School of Information Technology

HDR Project List

Melbourne Burwood and Geelong Waurn Ponds

The mission of the School of Information Technology is to carry out cutting-edge research and research training and produce research outcomes with a high level of innovation and engagement. The school's research is conducted across three research themes [Smart data-driven world, Creating future digital technologies and Cybersecurity] and comprises three research centres [Centre for Software, Systems and Society, Data to Intelligence Research Centre, Centre for Internet of Things ECOsystems Research and Experimentation] and one strategic research centre [Centre for Cyber Resilience and Trust].

Information technology is an essential tool for innovation and productivity across a wide range of sectors. With a thriving industry at the very centre of the way we work, research studies in the field will open you up to a diverse range of career opportunities.

Need a supervisor? Explore the project list to connect with academics across our mix of disciplines; applied mathematics, applied robotics, artificial intelligence, data analytics, distributed systems, cognitive science, cyber security, computer science, human-computer interaction, interactive media design, Internet of Things, IT services, strategy and management, networking, mobile and apps development, software engineering and virtual reality and augmented reality.

Project list

Integrating Human Values and Ethics in (AI) Software using Generative AI

Abstract: The project aims to develop a framework for integrating human values and ethics into software systems using generative AI techniques, addressing the growing need to align technology with human values and ethical considerations.

References:

Mougouei, D., Perera, H., Hussain, W., Shams, R., & Whittle, J. (2018, October). Operationalizing human values in software: A research roadmap. In Proceedings of the 2018 26th ACM joint meeting on European software engineering conference and symposium on the foundations of software engineering (pp. 780-784).

Perera, H., Hussain, W., Whittle, J., Nurwidyantoro, A., Mougouei, D., Shams, R. A., & Oliver, G. (2020, June). A study on the prevalence of human values in software engineering publications, 2015--2018. In Proceedings of the ACM/IEEE 42nd International Conference on Software Engineering (pp. 409-420).

Perera, H., Hussain, W., Mougouei, D., Shams, R. A., Nurwidyantoro, A., & Whittle, J. (2019, September). Towards integrating human values into software: Mapping principles and rights of GDPR to values. In 2019 IEEE 27th international requirements engineering conference (RE) (pp. 404-409). IEEE.

Key words: Human Values, Ethics, Software and Generative AI

Principal Supervisor:	Dr Davoud Mougouei
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Course	S913 Doctor of Philosophy (Information Technology)
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Impact Theme	Advancing, society, culture and the economy
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
Scholarship	Applicants will need to complete an Expression of Interest and if successful apply for a Deakin University Postgraduate Research Scholarship
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Improving Robustness of Artificial Neural Networks on Tabular Data with D-Layers

Abstract: Given the wide-spread use of Artificial Neural Networks (ANN), their robustness has turned out to be an Achilles heel for researchers and practitioners of data science. In this study, we are interested to explore methods to improve the robustness of ANN models. In the recent past, our group has shown various methods that make sue of quantisation and discretisation and has been shown to improve the robustness of ANN models. This research will build on our proposed D-Layer strategy. The work will explore the integration of embedding layers which will suit an implicit discretisation (instead of explicit) to improve the robustness against modern adversarial attacks as well as covariate as well as concept drift. The project will integrate the idea of supervised discretisation as well as incremental discretisation using Hoeffding bounds. The project will explore the integration of k-bit quantisation, and model compression. The goal of the study is to develop a model that leads to a) a robust model, b) faster convergence, and c) stable learning.

References:

Xia, H. and Zaidi, N. and Zhang, Y. and Li, G. Improving Neural Network's Robustness on Tabular Data with D-Layers, Data Mining and Knowledge Discovery (2023)

Zhou, J. and Zaidi, N. and Zhang, Y. and Montague, P. and Kim, J and Li, G. Leveraging Generative Models for Combating Adversarial Attacks on Tabular Datasets, PAKDD2023: Advances in Knowledge Discovery and Data Mining (2023)

Zhou, J. and Zhang, Y. and Zaidi, N. and Li, G. Discretization inspired defence Algorithm against Adversarial Attacks on Tabular Data, PAKDD2022: Advances in Knowledge Discovery and Data Mining (2022)

Zhang, Y. and Zaidi, N. and Zhou, J. and Li, G. Interpretable Tabular Data Generation, Knowledge and Information Systems (2023)

Key words: Artificial Neural Networks, Robustness, Adversarial Attacks, Covariate Drift and D-Layer

Principal Supervisor:	Dr Nayyar Zaidi
Associate Supervisor:	Prof Gang Li
School	School of Information Technology
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Course	S913 Doctor of Philosophy (Information Technology)
Campus	Melbourne Burwood
Impact Theme	Building safe and secure communities
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
Scholarship	Applicants will need to complete an Expression of Interest and if successful apply for a Deakin University Postgraduate Research Scholarship
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Tabular Data Generation

Abstract: Despite the advancements in structured data generation such as images and text, etc., tabular data generation remains to be a challenging problem. In the recent past, we have proposed an effective model of tabular data generation — GANBLR, that leads to state of the art results. This project will build on GANBLR framework, to develop a new tabular data generation algorithm which is unsupervised (that is, the goal is to create a model for unsupervised tasks such as clustering). It will systematically explore models such as restricted Boltzmann Machines, AnDE, AnJE and Markov Random Fields to develop effective models of data generation. The quality of the model will be assessed in terms of privacy preserving, fairness and robustness-contribution.

References:

Zhang, Y. and Zaidi, N. and Zhou, J. and Li, G. Interpretable Tabular Data Generation, Knowledge and Information Systems (2023)

Zhang, Y. and Zaidi, N. and Zhou, J. and Li, G. GANBLR: A Tabular Data Generation Model, ICDM2021: IEEE International Conference on Data Mining (2021)

Zhang, Y. and Zaidi, N. and Zhou, J. and Li, G. GANBLR++: Incorporating Capacity to Generate Numeric Attributes and Leveraging Unrestricted Bayesian Networks, SDM2022: SIAM International Conference on Data Mining (2022)

Key words: Supervised/Unsupervised data generation, Bayesian/Markov Networks and Averaged N-Dependence Models

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Course	S913 Doctor of Philosophy (Information Technology)
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Impact Theme	Creating smarter technologies
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
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Knowledge Guided Machine Learning through Deep and Broad Learning

Abstract: Machine Learning models rely entirely on data. Though, this is the norm, this can be considered as a vulnerability. The next generation of machine learning models are envisioned to incorporate human knowledge which is generally referred to as human-in-the-loop learning or knowledge guided machine learning. This project will build on our proposed WBD model (wide-broad-deep learning framework) to develop an integrated knowledge guided machine learning model. The broad part in WBD is a Bayesian Network which is interpretable (and can be configured by humans). The project will explore ways to utilize broad in deep learning by a) sampling data during the training, and b) exploring various bayesian networks structures based on generative flow networks alongside reinforcement learning. The goal is to produce a Bayesian Network model that quickly adapts with changes in data, however, works in collaborative with the deep component. The resulting framework is robust to outliers, has better classification performance and can adapt easily with changes in data distribution.

References:

Zhang, Y. and Zaidi, N. and Zhou, J. and Li, G. Interpretable Tabular Data Generation, Knowledge and Information Systems (2023)

Zhang, Y. and Zaidi, N. and Zhou, J. and Li, G. GANBLR: A Tabular Data Generation Model, ICDM2021: IEEE International Conference on Data Mining (2021)

Zhang, Y. and Zaidi, N. and Zhou, J. and Li, G. GANBLR++: Incorporating Capacity to Generate Numeric Attributes and Leveraging Unrestricted Bayesian Networks, SDM2022: SIAM International Conference on Data Mining (2022)

Key words: Wide and Deep Learning, Artificial Neural Networks, Bayesian Networks, Generative Flow Networks and Reinforcement Learning

Principal Supervisor:	Dr Nayyar Zaidi
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Impact Theme	Creating smarter technologies
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Topological Data Analysis

Abstract: Topological data analysis (TDA) extracts topological features to quantify the shape of data. TDA has found applications in many fields, including computer vision. In TDA, persistence diagrams (PDs) are topological descriptors of data. However, PDs are not vector so they cannot be directly used in machine learning methods. Recent efforts have transformed PDs into vectors to enable machine learning tasks (classification, regression, dimension reduction, etc). However, existing methods highly depend on pre-defined polynomials to map PDs to vector representations. This presentation introduces two recent advances in PD representation: polynomial representations and Hilbert space embeddings. These representations could extract more discriminative topological features without requiring pre-defined polynomials. The representations enable applying various machine learning tasks to PDs and extracting insights from different types of topological datasets. Our work seeks to open new research directions and applications of TDA in chemical/biological science, and materials engineering.

References:

Zhichao Wang, Qian Li, Gang Li, and Guandong Xu. Polynomial representation for persistence diagram. The IEEE Conference on Computer Vision and Pattern Recognition (CVPR 2019), June 16- 20th, Long Beach, CA, (PPT Handouts),2019.

Key words: Machine learning, Topology and Artificial intelligence

Principal Supervisor:	Prof Gang Li
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Combating Adversarial Attacks on Tabular Datasets

Abstract: When working with large tabular datasets, Artificial Neural Network (ANN) models are preferred due to their in-core data processing capabilities. However, ANN models are vulnerable to adversarial attacks, which has led to a surge in research on developing effective defence strategies against such attacks. Generative models have been found to be more robust to adversarial attacks compared to discriminative models. This has led to the question of whether generative models can be used to defend discriminative models against adversarial attacks. The aim of this talk is to explore the potential of generative models in protecting ANN models from adversarial attacks, and to introduce some recently proposed techniques, e.g., D2A3, gD2A3 that take advantage of the generative-discriminative equivalence of certain ANN models.

References:

Zhichao Wang, Qian Li, Gang Li, and Guandong Xu. Polynomial representation for persistence diagram. The IEEE Conference on Computer Vision and Pattern Recognition (CVPR 2019), June 16- 20th, Long Beach, CA, (PPT Handouts),2019.

Key words: Tabular data, Robust AI, Generative model and Adversarial learning

Principal Supervisor:	Prof Gang Li
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Course	S913 Doctor of Philosophy (Information Technology)
Campus	Melbourne Burwood
Impact Theme	Building safe and secure communities
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
Scholarship	Applicants will need to complete an Expression of Interest and if successful apply for a Deakin University Postgraduate Research Scholarship
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Racism in Cyber Space

Abstract: Racism is increasingly recognised as a key driver of unfair inequalities in power, resources and opportunities across racial groups. A comprehensive understanding of racism is beneficial to activist groups, policymakers and governments. Traditional approaches, such as surveys and interviews, are usually time-consuming and inefficient in capturing the occurrence of large-scale racism. In this study, we will investigate from the data science perspective, and come up with various measurements and strategies to mitigate cyber racism.

References:

Shu Li, Gang Li, Rob Law, and Yin Paradise. Racism in tourism reviews. Tourism Management, 2020.

Key words: Racism, Cyber space and Data analysis

Principal Supervisor:	Prof Gang Li
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School	School of Information Technology
Strategic Research and Innovation Centre	Centre for Cyber Resilience and Trust (CREST)
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Impact Theme	Building safe and secure communities
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Efficient artificial intelligence technique via matrix approximations

Abstract: Artificial Intelligence (AI) has gained significant attention in recent years, revolutionising various industries and domains. One of the key challenges in AI is the computational complexity associated with large-scale data processing and analysis. Matrix approximations through randomised linear algebra offer a powerful tool to reduce the computational burden in AI algorithms by approximating high-dimensional data matrices. By leveraging the properties of matrix factorisation and low-rank approximations, we investigate how these techniques can significantly reduce the dimensionality of data while preserving important features and patterns. This line of research proposes reducing computational expenses of machine learning models where heavy matrix computations are required.

References:

Eshragh A., Roosta F., Nazari A., Mahoney M. (2022) 'LSAR: Efficient Leverage Score Sampling Algorithm for the Analysis of Big Time Series Data', Journal of Machine Learning Research (JMLR), 23(22):1-36.

Key words: Artificial intelligence, Machine learning, Randomised linear algebra, Matrix approximation, Computational efficiency

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Impact Theme	Creating smarter technologies
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Using artificial intelligence in optimising manufacturing processes

Abstract: Artificial Intelligence (AI) has emerged as a transformative technology with vast potential to revolutionise every aspect of our life including the production and manufacturing sectors. This research explores the applications of AI in optimising manufacturing processes considering limited resources and a competitive international market. The integration of AI into manufacturing systems offers numerous advantages, including increased efficiency, reduced operational costs, enhanced product quality, and greater adaptability to changing demands. The research also examines how AI-driven data analytics and machine learning algorithms enable manufacturers to process large-scale data gathered from sensors, machinery, and production lines. These capabilities facilitate real-time monitoring and predictive maintenance, minimizing downtime and preventing unexpected failures. Moreover, AI-powered data analytics help in identifying inefficiencies and bottlenecks, providing valuable insights for process improvement. Furthermore, the research focuses on the concept of AI-driven optimisation and matheuristic algorithms that streamline production planning and scheduling. metaheuristic techniques such as genetic algorithms, simulated annealing, and reinforcement learning help manufacturers maximize resource utilization, minimise lead times, and optimise production sequences, thereby increasing overall productivity.

References:

Nazari, A., Thiruvady, D., Elmi, A., & Schneider, J. G. (2020, December). Simulated Annealing for Single and Mixed Model Assembly Line Balancing with Setups. In 2020 IEEE Symposium Series on Computational Intelligence (SSCI) (pp. 2762-2769). IEEE.

Thiruvady, D., Elmi, A., Nazari, A., & Schneider, J. G. (2020, November). Minimising Cycle Time in Assembly Lines: A Novel Ant Colony Optimisation Approach. In Australasian Joint Conference on Artificial Intelligence (pp. 125-137). Cham: Springer International Publishing.

Key words: Artificial intelligence, Manufacturing, Optimisation, Machine learning and Assembly lines

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Learning and Optimization Methods for Battery Swapping at Electric Vehicle (EV) Charging Stations

Abstract: EV markets are burgeoning but long EV charging time is holding back the momentum. Battery swapping can be a solution to the reduction of charging time, thereby creating a niche market. This project intends to develop an operation model for an EV maker so that charging EV batteries can be done in a sustainable way. First, EV batteries are swapped and collected at nearby charging stations. The collected batteries are either locally charged or transported to another site for charging that has rich renewable energy or low electricity prices. For instance, community batteries can be implemented to collect excess household solar generation and use it to charge EVs. Fully charged batteries can then be used locally or transported to another site for battery swapping. This procedure involves battery recycling, the use of renewable energy, and battery storage at right time and right places, thereby creating a circular economy. To support EV battery swapping, optimisation and learning methods for logistics such as battery transportation and charging control must be developed accordingly, which is the main goal of this project.

References:

W. Hua, H. Xiao, W. Pei, W.-Y. Chiu, J. Jiang, H. Sun, and P. Matthews, "Transactive energy and flexibility provision in multi-microgrids using Stackelberg game," CSEE J. Power Energy Syst., vol. 9, no. 2, pp. 505–515, Mar. 2023.

B.-C. Lai, W.-Y Chiu, and Y.-P. Tsai, "Multiagent reinforcement learning for community energy management to mitigate peak rebounds under renewable energy uncertainty," IEEE Trans. Emerg. Topics Comput. Intell., vol. 6, no. 3, pp. 568–579, Jun. 2022.

Y.-C. Chuang and W.-Y. Chiu, "Deep reinforcement learning based pricing strategy of aggregators considering renewable energy," IEEE Trans. Emerg. Topics Comput. Intell., vol. 6, no. 3, pp. 499–508, Jun. 2022

S.-J. Chen, W.-Y. Chiu, and W.-J. Liu, "User preference-based demand response for smart home energy management using multiobjective reinforcement learning," IEEE Access, vol. 9, pp. 161627–161637, Dec. 2021.

Key words: Renewable energy, Machine learning, Optimisation, Electric vehicles and Battery swapping

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Impact Theme	Creating smarter technologies
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
Scholarship	Applicants will need to complete an Expression of Interest and if successful apply for a Deakin University Postgraduate Research Scholarship
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Differential equations and EV charging networks

Abstract: EV markets are expected to increase year by year, but the underlying power grid infrastructure is difficult to change due to various constraints. A better solution is to apply an intelligent EV charging and coordination strategy to manage a fleet of EVs. This project aims to investigate the EV charging network from the perspective of system dynamics described by differential equations. By modelling charging behaviours, a system operator can understand if the current power infrastructure has enough capacity for charging a specific number of EVs, providing valuable information for region grid operations.

References:

Bae, S., & Kwasinski, A. (2011). Spatial and temporal model of electric vehicle charging demand. IEEE Transactions on Smart Grid, 3(1), 394-403.

Hemavathi, S., & Shinisha, A. (2022). A study on trends and developments in electric vehicle charging technologies. Journal of energy storage, 52, 105013.

Zheng, Y., Luo, J., Yang, X., & Yang, Y. (2020). Intelligent regulation on demand response for electric vehicle charging: a dynamic game method. IEEE Access, 8, 66105-66115.

Key words: EV charging network, Differential equations and System dynamics

Principal Supervisor:	A/Prof Wei-Yu Chiu
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School	School of Information Technology
Course	S913 Doctor of Philosophy (Information Technology)
Campus	Geelong Waurn Ponds
Impact Theme	Enabling a sustainable world
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
Scholarship	Applicants will need to complete an Expression of Interest and if successful apply for a Deakin University Postgraduate Research Scholarship
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Learning-based control methods for EV charging networks

Abstract: The number of electric vehicles (EVs) is increasing, but uncoordinated EV charging can put much burden on the underlying power grids. Ideally, charging EVs at low electricity prices or during the period of low power load is desired, but it can be difficult to achieve this because the system of interest often suffers from much uncertainty. For example, it is uncertainty how many EVs will need to be charged in a given period; even if that number can be estimated accurately, the amount of energy needed is also uncertain. This is where a learning-based method can be useful for developing an EV charging strategy in consideration of system uncertainty. This project aims to develop machine learning based EV charging strategy (reinforcement learning in particular) at charging stations so that power supply and demand can be balanced in consideration of system uncertainty.

References:

Abdullah, H. M., Gastli, A., & Ben-Brahim, L. (2021). Reinforcement learning based EV charging management systems–a review. IEEE Access, 9, 41506-41531.

Li, S., Hu, W., Cao, D., Dragičević, T., Huang, Q., Chen, Z., & Blaabjerg, F. (2021). Electric vehicle charging management based on deep reinforcement learning. Journal of Modern Power Systems and Clean Energy, 10(3), 719-730.

Li, H., Wan, Z., & He, H. (2019). Constrained EV charging scheduling based on safe deep reinforcement learning. IEEE Transactions on Smart Grid, 11(3), 2427-2439.

Key words: EV charging network, EV charging strategies and Machine learning

Principal Supervisor:	A/Prof Wei-Yu Chiu
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Course	S913 Doctor of Philosophy (Information Technology) S813 Master of Science (Information Technology)
Campus	Geelong Waurn Ponds
Impact Theme	Enabling a sustainable world
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
Scholarship	Applicants will need to complete an Expression of Interest and if successful apply for a Deakin University Postgraduate Research Scholarship
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Bayesian network and EV networks

Abstract: A Bayesian network (BN) is a probabilistic graphical model that can be used to represent and extract knowledge from an uncertain event. A BN consists of nodes and edges representing random variables and conditional probabilities, respectively. This technique may be applied to understand an electric vehicle (EV) network, where charging and discharging events occur stochastically. In an EV network, nodes could be EV charging stations and edges could model the interaction between nearby stations. Interesting insights can be gained, but by far, limited research has been conducted. This project intends to release the power of BN to better understand an EV networks so that better planning for EV charging/discharging can be made.

References:

Hosseini, S., & Sarder, M. D. (2019). Development of a Bayesian network model for optimal site selection of electric vehicle charging station. International Journal of Electrical Power & Energy Systems, 105, 110-122.

Chiş, A., Lundén, J., & Koivunen, V. (2016). Reinforcement learning-based plug-in electric vehicle charging with forecasted price. IEEE Transactions on Vehicular Technology, 66(5), 3674-3684.

Key words: Bayesian network, EV charging and discharging and EV network

Principal Supervisor:	A/Prof Wei-Yu Chiu
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School	School of Information Technology
Course	S913 Doctor of Philosophy (Information Technology)
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Impact Theme	Enabling a sustainable world
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
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New solution paradigms for Combinatorial Optimization

Abstract: In the last few decades, mathematicians and computer scientists have collectively contributed significantly to improving the way we live by understanding the needs of end-users, creating computerized systems to automate previously time-consuming and labour-intensive processes. Automation supported by mathematical optimization brings enhanced efficiency and, more importantly, results in huge social and economic benefits. For instance, Ford Motor developed an Integer Programming (IP) model to shorten the planning process, optimised global procedures and saved USD 250M [1]. Baosteel applied IP for production planning, and just their main Shanghai plant alone reduced annual carbon monoxide emissions by over 500,000 tons in 2013 [2]. Integration of Constraint Programming (CP) and IP to improve the performance of IP is a hot research area in recent years. For example, in logic-based Benders Decomposition or Branch-and-check, where hard constraints are relaxed from a mixed-integer programming formulation [3]. IP is used to solve the relaxed problem, whilst Constraint Programming is used for checking the feasibility of the omitted constraints. There are, however, other promising opportunities for CP-IP integration yet to be explored. The research team has a few innovative ideas, and this research project is to investigate theoretical and computational aspects of these new ideas.

References:

D.-S. Chen, R. Batson and D. Yu, Applied Integer Programming: Modeling and Solution, Wiley, 2011. INFORMS, "2013 Franz Edelman Finalists," Link to reference.

E. Lam, G. Gange, P. J. Stuckey, P. van Hentenryck, J.J. Dekker, Nutmeg: a MIP and CP hybrid solver using branch-and-check

Key words: Industrial Engineering, Optimisation, Integer Programming and Constraint Programming

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Impact Theme	Creating smarter technologies
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
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Special purpose integer programming solvers

Abstract: In this project, we examine a number of real-life planning optimization problems that involve solving integer programming problems with some special structures. Our aim is to develop an integer programming solver that is specially designed to rapidly solve these planning optimization problems to optimality or near optimality with better performance than commercial or open source general integer programming solvers.

References:

D.-S. Chen, R. Batson and D. Yu, Applied Integer Programming: Modeling and Solution, Wiley, 2011. INFORMS, "2013 Franz Edelman Finalists," Link to reference.

E. Lam, G. Gange, P. J. Stuckey, P. van Hentenryck, J.J. Dekker, Nutmeg: a MIP and CP hybrid solver using branch-and-check

Key words: Operations Research and Optimisation	
Principal Supervisor:	A/Prof Vicky Mak
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Frequency Plan Design for Multibeam Satellite Constellations

Abstract: The combination of next generation large satellite constellations and tighter steerable beams will offer an enormous flexibility in resource allocation. However, optimally allocate these resources such as bandwidth and power is a highly complex optimization problem, particularly due to the high-dimensional and dynamic operating environments. In this research, our aim is to develop rapid solution algorithms for constellations with thousands of beams. The output of the algorithm will provide a frequency plan that maximises allocated bandwidth whilst observing power consumption and other system constraints such as handovers and interfering power restrictions.

References:

J. J. Garau-Luis, S. Aliaga, G. C. Vila, N. Pachler, E. Crawley and B. Cameron, "Frequency Plan Design for Multibeam Satellite Constellations Using Integer Linear Programming," in IEEE Transactions on Wireless Communications

Key words: Optimization and Satellite communications

Principal Supervisor:	A/Prof Vicky Mak
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Efficient Large Language Model Learning and Adaption

Abstract: Large language models such as ChatGPT and GPT4 are costly to train and deploy on low recourse scenarios. This project aims to explore efficient methods for large language model learning in low resource situations. We will investigate several aspects for large language models, including efficient fine tuning, continual learning, fact error checking and bias detection and correction. Expected outcomes of this project will be leveraged by small and medium size organisations where data and computing resources are not rich.

References:

Jacob Devlin, Ming-Wei Chang, Kenton Lee, and Kristina Toutanova. 2019. BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding. In Proceedings of the 2019 Conference of the North American Chapter of the Association for Computational Linguistics: Human Language Technologies, Volume 1 (Long and Short Papers), pages 4171–4186, Minneapolis, Minnesota. Association for Computational Linguistics.

Hoffmann, J., Borgeaud, S., Mensch, A., Buchatskaya, E., Cai, T., Rutherford, E., & Sifre, L. (2022). An empirical analysis of compute-optimal large language model training. Advances in Neural Information Processing Systems, 35, 30016-30030.

Key words: Large Language Model, Text Generation, Natural Language Processing and Artificial Intelligence

Principal Supervisor:	Dr Ming Liu
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Impact Theme	Creating smarter technologies
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Deep emotion and behaviour recognition

Abstract: Human emotion are often expressed using facial emotions and bodily gestures. Detecting emotional behaviours is important in the field of Artificial Intelligence (AI), such as for improving human machine interactions, and behavioural detection. Accurately detecting the various emotional behaviours from videos is challenging due to various factors, such as background noise and the scene complexity with multiple objects and people. The aim of the project is to propose novel deep learning-based algorithms for accurately profiling emotions from videos and other modalities.

References:

Thuseethan, S., Rajasegarar, S. and Yearwood, J., 2021. Deep continual learning for emerging emotion recognition. IEEE Transactions on Multimedia, 24, pp.4367-4380

Thuseethan, S., Rajasegarar, S. and Yearwood, J., 2022. EmoSeC: Emotion recognition from scene context. Neurocomputing, 492, pp.174-187

Thuseethan, S., Rajasegarar, S. and Yearwood, J., 2023. Deep3DCANN: A Deep 3DCNN-ANN framework for spontaneous micro-expression recognition. Information Sciences, 630, pp.341-355

Key words: Emotion recognition, Deep learning, Artificial intelligence and Computer vision

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Crowd Behaviour Analysis and Anomaly Detection

Abstract: Crowd behaviour analysis from videos is important for leaning anomalous crowd movement patterns, surveillance and emotion behavioural studies. Devising automated models for crowd behaviour analysis is challenging, and only limited research has been done in the past in this context. It has challenges in terms of detecting collective and individual behaviours in a crowded scene from videos and handling occlusions and partial images from the scenes. The aims of this project include surveying the existing state-of-the-art methodologies in detecting crowd behaviours and proposing novel suits of deep learning based intelligent crowd behaviour analysis frameworks.

References:

E. A. Veltmeijer, C. Gerritsen and K. Hindriks, "Automatic emotion recognition for groups: a review," in IEEE Transactions on Affective Computing, 2021

Yang, M., Feng, Y., Rao, A.S., Rajasegarar, S., Tian, S. and Zhou, Z., 2023. Evolving graph-based video crowd anomaly detection. The Visual Computer, pp.1-16

Rezaee, K., Rezakhani, S.M., Khosravi, M.R. et al. A survey on deep learning-based real-time crowd anomaly detection for secure distributed video surveillance. Personal Ubiquitous Computing (2021)

Key words: Crowd behaviour, Deep learning, Pattern recognition and Anomaly detection

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Deep incremental and continual learning

Abstract: Nowadays, with the increased amount of data collected, it has become paramount to develop novel techniques to continually absorb new knowledge in the data in a timely manner. The deep learning algorithms need to be designed to work with incremental and continual learning capabilities to absorb and model the emerging changes in the patterns effectively. Class Incremental Learning aims to incrementally add new class data, which has been increasingly noted as a means of achieving this objective. This project aims to formulate a generalized continual and incremental class Learning frameworks and pattern learning frameworks for timely capturing the emerging patterns in a computationally efficient manner.

References:

Thuseethan, S., Rajasegarar, S. and Yearwood, J., 2021. Deep continual learning for emerging emotion recognition. IEEE Transactions on Multimedia, 24, pp.4367-4380.

S. Kanagarajah, A. Ambegoda and R. Rodrigo, "SATHUR: Self Augmenting Task Hallucinal Unified Representation for Generalized Class Incremental Learning", 2022 26th International Conference on Pattern Recognition Worshops, 2022.

S. Hou, X. Pan, C. C. Loy, Z. Wang, and D. Lin, "Learning a unified classifier incrementally via rebalancing," in Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition, 2019, pp. 831–839.

Key words: Continual learning, Incremental learning, Deep learning and Emerging patterns

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A framework for Vulnerability scoring and risk assessment of smart grid using the dynamic performance measurements and physical impact analysis of the power systems networks

Abstract: Power systems networks are extensively being integrated with the corporate network as part of the Industry 4.0 [1-2] which has combined the cyber world and the physical world and formed the industrial internet. This integration of power system network facilitates monitoring and control of the physical systems from remote locations, which increases the productivity of the industries and maximize economic benefit through a less expensive data acquisition, execution of business analytics on the collected data, faster automated mining of the data and integration of intelligent decisions into the power networks. This proposed framework will consider an Automatic Generation Control system of smart grid as the testbed [6-9]. Simulation prototype will be developed using automatic generation control (AGC) measures and an Observer for the system. The measurement/ observations will be collected based on different power system parameters including voltage, current, power of different buses, total power generated, total power demand which are used by the SCADA master controller units and HMI to operate the system. Furthermore, different types of samples would be generated such as overloaded, under loaded, faulty condition, normal condition and attack conditions. Then it will test how dynamic performance of AGC is affected when vulnerabilities are exploited.

References:

YA Ahmed, B Koçer, Shamsul Huda, BAS Al-rimy, MM Hassan , A system call refinement-based enhanced Minimum Redundancy Maximum Relevance method for ransomware early detection Journal of Network and Computer Applications, 102753

S Sharmeen, Shamsul Huda, J Abawajy, MM Hassan, An adaptive framework against android privilege escalation threats using deep learning and semi-supervised approaches, Applied Soft Computing 89, 106089

S Sharmeen, YA Ahmed, Shamsul Huda, BŞ Koçer, MM Hassan, Avoiding future digital extortion through robust protection against ransomware threats using deep learning based adaptive approaches, IEEE Access 8, 24522-24534

MM Hassan, A Gumaei, Shamsul Huda, A Almogren, Increasing the Trustworthiness in the Industrial IoT Networks Through a Reliable Cyberattack Detection Model, IEEE Transactions on Industrial Informatics 16 (9), 6154-6162

Shamsul Huda, J Abawajy, B Al-Rubaie, L Pan, MM Hassan , Automatic extraction and integration of behavioural indicators of malware for protection of cyber–physical networks, Future Generation Computer Systems 101, 1247-1258

Key words: Power systems networks , Automatic Generation Control system and National vulnerability Database (NVD)

Principal Supervisor:	Dr Shamsul Huda
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Impact Theme	Enabling a sustainable world
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
Scholarship	Applicants will need to complete an Expression of Interest and if successful apply for a Deakin University Postgraduate Research Scholarship

An intelligent cyber threat modelling framework and Robust trust boundary protection for smart Grid

Abstract: Smart grid is the biggest and most complex industrial internet which is segmented into a number of large domain such as generation domain, transmission domain, distribution domain, distribution energy resource domain and customer domain. This heterogeneous communication infrastructure of the grid involves a wide range of protocols such as Zigbee, DNP3.0, Modbus, IEC61850, ICCP (IEC69870-5). Therefore, the attack surface of smart grid and related attack vectors is extremely large combining the numerous devices of the grid, communications systems, protocols, control software and operating systems. Attackers uses a wide range of powerful techniques and tools to conduct cyber espionage to steal login credential and compromise the subsystems. The compromise of the grid control system could potentially impair the proper functioning of the grid and serious damage. This project takes a holistic multilevel approach to realize and characterise the interdependencies between the various subsystems and devises intelligent mechanisms for gathering threat intelligence. A distributed and multi-staged malicious activity detection engine will be developed for identifying and predicting the cyber threats and attacks. The theoretical basis of this distributed and multi-staged detection engine is derived from the core architectural characteristics of smart grid domains. The different functional layers of smart grid such as process, field, station, operation and enterprise management and their hierarchical relationship govern the topology and industrial protocols of the grid. A lightweight suspicious activity or event detection system will be developed and deployed at each functional layer which is based on the inherent narrowed-down scope of networks, related protocols and architecture of the corresponding functional layer. This makes the detection system suitable to be deployed on time critical and constrained devices in the functional layers. Detection engines form different layers will be multi-staged based on the hierarchical relationship of functional layers and will be fed from lower to upper layers as input probe for upper layers and reverse way to provide as command feedback for protection and prevention.

References:

Shamsul Huda, Mehedi Hassan, Shaila Sgarmeenm Jemal Abawajy, An adaptive trust boundary protection for IIoT networks using deep-learning feature extraction based semi-supervised model, IEEE Transactions on Industrial Informatics, (2020), will be online soon.

YA Ahmed, B Koçer, Shamsul Huda, BAS Al-rimy, MM Hassan , A system call refinement-based enhanced Minimum Redundancy Maximum Relevance method for ransomware early detection Journal of Network and Computer Applications, 102753

Key words: Cyber threat modelling, Smart grid and Trust boundary protection

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Impact Theme	Enabling a sustainable world
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A scalable and efficient real-time sensitive data exfiltration monitoring and prevention framework:

Abstract: Data exfiltration is a growing and persistent threat to public and private organisations as well as individuals. As a recent defence-related information about Australia's war planes and navy vessels exfiltration demonstrates, even organisations with physical perimeters considered as highly secure do not escape exfiltration of high-valued organisational data. This makes an early detection of data exfiltration attacks a core requirement of organisations cybersecurity program. In light of this, we propose to develop novel systems and methods for early detection and prevention of sensitive and proprietary data exfiltration by malicious entities. Specifically, The aim of this project is to develop real-time learning algorithms for early detection and prevention of an enterprise data exfiltration without disrupting legitimate traffic.

References:

Verble, J. (2014). The NSA and Edward Snowden: surveillance in the 21st century. SIGCAS Computers and Society, 44(3):14–20. 2.

Dan Conifer (12 Oct 2017), Hacker codenamed 'Alf' from Home and Away stole secret data on Joint Strike Fighter jets and surveillance planes. Link

Key words: Data exfiltration, Monitoring and Prevention of exfiltration

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Impact Theme	Creating smarter technologies
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Protective Security for social media: Developing A privacy-preserving Mechanism to Calculate Social Trust Factor

Abstract: Social media has become one of the widely embraced online activities, with a staggering number of users. In 2021, the global user base for social media exceeded 4.26 billion individuals, and this figure is expected to surge to nearly six billion by 2027. While the cyber harm and cyber security has been a concern in the connected social networking platforms, the social media data of the individuals can help to build an index that can help to identify behavioural metrics of individuals based on their activities. This PhD project will use a privacy-preserving mechanism to capture and analyse individual personal information and build a Social Trust Factor that can be used for establishing trust and credibility in a physical world. The proposed social trust factor will contribute to enhance the security aspects of two big pillars of protective security defined by the Australian Government, namely "personnel security" and "information security". To this end, the proposed trust factor will help to measures the integrity and reliability of individuals who have access to sensitive areas or information.

References:

Yixuan Zhang, Joseph D Gaggiano, Nutchanon Yongsatianchot, Nurul M Suhaimi, Miso Kim, Yifan Sun, Jacqueline Griffin, Andrea G Parker, What Do We Mean When We Talk about Trust in Social Media? A Systematic Review. Link

Key words: Cyber security, Social media, Trust and Protective security

Principal Supervisor:	Dr Adnan Anwar
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Impact Theme	Building safe and secure communities
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
Scholarship	Applicants will need to complete an Expression of Interest and if successful apply for a Deakin University Postgraduate Research Scholarship
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Security and Privacy Attacks in Energy System

Abstract: This project aims a complete threat and vulnerability analysis for cyber-physical energy grid to identify key security weaknesses within the physical network, operational software systems and/or devices. Finally, improved and robust cyber-attack defence mechanisms will ensure secured and reliable operation of the grid without any cyber-related misbehaviours. This project also targets to develop data-driven distributed consensus based detection system to identify the misbehaviour in the streaming data due to the cyber-attack at the field devices of the SCADA system.

References:

M. A. Husnoo, A. Anwar, N. Hosseinzadeh, S. N. Islam, A. N. Mahmood and R. Doss, "A Secure Federated Learning Framework for Residential Short Term Load Forecasting," in IEEE Transactions on Smart Grid, Link.

Haftu Tasew Reda, Adnan Anwar, Abdun Naser Mahmood, and Zahir Tari. 2023. A Taxonomy of Cyber Defence Strategies Against False Data Attacks in Smart Grids. ACM Comput. Surv. 55, 14s, Article 331 (December 2023), 37 pages. Link

Comprehensive survey and taxonomies of false data injection attacks in smart grids: attack models, targets, and impacts," Renewable and Sustainable Energy Reviews, Elsevier, 2022 (IF 15.9)

Key words: Cyber Attack, Energy System and Data Integrity Attack

Principal Supervisor:	Dr Adnan Anwar
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Enhancing Smart Microgrid Security and Efficiency Using AI-enabled Multiaccess Edge Computing

Abstract: The project will develop secure AI-based edge computing mechanisms for securely analysing and processing distributed renewable energy generation and consumer power data in smart microgrid.

References:

A. Mishra, N. Gupta and B. Gupta, "Defense mechanisms against DDoS attack based on entropy in SDN-cloud using POX controller", Telecommun. Syst., vol. 77, no. 1, pp. 47-62, 2021.

J. Chen and X. Ran, "Deep learning with edge computing: A review", Proc. IEEE, vol. 107, no. 8, pp. 1655-1674, Aug. 2019.

Z. Tian, Y. Wang, Y. Sun and J. Qiu, "Location privacy challenges in mobile edge computing: Classification and exploration", IEEE Netw., vol. 34, no. 2, pp. 52-56, Mar./Apr. 2020.

Key words: Cybersecurity, Cyberattacks, Smart Grid, Edge Computing and Artificial Intelligence

Principal Supervisor:	Dr Adnan Anwar
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Impact Theme	Enabling a sustainable world
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
Scholarship	Applicants will need to complete an Expression of Interest and if successful apply for a Deakin University Postgraduate Research Scholarship
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Aligned Autonomous Artificial Intelligence (AI)

Abstract: As Artificial Intelligence (AI) emerges into everyday life it has become increasingly important that these systems align to human society. This is particularly the case with embodied agents that will frequently need to have incidental interactions with people outside of those it is directly supporting. For instance, a robot tasked to shop for a person must accomplish its task in a shared environment with other people. It must autonomously decide how to interact with others to ensure it successfully accomplishes its task without also overly affecting other people in the environment. Current research in this area is both in its infancy, as well as crucially needed. This project will investigate the factors important to ensuring autonomous systems are aligned and develop new algorithmic approaches capable of ensuring autonomous agents maintain alignment to these ideals during both their learning and operational phases. In particular, this project will develop methods capable of sitting alongside traditional Reinforcement learning methods but are able to tailor policies being learnt and ensure selected policies meet critical criteria without the need for direct human supervision during operation.

References:

Vamplew, P., Dazeley, R., Foale, C., Firmin, S., & Mummery, J. (2018). Human-aligned artificial intelligence is a multiobjective problem. Ethics and Information Technology, 20, 27-40.

Vamplew, P., Foale, C., Dazeley, R., & Bignold, A. (2021). Potential-based multiobjective reinforcement learning approaches to low-impact agents for AI safety. Engineering Applications of Artificial Intelligence, 100, 104186.

Hayes, C. F., Rădulescu, R., Bargiacchi, E., Källström, J., Macfarlane, M., Reymond, M., ... & Roijers, D. M. (2022). A practical guide to multi-objective reinforcement learning and planning. Autonomous Agents and Multi-Agent Systems, 36(1), 26.

Dazeley, R., Vamplew, P., Foale, C., Young, C., Aryal, S., & Cruz, F. (2021). Levels of explainable artificial intelligence for human-aligned conversational explanations. Artificial Intelligence, 299, 103525.

Dazeley, R., Vamplew, P., & Cruz, F. (2023). Explainable reinforcement learning for broad-xai: a conceptual framework and survey. Neural Computing and Applications, 1-24.

Key words: AI Alignment, Multi-objective Reinforcement Learning, Safe and Ethical RL

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Conversational-based explainable reinforcement learning

Abstract: With the emergence of autonomous AI systems into shared human domains there is a growing need for systems that can explain their reasoning to a lay audience. This requires systems to go beyond current transparent debugging-based approaches and requires fully contrastive and counterfactual-based comparison of policy options considered by the agent. Explanations need to be designed to provide the right level of detail in an explanation to satisfy all stakeholders, such as: users, safety certifiers or agencies, accident investigators, lawyers and expert witnesses, and the wider public. This project will explore, develop and assess new methods for explaining behaviour in an autonomous agent using a conversational approach. Using a multi objective approach it will illustrate the how pareto optimal policies can be compared to provide both Counterfactual and contrastive explanations. It will provide explanations that consider the agent's internal motivations, its understanding of other entities intentions and its beliefs about those entities' cultural expectations of the agent's behaviour. Using the conversational framework in Dazeley, et al (2023) the agent will provide the explanations through an interactive approach allowing the user to drill down to their desired level of detail about an event.

References:

Dazeley, R., Vamplew, P., Foale, C., Young, C., Aryal, S., & Cruz, F. (2021). Levels of explainable artificial intelligence for human-aligned conversational explanations. Artificial Intelligence, 299, 103525.

Dazeley, R., Vamplew, P., & Cruz, F. (2023). Explainable reinforcement learning for broad-xai: a conceptual framework and survey. Neural Computing and Applications, 1-24.

Vamplew, P., Dazeley, R., Foale, C., Firmin, S., & Mummery, J. (2018). Human-aligned artificial intelligence is a multi-objective problem. Ethics and Information Technology, 20, 27-40.

Vamplew, P., Foale, C., Dazeley, R., & Bignold, A. (2021). Potential-based multi objective reinforcement learning approaches to low-impact agents for AI safety. Engineering Applications of Artificial Intelligence, 100, 104186.

Hayes, C. F., Rădulescu, R., Bargiacchi, E., Källström, J., Macfarlane, M., Reymond, M., & Roijers, D. M. (2022). A practical guide to multi-objective reinforcement learning and planning. Autonomous Agents and Multi-Agent Systems, 36(1), 26.

Key words: Explainable AI (XAI); Explainable Reinforcement Learning (XRL); AI Alignment; Multi-objective Reinforcement Learning; Safe and Ethical RL

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AI Alignment: Detecting deception in Large Language Models

Abstract: Recent progress in Artificial Intelligence has been rapid, which raises the possibility that such systems may exceed human level in the near term. This means AI would exceed human capability at all tasks, including social persuasion. If the AIs values are misaligned with humanities values, broadly construed, this will pose an existential risk. Concerningly, there has been very little research on how to align artificially intelligent systems. One research agenda is to develop techniques to detect deception. Concretely, it is possible for large language models to output falsity while internally representing what is true. The existing techniques e.g., contrast consistent search are promising but their performance is still too low to reliably detect deception. This project will extend these techniques such that deception can be reliably detected in language models. The approach will be to do this in a manner that can be generalised to future systems. This means the techniques will be agnostic to the architecture used. We will also focus on unsupervised techniques as these have a greater chance of generalising to future systems, since human labelled data is error prone and less scalable.

References:

Vamplew, P., Dazeley, R., Foale, C., Firmin, S., & Mummery, J. (2018). Human-aligned artificial intelligence is a multiobjective problem. Ethics and Information Technology, 20, 27-40.

Goodger, N., Vamplew, P., Foale, C., & Dazeley, R. (2023). A NetHack Learning Environment Language Wrapper for Autonomous Agents.

Dazeley, R., Vamplew, P., Foale, C., Young, C., Aryal, S., & Cruz, F. (2021). Levels of explainable artificial intelligence for human-aligned conversational explanations. Artificial Intelligence, 299, 103525.

Dazeley, R., Vamplew, P., & Cruz, F. (2023). Explainable reinforcement learning for broad-xai: a conceptual framework and survey. Neural Computing and Applications, 1-24.

Goodger, N., Vamplew, P., Foale, C., & Dazeley, R. (2021, November). Language Representations for Generalization in Reinforcement Learning. In Asian Conference on Machine Learning (pp. 390-405). PMLR

Key words: AI Alignment and Large Language Models

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Impact Theme	Creating smarter technologies
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
Scholarship	Applicants will need to complete an Expression of Interest and if successful apply for a Deakin University Postgraduate Research Scholarship
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Multi-label Learning with Context Awareness

Abstract: Object detection is the key component in multiple applications such as autonomous vehicles and surveillance. However, the logical relationships between objects and their actions are not always taken into account. This lack of semantic constraints results in contradictions in the prediction of multiple objects, for example, a model classifies a leaf image as tomato and it has scab disease, while scab disease does not appear in tomato (mostly in apple). In autonomous vehicles, we found that in many cases a deep learning model classifies a car's action as "running" while the traffic light is "red". In this project, we compare different methods to incorporate commonsense knowledge to improve the performance and the logical plausibility of multilabel prediction.

References:

Tran, S. (2023) 'Neurosymbolic Reasoning and Learning with Restricted Boltzmann Machines', the AAAI Conference on Artificial Intelligence 37 (5), 6558-6565.

Key words: Multi-label learning, Machine Learning and Knowledge Integration

Principal Supervisor:	Prof Richard Dazeley
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Understanding and Enhancing Emotional States in Extended Reality

Abstract: The project aims to explore the emotional states of users while they are exposed to extended reality (XR) experiences, such as virtual reality (VR) and augmented reality (AR). XR technologies have the potential to evoke strong emotional responses in users due to their immersive nature and ability to transport users to new virtual environments. Understanding and harnessing these emotional states can lead to various applications, including improved XR experiences, mental health interventions, and user-cantered design.

References:

Nakisa, Bahareh, et al. "Evolutionary computation algorithms for feature selection of EEG-based emotion recognition using mobile sensors." Expert Systems with Applications 93 (2018): 143-155.

Nakisa, Bahareh, et al. "Long short-term memory hyperparameter optimization for a neural network-based emotion recognition framework." IEEE Access 6 (2018): 49325-49338.

Nakisa, Bahareh, et al. "Automatic emotion recognition using temporal multimodal deep learning." IEEE Access 8 (2020): 225463-225474.

Sardari, S., Nakisa, B., Rastgoo, M. N., & Eklund, P. (2022). Audio based depression detection using Convolutional Autoencoder. Expert Systems with Applications, 189, 116076.

Rastgoo, M. N., Nakisa, B., Maire, F., Rakotonirainy, A., & Chandran, V. (2019). Automatic driver stress level classification using multimodal deep learning. Expert Systems with Applications, 138, 112793.

Key words: Deep learning, Extended reality, Physiological signals and Computer vision

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Impact Theme	Improving health and wellbeing
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
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Anomaly Detection Model Based on a Nonlinear Fitting Local Interpretation Approach

Abstract: The research topic is mainly based on nonlinear approximate local explanation methods to explain anomaly detected by applying deep learning. Combined with feature correlation, a method is found to perform correlation fitting on the local nonlinear decision boundary to obtain relatively accurate fitting results, so as to obtain important features that affect decision-making. Correlation verification is carried out on the selected important features to prove whether these features are the main reasons for the detection results. At present, while the application of deep learning can improve the efficiency and accuracy of anomaly detection, the lack of interpretability has limited its widespread applications in real-world tasks. Due to the ambiguous nature of the neural networks, it is currently impossible to judge whether the decision made by the current neural network is correct. Therefore, it is necessary to study interpretability methods for anomaly detection. Considering that most of the current interpretation methods are aimed at local linear features, while ignoring some local nonlinear situations, resulting in low interpretation. Furthermore, most of the current interpretation methods assume that different features are not relevant, however, in security applications, such as reverse engineering and anomaly analysis, usually use models with higher scalability and stronger feature correlation. By interpreting the anomaly detection results, the detected anomaly can be analyzed, and further improved.

References:

Pang, G., Shen, C., Cao, L., & Hengel, A. V. D. (2021). Deep learning for anomaly detection: A review. ACM computing surveys (CSUR), 54(2), 1-38.

Ma, X., Wu, J., Xue, S., Yang, J. et al (2021). A comprehensive survey on graph anomaly detection with deep learning. IEEE Transactions on Knowledge and Data Engineering.

Abusitta, A., de Carvalho, G. H., Wahab, O. A., Halabi, T., Fung, B. C., & Al Mamoori, S. (2023). Deep learning-enabled anomaly detection for IoT systems. Internet of Things, 21, 100656.

Key words: Anomaly detection, Neural networks and Deep learning

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Design and Development of Inclusive IoT Systems

Abstract: The Internet of Things (IoT) has transformed the way humans interact with technology, offering pervasive computation and connectivity [1]. However, ensuring inclusivity in IoT design is essential to cater to the diverse needs of users such as disabilities, gender diversity, and neurodiversity [2, 3]. Building inclusive IoT systems is non-trivial due the complexity of IoT technology, which encompasses heterogenous interconnected sensors, actuators, devices and services that work together. Ensuring inclusivity across this complex network of devices and services requires specialized knowledge and expertise. Furthermore, there are also challenges with identifying diverse user needs, lack of standards and guidelines, costs, education and awareness [4, 5]. This research project aims to investigate and address the diverse aspects involved in the design and development of inclusive IoT ecosystems, for selected domains such as digital health/education/smart cities. By understanding and accommodating these aspects, the outcomes of this project will contribute to create technology that is accessible, empowering, and beneficial to all individuals, and therefore sustainable in the long-term.

References:

Kirimtat, A., Krejcar, O., Kertesz, A. and Tasgetiren, M.F., 2020. Future trends and current state of smart city concepts: A survey. IEEE access, 8, pp.86448-86467.

Soares Guedes, L., Gibson, R.C., Ellis, K., Sitbon, L. and Landoni, M., 2022, October. Designing with and for People with Intellectual Disabilities. In Proceedings of the 24th International ACM SIGACCESS Conference on Computers and Accessibility (pp. 1-6).

Strengers, Y. and Kennedy, J., 2021. The smart wife: Why Siri, Alexa, and other smart home devices need a feminist reboot. MIT Press.

Davis J. U., Devine J., Ellis K., Fleet C., Fogarty J., Follmer S., Gotfrid T., Hodges S., Hofmann, M., Kushalnagar, R., Mankoff, J., Reinders, S., Seyed, T., Stangl, A., Wobbrock, J., Wu, T., Yang, X., 2021. Challenges to Inclusive and Accessible Prototyping, Isotyping and Production. Accessible Computer Science Education Fall Workshop, Microsoft Research

Hamidi, F., 2019. DIY Assistive technology prototyping platforms: an international perspective. IEEE Pervasive Computing, 18(4), pp.12-16.

Key words: IoT, Inclusive tech and Smart Cities

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Quality of Service- Aware Edge-Fog-Cloud technologies for Smart Grid

Abstract: Quality of Service (QoS)-aware edge and fog technologies play a crucial role in optimizing the performance and reliability of smart grid systems. Smart grids integrate advanced communication and information technologies into the traditional power grid to enable real-time monitoring, control, and management of electricity generation, distribution, and consumption [1]. Edge and fog technologies facilitate real-time data analytics at the grid's edge, enabling immediate insights into power consumption patterns, grid stability, and potential faults [2, 3]. This information can be utilized to optimize energy distribution, predict demand, and prevent potential failures. QoS-aware edge and fog technologies also prioritize low-latency communication for time-critical applications, such as grid monitoring, protection, and control. This minimizes communication delays and enhances the overall grid performance. However, applying edge and fog technologies to a smart grid architecture is non-trivial due to challenges with distributed ownership, connectivity, data fusion, data storage, load-balancing and issues with security and privacy [4]. This project investigates how edge, fog and cloud technologies can be used to improve the QoS of the smart grid and also improve the computational and communication latency of the grid data.

References:

Judge, M.A., Khan, A., Manzoor, A. and Khattak, H.A., 2022. Overview of smart grid implementation: Frameworks, impact, performance and challenges. Journal of Energy Storage, 49, p.104056.

Al-Turjman, F. and Abujubbeh, M., 2019. IoT-enabled smart grid via SM: An overview. Future generation computer systems, 96, pp.579-590.

Veloso, A.F.D.S., de Moura, M.C., Mendes, D.L.D.S., Junior, J.V., Rabêlo, R.A. and Rodrigues, J.J., 2021, October. Towards sustainability using an edge-fog-cloud architecture for demand-side management. In 2021 IEEE International Conference on Systems, Man, and Cybernetics (SMC) (pp. 1731-1736). IEEE.

Li, J., Gu, C., Xiang, Y. and Li, F., 2022. Edge-cloud Computing Systems for Smart Grid: State-of-the-art, Architecture, and Applications. Journal of Modern Power Systems and Clean Energy, 10(4), pp.805-817.

Key words: Edge computing, Fog computing, Smart Grid and Quality of Service

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Towards Effective and Sustainable Human-AI Teams

Abstract: There is growing research interest in human-AI collaboration and studies have examined human-AI collaboration from multiple perspectives. For example, Makovi et al (Makovi 2023) investigated how humans treat machines differently than other humans in a stylized society of beneficiaries, helpers, punishers, and trustors. Turel and Kalhan investigated algorithm aversion amongst humans (Turel and Kalhan 2023) and found that people can develop an implicit bias against AI systems. Designing and development of systems that facilitate teams of humans and AIs to work together is another challenge. While there have been a few studies focusing on aspects such as adoption of UX variants for AI generated code translation (Weisz et al 2021), and using machine learning for software quality (Kotti, Galanopoulou, and Spinellis, 2023), the area remains under researched. Many challenges remain, such as domain specific technical issues, as well as human-centric, social, ethical and collaborative aspects. This research project aims to investigate and address the aforementioned areas of research. The outcomes of this project will contribute to create inclusive and effective technology able to make better decisions with consideration to ethical, responsible and explainable AI.

References:

Makovi, K., Sargsyan, A., Li, W., Bonnefon, J.F. and Rahwan, T., 2023. Trust within human-machine collectives depends on the perceived consensus about cooperative norms. Nature Communications, 14(1), p.3108.

Turel, O., Kalhan, S.,2023. Prejudiced Against The Machine? Implicit Associations And The Transience Of Algorithm Aversion. Accepted. To be published.

Weisz, J.D., Muller, M., Houde, S., Richards, J., Ross, S.I., Martinez, F., Agarwal, M. and Talamadupula, K., 2021, April. Perfection not required? Human-AI partnerships in code translation. In 26th International Conference on Intelligent User Interfaces (pp. 402-412).

Kotti, Z., Galanopoulou, R. and Spinellis, D., 2023. Machine learning for software engineering: A tertiary study. ACM Computing Surveys, 55(12), pp.1-39

Key words: Human-AI, Responsible AI, Socio-technical Systems and Human-Centric AI

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Edge-Enabled Drone-Assisted Livestock Management

Abstract: Drone-assisted livestock management is the application of unmanned aerial vehicles (drones) in agricultural practices to monitor, manage, and optimize livestock farming operations [1-2]. Drones offer various benefits, including increased efficiency, cost-effectiveness, and data-driven decision-making. Some ways in which drones are used in livestock management are livestock monitoring, pasture management, fencing and security, search and rescue, water resource monitoring, precision livestock farming, livestock behaviour studies, and etc. By integrating drone data with other agricultural technologies, such as GPS tracking and data analytics [3], farmers can implement precision livestock farming practices. This approach optimizes resource usage, reduces waste, and enhances overall farm productivity. The data-driven drone technology can also be enhanced using communication technologies such as LoRa [4] and edge computing [5] in remote farming.

References:

M. A. Mendoza, M. R. Alfonso and S. Lhuillery, "A battle of drones: Utilizing legitimacy strategies for the transfer and diffusion of dual-use technologies", Technol. Forecasting Social Change, vol. 166, May 2021.

X. Jiang, M. Sheng, N. Zhao, C. Xing, W. Lu and X. Wang, "Green UAV communications for 6G: A survey", Chin. J. Aeronaut., May 2021.

F. Sarwar, A. Griffin, P. Periasamy, K. Portas and J. Law, "Detecting and counting sheep with a convolutional neural network", Proc. 15th IEEE Int. Conf. Adv. Video Signal Based Surveill. (AVSS), pp. 1-6, Nov. 2018.

M. Behjati, A. B. Mohd Noh, H. A. H. Alobaidy, M. A. Zulkifley, R. Nordin and N. F. Abdullah, "LoRa communications as an enabler for Internet of Drones towards large-scale livestock monitoring in rural farms", Sensors, vol. 21, no. 15, pp. 5044, Jul. 2021.

Y. Kalyani and R. Collier, "A systematic survey on the role of cloud fog and edge computing combination in smart agriculture", Sensors, vol. 21, no. 17, pp. 5922, Sep. 2021.

Key words: Edge computing, Smart farming, Machine learning and Drones

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Drone and Data-Driven Smart Farming

Abstract: Digital farming, also known as smart farming or precision agriculture, is a cutting-edge approach that leverages advanced technologies to revolutionize the agricultural industry [1-2]. In this innovative system, farmers utilize a myriad of digital tools such as sensors, drones, autonomous machinery, and data analytics to optimize crop production [3-4] and livestock management. These devices enable real-time monitoring of essential variables like soil moisture, nutrient levels, and weather conditions, allowing farmers to make data-driven decisions and apply resources efficiently [5]. Through the integration of artificial intelligence and machine learning algorithms, digital farming empowers growers to predict crop yields, detect diseases early on, and even automate irrigation and fertilization processes. This project aims to investigate how drone technology, in conjunction with sensors and data analytics technologies can be used to make farming more sustainable, productive, and economically viable.

References:

Y. Inoue and M. Yokoyama, "Drone-Based Optical, Thermal, and 3d Sensing for Diagnostic Information in Smart Farming – Systems and Algorithms –," IGARSS 2019 - 2019 IEEE International Geoscience and Remote Sensing Symposium, Yokohama, Japan, 2019, pp. 7266-7269

P. Tripicchio, M. Satler, G. Dabisias, E. Ruffaldi and C. A. Avizzano, "Towards Smart Farming and Sustainable Agriculture with Drones," 2015 International Conference on Intelligent Environments, Prague, Czech Republic, 2015, pp. 140-143

P. Tripicchio, M. Satler, G. Dabisias, E. Ruffaldi and C. A. Avizzano, "Towards Smart Farming and Sustainable Agriculture with Drones," 2015 International Conference on Intelligent Environments, Prague, Czech Republic, 2015, pp. 140-143

M. A. Al-Shareeda, S. Manickam and M. A. Saare, "Intelligent Drone-based IoT Technology for Smart Agriculture System," 2022 International Conference on Data Science and Intelligent Computing (ICDSIC), Karbala, Iraq, 2022, pp. 41-45

Y. Inoue and M. Yokoyama, "Drone-Based Optical, Thermal, and 3d Sensing for Diagnostic Information in Smart Farming – Systems and Algorithms –," IGARSS 2019 - 2019 IEEE International Geoscience and Remote Sensing Symposium, Yokohama, Japan, 2019, pp. 7266-7269

Key words: Drones, Smart farming, Data analytics, Machine learning and Sensors

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Wearable Technologies

Abstract: The Internet of Things (IoT) is rapidly growing, and with this the improvement in the availability and variety of embedded platforms. IoT technologies are now being deployed in many applications including home, business, logistics, transport, military and etc. An emerging research area in IoT is wearable technology in which users wear the technologies. Wearable technologies can be useful in a variety of areas with the focus being on activity monitoring or sensing. Some examples of such applications are as, sports, safety, health and rehabilitation, elderly care and education Health and rehabilitation, elderly care and education. To solve these problems using wearable technologies, there are several research challenges that need to be solved, as follows. Use of appropriate hardware and sensors Networking of sensors on individual vs groups of people Tracking of individuals and groups of people Coordination approaches – central and distributed approaches. Data Fusion from multiple sensing sources Dealing with challenging environmental conditions Long range interaction with wearable technology This research will take an experimental approach, utilizing IoT embedded nodes such as ESP and ARM micro-controllers, communications technologies including WiFi, Bluetooth and 5G, networking technologies such as software defined networking (SDN) and network function virtualisation and machine learning and AI technologies.

References:

C. K. Bhardwaj and R. B. Agnihotri, "Wearable Advancements and its Implementation in Sports," 2019 4th International Conference on Information Systems and Computer Networks (ISCON), Mathura, India, 2019, pp. 37-41. Link

S. Coyle, D. Morris, K. -T. Lau, D. Diamond and N. Moyna, "Textile-Based Wearable Sensors for Assisting Sports Performance," 2009 Sixth International Workshop on Wearable and Implantable Body Sensor Networks, Berkeley, CA, USA, 2009, pp. 307-311. Link

A. Aldousari, M. Alotaibi, F. Khajah, A. Jaafar, M. Alshebli and H. Kanj, "A Wearable IOT- based Healthcare Monitoring System for Elderly People," 2023 5th International Conference on Bio-engineering for Smart Technologies (BioSMART), Paris, France, 2023, pp. 1-4. Link

M. N. Al Hossain, A. Pal and S. K. A. Hossain, "A wearable sensor based elderly home care system in a smart environment," 2015 18th International Conference on Computer and Information Technology (ICCIT), Dhaka, Bangladesh, 2015, pp. 329-334. Link

Key words: Internet of Things, Wearables and Embedded Systems

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Enhancing Robotic Manipulation Capabilities through Machine Learning

Abstract: This PhD project proposal aims to advance the field of robotic manipulation by leveraging cutting-edge machine learning techniques, specifically focusing on computer vision and learning from demonstration. The project's primary goal is to enhance the manipulation capabilities of robotic arms, with a specific emphasis on grasping, non-prehensile manipulation (e.g., pushing objects), and deformable object manipulation. Theoretical Background: Robotic manipulation is a crucial aspect of automation, but it remains a challenging task due to the inherent complexities of real-world scenarios. Traditional control approaches often struggle to adapt to varying object shapes and environments. By employing machine learning tools, we seek to overcome these limitations and enable robots to learn from experience, significantly improving their dexterity and adaptability. Expected Impact: This research holds significant potential for revolutionizing various industries, including manufacturing, logistics, and healthcare. Improved robotic manipulation capabilities could lead to increased productivity, reduced costs, and enhanced safety in industrial settings. Moreover, advancements in deformable object manipulation can have profound implications in fields such as service or industrial robotics. Research Questions: How can deep learning models be trained to perform robust and precise grasping of diverse objects? Can non-prehensile manipulation strategies be learned through demonstration and adapted for various scenarios? How can deformable object manipulation be achieved through a combination of visual perception and machine learning algorithms?

References:

Newbury, Rhys, et al. "Deep learning approaches to grasp synthesis: A review." IEEE Transactions on Robotics (2023).

Key words: Robotics, AI, Machine Learning, Robotic Manipulation and Deep Learning

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Safe and Effective Robot Navigation in Human Environments

Abstract: This PhD project proposal seeks to address the critical challenges associated with robot navigation in human environments, with a strong focus on safety and efficiency. The project aims to develop intelligent navigation systems that enable robots to operate seamlessly both outdoors and indoors, enhancing applications such as package delivery in urban areas and personalized assistance in offices or homes. Theoretical Background: Navigating in human environments poses unique obstacles due to the dynamic and unpredictable nature of human interactions. Conventional navigation approaches often struggle to handle pedestrian-rich scenarios and lack the capability to ensure safe and socially acceptable robot behaviour. This research draws upon computer vision techniques, including person detection and tracking, to perceive and interpret the surrounding environment accurately. Additionally, machine learning algorithms will be employed to enable robots to learn from data and optimize their navigation strategies. Expected Impact: The outcomes of this project are far-reaching, promising significant advancements in the domain of service robotics. By addressing safety concerns and incorporating human-robot interaction principles, the proposed navigation systems will inspire greater trust and acceptance of robots in various human-centric settings. Additionally, the deployment of legged robots in outdoor environments and wheeled robots indoors will lead to improved logistics efficiency and personalized assistance, ultimately enhancing the quality of life for individuals. Research Questions: How can computer vision techniques be integrated into robot navigation to ensure robust person detection and tracking? Can machine learning algorithms effectively learn navigation strategies that account for human behaviour and preferences in different environments? How can human-robot interaction principles be applied to design socially acceptable robot behaviour during navigation?

References:

Tidd, Brendan, et al. "Passing through narrow gaps with deep reinforcement learning." 2021 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS). IEEE, 2021

Key words: AI, Robotics, Mobile Robots, Robot Navigation and Deep Learning

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Dynamic Modelling for Resilient Smart Grids: Enhancing Robustness and Security in Energy Distribution Systems

Abstract: The emergence of smart grid systems has transformed the landscape of energy generation, storage, and distribution. However, the inherent complexity and dynamical nature of smart grids pose new challenges in system reliability and optimality. Dynamical modelling on complex networks offers some key advantages in addressing these challenges. Built on the CI's research in graph neural networks and neural dynamical models, this project aims to develop dynamically modelling techniques in smart grids that will optimise energy generation and distribution and ensure reliable operation of future energy distribution systems. The project consists of the following components: 1. Modelling of energy generation and consumption patterns: We will develop data-driven adaptive models to capture spatial and temporal dynamical patterns in smart grids, incorporating factors such as regional weather conditions and consumer behaviours. 2. Resilient smart grids: We will develop mathematical and computational models that help reveal network vulnerability, including nonlinear cascading effects of failures. The models enable simulation to suggest risk mitigation mechanisms. 3. Demand and market dynamic prediction: We will develop models to explain and simulate market dynamic and effectiveness of consumer behaviour incentives. The model will enable optimising energy generation schedule and market interventions.

References:

Liu, Bing, Wei Luo, Gang Li, Jing Huang, and Bo Yang. "Do We Need an Encoder-Decoder to Model Dynamical Systems on Networks?." arXiv preprint arXiv:2305.12185 (2023).

Key words: Neural ODE, Dynamical Models, Deep Learning, Graph Neural Networks and Complex Networks

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Plastic Waste Management and Recycling with Hyperspectral/LiDAR Imaging from Unmanned Aerial Vehicles (UAVs) in Landfills and Agricultural Farmlands

Abstract: As the world grapples with plastic wastes, UAV imagery can be an effective tool to identify plastic waste hotspots and monitor plastics in landfills for efficient plastic waste recycling. UAV imagery can also be used to track large-scale plastic usage in agricultural farmland to prevent them ending up in landfills and hence, contribute to plastic circular economy. This PhD project aims to develop smart aerial image sensing tools with novel image processing and machine learning techniques to autonomously survey large areas, identify plastic waste hotspots, monitor landfill sites for plastic waste, and track the progress of plastic waste management initiatives, allowing for more informed decision-making and resource allocation. One of the innovative approaches of this project will be exploiting multimodal imaging, combining the best of visual spectral, multispectral, hyperspectral, and LiDAR imaging. This project will be supervised jointly by the members of the Smart Sensing, Coding, and Analytics (SmaSCA) Lab in the Centre for Internet of Things ECOsystems Research and Experimentation (CITECORE). The Lab has access to research collaborators with Certified CASA Drone Licences at the Centre for Smart Analytics (CSA) in Federation University. Metropolitan and rural city councils are the potential industry partners.

References:

Natalia Sliusar, Timofey Filkin, Marion Huber-Humer, Marco Ritzkowski, "Drone technology in municipal solid waste management and landfilling: A comprehensive review," Waste Management, Vol. 139, 2022.

Silvia Serranti, Aldo Gargiulo, Giuseppe Bonifazi, "Characterization of post-consumer polyolefin wastes by hyperspectral imaging for quality control in recycling processes," Waste Management, Vol. 31, 2011.

Yan Zheng, Jiarui Bai, Jingna Xu, Xiayang Li, Yimin Zhang, "A discrimination model in waste plastics sorting using NIR hyperspectral imaging system," Waste Management, Vol. 72, 2018.

Abderrahim Nemmaoui, Fernando J. Aguilar, Manuel A. Aguilar, Rongjun Qin, "DSM and DTM generation from VHR satellite stereo imagery over plastic covered greenhouse areas," Computers and Electronics in Agriculture, Vol. 164, 2019.

Key words: Image processing, Machine learning, Aerial imaging and Waste management

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Video Coding for Connected Machines and Humans

Abstract: Machine-to-machine and machine-to-human video communications are expected to increase many folds due to the rise of artificial intelligence (AI) driven video analytics performed at the edge of the networks in intelligent transportation, intelligent video surveillance, smart city, and industrial automation systems, some of the frontiers of the Fourth Industrial Revolution (Industry 4.0). In response, MPEG has recently issued a Call for Evidence (CfE) for Video Coding for Machines (VCM), which can collaboratively compress both a video stream and previously extracted features from that video for multiple machine analysis tasks. This PhD project aims to develop a fully functional VCM implementation, which will bring the best of both video compression for human consumption and deep feature compression techniques for connected machines. The project is expected to impact autonomous analysis, video streaming, surveillance, and health industries by improving compression and enriching the content of ultra-high-resolution imagery. This project will be supervised jointly by the members of the Smart Sensing, Coding, and Analytics (SmaSCA) Lab in the Centre for Internet of Things ECOsystems Research and Experimentation (CITECORE).

References:

MPEG, "Draft call for evidence for video coding for machines," ISO/IEC JTC1/SC29/WG11, 2020.

L. Duan et al., "Video coding for machines:collaborative compression and intelligent analytics," IEEE Trans. Image Process., 2020.

F. Afsana, M. Paul, M. Murshed, and D. Taubman, "Efficient high-resolution video compression scheme using background and foreground layers", IEEE Access, 2021.

S. Shahriyar, M. Murshed, M. Ali, and M. Paul, "Depth sequence coding with hierarchical partitioning and spatial-domain quantization," IEEE Trans. Circuits Syst. Video Technol., 2020.

S. Young, D. Taubman, and B. Girod, "Transform quantization for CNN compression," IEEE Trans. Pattern Anal. Mach. Intell., 2021.

Key words: Video coding, Image processing, Deep learning and Autonomous sensing

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Data-driven Immersive Visualization System for Sustainable Advancing Smart Manufacturing

Abstract: This project focuses on immersive visualisation development aligns on themes of sustainable industries leading to circular economy via an effective manufacturing ecosystem [1]. It will provide a practical solution of Industry 4.0 technologies to real-world manufacturing challenges to foster sustainable industries by bolstering their competitiveness and embrace advancements in the rapidly evolving global manufacturing landscape. It promotes resource optimisation, renewable energy integration, and data-driven circular economy practices. Data-driven solution incorporating with virtual reality would contribute to a greener and more sustainable future in different domains [2]. However, challenges like virtual reality interaction design and real-time data processing constraints are under addressed [3, 4]. This project exemplifies technological innovation with Industry 4.0 data collection, processing, and visualisation system tailored for smart manufacturing. The primary focus is on aiding local industries within the Australian manufacturing sector in enhancing their productivity and sustaining their competitiveness through the adoption of cutting-edge Industry 4.0 technologies in their day-to-day operations. A pivotal aspect of this project involves developing a user-friendly visualisation interface, empowering manufacturers to effortlessly access and comprehend the data and insights generated by the system. Such user-centric visualisations will enable manufacturers to make informed decisions and promptly implement changes to enhance manufacturing operations.

References:

[1] Rebelo, J., Andrade, C., Costa, C., Santos, M.Y. (2020). An Immersive Web Visualization Platform for a Big Data Context in Bosch's Industry 4.0 Movement. In: Themistocleous, M., Papadaki, M. (eds) Information Systems. EMCIS 2019. Lecture Notes in Business Information Processing, vol 381. Springer, Cham. Link

[2] Jiawei Huang, Melissa S. Lucash, Robert M. Scheller & Alexander Klippel (2021) Walking through the forests of the future: using data-driven virtual reality to visualize forests under climate change, International Journal of Geographical Information Science, 35:6, 1155-1178, Link

[3] J. Pirker, E. Loria, S. Safikhani, A. Künz and S. Rosmann, "Immersive Virtual Reality for Virtual and Digital Twins: A Literature Review to Identify State Of The Art and Perspectives," 2022 IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops (VRW), Christchurch, New Zealand, 2022, pp. 114-115, Link

[4] M Eswaran, M V A Raju Bahubalendruni, "Challenges and opportunities on AR/VR technologies for manufacturing systems in the context of industry 4.0: A state of the art review, " Journal of Manufacturing Systems, vol 65, 2022, pp260-278, Link

Key words: Sustainable industries, Data-driven circular economy practices, Visualisation and Digital immersive model

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Impact Theme	Enabling a sustainable world
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
Scholarship	Applicants will need to complete an Expression of Interest and if successful apply for a Deakin University Postgraduate Research Scholarship

Computer Vision System for Varroa Mite Detection and Streamlined Biosecurity Emergency Responses in Commercial Beekeeping

Abstract: The decline of honeybee populations poses a significant threat to global food security. Varroa destructor mites are a primary contributor to bee colony losses, which has recently been detected in mainland Australia, triggering alarming responses across NSW and VIC borders. This proposed PhD project seeks to develop a cutting-edge Computer Vision System (CVS) for the early detection of Varroa mites in beehives. By harnessing the power of artificial intelligence and image processing, this system aims to provide beekeepers with a rapid and non-invasive tool for monitoring mite infestations, ultimately enabling timely biosecurity interventions. Drawing upon recent advancements in computer vision techniques (He et al., 2016), the CVS will process high-resolution images/videos of bee frames to accurately identify Varroa mites (Wachowicz et al., 2022). Additionally, the project will explore the integration of other sensor technologies, such as temperature and humidity sensors, for efficient hive inspections (Anderson et al., 2019). By developing a real-time monitoring system (Zhang et al., 2019), this project aims to streamline biosecurity emergency responses, thereby safeguarding bee populations and sustaining pollination services crucial to agricultural ecosystems (Potts et al., 2010).

References:

He, K., Zhang, X., Ren, S., & Sun, J. (2016). Deep residual learning for image recognition. In Proceedings of the IEEE conference on computer vision and pattern recognition (CVPR).

Anderson, D. J., Gaston, A. K., & Lin, Y. (2019). Using drones and machine learning to understand honey bee behavior in the field. In Proceedings of the 2019 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2019 ACM International Symposium on Wearable Computers.

Zhang, Q., Shen, W., Xu, C., & Zhang, L. (2019). Deep learning in remote sensing: A comprehensive review and list of resources. IEEE Geoscience and Remote Sensing Magazine, 7(3), 8-36.

Potts, S. G., Biesmeijer, J. C., Kremen, C., Neumann, P., Schweiger, O., & Kunin, W. E. (2010). Global pollinator declines: Trends, impacts, and drivers. Trends in Ecology & Evolution, 25(6), 345-353.

Key words: Computer Vision, Food Security, Biosecurity, Image Processing and Deep Learning

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Impact Theme	Enabling a sustainable world
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
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Multimodal Decision Support System to Identify Hive Health Status in Commercial Beekeeping

Abstract: The health and well-being of honeybee colonies are critical to the sustainability of commercial beekeeping operations. This proposed PhD project aims to develop a Multimodal Decision Support System (MDSS) that combines data from various sources, including visual, audio, and environmental sensors, to comprehensively assess hive health status. By leveraging state-of-the-art machine learning techniques (Goodfellow et al., 2016), this MDSS will provide commercial beekeepers with a robust tool for early detection of health issues, allowing for timely interventions to prevent colony losses. The MDSS will incorporate image analysis techniques (Russakovsky et al., 2015) to monitor bee behaviour and hive conditions, audio analysis for detecting unusual sounds indicative of distress or diseases, and environmental sensor data (e.g., temperature, humidity) to assess hive microclimates (Liang et al., 2022). By integrating these multiple modalities, inspired by recent advancements in multimodal deep learning (Ngiam et al., 2011), this project aims to create a holistic and real-time decision support system that empowers beekeepers to make informed choices for hive management and disease prevention.

References:

Goodfellow, I., Bengio, Y., Courville, A., & Bengio, Y. (2016). Deep learning (Vol. 1). MIT press Cambridge.

Russakovsky, O., Deng, J., Su, H., Krause, J., Satheesh, S., Ma, S., & Berg, A. C. (2015). ImageNet large scale visual recognition challenge. International Journal of Computer Vision, 115(3), 211-252.

Ngiam, J., Khosla, A., Kim, M., Nam, J., Lee, H., & Ng, A. Y. (2011). Multimodal deep learning. In Proceedings of the 28th international conference on international conference on machine learning (ICML'11).

Liang, A., 2022, October. Effectiveness of Transfer Learning, Convolutional Neural Network and Standard Machine Learning in Computer Vision Assisted Bee Health Assessment. In 2022 International Communication Engineering and Cloud Computing Conference (CECCC) (pp. 7-11). IEEE.

Key words: Sensor technology, Multimodal Data, Beekeeping, Machine Learning and Hive Health

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Scholarship	Applicants will need to complete an Expression of Interest and if successful apply for a Deakin University Postgraduate Research Scholarship
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Developing Robust and Flexible Machine Learning methods for practical applications

Abstract: Most existing Machine Learning (ML) algorithms assume that all data features are numeric and represent data instances as points in a multidimensional geometric space. They use distances between points in the space as a measure of their similarities and use them to extract patterns from data. However, in practice, this assumption may not hold because of: (i) the sensitivity of data representation (i.e., the relative positions of data points in the space depend on units/scales used to measure/represent data features), and (ii) the heterogeneity of real-world data that can come from a variety of sources in different forms (e.g., numeric and categorical). Therefore, many existing ML algorithms may be limited in solving practical problems. While there are techniques to convert categorical features into numeric features such as one-hot encoding and label encoding, this conversion process often results in information loss and/or addition of irrelevant/noisy information that can degrade the algorithms' performance. In this project, we aim to develop ML methods that are robust (not sensitive to data representation) and flexible (able to handle domains with numeric, categorical or mixed data features) to learn patterns from heterogeneous data coming from different sources/sensors that might have been represented in different units/scales.

References:

Hancock, J. T. and Khoshgoftaar, T. M. (2020) 'Survey on categorical data for neural networks', Journal of Big Data, vol. 7, art. no. 28.

Fernando, T.L. and Webb, G.I. (2017) 'SimUSF: an efficient and effective similarity measure that is invariant to violations of the interval scale assumption'. Data Min Knowl Disc, vol. 31, pp. 264–286.

Stevens, S. S. (1946) 'On the theory of scales of measurement', Science, vol. 103, no. 2684, pp. 677––680, 1946

Aryal, S., Ting, K. M., Washio, T. and Haffari, G. (2020) 'A comparative study of data-dependent approaches without learning in measuring similarities of data objects', Data mining and knowledge discovery, vol. 34, no. 1, pp. 124–162, 2020.

Aryal, S. and Wells, J. R. (2021) 'Ensemble of local decision trees for anomaly detection in mixed data', in Proceedings of the European Conference on Machine Learning and Principles and Practice of Knowledge Discovery in Databases, 2021, pp. 687–702.

Key words: Robust Machine Learning, Heterogeneous Data, Units and Scales of Measurement, Anomaly Detection and Clustering

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Generalized deep incremental learning

Abstract: Many real-world machine learning systems demand the ability to continually absorb new knowledge, an ability mirrored by humans and animals throughout their lifetime. Class Incremental Learning (CIL), an approach aiming to incrementally add new class data, has been increasingly noted as a means of achieving this objective. However, existing techniques often incorporate certain assumptions such as constant class count across learning phases, non-reappearing classes, and balanced training samples across classes to simplify the learning setting. These assumptions rarely hold in real-world applications. This project aims to formulate a Generalized Class Incremental Learning (GCIL) frameworks that systematically alleviates CIL restrictions. Further, novel computationally efficient methods for GCIL suitable for small edge devices will be developed.

References:

S.-A. Rebuffi, A. Kolesnikov, G. Sperl, and C. H. Lampert, "iCaRL: Incremental classifier and representation learning," in Proceedings of the IEEE conference on Computer Vision and Pattern Recognition, 2017, pp. 2001–2010.

B. Zhao, X. Xiao, G. Gan, B. Zhang, and S.-T. Xia, "Maintaining discrimination and fairness in class incremental learning," in Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition, 2020, pp. 13 208–13 217.

Key words: Incremental learning, Dynamic model update, Deep learning and Edge devices

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Impact Theme	Creating smarter technologies
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
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Avatar Decoder Pipeline for Multiple Simultaneous Avatar Appearances based on Trusted Relationships

Abstract: Avatars are virtual representations of users in the virtual world. Prior work has demonstrated the importance of visual representation towards user's identity, privacy, and interactions with others, in terms of self-confidence, trust and privacy. This project explores a novel technique for avatar mesh decoder, to enable simultaneous multiple virtual representations of the same user to individual online participants, based on an established trust relationship. The focus area is a new concept in terms of identity, authentication, and privacy relating to VR devices and technologies, as well as a novel perspective on societal consideration of multiple identities and virtual representation of our avatars in virtual worlds.

References:

Lin, Jinghuai, and Marc Erich Latoschik. "Digital body, identity and privacy in social virtual reality: A systematic review." Frontiers in Virtual Reality 3 (2022): 974652. Freiwald, Jann Philipp, Julius Schenke, Nale Lehmann-Willenbrock, and Frank Steinicke. "Effects of avatar appearance and locomotion on co-presence in virtual reality collaborations." In Proceedings of Mensch und Computer 2021, pp. 393-401. 2021.

Freeman, Guo, Samaneh Zamanifard, Divine Maloney, and Alexandra Adkins. "My body, my avatar: How people perceive their avatars in social virtual reality." In Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems, pp. 1-8. 2020.

Ospina-Bohórquez, Alejandra, Sara Rodríguez-González, and Diego Vergara-Rodríguez. "A review on multi-agent systems and virtual reality." In Distributed Computing and Artificial Intelligence, Volume 1: 18th International Conference 18, pp. 32-42. Springer International Publishing, 2022.

Key words: Virtual Reality and Avatar Interactions

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Augmented Reality Multipresence

Abstract: Augmented reality (AR) is an interactive medium in which virtual information is overlaid on real world objects. AR visualisation can be most useful when acting as communication medium among remote users, especially for tasks guidance between an expert and novice user. Virtual instructions or interactions created by an expert located remotely can be overlaid directly on the tasks for the local user to follow. We are looking for students interested in exploring the concept of multipresence that supports seamless, natural, and engaging interactions among users that are located in multiple locations. Multipresence can be applied to various collaboration scenarios, including teaching, tasks instructions, and shared design activities. The AR multipresence platform can support the capturing and rendering of multi-sensory channels of interactions, including body movement, speech, eye tracking, haptics, touch interactions as well as exchange of 3D physical objects and environmental mapping. User can connect with the multipresence platform via virtual reality or augmented reality technologies, including mobile devices, tablet, and stand-alone VR and AR headsets.

References:

Cao, Yuanzhi, Xun Qian, Tianyi Wang, Rachel Lee, Ke Huo, and Karthik Ramani. "An exploratory study of augmented reality presence for tutoring machine tasks." In Proceedings of the 2020 CHI conference on human factors in computing systems, pp. 1-13. 2020.

Regenbrecht, Holger, and Thomas Schubert. "Measuring presence in augmented reality environments: design and a first test of a questionnaire." arXiv preprint arXiv:2103.02831 (2021).

Key words: Augmented reality and Presence

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Empowering Human in the Metaverse

Abstract: The Metaverse typically represents a network of virtual environments with large-scaled spatial data, within which human entities are often represented with virtual avatars. The project expands the Metaverse concept as a holistic synergy of digital and physical environments, within which human workers manage, analyse, train, educate, and explore. We recognise an opportunity to enable Australian industry sectors to enhance their physical operations through Metaverse techniques and technologies, to boost Australia's digital economy. The core objective is to empower human performance, capabilities, and safety within the Metaverse, to seamlessly facilitate communication and cross interactions between digital and physical entities. Our research object focuses on supporting digital assets to mirror and to sustain physical assets. We aim to innovate in the areas of assets management, authentication, and authorship across physical and digital realms, allowing digital assets to mirror physical assets with life cycle transactions. We aim to apply circular economy methodologies to support exchange and trade of digital and physical resources within urban ecosystems of the Metaverse, thus enabling digital technology to make physical resources sustainable.

References:

Andrew Irlitti, Mesut Latifoglu, Qiushi Zhou, Martin N Reinoso, Thuong Hoang, Eduardo Velloso, and Frank Vetere. 2023. Volumetric Mixed Reality Telepresence for Real-time Cross Modality Collaboration. In Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems (CHI '23).

Association for Computing Machinery, New York, NY, USA, Article 101, 1–14. Link

Key words: Virtual reality, Human computer interaction and Augmented reality

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Scholarship	Applicants will need to complete an Expression of Interest and if successful apply for a Deakin University Postgraduate Research Scholarship
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Cybercrime in the Indo-Pacific region

Abstract: Cybercrime is now without borders, and we see cybercriminals are taking the advantages using developing and less developed countries as hubs to commit cybercrime. New technologies such as AI and IoT are also being used by cybercriminals. The challenges such as cross-border crime investigation and legal assistance exist. How to tackle these challenges are key to successful reducing crime opportunities to cybercriminlas. This project aims to understand cybercrime in countries in the Indo-Pacific region, especially those less researched countries. It could include issues relating to cybercrime laws; challenges facing specific country/countries in the region in cybercrime investigation; issues relating to the establishment of cybercrime convention and the segmentation of laws and policies in combating cybercrime; cyber capacity building and cyber security awareness raising in the region; effective public and private collaboration; how new technologies facilitated traditional crime and/or generate new type of crime, and how to minimise the impact of the segmentation of laws relating to data protection and cyber security.

References:

Smith, R., Sarre, R., Chang, L.Y.C., and Lau, L. (eds)(2023) Cybercrime in the Pandemic Digital Age and Beyond.

Cham: Palgrave Macmillan; Chang, L.Y.C., Zhong, Y., and Grabosky, P. (2018) "Citizen co-production of cyber security: Self-Help, Vigilantes, and Cybercrime", Regulation & Governance, 12(1): 101-114.

Chang, L.Y.C., (2017) "Cybercrime and cyber security in ASEAN", in Liu, J., Travers, M. and Chang, L. (eds) Comparative Criminology in Asia (Pp. 135-148). New York: Springer.

Key words: Cybercrime, Public-private collaboration, Cyber capacity building and Cybercrime investigation

Principal Supervisor:	Dr Lennon Chang
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Campus	Melbourne Burwood
Impact Theme	Building safe and secure communities
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
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Understanding and addressing susceptibility to threats posed by digital disinformation

Abstract: Disinformation has become a significant concern worldwide posing a serious threat to political legitimacy, democratic process and institutions, citizens' quality of life, and social cohesion, to name a few. While research on public-private collaboration against disinformation is emerging in Australia, most of it is focused on English-speaking users. Empirical research on the impact of disinformation on Chinese-speaking users in Australia, is still scarce. This project will contribute to current academic debate on countering disinformation, with a focus on Chinese-speaking users in Australia. The primary aim of this project is to understand what makes disinformation appealing to people and what potentially makes the information seem more believable. This project will investigate how personal traits are associated with how people receive and verify information to effectively counter disinformation operations, including fake news, conspiracy theories and propaganda, by mobilising collaboration between government, platform providers and civil society. It will use innovative interdisciplinary methods to learn more about how disinformation can be systematically discovered and how to categorise disinformation clusters that are more likely to be believed and disseminated.

References:

Nguyen, S. et al (2022) 'Studying mis- and disinformation in Asian diasporic communities: The need for critical transnational research beyond Anglocentrism', Harvard Kennedy School (HKS) Misinformation Review.

Chang, L.Y.C., Mukherjee, S., and Coppel, N. (2021) 'We are all victims: Questionable content and collective victimization in the digital age', Asian Journal of Criminology, 16: 37-50.

Key words: Disinformation, Artificial intelligence, Fake news, Diaspora and Democracy

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Impact Theme	Advancing, society, culture and the economy
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
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Smart Fleet Management System (application) for a Network of Electric Vehicles

Abstract: The global market share of electric vehicles (EVs) is on the rise, resulting in a rapid increase in their charging demand in both spatial and temporal domains. EVs fleet management is overseeing the charging needs of fleet drivers and electric vehicles as well as ensuring the charging infrastructure is optimized to fulfill those needs. The volume of vehicles and distances travelled must be analysed to determine the number of depot and/or "on the road" charge points required and the distance between them – whether owned and operated by the fleet owner, public charge points, or home-based charge points for lighter vehicles. In this project we aim to propose a real-time monitoring system for our smart fleet management system. As EV fleet management has additional data to consider – charging behaviour, charging station health, state of charge, energy consumption and charging session data – such as time and location, there is a need of a real-time analytics to support fleet managers in their business decision making processes.

References:

Z Moghaddam, I Ahmad, D Habibi, QV Phung IEEE Transactions on transportation electrification 4 (1), 76-88

Key words: Fleet management, Monitoring/ error detection, Electric vehicle charging stations.

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Impact Theme	Enabling a sustainable world
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Scholarship	Applicants will need to complete an Expression of Interest and if successful apply for a Deakin University Postgraduate Research Scholarship
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Quantum Machine Learning for Cyber Attack Detection in Networks of Varied Scale

Abstract: This PhD research project aims to revolutionize cyber-attack detection by harnessing the power of quantum machine learning techniques. The ability to identify and mitigate cyber-attacks is of paramount importance. Traditional methods struggle to keep pace with the sophistication of modern threats, highlighting the need for innovative approaches. This research will leverage quantum computing's inherent capacity to process complex patterns and relationships in vast datasets to develop a novel framework for cyber-attack detection. By integrating quantum machine learning algorithms with network traffic analysis, the project seeks to enhance the accuracy and efficiency of identifying anomalous behaviours associated with cyber-attacks across networks of varying sizes. The anticipated outcomes include the creation of advanced quantum machine learning models tailored to the intricacies of network data, contributing to the field's theoretical understanding and practical application. The project's interdisciplinary nature will foster collaboration between quantum computing and cybersecurity communities, with the goal of achieving breakthroughs in both domains. The research's ultimate impact lies in strengthening the security posture of organizations and individuals against cyber threats, while also yielding high-quality publications that disseminate valuable insights to the academic and industry communities.

References:

Liang, J. M., Shen, S. Q., Li, M., & Li, L. (2019). Quantum anomaly detection with density estimation and multivariate Gaussian distribution. Physical Review A, 99(5), 052310.

Ngairangbam, V. S., Spannowsky, M., & Takeuchi, M. (2022). Anomaly detection in high-energy physics using a quantum autoencoder. Physical Review D, 105(9), 095004.

Key words: Quantum machine learning, Anomaly detection and cyberattacks

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Impact Theme	Building safe and secure communities
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
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Post-Quantum Cryptography Applications: Safeguarding Digital Communication in an Era of Quantum Threats

Abstract: The rapid advancement of quantum computing poses a critical threat to classical cryptographic protocols, necessitating the exploration of post-quantum cryptography (PQC) for ensuring the security of digital communication in a quantum-vulnerable landscape. This PhD research project aims to investigate the practical applications of post-quantum cryptographic schemes in diverse real-world scenarios. The project will begin by testing prominent PQC candidates, evaluating their security, efficiency, and suitability for various use cases. Subsequently, novel hybrid cryptographic solutions will be proposed, integrating select PQC primitives with existing classical cryptography to ensure robustness against quantum attacks while maintaining acceptable performance levels. The research will extend to examining the deployment challenges of PQC in existing communication protocols and infrastructure, addressing compatibility, scalability, and interoperability concerns. Performance benchmarks and comparative analyses will be carried out to quantify the advantages and limitations of the proposed solutions. The outcomes of this research will contribute to the practical implementation of post-quantum cryptography, ensuring the long-term security of digital communication in the growing quantum threat landscape. This project seeks providing insights into the integration of PQC within real-world systems.

References:

Nosouhi, Mohammad Reza, et al. "Weak-Key Analysis for BIKE Post-Quantum Key Encapsulation Mechanism." IEEE Transactions on Information Forensics and Security 18 (2023): 2160-2174.

Nosouhi, Mohammad Reza, et al. "DU-QS22: A Dataset for Analyzing QC-MDPC-Based Quantum-Safe Cryptosystems." EAI International Conference on Applied Cryptography in Computer and Communications. Cham: Springer Nature Switzerland, 2022.

Key words: Post-quantum cryptography, IP protocols and Cybersecurity

Principal Supervisor:	Dr Lei Pan
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Impact Theme	Building safe and secure communities
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
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Creative AI with generative models

Abstract: Artificial Intelligence (AI) has been widely applied in many research fields and become a core component for many smart applications. However, a well-known bottleneck of the current AI algorithms is the lack of data for training and validation of AI models. This project aims to address this issue by developing new methods, called creative AI, for generating images without collection and annotation. The project will develop generative models for data synthesis with a focus on image and video synthesis. Two case studies: scene decoration and video creation will be investigated. The project will promote the application of AI to solve complex and real-world problems with a potential for high-value commercial products.

References:

Ka Chun Shum, Hong-Wing Pang, Binh-Son Hua, Duc Thanh Nguyen, Sai-Kit Yeung. Conditional 360-degree Image Synthesis for Immersive Indoor Scene Decoration. IEEE Int. Conf. Computer Vision (ICCV) 2023

Hong-Wing Pang, Yingshu Chen, Binh-Son Hua, Duc Thanh Nguyen, Sai-Kit Yeung. Neural Scene Decoration from a Single Photograph. European Conf. Computer Vision (ECCV), 2022.

Key words: Image synthesis, Video synthesis and Generative models

Principal Supervisor:	Dr Duc Thanh Nguyen
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Impact Theme	Creating smarter technologies
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
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Automatic animal monitoring in the wild through Artificial Intelligence

Abstract: This project will advance the knowledge base of AI techniques in wildlife monitoring to tackle practical challenges. Specifically, the aims of the project include: (a) Developing an integrated AI-based framework for animal monitoring in natural habitat, that effectively and efficiently engages human experts with computer algorithms (b) Developing an efficient data annotation tool that supports automated assistive functionalities including smart data sampling for labelling and semi-automatic data labelling. Those assistive functionalities can help to leverage the scale of datasets, (c) Developing novel AI algorithms for animal monitoring from video data. These algorithms include semantic change detection (for identifying video segments containing semantic motion within video streams), animal screening from videos, and scalable hierarchical neural networks for animal detection and recognition.

References:

Thi Thu Thuy Nguyen, Anne Eichholtzer, Don Driscoll, Nathan Semianiw, Dean M Corva, Abbas Z Kozani, Thanh Thi Nguyen, Duc Thanh Nguyen. Sawit: A Small-Sized Animal Wild Image Dataset with Annotations. Media Tools and Applications, 2023

Key words: Artificial intelligence and Automatic wildlife monitoring

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Automatic 3D Scene Understanding

Abstract: This project addresses a challenging problem: whether the real-world of a scene can be automatically comprehended from a set of images captured at different viewpoints of that scene. Technically, the task includes reconstructing the three-dimensional (3D) model of a scene in the real-world system and reasoning what can be seen in the scene. The project aims to develop: (a) a high quality and real-time 3D reconstruction method (b) a semantic scene segmentation method (c) a 3D object recognition method (d) a 3D object and scene completion method. In the project, contemporary computational models and technologies in Computer Vision, Pattern Recognition, and Machine Learning such as real-time 3D reconstruction and deep learning will be advanced. The proposed techniques will be illustrated in a mobile-based automatic navigation application.

References:

Quang-Hieu Pham, Thanh Nguyen, Binh-Son Hua, Gemma Roig, Sai-Kit Yeung. Jsis3d: Joint semantic-instance segmentation of 3d point clouds with multi-task pointwise networks and multi-value conditional random fields. IEEE/CVF Conf. Computer Vision and Pattern Recognition (CVPR) 2019.

Key words: 3D scene understanding and 3D computer vision

Principal Supervisor:	Dr Duc Thanh Nguyen
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Impact Theme	Creating smarter technologies
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
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Automatic Detection of DeepFakes through Machine Learning and Computer Vision

Abstract: Face synthesis and deep learning techniques can be exploited for generating so-called deepfakes for malign purposes, such as impersonation of politicians, identity theft, and defamation by transferring a person's face onto others' bodies in pornographic images or videos. Therefore, effective deepfake detection techniques are in acute need. However, one major limitation of existing deepfake detection methods is that they are not future proof (i.e., unable to detect deepfakes created with new generative methods that are not encountered in the training phase of the detector. The proposed project is to investigate into the feasibility of incorporating transfer learning and continual learning into the new deepfake detection models that we have developed recently to enable the new deepfake detector to discern deepfakes created with generative methods that are not encountered in the initial training process.

References:

H. Wang, V. Sanchez, and C.-T. Li, "Age-Oriented Face Synthesis with Conditional Discriminator Pool and Adversarial Triplet Loss," IEEE Transactions on Image Processing, vol. 30, pp. 5413 – 5425, 2021

H. Zhao, B. Liu, Y. Hu, J. Li, and C.-T. Li, "Hybrid Domain Meta-Learning Network for Face Forgery Detection and Localization in Deepfakes," International Joint Conference on Neural Networks (IJCNN), Gold Coast, Australia, 18-23 June 2023

S. Fung, X. Lu, C. Zhang and C.-T. Li, "DeepfakeUCL: Deepfake Detection via Unsupervised Contrastive Learning," International Joint Conference on Neural Networks (IJCNN), Shenzhen, China, 18-22 July 2021

B. Yan, C.-T., and X. Lu, "Deepfake detection via joint unsupervised reconstruction and supervised classification. arXiv preprint arXiv:2211.13424, 2022.

L. Collins, C.-T. Li, B. Yan, Y. Hu, X. Lu, and Y. Zhu, "ElasticWeight Consolidation and Transfer Learning: A New Paradigm for Deepfake Detection, " submitted to IEEE/CVF Winter Conference on Applications of Computer Vision (WACV), Waikolao, Hawaii, USA, Jan 2024

Key words: Deepfakes, Deepfake detection, Multimedia forensics and security and Misinformation

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Impact Theme	Building safe and secure communities
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Continual Machine Learning with Limited and Dynamic Data

Abstract: A acute challenge in machine learning is for the model to learn tasks in dynamic environments wherein the underlying data characteristics changes over time. This issue is often known as concept drift. When deployed in dynamic or congested environments wherein the characteristics of new data and tasks differ significantly from the ones involved in its initial training phase, a machine learning model often performs poorly due to the concept drift issue. A natural response to this issue is to allow the models to improve themselves through continual learning of the new tasks based on the new data. However, after incrementally learning a few new tasks based on limited new streaming data, a rigid machine learning model initially trained by optimising an objective function is prone to a catastrophic forgetting of the previously acquired knowledge. This is often due to the fact that the optimality of the objective function of the training set may differ significantly from the optimality of the limited new streaming data. This project is intended to develop an effective continual learning method that is able to update itself incrementally based on the streaming data.

References:

S. Lin, C.-T. Li and A. Kot, "Multi-Domain Adversarial Feature Generalization for Person Re-Identification", IEEE Transactions on Image Processing, vol. 30, pp. 1596-1607, 2021

G. I. Webb, L. K. Lee, F. Petitjean and B. Goethals, "Understanding Concept Drift," Apr. 2017, arXiv:1704.00362 [Online].

M. De Lange et al., "A Continual Learning Survey: Defying Forgetting in Classification Tasks," in IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 44, no. 7, pp. 3366-3385, 1 July 2022

G. Yang et al., "Continual Attentive Fusion for Incremental Learning in Semantic Segmentation," in IEEE Transactions on Multimedia, 2023

V. K. Verma, K. Liang, N. Mehta and L. Carin, "Meta-learned attribute self-gating for continual generalized zero-shot learning," Feb. 2021. [Online].

Key words: Deep learning, Continual learning, Concept drift and Catastrophic forgetting

Principal Supervisor:	Prof Chang-Tsun Li
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Impact Theme	Creating smarter technologies
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
Scholarship	Applicants will need to complete an Expression of Interest and if successful apply for a Deakin University Postgraduate Research Scholarship
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A Deep Learning Based Mechanism to Combat Emerging Cyber-Threats in IoT's

Abstract: The Internet of Things (IoT) is a field of technology that enables the interconnection of numerous assets. Multiple protocols are used for communication across the many networks and networking devices that comprise the Internet of Things. Despite its many benefits, IoT devices are vulnerable to a wide range of attacks that can lead to stolen data and financial losses due to their diverse and widespread connectivity. The heterogeneous character of the problem exacerbates the inability to settle on a single security solution. As a result, inadequate security could endanger both the individual devices and the system as a whole. Due to their dynamic nature, IoT devices are vulnerable to a wide variety of security threats, including DoS attacks, DDoS attacks, and other malicious software. This scientific study proposes a DL-driven hybrid framework to detect intrusion in the IoT ecosystem. This approach can be used in SDN-based, fog-based, and Edge-based scenarios in IoT infrastructure. We will also apply advanced techniques such as Federated Learning and Explainable AI. We will consider the publicly available start-of-the-art datasets such as N-BaIoT and CICDDoS. We will use standard evaluation metrics such as Accuracy, Precision, Recall, F1-Score, FPR, FNR, FDR, FOR, TPR, TNR, and MCC. Furthermore, we will compare our proposed framework with the most recent approaches used in the literature. Finally, we will apply the 10-fold cross-validation to prove that our results are unbiased.

References:

Thakkar and R. Lohiya, "Fusion of statistical importance for feature selection in Deep Neural Network-based Intrusion Detection System," Information Fusion, vol. 90, pp. 353-363, February 2023

Javeed, Danish, et al. "A Hybrid Deep Learning-Driven SDN Enabled Mechanism for Secure Communication in Internet of Things (IoT)." Sensors vol. 21, no. 14, 2021

A. S. Dina, A. B. Siddique, D. Manivannan, "A deep learning approach for intrusion detection in Internet of Things using focal loss function," Internet of Things, vo. 22, July 2023

Z. Wang, X. Xie, L. Chen, S. Song, and Z. Wang, "Intrusion Detection and Network Information Security Based on Deep Learning Algorithm in Urban Rail Transit Management System," IEEE Transactions on Intelligent Transportation Systems, vol. 24, no. 2, February 2023

Y. Kongsorot, P. Musikawan, P. Aimtongkham, and I. You, "An Intrusion Detection and Identification System for Internet of Things Networks Using a Hybrid Ensemble Deep Learning Framework," IEEE Transactions on Sustainable Computing, August 2023

Key words: Intrusion Detection, Internet of Things, Cyber Security, Deep Learning, SDN and Federated Learning

Principal Supervisor:	Prof Chang-Tsun Li
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Impact Theme	Building safe and secure communities
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Scholarship	Applicants will need to complete an Expression of Interest and if successful apply for a Deakin University Postgraduate Research Scholarship

Mining Massive Trajectory Data

Abstract: 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.

References:

Sousa, R. S. D., Boukerche, A., & Loureiro, A. A. (2020). Vehicle trajectory similarity: models, methods, and applications. ACM Computing Surveys (CSUR), 53(5), 1-32.

Key words: Trajectory analysis, Pattern recognition and Big data

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Time Series Anomaly Detection

Abstract: 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.

References:

Cook, A. A., Mısırlı, G., & Fan, Z. (2019). Anomaly detection for IoT time-series data: A survey. IEEE Internet of Things Journal, 7(7), 6481-6494.

Key words: Time series and Anomaly detection

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Impact Theme	Creating smarter technologies
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Identification of Malware Behaviour

Abstract: Malware can cause enormous loss and adverse effects in any computing device., Iits analysis and detection are an important research topic in cybersecurity as malware keeps evolving. Existing malware detection methods are signature-based and unreliable against new malicious codes. This project aims to propose an adaptive data-driven algorithm based on frequent pattern and association rule mining to detect various kinds of malware. The proposed algorithm will generate insights into malware behaviour and provide potential defence strategies.

References:

Muzaffar, A., Hassen, H. R., Lones, M. A., & Zantout, H. (2022). An in-depth review of machine learning based android malware detection. Computers & Security, 102833.

Key words: Malware detection and Cybersecurity

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Exploring Human-Centric Software with Generative AI: Balancing Opportunities and Risks

Abstract: This project aims to cultivate a future where software is designed to be more human-centric, trustworthy, and socially responsible. Our focus is on aligning software with human needs, as we delve into the potential benefits and risks that generative AI brings to the next wave of software development. Building on a track record of world-class research led by experts in Computing and Sociopsychology, our project has two primary objectives: 1. To investigate the impact of generative AI on human values and emotions within software systems. 2. To develop a framework that utilizes generative AI to create software that incorporates human values and emotional considerations.

We are seeking passionate candidates who are interested in:

• Contributing to a future where software prioritizes human values and emotions.

• Conducting groundbreaking research in collaboration between Computing and Sociopsychology experts.

• Sharing findings through high-quality publications and conference presentations.

• Creating tools to help software practitioners integrate human values and emotions into their software development processes.

References:

Davoud Mougouei, Harsha Perera, Waqar Hussain, Rifat Shams, and Jon Whittle. 2018. Operationalizing Human Values in Software: A Research Roadmap. In Proceedings of the 2018 26th ACM Joint Meeting on European Software Engineering Conference and Symposium on the Foundations of Software Engineering - ESEC/FSE 2018. 780–784.

Davoud Mougouei. 2020. Engineering Human Values in Software through Value Programming. Proceedings of the IEEE/ACM 42nd International Conference on Software Engineering Workshops (2020), 133–136.

Harsha Perera, Waqar Hussain, Jon Whittle, Arif Nurwidyantoro, Davoud Mougouei, Rifat Ara Shams, and Gillian Oliver. 2020. A Study on the Prevalence of Human Values in Software Engineering Publications, 2015 – 2018. In Proceedings of the ACM/IEEE 42nd International Conference on Software Engineering (Seoul, South Korea) (ICSE '20). Association for Computing Machinery, New York, NY, USA, 409–420.

Key words: Software, Artificial Intelligence, Human Values, Emotions and Generative AI

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Hierarchical federated learning framework for safe and secure connected and autonomous vehicles

Abstract: This proposal aims at constructing a hierarchical federated learning for safe and secure connected and autonomous vehicles (CAVs). The constructed framework will combine elements of AI/ML (e.g., FL aggregation mechanisms), connectivity (e.g., 5G/6G optimised scheduling and resource allocation) and computation (e.g., device/fog/edge/cloud computing) to support significant use cases in the automotive industry.

References:

A Makkar, U Ghosh, DB Rawat, JH Abawajy, FedLearnSP: preserving privacy and security using federated learning and edge computing, IEEE Consumer Electronics Magazine 11 (2), 21-27, 2021.

Z Zhou, J Abawajy, M Shojafar, M Chowdhury, DEHM: an improved differential evolution algorithm using hierarchical multistrategy in a cybertwin 6G network, IEEE Transactions on Industrial Informatics 18 (7), 4944-4953, 2022.

M Shojafar, M Mukherjee, V Piuri, J Abawajy, Security and privacy of federated learning solutions for industrial IoT applications, IEEE transactions on industrial informatics 18 (5), 3519-3521, 2021.

Z Zhou, M Shojafar, J Abawajy, H Yin, H Lu, ECMS: An edge intelligent energy efficient model in mobile edge computing, IEEE Transactions on Green Communications and Networking 6 (1), 238-247, 2021.

Z Zhou, M Shojafar, J Abawajy, AK Bashir, IADE: An improved differential evolution algorithm to preserve sustainability in a 6G network, IEEE Transactions on Green Communications and Networking 5 (4), 1747-1760, 2021.

Key words: Cybersecurity, Federated Learning, Privacy Preserving, Scheduling and Resource Allocation.

Principal Supervisor:	Prof Jemal Abawajy
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Impact Theme	Building safe and secure communities
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
Scholarship	Applicants will need to complete an Expression of Interest and if successful apply for a Deakin University Postgraduate Research Scholarship
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Authentication Mechanism with Quantum Attacks Resilience

Abstract: The project aims to develop new lightweight quantum-proof authentication mechanism IoVT systems for applications with a high level of security such as smart healthcare and public safety. The new method will be able to resist to quantum attacks and be able to provide security features such as perfect forward secrecy and no key escrow problem.

References:

Hayo Baan, Sauvik Bhattacharya, Scott Fluhrer, Oscar Garcia-Morchon, Thijs Laarhoven, Ronald Rietman, Markku-Juhani O Saarinen, Ludo Tolhuizen, and Zhenfei Zhang. 2019. Round5: Compact and fast post-quantum public-key encryption. In International Conference on Post-Quantum Cryptography. Springer, 83–102.

Daniel J Bernstein and Tanja Lange. 2017. Post-quantum cryptography. Nature 549, 7671 (2017), 188–194.

Key words: Authentication, Quantum Attacks, Quantum-Proof, IoVT systems and Cybersecurity

Principal Supervisor:	Prof Jemal Abawajy
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Impact Theme	Building safe and secure communities
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
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Creating Robust and Scalable Internet of Things Technologies

Abstract: The Internet of Things (IoT) is rapidly growing, with the prospect of billions of Internet-connected devices providing ubiquitous services in the next few years. IoT technology can enable efficient transport, advanced healthcare, smart-home management, 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 project is to improve the development of IoT applications using Software Engineering principles. There are many aspects of developing IoT applications that can benefit from further academic research, the use of software engineering and the application of advanced techniques from other areas. There are a lot of challenges to improve the robustness and scalability of IoT applications, including: 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 wide area networks for IoT applications, Software Defined Networking (SDN) Adaptation for IoT Networks, and Integration of IoT with Cloud and Edge infrastructure.

References:

Mineraud, J., Mazhelis, O., Su, X., & Tarkoma, S. (2016). A gap analysis of Internet-of-Things platforms. Computer Communications, 89, 5-16, https://www.sciencedirect.com/science/article/pii/S0140366416300731 Olorunnife K, Lee K, Kua J. Automatic Failure Recovery for Container-Based IoT Edge Applications. Electronics. 2021; 10(23):3047. Link

Key words: Internet of Things, Platforms, Scalability, Robustness and Smart

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Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
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Creating Smart Technologies for Energy Efficient living and working

Abstract: There is increasing pressure on people to reduce their energy consumption due to increasing energy costs and environmental impact concerns. Energy is consumed in almost any aspect of how people live, work, travel and interact with each other. To tackle this problem, people need to understand how much energy they are consuming, what that usage is for (e.g. heating a house, running home appliances, lighting an office space), and what ways they can use to reduce their energy use. To effectively reduce energy consumption requires the monitoring of device consumption in the home, collection of this data, correlation with household activities and analysis to determine optimal settings and schedules for devices and appliances. Smart technologies offer the ability to monitor energy usage live and adjust appliance energy consumption, balancing this with energy production from solar panels. This project aims to create smart technologies to give people the tools to make decisions about their energy impact and create automation technologies to enable smart energy usage. The project will use the latest AI, data analytics, and machine learning techniques to analyse energy consumption and production patterns, identify inefficiencies, and subsequently offer recommendations to improve energy usage in the future.

References:

Zhou, K., & Yang, S. (2016). Understanding household energy consumption behavior: The contribution of energy big data analytics. Renewable and Sustainable Energy Reviews, 56, 810-819. Link

J. Hu and A. V. Vasilakos, "Energy Big Data Analytics and Security: Challenges and Opportunities," in IEEE Transactions on Smart Grid, vol. 7, no. 5, pp. 2423-2436, Sept. 2016. https://doi.org/10.1109/TSG.2016.2563461Link

Hossein Motlagh N, Mohammadrezaei M, Hunt J, Zakeri B. Internet of Things (IoT) and the Energy Sector. Energies. 2020; 13(2):494. Link

Key words: Smart energy, Internet of Things and Energy efficiency

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Heterogeneous Multi-Robot Coordination

Abstract: In today's rapidly evolving technological landscape, robots are increasingly being deployed in diverse applications, ranging from disaster response and environmental monitoring to industrial automation and healthcare. A significant advancement in robotics is the use of heterogeneous multi-robot systems, where robots with varying capabilities and characteristics collaborate to accomplish complex tasks. The motivation for this project is to improve the coordination capabilities of heterogeneous robot teams using strategies that capitalize on diverse strengths of the robots. Coordinating robots with varying mobility, sensing, and manipulation abilities poses multifaceted challenges. For example, a scenario involving multiple drones, land and sea robots, all coordinating to search for and rescue victims in a coastal forest fire. Efficiently allocating tasks requires innovative strategies that leverage each robot's strengths while optimizing overall performance. Addressing risks associated with collision avoidance, resource constraints, and environmental hazards is crucial to ensure safe and effective operations. Adapting coordination strategies and decision-making processes in real time, especially in response to unexpected obstacles, demands robust adaptive behaviours.

References:

Liu, C., Zhao, J. and Sun, N., 2022. A review of collaborative air-ground robots research. Journal of Intelligent & Robotic Systems, 106(3), p.60. Kiener, J. and Von Stryk, O., 2010. Towards cooperation of heterogeneous, autonomous robots: A case study of humanoid and wheeled robots. Robotics and Autonomous Systems, 58(7), pp.921-929.

Rizk, Y., Awad, M. and Tunstel, E.W., 2019. Cooperative heterogeneous multi-robot systems: A survey. ACM Computing Surveys (CSUR), 52(2), pp.1-31. Halder, S. and Afsari, K., 2023. Robots in inspection and monitoring of buildings and infrastructure: A systematic review. Applied Sciences, 13(4), p.2304.

Verma, J.K. and Ranga, V., 2021. Multi-robot coordination analysis, taxonomy, challenges and future scope. Journal of intelligent & robotic systems, 102, pp.1-36.

Key words: Robotics, Multi-robot, Coordination, Collaboration and Heterogenous robot teams

Principal Supervisor:	A/Prof. Kevin Lee
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Exploring Emerging Technologies for Encouraging Healthy Eating Practices among Kindergarten Children

Abstract: This project aims to explore the role of emerging technologies in enhancing the kindergarten education on healthy eating. While the goal of kindergarten program in Australia is to support literacy and overall development of 3-5-year-old children, it limits in introducing the concepts of healthy eating. Practising healthy eating from childhood is essential as studies suggest that eating habits formed during childhood are likely to track until adulthood, and that it also reduces a child's chances of developing diseases like obesity, bowel cancer and heart diseases at later stage in life. Some of the topics under healthy eating practices include: 1. What to eat: categorisation of food under different food groups (e.g., dairy, carbohydrates, meat and lentils, grains, and fruits); Eating balanced diet 2. Why to eat healthy: to feel energetic, have proper bowel movements, and proper sleep 3. When to eat: understanding the hunger-satiety cues (i.e., when to eat and when to stop), and following recommended portion sizes for different food categories. The project explores the amalgamation of design, play and technology to raise a physically independent and healthy future generation by creating awareness on different aspects of healthy eating.

References:

Rohit Ashok Khot, Jason Ng, and Deepti Aggarwal. 2022. Crafting Tangible Interfaces for Human Digestion: Unpacking the Research through Design Prototyping Journey. In Sixteenth International Conference on Tangible, Embedded, and Embodied Interaction (TEI '22). Association for Computing Machinery, New York, NY, USA, Article 28, 1–15. Link

Rohit Ashok Khot, Deepti Aggarwal, Jung-Ying (Lois) Yi, and Daniel Prohasky. 2021. Guardian of the Snacks: Toward Designing a Companion for Mindful Snacking. Proc. Multimodality & Society 1, no. 2 (June 2021): 153–73.

Deepti Aggarwal, Thuong Hoang, Bernd Ploderer, Frank Vetere, Rohit Ashok Khot and Mark Bradford. 2020. Lessons Learnt from Designing a Smart Clothing Telehealth System for Hospital Use. In 32nd Australian Conference on Human-Computer Interaction (OzCHI '20). Association for Computing Machinery, New York, NY, USA, 355–367.

Key words: Emerging Technologies, Internet of Things, Healthy Eating Practices, Early Childhood Education and Hybrid games

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Impact Theme	Improving health and wellbeing
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Quantum sensing using squeezed states

Abstract: Quantum sensing with squeezed light is an innovative technique in quantum optics and metrology that enhances measurement precision beyond classical limits [3,4] by leveraging the unique properties of quantum light, specifically squeezed states. Quantum sensors can achieve high sensitivity and precision, enabling precise measurements of diverse things including time, acceleration, and gravity. These advancements have potential applications in geophysical exploration, navigation, and fundamental physics research. Quantum sensors can surpass classical sensor limitations imposed by the Heisenberg uncertainty principle, enabling novel sensing and metrology approaches. Additionally, quantum communications can network quantum sensors to further improve their sensitivity and reveal more information using quantum entanglement and superposition principles. Squeezed states, have shown potential for augmenting the sensitivity of atomic interferometers, and enhancing the detection of weak magnetic fields in optical magnetometry. Achieving higher levels of squeezing is therefore of significant importance for advancing quantum sensing capabilities.

References:

R. R. Joseph, L. E. Rosales-Zárate and P. D. Drummond, Phase space methods for Majorana fermions. J Phys A 51, 245302 (2018).

F.-X. Sun, Q. He, Q. Gong, R. Y. Teh, M. D. Reid, and P. D. Drummond, Physical Review A 100, 033827 (2019).

Lawrie, B.; Pooser, R.; Maksymovych, P. Squeezing Noise in Microscopy with Quantum Light. Trends Chem. 2020, 2, 683–686

Purdy, T. Bright squeezed light reduces back-action. Nat. Photonics 2020, 14, 1–2.

Joseph, R. R., van Rhijn, J., & Drummond, P. D. (2023). Midpoint projection algorithm for stochastic differential equations on manifolds. Physical Review E, 107(5), 055307

Key words: Quantum squeezed states, Quantum Phase space methods and Quantum sensing

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5G and Beyond Network Infrastructure Security

Abstract: The future networks (5G and 6G) are becoming extremely heterogeneous, especially with the skyrocketed growth of Internet of Things (IoT) technology. This heterogeneity critically impacts the effective utilization of complex network infrastructure management which eventually impacts the quality of service (QoS) of application and the security of the network resources. The aim of the project is a) to understand the concept extreme heterogeneity in future networks and b) to analyse how this heterogeneity impacts the QoS and security? Based on this understanding in future networks context, a scheme will be proposed to alleviate the heterogeneity in order to meet the end-to-end delay requirement of application and to enhance the network infrastructure security.

References:

Sood, K., Karmakar, K.K., Varadharajen, V., Kumar, N., Xiang, Y. and Yu, S., 2021. Plug-in over plug-in evaluation in heterogeneous 5G enabled networks and beyond. IEEE Network, 35(2), pp.34-39.

Nguyen, D.D.N., Sood, K., Xiang, Y., Gao, L., Chi, L. and Yu, S., 2023. Towards IoT Node Authentication Mechanism in Next Generation Networks. IEEE Internet of Things Journal.

Key words: Network security, 5G telecom security, Intrusion detection systems and Deep learning

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Investigating a Feasible Solution to Protecting User and Data Privacy in New Networking Paradigms

Abstract: Millions of users are connecting to networks but there is no thought about data retention policies. The technology has been designed in such a way that a common man has no door to escape. Eventually the user identity and user data privacy get compromised. Unfortunately, Australia does not have a good regulation to defend this situation and hence industries are wildly rolling the boll to run businesses. In this project, we aim to investigate a novel cross-border solution to mitigate this critical issue. A novel solution will be proposed and evaluated.

References:

Brunotte, W., Specht, A., Chazette, L. and Schneider, K., 2023. Privacy explanations–A means to end-user trust. Journal of Systems and Software, 195, p.111545.

Fainmesser, I.P., Galeotti, A. and Momot, R., 2023. Digital privacy. Management Science, 69(6), pp.3157-3173.

Key words: Data and user privacy, Privacy regulation and Privacy protocol

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Investigating a Novel Approach to Design a Robust Intrusion Detection System

Abstract: In state-of-the-art works, recently K. Sood et. al [1] proposed deep learning based effective architecture for intrusion detection in 5G networks. By reducing the traffic feature vectors the authors have reduced the model training time eventually the model is effective in real-time decision making. There are certain limitations of the work done by [1]. Firstly, the authors have not analysed how feature extraction in real-world (time series data) will affect the performance of the IDS. Secondly, it is with the high probability possible that the IDS may not get enough samples for decision making [2]. In both cases, it is important to strengthen the IDS ability so that even with the smaller number of samples and in the presence of ongoing attack the model's performance should not be compromised [1], [3]. The candidate, in his PhD study, aims to bridge the limitations of the existing work proposed by [1]. The overall aim is to investigate an approach to design autonomous IDS with accurate decision-making ability even in the presence of less or compromised samples. Few-shot leaning or ensemble approaches may be borrowed and evaluated on top of which a novel approach will be proposed.

References:

Sood, K., Nosouhi, M.R., Nguyen, D.D.N., Jiang, F., Chowdhury, M. and Doss, R., 2023. Intrusion detection scheme with dimensionality reduction in next generation networks. IEEE Transactions on Information Forensics and Security, 18, pp.965-979.

Sood, K., Nosouhi, M.R., Kumar, N., Gaddam, A., Feng, B. and Yu, S., 2021. Accurate detection of IoT sensor behaviors in legitimate, faulty and compromised scenarios. IEEE Transactions on Dependable and Secure Computing.

Liu, X., Wang, A., Xu, B., Zheng, K. and Yao, X., 2022. Robustness-Based Transmission Strategy for Wireless-Powered Communication Networks. Wireless Communications and Mobile Computing, 2022.

Key words: Intrusion detection system, Deep learning, Cyber security, Network security and Telecom security

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Automatic Model Parameter Tuning for Resource-limited IoT Devices

Abstract: Deep architectures are typically trained by minimizing a non-convex loss function through underlying optimization algorithms, e.g., stochastic gradient descent or its variants [1]. It takes a fairly large amount of time to find the best-suited optimization algorithm and its optimal hyperparameters (e.g., learning rate, batch size, and local epoch) for training a model to the desired accuracy [2]. It is a major challenge for academicians and industry practitioners alike, especially in the case of training models in resource limited IoT devices [3]. It has been widely demonstrated that hyperparameters often need to be dynamically adjusted as the training progresses, irrespective of the initial choice of configuration [4]. If not adjusted dynamically, the training might get stuck in a bad minimum, and no amount of training time can recover it [5]. Considering the unique features of IoT scenarios, we aim to develop an IoT-related framework that automatically fine-tunes model hyperparameters in real time, adapting to the dynamic IoT environment while conserving energy, memory, and processing power. Our proposed solution will empower various IoT applications, e.g., predictive maintenance, anomaly detection, and environmental monitoring, and support IoT devices to continually enhance their performance without human intervention, thereby maximizing efficiency and accuracy for model training.

References:

[1] Ding, Q., Kang, Y., Liu, Y., Lee, T., Hsieh, C. and Sharpnack, J. (2022) 'Syndicated bandits: a framework for auto tuning hyper-parameters in contextual bandit algorithms', 36th Conference on Neural Information Processing Systems (NeurIPS 2022), 35, pp.1170-1181.

[2] Baydin, A., Cornish, R., Rubio, D., Schmidt, M. and Wood, F. (2018) 'Online learning rate adaptation with hypergradient descent', International Conference on Learning Representations (ICLR), 2018.

[3] Ro, Y. and Choi, J. (2021) 'Autolr: layer-wise pruning and auto-tuning of learning rates in fine-tuning of deep networks', 25th AAAI Conference on Artificial Intelligence (AAAI-21), 35(3), pp. 2486-2494.

[4] He, F., Liu, T. and Tao, D. (2019) 'Control batch size and learning rate to generalize well: Theoretical and empirical evidence', 33rd Conference on Neural Information Processing Systems (NeurIPS 2019), 32, pp. 1143-1152.

[5] Li, Z., Lyu, K. and Arora, S. (2020) 'Reconciling modern deep learning with traditional optimization analyses: The intrinsic learning rate', 34th Conference on Neural Information Processing Systems (NeurIPS 2020), 33, pp.14544-14555.

Key words: Machine Learning, Internet of Things, Fine Tuning and Parameter Optimization

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Data Integrity Verification in Heterogeneous Edge Environments

Abstract: Edge computing, a burgeoning research area, motivates App vendors to cache data replicas on geographically distributed edge servers to deliver better services [1]. This benefit also incurs more data integrity audit overhead on App vendors, which calls for more efficient edge data integrity (EDI) verification approaches [2]. However, existing EDI solutions totally rely on an implicit resource homogeneity assumption-edge servers have identical resource availability throughout EDI inspection execution in each round-but it rarely holds in reality [3][4]. The edge servers with insufficient computation and/or communication capacity greatly limit overall EDI verification efficiency from a round perspective [5]. Thus, our research delves into developing novel EDI verification techniques to address the unique challenges posed by heterogeneous edge environments, including resource constraints, network volatility, and security vulnerabilities. By leveraging cutting-edge cryptographic techniques, distributed ledger technologies, and machine learning algorithms, we aim to devise robust and efficient mechanisms for detecting tampering, data corruption, and unauthorized modifications. The output of our work can benefit various domains, e.g., smart transportation, smart healthcare, smart cities, and beyond. Ultimately, our research seeks to establish a solid foundation for safeguarding the integrity of data at the edge, enhancing the trustworthiness and reliability of emerging edge computing paradigms.

References:

[1] Mei, Q., Xiong, H., Chen, Y. and Chen, C. (2022) 'Blockchain-enabled privacy-preserving authentication mechanism for transportation cps with cloud-edge computing', IEEE Transactions on Engineering Management (Early Access).

[2] Tong, W., Chen, W., Jiang, B., Xu, F., Li, Q. and Zhong, S. (2022) 'Privacy-preserving data integrity verification for secure mobile edge storage', IEEE Transactions on Mobile Computing, 22(9), pp. 5463-5478.

[3] Li, B., He, Q., Chen, F., Dai, H., Jin, H., Xiang, Y. and Yang, Y. (2021) 'Cooperative assurance of cache data integrity for mobile edge computing', IEEE Transactions on Information Forensics and Security, 16, pp.4648-4662.

[4] Cui G., He Q., Li B., Xia X., Chen F., Jin H., Xiang Y., Yang Y. (2021) 'Efficient verification of edge data integrity in edge computing environment', IEEE Transactions on Services Computing, 15(6), pp. 3233-44.

[5] Zhao, Y., Qu, Y., Xiang, Y., Shi, C., Chen, F. and Gao, L. (2023) 'Long-term over one-off: heterogeneity-oriented dynamic verification assignment for edge data integrity', IEEE Transactions on Mobile Computing (Early Access).

Key words: Data Integrity, Edge Computing, Security, Heterogeneous Environment and Corruption Detection

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Development of Defence Mechanisms against Attacks in Federated Learning

Abstract: Federated Learning (FL) has gained prominence in decentralized machine learning systems [1] [2], but it is susceptible to various attacks such as adversarial, data poisoning, and model inversion attacks [3]-[5]. This project aims to develop robust defence mechanisms against these attacks, enhancing the security and reliability of FL systems. The project will focus on the design and evaluation of novel techniques to detect, mitigate, and recover from attacks while preserving data privacy. The key objectives include: (1) identifying and classifying attacks during the FL process, leveraging anomaly detection and adversarial robustness techniques, (2) designing strategies to mitigate the impact of detected attacks, including retraining affected models and updating global aggregation methods, (3) implementing differential privacy mechanisms to safeguard sensitive data shared by clients during FL iterations, and (4) enhancing model robustness through advanced regularization and optimization techniques. This project will contribute to the advancement of robust FL techniques, addressing security vulnerabilities and ensuring the reliability of collaborative machine learning across distributed devices.

References:

[1] McMahan, H. B. et al. (2017). 'Communication-Efficient Learning of Deep Networks from Decentralized Data', Proceedings of the 20th International Conference on Artificial Intelligence and Statistics (AISTATS) 2017, Fort Lauderdale, Florida, USA.

[2] Bonawitz, K. et al. (2019). 'Towards federated learning at scale: System design.' Proceedings of the 2nd ACM SIGOPS/EuroSys European Conference on Computer Systems, New York, USA.

[3] Bagdasaryan, E. et al. (2020). 'How to backdoor federated learning', Proceedings of the Twenty Third International Conference on Artificial Intelligence and Statistics, PMLR 108:2938-2948, 2020.

[4] Pillutla K. et al (2022). 'Robust Aggregation for Federated Learning', IEEE Transactions on Signal Processing, 70: 1142-1154.

[5] Melis L. et al. (2019). 'Exploiting Unintended Feature Leakage in Collaborative Learning', IEEE Symposium on Security and Privacy (SP), San Francisco, CA, USA.

Key words: Federated Learning, Network security, Privacy protection and Decentralised system

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Reducing the adverse effect caused by distortions on image processing using AI

Abstract: In the contemporary era of technological advancements, the significance of images, such as earth observation images [1], brain Magnetic Resonance Images (MRI) [2], and Photoacoustic imaging [3], cannot be overstated. However, these images often suffer from distortions and artifacts, undermining their usability and potential impact across diverse applications. This research proposal aims to address this critical issue by delving into the various distortions prevalent in different application domains, assessing their implications, and subsequently introducing a pioneering AI-based methodology to detect and rectify performance degradation caused by distortions and adversarial attacks in image processing. The primary goal of this research endeavour is to develop a novel AI-driven approach that can effectively identify and mitigate distortions, enhancing the usability and reliability of images. This proposed approach will amalgamate cutting-edge deep learning techniques [4], such as Deep Convolutional Neural Networks (CNN) and Artificial Neural Networks (ANN), and culminate in the creation of an innovative hybrid mechanism. Through this approach, we intend to revolutionize the realm of image processing, improving the quality and applicability of images in various domains. Through the successful execution of this project, we anticipate a remarkable and lasting impact across multifarious domains.

References:

[1] A. Mallet and M. Datcu, "Rate Distortion Based Detection of Artifacts in Earth Observation Images," in IEEE Geoscience and Remote Sensing Letters, vol. 5, no. 3, pp. 354-358, July 2008

[2] I. Fantini, L. Rittner, C. Yasuda and R. Lotufo, "Automatic detection of motion artifacts on MRI using Deep CNN," 2018 International Workshop on Pattern Recognition in Neuroimaging (PRNI), Singapore, 2018, pp. 1-4

[3] D. Allman, A. Reiter and M. A. L. Bell, "Photoacoustic Source Detection and Reflection Artifact Removal Enabled by Deep Learning," in IEEE Transactions on Medical Imaging, vol. 37, no. 6, pp. 1464-1477, June 2018

[4] D. Allman, A. Reiter and M. A. L. Bell, "Photoacoustic Source Detection and Reflection Artifact Removal Enabled by Deep Learning," in IEEE Transactions on Medical Imaging, vol. 37, no. 6, pp. 1464-1477,

Key words: Image processing, Image distortions and Magnetic Resonance Images

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Developing a Robust Security Framework for Smart Contract Applications Using Deep Learning Techniques

Abstract: Industries such as finance and healthcare are increasingly intrigued by the potential of blockchain and smart contracts to revolutionize their operations. The distributed ledger technology offered by blockchain aligns well with sectors that prioritize trust [1]. Self-executing smart contracts eliminates the need for intermediaries and as a result cost overheads are removed [2]. Functioning on blockchain networks, they enable dependable and decentralized transactions [3]. Bitcoin, a decentralized digital currency functioning on a peer-to-peer network, can be integrated with smart contracts using technologies like Atomic Swaps [4]. Given their immutability and value, ensuring the security of smart contracts is paramount. A critical challenge involves detecting vulnerabilities in the code, prompting researchers to develop preventive techniques. Furthermore, security is reinforced by advancements in deep and machine learning [5]. The objective of this PhD project is to introduce a resilient security framework designed for blockchain-driven smart contract applications, employing deep learning-based techniques. Accordingly, we intend to fuse the merits of each approach to achieve a thorough evaluation of the smart contract code, while also aligning with established industry norms and optimal methodologies.

References:

[1] I. Natgunanathan, P. Praitheeshan, L. Gao, Y. Xiang, and L. Pan, "Blockchain-Based Audio Watermarking Technique for Multimedia Copyright Protection in Distribution Networks," in ACM Trans. Multimedia Comput. Commun. Appl., vol. 18, no. 3, Mar. 2022.

[2] D. Macrinici, C. Cartofeanu, and S. Gao, "Smart contract applications within blockchain technology: A systematic mapping study," Telemat. Informatics, vol. 35, no. 8, pp. 2337–2354, Dec. 2018

[3] P. Kayal and P. Rohilla, "Bitcoin in the economics and finance literature: a survey," SN Bus. Econ., vol. 1, no. 7, p. 88, Jun. 2021,

[4] G. Caldarelli, "Wrapping Trust for Interoperability: A Preliminary Study of Wrapped Tokens," Information, vol. 13, no. 1, p. 6, Dec. 2021

[5] V. Patel, L. Pan, and S. Rajasegarar, "Graph deep learning based anomaly detection in ethereum blockchain network," in Proc. 14th Int. conf. on network and system security, Nov. 2020, pp. 132–148.

Key words: Security, Deep Learning, Blockchain, Smart Contract and Machine learning

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Privacy-Preserving Federated Learning for Intrusion Detection in IoT Networks

Abstract: This project aims to enhance privacy-preserving intrusion detection by leveraging federated learning in IoT networks. The objective is to develop a distributed and collaborative learning framework that enables IoT devices to collectively learn intrusion detection models without compromising sensitive data. By aggregating local model updates instead of sharing raw data, this approach ensures privacy preservation while improving the accuracy and robustness of intrusion detection systems in IoT environments. The project will explore techniques such as differential privacy, secure aggregation, and cryptographic protocols to address privacy concerns in federated learning for intrusion detection.

References:

A Alazab, A Khraisat, S Singh, T Jan, M Alazab - Electronics, 2023

Key words: Federated Learning Intrusion Detection IoT Networks security threats Machine learning

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Deep learning techniques for Intrusion detection system (IDS)

Abstract: Deep learning techniques, which are a type of machine learning that involves training artificial neural networks on large amounts of data, can be used to improve the accuracy and effectiveness of intrusion detection systems (IDS). One-way deep learning can be applied to IDS is by using it to analyse network traffic and identify patterns and anomalies that may indicate a security threat. This can be done using deep learning algorithms to analyse the content of network packets, as well as the metadata associated with the packets, such as the source and destination addresses and port numbers. However, implementing and maintaining an effective IDS can be challenging, and there are several problems and challenges that need to be addressed to ensure the system is effective. Some of the key challenges and problems in intrusion detection systems include:

• False positives: IDSs can generate false positives, which are alerts for activity that is not actually malicious. This can lead to a high volume of false alarms, which can be costly and time-consuming to investigate.

• False negatives: IDSs can also generate false negatives, which are cases where malicious activity is not detected. This can result in security breaches going undetected, potentially causing considerable damage.

• Evolving threats: Cyber threats are constantly evolving, and it can be difficult for an IDS to keep up with new types of attacks. As a result, IDSs need to be regularly updated with new detection signatures and rules to remain effective.

• Scalability: As networks and systems grow, it can be challenging for an IDS to scale and keep up with the increased volume of traffic and data.

References:

A Review on the Internet of Things (IoT) Forensics: Challenges, Techniques, and Evaluation of Digital Forensic Tools A Alazab, A Khraisat, S Singh - 2023

Key words: Federated Learning Intrusion Detection IoT Networks security threats Machine learning

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Privacy-Preserving Federated Learning for Intrusion Detection in IoT Ne

Abstract: This project aims to enhance privacy-preserving intrusion detection by leveraging federated learning in IoT networks. The objective is to develop a distributed and collaborative learning framework that enables IoT devices to collectively learn intrusion detection models without compromising sensitive data. By aggregating local model updates instead of sharing raw data, this approach ensures privacy preservation while improving the accuracy and robustness of intrusion detection systems in IoT environments. The project will explore techniques such as differential privacy, secure aggregation, and cryptographic protocols to address privacy concerns in federated learning for intrusion detection.

References:

Enhancing Privacy-Preserving Intrusion Detection through Federated Learning A Alazab, A Khraisat, S Singh, T Jan, M Alazab - Electronics, 2023

Key words: Federated Learning, Intrusion Detection , IoT Networks security threats and Machine learning

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Using Reinforcement Learning Algorithm via Markov Decision Process to create a lightweighted reputation-based zero trust model

Abstract: The zero-trust framework have become a promising approach to address the vulnerability that exists in traditional perimeter-based network security and has fast become an emerging trend in addressing the challenges in modern network security. The key to zero-trust security Is to establish trust of each entity in the network, and the trust can be used to enforce different policies for dense and network access (Ge & Zhu, 2022.) Trust evaluation and trust-based policy are what comprise zero-trust security models and there are various challenges that arise in designing zero-trust security models which includes limited observations of the agent's footprint and asymmetric Information that results in uncertainties in decision-making and the footprints of agents are usually observed through system alerts and monitoring Information (Ge & Zhu, 2022.) Since zero trust Is an access control approach that removes the assumption of trust based on past decisions and ensures that trust is established every time at the point of decision-making (Shore et al., 2021) it is pertinent to have a metric to ascertain the trustworthiness of any agent on the network. According to (Imran et al., 2020.), existing trust mechanisms tend to be restricted to a single network, whereas most users are typically involved in multiple heterogeneous network, and basing trust decisions on multiple heterogeneous networks has the advantage that the trust values are based upon diversified information that can accurately reflect a user's behaviour. This useful idea confirms why heterogeneous sources of information are required for a more useful trust score. Recent research works have explored the Implementation of zero trust security for managing trust in collaborative Intrusion detection systems, trust-based virtualization architecture etc. (Ge & Zhu, 2022.) Despite these implementations, most of the works relied on evaluating the trust of a user based on a predefined risk assessment using homogenous data and have neglected the importance of computing trust for managing access request for heterogenous source data, and the need to design a policy that can be adaptive to different network environments. Based on the current problems identified through literature review, this work will explore the use of machine learning to calculate trust scores from heterogenous sources and apply access control policies. Furthermore, the work aims to develop a light-weighted trust evaluation engine that can be deployed closer to the edge devices.

References:

Xiao, S. et al. (2022) "SOK: Context and risk aware access control for zero trust systems," Security and Communication Networks, 2022, pp. 1–20. Link

Campbell, M. (2020) "Beyond zero trust: Trust is a vulnerability," Computer, 53(10), pp. 110–113. Link

Manan, A. et al. (2022) "Extending 5G services with Zero trust security pillars: A modular approach," 2022 IEEE/ACS 19th International Conference on Computer Systems and Applications (AICCSA). Link

Key words: Zero Trust Architectures, Cybersecurity, Policy Enforment Point and Acess control

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Blockchain-enabled data marketplace

Abstract: This project explores how blockchains enable transparent and incentive-compatible data marketplace. The limitations of current marketplace include privacy (of data and computation running on the data), data discovery, and payment. The Blockchains offers transparency in data usage and payment, and it can serves as platform for efficient data discovery. The challenge is to leverage blockchains while maintaining privacy and reducing performance overhead. One potential approach is off chain computation with trusted hardware. Another approach is to rely on zero knowledge proof systems, which ensures high security at the cost of performance.

References:

Javen Kennedy, Pranav Subramaniam, Sainyam Galhotra, Raul Castro Fernandez. Revisiting Online Data Markets in 2022 - A Seller and Buyer Perspective. SIGMOD Record 2022.

Key words: Blockchain, Privacy-Preserving data analytics and Data marketplace

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Enhancing blockchain fairness

Abstract: Decentralized finance is overtaking cryptocurrency as the killer application of blockchain, with its total locked value in billions of USD. The transparency of blockchain enable a new kind of attacks, namely Maximal Extract Value attacks (MEVs). Such attacks undermine fairness, in the sense that some transactions are deliberately excluded or delayed [2]. This project explores solutions that all the layers of the blockchain stack to enable fair transaction processing in blockchain. The challenges include a rigorous definition of fairness in the blockchain context, and designing a solution with small overhead.

References:

Lioba Heimbach, Roger Wattenhofer. SoK: Preventing Transaction Reordering Manipulations in Decentralized Finance. AFT 2022.

Key words: Blockchains, Fairness and Privacy

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Transparent data process systems

Abstract: A transparency log stores data in a hash chain, and it is maintained by multiple parties belonging to different trust domain. They enable new kinds of applications in which integrity violation is publicly detectable. Examples include certificate transparency, and blockchain. Early works have looked at domain-specific application [1] and a restricted set of computations [2]. This project aims to explore new applications of transparency logs that entail complex data process logic and require protection of data privacy. The early focus will be on federated machine learning systems.

References:

[1] Daniël Reijsbergen, Yeng Zhang, Augn Maw, Tien Tuan Anh Dinh, Jianying Zhou. Towards transparent pricing with privacy. ESORICS 2021.

[2] Daniel Reijsbergen, Aung Maw, Zheng Yang, Tien Tuan Anh Dinh, Jianying Zhou. TAP: transparent and privacy-presrving data services. USENIX Security 2023

Key words: Data analytics, Federated machine learning, blockchain and Security

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Strategic Research and Innovation Centre	Centre for Cyber Resilience and Trust
Course	S913 Doctor of Philosophy (Information Technology)
Campus	Melbourne Burwood
Impact Theme	Building safe and secure communities
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
Scholarship	Applicants will need to complete an Expression of Interest and if successful apply for a Deakin University Postgraduate Research Scholarship
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Algorithms for Generalised Convexity

Abstract: The aim of this project is to develop algorithms for nonconvex (and nonsmoothed) optimisation. Several approaches to generalising convexity exist and provide a strong theoretical framework for the development of numerical methods. In this project you will work with these theoretical tools to generalise convex optimisation algorithms to the nonconvex settings. In particular we will focus on quasiconvexity, and on abstract convexity (Rubinov, 2000), and will aim to apply our algorithms to several problems, ranging from artificial intelligence and machine learning to approximation theory (Diaz Millan et al., 2023).

References:

Díaz Millán, R, Sukhorukova, N and Ugon, J. (2023) "Application and issues in abstract convexity". Communications in Optimization Theory. arXiv: 2202.09959v1; Rubinov, A. (2000) 'Abstract Convexity and Global Optimization'. Springer US.

Key words: Optimisation, Convexity, Abstract convexity, Quasiconvexity and Pseudoconvexityt

Principal Supervisor:	A/Prof. Julien Ugon
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School	School of Information Technology
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	S813 Master of Science (Information Technology)
Campus	Melbourne Burwood
Impact Theme	Creating smarter technologies
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
Scholarship	Applicants will need to complete an Expression of Interest and if successful apply for a Deakin University Postgraduate Research Scholarship
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Data-Centric Privacy Issues in IoT-Empowered Smart Home Environments: A Comprehensive Study and Mitigation Framework

Abstract: The rapid proliferation of Internet of Things (IoT)-empowered smart home devices has introduced unparalleled convenience and control into our daily lives. However, this convenience comes at the cost of significant privacy concerns, as these interconnected devices continuously collect and transmit massive amounts of personal data to a variety of third parties and clouds (e.g., system management, service provider, manufacturer). This research proposes a comprehensive study to investigate data-centric privacy issues in smart home environments. By employing a mixed-methods approach, including data analysis, surveys, interviews, and experiments, we will identify the types and magnitude of data collected by various IoT devices and assess the data usage practices of smart home companies. The study will explore user perceptions of privacy in smart homes, potential manipulations, and threats to personal privacy. Based on the findings, a privacy preservation framework will be developed to empower users in making informed decisions about their data and regain control over their privacy in IoT-enabled smart homes. Meanwhile, we will develop technologies to validate the framework.

References:

Hany F. (2020), 'Iot security, privacy, safety and ethics', Digital twin tech- nologies and smart cities, pages 123–149

Key words: Smart home, Privacy, Cybersecurity and Data

Principal Supervisor:	Dr Jack Li
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Impact Theme	Building safe and secure communities
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
Scholarship	Applicants will need to complete an Expression of Interest and if successful apply for a Deakin University Postgraduate Research Scholarship
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Fostering Entrepreneurial Mindset in Higher Education: A Comprehensive Exploration of the Australian Startup Year Initiative

Abstract: This research proposal aims to investigate strategies for cultivating an entrepreneurial mindset among students participating in the Australian Government's Startup Year initiative. As the government commits to funding 2000 graduates to embark on entrepreneurial journeys, it becomes crucial to understand how higher education institutions can effectively prepare these students for success in the startup ecosystem. The study will employ a mixed-methods approach, combining qualitative interviews, surveys, and longitudinal case studies to gather insights from students, educators, entrepreneurs, and industry experts. The research will delve into the perceptions, experiences, and challenges faced by Startup Year participants as they transition from academia to entrepreneurship. By analyzing various pedagogical approaches, curriculum design, mentorship models, and support systems, the study aims to identify best practices that promote the development of key entrepreneurial competencies such as risk-taking, innovation, resilience, and opportunity recognition. The outcomes of this research will provide actionable recommendations for higher education institutions and policymakers to optimize the effectiveness of the Startup Year initiative. By understanding the factors that contribute to a successful entrepreneurial mindset development, this study seeks to enhance the program's impact on graduates' startup ventures and overall contributions to the Australian innovation landscape.

References:

Cui, J., Sun, J., & Bell, R. (2021). 'The impact of entrepreneurship education on the entrepreneurial mindset of college students in china: The mediating role of inspiration and the role of educational attributes'. The International Journal of management education, 19(1), 100296

Key words: IT entrepreneurship education, Mindset, Curriculum and Assessment

Principal Supervisor:	Dr Jack Li
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Course	S913 Doctor of Philosophy (Information Technology)
	S813 Master of Science (Information Technology)
Campus	Melbourne Burwood
Impact Theme	Advancing, society, culture and the economy
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
Scholarship	Applicants will need to complete an Expression of Interest and if successful apply for a Deakin University Postgraduate Research Scholarship
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Enhancing Protective Privacy in E-Safety: Safeguarding Your Smart Home Environment in the IoT Ecosystem

Abstract: The proposed PhD project seeks to address the critical challenges of protective privacy in the realm of e-safety, with a specific focus on safeguarding users' smart home environments in the IoT ecosystem. The research aims to explore and analyze the evolving landscape of digital threats, including potential privacy breaches, data leaks, and unauthorized access to smart home devices. The study will conduct a comprehensive analysis of existing e-safety frameworks, policies, and technologies, identifying their limitations and gaps concerning the unique context of smart homes. Innovative and proactive strategies will be developed, incorporating user authentication methods, content filtering algorithms, and effective reporting mechanisms tailored to the smart home environment. The ultimate goal is to contribute to the creation of robust and effective protective privacy measures, ensuring the safety and security of individuals in their digital interactions within the smart home ecosystem.

References:

Farsi, M., Daneshkhah, A., Hosseinian-Far, A. and Jahankhani, H. eds., (2020). 'IoT security, privacy, safety and ethics', Digital twin technologies and smart cities, Berlin/Heidelberg, Germany: Springer.

Key words: Smart home, Data leak and User authentication

Principal Supervisor:	Dr Jack Li
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School	School of Information Technology
Strategic Research and Innovation Centre	Centre for Cyber Resilience and Trust
Course	S913 Doctor of Philosophy (Information Technology)
Campus	Melbourne Burwood
Impact Theme	Building safe and secure communities
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
Scholarship	Applicants will need to complete an Expression of Interest and if successful apply for a Deakin University Postgraduate Research Scholarship
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Android Ransomware Detection System with Federated Multimodal Deep Learning

Abstract: Ransomware is neither a virus nor worm. It is a unique class of malware of its own. Ransomware had rampaged the cyber world since 2013. Since it has been so successful that it has spread to android operating system. This is due to the fact that there are more users than any other operating system and most of the android users do not have antivirus installed in their mobile phone. The traditional android ransomware detection system relies on signatures and fails to detect new and evolving variants. This project aims to develop an innovative Android malware detection system using federated multimodal deep learning techniques. Android ransomware features such as Opcode, API, String, and permission, diverse aspects of applications will be analyzed and used. Our design specifically focuses on the distinctive characteristics of ransomware, utilizing a multimodal deep learning architecture to fuse multiple information sources. We will also take advantage of technique such as federated learning to ensure other malware detection in other android OS will receive the update via peer-to-peer model. This approach ensures adaptability and learning capabilities for new ransomware variants, enhancing effectiveness in detecting evolving techniques and evasion strategies. Our proposed solution actively identifies and mitigates ransomware threats, significantly bolstering the security of Android devices and also help to keep other android devices in the network protected.

References:

T. Kim, B. Kang, M. Rho, S. Sezer and E. G. Im, "A Multimodal Deep Learning Method for Android Malware Detection Using Various Features," in IEEE Transactions on Information Forensics and Security, vol. 14, no. 3, pp. 773-788, March 2019. Link

Key words: Ransomware, Early detection and Federated Multimodal Deep Learning

Principal Supervisor:	Dr Luxing Yang
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School	School of Information Technology
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Campus	Melbourne Burwood
Impact Theme	Building safe and secure communities
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
Scholarship	Applicants will need to complete an Expression of Interest and if successful apply for a Deakin University Postgraduate Research Scholarship
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Industrial Internet of Things Security and Privacy

Abstract: The Industrial Internet of Things (IIoT), including cloud and edge computing and cyber-physical systems, has initiated a profound digital disruption for our critical infrastructure systems, including transport, manufacturing, gas and oil, energy, water, healthcare, and critical mission military systems. These industries that use IIoT solutions have complex infrastructures, interconnecting many devices, sensors, smart meters, industrial robots, and communication software, rendering them vulnerable targets for cyber attackers. This highlights the critical significance of system security and data privacy. Students have a broad scope to select a topic within this field. Some areas of current research activity include: Privacy-preserving techniques using Artificial intelligence for IIoT, Cyber physical and edge computing systems. Vulnerability analysis of MQTT, QMQTT, COAP, Websocket, and OPC-UA. Security for IIoT devices and networks, including 5G and satellite. Threat attribution and intelligence for IIoT systems Resilient generative machine learning and/or quantum machine learning in automatic security and privacy solutions

References:

AL-Hawawreh Muna, Moustafa Nour, and Sitnikova Elena. "Identification of malicious activities in industrial internet of things based on deep learning models." Journal of information security and applications 41 (2018): 1-11.

Al-Hawawreh, Muna, Frank Den Hartog, and Elena Sitnikova. "Targeted ransomware: A new cyber threat to edge system of brownfield industrial Internet of Things." IEEE Internet of Things Journal 6.4 (2019): 7137-7151.

Al-Hawawreh, Muna, Elena Sitnikova, and Neda Aboutorab. "X-IIoTID: A connectivity-agnostic and device-agnostic intrusion data set for industrial Internet of Things." IEEE Internet of Things Journal 9.5 (2021): 3962-3977.

Al-Hawawreh, Muna, Nour Moustafa, and Jill Slay. "A threat intelligence framework for protecting smart satellite-based healthcare networks." Neural Computing and Applications (2021): 1-21.

Al-Hawawreh, Muna, and M. Shamim Hossain. "A privacy-aware framework for detecting cyber-attacks on internet of medical things systems using data fusion and quantum deep learning." Information Fusion (2023): 101889.

Key words: Industrial Internet of Things (IIoT), Critical infrastructure, Security, Privacy and Artificial Intelligence

Principal Supervisor:	Dr Muna Al-Hawawreh
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Campus	Geelong Waurn Ponds
Impact Theme	Building safe and secure communities
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
Scholarship	Applicants will need to complete an Expression of Interest and if successful apply for a Deakin University Postgraduate Research Scholarship

Building a Circular Economy in Australia's Electronics Industry: From E-Waste Disassembly to Sustainable Supply Chain Strategies

Abstract: Electronic waste is a significant environmental problem in the 21st century. We aim to optimize e-waste disassembly line balancing to ensure safe and efficient disassembly. Disassembly of e-waste is complex due to the variety of products, hazardous materials, uncertainty of tasks, and component value. The project will utilize advanced optimization techniques, such as mixed-integer linear programming models and AI-based metaheuristics, to balance e-waste disassembly lines. Our workstation assignments will optimise the disassembly of electronic devices and the removal of hazardous components. Using a successful model of e-waste disassembly line balancing, this project will extend research into electronic device supply chains and production. This extension examines electronic device lifecycle analysis to understand the necessity of holistic environmental sustainability. The model incorporates insights from e-waste disassembly line balance to develop an optimised supply chain model. We will adapt optimisation techniques for inventory management, transportation logistics, and supplier selection in the previous model. By examining the entire lifecycle of electronic devices and addressing their environmental impact at each stage, the extension of the project intends to reduce e-waste and promote sustainable electronics. The findings of this project will benefit electronics manufacturers, supply chain managers, policy makers, and environmental organizations.

References:

Mete, S., Çil, Z. A., Ağpak, K., Özceylan, E., & Dolgui, A. (2016). A solution approach based on beam search algorithm for disassembly line balancing problem. Journal of Manufacturing Systems, 41, 188-200.

Diri Kenger, Z., Koç, Ç., & Özceylan, E. (2020). Integrated disassembly line balancing and routing problem. International Journal of Production Research, 58(23), 7250-7268.

Key words: Disassembly line balancing, Supply chain, Mixed-integer linear programming models and Metaheuristics

Principal Supervisor:	Dr Atabak Elmi
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Campus	Melbourne Burwood
Impact Theme	Enabling a sustainable world
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
Scholarship	Applicants will need to complete an Expression of Interest and if successful apply for a Deakin University Postgraduate Research Scholarship
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Scheduling Problem in Distributed Job Shop Manufacturing Systems Considering Energy Consumption and Carbon Emission: An Australian Context

Abstract: Decentralization and Industry 5.0 have pushed Distributed Manufacturing Systems (DMS) to relevance. In Australia, environmental sustainability and energy efficiency are paramount. This research develops comprehensive mathematical models and metaheuristic algorithms to address these challenges. Optimising schedules, reducing carbon emissions, and improving energy efficiency will be our focus. Objectives: Analysis and understanding of Australian DMS planning and scheduling, Development of mathematical models that incorporate energy consumption and carbon emissions, Design of metaheuristic algorithms to solve the proposed mathematical models. As part of the project, we will review literature and existing datasets on DMS, energy consumption, and carbon emissions. To address energy and emissions gaps, mathematical models will be developed. Metaheuristic algorithms will then be developed to solve the proposed models. In the final phase, real-world data from Australian industries will be used to validate these algorithms against existing methods and benchmark problems. A set of robust mathematical models and metaheuristic algorithms will optimize scheduling in DMS based on energy consumption and carbon emissions. Australian manufacturing will benefit greatly from the research, both theoretically and practically. Industry can transition to more sustainable and efficient operations, and policy makers can formulate regulations that promote sustainability.

References:

Avci, M., Avci, M. G., & Hamzadayı, A. (2022). A branch-and-cut approach for the distributed no-wait flowshop scheduling problem. Computers & Operations Research, 148, 106009. Distributed assembly permutation flow shop problem; Single seekers society algorithm.

Elmi, A., Solimanpur, M., Topaloglu, S., & Elmi, A. (2011). A simulated annealing algorithm for the job shop cell scheduling problem with intercellular moves and reentrant parts. Computers & industrial engineering, 61(1), 171-178.

Elmi, A., Thiruvady, D. R., & Ernst, A. T. (2022). Blocking Cyclic Job-Shop Scheduling Problems. Algorithms, 15(10), 375.

Key words: Distributed Manufacturing Systems, Job Shop Scheduling, Optimisation and Metaheuristics

Principal Supervisor:	Dr Atabak Elmi
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Impact Theme	Enabling a sustainable world
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
Scholarship	Applicants will need to complete an Expression of Interest and if successful apply for a Deakin University Postgraduate Research Scholarship
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Enhancing education through smart technologies

Abstract: At Deakin, the School of Information Technology is pioneering new approaches to assessment and ways of supporting student learning. This project will join an active team who are working on building smart technologies to support student learning using frequent formative feedback, outcomes-based assessment, and delayed summative grading. This project will work on integrating artificial intelligence into software platforms to enhance student learning by providing personalised, timely and specific support on high cognitive tasks. Using a mixed-method approach, the project will look to evaluate the impact of planned innovations through application in real-world contexts. Results from this will include new approaches to integrating artificial intelligence within educational tools, and a better understanding of the impacts of these on staff, students, and other education stakeholders. There are currently opportunities for multiple separate, but related, projects in this area.

References:

Law CY, Grundy J, Baggo KV, Cain A, Vasa R (2023) "Case study of designing and evaluating an independent open learner model tool", Higher Education Pedagogies, 8(1)

Renzella J, Cain A, Schneider J (2022) "Verifying student identity in oral assessments with deep speaker", Computers and Education: Artificial Intelligence, Volume 3 Cain A, Grundy J, Woodward CJ (2017) "Focusing on learning through constructive alignment with task-oriented portfolio assessment", European Journal of Engineering Education, 43(4), pp. 569-584.

Key words: Artificial intelligence, Education, Assessment and Feedback

Principal Supervisor:	A/Prof. Andrew Cain
Associate Supervisor:	A/Prof. Julien Ugon, Dr Chathu Ranaweera and A/Prof. Simon James
School	School of Information Technology
Course	S913 Doctor of Philosophy (Information Technology)
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Campus	Melbourne Burwood
Impact Theme	Creating smarter technologies
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
Scholarship	Applicants will need to complete an Expression of Interest and if successful apply for a Deakin University Postgraduate Research Scholarship
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New thinking for 6G era: Convergence of Communication, Computation, and Intelligence

Abstract: Telecommunication technologies are rapidly evolving to enhance the way we live, work, and interact with our surroundings. The current 5G technology marked a significant transition towards facilitating data intensive application while interconnecting the Internet of Things (IoT) and industrial automation frameworks. These advancements are not sufficient to support the exponential growth in a wider range of smart applications and services. Sixth Generation (6G) mobile technology is now being researched and developed to support a range of emerging applications including telesurgeries, extended reality, and autonomous vehicles that require extremely high bandwidth, ultra-low latency, and high reliability. In the 6G era, there will be a convergence of the digital, physical, and human realms with the prediction of supporting 500 billion connected devices by 2023. Artificial Intelligence(AI), software defined architectures, robust computation capabilities will be combined with communication technologies to the targeted key performance indicators of 6G. Rather than treating each of these processes and technologies independently which is the case in the current 5G technology, unified frameworks that bring the synergies of these entities will be required to support high bandwidth, ultra-low latency and high reliable communication in 6G in the most scalable, cost-effective and energy efficient manner. This project aims to create new architectures, frameworks, and resource allocation mechanisms to support super converged 6G networks. The project will use optimization techniques, AI and machine learning techniques to develop the frameworks using a variety of simulation tools. Real network data will be collected and used to validate the proposals.

References:

X. Tang et al., "Computing power network: The architecture of convergence of computing and networking towards 6G requirement," in China Communications, vol. 18, no. 2, pp. 175-185, Feb. 2021,Link.

Zhou, Yiqing, et al. "Service-aware 6G: An intelligent and open network based on the convergence of communication, computing and caching." Digital Communications and Networks 6.3 (2020): 253-260.

Key words: 6G, communications, Optimisation, Artificial Intelligence and Machine Learning

Principal Supervisor:	Dr Chathu Ranaweera
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Campus	Melbourne Burwood
Impact Theme	Creating smarter technologies
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
Scholarship	Applicants will need to complete an Expression of Interest and if successful apply for a Deakin University Postgraduate Research Scholarship
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Energy Efficient Computing and Communications: Fueling a Sustainable Future

Abstract: With hundreds and thousands of diverse networked devices such as computers, autonomous cars, and Internet of Things devices being connected to the Internet every day, the energy demand of these digital systems, including both networking and computing, is accelerating rapidly. The energy cost (computing and communications) of systems that support a wide range of next generation services and applications, is becoming a significant contributor to global energy consumption and greenhouse gas emissions. Energy-efficient solutions are crucial to mitigate the environmental impact and reduce the carbon footprint associated with these technologies and services provided. The challenge is that different services use a range of diverse communication and computation technologies such as WiFi, 5G, optical networks, cloud computing, and edge computing. The energy efficient approach implemented in one domain can impact the performance of critical applications. This project aims to develop innovative approaches for energy-efficient communication and computation that will lead to advancements in hardware design, software optimization, and system architectures, fostering energy efficiency in various sectors without compromising the performance. The project outcomes will help information and communication technology sectors to become more conscious of sustainability and environmental concerns and adapt energy efficient approaches that will help build a sustainable future.

References:

Ale, Laha, et al. "Delay-aware and energy-efficient computation offloading in mobile-edge computing using deep reinforcement learning." IEEE Transactions on Cognitive Communications and Networking 7.3 (2021): 881-892.

R. Fereira, C. Ranaweera, K. Lee, and J.-G. Schneider, "Energy efficient node selection in edge-fog-cloud layered iot architecture," Sensors, vol. 23, no. 13, 2023.

M. Warade, K. Lee, C. Ranaweera and J. -G. Schneider, "Optimising workflow execution for energy consumption and performance," 2023 IEEE/ACM 7th International Workshop on Green and Sustainable Software (GREENS), Melbourne, Australia, 2023, pp. 24-29, Link.

Key words: Communications, Computing, Energy and Sustainability

Principal Supervisor:	Dr Chathu Ranaweera
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Campus	Melbourne Burwood
Impact Theme	Creating smarter technologies
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
Scholarship	Applicants will need to complete an Expression of Interest and if successful apply for a Deakin University Postgraduate Research Scholarship
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Paving the Way for Future Wireless Networks: The Vital Role of Optical Communication Technologies

Abstract: The sixth-generation wireless technology (6G), which is the next giant leap in the evolution of wireless communication has already been gaining enormous interests from academia, industry, and public due to its capabilities and services. Optical transport networks which connect wireless network data with the core network (rest of the world) is becoming increasingly important as a key element of 6G ecosystem due to the increasing demand for high data rates and low latency of new 6G applications and use cases. Optical networks can facilitate reliable, secure and low-latency communication. However, optical and wireless technologies operate in different domains and with different standards. Integration of optical transport networks and 6G needs careful consideration with emphasis on bringing network intelligence and softwarization to meet the requirements of the future. This project will investigate 1) how network virtualization can be enabled for efficient sharing of resources across the optical-wireless converged networks to enhance flexibility and agility of the network; 2) how machine learning and optimization techniques can be used to understand the underlaying converged network architectures and optimally allocate resources to achieve sub millisecond latency and high reliability for diverse applications.

References:

C. Ranaweera et al., "Design and deployment of optical x-haul for 5G, 6G, and beyond: progress and challenges [Invited]," in Journal of Optical Communications and Networking, vol. 15, no. 9, pp. D56-D66, September 2023, Link

C. Ranaweera, J. Kua, I. Dias, E. Wong, C. Lim and A. Nirmalathas, "4G to 6G: disruptions and drivers for optical access [Invited]," in Journal of Optical Communications and Networking, vol. 14, no. 2, pp. A143-A153, February 2022, Link

Key words: Optical networking, 6G, Machine learning, Optimization and Network virtualization

Principal Supervisor:	Dr Chathu Ranaweera
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	S813 Master of Science (Information Technology)
Campus	Melbourne Burwood
Impact Theme	Creating smarter technologies
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
Scholarship	Applicants will need to complete an Expression of Interest and if successful apply for a Deakin University Postgraduate Research Scholarship
More information	Contact sebe-hdr-admissions@deakin.edu.au

Enhancing engagement through gamification and game-based learning platforms

Abstract: At Deakin, the School of Information Technology is pioneering new approaches to assessment and ways of supporting student learning. This project will join an active team who are working on building smart technologies to support student learning in computing. This project will explore methods for applying gamification and game-based learning in computing education and will develop and evaluate game-based learning tools for computing education, and gamification to support frequent formative feedback, outcomes-based assessment, and delayed summative grading. Using an iterative design-based research approach, this project will seek to develop prototypes and apply them in a real-world context to evaluate their impact on student engagement and learning. Results from this will include new methods and tools to engage students, and evaluations of these to better understanding of the impacts of these on staff, students, and other education stakeholders. There are currently opportunities for two spearate, but related, projects in this area.

References:

Bakhanova E, Garcia Marin J, Raffe W, Voinov A (2022) "Gamified process of conceptual model development with stakeholders", Proceedings of the International Environmental Modelling and Software Society Conference

Renzella J, Cummaudo A, Cain A, Grundy J, Meyers J (2018) "SplashKit: A development framework for motivating and engaging students in introductory programming", IEEE International Conference on Teaching, Assessment, and Learning for Engineering Education.

Meyers J, Cain A, Renzella J, Cummaudo A (2018) "A proposal for integrating gamification into task-oriented portfolio assessment", IEEE International Conference on Teaching, Assessment, and Learning for Engineering Education.

Cain A, Grundy J, Woodward CJ (2017) "Focusing on learning through constructive alignment with task-oriented portfolio assessment", European Journal of Engineering Education, 43(4), pp. 569-584.

Key words: Gamification, Education and Engagement

Principal Supervisor:	A/Prof. Andrew Cain
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Course	S913 Doctor of Philosophy (Information Technology)
	S813 Master of Science (Information Technology)
Campus	Melbourne Burwood
Impact Theme	Creating smarter technologies
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
Scholarship	Applicants will need to complete an Expression of Interest and if successful apply for a Deakin University Postgraduate Research Scholarship
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AI-driven tools for video game design and development

Abstract: The games industry is the largest entertainment industry in the world, with games being played by people of all ages, genders, and cultures. It is estimated that the industry will generate over AUD500 billion in global revenue in 2024 and has recently become an Australian federal priority. With such high market demand, there is a need for technological innovation to keep pace to augment the skills and knowledge of professional and aspiring game developers alike. By giving programmers, designers, and artists intelligent tools that accentuate their existing practices, teams can realise more ambitious projects in shorter development cycles and create more personalised and meaningful experiences for their player-bases. Projects will contribute to the rapidly evolving research field of artificial intelligence in games, including the application of machine learning and computational creativity techniques to areas such as design and development toolsets for game production pipelines, believable and engaging artificial agents within games, and personalised procedural content generation to tailor game content to individual players at run-time. Candidates in this area will work closely with the local Melbourne game development industry to undergo requirement elicitation and to iteratively co-design and methodically evaluate prototypes within the context of the growing Australian games industry.

References:

Brand, J. E., & Jervis, J. (2021). "Digital Australia 2022". Eveleigh, IGEA. Department of Foreign Affairs (2022), "Roadmap for recovery", Business Envoy, pp. 7.

Yannakakis, G. N., & Togelius, J. (2018) "Artificial intelligence and games", Vol. 2, New York: Springer.

Key words: Games, Machine learning, Human-computer interaction and Computer science

Principal Supervisor:	A/Prof. William Raffe
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Course	S913 Doctor of Philosophy (Information Technology)
	S813 Master of Science (Information Technology)
Campus	Melbourne Burwood
Impact Theme	Advancing, society, culture and the economy
Expression of Interest	Applicants are encouraged to contact the nominated principal supervisor to discuss project suitability and complete and Expression of Interest form
Scholarship	Applicants will need to complete an Expression of Interest and if successful apply for a Deakin University Postgraduate Research Scholarship
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Application domain explainability of Deep learning (DL) models

Abstract: The decision-making process of deep learning models are of black-box nature. Explainability approaches in computer vision often focus on highlighting interesting pixels or a region which might have played an important role in the model's decision-making. This essentially points "what" a model is looking into while making such a decision with no explanation "why" it is doing so. The later question is important in explaining how a model should work or look into the input space to grab features that makes sense. This may require twiking the model architecture, layers or related processes to guide a model what it should learn and use in decision-making which reflects a common understanding from corresponding domain knowledge.

References:

Habib A, Karmakar C, Yearwood J. Interpretability and optimisation of convolutional neural networks based on sinc-convolution. IEEE Journal of Biomedical and Health Informatics. 2022 Jun 24;27(4):1758- 69.

Key words: Deep-learning, Explainable AI, Black-box modelling, Model interpretability and Application domain interpretability

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Impact Theme	Creating smarter technologies
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Context aware framework for extracting non-linear biomarkers from physiological signals using wearable sensors in everyday settings

Abstract: Clinical adoption of wearable devices remains limited due to the lack of contextual adjustments for biomarkers extracted from these devices. Factors like physiological and non-physiological elements hinder the effective use of these biomarkers for clinical decisions. This project aims to investigate and create an innovative entropy-based biomarker extraction framework from wearable devices during daily life. The framework will account for physiological interactions and motion artifacts, showcasing its potential in continuous monitoring of chronic patients and elderly care, thus alleviating the strain on Australian hospitals.

References:

Udhayakumar, Radhagayathri K, Karmakar, Chandan & Palaniswami, Marimuthu 2018, 'Understanding irregularity characteristics of short-term HRV signals using sample entropy profile', IEEE Transactions on Biomedical Engineering, vol. 65, no. 11, pp. 2569–2579

Udhayakumar, Radhagayathri K, Karmakar, Chandan & Palaniswami, Marimuthu 2019, 'Multiscale entropy profiling to estimate complexity of heart rate dynamics', Physical Review E, vol. 100, no. 1, pp. 012405

Motin, Mohammod Abdul, Karmakar, Chandan Kumar & Palaniswami, Marimuthu 2019, 'PPG Derived Heart Rate Estimation During Intensive Physical Exercise', IEEE Access, vol. 7, pp. 56062–56069

Radhagayathri K. Udhayakumar, Chandan Karmakar & Marimuthu Palaniswami 2019, 'Cross Entropy Profiling to Test Pattern Synchrony in Short-Term Signals', 2019 41st Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), doi:10.1109/embc.2019.8857272, DP190101248 (2019-2020)

Chandan Karmakar, Radhagayathri Udhayakumar & Marimuthu Palaniswami 2020, 'Entropy Profiling: A Reduced—Parametric Measure of Kolmogorov—Sinai Entropy from Short-Term HRV Signal', Entropy, vol. 22, no. 12, pp. 1396, doi:10.3390/e22121396, DP190101248 (2019-2021)

Key words: K-S Entropy, Physiological Context, Non-physiological Context, Biomarker

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Physiological, contextual and behavioural data based models for monitoring physiological and pathophysiological conditions

Abstract: Integrating physiological, contextual, and behavioural data-driven models within healthcare represents a dynamic strategy that holds significant potential for enhancing monitoring and diagnosing physiological and pathophysiological conditions. The amalgamation of physiological measurements with contextual insights, including environmental factors and patient activities, facilitates a more comprehensive and precise grasp of an individual's health status. This comprehensive methodology enables the identification of subtle shifts in physiological parameters that could indicate the initiation of pathophysiological conditions. Moreover, the integration of behavioural data, spanning lifestyle preferences and habits, augments the depth of understanding regarding an individual's health trajectory. Analysing patterns and deviations in behaviour can serve as early indicators of potential health concerns, augmenting the predictive capacity and pre-emptive measures against adverse health events. Underscoring the multidimensional nature of health monitoring models that synergize physiological, contextual, and behavioural data, this approach heralds the potential for a revolutionary transformation of healthcare practices. By furnishing personalized, timely, and effective interventions, it has the capacity to elevate patient outcomes and alleviate the strain on healthcare systems. Ultimately, the integration of these data-driven models contributes to a refined understanding of health dynamics, fostering improved well-being and reduced healthcare burdens.

References:

A. Habib, M. Motin, T Penzel, M Palaniswami, J Yearwood and C. Karmakar, "Performance of a Convolutional Neural Network Derived from PPG Signal in Classifying Sleep Stages", IEEE Transactions on Biomedical Engineering, 2022.

S. Rani, S. Shelyag, C. Karmakar, Y. Zhu, R. Fossion, J. Ellis, SPA. Drummond, M. Angelova, "Differentiating acute from chronic insomnia with machine learning from actigraphy time series data", Frontiers in Network Physiology, 2022.

E. Keenan, C. Karmakar, F. Brownfoot and M. Palaniswami, "Personalized Anatomic Modeling for Noninvasive Fetal ECG: Methodology and Applications", IEEE Transactions on Instrumentation and Measurement, 2021.

M. Sapina, C. Karmakar, K. Kramaric, M. Kosmider, M. Garcin, D. Brdaric, K. Milas, and J. Yearwood, "Lempel-Ziv complexity of the pNNx statistics- an application to neonatal stress", Chaos, Solitons & Fractals, 2021.

Key words: Physiological signal, Biomarker, Contextual information, Pathophysiology and Monitoring

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Uncertainty Management in Internet of Things through Trust-Based Collaborative Systems

Abstract: The research aims to enhance risk management and decision-making in protective security and defence by implementing trust-based collaborative systems for Internet of Things (IoT) systems. In the face of uncertainties in evolving threats, such systems provide a framework for effectively mitigating risks and making informed decisions. By fostering trust among stakeholders and enabling trusted collaboration, these systems facilitate the sharing information, expertise, and resources. The research will explore various techniques and methodologies for establishing trust, analysing uncertainties (e.g., Epistemic and Aleatoric), and leveraging collaborative approaches to enhance the overall effectiveness of risk management and decision-making processes in protective security and defense for large-scale IoT systems.

References:

Ismail, S., Shah, K., Reza, H., Marsh, R., & Grant, E. (2021). Toward management of uncertainty in self-adaptive software systems: IoT case study. Computers, 10(3), 27.

Tissaoui, A., & Saidi, M. (2020). Uncertainty in IoT for smart healthcare: Challenges, and opportunities. In The Impact of Digital Technologies on Public Health in Developed and Developing Countries: 18th International Conference, ICOST 2020, Hammamet, Tunisia, June 24–26, 2020, Proceedings 18 (pp. 232-239). Springer International Publishing.

Cofta, P., Karatzas, K., & Orłowski, C. (2021). A conceptual model of measurement uncertainty in iot sensor networks. Sensors, 21(5), 1827.

Key words: Uncertainty Management, Internet of Things, Trust, Security and Privacy

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Impact Theme	Advancing, society, culture and the economy
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Design and Development of a Federated Zero Trust Architecture using Blockchain

Abstract: The prevalence of cloud computing services is undeniable, with virtually every organization utilizing them. Additionally, even if a company does not permit BYOD, employees often bring personal devices for communication. The shift towards remote work, especially post-pandemic, has blurred the distinction between trusted and external enterprise networks. This evolving landscape has led to a new cybersecurity paradigm called zero-trust architecture. This approach provides on the principle of constant verification rather than trust. This research aims to design and implement a zero-trust architecture using an innovative zero-trust algorithm. This algorithm will facilitate dynamic access control and continuous monitoring, aligning with the core principles of never trusting and continuously verifying.

References:

He, Y., Huang, D., Chen, L., Ni, Y., & Ma, X. (2022). A survey on zero trust architecture: Challenges and future trends. Wireless Communications and Mobile Computing, 2022.

Syed, N. F., Shah, S. W., Shaghaghi, A., Anwar, A., Baig, Z., & Doss, R. (2022). Zero trust architecture (zta): A comprehensive survey. IEEE Access, 10, 57143-57179.

Chen, B., Qiao, S., Zhao, J., Liu, D., Shi, X., Lyu, M., ... & Zhai, Y. (2020). A security awareness and protection system for 5G smart healthcare based on zero-trust architecture. IEEE Internet of Things Journal, 8(13), 10248-10263.

Key words: Federated Learning, Zero Trust Architecture, Blockchain, Security, Privacy and Trust

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Explainable Machine Learning for Securing Access Control in the Internet of Medical Things (IoMT)

Abstract: With the rapid growth in wireless sensing technologies, portable wearable devices, and the future Internet, there is a huge demand for Internet of Medical Things (IoMT) applications and services in our everyday life. However, one important issue in IoMT is the provision of security and privacy of the critical and non-critical information of users, devices, services, and applications at scale. This project is aimed to report on the design and development of emerging access control technologies for smart IoMT applications using an Intrusion Detection System (IDS) that can automatically analyze network data including network traffic and device logs to detect intrusions. However, the current automated IDSs are used as black boxes, and they do not provide any information about the reasons behind their predictions. It should be clear to cybersecurity experts which features of the network data have caused this intrusion. To address this gap and provide a better explanation of IDS decisions, this project aims to identify the state-of-the-art techniques to develop an explainable IDS. This research further calls for better designing the IoMT infrastructures, optimizing human engagement, and advocating intelligent access control solutions using blockchain based IDS in the broad context of IoMT to create a fertile ground for research and innovation.

References:

Qiu, J., Tian, Z., Du, C., Zuo, Q., Su, S., & Fang, B. (2020). A survey on access control in the age of internet of things. IEEE Internet of Things Journal, 7(6), 4682-4696.

Pal, S., Hitchens, M., Varadharajan, V., & Rabehaja, T. (2019). Policy-based access control for constrained healthcare resources in the context of the Internet of Things. Journal of Network and Computer Applications, 139, 57-74.,

Pal, S. (2021). Internet of Things and Access Control: Sensing, Monitoring and Controlling Access in IoT-Enabled Healthcare Systems (Vol. 37). Springer Nature.

Key words: Explainable Machine Learning, Access Control, Internet of Medical Things (IoMT), Security, Privacy and Trust

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Multi-label Learning with Context Awareness

Abstract: Object detection is the key component in multiple applications such as autonomous vehicles and surveillance. However, the logical relationships between objects and their actions are not always taken into account. This lack of semantic constraints results in contradictions in the prediction of multiple objects, for example, a model classifies a leaf image as tomato and it has scab disease, while scab disease does not appear in tomato (mostly in apple). In autonomous vehicles, we found that in many cases a deep learning model classifies a car's action as "running" while the traffic light is "red". In this project, we compare different methods to incorporate commonsense knowledge to improve the performance and the logical plausibility of multilabel prediction.

References:

Tran, S. (2023) 'Neurosymbolic Reasoning and Learning with Restricted Boltzmann Machines', the AAAI Conference on Artificial Intelligence 37 (5), 6558-6565.

Key words: Multi-label learning, Machine Learning and Knowledge Integration

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Context-Aware Federated Learning Framework for Smart Environments

Abstract: This project aims to address data ownership and privacy barriers that are limiting the widespread adoption of artificial intelligence technologies. This project expects to generate new knowledge in real-time decision making and knowledge transfer using innovative approaches to analyse data directly on users' mobile devices like smartphones without sending sensitive user data to the cloud. Expected outcomes include the development of a novel federated learning framework and a set of unique selection models and incentive techniques that will advance machine learning solutions. This should provide significant benefits, such as encouraging the development of novel smart applications in public health, transport, and community safety.

References:

Azadeh Ghari Neiat, Athman Bouguettaya, and Mohammed Bahutair. (2022), "A deep reinforcement learning approach for composing moving IoT services." IEEE Transactions on Services Computing 15, no. 5, pp 2538-2550.

Ngo, Thang, Dinh C. Nguyen, Pubudu N. Pathirana, Louise A. Corben, Martin B. Delatycki, Malcolm Horne, David J. Szmulewicz, and Melissa Roberts. (2022) "Federated deep learning for the diagnosis of cerebellar ataxia: Privacy preservation and auto-crafted feature extractor." IEEE Transactions on Neural Systems and Rehabilitation Engineering 30, pp. 803-811

Nguyen, Dinh C., Quoc-Viet Pham, Pubudu N. Pathirana, Ming Ding, Aruna Seneviratne, Zihuai Lin, Octavia Dobre, and Won-Joo Hwang. (2022) "Federated learning for smart healthcare: A survey." ACM Computing Surveys (CSUR) 55, no. 3, pp 1-37.

Key words: Federated Learning, Mobile Computing, Machine Learning, Data Privacy and IoT

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Optimal control modelling the dynamics of infectious diseases

Abstract: Controlling the spread of infection requires effective control strategies. Mathematical modeling, particularly optimal control techniques, provide a powerful tool for understanding disease dynamics and designing intervention strategies. This project will explore the application of optimal control methods in modeling the spread of infectious diseases.

References:

Evans, R.J. and Mammadov, M. (2015). Dynamics of Ebola epidemics in West Africa 2014, F1000 Research, Link

Evans, R.J. and Mammadov, M. (2015). Predicting and controlling the dynamics of infectious diseases. The 54th IEEE Conference on Decision and Control, Osaka, Japan, December 15-18, 2015.

Key words: Optimal control, Spread of infection and Mathematical modelling

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Projection algorithms for optimisation problems

Abstract: We will study projection methods in Optimisation, focusing our attention on possible relaxations of existing hypotheses in the literature, and developing new methods with inexact projections.

References:

Burachik, R. , Díaz Millán, R. (2020) 'A projection algorithm for non-monotone variational inequalities', Set-Valued and Variational Analysis, 28, pp.149–166.

Díaz Millán, R., Ferreira, O.P., Ugon, J. (2023) 'Approximate Douglas–Rachford algorithm for two-sets convex feasibility problems', Journal of Global Optimization, 86(3), pp. 621-636.

Key words: Inexact Projection, Variational inequalities and Optimisation

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Multipath TCP and AQM in FreeBSD: Analysis, Design and Implementation

Abstract: This research builds a foundation towards evaluating L4S (Low Latency Low Loss Scalable) by analysing and developing an experimental platform and implementing Deep Reinforcement Learning (DRL)-based MPTCP (DRL-MPTCP) and AQM (DRL-AQM) protocol stacks in FreeBSD for the Internet community. Having an independent and interoperable implementation is a major foundation for Internet Engineering Task Force's (IETF) recognition of new MPTCP and low delay AQM algorithms. This research implements DRL-MPTCP, schedulers and DRL-AQM (separate queuing) in FreeBSD and makes them publicly available as dynamically pluggable user and kernel modules for testing and experimentation by the wider community. Based on our implementation experience, we will present new insights and concise descriptions of DRL-MPTCP and low delay DRL-AQM in FreeBSD 13-RELEASE to assist other parallel initiatives for developing L4S-compatible protocol stacks. We will use data generated and collected from our live testbed to evaluate and test our DRL-MPTCP and DRL-AQM implementations. . We will identify several implementation-specific concerns that impact DRL-MPTCP's, schedulers and low delay AQM's behaviours and seek ways to extend for L4S experimentation in the wild.

References:

S. R. Pokhrel and A. Walid, "Learning to Harness Bandwidth with Multipath Congestion Control and Scheduling," in IEEE Transactions on Mobile Computing, 2021, Link

J. Kua, G. Armitage, P. Branch, J. But, "Adaptive Chunklets and AQM for Higher-Performance Content Streaming", ACM Transactions on Multimedia Computing, Communications, and Applications, vol. 15, no. 4, article 115, December 2019

S. R. Pokhrel, J. Choi and A. Walid, "Fair and Efficient Distributed Edge Learning With Hybrid Multipath TCP," in IEEE/ACM Transactions on Networking, vol. 31, no. 4, pp. 1582-1594, Aug. 2023, Link

Key words: Internet Congestion Control, Low Delay Communication and TCP Protocols

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Language Model Driven LMS for Personalised Teaching and Learning

Abstract: This research project aims to explore OpenAI model's advanced natural language processing capabilities to create an intelligent and interactive learning environment within LMS platforms. The prime goal is to create a more intuitive, interactive, and effective T/L for students, empowering them to succeed. Key Research Questions: How can LMS features be optimised to provide personalised, interactive, and effective support to T/L? How can user experience be optimised to ensure seamless and intuitive interactions, and what measures can be taken to address potential concerns or challenges related to privacy, data security, and AI-driven T/L? To what extent can the integration of models such as ChatGPT be adopted under the LMS? e.g. Limiting factors can be class sizes, levels of complexity, and technical and pedagogical considerations. We will focus on developing a holistic framework that seamlessly incorporates ChatGPT like models into LMS modules. The integration aims to enable dynamic conversations between learners and the AI model, offering personalised guidance, clarifications, and explanations on the course. The LMS APIs and T/L interfaces will have real-time interactions, ensuring that ChatGPT understands the context of the course materials and T/L deliverables with relevant insights to learners.

References:

FIRAT, Mehmet. "Integrating AI applications into learning management systems to enhance e-learning." Instructional Technology and Lifelong Learning 4.1 (2023): 1-14

Pokhrel, Shiva Raj, and Jinho Choi. "Federated learning with blockchain for autonomous vehicles: Analysis and design challenges." IEEE Transactions on Communications 68.8 (2020): 4734-4746.

Link

Key words: OpenAI, Learning Management System, personalised, interactive, and private Teaching and Learning and Federated Learning

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Enhancing Learning through Integration of Machine Learning and Generative AI: A Student-Centric Approach

Abstract: Modern educational paradigms are witnessing a transformational shift propelled by technological advancements. Learning Management Systems (LMS) play a pivotal role in facilitating remote and personalised learning experiences. The integration of Machine Learning (ML) and Generative Artificial Intelligence (Generative AI) within LMS holds promising potential to revolutionise pedagogical approaches. This research endeavour seeks to explore how the fusion of ML and Generative AI can elevate LMS functionalities to provide enhanced learning experiences, promoting student engagement, comprehension, and overall educational outcomes. Research Objectives: The overarching goal of this research is to investigate the synergy between Machine Learning and Generative AI within the context of Learning Management Systems. The specific objectives are as follows: i) Enhanced Personalisation ii) Content Generation and Adaptation iii) Real-time Feedback and Assessment

References:

Pokhrel, Shiva Raj, and Jinho Choi. "Federated learning with blockchain for autonomous vehicles: Analysis and design challenges." IEEE Transactions on Communications 68.8 (2020): 4734-4746.

Nanayakkara, Shanika I., Shiva Raj Pokhrel, and Gang Li. "Improving Federated Aggregation with Deep Unfolding Networks." arXiv preprint arXiv:2306.17362 (2023).

Key words: Student Cetric Learning and Generative AI

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

Abstract: The Transmission Control Protocol (TCP) has been the de facto transport protocol on the Internet for the past four decades. Despite many refinements over the years, its fundamental principles for reliable data transfer have remained essentially unchanged. In recent years, however, momentum has been building for a major rethink of TCP. This is reflected, for example, in Google's development of Quick UDP-based Internet Connections (QUIC) and Bottleneck Bandwidth and Round-trip Time (BBR), as well as new data networking and congestion control strategies. Recent work in transport protocols focused on IETF's recommendations for Low Latency, Low Loss, and Scalable Throughput (L4S) Internet Service Architecture [RFC9330] and Active Queue Management (AQM) [RFC7567]. It is critical to ensure that future Internet service architecture addresses the challenges posed by the emerging technologies, such as the Metaverse which requires immersive real-time streaming applications. This project will identify and characterise the communication and networking challenges for realising these applications. This project will also focus on the key enablers and implementation recommendations to achieve a ubiquitous, seamless and embodied access to the Metaverse, including leveraging cutting-edge next-generation communication solutions and the cloud-edge computation framework to deliver low-latency immersive interactions and experiences across the network.

References:

De Schepper, K., Bagnulo, M., & White, G. (2023). RFC 9330: Low Latency, Low Loss, and Scalable Throughput (L4S) Internet Service: Architecture.

Baker, F., & Fairhurst, G. (2015). RFC 7567: IETF recommendations regarding active queue management.

Xu, M., Ng, W. C., Lim, W. Y. B., Kang, J., Xiong, Z., Niyato, D., Yang, Q., Shen, X. & Miao, C. (2022). A full dive into realizing the edge-enabled metaverse: Visions, enabling technologies, and challenges" IEEE Communications Surveys & Tutorials, 25(1), pp. 656-700

Ning, H., Wang, H., Lin, Y., Wang, W., Dhelim, S., Farha, F., Ding, J. & Daneshmand, M. (2023). A Survey on the Metaverse: The State-of-the-Art, Technologies, Applications, and Challenges. IEEE Internet of Things Journal. 10 (16), pp. 14671-14688,

Ye, J., Leung, K. C., & Low, S. H. (2021). Combating bufferbloat in multi-bottleneck networks: Theory and algorithms. IEEE/ACM Transactions on Networking, 29(4), 1477-1493.

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

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Hybrid and Decomposition Optimisation Techniques to Multi-Component Bin Cutting and Packing Problems

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

References:

Iori, M.; de Lima, V. L.; Martello, S.; Miyazawa, F. K.; and Monaci, M. 2021. Exact solution techniques for two-dimensional cutting and packing. European Journal of Operational Research, 289(2): 399–415.

Oliveira, Ó; Gamboa, D.; Silva, E. 2023. An introduction to the two-dimensional rectangular cutting and packing problem. International Transactions in Operational Research, 30(6): 3238–3266.

Lodi, A.; Martello, S.; and Vigo, D. 1999. Heuristic and Metaheuristic Approaches for a Class of Two-Dimensional Bin Packing Problems. INFORMS Journal on Computing, 11(4): 345–357.

Key words: Combinatorial Optimisation; Optimisation Methods; Algorithms Design; Cutting and Packing Problems;

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Human-Centric Requirements Engineering

Abstract: Humans are a key part of software development, including customers, designers, coders, testers, and end-users. While most current software engineering research and practices are function, data, or process-oriented, human-centric software engineering focuses on the human factors in engineering software systems. At present, there are major issues with misaligned software applications related to human factors, such as accessibility, usability, emotions, personality, age, gender, and culture. We aim to investigate enhanced theory, models, tools, and capability for next-generation human-centric software engineering aiming to achieve significant benefits of greatly improved software quality and user experience, developer productivity, and cost savings. Specifically for this project, we aim to use emerging technologies such as virtual reality (for simulating different application scenarios), multimodal learning (for detection of human behaviours and emotions) and large language models (to better understand user requirements) to improve the collection and analysis of software requirements.

References:

Xiao Liu, Human-Centric Software Engineering, Link

O. Wang, X. Liu, B. Cheng, C. Arora, T. Hoang, VR4HcRE: Virtual Reality Platform for Human-centric Requirements Elicitation, 21st IEEE International Symposium on Mixed and Augmented Reality (ISMAR'22, Posters Track), accepted on 16 August 2022.

D. Shao, X. Liu, B. Cheng, O. Wang, T. Hoang, Edge4Real: A Cost-Effective Edge Computing based Human Behaviour Recognition System for Human-Centric Software Engineering, 35th IEEE/ACM International Conference on Automated Software Engineering (ASE20 Demo Track), accepted on 04 July 2020.Video

Wang, B. Cheng, T. Hoang, C. Arora, X. Liu, Virtual Reality Enabled Human-Centric Requirements Engineering, 2nd International Workshop on Human-Centric Software Engineering and Cyber Security, colocated with 36th IEEE/ACM International Conference on Automated Software Engineering, Melbourne, Australia, 2021.

B. Cheng, O. Wang, D. Shao, C. Arora, T. Hoang and X. Liu, Edge4Emotion: An Edge Computing based Multi-source Emotion Recognition Platform for Human-Centric Software Engineering, 21st IEEE/ACM international Symposium on Cluster, Cloud and Internet Computing (CCGrid 2021 Poster Track), accepted on 27/02/2021. Link

Key words: Human Factors, Requirements Engineering, Virtual Reality, Multimodal Learning and Large Language Models

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Mobile Edge Computing based Smart UAV Delivery System

Abstract: We are using the Smart UAV Delivery System as a major application scenario for our research in edge computing based smart systems. The last-mile delivery problem is a key challenge in logistics which consumes a significant part of the package delivery time and cost as it is heavily rely on human delivery. Smart logistics system tries to use autonomous drones and vehicles for last-mile delivery (https://www.antwork.link/). However, current solutions are mainly cloud based where the cloud datacentre will become a performance bottleneck when there are a large number of UAVs flying in the sky and requesting constant services. Therefore, to meet the future demand, we are investigating the solution of edge computing based Smart UAV Delivery System. Specifically, we are interested in the following topics: System architecture and the development of the prototype system, software testing of UAV systems, resource management, task scheduling and service migration, edge intelligence, security and privacy issues.

References:

Xiao Liu, MEC based Smart UAV Delivery System, Link

J. Xu, X. Liu, X. Li, L. Zhang, Y. Yang, EXPRESS: An Energy-Efficient and Secure Framework for Mobile Edge Computing and Blockchain based Smart Systems, 35th IEEE/ACM International Conference on Automated Software Engineering (ASE20 Demo Track), Video

X. Li, L. Gong, X. Liu, F. Jiang, W. Shi, L. Fan, H. Gao, R. Li, J. Xu, Solving the Last Mile Problem in Logistics: A Mobile Edge Computing and Blockchain based UAV Delivery System, Concurrency and Computation: Practice and Experience, Link

J. Xu, X. Liu, X. Li, L. Zhang, J. Jin, and Y. Yang, Energy-aware Computation Management Strategy for Smart Logistic System with MEC, IEEE Internt of Things Journal, accepted on 16 September 2021.

R. Li, X. Li, J. Xu, F. Jiang, Z. Jia, D. Shao, L. Pan, X. Liu ,Energy-Aware Decision-Making for Dynamic Task Migration in MEC based UAV Delivery System, Concurrency and Computation: Practice and Experience, accepted on 06 November 2020.

L. Chu, X. Li, J. Xu, A. Ghari Neiat and X. Liu, A Holistic Service Provision Strategy for Drone-as-a-Service in MEC-based UAV Delivery, 2021 IEEE International Conference on Web Services (ICWS2021), accepted on 9 July 2021.

H. Luo, T. Chen, X. Li, S. Li, C. Zhang, G. Zhao, X. Liu, KeepEdge: A Knowledge Distillation Empowered Edge Intelligence Framework for Visual Assisted Positioning in UAV Delivery, IEEE Transactions on Mobile Computing, accepted on 4 March 2022. Link

Key words: Edge Computing, UAV, Drone Delivery, Smart System and Edge Intelligence

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AI-Native Semantic Communication

Abstract: Semantic communication (SC) is an emerging approach to communication system design that aims to convey the meaning or semantics behind transmitted bits, in addition to the bits themselves. While traditional communication systems focus solely on transmitting bits at Level A, SC encompasses Levels B and C, aiming to convey the semantics behind the bits and maximize their effectiveness for specific tasks, respectively. Recent advances in machine learning (ML) have given substance to initial SC concepts, positioning SC as a key enabler for 6G and beyond.

References:

Seo, S., Park, J., Ko, S.W., Choi, J., Bennis, M., & Kim, S.-L. (2023) 'Towards Semantic Communication Protocols: A Probabilistic Logic Perspective', IEEE Journal on Selected Areas in Communications, June 2023.

Seo, H., Park, J., Bennis, M., & Debbah, M. (2023) 'Semantics-Native Communication via Contextual Reasoning', IEEE Transactions on Cognitive Communications and Networking, February 2023.

Choi, J., Loke, S.W., & Park, J. (2022) 'A Unified Approach to Semantic Information and Communication based on Probabilistic Logic', IEEE Access, December 2022.

Yun, W., Park, S., Lee, R., Park, J., Ko, Y.-C., & Kim, J. (2023) 'Semantic Communications and Networking', Fundamentals of 6G Communications and Networking, Springer (editors: Lin, X., Zhang, J., Liu, Y., & Kim, J.), to be published in October 2023.

Barbarossa, S., Comminiello, D., Grassucci, E., Pezone, F., Sardellitti, S., & Di Lorenzo, P. (2023) 'Semantic Communications based on Adaptive Generative Models and Information Bottleneck', IEEE Communications Magazine, June 2023.

Key words: Semantic communication, 6G, machine learning, Distributed learning and Generative AI

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Multilingual Fake News Detection and Intervention

Abstract: Nowadays, massive misinformation is constantly being generated on the Internet. For example, the emergence of the Coronavirus Disease 2019 (COVID-19) epidemic has produced massive information related to COVID-19. Information distribution platforms such as mass media and social media allow information to be spread widely. Unfortunately, not all of the information is accurate or trustworthy. Some of the information spreading around those platforms can be categorised as misinformation or even be fake news. This project aims to develop a complete set of strategies for multilingual fake news detection and intervention. Based on these emerging demands and to address the research challenges behind them, this project aims: to collect and analyse the data in regarding individual online behaviour characteristics in fake news propagation and communication; to conduct theoretical analysis about the existing fake news detection models, and design a multilingual fake news detection model using advanced machine learning techniques such as large language models; to apply the proposed fake news detection method into the process of risk communication management to intervene the spread of fake news, and help authoritative organisations to generate their customised warning policies.

References:

Xiao Liu, Multilingual COVID-19 Fake News Detection and Intervention https://counterinfodemic.org/

Key words: Fake News, Misinformation, Multilingual, Social Media and Large Language Models

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