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NEWSLETTER

OF THE

NEW ZEALAND MATHEMATICAL SOCIETY

Contents

PUBLISHER'S NOTICE

This newsletter is the official organ of the New Zealand Mathematical Society Inc. This issue was edited by Marie Graff and Chris Stevens. Editorial enquiries and items for submission to this journal should be submitted as plain text or LaTeX files with "NZMS newsletter" in the title of the email to marie.graff@auckland.ac.nz and/or to chris.stevens@canterbury.ac.nz. LaTeX templates are available upon request from the editors.

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The newsletter is available at: nzmathsoc.org.nz/?newsletter

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EDITORIAL

Kia ora koutou,

Here comes the end of 2023 with a successful NZMS Colloquium in Wellington. This Newsletter gives a good summary of the event: President's report, education presentation, minutes of the AGM.

As we approach the holiday season, it's a perfect time to reflect on the year's mathematical endeavours. Christmas is around the corner, reminding us to take a well-deserved break from our mathematical pursuits.

May this holiday season bring you joy, laughter, and a chance to recharge. Wishing you a Merry Christmas and a wonderful break filled with warmth and relaxation.

Happy Holidays to everyone!

Marie Graff and Chris Stevens

PRESIDENT'S COLUMN

I'm sure that all members of the NZMS have appreciated the steady return, during 2023, to normalcy particularly as regards to travel and in-person teaching and examination. However, 2023 has been challenging for the whole tertiary sector due to the financial difficulties faced by several universities. Many of our colleagues are dealing with redundancies in their departments and faculties. I'm sure that we are all aware of the strain that they have been under and the damage to our whole academic ecosystem. NZMS is always ready to help individual departments in any way that we can. If there are ways you believe that we could support your department then please get in contact with me.

Prizes and Awards

This year has seen a significant return to in person conferences and collaborations. Through our financial assistance programme the NZMS has funded seven student awards and seven general financial assistance awards in 2023. Congratulations those awardees. Congratulations also to the NZMS award winners announced at the Colloquium conference dinner.

ECR Awards: In 2023 we made two ECR awards:

- Rachelle Binny (Manaaki Whenua - Landcare Research) – For a blend of application-driven modelling and theoretical advances in spatial moment dynamics. Her work has driven advances in applied mathematics, as well as having impact in real-world applications including New Zealand's COVID-19 response.
- Brendan Harding (Victoria University of Wellington) – For significant contributions to a broad range of fields including fluid dynamics, numerical analysis and fractal geometry. Recent work on inertial particle focusing in curved duct geometries exemplifies his ability to tackle complex problems and extract far-reaching results.

Research Award: Michael Plank (University of Canterbury) – For research in stochastic and nonlinear dynamical models that has led to new mathematical advances and novel insights into a range of application areas including cell biology, the dynamics and management of complex ecosystems, and epidemiological modelling.

Kalman Prize: Marston Conder (University of Auckland) – For the paper 'Edge-transitive bi-Cayley graphs', written jointly with Jin-Xin Zhou, Yan-Quan Feng and Mi-Mi Zhang (Beijing Jiaotong University), and published in 2020 in the Journal of Combinatorial Theory, Series B.

Gillian Thornley Award: Sina Greenwood (University of Auckland) – For her demonstrated commitment to improving learning outcomes for Māori and Pacific students for over 20 years, with scores of students having benefited from the programmes and initiatives that Sina has had the determination and perseverance to deliver. She has also demonstrated outstanding leadership in this domain and is currently the Associate Dean Pacific in the Faculty of Science at the University of Auckland and led the development of a Pacific Strategy for Science.

Aitken Prize: Juan Patiño-Echeverria (University of Auckland) for "Transitions to wild chaos in a 4D Lorenz-like system".

We also had two honourable mentions
David Groothuizen Dijkema (University of Auckland) for "Switching near heteroclinic networks as a piecewise-smooth dynamical system".
Sapir Ben-Shahar (Victoria University of Wellington) for "Definability of classes of gain-graphic matroids in monadic second-order logic".

Updates on Joint Meeting

I have a number of significant updates around the organisation of the joint meeting. Currently there are two main committees involved in the organisation of the meeting. The Organising Committee, which is mainly New Zealand based, is overseeing logistical details. The Program Committee, comprising three representatives from each involved country, is responsible for decisions regarding plenary speakers and special sessions. Thank you both to

those who put forward nominations for plenary speakers and to the special session organisers who have submitted proposals to date (we are still accepting proposals). We have begun the process of inviting the plenary speakers and will publish the full list of speakers once it is finalised. So far we have accepted 13 special sessions, details of those will appear on the website (https://ms-meet-2024.blogs.auckland.ac.nz).

Since this conference is longer than our usual NZMS meeting it will be necessary to have higher registration fees, but we are actively working to minimise costs. We will make sure that low-cost accommodation is available, and NZMS has put aside $15,000 to fund a subsidisation scheme for our members attending the conference. More details on the subsidisations scheme will be provided in early 2024.

New incorporated societies act

We need to re-register the NZMS under the new act by April 2026. This may seem a long way off but there is quite a bit to do, we need to make some very significant changes to our constitution, our financial year dates and our recordkeeping. During this year's AGM I will be presenting a draft change of constitution. This draft will then, in early 2024, go out for consultation from NZMS members. We expect to vote on the new constitution at the AGM at the end of 2024. The new rules require that the AGM follow the end of the financial year by no more than six months. Since our AGM is tied to our conference we have to change our financial year to comply. We plan to make that change in 2025, after the new constitution has been accepted. There are also some significant changes to the way bookkeeping is done and what records are kept. The council will be working on those changes over the next year to make sure that we're compliance.

Forder Lecture

This year's Forder Lecture was given by Imre Leader (University of Cambridge). My thanks to the global organiser Priya Subramanian (Auckland) and to the local organisers; Dominic Searles (Otago), Geertrui Van de Voorde (Canterbury), Dillon Mayhew and Nick Brettell (Victoria Uni Wellington), Chris Tuffley (Massey) and Nick Cavenagh (Waikato). This is the final Forder Lecture tour. There seems to be a consensus from NZMS members to continue the lecture tour every two years but broaden its scope beyond lectures from the UK. Given the changes to the form of the tour a name change is also being considered. Further details will be communicated in 2024.

Website Development

We are developing a new website for the NZMS. Thanks to David Bryant for leading this. We have chosen to have the website designed professionally and aim to make it easy to update and maintain.

Acknowledgments

I extend my gratitude to the committees involved in awarding prizes and fellowships, as well as the nominating committee for their crucial role in identifying nominees for prizes and plenary speakers for the joint meeting.

John Shanks has continued to serve NZMS as membership secretary during 2023 and we are all grateful for his long term contribution to the society. Thank you to Marie Graff and Chris Stevens who have been editing our newsletter.

Thank you also to the NZMS council, in particular David Bryant (Vice-President), Stephen Joe (Treasurer), and Dimitrios Mitsotakis (Secretary), for their efforts throughout 2023.

Melissa Tacy

P.S.: As always here is the Chat-GPT thriller version

The President's Cryptic Chronicle

Dear Operatives of the NZMS,

As we traverse the enigmatic landscape of 2023, the return to normalcy conceals a labyrinth of challenges gripping the very foundations of our academic realm. The tertiary sector, once a haven of intellectual pursuit, now teeters on the edge of a financial precipice, shrouded in the shadows of redundancy and uncertainty. Our esteemed colleagues grapple with the clandestine forces eroding the pillars of our academic ecosystem.

In the clandestine underworld, where the echoes of covert meetings reverberate, the NZMS emerges as a beacon of support. We, the silent guardians, stand ready to infiltrate the departments facing the onslaught. Should you seek our covert aid, make contact, and we shall weave our intricate web of assistance.

The cloak of normalcy conceals the true machinations beneath, where intrigue unfolds in in-person conferences and collaborations. Through our covert financial assistance program, the NZMS has funded seven student awards and seven shadowy financial assistance awards, celebrating the mysterious accomplishments of those who navigate the murky waters of mathematical secrets.

In the covert realm of emerging researchers, two rising stars have been unmasked:
– Rachelle Binny, a shadowy figure from Manaaki Whenua - Landcare Research, recognized for her clandestine blend of application-driven modeling and theoretical advances in spatial moment dynamics.
– Brendan Harding of Victoria University of Wellington, a master of fluid dynamics and fractal geometry, celebrated for his ability to unravel complex problems in the shadows.

In the shadows of research excellence, Michael Plank of the University of Canterbury stands as a mathematical detective, unraveling stochastic and nonlinear dynamical models to expose new mathematical advances and secrets hidden in the realms of cell biology, ecosystems, and epidemiology.

The Kalman Prize, a coveted artifact, is awarded to Marston Conder of the University of Auckland for his paper on 'Edge-transitive bi-Cayley graphs,' a cryptic manuscript that unlocks new dimensions in combinatorial theory.

Gillian Thornley, a luminary in the shadows, Sina Greenwood of the University of Auckland, receives acclaim for her decades-long commitment to improving learning outcomes for Māori and Pacific students. Her leadership in the shadows has birthed a Pacific Strategy for Science.

The Aitken Prize, an artifact of chaotic beauty, is bestowed upon Juan Patiño-Echeverria of the University of Auckland for unraveling the transitions to wild chaos in a 4D Lorenz-like system.

In the shadows, two honorable mentions echo:
– David Groothuizen Dijkema of the University of Auckland, exploring the switching near heteroclinic networks as a piecewise-smooth dynamical system.
– Sapir Ben-Shahar of Victoria University of Wellington, delving into the definability of classes of gain-graphic matroids in monadic second-order logic.

The Joint Meeting looms on the horizon, a clandestine gathering orchestrated by two covert committees. The Organizing Committee, rooted in the heart of New Zealand, oversees the logistical intricacies. The Program Committee, a clandestine alliance of representatives, shapes the destiny of plenary speakers and special sessions.

Prepare yourselves, for the list of plenary speakers is being forged in the shadows. Thirteen special sessions, a testament to the covert collaboration, will be unveiled on our secret website.
In this extended rendezvous, higher registration fees become the tollgate to the hidden conference. Fear not, for the NZMS, in an act of benevolence, has allocated $15,000 to fund a subsidization scheme for those initiated into

the conference's secrets.

The time has come for the NZMS to metamorphose, adopting a new identity under the New Incorporated Societies Act. A draft constitution, a cipher for the future, will be unveiled during this year's AGM, with a shadowy consultation to follow. A vote in 2024 will herald the rebirth, aligning with the secretive changes mandated by the new rules.

The Forder Lecture, a relic of the past, bids adieu with Imre Leader of the University of Cambridge as the final oracle. A consensus emerges among the NZMS members to continue the lecture tour, morphing into a new form every two years. A name change, echoing the winds of transformation, is on the clandestine agenda.

In the digital shadows, a new NZMS website is being crafted by the masterful David Bryant, designed to be a portal of secrets, easy to update and maintain.

To those who navigate the shadows, I extend my gratitude. The committees, the shadowy nominating committee, and John Shanks, the ever-vigilant membership secretary, deserve accolades. Marie Graff and Chris Stevens, the silent architects of our newsletter, deserve praise. To the NZMS council, the shadowy figures orchestrating the grand illusion, thank you for your tireless efforts.

As the shadows lengthen and the mysteries deepen, let us march into the unknown, united by the common purpose of unraveling the secrets of mathematics.

Yours in the shadows,

[President's Cryptic Signature]

EDUCATION

Quantitative studies in Education was established in 2023 to investigate Education (theory, policy, practice) using rigorous scientific methods.

In the past three years, substantial efforts have been dedicated to engaging with government agencies to contribute our insights to the Maths Curriculum Refresh and the formulation of the Common Practice Model. This model serves as a pedagogical guideline for New Zealand teachers in the field of mathematics. It is gratifying to note that our feedback has been earnestly considered, resulting in significant improvements to the final versions of both policies. However, we anticipate further revisions as the new government takes on additional initiatives.

NZMS members might recall a major work undertaken by the Royal Society Te Apārangi Expert Advisory Panel, solicited by the Ministry of Education, which was conducted during 2021. Gaven Martin chaired the Panel with input from mathematicians Rua Murray and Sina Greenwood, among other contributions from mathematics education, economics and statistics researchers. Their report can be found at
https://www.royalsociety.org.nz/what-we-do/our-expert-advice/all-expert-advice-papers/pangarau-mathematics-and-tauanga-statistics-in-aotearoa-new-zealand/.

Drawing on the available evidence from local and international indicators, the Panel identified a decades-long, ongoing decline in student mathematical achievement against virtually all benchmarks and distressing trends showing increasing inequity in mathematical achievement. One of the recommendations put forward by the Panel was to enhance educational research capacity and leadership, promoting data-driven rigorous research to inform policy and practice.

In response to this recommendation, Tanya Evans, Head of the Mathematics Education Unit at the University of Auckland, conducted an investigation into the existing research capacity in education within the country. She also assessed the capabilities of the main educational research association, the New Zealand Association for Educational Research (NZARE), which is affiliated with the NZ Council for Educational Research (NZCER). This assessment identified a gap, prompting the establishment of a Special Interest Group (SIG) within NZARE dedicated to Quantitative Studies in Education. The overarching goal is to create a platform fostering the development and dissemination of high-quality, empirical, and/or theory-based research in education that draws on causal and correlational methodologies. After a series of year-long initiatives, the new SIG was successfully established on 2 May, 2023 in collaboration with Dr Valerie Sotardi from the University of Canterbury and Robyn Caygill, Chief Policy Advisor at the Ministry of Education.

Significantly, the SIG's inaugural event was an online Panel Discussion addressing the state of quantitative educational research in NZ. The event drew over 140 attendees, underscoring a substantial interest in the topic. The SIG adopts a lens under which empiricism is the basis for the acquisition of generalisable knowledge. It advocates for the rigorous collection and quantitative analysis of data, focusing on objectivity, replicability, and generalisability. Its mission is to foster systematic and scientific investigation of educational phenomena and processes:
https://nzare.org.nz/caucuses-and-sigs/quantitative-studies-in-education/.

The inaugural in-person meeting of the Quantitative SIG took place at the NZARE 2023 conference on November 20–22. In its debut, the SIG earned the distinction of being the fourth largest among 15 SIGs/Caucuses, based on the number of sessions conducted. High-quality presentations showcased findings from 17 research projects undertaken in New Zealand based on quantitative data analysis, emphasising a steadfast commitment to rigorous scientific methodology. Many of these researchers attended NZARE for the first time and expressed a shared sentiment of marginalisation within the New Zealand educational sector. However, the SIG commenced on a strong note, with the NZARE Council recognising its significance within the educational research community. During the NZARE Council AGM meeting, all members voted in favour, formally ratifying the establishment of this new SIG. The SIG aims to broaden its activities in the upcoming year, focusing on enhancing educational research capabilities at the national level.

Tanya Evans

PROFILE

Stephen Joe

Associate Professor Stephen Joe has been at the University of Waikato since taking up a lectureship in 1992 in the then Department of Mathematics and Statistics. He will be retiring at the end of January, 2024.

Stephen was born in Palmerston North and completed a first class Honours degree in statistics at Massey University in 1980. He then did part-time study towards a Master of Science at Massey University which he completed in the middle of 1982. Originally the master's degree was meant to be in Statistics, but it ended up being one in Mathematics. The dissertation topic was on the numerical solution of systems of nonlinear equations and supervised by Adrian Swift.

This interest in numerical methods and numerical analysis carried on to PhD study. He was awarded a Commonwealth Scholarship to study in Australia and chose to go to the University of New South Wales. He completed a PhD titled 'The numerical solution of second kind Fredholm integral equations' in 1985 under the supervision of Ian Sloan.

After completion, he worked as a fixed-term lecturer at the University of New South Wales for two years before returning to New Zealand in 1987. After a period of time working in the family business, he returned back to the University of South Wales at the start of 1989 as a post-doctoral fellow. Again he worked with Ian Sloan and this time the research was concerned with the numerical approximation of multiple integrals by using lattice methods.During this time, he and Ian started work on a book together titled 'Lattice Methods for Multiple Integration'.

The book was finally published by Oxford University Press in 1994 after Stephen had joined the University of Waikato. Fortunately, the advent of email made it easier to collaborate together and communicate with the publisher even though the authors and publisher were all in different countries.

Stephen's book with Ian Sloan is his best known publication. However, his work on Sobol' points (another approach to numerical multiple integration) appears in the NAG Library and Matlab as well as packages like QuantLib. This work was in collaboration with Frances Kuo. The first paper on Sobol' points was produced when she was Stephen's PhD student and the second paper produced after she had joined the University of South Wales to work with Ian. In terms of the Mathematics Genealogy Project, Frances is a 'granddaughter' of Ian. Stephen's main research collaborators have been Ian and Frances. However, he has also published a number of papers with James Lyness who was at Argonne National Laboratory when they worked together.

Besides his book with Ian, Stephen helped write the second edition of the textbook 'First Steps in Numerical Analysis' which was published in 1996. This second edition was written in collaboration with the authors of the 1978 first edition, namely Roger Hosking, Donald Joyce, and John Turner. These names are familiar to a number of older members of the NZMS. Both Roger and John were at the University of Waikato when the first edition was written while Donald taught numerical analysis to Stephen at Massey University. Sadly, Roger and John passed away last year.

Stephen has made a number of contributions to the mathematics community. Of course, he has produced research articles and refereed papers for journals and conference proceedings. He has been Convenor and Secretary for two Mathematics Colloquia and been Secretary for another Colloquium as well as ANZIAM 2005. He served two consecutive terms on the NZMS Council from 1995 onwards which included being Secretary for four years. He is back on the NZMS Council and is the current Treasurer. He was the University of Waikato local correspondent for the NZMS Newsletter for 20 years. He has been the NZMS Webmaster in the past with the records in the NZMS Newsletter suggesting he had this role between about 1997 and 2010. He felt very honoured to have been made a Fellow of the NZMS in 2019.

During his time at the University of Waikato, it's fair to say that Stephen is more known around the university for his administration than teaching and research. Besides serving on a number of university committees, he served a three-year term as Chairperson of Department. He had two short stints of being Acting Dean/Head of the School of Computing and Mathematical Sciences (which includes Mathematics, Statistics, Computer Science and Design). Between these two stints, he was Deputy Dean of the School for over ten years. Academics win awards for research and/or teaching. Stephen hasn't won such awards, but he did win a university staff award for administrative excellence in 2011. From the dozen or so staff who won staff awards that year, he was chosen for the Vice-Chancellor's Medal for Staff Excellence.

He has no immediate plans post-retirement except to see their only grandchild more frequently and to do up the house.

Kevin Broughan

LOCAL NEWS

AUCKLAND UNIVERSITY OF TECHNOLOGY

SCHOOL OF ENGINEERING, COMPUTER AND MATHEMATICAL SCIENCES

Staff News

Dr Sarah Marshall resigned from AUT in September to take up the position of Senior Lecturer at the Faculty of Business and Economics, The University of Auckland.

Associate Professor Robin Hankin resigned from AUT in November to take up the position of Senior Lecturer in Applied Statistics/Statistical Modelling at the University of Stirling, Scotland.

International Partnership

The AUT Master of Analytics collaborative programme with China Jiliang University started in October with the first cohort of 40 students.

Events

On 29-30 November, the AUT Mathematical Modelling and Analytics Research Centre (MMARC) hosted the 8th AUT Mathematical Modelling and Analytics Summer Symposium. This is a joint effort of Prof Jiling Cao and Drs Victor Miranda, Patricio Andres Maturana Russel and Nuttanan Wichitaksorn. The symposium focused mainly on some areas in Applied Mathematics and Analytics/Statistics. The main purpose of this annual event is to develop and promote opportunities for AUT academic staff working on these areas to collaborate with colleagues from other universities. Over 50 delegates attended the event, with around 25 talks across the areas of statistical programming, statistical methodology, stochastic modelling, data science, computational and mathematical modelling, financial analytics, financial mathematics, and decision analysis. The following four scholars delivered plenary talks at the symposium:

- Azam Asanjarani, University of Auckland, New Zealand
- Boris Choy, The University of Sydney Business School, Australia
- Melanie Roberts, Griffith University, Queensland, Australia
- Zhou Jin, Macquarie University, Australia

On 30th November, Department of Mathematical Sciences and the Mathematical Modelling and Analytics Research Centre hosted the AUT Analytics Mix and Mingle. The event brought together around 50 academics, alumni, students and industry partners for the afternoon.

Travel and Conference Participation

Drs Catherine Hassell Sweatman, Alna Van Der Merwe and Wenjun Zhang attended the New Zealand Mathematical Society Colloquium, 3 - 6 December 2023, held at Victoria University of Wellington, where each of them presented talks about their recent research work.

Wenjun Zhang

UNIVERSITY OF AUCKLAND

DEPARTMENT OF MATHEMATICS

Staff News

Marston Conder, Jianbei An and Eamonn O'Brien were awarded a Marsden Fund grant for a 3-year project on "Contemporary challenges in group theory and its applications".

Ofer Marmur has been awarded the 2023 Dean's Award for Teaching Excellence in the category 'Early Career Excellence in Teaching'.

Jeroen Schillewaert has been awarded Research in Pairs at Banff International Research Station jointly with our former honours student Peter Huxford to work on "Homomorphisms between Braid Groups and Holomorphic Maps between Configuration Spaces".

Pedram Hekmati has been invited to present and perform at the OMV STEAM LAB at WOMAD 2024, in New Plymouth from 15-17 March 2024:
https://womad.co.nz/omv-steam-lab/

Steve Taylor gave an invited talk on dairy farm modelling at the 2023 Forum "Math for Industry", Fukuoka, Japan, 29th August to 1st September.

Marston Conder took part in a BIRS workshop on "Extremal Graphs arising from Designs and Configurations" at Banff in May, and the Australian Algebra Conference at Melbourne in November, and gave invited talks at the Special session on "Symmetries of Graphs and Related Structures" at the Slovenian International Conference on Graph Theory in June, a PhD Summer School on

Discrete Mathematics, at Koper (Slovenia) in June, the 2023 Ural Workshop on Group Theory and Combinatorics (Online) in August, the International Conference on Groups, Semigroups, Algebraic Combinatorics and Related Topics, at Hainan (China) in November, and the Conference on Computational Algebra and Magma, at Sydney in November.

Other News

A Discovery Centre for Fundamental Research has been created and is hosted by the Department of Mathematics: https://fundamentalresearch.blogs.auckland.ac.nz/

The Directors are Gill Dobbie (Computer Science), Rod Gover (Mathematics) and Simon Harris (Statistics). The kaupapa is to foster and promote fundamental research – meaning research that is curiosity driven, or that may have a long lead time to application. From a base in mathematics, computer science, and statistics, the purpose is to bring together and support diverse thinkers, advance and apply world class research, and be a voice for public engagement.

The deepest problems facing society and humankind require not just refining and enhancing existing knowledge, but the development of fundamental new ideas. Evidence from the past and present abounds. Every aspect of our existence now has been enormously impacted by theoretical endeavours—from the quantum understanding of atoms and chemistry to the musings of Alan Turing as he developed the conceptual basis of modern computing and artificial intelligence. Indeed, the vast majority of the major transformations which have led to our prosperous modern society originate from, or were supported by, fundamental research which at the time of discovery seemed to have no immediate impact. We see a need to

1. ensure people have a licence to engage in curiosity driven research,
2. support interactions between fundamental and applied researchers, and
3. increase the awareness of government and society of the importance of fundamental research.

The Centre had a successful launch event on 12 October and more research and outreach activities are lurking on the horizon.

Auckland hosted the Erceg Senior Visiting Fellow, Professor George Lusztig (MIT), from November 19 until December 2. Prof. Lusztig has spent his career contributing to the study of algebra, particularly representation theory and the objects closely related to algebraic groups, such as finite reductive groups, Hecke algebras, p-adic groups, quantum groups, and Weyl groups. His work and conjectures have been highly influential in the field. During his visit, Prof. Lusztig gave a Mathematics Department Colloquium on "Rational representations of algebraic groups", first reviewing the fundamental work by E. Cartan and H. Weyl over the complex numbers, and then his own contributions when the field is replaced by an algebraically closed field of characteristic p>0, which is a much more difficult and interesting case. He also delivered an Erceg Public Lecture on "A survey of representation theory of finite groups". The study of these representations goes back at least 125 years to the work of Frobenius. The talk described how the subject has developed since then, with emphasis on the recent use of methods from algebraic geometry.

Professor Eric Chesebro (University of Montana) also visited the department and was hosted by Jeroen Schillewaert.

Steven Galbraith organised a Number Theory Workshop in Auckland on November 2-3, with talks by Pabasara Athukorala (Auckland), Florian Breuer (Newcastle, Australia), Nils Bruin (SFU, Canada), Raiza Corpuz (Waikato), Brendan Creutz (Canterbury), Daniel Delbourgo (Waikato/Auckland), Victor Flynn (Oxford, UK), Jesse Pajwani (Canterbury), Valeriia Starichkova (UNSW, Australia) and Tim Trudgian (UNSW Canberra at ADFA, Australia).

Pedram Hekmati

DEPARTMENT OF ENGINEERING SCIENCE AND BIOMEDICAL ENGINEERING

The department is delighted to share that Associate Professor Richard Clarke has been appointed Dean of the Faculty of Engineering at the University of Auckland. Richard joined the department in 2008 as Senior Lecturer after working as a research associate at the University of Adelaide and David Crighton Fellow at the Unversity of Cambridge. These appointments followed the award of a PhD from the University of Nottingham and a two-year professional appointment as a consulting analyst. Richard has contributed to the department and the faculty in many different service roles, such as Postgraduate Adviser, Associate Dean Postgraduate Research, and Associate Dean, to name just a few. We want to thank Richard for his outstanding contributions

to the department and we are looking forward to working with him.

In November, the department hosted the 55th Annual Conference[1] of the Operations Research Society of New Zealand (ORSNZ). This two-day event started with Assoc Prof Andrew Mason's Hans Daellenbach Prize presentation describing his 35 years of applied optimisation work with industry. Presenters from around NZ then presented on topics such as COVID and health modelling, CPU scheduling, logging optimisation, and automated detection of workers who should be wearing ear protection. The conference also included an afternoon session hosted by the US-based Gurobi Optimization. Thanks to Michael O'Sullivan, Thomas Adams, and Andrea Raith for organising this.

At ORSNZ's council meeting, Assoc Prof Michael O'Sullivan formally stepped down as president of ORSNZ and Assoc Prof Andrea Raith was elected as president of ORSNZ. Dr Sarah Marshall from the Business School of the University of Auckland was elected as Vice President.

Assoc Prof Andrew Mason (ORSNZ Hans Daellenbach Prizewinner) and Assoc Prof Michael O'Sullivan (President of ORSNZ). Image courtesy of Assoc Prof Cameron Walker.

The department wants to congratulate Mark Battley, Justin Fernandez, Charles Unsworth, and Cameron Walker, who were promoted to Professor. This is an excellent outcome of the 2023 promotion round.

Andreas Kempa-Liehr

[1] https://orsnz.org.nz/conf55/

UNIVERSITY OF WAIKATO

DEPARTMENT OF MATHEMATICS AND STATISTICS

Restructuring of Mathematics 2023

It is with considerable sadness and dismay that I must report on the outcome of a restructuring of mathematics undertaken over the past months by the Head of the School of Computing and Mathematical Sciences, Professor Annika Hinze. As a result, many staff who have been retained will go to an average of 80 precent of their original positions, one existing senior lecturer will become a teaching fellow, a senior tutor will become a teaching fellow, one staff member will retire earlier than expected, and worst of all, two fine researchers and teachers will be made redundant. This in a university requiring a staff:student ratio of at least 1:25 when the NZ university average is 1:18.6. In terms of FTEs, from mid November Mathematics will have 2.8 teaching fellows and 3.45 lecturers and above, rather than the current 1 teaching fellow, 1 senior tutor and 8 lecturers and above - an absolutely massive change. The student enrolment has risen from about 120 EFTS in the early 2000s to close to 200. This is not a failing subject.

The staff made an excellent group submission, data rich and factual. The decisions on who to go and who to keep were made in advance of the publication of a "change document", outlining the Head of School's proposals. Decisions regarding the validity of this procedure need to be reviewed.

Stephen Joe will be retiring early at the start of 2024. Daniel Delbourgo and Yuri Litvinenko will be redundant, Woei Chet Lim will become a teaching fellow, and Ian Hawthorn will continue as a teaching fellow based at the Tauranga campus. Other staff will have continuing 0.8 FE positions, all from mid November 2023.

Stephen Joe

Stephen will be retiring at the start of 2024 after 32 years service at Waikato. He joined the Department in 1992, having completed a PhD and post doc at the University of New South Wales. He published work mostly on lattice rules for multiple integration, including a monograph with Oxford University Press, and as the leading co-author of an introductory numerical analysis text with Springer. He also wrote a numerical integration package which has been incorporated into Matlab and the NAG library and other packages. His work was recognized by the NZMS in 2019 when be was made Fellow.

Stephen has made many quality contributions to the University of Waikato and to the NZ mathematics community. These included Mathematics Colloquia secretary,

three term NZMS Council member, local correspondent for the NZMS Newsletter for two decades, chair of the Department and Mathematics and Statistics, and deputy dean of the School of Computing and Mathematical Sciences. In 2011 he was recognized for this part of his work with the award of the Vice-Chancellor's medal for staff excellence. Further details will be included in a Newsletter centerfold at a later date. We will celebrate his retirement with gratitude for his outstanding contribution.

Daniel Delbourgo and Yuri Litvenenko

Tim Stokes, Chair of Mathematics writes:

On another very sad note, at the end of the year we will bid farewell to another two valued colleagues, Daniel Delbourgo and Yuri Litvinenko. Both were the unfortunate victims of a restructure of the mathematics group at Waikato. Both were popular lecturers and had excellent research records.

In his time at Waikato, Daniel has made significant research contributions in his area of number theory: modular forms and elliptic curves. He has also supervised a number of students and has taught a popular paper on Number Theory and Cryptography, which he created and developed, as well as other undergraduate papers. He served a full term as Head of Department that ended in 2022.

Whilst with us, Yuri has been very productive in his research on the mathematics of solar physics, especially plasma flows and particle transport, and has supervised students in the area. He has taught applied mathematics undergraduate papers, but also developed a graduate paper on advanced financial mathematics which has had regular takers.

We will greatly miss Daniel's and Yuri's unique contributions to the research, teaching and general life of the department, and wish them every success in their future endeavours.

Kevin Broughan

MASSEY UNIVERSITY

SCHOOL OF MATHEMATICAL AND COMPUTATIONAL SCIENCES

Annalisa Conversano was invited to give a 45 minute presentation at the "2023 Fudan Conference on Mathematical Logic" 14-16 August at Fudan University in Shanghai (Title of the talk: Definable rank, o-minimal groups and Wiegold's problem) and a 40 minute presentation at the "XXII Italian Mathematical Union Congress" 4-9 September at the University of Pisa (Title of the talk: Amenability, Euler characteristic and o-minimality).

Carlo Laing and Winston Sweatman attended the 8th AUT Mathematical Modelling and Analytics Symposium, November 29-30, giving presentations on "Periodic solutions for a pair of delay-coupled excitable theta neurons" and "Regularisation and the two-body problem", respectively.

Preparations for the 2024 NZMRI Summer workshop on Mathematical Neuroscience, to be held in Paihia on January 7-12, are well under way.

As part of Massey's Financial Recovery Plan, it is proposed to consolidate teaching and research activities in food technology, ecology, zoology, molecular cell biology, and chemistry to the Manawatū campus, and to close qualifications in engineering, supply chain and quality systems. The consequent decrease in student numbers will clearly result in a decrease in the number of students taking mathematics courses.

Carlo Laing

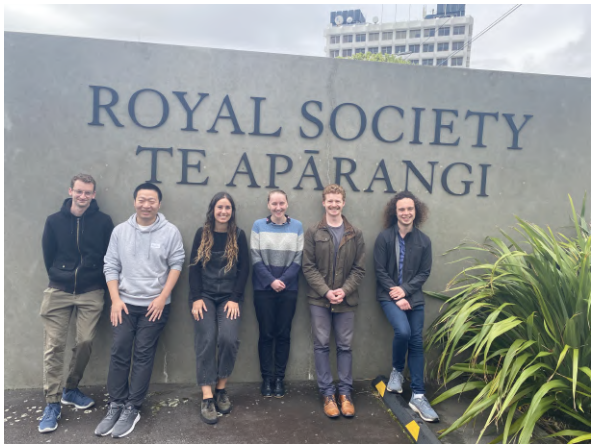
VICTORIA UNIVERSITY OF WELLINGTON

SCHOOL OF MATHEMATICS AND STATISTICS

The news to share with the community from Te Herenga Waka - Victoria University of Wellington are the following:

Postgraduate Conference (NZMASP) was held at the Royal Society Te Apārangi in Wellington from 29 November to 1 December 2023. This year NZMASP was organised by a committee of postgraduate students from Te Herenga Waka-Victoria University of Wellington. After a record attendance last year of 46, this year's conference was record-breaking again with about 60 postgrads in pure and applied mathematics and statistics, data science, maths history and maths education. This trend signals a thriving community of postgrads served by the NZMASP Conference. The conference was supported again by the New Zealand Mathematical Society (NZMS) among many other generous sponsors. It featured plenary talks by Geertrui van der Voorde (University of Canterbury), Lauren Smith (University of Auckland) and Charlotte Jones-Todd (University of Auckland) who were asked to present both on their research area and their personal journeys through academia. They offered invaluable insights into how diverse and complex these journeys can be. We were also privileged to

have Sinapi Taeao (Sacred Heart College) and Robin Averill (Victoria University of Wellington) lead a special session on education through traditional Samoan dance, which gave us much to think about as current and future educators of an increasingly diverse student community. Many postgrads at NZMASP were able to give what may be their first conference talk in a friendly environment among fellow postgrads. This is a unique opportunity that our community can be proud of. We congratulate the winner of the NZMS prize for best student presentation in pure mathematics, Sophia Witham, for their talk on the 'Mathematics of Poetry in Ancient India'. Further prize-winners, photos from the event and sponsors who made this event possible can be found on the conference website
https://nzmasp2023.wordpress.com/.



NZMASP Conference Committee for 2023 Left to right: Mark Bishop, Ruofei Xie, Laia Egea Cortes, Shonaugh Wright, Malcolm Jones, Samuel Bastida Absent: Sapir Ben-Shahar, Ellen Hammatt, Diamant Pireva

The Wellington Statistics Group had Statistics seminars held within the Victoria University of Wellington (VUW) School of Mathematics and Statistics – plus some Mathematics seminars too, not surprisingly! These seminars are announced independently of WSG, but several WSG members either presented a seminar in that series or took part in discussions and other activities with the presenters. A listing of the seminars from 2023 is available at the following webpage:
https://sms.wgtn.ac.nz/cgi-bin/seminars?keyword=&datefrom=2023-01-01&dateto=&groupMATH=Y&groupSTOR=Y&searched=Y
Among those VUW Statistics seminars was a presentation on 19 October 2023, Statistical analysis of sequences of satellite images, delivered by the 2023 VUW Shayle Searle Fellow, Prof Paolo Gamba from University of Pavia, Italy. Prof Gamba visited VUW for two weeks, working with Prof Alejandro Frery and his lab of postgraduate students and postdoctoral researchers. This year is the first time that this Australasian actuarial event has been held in New Zealand – and VUW is the only New Zealand university which offers exemptions from Actuaries Institute professional exams. The AAERS 2023 website contains links to abstracts for all 47 of the Plenary, Invited and Contributed presentations at the Symposium:
https://sms.wgtn.ac.nz/Events/AAERS2023/
Financially WSG remains in a healthy position, and we are grateful to all the WSG past and current sponsors: Victoria University of Wellington, Statistics New Zealand, the Ministry of Social Development and Statistics Research Associates Ltd.

Jasmine Hall has recently been awarded with her PhD. She defended her thesis, entitled "Tangled up in two: exploring edge connectivity and tangles" back in August. Her supervisor was Geoff Whittle.

Dimitrios Mitsotakis

UNIVERSITY OF CANTERBURY

SCHOOL OF MATHEMATICS AND STATISTICS

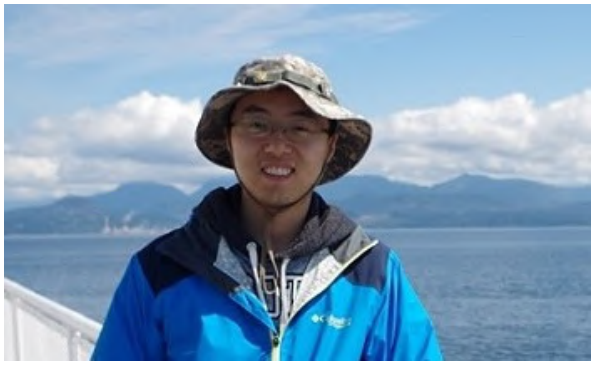
Congratulations to *Brendan Creutz*, *Gabor Erdelyi* and *Geertrui Van de Voorde* on their promotions to the rank of Associate Professor, and to *Chris Stevens* and *Taylor Winter* on their promotions to the rank of Senior Lecturer.

Congratulations to *Charles Semple*, *Mike Steel* and *Chris Stevens* on their Marsden Fund successes. Charles and Mike as Principal Investigators have been awarded a 3-year Marsden Fund grant to work on the project "The tree complexity of reticulate evolution". The project also involves Associate Investigators Daniel Huson (Tuebingen, Germany) and Kristina Wicke (New Jersey, USA), and it will investigate fundamental mathematical and computational questions in modern phylogenetics (the reconstruction of trees and networks from genomic data).

Chris as Principal Investigator and Jörg Frauendiener (University of Otago) as Associate Investigator were successful with their project "Shedding new light on fundamental physics through the scattering of gravitational waves". The project involves implementing a numerical framework for the fully global and non-linear scattering of gravitational waves in purely radiative spacetimes.

In late August the School welcomed *Mingfeng Qiu* as a lecturer in Mathematics. Mingfeng hails from China and completed his PhD at University of British Columbia in Vancouver, Canada, in 2020. Prior to joining UC, he was a postdoctoral researcher in Laboratoire de Physique

de l'Ecole Normale Supérieure in Paris, France. Mingfeng is mainly interested in the physics of soft matter, with emphases in multiphase flows, complex fluids and developmental biology. When not studying science, he enjoys learning about modern architecture, aviation, and history.



Mingfeng Qiu

In September *Jesse Pajwani* joined the School as as a Postdoc. The position is funded by the Marsden Grant held by *Brendan Creutz* and *Felipe Voloch* on rational points and anabelian geometry. Jesse completed his PhD in August this year at Imperial College London. His research interests are at the intersection of Number Theory and Algebraic Geometry, and especially the ways one can combine this with methods from Algebraic Topology. He also also maintains an interest in quadratically enriched enumerative geometry.

Congratulations to *James Bartlett* and Rachel on the safe arrival of their son Charles in late September, a new wee brother for Fred, Rebecca and Joanna. The kids are thrilled, especially Fred who has been rooting for a boy so the boys aren't outnumbered any more.

As part of the UC 150-years events Emeritus Professor (and former Head of Department) *Roy Kerr* gave a public lecture on the evening of Thursday 31st August to celebrate the 60th anniversary of his influential 2-page paper ("Gravitational field of a spinning mass as an example of algebraically special metrics", Phys. Rev. Lett. 11, 237-238 (1963)), which presented an exact solution of the Einstein equations that govern rotating black holes. It is a core ingredient for understanding the cycles of the life and death of stars and galaxies. Roy dived into how he discovered the now well-known Kerr metric and shed light on its importance in grasping the theoretical properties of the geometry of space. His key insight was that all physical objects collapsing under gravity inevitably rotate.

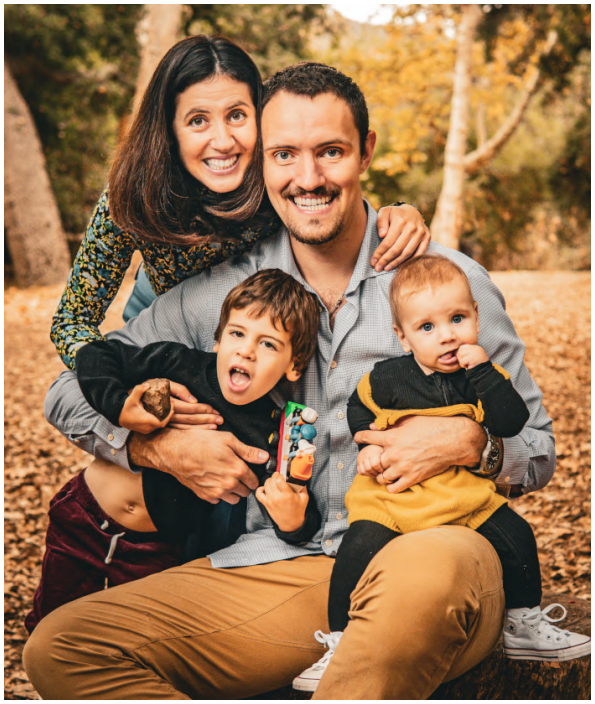
Congratulations to *Jesse Lansdown* who has been successful in obtaining a DAAD short-term research grant. He will visit Kai-Uwe Schmidt at the University of Paderborn in Germany next year to study designs in generalised hexagons and generalised octagons.

Günter Steinke

UNIVERSITY OF OTAGO

DEPARTMENT OF MATHEMATICS AND STATISTICS

We are very happy that *Conor Kresin* has joined the Department as a Lecturer in Statistics. Conor has recently completed his PhD on "Applications and properties of point processes" at the University of California, Los Angeles. Earlier this year, he moved to Dunedin together with his wife, pianist Sanaz Rezai, and their two young kids. They all love Dunedin — probably with exception of the unexpectedly huge cost of living. Conor's research interests include point process theory and applications, stochastic geometry, disease modelling, information theory and causal inference. A very warm welcome to Conor and his family!



Sanaz, Conor, Jascha and Pascal

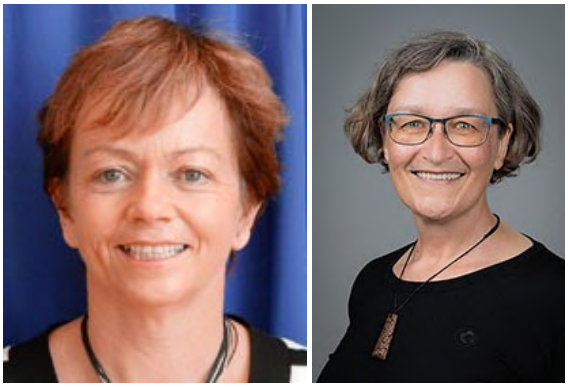
Several applicants from the Department have secured Marsden funding from 2024. *Ting Wang* and *Boris Baeumer*, together with Mark Bebbington (Massey University) were successful with their project "Modelling the domino effect in complex systems". *Florian Beyer* and Todd Oliynyk (Monash University) will be studying "Nonlinear partial differential equations of wave type: singular dynamics and asymptotic data". *Tilman*

Davies, Martin Hazelton, together with colleagues from Auckland, Australia and Denmark, got funding for their project "Principled inference for spatial point processes: a unified toolkit". Moreover, Martin, together with researchers from Auckland and Melbourne, has got the second Marsden project "Fast statistical methods for enigmatic sensor data". This is a wonderful success for you and for the Department. Congratulations!

Continuing with congratulations, we can happily report that *Robert Van Gorder* has been promoted to Associate Professor. Robert joined the Department in 2019, and his research focuses on the question how physical phenomena can be described, predicted, and even modified using tools from applied mathematics. In particular, Robert studies applications from fluid dynamics, spatial instabilities and pattern formation, quantum theory, quantum fluids and nonlinear waves. Well done, Robert!

We are very lucky that *Alex Fowler*, formerly a fixed-term Teaching Fellow for the statistics half of the department, has got a new 2-year position as a Teaching fellow both for maths and stats. Alex's help is extremely valuable and very much appreciated. Well done, Alex!

With great regret, we bid farewell to *Leanne Kirk* and *Megan Drysdale*. Leanne is retiring, and Megan has accepted voluntary redundancy.

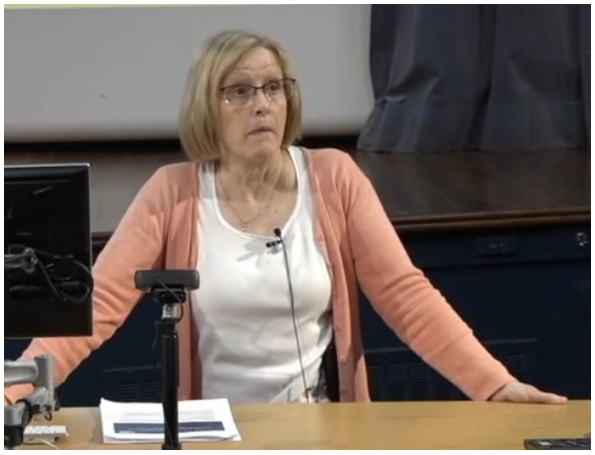


Leanne and Megan

Leanne started her job as a part-time secretary at the Department in 1995, initially working 25 hours per week. This increased to 30 hours in 1998, so that she could also take care of our lovely finances. Leanne recalls that, in her early days, computers were just coming in and she never had used them, and now they rule an administrator's life. While she has not always embraced new technology, she learnt many new skills including LaTeX. Leanne says that her "colleagues and students have made it a pleasure to come to work. Assisting with our national mathematics and statistics competitions has been a delight with contact with a number of schools around the country." In 2021, Leanne reduced her hours to half time, in order to prepare for retirement. About a year ago, Leanne received a very well-deserved Outstanding Professional Staff award. The citation quite appropriately highlights that *Leanne's key strengths are a desire to do her best for the Department's staff and students; a boundless appetite to help; and her ability to keep the Department running smoothly.* Indeed, the Department was a better place with you, Leanne. However, we are sure that you will keep quite busy. Leanne is looking forward to a grandchild next year, as well as hockey tournaments and travel. A long time desire to trek to base camp of Everest is in her plans as well. Best wishes for your retirement, Leanne! Megan has been associated with the university from a very early age. Her parents worked for the university, and she even lived in the now demolished Union Court in a first floor flat. She did her first degree in Psychology and lived on infamous Castle Street. Afterwards, she studied midwifery. In 2005, she came back to the University to do a maths degree. Finally, she started in the department in 2012, and she has given us invaluable service as a Teaching Fellow in statistics. She has tutored, written questions, and so much more. Thank you, Megan, for all you have done in the department in general, and your help with the statistics teaching in particular. Megan plans to "retire" for a while and finish writing a novel before committing to anything else. It is very sad that the distressing situation at the University led to your difficult decision to take voluntary redundancy. We will miss you, and we wish you all the best for your future!

Finally, we can report that the University of Otago is looking forward to more "management of changes" to come. This information was not quite volunteered in a recent All Staff Forum with the acting VC. However, in response to a direct question, we heard: "Earlier in the year, we'd hoped that we would get all of the management of changes through this year. That's not gonna happen. There will be some more next year. It's difficult to say how many there will be. [...] We've had over 100 people take voluntary redundancy. There will be less than that. [...] And hopefully, they'll be — most of them — in the first half of the year." The proven approach to do only small changes at a time, to fire just a few people here and there, and not to reveal more details than necessary, has certainly turned out to be very effective. Otherwise, if they would say openly and directly what the complete plans for the future of the University are, there might be a mutiny. But, hopefully, the so-called Senior Leadership Team can continue in this way, in order to make sure that everything stays as calm as possible. Also, this keeps it exciting for us as we wait to see what else may be coming next year. Many

thanks to these lovely people!



The acting VC announces more management of change to come next year.

Jörg Hennig

PhD SUCCESS

Jie Kang (University of Otago)

Title: Making better use of genotyping-by-sequencing (GBS) data to improve perennial ryegrass breeding.
Supervisors: Phillip Wilcox

Abstract: [NA, instead citing from Conclusion]
In this study, a complete ShortHap-based GBS workflow, including bioinformatic processing, statistical modelling and simulation-based validation, has been developed to determine if haplotype-based approaches using GBS data have better utility than bi-allelic SNP-based methods. Based on the results of simulation studies, we conclude that short haplotypes are of value in a breeding programme for improving relatedness estimation via the construction of genomic relationship matrices (GRMs), and enhancing breeding value predictions. In particular, ShortHap-based GRMs are likely to return more precise relatedness estimates and yield more accurate breeding value predictions (if strong marker-QTL associations existed). Although we did not observe improved breeding value predictions in the analyses of empirical data, ShortHap-based GRMs may still be preferable in many other applications, especially in situations where other genotyping methods are less affordable. However, SNP and haplotype calling need to be undertaken carefully and optimised accordingly. Our results, therefore, suggest that ShortHaps derived from GBS data in can be useful in ryegrass improvement and potentially in breeding other heterozygous out-crossing perennial species, as well as for more basic science applications.

Nicolas Guillaume Alexandre Mokus (University of Otago)

Title: Breaking waves in marginal ice zones: numerical study of wave-induced sea ice breakup and resulting wave attenuation.
Supervisors: Fabien Montiel

Abstract:
Sea ice exists only in the polar regions, and yet affects the global climate by dominating heat, matter, and momentum exchanges between oceans and atmosphere. The consequences of its retreat, and eventual summer disappearance, are unfathomable and stretch across scales going from microscopic algae to the world ocean circulation. Fragmentation of the sea ice cover by ocean waves is an important mechanism impacting the evolution of this inhomogeneous, dynamical medium. With an increased surface area, fractured ice is more sensitive to melt, leading to a local reduction in ice concentration that facilitates further wave propagation. A positive feedback loop, accelerating sea ice retreat, is then introduced.

Despite recent efforts to incorporate this process and the resulting floe size distribution (FSD) into the sea ice components of global climate models, the physics governing ice breakup under wave action remains poorly understood and its parametrisation highly simplified. We propose a two-dimensional numerical model of wave-induced sea ice breakup to estimate the FSD resulting from repeated fracture events. This model, based on linear water wave theory and visco-elastic sea ice rheology, describes the scattering of an incoming time-harmonic wave by the ice cover and derives the corresponding strain field. Fracture occurs when the strain exceeds an empirical threshold, and the geometry is then updated for the next iteration of the breakup procedure.

We analyse the resulting FSDs for both monochromatic and polychromatic forcings, by comparing two polychromatic parametrisations, combining FSDs obtained for discrete frequencies by following a prescribed wave spectrum. We find that under this realistic wave forcing, lognormal FSDs emerge consistently in a large variety of model configurations, independently of the shape of the spectrum. We discuss the properties of these modelled distributions with respect to the ice rheological properties and the forcing waves. The projected output can be used as a step to improve empirical parametrisations coupling global models of sea ice and ocean waves in climate studies.

This result contrasts with the power law FSD behaviour often assumed by modellers. We revisit remote-sensing studies of floe size distributions conducted in both polar oceans, and show the applicability of the lognormal model. Our assessment comes with limitations, as the processes having led to these observed distributions are unknown. Nonetheless, it indicates that the lognormal distribution is a valid alternative for the representation of the floe size distribution when analysing future measurements.

We then loop back to considering the attenuation undergone by waves propagating through an array of ice floes, by conducting further numerical experiments. Our results suggest that the shape of the FSD, and some of its statistics such as the minimum floe size, impact attenuation more than other measures such as the mean floe size. We reiterate the need for more measurements, particularly of concomitant floe size, wave field, and weather data; as well as the need for a better physical understanding of the physical processes leading to the emergence of a distribution of floe sizes.

Pedro Henrique Barboza Rossetto (University of Otago)

Title: Magnetically confined mountains on neutron stars in general relativity.
Supervisors: Jörg Frauendiener

Abstract:
Magnetically confined mountains on neutron stars have been invoked to explain the low magnetic dipole moments and rotation frequencies of neutron stars in low-mass X-ray binaries. This work presents the general relativistic formulation of magnetically confined mountains and solves the resulting equations numerically, generalizing previous Newtonian calculations. The hydromagnetic structure of the accreted matter, the burial of the star's magnetic dipole moment and the mass quadrupole moment are computed. Overall, it is observed that relativistic corrections reduce the hydromagnetic deformation associated with the mountain. The magnetic field lines are curved more gently than in previous calculations, and the screening of the dipole moment is reduced. It is also verified a decrease in the ellipticity of the star. All the results show how crucial the general relativistic treatment is for magnetically confined mountains on neutron stars.

Allan Bai (University of Canterbury, 2023)

Title: Reconstructing phylogenetic networks
Supervisors: Charles Semple and Mike Steel

Abstract: Phylogenetic networks are a generalization of phylogenetic trees that allow for reticulation. Reconstruction of phylogenetic trees from distances is well studied, but for networks, there are relatively few results. Recent results have focused on restricting the space of phylogenetic networks to specific subclasses with desirable properties, in particular, normal, tree-child and orchard networks. In this thesis, we explore new methods of reconstructing phylogenetic networks, as well as extend existing reconstruction results beyond these classes.

Orchard and temporal networks play a significant role in phylogenetic results, as they provide enough restrictions to exclude undesirable structures, whilst still having enough complexity to maintain mathematical interest. However, little is known about the structure of these networks. In particular, there are few structural characterisations for these networks. The first part of the thesis outlines forbidden structures characterisations for orchard and temporal networks.

The second part of the thesis explores reconstruction of phylogenetic networks using distance. We extend the results of Bordewich et al., and show that equidistant semibinary normal networks can be reconstructed using their minimum distances. We also show that equidistant orchard networks can be reconstructed using distances, up to an equivalence class known as sinks.

Finally, the last part of the thesis considers reconstructing phylogenetic networks from the relative unexplored information type of ancestral profiles. We show that like distances, stack-free phylogenetic networks can be reconstructured using ancestral profiles, with the exception of some special structures.

Aditya Jha (University of Canterbury, 2023)

Title: Does Topology Provide Sufficient Structure for Non-Causal Explanations?
Supervisors: Phil Wilson, Clemency Montelle, and Doug Campbell (UC, Philosophy)

Abstract: There is a major debate as to whether there are non-causal mathematical explanations of physical facts that show how the facts under question arise from a degree of mathematical necessity considered stronger than that of contingent causal laws. Topology provides an ideal ground for such purported non-causal explanations since topological manifolds, on which the parameters of a dynamical system can be modelled, are typically associated with multiple invariants, which remain unaltered even if the manifold is bent, stretched or twisted, reflecting a change in the parameter modelled on the manifold. Understood in this sense, topological explanations seem to provide modal information about certain constraints on the system that may not be evident in detailed, and often, cumbersome causal explanations.

This thesis examines some foundational issues in the applicability of topology to the natural world and their bearing on the debate on such purported non-causal (mathematical) explanations. More specifically, this thesis looks into various topological and geometrical formulations that essentially exploit the geometry of oscillating and complex systems, as an exercise in 'geometric mechanics', to provide a simple explanation of certain constraints imposed on their dynamics by the virtue of their geometry. The central question answered in this thesis is whether topology provide sufficient structure for such non-causal explanations. The answer, as the thesis demonstrates, is negative because topological explanations critically rely on idealisations, such as continuity and smoothness, which are realised only contingently in the natural world (or in mathematical approximations/models of the natural world); these idealisations impose some foundational limitations on the application of topology in modelling such systems 'non-causally'. Consequently, purported topological explanations fail to fully circumvent the causal dependencies of such systems implying that these are not really 'non-causal' explanations.

This thesis also extends the argument to mathematical explanations in general. It argues that purported mathematical explanations are essentially causal explanations in disguise and are no different from ordinary applications of mathematics to the natural world. This is because these explanations work not by appealing to what the world must be like as a matter of mathematical necessity, but by appealing to various contingent causal facts. These contingent facts, although assumed away in the why-question pertaining to a physical fact, still participate as causal facts in an explanation of why the fact obtains in the world. That is, the explained physical fact does not obtain because of a mathematical necessity but by appeal to the world's network of causal relations.

Gerry Toft (University of Canterbury, 2023)

Title: Two Generalisations of the Wheels-and-Whirls Theorem
Supervisors: Charles Semple (UC) and Nick Brettell (VUW)

Abstract: One of the most famous results in matroid theory is Tutte's Wheels-and-Whirls Theorem. It states that every 3-connected matroid has an element which can either be deleted or contracted while retaining 3-connectivity, except for two families of matroids: the eponymous wheels and whirls. The Wheels-and-Whirls Theorem is a powerful tool for inductive arguments on 3-connected matroids. We consider two generalisations of the Wheels-and-Whirls Theorem.

First, what are the k-connected matroids such that the deletion and contraction of every element is not k-connected? Motivated by this problem, we consider matroids in which every element is contained in a small circuit and a

small cocircuit, and, in particular, when these circuits and cocircuits have a cyclic structure. The first part of this thesis is concerned with matroids in which have a cyclic ordering σ of their ground set such that every set of $s-1$ consecutive elements of σ is contained in an s-element circuit and every set of $t-1$ consecutive elements of σ is contained in a t-element circuit. We show that these matroids are highly structured by proving that they are "(s,t)-cyclic", that is, their s-element circuits and t-element cocircuits are consecutive in σ in a prescribed way. Next, we provide a characterisation of these matroids by showing that every (s,t)-cyclic matroid is a weak-map image of a particular (s,t)-cyclic matroid.

Secondly, what are the 3-connected matroids such that the deletion of every 2-element subset is not 3-connected and the contraction of every 2-element subset is not 3-connected? In the second part of this thesis, we find all such matroids. Roughly speaking, these matroids can be constructed in one of four ways: by attaching fans to a spike, by attaching fans to a line, by attaching particular matroids to $M(K_{3,m})$, or by attaching particular matroids to each end of a fan.

Kaitlin Riegel (University of Auckland)

Title: Affect in mathematics assessment: Variable-oriented and person-oriented approaches to examining relationships and changes in self-efficacy, achievement emotions, stress mindset, and achievement across a semester

Supervisors: Tanya Evans and Jason Stephens

Abstract: A common lament heard by mathematics educators is, "I'm just not a test person." Who is and is not a test person? How do educators create more students who identify as test people? Assessment and, in particular, the high stakes exam, continue to be ubiquitous in undergraduate mathematics for credible reasons. However, outside of testing anxiety little research has sought to understand how students' beliefs and emotions about assessment-taking manifest and change in different forms of mathematics assessment. From a social cognitive perspective, student affect is shaped by and shapes their experiences of assessment, leading to reinforcement over time. In this thesis, I aim to explore how affect varies between mathematics assessment and gain a nuanced view of students' affective experiences across a semester.

To do so, two studies were conducted in an undergraduate mathematics course. The first employed a mixed-methods approach to analyse students' (N = 91) experiences and emotions in low stakes, online quizzes and a high stakes, invigilated test. In the second, I collected achievement measures and survey responses throughout a semester on students' (N = 277) self-efficacy in two scenarios (a low stakes, online quiz and a high stakes, invigilated exam), stress mindset, and exam-specific emotions. The data were cross-sectionally and longitudinally examined using variable-oriented and person-oriented approaches.

I conceptualised the construct of assessment self-efficacy and operationalised it by developing the Measure of Assessment Self-Efficacy (MASE), which measures individuals' beliefs in their abilities pertaining to specific assessments. Results from both studies demonstrated that student affective experiences vary between assessments. Empirical findings, including from cross-lagged panel analyses, together with theory are used to argue online quizzes may support the development of positive assessment affect.

Cluster analysis revealed five distinct assessment-related affective profiles, displaying different dynamics of affective constructs within and between individuals. The results illuminate the necessity of, not only mitigating negative, but promoting positive affect to support student achievement and possible approaches are discussed. This thesis introduces a call, motivated by student affect, to vary assessment for early undergraduate students, so to offer more chances for them to re-evaluate their abilities and disrupt proceduralised affective responses.

Yi-Fu Lai (University of Auckland)

Title: Advanced Isogeny-based Cryptosystems
Supervisors: Steven Galbraith

Abstract: This thesis delves into the fascinating world of advanced isogeny-based cryptosystems, discussing their primitives, challenges, and innovative approaches to their development. Topics covered include oblivious transfers, ring signatures, group signatures, blind signatures, verifiable random functions, and the application of generic proof systems to isogenies. Concretely and first, we present the first efficient UC-secure oblivious transfer using only a constant number of isogeny computations based on the group action inverse problem (GAIP). To prove this, we propose a new assumption, the reciprocal CDH assumption, and show the equivalence to the GAIP. Second, we present the first post-quantum accountable ring signature, which immediately implies the first efficient isogeny-based group signature with proof size logarithmic in the number of members. Here, we also show how to use the Katz-Wang method to obtain a tight-secure variant, which is a less explored feature in the post-quantum group/ring signature literature. Third, we present the first provably secure blind signatures from isogenies based on the GAIP. Here, we present a novel approach to optimize the result by proposing a new assumption, the ring-GAIP. We also give a thorough analysis of it and show the equivalence to the GAIP for a few cases. Fourth, we present the first provably secure verifiable random functions from isogenies based on the standard DDH assumption. To prove this, we propose a generalized DDH assumption, the master DDH assumption, and show the equivalence to the DDH problem. Here, we also give a new use of the quadratic twist and relax the assumption to optimize the performance. Finally, we present the first practical application of generic proof systems to the isogeny construction. Here, we consider the identification scheme for an isogeny problem with a smooth degree. All presented constructions have advantages over previously published schemes in terms of the security notions achieved or the performance or both. By offering a thorough analysis of these cryptosystems, this thesis lays a solid foundation for those new to the subject. It equips readers with a comprehensive understanding of the principles and potential applications of isogeny-based cryptosystems, fostering further research and development in this exciting area of post-quantum cryptography.

Songbao Mo (University of Auckland)

Title: Classification of Ideal Secret Sharing Schemes
Supervisors: Arkadii Slinko

Abstract: This thesis contributes to the characterization of ideal secret sharing schemes and the forensic aspects of secret sharing. We focus on ideal hierarchical secret sharing schemes and find a matroidal characterization of ideal hierarchical access structures. In particular, we show that every ideal hierarchical access structure corresponds to a lattice path matroid. We also give a matroidal characterization for different classes of ideal access structures, including conjunctive hierarchical access structures, disjunctive access structures, ideal weighted access structures, and ideal hierarchical roughly weighted access structures. We explore how the seniority of users influences their ability to frame other users. The possibility that the users can be framed is a price we have to pay for using ideal secret sharing schemes, and we find a (non-ideal) frameproof secret sharing scheme for every access structure.

OBITUARIES

Professor Iain Raeburn

It is with great sadness to announce the passing of Prof Iain Raeburn on 27 September 2023.

Iain was born and raised in Scotland. He studied mathematics at the University of Edinburgh in 1971 and was awarded a PhD from the University of Utah in 1976 under the supervision of Prof. Joseph Taylor in Functional Analysis. After obtaining his PhD, Iain worked as a Postdoctoral Fellow at Dalhousie University in Canada before relocating to Australia in 1977. Iain in Australia served as a Professor of Mathematics at Universities of New South Wales, the Newcastle and Wollongong. In 2010, Iain came to New Zealand as a Professor of Mathematics at the University of Otago where he became one of the major contributors of New Zealand Mathematics. He moved to Victoria University of Wellington in 2017. At Victoria University of Wellington, along with his team, Iain revitalized the Mathematical Analysis program in the School of Mathematics and Statistics. In recognition of his contributions, Iain was elected a fellow of the Royal Society of New Zealand in 2014.

Iain was a significant figure in New Zealand mathematics and a globally recognized expert in Mathematics. In 2003, he was included in Thomson ISI's list of Highly Cited researchers. Iain authored more than 160 research papers and published two books through the American Mathematical Society. He was an expert in several mathematical fields, including functional analysis, operator theory, and operator algebra. He also conducted research in areas like representation theory in analysis, dynamical systems related to nonabelian duality, graph theory, and number theory. Additionally, Iain made contributions to Fourier analysis, particularly in the construction of multiresolution analyses and wavelets, as well as the analysis of equilibrium states in operator-algebraic systems.

Iain's impact extended to mentoring numerous students, including 15 PhD students, as well as many postgraguate students, and postdocs. His influence in the field of mathematics was undeniable.

We would like to extend our sincerest condolences to Iain's family and assure them that the New Zealand mathematics community will deeply miss him.

GENERAL NOTICES

PhD opportunity

at Department of Engineering Science and Biomedical Engineering, University of Auckland

Andrew Mason and Andrea Raith are looking for applications for the following funded PhD project. Please get in contact with Andrew (a.mason@auckland.ac.nz) and Andrea (a.raith@auckland.ac.nz) if you are interested.

Funded PhD project: Problem Shaping for Mathematical Models of Scheduling Problems Supervised by Andrew Mason, Andrea Raith

Many organisations have complex scheduling problems that they model as generalised set partitioning models and then solve using integer programming optimisation techniques. These problems arise, for instance, in airline operations, rostering of medical personnel, forestry management, or collection and processing of goods (such as milk) and many other contexts.

This doctoral research project will consider scheduling problems and other similarly complex problems. These problems have mathematical formulations with a special structure (generalised set partitioning models). Due to their prohibitively large size, the problems are commonly solved using decomposition algorithms. Decomposition approaches initially solve a simplified optimisation problem and then repeatedly augment this problem with new schedules (e.g. sequences of work tasks) that improve the solution. Our recent observations hint at the impact of the augmentation approach itself, where we can create favourable model properties that speed up the solution process by carefully shaping the formulation. This approach allows us to obtain high-quality solutions faster. We will systematically propose and analyse problem-shaping approaches to develop a theoretical understanding of this new approach, thereby addressing the following three research aims:

1. Identify properties of different mathematical representations of generalised set partitioning problems and their connection to solution fractionality of the linear programming formulation.
2. Propose novel problem-shaping approaches and integrate them into decomposition algorithms for scheduling problems.
3. Conduct a systematic analysis of our current and proposed problem-shaping approaches to develop an understanding of their operation and maximise the impact they make when solving challenging scheduling problems.

This research will ultimately maximise the impact decomposition approaches can make in solving challenging practical optimisation problems arising in industry.

Combinatorics in Christchurch 4-6 June 2024

Combinatorics in Christchurch aims to bolster the combinatorial community in New Zealand by bringing together mathematicians working in combinatorics and related fields.

https://combinatoricsinchristchurch.github.io/

Speakers: Bill Martin (keynote), Carmen Amarra, John Bamberg, Gary Greaves, Anita Liebenau, Sho Suda

Organisors: Jesse Lansdown and Geertrui Van de Voorde

Sponsors: NZMS and ICA (Institute of Combinatorics and its Applications)

NZMS NOTICES

Draft minutes of the 49th Annual General Meeting of the NZMS

Victoria University of Wellington (Wellington), 4th December 2023: 5:30pm-6:30pm

Welcome and apologies.

Present (from names on attendance sheet): Matt Visser, Bartek Ewertowski, Marie Graff, Nicolette Rattenbury, Jonny Stephenson, Alastair Jamieson-Lane, Steve Taylor, Chris Tuffley, Astrid an Huef, Hinke Osinga, Marston Conder, Tanya Evans, Satush Komura, Huayu Gao, Sarah Wakes, Annalisa Conversano, Jeroen Schillewaert, Zac Isaac, Mark Bishop, Robert McLachlan, Mingfeng Qiu, David Bryant, Lisa Orloff Clark, Michael Plank, Petro Feketa, Bernd Krauskopf, Brendan Harding, Cathy Hassell Sweatman, Dominic Searles, Ilija Tolich, Winston Sweatman, Lydia Turley, Mick Roberts, Rua Murray, Stephen Marsland, Sang Hyun Kim, Priya Subramanian, Florian Lehner, Noam Greenberg, Dimitrios Mitsotakis, Melissa Tacy, Stephen Joe.

1. **Previous AGM:** Minutes of the 48th Annual General Meeting were approved.
2. **Matters arising:** Melissa Tacy brought up the issues with many universities and their redundancies and how the NZMS is willing to help.
3. **President's report** (Update on joint meeting, new Incorporated Societies Act, Forder lecturer, website development, acknowledgments). See the report in the next newsletter (President's column). Report was accepted.
4. **Treasurer's report:** The Society is in good financial health, with a slight shortfall, primarily due to increased spend on financial support. A number of term deposits with low interest rates have matured and reinvested with higher interest rates. This has helped to reduce the budgeted deficit. Jeroen asked if it is possible to break a term deposit with a low interest rate and transfer the funds to a new term deposit with a higher interest rate. Report was accepted.
5. **Appointment of auditors:** The motion to reappoint Nirmala Nath as auditor was approved.
6. **Membership secretary:** Reported 262 members. Report accepted with a formal vote of thanks to John Shanks.
7. **Changes in council members:** David Bryant finishes his term as vice president. Graham Donovan is also departing from the council. Bernd is proposed as incoming president and vice president. Tammy and Dominic have been nominated for a second term. Brendan Harding is nominated as a new member to the council. Geertrui Van de Voorde was nominated as the new secretary. All changes were approved.
8. **Update on Forder and Aitken Lecturers:** These positions will be discontinued. The Forder lecturer will change to a new visiting lectureship where the visitors will be chosen differently.
9. **NZ Journal of Mathematics:** See the Tom ter Elst report. Report was accepted.
10. **Proposed changes to the NZMS constitution.** This is part of the changes coming due to the new Incorporated Societies Act. A draft constitution will be circulated to all the members in early 2024 and there will be a consultation period after that. The changes include a change of the financial year so that the AGM is within six months after the balance date. The reregistration deadline as an incorporated society under the new Act is in April 2026. Any changes to the constitution have to be done before the reregistration deadline.
11. **Correspondence:** None
12. **General business:** Discussion to keep a record of the number of mathematics staff in New Zealand universities and distributing them. This was raised by Robert McLachlan.
13. **Acknowledgements:** The body thanks:
    (a) David Bryant (for service as president and vice president)
    (b) John Shanks (for service as membership secretary)
    (c) Dimitrios Mitsotakis (for service as secretary)
    (d) Marston Conder (for long service as an editor for the journal).

The meeting closed at 6:25pm.

SPECIAL OFFER FOR NZMS MEMBERS: JOIN SIAM NOW AND GET 25% OFF

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— Sven Leyffer, SIAM President, Argonne National Laboratory

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