SIT723 - SIT724 Research Projects 2021

School of Information Technology

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Project Title	P1 – OnTrack Enhanced Education
Supervisor(s)	Andrew Cain, Jake Renzella, Laura Tubino, Julien Ugon, Richard Dazeley, Guy Wood-Bradley
Email	andrew.cain@deakin.edu.au
Campus	Any
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	OnTrack is a learning management system designed to support a task-oriented approach to assessment that helps drive student learning. The OnTrack team are looking for research students interested in applying their skills to the design, development, or enhancement of this platform and the evaluation of improvements made. Planned enhancements include hardware support to help improve in class assessment times, analysis and evaluation of student performance using artificial intelligence, further gamification of the student experience, and enhanced interface development to improve feedback time and quality. Other ideas for research and development designed at improving the experience of using OnTrack to support student learning are also welcomed to be discussed with the team.
Student Necessary Skills	This project supports a range of interests and skills, but will be best suited to students with software development skills. Projects may incorporate activities related to data analytics, software development, device development, artificial intelligence or user experience evaluations and improvements.

Project Title	P2 – Machine Learning with Quantum Computing
Supervisor(s)	Lei Pan and Sutharshan Rajasegarar
Email	l.pan@deakin.edu.au
Campus	Burwood
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
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. • 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 or two algorithms in the reviewed papers with novel contributions. The final part includes empirical evaluation and theoretical analysis of these algorithms.
Student Necessary Skills	In-depth knowledge of machine-learning and deep learning algorithms and familiarity in quantum mechanisms. Knowledge in Python programming.

Project Title	P3 – Engineering of Software for Quantum Computing
Supervisor(s)	Jean-Guy Schneider, Kevin Lee, Chetan Arora
Email	jeanguy.schneider@deakin.edu.au , Kevin.lee@deakin.edu.au, Chetan.arora@deakin.edu.au
Campus	Burwood, Cloud
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	All computing systems rely on a fundamental ability to store and process information. Traditional computers manipulate individual bits that store information as binary 0 and 1 states, and many computing and programming models have been developed based on manipulating binary states. Quantum computers, on the other hand, leverage quantum mechanical phenomena to store and manipulate information – they rely on quantum bits, or qubits – and use different programming models. How to effectively create software that exploits the possibilities offered by Quantum Technology is, however, not widely understood at present. Despite their exotic nature, there is an emerging community of industry and academics that are beginning to explore ways to develop software for Quantum Computing. In particular, Microsoft has recently launched their Quantum Development Kit, and the Q# programming languages. Because of the improved accessibility, interest in Quantum Computing is increasing rapidly. This project will explore and experiment with tools, techniques and processes how to create software prototypes for computationally-intensive computing problems that exploit the fundamentals of Quantum Computing. The following are a list of projects within this research theme. **Projects** • Comparison and Evaluation of Quantum Computing Simulators • Evaluation of Quantum Computing for application development • Software Engineering Lifecycle for Quantum Computing • Hardware emulation of Quantum Computers using Field-programmable gate arrays (FPGA) Depending on progress in a project, it is anticipated that the work will be published in a suitable workshop/symposium/conference.
Student Necessary Skills	Programming language experience – ideally a mix of procedural, functional, and declarative programming models

Project Title	P4 – Software Engineering for Internet of Things
Supervisor(s)	Kevin Lee, Chetan Arora, Jonathan Kua
Email	Kevin.lee@deakin.edu.au, Chetan.arora@deakin.edu.au, jonathan.kua@deakin.edu.au
Campus	Burwood, Cloud
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	The Internet of Things (IoT) technology can enable efficient transport, advanced healthcare, smart-home management, optimisation of energy usage in factories and optimised 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 theme 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.** • 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)
Student Necessary Skills	Programming language experience – e.g. C/Python/Node.JS, Hardware may be used – e.g. Raspberry Pi and Arduino

Project Title	P5 - Software Engineering for Recommendation (AI) Systems
Supervisor(s)	Dr. Chetan Arora, Dr. Muneera Bano, Dr. Niroshinie Fernando, A/Prof. Mohamed Abdelrazek, Prof. Jean-Guy Schneider
Email	Chetan.arora@deakin,edu.au
Campus	Burwood, Cloud
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	The aim of this research theme is to tackle specific challenges in the specification of AI-based systems, the training and testing of ML components, as well as their integration into practical software systems. Four projects in this theme are as follows: **P1. Capturing requirements for better tuning recommendation systems**: Recommendation systems typically recommend the content based on explicit interactions of the users, i.e., capture the (dis)likes of users, however, majority of the user interaction is implicit. This project will explore ways of capturing the implicit interaction and utilizing it for improving the recommendations. **P2. Life in a Filter Bubble: The Ethical Implications of Recommendation Systems**: Conduct research on ethical dimensions of recommendation systems of social media platforms and how they define trends around the world; Explore how much control various social media platforms provide content control to its users for recommendation systems; Based on existing recommendation systems on social media what ethical issues can arise for the users; and what are the ethical guidelines for the users? **P3. Experimenting with the current recommendation systems on various social media platforms to understand the recommended content (exploratory study)** - Creating new blank profiles across various social media platforms for this experiment; Collect data from various selected social media platforms that makes recommendations; Experiment by clicking content & monitor the recommendation behaviour across the platforms, over a selected period of time; How recommendations in one platforms connect to another e.g. google search and YouTube; Compare results to existing research on the topic. **P4. UI design patterns for ML systems** - AI/ML models are great! However, these models are inherently problematic in many ways. One problem is the uncertainty and probabilistic nature of the models. In this project, we want to investigate the impact of these models on end-users and how we could design the UI of our new software systems to communicate such uncertainties without overloading the end-user.
Student Necessary Skills	Strong programming skills / Good understanding of machine learning and recommendation systems

Project Title	P6 - Software Engineering for Machine Learning (ML) Models
Supervisor(s)	Dr. Chetan Arora, Dr. Muneera Bano, Dr. Niroshinie Fernando, A/Prof. Mohamed Abdelrazek, Prof. Jean-Guy Schneider
Email	Chetan.arora@deakin,edu.au
Campus	Burwood, Cloud
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	The aim of this research theme is to tackle specific challenges in the specification of AI-based systems, the training and testing of ML components, as well as their integration into practical software systems. Four projects in this theme are as follows: **P1. Characterizing bias in training data of ML systems**: Selecting the right training data is critical in the implementation of ML-components that exhibit the desired behaviour. More often than not, either consciously or not, training data selected for ML includes biases. The aim of this project is to identify novel ways to classify the key "components" of training data and detect potential bias. **P2. Resilience requirements of autonomous vehicles**: The autonomous vehicles are trained on the images. These images are the basis of resilience requirements of these systems. This project will focus on resiliency aspects of the training data for autonomous vehicles by mutating the training data. **P3. Software testing of ML trained models** - Quality assurance practices, such as software testing are done to ensure that the software system works according to the requirements. ML models are black-boxes which are difficult to test. This project will focus on the software testing aspects of ML models.
Student Necessary Skills	Strong programming skills / Good understanding of machine learning and recommendation systems

Project Title	**P7 – Natural Language Processing based Analysis of Software Artefacts**
Supervisor(s)	A/Prof. Mohamed Abdelrazek, Dr. Chetan Arora
Email	Mohamed.abdelrazek@deakin,edu.au
Campus	Burwood, Cloud
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	**P1. Information extraction from NL Requirements Documents**. Natural language (NL) is used prevalently for expressing systems and software requirements. Most requirements capture the structural information or "what" aspects of the systems. Building structural and behavioral models is an important step for transitioning from informal requirements expressed in NL to precise and analyzable specifications. This project will focus on extracting models from the NL Requirements using NLP and ML. **P2. Mining Software Repositories into Chatbot for Software Engineering Students** By now, as a student you probably have realised that lots of info and challenges you run into are known and probably have been addressed and solved – whatever you are looking for. In this project, we want to layout the foundations for a chatbot for software engineers that provides curated information to software engineers as they work on their code. When an error occur, they can quickly get an answer from the bot on what happened and how they could work around the problem. These info could be initially extracted from solved problem on stackoverflow and other platforms. **P3. Code2Vec: learning representations of code using machine learning.** In order to adopt machine learning in software engineering, programming, vulnerability analysis, etc. we need to be able to convert code into numerical representation – e.g. vector that we can then use as input to many of the existing machine learning models – e.g. clustering, SVM, CNN, LSTM, etc. There are many word embedding techniques available, however source code introduce unique attributes that do not exist in natural language (text) – e.g. code has hierarchies – nested code, etc. which make these techniques less effective. Hence, there is now research in how to create code2vec techniques that best capture code representation and thus be able to apply these representations to develop many relevant software engineering use cases. This project aims at understanding the current state-of-the-art in code2vec, benchmark existing techniques and possibly optimise some of these, and develop ML models for one or two applications – e.g. vulnerability analysis, code recommender systems, intent understanding (e.g. auto generate documentation from code).
Student Necessary Skills	Strong problem solving and critical thinking skills Strong programming skills in python and java.

Project Title	P8 – Software-centred Design of IoT Systems
Supervisor(s)	A/Prof. Mohamed Abdelrazek, Dr. Chetan Arora, Dr. Niroshinie Fernando
Email	Mohamed.abdelrazek@deakin,edu.au
Campus	Burwood, Cloud
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	**P1. Blockly-powered IoT requirements modelling** - Requirements engineering is a critical task in software engineering. Get system requirements wrong, and you get the wrong product for your clients. In IoT systems, this could lead to disasters as these systems tend to offer partial/full automation. In this project, we aim to research requirements modelling techniques and develop a requirements modeling framework using Blockly for IoT systems. The initial work on the modelling framework exists and can be leveraged for this project. **P2. Developing virtual IoT testbed using software containers** - Engineering IoT systems is challenging on many ways. One big challenge we face is lack of the sensors that we want to use for our projects. In this project we want to build a virtual environment, testbed, for IOT developers so they could use it for developing, testing and debugging their IOT applications without having access to the physical sensors.
Student Necessary Skills	Strong problem solving and critical thinking skills Strong programming skills in python and Java.

Project Title	P9 – Digital Solutions for Mental Health and Wellbeing
Supervisor(s)	A/Prof. Mohamed Abdelrazek, Dr. Alessio Bonti, Prof. Phil Rays
Email	Mohamed.abdelrazek@deakin,edu.au
Campus	Burwood, Cloud
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	**P1. Developer analytics: Assessing developers' wellbeing using ECG**. You will be a software engineer, how would you take care of your health and wellbeing. What do you enjoy vs hate and stress on in your job? In this project, we want to collect and use ECG data to learn more about the wellbeing of software engineers during their work days. We should then be able to understand the different activities that software engineers do during the day and use this to give them some recommendations in time. **P2. Mental health sensing**. Mental health is becoming a major issue in work environments. According to recent studies heart attack was 11 percent higher on Mondays than other days in the week. In this project, we aim to develop a mental health sensing app that learns from user behaviour potential mental health behaviour biomarkers issue that might be developing and potential introduce necessary interventions. **P3. Developing engaging digital health platform for elderly**. Hundreds of health apps and wearables are currently in the market. However, the adoption of the technology by elder people is very limited. In this project, we want to develop engaging digital health platform that takes into consideration user emotions as first class citizen when engineering the platform. **P4. Health apps on Temi**. The team now has access to Temi robot. The idea is to develop digital health platform that assist elder people living alone to keep up and connect with care givers and GPs via Temi. Temi supports video calls, follow-me, and can run apps.
Student Necessary Skills	Strong problem solving and critical thinking skills Strong programming skills in python and Java.

Project Title	**P10 – AI Apology: Beyond Explainable Reinforcement Learning [SEE NEXT SLIDE AS WELL]**
Supervisor(s)	A/Prof Richard Dazeley / Dr Sunil Aryal / Dr Francisco Cruz / Dr Bahareh Nakisa
Email	richard.dazeley@deakin.edu.au / sunil.aryal@deakin.edu.au / francisco.cruz@deakin.edu.au bahar.nakisa@deakin.edu.au
Campus	Waurn Ponds
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	**Theme Overview** Two of the primary aims in explainable artificial intelligence (XAI) is to improve trust and understanding in human users. However, most XAI approaches focus on providing understanding of an AI's decision in the hope that it will improve trust. Trust though also requires the agent to show it understands and considers people's needs. This requires the agent to be able to both illustrate empathy and to be able to alter future behaviour to match that understanding. One approach to accomplish this is through the human cultural practise of apologising for past mistakes. A genuine apology consist of three stages: acknowledgement - recognition that a behaviour has caused harm; Remorse / Empathy – acknowledgement of how the person would feel as a result of that behaviour; Restitution – an offer of how to alter future behaviour to avoid future harm. The generation of an apology from an AI system is currently an unexplored domain of XAI. An agent capable of generating an apology will need to perform three primary tasks. These three tasks will make up three separate major thesis topics, while a fourth topic will investigate the combination of the three components and the delivery of the final apology. [SEE NEXT SLIDE …]
Student Necessary Skills	Python Programming / Reinforcement Learning / Open AI Gym / Deep Learning

Project Title	**P10 – AI Apology: Beyond Explainable Reinforcement Learning**
Supervisor(s)	A/Prof Richard Dazeley / Dr Sunil Aryal / Dr Francisco Cruz / Dr Bahareh Nakisa
Email	richard.dazeley@deakin.edu.au / sunil.aryal@deakin.edu.au / francisco.cruz@deakin.edu.au bahar.nakisa@deakin.edu.au
Campus	Waurn Ponds
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	**Projects** **Thesis Project 1: Recognition of harm** The first project involves being able to identify when the result of an agent's behaviour (both deliberate and accidental) has caused an undesired outcome for another actor. This process will require modelling of the of desired result of the other actors (people) in the environment and the matching of real outcomes observed against their desired outcomes. **Thesis Project 2: Emotion prediction/recognition** This second project will focus on recognising how an actor(person) feels as a result of the harm incurred. This will involve predicting what the emotional result is for the person. This will require modelling of the user's change in emotional state during their interactions. **Thesis Project 3: Identifying alternative behaviours** The third project involves identifying counterfactuals that would have resulted in a more desirable outcome for another actor (person). Using Multiobjective Reinforcement Learning this project will identify alternative pareto optimal policies that identify preferred actions for the actor. **Thesis Project 4: Generating an apology** The final project will use the outcome of each of the other projects (or a simulation of the outcome if the projects are done in parallel) to generate an apology. The apologies generated will be assessed via a survey of human participants.
Student Necessary Skills	Python Programming / Reinforcement Learning / Open AI Gym / Deep Learning

Project Title	P11 – Deep learning for Image Classification
Supervisor(s)	Atul Sajjanhar
Email	atul.sajjanhar@deakin.edu.au
Campus	Burwood
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	Deep Learning is the state-of-art in Machine Learning. The project will involve research in deep learning based on deep neural networks. You will gain an understanding of widely used frameworks for deep learning. Libraries will be used to pre-process images prior to training and testing classification models. The project will use pre-trained models such as VGG and Inception for classification of images.
Student Necessary Skills	Programming skills are required. Prior experience in python programming will be useful.

Project Title	P12 - Anomalous activity detection from videos
Supervisor(s)	Sutharshan Rajasegarar, Others involved: John Yearwood, Thuseethan Selvarajah
Email	sutharshan.rajasegarar@deakin.edu.au
Campus	Burwood
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	Detecting anomalous activities from video is important for monitoring and enforcing security measures. This require analysing frames of images from videos to identify normal objects, activities, movement patterns, etc to automatically identify the anomalous objects or activities or trajectories in a timely manner. Methods, such as machine learning methods, Deep learning and quantum 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 anomaly detection methods using several learning methods in videos and images. Implementing and comparing some of the latest methods for detecting anomalies using publicly available data. Propose novel improvements to the existing methods, implement and evaluate them.
Student Necessary Skills	• Knowledge of deep learning algorithms. • Programming Knowledge in Python. • Knowledge of image/video processing.

Project Title	P13 - Emotion and behaviour detection from videos
Supervisor(s)	Sutharshan Rajasegarar, Others involved: John Yearwood, Thuseethan Selvarajah
Email	sutharshan.rajasegarar@deakin.edu.au
Campus	Burwood
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
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.
Student Necessary Skills	• Knowledge of deep learning algorithms. • Programming Knowledge in Python. • Knowledge of image/video processing.

Project Title	P14 – Emotion Analysis using EEG, Physiological and Video Signals
Supervisor(s)	Dr. Imran Razzak
Email	Imran.razzak@deakin.edu.au
Campus	
Start Date	☒ T1-2021 ☒ T2-2021 ☐ T3-2021
Project Description	Emotion is a psycho-physiological process triggered by conscious and/or unconscious perception of an object or situation and is often associated with mood, temperament, personality and disposition, and motivation. Emotions play an important role in human communication and can be expressed either verbally through emotional vocabulary, or by expressing non-verbal cues such as intonation of voice, facial expressions and gestures. In this project students will be working on multimodal data for the analysis of emotions and behaviour of an individual.
Student Necessary Skills	Deep Learning

Project Title	P15 – Expert Level Chest Radiograph Analysis
Supervisor(s)	Dr. Imran Razzak
Email	Imran.razzak@deakin.edu.au
Campus	
Start Date	☒ T1-2021 ☒ T2-2021 ☐ T3-2021
Project Description	Chest radiography is the most common imaging examination globally, critical for screening, diagnosis, and management of many life threatening diseases. Automated chest radiograph interpretation at the level of practicing radiologists could provide substantial benefit in many medical settings, from improved workflow prioritization and clinical decision support to large-scale screening and global population health initiatives. Student will be working on chest radiograph interpretation using explainable AI.
Student Necessary Skills	Deep Learning

Project Title	**P16 – Unbiasing Face Recognition: Reinforcement Learning with Causal Modelling**
Supervisor(s)	Dr. Imran Razzak
Email	Imran.razzak@deakin.edu.au
Campus	
Start Date	☒ T1-2021 ☒ T2-2021 ☐ T3-2021
Project Description	Law enforcement, surveillance, airport passenger screening, CCTV use a wide range of advanced technologies to automate and scale their work while maintaining accuracy. Some big technology players have stop selling their facial recognition system to law enforcement agencies over racial bias. Some big technology players have stopped selling their facial recognition system to law enforcement agencies over racial bias. Face recognition is a particularly powerful tool in the application armoury, but also potentially dangerous. African and Asian faces are more likely to be misidentified than white men, depending on the particular algorithm and type of search. Despite widespread adoption of face recognition, it was recently banned for use by police and local agencies in the US. Amazon announced a one-year pause in Rekognition, a controversial facial recognition. No facial analysis system is perfectly accurate against bias. Recent theories in cognitive science showed that human understand and represent the knowledge of the world through causal relationships, thus efficient for the complicated task such as face recognition. In this project, we propose to break the unbiasing ice through explainable deep reinforcement learning with the causal lens.
Student Necessary Skills	Deep Learning

Project Title	P17 – Animal detection from images and videos
Supervisor(s)	Dr Duc Thanh Nguyen
Email	duc.nguyen@deakin.edu.au
Campus	Waurn Ponds, Burwood
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	This project aims to develop a detection algorithm which is able to recognise and detect animals captured by cameras in their wildlife under severe environmental conditions, e.g., low illumination, occlusions.
Student Necessary Skills	Python programming, knowledge in Machine Learning/Deep Learning, and Computer Vision

Project Title	P18 – Animal recognition from images and videos
Supervisor(s)	Dr Duc Thanh Nguyen
Email	duc.nguyen@deakin.edu.au
Campus	Waurn Ponds, Burwood
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	This project aims to develop an animal recognition algorithm based on deep learning to address the problem of object recognition from scarce data.
Student Necessary Skills	Python programming, knowledge in Machine Learning/Deep Learning, and Computer Vision

Project Title	P19 - Semantic background subtraction for video processing and analysis
Supervisor(s)	Dr Duc Thanh Nguyen
Email	duc.nguyen@deakin.edu.au
Campus	Waurn Ponds, Burwood
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	This project aims to investigate existing state-of-the-art background subtraction methods applied in video analysis and develop a new background subtraction algorithm that is able to incorporate semantic and motion information using deep learning.
Student Necessary Skills	Python programming, knowledge in Machine Learning/Deep Learning, and Computer Vision

Project Title	P20 – Next Generation AI for Adversarial Networks
Supervisor(s)	Dr. Adnan Anwar
Email	adnan.anwar@deakin.edu.au
Campus	Burwood
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	In the age of Internet-of-thing, the enormous amount of data attracts cyber attacker to launch various types of cross-site scripting, ransomware, SQL injections, email spoofing, audit-train-falsification not only through the traditional internet, but also based on weak security measures of the smart devices and IoT protocols. The amount of data and the velocity has made it challenging for the traditional security systems to detect an attack and cyber threat efficiently and accurately. Advanced Machine Learning (ML) based models and techniques can be a viable solution to mitigate security threats. ML algorithms can update the models in real-time as per the requirements; mine and process big data efficiently and effectively; and detect attack with veracity. Lightweight property is another key aspect. On top of that, a machine learning model itself could be vulnerable by new types of adversarial attacks. This domain is known as adversarial machine learning (AML). This project has two phases: i. Develop a lightweight but accurate ML model for cyber-threat detection, ii. Protect the model against adversarial attacks. This project will help the students to enhance their skills and experience in the area of machine learning and artificial intelligence. Outputs from this project will help to understand some industry practices on cyber threat analysis. Students will also develop hands-on experience in advanced machine learning models and implementations. Curious to know what is AML? https://thenextweb.com/neural/2020/07/24/what-is-adversarial-machine-learning-syndication/
Student Necessary Skills	Python (or similar) coding at least basic level (and interest to learn more), analytical mindset, passion in machine learning

Project Title	**P21 - Verifying the Second Principle of Feature Engineering**
Supervisor(s)	Dr. Nayyar A. Zaidi
Email	Nayyar.zaidi@deakin.edu.au
Campus	Burwood
Start Date	☒ T1-2021 ☐ T2-2021 ☐ T3-2021
Project Description	The second principle of Feature Engineering dictates that " Compared to the model that is trained on refined-data -- the model that is trained on raw-data is likely to improve its performance as the size of the input raw-data gets bigger, with performance asymptoting towards Bayes optimal error". This project will explore and study this principle in detail. It will first identify a data source and then do manual feature engineering in form of feature construction to create refined data, and then study if the second principle holds. The project will also study different form of raw-data handling techniques, such as matrix and tensor factorization.
Student Necessary Skills	Machine Learning, Deep Learning, Tensorflow, Python, Linear Algebra, Probability

Project Title	P22 - Metric Learning with Siamese Networks on Transactional Data
Supervisor(s)	Dr. Nayyar A. Zaidi
Email	Nayyar.zaidi@deakin.edu.au
Campus	Burwood
Start Date	☒ T1-2021 ☐ T2-2021 ☐ T3-2021
Project Description	Metric Learning problems have resurged with success of representation learning. In this project, we will study the efficacy of simplest metric learning algorithm trained with Siamese Networks on Transactional Data. Note, Siamese networks are applied on structured data and their efficacy on transactional data is still to be determined.
Student Necessary Skills	Machine Learning, Deep Learning, Tensorflow, Python, Linear Algebra, Probability

Project Title	P23 - Analysis of blockchain-based anomaly detection algorithms
Supervisor(s)	Lei Pan and Sutharshan Rajasegarar
Email	l.pan@deakin.edu.au
Campus	Burwood
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	Anomaly detection is a topic underpinning machine learning practice in expert systems and many other industrial systems. Due to its wide applications, anomaly detection also becomes more and more popular in blockchain-based systems. For example, there are research papers recently published on anomaly detection conducted on blockchain systems, such as the following papers: 1. Prado-Romero, M.A., Doerr, C. and Gago-Alonso, A., 2017, November. Discovering bitcoin mixing using anomaly detection. In Iberoamerican Congress on Pattern Recognition (pp. 534-541). Springer, Cham. 2. Signorini, M., Pontecorvi, M., Kanoun, W. and Di Pietro, R., 2018. BAD: Blockchain anomaly detection. arXiv preprint arXiv:1807.03833. 3. Chen, T., Zhu, Y., Li, Z., Chen, J., Li, X., Luo, X., Lin, X. and Zhange, X., 2018, April. Understanding ethereum via graph analysis. In IEEE INFOCOM 2018-IEEE Conference on Computer Communications (pp. 1484-1492). IEEE. 4. Chen, T., Li, Z., Zhu, Y., Chen, J., Luo, X., Lui, J.C.S., Lin, X. and Zhang, X., 2020. Understanding Ethereum via Graph Analysis. ACM Transactions on Internet Technology (TOIT), 20(2), pp.1-32. 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 mentioned in some papers. The final part is the benchmark results of running these algorithms with respect to standardized datasets and propose improved algorithms.
Student Necessary Skills	Machine learning in Python

Project Title	**P24 - Anomaly detection in very low frequency radio wave time series**
Supervisor(s)	Dr S. Shelyag
Email	Sergiy.shelyag@deakin.edu.au
Campus	Burwood
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	Very low frequency radio waves from standard radio transmitters can travel vast distances around the Earth. On their way, they collect the information about the medium they propagate through. This information includes noise, regular variations, such as day-night, or seasonal changes, as well as the transient information on large-scale geophysical anomalies and events, such as earthquakes, volcano eruptions, tsunamis. A network of receivers has been created around the globe to receive those radio waves. Currently, the big question is how to understand and analyse the very low frequency radio wave propagation data in a hope to better understand and forecast geophysical hazards. In this project, we will be looking at ways to answer this big question. We will be using a variety of methods for time series analysis on already existing time series in order to find the best ways to post-predict known large-scale geophysical events. Our aim will be to find the signatures of those events in the data before they occurred at the Earth surface. A publication is expected on successful completion of the project.
Student Necessary Skills	Ability to program with any programming language; basic knowledge in data science, data cleaning, machine learning.

Project Title	P25 - Trajectory analysis from data
Supervisor(s)	Ye Zhu and Sutharshan Rajasegarar
Email	Ye.zhu@deakin.edu.au
Campus	Burwood
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	Learning trajectory patterns from moving objects' Spatio-temporal data are useful to extract their important habitual behaviours. These results could be widely used in application fields such as object motion prediction, abnormal detection and traffic monitoring. It also can help to speed up and improve the results of trajectory optimisation processes and provide meaningful decisions for human mission designers. Trajectories can be obtained from traffic data, mobile sensor-based data collections, or videos. In this project, students will perform a critical literature survey on one of these domains, implement and compare existing works; propose novel algorithms to identify the patterns from the trajectory data. They will utilise the machine learning and deep learning methods to model the behaviour.
Student Necessary Skills	Programming knowledge in Python or Matlab

Project Title	P26 - Time Series Anomaly Detection
Supervisor(s)	Ye Zhu and Sutharshan Rajasegarar
Email	Ye.zhu@deakin.edu.au
Campus	Burwood
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	Time-series data popularly exists in all forms of sensor data, stock markets, and different kinds of temporal tracking and forecasting applications. In the last decades, although time-series data have attracted an explosion of interest in the data mining community, time-series data mining is still far behind another kind of data mining techniques. The problem definitions in the time-series scenario are significantly diverse. Anomaly detection problem for time series is usually formulated as identifying outlier instances relative to some standard or usual signal. In this project, students will explore the definition of different kinds of anomalies existing in time series and investigate existing anomaly detection methods. Furthermore, students will evaluate the performance of these methods on large real-world time-series datasets, then identify the challenging issues and potential directions for further research.
Student Necessary Skills	Programming knowledge in Python or Matlab

Project Title	P27 - Investigation of physical activity patterns with data analytics and wearable devices in sports
Supervisor(s)	Sutharshan Rajasegarar, Prof. Maia Angelova
Email	sutharshan.rajasegarar@deakin.edu.au
Campus	Burwood
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	Monitoring physical activities with wearable devices, such as wrist worn or body worn accelerometer devices, is increasingly popular and cost-effective way to study performance, training and well-being of athletes in sports. The research challenge is to analyse sensor data, alone or in combination with other data, and to investigate for patterns of movement activities. Identification and classification of patterns of different movements is central to monitoring and analysing athlete's performance and athlete's fatigue. The aim of this project include performing critical literature survey on the latest physical activity monitoring methods, sensors used and the various machine learning methods, including deep learning methods. Study the associations between different time series signals/data measured with accelerometers, GPS, etc from the human movements. Physical activities such as running, walking, jumping, specific movements of arms and legs, etc will be investigated using physical/physiological time series. Extract features from the signals and model using tools and methods from data analytics, such as machine learning, including deep learning algorithms. Propose novel methods for detecting the activities from the signals, visualise the results and perform empirical comparison analysis with existing algorithms.
Student Necessary Skills	• Knowledge of machine learning, including deep learning algorithms. • Programming Knowledge in Python.

Project Title	P28 - Detecting activities of daily living using wearable devices and Machine learning
Supervisor(s)	Chandan Karmakar and Sutharshan Rajasegarar
Email	karmakar@deakin.edu.au, sutharshan.rajasegarar@deakin.edu.au
Campus	Burwood
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	Wearable devices based on accelerometer sensors are becoming popular, and mostly used for detecting physical activities. Many of our daily gadgets e.g. smart phone also include this sensor. Recently, accelerometer sensors have been used for many applications, including medical condition diagnostic, etc. In this project we aim to use off-the-shelf accelerometer device to detect different activities performed, such as drawing shapes by hand, eating, drinking, and walking. The project involves a complete cycle of data analytic activities i.e., from data collection to train deep learning and machine learning models and detecting the activities accurately from the data. The project activities involve conducting critical literature review on the currently published literature, data collection, implementing existing algorithms and comparing results, proposing novel improved methodologies to accurately detect the patterns and activities from data using deep learning and machine learning. Empirical and theoretical analysis of results.
Student Necessary Skills	Knowledge of machine-learning and deep learning algorithms. Programming Knowledge in Python.

Project Title	P29 - Energy consumption pattern analysis
Supervisor(s)	Dr. Adnan Anwar and Dr. Sutharshan Rajasegarar
Email	adnan.anwar@deakin.edu.au sutharshan.rajasegarar@deakin.edu.au
Campus	Burwood
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	Analysis of (electrical) energy consumption and supply are important for effective monitoring and management of the network assets. For example, finding energy consumption patterns, based on time series data will provide insights into customer behaviour, help find anomalies, and devise load balancing mechanisms. The aim of the project includes, performing literature survey on existing energy analysis methods, analysing existing work on forecasting demand using machine learning/deep learning methods. Implementing and comparing some of the existing methods using the publicly available datasets. Propose novel improvements to the existing methods and compare them empirically. Investigate findings and/or anomalies or misbehaviours based on the model.
Student Necessary Skills	• Knowledge of machine learning, including deep learning algorithms. • Programming Knowledge in Python.

Project Title	**P30 - Social Behavioural Anomaly Source Tracing of Online Fake Messages/News via Blockchain Technologies**
Supervisor(s)	Dr Frank Jiang, Prof Robin Doss,
Email	Frank.Jiang@deakin.edu.au ; Robin.Doss@deakin.edu.au
Campus	Burwood
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	Social behavioural anomaly detection is of critical importance to prevent malicious activities such as bullying, terrorist attack planning, account misuse and fraud information disseminations. New types of anomalous behaviours arise increasingly nowadays, which provoke tremendous security concerns. Currently, Australian E-safety commissioners' group have shown strong interests in the related project topics. There are two categories of anomalies for individuals: 1) Individual behaviour differs from the group behaviours. 2) At certain moment, the individual behaviours differ from the usual/normal activity. This project aims at resolving the second category of anomalies since the first category has been widely researched. By incorporating the Blockchain technology, it is expected a new breakthrough can be done from the perspective of the IT social network structure, and thus influence further the state-of-the-art of social users' anomaly detection system. Blockchain technique, as a new secured distributed ledger, featured with transparency, traceability and identity management, enables a new anonymous behavioural anomaly detection paradigm. The outcome of this research includes: • A new social behaviour and information classification method to meet the requirement of blockchain analysis. • An intelligent system for discovering network abnormal users and sourcing information based on block chaining Technology. Research Activities: 1) Be part of the SPYRIT IoT team, fortnightly project meetings closely and building up work on the blockchain framework, development of new blockchain-based Scheme; 2) Construct social relations via a developed weighted-blockchain based social network structure; 3) Acquire the account/user activity histograms through our customised crawler programs via blockchain traceability, transparency capabilities, Further apply classification models to discover the unusual activities/behaviours of the social nodes.
Student Necessary Skills	1) Computer Networks and Cyber Security 2) Social platform, Crawler programs, Python programming language

Project Title	P31 – Cold-start Contract Cheating Identification from Side Information Using Latent Linear Writing Style Representation
Supervisor(s)	Imran Razzak and Mohamed Reda Bouadjenek
Email	Imran.razzak@deakin.edu.au & reda.bouadjenek@deakin.edu.au
Campus	Waurn Ponds
Start Date	☒ T1-2021 ☒ T2-2021 ☐ T3-2021
Project Description	Contract cheating is a dishonest behaviour that occurs when a student outsources an assignment to a third party for completion and submits it as his own work, or even when two students swap their assignments with each other. Teachers often find it difficult to deal with contract cheating, in particular when they feel lacking sufficient evidence to support their claim. Patterns used to identify contract cheating include misrepresented bibliographic data, inappropriate references, irrelevant material and generalised text that did not address the assessment question or grading criteria. However, given the scale of the problem, automatic techniques to efficiently identify contract cheating cases are needed. For that goal, advanced machine learning and natural language processing methods can be used to efficiently analyze a huge set of assignments to discover markers that could be used to identify potential contract cheating cases. While previous work has focused on stylometry for authorship authentication in academic and non-academic settings, we argue that (a) existing work has focused on only extracting basic attributes of documents to determine if the same individual wrote them (e.g., rare words count, average sentence length, average syllables in a word, etc.), (b) the developed methods are not necessarily topic independent, thus providing a poor generalization, and (c) we are not aware of any work that has addressed the cold-start problem in this setting. To this end, this project aims to answer the following high-level research questions: RQ1: How can we identify if a student has outsourced an assignment? RQ2: What are the topic-independent key markers that could be used to identify potential contract cheating cases? RQ3: How to deal with a student who has no history of submitted assignments? What side information can we use to capture his writing style?
Student Necessary Skills	Deep Learning, Machine Learning, Information Retrieval, Natural Language Processing

Project Title	P32 - Deep Question Answering Systems for Information Retrieval
Supervisor(s)	Mohamed Reda Bouadjenek, Chetan Arora
Email	reda.bouadjenek@deakin.edu.au
Campus	Waurn Ponds
Start Date	☒ T1-2021 ☒ T2-2021 ☐ T3-2021
Project Description	Today, most commercial search engines like Google tend to provide short answers to queries that are identified to be factoid questions, as a Question Answering (QA) system would do. For example, for the query “What is the capital of France?”, Google would simply answer “Paris”. Usually, the retrieval process of such a typical QA feature is based on two main phases: (i) The first step is to retrieve documents from the collection that presumably contain the right answers. (ii) The second phase is to extract the answers from these documents in the form of passages, which are then formatted and presented to the user. In this project, the students will be mainly responsible for developing a full QA system as well as the following duties: • Implementing an information retrieval module. • Implementing the general QA architecture depicted above using existing benchmark, collections and datasets for QA (e.g., TREC QA, Wikipedia, e bAbI, CNN / Daily Mail, and MCTest). • Implementing baselines for the Answer Processing Module described above. • Implementing and developing the dual input recurrent unit described above. • Using conventional IR/NLP metrics to evaluate and compare the baselines against the proposed method. • Presenting and analyzing the obtained results in a scientific manner. • If possible, improving the proposed architecture using the power of attention mechanisms in the goal of achieving better results.
Student Necessary Skills	Deep Learning, Machine Learning, Information Retrieval, Natural Language Processing

Project Title	P33 – Information extraction from mathematical optimization text
Supervisor(s)	Vicky Mak and Bahadorreza Ofoghi and John Yearwood
Email	vicky.mak@deakin.edu.au, b.ofoghi@deakin.edu.au
Campus	Burwood
Start Date	☒ T1-2021 ☐ T2-2021 ☐ T3-2021
Project Description	Unstructured textual data can bear several important and valuable domain-specific pieces of information. Such information can be extracted to form a structured representation of the textual data using natural language processing techniques. With a focus on mathematical optimization texts, this project aims at extracting and representing data from text, such as the number of solvers or machines available to solve an optimization problem, the capacity of each solver, etc. The student will work with their supervisors to gain required domain knowledge in the mathematical optimization field, carry out relevant research activities to find suitable information extraction mechanisms, and develop the software solution to the problem.
Student Necessary Skills	Working knowledge of Python programming, a good understanding of natural language processing, a basic knowledge of mathematical optimization.

Project Title	P34 – Natural Language Processing Wiki at Deakin
Supervisor(s)	Bahadorreza Ofoghi
Email	b.ofoghi@deakin.edu.au
Campus	Burwood
Start Date	☐ T1-2021 ☒ T2-2021 ☐ T3-2021
Project Description	Natural language processing (NLP) is a major subdomain within the Computer Science field that has applications in several real-life domains, e.g., health informatics, legal analytics, and human- computer interaction interfaces. This project starts to develop a wiki site for the NLP domain with a focus on the major NLP techniques (statistical and machine learning-based), their current software development tools and packages, as well as publicly available, relevant data sets that can be used to develop NLP models and solutions. The student will carry out research to find relevant NLP topics and tools for the wiki. The wiki will serve as an integrated information hub for the research-active staff members and students within the School of IT (and Deakin University).
Student Necessary Skills	Development skills with WordPress, research skills to find and summarize NLP concepts and tools, a basic understanding of NLP, machine learning, and their applications.

Project Title	P35 – The literature analysis of ontology translation using rule-based grammars and structural techniques
Supervisor(s)	Vicky Mak and Bahadorreza Ofoghi and John Yearwood
Email	vicky.mak@deakin.edu.au, b.ofoghi@deakin.edu.au
Campus	Burwood
Start Date	☒ T1-2021 ☐ T2-2021 ☐ T3-2021
Project Description	Ontologies (as a specific type of digital, semantic, and structured representation of knowledge) play an important role in knowledge-driven solution development and automation. There are cases where more than one ontology is required to develop specific solutions in multidisciplinary fields. This project aims at reviewing the relevant literature on how translation occurs across ontologies that are relevant to each other but include different concepts. The student will critically review and synthesize the existing research work especially in the domain of rule-based ontology translation and alignment.
Student Necessary Skills	Good literature review skills, a basic understanding of semantic structures and ontologies

Project Title	P36 – Creating an optimization question generation data set using crowdsourcing
Supervisor(s)	Vicky Mak and Bahadorreza Ofoghi and John Yearwood
Email	vicky.mak@deakin.edu.au, b.ofoghi@deakin.edu.au
Campus	Burwood
Start Date	☒ T1-2021 ☐ T2-2021 ☐ T3-2021
Project Description	Natural language question generation is the automated task of creating grammatical, meaningful questions with reference to given textual passages. In order to develop a domain-specific question generator for the domain of mathematical optimization, this project will focus on manual creation of a textual data set with pairs of passages and their relevant questions. The student will make use of the Amazon Mechanical Turk service to create the data set. The student will use statistical techniques to analyse the reliability and accuracy of the curated data set.
Student Necessary Skills	Working knowledge of Python programming, a good understanding of cloud-based services, basic data engineering and analysis skills

Project Title	P37 – Passage ranking for question answering using deep learning
Supervisor(s)	Bahadorreza Ofoghi
Email	b.ofoghi@deakin.edu.au
Campus	Burwood
Start Date	☒ T1-2021 ☐ T2-2021 ☐ T3-2021
Project Description	Fact-seeking question answering (QA) is an automated natural language processing application that extracts exact answers to natural language questions. As part of the QA processing pipeline, relevant passages of text are retrieved and ranked in response to a given question, from within which, answers are extracted. This project will focus on developing deep learning solutions to answer passage retrieval and ranking using state-of-the-art models including Bidirectional Encoder Representations from Transformers (BERT). The student will use their research abilities to carry out several experiments and enhance an existing Python solution to answer passage ranking.
Student Necessary Skills	Development skills with Python, keras, and tensorflow, a good understanding of NLP and deep learning, research skills to find relevant enhancement solutions for the deep learning model, working knowledge of HPC clusters and Linux environments.

Project Title	P38 - COVID-19 on Social Media: Detection of Misinformation on Twitter
Supervisor(s)	Dr. Imran Razzak
Email	Imran.razzak@deakin.edu.au
Campus	
Start Date	☒ T1-2021 ☒ T2-2021 ☐ T3-2021
Project Description	Since 2019, COVID-19 has been spreading exponentially across the world. With the social distancing policies in place, the conversation about COVID-19 is also increasing and has become a major source of misinformation. As the number of people relying mostly on social media platforms for news, detecting misinformation has emerged as a major task in these unprecedented times. In addition to being malicious, the spread of misinformation poses a serious public health risk. In this work we will apply permutation based approach to detect misinformation related to COVID-19.
Student Necessary Skills	Deep Learning

Project Title	**P39 - Blockchain-Based Authentication and Privacy Preserved Learning Scheme for Drone-based Fog Infrastructure**
Supervisor(s)	Dr Frank Jiang, Dr Xiao Liu
Email	Frank.Jiang@deakin.edu.au; Xiao.Liu@deakin.edu.au ;
Campus	Burwood
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	Interconnected vehicles/drones are one of the key nodes in the fog infrastructure as the extension of cloud computing. It is a distributed computing infrastructure oriented and can extend computing power and data analytics to the "edge" of the network. It enables customers to analyse and manage data locally, thus obtaining instant insights through links. Fog computing has certain mobility integrating network, computing, storage and application core competencies on the edge side of the network near the object or data source. We aim to establish an edge fog computing infrastructure to provide a real-time and safe computing platform with the blockchain as the core technique to interconnect the vehicle network. To achieve the secured interconnected vehicular edge system, this project proposes an advanced blockchain-based authentication scheme for autonomous vehicular within the fog infrastructure. As an emerging technology that attracts extensive attentions in both industries and academia recently, the blockchain technology suits a decentralized application environment that possesses the characteristic of the distributed consensus. The expected outcome of this research includes: • A new classification method for connected users and information in vehicle network meets the needs of blockchain analysis. • An intelligent system for discovering connected vehicles and information based on block chaining technology. • An algorithm for information chain authentication and reconstruction based on blockchain technology.
Student Necessary Skills	Preferred Knowledge/Skills (at least 2 of them): • Computer Networks / VANET Simulators / Minimal understanding of cyber security issues, network architecture and services. / A willingness to learn new technical concepts in Security / Enthusiasm to explore the new knowledge domain and solve the identified research questions.

Project Title	P40 - Supporting Emerging Internet of Things (IoT) Applications in Next-Generation Communication Networks
Supervisor(s)	Chathu Ranaweera, Jonathan Kua, Imali Dias
Email	{chathu.ranaweera, jonathan.kua, imali.dias}@deakin.edu.au
Campus	All
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	The fifth generation (5G) mobile technology promises higher bandwidth capacities, lower latencies and higher reliability for emerging time-sensitive and mission-critical applications. As part of the Internet of Things (IoT), it is also predicted that number of diverse connected devices will reach 500 billion by 2030, which will be significantly greater than the expected world population. Providing communication and networking support for billions of devices, along with satisfying the stringent quality of service requirements of such devices is an active area of research. Communication technologies for 5G and beyond expect to support emerging IoT applications, such as autonomous vehicles, remote surgery, industrial automation and control, smart grid, and immersive streaming applications. Some applications such as remote surgeries will require a reliable communication that supports sub-millisecond delays and extremely low error rates whilst applications such as virtual reality require very high spectral efficiency and IoT applications will requires ubiquitous connectivity and, in some cases, power transmission efficiency. This research project aims to investigate diverse techniques that we can be used to enable cost-effective, ultra-reliable, and low-latency communication in next generation networks to support diverse emerging applications. In particular, the project aims to address the following topics: • Characterisation of the communication requirements of different real-world IoT scenarios, ranging from backhaul optical networks to smart applications, and their impact on current networking protocols on the Internet. • Developing integrated network protocols for low-latency communication for interactive services, IoT actuation and automation, with the application of self-learning techniques using machine learning. • Design considerations for emerging streaming technologies, including the coding, packaging, transport and delivery of content.
Student Necessary Skills	Programming e.g. Python, C++, data analysis (e.g. Matlab) / Background in networking / Background in data analysis & machine learning would be advantageous

Project Title	P41 – Raspberry Pi 4-based Cluster Computing
Supervisor(s)	Jean-Guy Schneider, Kevin lee
Email	jeanguy.schneider@deakin.edu.au Kevin.lee@deakin.edu.au
Campus	Burwood, Cloud
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	Powerful computational clusters are used to perform massive computational tasks such as for climate simulations, drug discovery and data mining. Unfortunately, computing clusters are very expensive, which limits the possibility of experimentation with them. This means the scientists are not necessarily using the more efficient resources for their computation demands. This project will use a home-grown Raspberry Pi-4 cluster which we have built to experiment with cluster computing approaches. These approaches include workflow processing, container-based execution, big-data processing and energy-efficient computation. The following are a list of projects within this area. Projects • Docker and Kubernetes cluster-computing • Energy-aware cluster computing • Recommendation engine for efficient cluster computing • Personal workflow engine processing • Frameworks for managing computation between a cluster, edge and cloud computing infrastructure Depending on progress in the project, it is anticipated that the work will be published in a software engineering conference.
Student Necessary Skills	Programming language experience – e.g. C/Python/Node.JS

Project Title	P42 – Integration of IoT-enabled Indoor Wireless Networks
Supervisor(s)	Imali Dias, Chathu Ranaweera, Jonathan Kua
Email	{imali.dias, chathu.ranaweera, jonathan.kua}@deakin.edu.au
Campus	All
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	Indoor wireless networking technologies such as WiFi have long been used in providing many services such as day-to-day internet access and home automation. Indoor wireless networks, however, are constrained in data rates and bandwidths due to the limited availability of radio spectrum. Recent developments in diverse IoT applications and services have demanded improvements in indoor wireless networks in both data rates and latency, prompting many hardware, architecture and protocol-wise improvements on indoor wireless networks. As a result, diverse indoor wireless technologies (such as 60 GHz WiFi) are emerging to facilitate the new breed of user applications ranging from low-latency internet of things (IoT) applications such as remote education, tele-surgery and home automation to bandwidth-hungry applications including mixed reality and hologram. Although a significant amount of research has been carried out on IoT-supportive multi-gig indoor wireless networks, research on integrating these indoor wireless networks with the rest of the network that provides access to Internet is still at its infancy. As such, under this proposed research, we will investigate potential technologies and architectures that can be used to integrate indoor wireless networks with the access and core networks. The key areas addressed in this study are as follows. • Analyse the latencies experienced by user data at different network segments along the data transmission path and implement a framework for latency-constrained data transmission. • Incorporate machine learning techniques to predict user behaviours and allocate resources across the integrated network. • Analyse the abilities of different communication technologies such as 5G and optical to connect indoor wirelesses networks to Internet. • Investigate and implement secure data transmission to support IoT applications that require high-level of security such as tele-surgery. • Analyse the trade-offs between different Quality of Service (QoS) parameters such as latency, reliability, security and energy efficiency of the proposed protocols. • Incorporate energy-efficient data transmission strategies to minimise energy consumption.
Student Necessary Skills	Programming e.g. Python / Background in networking / Background in data analysis & machine learning would be advantageous

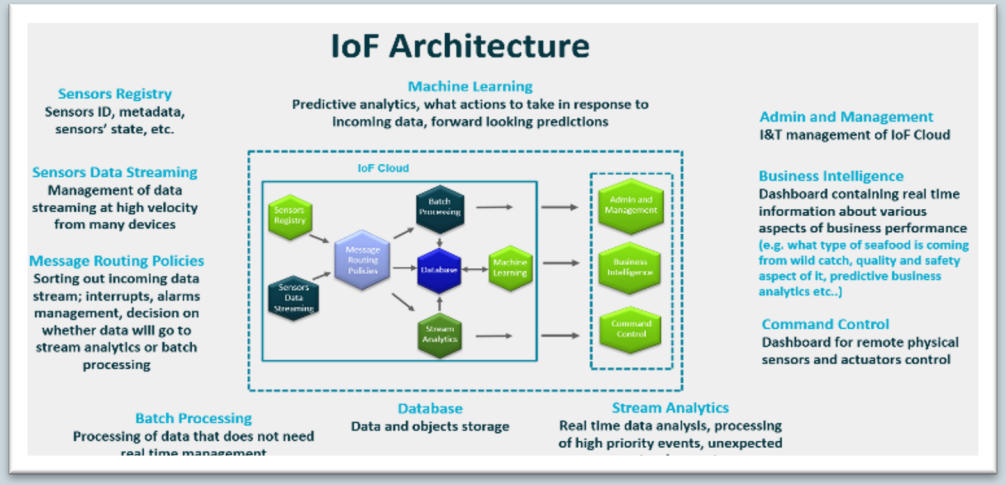
Project Title	P43 – Next-generation Internet of Things Networks Access Control
Supervisor(s)	Dr. Keshav Sood and Dr. Jesse Laeuchli
Email	Keshav.sood@deakin.edu.au; j.laeuchli@deakin.edu.au
Campus	All
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	Extremely heterogeneous Internet of Things (IoT) devices impact the decision making ability of autonomous and Intelligent IoT access control security systems. Access Control system allows an entity to securely access the network and resources and ensures the confidentiality of information by guiding the network to share information with authorized entities only. We observe that the big data generated by heterogeneous IoT devices (or eventually IoT networks) can be used for making predictions and prescription of the solutions for intelligently handling real-time situations in IoT networks (from access control context). In this project we aim to design an autonomous-intelligent IoT access control architecture for next-generation heterogeneous networks for Australians. We will address the following questions. • What Is Revolutionized with Intelligence? • Where Is Intelligence Needed? • When Is Intelligence Required? • Who Needs to Be Intelligent? • How Can Intelligence Be Brought to IoT Devices? Our work (starts from a systemic review of the current state-of-the-art and ends by proposing an effective scheme) will enable 5G IoT network providers to offer more secure network services and efficiently prioritise their resources on higher value-adding services. Eventually this would also save significant operational and capital expenditure or costs.
Student Necessary Skills	Moderate to good understanding of network design / Minimal to moderate understanding of cyber security issues / Good knowledge of machine learning or Python language / A willingness to learn new technical concepts in 5G, SDN and IoT

Project Title	P44 - Detecting Sensor Faults and Anomalies in Internet of Things
Supervisor(s)	Dr Anuroop Gaddam, Dr. Keshav Sood
Email	anuroop.gaddam@deakin.edu.au; Keshav.sood@deakin.edu.au;
Campus	All
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	Over the past few years, the Internet of Things (IoT) has gained significant recognition to become a novel sensing paradigm to interact with the physical world. The sensors within the Internet of Things are indispensable parts and are the first port to capture the raw data. As the sensors within IoT are usually deployed in environments which are harsh, which inevitably make the sensors venerable to failure and malfunction. Beside sensor faults and malfunctions, the inherent environment where the sensors are usually installed could also make the sensor to fail prematurely. These conditions will make the sensors within the IoT to generate unusual and erroneous data, often known as outliers. Outliers detection is very crucial in IoT to detect the high probability of erroneous reading or data corruption, thereby ensuring the quality of the data collected by sensors. Data anomalies, abnormal data or outliers are considered to be the sensor data streams that are significantly distinct from the normal behavioural data. As the Internet of Things are very different from the Wireless sensor networks there is a huge necessity for developing adequate protocols and techniques to address unique challenges and constraints of IoT. The scope of project includes developing models to provide the highest accuracy in detecting sensor faults and outliers in IoT context.
Student Necessary Skills	• Moderate to good understanding of network design • Minimal to moderate understanding of hardware design • A willingness to learn new technical concepts in WSN and IoT • Good knowledge of machine learning or Python language

Project Title	P45 - IoT-enabled Discrete, Outdoor Deployable Gait Monitoring System
Supervisor(s)	Dr Anuroop Gaddam, Dr. Keshav Sood
Email	anuroop.gaddam@deakin.edu.au; Keshav.sood@deakin.edu.au;
Campus	All
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	Walking is crucial to maintaining health and wellbeing in older age. A decline in community ambulation (walking for transport or recreation) is associated with loss of independence for community-dwelling older people and is a predictor of residential care admission and mortality. Key components of ambulation are gait speed, the ability to walk while performing concurrent cognitive and motor tasks and the ability to negotiate unpredictable terrain. The decline in mobility increases risks of frailty via reductions in strength, power and muscle mass with major negative implications on psychological health. Unfortunately, gait is usually measured on a specially designed walk path, which has to be done at clinics or health institutes. Wearable tracking services using an accelerometer, or an inertial measurement unit can measure the gain for a certain time interval, but not all the time, due to the lack of a sustainable energy source, and inconvenience to the elderly user. To tackle these shortcomings, this research develops an IoT framework and a prototype that can be embedded in outdoor landscapes to monitor individuals' gait and identify patterns of gait change. The sensorized landscape would be positioned in an area frequented by target users to improve data collection opportunities. To create a gait profile for the individual and estimate the individual's fall risk from the spatial-temporal data collected by the sensors, the research also needs to be focused on developing machine learning / AI techniques. This project involves collaborating with multi-disciplinary research teams.
Student Necessary Skills	• Moderate to good understanding of network design • Minimal to moderate understanding of hardware design • A willingness to learn new technical concepts in WSN, IoT, electronics, signal processing and health informatics. • Good knowledge of machine learning or Python language

Project Title	P46 - Designing a Trust Management Framework for the Internet of Things
Supervisor(s)	Dr Anuroop Gaddam, Dr. Keshav Sood
Email	anuroop.gaddam@deakin.edu.au; Keshav.sood@deakin.edu.au;
Campus	All
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	The Internet of Things (IoT) consists of a huge number of entities like the users, various sensors other devices and applications connected through a communication infrastructure. In many scenarios (e.g. Industrial, agricultural and health monitoring) the IoT's are deployed in large-scale often communicating external entities or working together to collect, process the data from physical environments. As IoT is a dynamic system, there raises a new fundamental issue of knowing whether an individual IoT entity can securely communicate with another and if so, then to what extent. In the IoT, entities must interact with one another often in unknown and uncertain circumstances. Therefore, in such systems, it is important to include mechanisms that can help in such interactions by overcoming this uncertainty. There is a significant need to develop a trust model for the IoT, considering the highly dynamic nature and other distinct characteristics of such systems using Machine Learning (ML) techniques. Trust mechanisms allow entities to decide whether or not to interact with other entities. The student needs to research on the metrics and methods for establishing trust in dynamic IoT systems and develop a trust management framework that can improve access control mechanisms easing the decision-making process under uncertainty in large-scale IoT systems.
Student Necessary Skills	• Moderate to good understanding of network design • Minimal to moderate understanding of cyber security issues • A willingness to learn new technical concepts in 5G, SDN and IoT • Good knowledge of machine learning or Python language

Project Title	P47 – Co-simulator for Modeling Cyber-Physical Systems
Supervisor(s)	Dr. Adnan Anwar
Email	adnan.anwar@deakin.edu.au
Campus	Burwood
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	The Smart Grid system is one of the key infrastructures to sustain our future society. It is a complex system that comprises two independent parts: PHYSICAL power grids and communication networks based CYBER layer. To understand the impact of a cyber-physical smart grid, it is important to develop a simulator that captures both cyber and physical phenomena. In this project, the aim is to develop a smart grid Co-simulation Framework. The role of the student will be to focus on the integration of the network simulator with energy system simulator. Supervisor's previous work will be a starting point. The project has main aims from where students can choose one (or both) based on their experience and interest. Aim1: Backend modelling of the co-simulators and improve the simulator performances and usages Aim2: Display the simulation in a GUI based front-end.
Student Necessary Skills	Programming skills in Java, C++, python or others. Passionate to do programming.

Project Title	**P48 - Internet of Food Platform for Cold Food Supply Chain**
Supervisor(s)	Arkady Zaslavsky & Karolina Petkovic (CSIRO, Clayton)
Email	arkady.zaslavsky@deakin.edu.au
Campus	Burwood
Start Date	☒ T1-2021 ☒ T2-2021 ☐ T3-2021
Project Description	The major project objective is the development of a prototype Internet of Food (IoF) platform for a selected food supply chain (e.g. cold fish and seafood supply chain, beef food supply chain, etc.) The proposed IoF architecture is presented on Figure 1.  Figure 1 Internet of Food Architecture **Scope:** • Sensors data streaming module. Initially platform will need to collect only temperature from several sensors. Temperature data will need to be displayed on customer dashboard in real time. • Development of customer dashboard prototype that can be used for IoF platform demonstration purposes when engaging external collaborators and customers. • The dashboard will display incoming temperature data stream. • Machine learning algorithm for correlating food temperature with its safety and nutritional quality.
Student Necessary Skills	

Project Title	P49 – A Novel Multipath Data Scheduling for Future IoT Systems
Supervisor(s)	Shiva Pokhrel
Email	Shiva.Pokhrel@deakin.edu.au
Campus	
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	With the growing presence of the Internet of Things and Cyber Physical Systems in industry, the use of WiGig or 5G for Industrial IoT (IIoT) is already evident. Automation with data exchange within and among manufacturing plants is undergoing a tremendous change along with IIoT, which is made possible by the gradual convergence of information technology (IT) with operational technology (OT). Such a convergence can be potentially benefitted by jointly using recent advances in communication technologies, e.g., coexisting WiGig and 5G. In this project, we first analyze the existing technical challenges for the coexistence of WiGig and 5G for IT/OT convergence, then develop and evaluate a robust multipath protocol (drawing on WiGig and 5G seamlessly) to create ultrareliable and smooth connectivity. The project will provide a dynamic architecture for the future industrial communications, connecting industrial robots timely, analyzing data precisely and delivering real-time insights reliably.
Student Necessary Skills	Programming Python, Matlab, Distributed Machine Learning

Project Title	**P50 - Network traffic analysis with deep learning**
Supervisor(s)	Lei Pan and Sutharshan Rajasegarar
Email	l.pan@deakin.edu.au
Campus	Burwood
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
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, reply 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, the link below contains a few datasets and several research papers: https://sites.google.com/a/uah.edu/tommy-morris-uah/ics-data-sets 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.
Student Necessary Skills	Data mining algorithms with machine-learning project experiences (Python + scikit-learn preferred).

Project Title	P51 - Cooperative Smart Data Transfer in Vehicular Networks
Supervisor(s)	Dr Jonathan Kua, Prof Seng Loke
Email	{jonathan.kua, seng.loke}@deakin.edu.au
Campus	All
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	The combination of high-capacity mobile networking technologies and the growing popularity of bandwidth-hungry applications (such as video streaming, social media applications, and emerging VR/AR application data) has tremendously increased the demand for mobile network resources. Connected and automated driving vehicles further increase the network load, as they often require a large amount of data transfer between vehicles and remote cloud/edge computing infrastructure. In addition to bandwidth-hungry applications, the continuous collecting, maintaining, and sending and receiving of situational updates can potentially overload the vehicle-to-network (V2N) communication infrastructure. Hence, it is important to consider a cooperative method for smart data transfer among inter-connected vehicles to mitigate the load on existing V2N networks. For example, vehicles in a vicinity can use vehicle-to-vehicle (V2V) technology to form a group, known as “vehicular micro-cloud”. Each member downloads a subset of data segments that comprise an original data content, and then exchanges those segments with other members so they can reconstruct the original content if needed. This mechanism enables a group of vehicles to collectively serve as a virtual content delivery server. This is particularly relevant as in-built infotainment systems often require real-time retrieval of video content from remote content servers. This research project aims to design a local coordination and cooperation smart data transfer scheme for vehicular networks that achieve the following goals: The formation of vehicular micro-cloud that facilitates efficient data transfer and downloads. Coordination of micro-cloud group members to reduce redundant data download via V2N while keeping the channel resource overhead to the minimum. An efficient video streaming coordination data transfer scheme for in-built infotainment systems.
Student Necessary Skills	Programming (Python, C++), scripting (e.g. Bash shell), data analysis (e.g. Matlab)

Project Title	P52 - Anonymisation of trajectory data
Supervisor(s)	Dr. Rolando Trujillo
Email	rolando.trujillo@deakin.edu.au
Campus	Burwood
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	Mobile communication has grown quickly in the last two decades. Connections can be wirelessly established from almost any habitable place in the earth, leading to a plethora of connection-based tracking mechanisms, such as GPS, GSM, RFID, etc. Trajectories representing the movement of people are consequently being gathered and analysed in a daily basis. However, a trajectory may contain sensitive and private information, which raises the problem of whether spatio-temporal data can be published in a private manner. The goals of this project are twofold: evaluate trajectory anonymisation methods in terms of utility and privacy offered, and put forward an efficient and novel trajectory anonymisation heuristic with state-of-the-art performance.
Student Necessary Skills	Strong programming skills

Project Title	P53 – Avoiding Geographic Regions in Tor
Supervisor(s)	Dr Frank Jiang, Prof Robin Doss, Dr Morshed Chowdhury
Email	Frank.Jiang@deakin.edu.au ; Robin.Doss@deakin.edu.au ; morshed.chowdhury@deakin.edu.au
Campus	Burwood
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	Traffic-analysis attacks are a persisting threat for Tor users. When censors or law enforcement agencies try to identify users, they conduct traffic-confirmation attacks and monitor encrypted transmissions to extract metadata—in combination with routing attacks, these attacks become sufficiently powerful to de-anonymize users. While traffic-analysis attacks are hard to detect and expensive to counter in practice, geographical avoidance provides an option to reject circuits that might be routed through an untrusted area. Unfortunately, recently proposed solutions introduce severe security issues by imprudent design decisions. In this research, we approach geographical avoidance starting from a thorough assessment of its challenges. These challenges serve as the foundation for the design of an empirical avoidance concept that considers actual transmission characteristics for justified decisions. Furthermore, we address the problems of untrusted or untransparent ground truth information that hinder a reliable assessment of circuits. Taking these features into account, we conduct an empirical simulation study and compare the performance of our novel avoidance concept with existing approaches. Our results show that we outperform existing systems by 22% fewer rejected circuits, which reduces the collateral damage of overly restrictive avoidance decisions. In a second evaluation step, we extend our initial system concept and implement the prototype TrilateraTor. **Expectations:** Producing a platform as the prototype which satisfies the requirements of a practical deployment, maintaining Tor's original level of security, provides reasonable performance, and overcomes the fundamental security flaws of existing systems. Students will work on the experiments and produce publishable results/research outcome.
Student Necessary Skills	Preferred Knowledge/Skills (at least 1 of them): 1) Computer Networks and Cyber Security 2) Probability theory.

Project Title	**P54 – OT/IT converged Security, Trustworthiness and Robustness for Critical Infrastructure**
Supervisor(s)	Dr Frank Jiang; Prof Robin Doss,
Email	Frank.Jiang@deakin.edu.au ; Robin.Doss@deakin.edu.au
Campus	Burwood
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	The evolving landscape of Information Technology (IT) and Operational Technology (OT) convergence has provoked further security concerns in the Industrial 4.0 framework for Critical Infrastructures within Australia. Conventionally, IT comprises of the enterprise network/business apps, and OT encompasses the hardware and software that monitors and manages physical equipment and processes, such as distributed control systems (DCS), supervisory control and data acquisition (SCADA) systems, and industrial internet-connected devices (smart devices/IIoT). OT and IT have not overlapped historically, and they were managed separately in the past. OT security is confronting new attack surfaces on ICS, where malicious attacks could result in a catastrophic state for the industry, the factory, or even the critical infrastructures, e.g., water supply and electrical power systems. There are tremendous security threats to the OT networks, such as infiltration via remote access, spear phishing, malware injected through internet connections, and targets physical equipment and processes like HMI (human machine interface) interfaces, DCSs, and PLCs. The **objectives** of this project are to: 1. Develop a lightweight authenticated key agreement (AKA) protocol with perfect forward secrecy (PFS) and dynamic authentication credential (DAC) to enhance the security and robustness in both IT and OT networks. 2. Develop a reliable cyberattack detection model to increase the trustworthiness in IT-OT networks. 3. Develop a secure and efficient data sharing scheme based on blockchain in IT-OT networks. 4. Develop a unified approach to IT-OT security management based on model-driven and comprehensive visibility.
Student Necessary Skills	• Moderate to good understanding of networked control systems, as well as the basic understanding for the critical infrastructure • Minimal understanding of cyber security issues, network architecture and services. • A willingness to learn new technical concepts in Security • Enthusiasm to explore the new knowledge domain and solve the identified research questions.

Project Title	P55 - Next-generation Network Security Orchestration
Supervisor(s)	Dr. Keshav Sood and Dr Anuroop Gaddam
Email	Keshav.sood@deakin.edu.au; anuroop.gaddam@deakin.edu.au
Campus	All
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	The high speed transmission rate of next generation networks although is an advantage, but this bring unique security challenges. In this work we will explore application scenarios where even after the deployment of 5G, security is at high risk. Each scenario will be studied and a solution to patch the gaps will be proposed and validated. Our work (starts from a systemic review of the current state-of-the-art, and ends by proposing an effective scheme) will enable 5G enabled network providers to offer more secure network services and efficiently prioritise their resources on higher value-adding services. Eventually this would also save significant operational and capital expenditure or costs.
Student Necessary Skills	• Moderate to good understanding of network design • Minimal to moderate understanding of cyber security issues • A willingness to learn new technical concepts in 5G, SDN and IoT • Good knowledge of machine learning or Python language

Project Title	P56 – Abnormal DNS Traffic Detection for Cyber Security
Supervisor(s)	Gang Li, Ye Zhu
Email	gang.li@deakin.edu.au, ye.zhu@deakin.edu.au
Campus	Burwood
Start Date	☒ T1-2021 ☒ T2-2021 ☐ T3-2021
Project Description	DNS is a critical and foundational protocol of the internet – often described as the "phonebook of the internet", which maps the domain names to IP addresses. However, DNS' ubiquity (and frequent lack of scrutiny) can enable very elegant and subtle methods for communicating, and sharing data, beyond the protocol's original intentions. Free tools are available for attackers to create covert channels over DNS for the purposes of hiding communication or bypassing policies put in place by network administrators. This **project theme** (and its subprojects) represents a collective effort in understanding the security loopholes related to DNS service and developing methods to identify abnormal DNS traffic for risk mitigation. Students in this project will be guided by the supervisors and complete the following tasks related to different aspects of DNS security: 1. To complete a literature review on DNS security issues and the corresponding state-of-the-art mitigation methods 2. To develop various methods to identify abnormal DNS traffic, and evaluate the performance against state-of-the-art methods 3. To develop methods to identify encrypted DNS traffic, such as DNS over https, or DNS over TLS, and evaluate the possibility of a complete detection 4. To establish and maintain an open-source repository for the related research data sets, and the developed tools
Student Necessary Skills	1. Foundational Internet knowledge, especially DNS queries/responses and related protocols, coding 2. Statistics and Data Science knowledge 3. Python programming skills, git/GitHub usage, 4. Time/task management, and teamwork

Project Title	P57 - Digital Forensics for Drone Data
Supervisor(s)	Dr. Zubair Baig
Email	Zubair.baig@deakin.edu.au
Campus	Online, WP
Start Date	☒ T1-2021 ☐ T2-2021 ☒ T3-2021
Project Description	Digital forensics is a critical field of study that involves the acquisition, handling and processing of evidence as captured from cyber crime incidents; for criminal implication in the court of law. The extraction of data obtained from heterogeneous crime scene sources and its subsequent processing is a tedious task. More so if the evidence comprises drones that may have been involved in criminal activities in general and cybercrime in particular. Through this project, data sets obtained from the CFReDS Project on Drones images comprising over 79 actual drone datasets that had underwent actual flights, will be evaluated using several Digital Forensic tools, with the purpose of extracting valid evidence that may be presented in the court of law, as part of a cybercrime investigation. The tasks comprising this project are: 1. Analysis of 2-3 Drone data sets obtained from https://www.cfreds.nist.gov/ 2. Study of several digital forensic tools (e.g., Scalpy, Autopsy, SIFT, FTK), and mastering the art of digital forensics and appertaining investigations. 3. Systematic forensic analysis of the datasets. 4. Running tools including GNUPlot, to prepare visulatisations of the results obtained. 5. Reporting of the findings.
Student Necessary Skills	Software toolkit usage, Basic Python Scripting.

Project Title	P58 – IoT Network Traffic Classification using AI
Supervisor(s)	Dr. Zubair Baig
Email	Zubair.baig@deakin.edu.au
Campus	Online, WP
Start Date	☒ T1-2021 ☐ T2-2021 ☒ T3-2021
Project Description	The Internet of Things (IoT) as an integral part of our lives; smart TVs, mobile gadgets, smart electricity meters, Google Talk, etc. Essentially, IoT devices are smaller scale computers that can carry out numerous computational, sensing and storage related tasks; producing large volumes of data and exposing their vulnerabilities for potential exploit by the adversary class. In this project, adversarial activities in IoT platforms/networks will be analysed based on application of Extreme Learning Machines (ELM) for traffic classification. The intent of this project is to produce an analysis of live network traffic in IoT platforms, and to classify the same as normal or malicious. The dataset to be used can be found here [alternates will also be discussed]: https://www.stratosphereips.org/datasets-iot23 The tasks comprising this project will be: 1. Analysis of IoT network traffic 2. Study of ELMs. 3. Design of an IoT network traffic classifier 4. Testing of the IoT classifier on live traffic.
Student Necessary Skills	Software toolkit usage, Basic Python Scripting.

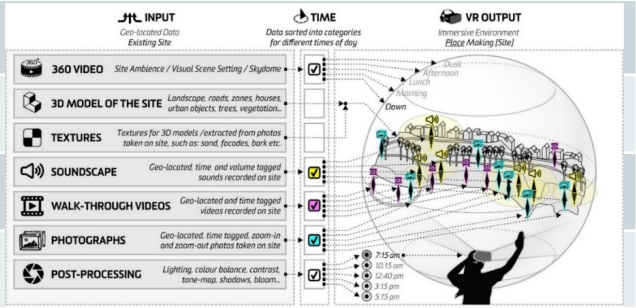
Project Title	**P59 - Exploring the vulnerabilities in Federated Identity Management (FIM) protocols' specifications and implementations and developing techniques for their mitigations.**
Supervisor(s)	Shamsul Huda and Frank Jiang
Email	Shamsul.huda@deakin.edu.au and Frank.Jiang@deakin.edu.au
Campus	Burwood
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	Abstract: Recent COVID 19 development has forced many organizations and their employees to work from home. This immensely increases corporate users and individuals to accomplish their everyday activities via online, use massively single sign-on (SSO) approach using either corporate managed or BYOD. Federated Identity Management (FIM) is a popular framework for SSO system. FIM framework help individuals and corporate organizations to manage their account credentials, authentication and authorization very easily. Different protocols such as SAML, OAuth 2.0, Open ID and open ID connect propose partial or complete solutions for FIM. Large organization including Facebook, google, LinkedIn, Twitter, Amazon, Microsoft have taken the lead to be the identity providers as part of FIM framework implementation. Corporate organizations also are now acting as identity providers. The current core specification of FIM standards allow the clients, identity providers and resources servers poorly configured and incorrectly implemented applications. This makes the client applications, user agents and application of resources servers more vulnerable when combined with existing web vulnerabilities. This poses high security and privacy threats to the users' resources (e.g. stealing sensitive log-in information and full control of users' resources stored in the resources servers). This project will explore the vulnerabilities related to FIM standards and their implementation, develop threat models, vulnerability detection tool and propose mitigations techniques to protect the users of SSO systems.
Student Necessary Skills	Knowledge on the top web application and software vulnerabilities, experience of setting-up and working in hacking environments to exploit those vulnerabilities, Web-debugger tool, different proxy tools.

Project Title	P60 - Cyber Security Analysis for the Internet of Electric Vehicles- Intrusion Detection Method
Supervisor(s)	Dr Valeh Moghaddam
Email	Valeh.moghaddam@deakin.edu.au
Campus	Geelong
Start Date	☐ T1-2021 ☒ T2-2021 ☐ T3-2021
Project Description	The use of Electric Vehicle (EV) is growing rapidly due to its environmental benefits. However, the major problem of these vehicles is their limited battery, the lack of charging stations and the re-charge time. Introducing Information and Communication Technologies, in the field of EV, will improve energy efficiency, energy consumption predictions, availability of charging stations, etc. The Internet of Vehicles based only on Electric Vehicles (IoEV) is a complex system includes vehicles, humans, sensors, road infrastructure and charging stations. All these entities communicate using several communication technologies (ZigBee, 802.11p, cellular networks, etc). IoEV is therefore vulnerable to significant attacks such as DoS, false data injection, modification. Hence, security is a crucial factor for the development and the wide deployment of Internet of Electric Vehicles (IoEV). In this research, the main objective is to present an overview of security issues of the IoEV architecture and propose methodologies as solutions to overcome these issues.
Student Necessary Skills	• Knowledge of Cybersecurity / Good understanding of network design / Programming knowledge, such as Matlab, Python / Knowledge of EV applications

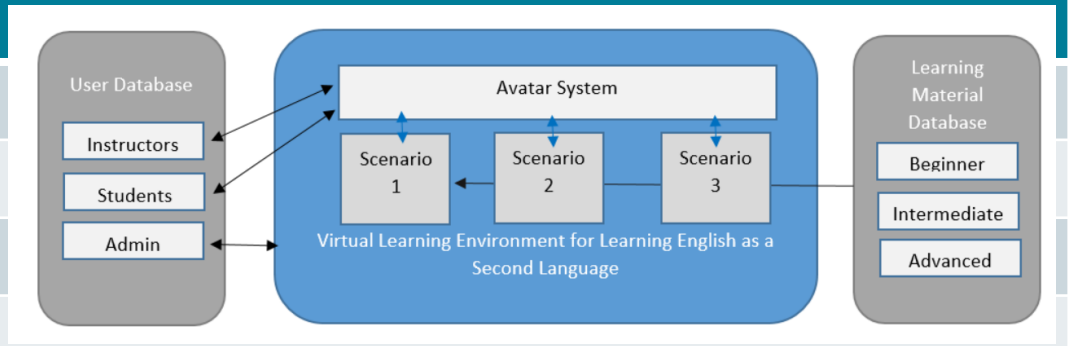
Project Title	**P61 – Emotional Embodiment for Behavioural Change**
Supervisor(s)	Thuong Hoang
Email	thuong.hoang@deakin.edu.au
Campus	Burwood
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	The disconnection between people and natural landscapes (‘nature deficit disorder’) is well-documented and of concern to educationalists and to governments given its impact on mental health and well-being, especially with the increasing rate of urbanisation. This second stage investigates, design, and evaluate the impact of augmented and virtual reality experiences on promoting individual and community behavioural changes for biodiversity/nature conservation as well as increasing wellbeing through connection with nature. The focus of this stage is to investigate the extent of emotional connection enabled by mixed reality technology via embodiment of endangered animals. The innovative approach of the project creates virtual reality experiences that immerses the users in a virtual natural landscape, not as human, but embodied as one of the endangered Corroboree Frog or Orange-bellied Parrot. This approach creates a powerful connection with nature by seeing through the eyes of an endangered species, which is not possible using other medium or technologies.
Student Necessary Skills	Experience in Unity/Unreal game engine

Project Title	P62 - Avatar Decoder Pipeline for Multiple Simultaneous Avatar Appearances based on Trusted Relationships
Supervisor(s)	Thuong Hoang
Email	thuong.hoang@deakin.edu.au
Campus	Burwood
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	The project presents a novel technique for an avatar mesh decoder, to enable simultaneous multiple virtual representations of the same user to individual online participants, based on an established trust relationship. Our concept of avatar decoder pipeline implements a one-to-many relationship between rig and avatar meshes, where user movements will control a single avatar rig, while different meshes will be rendered on other participants' headsets based on their existing relationship with the user. A stranger will only see a generic, potentially application relevant avatar, while their friends will see a detailed or photorealistic avatar that reveals facets of identity. Crucially, different avatar details will be available to different relations; identities and trust are decentralised but governed through the pipeline facilitating encrypted relations of trust. The pipeline infrastructure includes multiple avatar meshes (skins) and an authentication server. User's skeleton rig movements are synced as networked objects to the virtual reality multiplayer server and their avatar skins appropriate for different trust levels are encrypted. Upon encountering the user in the virtual world, the viewers will use a session key obtained through authentication of trust relationship with the user, to decrypt the correct avatar skin that is meant to be seen. The pipeline enables private interactions between trusted parties in a public virtual setting.
Student Necessary Skills	Experience in Unity/Unreal game engine / Knowledge of VR development

Project Title	**P63 – Designing Healthy Future Places through Collective Place-making in Social VR**
Supervisor(s)	Dr. Rui Wang, Dr. Thuong Hoang
Email	Rui.Wang@deakin.edu.au, Thuong.Hoang@deakin.edu.au
Campus	Burwood / Cloud
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	The increasing ubiquity of Virtual Reality (VR) technology provides new opportunities to represent built environment and urban information in innovative ways and to share the intangible aspects of young people's sense of places. This project aims to connect the young community groups by creating a platform that enables a blended space where they share ideas, opinions, stories and memories to create a future space that enhances social connectedness, sense of place and health and well-being. Several "research by design" prototypes will be developed and case studies with our partners – School of Architecture and Built Environment and City of Greater Geelong will be conducted. The social VR platform, where residents can share their thoughts about their local places, acts as a bridge to connect residents with their neighbourhood. This may have a sustainable effect in improving their health and well-being by enabling new opportunities for everyone to shape the future of the places they live in. The platform will be made available to local communities with an existing media library, and a basic virtual scenario demonstrating the site where new development or retrofitting is proposed. The residents can experience the place virtually, view the design of a new development (a playground for instance) proposed by the city council, change the design elements and provide feedback in the virtual place. The project focuses on the following research questions: • What is the role of social VR in addressing real-world problem of how to effectively involve young people in their local communities in designing and forming our future places through VR, the technology for the next generation? • How can we leverage emerging VR technology to involve children and adolescents in the key processes of place-making and how will this have an impact on their social connectedness, sense of place and health and well-being?
Student Necessary Skills	Development skills with Unity, either as programmer or 3D artist



Project Title	**P64 – Learning English as a Second Language with XR**
Supervisor(s)	Dr. Rui Wang, Dr. Thuong Hoang
Email	Rui.Wang@deakin.edu.au, Thuong.Hoang@deakin.edu.au
Campus	Burwood / Cloud
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021



Project Description

Leveraging the AR/VR technology, this project will explore and investigate how situated learning pedagogy can be applied in designing an interactive virtual environment for people to learn English as a second language.

Funded by industry partner, a proof-of-concept (PoC) prototype application will be designed and developed to facilitate learners to learn English in 3D interactive environments. The PoC prototype will be developed using the state-of-art game engine technology (Unity3d), targeting at different platforms including desktop based application, mobile application with an AR component, and the highly immersive virtual reality head-mounted displays (HMDs). Several scenarios will be designed and developed to enable situated learning, which may include general situations (such as scenarios in international airports, restaurants and cafes, hotel and accommodations, university administration etc). Dialogues and activities will be designed to cover intended learning outcomes, with an embedded avatar system that enables multiple users communicating in their chosen virtual scenario.

The diagram above illustrates the overall structure of the PoC prototype. During the current project phase, the focus is on the beginner level of learning materials.

The student(s) will be working with a dedicated project team (including software developers, XR researchers and pedagogy educators) on both the development of the prototype and research that investigates the following research questions:

- How situated learning pedagogy can be usefully adopted when designing an interactive virtual environment for learning English as a second language?
- What roles do different technologies, such as HMD based virtual reality and mobile based augmented reality play in learning English as a second language?

Student Necessary Skills

Development skills with Unity, either as programmer or 3D artist

Project Title	P65 – Alignment of Two Sequences
Supervisor(s)	Robert Dew
Email	robert.dew@deakin.edu.au
Campus	Waurn Ponds
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	Measuring the percentage of similarity between two sequences is used in many areas. For example, matching two DNA sequences. Part of a text steganography project requires comparing smaller messages, rather than extremely lengthy DNA sequences. For example, we might want to compare two messages as in Figure 1a. Identifying which words are the same in each sequence and retaining word order is important to determine similarity. Using a technique of identifying longest sub sequences can produce the following alignment (Figure 1a, matching words are highlighted in yellow). However, a better alignment was detected by accident (Figure 1b). This project is to survey algorithms for aligning messages (small, medium, large), and identify gaps in the literature.
Student Necessary Skills	Algorithms

	M1	M2
1		THE
2		CAT
3		CHASED
4		THE
5		DOG
6		AND
7	THE	THE
8	DOG	DOG
9	CHASED	CHASED
10	THE	THE
11		FAST
12	CAT	CAT
13	AND	
14	THE	
15	CAT	
16	CHASED	
17	THE	
18	BIRD	

Figure 1a

	M1	M2
1	THE	THE
2	DOG	CAT
3	CHASED	CHASED
4	THE	THE
5	CAT	DOG
6	AND	AND
7	THE	THE
8	CAT	DOG
9	CHASED	CHASED
10	THE	THE
11	BIRD	FAST
12		CAT

Figure 1b

Project Title	**P66 - Anti-collision algorithms for RFID systems**
Supervisor(s)	Jiho Choi
Email	Jiho.choi@deakin.edu.au
Campus	
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	Radio frequency identification (RFID) becomes popular due to its advantages over alternative technologies (e.g., the ability to identify objectives with distance) and will be part of the Internet-of-Things (IoT) in the near future. Since there can be multiple RFID tags in the interrogation zone of a reader, there should be anti-collision protocols. In this project, the following tasks are to be carried out: A) The literature review on anti-collision protocols for RFID B) Building models to simulate anti-collision protocols C) Simulation of anti-collision protocols (MATLAB can be used)
Student Necessary Skills	

Project Title	P67 – Multiple Antennas for RFID systems
Supervisor(s)	Jiho Choi
Email	Jiho.choi@deakin.edu.au
Campus	
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	Radio frequency identification (RFID) becomes popular due to its advantages over alternative technologies (e.g., the ability to identify objectives with distance) and will be part of the Internet-of-Things (IoT) in the near future. To improve the interrogation zone, multiple-antenna or multiple-input multiple-output (MIMO) technology can be used. In this project, the following tasks are to be carried out: A) The literature review on MIMO technology for RFID B) Building models to simulate MIMO technology for RFID C) Simulation of MIMO RFID (MATLAB can be used)
Student Necessary Skills	

Project Title	P68 – Performance evaluation of multiple access techniques in NFC systems
Supervisor(s)	Jiho Choi
Email	Jiho.choi@deakin.edu.au
Campus	
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	NFC is a key technology based on RFID protocols, which is widely used by the IoT. NFC has been frequently used for diverse applications, such as intelligent transportation, industrial automation, smart homes, and other fields. The popularity of NFC is due to advantages such as its low-cost, convenience, reliability, and ability to integrate with smartphones. It works in three different operating modes such as a) reader/writer mode, b) peer to peer mode, c) card emulation mode. 1) Find out and provide a summary of all the communication protocols used in NFC technology and the differences between these three modes. 2) Find the conventional multiple access techniques used by NFC and/or RFID technologies.
Student Necessary Skills	

Project Title	**P69 - Massive data collection using NFC-enabled mobile phones**
Supervisor(s)	Jiho Choi
Email	Jiho.choi@deakin.edu.au
Campus	
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	NFC is a key technology based on RFID protocols, which is widely used by the IoT. NFC has been frequently used for diverse applications, such as intelligent transportation, industrial automation, smart homes, and other fields. The popularity of NFC is due to advantages such as its low-cost, convenience, reliability, and ability to integrate with smartphones. It works in three different operating modes such as a) reader/writer mode, b) peer to peer mode, c) card emulation mode. 1) Find out all the communication protocols used in NFC/RFID technologies for reader/writer mode. 2) Design one systematic approach to read data from a set of NFC tags using one NFC-enabled mobile phone. 3) Provide a comprehensive clarification of your system model along with some simulations to show the performance of your approach in terms of throughput, collisions, and bandwidth efficiency.
Student Necessary Skills	

Project Title	**P70 - Peer-to-peer data exchange routing using NFC-enabled mobile phones**
Supervisor(s)	Jiho Choi
Email	Jiho.choi@deakin.edu.au
Campus	
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	NFC is a key technology based on RFID protocols, which is widely used by the IoT. NFC has been frequently used for diverse applications, such as intelligent transportation, industrial automation, smart homes, and other fields. The popularity of NFC is due to advantages such as its low cost, convenience, reliability, and ability to integrate with smartphones. It works in three different operating modes such as a) reader/writer mode, b) peer to peer mode, c) card emulation mode. 1) Find out all the communication protocols used in NFC/RFID technologies for peer-to-peer mode. 2) Investigate one systematic approach to exchange data between two NFC-enabled mobile phones. ➢ How does a packet find its destination in presence of multiple mobile phones? 3) Provide a comprehensive clarification of your system model along with some simulations to show the performance of your approach in terms of successful transmission and delay.
Student Necessary Skills	

Project Title	**P71 – Task Allocation for Swarms of Robots**
Supervisor(s)	Jan Carlo Barca and Kevin Lee
Email	Jan.barca@deakin.edu.au
Campus	Burwood
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	This exciting project will investigate how swarms of drones can be allocated tasks in a firefighting scenario where the drones are disconnected from the cloud, and from human operators. The algorithms which will be developed as a part of this project should allow the swarm to autonomously carry out multiple tasks such as extinguishing fires and retrieving people that are trapped behind the fire front in parallel. Algorithms will be developed using Gazebo, the preferred simulator in DARPAs virtual robotics challenge. Depending on time and progress, the work can be evaluated using the Crazyflie drone platform. The selected student will be given an opportunity to publish his/her work internationally if the output is of high quality.
Student Necessary Skills	Python

Project Title	P72 – Goal Reasoning for Robotic Swarms
Supervisor(s)	Jan Carlo Barca and Kevin Lee
Email	Jan.barca@deakin.edu.au
Campus	Burwood
Start Date	☒ T1-2021 ☒ T2-2021 ☒ T3-2021
Project Description	At present robotic swarms must be told what goals to achieve and how goals can be decomposed into sub-goals. This constraint is limiting for swarms that perform missions in complex environments when it is not feasible to manually engineer/encode complete knowledge of what goal(s) should be pursued for every conceivable state. This is also a major drawback in situations where actions fail, new opportunities arise or events take place that strongly motivate changing the goals. This exciting project will address the above issue by investigating how intelligent robotic swarms can reason about, formulate, select and manage their goals/objectives autonomously. Algorithms will be developed using Gazebo, the preferred simulator in DARPAs virtual robotics challenge. Depending on time and progress, the work can be evaluated using the Crazyflie drone platform.
Student Necessary Skills	Python

Project Title	**P73 – Flow shop scheduling problem; Discrete differential evolution algorithm, Simulated Annealing, Tabu Search**
Supervisor(s)	Atabak Elmi, Dhananjay Thiruvady
Email	atabak.elmi@deakin.edu.au, dhananjay.thiruvady@deakin.edu.au
Campus	
Start Date	☐ T1-2021 ☐ T2-2021 ☒ T3-2021
Project Description	This research will investigate solving the flow shop scheduling problem (FSP), with and without sequence dependent setup times between the jobs. Flow shop scheduling is a special case of job shop scheduling where there is strict order of all operations to be performed on all jobs. Flow shop scheduling may apply as well to production facilities as to computing designs. The FSP consists in scheduling N different jobs (1,2,...,N) with given processing times on a set of M machines (1,2,...,M), where the processing sequence of all jobs on machines are identical. Each job has exactly one operation to be processed on each machine. It is assumed that each job can be processed on at most one machine at a time and that each machine can process at most one job at a time. FSP determines the processing sequence of jobs within the workshop. The objective of the problem is minimising the makespan which is the completion of operation for all the parts. Due to the complexity of the problem, exact methods are not efficient in solving the problem in a reasonable time. Therefore, the Discrete Differential Evolution algorithm, Simulated Annealing and Tabu Search methods will be investigated for solving the problem.
Student Necessary Skills	C++ programming, Mathematical modelling

Project Title	**P74 – Job shop scheduling problem; Discrete differential evolution algorithm, Simulated Annealing, Tabu Search**
Supervisor(s)	Atabak Elmi, Dhananjay Thiruvady
Email	atabak.elmi@deakin.edu.au, dhananjay.thiruvady@deakin.edu.au
Campus	
Start Date	☐ T1-2021 ☐ T2-2021 ☒ T3-2021
Project Description	This research will investigate solving the job shop scheduling problem (JSP), with and without sequence dependent setup times between the jobs. The job shop scheduling problem is among the hardest combinatorial optimization problems. Not only is it NP-hard, but even among the members of the latter class it appears to belong to the more difficult ones. The JSP consists in scheduling N different jobs (1,2,...,N) with given processing times on a set of M machines (1,2,...,M), where the processing sequence of jobs on the machines are different. Each job has exactly one operation to be processed on each machine. It is assumed that each job can be processed on at most one machine at a time and that each machine can process at most one job at a time. JSP determines the processing sequence of jobs on machines. The objective of the problem is minimising the makespan which is the completion of operation for all the parts. Due to the complexity of the problem, exact methods are not efficient in solving the problem in a reasonable time. Therefore, the Discrete Differential Evolution algorithm, Simulated Annealing and Tabu Search methods will be investigated for solving the problem.
Student Necessary Skills	C++ programming, Mathematical modelling