UNSW SYDNEY

School of Mathematics and Statistics

Postgraduate Conference 2022

Book of Abstracts

Wednesday 10 August

Colombo Theatres

Welcome to our 9th annual Postgraduate Conference! We hope you enjoy today's event.

Welcome!

Welcome to the 9th annual School Postgraduate Conference!

Undertaking a research degree during a pandemic has been challenging for all our students. Doing a PhD or MSc is more than just staring at papers on a screen or doing another run of the data. An important part is being able to discuss your work with other people, to take in their ideas, and to be able to offer yours. Our conference provides a wonderful opportunity for that and so it is a relief to be able to welcome most of our students back on campus for this year's event. For most of them, this will be their first opportunity to present their work to a live audience!

For a number of reasons, not every student can make it to the conference, so a few of the talks have been pre-recorded for us to view. But we hope to be able to talk to those students after their presentations have been shown.

A new part of the conference this year is our "Hello Session". This will provide an opportunity for our newest HDR students to introduce themselves and to let us know, in just a few minutes, what they are planning on doing during their candidature.

The conference is also a time to celebrate the achievements of our HDR students, so in the next few pages you will find lists of our recent graduates, and of the impressive work that they have managed to get published.

As usual there will awards for the best talks from the three departments. Voting, as well as any last-minute schedule changes and links to the video talks can be accessed via

https://web.maths.unsw.edu.au/~iand/PG-Conf/pg-conf-2022.html

Enjoy the day!

Thanks

The conference is an opportunity not just for our students to present their research, but also to get some experience at the important professional skills of running such a meeting.

I'd like to thank Bill Deng, Brock Sherlock and Thomas Xuan who helped out this year with the organisation. And as usual, Susannah Waters, Markie Lugton and Beatta Zarribi provided a good deal of help with promotion, catering and wise advice.

Ian Doust

Director of Postgraduate Studies (Research Students, Candidature and Examination)

School of Mathematics and Statistics, UNSW

Speakers at the Hello Session

- Anson Macdonald
- Brock Sherlock
- Dilshan Wijesena
- Hongzhi Liao
- Josef Bisits
- Joshua Connor
- Joshua Graham
- Joshua Ham
- Kevin Pan
- Ryan Seelig
- Samuel Mason
- Stuart-James Burney
- Yerlan Nessipbayev

Our postgraduate research students and their recent achievements

The conference is a chance to celebrate the achievements of our postgraduate students. It is particularly nice to acknowledge those students who have successfully completed their degrees in the last 12 months, and those who have managed to get their work published. As you can see from the lists below, their research covers an incredibly broad range of topics.

Recent completions:

- **Eduardo Vitarelli de Queiroz**, PhD, "Characterising internal tides in a region of dynamic circulation: The East Australian Current at 27°S", Supervisory team: Moninya Roughan, Colette Kerry and Shane Keating.
- **Yi-Lung Chen,** PhD, "Advances in Monte Carlo methods: Exponentially tilted sequential proposal distributions and regenerative Markov chain samplers", Supervisory team: Zdravko Botev and Josef Dick.
- **Ziyu (Nero) Li,** MSc, "Random Substitution Networks and Graph Fractal Dimensions", Supervisory team Thomas Britz and Anita Liebenau.
- **Elliot Dovers,** PhD, "Fast methods for fitting log-Gaussian Cox Process models in Ecology", Supervisory team: David Warton and Gordana Popovic.
- **Saleh Almuthaybiri,** PhD, “Solutions to differential equations via fixed point approaches: New mathematical foundations and applications”, Supervisory team: Chris Tisdell and Chris Goodrich.
- **Michaela Hall,** PhD, “Mathematical modelling of human immunodeficiency virus and human papillomavirus disease transmission dynamics, natural history, and control interventions”, Supervisory team: John Murray, Karen Canfell and Adelle Coster.
- **Junze (Douglas) Zhang**, MSc, “Complex structures on stratified Lie Algebras”, Supervisory team: Alessandro Ottazzi, Michael Cowling and Ian Doust.
- **Farah El Rafei**, PhD, “Existence, uniqueness and approximation of solutions to the stochastic Landau-Lifschitz equation of the real line”, Supervisory team: Thanh Tran and Beniamin Goldys.
- **Kevin Limanta**, PhD, “Super Catalan numbers and Fourier summations over finite fields, Supervisory team: Norman Wildberger and Daniel Chan.
- **Robert Nguyen**, PhD, “New statistical tools for understanding Australian sport”, Supervisory team: David Warton and Jakub Stoklosa.

Publications of current and recent postgraduate students

Abel, R. Julian R.; Britz, Thomas; **Bunjamin, Yudhistira A.**; Combe, Diana. Group divisible designs with block size 4 where the group sizes are congruent to 2 mod 3. *Discrete Math.* 345 (2022), no. 112740.

Abel, R. Julian R.; Britz, Thomas; **Bunjamin, Yudhistira A.**; Combe, Diana. Group divisible designs with block size 4 and group sizes 2 and 5. *J. Combin. Des.* 30 (2022), 367-383.

Abernathey, R.; **Bladwell, C.**; Froyland, G.; Sakellariou, K. Deep Lagrangian connectivity in the global ocean inferred from Argo floats. J. Phys. Oceanogr. 52 (2022), 951-963.

Akhymbek, Meiram; Levitina, Galina. Trotter-Kato product formula in symmetric F-normed ideals. *Studia Math.* 266 (2022), 167-191.

Almuthaybiri, S.S.G. Solutions to differential equations via fixed point approaches: new mathematical foundations and applications. *Bull. Aust. Math. Soc.* 106 (2022), 163-164.

Almuthaybiri, S.S.; Jonnalagadda, J.M.; Tisdell, C.C. Existence and uniqueness of solutions to discrete, third-order three-point boundary value problems. *Cubo (Temuco)* 23 (2021), 441-455.

Almuthaybiri, S.S.; Jonnalagadda, J.M.; Tisdell, C.C. Existence and uniqueness of solutions to third-order boundary value problems. *Trends Comput. Appl. Math.* 22 (2021), 221-240.

Almuthaybiri, S.S.; Tisdell, C.C . Uniqueness of solutions for a coupled system of nonlinear fractional differential equations via weighted norms. *Comm. Appl. Nonlinear Anal.* 28 (2021), 65-76.

Amini-Harandi, Alireza; Doust, Ian; **Robertson, Gavin**. Roundness properties of Banach spaces. *J. Funct. Anal.* 281 (2021), Paper No. 109230.

Bamberg, J.; Bishnoi, A.; **Lesgourgues, T.** The minimum degree of minimal Ramsey graphs for cliques. *Bull. London Math. Soc.* (2022). https://doi.org/10.1112/blms.12658.

Bladwell, C.; Holmes, R.M.; Zika, J.D. Internal salt content: A useful framework for understanding the oceanic branch of the water cycle. *J. Phys. Oceanogr.* 51 (2021), 2167-2179.

Denes, Michael C.; Froyland, Gary; Keating, Shane R. Persistence and material coherence of a mesoscale ocean eddy. *Phys. Rev. Fluids* 7 (2022), 034501.

Elzahaby, Y.; Schaeffer, A.; Roughan, M.; Delaux, S. Oceanic circulation drives the deepest and longest marine heatwaves in the East Australian Current system. *Geophysical Research Letters* 48 (2021), e2021GL094785

Elzahaby, Y.; Schaeffer, A.; Roughan, M.; Delaux, S. Why the mixed layer depth matters when diagnosing marine heatwave drivers using a heat budget approach. *Frontiers Climate* 4 (2022), 838017.

Hall, M.T.; Smith, M.A.; Simms, K.T.; Barnabas, R.; Murray, J.M.; Canfell, K. Elimination of cervical cancer in Tanzania: Modelled analysis of elimination in the context of endemic HIV infection and active HIV control, *International Journal of Cancer* 149 (2021), 297-306

Kirubakaran, Ranita; Hennig, Stefanie; **Maslen, Ben**; Day, Richard O.; Carland, Jane E.; Stocker, Sophie L. Evaluation of published population pharmacokinetic models to inform

tacrolimus dosing in adult heart transplant recipients. *British Journal of Clinical Pharmacology* 88 (2022), 1751-1772.

Lee, D.; Schaeffer, A.; and Groeskamp, S. Drifting dynamics of the bluebottle (Physalia physalis). *Ocean Sci.* 17 (2021) 1341–1351.

Muskovic, Walter; Slavich, Eve; **Maslen, Ben**; Kaczorowski, Dominik C.; Cursons, Joseph; Crampin, Edmund; Kavallaris, Maria. High temporal resolution RNA-seq time course data reveals widespread synchronous activation between mammalian lncRNAs and neighbouring protein-coding genes. *Genome Research* (2022), gr-276818.

Maslen, Ben; Lim, Michelle. R package 'ecopower'. (2021).

Mathur, A.; Moka, S.; Botev, Z. Variance Reduction for Matrix Computations with Applications to Gaussian Processes. In: Zhao, Q., Xia, L. (eds) Performance Evaluation Methodologies and Tools. VALUETOOLS 2021. Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering, vol 404. (2021), Springer, Cham.

Nguyen, Robert; Day, James; Warton, David; Lane, Oscar. fitzRoy - An R package to encourage reproducible sports analysis. *The R Journal* 12 (2020), 82-106.

Rahman, P.; Beranger, B.; Sisson S.; Roughan, M. Likelihood-based inference for modelling packet transit from thinned flow summaries. *IEEE Transactions on Signal and Information Processing over Networks* 8 (2022), 571-583.

Pan, Rong, R.; Abel, R. Julian R.; **Bunjamin, Yudhistira A.**; Feng, Tao; Tsang Ung, Tiana J.; Wang, Xiaomiao. Difference matrices with five rows over finite abelian groups. *Des. Codes Cryptogr.* 90 (2022), 367--386.

Pan, Rong, R. Abel, R. Julian R.; **Bunjamin, Yudhistira A.**; Feng, Tao; Wang, Xiaomiao; Zhang, Menglong. Difference matrices with four rows over generalized dihedral groups. *J. Combin. Des.* 30 (2022), 298--341.

Smith, M.A.; Burger, E.A.; Castanon, A.; de Kok, I.M.C.M.; Hanley, S.; Rebolj, M.; **Hall, Michaela T.**; Jansen, Erik E.L.; Killen, James; O'Farrell, Xavier; Kim, Jane J.; Canfell, Karen. Impact of disruptions and recovery for established cervical screening programs across a range of high-income country program designs, using COVID-19 as an example: A modelled analysis. *Preventive Medicine* 151 (2021), 106623.

Smith, Megan A.; **Hall, Michaela T.**; Saville, Marion; Brotherton, Julia M.L.; Simms, Kate T.; Lew, Jie-Bin ; Bateson, Deborah; Skinner, S. Rachel; Kelaher, Margaret; Canfell, Karen. Could HPV testing on self-collected samples be routinely used in an organized cervical screening program? A modeled analysis. *Cancer Epidemiol Biomarkers and Prevention* 30 (2021), 268–277.

Schedule

Start time	Plenary Colombo A	Colombo B	Colombo C	Colombo A
8:50 AM	**Welcome**			
9:00 AM	**Fiona Kim** Evaluating and mitigating implicit bias in student evaluations of teaching			
Session 1	*Chair: Ian Doust*	*Chair: Chris Bladwell*	*Chair: Jeremy Nugent*	*Chair: Prosha Rahman*
9:35 AM		**A Abi Srikumar** Approximating distribution functions in uncertainty quantification using quasi- Monte Carlo methods	**P Christian Bagshaw** Square-free smooth polynomials in residue classes and irreducible polynomial generators	**S Ben Duthie (V)** Single-Model Deep Learning: An Efficient Approach to Uncertainty Quantification and Handling Domain Shift
10:00 AM		**A Dinh (Ryan) Tran** Sparse optimization: A generalized version of MCP regularization	**P Aayush Bhattacharya** A presentation of q-Schur algebra of type B	**S Saman Forouzandeh** Multi-Criteria Recommender System based on Heterogeneous Graphs with Deep Learning Methods
10:25 AM		**A Haoxuan (Peter) Wu** Adjustable robust optimization for radiotherapy with evolving uncertainty through first order methods	**P Bill Deng** The RO(C2 x C2)-graded cohomology ring of the point	**S Hakiim Jamaluddin** Optimal designs for symbolic data
10:50 AM	Break			
11:10 AM	**Chris Bladwell** Time-averaging for ocean model budgets			
Session 2	*Chair : Abi Srikumar*	*Chair: Guanting Liu*	*Chair: Christian Bagshaw*	*Chair: Saman Forouzandeh*
11:45 AM		**S Qian Jin** Interpretable Artificial Neural Networks	**P Christian De Nicola Larsen** On Groups Constructed Using Jones' Technology	**S Michelle Lim (V)** Estimating effect size in multivariate analysis using bootstrap inversion
12:10 PM		**S Xiongwen Ke** On the optimization of Bayesian deep learning	**P Eva-Maria Hekkelman** Expanding the density of states	**S Ben Maslen** Developing methods to automatically detect animals in ecological monitoring videos
12:35 PM		**S Kai Yi** Approximate Equivariance SO(3) Needlet Convolution	**P Alan Stoneham** A Generalisation of the Spectral Theorem for Bounded Self-adjoint Operators	**S Maeve McGillycuddy (V)** Model-based hypothesis testing for multivariate abundance data
1:00 PM	Break			
Session 3		*Chair: Haoxuan (Peter) Wu*	*Chair: Christian De Nicola Larsen*	*Chair: Hakiim Jamaluddin*
1:50 PM		**A Youstina Elzahaby (V)** Characteristics and Synoptic Patterns of Marine Heatwaves and their drivers in the Tasman Sea	**P Zhi Yee Chng** On the Ramsey numbers $R(T_n, W_8)$ for tree graphs versus the wheel graph W_8 for $\Delta(T_n) \geq n-5$	**S Prosha Rahman** A precis on Symbolic Data Analysis and its new horizons
2:15 PM		**A Daniel Lee (V)** BBDrift v1.0: a new Lagrangian particle tracking module for the Bluebottle	**P Jackson Ryder** Normal families of elements in indexed algebras	**S Rianti Siswi Utami (V)** Joint modeling of longitudinal and multi-state data with functional predictors
2:40 PM		**S Leyang Zhao** Regularized distributionally robust optimization and applications in index tracking	**P Thomas Lesgourgues (V)** Using finite geometry tools in extremal graph theory	**S Ashwaq Zarban** Vulnerable exchange option under DRSJD models
3:05 PM	Break			
3:20 PM	**Yudhi Bunjamin** The cutting edge of designs			
Session 4	*Chair: Alan Stoneham*	*Chair: Xiongwen Ke*	*Chair: Jackson Ryder*	*Chair: Ian Doust*
3:55 PM		**S Guanting Liu** Estimation of skew-diffusion and its local time	**P Hongyin Zhao** Diagonality modulo hybrid Lorentz-(p,1) ideals in semi-finite factors	**Hello Session**
4:20 PM		**S Anant Mathur** Optimization methods for the Column Subset Selection Problem (CSSP)	**P Jeremy Nugent** Semi-degenerate superintegrable systems	
4:45 PM		**S Thomas Xuan** Stochastic Variational Bayes Approximation for GARCH Time Series Models	**P Jimeng Lu** Translation invariant operators on noncommutative spaces	
5:10 PM	Final comments and prize giving			
5:20 PM	Post-event drinks			

Abstracts

Square-free smooth polynomials in residue classes and irreducible polynomial generators

Colombo C

Session 1

Christian Bagshaw

Euclid's proof of the infinitude of the primes naturally gives rise to a procedure for producing an infinite sequence of primes: multiply the primes currently in your sequence, and take as the next term the smallest prime factor of this product plus 1. Little is known about these sequences and the primes contained within them, but a number of relaxations and variations have been investigated. Naturally, questions arise about the distribution of squarefree integers in arithmetic progressions.

Supervisor/s: Igor Shparlinski and Bryce Kerr

About the speaker: I am from Canada, and I completed my undergraduate degree at the University of Calgary in Alberta, Canada. I moved to Sydney start my PhD last September, and was one of the lucky ones who got to spend 2 weeks in hotel quarantine.

A presentation of q-Schur algebra of type B

Aayush Bhattacharya

Quantum groups are a class of algebras obtained by deforming the universal enveloping algebras of lie algebras. In classical representation theory, there exists a duality between universal enveloping algebras and symmetric group algebras. In the late 1980s, this was extended to the quantum Schur-Weyl duality between the quantum group and the associated Hecke algebra. Quantum-Schur algebras (q-Schur algebras) are a class of algebras realized as permutation modules of these Hecke algebras, which form the "bridge" used in this duality. As objects arising from the study of lie algebras, the categorization into type A-G, and affine also extends to the quantum case. The famous Beilinson-Lusztig-MacPherson paper "A geometric setting for the quantum deformation of GL_n" provides a method for finding a monomial basis and presentation for the q-Schur algebra and quantum group in the type-A case. In the Du and Wu paper "A new realisation of the i-quantum group $U^j(n)$", they extrapolate this method to find the monomial basis of the type B quantum group and q-Schur algebra. My research is to use this monomial basis to find a presentation of the type B q-Schur algebra, using the methods of Beilinson-Lusztig-MacPherson.

Supervisor/s: Jie Du

About the speaker: I did my undergrad with honours at Usyd, and I am from Sydney. I am still in my first year of my PhD at UNSW (11 months in). Some odd hobbies I have are swimming at the beach at night and driving in heavy traffic (that's a joke, I just enjoy driving). Coping with the pandemic involved a lot of video calls with friends to avoid going crazy.

Time-averaging for ocean model budgets

Christopher Bladwell

Plenary Colombo A
Session 2

Ocean models provide an experimental tool to study the mechanisms which drive changes in the ocean's state. In this talk we discuss methods to analyse how physical processes contribute to the tendency (time derivative) of a property of the model. When applied to ocean heat content, the way these processes are conventionally analysed describes the change in weather between two instances in time rather than the change in climate over a long period. We present an alternative approach to time-averaging model budgets. Through a comparison with conventional methods, we demonstrate that time-averaging can influence the interpretation of physical processes and their role in ocean heat content change.

Supervisor/s: Jan Zika

About the speaker: I am in the late stages of my PhD in ocean modelling which I am finishing part time. Outside of my research I like outdoor sports such as hiking, running and rock climbing.

The cutting edge of designs

Yudhistira Andersen Bunjamin

A *block design* is a combinatorial object that consists of a set of *points* X and a collection of subsets of X called *blocks*. Such combinatorial designs occur very naturally in the context of experimental designs where we would like to study how treatments interact without having to run trials for every possible combination of them.

Constructing block designs is conventionally done by exploiting possible symmetries. We explore an alternative approach where we use the *Michael's edge* of a block design which is a sub-design that a block design must contain.

This talk aims to give a broad overview of the study of block designs by introducing two extensively-studied classes of block designs, namely *balanced incomplete block designs* and *group divisible designs*. This will be done by discussing the usefulness of the Michael's edge approach of studying block designs and drawing connections to potential applications of block designs in various areas of applied mathematics and statistics.

Supervisor/s: Catherine Greenhill, Diana Combe, Julian Abel

About the speaker: I grew up in Jakarta, Indonesia before coming to UNSW Sydney for my undergraduate studies, completing a Bachelor of Science (Adv. Math.) majoring in Statistics in 2017. Prior to starting my PhD candidature in 2019 Term 3, I worked as a STEM Learning Designer in industry. This year, I celebrate having been to just as many of our school's Postgraduate conferences as a PhD student as I did prior to starting my PhD.

On the Ramsey numbers $R(T_n, W_8)$ for tree graphs versus the wheel graph W_8 for $\Delta(T_n) \geq n - 5$

Zhi Yee Chng

Given two simple graphs G and H, the Ramsey number $R(G, H)$ is the smallest integer n such that, for any graph of order n, either it contains G or its complement contains H. Let T_n be the tree graph of order n and W_8 be the wheel graph of order 9. Notice that for the graph $2K_{n-1}$, neither it contains T_n nor its complement contains W_8 for any tree graph of order n, hence $R(T_n, W_8) \geq 2n-1$. However, if we consider the graph $K_{n-1} \cup K_{4,\ldots,4}$, it does not contain some tree graph with maximum degree at least $n - 5$ and its complement does not contain W_8. Hence $2n - 1$ is not generally the best lower bound of $R(T_n, W_8)$ for these tree. In our work, we study the Ramsey results on these trees and determine the exact value of $R(T_n, W_8)$ for each tree graph T_n with maximum degree at least $n - 5$.

Supervisor/s: Dr. Thomas Britz

About the speaker: Currently in my third year of PhD studies at UNSW, under the supervision of Dr. Thomas Britz. Had completed my master studies in 2018, also at UNSW and previously did my Bachelor studies at University of Malaya, Malaysia. Still staying alive and surviving through the pandemic and hopefully able to complete my PhD by next year.

On Groups Constructed Using Jones' Technology

Christian De Nicola Larsen

Within the last decade, Vaughan Jones pioneered a powerful method of constructing actions of R. Thompson's groups F, T and V from certain functors. Often, the obtained group action is on an object of the target category of the functor. For example, if the target category is the category of groups, a new group is obtained via taking a semidirect product. In this talk we will discuss some of the "Thompson-like" groups constructed using Jones' method and some of the work that has been done to understand these groups.

Supervisor/s: Arnaud Brothier, Pinhas Grossman, Ian Doust

About the speaker: I graduated from UNSW in 2020 with a Bachelor of Advanced Science, mathematics honours, and a physics major. I am now in my second year of my PhD under the supervision of Arnaud Brothier, Pinhas Grossman, and Ian Doust. I have been coping with the pandemic by lifting heavy weights and hanging out with my cats.

The RO(C2 x C2)-graded cohomology ring of the point

Bill Deng

In algebraic topology, one associates to each topological space an algebraic structure such as a group, ring or module that is invariant under homotopy equivalence. In the 1960s, Bredon extended this theory to topological spaces with an action of a fixed group G, which then developed into what is known as $RO(G)$-graded cohomology. The computations in this new theory were difficult, and in particular the cohomology groups of the point were non-trivial. Recently, these groups played a key role in resolving a longstanding problem in algebraic topology, which led to a sharp increase in the interest in $RO(G)$-graded cohomology groups. Many of these groups are still unknown, and we focus in particular on the case where $G = C_2 \times C_2$, the Klein four-group. Notably, we will use a powerful connection with Bredon motivic cohomology to help elucidate the structure of the cohomology ring.

Supervisor/s: Mircea Voineagu

About the speaker: I am a local student and I have been with UNSW for all of my studies so far. I obtained my bachelors in 2016 in Computer Science and Mathematics, and I worked briefly as a software engineer before deciding to pursue a PhD. I am currently in my second year, and I hope to reach the inflection point of the learning curve soon!

Single-Model Deep Learning: An Efficient Approach to Uncertainty Quantification and Handling Domain Shift

Ben Duthie

In decision making it is often critical to have an idea of not just the point prediction but also the predictive uncertainty to ensure an informed decision can be made. This is especially crucial in high risk situations where a number of actions or choices are available. In order to properly assess the merit of each decision and make an informed choice the risk needs to be carefully considered. Such settings include: self-driving cars, defence and financial systems, and machine-learning aided medical diagnoses from imaging.

However, accurately modelling uncertainty quantification is a major challenge in deep learning and is an active and ongoing field of research. This challenge is primarily due to neural networks having a natural tendency to make overconfident predictions and assign high confidence to out-of-distribution (OOD) inputs.

Currently the most popular approaches to estimate predictive uncertainty in deep learning are methods which utilise model averaging. This is achieved by combining the predictions from multiple neural networks, such as Deep Ensembles (DEs) and Bayesian neural networks (BNNs). The main drawback of these approaches is their high memory and computational cost, which reduces their practicality in time sensitive industrial-scale environments. Consequently, there is a demand for the development of efficient uncertainty estimation. This is primarily due to the above methods not satisfying the model prerequisites in these safety-critical applications which require real-time decision-making.

There have been a number of proposed approaches to the development of efficient uncertainty estimation in deep learning. An approach which is currently showing a lot of promise in this area are Neural Gaussian Processes (NGPs). NGPs aims to combine the representational power of neural networks with the reliable uncertainty estimates of Gaussian Processes (GPs). This method provides a robust way of naturally dealing with OOD inputs and domain shift, whilst maintaining the ability for decisions to be made quickly. However, there are still a number of shortcomings which need to be addressed, as these methods are still subject to falsely reporting overconfident predictions on OOD inputs and are also suffering from poor uncertainty calibration, especially under domain shift.

This project will therefore focus on the development of single-model deep uncertainty quantification, and will provide crucial insights and solutions into these shortcomings which are prohibiting the safe deployment of these methods. As a result of this project, we hope to provide further confidence to the deployment of these methods in time-sensitive high-risk environments.

Supervisor/s: Scott Sisson

About the speaker: After working as an engineer for 2 years I decided to go back an pursue a career focusing on mathematics. I completed my masters in financial maths at UNSW, and from this worked as a data scientist for a number of years. After spending time in the industry I realised just how many interesting areas of research there are to pursue as this is an industry which is just exploding with growth. These

events have ultimately lead me to my current research focus which is specifically dealing on uncertainty quantification in deep learning.

Characteristics and Synoptic Patterns of Marine Heatwaves and their Drivers in the Tasman Sea

Colombo B
Session 3

Youstina Elzahaby

Although the impacts of marine heatwaves (MHWs) can extend well below the ocean surface, little is known about how oceanic and atmospheric forcings control their vertical structure. Here, we relate the MHW drivers to their sub-surface characteristics in different dynamical regimes including the East Australia Current and the western coast of New Zealand. We detect MHWs in the depth-dependent surface mixed layer over 30-years and use a heat budget to identify the dominant mechanisms driving them. We show that MHWs in the Western Boundary Current (WBC) jet are predominantly driven by air-sea heat-flux whilst in the WBC extension, MHWs are advection-driven. The deepest and longest MHWs are advection-driven and are more prevalent in autumn and winter. Surface (latent) flux-driven MHWs are shallower and occur predominantly in summer. Additionally, we show that when using a heat budget, the diagnosis of an event's dominant driver is sensitive to the mixed layer depth (MLD) definition. Further, we identify distinct oceanic and atmospheric synoptic patterns during MHWs using self-organinsing maps. We show their frequency of occurrence in a 30-year period (1985-2014) and the extent of pattern persistence in the lead-up to an event. Surface mechanisms tend to have sub 2 weeks lead time whilst the sub-surface temperature anomalies are apparent at least a month in advance of MHW onset. Demonstrating how MHW characteristics are linked to ocean advection and air-sea heat-flux anomalies helps in understanding and managing the impact of MHWs, especially below the surface where observations are sparse and ecological impact is high. Moreover, identifying the regional typology of MHWs, the corresponding large scale synoptic patterns and their respective lead-time, provides an important guideline for predictability of these extreme events.

Supervisor/s: Amandine Schaeffer, Moninya Roughan and Sebastien Delaux

About the speaker: Youstina is currently in the USA.

Multi-Criteria Recommender System based on Heterogeneous Graphs with Deep Learning Methods

Colombo A
Session 1

Saman Forouzandeh

Commercial interests in social networking have become prevalent in recent years, and organizations present various products and services to the users of this platform. In this regard, recommender systems can discover what users need and find users' interests by looking at their behaviors and how they interact with items. Ultimately, they provide various recommendations to users according to their analysis. The heterogeneity of nodes, the low accuracy of recommendations, numerous low-value and low-importance relations between multiple nodes, and the discovery of a community of users with similar interests and requirements are fundamental challenges in this field. We will produce more accurate recommendations, discover more significant relationships between different entities, and make group recommendations using deep learning strategies. So, this research uses multi-criteria recommender systems, attention mechanisms, and semi-supervised deep embedded clustering to analyze the problems mentioned.

Supervisor/s: Dr. Pavel N. Krivitsky and Prof. Wenjie Zhang

About the speaker: I'm from Iran and have studied in Iran up to my master's in computer science. Fortunately, I got a scholarship from the University of New South Wales and started online for five months. I was very annoyed during this time, which was awful because the internet speed was deficient. Due to Iran's restrictions, I couldn't have constructive interaction with my supervisors, and I fell behind in my studies. I came to Sydney on December 2, 2021, and I worked very well during this time. I have prepared two papers, and we are at the final submission stage. I am delighted that I was able to work hard, and I want to publish more papers in the future.

Expanding the density of states

Eva-Maria Hekkelman

The density of states is a concept in solid state physics describing various electrical properties of a material, but whose existence is notoriously difficult to prove in general situations. This talk revolves around a formula for the density of states for a class of discrete metric spaces, which has the advantage that it is guaranteed to be well-defined – and it agrees with the density of states if that exists. The class of metric spaces that are considered includes all crystals, as well as certain models of quasicrystals and random subgraphs of $\mathbb{Z}^n$ resulting from percolation.

Supervisor/s: Fedor Sukochev, Cosupervisors: Ed McDonald (Penn State University), Dmitry Zanin

About the speaker: I'm a Dutch first-year student who was really looking forward to doing my PhD in a warm and sunny city, but from what I've seen since I arrived I think I have been scammed. Still having a good time though! I also play the cello in the UNSW student orchestra.

Optimal designs for symbolic data

Ahmad Hakiim Jamaluddin

The extraction and analysis of the full information contained in large data sets require massive computational efforts. The computational burden can be reduced significantly by summarising or aggregating the data into some objects that are easier to work with. The philosophy behind this approach aligns with the concepts developed in symbolic data analysis (SDA), a recently emerging field of statistics. As such, our data summaries or aggregates are seen as symbols, statistical units that exhibit internal variations as opposed to the standard point-wise observations. There are no restrictions as to what form a symbolic random variable can take although most of the literature has focused on interval- and histogram-valued data. In this talk, I will discuss a statistical methodology to assist with the design of the aggregation procedure of raw data into symbolic data, which has received almost no attention to date.

Supervisor/s: Scott Sisson and Boris Beranger

About the speaker: I am a coffee-addict. I enjoy playing table-tennis, running, jogging, brisk-walking (and just recently swimming).

Interpretable Artificial Neural Networks

Qian Jin

Deep learning techniques have seen a huge development in the last decades with the introduction of the back-propagation algorithm and GPU implementations. Deep learning models can be used to approximate high-dimensional functions with high accuracy, but it works as a black box and lacks explanation and interpretation. Model interpretation and inference are important in industry, especially in medical applications. In this talk, I will discuss the connection between Deep Learning and statistical modelling and give the direction of producing more interpretable neural network models with a benefit both from the methodology behind statistical modelling and deep learning and for the applied settings. In particular, we will consider applications in medical imaging, with a focus on brain MRI, and discuss challenges and open questions.

Supervisor/s: Pierre Lafaye de Micheaux; Clara Grazian

About the speaker: Hi, my name is Qian Jin, from Shanghai, China. I completed my Bachelor's degree in Applied Mathematics at Shanghai University and a Master's Degree in Statistics at Australian National University. I'm currently doing my PhD in statistics since Sep 2021.

On the optimization of Bayesian deep learning

Xiongwen Ke

Bayesian neural networks (BNNs) can improve the robustness and uncertainty quantification of modern deep learning. However, they often underperform on metrics such as accuracy and do not scale well. A possible reason is that the best optimization strategy and parameterization for BNNs remain unknown. A second challenge is maintaining a distribution over weights incurs a significant cost both in additional parameters and runtime complexity.

In this work, we propose a new optimization algorithm which is tailored to BNN. To address the computational challenge, we perform Bayesian inference on nodes space rather than weight space. Using our parametric strategy, BNN has less than 0.1% more parameters than traditional NN and its training time is only around 10% more. Combing with these two techniques, we achieve the state-of-the-art performance on log-likelihood and accuracy in classification task from CIFAR-10/100 and ImageNet dataset.

Supervisor/s: Yanan Fan

About the speaker: I am PhD student from statistics. This is my last postgrad conference. I will finish on Feb 2023.

Evaluating and mitigating implicit bias in student evaluations of teaching

Plenary Colombo A
Session 1

Fiona Kim

This research aims to understand the prevalence of implicit bias in student evaluations of teaching (SET) by using natural language processing techniques to identify drivers behind the discrepancies amongst lecturer ratings. To the best of our knowledge, previous studies exploring bias in the higher education setting haven't incorporated student comments into the models, though the richness of this qualitative data can prove to provide compelling insights in this area. This study aims to fill that gap by converting student comments into a numerical score and using the results as features to predict the ordinal SET scores students assign their lecturers. The results show a potential bias against lecturers from a minority group. To mitigate these biases, the effectiveness of an intervention message is explored, with findings showing that the messaging influences the behaviour of the students, making them more favourable to those of a different gender and/or ethnicity group to themselves.

Supervisor/s: Yanan Fan & Emma Johnston

About the speaker: Prior to commencing her PhD, Fiona spent years working as an Analytics and AI Consultant with Deloitte Consulting. She graduated with First Class Honours in Economics from UWA.

BBDrift v1.0: a new Lagrangian particle tracking module for the Bluebottle

Colombo B
Session 3

Daniel Lee

The Bluebottle (Physalia physalis) is a colonial animal resembling a jellyfish that is well known to Australian beachgoers for the painful stings delivered by their tentacles. Despite being a common occurrence, the origin of the Bluebottle before reaching the coastline is not well understood and there is a lack of publicly available tools or models for this purpose. Previous studies that used Lagrangian particle tracking to simulate Bluebottle drift involved numerical models in combination with simple assumptions to calculate the drift of this species, excluding complex drifting dynamics. I have developed BBDrift, an open-access particle tracking module for simulating Bluebottle drift in a Lagrangian framework based on the hydrodynamic and aerodynamic forces acting on the Bluebottle. A sensitivity analysis has shown the influence of different parameterization on Bluebottle drift, including sail orientation and shape. BBDrift provides ecological modellers with a convenient and flexible tool, encouraging more research in this field. This can lead to a better understanding and forecasting of Bluebottle drift and potential beachings, helping prevent stings from impacting tens of thousands of beachgoers per year.

Supervisor/s: Amandine Schaeffer, Moninya Roughan

About the speaker: After 2.5 years in the corporate world, I returned to UNSW to pursue my interests in maths, science and research. In 2020 I completed my Honours in Applied Mathematics at UNSW, supervised by Amandine Schaeffer. In 2021 I started my PhD. After finishing my PhD I am interested in a future career in research.

Using finite geometry tools in extremal graph theory

Thomas Lesgourgues

Extremal graph theory aims at finding structures maximising or minimising a given properties, under certain constraints. Often these structures must exhibit some deep regularity properties. Finite geometry tools (e.g. projective planes over a finite field) are then a very useful source of ideas to build our constructions. In this talk I will present two extremal graph problems, how they relate to finite geometry, and examples of such constructions yielding bounds for our graph problems.

Supervisor/s: Anita Liebenau

About the speaker: Thomas is currently in Europe at a number of combinatorics conferences.

Estimating effect size in multivariate analysis using bootstrap inversion

Michelle Lim

Multivariate analysis is widely used to study ecological communities, using abundance data collected simultaneously across many taxa. Effect size measures are widely used in statistics - for example to report on the size of a treatment effect, for meta-analysis, power simulation or equivalence testing - but measuring effect size in an intuitive way is challenging in the multivariate setting, where many parameters are used to capture the multivariate effect (β_j for taxon j). Here we explore an approach which reduces effect size to a single parameter (ρ) by using domain knowledge to classify taxa as "increasers" ($\beta_j = \rho$), "decreasers" ($\beta_j = -\rho$) and "no-effect" ($\beta_j = 0$) taxa. We have previously used this parameterisation to develop procedures for power analysis and equivalence testing of multivariate abundance data (implemented in R package `ecopower`), and in this study, we address the question of how to estimate and make inferences about ρ from a given multivariate dataset. We apply bootstrap inversion, a simulation-based approach which uses the duality between hypothesis testing and confidence intervals, and explore different stochastic optimisation tools to construct a confidence interval for ρ in an efficient and stable fashion.

Supervisor/s: David Warton

About the speaker: Michelle has a keen interest in developing easy-to-use software to support applied researchers, particularly ecologists, in their analyses.

Estimation of skew-diffusion and its local time

Colombo B

Session 4

Guanting Liu

The parametrix method is a classical method in order to construct fundamental solutions for parabolic type partial differential equations using a "Taylor-like" expansion argument. It has been introduced into stochastic analysis using a semigroup approach, to obtain weak uniqueness and density representations for stochastic differential equations. Results have been obtained for skew diffusions, and also for diffusion paired with its local time, and our project is focused on applying the parametrix method to obtain weak uniqueness and explicit density representations for skew diffusion with its local time.

Supervisor/s: Libo Li

About the speaker: I am from PR China and I've been stubborn not picking a preferred name. I am in my 4th year and I really should lock up myself and work. Yes I had been stuck overseas for 2 years. I did my 5-year undergrad here at UNSW as well. I've gotten into fitness during the pandemic.

Translation invariant operators on noncommutative spaces

Jimeng Lu

Translation invariant operators on various function spaces have always been the object of intensive study. Generally speaking, a bounded translation invariant operator can be characterized by convolution with a suitable discrete measure in a wide range of function spaces. A classical result with regard to the boundedness of translation invariant operators is A.M. Shteinberg's proof of G. Pisier's conjecture in 1984 that every bounded convolution operator on $L^{p,\infty}$ over a compact group is also bounded on L^p for $0 < p < 2$. We are concerned whether such characterizations and boundedness properties still hold true for translation invariant operators on function spaces over noncommutative planes.

Supervisor/s: Fedor Sukochev, Dmitriy Zanin

About the speaker: I'm Jimeng from China. Arrived in Sydney in February. Wish the pandemic will come to an end asap.

Developing methods to automatically detect animals in ecological monitoring videos

Colombo A

Session 2

Ben Maslen

With the rise of camera traps and monitoring video cameras, capturing image and video data of wildlife has never been easier for Ecologists. This is vital in managing wildlife populations and our impact on to them as a non-invasive and relatively inexpensive sampling method. These monitoring methods are however being held back by the vast amount of time it takes to analyse and categorise monitoring footage and camera trap data. As part of my thesis, I am developing methods to automate this procedure through computer vision algorithms such as convolutional neural networks or self-attention models. Of particular interest to my thesis, is improving existing algorithms by including an animal's short term movement pattern into the detection pipeline. Movement information can be modelled using frame differencing, optical flow, background subtracting or short-term tracking; all of which will be trialled and compared throughout my thesis. This movement information has been largely underutilised in literature and is freely available in monitoring videos and camera traps to improve detections. This research will help to allow Ecologists to spend more time in the field doing what they love and provide an opportunity to massively upscale the use and impact of ecological monitoring videos.

Supervisor/s: David Warton, Gordana Popovic, Dadong Wang

About the speaker: I grew up in Newcastle and moved to Sydney to do my undergraduate degree at UNSW. I spent a few years working as a statistical analyst/consultant and have now come back to UNSW to do my PhD (in my second year). I also happen to be the president of UNSW Underwater Rugby club, and will be travelling to Berlin in November to represent Australia at a global competition!

Optimization methods for the Column Subset Selection Problem (CSSP)

Colombo B
Session 4

Anant Mathur

In this talk, I will discuss the problem of Column Subset Selection Problem (CSSP), where the goal is to select a small but representative sample of column vectors from a large matrix. This method is among the leading tools for constructing small low-rank approximations of large datasets in machine learning and scientific computing. It is well-known that solving the exact problem is NP-hard in general and the best current methods consist of either randomly sampling or greedily selecting columns. Recent work has been done in a different context, best subset selection in linear regression, to show that you can approximate the solution through a continuous optimization algorithm. This method turns out to be very fast, making the problem feasible when the data set is very large. I will show how one can extend this idea to formulate a continuous optimization framework for solving the Column Subset Selection Problem in matrices.

Supervisor/s: Dr. Zdravko Botev & Prof. Spiridon Penev

About the speaker: I did my undergraduate studies at UNSW and now I'm in my second year of PhD. I enjoy watching lots of sport but I'm no good at playing any of them!

Model-based hypothesis testing for multivariate abundance data

Maeve McGillycuddy

Ecologists frequently wish to use multivariate abundance data to test hypotheses about ecological communities and their response to experimental treatments or environmental perturbations, currently achieved using resampling methods (e.g. via the mvabund or vegan package). However, this approach becomes problematic when random effects are desired in the model, e.g. for hierarchical or repeated measures sampling designs, because resampling techniques typically do not extend naturally to the mixed models setting. Instead we explore a model-based inference approach, using generalised latent variable models fitted via the `glmmTMB` package in `R`. The `glmmTMB` package is an extension of `lme4` for mixed modelling, capable of accommodating complex study designs, to which we have added factor analytical functionality (via the `rr` variance structure) to handle multivariate responses with high dimension.

We express the problem of testing for a (multivariate) treatment effect as a test of whether a fixed effect and variance component is zero. Standard tests such as the likelihood ratio and Wald tests are not asymptotically Chi-squared distributed as standard regularity assumptions are not satisfied, because the null value of the variance component is on the boundary of the parameter space. We examine the appropriateness of the likelihood ratio test and compare the performance to resampling.

Supervisor/s: David Warton, Gordana Popovic

About the speaker: I studied Financial Mathematics and Actuarial Science at UCC, Ireland. With no interest in the financial world, I made a great decision to move across the globe to do a PhD in ecological statistics in 2019. To remain sane I rock climb and visit breweries, otherwise you'll probably find me in the Blue Mountains!

Semi-degenerate superintegrable systems

Jeremy Nugent

Superintegrable systems are physical systems with the maximal possible symmetry. They are interesting objects because they are rare (sort of), their physical properties are simpler than a 'standard' physical system, and their symmetry algebras aren't linear, but quadratic. Most of the study for superintegrable systems has been for the *nicest* cases, however if we relax an assumption, we can recover Semi-degenerate superintegrable systems which are still interesting but with some added hurdles.

Supervisor/s: A/Prof. Jonathan Kress, Dr. Joshua Capel

About the speaker: I grew up in the far away mystical land of Kenthurst. I have been studying at UNSW since most current PhD students were in high school (or possibly primary school). I love my wife and child (soon to be children) and I enjoy a lot of different types of music and making my own music.

A precis on Symbolic Data Analysis and its new horizons

Prosha Rahman

Symbolic Data Analyis (SDA) is a new field of statistics in which the observed data —symbols— contain some internal variation, as opposed to points in Euclidean space, for example. These symbols can be observed at face-value, but are frequently obtained through aggregation and summarisation of large datasets. The landscape of existing SDA literature is dominated by analyses, construction, and conclusions in the former setting. We shall inspect results of the latter case, which builds upon the work of Beranger et al. (2018). This discussion will compare results between each setting, as well as present some novel asymptotic results within SDA. We shall conclude the discussion by presenting some conjectures —to be hopefully proved within this thesis— and future directions of research.

Supervisor/s: Scott Sisson and Boris Beranger

About the speaker: I studied undergrad and honours at UNSW (been here for 9 years!). My first paper took 3 years to get published. I won the Sydney Shires first grade championship (Cricket) a few months ago. I hate the cold.

Normal families of elements in indexed algebras

Jackson Ryder

While it is well known that in a commutative domain one can always localise and adjoin a two-sided inverse for any non-zero element, such as how we construct $\mathbb{Q}$ from $\mathbb{Z}$, in the noncommutative case it is possible that no such ring of fractions exists, or even that only a "right-not-left" or "left-not-right" ring of fractions exists. However if an element g of a domain R is normal, in the sense that gR=Rg, then it is always possible to adjoin an inverse to g which creates a two-sided ring of fractions. This idea also extends naturally to graded domains. Furthermore, it can be extended to the case of indexed algebras, a class of bigraded algebras which arise in noncommutative algebraic geometry. For indexed algebras, however, a single normal element must be replaced with a 'normal family of elements'. We will show how this is done, and also that these normal families of elements share many of the same desirable properties of normal elements in the ungraded case.

Supervisor/s: A/Prof. Daniel Chan

About the speaker: I am originally from Queensland and completed my bachelors at the University of Queensland in 2019. I undertook my honours year at UNSW in 2020, most of which was still spent in Queensland, and began my PhD here at the start of the 2021. In my free time I enjoy going to the gym and powerlifting.

Approximating distribution functions in uncertainty quantification using quasi- Monte Carlo methods

Colombo B

Session 1

Abi Srikumar

As high-dimensional problems become increasingly prevalent in many applications, the effective evaluation of these problems within the limits of our current technology poses a great hurdle due to the exponential increase in computational cost as dimensionality increases. One class of strategies for evaluating such problems efficiently are quasi-Monte Carlo (QMC) methods. Recently the application of quasi-Monte Carlo methods to approximate expected values associated with solutions to elliptic partial differential equations with random coefficients in uncertainty quantification has been of great interest. In this talk, we look into extending this from the computation of expected values to the approximation of distribution functions by reformulating these functions as expectations of an indicator function. However this requires the integration of discontinuous functions and hence the need for preintegration, whereby we integrate out a single variable of the discontinuous function in order to obtain a function of one dimension less with sufficient level of smoothness to apply QMC methods. We also present some theoretical results regarding the error bounds associated with such approximations and the results of numerical experiments.

Supervisor/s: Frances Kuo, Ian Sloan and Alec Gilbert

About the speaker: Hi! :D I am a second year PhD student studying the application and theory of quasi-Monte Carlo methods. I was in Austria/Germany over the last three weeks so hopefully the jetlag doesn't come through in the presentation :P

A Generalisation of the Spectral Theorem for Bounded Self-adjoint Operators

Colombo C
Session 2

Alan Stoneham

A classic result in the spectral theory of operators is the spectral theorem for self-adjoint operators on Hilbert spaces. A generalisation of this theorem for operators on Banach spaces was established with the theory of well-bounded operators, which are operators that possess a functional calculus for the absolutely continuous functions on some interval $[a, b]$. Such operators have real spectrum, and adapting this theory to operators with complex spectrum has been met with limited success, largely due to complications in defining absolutely continuous functions on subsets of the complex plane $\mathbb{C}$. Over the 2000s, Ashton and Doust developed a new notion of absolute continuity for functions defined on compact subsets of $\mathbb{C}$. In this talk, we will discuss a generalisation of the theory of well-bounded operators to some operators with complex spectrum using Ashton-Doust absolute continuity.

Supervisor/s: Ian Doust

About the speaker: I did my undergraduate studies at UNSW with a second major in physics. I am expecting to submit by the end of the year. I also enjoy playing bridge and have played on the NSW youth team a couple of times.

Sparse optimization: A generalized version of MCP regularization

Colombo B
Session 1

Dinh Duy (Ryan) Tran

Sparse optimization is an active area of research which has many applications such as image processing, neural-network, etc; and its performance greatly depends on the choice of sparsity-induced regularization. Some well-known examples of such regularization are ℓ_0 norm and its convex relaxation ℓ_1-norm. However, it has been shown that the discontinuity of ℓ_0-norm has negative impact on the stability of the optimization algorithm, while ℓ_1 does not perform well in complex cases such as high dimensional problems or data matrix with high mutual-coherence. Thus, some continuous non-convex regularizations such as MCP, SCAD and ℓ_p-norm $(0 < p < 1)$ have been investigated due to their promising numerical results in those scenarios. In this talk, we will introduce a new class of non-convex regularization which generalizes the MCP, and if time permits, we will also provides overview on convergence-rate analysis of optimization algorithm under Kurdyka-Lojasiewicz assumption.

Supervisor/s: Josef Dick, Guoyin Li

About the speaker: Ryan is nearing the end of his PhD studies.

Joint modeling of longitudinal and multi-state data with functional predictors

Rianti Siswi Utami

Time-to-event data refers to time until the occurrence of certain event, such as time to death of HIV patients. When the event of interest is more than one, for example, healthy - diseased - dead, then it is considered as multi-state data. In some cases, the event can be affected by longitudinally measured independent variable taken from the subject itself, such as blood pressure or CD4 counts. It then leads to reverse dependency because the existence of the independent variable depends on the subject's survival. Joint model of longitudinal and time-to-event data arises to analyse this type of dependency. In the joint model, the longitudinal and time-to-event data are modelled in separate submodels and then linked together through an association parameter. One of recent developments of the joint model includes multi-state data as the event of interest. Another recent development incorporates functional data, such as growth curve and heart rate, as predictors in both submodels. In this talk I will discuss the combination of multi-state data and functional predictors in the joint model. I will explain the main idea of model formulation and parameter estimation.

Supervisor/s: Prof. Jake Olivier, A/Prof. Pierre Lafaye de Micheaux, A/Prof. Maarit Laaksonen

About the speaker: I am from Indonesia and I took my undergraduate and master degrees in Universitas Gadjah Mada, Indonesia. Currently, I am in my third year of my PhD.

Adjustable robust optimization for radiotherapy with evolving uncertainty through first order methods

Colombo B

Session 1

Peter Wu

Adjustable robust optimization (ARO) which is an extension of the commonly used static (single-stage) robust optimization has proved to be a powerful deterministic methodology to handle multi-stage decision-making problems with fixed uncertainties. However, in many multi-stage models, uncertainty evolves over time and has to be represented as a function of time rather than using fixed uncertainty sets for different times. We look at an ARO approach to time-dependent uncertainty sets for an affinely adjustable multi-stage linear model, with a particular application in radiotherapy. We also introduce first order splitting algorithms such as accelerated proximal gradient and proximal ADMM and look at the potential to solve ARO through these methods.

Supervisor/s: Guoyin Li

About the speaker: I'm a 2nd year PhD student focusing on first order methods in optimisation. I've recently come back to campus after a long period of working from home. I have a great recipe for stir fry pork.

Stochastic Variational Bayes Approximation for GARCH Time Series Models

Colombo B

Session 4

Thomas Xuan

Variational Bayes (VB) has become increasingly popular for both Machine Learning community and Bayesian inference in some computationally challenging posteriors. VB is an attractive alternative to the traditional Markov Chain Monte Carlo sampling method as VB in general has much less computational cost, especially in the high dimensional case. It is an optimization-based technique to approximate the posterior distribution from a family of known densities. Stochastic optimization algorithms are implemented in order to find a stable and optimal unbiased estimator. In this talk, VB is applied into the well-known econometric time series Generalized Autoregressive Conditional Heteroskedasticity (GARCH) models. It builds up the foundations and can be further extended to the missing data area or sequential updating version that can be essential in the portfolio optimization framework.

Supervisor/s: Dr. Feng Chen and Dr. Clara Grazian

About the speaker: I did Bachelor of Advanced Mathematics (Honours) and Commerce in UNSW. I was originally from China, but I have been in Australia for more than 10 years. This year is my second year of my PhD study. During the pandemic, I play some chess games when I have some free time.

Approximate Equivariance SO(3) Needlet Convolution

Kai Yi

This paper develops a rotation-invariant needlet convolution for rotation group SO(3) to distill multiscale information of spherical signals. The spherical needlet transform is generalized from S^2 onto the SO(3) group, which decomposes a spherical signal to approximate and detailed spectral coefficients by a set of tight framelet operators. The spherical signal during the decomposition and reconstruction achieves rotation invariance. Based on needlet transforms, we form a Needlet approximate Equivariance Spherical CNN (NES) with multiple SO(3) needlet convolutional layers. The network establishes a powerful tool to extract geometric-invariant features of spherical signals. The model allows sufficient network scalability with multi-resolution representation. A robust signal embedding is learned with wavelet shrinkage activation function, which filters out redundant high-pass representation while maintaining approximate rotation invariance. The NES achieves state-of-the-art performance for quantum chemistry regression and Cosmic Microwave Background (CMB) delensing reconstruction, which shows great potential for solving scientific challenges with high-resolution and multi-scale spherical signal representation.

Supervisor/s: Yanan Fan

About the speaker: I'm third year PhD student in School of Mathematics and Statistics. I'm interested in Geometric Deep Learning, Graph Neural Network and Bayesian Inference. I studied in Shanghai for two years because of Covid and have just returned to Sydney.

Vulnerable exchange option under DRSJD models

Colombo A

Session 3

Ashwaq Zarban

In recent years, more and more financial institutions trade with their counterparties in the over-the-counter (OTC) market. The exchange option is one of them that requires considering credit risk when pricing such an option. Our work take into account the pricing of vulnerable exchange options under our suggested models in which all the parameters in the dynamic are modulated by a continuous-time Markov process with a finite state space.

Supervisor/s: Dr. Donna Salopek & Dr. David Colwel

About the speaker: I am from Saudi Arabia. I got my master's degree at Queensland University in Brisbane. I am in my final year. My family especially my kids is my inspiration to do my degree. In my leisure time, if there is any, I love reading storybooks especially crime ones.

Diagonality modulo hybrid Lorentz-$(p,1)$ ideals in semi-finite factors

Hongyin Zhao

Let H be a infinite dimensional separable Hilbert space and $B(H)$ be the set of all bounded operators on H. Let $n \in \mathbb{N}$. Suppose $\alpha = (A_1, \ldots, A_n)$ is an n-tuple of commuting self-adjoint operators in $B(H)$, it is called a diagonal n-tuple if there exists a unitary $U \in B(H)$ such that $(U^*A_1U, \ldots, U^*A_nU)$ is a n-tuple of diagonal operators. In general, α is not diagonal. A classical result of Voiculescu showed that the spectral measure of α is singular if and only if there exists compact operators $(C_1, \ldots, C_n)$ in the Lorentz class $\mathcal{C}_{n,1}$, such that $(A_1 - C_1, \ldots, A_n - C_n)$ is diagonal. We prove that if $B(H)$ is replaced with a certain type of von Neumann factor $\mathcal{M}$, then $(A_1, \ldots, A_n)$ is diagonal modulo the Lorentz ideals $L_{n,1}(\mathcal{M})$ if the spectral measure of $(A_1, \ldots, A_n)$ is singular; and the reverse direction is not true.

Supervisor/s: Fedor Sukochev

About the speaker: I am from China and have been in Australia since November 2021. I do my previous study in Harbin, China. I am in my second year of PhD. I improve my cooking skill in pandemic.

Regularized distributionally robust optimization and applications in index tracking

Colombo B
Session 3

Leyang Zhao

In recent years, distributionally robust optimization (DRO) has received a lot of interest due to its ability to reduce the worst-case risk when there is perturbation to the data- generating distribution. On the other hand, variable selection and regularization is a research area that aims to identify the important features and remove the redundant ones. We propose an optimization model that is a regularized version of the canonical distributionally robust optimization problem where the ambiguity set is described by the Kullback-Leibler (KL) divergence. The regularized DRO problem can be equivalently reformulated as a nonlinear conic programming problem. More generally, if the regularization can be written as difference of convex functions, a solution for the regularized DRO problem can be found by solving a sequence of conic linear programming problems. We apply the proposed regularized DRO model to both simulated and real financial data, and demonstrate its superior performance in comparison with some non-robust models.

Supervisor/s: Spiridon Penev, Guoyin Li

About the speaker: Prior to my PhD, I completed my Masters degree here at UNSW and Bachelor's degree at University of Melbourne. I am from China and I am in my last year of PhD.