Virtual, Digital and Computational Environments

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Federation Business School

Project 1 - PhD, Program Code BU0

Every Crypto breath in the world: The current global position and forecasting of the cryptocurrency market

Outline

The proposed study investigates how blockchain technology can be applied to support sustainable infrastructure investment that is aligned with climate finance objectives to enable new business models in rural areas. Cryptocurrencies backed by blockchain technology have the potential to disrupt and bring positive benefits to payment transaction methods, finance, and society in general. Potential benefits include decreased transaction costs, improved anonymity and privacy protections, faster payment transactions, and an inflation-free, globally inclusive currency (Chuen, Guo, & Wang, 2017). Further, blockchain technology can improve market efficiency, leading to social and environmental benefits (e.g. providing a platform for the efficient exchange, paperless money and management of green bonds/finance and carbon credits), which set the base to achieve PRME (Principles for Responsible Management Education) six principles. However, the adoption of blockchain-based cryptocurrencies has been slowed by the poor public understanding of the cryptocurrency market. Investment in cryptocurrencies by more sophisticated players is hindered by poor understanding of the relationship between cryptocurrencies and other financial instruments.

The proposed study will address key issues pertaining to blockchain and crypto solutions, particularly in the rural context. From a social perspective, stakeholder perceptions on blockchain-based opportunities will be surveyed in order to identify information, policies, and technologies market participants think are necessary to leverage private finance by providing appropriate incentive structures (e.g. carbon markets) for businesses and industries to transition into low carbon technologies and to facilitate investments into profitable low-carbon interventions (e.g. through green bonds). Secondly, investment barriers to cryptocurrency adoption will be addressed by performing a market characterisation and econometric analysis of the cryptocurrency market. This will include investigating the co-movement and causation between cryptocurrencies and conventional assets, as well as producing a predictive model for cryptocurrency returns. Using this combined socio-econometric approach, the work will further the rational adoption of blockchain-based cryptocurrencies.

Supervisory team

Dr Sisira Colombage
Dr Qingguo Zhai
Project 2 PhD, Program Code BU0

Blockchain Application in Regional University

Outline

Through advanced technology, there is a worldwide shift in Higher Education towards internationalization of curriculum programs. Like many universities globally, Federation University has sought to expand the internationalization through partnership programs. Assessment moderation is a quality assurance process that plays a central role in the teaching, learning, and assessment cycle.

The problem: One of the major obstacles in this model is the substantial amount of verification of updated course descriptions, discussion of assessment tasks and moderation of marking of students assessment tasks over the delivery and ratification at the end of each semester. There is an increasingly high priority placed on the validity, transparency, efficiency and equality of assessment practices.

The project: The proposed three-year research project is a Blockchain application for regional universities in Australia to address the efficiency and transparency of business delivery model.

Anticipated benefits: The Blockchain powered project aims to create a more transparent, cost efficient and technologically advanced form of higher education system. It anticipates that all existing partners and potential ones would integrate into the Blockchain network to create an efficient, simplified, and ubiquitous environment to reduce the layers of verifications and overcome procedural and administrative barriers.

Supervisory Team

Dr. Damian Morgan
Dr. Helen Song-Turner
School of Health and Life Sciences

Project 3 - PhD, Program Code SU0

Investigating the use of virtual reality technology in tertiary education

Outline

Engaging students in tertiary education to promote long-life learning can be challenging. Virtual and augmented reality are technologies that are inherently “fun” promoting intrinsic motivation. This project will investigate the use of virtual reality (VR) technologies in veterinary education and its ability to enhanced learning. VR scenarios will be designed and aligned to intended learning outcomes of courses. A pilot study will be conducted to optimise the survey and VR scenario on Federation University students and academics in the area of parasitology. The optimised VR scenario and surveys will then be tested on larger cohorts of students (~300) from Federation University, University of Sydney and Latrobe University. The data will be used to develop a predictive model of how learning outcomes can be enhanced through refining VR teaching methods to maximise perceptions of usefulness, enjoyment and satisfaction. These three qualities have been shown to be antecedents to increase student engagement which in turn leads to positive education outcomes including deeper and fuller knowledge understanding and retention. In addition, the model and survey tool developed can be refined and applied to other contemporary digital teaching tools and methods to provide an understanding of the student experience of use of these platforms.

Supervisory team

Principal Supervisor: Dr Sarah Preston
Co-supervisors:
Dr Lara Wakeling, Federation University
Associate Prof David Piedrafita, Federation University
Mr Evan Dekker, Federation University
Dr Damien Whitburn, Deakin University
School of Science, Engineering and Information Technology

Project 4 - Masters by Research, Program Code CV9
Meeting QoS Requirements in IoT Applications

Outline
Sensor networks constitute the basic building blocks of IoT applications. Data collected by sensors can be processed in the edge/fog network or at the cloud level depending on an application's service need (e.g., priority service), cost model and capacity of data communication in various parts of the network. One of the biggest challenges that IoT applications face today is to ensure quality of a particular application, for example, meeting the latency requirement in a critical medical application like remote surgery.

This research will optimize data processing locations in a distributed way to ensure QoS requirement of data delivery, taking into account the required set of constraints in a specific context, such as user's need, data transmission policy, current network congestion level and resource availability. The developed technique will be tested using real world sensors used in different applications deployed through the IoT lab of Federation University Australia.

Supervisory Team
Principal Supervisor: Prof Joarder Kamruzzaman
Co-supervisors:
Dr Muhammad Usman
Dr Sally Firmin
Dr Gour Karmakar
Project 5 - Masters by Research, Program Code EI9

Determine the phreatic surface using soil water content on slope measured by Unmanned Aerial Vehicle (UAV) based imaging sensor

Outline

Slope stability analysis is sensitive to input-data, and slope design and evaluation conventionally employs one set of data. However, the phreatic surface of groundwater seasonally fluctuates and rises substantially in environments of shallow unconfined aquifer in pronounced wet raining seasons, and ground settlement changes when groundwater varies. So it is critical to timely update groundwater data in slope stability evaluation. To address this, this project uses unmanned aerial vehicle (UAV) based imaging techniques to survey the slope to acquire latest water content, analyse the variation of the soil water content on slope so as to determine the phreatic surface, and then updates the groundwater input data for slope stability evaluation.

Supervisory team

Principal Supervisor: Dr Greg You
Co-supervisor:
A/Prof Shyh Wei Teng
Dr Manoj Khandelwal
Prof Thomas Baumgartl
Prof Guojun Lu
**Project 6 - Masters by Research, Program Code CV9**

**Competition-based many-to-many academic collaborator recommendation**

**Outline**

Scientific collaboration has become of great importance to the scientific community in undertaking research. However, it is difficult and time-consuming for scholars to find relevant collaborators because of the rapid rise of scholarly data and new scholars joining academia. Due to the limited time and collaboration ability of collaborators, scholars may need to compete with each other to win collaboration opportunities. Collaboration recommendations generated by most existing methods is usually locally optimised. In contrast, this project will focus on improving globally-optimised collaboration recommendations based on completion.

This project will explore matching optimisation mechanisms such as market matching theory in order to iteratively recommend a collaborator with the highest match to each target scholar based on competition. The competition will be a two-way process, i.e., the set of targets will compete with each other to win their best match from the set of collaborators and vice versa. This will, in turn, maximize the overall benefits of the collaboration. The expected outcome of this project is a novel solution for group collaborator recommendation (many-to-many collaboration matching), which will result in globally-optimised collaboration recommendation.

**Supervisory team**

Principal Supervisor: A/Prof Feng Xia

Co-supervisor: Dr Nargiz Sultanova
Project 7 - Masters by Research, Program Code CV9

Water quality monitoring through the Internet of Things

Outline
Water keeps us, animals and plants alive but also plays a vital role in spreading contaminants and diseases. For this reason, any water utility company is obliged to monitor water quality on an on-going basis. Currently, this process is either done manually or automatically. Current processes are not only costly but also vendor locked-in. The purpose of the project is to develop a smart and cost-effective Internet of Thing (IoT) based sensor network that will monitor the quality of storm and drain water flowing to dams, lakes, and ponds. The monitoring system will also alert authority through SMS or email when there is an issue with water quality.

If designed correctly, the proposed IoT-based sensor network could act as an innovative, cost-effective and autonomous system for detecting the presence of various contaminants. The proposed system will promote a safe and sustainable environment, improve water usage and management, and reducing water-borne disease risk and improve water quality.

Supervisory team
Principal Supervisor: Dr Gour Karmakar
Co-supervisor:
Dr Suryani Lim
Dr Tanveer Choudhury
A/Prof Andrew Barton
Prof Joarder Kamruzzaman
Project 8 - PhD, Program Code CU0

Data dependent similarity-based machine learning approach to criminal intelligence problems

Outline

Criminal Intelligence is information compiled, analysed, and/or disseminated in an effort to anticipate, prevent, or monitor criminal activity. Rapid advances in data acquisition have created new challenges and opportunities for practitioners, including profiling and predictive policing, forecasting crime risk and crime rates, and legal and adversarial decisions. The underlying machine learning tasks for this problem set are difficult because of the high dimensionality, but more importantly the ill-structuredness of the domain requiring a more sophisticated and adaptable notion of similarity.

This project aims to create a new similarity-based machine learning approach to solve this problem by making use of existing state-of-the-art data dependent similarity measures.

Supervisory Team

Principal Supervisor: Dr Giles Oatley

Co-supervisors:

Dr Suryani Lim
Project 9 - PhD, Program Code CU0

The Detection of File-Less Malware

Outline

Traditional malware consists of compiled programs that reside on either the file system or in the boot loader. Significant research has been performed in the detection of traditional malware. File-less malware is a recent development that aims to avoid detection by making use of obfuscated scripts that are often stored in the Windows registry. File-less malware uses techniques that abuse existing operating system utilities and scripting languages. The use of File-less malware techniques are increasing and aim to blur the line between malware and benign programs. File-less malware consists of obfuscated scripts that are de-obfuscated as the script is executed.

The aim of this project is to perform dynamic analysis of File-less malware samples, to document the operation of common file-less malware variants, to generate features for detection, and to evaluate machine learning techniques that can be used for the detection of a wide variety of File-less malware.

Supervisory Team

Principal Supervisor: Dr Iqbal Gondal

Co-supervisors:

Joarder Kamruzzaman
Identifying Fake News and Postings in Online Social Media

Outline

With the easy accessibility of Internet connectivity, online social media such as Facebook and Twitter are great sources to disseminate information. Often citizens can reach an incident site before a news agency does or witness an incident first hand and report directly in social media. However recently social media has been engulfed with fake messages and postings with fake 'likes' and comments. There is ample evidence that many Twitter and Facebook accounts spread hoaxes and unconfirmed information with attention grabbing lines such as ‘BREAKING NEWS!’ These posts may create social conflict, tarnish business image or even jeopardize an individual’s or group’s safety, defeating one of the original purposes of the internet to share information for peace and human rights. Although some work has been done for the automatic detection of fake news in online social media, current techniques fail to achieve the desired level of detection accuracy within a reasonable time.

This project will use a combination of machine learning, natural language processing and opinion formation dynamics in social networks. The project will build on the supervisory team’s recent works on machine learning, and understanding opinion and trust formation among users in social networks. The outcome of the project is likely to attract commercial interest.

Supervisory Team

Principal Supervisor: Prof Joarder Kamruzzaman

Co-supervisors:

Dr Gour Karmakar
Dr Sally Firmin
Dr Tanveer Chowdhury
Outline

In the post-genomic era, holistic understanding of biological systems in all their complexity is critical in comprehending nature’s choreography of life. Biological processes and systems can be abstracted as multi-layered networks interacting with each other to create a complete biological system. Understanding the interactions of genes plays a vital role in the analysis of complex biological systems. Gene regulatory networks (GRNs) are the most important organization layer within a cell. They represent the relationship among genes of a genome.

Reconstructing the GRN of a genome is a crucial step in uncovering the complete biochemical networks of cells. A GRN helps in understanding interactions at the cellular level and has immense potential for application in genetic engineering. Moreover, knowledge about GRNs provides valuable evidence for the therapeutic studies of complex diseases. GRNs are large networks and their mathematical models usually contain thousands or tens of thousands of variables. Optimisation problems from these models are large scale and highly nonlinear.

Despite a significant progress in this area, the development of accurate and efficient numerical algorithms for reconstructing GRNs is still an open problem. The aim of this proposal is develop large scale suitable ensemble based GRN modelling and develop deterministic optimisation algorithms for learning the model parameters.

Supervisory Team

Principal Supervisor: A/Prof Madhu Chetty
Co-supervisors:
Prof Adil Baghirov
Prof Fadi Charchar
Variational Analysis of Regularity/Transversality Properties with Applications to Optimisation

Outline

Regularity properties of real-valued functions, set-valued mappings and collections of sets are to be investigated using techniques of variational analysis and applied to constraint qualifications in optimisation problems, qualification conditions in subdifferential and coderivative calculus and convergence of computational algorithms.

This project involves developing necessary and sufficient, primal and dual, linear and nonlinear conditions for error bounds, metric (sub- and semi-) regularity, Aubin property, calmness, and (sub-, semi- and intrinsic) transversality.

Stability of generalised equations subject to canonical and more general nonlinear perturbations are to be studied.

The topic is broad, and the actual scope of the project can be further discussed and adjusted depending on the experience and research interests of the applicant. Several PhD projects within the proposal are possible.

Supervisory Team

Principal Supervisor: Prof Alexander Kruger

Co-supervisors:

A/Prof David Yost

Dr Minh Dao
Project 13 - PhD, Program Code CU0

Fraud detection based on graph learning in social networks

Outline

Research has shown that social networks are the main source of obtaining confidential information to carry out fraudulent activities, such as laundering transactions and false information spreading. As large amounts of information are made public, how to conduct fraud detection to increase the security and privacy of social networks becomes an important problem. However, it is difficult to detect fraud in the age of big data. The small number of fraudulent samples are difficult to detect in big data with existing supervised learning methods and it is also difficult to distinguish different types of fraud from multi-source data.

During this study, the student will focus on studying the following three questions in response to the above difficulties and challenges:

1. How to detect fraud with few labelled fraudulent samples
2. How to distinguish different types of fraud with multi-source data
3. How to explain the fraud detection results.

To address these questions, this project will develop a suite of innovative solutions taking advantage of the graph learning framework. The outcomes of this research will lead to several high-quality publications in leading journals and conferences.

Supervisory team

Principal Supervisor: A/Prof Feng Xia

Co-supervisor:

Dr Muhammad Usman
Dr Taiwo Oseni
Project 14 - PhD, Program Code GU0

Human - Artificial Intelligence (AI) interaction techniques for decision making using big data analytics.

Outline

Data analysis is a key part in intelligent decision making. With the advancement of IOT, data became available in massive capacities in many complicated systems/applications. With this big data, data processing for decision making became a problem. Most researchers have used modern AI techniques to overcome this issue. Modern AI techniques such as ANN and Machine learning algorithms are widely used in big data analytics.

Even with current technologies, some of the complex decisions still have to be made with human inputs. For some applications, it will be much more efficient to develop AI techniques to pre-process big data and present in a such a way for humans to make decisions. Furthermore, AI techniques can be used in any sequence of the human decision-making process, pre-process, post-process after human input, or in the middle of the process.

This PhD project proposes to investigate the best possible Human - Artificial Intelligence (AI) interaction techniques for decision-making using big data analytics.

Supervisory Team

Principal Supervisor: Dr Gayan Kahandawa
Co-supervisors:
Dr Tanveer Choudhury
Dr Linh Nguyen
Project 15 - PhD, Program Code GU0

Application of Artificial Neural Networks (ANN) in modelling water filtration technologies

Outline

Stormwater filtration technologies play a significant role in improving water quality and making treated water available for several non-potable uses. However, during treatment processes, contaminants such as suspended solids lead to clogging of vegetated and non-vegetated filters, especially those with high infiltration rates. There are several parameters that affect clogging of filters and a major challenge is to understand the parameter interdependencies, correlations and their individual effects. A robust methodology is thus required to accurately predict clogging for diverse operational conditions in different catchment conditions. Such models would further help with predictive maintenance and asset management and hence contribute and uptake of these technologies.

This project employs the use of Artificial Neural Networks (ANN) to model and predict clogging performance of filters under different operational conditions. Comparative analysis with other predictive modelling approaches shall also be undertaken to guide development of information systems that can guide data collection in these decentralised systems.

Supervisory Team

Principal Supervisor: Dr Harpreet Kandra

Co-supervisors:

Dr Tanveer Choudhury
A/Prof Andrew Barton
Project 16 - PhD, Program Code CU0

Evaluating trustworthiness of an Internet of Things agent

Outline

Trust for automation using the Internet of Things (IoT) across the world requires assessing the trustworthiness of an interactive IoT agent on the fly using the footprint left as big data in both physical and virtual spaces. Existing approaches lack in adopting an effective principle for measuring trust. These approaches exploit social interactions, relationships, and other available information.

Using big data, this project will develop an innovative approach for trustworthiness measures of an IoT agent based on ethical models and other well-accepted and intuitive ways used in measuring the trust for real-world applications. The outcome of this project will increase the speed of automation and promote reliable and cost-effective solutions for many industrial and government sectors related to security, data forensic, transportation, water, finance and health.

Supervisory Team

Principal Supervisor: Dr Gour Karmakar

Co-supervisors:

Prof Joarder Kamruzzaman

Prof Iqbal Gondal

Dr Suryani Lim
Investigating using virtual reality to teach mining sampling in tertiary education

Outline

Mining engineering concepts and processes in tertiary education are traditionally taught via powerpoint presentations, class discussions, and onsite mining facility field trips. While learning and experiencing mining processes onsite is the gold standard for learning in this context, it requires additional transportation, safety and financial resources. Sampling in mining is a fundamental process that involves several methods of material sample collection to be used for testing, analysis and quality control. It is critical that the collection of these samples is of the utmost accuracy to ensure they are representative of the entirety of the material being mined.

This project seeks to utilize virtual reality (VR) to simulate the process of sampling in a mining context as an interactive alternative to onsite mine field trips, so that tertiary students can actively experience what is involved in collecting mining samples. It would also allow more interaction than physically possible during mine onsite field trips such as when operating dangerous mining machinery.

The project will develop VR software for tertiary mining students with a pilot study for gathering feedback from students via questionnaires into the VR experience’s effectiveness for teaching mining sampling processes.

Supervisory team

Principle supervisor: Dr Larissa Koroznikova – will provide mining sampling experience, as well as tertiary teaching advice, along with project supervision

Co supervisors:

Dr Manoj Khandelwal – will provide additional mining tertiary education experience

Sara Warren – will provide BOLD teaching experience and quality advice

Evan Dekker – will provide technical support and advice