective of the research is ‘How to effectively detect plant diseases integrating Machine Learning and Ontology through incorporating the extra symptoms.’ The study is conducted by following the constructive research methodology. It includes systematically identifying all possible parameters that impact plant disease detection, modeling the ontology, and building a system of multiple machine-learning models to address the relevant problem. Ontology, a knowledge framework, is being designed and developed to integrate domain-specific plant disease knowledge to enhance the accuracy of disease prediction. Currently, a suitable representative structure is being constructed. Machine Learning techniques are being explored to develop an appropriate predictive model that can be systematically integrated with the modeled ontology for efficient plant disease prediction. The tomato plant is selected for the proposed research, and a combined dataset from PlantVillage, PlantDoc, and Taiwan Tomato datasets is used to train the predictive model. YOLO NAS model is used for live disease detection, while YOLOv8 is used to create a segmentation mask as a background filtering technique. Deep learning models are trained with different architectures and transfer learning for accurate disease prediction on other base models such as ImageNet, MobileNet, and VGG16. A mixed approach that uses qualitative and quantitative measures, with domain experts evaluating and validating the accuracy of Ontology, will be used to evaluate the proposed model. The outcome of the proposed research is to contribute to the agricultural domain by advancing plant disease detection methods, improving the ability for early disease diagnosis, and improving disease management practices for better decision-making.

Keywords— Plant Disease Detection, Deep Learning, Ontology, Non-Leaf symptoms

Comparative Analysis of Extensible Approaches for Document Layout Segmentation

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Abstract— In document analysis and understanding, document layout segmentation is an important task to extract the text from document images. As the demand increases for efficient methods to process and analyse complex document layouts, this study was conducted by comparing and analysing several object detection models which can be used for the segmentation task and extensible approaches for document layout segmentation. Currently, document layout segmentation models perform well for specific document types used to train the model; however, when the models are further extended to the new document types, they perform poorly. Hence, it needs an extensible generalised approach. The study mainly focused on evaluating the performance of object detection models MaskRCNN, FastRCNN, and FasterRCNN, in addition to evaluating extensible approaches: Transfer learning, Ensemble learning, and Continual learning such that it could incorporate new document types with minimal retraining and process unseen document types.

Using a quasi-experimental research design, this study examines the efficiency of various document layout segmentation approaches. Experiments were conducted on four selected document types: newspapers, research papers, forms and invoices comparing the mean average precision as the base metric where Mask RCNN outperformed Faster RCNN and Fast RCNN with mAP at 57.6% while other models having a mAP at 51.9% and 50.8% respectively. Hence, Mask RCNN was considered the object detection model for evaluating the extensibility.

Comparing extensible approaches, it was noticed that ensemble learning has outperformed the other approaches by a remarkable margin. In contrast, continual learning, a promising but challenging approach, encounters difficulties with limited or unbalanced datasets. On the other hand, transfer learning requires more improvements for the extensibility of document layout segmentation. The study highlights the need for extensible approaches in document layout segmentation and investigates an unexplored research area in continual learning in document segmentation. The findings contribute to further research to improve various disciplines, including document analysis, text extraction, reading order detection and similar tasks.

Keywords— Document Layout Segmentation, Object Detection, Extensible Approaches, Ensemble Learning, Transfer Learning, Continual Learning

Enhance User Experience in Web Based AR with Dynamic Content

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Abstract— Augmented Reality (AR) applications have revolutionized the way we interact with the physical world by using digital content. A number of factors influence the interaction to be a near realistic experience to the human user such as elapsed loading time. However, with the enhanced features of AR technologies, increased number of applications and heterogeneous end users have forced AR applications to work on end user devices with minimal modification to their devices or environment, for example deploying AR by using only the web browser. Making the AR experience more realistic while having less control over the rendering endpoint is a challenging task. Content loading delays have been identified as a prominent factor affecting the realistic experience to the end user and keeping the user device focused on the physical space targeted to augment the digital content. In addressing the problem, we aim to elevate user experience of web-based Augmented Reality (AR) contexts focusing on reducing the content loading time when loading dynamic content on dynamic targets. A comprehensive review has been carried out to identify the different factors influencing the user experience in web-based AR applications on dynamic content and targets. Furthermore, we propose predictive models that can evaluate user experiences within web-based AR contexts. The models are drawn from a predefined set of factors, including content complexity, interactivity, and contextual relevance, empowering AR content developers to provide a more immersive user experience. Additionally, effective UI/UX strategies will be explored during the content-loading phase to maximize user engagement while minimizing distractions. Interactive UI/UX strategies are employed to ensure users remain engaged within the application while focusing the device on the target to enjoy a seamless and captivating AR experience.

Keywords— Augmented Reality, User Experience, Dynamic Content, Content Loading

Exploring the Efficacy of Gamification in Developing a Learning Platform for Students with Dyslexia in Sri Lanka.

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Abstract— Inclusive educational practices play a crucial role in creating an environment where students with dyslexia can thrive. This involves adopting inclusive teaching strategies and providing accommodations and assistive technologies. There's a significant need to create a public platform for Sri Lankan dyslexic students that combines reading support with motivating gamification elements. This research addresses a gap in accessible learning platforms for this specific group and aims to develop a prototype of a gamified reading platform tailored to their needs. The research methodology involves developing a working prototype of a gamified learning tool and evaluating its usability with dyslexic students who have elementary-level Sinhala reading skills. These participants engage in a realistic sample scenario that emulates actual system usage, encompassing tasks tailored for dyslexic students. The evaluation combines qualitative methods, including conducting interviews and collecting open-ended responses to explore their thoughts, challenges, and suggestions related to the usability of the system, and quantitative measures including task completion rates and error rates. The research has involved conducting a comprehensive literature review, engaging in consultations with specialist educators and medical professionals, identifying specific requirements, generating wireframes, and designing high-fidelity prototypes in accordance with dyslexic style guidelines, Human-Computer Interaction (HCI) principles, and gamification strategies. These prototypes undergo heuristic and usability evaluations as part of the ongoing research into accessible design and educational innovation. The use of gamification principles has potential to significantly enhance the learning process for dyslexic students. By applying these principles, we can create an interactive and immersive environment that encourages active participation, self-directed learning, and skill development.

Keywords— Dyslexia, Gamification, Human-Computer Interaction (HCI)

Improving Low-Level Isolation of Containers: Leveraging Microkernel Design

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Abstract— The container is a concept in virtualization that groups code and dependencies into a single isolated unit. It leverages the operating system's kernel features to manage and run processes within its isolated environment. While current implementations offer seamless integration and enhanced performance, they do come with inherent limitations. The design and architecture of the kernel serve as a critical factor in enhancing key container characteristics, such as isolation, owing to its dependency on kernel functionality. While it affects the level of isolation provided within a container, it also affects the isolation provided among containers. A deeper understanding of container implementations underscores the importance of shifting the primary focus from containers themselves to the underlying kernel and its inherent strengths. The majority of contemporary container engines are optimized for monolithic kernels, which, by definition, prioritize performance over isolation. In contrast, microkernels are designed to provide higher levels of isolation at the cost of performance. It is important to explore how the capabilities of microkernels and the requirements of containers could interact to collectively find a stronger position in terms of isolation. While the exploration for a highly isolated container solution on microkernels is captivating, it's a task that demands collaboration from a diverse and large group of individuals. This study primarily focuses on exploring improvements in file system isolation achieved through microkernel design. In monolithic implementations, a single host file system is perceived as distinct file systems by individual containers. Conversely, the microkernel approach, facilitated by the use of servers, enables each container to have its independent file system, distinct from the file systems of other containers and the host file system. Our chosen methodology currently employs GNU Hurd, a distribution based on the GNU Mach microkernel, as the underlying environment. Within this framework, ongoing efforts involve exploring technologies like Subhurd to establish a container environment and ongoing experimentation with various approaches, including the use of translators, to potentially enhance file system isolation when compared to Linux-based container implementations. A comprehensive evaluation of performance and isolation is also underway to identify the strengths and weaknesses of the proposed method.

Keywords— Microkernel, Containers, Isolation, GNU Hurd, Operating systems, File systems

Optimizing Black Tea Fermentation through Climatic Variations: A Deep Learning Approach

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Abstract— Ceylon Tea is renowned worldwide for its high quality, aroma, and taste and serves a significant role in the Sri Lankan economy as a primary agricultural export crop. It comes in different unique flavors due to various weather conditions and processing. Among these varieties, black tea is the only tea that goes through oxidization during processing, which is a crucial step contributing to the tea's flavor, color, aroma, and overall quality. It is the critical process that sets black tea apart from other types of tea and makes it a beloved beverage worldwide. The manufacturing process of black tea always deals with four primary stages: plucking and withering, rolling, fermentation, firing, and packing. Among these, the process and the time taken to fermentation play a significant role in deciding the quality of the Tea. The optimum time for fermentation depends on several factors, including the factory's unique climatic and processing conditions. In Sri Lanka, three kinds of Black tea are produced from each set of batches, named “Dhool 1, Dhool 2, Dhool 3,” according to their particle size, mapped to their quality: First, Second, and Third, respectively. Furthermore, the duration of fermentation is varied by the Dhool number of a given batch due to various sizes of tea particles with climatic changes and overall time spent on steps before fermentation. However, at present, the fermentation level is determined entirely through color observation using the naked eye, which is error-prone. Hence, the proposed study aims to investigate the potential of employing digital images of tea particles to track the fermentation process of black tea production under varying climatic conditions. The green copper color is used to measure the degree of fermentation over each climatic change; additionally, the humidity and temperature measures are added as main parameters along with RGB values with corresponding time intervals. The research includes three main phases: image pre-processing, Dhool classification, and predicting the optimum fermentation level over climatic changes. Image pre-processing techniques are applied to enhance the quality of the images, remove noise, and extract features. Different machine learning techniques, along with the green copper color metric, humidity, temperature data, and RGB values obtained at specific time intervals, have been employed to classify the Dhool and optimize the fermentation time. Through the proposed study, we aim to contribute valuable insights to the field of tea production and enhance the overall quality.

Keywords— Black Tea, Optimum Fermentation Time, Image processing, Dhool, Deep Learning

Performance analysis of Multipath TCP in user space using DPDK

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Abstract— Most network communication today relies on the Transmission Control Protocol (TCP) due to its reliability and connection-oriented nature. While TCP provides essential communication characteristics, it has certain limitations. One such limitation is its inability to effectively utilize multiple network interfaces within a device, a challenge known as the multi-homing problem. In the past, when devices had only one network interface, this limitation was not significant. However, in today's technological landscape, devices as small as smartphones support multiple network interfaces, such as Wi-Fi and LTE connectivity. To address this limitation, the Internet Engineering Task Force (IETF) has proposed the Multipath Transmission Control Protocol (MPTCP) as an extension of TCP. MPTCP's modified design is crucial for ensuring compatibility with the widely-used TCP, given the challenges of introducing a new protocol in the face of TCP's popularity. The most commonly used implementation of MPTCP involves a forked version of the Linux kernel, which integrates MPTCP with the existing TCP stack. However, technologies like the Data Plane Development Kit (DPDK) enable user space packet processing, bypassing the kernel's processing. User space packet processing avoids per-packet interrupts that require frequent user mode to kernel mode switching, reducing performance overhead. DPDK offers raw packet processing capabilities but poses a barrier to developing a user space MPTCP implementation since MPTCP relies on services provided by TCP. Several open-source projects have developed user-space TCP/IP stacks that operate on top of kernel bypass technologies like DPDK. This study aims to leverage such a stack and adapt it to support MPTCP. We anticipate that this modification will lead to performance improvements in MPTCP, akin to those observed in TCP.

Keywords— MPTCP, DPDK, Userspace, Linux Kernel

Real-Time Driving Assistance at Night for Sri Lankan Context

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Abstract— Nighttime driving poses significant challenges for drivers, including the detection of pedestrians and cyclists, identification of potholes in low-visibility situations. These factors have contributed to a series of road accidents. Currently, there is no automated system capable of handling these challenging situations in Sri Lanka. The proposed system utilizes AI and real-time video processing, combined with voice commands, to enhance driver safety. The enhancements include improving pedestrian and cyclist visibility, developing a reliable pothole detection system. Achieving these objectives relies on the extensive collection of data for training models. We gather datasets to train these models and develop specialized computer vision and machine learning models tailored for real-time, low-light scenarios. The application facilitates intuitive voice commands, providing real-time alerts and visual cues to reduce nighttime driving accidents. Through rigorous data collection, testing, and the development of the aforementioned solutions, nighttime driving safety in Sri Lanka is significantly enhanced by addressing current challenges.

Keywords— Nighttime driving, pedestrian detection, cyclist detection, pothole detection, real-time video processing, machine learning, driver safety, low-visibility scenarios.

Scheduling MPTCP Subflows on Highly Asymmetric Links

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Abstract— Multipath TCP (MPTCP) is an extension of the Transmission Control Protocol (TCP) that allows the simultaneous use of multiple available network interfaces to transmit and receive data. MPTCP can improve the throughput, lower the latency, and provide higher resilience to network failures. MPTCP creates a number of network connections (subflows) between the destination and presents a single endpoint to the application. MPTCP schedulers multiplex data over subflows based on their end-to-end path metrics. In this study, we found that the presence of asymmetric links within an MPTCP connection can lead to suboptimal performance. We explored the architecture of the Linux implementation of MPTCP and identified the design choices that lead MPTCP to underperform in the presence of highly asymmetric links. To test the behaviour of MPTCP an emulation testbed was built using the Mininet emulator. We conducted comprehensive experiments in this controlled environment to analyze MPTCP behavior under asymmetric subflows in terms of bandwidth and latency.

We designed a novel scheduling algorithm tailored to mitigate the impact of asymmetric subflows and implemented it in the Linux kernel. Building a scheduling algorithm for MPTCP in the Linux kernel is not a straightforward task. Several iterations of the algorithm had to be investigated in order to develop a practically deployable algorithm. The proposed algorithms were implemented in the Linux Kernel and were tested in the testbed. These algorithms were tested for their suitability to be used over highly asymmetric links under several test scenarios. Finally, we proposed the “Extended Dynamic Scheduler Algorithm” which observes the MPTCP connection and adjusts its subflows to limit the effect of asymmetric subflows in the MPTCP connection. The algorithm also has its own kickback policy where the throughput of the connection starts to improve when the asymmetry of the subflows decreases.

Keywords— Multipath TCP, Computer Networks, Operating Systems.

SeEar: Low-Cost Augmented Reality Glass for Deaf and Hard-of-Hearing Impaired

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Abstract— Hearing loss is a global challenge, especially pronounced in developing countries, posing challenges in daily life, from learning, social interactions to safety. Augmented Reality (AR) holds great promise for bridging the gap in access to spoken words and environmental sounds. However, designing effective, affordable, and localized speech recognition and visual interfaces remains a significant research challenge. This research-in-progress explores the design of optimized interfaces tailored to the needs of deaf and hard of hearing individuals. A key focus is affordability, realized through a low-cost AR glass prototype utilizing common smartphones and transparent headsets. While use of real-time caption systems have been studied in conversations, addressing the unique challenges faced by this community during the learning and social interactions remains unaddressed. Our study adopts the use of real-time captions and in-depth examination of novel text presentation methods, interactive text visualizations, keyword highlighting techniques and words per line optimizations specifically for the Sinhala language to enhance comprehension, readability, reading speed, and mitigate information overload. Furthermore, we extend the scope by leveraging AR to address challenges in accessing surrounding sound information. We designed a visual interface incorporating icons and text to convey sound characteristics, considering factors such as sound type classification, loudness, direction, and importance based on user feedback. The research adopts a participatory design approach, collaborating with Dr. Reijntjes School for the Deaf, Sri Lanka with over 100 deaf children. We gained valuable insights into user needs and usage scenarios through interviews, focus groups, and iterative design, resulting in an empirical understanding of their requirements. We used interactive prototyping to develop high-fidelity prototypes, which we test in the field to assess the impact on usability, reading comprehension, reading speed, and cognitive load. This research not only contributes to the field of accessibility and AR but also offers practical solutions to improve the lives of individuals with hearing impairments, particularly in regions where these challenges are more pronounced.

Keywords— augmented reality, accessibility, novel text presentations, keyword highlighting, interactive prototyping, sound characteristics

Telltale Twin: MPTCP Subflow as a Passive Probe on Other Subflows

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Abstract— Transmission Control Protocol (TCP) is the de facto standard connection-oriented transport layer protocol used on the Internet. TCP was designed in 1970's and it has evolved since then without any drastic changes. TCP connection is uniquely identified by a 4-tuple, <source IP, source port, destination IP, destination port>. This implicitly assumes a single network interface at the source and the destination. However, modern devices are also equipped with more than one network interface. However, due to the limitation in TCP, these multiple interfaces cannot be utilized at the same time. This is known as the multihomed problem of TCP. There are a number of solutions proposed for the multihomed problem of TCP. Multipath Transmission Control Protocol (MPTCP) is one of the solutions proposed by the Internet Engineering Task Force (IETF). MPTCP is backward compatible with traditional TCP. With the help of MPTCP applications can create a single TCP connection that is multiplexed over the available network interfaces. MPTCP scheduler multiplexes data over the available interfaces and these subflows are goin through different Internet Service Providers (ISPs).

MPTCP schedules subflows based on the end-to-end path characteristics of the paths through different network interfaces. Therefore, the characteristics of one subflow depend on its own path metrics as well as the metrics of the other paths. Each subflow is a telltale twin of the other subflows. When one subflow of the MPTCP connection goes through an ISP that ISP can potentially get information about the paths available through the other ISPs.

The research was conducted to validate the hypothesis that an ISP, or the man in the middle (MiM), can extract network-related information from unseen subflows by analyzing the visible subflow. To test this hypothesis, a number of experiments were conducted in a virtual network deployed in the Mininet network emulator under different network conditions. Packet traces were extracted from a point in between the endpoints of a subflow to simulate a MiM. Preliminary results show that the sequence numbers of the MPTCP data acknowledgments and the TCP acknowledgments of an observed subflow can be used to infer the link conditions of the unseen subflow.

Keywords— MPTCP, Man in the Middle, Network conditions

Utilizing Multi-sensory Cues to Enhance Art Gallery Experience: Focus on Entertainment for the Visually Impaired

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Abstract— Assistive technologies play a major role in bridging the accessibility gap in art and culture. Despite the constant advancements in these areas, a notable research gap can be seen in engaging visually impaired individuals to independently experience and interpret paintings through other sensory means, which prompted the authors to address this critical shortcoming. The research is aimed at conveying a painting to visually impaired individuals using multi-sensory stimuli (tactile, auditory, and somatosensory) to compensate for the loss of input from the sense of sight. An apparatus (named SEMA - Specially Enhanced Multisensory Art) is prepared with a painting on the inner walls that incorporates descriptive outputs of the aforementioned stimuli. Primarily, temperature control systems and directional speakers are used to achieve this end. Currently, the structure of the apparatus along with the temperature control system are completed and the technical evaluations of the apparatus are being conducted. To measure the usability and user experience of the system, two subject groups are taken into account; the treatment group consists of visually impaired individuals who experience SEMA at their own pace individually, and the control group consists of people with a sense of sight who observe the same painting without the additional sensory stimuli. The feedback collected from the questionnaire given to each individual is then subjected to a word vectorization process. The aim is to reduce the distance between the two groups' vector points in an iterative process of changing the inputs of SEMA. The research goal here is to enable visually impaired individuals to provide a description of the painting that closely mirrors the description provided by those with sight.

Keywords— Multisensory, HCI, Visually Impaired, Assistive Technology, Tactile, Auditory, Art, Painting



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