2024 Research Projects

School of Information Technology

DEAKIN UNIVERSITY

Deakin University CRICOS Provider Code: 00113B

Projects

Project Discipline: Applied IT/Emerging Technologies

Advancing Speech Privacy: Enhanced Speaker De-Identification Mechanisms

Supervisor: Dr Iynkaran Natgunanathan, iynkaran.natgunanathan@deakin.edu.au

Associate Supervisor: Assoc Prof Chandan Karmakar

Campus: Melbourne Burwood;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Applied IT/Emerging Technologies

Project Description:

In an era where the distinctive qualities of our voices can inadvertently expose personal information, our project, "Advancing Speech Privacy," addresses the pressing issue of privacy leakage through speech signals. The project's core objective is to design an advanced speaker de-identification system that mitigates privacy concerns while retaining the crucial information embedded in the speech. This presents a unique opportunity for students to contribute to cutting-edge technology that safeguards personal data during communication.

The project unfolds in three integral phases. Firstly, students will delve into a comprehensive literature review, gaining insights into existing speaker de-identification algorithms. In the subsequent phase, participants will implement two of the latest algorithms, acquiring hands-on experience with state-of-the-art technologies. The final part of the project involves exploring the development of an enhanced speaker de-identification mechanism. Leveraging techniques such as Voice Obfuscation, Pitch Modulation, and Spectral Modification, students will investigate novel approaches to strike a delicate balance between preserving content and ensuring speaker anonymity.

This project is expected to be at the forefront of privacy-centric technological advancements and make a lasting impact on speech signal processing.

Keywords: Speech processing, Signal processing, Machine learning

Necessary Skills:

- Matlab or Python
- Speech processing or Audio signal processing
- Machine learning

Vision-based Robotic Manipulation

Supervisor: Dr Akan Cosgun, akan.cosgun@deakin.edu.au

Associate Supervisor: N/A

Campus: Melbourne Burwood;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Applied IT/Emerging Technologies

Project Description:

It is second nature for humans to use their hands to manipulate objects around them. For robots to be more effective, they should also have advanced manipulation skills.

The aim of project is to use cutting edge machine learning techniques to develop generalisable, human-level manipulation skills for robots. These techniques include self-supervised learning, learning from human demonstrations and sim-to-real transfer learning. Students will focus one aspect of robotic manipulation such as picking up objects and placing them, non-grasping interactions such as pulling, pushing and dragging objects. Another aspect the student can study is how to fuse sensor data from various sensors such as cameras, haptic sensors and microphones.

Perhaps the best part of the project is that the students would have access to world-class robotics equipment that we have in the Robotics Lab, including Universal Robots UR3e, uFactory xArm 7, Kinova Gen3 Lite and Wonik Allegro Robotic Hand.

Keywords: AI, Robotics, Robotic Manipulation.

Necessary Skills:

- Experience with Python Programming.

Developing a LiDAR-Enabled IoT Health Monitoring System

Supervisor: Dr Anuroop Gaddam, Anuroop.Gaddam@deakin.edu.au

Associate Supervisor: Dr Dhananjay Thiruvady

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Applied IT/Emerging Technologies

Project Description:

Embark on a cutting-edge journey with our "SmartAge Wellness Guardian" project, aimed at redefining health monitoring for the elderly population in Australia. As our senior citizens increasingly embrace independent living, the demand for advanced and noninvasive health monitoring solutions has never been more critical.

Innovation Unleashed:

Our project proposes a groundbreaking fusion of LiDAR (Light Detection and Ranging) technology with the Internet of Things (IoT), unlocking a realm of possibilities for health management. Picture a future where the precision of LiDAR in tracking human activity within confined spaces harmonizes seamlessly with the connectivity prowess of IoT. The result? A revolutionary LiDAR-Enabled IoT Ubiquitous Health Management System designed to empower the elderly with proactive health monitoring capabilities.

Transformative Features:

Precision Tracking: LiDAR's unparalleled precision allows us to monitor every nuanced movement within confined spaces, ensuring accurate and detailed activity tracking.

Connectivity Beyond Boundaries: The integration with IoT ensures real-time connectivity, enabling caregivers and healthcare professionals to access vital health data remotely.

Smart Machine Learning: Our system employs advanced machine learning algorithms to detect patterns and anomalies in the data, providing real-time insights for proactive interventions and personalized care.

Feasibility, Benefits, and Potential:

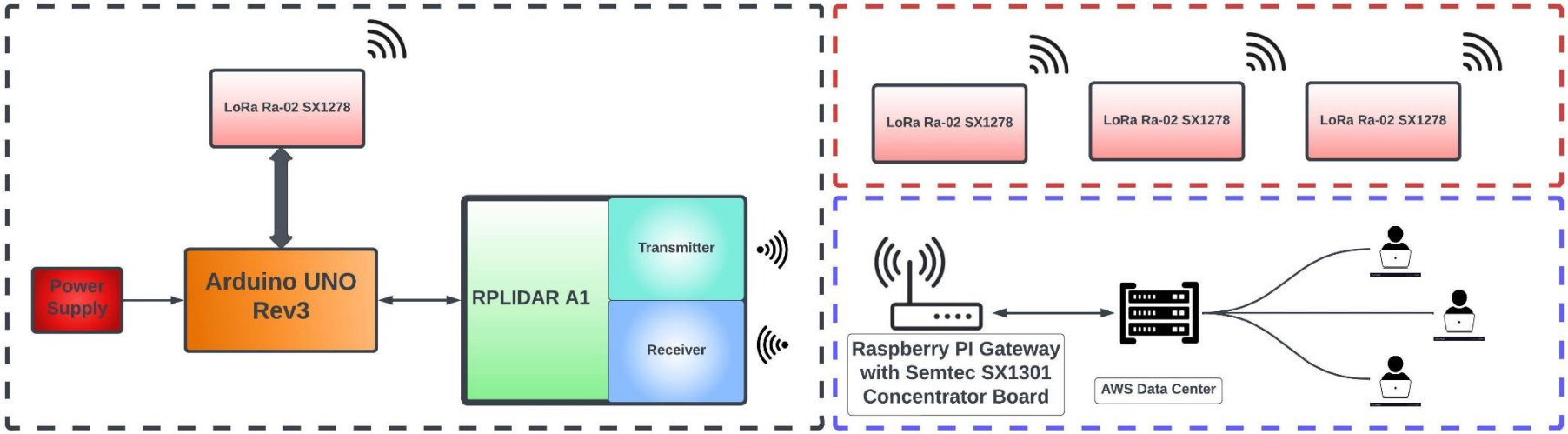
This project dives into the exploration of the system's feasibility, outlining the myriad benefits it offers to both the elderly and their caregivers. From enhancing the overall well-being of older adults to preserving their independence in a chosen environment, our project aims to be a game-changer in elderly care.

Why Choose this Project?

Impactful Social Contribution: Be a part of a project that directly contributes to improving the lives of the aging population, fostering independence, and providing peace of mind to families.

Cutting-edge Technology Exposure: Work with state-of-the-art LiDAR technology and IoT, gaining valuable experience in the rapidly evolving field of health tech.

Innovative Problem-Solving: Tackle real-world challenges by developing a system that addresses the pressing need for advanced health monitoring solutions in a growing demographic.



Keywords: 2D Mapping, Activity Recognition, Ageing Population, Dementia, Elderly Care, Health Monitoring, Human Activity Recognition, Internet of Things, LiDAR

Necessary Skills:

- Programming Skills: Any programming languages such as Python or C++, or Java.
- Data Science and Machine Learning: Understanding of machine learning algorithms for analysing health data and detecting patterns and anomalies.
- Problem-Solving and Critical Thinking: Strong analytical and problem-solving skills to address challenges in health monitoring and data interpretation.
- Communication and Collaboration: Effective communication skills to collaborate with interdisciplinary team members, caregivers, and potential end-users.

Machine Learning Tools for Game Design and Development

Supervisor: Assoc Prof William Raffe, william.raffe@deakin.edu.au

Associate Supervisor: TBD

Campus: Melbourne Burwood;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Applied IT/Emerging Technologies

Project Description:

State of the art breakthroughs in large language models, such as ChatGPT, and generative art models, such as Stable Diffusion, have the potential to both positively and negatively disrupt many industries. This project specifically focuses on the games industry and aims to understand how these emerging tools can be used to augment the game design and development pipeline, giving professionals more power to create compelling player experiences, rather than replacing the professional altogether. You may choose to approach this challenge in one of three ways, depending on your existing skillset.

1) If you have skills in games development (such as in Unity or Unreal), you may investigate the application of existing and readily available machine learning tools into your development process, analysing how it adjusts your own workflow.

2) If you have skills in human-computer interaction design, you may conduct use studies with industry professionals, educators, and/or students in game design and development to understand how perceive this emerging technology, both in terms of the benefits and risks, and how they foresee it fitting in with their workflow.

3) If you have skills in machine learning, you may investigate the customisation and enhancement of existing models to produce more useful outputs for one aspect of the games development pipeline.

Keywords: Games, virtual reality, interaction design, machine learning

Necessary Skills:

An in-depth knowledge of at least one of the following areas:

- 1) game / virtual reality development in a 3D game engine
- 2) human-computer interaction design (HCI)
- 3) machine learning (ML)

Designing Digital Games for Encouraging Healthy Eating Practices among Kindergarten Children

Supervisor: Dr Deepti Aggarwal, deepti.aggarwal@deakin.edu.au

Associate Supervisor: N/A

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 3;Trimester 2;

Project type: Individual

Project Discipline: Applied IT/Emerging Technologies

Project Description:

This project aims to explore the role of digital games in enhancing the kindergarten education on healthy eating. While the goal of kindergarten program in Australia is to support literacy and overall development of 3-5-year-old children, it limits in introducing the concepts of healthy eating. Practising healthy eating from childhood is essential as studies suggest that eating habits formed during childhood are likely to track until adulthood, and that it also reduces a child's chances of developing diseases like obesity, bowel cancer and heart diseases at later stage in life.

Some of the topics under healthy eating practices include:

1. What to eat: categorisation of food under different food groups (e.g., dairy, carbohydrates, meat and lentils, grains, and fruits); Eating balanced diet

2. Why to eat healthy: to feel energetic, have proper bowel movements, and proper sleep

3. When to eat: understanding the hunger-satiety cues (i.e., when to eat and when to stop), and following recommended portion sizes for different food categories.

You will design a digital game on one of the above mentioned three topics (i.e., 'what', 'why', and 'when' aspects of healthy eating). The designed game will be tested with 3–5-year-old children and kindergarten educators at a collaborating day-care facility in Melbourne.

Keywords: Digital Games, Internet of Things, Healthy Eating Practices, Early Childhood Education.

Necessary Skills:

Essential skills (either one of the following):

- Android app/game development
- Arduino board development

Design an interpretable deep learning model by incorporating domain-knowledge for sleep stage classification from electrocardiogram (ECG) signal.

Supervisor: Dr Ahsan Habib, habib@deakin.edu.au

Associate Supervisor: Assoc Prof Chandan Karmakar

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Applied IT/Emerging Technologies

Project Description:

Creating a deep learning model involves stacking a number of layers including convolution, pooling and activation. A model designed following this traditional way often yields high accuracy but unfortunately, loses explainability, meaning these models decision-making goes beyond human level understanding. This probably is one of the reasons they are called black-box models and people are reluctant in using them in sensitive domain such as healthcare. On the other hand, ECG signal modality has the potential of continuous home-based monitoring for quality of sleep using wearable sensors (Internet of Medical Things - IoMT).

A model should be designed in such a way that its decision-making satisfies the background knowledge or domain-specific rules. This may require changes to: input, loss-function or network architecture. In this project, a student will explore state-of-the-art deep learning design methods to identify suitable approaches to be applied for the sleep-stage classification task from ECG signals to better understand the quality of sleep. The student will require to perform simulation, analyse methods of background knowledge incorporation in deep learning models and apply to the given task of sleep stage classification.

Keywords: eXplainable AI, inclusion of domain-knowledge, deep learning, ECG

Necessary Skills:

- Python machine learning packages including scikit-learn is required, knowledge of deep learning (Keras, PyTorch) is appreciated.

Deep learning model for sleep stage analysis from Actigraphy and ECG data

Supervisor: Dr Ahsan Habib, habib@deakin.edu.au

Associate Supervisor: Assoc Prof Chandan Karmakar

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Applied IT/Emerging Technologies

Project Description:

Analysis of sleep quality requires to understand different sleep stages a person goes through using recordings coming from body worn sensors such as electrocardiogram, photoplethysmography or actigraphy. Deep learning (DL) is a cutting edge AI technique which is able to learn patterns from data itself. Although DL models require data for training, recently, a number of large sleep datasets are available for public use which will facilitate sleep related research. The recordings of these datasets contain multi-modality of signals including ECG, PPG and EEG.

A focus of this study is to make best of large datasets to design better DL models than before and then use the trained models to see if they can be deployed in wearable sensors, smartphone or cloud. Students will perform literature review, run simulation, generate results and draft paper for submission in conference or journals.

Keywords: deep learning, sleep staging, electrocardiogram, actigraphy, photoplethysmogram

Necessary Skills:

- Python machine learning packages including scikit-learn is required, knowledge of deep learning
- (keras, tensorflow, PyTorch) is appreciated.

Energy Efficient Computing and Communications: Fuelling a Sustainable Future

Supervisor: Assoc Prof Chathu Ranaweera, chathu.ranaweera@deakin.edu.au

Associate Supervisor: Assoc Prof Kevin Lee

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Applied IT/Emerging Technologies

Project Description:

With hundreds and thousands of diverse networked devices such as computers, autonomous cars, and Internet of Things devices being connected to the Internet every day, the energy demand of these digital systems, including both networking and computing, is accelerating rapidly. The energy cost (computing and communications) of systems that support a wide range of next generation services and applications, is becoming a significant contributor to global energy consumption and greenhouse gas emissions. Energy-efficient solutions are crucial to mitigate the environmental impact and reduce the carbon footprint associated with these technologies and services provided. The challenge is that different services use a range of diverse communication and computation technologies such as WiFi, 5G, optical networks, cloud computing, and edge computing. The

energy efficient approach implemented in one domain can impact the performance of critical applications. This project aims to develop innovative approaches for energy-efficient communication and computation that will lead to advancements in hardware design, software optimization, and system architectures, fostering energy efficiency in various sectors without compromising the

performance. The project outcomes will help information and communication technology sectors to become more conscious of sustainability and environmental concerns and adapt energy efficient approaches that will help build a sustainable future.

Keywords: Communications, Networks, Computing, Energy and Sustainability

Necessary Skills: Programming

Language Model Driven LMS for Personalised Teaching and Learning

Supervisor: Dr Jonathan Kua, jonathan.kua@deakin.edu.au

Associate Supervisor: Dr Shiva Pokhrel

Campus: Melbourne Burwood;Cloud;

Start: Trimester 1;Trimester 2;

Project type: Individual

Project Discipline: Applied IT/Emerging Technologies

Project Description:

This research project aims to explore OpenAI model's advanced natural language processing capabilities to create an intelligent and interactive learning environment within LMS platforms. The prime goal is to create a more intuitive, interactive, and effective T/L for students, empowering them to succeed.

Key research questions include: How can LMS features be optimised to provide personalised, interactive, and effective support to T/L? How can user experience be optimised to ensure seamless and intuitive interactions, and what measures can be taken to address potential concerns or challenges related to privacy, data security, and AI-driven T/L? To what extent can the integration of models such as ChatGPT be adopted under the LMS? E.g., Limiting factors can be class sizes, levels of complexity, and technical and pedagogical considerations.

We will focus on developing a holistic framework that seamlessly incorporates ChatGPT like models into LMS modules. The integration aims to enable dynamic conversations between learners and the AI model, offering personalised guidance, clarifications, and explanations on the course. The LMS APIs and T/L interfaces will have real-time interactions, ensuring that ChatGPT understands the context of the course materials and T/L deliverables with relevant insights to learners.

Keywords: OpenAI, Learning Management System, personalised Teaching and Learning, Federated Learning

Necessary Skills:

- Machine Learning, Python programming, computer science education background desirable.

Revolutionizing Smart Meter Privacy with Solar Power Forecasting

Supervisor: Dr Iynkaran Natgunanathan, iynkaran.natgunanathan@deakin.edu.au

Associate Supervisor: Prof Yong Xiang

Campus: Melbourne Burwood;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Applied IT/Emerging Technologies

Project Description:

Embark on an innovative research venture focusing on smart meter technology, energy consumption, and privacy enhancement. Smart meters offer real-time energy monitoring with advantages in billing sophistication and power distribution efficiency. However, privacy concerns pose a significant challenge to real-time data collection. In this project, we'll explore a pioneering solution—leveraging solar power forecasting with weather data to enhance privacy effectively, promising a less complex mechanism.

Students will initiate the project with a comprehensive literature survey on smart meter privacy, gaining insights into existing mechanisms. Subsequently, they will implement two cutting-edge privacy-protecting algorithms using Matlab or Python. With guidance, students will contribute to proposing a streamlined algorithm, balancing robust privacy and cost-effectiveness. Join us in shaping the future of smart meter technology and privacy practices, where students play a crucial role in driving innovation.

Keywords: Smart meter, solar forecasting, privacy, Python, energy management, machine learning

Necessary Skills:

- Matlab or Python
- Signal processing
- Machine learning

Audio Feature Design: Safeguarding Against Adversarial Attacks

Supervisor: Dr Iynkaran Natgunanathan, iynkaran.natgunanathan@deakin.edu.au

Associate Supervisor: Prof Yong Xiang

Campus: Melbourne Burwood;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Applied IT/Emerging Technologies

Project Description:

In an era where adversarial attacks on audio signals pose a formidable challenge, this project endeavors to design and identify features resilient to manipulations like noise addition, amplification, time-scaling, and pitch-scaling. Students participating in this project will embark on a journey to fortify audio feature extraction against intentional and unintentional attacks, contributing to the development of robust audio processing techniques.

The project unfolds in three pivotal phases. Initially, students will explore popular features extracted from audio signals and investigate common adversarial attacks in audio signal processing. The second phase involves hands-on implementation using Matlab or Python, where students will write code to extract identified features and simulate the identified attacks. Guided by their findings, the final phase presents an exciting opportunity to delve into the creation of novel features resilient to a spectrum of attacks.

This project promises a blend of theoretical exploration and practical implementation, allowing students to leave a lasting impact on the evolving field of secure audio signal processing.

Keywords: Audio signal processing, signal processing attacks, feature extraction

Necessary Skills:

- Audio signal processing • feature extraction
- Matalb or Python

Wearable Smart Medication Reminder System for Patients

Supervisor: Dr Iynkaran Natgunanathan, iynkaran.natgunanathan@deakin.edu.au

Associate Supervisor: Assoc Prof Sutharshan Rajasegarar, Assoc Prof Chandan Karmakar

Campus: Melbourne Burwood;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Applied IT/Emerging Technologies

Project Description:

In the pursuit of elevating patient care and adherence, this project, " Wearable Smart Medication Reminder System," aims to develop an innovative solution utilizing wearable technology. Recognizing the critical importance of medication reminders for disease management and treatment effectiveness, the project centers on creating a smart system that seamlessly integrates into patients' daily lives.

The first phase involves a comprehensive exploration of existing medication reminder systems, identifying strengths and limitations. In the subsequent phase, students will utilize a wearable sensor, such as an accelerometer, to collect data related to medication intake. Through data analysis techniques, meaningful insights will be extracted to understand patient behavior and medication adherence patterns. The final and most exciting phase focuses on the development of a smart system capable of automatically identifying whether a patient has taken medication on time, and providing timely alerts when needed. This cutting-edge wearable promises to revolutionize healthcare by empowering patients and improving overall medication adherence.

This project is expected to be at the forefront of healthcare innovation, merging technology and patient well-being to make a tangible impact on the lives of individuals managing their health through medication regimens.

Keywords: Wearable sensors, patient care, healthcare

Necessary Skills:

- Audio signal processing • feature extraction

Security in Distributed Machine Learning

Supervisor: Prof Jinho Choi, jinho.choi@deakin.edu.au

Associate Supervisor: Dr Jihong Park

Campus: Melbourne Burwood;

Start: Trimester 1;Trimester 2;

Project type: Individual

Project Discipline: Applied IT/Emerging Technologies

Project Description:

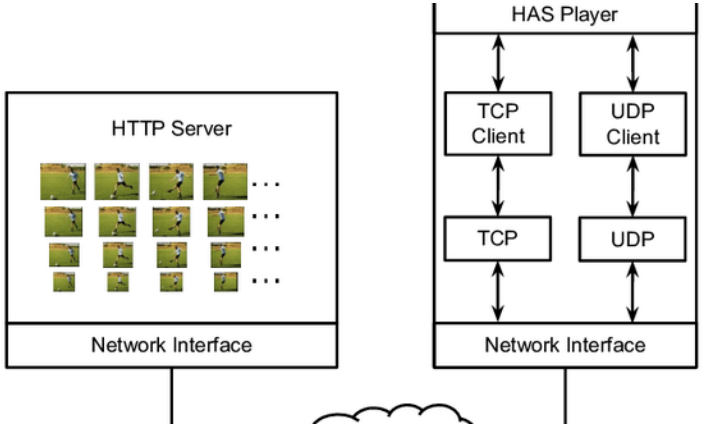
In distributed machine learning, datasets are shared and parameter vectors are exchanged among users or nodes through communication channels or networks. This collaborative approach enables multiple entities to collectively train a machine learning model without the need for centralized data storage. However, the decentralized nature of this process introduces security challenges that necessitate careful consideration. Privacy concerns arise due to the sharing of sensitive data, and the communication channels become potential targets for adversarial attacks. Additionally, the exchange of model parameters opens avenues for malicious entities to manipulate the learning process or gain insights into the training data. Thus, understanding possible attacks and implementing effective countermeasures is necessary. In this project, we investigate possible attacks and consequences.

Keywords: distributed machine learning; attacks; communication networks

Necessary Skills:

- good mathematical background; machine learning

Media over QUIC (MoQ) for Interactive Streaming over Future Networks



Supervisor: Dr Shiva Pokhrel, shiva.pokhrel@deakin.edu.au

Associate Supervisor: Dr Jonathan Kua

Campus: Melbourne Burwood;Cloud;

Start: Trimester 1;Trimester 2;

Project type: Individual

Project Discipline: Applied IT/Emerging Technologies

Project Description:

Media over QUIC (MoQ) represents a novel paradigm designed to establish a streamlined, low-latency solution for media ingestion and dissemination. Its capability to accelerate connections, mitigate latency, and enhance congestion control positions MoQ as a promising remedy to the challenges posed by contemporary Internet traffic.

This project delves into the intricacies of MoQ, undertaking a comprehensive exploration of its architecture, functionality, and potential impact on network performance and security. The primary goal is to uncover the performance characteristics and adaptability of MoQ's network components across diverse bandwidth scenarios. The study aims to develop novel machine learning-based approaches for MoQ and model on the interplay between client-induced delays and the network's handling mechanisms, which can influence bitrates and potentially result in packet loss, ultimately impacting overall stream quality.

Keywords: Data Transport over Modern Network using Machine Learning

Necessary Skills:

- Machine Learning, Transport Protocols, Coding, Programming C++

Autonomous Navigation using Robotic Dogs

Supervisor: Dr Akan Cosgun, akan.cosgun@deakin.edu.au

Associate Supervisor: N/A

Campus: Melbourne Burwood;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Group

Project Discipline: Applied IT/Emerging Technologies

Project Description:

It is crucial for mobile service robots to be able to safely move among people. Traditionally, path planning for mobile robots involves finding the shortest path to a goal

position, however, in human environments, additional criterion needs to be considered. For instance, the robot should not get very close to people or move too fast,

because it will scare off people. Moreover, the robot's actions should be predictable so that humans understand where the robot wants to go. This requires designing of

human-robot interaction methods that enables smooth and safe navigation among people.

The project can involve the detection and tracking of humans, path planning in partially observable environments, obstacle avoidance in crowded environments and generating predictable robot motions. The developed algorithm can be tested in user studies to understand what people expect from mobile robots.

The students will work with a Unitree Go1 robot, which is equipped with a LIDAR sensor and a bunch of cameras.

Keywords: AI, Robotics, Robotic Dog. **Necessary Skills:** Python Programming

Service Robot for Homes and Offices

Supervisor: Dr Akan Cosgun, akan.cosgun@deakin.edu.au

Associate Supervisor: N/A

Campus: Melbourne Burwood;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Group

Project Discipline: Applied IT/Emerging Technologies

Project Description:

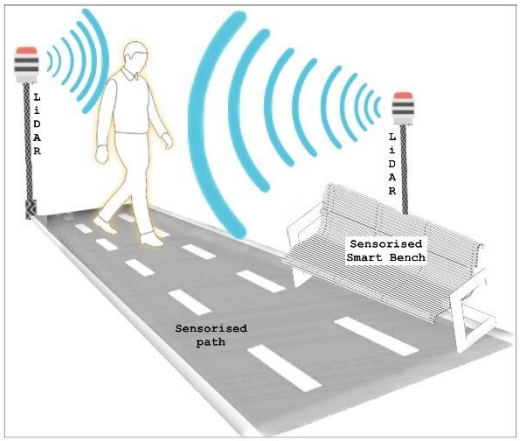
This project aims to push the boundaries of service robotics by leveraging the capabilities of the "Hello Robot" platform which is capable of autonomous navigation as well as picking up objects. The primary technical focus will be on enhancing the autonomous navigation system, developing spatial awareness, as well as object detection and grasping capabilities of the robot. The student will implement state-of-the-art computer vision techniques, possibly incorporating deep learning models for object recognition. The challenge extends to developing a sophisticated grasping mechanism that combines kinematic control for optimal manipulation of diverse, everyday objects. Additionally, the project will explore techniques for seamless integration of these technical components, ensuring a cohesive and efficient robotic system, especially for long-term autonomy. The outcome of this project will be a demonstration of the autonomous pick and place capabilities of the robot, and the research is expected to contribute to the broader field of autonomous service robotics with practical implications for homes and offices.

Keywords: AI, Robotics.

Necessary Skills:

- Python programming. ROS is a plus.

Early Detection of Gait Disorders Using an IoT LiDAR-Based Monitoring System



Supervisor: Dr Anuroop Gaddam, Anuroop.Gaddam@deakin.edu.au

Associate Supervisor: N/A

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Group

Project Discipline: Applied IT/Emerging Technologies

Project Description:

This project aims to create an innovative system for the early detection of gait disorders among the elderly, utilizing state-of-the-art technology. It is part of the IIT (India) SPARC grant, necessitating collaboration with teams from both Australia and India.

Walking is vital for maintaining health and well-being in older age. A decline in community ambulation is associated with a loss of independence and predicts residential care admission and mortality in older individuals. Our project tackles these challenges by developing an IoT-based framework and prototype embedded in outdoor landscapes. This system monitors individuals' gait and identifies patterns of gait change using IoT sensors and LiDAR.

Picture yourself as a valuable member of a team designing a system capable of seamlessly capturing data on mobility, posture, and gait – crucial indicators of a person's well-being. Leveraging the power of the Internet of Things, this system will collect real-time data from individuals as they go about their daily lives. The sensorised landscape will be strategically positioned in areas frequented by target users, maximizing data collection opportunities.

By analyzing gait patterns and identifying deviations, our framework serves as an early warning system. This empowers healthcare providers, caregivers, and individuals themselves to take proactive steps toward better health.

To ensure the success of this project, you will delve into machine learning and AI techniques to create a gait profile for each individual and estimate their fall risk using the spatial-temporal data collected by the sensors. This collaborative effort involves working with multi-disciplinary research teams.

Keywords: Internet of Things, Machine Learning, Python Programming

Necessary Skills:

- Moderate understanding of wireless sensors and Internet of Things design
- Moderate to good knowledge of machine learning / any programming language

IoT-based approach to detecting sensor failures, anomalies, and outliers

Supervisor: Dr Anuroop Gadddam, Anuroop.Gadddam@deakin.edu.au

Associate Supervisor: N/A

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Group

Project Discipline: Applied IT/Emerging Technologies

Project Description:

Internet of Things (IoT) has become an essential and productive technology that has changed the traditional way of living into a high-tech lifestyle. Recent advancements in communication networks, sensors and microcontrollers have also contributed towards the use of IoT in many parts of day-to-day life and in industry alike including health, education, and industry automation. A typical IoT system consists of various sensors that collects data from the environment, a microcontroller that processes this data, and an actuator that perform a certain action on the environment based on these processed data: all connected through the Internet.

A well-functioning IoT device depends upon the correct operation of the sensors within it. The correct operation of the sensors within the IoT device plays a vital role in the overall performance of the system and the dependent processes, applications. The IoT sensors are often deployed in harsh remote environments; guaranteeing the sensor's correct operation and predicting malfunctions is quite difficult.

To address these issues, this project aims to propose a machine-learning based solution in identifying, and predicting the sensor faults, errors, anomalies, and outliers within the IoT sensor networks. The main questions addressed in this project are as follows

- Hardware implementation of the IoT setup for detecting environmental data
- Collecting real-time data from the sensors to model the correct behaviour of the sensors
- Design a machine-learning based algorithm to predict the type of anomalies in sensors
- Use of edge technologies to mitigate the end-to-end latency in detecting the outliers and taking necessary action.

Keywords: Internet of Things, sensors, error detection, outliers, Embedded Systems.

Necessary Skills:

- Hardware experience: Raspberry Pi, Arduino, sensors
- Programming language experience
- Machine learning and networking basics

Design deep learning-based regressor for measuring severity level of massive depressive disorder (MDD) from ECG signals

Supervisor: Dr Ahsan Habib, habib@deakin.edu.au

Associate Supervisor: Assoc Prof Chandan Karmakar

Campus: Cloud;Geelong Waurn Ponds;Melbourne Burwood;

Start: Trimester 3;Trimester 2;Trimester 1;

Project type: Group

Project Discipline: Applied IT/Emerging Technologies

Project Description:

Deep learning (DL) models are advanced AI algorithms which are popular for their great success in different applications including image classification, segmentation, natural language processing and more. These models are also popular in analysing physiological signals such as ECG signal to detect cardiac anomalies or measuring sleep quality from overnight PPG data (collected from fingertip). Wearable sensors such as smart watch are now-a-days used by mass population in daily lives to measure vital signs (heart rate) during activities including exercise, sports etc. Data collected from wearable sensors are also used in detection of psychological disorders. You can find MDD detection studies in literature, mostly from brain signals (EEG) as below -

1. Machine learning approaches for MDD detection and emotion decoding using EEG signals (https://www.frontiersin.org/articles/10.3389/fnhum.2020.00284/full)

2. EEG Based Major Depressive Disorder (MDD) Detection Using Machine Learning (https://link.springer.com/chapter/10.1007/978-3-031-04112-9_13)

3. Decision support system for major depression detection using spectrogram and convolution neural network with EEG signals (https://onlinelibrary.wiley.com/doi/abs/10.1111/exsy.12773)

A limited study available in the literature for MDD detection using ECG recordings which is easy to acquire using wearable sensors. In this project, students will explore DL techniques for the detection of MDD, as well as, the severity level from ECG (cardiac) signal, instead of EEG (brain) signal. They will perform

literature review on MDD severity prediction using DL models (possibly regressor), run simulation, generate results and draft paper for submission in conference or journals.

Keywords: Physiological signals, signal processing, deep learning, major depressive disorder

Necessary Skills:

- Python machine learning packages including scikit-learn is required
- Knowledge of deep learning (keras, tensorflow, PyTorch) is appreciated

Improved deep learning model design for federated learning for sleep stage classification

Supervisor: Dr Ahsan Habib, habib@deakin.edu.au

Associate Supervisor: Assoc Prof Chandan Karmakar, Dr Shantanu Pal, Dr Iynkaran Natgunanathan

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 3;Trimester 2;Trimester 1;

Project type: Group

Project Discipline: Applied IT/Emerging Technologies

Project Description:

Federate learning (FL) is a distributed collaborative machine learning (ML) and deep learning (DL) approach enabling the training of models with local data at network edges followed by their aggregation at a server node towards building a global ML model. FL is a promising solution to address, among others, geographically distributed nature of sensitive datasets such as patient data in hospitals, which has growing data privacy concerns. However, due to the nature of distributed training in FL, the deep learning models perform poorly and much work needs to be done for them to be used in real world applications.

A focus of this study is the understand the nature of learning happens in FL and how to improve them to generate better global DL models. Students will explore federated learning, adaptive learning strategy in DL models and update the training strategy in FL process for sleep stage classification using a number of signal modality such as electrocardiogram (ECG) and electroencephalogram (EEG). They will perform literature review, run simulation, generate results and draft paper for submission in conference or journals.

Keywords: Federated learning, electrocardiogram, electroencephalogram, sleep stage

Necessary Skills:

- Python machine learning packages including scikit-learn is required, knowledge of deep learning (keras, tensorflow, PyTorch) is appreciated.

Investigate transfer learning to develop personalised sleep stage classifier

Supervisor: Dr Ahsan Habib, habib@deakin.edu.au

Associate Supervisor: Assoc Prof Chandan Karmakar, Dr Shantanu Pal, Dr Iynkaran Natgunanathan

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Group

Project Discipline: Applied IT/Emerging Technologies

Project Description:

Transfer learning is a mechanism to reuse a trained deep learning (DL) model from a source domain (dataset) to be used in a target domain (dataset). This is done, in most of the cases, to address the limited data sample issue in the target domain. A DL model is trained using a lot of data samples in a source domain. Later, the trained model is updated, either part or all of the layers, using the limited data samples in the target domain. The idea of transfer learning can be extended to formulate a problem if a DL model can be trained with global dataset and then customised for a target subject in order to increase the performance of the model. This can be thought of an initial setup of a wearable device to be used for a subject for the first time. A generic model may perform poorly for a user and a guaratee is required that the global model is performing better for target users.

A focus of this study is to understand the transfer learning and how to adapt a global model for a target domain using supervised, semi-supervised or unsupervised way. Students will perform literature review, run simulation, generate results and draft paper for submission in conference or journals.

Keywords: deep learning, transfer learning, domain adaptation, sleep staging

Necessary Skills:

- Python machine learning packages including scikit-learn is required, knowledge of deep learning (keras, tensorflow, PyTorch) is appreciated.

Envisioning the Digital Transformation in STEM Education: The Role of AI technologies in Improving Student Learning Experiences and Outcomes

Supervisor: Dr Elicia Lanham, elicia.lanham@deakin.edu.au

Associate Supervisor: Dr Glory Lee

Campus: Melbourne Burwood;Cloud;Geelong Waurn Ponds;

Start: Trimester 1;Trimester 2;

Project type: Group

Project Discipline: Applied IT/Emerging Technologies

Project Description:

This research project aims to investigate the impact of AI technologies on learning experiences and outcomes in STEM education in Australia, and to propose new considerations for an improved digital learning framework in a digital transformation era.

The key research questions are:

- What is the current state of AI technologies adoption in education?
- How do AI technologies impact student learning experiences and outcomes?
- What are the key considerations for an improved digital learning framework that takes into account the impact of AI technologies on student learning?

This project will incorporate both qualitative and quantitative data collection and analysis. The data collection methods include but not limit to a survey of education institutions and students in Australia, in addition with in-depth interviews with teachers, administrators, and/or experts in the field of digital education. The data collected will be analysed using statistical methods and thematic analysis, respectively.

This project is expected to contribute to a deeper understanding of the impact of AI technologies on student learning experiences and outcomes in higher education in Australia. The findings will inform the development of a robust and effective digital learning framework that supports the integration of AI technologies into STEM education, with a focus on enhancing student learning experiences and outcomes.

[Depending on progress in the project, it is anticipated that the work will be published in educational technology and innovation conferences and journals.]

Keywords: Artificial Intelligence Integration, STEM Education Analytics, Digital Pedagogy Innovation, Educational Data Mining, E-Learning System Development.

Necessary Skills:

- Knowledge of AI and machine learning concepts
- Experience in Deakin's Low Risk Human Ethics application
- Data collection and statistical analysis skills
- Qualitative research skills
- Critical thinking
- Good written and verbal communication skills.

Low Latency Data Transport Protocols and Internet Service Architecture for Emerging Technologies

Supervisor: Dr Jonathan Kua, jonathan.kua@deakin.edu.au

Associate Supervisor: Dr Shiva Pokhrel

Campus: Melbourne Burwood;Cloud;

Start: Trimester 1;Trimester 2;

Project type: Group

Project Discipline: Applied IT/Emerging Technologies

Project Description:

The Transmission Control Protocol (TCP) has been the de facto transport protocol on the Internet for the past four decades. Despite many refinements over the years, its fundamental principles for reliable data transfer have remained essentially unchanged. In recent years, however, momentum has been building for a major rethink of TCP. This is reflected, for example, in Google's development of Quick UDP-based Internet Connections (QUIC) and Bottleneck Bandwidth and Round-trip Time (BBR), as well as new data networking and congestion control strategies. Recent work in transport protocols focused on IETF's recommendations for Low Latency, Low Loss, and Scalable Throughput (L4S) Internet Service Architecture [RFC9330] and Active Queue Management (AQM) [RFC7567].

It is critical to ensure that future Internet service architecture addresses the challenges posed by the emerging technologies, such as the Metaverse which requires immersive real-time streaming applications. This project will identify and characterise the communication and networking challenges for realising these applications. This project will also focus on the key enablers and implementation recommendations to achieve a ubiquitous, seamless and embodied access to the Metaverse, including leveraging cutting-edge next-generation communication solutions and the cloud-edge computation framework to deliver low-latency immersive interactions and experiences across the network.

Keywords: Internet Congestion Control, Transmission Control Protocol, Active Queue Management, Low-Latency Networking

Necessary Skills:

- Computer networking, python programming, machine learning, knowledge on operating systems and kernel development highly desirable.

Advancing Healthcare Through Accelerated Biomedical Image Processing

Supervisor: Dr Iynkaran Natgunanathan, iynkaran.natgunanathan@deakin.edu.au

Associate Supervisor: Assoc Prof Chandan Karmakar

Campus: Melbourne Burwood;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Group

Project Discipline: Applied IT/Emerging Technologies

Project Description:

Dive into the realm of image processing, a cornerstone of modern healthcare, and discover how it has elevated treatment plans to new heights. Biomedical imaging, a key player in disease identification and treatment monitoring, now faces the exciting challenge of managing the surging volume of ultrasound and MRI images.

In the project's initial phase, students will examine existing non-hardware mechanisms designed to speed up biomedical image processing. The second phase invites hands-on exploration as students implement two cutting-edge mechanisms currently at the forefront of rapid biomedical image processing. The final phase is where the real innovation happens – with guidance, students will explore the development of an accelerated biomedical image processing mechanism. Techniques like Region of Interest (ROI), Incremental Processing, and Identification and Selective Processing will be investigated, with machine learning techniques magnifying their impact. This project can be a catalyst for progress in medical diagnostics and contribute to the future of healthcare.

Keywords: Image processing, Image classification, biomedical imaging, Machine learning

Necessary Skills:

- Image processing
- Matlab or Python
- Signal processing

Project Discipline: Cyber Security

Improving EVM runtime

Supervisor: Dr Anh Dinh, anh.dinh@deakin.edu.au

Associate Supervisor: N/A

Campus: Melbourne Burwood;

Start: Trimester 2;Trimester 3;Trimester 1;

Project type: Individual

Project Discipline: Cyber Security

Project Description:

The current gas pricing mechanism in Ethereum execution engine, EVM, is not optimal. This project quantifies the opportunities for by looking at the Ethereum trace, and determining how many transaction execution traces can be shared/merged.

Keywords: blockchains; databases; query execution

Necessary Skills:

- excellent programming skill
- familiar with distributed systems
- strong background in databases

Deep Learning Approaches to Detect Malware

Supervisor: Dr Atul Sajjanhar, atul.sajjanhar@deakin.edu.au

Associate Supervisor: N/A

Campus: Melbourne Burwood;

Start: Trimester 1;Trimester 2;

Project type: Individual

Project Discipline: Cyber Security

Project Description:

Cybersecurity attacks have increased several folds in recent years. Malware attack is one category of cybersecurity attacks caused by malicious software. Malware is used by perpetrators to execute unauthorized actions on the victim's system causing harm to computer hardware, computer network and other resources. In this project, you will use deep learning approaches to detect malicious software by examining binaries and identifying anomalies. These techniques can be used to pre-emptively warn users of potential threats from software.

The expected outcomes are:

1. functioning code (in Python) using a deep learning framework to detect anomalies in software binaries;

2. compare and evaluate effectiveness of deep learning models to detect malware using publicly available malware datasets.

Keywords: Cybersecurity, Deep Learning, Python Programming

Necessary Skills:

- Python programming
- Experience in deep learning frameworks

Centre for Cyber Resilience and Trust (CREST) - Multiple projects with scholarship support

Supervisor: Centre for Cyber Resilience and Trust (CREST), crest@deakin.edu.au

Associate Supervisor: TBD

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Cyber Security

Project Description:

Research projects are available in the following areas:

• Data security: cryptography, digital forensics, secure communication, integrity, authentication, access control, and data erasure, Blockchain-enabled authentication and authorisation.

• Software and system security: security principles, static and dynamic testing, formal verification, security requirements, and threat modelling.

• Network security: zero trust architectures, distributed systems, cloud security, virtualisation, network services, and network defences.

• Human security: identity management, social engineering, security awareness, usable of security and privacy, social behavioural privacy and security.

• Organisational security and cybercrime: risk management, governance, cyber policy, laws, ethics, and compliance.

• Data Privacy: privacy-preserving technologies, data masking, anonymity, and legal aspects of privacy.

• Security analytics: threat intelligence, network traffic analysis, malware detection, continuous authentication, security orchestration, automation and response.

CSRI offer $10k Cyber Security CRC scholarships and $4K CSRI Summer Scholarships. They are open to both domestic and international students, including PG students.

Keywords: Cyber Security

Necessary Skills:

- A proven interest in cyber security
- Excellent written and oral English skills
- Commitment, team working, self-motivated and a critical mind
- Strong academic performance (WAMS > 80)

Comparative Analysis of Weight-Based and Fuzzy-Based Trust Score Calculation Methods for Zero Trust Engines

Supervisor: Dr Jack Li, jack.li@deakin.edu.au

Associate Supervisor: N/A

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Cyber Security

Project Description:

This project aims to compare weight-based and fuzzy-based methods for trust score calculation in zero trust engines. Trust score calculation is a critical component of zero-trust architectures, and selecting an appropriate method is essential for ensuring effective security and trustworthiness. The project will involve developing algorithms for both weight-based and fuzzy-based approaches and evaluating their performance and effectiveness through experiments. The findings will provide insights into the strengths, weaknesses, and suitability of each method for different scenarios, assisting in the advancement of trust score calculation techniques in zero trust engines.

Keywords: zero-trust

Necessary Skills:

- Knowledge and skills in fuzzy measures
- Knowledge in zero-trust architecture

Post-quantum Hash-based Signatures

Supervisor: Dr Je Sen Teh, j.teh@deakin.edu.au

Associate Supervisor: N/A

Campus: Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Cyber Security

Project Description:

The emergence of quantum computers will pose a threat to existing cryptographic algorithms, notably public-key algorithms that rely on hard problems such as the discrete logarithm problem or factoring large integers. To proactively address this problem, NIST initiated a process to elicit and standardise post-quantum cryptographic algorithms.

In this project, the focus is on hash-based signatures. Unlike other design paradigms used for post-quantum schemes such as lattices, the security underpinnings of hash functions are well-established and are more easily understood.

First, the student will conduct a critical review of hash-based signatures before selecting and implementing one of the hash-based signatures. A detailed analysis of its performance will be conducted. Finally, possible improvements to the design will be investigated in terms of reducing signature sizes or increasing signing speed.

Interesting findings can potentially be published in a journal or conference publication.

Students can go through the following article to learn the basics of a one-time hash-based signature: https://www.geeksforgeeks.org/lamport-one-time-signature-scheme/

Keywords: Post-quantum cryptography, hash functions, digital signatures

Necessary Skills:

- Strong programming skills (C, C++, Python) - Essential
- Good skills in mathematics, probability and statistics - Essential
- Basic knowledge of cryptography – Preferred

Enhancing Blockchain Consensus: A Comparative Study and Implementation

Supervisor: Dr Nasrin Sohrabi, nasrin.sohrabi@deakin.edu.au

Associate Supervisor: N/A

Campus: Melbourne Burwood;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Cyber Security

Project Description:

The emergence of blockchain technology paved a new way on designing decentralized and distributed systems. The extensive studies conducted on this technology suggest the technology has major limitations that are rooted in the consensus component of the blockchain, which is a core element of the technology. The project aims to delve into the world of blockchain consensus algorithms, exploring their characteristics, strengths, and weaknesses. It involves a comprehensive comparative study of existing consensus mechanisms, leading to the implementation and testing of a novel or improved consensus algorithm to address identified challenges.

Keywords: Consensus algorithms, Blockchain

Necessary Skills:

- Moderate/good understanding of distributed systems.
- Moderate understanding of blockchain systems.
- Familiar with Java programming language.
- Moderate/good understanding of consensus algorithms

Developing a quantitative cyber-risk and safety management model for digital health care systems

Supervisor: Dr Shamsul Huda, Shamsul.Huda@deakin.edu.au

Associate Supervisor: Dr Ansam Khraisat

Campus: Melbourne Burwood;Geelong Waurn Ponds;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Cyber Security

Project Description:

Adoption of IoT devices in health care industries has been a significant breakthrough that enables unprecedented horizontal and vertical connectedness and collaboration across different care service providers. This is facilitating easy collection of patients' data such as blood pressure and sugar level, body temperature, heart rate and their variabilities and many other health parameters through wireless communications. Integration of IoT devices enables more shophisticated and automated monitoring/ controlling of patient care systems, allows patients more mobility in hospitals, improves the quality of care and reduce costs. However, due to large attack surface, this interconnection poses severe cyber security risk including privacy and integrity of patients' data. In more critical situation, any integrity violation of data may result very costly damage on the patients and could result a life threatening condition. This research thoroughly addresses the cyber risk of the integration of IoT devices and other clinical gadgets including Implantable Medical Devices, Radio Frequency Identification labels, and wearable gadgets.

This research will accomplish a comprehensive study of recent cyber incidents in hospitals, identify assets and their vulnerabilities through the analysis of security architecture, protocols and software and threat modelling. Then develop a quantitative risk assessment model by using different risk assessment standards, AI tools and scoring systems including CVSS. Following the risk assessment model, a medical devices safety management model and a guideline would be proposed to fulfill the existing gap.

Keywords: Cyber-risk, Digital Health care, Internet of Medical Things

Necessary Skills: Threat modeling, vulnerability analysis, awareness of security standards

Developing a quantitative cyber-risk and safety management model for digital health care systems

Supervisor: Dr Shamsul Huda, Shamsul.Huda@deakin.edu.au

Associate Supervisor: Dr Ansam Khraisat

Campus: Melbourne Burwood;Geelong Waurn Ponds;

Start: Trimester 1;Trimester 2;

Project type: Individual

Project Discipline: Cyber Security

Project Description:

Adoption of IoT devices in health care industries has been a significant breakthrough that enables unprecedented horizontal and vertical connectedness and collaboration across different care service providers. This is facilitating easy collection of patients' data such as blood pressure and sugar level, body temperature, heart rate and their variabilities and many other health parameters through wireless communications. Integration of IoT devices enables more shophisticated and automated monitoring/ controlling of patient care systems, allows patients more mobility in hospitals, improves the quality of care and reduce costs. However, due to large attack surface, this interconnection poses severe cyber security risk including privacy and integrity of patients' data. In more critical situation, any integrity violation of data may result very costly damage on the patients and could result a life threatening condition. This research thoroughly addresses the cyber risk of the integration of IoT devices and other clinical gadgets including Implantable Medical Devices, Radio Frequency Identification labels, and wearable gadgets.

This research will accomplish a comprehensive study of recent cyber incidents in hospitals, identify assets and their vulnerabilities through the analysis of security architecture, protocols and software and threat modelling. Then develop a quantitative risk assessment model by using different risk assessment standards, AI tools and scoring systems including CVSS. Following the risk assessment model, a medical devices safety management model and a guideline would be proposed to fulfill the existing gap.

Keywords: Cyber-risk, Digital Health care, Internet of Medical Things

Necessary Skills: Threat modeling, vulnerability analysis, awareness of security standards

Assessing E-Safety Knowledge, Attitudes, and Behaviors through Surveys and Interviews

Supervisor: Dr Jack Li, jack.li@deakin.edu.au

Associate Supervisor: N/A

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Group

Project Discipline: Cyber Security

Project Description:

This project aims to enable students to assess e-safety knowledge, attitudes, and behaviours through surveys and interviews. Students will design and conduct a comprehensive assessment among a target group (e.g., students, faculty, and staff). The project encompasses research design, data collection, data analysis, and reporting of findings. Ethics considerations will be emphasized, and students may need to obtain ethics approval.

Keywords: e-safety

Necessary Skills:

- Conducting surveys through questionnaires and data analysis
- Strong skills in academic writing

Automated Cryptanalysis of Lightweight Block Ciphers

Supervisor: Dr Je Sen Teh, j.teh@deakin.edu.au

Associate Supervisor: N/A

Campus: Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Group

Project Discipline: Cyber Security

Project Description:

Block ciphers are cryptographic primitives that are widely used to secure both data-at-rest and data-in-transit. More recently, lightweight variants of block ciphers have been introduced for resource-constrained applications such as RFID, IoT and smart devices.

To verify the security claims made by the designers and also to discover vulnerabilities, block ciphers need to go through third-party cryptanalysis or attacks. Many automated tools based on machine or deep learning and constraint programming solvers (SAT, SMT, MILP, CP) have been proposed to aid cryptanalysis.

The first part of this project involves conducting a critical literature review of published literature related to automated cryptanalysis. Students are then expected to select and implement one of the approaches to cryptanalyse at least one symmetric-key primitive (block cipher, stream cipher, hash function, etc.). A student can either propose attacks on new ciphers or attempt to improve attacks on well-established ones. Students may go further to improve these tools and approaches to be more efficient.

New or improved cryptanalysis results can be potentially published in security or cryptography-related journals or conferences.

Since there are many cryptanalytic tools to implement and possible cipher targets, this project is open to more than one student.

References:

On the security of lightweight block ciphers against neural distinguishers: Observations on LBC-IoT and SLIM, WJ Teng, JS Teh, N Jamil, Journal of Information Security and Applications 76, 103531

On the resistance of new lightweight block ciphers against differential cryptanalysis, YY Chan, CY Khor, BT Khoo, JS Teh, WJ Teng, N Jamil, Heliyon 9 (4)

Keywords: Cryptography, Cryptanalysis, Machine Learning, Constraint Programming, SMT, SAT, MILP

Necessary Skills:

- Strong programming skills (C, C++, Python) - Essential
- Good skills in mathematics, probability and statistics - Essential
- Basic knowledge of machine learning - Preferred
- Basic knowledge of cryptography – Preferred

Evaluating Cyber Risk and Harm Reduction

Supervisor: Assoc Prof Lei Pan, l.pan@deakin.edu.au

Associate Supervisor: N/A

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Group

Project Discipline: Cyber Security

Project Description:

Risk Management is a cornerstone of Cyber Security Policy across all spectrums of business, with companies especially focussed on matching their operational budgets against risk management strategies requested (or in some cases required) by auditors, legislation or stockholders. For all the focus on risk management however, most companies rely on advice provided by auditors and consultants. Unfortunately, the existing models and the data underpinning the expert models are confidential; and peer reviewed studies frequently suffer from using the same publicly available data sets with different grouping mechanisms and risk reduction hypotheses.

This project seeks to evaluate published and accepted risk mitigation and harm reduction strategies using data collected as part of the project. Its focus will be paid to breaches that have not been publicly disclosed and careful consideration of control factors will be used to segregate data groups. These findings will be used to evaluate the causal model of cyber risk established by Woods, D. W. and Bohme, R. (2021) 'SoK: Quantifying Cyber Risk', 2021 IEEE Symposium on Security and Privacy (SP), SP, pp. 211– 228.

This evaluation will focus on establishing which security interventions can be shown to reduce harm through empirical data that can be publicly disseminated. It will allow further research to build on the thesis with more data and allow business operators who cannot benefit from expert advice derived from their confidential business data to make informed decisions regarding their own risk management strategies.

The project consists of four parts:

1. Critical literature review to build a baseline of commonly agreed, effective cyber risk mitigation strategies and cyber harm reduction strategies

2. Collection of cyber breach data with a focus on non-publicly disclosed breaches leveraging direct responses and historical insurance data

3. Perform a comparative analysis of data collected in order to compare against the baseline established in part 1 with particular focus on the effectiveness of insured breach harm reduction contrasted against uninsured breach harm reduction

4. Publish the findings in a conference paper

Keywords: Cyber Risk Management, Cyber Harm Reduction, Causal Model

Necessary Skills:

- Knowledge in cyber risk management, data breach, and cyber insurance

Enhancing System's Performance & Secuirty by Detecting Anomaly within System Logs

Supervisor: Dr Nasrin Sohrabi, nasrin.sohrabi@deakin.edu.au

Associate Supervisor: N/A

Campus: Melbourne Burwood;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Group

Project Discipline: Cyber Security

Project Description:

This project aims to design/build an anomaly detection system that monitors server logs to identify abnormal patterns in system performance. The designed system will analyze the log entries of the system to detect irregularities, potential security threats, or performance bottlenecks that may impact the reliability and efficiency of server operations.

Keywords: anomaly detection, system performance

Necessary Skills:

- Basic knowledge in Machine Learning and Deep Learning.
- Programming skills in Python

Developing a contextualized solution to the cyber threats for space systems: Risk modelling, prediction, and prevention of cyber-threats for satellite systems

Supervisor: Dr Shamsul Huda, Shamsul.Huda@deakin.edu.au

Associate Supervisor: Prof Robin Doss, Prof Jemal Abawajy, A/Prof Zubair Baig, Dr Naeem Sayeed

Campus: Melbourne Burwood;Geelong Waurn Ponds;

Start: Trimester 1;Trimester 2;

Project type: Group

Project Discipline: Cyber Security

Project Description:

Space domain is significantly being targeted to achieve counterspace capabilities by the state and not-state actors to deceive, deny or destroy military and civilian space systems of the enemies. There is a significant growth in the number of countries who have acquired very strong capabilities to conduct offensive cyberattacks against non-space targets. This raises serious concerns that offensive cyberattacks can be conducted to the space systems as well. Particularly mega-constellations of satellites in low-Earth Orbit (LEO) for remote areas' broadband connectivity, Ground based data distribution network of Command-control-communication (C3) satellite, space related subsystem of C3 system of defence and Commercial Ground Stations-as-a-Service (CGSAAS) are the primary cyberattack targets to destroy and disrupt the command and control of military forces. In addition, thousands of small satellites in LEO (mega-constellations) are constituting as the backbone network of future C3 network which increases the attack surface exponentially. Several recent examples demonstrate the evidence of cyberattacks in space system including AcidRain malware attack on Ukrainian ViaSat to destroy C3 system of Ukranian Force in 2022 and Hacking of Russia's space agency "control centre of Roscosmos" in 2022. Cyberattacks can cause non-reversible effect on space system like other counterspace threats such as Directed Energy Weapons or Kinetic Energy Weapons.

The objective of this research is to develop a comprehensive risk assessment model and contextualized solution to the cyberthreat for space systems and their missions by considering cyber-risk throughout the life-cycle of the space systems, and assets. This will develop a life-cycle based threat model such that successful mission continuity and system resiliency in the space can be achieved against an ongoing counterspace threats. It also considers to develop continuous monitoring and detection algorithms for counterspace threats by developing advanced network probes, analytics and real-time prediction models for protection from cyberthreats.

Keywords: mega-constellations, Cyber vulnerabilities in the satellite ground stations networks, life-cycle of the space systems

Necessary Skills:

- Vulnerability analysis
- Threat modeling
- AI tools
- Knowledge of Secuity architecture, and protocols, applying security standards.

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Generative AI for Music Composition

Supervisor: Dr Akan Cosgun, akan.cosgun@deakin.edu.au

Associate Supervisor: N/A

Campus: Cloud;Geelong Waurn Ponds;Melbourne Burwood;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

The main objective of this project is to explore the exciting field of generative artificial

intelligence (AI) for music composition and its potential impact on the creative process. The student will conduct research in the cutting edge methods and libraries into the generative AI capabilities for music generation. The particular goal of the project is open to discussion and can include the AI-based generation of melody, rhythm, vocals or lyrics.

The project involves identifying datasets that relate to training AI models music composition, training and fine-tuning the neural network models using the collected datasets, optimizing the models' performance and their ability to generate coherent music. The output of the models will be evaluated based on musicality, coherence, and originality. The student will also have the opportunity to experiment with different parameters and techniques to enhance the generated music. The expected outcome is to be able to demonstrate the generated music, and develop insight their creative process and the implications of generative AI in music composition.

Keywords: Generative AI, Machine Learning, Deep Learning.

Necessary Skills:

- Python Programming. Experience with Machine/Deep Learning.

Cognitive Workload Detection and Classification

Supervisor: Dr Atul Sajjanhar, atul.sajjanhar@deakin.edu.au

Associate Supervisor: Dr Glory Lee

Campus: Melbourne Burwood;Cloud;

Start: Trimester 1;Trimester 2;

Project type: Individual

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

Human operators can experience significant fluctuations in cognitive workload (CW) while performing cognitive tasks. Generally, high CW is considered to impact negatively on task performance. On the other hand, low CW can cause lapses of attention and poorer subsequent recall from long-term memory. The ultimate aim of the project is to monitor the CW and improve the efficacy of task performance by managing fluctuations in CW.

Measurement of CW is a significant challenge because it is subjective in nature and it is a time-critical evaluation. Physiological measures have been adopted by researchers for predicting CW. In this project, we propose to use eye-fixation data for non-intrusive computation of CW.

The project will develop insights into the relationship between eye-fixation and CW. We will define a machine learning based framework to model the relationship and deliver the end-to-end CW classification from eye-fixation data. Temporal visualisation will be used to display CW and highlight anomalous patterns in CW.

Keywords: Human-Machine Intelligent Systems, Machine Learning, Cognitive Workload, Classification

Necessary Skills:

- Programming skills are required
- Data analytics and mining skills
- Algorithm Design skills
- Proficiency in Python is preferred
- Data visualisation skills

Redesigning Learning based 360° Video Super-resolution with Perceptual Focus for Better Immersivity

Supervisor: Dr Glory Lee, glory.lee@deakin.edu.au

Associate Supervisor: Mr Arbind Agrahari Baniya

Campus: Melbourne Burwood;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

There is a growing trend of consumption of 360° videos to induce immersive experience for users in various domains like Education 4.0, real estate marketing, video-on-demand streaming, and mental health interventions, etc. Unlike traditional 2D videos, 360° videos comprise of multiple views for a given scene along time instances captured from multiple cameras and stitched together for one single 360° wider view video. To create true immersive experience, the visual quality of viewer's Field of View (FoV) needs to be sufficiently high in its resolution whilst resulting dramatical increase in data volume for supporting all views with fine resolution.

Storing, encoding, and transmission of such 360° videos become more challenging due to the desired high visual quality standard in such demanding data volume. To address this over the hardware limitation, computational super-resolution becomes a desired software solution that can be used to automatically transform low resolution 360° videos to higher resolutions. Unlike for 2D videos, there are very limited work done in the field for the emerging 360° videos. This project is part of research which is focused on developing deep learning-based video super-resolution specifically designed for 360° videos.

Student(s) participating in this project will focus on redesigning the training and optimisation of these deep learning models to help it produce 360° videos of higher resolution with better perceptual quality. We will be looking into unique features of 360° videos and how that can help us design novel loss functions so that the models can be trained to produce super-resolution outcomes with better perceptual quality for human viewers. The outcomes generated will be evaluated using full-reference perceptual quality metrices popularly used in computer vision domain. Furthermore, outcomes from new models will be compared with benchmarks to understand changes in Quality of Experience (QoE).

Keywords: Video Super-resolution, Deep Learning, Optimisation and Loss Functions, 360° Video Technology

Necessary Skills:

- Programming skills (Python and PyTorch) are required
- Some experience with deep learning model training and testing
- Familiarity with video technology
- Comfortable to work with Linux environment and shell scripts
- Any experience with SLURM technology is a plus (but not mandatory)

Building Diffusion Models using Koopman

Supervisor: Prof Jinho Choi, jinho.choi@deakin.edu.au

Associate Supervisor: Dr Jihong Park

Campus: Melbourne Burwood;

Start: Trimester 1;Trimester 2;

Project type: Individual

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

Diffusion models are utilized in generative artificial intelligence (AI) to simulate and generate complex datasets. These models operate based on the concept of information spreading or diffusion through a network, capturing the dynamic interplay and interactions within the system. By leveraging diffusion processes, these models can effectively generate synthetic data that mirrors the intricate patterns and dependencies present in real-world datasets. In this project, the Koopman operator is to be used to perform backward and forward processes for diffision models.

Keywords: Diffision models; Koopman operator theory

Necessary Skills:

- Good mathematical background
- Coding experiences for Machine Learning

Quantum Machine Learning

Supervisor: Assoc Prof Lei Pan, l.pan@deakin.edu.au

Associate Supervisor: Assoc Prof Sutharshan Rajasegarar

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

Quantum computers are becoming a reality in our life with giant companies like Google, Microsoft and IBM experimenting prototypes. The advantages of the quantum computers and quantum algorithms are obvious in superb performance. However, the quantum algorithms have not been fully investigated in the context of machine learning algorithms. Existing studies only present primitive ideas, such as

• Biamonte, J., Wittek, P., Pancotti, N., Rebentrost, P., Wiebe, N. and Lloyd, S., 2017. Quantum machine learning. Nature, 549(7671), pp.195-202.

• Schuld, M., Sinayskiy, I. and Petruccione, F., 2015. An introduction to quantum machine learning. Contemporary Physics, 56(2), pp.172-185.

• Saggio, V., Asenbeck, B.E., Hamann, A., Strömberg, T., Schiansky, P., Dunjko, V., Friis, N., Harris, N.C., Hochberg, M., Englund, D. and Wölk, S., 2021. Experimental quantum speed-up in reinforcement learning agents. Nature, 591(7849), pp.229-233.

• Liu, N. and Rebentrost, P., 2018. Quantum machine learning for quantum anomaly detection. Physical Review A, 97(4), p.042315. The project consists of three major parts:

The first part of this project is to conduct a critical literature review on the currently published literature. Then the students are expected to improve one QML algorithms in the reviewed papers with novel contributions. The final part includes empirical evaluation and theoretical analysis of these algorithms.

Keywords: Quantum computing, machine learing

Necessary Skills: machine learing

IOT network traffic analysis with deep learning

Supervisor: Assoc Prof Lei Pan, l.pan@deakin.edu.au

Associate Supervisor: Assoc Prof Sutharshan Rajasegarar

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

Industry control systems (ICSs) are the important for our daily lives because they control critical infrastructure like power grid, water treatment, gas pipes. However, security attacks like false data injection, replay attacks, and DoS attacks greatly endanger the safety and security of ICSs. Contemporary approaches employ machine learning and deep learning algorithms to detect these attacks at the next work level. For example, this link contains a few datasets and several research papers.

The project consists of three major parts:

The first part of this project is to conduct a critical literature review on the currently published literature. Then the students are expected to implement the algorithms in the reviewed papers. The final part is the benchmark results of running these algorithms with respect to one or two datasets, and propose improved algorithms.

Keywords: Internet of Things, Network Traffic Modelling, Machine Learning, Python Programming

Necessary Skills:

- Python programming in machine learning, ideally completion of SIT744 and SIT720/SIT719

Exploring the use of deep learning techniques for anomaly detection in cybersecurity

Supervisor: Dr Leon Yang, leon.yang@deakin.edu.au

Associate Supervisor: N/A

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

This research aims to leverage advanced deep learning models, such as convolutional neural networks (CNNs) or recurrent neural networks (RNNs), to enhance anomaly detection in cybersecurity systems. Traditional methods often struggle to adapt to evolving cyber threats and may generate false positives. Deep learning models have shown promise in learning intricate patterns and behaviors within large datasets. The study could involve implementing and fine-tuning deep learning algorithms on real-world cybersecurity datasets, evaluating their performance, and comparing them with traditional methods.

Keywords: Data Science, Machine Learning, Cyber Security

Necessary Skills:

- Python programming or equivalent.
- Basic knowledge of Machine Learning and Data Science.

Large Language Model for Professional Training

Supervisor: Dr Leon Yang, leon.yang@deakin.edu.au

Associate Supervisor: N/A

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

Large language models (LLM) hold significant promise in offering diverse benefits and opportunities for individuals across various educational and professional stages. They play a crucial role in fostering the advancement of essential skills such as reading, writing, mathematics, science, and language proficiency. Through personalized practice materials, summaries, and explanations, these models contribute to elevating student performance and enhancing overall learning experiences.

In this project, we aim to outline how LLM applications such as ChatGPT are developed, and how they are being leveraged in professional training. It is also important to identify the limitations of LLM and why we should use these models with caution in professional training.

Keywords: Large Language Models, Education, Professional Training

Necessary Skills:

- Prompt Engineering
- Python programming or equivalent

Exploring Machine Learning for Predictive Analysis of Random Processes in Diverse Fields

Supervisor: Dr Mehdi Tavakol, mehdi.tavakol@deakin.edu.au

Associate Supervisor: N/A

Campus: Melbourne Burwood;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

Imagine a world where machines can predict financial market trends, foresee weather changes, and decipher hidden signals within data. This project is all about exploring the incredible capabilities of machine learning in diverse fields such as finance, weather forecasting, and signal processing. The primary goal is to boost predictive accuracy, study the complexities of randomness, and push the boundaries of machine learning in understanding and analysing random processes. Students engaged in this project will study the exciting realm of machine learning, focusing on developing models that can not only foresee but also classify and define random phenomena. It is an opportunity to uncover patterns, trends, and the fundamental structures hiding within randomness using various machine learning algorithms, especially in analysing time-series data, stochastic systems, and probabilistic models.

The project at hand is aimed to employ machine learning techniques in analysing random processes. The core emphasis lies in studying models that possess the ability to predict, categorise, and characterize random occurrences. Through the exploration of diverse machine learning algorithms, the project will specifically concentrate on time-series data, stochastic systems, and probabilistic models. By examining these, the research aims to unearth hidden patterns, identify trends, and reveal the underlying structures within the vast realm of random processes. Ultimately, this initiative aims to not only enhance our predictive capabilities but also to advance the understanding and utilisation of machine learning in deciphering the complexities inherent in random phenomena across various real-world applications.

Keywords: Random processes, machine learning.

Necessary Skills:

- Programming language experience --- Python, R, or MATLAB. Understanding the basics of data manipulation and analysis is essential. Knowledge of libraries like NumPy, Pandas, or scikit-learn in Python would be particularly helpful.
- Machine learning and networking basics: A foundational understanding of machine learning concepts is necessary. This includes knowledge of supervised and unsupervised learning techniques, classification, regression, clustering, and model evaluation methods.
- Statistics and Probability: A solid understanding of statistics and probability theory is crucial. This knowledge is essential for comprehending the probabilistic models and stochastic systems that underpin the analysis of random processes.

Recommenders Systems Data Generation

Supervisor: Dr Nayyar Zaidi, nayyar.zaidi@deakin.edu.au

Associate Supervisor: Prof Gang Li

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

Last few years have seen great success in the creation of structured data generation, such as images and text. There has been lot of work in the area of tabular data generation. However, the application of tabular data generation to that of recommender systems (RS) data, i.e., the utility matrix is not clear. This research will be the first of its kind in studying the generation of recommender system data. As the first stage, it will investigate methods such as GANBLR, MEG, CTGAN and other related methods in generating RS data. The second stage of this project will involve proposition of novel algorithms for RS data generation. The project will exploit salient pattern in RS data that is of correlation among the input features and the use of hidden latent features to modify MEG algorithm algorithm and shape a new novel algorithm. The last stage of this project will involve writing the paper for ICDM2024 or CIKM2024.

Keywords: Data Generation, Machine Learning, GANBLR, Recommender Systems

Necessary Skills:

- Excellent Machine Learning knowledge
- Proficient with Python, PyTorch or TensorFlow.

Use of Marginal and Conditional Divergences for Data Generation

Supervisor: Dr Nayyar Zaidi, nayyar.zaidi@deakin.edu.au

Associate Supervisor: Prof Gang Li

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

Last few years have seen great success in the creation of structured data generation, such as images and text. There has been lot of work in the area of tabular data generation. The state of the art tabular data generation model leverages Bayesian networks, e.g., GANBLR or MEG. In this work we will aim to learn a sub-class of Graphical Models which are decomposable and leverage conditional divergences to learn them effectively in a GAN framework. The outcome of this research will be proportion of a modified GANBLR model with uses a special class of graphical models. The work will work on proposition of such algorithm, as well as thorough evaluation and testing. The second phase of this project will involve writing the report for publication in conferences such as ICDM, CIKM or ECML-PKDD.

Keywords: Machine Learning, Data Generation, Restricted Boltzmann Machines, GANBLR

Necessary Skills:

- Excellent understanding of Machine Learning
- Good skills in Python, PyTorch and TensorFlow
- Ability to prototype in Python and reading relevant research papers

Graphical Model Learning via Reinforcement Learning

Supervisor: Dr Nayyar Zaidi, nayyar.zaidi@deakin.edu.au

Associate Supervisor: Prof Gang Li

Campus: Melbourne Burwood;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

Structure learning is such an important aspect of any graphical models in Machine Learning. It boils down to fining links among the covariates to maximising a certain goal to achieve an objective. In this work we will make use of Bayesian Networks as as example of graphical models, and study their structure learning with reinforcement learning (RL). The first part of this project will study some latest works in this area especially with-in-the context of flow-networks for Bayesian Network structure learning. The second part of the project will involve formulating a novel algorithm for incorporating reinforcement learning for structure learning. The work will explore the study in the context of decision making in mid-frequency trading, and see how a better structure can be learned through an RL-based feedback loop. The final stage of this project will involve writing the paper for conferences such as KDD, ICDM or ECML-PKDD.

Keywords: Machine Learning, Data Generation, Reinforcement Learning, Bayesian Networks

Necessary Skills:

- Excellent understanding of Machine Learning
- Good skills in Python, PyTorch and TensorFlow
- Ability to prototype in Python and reading relevant research papers

Quantum simulations in Qiskit

Supervisor: Dr Ria Rushin Joseph, ria.joseph@deakin.edu.au

Associate Supervisor: Assoc Prof Sutharshan Rajasegarar

Campus: Melbourne Burwood;

Start: Trimester 1;Trimester 2;

Project type: Individual

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

Examining the dynamic behaviour of one-dimensional Fermi gases [2, 4] at finite temperatures, has been effectively addressed through the utilization of the Majorana P-function method [1], as outlined in the publication [2]. This project endeavours to reshape the simulation of this intricate problem by adapting it for execution on quantum computing platforms such as IBM Qiskit or similar alternatives [3,5]. The overarching goal is to shift from classical to quantum computational paradigms, enabling the simulation of authentic quantum problems on quantum computers. This strategic transition aims to circumvent challenges associated with classical computing, particularly those arising with an increase in system size. By thoroughly investigating this quantum approach, valuable insights may be gained, offering a promising avenue for overcoming hurdles in large-scale simulations of quantum problems.

[1] Joseph, R. R., Rosales-Zárate, L. E., & Drummond, P. D. (2018). Phase space methods for Majorana fermions. Journal of Physics A: Mathematical and Theoretical, 51(24), 245302.

[2] Joseph, R. R., Rosales-Zárate, L. E., & Drummond, P. D. (2018). Finite-temperature dynamics

of shock waves in an ultracold Fermi gas. Physical Review A, 98(1), 013638.

[3] Brown, K. L., Munro, W. J., & Kendon, V. M. (2010). Using quantum computers for quantum simulation. Entropy, 12(11), 2268-2307.

[4] He, W. B., Chen, Y. Y., Zhang, S., & Guan, X. W. (2016). Universal properties of Fermi gases in one dimension. Physical Review A, 94(3), 031604.

[5] haq Shaik, E., & Rangaswamy, N. (2020, October). Implementation of quantum gates based logic circuits using IBM Qiskit. In 2020 5th International conference on computing, communication and security (ICCCS) (pp. 1-6). IEEE.

The project will unfold through a structured three-step process:

1. Conducting a comprehensive literature review.

2. Developing representations of the quantum system within the quantum simulator.

3. Executing the implementation on an actual quantum computer.

Keywords: qiskit, quantum computer, quantum simulation

Necessary Skills:

- Python programming in Qiskit, Linear algebra

Reinforcement learning with non-monotonic rewards using scalarised multiobjective non-linear decomposed rewards

Supervisor: Prof Richard Dazeley, richard.dazeley@deakin.edu.au

Associate Supervisor: Dr Thommen George

Campus: Geelong Waurn Ponds;Melbourne Burwood;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

Reinforcement Learning typically assumes an agent aims to maximise its reward. However, there is evidence that humans/animals do not aim to maximise a reward and instead simply aim to reach a level of reward that satisfies its requirements. For example, people stop eating when full even if there is still food available. Furthermore, people can even have a negative reward for an action that used to be positive. For instance, the pleasure of eating chocolate becomes a negative once you have had too much. This type of reward represented a non-monotonic reward which current RL methods can not learn.

This project aims to develop an approach that can learn to optimise for a non-monotonic reward. This will be accomplished through reward decomposition over multiple objectives. Each objective is itself non-linear but still monotonic. These monotonic functions can then be linearly scalarised into a single non-monotonic function. An agent then aims to maximise this scalarised combination of objectives to find the optimal point of maximal reward. Such an agent can automatically moderate its behaviour to not overindulge. Such an agent is key to the development of self-rewarding agents based on curiosity-based learning and can provide an approach to soft-thresholding for non-linear multiobjective problems.

Keywords: Reinforcement Learning (RL), Multiobjective Reinforcement Learning (MORL), Machine Learning, Programming.

Necessary Skills: Strong Python Programming, Machine Learning knowledge.

Optimisation Techniques to Multi-Component Bin Cutting and Packing Problems

Supervisor: Dr Sergey Polyakovskiy, sergey.polyakovskiy@deakin.edu.au

Associate Supervisor: N/A

Campus: Melbourne Burwood;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

Cutting and packing problems search for a feasible packing of small items into large objects so as to minimize the respective production costs. Their real-life applications often consist of several sub-problems of different nature. Not only do they combine several optimisation aspects into a single problem, but they also emanate from the compounded complexity of conflicting issues in numerous areas like logistics, planning and manufacturing. Solving them requires a thorough understanding of both their compounded and their individual natures. As traditional optimisation methods may demonstrate only limited efficiency for such problems, designing decomposition approaches hybridizing several algorithmic techniques to handle their specificity and complexity appears promising. Therefore, the focus of this research is on the design and application of perspective hybrid and decomposition optimisation methods, search strategies, and learning techniques to advance the search process. On the application side, it aims to develop state-of-the-art solution techniques to a number of multi-component optimisation problems prevailing in the industry.

Keywords: Optimisation, Algorithms Design, Cutting and Packing Problems, Decomposition Techniques

Necessary Skills:

- Strong programming skills in Java or C#
- Understanding of combinatorial optimisation techniques such as meta-heuristics (Desired)
- Understanding of integer/constraint programming techniques (Desired)

3D Image Classification through Deep Learning Techniques

Supervisor: Dr Son Tran, son.tran@deakin.edu.au

Associate Supervisor: N/A

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

3D point cloud classification lies has pivotal role in self-driving vehicles by enhancing perception and decision-making capabilities. By accurately identifying and classifying objects in the surrounding environment, such as pedestrians, vehicles, and obstacles, the technology enables precise obstacle detection and avoidance.

In this project, we will develop a deep learning model for 3D point cloud classification. We investigate the integration of feature extraction techniques for improved representation and explore the impact of different network architectures on classification performance. For evaluation, we compare the proposed model on benchmark datasets with existing methods.

In particular, we will design a Structural Graph Neural Networks (SGNNs) specifically for 3D point cloud classification, leveraging the inherent structure of the data by treating the point cloud as a graph. Unlike traditional GNNs, SGNNs integrate both geometric and topological information, allowing them to capture both local and global structural features. SGNNs use hierarchical representations and graph pooling mechanisms to discern multi-scale features, crucial for recognising objects of varying sizes in complex 3D scenes.

Keywords: predictive data analytics, deep learning, 3D classification

Necessary Skills: Programming skills (any programming languages, Python is a plus), basic knowledge of machine learning**,** good reading and writing skills.

Clustering performance evaluation in the literature – A review

Supervisor: Dr Sunil Aryal, sunil.aryal@deakin.edu.au

Associate Supervisor: Dr Reda Bouadjenek

Campus: Geelong Waurn Ponds;Melbourne Burwood;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

Clustering is an unsupervised machine tasks of partitioning a set of data objects into multiple subsets such as objects in belonging to a subset are more similar than objects belonging in different subsets. It has application in real-world applications such as market/customer segmentation in marketing, communities' detection in social media, functional grouping of genes/proteins, etc. A wide range of clustering techniques/methods and evaluation metrics have been used in the literature. Because it is an unsupervised task, evaluation of clustering results in real-world application is challenging. This project aims to review approaches/metrics used to evaluate clustering results in the literature and assess their usefulness in real-world problems where ground truth (true grouping of data objects) is not known.

Keywords: Machine Learning, Deep Learning, Unsupervised Learning, Clustering, Cluster Analysis, Area Under the ROC Curve, F-Measure, Cluster purity, Silhouette Coefficient, Rand Index, NMI, FMI, etc.

Necessary Skills:

- Strong python programming and a very good understanding of Machine Learning, Deep Learning, particularly unsupervised learning for clustering

Emotion and behaviour detection from videos

Supervisor: Assoc Prof Sutharshan Rajasegarar, sutharshan.rajasegarar@deakin.edu.au

Associate Supervisor: Prof. John Yearwood, Dr. S Thuseethan

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

Detecting human emotions and behaviours from videos and images are important for monitoring purposes as well as for Artificial Intelligence (AI) applications. The challenge is to identify these different types of emotions and behaviours from in-the-wild videos and images accurately and in a timely manner. Methods, such as classical machine learning methods and deep learning methods can be used to identify the various emotions in different scenarios. The aim of the project includes, performing critical literature survey on existing emotion detection methods in various applications. Implementing and comparing some of the latest methods for detecting emotions using publicly available data. Propose novel algorithms for detecting emotional behaviours accurately. Implement those algorithms, evaluate them and empirically as well as theoretically compare with existing algorithms.

Keywords: video processing, image processing, Machine Learning, Deep learning, AI.

Necessary Skills:

- Knowledge of deep learning algorithms
- Programming Knowledge in Python

Quantum machine learning methodologies for Anomaly detection

Supervisor: Assoc Prof Sutharshan Rajasegarar, sutharshan.rajasegarar@deakin.edu.au

Associate Supervisor: Assoc Prof Lei Pan

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

Quantum computing and quantum machine learning/quantum-AI technologies have been accelerating in development nowadays. It's use has been demonstrated in various fields. An important research in quantum machine learning is in anomaly detection. Detecting anomalies in data is important for finding interesting events or cyber security threats. Quantum machine learning based methods can be used to model the normal patterns in the data and find the anomalies. The aim of the project includes, performing literature survey on existing quantum machine learning based anomaly detection methods, Implementing and comparing some of the latest methods, and or detecting anomalies using publicly available data, propose improvements to the existing methods and evaluate them, and publish the findings as a research paper.

Keywords: Quantum machine learning, deep learning, anomaly detection, outlier detection

Necessary Skills:

- Programming knowledge in Python
- Knowledge about Machine learning, Deep learning, Quantum computing

Machine learning based cyber-attack detection

Supervisor: Assoc Prof Sutharshan Rajasegarar, sutharshan.rajasegarar@deakin.edu.au

Associate Supervisor: Assoc Prof Lei Pan

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

With the advancement in AI and internet of Things (IoT), it has become economically viable to deploy large scale networks for communication and data collection purposes with various sensors, computers and communication devices interconnected with internet. A challenge here is to detect any unusual or anomalous activities in the network, such as cyber-attacks, from the data that has been communicated in the network. The aim of the project includes (i) critical review of cyber attack detection methodologies using deep learning/machine learning/large language models in the literature (ii) implementing them and comparing their performances (iii) proposing improved methodologies to detect them (iv) evaluating and comparing the performances, and (v) writing and publishing a research paper based on the work.

Keywords: cyber attacks, deep learning, anomaly detection, large language models

Necessary Skills:

- Programming Knowledge in Python
- Knowledge of deep learning algorithms

Machine learning based plant disease/health monitoring from mobiles, drones and satellite data

Supervisor: Assoc Prof Sutharshan Rajasegarar, sutharshan.rajasegarar@deakin.edu.au

Associate Supervisor: Dr S. Thuseethan, Prof John Yearwood

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

Monitoring crop/plant health, such as detecting diseases, pests, and growth imperfections in a timely manner is important for the agriculture industry. A challenge is how to detect the onset of health issues in plants accurately from various sensor data, such as images and videos captured from mobiles, drones and satellites. This will enable farmers to take necessary mitigation steps. The aim of the project include: i) performing comprehensive literature survey on the state of the art machine learning/ deep learning based methods for crop health monitoring ii) implementing some of the latest methods and comparing their performance with various metrics iii) propose and implement novel machine learning/deep learning based methods for highly accurate and fast detection of health issues in plants/crops and evaluate them, including comparing with other existing methods (iv) writing and publishing a research paper based on the work.

Keywords: drones, smart agriculture, plant disease monitoring, deep learning

Necessary Skills:

- Python programming
- Machine learning/deep learning knowledge

Smart fleet management system (application) for a network of Electric Vehicles-Real-time Charging Scheduling and Routing Strategy

Supervisor: Dr Valeh Moghaddam, valeh.moghaddam@deakin.edu.au

Associate Supervisor: Dr Adnan Anwar

Campus: Melbourne Burwood;

Start: Trimester 2;

Project type: Individual

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

The global market share of electric vehicles (EVs) is on the rise, resulting in a rapid increase in their charging demand in both spatial and temporal domains. EVs fleet management is overseeing the charging needs of fleet drivers and electric vehicles as well as ensuring the charging infrastructure is optimized to fulfill those needs. The volume of vehicles and distances traveled must be analysed to determine the number of the depot and/or “on the road” charge points required and the distance between them – whether owned and operated by the fleet owner, public charge points, or home-based charge points for lighter vehicles. This directly addresses the issue of range anxiety, ensuring vehicles have access to charge points when and where they need them, whether on the road or at the depot, so they can complete their missions. In this research project, we aim to focus on a joint charging scheduling/ routing strategy to operate an optimal EV fleet.

Keywords: Routing, Scheduling, Electric vehicle, Charge/ Discharge, Data analytics

Necessary Skills:

- Good knowledge of Mathematical modeling, Machine learning/ Deep learning
- Knowledge of classification and neural networks (desirable)

Forecast BAU energy values

Supervisor: Prof Vicky Mak-Hau, vicky.mak@deakin.edu.au

Associate Supervisor: N/A

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

Deakin University is committed to being carbon neutral and powered by 100% renewable electricity by 2025. Carbon Neutral 2025 (CN2025) is Deakin's plan to achieve carbon neutrality. It will implement projects across Deakin's buildings to reduce energy and emissions via projects such as improving Building Automation Systems, upgrading old lighting, upgrading new energy efficient Heating, Ventilation and Air Conditioning (HVAC) and installing on-site solar PV.

A key component of CN2025 is to Measure and Verify energy savings achieved by the projects. Whilst a global protocol (IPMVP) is established, and guidelines exist on how to measure and verify energy savings, the conceptual challenge is that the energy savings cannot be measured. Rather, savings are calculated as the difference between "real" actual measurements, taken after the project has been delivered installed, and "business as usual" (BAU) values that would have been measured if the project had not been delivered.

BAU energy values are estimated by taking pre-project measurements, and adjusting those to post-project conditions by using a transparent, predetermined and pre-agreed M\&V computational methodology. The challenge is how estimation of the BAU values are performed and how uncertainty (error) in the estimation can be minimised and quantified so all parties have confidence in the calculated energy savings which rely on the estimated Baseline Energy values.

The project is looking to develop predictive models that can forecast BAU energy values based on pre-project measurements drawn from Deakin's energy metering, as well as variables such as operational data from Deakin's IoT and operational platforms, along with weather data, and other variables as deemed necessary.

Keywords: Machine Learning **Necessary Skills:** Data analytical knowledge and skills

Unravel quantum computing techniques used in lattice-based cryptography proofs

Supervisor: Dr Yang Li (Kelvin), kelvin.li@deakin.edu.au

Associate Supervisor: N/A

Campus: Melbourne Burwood;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

Setting aside its prominent features of being quantum safe and worst case hard, the security of lattice-based cryptography is established using the same computational complexity techniques as that in number-theoretical cryptography.

The mathematical foundations of lattice-based cryptography schemes are computational lattice problems that are either proved or strongly believed to be infeasible to solve in a reasonable time (i.e., polynomial time in most cases). To rely the security of a cryptographic scheme on a lattice problem is to establish a polynomial time reduction from the problem to the scheme. This way, the reduction will be part of a solution to the hard lattice problem, should the security of the cryptographic scheme be compromised.

In some hardness proofs of lattice-based problems, in order to achieve polynomial running time and reasonably small approximation factors, the reduction is sometimes a hybrid of classical (i.e., non-quantum) and quantum steps. The hardness proof of learning with error (LWE) is an example of a hybrid reduction, where quantum computing techniques played a pivotal role to transform the approximate solution of a closed vector problem in the dual lattice to the solution of a discrete sampling problem in the lattice.

This project will take a deeper investigation into quantum computing techniques used to prove lattice-based problems (e.g., LWE and Ring-LWE), with the following questions to be answered.

1. What are the key quantum computing components used in these proofs, e.g., quantum fourier transform?

2. How do these quantum techniques bridge the reduction gaps?

3. What are the limitations of classical computing techniques to establish the same reductions? An example is Peikert's effort to replace the quantum step in LWE proof. It resulted in a less preferred security guarantee that is based on a non-standard lattice problem and larger modulus q.

References:

O. Regev. On lattices, learning with errors, random linear codes, and cryptography. Journal of the ACM (JACM), 56(6):1–40, 2009.

C. Peikert. Public-key cryptosystems from the worst-case shortest vector problem. In Proceedings of the 41st annual ACM symposium on Theory of computing, pages 333–342, 2009.

Keywords: lattice-based cryptography, learning with errors, quantum computing, quantum fourier transform

Necessary Skills:

Basic understanding of the following fields:

- computational complexity theory
- lattice-based cryptography
- quantum computing

Time Series Anomaly Detection

Supervisor: Dr Ye Zhu, ye.zhu@deakin.edu.au

Associate Supervisor: Assoc Prof Sutharshan Rajesegarar

Campus: Melbourne Burwood;Cloud;

Start: Trimester 1;Trimester 2;

Project type: Individual

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

Time series anomaly detection is the task of identifying unusual patterns or events in temporal data that do not conform to normal behaviour. It has many applications in various domains, such as finance, health care, security, and manufacturing. However, it also poses many challenges, such as high dimensionality, noise, seasonality, and non-stationarity of the data. This project focuses on developing novel and effective methods for time series anomaly detection using statistical models and deep learning methods.

Keywords: Time Series, Anomaly Detection

Necessary Skills:

- Python programming
- Basic machine learning
- Statistics background

Data Stream Clustering for Real-Time Data Analysis

Supervisor: Dr Ye Zhu, ye.zhu@deakin.edu.au

Associate Supervisor: Prof Gang Li

Campus: Melbourne Burwood;Cloud;

Start: Trimester 1;Trimester 2;

Project type: Individual

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

Data stream clustering is the task of grouping similar data points from a continuous and unbounded stream of data. It can enable real-time data analysis for various domains, such as sensor networks, social media, e-commerce, and cyber security. However, it also poses many challenges, such as limited memory, evolving data distribution, concept drift, and outlier detection. We are looking for master students who are interested in developing novel and effective methods for data stream clustering. The students will work on topics such as online learning, incremental clustering, adaptive clustering, and stream summarization.

Keywords: Data Stream, Data Analysis, Clustering

Necessary Skills:

- Python programming
- Basic machine learning
- Statistics background

Navigational Agents in Games via Reinforcement Learning

Supervisor: Assoc Prof William Raffe, william.raffe@deakin.edu.au

Associate Supervisor: TBD

Campus: Melbourne Burwood;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Group

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

For many decades, the navigation of non-player characters (NPCs) in games has been handled with navigation grids (such as nav-meshes) that are processed using traditional graph traversal algorithms such as A*. These techniques, while generally useful and stable, are typically limited to simple and static environments, combined with simple agent actions. However, more and more games are including complex action sets and dynamically changing environments, reducing the effectiveness of these techniques and often causing the NPC action set to be limited or the game to be player-to-player (e.g. online multiplayer) interactions only. A new line of work is emerging in the games research field to overcome these limitations by using reinforcement learning agents to learn complex action sets and adapt to changing environments. In this project, you will work in this area, building upon recent developments in this area and pushing the state of the art in agent navigation in games. Due to the advanced nature of this work, this project is suitable as a group project.

Keywords: game development, reinforcement learning

Necessary Skills:

- A strong knowledge of machine learning, preferably with past experience in reinforcement learning techniques.

An Intelligent Solution for Occupational Injury Risk Mitigation

Supervisor: Dr Leon Yang, leon.yang@deakin.edu.au

Associate Supervisor: N/A

Campus: Geelong Waurn Ponds;Melbourne Burwood;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Group

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

Handling large, heavy, or awkward objects during manual lifting poses a significant risk of musculoskeletal disorders (MSDs) for employees. These disorders encompass various injuries such as sprains, strains, fractures, and soft-tissue damage to the back and shoulders. Surprisingly, more than half of MSD cases result from a lack of awareness regarding proper postures during movement or lifting.

To address these occupational health and safety (OHS) concerns, the proposed project aims to employ advanced computer vision and image processing techniques. The objective is to develop a solution that accurately tracks employees' postures when moving or lifting substantial objects by hand. This innovative system serves a dual purpose: during the training stage, it can educate staff on safe postures for these activities, and in day-to-day operations, it continuously monitors the safety of all relevant employees in their working environments.

The project can operate with a standard webcam as the input source. As the solution evolves, there is potential for expansion to incorporate high-resolution cameras, coupled with the processing capabilities of a high-end PC for enhanced performance.

Keywords: Computer Vision, Image Processing, Machine Learning

Necessary Skills:

- Python programming or equivalent.
- Basic knowledge of Computer Vision, Image Processing, and Machine Learning.
- Web and cloud programming skills are preferred.

Restricted Boltzmann Machines for Tabular Data Generation

Supervisor: Dr Nayyar Zaidi, nayyar.zaidi@deakin.edu.au

Associate Supervisor: Prof Gang Li

Campus: Melbourne Burwood;Geelong Waurn Ponds;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Group

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

Restricted Botzmann Machines (RBM) are standard classical classification algorithms, which have solid foundations in Physics and theoretical Machine Learning. Their training can be computationally intensive, however, with the recent advancements in algorithms such as contrastive divergence, they can be trained rather efficiently. This paper will explore their data generation ability. In the last few years, there has been plethora of research in tabular data generation, with state of the art models such as GANBLR, CTGAN, TableGAN, etc. RBMs are not explored. In the first stage of this project, we aim to explore the data generation capability of RBM and see how it compares with the other algorithms. The second stage will involve modifying RBM to be trained in game-theoretic manner similar to GAN framework, and proposing a new algorithm for tabular data generation using RBM. The final stage of this project will involve writing the paper for conferences such as ICDM, ECML-PKDD or KDD.

Keywords: Machine Learning, Data Generation, Restricted Boltzmann Machines, GANBLR

Necessary Skills:

- Excellent understanding of Machine Learning
- Good skills in Python, PyTorch and TensorFlow
- Ability to prototype in Python and reading relevant research papers

Safely exploring with Rule-based Multiobjective Reinforcement learning

Supervisor: Prof Richard Dazeley, richard.dazeley@deakin.edu.au

Associate Supervisor: Dr Thommen Karimpanal

Campus: Geelong Waurn Ponds;Cloud;Melbourne Burwood;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Group

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

Reinforcement learning (RL) agents learn through trial-and-error. However, most work is based on the idea that the error is not catastrophic or even particularly damaging. However, in the real world there are many things an agent can do that could present a disaster. For example, we do not want an agent learning to drive crashing a car multiple times before learning to turn. Current approaches to RL cannot learn without making mistakes preventing their widespread application in real world domains.

Multiobjective reinforcement learning allows us to place constraints on an agent through secondary, tertiary, or nth objectives. These objectives can be safety aligned to restrict an agent from exploring in dangerous places. However, it still must know where those unsafe areas are and the degree to which they are unsafe. Developing such a reward mechanism during design is generally too difficult for non-trivial tasks.

In this project you will design an algorithm that uses an incrementally built knowledge-based system that allows a user to easily identify unsafe situations and instruct the agent. The agent using these rules to define safety thresholds on an auxiliary objective will learn to solve a driving task such that it never has an accident even while learning.

Keywords: Reinforcement Learning (RL), Multiobjective Reinforcement Learning (MORL), Impact Minimisation, Safe RL, Ripple Down Rules, Simplified Autonomous Vehicles, Machine Learning, Programming

Necessary Skills:

- Strong Python Programming. Machine Learning knowledge, Understanding of Knowledge Based Systems preferred but not essential

Vehicle Routing with Loading Constraints

Supervisor: Dr Sergey Polyakovskiy, sergey.polyakovskiy@deakin.edu.au

Associate Supervisor: N/A

Campus: Cloud;Melbourne Burwood;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Group

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

This project deals with a class of real-world optimisation problems in the area of transportation logistics. Given a heterogeneous fleet of vehicles, the problem searches for a set of routes of the minimal total cost that serve a set of customers with known demands of rectangular items. Each route must start from and terminate at the central depot. Each customer must be visited only once by one of the vehicles. The capacity of each vehicle must not be violated by the total weight of assigned items, while the items must fit into the vehicle and not overlap. In addition, the order that each route visits its customers must be feasible in regard to loading/unloading of the items into/from the vehicle. Because solving large instances of the problem to optimality is computationally challenging, this project focuses on effective heuristic algorithms that can produce state-of-the-art solutions to benchmark and real-life problems.

Keywords: Optimisation, Algorithms Design, Vehicle Routing, Bin Packing

Necessary Skills:

- Strong programming skills in Java or C#
- Understanding of combinatorial optimisation techniques such as meta-heuristics (Desired)
- Understanding of integer/constraint programming techniques (Desired)

Advanced Routing for a Mixed Fleet of Electric Vehicles

Supervisor: Dr Sergey Polyakovskiy, sergey.polyakovskiy@deakin.edu.au

Associate Supervisor: N/A

Campus: Cloud;Melbourne Burwood;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Group

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

Because the transportation, especially in Australia where distances are vast, is the major contributor to pollution and climate changes, many logistics companies have become not only cost but also CO2 emissions focused. One of solutions to assist positive changes is to use electric vehicles (EVs) instead of conventional vehicles. This makes the electric vehicle routing problem particularly interesting for such logistics companies. Given a fleet of EVs, a set of customers, and a set of charging stations, it searches for the best possible (shortest) routes that serve the customers starting and ending at the central depot. Since EVs have limited driving range due to their battery capacities, they may need to visit recharging stations while serving the customers along their routes. There are different variants of this problem that may consider numerous characteristics of real-life applications, including heterogeneity of the fleet, time constraints, charging infrastructure, charging profiles, and limited charging capacity. Vehicle routing problems are known to be computationally hard to solve. Finding an efficient solution in a reasonable time is challenging due to a huge solution space that is intrinsic to this class of problems. Prospective approaches to the problem are those that hybridize several algorithmic techniques. This project is inspired by the success of such approaches, especially those that can explore solution space by learning the problem's model from existing effective solutions.

Keywords: Optimisation, Algorithms Design, Vehicle Routing, Logistics

Necessary Skills:

- Strong programming skills in Java or C#
- Understanding of combinatorial optimisation techniques such as meta-heuristics (Desired)
- Understanding of integer/constraint programming techniques (Desired)

Multi-Output Deep Learning for Leaf Disease and Plant Species Prediction

Supervisor: Dr Son Tran, son.tran@deakin.edu.au

Associate Supervisor: N/A

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Group

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

The proposed research aims to apply and compare techniques for relational multi-output deep learning, focusing on predicting multiple outputs where inherent relationships exist among the output variables. Traditional multi-output prediction models often treat outputs independently, neglecting potential dependencies that may exist between them. This research seeks to bridge this gap by exploring advanced deep learning architectures capable of capturing and exploiting the underlying relational structures among multiple output variables.

The primary objective of this research is to design and implement a framework for multi-output deep learning that can effectively model and predict multiple interrelated output variables. By acknowledging and leveraging the dependencies among outputs, we aim to enhance the accuracy and interpretability of predictions, making the model more adaptable to real-world scenarios where outputs are intricately linked.

We will develop novel deep learning architectures that explicitly consider and model relationships between multiple output variables. We will integrate attention mechanism and graph neural networks to capture and incorporate dependencies within the model. The project will utilise appropriate evaluation metrics to assess the model's predictive performance, considering both individual output accuracy and the preservation of relational dependencies. We will employ leaf images where multiple outputs exhibit meaningful relationships between plant species and disease types. This ensures the applicability and generalisability of the proposed relational multi-output deep learning framework across various domains.

Research Question and Outcome 1: The first research question focuses on modelling the relationships between plant species and diseases and integrating the relationships into deep learning models. We will investigate whether such integration could improve the prediction performance. The outcome will include an integration approach and a comparative analysis with existing approaches.

Research Question and Outcome 2: The second question focuses on enabling a deep learning model to be updated with more tasks, e.g. learning to predict new species of plants and new diseases, without affecting the performance of other tasks. The outcome will include a continual learning algorithm for deep networks and a comparative analysis with existing approaches.

Keywords: Predictive Data Analytics, Multi-output Deep learning, Plant Pathology

Necessary Skills:

- Programming skills (any programming languages, Python is a plus)
- Basic knowledge of machine learning
- Good reading and writing skills.

Efficient federated learning methodologies for modelling

Supervisor: Assoc Prof Sutharshan Rajasegarar, sutharshan.rajasegarar@deakin.edu.au

Associate Supervisor: Assoc Prof Lei Pan

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Group

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

With the advancement of AI and internet of things (IoT), the amount of data collected from various devices has increased. It is important to process them quickly to learn a model to perform various tasks such as anomaly detection, classification, cybersecurity, monitoring, and prediction. This has brought about challenges in processing them in a timely manner and with small computing resources, such as on the edge devices or sensor devices. The aim of the project includes (i) critical review of various federated machine learning and deep learning methods in the literature (ii) implementing them and comparing their performances (iii) proposing improved federated methodologies depending on the application/task (iv) evaluating and comparing the performances, and (v) writing and publishing a research paper based on the work.

Keywords: Federated learning, distributed learning, IoT, machine learning, deep learning

Necessary Skills:

- Knowledge of machine learning, deep learning algorithms
- Programming Knowledge in Python

Analysis and Prediction of Electric Vehicle Charging Behaviour

Supervisor: Dr Valeh Moghaddam, valeh.moghaddam@deakin.edu.au

Associate Supervisor: Assoc Prof Sutharshan Rajasegarar

Campus: Melbourne Burwood;

Start: Trimester 2;Trimester 1;

Project type: Group

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

Electric vehicles (EVs) usage has started to increase in many countries, including Australia. A challenge here is the rapid increase in their charging demand in both spatial and temporal domains. Therefore, it is important to analyse the EV charging behaviour and perform an accurate prediction of likely demands in the short and long terms. The aim of the project includes performing a comprehensive literature survey of existing EV charging behaviour analysis and prediction methods including machine learning and deep learning methods, implementing, and comparing some of the latest methods for forecasting the EV charging behaviour, proposing and implementing improved forecasting models and comparing with other existing methods in the literature, and preparing and presenting the results in the form of report and publication.

Keywords: Electric Vehicle charging behaviour, Machine learning, deep learning

Necessary Skills:

- Good knowledge of Machine learning, Deep learning, and Programming knowledge, such as Python

Mining Massive Trajectory Data

Supervisor: Dr Ye Zhu, ye.zhu@deakin.edu.au

Associate Supervisor: Prof Gang Li

Campus: Melbourne Burwood;Cloud;

Start: Trimester 1;Trimester 2;

Project type: Group

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

Trajectory data is the record of the spatial and temporal movements of objects, such as vehicles, animals, or humans. Mining massive trajectory data can reveal valuable insights into the behavior, preferences, and patterns of the objects and their environment. It can also enable various applications, such as traffic management, urban planning, wildlife conservation, and location-based services. We are looking for master students who are interested in developing novel and effective methods for mining massive trajectory data. The students will work on topics such as clustering, classification, outlier detection, pattern mining, and visualization of trajectory data.

Keywords: Trajectory mining, data analysis

Necessary Skills:

- Python programming
- Basic machine learning
- Statistics background

Anomaly detection for industrial quality assurance

Supervisor: Dr Ye Zhu, ye.zhu@deakin.edu.au

Associate Supervisor: Prof Gang Li

Campus: Melbourne Burwood;Cloud;

Start: Trimester 1;Trimester 2;

Project type: Group

Project Discipline: Mathematics/AI/Data Science/Data Analytics

Project Description:

In modern manufacturing, quality assurance plays a crucial role in ensuring product integrity and customer satisfaction. Traditional quality control methods, often relying on manual inspection, are time-consuming, labor-intensive, and prone to human error. Anomaly detection, a data-driven approach, offers a promising solution to automate and enhance quality assurance processes. This research aims to explore techniques to implement anomaly detection in real-time, enabling immediate identification and correction of defects.

Keywords: Anomaly detection, quality assurance

Necessary Skills:

- Python programming
- Basic machine learning
- Statistics background

Project Discipline: Software Engineering/Computer Science

Improving engagement in SIT102 with Arcade Machines

Supervisor: Prof Andrew Cain, andrew.cain@deakin.edu.au

Associate Supervisor: N/A

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Software Engineering/Computer Science

Project Description:

It is crucial for mobile service robots to be able to safely move among people. Traditionally, path planning for mobile robots involves finding the shortest path to a goal position, however, in human environments, additional criterion needs to be considered. For instance, the robot should not get very close to people or move too fast, because it will scare off people. Moreover, the robot's actions should be predictable so that humans understand where the robot wants to go. This requires designing of human-robot interaction methods that enables smooth and safe navigation among people.

The project can involve the detection and tracking of humans around the robot using cameras and LIDAR, path planning in partially observable environments, obstacle avoidance in crowded environments, generating predictable robot motions. The developed algorithm can be tested in user studies to understand what people expect from mobile robots. The project will aim towards a specific application, such as autonomously following a person, guiding a person, getting on/off an elevator, delivering an object to a human or taking good pictures of people.

The project can be carried out on several different robotic platforms. We have several robots to choose from in the lab – Unitree Go1 Robotic Dog, Turtlebot 4 or Zumo robot. Depending on the robot platform chosen, indoor or outdoor navigation can be considered. This is a hands-on project, and the student is expected to demonstrate the developed algorithm on the robot. The job involves software development for robots, either in Python or C++, within the Robot Operating System (ROS).

Keywords: Robotics, AI, Machine Learning

Necessary Skills: Should be proficient in Machine Learning

Improving engagement in IT Education through hands-on technologies

Supervisor: Prof Andrew Cain, andrew.cain@deakin.edu.au

Associate Supervisor: Assoc Prof Kevin Lee, Dr Imali Dias

Campus: Melbourne Burwood;Cloud;

Start: Trimester 1;Trimester 2;

Project type: Individual

Project Discipline: Software Engineering/Computer Science

Project Description:

This project will investigate the benefits of using hardware technologies to engage students in first year programming units at Deakin. The project will first complete a literature review of the use of embedded systems technologies including Arduinos, Raspberry Pis, and DevOps automated pipeline deployment technologies in the education space. The project will investigate what are the challenges for uses these technologies in class.

This is an exciting and challenging project which will have real impact for students. The project will be published in IT education research literature.

Keywords: Internet of Things, Embedded Systems, Education Technologies

Necessary Skills:

- Embedded system, Linux, and programming skills

Investigating the gamification of Programming Education

Supervisor: Prof Andrew Cain, andrew.cain@deakin.edu.au

Associate Supervisor: Assoc Prof Kevin Lee

Campus: Melbourne Burwood;Cloud;

Start: Trimester 1;Trimester 2;

Project type: Individual

Project Discipline: Software Engineering/Computer Science

Project Description:

Gamification is the idea of introducing game mechanics to non-gaming contexts to try to incentivise improved performance. In education, student performance is heavily dependent on the engagement and enthusiasm of students, so it's logical to investigate the possibility benefit of gamifying learning – particularly for programming.

The project will initially conduct an extensive literature review of gamification in IT education and similar areas. Depending on the results of this, it is likely that the project will seek to integrate gamification approaches into Deakins OnTrack learning management system. The focus will be on trying to improve programming engagement in first year programming units.

This is an exciting project which will excite many students in programming units in the future. The project will be published in IT education research literature.

Keywords: Gamification, Education Technologies

Necessary Skills:

- Programming skills

Ontrack in-class tablet

Supervisor: Prof Andrew Cain, andrew.cain@deakin.edu.au

Associate Supervisor: Assoc Prof Kevin Lee

Campus: Melbourne Burwood;Cloud;

Start: Trimester 1;Trimester 2;

Project type: Individual

Project Discipline: Software Engineering/Computer Science

Project Description:

Ontrack has proven to be a great tool to for supporting student learning through providing regular task feedback. One situation that continues to be a challenge is in the use of ontrack in the classroom. For tutors to sign off work or students to ask questions about submissions in the classroom requires the tutor to carry around a laptop or a student to show their screen.

This project will build an ontrack tablet which will allow class tutors to register students, read and mark student work in class, make audio and video notes for students, and check on student progress. The device will be built from a raspberry Pi, screen, and will involve 3D printing an enclosure in the School of IT Makerspace. It is expected that multiple prototypes will be built and evaluated with classes. This is an exciting and challenging project which will have real impact for students. The project will be published in IT education research literature.

Keywords: Internet of Things, Embedded Systems, Education Technologies

Necessary Skills:

- Embedded system, Linux, and programming skills

6G and beyond: Convergence of Communication, Computation, and Intelligence

Supervisor: Assoc Prof Chathu Ranaweera, chathu.ranaweera@deakin.edu.au

Associate Supervisor: Assoc Prof Kevin Lee

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Software Engineering/Computer Science

Project Description:

Telecommunication technologies are rapidly evolving to enhance the way we live, work, and interact with our surroundings. The current 5G technology marked a significant transition towards facilitating data intensive application while interconnecting the Internet of Things (IoT) and industrial automation frameworks. These advancements are not sufficient to

support the exponential growth in a wider range of smart applications and services. Sixth Generation (6G) mobile technology is now being researched and developed to support a range of emerging applications including telesurgeries, extended reality, and autonomous vehicles that require extremely high bandwidth, ultra-low latency, and high reliability. In the 6G era, there will be a convergence of the digital, physical, and human realms with the prediction of supporting 500 billion connected devices by 2030. Artificial Intelligence (AI), software defined architectures, robust computation capabilities will be combined with communication technologies to the targeted key performance indicators of 6G. Rather than treating each of these processes and technologies

independently which is the case in the current 5G technology, unified frameworks that bring the synergies of these entities will be required to support high bandwidth, ultra-low latency and high reliable communication in 6G in the most scalable, cost-effective and energy efficient manner. This project aims to create new architectures, frameworks, and resource allocation mechanisms to support super converged 6G networks. The project will use optimization techniques, AI and machine learning techniques to develop the frameworks using a variety of simulation tools. Real network data will be collected and used to validate the proposals.

Keywords: Communication networks, 5G, Machine learning, Edge computing, Optimisation, Energy

Necessary Skills:

- Programming e.g. Python, C++, data analysis, background knowledge in computer networks

Integrating Human Values and Ethics into Software using Generative AI

Supervisor: Dr Davoud Mougouei, davoud.mougouei@deakin.edu.au

Associate Supervisor: Assoc Prof Kevin Lee

Campus: Melbourne Burwood;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Software Engineering/Computer Science

Project Description:

As software applications become increasingly prevalent in our daily lives, it is crucial to ensure that these systems not only demonstrate intelligence and efficiency but also embody and promote ethical principles. It is also important to recognize and integrate human values such as benevolence, security, and respect for traditions into software to avoid socio-economic reparations of breaching those values.

This project thus aims to develop a framework for integrating human values and ethics into software systems using generative AI techniques, addressing the growing need to align technology with human values and ethical considerations. By leveraging the power of generative AI, the project seeks to create user-centric software that aligns with the values of its users. This alignment empowers users by providing personalized experiences that reflect their preferences, cultural norms, and ethical considerations. It fosters increased user satisfaction, engagement, and trust in technology.

Moreover, this project contributes to the broader field of ethical AI development. By establishing a framework for integrating human values into software, it provides insights, methodologies, and best practices for future developers. This knowledge enables the responsible and widespread adoption of ethical AI principles, fostering a future where technology is more human-centric, trustworthy, and socially responsible.

A research roadmap that explores the opportunities and threats of using generative AI (e.g. ChatGPT) for integrating human values in software.

Using generative AI for detecting patterns and anti-patterns for integrating human values in software.

Value-driven recommender systems that assist developers make informed decisions about their design choices.

Keywords: Generative AI

Necessary Skills:

- Must be passionate about forming a future, where human values and ethics are respected by the (AI) Software.
- Must be competent in Python
- Must be interested in taking independent research with limited guidance, write code, report the findings etc.

Joint optimisation of app data caching and computation offloading in edge computing

Supervisor: Dr Feifei Chen, feifei.chen@deakin.edu.au

Associate Supervisor: Assoc Prof Lei Pan

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 2;

Project type: Individual

Project Discipline: Software Engineering/Computer Science

Project Description:

The world has witnessed exponentially growing mobile data traffic in this decade promoted by a huge increase in mobile devices and Internet of Things (IoT) connected devices. This explosion of mobile data traffic has led to increases in network latency and network congestion. In recent years, edge computing has emerged as a new computing paradigm that pushes computing and storage resources to the edge of the cloud. These edge servers, each powered by one or many physical machines, are deployed at base stations or access points that are geographically close to devices.

The key to providing high-quality services with low latency is to cache the right data across the edge server network and offload users' tasks to the right edge servers. Existing studies on data caching and/or computation offloading are mostly from the edge infrastructure provider's perspective or the user's perspective, e.g., maximizing success rate, minimizing system energy consumption, or balancing the overall workload. App vendors are edge infrastructure providers' customers in the edge computing environment, in addition to the edge service and device users. They hire computing and storage resources on edge servers from edge infrastructure providers based on the pay-as-you-go scheme so that they can host applications to serve their app users. From the app vendor's perspective, the cost-effective data caching and computation offloading strategy must consider both the benefit obtained from providing low-latency services to their users and the cost incurred based on the pay-as-you-go scheme.

This project aims to investigate the joint data caching and computation offloading strategy from the app vendor's perspective, pursuing the trade-off between the benefit and cost. The approach proposed in this project will be developed on the edge platform for automatically creating strategies for app vendors.

Keywords: Edge Computing, Optimisation, Computing offloading, data caching

Necessary Skills:

- Programming skills, such as programming with Python or Java.
- Have a good understanding of Cloud Computing.
- Have a good ability of essay reading and algorithm learning

Exploring Edge Computing Integration in AI-Enabled Microgrids

Supervisor: Dr Imali Dias, imali.dias@deakin.edu.au

Associate Supervisor: Dr Niroshinie Fernando, Prof Seng Loke, Dr Saman Gorji

Campus: Melbourne Burwood;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Software Engineering/Computer Science

Project Description:

A microgrid is a small 'subset' of the electricity grid that provides energy generation and storage at a local level. They can incorporate renewable energy generation as well as battery energy storage. Some microgrids can operate independently of the grid during power outages, which can be particularly helpful for communities in regional and rural settings.

Microgrid operations need efficient and secure ways to process large volumes of data, to offer intelligent predictions in near-real time via AI. Although such data processing can be done in the Cloud, due to problems with latency and privacy, Micro grids cannot totally depend on Cloud computing. Edge computing is needed to function as an intermediary between the cloud and the Microgrid to offer localised computing resources for the efficient provision of AI-enabled services.

In this project, we will use Deakin's Microgrid arrays in Geelong to collect actual grid data and implement machine learning algorithms in an edge computing server to carry out data analytics in near-real time.

This project is a starting step for further research supporting Australia's transition to net zero by 2050. As the energy landscape undergoes transformative shifts towards sustainability, this project presents significant potential for cultivating research capabilities and building collaborations.

Note: This project offers a top up scholarship of 1000 AUD for high-achieving students with >=80 WAM. This offer will take place after a successful interview.

Keywords: Internet of Things, edge, machine learning, micro grid.

Necessary Skills:

- May require Hardware experience: Raspberry Pi, Arduino etc
- Programming language experience – C/C++/Python/Node.JS or others
- Machine learning and networking basics

Developing Scenarios and Simulations to Assess E-Safety Awareness

Supervisor: Dr Jack Li, jack.li@deakin.edu.au

Associate Supervisor: N/A

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Software Engineering/Computer Science

Project Description:

Design an intelligent programmable charger as a graduation project. The charger should have the capability to automatically query and analyze time-of-use electricity price data, and then determine and utilize the most cost-effective charging time slots for household appliances. The charger should also provide users with information on charging time slots, charging capacity, and pricing details.

The project is expected to be completed within the specified timeline. The student will need to submit a comprehensive report documenting the charger's design, implementation, and evaluation. Additionally, a presentation showcasing the charger's features, functionality, and project outcomes will be required.

Keywords: e-safety

Necessary Skills:

- Programming Languages: Python, C++, or Java
- Database: MySQL or SQLite
- User Interface Development: Tkinter, PyQt, or JavaFX
- Data Analysis and Reporting: Pandas, matplotlib, or Tableau
- Hardware Integration: integrate the charger with microcontrollers or IoT devices
- Communication Protocols: RESTful APIs or MQTT
- Testing and Validation: unit testing, integration testing, and user acceptance testing.

Energy Efficient Information and Communication Technologies

Supervisor: Assoc Prof Kevin Lee, kevin.lee@deakin.edu.au

Associate Supervisor: Assoc Prof Chathu Ranaweera

Campus: Melbourne Burwood;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Software Engineering/Computer Science

Project Description:

With hundreds and thousands of diverse networked devices (computers, autonomous cars, VR/AR, IoT) are being connected to Internet/ networks every day, the energy demand of these digital systems including networks is accelerating at a soaring rate. By using energy-efficient ICT devices, we can reduce the carbon footprint and help combat climate change.

This project will focus on building mechanism, architectures, frameworks and algorithms to help enhance the energy efficiency in Information and Communication Technologies. In particular,

•Investigate methods that can be used for energy cost savings: Energy-efficient ICT technologies can reduce energy costs, both for the individuals and organizations that use them, as well as for the larger energy grid.

•Explore resource conservation mechanism: Energy-efficient ICT can help conserve limited natural resources by reducing the demand for energy, thus helping to preserve the environment for future generations.

•Design frameworks that Increase reliability: Energy-efficient ICT devices are often designed to use less power, which means they are less likely to overheat and break down. This can result in increased reliability and a longer lifespan for these devices.

Keywords: Energy Efficiency, Renewable Energy, Communication Networks, Internet of Things

Necessary Skills:

- Programming language experience – e.g. C/Python/Node.JS
- Machine Learning Techniques will be used.
- Hardware may be used – e.g. Raspberry Pi and Arduino

Can the edge-fog-cloud architecture save energy and pave way for sustainable computing in IoT?

Supervisor: Assoc Prof Kevin Lee, kevin.lee@deakin.edu.au

Associate Supervisor: Assoc Prof Chathu Ranaweera, Dr Niroshinie Fernando

Campus: Melbourne Burwood;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Software Engineering/Computer Science

Project Description:

Internet of Things (IoT) has gained significant momentum in recent years as it promises revolutionised experience across many aspects of everyday life such as transportation, healthcare, education, and entertainment. Edge-fog-Cloud architecture has been proposed to support the computational needs of IoT. However, the energy consumed by such an architecture has an environmental impact as it contributes to significant amount of CO2 emissions, especially considering the potentially billions of IoT devices that will need to be serviced. Different techniques have been proposed to reduce the energy consumed by the Edge-Fog-Cloud architecture. The energy impacts of these architectures considering different constraints are not yet well understood.

In this project, we will conduct a thorough review of the state-of-the-art in edge-fog-cloud approaches, their ability to save energy and impact on quality of service. Students are expected to classify and critique existing techniques according to different applications, technology used, and other verticals. The research gaps identified through this review will be examined in the following trimester via simulations and other experiments.

Depending on progress in the project, it is anticipated that the work will be published in energy-related conferences and journals.

Keywords: Energy, IoT

Necessary Skills:

- Excellent academic writing & critical thinking skills are essential. Programming skills & simulation experience will be a plus.

User-Centric Charging App with Community Battery

Supervisor: Dr Valeh Moghaddam, valeh.moghaddam@deakin.edu.au

Associate Supervisor: Dr Asef Nazari

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 2;Trimester 3;

Project type: Individual

Project Discipline: Software Engineering/Computer Science

Project Description:

Create an innovative mobile app tailored for users of public Electric Vehicle (EV) charging stations, aiming to elevate the charging experience through seamless integration with a community battery. This user-centric application empowers EV owners to personalize their charging preferences, enabling them to set preferred charging times and levels while considering time-sensitive constraints. Employing advanced algorithms, the app intelligently suggests optimal charging times by dynamically analysing user preferences and real-time data on energy availability from the community battery. The integration with the community battery not only enhances sustainability by optimizing renewable energy use but also contributes to grid stability. The app considers basic grid constraints, avoiding peak periods to ensure responsible charging practices. Real-time notifications keep users informed about optimal charging opportunities, grid conditions, and renewable energy availability.

Keywords: Mobile App, Community battery, Charging Stations, User Preferences

Necessary Skills:

- Front-end/ Back-end development, Mobile app development, Data analysis

Improving SIT102 engagement using Arcade games

Supervisor: Prof Andrew Cain, andrew.cain@deakin.edu.au

Associate Supervisor: Assoc Prof Kevin Lee

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 2;

Project type: Group

Project Discipline: Software Engineering/Computer Science

Project Description:

Students at Deakin create games with SplashKit in their first programming unit – SIT102. As a school we are always trying to excite students and engage them in their studies. For programming, the best motivator is for students to see people playing their game. The school has 4 full-size arcade machines which we would like to allow students to upload their games to for people to play.

This project will build an automated pipeline for SIT102 students to submit their games to a portal, providing game information, metadata, and images. It will also create an automated graphical game manager on the arcade machine that will allow users to pick games, play them and rate them.

This is an exciting project which will excite many students in programming units in the future. The project will be published in IT education research literature.

Keywords: Arcade Machine, Games, Programming

Necessary Skills:

- Programming skills, Linux and familiarity with Raspberry Pi hardware

Internet of Things (IoT) Based Interoperability and Standardisation in Healthcare: Improving Patient Outcomes

Supervisor: Dr Anuroop Gaddam, Anuroop.Gaddam@deakin.edu.au

Associate Supervisor: N/A

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Group

Project Discipline: Software Engineering/Computer Science

Project Description:

Interoperability and standardisation are key challenges in the healthcare industry. With the increasing use of Internet of Things (IoT) devices in healthcare, it is crucial to ensure that these devices can communicate with each other and with other healthcare systems in a standardized way. This will enable the development of new healthcare applications and services, improve the quality of care, and reduce healthcare costs.

The objective of this research is to investigate the use of IoT-based interoperability and standardisation in healthcare and evaluate its impact on patient outcomes. This research will be conducted in two phases. In the first phase, a systematic review of the literature will be conducted to identify the current state of IoT-based interoperability and standardisation in healthcare. This will include a review of existing standards, protocols, and frameworks for IoT-based healthcare applications, as well as case studies and examples of successful implementation. In the second phase, a case study will be conducted to evaluate the impact of IoT-based interoperability and standardisation on patient outcomes. The case study will involve the implementation of an IoT-based healthcare application that leverages existing standards and protocols. The application will be tested in a clinical setting, and patient outcomes, such as quality of care, patient satisfaction, and healthcare costs, will be evaluated.

Expected Outcomes: The expected outcomes of this research are:

- A comprehensive review of the current state of IoT-based interoperability and standardisation in healthcare.
- An evaluation of the impact of IoT-based interoperability and standardisation on patient outcomes.
- Recommendations for the development of new standards, protocols, and frameworks for IoT-based healthcare applications.

- Insights into the challenges and opportunities for the adoption of IoT-based interoperability and standardisation in healthcare.

Keywords: Internet of Things, Health Monitoring, Machine Learning, Sensing Systems

Necessary Skills:

- Programming e.g. Python, data analysis
- Background in data analysis and machine learning would be advantageous

Can we save energy by sharing them with others and help save the planet?

Supervisor: Assoc Prof Chathu Ranaweera, chathu.ranaweera@deakin.edu.au

Associate Supervisor: Assoc Prof Kevin Lee

Campus: Melbourne Burwood;Geelong Waurn Ponds;Cloud;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Group

Project Discipline: Software Engineering/Computer Science

Project Description:

With the increasing usage of distributed power generation such as using solar panel at the user end (or demand side), an increasing number of traditional energy consumers is now becoming prosumers. This introduces new pathways to efficiently use the energy using new paradigms such Peer-to-Peer Energy sharing between prosumers and reduce the CO2 emission. Peer to peer energy sharing offers the possibility for people to have an increased level of control over their energy supply and consumption. However, this also adds another level of complexity to demand side management. To fully understand the implications and advantageous provided by Peer-to-Peer energy sharing and how to control the demand side management to gain the full benefits that can offer from those new paradigms, we are required to analyse different energy consumer and prosumer scenarios under different environmental conditions. Therefore, in this project we will first analyse the possibility of peer-to-peer energy sharing under different scenarios using real data. Then, we will study the performance and ability of various machine learning algorithms to enhance the energy management in a microgrid environment that has solar panels, wind turbine generator, energy storage, and prosumers. Depending on progress in the project, it is anticipated that the work will be published in Energy-aware conferences and journals.

Keywords: Energy, IoT, Machine Learning

Necessary Skills:

- Programming skills in Python language, experience Machine learning

Software Engineering for the Internet of Things

Supervisor: Assoc Prof Kevin Lee, kevin.lee@deakin.edu.au

Associate Supervisor: Assoc Prof Chathu Ranaweera, Dr Imali Dias

Campus: Melbourne Burwood;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Group

Project Discipline: Software Engineering/Computer Science

Project Description:

The Internet of Things (IoT) is rapidly growing, with the prospect of billions of Internet-connected devices providing ubiquitous services in the next few years. IoT technology can enable efficient transport, advanced healthcare, smart-home management, optimization of energy usage in factories and optimized logistics for businesses. The scale of IoT deployment and the wide areas it is being deployed means that there needs to be a focus on the reliability and resilience of IoT development.

The motivation for this project is to improve the development of IoT applications using Software Engineering principles. There are many aspects of developing IoT applications that can benefit from further academic research, the use of software engineering and the application of advanced techniques from other areas. IoT can be used with different networking technologies such as WAN or satellite links. There are many programming languages, development platforms and service styles that IoT applications can be built using. IoT applications are increasingly dependent on interaction with edge computing and cloud computing infrastructure. This theme encompasses projects within these areas, with a focus on improving the development of IoT applications.

There will be multiple projects in this theme. It is expected that these projects will use a common IoT platform consisting of Node.JS services deployed on Raspberry PIs, which may additionally use Arduino for data collection and control. For data transmission, aggregation, storage and management, Wi-Fi, raspberry Pi edge nodes, cloud services and MongoDB databases will be used. The following are a list of projects within this area.

Projects

- The adaptation of IoT applications based on changes to their operating conditions (e.g., Dealing loss of network connectivity, data corruption)

- Seamless Migration of edge-based microservices for IoT Applications
- Real-time communications using WAN for IoT applications
- Software Defined Networking (SDN) Adaptation for IoT Networks
- Integration of IoT with Cloud and Edge infrastructure (e.g., IoT applications on AWS)
- Hardware network cluster for networking experimentation

Keywords: Software Engineering, IoT

Necessary Skills:

- Programming language experience – e.g. C/Python/Node.JS
- Hardware may be used – e.g. Raspberry Pi and Arduino

Wearable Technologies

Supervisor: Assoc Prof Kevin Lee, kevin.lee@deakin.edu.au

Associate Supervisor: Dr Imali Dias, Assoc Prof Chathu Ranaweera

Campus: Melbourne Burwood;

Start: Trimester 1;Trimester 2;Trimester 3;

Project type: Group

Project Discipline: Software Engineering/Computer Science

Project Description:

The Internet of Things (IoT) is rapidly growing, and with this the improvement in the availability and variety of embedded platforms. IoT technologies are now being deployed in many applications including home, business, logistics, transport, military and etc. An emerging research area in IoT is wearable technology in which users wear the technologies.

Wearable technologies can be useful in a variety of areas with the focus being on activity monitoring or sensing. Some examples of such applications are as follows.

- Sports - Tracking players
- Safety – Crowd monitoring.
- Health and rehabilitation – Continuous monitoring of patient vitals.
- Elderly care - Supporting elderly people living with Dementia by using wearable technologies to track movements and alert caregivers of unusual patterns
- Education – Help students with learning disabilities. To concentrate.

To solve these problems using wearable technologies, there are several research challenges that need to be solved, as follows.

- Use of appropriate hardware and sensors
- Networking of sensors on individual vs groups of people

- Tracking of individuals and groups of people
- Coordination approaches – central and distributed approaches.
- Data Fusion from multiple sensing sources
- Dealing with challenging environmental conditions
- Long range interaction with wearable technology

There are multiple projects involving investigative research in these areas. The project will take an experimental approach, utilizing IoT embedded nodes such as ESP and ARM micro-controllers, communications technologies including LoraWAN, WiFi, Bluetooth and 5G, and advanced networking technologies such as software defined networking (SDN) and network function virtualisation.

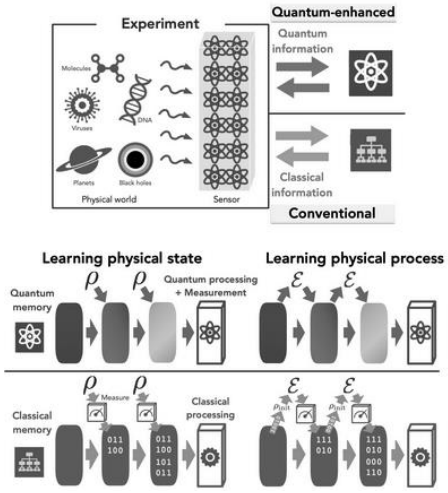
It is anticipated that the project will be published in an IoT journal and would be an excellent start to a PhD project.

Keywords: Internet of Things, Wearables, Embedded Systems.

Necessary Skills:

- Programming language experience – e.g., C/Python/Node.JS
- Hardware may be used – e.g., Raspberry Pi, Arduino. Networking experience.

Quantum Computation at Deakin IoT Research Lab



Supervisor: Dr Shiva Pokhrel, shiva.pokhrel@deakin.edu.au

Associate Supervisor: Dr Jonathan Kua

Campus: Melbourne Burwood;Cloud;

Start: Trimester 1;Trimester 2;

Project type: Group

Project Discipline: Software Engineering/Computer Science

Project Description:

The Deakin IoT Research Lab invites applications for research in quantum computation research. Aligned with the pioneering work at Amazon and Bell Labs, the project spans quantum complexity theory, cryptography, quantum algorithms (focusing on quantum machine learning, quantum federated learning and DNA analysis over genomic datasets), and quantum information. We encourage applications from exceptional future innovators with years of experience in coding and machine learning, particularly welcoming women and minority candidates. Situated within the Deakin University campus, our lab provides state-of-the-art facilities for collaborative research, fostering an inclusive and dynamic environment. Interested candidates should submit detailed CVs and research statements, contributing to the Deakin IoT Research Lab's exploration of quantum computation advancements.

Keywords: Quantum Machine Learning, Post Quantum Security

Necessary Skills:

- Machine Learning, Coding, Quantum Computing