

## **Women in Mathematics and IT Day 12 May 2023**

### **Deakin University**

We have been celebrating Women in Mathematics every year since Professor Lynne Batten initiated the event. This tradition was then continued by Professor Maia Angelova and Dr Kerri Morgan who joined Deakin in 2017 and 2018 respectively. The Women in Mathematics and IT Day (12 May) is a wonderful opportunity to celebrate the achievements of women mathematicians and IT.

Each year, we change the focus of the event. The 2023 event is focused on the achievements of women mathematicians who work in multidisciplinary domains, to promote mathematics and information technology (IT) as career paths to girls and women in mathematics, IT and engineering and to showcase career paths of women in academia and industry.

To achieve this aim, we will have three keynotes, one questions and answer (Q&A) session and a poster session. In parallel, we will be facilitating networking during the lunch and coffee breaks. We have invited as keynote speakers prominent women leaders from academia and industry whose careers are based (or started) in mathematics and who are in different stages of their careers.

There will be a session with short presentations and posters after lunch with prizes awarded for the three best posters.

A question and answer (Q&A) session will follow with focus on careers and how to achieve our potential and dreams.

The event will be in Deakin Downtown from 9:30am to 5pm on 12 May.

Website:

<https://blogs.deakin.edu.au/math/women-in-maths/>

## Program

Activity	Time	Speaker	Tentative title
Registration and Morning Tea	9:30-10:00		
Opening and Welcome	10:00-10:15	Prof Maia Angelova, Deakin	Welcome Address
Keynote 1	10:15-11:00	Ms Kerry Kirk, Principal Advisor Data Ethics and Privacy Department of Premier and Cabinet	Empowering women in Math and Information Technology Careers – Finding your own path to building a successful career in ICT
Coffee Break and Networking	11:00-11:15		
Keynote 2	11:15-12:00	A/Prof Beata Ujvari, Deakin	Applying Tools from Mathematics and Evolutionary Ecology to Cancer Research and Treatment
Lunch and Networking	12:00-13:00		
Short presentations and posters	13:00-13:15	Ms Kerry Anne Farrea;	LEO Satellite Authentication: Building Trust in the Sky
Poster session	13:15-14:15	Ms Sunita Rani Mr Ishara Bandara Mr Dat Le Ahnh Ms Alex Wu	Showcasing PhD and undergraduate students research
Q&A Session	14:15-15:15	Panel: Prof Maia Angelova, Prof Jo Coldwell-Neilson, A/Prof Julien Ugon, Dr Chathu Ranaweera, Dr Chandan Karmakar	Career Opportunities for Women in Mathematics and IT
Coffee Break and Networking	15:15-15:30		
Keynote 3	15:30-16:15	Dr Nadezda Sukhorukova, Swinburne	Mathematics, Deep Learning and AI
Concluding Remarks and Close	16:15-16:30	Professor Maia Angelova	Poster Prizes and Closing Remarks

## **Keynotes:**

### **Kerri Kirk**

Principal Advisor Data Ethics and Privacy Department of Premier and Cabinet  
(current Chair of ITAB)

### **Empowering women in Math and Information Technology Careers – Finding your own path to building a successful career in ICT**

Kerry Kirk will share her experience of building her career in the ICT industry and how math has been instrumental in her work.

She will critique the conventional wisdom of how to build a career and share an alternate formula for career success that you might find useful to build success in your career.

For the second year in a row, the world has not made progress on the UN's sustainable development goals. Kerry shares her understanding of how ICT and math can have influence in the world and how she believes women can overcome obstacles and can contribute to solving wicked problems.

Kerry Kirk has held both technical and managerial roles, in her varied career working in the information Communication and Technology industry. She has carved out a varied career working in the ICT service industry (including PWC and Verizon) and client side, once employed by Australia's then largest private company and is now a data and AI ethicist in the Victorian Government's Centre for Data Insights. A past President of the Victorian Chapter of the ACS, Kerry has a Master of Management (Technology) Degree from Melbourne University, chairs the IT Advisory Board for the School of IT at Deakin University, and has two adult children.

### **Dr Beata Ujvari**

A/Professor in Bioinformatics and Genetics at the School of Life and Environmental Science, Deakin University

### **Applying tools from mathematics and evolutionary ecology to cancer research and treatment**

Cancer is not only a major cause of human death worldwide that touches nearly every family on the planet, but also a disease that affects all other multicellular organisms. Despite this, oncology and other sciences, such as mathematics, ecology and evolution have until very recently developed in relative isolation. Although the first synergistic approaches to understand cancer were proposed in the mid-1970s by J. Cairns and P.C. Nowell, it is only during the last decade that the scientific community started to fully realize that adopting evolutionary principles and mathematical and ecological approaches to cancer could greatly enhance our understanding of neoplastic progression, improve cancer prevention and therapies.

Cancer research is now at a crossroad, needing novel ideas, major innovation, and new and unprecedented transdisciplinary approaches. Auspiciously, an increasing number of scientists and clinicians are now actively involved in pursuing interdisciplinary research and apply an evolutionary ecology view to cancer emergence and progression. This scientific community capitalizes on a panel of specialists using different, yet complementary approaches to cancer: mathematics,

ecology, cell and evolutionary biology, and clinical research. This interdisciplinary field of study is also now moving beyond its descriptive phase and into the new dimensions of applying the theoretical understanding of cancer adaptations to treatment and prevention.

Apart from cancer being a problem of humanity, it also has, a so-far largely underestimated but significant impact on ecosystem functioning. Similar to humans, benign and malignant tumours are frequent in animals and prior to eventually causing death, cancer is likely to influence the organisms' fitness by reducing competitive abilities, increasing susceptibility to pathogens, and vulnerability to predation. Despite the potential importance of these ecological impacts, oncogenic phenomena are rarely incorporated into ecosystem modelling.

I will provide an overview on mathematical models now being an integral part of cancer biology, not only to derive a mechanistic understanding of dynamic processes in cancer, but also in developing novel treatment strategies. I will also illustrate how knowledge from human cancer research coupled with mathematical and ecological approaches can be translated to conservation biology and such, contribute to the protection of an endangered Australian icon, the Tasmanian devils. I hope to demonstrate that the field of mathematical modelling is instrumental in aiding our understanding of human and wildlife cancer biology and treatment.

Beata Ujvari is an Associate Professor in Bioinformatics and Genetics at the School of Life and Environmental Sciences at Deakin University, Australia. She is an evolutionary ecologist with her research focusing on the interactions between organisms and their environment and these effects on organismal fitness. Her research aims to explore the significance of genetic organismal responses to both macro- and micro environmental challenges. She has authored >150 refereed scientific work on transdisciplinary topics such as evolution, genetics and ecology. She edited the first textbook on the topic of Ecology and Evolution of Cancer, published by Academic Press. She is currently co-directing the "CANECEV Laboratory Without Borders ", an international team studying cancer ecology and evolution.

### **Dr Nadia Sukhorukova**

Senior Lecturer, Swinburne University of Technology, Department of Mathematics.

### **Mathematics, Deep Learning and AI**

Nadia Sukhorukova is holding two PhD degrees, both are in Applied Mathematics. The first one was obtained at the University of Ballarat (Australia) in 2004 (Data clustering through nonsmooth optimisation) and the second one was completed at St-Petersburg State University (Russia), Department of Applied Mathematics, 2006 (Remez algorithm for polynomial spline approximation). Both projects are in the area of applications of modern optimisation. She was always interested in applications and was involved in a number of applied and industrial projects, mostly in the area of Operations Research and Data Analysis. In her talk, Nadia is going to talk about her personal journey as an applied mathematician. She will also talk about deep learning, a very commonly used technique for data analysis, which also has very deep mathematical roots.

## **Short Talks**

### **Kerry Anne Farrea**

PhD student, Deakin University

#### **LEO Satellite authentication: Building Trust in the Sky**

As the world becomes increasingly reliant on Low Earth Orbit (LEO) satellite communication, the need for robust and effective satellite security measures has never been more important. In this presentation, we will explore the security threats and challenges that LEO satellites face, the importance of space-based security, and the measures that can be taken to protect them. Additionally, we present a proof of concept (POC) LEO satellite-to-satellite mutual authentication scheme based on a combination of Physical layer and Upper layer Authentication methods for use in modern network applications. We analyse our protocol with the formal verification tool Scyther, and results show it can resist various attacks identified in the satellite network and improve the efficiency of satellite communication for use in modern applications.

Kerry Anne Farrea, is from Rhode Island, United States where she earned a Master of Science in Homeland Security and Cybersecurity. After graduation, she worked as an Information Security Engineer contracting with the US Department of Defence (DoD) where she gained experience in a collaborative environment of network design and system configurations for risk detection and cyber threat mitigation. She is a Cyber Security Cooperative Research Centre (CSCRC) Scholarship recipient, currently enrolled in a PhD program at Deakin University. Her research, conducted under the supervision of Dr. Zubair Baig, Prof. Robin Doss, and Dr. Donxiu Liu, aims to define and validate a novel mutual authentication scheme for space-based networks. Her research interests include an integrated Cloud-based Edge platform, Ad-Hoc Networks, and Lightweight Dynamic Authentication Methods.

## **Posters**

### **Sunita Rani**

PhD student, Deakin University

#### **Sleep Patterns of Adults with Chronic Insomnia and their Bed Partners During the Weekdays and on Weekends Using Actigraphy Data.**

Sleep deprivation is a common consequence of modern life, which can lead to a variety of serious health problems. Insomnia is the second most common mental disorder which adversely affects the quality of life. There are several factors that contribute to irregular sleep patterns and disruptions in sleep during the day. Our study examines the sleep of individuals with chronic insomnia and their healthy bed partners. This study aims to determine how sleep activity differs on weekdays and weekends by analysing data obtained from multi-night actigraphy recordings. The actigraphic data was used to calculate statistics, fractals, and sleep parameters. Results indicate that individuals with chronic insomnia and their healthy bed partners have subtle differences in their sleep patterns during the weekdays and weekends.

Sunita Rani is a final-year doctoral student in information technology at Deakin University. She received her Master's degree in Information Technology (Health) in 2016 from the University of Melbourne. In the past, she has completed two postgraduate programs: a Master of Science in Computer Science and a Master of Computer Science from an Indian University (2003, 2005). Before beginning her PhD program, she worked in the aged care industry for 12 years, and her experience assisted in choosing the topic for her dissertation. Sunita is a highly dedicated, innovative, collaborative and passionate educator with over 10 years of teaching experience and currently working as a sessional academic in The University of Melbourne and RMIT university. She is committed to engaging her students and helping them develop a range of subject-specific skills.

### **Ishara Bandara**

PhD Student Deakin University

### **Region Based Ball Possession Entropy for Team Performance Analysis in Soccer**

This work analyses the spatio-temporal events in soccer matches with information theory concepts. Spatio-temporal event log dataset have been used to analyse region-based ball possession randomness of the team with the concepts of information theory. Further, this work also determines how the region based entropy values impact and contributes for a match result using the concepts of entropy and algorithmic complexity. Soccer field was divided into 30 regions and the amount of ball possession time in each region has been calculated for a certain time period to calculate entropy values per team. Entropy difference between two teams for each time period has been proposed as features for machine learning models. Shannon entropy, Kullback-Leibler divergence, Lempel-Ziv complexity have been used for this feature extraction. Random Forest, GLM and XGBoost machine learning algorithms have been tested with these extracted features. Discussed approach in this work has achieved a mean accuracy of 0.83 for predicting the winner in matches which ended up with a result for elite men's football data. Finally, this work analyses playing patterns and strategies in various competitions and identifies valuable insights and hidden patterns in modern soccer game.

Ishara Bandara is a first-year doctoral student at Deakin University, Melbourne. His research interests include Sports Analytics, Data Analytics, time series data.

### **Dat Le Ahnh**

PhD Student Deakin University

### **A Single Variate Multiple Time Series Framework with Neural Hierarchical Interpolation for Real Estate Forecasting**

Machine learning (ML) has been widely applied in various fields to improve performance and efficiency. One area where ML has shown significant promise is in time series predictions. Time series predictions refer to forecasting future values of a variable based on historical data. This has been used in a wide range of applications, including financial forecasting, weather forecasting, and demand forecasting. In this paper, we aim to improve the accuracy of the real estate prices prediction when the

original data has three typical crucial issues, namely missing data, non-stationary, and not big. In particular, we propose an effective framework that contains various ML techniques to predict real estate prices, including three main components: data imputation (by interpolation, k-nearest neighbors, random forest), clustering (by Euclidean, dynamic time warping, dynamic time warping with Barycenter averaging, soft dynamic time warping, weighted dynamic time warping) and forecasting (by recurrent neural network, long short-term memory, gated recurrent unit, neural hierarchical interpolation for time series), which is called as ICF. After running 120 sub-settings, we demonstrate that the new ICF framework has an enormous potential to successfully address the three typical severe problems as mentioned above. Especially, extensive experiments on monthly US real estate price dataset show that our ICF framework has gained significant forecasting performance when a state-of-the-art method, called Neural Hierarchical Interpolation for Time Series (N-HITS), is incorporated, even when we experimented the model with one of the most volatility periods of real estate market in the past decade. The N-HITS method with clustering has outperformed compared to N-HITS without clustering as well as RNN, LSTM, and GRU methods.

Dat Le is a first-year doctoral student at Deakin University. He has a bachelor's degree in International Business Management and a master's degree in Econometrics and Informatics. Throughout his academic career, he has developed a strong foundation in statistical analysis, machine learning, and data mining in finance. For now, he is focusing on apply state-of-the-art ML and DL techniques to predict time series financial index. Before beginning his PhD at Deakin University, Dat Le gained a decade of experience working for various finance organizations, including consulting firms and retail banks. During this time, he quickly developed expertise in financial modelling and analysis, utilizing his technical skills to provide valuable insights to clients. Dat Le's finance expertise extends to financial internal risk management, operational optimization, and investment analysis.

### **Alex Wu**

Undergraduate student, Deakin University

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

There is a growing trend of consumption of 360° videos to induce immersive experience for users in various domains like Education 4.0, real estate marketing, video-on-demand streaming, and mental health interventions, etc. Unlike traditional 2D videos, 360° videos comprise of multiple views for a given scene along time instances captured from multiple cameras and stitched together for one single 360° wider view video. Storing, encoding, and transmission of such 360° videos become more challenging due to the desired high visual quality standard in such demanding data volume. To address this over the hardware limitation, computational super-resolution becomes a desired software solution that can be used to automatically transform low resolution 360° videos to higher resolutions. In addition, Quality of Experience (QoE) is a measure of how satisfactory an application or service is to the end-user based on their subjective perception and is the ultimate goal of video quality improvement. It should be mapped to objective assessment to assist software

solution. This research also studied the unique characteristics of 360° videos to develop better assessment metrics for machine learning models.

Alex Wu is a second-year student of Bachelor of Computer Science, tutor of HelpHub and recipient of 2022 ADR summer research prize. She is passionate in programming and technology and is dedicated to make a meaningful impact in the field of Computer Science.